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Are computer-implemented inventions entitled to be protected by intellectual property law?

PANG, Ya-Fang

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Are computer-implemented inventions entitled to be protected by intellectual property law?

Ya-Fang Pang

A thesis submitted in partial fulfilment of the requirements of Sheffield Hallam University for the Degree of Doctor of Philosophy

June 2025

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ABSTRACT

The patentability of computer-implemented inventions (CIIs), particularly software, remains a contentious and complex issue within intellectual property law. The controversies are characterised by persistent legal uncertainty and divergent jurisprudential approaches across major jurisdictions like the US and Europe. This thesis investigates the essential question of whether, and under what conditions, computer-implemented inventions are entitled to be protected by intellectual property law; primarily with a focus on the patent protection for software. It critically examines these issues based on the context of the dynamic smartphone industry whilst also acknowledging the emerging challenges posed by Artificial Intelligence (AI). This thesis investigates the essential question of whether, and under what conditions, computer-implemented inventions are entitled to be protected by intellectual property law. In doing so, it considers patent protection not merely as a reward for R&D investment, but as a critical mechanism for defining proprietary boundaries in the market, thereby ensuring that intangible assets can be securely traded and commercialised.

This study identifies that while copyright offers foundational protection for the literal expression of software code against literal copying (e.g., 'cut and paste' infringement), as mandated by international agreements like the TRIPS Agreement implemented in regional and national laws, it inherently fails to demonstrate same precise protection to the functional aspects that often constitute the core innovative value of software. Patent law, in principle, is essential for protecting the technical inventions and functional concepts inherent in the software. However, the application of traditional patentability criteria—novelty, inventive step (non-obviousness), and industrial applicability—to software is fraught with difficulties. These challenges are exacerbated by statutory exclusions for "programs for computers as such" (under the European Patent Convention) or judicial exceptions for "abstract ideas" (following the US *Alice Corp.* decision), leading to inconsistent examination practices and high rates of patent invalidation in courts (as evidenced in Chapter 5 and 6). Furthermore, this study clarifies that while copyright acts as a fallback for protecting literal code, it fails to protect the underlying functional innovation.

This study employs the patent practices in the US and Europe. It scrutinises

historical evolution, from early industrial eras to the current knowledge-based and AI-driven economy, with landmark case law and patent office guidelines to identify systemic problems including legal uncertainty, patent quality concerns, impacts on innovation incentives, and competition issues. A timely analysis of the profound implications of AI and generative AI for software is also introduced.

Key findings show that unclear and inconsistent criteria for software patentability create legal uncertainty and market distortions. The study finds that while both US and EU systems allow software patents under certain conditions, their tests and rationales differ, causing challenges for global innovators. The thesis argues that neither a full ban nor an overly permissive approach effectively serves the patent system's goals for software. To address these deficiencies, the thesis proposes a novel, structured five-dimensional examination model, as a sui generis examination model applied within the existing legal frameworks, rather than advocating for a new legislative act for software patents, which integrates five core evaluative aspects: novelty, inventive step (non-obviousness), technical character (technical effect), industrial applicability, and economic significance. Each aspect is further delineated by specific indicators designed to enhance consistency, predictability, and the quality of patent examination for computer-implemented inventions. The application of this model to leading patent cases demonstrates its potential utility in providing a more transparent and doctrinally grounded framework for assessing software-related inventions.

Ultimately, this thesis contributes to the existing body of knowledge through the creation of the abovementioned model which aims to assist patent offices, applicants, and judicial bodies in navigating the complexities of software IP, further fostering a more balanced and effective patent system that supports genuine technological innovation in the software industry.

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Chapter 1

Introduction

1.1 Overview

Intellectual property (IP) rights have assumed increasing importance for industrial and technology development. Steam and electrification are regarded as the first and the second industrial revolutions respectively. In the late 18th to the early 20th centuries, machines harnessing steam or electrical power began to replace traditional hand tools, enabling the rapid and large-scale production of various goods, fundamentally altering manufacturing processes and societal structures.[1] The first two industrial revolutions were the first stages that enhanced people's wealth, promoting urban development in the so-called traditional economy. In the early part of the 21st century, computers promoted digital production and this period is regarded as the third industrial revolution, which led to the globalisation of the knowledge-based economy. Such economic pattern is embodied in the digital world where computerised instructions not only control many aspects of human daily routines, but also capable for further functionality like entertainment and data processing. For example, software embedded in everyday devices, from smart appliances managing household tasks to sophisticated systems in vehicles controlling navigation and safety features, alongside ubiquitous applications for communication, media consumption, and complex data analytics, all exemplify the pervasiveness of computerised instructions in modern life.[2]

In the knowledge-based industry, the generation and exploitation of knowledge play a predominant part in the creation of wealth, heavily reliant on information technology, research and development, and skilled human capital.[3]

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[1] See, e.g., David S. Landes, The Unbound Prometheus: Technological Change and Industrial Development in Western Europe from 1750 to the Present (2nd edn, Cambridge University Press 2003) Chapters 2-5; See also Joel Mokyr, The Lever of Riches: Technological Creativity and Economic Progress (Oxford University Press 1990) Part III ("The Industrial Revolution and After").

[2] Manuel Castells, The Rise of the Network Society.

[3] See, e.g., Walter W. Powell and Kaisa Snellman, 'The Knowledge Economy' (2004) 30 Annual Review of Sociology 199.

Applications for computers and other similar devices have become pervasive and are enhanced at a fast pace. The knowledge-based economy manifests the demands of the society and thus leads to an even more sophisticated industry where the products and services are provided by the applications with high complexity machines. The fourth industrial revolution is characterized by the convergence of digital, biological, and physical domains, with Artificial Intelligence (AI) serving as a critical driver of this transformation. Unlike previous eras, this revolution is defined by sophisticated algorithms that enable autonomous decision-making. A prime example is the autonomous vehicle; governed by advanced software, these systems interpret environmental data to navigate complex routes without human intervention. Furthermore, the advent of cloud computing has revolutionised the distribution of technology, facilitating instantaneous, borderless transmission. Consequently, the knowledge-based economy within the fourth industrial revolution presents unprecedented complexity and dynamism, particularly within the software sector. These shifting paradigms constitute a critical area requiring rigorous legal and economic investigation.

Amidst these historical shifts, one fundamental principle remains constant throughout all industrial revolutions: for proprietary rights to be effectively utilised for earning profits, the subject-matter of the proprietary claim, whether it is a tangible asset or an intellectual property right, must be defined with sufficient precision to be clearly claimable and enforceable by rights holders.[4] Given the flourishing development of smartphones, AI, and cloud technology, a new and increasingly complex era of the knowledge-based economy is rapidly unfolding,[5] , wherein the software industry plays a pivotal role.

The knowledge-based economy is different from the traditional economy. It does not always require factories or equipment to generate profits. For instance, major software companies and digital service providers can achieve significant global market capitalisation primarily through the development and licensing of intangible assets like software, algorithms, and data, rather than through the ownership of large-scale manufacturing facilities typical of earlier industrial eras. Unlike traditional industrial models reliant on tangible assets, the knowledge-based economy is characterized by the rapid scalability of intangible assets, which often generate higher marginal returns.[6] Consequently, computer-

[4] See, e.g., Landes & Posner, The Economic Structure of Intellectual Property Law.

[5] See, e.g., Klaus Schwab, The Fourth Industrial Revolution (Penguin Random House 2017).

[6] Haskel & Westlake, 2017.

implemented inventions (CIIs) have evolved into a primary driving force in modern commercial activities, a trend distinctly reflected in the revenue structures of major technology corporations. Software is not only a selling point to attract consumers; it also helps corporations to immense wealth by virtue of its high investment return.

Facilitating this economic shift, the methods of accessing and circulating software have diversified significantly. Users download programs onto their computers or similar devices and transfer them electronically across the internet. Furthermore, the advent of cloud computing has revolutionised the distribution of technology, facilitating instantaneous, borderless transmission. Cloud-based services, for example, allow users to access software applications and data remotely from various devices without needing to install the software locally or manage physical storage media. It allows wider, faster, and often more cost-effective distribution and access. The software transmission has thus, in many cases, been improved to a wider, faster, and more cost-effective distribution model, which potentially offers greater security against unauthorized copying and piracy. This evolving landscape of software distribution and access also causes concern and necessitates ongoing consideration of how to alter or adapt the landscape of intellectual property protection for it.

1.1.1 The Impact of Cloud Computing and Distribution Models

With the reported increase of software patents invented by or applied for by small entities in some analyses or specific periods,[7] it is often argued that a more accessible system encourages more individuals and smaller firms to engage in software development and therefore contribute to the industry. Nevertheless, software is often initially classified into patent exclusion categories in principle under many national and regional patent laws (e.g., "programs for computers as such" in Europe, or as potentially "abstract ideas" in the US). This initial classification can be due to the historical absence of globally standardised and comprehensive legal frameworks or clear, universally accepted definitions specifically tailored to classify and assess patentable software inventions, distinguishing them from non-patentable algorithms or business methods. It is argued that such ambiguity or initial exclusionary stance

[7] Statistics on patent applications by firm size are periodically published by major patent offices and international organizations. For example, the European Patent Office (EPO), Patent Index 2024 (EPO March 2025) often includes data on SME patenting activity. Available at < https://www.epo.org/en/about-us/statistics/patent-index-2024> accessed 21 May 2025.

is not conducive to encouraging all individuals and smaller enterprises to engage in software development with the aim of seeking patent protection. Therefore, may not optimally allow them to contribute to the industry through patented innovations; especially for small entities that may lack the resources to navigate complex patent eligibility hurdles. Since functional software includes functionality, languages, and interfaces and so on, it is often contended that its value and inventive contribution are more than just those of mere literature. When software has expressive and creative elements that are implemented to produce demonstrable technical effects and thus potentially satisfies the requirement of an inventive technological innovation,[8] this study posits that it should not be summarily dismissed from patent consideration merely due to its software nature. Hence, the conditions under which patents for functional software innovation should be considered to form a central inquiry of this thesis. Moreover, the patent system should be enabled to play its role of innovation incentives more effectively in the software industry, a role that some scholars argue is currently undermined by legal uncertainty and the high costs or complexities of patenting software (as discussed in Chapter 2, e.g., Walsh's arguments).

Software should not be treated as an ordinary kind of invention even it is hardly incarnated as a physically examinable invention in the traditional sense, especially when its core inventive contribution lies in functionality and technical effect rather than physical form. Whether a software patent application describes a patentable invention or not should be assessed against a set of common, clear, and consistently applied determinations. However, such common definitions are, as this thesis will explore, arguably still difficult to discern with complete uniformity across all jurisdictions, even though software patents have been granted for years in most developed countries.[9] While copyright law tends to offer clear protection to computer programs as literary works, there is hardly any explicit, unambiguous statutory language found in many core patent law provisions to confirm patent protection for such inventions; especially in jurisdictions like the EU where "programs for computers" are listed as an exclusion.

It is worth noticing that the Technical Boards of Appeal of the European Patent

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[8] The requirement for a technical effect or technical contribution is a key element in assessing the patentability of software-related inventions, particularly in Europe. This concept distinguishes patentable software from mere abstract ideas or non-technical business methods. See discussion in Chapter 5, Section 5.2.2.

[9] See, e.g., Landes & Posner, The Economic Structure of Intellectual Property Law.

Office (EPO), an intergovernmental organisation responsible for granting European patents (as will be discussed in Chapter 5), have, through extensive case law, weakened the effect of the exclusion of computer programs "as such" when applied to computer-implemented inventions that demonstrate technical character (a concept further elaborated in Chapter 5). By contrast, the United States Patent and Trademark Office (USPTO) has for significant periods, been perceived as having taken relatively loose criteria on granting patents to such inventions, particularly before the *Alice Corp.* decision (details in Chapter 5) led to heightened scrutiny.[10] However, it is often argued that such perceived loose criteria on granting software patents can contribute to low quality patent problems that have long existed in the US. For example, patents with overly broad claims or those covering abstract ideas without sufficient inventive technical application.[11] Moreover, the patent laws and examination practices in several general trend of Asian Pacific jurisdictions, including Japan, South Korea, and China (with Taiwan also having its own distinct patent system), have evolved to address the patentability of software-related inventions. As will be detailed in Chapter 5 (Section 5.1.3.1), these jurisdictions often provide explicit or clearer pathways for patenting computer programs when they demonstrate technical character or are integrated into a technical process, albeit specific criteria and interpretations vary.

Low-quality software patents, characterised by claims that may be overly broad, lack sufficient inventive step, or cover trivial advancements, can become obstacles to innovation activities and hinder subsequent technological progress. Establishing suitable and commonly understood determinations for patentability can also help to avoid the occurrence of low-quality software patent problems. A set of commonly accepted guidelines or approaches, for instance, incorporating a more rigorous application of the "concrete and tangible result" concept (historically discussed in the US context)[12] or clearer criteria for assessing "technical character" (as in Europe),[13] to determine the patentability

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[10] See, e.g., Mark A. Lemley and Carl Shapiro, 'Probabilistic Patents' (2005) 19(1) Journal of Economic Perspectives 75, p. 79. Available at: https://www.aeaweb.org/articles?id=10.1257/0895330054048650 accessed 29 May 2025.

[11] See James Bessen and Michael J. Meurer, Patent Failure: How Judges, Bureaucrats, and Lawyers Put Innovators at Risk (Princeton University Press 2008) Chapter 7 ("Software Patents").

[12] State Street Bank & Trust Co. v. Signature Financial Group, Inc., 149 F.3d 1368, 1373 (Fed. Cir. 1998).

[13] See T 0208/84 (*VICOM/Computer-related invention*) [1987] OJ EPO 14; see also T 0641/00 (Two identities/COMVIK) [2003] OJ EPO 352.

of computer software are needed. When doing so, it is significant to take into consideration the peculiar structure of various patent systems in the world. Although it is difficult and time-consuming to establish a set of commonly accepted guidelines or approaches to software patent, it is still necessary to start engaging with this work. This study starts from an examination of the scope of patent protection to prevent the granting of patents to vague claims with trivial contribution to knowledge and thus aims to minimise the uncertainty in patent law. Whether this can be fully done through a single study is debatable, however, this thesis aims to contribute by proposing a structured examination model that enhances clarity and consistency, as detailed in Chapter 7.

1.1.2 The Disparate Impact of the Patent System on SMEs versus Large Corporations

Despite the fierce smartphone patent wars among the familiar large companies reported in the press or other media in the last decade,[14] individual software developers, small start-ups and small and medium enterprises (SMEs) also make significant contribution to software technology in reality.[15] While it is true that some start-ups, particularly those with sophisticated legal counsel or venture backing, may be very legally aware and proactively manage their intellectual property from an early stage, many individual developers and smaller SMEs often lack comparable resources. Unlike the large companies, these individual, small or medium enterprises may not have dedicated in-house legal departments where expertise is available to deal with patent issues. What makes matters worse is that the patent application fees are often not affordable for them.

On the other hand, if a patent infringement claim is filed against to a large company, its patent portfolio enables it to file a counter suit or negotiate for settlement and cross-licensing. In recent years, several of the big companies involved in the earlier smartphone patent wars (such as Apple, Samsung, and Google, among others) have demonstrated a keenness on building up patent

[14] See, e.g., Charles V. Trappey, Amy J.C. Trappey, and Yu-Hui Wang, 'Are Patent Trade Wars Impeding Innovation and Development?' (2016) 46 World Patent Information 64; see also Ronald A. Cass, 'Lessons from the Smartphone Wars: Patent Litigants, Patent Quality, and Software' (2015) 16(1) Minnesota Journal of Law, Science & Technology 1.

[15] See Organisation for Economic Co-operation and Development (OECD), SMEs, Entrepreneurship and Innovation (OECD Publishing 2010); see also Stuart J.H. Graham et al., 'High Technology Entrepreneurs and the Patent System: Results of the 2008 Berkeley Patent Survey' (2009) 24(4) Berkeley Technology Law Journal 1255.

portfolios for both dominant and defensive purposes.[16] A strategically constructed patent portfolio can be expected to obtain greater marginal revenues than individual patents due to the effect of synergy and enhanced bargaining power. The big companies apply their patent portfolios as an intangible asset for strategic actions. In the case of patent licensing and patent cross-licensing which involves two or more parties granting licenses to each other for patents covering certain technologies, these companies are able to ensure freedom to operate or to settle disputes and further implement effective business actions. Conversely, individual innovators and SMEs are more difficult to build extensive patent portfolios due to a shortage of financial funds.

For the larger companies, individual patents may function less as direct incentives for initial invention and more as strategic tools within a broader competitive landscape, potentially rendering traditional patent incentives less directly applicable or effective in the same way as for smaller entities.[17] Therefore, it is often argued as an urgent task to create a lower cost and easier application environment in the patent system, including shorter and simpler patent application procedures and affordable enforcement fees, especially for SMEs.[18] However, any such reforms would need to carefully consider potential downsides, such as whether significantly lowering costs or simplifying procedures might inadvertently lead to an increase in lower-quality patent applications if not accompanied by robust examination standards. The challenge lies in balancing accessibility with the need to maintain patent quality and the integrity of the system.[19]

In the knowledge-based economy, new forms of technology have brought about new economic patterns. It is argued by some commentators that the pursuit of intellectual property protection is no longer solely for the purpose of rewarding a right holder's efforts. It is also increasingly viewed by some as a tool for driving economic growth and securing competitive advantage, though this perspective

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[16] See, e.g., Bronwyn H. Hall and Rosemarie Ham Ziedonis, 'The Patent Paradox Revisited: An Empirical Study of Patenting in the U.S. Semiconductor Industry, 1979-1995' (2001) 32(1) RAND Journal of Economics 101.

[17] See, e.g., Bronwyn H. Hall and Rosemarie Ham Ziedonis, 'The Patent Paradox Revisited: An Empirical Study of Patenting in the U.S. Semiconductor Industry, 1979-1995' (2001) 32(1) RAND Journal of Economics 101

[18] See Organisation for Economic Co-operation and Development (OECD), SMEs, Entrepreneurship and Innovation (OECD Publishing 2010) Ch 3; see also European Commission, 'SMEs and Intellectual Property Rights' (2019).

[19] See, e.g., OECD, SMEs, Entrepreneurship and Innovation, available at < https://www.oecd.org/en/publications/the-digital-transformation-of-smes_bdb9256a-en.html> accessed 22 May 2025.

on the primary drivers and effects of intellectual property protection is subject to ongoing academic and policy debate.[20] Countries have different policies for dealing with software patents. To take a developed country for example, patent is a form of intellectual property right that regarded as an integral component of the commercial innovative activities and economic growth in the US.[21] In the beginning of the 1990s, the number of software-related patents granted annually in the US was less than half that of all other patents combined.[22] Nonetheless, by 2012, the number of software-related patents granted annually in the US had exceeded that of all other patents. This trend, further detailed with statistics up to 2016 in Chapter 5 (see Figure 6), indicates that for a significant period, software-related inventions became a dominant force in US patenting activity. The policies of some Asian Pacific countries have, at various times and to different extents, appeared to follow or be influenced by US precedents and approaches in protecting software-related inventions, as will be explored further in Chapter 5 (see Section 5.1.3.1 and the general discussion on Asian Pacific trends). [23]

As mentioned above, the perception by some critics that relatively loose criteria were applied on granting certain types of software or business method patents in the US, particularly in the era preceding key Supreme Court decisions like *Alice Corp*., is often linked to concerns about low-quality patent problems that have long existed in the US patent system. On the other side of the world, the patent system in Europe is unique when compared with other jurisdictions due to its regional nature and specific legal framework.[24]

European patent law, primarily governed by the European Patent Convention (EPC), has one of the most developed and debated regional patent systems, giving rise to both substantive and systematic disputes. The EPC negatively restrains the patentability of software inventions "as such" in Article 52(2)(c) and

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[20] Reto M. Hilty and Christophe Geiger, 'Patent software? A judicial and socio economic analysis' (2005) 36(6) IIC 638.

[21] Thomas A. Hemphill, 'The telecommunication and information industries: US patent policy and the criterion of non-obviousness' (2009) 26 Telematics and Informatics 2.

[22] Figure cited from Raymond Millien, "Alice who? "Over half the US utility patents issued annually are software related!" (IPWatchdog 2017) < http://www.ipwatchdog.com/2017/05/21/alice-over-half-u-s-utility-patents-issued-annually-software/id=83367/ > accessed 28 May 2017.

[23] Yanling Liu, 'Patenting business methods in the United States and beyond – globalisation of intellectual property protection is not always an easy game to play' (2011) 42(4) IIC 407.

[24] Bessen, James, and Michael J. Meurer. Patent Failure: How Judges, Bureaucrats, and Lawyers Put Innovators at Risk. Princeton, NJ: Princeton University Press, 2008.

(3). It is sometimes argued that this, coupled with the European Patent Office (EPO)'s examination approach focusing on "technical character," helps to ensure that the quality of such patents is better aligned with a technical concept of invention. On the other hand, while the EPO grants European patents, historically these functioned effectively as a 'bundle' of separate national patents upon grant. Consequently, the subsequent enforcement and challenges to validity (historically before the advent of the Unified Patent Court which aims to offer a single specialised jurisdiction) were often handled by national courts of the contracting states. These national courts, while applying law derived from the EPC, were not always strictly bound to identically follow every decision or indication settled by the EPO Boards of Appeal as binding precedent in the same way as domestic higher court rulings.[25] Accordingly, there was often an inherent difficulty for patent holders to enforce patents uniformly around the European territory prior to reforms aimed at greater harmonisation. [26] Therefore, employing comparative analysis for encompassing various patentability elements and to conclude on principles that might inform a more effective and consistent approach software patent system for the global market is needed.

The content of traditional intellectual property protections may not always adequately cover the particularity of today's digital economy model, the different ways of presentation of modern software inventions, and the diverse needs of different participants like big companies and SMEs. It is therefore necessary and, arguably, urgent for legal and policy discourse to continue considering the protection afforded to new technologies and to ensure that intellectual property protection adapts appropriately. Despite the increasing number of patent disputes in the software field, current criteria are not always able to fully cope with the problems led by obscure software patent scope or unclear eligibility standards.[27] This study seeks to clarify principles for assessing patentable software and therefore facilitate its lawful circulation and development.

1.1.3 The Context of Computer-Implemented Inventions (CIIs) and

[25] Nicolas Fox and William Corbett, 'UK and EPO approaches to excluded subject-matter and inventive step: are Aerotel and Pozzoli heading for the rocks?' 36(9) E.I.P.R. 569.

[26] See, e.g., Paul England, Cross-Border Enforcement of Patent Rights: A Fragmented World (Oxford University Press 2015).

[27] See, e.g., Mark A. Lemley, 'Software Patents and the Return of Functional Claiming' (2014) 66(2) Stanford Technology Law Review 365. Available at: < https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2117302 > accessed 23 May 2025.

Smartphones

The terms “computer-implemented inventions” (CIIs) or “software invention” refer to inventions which their implementation is conducted “by means involving a programmed computer”.[28] It is within this established framework that the protection of software and computer-implemented inventions has emerged, presenting unique challenges due to their often-intangible nature and functional characteristics. Software can be defined as instructions in the form of code designed to operate machines, such as computers. This category includes smartphones, which have been introduced to the public in recent decades and have profoundly impacted various aspects of daily life and commerce.[29] Before examining the controversies surrounding software protection, it is necessary to clarify the terminology used in this thesis. The term 'computer-implemented inventions' (CIIs) serves as a broad category for technical contributions realized through computing devices. As software represents the most significant and emblematic form of CII, this research treats the two terms as functionally equivalent for the purpose of discussion. Consequently, 'software' and ' computer-implemented inventions' are used interchangeably throughout this work depending on the specific context.

In order to make a deeper inspection of software patents and the current patent system, this study will frequently draw examples and case studies from the domain of software for portable devices, especially the smartphone. The rationale for this focus is threefold: Firstly, smartphones represent a ubiquitous and economically significant platform where software innovation is rapid, diverse, and highly competitive; Secondly, the smartphone industry has been a prominent arena for high-profile software patent litigation, revealing many of the systemic challenges this thesis addresses. Thirdly, software for portable devices often embodies the types of functional, user-facing, and network-dependent innovations that particularly test the boundaries of traditional patent law. However, the principles and the examination model developed are intended to have broader applicability to computer-implemented inventions beyond just this specific sector. By observing the software applied in such devices, this research expects to contribute to improving legal certainty and facilitating fair competition in the broader software and technology market, as

[28] David Bainbridge, ‘Court of Appeal parts company with the EPO on software patents’ (2007) 23 Computer Law & Security Report 200.

[29] Ronald A Cass, ‘Lessons from the Smartphone Wars: Patent Litigants, Patent Quality, and Software’ (2015) 16 Minn JL Sci & Tech 1, 46.

well as ensuring that patent protection ultimately serves the benefits of society.

1.2 Research Aims and Objectives

The primary aim of this thesis is to critically analyse the patent systems of two of the most developed and influential jurisdictions, the European Union (EU) and the US. This analysis will also draw insights from approaches in other important jurisdictions where relevant to illustrate diverse practices or emerging trends. The objective is to dissect their patent policies concerning software and computer-implemented inventions and to identify their respective merits and shortcomings, particularly regarding legal certainty, consistency, and the balance between incentivising innovation and ensuring access to technology. From this comparative doctrinal analysis, the thesis advocates for a sui generis approach—one that integrates technical functionality into the patent eligibility test. This concept is developed throughout the thesis and finalized as a structured examination model in Chapter 7. The approach is specifically tailored to the unique characteristics of software rather than a completely new legislative patent right.[30]

Furthermore, as will be discussed in the literature review (Chapter 2), some of the procedural issues or difficulties surrounding the patentability of software have reportedly affected the willingness of individual inventors and SMEs to file patent applications. For instance, the high costs associated with patent prosecution and enforcement, coupled with uncertainties in examination outcomes, can act as significant deterrents for resource-constrained innovators.[31] A software patent is granted based on the assessment of whether the claimed invention possesses 'technical character'—meaning it must contribute a technical solution to a technical problem beyond mere software-hardware interaction. This implies that the invention must be evidenced by specific technical features, such as the physical attributes of the implementing device or the technical nature of the activity, rather than remaining an abstract idea or business method.[32] In general terms, the granting of software patent

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[30] See, e.g., Pamela Samuelso *et al*., 'A Manifesto Concerning the Legal Protection of Computer Programs' (1994) 94(8) Columbia Law Review 2308. Available at: https://www.jstor.org/stable/1123142?seq=1 accessed 23 May 2025.

[31] See, e.g., Organisation for Economic Co-operation and Development (OECD), SMEs, Entrepreneurship and Innovation (OECD Publishing, 2023). An overview of SME patenting can also be found on WIPO's website:< https://www.oecd.org/en/publications/smes-entrepreneurship-and-innovation_9789264080355-en.html> accessed 23 May 2025. See also discussion in Chapter 2, Section 2.1 of this thesis.

[32] T 0208/84 *VICOM*; T 0641/00 *COMVIK*.

protection is underpinned by the patent bargain theory: exclusive rights are awarded in exchange for the disclosure of an invention that contributes to the technical state of the art, thereby fostering innovation and social welfare.[33]

1.2.1. The Rationale for Focusing on Smartphone Software

In order to make a deeper inspection of software patents and the current patent system, this study will frequently draw examples and case studies from the domain of software for portable devices, especially the smartphone. The rationale for this focus is threefold: Firstly, smartphones represent a ubiquitous and economically significant platform where software innovation is rapid, diverse, and highly competitive; Secondly, the smartphone industry has been a prominent arena for high-profile software patent litigation, revealing many of the systemic challenges this thesis addresses. Thirdly, software for portable devices often embodies the types of functional, user-facing, and network-dependent innovations that particularly test the boundaries of traditional patent law. However, the principles and the examination model developed are intended to have broader applicability to computer-implemented inventions beyond just this specific sector. By observing the software applied in such devices, this research expects to contribute to improving legal certainty and facilitating fair competition in the broader software and technology market, as well as ensuring that patent protection ultimately serves the benefits of society.

To carry out this aim, the following specific research objectives are targeted:

1. To conduct a foundational discussion on the legitimacy and underlying rationale for software patenting in the current knowledge age and to analyse the importance (e.g., in terms of economic impact, fostering specific types of innovation, and influence on market structures) of software patents in different jurisdictions around the world, drawing on existing literature and case law.
2. Given that the issuance of patents perceived to be of low quality or those with overly broad claims for inventions making only a trivial contribution to the state of the art can harm competition and create undue obstacles for subsequent innovators, this study will critically examine the scope of software patent eligibility and claim interpretation. This is to identify principles that could help prevent the granting of patents to claims suffering from functional over-breadth or lack of clarity, thereby ensuring a clear and

[33] See generally, William Fisher, 'Theories of Intellectual Property' (Cambridge University Press 2001).

substantial technical contribution and further minimise the uncertainty in patent law.

3. To analyse how current patent examination frameworks can be refined to better accommodate the functional nature of software, thereby providing a more suitable form of protection that enhances legal certainty and fosters technical innovation.
4. To explore through in-depth analysis of patent law and jurisprudence, methods for improving legal certainty surrounding software patentability, which in turn may encourage inventors to engage in innovation activities with greater confidence.
5. To illustrate the core doctrinal and comparative research methods employed in this thesis for the exploration of software patents so as to produce rational suggestions for enhancing the application of patent principles in this field within current mainstream patent systems globally.
6. To establish a timely and clearly defined patentable examination model for the application and examination of software inventions (as presented in Chapter 7), drawing upon the preceding analysis. This model is novel in its specific structured approach and multidimensional evaluative criteria tailored for computer-implemented inventions.
7. Finally, to briefly review the analyses throughout the thesis and identify the limitations of this research and possible future work for the ongoing development of the patent system in relation to software.

1.3 Methodology

To achieve the objectives above, the key discussion conducted in this thesis is mainly based on a doctrinal analysis of patent law, chosen for its suitability in dissecting legal principles, statutes, and case law to understand the existing legal framework and identify areas for doctrinal refinement. This is supplemented with comparative studies, particularly between the US and EU systems, to draw insights from different approaches and experiences. A more applicable *sui generis* approach to the examination of software patents is presented at the final stage (Chapter 7).

1.4 Scope and Limitations

The research focuses on the foundational patentability requirements—novelty, inventive step (non-obviousness), and industrial applicability—as these are central to global patent law and their application to software presents the most significant challenges. The expected results include the identification of criteria

that can be established for assessing inventions that produce technical effects, thus helping to consistently satisfy the requirement of novelty and non-obviousness (inventive step) in software patentability. These foundational patentability requirements – novelty, inventive step (non-obviousness), and industrial applicability/utility – are central to patent law globally and their application to software will be key focuses. Moreover, while this thesis does not primarily focus on procedural cost reduction, the proposed examination model, by aiming for greater clarity and predictability, could indirectly contribute to a more efficient patent application environment. The suggestion for a "low cost and easy application environment," often raised in literature concerning SMEs (as discussed in Chapter 2 by Walsh), highlights a broader policy goal. This thesis addresses it by focusing on enhancing substantive legal certainty which reduces wasted efforts and costs associated with ambiguous standards, rather than directly proposing changes to fee structures or administrative procedures, as such changes involve complex economic and institutional considerations beyond the doctrinal scope of this research and have potential downsides if not carefully balanced with patent quality objectives. In the context of this thesis, 'patent quality' is defined as the rigorous adherence to statutory requirements-specifically novelty, inventive step, and sufficiency of disclosure-ensuring that only genuine technical contributions are granted protection and that claims provide clear public notice.

From a utilitarian perspective, the justification for the patent system rests on the premise that the social benefits of incentivizing innovation must outweigh the social costs associated with granting monopoly rights.[34] Consequently, to determine whether software warrants patent protection, one must evaluate whether it effectively contributes to useful technical knowledge—thereby enhancing social welfare—rather than merely imposing restrictive costs on future development. To this end, the patentability requirements for software inventions in key jurisdictions will be summarised and discussed. Subsequently, the proposed sui generis model, comprising a conceptual framework, evaluative dimensions, and specific indicators, will be described in detail. Finally, Chapter 7 presents an analysis of illustrative situations, demonstrating the practical application of this model to the examination processes for software inventions.

[34] See generally, William D. Nordhaus, Invention, Growth, and Welfare: A Theoretical Treatment of Technological Change (MIT Press 1969); see also William M. Landes and Richard A. Posner, The Economic Structure of Intellectual Property Law (Harvard University Press 2003)

1.5 Thesis Overview

Chapter 2 (Literature Review) highlights and describes the importance of computer-implemented inventions, with a primary focus on software inventions, in the context of business strategies and investments in innovation. This chapter includes an interpretation of intellectual property rights applicable to computer software, particularly examining the blurred lines between copyright and patent protection. It also evaluates individual patenting problems and differing approaches to software patentability in key jurisdictions like the US and EU, and touches upon the debate surrounding *sui generis* protection for software.

Chapter 3 (Methodology) outlines the essential research strategies employed throughout this thesis, encompassing the major considerations in the choice of sources and methods. The approach is based primarily on a doctrinal analysis of patent law, which involves a critical examination of legal principles, statutes, and case law. This is supplemented with comparative studies, particularly focusing on the US and EU patent systems, to draw insights from different legal traditions and practices. The necessity and value of this study are demonstrated by identifying existing problems within current patent systems concerning computer-implemented inventions. The content further elaborates on the research aims, including the expectation of improving legal certainty to facilitate fair competition in the smartphone market and benefit society, illustrates the core methods used to conduct in-depth exploration for producing rational suggestions to current mainstream patent systems, and identifies the limitations of this thesis as well as potential areas for future work on the patent system.

Chapter 4 (Intellectual property and smartphone software) introduces the primary forms of intellectual property rights available for software, including copyright, patent, industrial design, and trade secret. It explains the protections available for software under these regimes in key jurisdictions such as the US and EU, and considers relevant international frameworks like the World Trade Organisation (WTO)'s Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS Agreement). This chapter further expounds on the commercial values of smartphone software, the phenomenon of "patent wars" in the smartphone market, and how market demands and societal expectations shape software innovation. Crucially, it also incorporates a new discussion on the ascent of AI and its profound implications for software IP, examining AI's impact on copyright, patent eligibility and inventorship for AI-implemented inventions, and the role of intellectual property protection in this sector. Finally,

the chapter discusses the strategic considerations in seeking robust protection and development of smartphone software through copyright or patent.

Chapter 5 (The evolution of technology, computer-implemented inventions and patent law) provides details on the definition of "invention" and "patent," traces the development of emerging technologies (including AI) and patent law, and analyses the value of software patents in different jurisdictions, noting the incremental number of such patents and recent trends. This chapter also explains the evolving criteria for the patentability of software patents in the US, EU, and other significant jurisdictions, supported by an analysis of key case law and legal doctrines that have shaped these criteria.

Chapter 6 (Patent for computer-implemented invention and potential problem) clarifies the patent framework for computer-implemented inventions (mainly software) and identifies potential problems present therein. The subjects of discussion include patentable subject-matter, exclusions from patentability, and the legal justifications for granting software patents. The discussion is also expanded to the potential problems arising from current patent systems, including legal uncertainty, issues of patent quality and the phenomenon of "patent trolling," the effectiveness of innovation incentives, and various competition issues.

Chapter 7 (A Proposed Examination Model for Software Patents: Structure, Application, and Implications) summarises key patentability legal bases for software inventions as identified from the preceding analysis. The evolution history of the software industry and its intellectual property protection is briefly concluded. The patentability criteria for software-related inventions in the US and EU, alongside principles from the TRIPS Agreement, are considered in depth in this chapter, highlighting identified challenges. To address the persistent issues of legal uncertainty and inconsistent application of these standards, this study establishes a structured examination model for software inventions. This model comprises five core evaluative aspects, each delineated by specific indicators designed to ensure comparable and comprehensive consideration during the examination process. The chapter details the conceptual framework and its operationalisation, including an illustrative approach for assigning weights or indices (offered as flexible guidance rather than rigid prescription). Through illustrative case studies, the application of the model demonstrates how it assists in determining whether software inventions exhibit the requisite technical character to satisfy novelty, inventive step, and industrial applicability. Finally, the chapter discusses the

potential for the broader applicability and 'globalisation' of the principles underlying this model.

Chapter 8 (Conclusions and Recommendations) summarises all the works undertaken in this thesis. The main conclusions derived from the research are presented in the form of a generalisation of the findings of this study. The limitations of this study and possible future work for the patent system in the context of software inventions globally are also stated in this chapter.

Chapter 2

Literature Review

This chapter undertakes a critical review of existing scholarly literature and authoritative commentary pertinent to the intellectual property (IP) protection of computer-implemented inventions (CIIs), with a particular focus on software and its role in the smartphone industry. The primary objective is to establish the current academic and legal context surrounding the research questions of this thesis, identify relevant debates, and highlight areas where further clarification or novel approaches are warranted. The discussion will demonstrate the multifaceted nature of software as an object of IP, examining its treatment under different intellectual property regimes and the inherent challenges this presents.

The chapter begins by exploring the recognised commercial and strategic value of computer-implemented inventions, particularly software patents, within dynamic high-technology sectors such as the smartphone industry. It will draw upon literature that analyses how IP, especially patents, influences business strategies, innovation incentives, and market competition among both major corporations and smaller software entities.

Subsequently, the review will delve into the complex and often blurred lines between copyright and patent protection for computer software. This section will consider scholarly arguments regarding the appropriate scope of each right in relation to different aspects of software, from its literal code to its functional and conceptual elements, and the implications of these distinctions for legal certainty and innovation.

The chapter will further examine the key issues and debates concerning the patentability of software more broadly. This includes a review of literature discussing subject-matter eligibility challenges, the application of criteria such as novelty, inventive step (non-obviousness), and technical effect, and the persistent problem of patent quality in the software domain. The role of different jurisdictional approaches, primarily those of the US and Europe, in shaping these debates will be a recurring theme.

Finally, the literature review will touch upon proposals and arguments for tailored or *sui generis* approaches to software protection, reflecting the ongoing

search for a legal framework that adequately balances the encouragement of software innovation with the preservation of a vibrant and competitive technological environment. By synthesising these diverse opinions of literature, this chapter aims to provide a comprehensive foundation for the subsequent doctrinal and comparative analysis undertaken in this thesis, ultimately informing the development of the proposed examination model for software invention.

2.1 The Foundation: General Principles of Patent Law and the Emergence of Software as a Subject of Protection

Patent law, as a core branch of IP, is designed to incentivise innovation by granting inventors exclusive rights to their inventions for a limited period, typically 20 years from the filing date, in exchange for public disclosure of the invention.[35] This exclusive right generally allows the patent holder to prevent others from commercially making, using, selling, offering for sale, or importing the patented invention without permission (as discussed in Chapter 4, Section 4.1.2).

To qualify for patent protection in most jurisdictions, an invention must typically satisfy several fundamental criteria: it must be novel (new and not previously disclosed to the public); it must involve an inventive step (or be non-obvious to a person skilled in the relevant technical field); and it must be capable of industrial application (or possess utility).[36] These requirements aim to ensure that patents are granted only for genuine technological advancements that contribute to the state of the art. Patent protection is generally afforded to concrete embodiments of idea, such as new products or processes , rather than to abstract ideas, scientific theories, or mathematical methods themselves (Chapter 4, Section 4.1.2; Chapter 5, Section 5.2.1.1).

It is demonstrated in Vishnubhakat's study from the mid-2010s that patent protection is often considered one of the significant elements to assist

[35] See World Intellectual Property Organization (WIPO), Learn from the past, create the future: Inventions and Patents (WIPO Publication No. 941E, 2020) pp. 8-10. Available at <https://www.wipo.int/publications/en/details.jsp?id=4536> accessed 28 May 2025.

[36] These general patentability criteria are harmonized to a significant extent by international agreements such as the TRIPS Agreement, Art. 27(1), which states: "...patents shall be available for any inventions, whether products or processes, in all fields of technology, provided that they are new, involve an inventive step and are capable of industrial application."

smartphone companies' business strategies and investments in innovation and production.[37] Patent protection plays a crucial role during decision making. Vishnubhakat's study highlights that patent protection plays a crucial role in decision-making strategies. Using the iPhone as a case study, he illustrates how Apple effectively utilised patent protection to secure its market position. After the iPhone was announced, Apple's competitors, such as Google with its Android platform and associated hardware partners, reportedly had to adapt and refine their own technological roadmaps and product strategies in response to the iPhone's market impact and innovative features. For instance, by accelerating development in areas like multi-touch interfaces and application ecosystems to ensure their offerings remained competitive and valuable to consumers.[38]

In this instance, companies have to make careful assessments to develop their business models and legal protection strategies in order to maximise profits. Vishnubhakat notes that patent is often perceived as an effective legal protection mechanism, partly by virtue of the default rules in the patent system (such as the right to exclude others) and the flexibility it offers for commercial exploitation.[39] Companies are entitled to deal with patents, such as entering into sales contracts or licensing agreements for their patented technology. They can even impose various conditions on such contracts, such as defining the scope of use, royalty terms, or field-of-use restrictions, subject to applicable competition laws.[40]

The study further emphasises that this form of protection is especially important in high-tech sectors such as the software industry. Proponents argue that patent protection not only encourages innovative activities by offering the potential for exclusivity and return on investment, but also assists in distributing innovation to consumers worldwide through mechanisms like licensing. The traditional economic justifications for the patent system include incentivizing invention by

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[37] Saurabh Vishnubhakat, 'The commercial value of software patents in the high-tech industry' (2015) CPIP of the George Mason University School of Law 5 < https://sls.gmu.edu/cpip/wp-content/uploads/sites/31/2014/04/The-Commercial-Value-of-Software-Patents.pdf > accessed 12 June 2016.

[38] Adam Lashinsky, Inside Apple: How America's Most Admired and Secretive Company Really Works.

[39] *Ibid.*, at 6.

[40] Patent licensing agreements, for instance, often contain clauses specifying the geographic territory of the license, the field of use, royalty rates and payment structures, and conditions regarding sublicensing or transferability. These conditions are generally permissible provided they do not violate competition law.

granting a temporary monopoly, encouraging the disclosure of inventions to the public, and facilitating the dissemination and commercialization of technology through licensing.[41]

Apart from Vishnubhakat's study which concerns the major companies in smartphone patent wars, Walsh has also directed her attention to small software entities which have little or no financial funding or patent portfolios to compare with the giant companies.[42] As far as the small entities are concerned, it is possible to produce software inventions with limited resources and equipment. Nevertheless, their abilities to successfully bring these products to the market are often limited by factors such as long development cycles and the challenges of commercialisation.[43] Before suggesting improvements, it is important to note that the current patent system in many jurisdictions typically involve significant costs for application, prosecution, and potential enforcement, and requires adherence to complex procedural and substantive legal requirements. Walsh's suggestion to promote a friendly patent system to small entities mainly focused on procedural issues; namely to create a low cost and easy application environment in the patent system including short and simple patent application procedure as well as affordable enforcement fees.[44] The underlying premise is that the patent system was not designed exclusively for big companies. While comprehensive global statistics specifically tracking software patents granted to SMEs versus large enterprises over time can be difficult to isolate, studies and reports from various national patent offices or organizations like WIPO and the OECD periodically analyze patenting trends by firm size and technology sector. For instance, the European Patent Office's Patent Index 2024 (EPO 2025) indicates that SMEs continue to be significant contributors to patent applications.[45] Consequently, despite the need for targeted research to pinpoint specific increases in certain periods, the evident contribution of smaller entities in technological niches supports the argument

[41] See WIPO (2020), n 1, p. 8.

[42] Professor Jacqueline S. Walsh is an academic and author focusing on intellectual property law, particularly concerning software and small entities. Her doctoral thesis, cited below, addresses these issues.

[43] Jacqueline S. Walsh, 'The future of the small software firm: A case for the proper balance of laws protecting software and competition' (2013) Faculty of Law University of Leicester < https://figshare.le.ac.uk/articles/thesis/The_Future_of_the_Small_Software_Firm_A_Case_for_the_Proper_Balance_of_Laws_Protecting_Software_and_Competition/10158173 > accessed on 5 September 2016 via Ethos.

[44] *Ibid*. 136-150.

[45] European Patent Office (EPO), Patent Index 2024 (Munich: EPO, March 2025). Available at: <https://www.epo.org/en/about-us/statistics/patent-index-2024> accessed 21 May 2025.

that a more accessible system could encourage more individuals to engage in software development and therefore contribute to the industry.

Having established the commercial significance of patents in the smartphone industry, it is necessary to examine the underlying legal frameworks governing these rights. The following section reviews the general principles of patent law and the specific emergence of software as a subject of protection.

2.2 Intellectual Property to Computer Software – the Blurred Lines Between Copyright and Patent

Before delving into the specific academic debates regarding the scope of protection, it is pertinent to note that this chapter focuses on reviewing the scholarly discourse surrounding the theoretical boundaries and overlaps of intellectual property rights. A comprehensive doctrinal definition and detailed classification of these regimes—including Copyright, Patent, Industrial Design, and Trade Secret—are systematically presented in Chapter 4. This structural arrangement is intended to align those foundational legal descriptions directly with the practical analysis of the smartphone industry, thereby ensuring that the subsequent examination of protection strategies (particularly in Section 4.3) is grounded in precise legal terminology and industrial context.

2.2.1 Copyright Protection for Software: Scope and Limitations

Computer software, as a unique form of intellectual creation, is afforded protection under various intellectual property regimes, with copyright being the most foundational and widely applied form of protection globally. Historically, as is detailed in Chapter 4 (Section 4.1.1), copyright law evolved to protect original works of authorship fixed in a tangible medium of expression. In the context of software, this means that computer programs, encompassing both human-readable source code and machine-executable object code, are generally treated as "literary works" under copyright law in most jurisdictions. This principle is enshrined in international treaties such as the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS Agreement), which mandates that computer programs "shall be protected as literary works under the Berne Convention".[46] Similarly, regional frameworks like the European Union's Software Directive (now codified in Directive 2009/24/EC) have long established copyright as the primary means of protecting computer

[46] Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS Agreement) Art 10(1).

programs.[47] In the US, copyright protection extends to original works of authorship, and software is considered such a work; the US Copyright Office will register computer programs, and US courts have affirmed that the "expression" in software is protectable.[48]

The core of copyright protection for software lies in safeguarding the literal expression of the code. This means that the specific sequence of instructions, the way programmers structure and write the code, and the particular textual and symbolic arrangement are protected to prevent unauthorised reproduction, distribution, and the creation of derivative works. These exclusive rights are explicitly codified in key jurisdictions; for instance, under 17 USC Section 106 in the US and Article 4 of the EU Software Directive (2009/24/EC). Copyright automatically subsists in an original work of authorship from the moment of its creation and fixation without requiring formal registration in many countries, although registration can provide certain procedural advantages, particularly in jurisdictions like the US.[49] The duration of copyright protection is also typically long, often lasting for the life of the author plus 70 years, or a fixed term for corporate works.[50]

However, it is crucial to understand the inherent limitations of copyright protection when it applies to software. A fundamental tenet of copyright law, often referred to as the idea-expression dichotomy, dictates that copyright protects only the expression of an idea, not the idea itself.[51] Consequently, copyright for software does not extend to the underlying algorithms, procedures, methods of operation, systems, concepts, principles, or discoveries that a program and its code describe, explain, or embody, regardless of the form in which they are practiced in such program.[52] This means that copyright cannot prevent others from independently developing software that performs the same function or achieves the same result, provided they do not copy the original

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[47] See Directive 2009/24/EC of the European Parliament and of the Council of 23 April 2009 on the legal protection of computer programs (codified version) OJ L 111, 5.5.2009, p. 16–22.

[48] See, e.g., U.S. Copyright Office, Compendium of U.S. Copyright Office Practices (3rd edn, 2021) Chapter 700. Available at <https://www.copyright.gov/comp3/> accessed 28 May 2025. For case law, see Computer Associates Int'l, Inc. v. Altai, Inc., 982 F.2d 693 (2d Cir. 1992).

[49] Berne Convention for the Protection of Literary and Artistic Works, Art 5(2).

[50] See 17 USC Section 302; see also Directive 2006/116/EC of the European Parliament and of the Council of 12 December 2006 on the term of protection of copyright and certain related rights, Article 1.

[51] See, e.g., Pamela Samuelson, 'Reconciling Copyright and Patent for Software: A Way Forward' (2023) 13 UC Irvine Law Review 1057, pp. 1060-1063.

[52] See, e.g., 17 USC Section 102(b).

program's specific copyrighted expression (i.e., its code or protected non-literal elements). While some jurisdictions have recognised copyright protection for certain "non-literal" elements of software, such as its structure, sequence, and organisation (SSO). This concept extends protection beyond the exact lines of source code to cover the software's underlying design, internal architecture, and logical flow. It is analogous to protecting the detailed plot and character relationships of a novel, rather than merely safeguarding the specific words used to tell the story. However, the scope of such protection is often debated and varies significantly, with courts generally cautious not to extend copyright to cover functional aspects that are more appropriately the domain of patent law.[53] These limitations highlight why copyright alone may not be sufficient to protect all commercially valuable aspects of a software invention, especially its novel functionalities and operational methods, leading to consideration of other intellectual property rights, notably patents.

2.2.2 Patent Protection for Software: Potential Scope and Inherent Challenges

Given the inherent limitations of copyright, which primarily protects the literal expression of software code rather than its underlying functionality or inventive concepts, patent law offers a potentially more robust avenue for safeguarding certain types of software innovations. Unlike copyright, patent protection can extend to the novel and non-obvious functional aspects of a software invention, such as its operational methods, system architectures, or the technical solutions it provides to technical problems. This focus on technical problem-solving aligns with the 'problem-and-solution approach' employed by the European Patent Office (EPO) and correlates with specific judicial tests developed in the UK, such as the *Aerotel* four-step test. (A detailed comparative analysis of these examination methodologies is provided in Chapter 5). This distinction is crucial, as the primary commercial value of much software often resides in what it does and how it does it, rather than merely in the precise wording of its source code. [54]

To qualify for patent protection, a software-related invention must, like any other invention, meet the stringent criteria of novelty, inventive step (or non-

[53] See, e.g., Dennis S. Karjala, 'Copyright Protection of Computer Program Structure' (2002) 64 Fordham Law Review 519.

[54] See, e.g., Pamela Samuelson, 'Reconciling Copyright and Patent for Software: A Way Forward' (2023) 13 UC Irvine Law Review 1057, pp. 1063-1066. Available at: https://scholarship.law.uci.edu/ulr/vol13/iss4/6/ accessed 18 May 2025.

obviousness), and industrial applicability (or utility), as outlined in general patent law principles (see Section 2.1 of this chapter). The process of obtaining a patent is significantly more arduous and costly than securing copyright protection. It involves formal application to a patent office, substantive examination by technically qualified examiners, and typically, a considerable waiting period.[55] Furthermore, in exchange for the grant of exclusive rights for a limited term (usually 20 years), the patent system mandates full public disclosure of the invention in a manner sufficiently clear and complete for it to be carried out by a person skilled in the art. This disclosure requirement, while promoting the dissemination of technical knowledge, contrasts sharply with the approach taken for trade secrets, which rely on confidentiality (see Section 4.1.4 of this thesis).

However, the application of patent law to software and computer-implemented inventions has been, and continues to be, fraught with significant challenges and controversies globally. A core issue stems from the fact that many national and regional patent laws contain explicit exclusions for "programs for computers" or "mathematical methods" when claimed "as such".[56] For example, Article 52(2)(c) of the European Patent Convention (EPC) lists "programs for computers" as subject matter that shall not be regarded as inventions, though Article 52(3) EPC qualifies this by stating the exclusion applies only to the extent to which a patent application relates to such subject-matter "as such". Similarly, while US patent law (35 USC Section 101) does not explicitly exclude software, judicial precedent has explicitly held that laws of nature, natural phenomena, and abstract ideas are not patentable.[57] These are the categories into which purely algorithmic or mathematical aspects of software might fall, thereby rendering them ineligible for patent protection.

Accordingly, a software invention must demonstrate more than just an algorithm or a set of instructions for a computer to be patentable. It must provide a 'technical solution' to a 'technical problem' or produce a 'further technical effect'. While this concept originated in earlier case law (T 1173/97) to describe effects extending beyond normal physical interactions, it remains the foundational

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[55] World Intellectual Property Organization (WIPO), Learn from the past, create the future: Inventions and Patents (WIPO Publication No. 941E, 2020) pp. 16-23. Available at https://www.wipo.int/publications/en/details.jsp?id=4536 accessed 18 May 2025.

[56] see, e.g., Noam Shemtov, 'Software protection – what can be patented and what can be copyrighted?' in Intellectual Property and Open Source: A Practical Guide to Protecting Code (Van Lindberg ed., O'Reilly Media 2008) Chapter 2.

[57] Alice Corp. Pty. Ltd. v. CLS Bank Int'l, 573 U.S. 208, 216 (2014).

criterion for eligibility within the EPO's modern 'two-hurdle' examination framework, as recently reaffirmed and refined by the Enlarged Board of Appeal in *G 1/19*.[58] In the US, following the *Alice*-framework,[59] an invention involving an abstract idea (such as many software algorithms) must include an "inventive concept" that transforms the claim into a patent-eligible application, for example, by improving the functioning of the computer itself or another technology, or by applying the abstract idea in a specific, non-conventional, and non-generic way. These requirements lead to considerable debate over what constitutes sufficient "technical character" or an "inventive concept" for software, resulting in legal uncertainty and different outcomes across jurisdictions. This will be explored in detail in Chapters 5 and 6 of this thesis. The challenge of distinguishing patentable software innovations from unpatentable abstract ideas or mere computerisations of known methods remains a central theme in the literature and in patent office and court practice.[60]

2.2.3 International and Regional Frameworks Affirming Copyright for Software

While patent law grapples with the functional aspects of software, the protection of computer programs as creative expressions under copyright law has achieved broad international consensus and codification. This foundational protection was significantly solidified at the international level by TRIPS Agreement, administered by the World Trade Organization (WTO); article 10(1) unequivocally stipulates that "computer programs, whether in source or object code, shall be protected as literary works under the Berne Convention (1971)."[61] This provision was pivotal because it mandated a minimum standard of copyright protection for software among all WTO member states, effectively globalising the principle that the creative expression embodied in computer code warrants protection akin to that afforded to traditional literary works like

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[58] T 1173/97 (IBM) & G 1/19 (Pedestrian Simulation).

[59] *Alice Corp. Pty. Ltd. v. CLS Bank Int'l, 573 U.S. 208 (2014)*; See also USPTO, 2024 Guidance Update on Patent Subject Matter Eligibility, Including on Artificial Intelligence (July 2024), available at <https://www.uspto.gov/sites/default/files/documents/ai-sme-update-2024.pdf> accessed 15 May 2025.

[60] See, e.g., Peter S. Menell, Mark A. Lemley, and Robert P. Merges, Intellectual Property in the New Technological Age: 2023 – Vol. I: Perspectives, Trade Secrets, and Patents (Clause 8 Publishing 2023) Chapter 4 (discussing subject matter eligibility challenges for software and business methods in detail).

[61] Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS Agreement) Art 10(1), Apr. 15, 1994, Marrakesh Agreement Establishing the World Trade Organization, Annex 1C, 1869 U.N.T.S. 299.

books and articles.[62] The rationale for treating software as a literary work under copyright stems from its nature as a set of instructions written by human authors using specific programming languages, exhibiting originality in its structure, sequence, and particular arrangement of code, makes it like other textual creations.[63]

Building upon this international standard, many regional and national legal frameworks have long affirmed copyright as the primary and most direct form of intellectual property protection for software. In Europe, for instance, the Council Directive 91/250/EEC on the legal protection of computer programs (commonly known as the Software Directive), adopted in 1991 and subsequently codified into Directive 2009/24/EC, explicitly established that member states shall protect computer programs, by copyright, as literary works within the meaning of the Berne Convention.[64] This Directive aimed to harmonise copyright protection for software across the EU, clarifying aspects such as the originality requirement, the scope of restricted acts (like reproduction and adaptation), and certain permitted exceptions (such as for interoperability or error correction).[65]

Similarly, in the US, copyright law provides robust protection for computer programs as original works of authorship.[66] The US Copyright Act extends protection to "literary works," a category that has long been interpreted by the US Copyright Office and federal courts to include computer programs, covering both their source code and object code.[67] Landmark US court decisions have further elaborated on the scope of copyright for software, for example, by developing tests to distinguish between protectable expression and unprotectable ideas or functional elements within a program, such as the "abstraction-filtration-comparison" test articulated in *Computer Associates Int'l,*

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[62] See World Intellectual Property Organization (WIPO), Understanding Copyright and Related Rights (WIPO Publication No. 909E, 2016) p. 18. Available at https://www.wipo.int/publications/en/details.jsp?id=4080 accessed 18 May 2025.

[63] See, e.g., U.S. National Commission on New Technological Uses of Copyrighted Works (CONTU), Final Report (1978) pp. 10-11.

[64] Directive 2009/24/EC of the European Parliament and of the Council of 23 April 2009 on the legal protection of computer programs, OJ L 111, 5.5.2009, p. 16.

[65] See Thomas C. Vinje, 'Copyright Protection of Computer Software in the European Community' (1992) 10(2) European Intellectual Property Review 41.

[66] 17 USC Section 102(a).

[67] U.S. Copyright Office, Compendium of U.S. Copyright Office Practices (3rd edn, 2021) Section 721 (Computer Programs). Available at <https://www.copyright.gov/comp3/> accessed 20 May 2025.

Inc. v. Altai, Inc. (as mentioned in Section 2.2.1).[68] The requirement for copyright protection in the US, is originality in the expression, not novelty or non-obviousness in the underlying functionality, which again underscores the distinction between copyright and patent.

Thus, there is a well-established legal basis globally for protecting the expressive elements of software through copyright. However, as highlighted in Section 2.2.1, the fundamental limitation of copyright – its inability to protect the functional ideas, algorithms, or operational methods implemented by the software – necessitates the consideration of other intellectual property regimes, particularly patent law, for safeguarding those aspects of software innovation that extend beyond mere literal expression.

2.2.4 The Blurred Lines: Academic Debates on Copyright's Scope and Patent's Role for Software Functionality

While the legal frameworks discussed above establish copyright as a primary means of protecting the expressive elements of software, and patent law as a potential avenue for safeguarding its functional innovations, the precise demarcation between these two regimes in the context of software remains a subject of considerable academic debate and judicial scrutiny. This blurred line often arises when attempting to define the scope of copyright protection for elements beyond the literal code, and when considering the patentability of software functionalities that might also be partly realised through expressive choices.

Scholarly critiques, such as those by Samuelson *et al.*, have raised concerns about potential overreach in copyright protection for software. For instance, they noted that in cases like *SAS Institute Inc v World Programming Ltd*,[69] the Court of Justice of the European Union (CJEU) appeared to some commentators to risk expanding the scope of copyright protection under the EU Software Directive to aspects such as computer program behaviour, language, and interfaces, elements which arguably lean towards functionality rather than pure expression.[70] Samuelson *et al.* argued that computer programs, which are ultimately developed to become machine processes regardless of whether

[68] Computer Associates Int'l, Inc. v. Altai, Inc., 982 F.2d 693 (2d Cir. 1992).

[69] Case C-406/10 SAS Institute Inc v World Programming Ltd [2012] 3 C.M.L.R. 4.

[70] Pamela Samuelson, Annemoon Geurts, and Thomas Vinje, 'Does Copyright Protection Under the EU Software Directive Extend to Computer Program Behaviour, Language and Interfaces?' (2012) 34(3) European Intellectual Property Review (EIPR) 158, p. 159.

they are in source code or object code, should not have their functional aspects solely considered under the umbrella of copyright, which is ill-suited to protect such utilitarian features.[71] This perspective highlights a central tension: if copyright is interpreted too broadly to cover the functional "behaviour" or "interfaces" of software, it could inadvertently grant patent-like protection without the rigorous examination, disclosure requirements, and limited term associated with patents. Although the European Commission faced opposition when attempting to formulate a specialised patent Directive for computer-implemented inventions, it is noteworthy that the Technical Boards of Appeal of the EPO have, through their jurisprudence, weakened the effect of the "programs for computers as such" exclusion, allowing patents for software that produces a "technical effect" and satisfies the requirements of novelty and non-obviousness (as will be explored in Chapter 5).[72]

The argument that granting patents to computer software, where its patentability criteria might seem vague or lack universal consensus, could lead to monopolies and harm competition is a frequently voiced concern.[73] However, Samuelson *et al.* further explained that inventions submitted for patent protection face intensive examination during the application process, and their validity can be challenged again by third parties post-grant.[74] While agreeing that copyright is an important intellectual property right for computer software, they emphasised that the EU Software Directive, in their view, was intended primarily to protect the literary aspects of programs, not to broadly cover functionality, programming languages, or interfaces.[75] Therefore, they concluded that patent protection for genuinely innovative functional aspects of software should be considered.

2.2.5 Cumulative Innovation and the Challenge of intellectual property Blocking

The cumulative and often derivative nature of software development introduces further complexities, as highlighted by Ghidini and Arezzo. They characterised much software innovation as "derivative invention," which means new inventions often necessarily build upon and utilise pre-existing inventions (or

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[71] *Ibid.*

[72] *Ibid.*

[73] See, e.g., James Bessen and Michael J. Meurer, Patent Failure: How Judges, Bureaucrats, and Lawyers Put Innovators at Risk (Princeton University Press 2008) at 147-164.

[74] *Ibid.*

[75] *Ibid.*

components thereof).[76] This is somewhat analogous to Isaac Newton's famous acknowledgment of "standing on the shoulders of giants," but in the context of IP, the pre-existing "shoulders" may themselves be protected by intellectual property rights. This creates potential blockages often referred to in academic literature as a patent thicket (a dense web of overlapping intellectual property rights that a company must navigate to commercialise new technology).[77] One inventor's intellectual property can indeed block another's opportunities for an advanced invention, especially if the earlier intellectual property right is broad or covers a foundational element.[78] This results in the difficulty of balancing innovation incentives and healthy competition, particularly in the dynamic information technology market. Ghidini and Arezzo indicated the phenomenon that while large enterprises often seek patent protection for their powerful intellectual property to secure market positions, small and medium enterprises (SMEs) may tend to rely more on copyright for their software, as it arises automatically, bears no cost for acquisition, and requires no test of substantive merit like patentability requirements.[79] However, they argued that if copyright were to be broadly interpreted to protect functional aspects of software, it could potentially lead to greater risks of anti-competitive concerns than patents.[80] This is because patent law, despite its own challenges, has built-in mechanisms like claim limitations, disclosure requirements, and a limited term, which are designed to circumscribe the scope of monopoly. Copyright, if misapplied to functional elements, could offer very long-term protection for broad functionalities without these safeguards. Their findings not only emphasised that anti-competition is not a problem unique to patents; more importantly, they pointed out that this issue is especially significant in the software industry regardless of which type of intellectual property is applied, due to network effects, the pivotal role of the adoption and regulation of standards, interoperability requirements, and the cumulative nature of software innovation.[81]

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[76] Gustavo Ghidini and Emanuela Arezzo, 'Patent and copyright paradigms vis-à-vis derivative innovation: the case of computer programs' (2005) 36(2) IIC - International Review of Intellectual Property and Competition Law 160, p. 161.

[77] Carl Shapiro, 'Navigating the Patent Thicket: Cross Licenses, Patent Pools, and Standard Setting' (2001) 1 Innovation Policy and the Economy 119.

[78] This illustrates the concept of "patent thickets" or "royalty stacking," where multiple overlapping IP rights can hinder subsequent innovation, a concern particularly relevant in cumulative technologies like software.

[79] Ghidini and Arezzo (2005), n 6, pp. 170-171.

[80] *Ibid.*

[81] *Ibid.*

A similar reason for clarifying the appropriate scope of intellectual property protection for different aspects of software was demonstrated by Lim and Longdin in their analysis with reference to the landmark US case *Oracle America, Inc. v. Google LLC*.[82] In an earlier phase of that protracted litigation, the US District Court for the Northern District of California had initially found that while the literal Java API code was copyrightable, the "structure, sequence, and organisation" of the API packages in question, being a "method of operation", was not copyrightable under 17 USC Section 102(b).[83] Lim and Longdin's commentary, reflecting on such judicial distinctions, underscored the importance of delineating between the conceptual and functional aspects of software (which, if protectable by intellectual property beyond trade secrets, would more appropriately fall under patent law) and its expressive aspects (protectable by copyright). If copyright were broadly extended to cover the functional elements or methods of operation within software such as those embodied in certain APIs, rights holders could effectively obtain intellectual property protection for such functionalities without undergoing the rigorous examination for novelty, non-obviousness, and subject-matter eligibility required by patent law, yet potentially enjoy protection for a much longer term (e.g., life of author plus 70 years, or 95 years for corporate works in the US, as established by the Sonny Bono Copyright Term Extension Act of 1998) compared to the much shorter twenty years typically afforded by patents.[84] This highlights the critical need, often emphasised in literature, to maintain a principled distinction between the protective regimes of copyright and patent to ensure that each serves its intended purpose within the broader intellectual property ecosystem for software.

To further clarify these distinctions, a brief comparison of copyright and patent protection for software reveals their respective strengths and weaknesses:

Copyright:

Advantages: Automatic protection upon creation; long duration; lower cost to obtain and maintain; protects literal code and potentially some non-literal structural elements.

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[82] Pheh Hoon Lim and Louise Longdin, 'The smartphone wars: patent and copyright as swords and shields'(2016) 38(5) European Intellectual Property Review (EIPR) 286.

[83] Oracle America, Inc. v. Google, Inc., 872 F. Supp. 2d 974, 977, 998-999 (N.D. Cal. 2012).

[84] See, e.g., U.S. Copyright Office, Copyright Basics (Circular 1, 2023) p. 6 (duration of copyright); 35 USC Section 154(a)(2) (term of patent).

Disadvantages: Does not protect functional ideas, algorithms, or methods of operation; cannot prevent independent creation of functionally similar software with different code.

Patent:

Advantages: Can protect novel and non-obvious functional aspects, methods, and systems implemented in software; provides broader protection against independent invention of the same functionality if claimed.

Disadvantages: Higher cost and complexity to obtain (requires application and substantive examination); shorter duration (typically 20 years); requires public disclosure of the invention; software faces specific eligibility challenges in many jurisdictions (e.g., exclusions for "programs for computers as such" or "abstract ideas").

This comparison demonstrates why a nuanced approach, often involving a combination of intellectual property rights, is necessary for comprehensive software protection, and why the debate over the appropriate scope for each right, particularly patents for software functionalities, continues to be a central theme in intellectual property law and policy.

2.2.6 The Need to Explore Patent Protection for Functional Software Innovations

The preceding review of literature and foundational legal principles highlights a critical tension in the intellectual property protection for computer software. On one hand, copyright has been firmly established internationally and in major jurisdictions like the EU and the US as the primary means of protecting the literal expression of computer programs, treating them akin to literary works. This provides a crucial baseline of protection against direct copying of code and, to a varying extent, some non-literal structural elements. However, the inherent limitation of copyright, encapsulated in the idea-expression dichotomy, is that it does not extend to the underlying algorithms, functionalities, operational methods, or technical concepts that often constitute the core innovative value of a software product.

On the other hand, while patent law offers the potential to protect these functional aspects by granting exclusive rights, its application to software is fraught with challenges. These include explicit statutory exclusions for "programs for computers as such" in jurisdictions like EU, and the judicial "abstract idea" exception in the US, both of which create hurdles for the

patentability of many software-related inventions. As discussed, academic commentators like Samuelson *et al.* have cautioned against an over-extension of copyright to cover software functionality, arguing that such an approach could bypass the rigorous examination and disclosure requirements inherent in the patent system, potentially leading to overly broad protection for unexamined ideas. Conversely, scholars such as Ghidini and Arezzo have highlighted the cumulative nature of software innovation and the difficulties in balancing intellectual property rights to foster both initial and derivative creation, noting that both expansive copyright and patent rights can pose challenges to competition and follow-on innovation in the software industry. The *Oracle v. Google*[85] litigation further highlighted the complexities in delineating between copyrightable expression and functional methods of operation within software interfaces.

This blurred line between what copyright can protect and what patent law might protect creates significant legal uncertainty for software developers, innovators, and investors. It necessitates a careful examination of how patent law, despite its challenges, can and should be applied to genuinely inventive functional aspects of software. This distinction is supported by judicial reasoning; for instance, the United States Court of Appeals for the Federal Circuit in *Oracle America, Inc. v. Google Inc.* explicitly noted that while copyright protects the expression of code, 'patent law... protects the functional aspects of the work'.[86] The limitations of copyright in safeguarding the core technical contributions of many software products underscore the importance of exploring patent protection as a vital mechanism for incentivising and rewarding such innovations. Therefore, this thesis will proceed in subsequent chapters (particularly Chapters 5 and 6) to delve deeper into the specific doctrinal and practical issues surrounding the patentability of software and computer-implemented inventions in key jurisdictions, forming the basis for proposing a more consistent and principled examination approach in Chapter 7. This exploration is crucial for ensuring that the intellectual property system effectively supports the continued development and dissemination of valuable software technologies, including those powering the ever-evolving smartphone ecosystem.

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[85] *Google LLC v Oracle America Inc* 593 US 1 (2021).

[86] Oracle America, Inc. v. Google Inc., 750 F.3d 1339, 1381 (Fed. Cir. 2014). The court emphasised that "anyone is free to write their own code to carry out exactly the same function or achieve the same result" under copyright law, implying that protection for the function itself falls within the domain of patent law.

2.3 Subject-Matter Evaluation

One of the foundational questions that must be asked before inspecting the patentability of a computer-related invention is whether the invention constitutes patentable subject matter under patent law.

Graham and Vishnubhakat asserted that the term “software patent” has no common definition for considering whether such application is patentable even though nearly all the computer programming patent applications in any technology can includes software elements.[87] They pointed out that, as it is hard to distinguish software elements and non-software elements, the elusive scope of software has, at times, been perceived as allowing the USPTO to take loose criteria on granting patents to such inventions. This perception, particularly in periods of rapid software patent growth, has fuelled debates about patent quality. While the requirements for patenting software are not always precisely or uniformly applied within and across jurisdictions, leading to concerns that patents may sometimes be granted to those inventions with perceived only minor advancement, which may potentially become obstacles and create lost opportunities for later researchers. The proliferation of such patents can intensify the challenges associated with 'low-quality patents (characterised by overly broad functional claims, vague boundaries, or questionable validity) which have long been a subject of discussion in the US patent system. A comprehensive analysis of these quality issues and their systemic implications, such as patent trolling, is presented in Chapter 6 (Section 6.2.2), while the historical trends illustrating this growth are contextualised in Chapter 5 (see Figure 6).[88]

Moir argued that a contribution to knowledge is the minimum requirement for inspecting inventiveness in patent application. His argument was based on the reason that there should be a balance between patent costs and patent benefits. If the patent benefits cannot offset patent costs, there is no reason to grant monopoly to such invention.[89] Consequently, the issuance of such low-quality patents, which offer limited benefits to innovation while imposing high costs, has been argued to harm competition.[90] It is urgent to minimise the uncertainty

[87] Stuart Graham and Saurabh Vishnubhakat, ‘Of smart phone wars and software patents’, (2013) 27(1) Journal of Economic Perspectives 74-75.

[88] See, e.g., John R. Allison, Mark A. Lemley, and David L. Schwartz, 'Our Divided Patent System' (2017) 82(6) University of Chicago Law Review 1073, pp. 1086-1095

[89] Hazel V.J. Moir, ‘An inventive step for the patent system?’ (2013) 35(3) E.I.P.R. 125.

[90] James Bessen and Michael J Meurer, Patent Failure: How Judges, Bureaucrats, and Lawyers Put Innovators at Risk (Princeton University Press 2008); see also Federal Trade

of intellectual property protection to software. This can be pursued, for example, through clearer and more consistently applied examination guidelines that adequately address the unique characteristics of software, fostering more rigorous application of patentability standards, and potentially through judicial clarification of claim scope and subject-matter eligibility, as this thesis aims to explore. This thesis will start from an examination of the scope of patent protection to prevent the granting of patents to vague claims with trivial contribution to knowledge and thus minimise the uncertainty in patent law. Furthermore, the validity of granted software patents has frequently been challenged in court, particularly in the US following the Supreme Court's decision in *Alice Corp. v. CLS Bank Int'l,* which led to a period of heightened scrutiny and increased invalidation rates for patents involving abstract ideas implemented on generic computers, a phenomenon that will be further detailed in Chapter 5.[91]

Software inventions, in their nature, often represent a high level of intellectual work but may require a relatively low level of effort or cost to reproduce the software product itself once the initial development is complete. Wren emphasised that what is essential when considering a patent claim for software is often the underlying method or algorithmic means employed for the purpose of achieving a specific, practical, and often technical result or solving a particular technical problem.[92] Unlike some traditional tangible inventions, the specific algorithmic compilation and internal logic which lead to the functionality of the end program is not always readily apparent or discernible to users simply from observing its operation. A complicating factor is that the functional know-how of some computer programs can sometimes be relatively easy to replicate or understand once the product or process is publicly available, even if the precise underlying code is not disclosed. In this regard, patenting computer programs without clear boundaries defining the inventive contribution, or with an insufficient inventive step, can intensify the difficulties for subsequent innovators and potentially stifle, rather than promote, creative activities.

As computer software inventions are not always directly analogous to traditional mechanical or chemical inventions where their patentability can often be

Commission, To Promote Innovation: The Proper Balance of Competition and Patent Law and Policy (2003).

[91] See, e.g., Christopher A. Cotropia *et al.*, 'Unpacking Patent Assertion Entities (PAEs)' (2016) 99 Minnesota Law Review 649.

[92] J D Wren ‘Theory and reality for software patents: good in concept, not so good in practice’ (2006) 22(13) Bioinformatics 1543.

reviewed on more tangible physical entities or well-established prior art categorisations, it seems that the patent requirements enumerated in patent law provisions are too general to take care of the hidden elements of software that makes it valuable. It is even harder to answer whether a particular computer program is patentable or not since there is not yet a universally recognised and precise legal definition of what constitutes a patentable software patent across all jurisdictions, albeit various criteria and tests have evolved, as discussed in Chapters 5 and 6. While this thesis does not aim to coin a single, all-encompassing definition, it seeks to contribute by proposing a more structured examination model (Chapter 7) that clarifies the criteria for assessing the patentability of computer-implemented inventions, thereby enhancing consistency and predictability.

2.3.1 General Principles of Intellectual Property Law and the Challenge of Emerging Technologies

Before delving into the specific challenges encountered in patenting computer-implemented inventions, it is instructive to briefly situate these issues within the broader context of intellectual property law's general objectives and its inherent interaction with technological advancement.

Intellectual property law, in its various forms including patents, copyright, trade secrets, and industrial designs (as outlined in Chapter 4), fundamentally aims to promote innovation, creativity, and economic development by granting creators and inventors certain exclusive rights over their intangible creations. These rights are intended to provide incentives for investment in research and development, facilitate the dissemination of knowledge, particularly in the case of patents which require disclosure, and foster fair competition by protecting distinctive signs trademarks and original designs.[93] The overarching goal is to strike a balance between rewarding intellectual endeavours and ensuring that the resulting knowledge and creations ultimately benefit society as a whole.[94]

The international intellectual property framework, supported by organisations like the World Intellectual Property Organization (WIPO) and underpinned by treaties such as the Paris Convention for the Protection of Industrial Property, the Berne Convention for the Protection of Literary and Artistic Works, and

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[93] See World Intellectual Property Organization (WIPO), What is Intellectual Property? (WIPO Publication No. 450E, 2020) pp. 3-5, Available at <https://www.wipo.int/edocs/pubdocs/en/wipo_pub_450_2020.pdf> accessed 20 May 2025.

[94] See, e.g., Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS Agreement) Art 7 ("Objectives").

prominently, the TRIPS Agreement, seeks to harmonise minimum standards of protection across different countries. The TRIPS Agreement, for instance, establishes baseline requirements for various intellectual property rights, including patents (Article 27) and copyright for computer programs (Article 10(1)), while also acknowledging the need for flexibilities, particularly for developing countries. [95] However, despite these international efforts, intellectual property rights remain largely territorial, meaning they are primarily granted and enforced within the boundaries of individual sovereign states or regional organisations. This territoriality, coupled with variations in national laws and enforcement practices, presents inherent challenges for innovators seeking global protection for their creations, an issue particularly relevant to software which can be easily disseminated globally.

2.3.2 The Tension Between Traditional Intellectual Property Doctrines and the Unique Attributes of Software

A recurrent theme in the history of intellectual property law is its dynamic and often reactive relationship with emerging technologies. Legal frameworks designed with then-current technologies in mind frequently face an "IP lag" when confronted with novel forms of innovation whose characteristics do not neatly fit into existing categories or satisfy established criteria for protection.[96] Software and computer-implemented inventions represent a significant contemporary example of this phenomenon. Their often-intangible nature, their functional aspects, their rapid development cycles, and their unique modes of creation and dissemination have posed and continue to pose substantial challenges to traditional patent and copyright doctrines. The difficulties in defining patentable subject matter for software, assessing inventive step for algorithmic innovations, and determining the appropriate scope of copyright for functional code elements are manifestations of this broader tension between established intellectual property principles and the specific attributes of software technology.

It is against this general backdrop of intellectual property law's objectives, its international dimensions, its inherent limitations, and its ongoing adaptation to technological change that the specific controversies and complexities

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[95] TRIPS Agreement, Arts 7, 8, 10(1), 27.

[96] See, e.g., Peter S. Menell, 'Tailoring Legal Protection for Computer Software' (1989) 41 Stanford Law Review 1329. Available at < https://wwws.law.northwestern.edu/research-faculty/clbe/events/roundtable/documents/menell_tailoring_legal_protection_for_computer_software.pdf> accessed 03 May 2025.

surrounding the patenting of software and computer-implemented inventions, particularly in leading jurisdictions like the US and the EU, must be understood. The following sections will delve into these more specific problems, building upon the foundational understanding of intellectual property principles and the unique nature of software.

2.4 Individual Problems in the US And the EU

When examining the application of patent law to software, distinct challenges and criticisms emerge within the specific contexts of major jurisdictions like the US and the EU. These problems often stem from the inherent nature of software itself, coupled with the particularities of each legal system.

In Europe, as Marsnik and Thomas noticed the peculiar structure of the European patent system makes the European patent law appear obscure in certain aspects, especially concerning the uniform application of patentability standards across member states.[97] The EPC provides a centralised system for granting European patents through the EPO. Once granted, a European patent essentially becomes a bundle of national patents in the EPC contracting states designated by the applicant. While the EPC aims to provide a harmonised substantive patent law for the granting procedure, the enforcement and validity of these national patents are typically handled by national courts. However, historically, national courts, when interpreting EPC provisions as transposed into their national laws, might not always have been strictly bounded to obey every nuance of the EPO's technical board of appeal decisions, nor did they always have to follow them as binding precedent in the same way they would follow decisions from their own higher national courts. It is certainly true that achieving perfect legal consistency across multiple languages and legal traditions is a common challenge in the EU, regardless of the specific field of law. Since there is not yet recognition to the definition of software and to the basic question of whether software is a patent subject-matter or not, it raises the level of inconsistency to associated problems. An obvious example of linguistic divergence impacting legal interpretation, as highlighted by Marsnik and Thomas, can be seen from the term "industry" while considering the industrial application requirement in patentability. In French and Dutch this term is referred in manufacturing business only whereas it refers to any kind of

[97] Susan Marsnik and Robert E. Thomas 'Drawing a line in the patent subject-matter sands, Does Europe provide a solution to business method and software patent problem?' (2011) Boston College International and Comparative Law Review 44-49.

industry in English.[98] This type of underlying systemic complexity can aggravate the uncertainty surrounding computer software inventions in Europe, as achieving a perfectly harmonised approach in practice remains an ongoing endeavour, despite significant convergence through the EPO's case law and guidelines (further discussion in Chapter 5).

2.4.1 The US Context: Patent Trolls, NPEs, and the Challenge of Ambiguity

Turning to the United States, Subramanian analysed the reasons why the US patent system fosters the patent troll phenomenon.[99] The term "patent troll," more formally referred to as a Non-Practicing Entity (NPE) that acquires patents for the purpose of asserting them against alleged infringers to obtain licensing fees or settlements, rather than for producing or commercialising the patented technology itself, describes entities that some argue leverage the patent system in a way that can stifle innovation.[100] One of the reasons identified by Subramanian for the prominence of this phenomenon in the US was the perception that obtaining certain types of patents, including some software and business method patents, was relatively easy. Some infringement litigations were even filed because patent holding companies in the information technology industry bought large portfolios of patents and enforced them aggressively in the industry.[101]

Ng argues that the overly strong patent protection in the US is led by the ambiguous patent claim in many cases. She noticed that software patents are proliferating albeit the absence of a global consensus on the patenting of such inventions remain.[102] She indicated that this was attributed to the fact that software accommodates greater degrees of abstraction than traditional

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[98] Susan Marsnik and Robert E. Thomas 'Drawing a line in the patent subject-matter sands, Does Europe provide a solution to business method and software patent problem?' (2011) Boston College International and Comparative Law Review 53.

[99] The term “patent troll” was first introduced by Peter Detkin who described it as someone “tries to make a lot of money off a patent that they are not practising, have no intention of practicing and in most cases have never practised ” Cited from Sujitha Subramanian, 'Patent trolls in the thicket: who is fishing under the bridge?' (2008) 30(5) E.I.P.R. 182.

[100] See, e.g., Mark A. Lemley and A. Douglas Melamed, 'Missing the Forest for the Trolls' (2013) 113 Columbia Law Review 2117, pp. 2119-2120 (defining and discussing NPEs). Available at: <https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2269087> accessed 28 May 2025.

[101] Sujitha Subramanian, 'Patent trolls in the thicket: who is fishing under the bridge?' (2008) 30(5) E.I.P.R. 186-187.

[102] Elizabeth Siew Kuan Ng, 'Patent trolling: innovation at risk' (2009) 31(12) E.I.P.R. 595.

inventions.[103]

Accordingly, this thesis takes this characteristic of software, it is often abstract and functional nature which differs from many traditional tangible inventions, as a significant ground for arguing that it should not always be treated as an ordinary kind of invention under patent law as its core inventive elements are not always easily incarnated or embodied as a physically examinable invention in the conventional sense.

2.5 The Evolving Standards for Technical Effect and Inventive Step (Non-Obviousness) in Software Patenting

The determination of whether a software invention possesses the requisite "technical effect" (a key consideration in Europe) or satisfies the "inventive step" / "non-obviousness" requirement (a universal patentability criterion) has been a central and evolving aspect of its patentability assessment. This section reviews key developments in how these standards have been applied, particularly in the US and the EU.

2.5.1 The Evolution of US Patentability Standards: From Physical Transformation to Inventive Concepts

The US Supreme Court in early cases, such as *Gottschalk* v. *Benson and Parker* v. *Flook,* initially grappled with the patentability of computer-implemented inventions, often focusing on whether they merely claimed mathematical algorithms or laws of nature. Subsequently, in *Diamond v. Diehr*, the Court found a process for curing synthetic rubber that utilised a mathematical formula and a programmed digital computer to be patentable, emphasising that the claim as a whole was to an industrial process, not just the algorithm itself.

This decision set the stage for the 'machine-or-transformation' test, which required computer-implemented inventions to be tied to a particular machine or to transform an article into a different state or thing to be patentable.[104] This test shares conceptual parallels with the 'technical character' requirement and 'problem-solution approach' discussed earlier regarding the EPO, as both seek to anchor software inventions in a tangible or technical reality to distinguish

[103] *Ibid*., at 594.

[104] *Gottschalk v Benson* 409 U.S. 63 (1972), *Parker v Flook* 437 U.S. 584 (1978), and *Diamond v Diehr,* 405 U.S. 175 184 (1981).

them from abstract ideas.

However, this test was later arguably supplanted or at least significantly broadened by the Federal Circuit in *State Street Bank & Trust Co. v. Signature Financial Group, Inc.*, where the court applied a "useful, concrete and tangible result" test to determine the patentability of computer software, leading to a period where many software and business method inventions were considered patentable.[105] Accordingly, inventions that implemented by data processing apparatus were patentable. The Federal Circuit in *Bilski* in the late 2000s referred back to the machine-or-transformation test.[106] The Supreme Court in *Bilski v. Kappos* affirmed the rejection of Bilski's claims related to a method of hedging risk, holding them to be an unpatentable abstract idea, yet it declined to endorse the machine-or-transformation test as the sole test for patent eligibility, leaving further clarification for future cases.[107]

Most recently, the Supreme Court in *Alice Corp* seems revealed that the US patent is employing a relatively rigorous approach to computer software in nowadays.[108] Its two-steps test investigation asked if a patent claim is directed to a prohibited category. If the answer is yes, the inquiry then proceeds to the second step, which asks whether the claim's elements, considered both individually and as an ordered combination, contain an "inventive concept" sufficient to "transform the nature of the claim" into a patent-eligible application. (the *Alice* mechanism) In other words, it must do more than simply recite the prohibited subject matter and apply it with conventional computer functions.[109]

With regard to the EU, the watershed decision in T 208/84 (*VICOM/Computer-related invention*) in the 1980s provided an early and influential clue to the patenting of computer programs. If the patent claim is a technical effect resulting from the programmed computer rather than the computer program itself, it does not fall within “programs of computers as such” exception in the EPC and is patentable.[110] According to the Technical Board of Appeal, the

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[105] *State Street Bank &Trust Co. v. Signature Financial Group Inc.* 149 F. 3d 1368 (Fed. Cir 1998).

[106] *In re Bilski*, 545 F 3d 943 (Fed. Cir. 2008)

[107] *Bilski v. Kappos,* 130 S. Ct. 3218, 3229-3230 (2010).

[108] *Alice v CLS Bank* 134 S.Ct. 2347 (2014) (Sup Ct (US)).

[109] The two-step framework from *Alice* involves first determining if the claims are directed to a patent-ineligible concept, and if so, then determining whether the claim's elements contain an "inventive concept" sufficient to transform the claimed abstract idea into a patent-eligible application. *Alice Corp.*, 573 U.S. at 217-218.

[110] Case T208/84 *VICOM/Computer-related invention*[1987] EPOR 74.

decisive factor is the “technical contribution” that the invention, when considered as a whole, makes to the state of art.[111] This concept remains central to European patent law today, serving as the essential criterion for assessing the inventive step within the modern 'problem-and-solution' approach. While the core principles of requiring a technical contribution and technical effect remained, the specific tests and their application by the EPO Boards of Appeal have evolved. It is not accurate to say that the technical contribution and technical effect tests had been overturned when entering the 21st century." Rather, the fundamental nature of patent law, requiring an inventive step, has always been central in Europe, and the assessment of inventive step for computer-implemented inventions became more clearly linked to features that contribute to the technical character of the invention. The so-called "any hardware approach," where the mere involvement of hardware was sometimes seen as sufficient to overcome the "as such" exclusion, was a feature of some earlier lines of EPO case law but has been refined. For example, in T 258/03 (*Hitachi/Auction method*), the Board further clarified the scope of an “invention” in the context of mixed technical and non-technical features, emphasising that for assessing inventive step, only features contributing to the solution of a technical problem by providing a technical effect are considered. Thus, both method claims and apparatus claims must demonstrate technical character through such features.[112]

Despite the establishment and evolution of these tests in both the US and Europe, Bainbridge pointed out that the US Supreme Court in *Bilski* refused to confirm the machine-or-physical transformation approach as the sole standard for patent eligibility as applied by its lower court; rather it left it open to courts to develop limitations that consist patent law. He also noticed that the previously adopted approaches in the US were too readily to grant software patent. It neglected the facts that the prior art of software [113], unlike other technologies, does not precisely appear in previous patents or scientific journals.[114]

Furthermore, Bakels also pointed out that it is the European patent law itself

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[111] *Ibid.* at reason No. 16.

[112] Case T258/03 *Hitachi* [2004] O.J.E.P.O.575 at reason No. 4.5.

[113] An invention is required to provide some new characteristics not known in the body of existing knowledge; the existing knowledge is the so-called ”prior art”. Cited from Vaibhav Choudhary, 'The patentability of software under intellectual property rights: an analysis of US, European and Indian intellectual property right' (2011) 33(7) E.I.P.R. 437.

[114] David I. Bainbridge , *Information Technology and Intellectual Property Law* (6th ed., Bloomsbury Professional 2014) 458.

causes the uncertainty to computer programs. The term “programs for computers as such” appears to be construed in various ways in the EPO practice.[115] He also noticed that the Enlarged Board of Appeal offered limited clarification regarding the subject-matter questions referred to it by the EPO President. Uncertainty to the determination of Article 52 EPC, novelty and inventive step, and technical effect to diverse and rapidly evolving software technologies, can remain a challenge for practitioners in the EU.

While the TRIPS Agreement sets out general requirements for patentability that are embedded into national law, it is evident that the courts and patent offices of the member countries of the WTO have been seeking and developing more detailed reviewing mechanisms based on these principles. It cannot be denied that these fundamental requirements are certainly the benchmark for each jurisdiction's patentability assessment. However, it has been realised that applying them to software patent examination may be confronted with several technical and conceptual problems.

An invention is required to be new to be patentable; it relies on a comprehensive prior art database to demonstrate that the given invention has not been made already. Davies indicated that software invention is normally not visible yet is rapidly developing. What have been done were rarely documented as prior art. The long-existing uncertainty on granting such patent also increases the level of difficulties in building up a comprehensive and easily navigable computer program-related prior art database.[116]

On the other hand, although jurisdictions like the EU embrace technical effect as a significant element in assessing inventive step and overcoming exclusions for computer-implemented inventions, there appears to be that no legal definition of the term "technical" that universally applies for all considerations involving computer software across all contexts.[117] Instead, its meaning is often elucidated through case law and examination guidelines by reference to examples and by focusing on whether the software solves a technical problem or achieves a specific technical purpose beyond its mere execution on a computer.

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[115] Reinier B Bakels ‘Software patentability: what are the right questions?’ (2009) 31(10) E.I.P.R. 515-523.

[116] Simon Davies, 'Searching computer-implemented inventions: the truth is out there' (2007) 29(3) E.I.P.R. 89.

[117] Vaibhav Choudhary, 'The patentability of software under intellectual property rights: an analysis of US, European and Indian intellectual property right' (2011) 33(7) E.I.P.R. 442.

2.6. *Sui Generis* Patent Type to Software

Choudhary summarised several reasons against software patent; nothing that a computer program is often merely the implementation of an algorithm formula which is not patent eligible and frequently fails to fully satisfy the inventive step requirement. Furthermore, critics contend that software patents can create monopolies in the market and therefore diminish competition. Besides, it is argued by some that even if certain software is not patentable, it can still be commercially attractive due to other factors like network effects, first-mover advantage, or copyright protection for its code, suggesting that the market for software innovation will not stop developing solely due to limitations on patentability.[118] This perspective posits that other incentives to create software exist, potentially rendering broad patent protection unnecessary or even counterproductive in some contexts. This thesis acknowledges the significant opposition to software patents, particularly from the open-source community and European scholars. For instance, the Karlsruhe Memorandum explicitly argued that software patents would 'hurt jobs and innovation' by imposing legal risks on developers.[119] However, it is also undeniable that such patents have been commonly issued in many key jurisdictions for several decades (as discussed in Chapter 5). While grant rates and eligibility standards fluctuate, the practice of seeking and granting patents for software-related inventions continues.

Guarda asserted that intellectual property rights are justified only when they properly perform their function that they are intended for. Any form of intellectual property protection may become problematic over-protection if it goes beyond the legal bounds affirmed by law or fails to achieve its intended policy objectives, such as fostering genuine innovation and a competitive market.[120] This general principle of intellectual property law, which requires a balance between private rights and public interest, is particularly relevant to patent law, where the grant of exclusive rights must be carefully calibrated to avoid stifling follow-on invention or creating undue market power. Doctrinal arguments often arise when applying these broad principles to specific technological fields like software, where the nature of innovation and market dynamics may differ from

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[118] Vaibhav Choudhary, 'The patentability of software under intellectual property rights: an analysis of US, European and Indian intellectual property right' (2011) 33(7) E.I.P.R. 445.
[119] Karlsruhe Memorandum on Software Patentability (2005), available at <https://fsfe.org/activities/swpat/memorandum.en.html> accessed 28 May 2025.

[120] Paolo Guarda ‘Looking for a feasible form of software protection: copyright or patent, is that the question?’ (2013) 35(8) E.I.P.R. 446-454.

those in traditional industries for which patent systems were initially designed. Guarda argued that the current patent system is not particularly adapted to software development. The uncertainties surrounding the patent requirements for software in many jurisdictions have led to a system which is often perceived by critics and some stakeholders as complex, expensive, and too difficult to be used effectively, especially by SMEs and individual developers.[121] The jurisprudence and literature referred to so far in this thesis provide evidence supporting this assertion. While Guarda, among other scholars, called for *sui generis* right to such inventions like software, so the patent system can move toward a new form of protection that satisfies the needs of human activities, this thesis takes a different approach: rather than proposing an entirely new *sui generis* legislative right, it aims to achieve a more tailored and effective application of existing patent law principles to software through a refined examination model, as will be detailed in Chapter 7.

In fact, the EU had tried to move to a similar direction. Despite of its failure eventually, a draft of a Proposal for a European Union Directive on the patentability of computer-related inventions was a response to the increasing number of program developer and software houses.[122] The proposal was ultimately rejected in 2005 due to a lack of consensus among member states regarding the broad patentability of software. Haunss noticed that some patent critics and open-source developers would prefer the status quo of software being largely unpatentable or having easy accessibility through non-proprietary means, rather than facing the legal uncertainty associated with a broader regime of software patents.[123] It demonstrated that a set of specialised criteria is a workable solution to the uncertainty of software patent, it also proves that this is not an easy task. This difficulty was not only shown in the failure of this proposed directive, but the opposition to software patent also remains based on the assertion that general access to knowledge and information is essential for innovation.[124]

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[121] See, e.g., James Bessen and Michael J. Meurer, Patent Failure: How Judges, Bureaucrats, and Lawyers Put Innovators at Risk (Princeton University Press 2008).

[122] Gustavo Ghidini and Emanuela Arezzo, 'Patent and copyright paradigms vis-à-vis derivative innovation: the case of computer programs'(2005) 36(2) IIC 159. It was published in February 2002 a "Proposal for a Directive of the European Parliament and of the Council on the Patentability of Computer-Implemented Inventions". The proposal was finally failed in the European Parliament's second reading in 2005.

[123] Sebastian Haunss, Conflicts in the Knowledge Society – The Contentious Politics of Intellectual Property (Cambridge University Press 2013) 97.

[124] Sebastian Haunss, Conflicts in the Knowledge Society – The Contentious Politics of

As programs for computer are expressly excluded from patentability in most of patent legislation, attempting to obtain such patent inevitably faces severe test in patent offices and patent courts. Attridge referred to US Supreme Court's decision in *Gottschalk v Benson* as an uncertain beginning in which the patent claim was a program that converted binary coded decimals into pure binary.[125] According to the Supreme Court's denial, the claim was an algorithm that enabling a computer to perform mathematical process. He argued that the court set up a misleading concept that if one algorithm is a mathematical process, then all program algorithms are likewise be mathematical processes and thus is not eligible for a patent.[126] He made reference to Wagner's statement saying that the decision placed computer algorithms "into the storehouse of knowledge available to the intellect and industry of all."[127] The Supreme Court failed to clarify the legal basis for its decision and, it is argued, sent the patent system into confusion for decades."[128] However, it has been observed that, after more than four decades of technological developments, patentability of mathematical models including algorithms has been softened in the US and many other countries despite cross-jurisdictional divergences remaining.[129]

Samuelson *et al.* in their early publication, highlighted that due to software's nature as an easily replicable information product, it requires little or no lead time for software to be massively produced or distributed; inventors had little time to prevent late comers producing products that similar in functionality.[130] They called for a new framework to protect software where the existing law did not provide proper remedy for the substantial source of value of a program. Moreover, they described the status quo for protecting the know-how of software as one that "may seem comfortable, but it is unstable." This instability arises because relying on traditional copyright merely protects the literal text of the code, thereby leaving the valuable functional behaviour, the program's core 'know-how', vulnerable to imitation, or conversely, leading courts to stretch copyright too far to cover utilitarian aspects. This dual nature of software as

Intellectual Property (Cambridge University Press 2013) 141.

125 *Gottschalk v Benson* (1972) 409 U.S.63.

126 Daniel J.M. Attridge, 'Challenging claims! Patenting computer programs in the Europe an and the USA '(2001) 1 I.P.Q. 32.

127 *Ibid.*

128 *Ibid. 31.*

129 Pheh Hoon Lim and Louise Longdin, 'The smartphone wars: patent and copyright as swords and shields'(2016) 38(5) E.I.P.R. 286.

130 Pamela Samuelson se al., 'A manifesto concerning the legal protection of computer programs' (1994) Vol.94:2308 Columbia Law Review 2364-2365.

both a functional work and an expressive work leads to the cycle of potential overprotection (e.g., if copyright is extended too broadly to functional aspects) and under protection (e.g., if patent law too readily excludes inventions that provide a technical contribution to solve a technical problem merely because they are implemented in software) under existing patent and copyright regimes. [131] This dual nature means that applying a single, traditional intellectual property framework without nuance can be problematic. Copyright, designed for expressive works, may not adequately protect the functional innovation, while patent law, designed for utilitarian inventions, grapples with the abstract and mathematical underpinnings of many software concepts.

Samuelson *et al.* attracted Laurie's attention with their proposals in their "manifesto concerning the legal protection of computer programs," They argued that traditional legal categories failed to capture the unique 'hybrid' nature of software—being textual like a literary work yet functional like a machine. Consequently, they proposed a sui generis framework including:

(1) Tailored anti-cloning protection: Unlike copyright which protects literal expression, or patents which protect broad ideas, this aimed to protect the industrial design and functional behaviour of the program against rapid market-destructive cloning, a common issue where 'look and feel' is copied without access to source code.[132]

(2) A registration scheme: Unlike copyright's automatic subsistence, this proposed a formal registration system to identify protectable innovative elements, thereby increasing public notice and reducing legal uncertainty.

(3) Automatic royalty-bearing licenses: To balance protection with access, they suggested a period of market exclusivity followed by compulsory licensing, allowing subsequent innovators to build upon the software by paying a fee rather than being blocked entirely.

Critically, while these proposals offered a theoretically coherent solution to the 'square peg in a round hole' problem of software IP, they faced significant practical hurdles. Implementing such a distinct sui generis regime would require a radical overhaul of the international intellectual property framework (such as the Berne and Paris Conventions), a task that proved politically insurmountable. However, their underlying diagnosis, that fitting software into traditional patent

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[131] *Ibid.*, 2364.

[132] Samuelson *et al.* (1994), n 13, pp. 2366-2414

and copyright boxes creates friction, remains valid. This persistent friction underscores the necessity of the approach taken in this thesis: rather than waiting for a new legislative regime, there is an urgent need to refine the application of existing patent laws through a more structured examination model.

Moreover, Laurie also referred to Dyson *et al.* who argued that current policy makers were trying to apply industrial age policy to deal with knowledge age phenomena.[133] [134] Dyson *et al.* suggested that while information might have been treated as a public good in the industrial age, knowledge in the "knowledge age" (or "third wave" as they termed it) inherently has characteristics of a private good due to its value and the ease of its replication and dissemination, thus requiring new modes of thinking about its protection. In their view, traditional patent and copyright paradigms might no longer be entirely sufficient or appropriate for all aspects of the knowledge age, and they too called for a new form of protection suited to the new age.[135] This perspective aligns with the broader call for *sui generis* approaches, suggesting that the unique attributes of digital information and software-based innovation may necessitate a departure from, or significant adaptation of, established intellectual property frameworks. While the specific proposals of Dyson *et al.* for a "*magna carta* for the knowledge age" were broad and visionary, their underlying diagnosis of the inadequacy of existing intellectual property for certain knowledge age products resonates with ongoing debates about software protection.

This research project will conduct a discussion on the legitimacy of software patent in knowledge age. The idea of seeking a new form of protection apart from patent and copyright mentioned by Dyson *et al.* seems too ambitious to be carried out in a research project. As Lim and Longdin indicated, neither courts nor the legislative or administrative source are free to rewrite core intellectual property principles overnight, as such principles are often deeply

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[133] Esther Dyson *et al.*, 'Cyberspace and the American dream: A *Magna Carta* for the knowledge age'(1994) Vol.11 No.4 New Perspectives Quarterly, Copyright Center for the Study of Democratic Institutions. Cited from Ronald S. Laurie, 'Comparison of patent and copyright protection for computer software Under US law', (1996) Vol.12, Issue 2 Computer Law & Security Review 85.

[134] They used the term "Second Wave" and "Third Wave" to express the idea of "industrial age" and "knowledge age" respectively.

[135] Ronald S. Laurie, 'Comparison of patent and copyright protection for computer software Under US law', (1996) Vol.12, Issue 2 Computer Law & Security Review 85.

embedded in national laws and international treaties.[136] It seems more realistic to first find out how appropriate patent policy and doctrine can be refined and applied to regulate software patentability rather than attempting to completely deny the applicability of patent law or invent an entirely new intellectual property right from scratch.

Being aware of the development of global information infrastructure, Laurie further express his expectation to see updated *sui generis* protection for software; however, he also gave concern to the potential problems that a new regime may come across.[137] One of these concerns is that patentees and relevant third parties will lose the ability to argue by analogy to the extensive body of case law developed under the current system; the other is that a completely new type of intellectual property protection would likely suffer from a lack of international harmonisation, especially when compared with the relatively more harmonised copyright protection for software explicitly confirmed by the TRIPS Agreement. Indeed, achieving international consensus and adoption for any new *sui generis* intellectual property right is a significant diplomatic and legal challenge, as evidenced by the lengthy processes involved in establishing and amending existing international intellectual property treaties. WIPO and national governments continue to debate how best to adapt existing intellectual property systems or whether new approaches are needed for emerging technologies like AI, highlighting the ongoing nature of this challenge rather than an immediate global move towards a specific *sui generis* software right.[138]

In this regard, before contemplating entirely new legislative frameworks, a crucial step is to ensure that existing patent policies are applied with the necessary specificity and understanding to address the unique characteristics of software and the demands of the knowledge-based economy. This involves developing clear and consistent examination standards and interpretative approaches that can be applied within the current international patent framework, aiming to enhance legal certainty and foster innovation.

2.7 Synthesizing the Literature: Identifying Gaps and

[136] Pheh Hoon Lim and Louise Longdin, 'The smartphone wars: patent and copyright as swords and shields' (2016) 38(5) E.I.P.R. 289.

[137] Ronald S. Laurie, 'Comparison of patent and copyright protection for computer software Under US law', (1996) Vol.12, Issue 2 Computer Law & Security Review 85.

[138] See, e.g., WIPO, Standing Committee on the Law of Patents (SCP) < https://www.wipo.int/en/web/scp> accessed 15 May 2025.

Justifying the Present Research

As mentioned above, patent plays the role not only encouraging innovation activities but also assisting to distribute innovation to consumers. The promotion of a friendly patent system to small entities on procedural issues has been suggested in the literature (see Section 2.1, discussion of Walsh) as a means to help software patents of small entities for better access to the market and provide more contributions to the industry. Currently, computer programs are generally subject to statutory exclusion from patentability in principle; they are deemed patentable only when satisfying specific criteria established by patent legislation and judicial precedent. However, functional software includes functionality, languages, and interfaces, and therefore its value often extends beyond that of mere literature. Hence, patent for functional software innovation should be considered. In other words, whether a software patent in an application has patentability or not that should be precisely regulated. A clear set of patentability examination criteria can also avoid the existence of low-quality software patent problems which may cause an obstacle and reduce the opportunities to later researchers. This thesis will start from the scope of patent to prevent granting patents to vague claims with trivial contribution to knowledge and thus minimise the uncertainty in patent law.

Software presents unique challenges for patent law. Software's often intangible and functional nature means it is not always easily assessed as a physical invention comparable to traditional mechanical devices, though it is important to acknowledge that many other fields of technology also involve intangible aspects or complex systems.[139] A set of commonly accepted guidelines or approaches for determining patentability in a concrete and understandable manner is needed; especially in the phenomena that each country in the world has its own peculiar structure of patent systems. Although establishing a set of commonly accepted guidelines or approaches is a tough task, it is still worth starting on the software to make a step forward. This thesis expects to contribute in this area, especially in the investigation of the principles underpinning the legitimate application of patent law to software in the current knowledge age.

[139] See, e.g., Pamela Samuelson, Randall Davis, Mitchell D. Kapor, and J. H. Reichman, 'A Manifesto Concerning the Legal Protection of Computer Programs' (1994) 94(8) Columbia Law Review 2308. Available at < https://www.jstor.org/stable/1123142> accessed 20 May 2025.

2.7.1 Summary of Key Challenges in the Current Patent System

In this section some of the procedural issues or difficulties analysed for the patentability judgment of software invention from the literature review are summarised as follows:

1. Firstly, companies across all industries, including the high-tech software sector, must make careful assessments when formulating business models and intellectual property strategies to maximise profits and protect innovation.[140] The specific challenges for software companies, particularly SMEs, lie in navigating a patent system that can be perceived as complex and costly.
2. Secondly, the call for a low-cost and easy application environment in the patent system, including shorter and simpler patent application procedures as well as affordable enforcement fees, is particularly resonant for small entities in the software field.[141] Whether such an environment can or should be created without compromising the system's integrity raises complex doctrinal and policy questions. A primary concern is the potential proliferation of patents that, while enjoying a presumption of validity and potential commercial value for assertion, rely on broad or ambiguous claims susceptible to invalidation (characterised as 'low quality' in the literature discussed in Section 2.3 and Chapter 6). This thesis approaches this by proposing clearer substantive examination criteria (Chapter 7), which, if consistently applied, could indirectly reduce uncertainty and wasted expenditure, rather than focusing primarily on procedural cost reduction.
3. Thirdly, the literature underscores the need for standard methods, including robust identification criteria, to objectively observe whether a software invention produces a genuine technical effect (as in the EPO) or a specific practical application (as in the US), thereby satisfying the requirements of novelty and non-obviousness (inventive step).[142]
4. Fourthly, determining whether the functional aspects of software should be

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[140] See Michael E. Porter, Competitive Strategy: Techniques for Analyzing Industries and Competitors.

[141] See, e.g., Organisation for Economic Co-operation and Development (OECD), Financing SMEs and Entrepreneurs: An OECD Scoreboard. An overview of SME patenting can also be found on WIPO's website: <https://www.oecd.org/en/publications/financing-smes-and-entrepreneurs-2024_fa521246-en.html> accessed 24 May 2025.

[142] See, e.g., EPO, Guidelines for Examination in the European Patent Office (March 2025), G-VII (Inventive Step) and G-II, 3.3-3.7 (Computer-Implemented Inventions). Available at <https://www.epo.org/en/legal/guidelines-epc> accessed 28 May 2025.

protected by patent legislation rather than solely by copyright often depends on an analysis of its core inventive ideas and functionality, distinguishing protectable technical solutions from mere expressions or abstract concepts. This distinction is vital, as argued in Section 2.2, and forms a key part of the examination model proposed later in this thesis. While some have suggested a *sui generis* system as a third way, this thesis explores refinements within the existing patent framework.[143]

5. Fifthly, the principle that software should not be eligible for patent protection if the benefits it creates cannot offset the societal costs of granting a monopoly, including potential antitrust and competition law concerns and the hindrance of follow-on innovation, is a crucial consideration underpinning patent policy.[144]
6. Sixthly, the question of whether a software patent should be granted often hinges on whether the invention, despite being implemented in software, allows a physical feature of an entity or the nature of an activity to perform a technical character or achieve a technical effect or not.
7. Seventhly, the term "technical" as it applies to software needs clearer articulation within patent examination guidelines and jurisprudence to confirm that a software patent fulfils the fundamental requirements of being a new and inventive technical solution.[145]
8. Finally, determining whether to grant patent protection for software should arguably consider how well the invention meets demonstrable needs of human activities and contributes to useful knowledge, aligning with the broader societal goals of the patent system.[146]

In response to the above issues identified from the literature, this study conducts a discussion on the legitimacy and appropriate scope of software patenting in the knowledge age. It seeks to find a way out of the conundrum posed by the dual nature of software as both a technology and a writing (expressive) work, thus aiming to mitigate the cycle of potential overprotection

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[143] See, e.g., Peter S. Menell, 'An Analysis of the Scope of Copyright Protection for Application Programs' (1989) 41 Stanford Law Review 1045.

[144] See William M. Landes and Richard A. Posner, The Economic Structure of Intellectual Property Law (Harvard University Press 2003) Chapter 11 ("Patent Law: The Economic Rationale").

[145] The definition and assessment of "technical character" for software inventions is a central issue in European patent law, extensively developed through EPO Board of Appeal decisions. See discussion in Chapter 5, Section 5.2.2.2 of this thesis, referencing cases like *VICOM* and *COMVIK*.

[146] See TRIPS Agreement, Art 7 ("Objectives").

and under protection in the existing patent system.

2.7.2 Research Limitations and Scope

However, some limitations are inherent in or have been identified for this study, including:

- At present, there is still no single, globally harmonised common definition of the patentability criteria specifically tailored for software in the world, which naturally affects the predictive outcome of any proposed model or analysis applied across diverse jurisdictions.
- The ability of software to enter the market is often limited by its development cycle and the challenges of commercialisation, which affects its value assessment in patent examination. This economic reality will also indirectly affect the practical impact of the legal solutions discussed in this study.
- It is pointed out in the literature (see Section 2.3) that distinguishing software elements (e.g., functional aspects) and non-software elements (e.g., the underlying hardware or the data being processed) is difficult. This will affect the examination criteria for, and the clarity of claims in, the granting of software patents.
- It is difficult to definitively determine in all cases whether a software patent claim has a sufficiently inventive underlying method or algorithmic means that leads to a patentable technical result, as distinct from an abstract idea.
- The problem of ambiguous software patent claims is common and can be seen in many cases.[147] While this thesis aims to propose a model that enhances clarity, it is difficult to completely avoid the possibility of low-quality software patents being granted due to the inherent complexities of the subject matter and examination processes.

Therefore, this literature review has established the complex legal and economic landscape surrounding software IP, highlighting the inadequacies of relying solely on copyright for functional protection and the persistent

[147] See, e.g., *Alice Corp. Pty. Ltd. v. CLS Bank Int'l*, 573 U.S. 208 (2014). See also Nautilus, Inc. v. Biosig Instruments, Inc., 572 U.S. 898 (2014). For a comprehensive analysis of the "fuzzy boundaries" and notice failure in software patents, see James Bessen and Michael J. Meurer, Patent Failure: How Judges, Bureaucrats, and Lawyers Put Innovators at Risk (Princeton University Press 2008).

challenges in applying patent law to software. It underscores the need for a more nuanced, consistent, and doctrinally sound approach to assessing the patentability of computer-implemented inventions, which this thesis will seek to address through a detailed examination of current legal frameworks and the proposal of a structured examination model in the subsequent chapters.

Chapter 3

Methodology

3.1 Introduction

Having provided the literature review in Chapter 2 which, along with the doctrinal analysis presented later in the thesis, establishes the research gap which this research project aims to fill, this chapter outlines the methods and methodologies used. A variety of possibilities have been considered when completing this thesis. However, it is important to acknowledge from the outset that as the core subject matter concerns the interpretation and application of legal principles to a complex technological field, the key discussion conducted in this thesis is primarily founded upon a doctrinal analysis of patent law. This doctrinal approach is enriched and contextualised by comparative studies, particularly drawing on the experiences from leading jurisdictions such including the US and the EU. Details of the reasons and processes for applying the methods are given in following sections.

Section 2 of this chapter demonstrates the necessity and value of this thesis by outlining the problems in the current patent system and how it attempts to deal with computer-implemented inventions (CIIs) including software. The purpose of its inclusion in the methodology chapter is to emphasise the central aim of this thesis with its expectation of improving legal certainty and facilitating fair competition in the smartphone market. Section 3 illustrates the core methods used to conduct in-depth exploration to produce rational suggestions to current mainstream patent systems across the world. Finally, Section 4 provides a critical review of the methodological approaches employed in this thesis, while also acknowledging the research limitations and outlining potential avenues for future work.

3.2 Research Motivation and Objectives

3.2.1 The Smartphone Industry

Software has been widely applied in various industries and businesses, ranging from automotive systems in vehicles and smart controls in household appliances to sophisticated medical diagnostic tools; it is especially essential in

computing technology and its applications including smartphones.[148] Within smartphones, software powers everything from the core operating system and communication functionalities, such as cellular connectivity and Wi-Fi, to diverse applications enabling navigation, financial transactions, social networking, and advanced camera features driven by computational photography algorithms. The conception of this thesis is based on the observations of my LLM research thesis which concerned patent abuse and competition issues in the so-called "smartphone patent wars". It was argued in that thesis that ambiguities and potential loopholes within patent law could allow speculators to take unconscionable advantage from their patents. The law facilitates such action in the form of communication technology patents, hardware patents and user-interface/design patents. This issue was observed in relation to various types of patents crucial to smartphone technology, including patents covering essential communication standards (Standard Essential Patents or SEPs), specific hardware components, and elements of user-interface design, leading to concerns about patent hold-up and royalty stacking.[149] During my LLM study, I had the intention of undertaking an in-depth examination of another integral part of smartphone technology, namely the patent landscape for software. By virtue of the infinite possibilities presented by computer-Implemented Inventions (CIIs), their patenting and enforcement are associated with unprecedented conundrums and complexities that this doctoral thesis seeks to address.

3.2.2 The Contentious Patent System for Computer-Implemented Inventions and Software

One of the findings in the aforementioned research suggests that the pursuit of profit is a primary driving force for smartphone companies' innovation.[150] Nevertheless, patent protection is necessary as it is the most powerful legal protection; patent holders are entitled to prevent unauthorised utilisation of a valuable idea and lawfully earn incomes including royalties or licensing fees. It is also, for the same reason, an instrumental device to ensure the wider

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[148] Saurabh Vishnubhakat, 'The commercial value of software patent in the high-tech industry' (2015)< http://cpip.gmu.edu/wp-content/uploads/2014/04/The-Commercial-Value-of-Software-Patents.pdf > accessed 16 April 2016.

[149] See, e.g., Mark A. Lemley and Carl Shapiro, 'Patent Holdup and Royalty Stacking' (2007) 85 Texas Law Review 1991; See also J. Gregory Sidak, 'The Meaning of FRAND, Part II: The Case of User-Interface Design Patents for Smartphones' (2014) 10(1) Journal of Competition Law & Economics 133

[150] See, e.g., Henry Chesbrough, Open Innovation: The New Imperative for Creating and Profiting from Technology (Harvard Business Press 2003)

circulation of patented innovation in the market.

While the smartphone market has matured and experienced fluctuations, including periods of sales decline such as the one first noted around 2016, more recent data from 2024 indicates a market recovery with 1.24 billion units shipped, and projections for 2025 suggest continued, albeit potentially slower, growth.[151] It can be inferred that while initial explosive growth in the number of smartphones to meet public demand had levelled off, smartphone companies continue to need to introduce innovative products to stimulate the demand for newer generation smartphones. Is patent law ready to cope with the new type of innovation that is essential to the blooming business after the introduction of the, revolutionary, first iPhone in 2007?

Software, encompassing a range of forms such as core operating systems (e.g., iOS, Android), firmware, application programming interfaces (APIs), and end-user applications (apps), collectively govern the substantiality of a smartphone's functions and critically defines the user's experience with a smartphone. Due to its expression in code, which is considered a form of literary work, it is widely articulated that computer programs written in program languages are generally eligible for copyright protection.[152] With respect to the computer-implemented inventions that carry out functional advancement to a smartphone, such as an algorithm that significantly improves battery life through novel power management techniques, or a new software-based sensor fusion method that enhances navigational accuracy in GPS-denied environments, it presents not just a composed expression but an innovative enhancement to achieve a specific technical purpose that makes smartphone handsets smarter. Therefore, this thesis will focus on the patentable issues of software inventions, including not only those integral to smartphones but also other computer-implemented inventions, for example, in fields like industrial automation, medical diagnostic software, or AI-driven data analytics platforms.

Figure 1 shows that the number of software related patents granted by the United States Patent and Trademark Office (USPTO) had a sharp rise in the late 20th century and kept increasing gradually thereafter. Whereas the number

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[151] See Daniel Thomas, 'Global smartphone sales fall for first time' Financial Times (2 May 2016). For more recent data and trends; see International Data Corporation (IDC), Worldwide Quarterly Mobile Phone Tracker (February 11, 2025) and International Data Corporation (IDC), Worldwide Smartphone Market Forecast to Grow 2.3% in 2025, (Press Release, 25 February 2025). Both IDC sources available via https://www.idc.com accessed 15 May 2025.

[152] See Berne Convention for the Protection of Literary and Artistic Works, Art. 2(1) (protecting "literary and artistic works"); WIPO Copyright Treaty (1996), Art. 4.

of such patents was less than one-third of all other patents in the US in 1990s, it first surpassed to the total number of other patents in 2011.[153] Nevertheless, Figure 2 demonstrates that although software related patents have been largely granted, such patents were mostly deemed invalid when challenged in the US federal courts[154] (the bar chart in Figure 2 demonstrates the statistic made after the striking court decision in *Alice* in 2014 in the US).[155]

Figure 1. Number of Software-Related Patents Granted by USPTO between 1991~2011

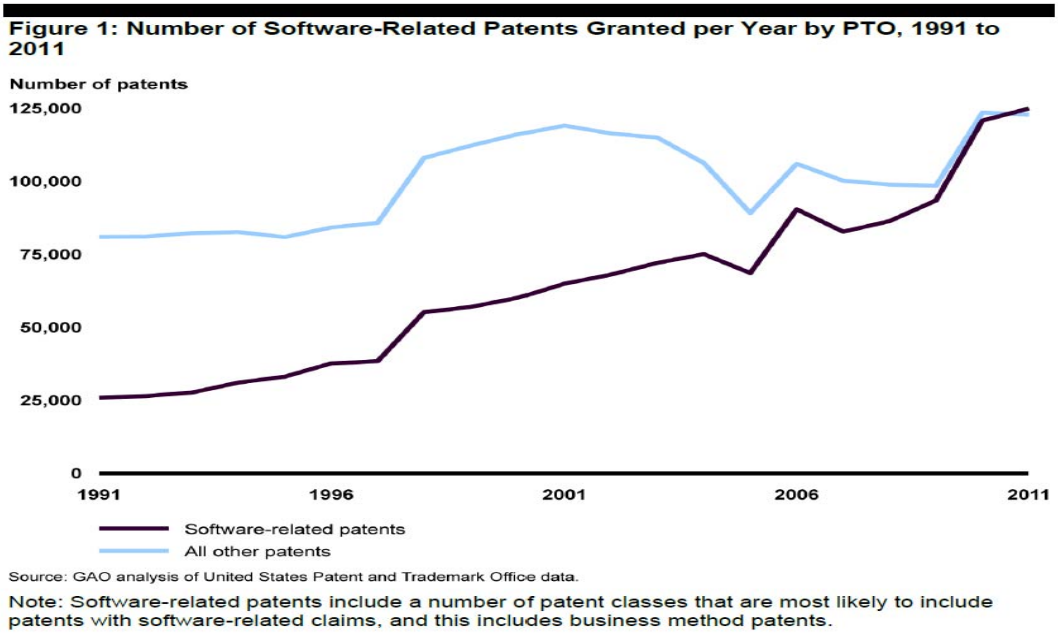
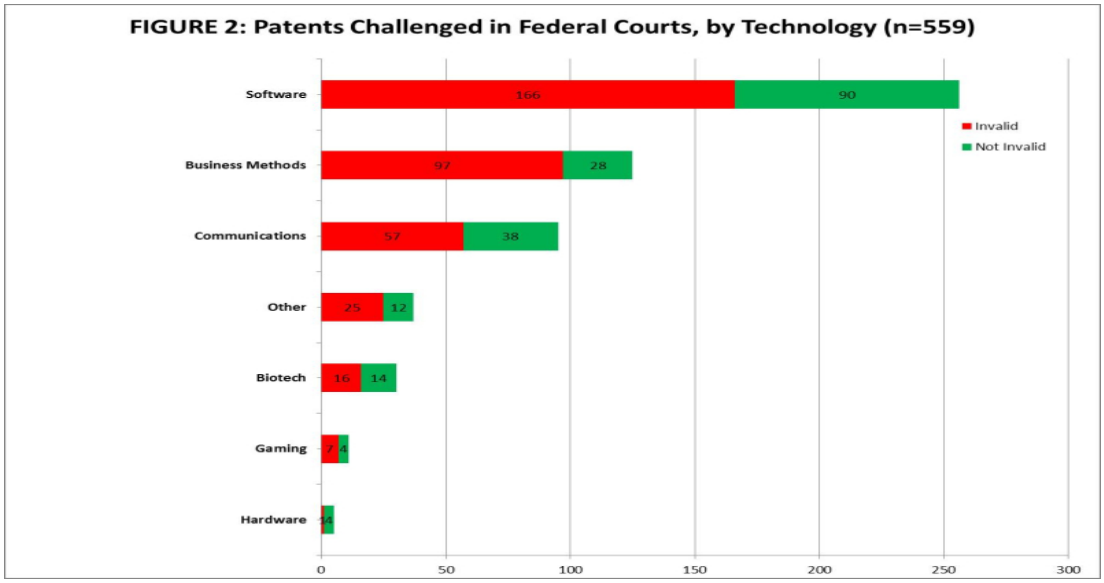


Figure 2. Trends in US Federal Court Decisions on Software-Related Patents Post-Alice (2014~)

[153] see, e.g., Randal C. Picker, 'The Invention of the Software Patent: A Brief History' (University of Chicago Law School, John M. Olin Law & Economics Working Paper No. 725, 2nd Series, 2015), available at https://chicagounbound.uchicago.edu/law_and_economics/33/ accessed 15 May 2025.

[154] Data regarding the invalidation rates of software-related patents in US federal courts, particularly after the *Alice* decision, has been a subject of significant analysis. See, e.g., John R. Allison, Mark A. Lemley, and David L. Schwartz, 'Our Divided Patent System' (2017) 82(6) University of Chicago Law Review 1073.

[155] *Alice Corp. Pty. Ltd. V CLS Bank International et al*, 573 U.S. (2014).



The trends observed up to the mid-2010s, particularly the "*Alice Storm*" following the Supreme Court's 2014 decision which led to heightened scrutiny and increased invalidation rates for software patents under 35 USC Section 101, continued to shape the landscape in subsequent years.[156] While the initial period after *Alice* saw a significant number of software patents invalidated, some analyses[157] indicate that the situation began to evolve. For instance, by the late 2010s and into the early 2020s, Section 101 eligibility remained a critical hurdle. There were signs of a potential stabilisation or a more nuanced application of the *Alice* framework by the Federal Circuit and in USPTO examination practices, partly influenced by subsequent judicial decisions and revised USPTO guidance (such as the 2019 Revised Patent Subject Matter Eligibility Guidance).[158] Studies reviewing[159] patent litigation trends up to the early 2020s continued to highlight Section 101 as a frequent basis for invalidity challenges; particularly in high-tech and software sectors, although the

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[156] *Alice* Corp. Pty. Ltd. v. CLS Bank Int'l, 573 U.S. 208 (2014). The impact of this decision on software patent eligibility is extensively discussed in Chapter 5 of this thesis.

[157] See, e.g., Sunnie Ning, Stabilizing Alice for Abstract Ideas: A Case for the Federal Circuit to Turn to USPTO Guidance, Harv. J.L. & Tech. Digest (Apr. 3, 2021); see also Cong. Research Serv., Patent-Eligible Subject Matter Reform: Background and Issues for Congress, R45918 (2023).

[158] See, e.g., John R. Allison, Mark A. Lemley, and David L. Schwartz, 'Understanding the Realities of Patent Litigation' (2023) 98 Notre Dame Law Review 647. For official guidance influencing examination, see USPTO, 2019 Revised Patent Subject Matter Eligibility Guidance, 84 Fed. Reg. 50 (Jan. 7, 2019) and subsequent USPTO memoranda clarifying its application. For a recent practitioner perspective on the *Alice* landscape and USPTO practices.

[159] See, e.g., Mark A. Lemley & Bhaven N. Sampat, Does Alice Target Patent Trolls?, 18 J. Empirical Legal Stud. 692 (2021); see also U.S. Patent & Trademark Office, The Artificial Intelligence Patent Dataset — 2023 Update (2024).

absolute rates of invalidation may have fluctuated.[160] Concurrently, the number of patent applications in software-related fields, including those involving artificial intelligence (AI), continued to be substantial at the USPTO. It reflects ongoing innovation and the perceived value of patent protection in these areas, albeit there are eligibility challenges.[161] For example, some analyses focusing on patent grants in AI and machine learning showed continued growth in patenting activity at the USPTO from 2018 through 2023.[162] Even with the *Alice* framework in place, it suggested that adequately drafted applications focused on specific technical improvements could still navigate the eligibility hurdles.[163] These more recent developments underscore the dynamic and often complex interplay between judicial precedent, patent office practice, and ongoing technological innovation in the realm of software patents.

This thesis explores this phenomenon – specifically, the high invalidation rates observed for software-related patents when challenged in court, despite their initial grant by patent offices. While acknowledging that patent quality issues and high invalidation rates can also affect other technological fields, especially in jurisdictions like the US where they have faced significant scrutiny (as partly reflected in Figure 2 concerning business methods), this study will focus primarily on the unique challenges and complexities inherent to software and computer-implemented inventions. The common underlying problem often relates to difficulties in applying traditional patentability criteria (novelty, inventive step, and subject-matter eligibility) to inventions characterised by their abstract nature, functional aspects, and rapid technological evolution, issues that are particularly acute for software. The first step is to inspect what leads to the outcome that software related patent granted by patent offices are considered invalid in the court and the critical analysis of patent law application in patent offices and the considerations indicated in the courts. Furthermore, this research identifies the risks from a legal perspective, as well as considering economic and social needs. Concerns regarding anti-competitive behaviour, such as the use of overly broad patents to block market entry or hinder follow-

[160] See, e.g., Unified Patents, 2023 Patent Dispute Report: Year in Review (January 2024) pp. 15-20.

[161] World Intellectual Property Organization (WIPO), World Intellectual Property Indicators 2024 (WIPO 2024)

[162] See U.S. Patent and Trademark Office, The Artificial Intelligence Patent Dataset — 2023 Update (February 2024).

[163] See, e.g., World Intellectual Property Organization. "The Story of Artificial Intelligence in Patents." WIPO, https://www.wipo.int/en/web/technology-trends/artificial_intelligence/story. Accessed 31 May 2025.

on innovation, are among the most critical issues threatening the industry (as extensively discussed in Chapter 6). Considering the findings in the thesis, this work will critically evaluate whether the current legal framework effectively protects computer-implemented inventions and fosters innovation. As significant deficiencies are identified throughout this thesis, the thesis will present a refined theoretical approach and a structured examination model in Chapter 7 to better achieve the goals of the patent system in the context of these technologies.

3.2.3 Aims of the Research - Precise Boundaries and Legal Certainty

Despite the fact that most of the jurisdictions do not stipulate computer-implemented inventions as a distinct category of patentable subject-matter in their statutes, often listing computer programs as an exclusion, market demand has brought about continuing investments on software advancement, particularly concerning smartphone software.[164] In this context, the role and impact of patent protection have become subjects of intense debate. While proponents argue that patent protection plays an important role, not only for the purpose of encouraging innovation incentives but also potentially for preserving healthy competition in the smartphone market, critics and observers rightly question the extent to which patents are solely or even primarily responsible for these outcomes, suggesting that innovation might have occurred regardless due to other market and technological drivers. Indeed, the very existence of different approaches to software patentability across jurisdictions, coupled with phenomena such as those illustrated by Figure 1 and Figure 2 (indicating both growth in software patenting and high invalidation rates), highlights a critical systemic issue. The relevance of this disparity lies in the evident disconnect between patent office examination practices and judicial validity assessments. The fact that numerous patents are granted by offices only to be subsequently invalidated by courts implies the absence of consistent standards to determine whether a computer-implemented invention is eligible for a patent. This leads to legal uncertainty for those who seek to ensure the protection of their intellectual efforts and those who are willing to lawfully access existing works.

After looking into the long thriving smartphone industry and its expecting future

[164] Examples can be seen in the Section 101 of the US Code (Tile 35) which only provide a general idea saying that any process, machine, manufacture, composition of matter, or new and useful improvement that satisfy patent requirements are patentable; in addition, article 52(2)(c) of the European Patent Convention excludes methods of doing business and programs of computers from patentability.

development, this thesis aims to clarify the value of patentable computer-implemented inventions in order to extinguish them from unpatentable products or those better be protected by copyright. The concept of computer-implemented inventions and software is relatively new in patent law in comparison with other industrial products. Moreover, it usually lies in the edge zone between patentable subject-matter and unpatentable exclusions like "programs for computers as such" or abstract mathematical algorithms and formula. This thesis aims to delineate precise boundaries for the patentability of computer-implemented inventions in order to maximise legal certainty for inventors, manufacturers, and relevant market participants, thereby ultimately benefiting consumers and society at large.

Given the above background and disputes surrounding the granting of computer-implemented inventions patents, the following section demonstrates the methods adopted in this thesis to seek for justifications for computer-implemented invention patent and a robust patent protection for them.

3.3 Answering the Question - Research Methods

3.3.1 Doctrinal Analysis

The main purposes of this thesis are to identify and analyse deficiencies within existing patent law as it applies to computer-implemented invention and software, and ultimately to suggest a comprehensive examination framework that caters to the new communication era. To achieve this, doctrinal analysis is employed as the predominant research method throughout this study.[165] Doctrinal analysis, in this context, involves a critical, systematic examination of legal rules, principles, and concepts derived from primary legal sources such as statutes (e.g., patent acts), case law, and international treaties, as well as authoritative secondary sources including legal scholarship and official guidelines from patent offices. This method is particularly suited for this research because the core issues revolve around the interpretation, application, and adequacy of existing legal doctrines in addressing the unique characteristics of computer-implemented inventions. While other research approaches, such as purely empirical studies focusing on quantitative data or socio-economic impact analyses can provide valuable context (and are indeed

[165] see, e.g., Terry Hutchinson, Researching and Writing in Law (4th edn, Lawbook Co. 2018) Ch 3 ('Doctrinal Research'). See also Ian Dobinson and Francis Johns, 'Qualitative Legal Research' in Mike McConville and Wing Hong Chui (eds), Research Methods for Law (2nd edn, Edinburgh University Press 2017) pp. 18-45.

referred to where appropriate in this thesis, as discussed later), they are not the primary means to address the fundamental legal questions concerning patentability criteria, claim construction, and the internal coherence of patent law itself. A doctrinal approach allows for an in-depth exploration of legal reasoning, the identification of inconsistencies or ambiguities within the law, and the development of legally grounded proposals for reform or improved application, such as the examination model proposed in Chapter 7.

The method is firstly applied to help appreciate the historical changes that have taken place in the patent examination of computer-implemented inventions. This is to establish a fundamental understanding of patent system and the factors that led to the evolution of patent examination which frames the starting point of this study. Despite intending to formulate a specialised examination model for computer-implemented inventions, analysing relevant statutes and court decisions is crucial since it helps to understand how the current law treats computer-implemented inventions and software. In accordance with patent law, computer-implemented inventions are literally, in principle, unpatentable because they are deemed as algorithms or formula. However, an examination of patent court decisions reveals that this is not always the case and that pathways to patentability exist under specific conditions.

With this systematic exposition and theoretical analysis conducted towards legal rules establish by patent law and patent authorities including patent courts, it was apprehended at the first stage of the study that, by referring to doctrinal analysis of current law and court judgement, the definition of patentable subject-matter as applied to computer-implemented inventions is, in fact, construed in different ways across and even within jurisdictions. This, once again, evidences the uncertainty of patenting computer-implemented inventions and confirms the motivation of the thesis. At this stage of progress, the thesis has sketched out in what circumstances computer-implemented inventions are or are not entitled for patent under substantive patent law in according to the doctrines expressed in court decisions, and engage in critically reviewed the execution of the law and approaches that are contentious.[166] The fundamental arguments of thesis are derived by this stage.

To look at the purpose of intellectual property (IP) in general, it is to promote

[166] See, e.g., Terry Hutchinson, Researching and Writing in Law (4th edn, Lawbook Co. 2018) Ch 3 ('Doctrinal Research'). See also Ian Dobinson and Francis Johns, 'Qualitative Legal Research' in Mike McConville and Wing Hong Chui (eds), Research Methods for Law (2nd edn, Edinburgh University Press 2017) pp. 18-45.

the progress of science and useful arts by granting their rights holders exclusive rights.[167] However, due to the unique nature of computer-implemented inventions that requires the collection of numerous ideas, its patentability has long faced debates.[168] The more such technical solutions are patented, the greater the difficulties subsequent inventors face when developing new software. This renders computer-implemented inventions a particularly complex subject-matter for patent examination.

Unlike copyright in which disputes normally occur in procedural issues such as licensing, controversies of computer-implemented invention patents are seemingly more related to the essence and function of products that defined in the substantial of patent law. The Berne Convention confirms that computer programs are protected by copyright as literary works, meaning that intellectual property rights to computer programs like software codes written in programming languages are less controversial under copyright law. However, a computer-implemented invention often contains more than that. There often seems to be no precise or universally agreed-upon legal basis within patent law for the intellectual property protection of those functional aspects of computer-implemented inventions that lie outside the boundaries of copyright.

This thesis applies doctrinal analysis, that is, the systematic interpretation and critical evaluation of legal texts and case law, to examine how computer-implemented inventions and software inventions are, or could be, situated within the existing framework of patent law. Apart from the legal claim of patent, patent litigation filed by smartphone companies and even non-practicing entities (NPEs) has shown that the current patent system has become a tool to block competitors to the market or claim monetary reward by NPEs, respectively.[169] The ambiguous terms in patent law generate a significant number of trivial and ambiguous patents. None of these seem to contribute the enhancement of technology. It seems contradict to the purpose of intellectual property protection. A doctrinal approach, specifically by analysing the underlying principles and policy objectives of patent law, helps to re-evaluate the assumptions behind current patent practices and observe whether current

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[167] Article 1, section 8 of the US Constitution which empowered the US Congress to promote science and useful arts.

[168] See, e.g., Pamela Samuelson, 'Reconciling Copyright and Patent for Software: A Way Forward' (2023) 13 UC Irvine Law Review 1057.

[169] see, e.g., Lauren Cohen *et al*., 'Patent Trolls: Evidence from Targeted Firms' (Working Paper, January 2024), available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2464303, accessed 22 May 2025.

law provides graspable and consistent judicial interpretation to deal with the perceived disorder in this emerging industry.

However, a pure doctrinal study divorced from comparative insights or practical considerations may lead to narrow or inadequately contextualised conclusions. Legislation requires comprehensive and omnibus consideration. It is dangerous to observe only a particular type of jurisdiction. To construct a patent examination model that is straightforward and aims to reduce computer-implemented invention patents disputes, an in-depth understanding and comparison of approaches between international treaties like Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS Agreement), regional systems (like the European Patent Convention (EPC)), and key national laws (like those of the US) is essential. This comparative element forms an integral part of the doctrinal analysis in this thesis. It facilitates a synthesis of potentially effective approaches drawn from different jurisdictions and sources of law (it will be stated in the following sub-section). It also assists in looking for rational patent law interpretation under the goal of greater international harmonisation.

The legal terms and their applications indicate that different countries may have different assessments of patentability. For example, while computer programs are listed as excluded from patentability "as such" in the EU under the EPC and are not explicitly listed as patentable subject-matter in some international treaties, they are not explicitly denied patentability under the general statements of Section 101 in US patent law.[170] The doctrinal analysis facilitates the concordance of national and international dimensions and provides scope for assessing their underlying rational and therefore the success of the new paradigm being presented.

There have been numerous studies that focused how patent law influences the development of computer-implemented inventions.[171] In some of these studies, empirical data was applied to demonstrate facts like the rates of issuing software patents in a certain jurisdiction and the growing number of litigation cases among major smartphone companies. Such research results are essential references for this thesis as they provide evidence of the perceived inefficiency of the current law in certain respects. Although these valuable

[170] See European Patent Convention (EPC) Art 52(2)(c) and 52(3); TRIPS Agreement Art 27; 35 USC Section 101.

[171] Stuart Graham and Saurabh Vishnubhakat, 'Of smart phone wars and software patents', (2013) 27(1) Journal of Economic Perspectives 67.

studies confirm the adverse impact of certain patent law applications or interpretations on the high-tech industry, they often do not articulate a concrete solution to improve or rectify the identified problems at the doctrinal or procedural level.

This thesis emphasises the significance of a reformative patent system and a refined approach to assessing computer-implemented inventions. It refers to quantitative data where relevant, for example, when discussing the volume of infringement litigations filed regarding such inventions or how the number of such cases may have shifted after an important judicial decision or the introduction of new examination doctrines. However, these data alone may not be able to definitively affirm or refute the legal conditions for determining patentability. This thesis aims to provide enhanced understanding of patent doctrines and propose improvements to their application to patent law in responding to the trend of technology development, rather than focusing on the empirical analysis of that technological development itself. It relies on doctrinal research, complemented by comparative analysis, to form a better system to deal with the new trend.

3.3.2 Comparative Studies[172]

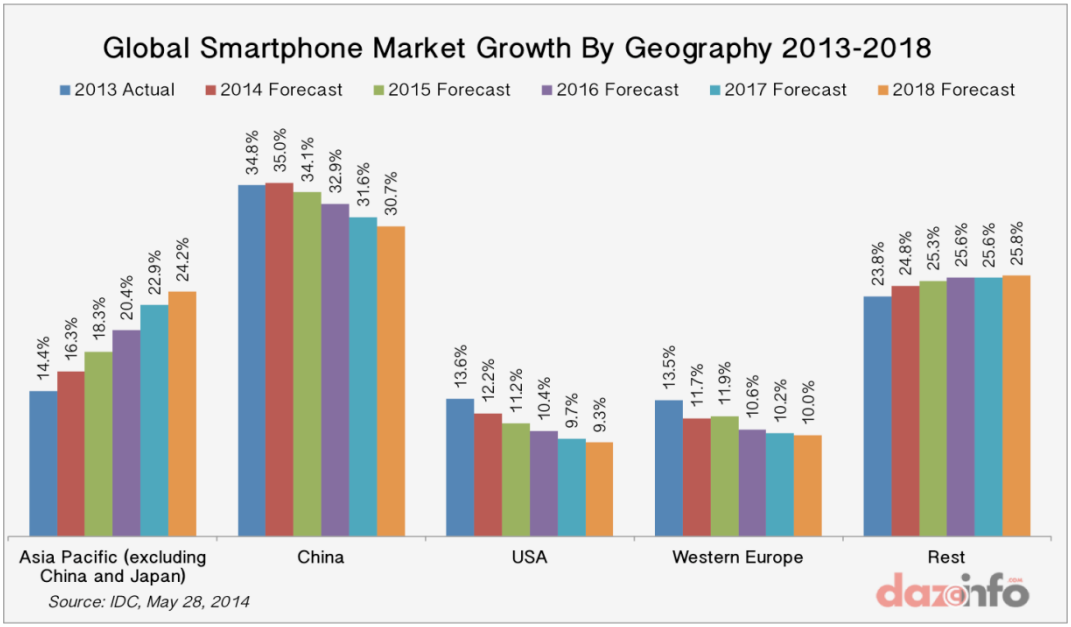
Smartphone business as well as computer-implemented inventions are flourishing internationally. However, although the TRIPS Agreements gives general criteria for patenting at international level, the absence of a specific international consensus or detailed provisions within TRIPS Agreement regarding the patentability of computer-implemented inventions has led to diverse national and regional approaches. This divergence can result in incompatibility on patent requirements and patent validity decisions across jurisdictions. Patent controversies are usually not just a case of domestic law. Their cross-border implications are significant, especially for global industries like smartphone manufacturing and software development. This thesis intends to form a more consistent understanding and approach to assessing computer-implemented invention patents; thus, comparative analysis is employed as a key method. This comparative approach focuses primarily on the legal systems of the US and the EU as administered by the European Patent Office (EPO). These jurisdictions were selected due to their significant roles in shaping global intellectual property norms, their substantial volume of software and computer-

[172] Jaap Hage, 'Comparative law as method and the method of comparative law'(2014) an No. 2014/11 Maastricht European Private Law Institute Working Paper <http://ssrn.com/abstract=2441090 > available via SSRN, accessed 15 May 2025.

implemented invention patent activity, and their representation of distinct, influential approaches to patent eligibility for such inventions. The US historically offering a broader path which has become more constrained post-*Alice*, and the EPO employing a "technical character" and "technical effect" approach within a framework that explicitly excludes "programs for computers as such." The aim is not to definitively conclude on a single best patent system, but rather to identify valuable insights, common challenges, and potential areas for doctrinal clarification or procedural improvement that could contribute to a more harmonised and predictable global environment for computer-implemented invention patentability.

Comparative studies are of significance to three main aspects in this thesis: Firstly, generating a comprehensive observation in order to identify research arguments and understand the differing legal rationales and policy considerations underpinning various approaches to computer-implemented invention patentability. Secondly, delimiting the scope and limitations of computer-implemented invention patent protection in different circumstances and against the background of patent cases from the selected jurisdictions. Thirdly, informing the objective construction of the structured examination model for computer-implemented inventions proposed in Chapter 7, by drawing on effective elements and addressing identified weaknesses in current systems.

Figure 3. The Global Smartphone Market Growth by Geography between 2013~2018



The analysis of the smartphone market (as detailed in Chapter 4) provides a relevant backdrop, indicating that despite market maturation in developed

regions like the US and Europe compared to the earlier dramatic growth observed in some pan-Asia regions, innovation in smartphone software and functionalities remains intense, driving continued intellectual property activity.[173] Smartphone markets in the developed regions appear to be mature. On the other hand, the US is regarded as a leading country that is influential to other jurisdictions regarding software patents, whereas European patent law under the EPC, as interpreted by the EPO and national courts, presents one of the most developed and debated regional patent systems.

The European approach gives rise to both substantive and systematic disputes that are worth inspecting. Furthermore, they are also considered meaningful in this thesis by virtue of several considerations. They both have long histories in dealing with the patenting of software inventions, initially with reluctance and later with evolving criteria for granting or denying such patents, and have granted a significant volume of software patents. Most importantly, they represent, at different times or in different aspects, spectrums of policy approaches, from periods of relative permissiveness concerning subject-matter eligibility (particularly in the US pre-*Alice* for certain software and business methods) to more formally constrained or specific approaches (such as the EPO's technicality requirements).[174] This thesis mainly analyses the US and Europe patent systems based on the above reasons and refers to the two jurisdictions as the main objects of comparison.

It should be clarified that, despite concentrating on the US and EU approaches, this thesis does not preclude the reference to other meaningful countries, where relevant, to illustrate particular points or trends; for example, South Korea, with major smartphone manufacturers like Samsung and a developed patent system. Moreover, China, which have seen substantial increases in smartphone market size and patenting activity, reflecting their growing importance in the global intellectual property landscape. These references serve to broaden the context rather than forming a primary comparative analysis.[175]

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[173] Bhavya Srivastava, 'Global smartphone market growth 2014-2018: Windows phone OS market to growth by 28%' (2014) Daseinfo < http://dazeinfo.com/2014/05/30/microsoft-corporation-msft-windows-phone-os-market-smartphone-global-2014-2018/ > accessed 20 Sep 2025. For recent global smartphone market data and trends (as of early 2025), see International Data Corporation (IDC), Worldwide Quarterly Mobile Phone Tracker (February 11, 2025) and International Data Corporation (IDC), Worldwide Smartphone Market Forecast to Grow 2.3% in 2025, (Press Release, 25 February 2025). Both IDC sources available via < https://www.idc.com> accessed 15 May 2025.

[174] See, e.g., John R. Thomas, Pharmaceutical Patent Law.

[175] see U.S. Chamber of Commerce, International IP Index (Annual Report, e.g., 12th Edition,

To clarify the arguments of this thesis, comparative analysis assists the observation on the advantages and disadvantages of different legal frameworks, such as the historically more liberal approach to subject matter eligibility for computer-implemented inventions in the US versus the EPO's more structured approach centred on technical character. In addition, the EPO's cautious attitude towards the patentability of "programs for computers as such" serves as a reminder. Despite the fact that software patents are indeed issued worldwide under various criteria, there are still many other considerations and legal hurdles to be addressed before granting such patents. The comparison focuses on the substantive patent law of the US and EU and then moves on to consider the inherent systematic problems which, as revealed in the case law, show that neither jurisdiction has demonstrated a perfect or universally accepted set of specific formulations for consistently determining computer-implemented inventions patents.

With regard to the scope of computer-implemented invention patentability, US patent law does not set up specialised statutory provisions explicitly defining the patentability of any particular invention, including computer software. Title 35 Section 101 of the USC merely provides a general principle on patent eligibility to all inventions with enumeration of subject-matter categories.[176] The US approach is thus often characterised as establishing broad statutory categories for patentable inventions within which judicial exceptions, such as for abstract ideas, operate.[177] The US Supreme Court has interpreted Section 101 in a way that has allowed the scope of patentable subject-matter to encompass newly emerging inventions. This adaptability was famously demonstrated in the biotechnology field when the Supreme Court held in *Diamond v. Chakrabarty* that genetically engineered microorganisms constituted patentable subject matter.[178] Consequently, Section 101 has been judicially deemed as a dynamic provision as it must continually be applied to new and unforeseen inventions.[179] For a period, obtaining certain types of

March 2024), available at https://www.theglobalipcenter.com/ipindex2024/ accessed 17 May 2025.

[176] Section 101 of Title 35 of the U S Code states that patent is available to "any new and useful process, machine manufacture, or composition of matter, or any new and useful improvement thereof".

[177] Domenico Colella and Francesca Besemer, 'Patentability of commercial methods and limits on distributing music via internet – the Italian and international situations' (2011) 22 1) Ent. L.R. 44.

[178] *Diamond v. Chakrabarty*, 447 U.S. 303 (1980).

[179] *Ibid.*

software patents might have appeared relatively straightforward under this provision, especially before the heightened scrutiny following key Supreme Court decisions. However, the Supreme Court also clarified that its interpretation of Section 101 does not infer that the statutory categories are without limits or that patentability applies to every discovery.[180] Despite being regarded as one of the most permissive patent systems regarding initial subject matter categories in the world for a considerable time, especially concerning business methods after the *State Street Bank* decision,[181] the development of US patent case law in considering computer software has been described as non-linear and, at times, inconsistent, particularly with the significant impact of the *Alice Corp*. decision. [182]

It is argued by some commentators that the US approach, particularly in certain periods, opened the door to patentability too widely for some software and business method inventions, ostensibly in order to encourage innovative activities and maintain its competition in the international market.[183] Even contentious subject-matter such as certain types of business methods, which are explicitly listed among exclusions from patentability "as such" in the EPC were for a time readily patented in the US. However, the large number of patents does not necessarily reflect the quality of patented works. Statistics from earlier periods (around the early 2010s) were sometimes cited to suggest that while over 50% of patents issued by the EPO might be perceived as having high technical quality by certain metrics or stakeholders, less than 30 % of patents issued by the USPTO were rated with comparable quality by those same measures, though such comparisons are inherently complex and depend heavily on the methodologies and definitions of quality used.[184] The problem of "bad patents" (patents of low quality or questionable validity) can consequently lead to increased risks of patent trolling and antitrust concerns.

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[180] *Ibid.*

[181] Yuko Matsuya, 'Legal Protection of Software-Copyright, Patent and Open Source-Challenges for Business in a Mixed Environment' (2012) MIPLC 22.

[182] The evolution of US case law on software patent eligibility, particularly the shifts in doctrine from State Street Bank through Bilski and *Alice* to subsequent Federal Circuit interpretations, illustrates this complex and sometimes inconsistent development. This is extensively discussed in Chapter 5 of this thesis.

[183] See, e.g., Robert P. Merges, 'Symposium: Software Patents: A Panel Discussion: Software Patents and the Role of the Federal Circuit' (2000) 13(2) Berkeley Technology Law Journal 369.

[184] Dr. Rao Vepachedu, information available online at < http://cardinal-ip.com/ip-news-strategy/quantity-over-quality-at-the-uspto/ > accessed 12 Sep 2016.

On the other hand, the EU approach on computer software, unlike the broad statutory categories for invention with judicially created exceptions seen in US patent law, means that the EPC does not define the term “invention” positively. Rather, Article 52(2) presents non-exclusive lists of what are not considered as invention within the meaning of its articles. Methods for doing business and programs for computers are enumerated in this list of exclusions. However, this exclusion is qualified by Article 52(3) of the EPC, which stipulates that the patentability of the subject-matter or activities referred to in Article 52(2) is excluded only to the extent to which a European patent application or European patent relates to such subject-matter or activities “as such”. It is often argued that this specific qualification contributes to ensuring the quality of such patents is better aligned with a 'technical' concept of invention. An assumption was often made that the examination processes in the EPO remain rigorous to avoid the problems of too many patents and low quality patents in the US during certain periods.[185] Despite the seemingly direct denial of patentability for programs for computers, the provision further states that the exclusion only applies when the European patent or patent application relates to such subject-matter or activities “as such”.[186] This clause implies, literally, that a patent claim may be accepted if it pertains to technical entities or processes involving a computer, provided the claimed subject-matter as a whole has technical character. This "as such" qualifier, and the associated requirement for "technical effect" or "technical character," have been the subject of extensive interpretation by the EPO Boards of Appeal and national courts. However, as some commentators argue, the evolving jurisprudence has at times led to debates about legal certainty in European patent law for software.[187] Due to the absence of a single, universally agreed upon definition or exhaustive list within the EPC to precisely delineate what always constitutes a sufficient “technical effect” or in what specific circumstances an invention definitively avoids the "as such" exclusion for all types of software, the European patent

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[185] David I Bainbridge, *Information Technology and Intellectual Property Law* (6th ed., Bloomsbury Professional 2014) 459, 460.

[186] Article 52(3) of the EPC.

[187] The interpretation of the "as such" qualifier for computer programs under Article 52(2)(c) and (3) EPC, and the associated requirement for "technical character" or "technical effect," has been extensively developed through the case law of the EPO Boards of Appeal. This evolving jurisprudence, while aiming to provide clarity, has also been a subject of considerable academic discussion regarding its complexity and the challenges in maintaining consistent legal certainty for software-related inventions. A detailed exposition of the EPO's approach and the various tests developed (such as the *COMVIK* approach) can be found in the EPO's own Guidelines for Examination, Part G, Chapter II, Sections 3.3-3.7 (as updated, e.g., March 2025 version).

authorities, particularly the EPO Boards of Appeal, have developed a substantial body of case law providing indications and tests (such as the *COMVIK* approach) to consider these issues, rather than a single, static "agreed indication."[188]

By inspecting the pros and cons of different patent systems in the US and EU and taking into consideration the different patterns of each, the research will be able to critically examine the problems of both historically permissive and more formally constrained patent standards for software. The aim is to identify principles that could contribute to more balanced policies to accommodate the development of software technology. The insights gained from this comparative doctrinal analysis directly inform the development of the structured examination model for computer-implemented inventions proposed in Chapter 7, which seeks to enhance consistency and clarity rather than proposing an entirely new *sui generis* patent paradigm in a legislative sense. This contribution to knowledge lies in providing a refined framework for applying existing patent principles more coherently to the specific challenges posed by software inventions. With the comparative study of these two systems, problematic or demonstrably ineffective approaches and policies can be identified.

However, a problem may be encountered that these jurisdictions have different legal traditions, economic priorities, and policy backgrounds. It will be a continuing challenge for global harmonisation that legal principles derived from the practical experience of each jurisdiction may not be directly transferable or equally suitable to a specialised patent category for software inventions if one were to be uniformly adopted globally. A policy that fits well into one jurisdiction may not be suitable for the other without careful adaptation. This problem is acknowledged, and the proposed examination model in Chapter 7, while drawing on universal patent principles, is designed to be adaptable and to highlight key evaluative dimensions rather than mandating a one-size-fits-all application of specific national doctrines.

3.3.3 Possibilities of Empirical Research

In choosing to pursue a doctrinal method, this does not mean that the possibility

[188] The EPO Boards of Appeal have developed a significant body of case law interpreting Art 52(2) and (3) EPC, notably establishing the "COMVIK approach" (see T 0641/00) which focuses on identifying technical contributions to solve a technical problem. This is further detailed in the EPO Guidelines for Examination. The jurisprudence is continuously evolving, as seen in decisions like G 1/19 (regarding simulations). This detailed framework is discussed in Chapter 5 of this thesis.

of gathering empirical data for corroborative evidence in order to produce an objective patent system was not considered. An empirical study on patent examiners in patent offices or judges in patent court may reflect the difficulties on patent law as they are the people who actually applying the law. However, the aim of this thesis is to ensure the certainty of patent law to everyone who needs the protection of patent law as well as who would ultilse the patented works, such as later researchers and consumers. The opinions of patent examiners and judges may help to satisfy the expectations of the legal adjudicators. Nevertheless, such opinions might not fully represent the diverse needs of other groups in society who are also significantly influenced by patent law, including innovators, businesses (especially SMEs), and the public.

It is agreeable that empirical analysis can help to evaluate aspects such as the speed of patent examination and the efficiency of relevant litigation decision making. However, while this thesis expects to set up clear and less changeable criteria for computer-implemented invention patent eligibility and examination with the aim of preventing failures in patent applications and litigation in the first place, its primary focus is not on proposing or empirically testing more efficient remedial procedures to cope with such problems after they arise.

On the other hand, considering the practical matter of this method, it appears to be difficult to get in touch with patent examiners and court justices in both the US and the EU on a scale sufficient for rigorous empirical research within the scope of this PhD. Meaningful qualitative research would require in-depth interviews with a substantial number of them with perhaps at least thirty of each, in order to ensure a degree of representativeness and to capture a range of perspectives on the application of patent law to computer-implemented inventions. It would also be necessary to make sure that all of them have significant experience. For example, having taken part in more than five cases that involve computer-implemented inventions in order to comment on the various types of computer-implemented invention patent applications and disputes.

Given the practical difficulties in accessing such a specialised and geographically dispersed cohort in sufficient numbers, the extensive time required for data collection and analysis, and the resource constraints available to this PhD thesis, empirical research of this nature was not deemed the most efficient or feasible primary method. Furthermore, while empirical data could illuminate current practices and challenges, it would not, in itself, provide the doctrinal clarity or normative framework that this thesis aims to develop. The

core research questions concerning the interpretation of legal principles and the construction of a coherent examination model are primarily addressed through doctrinal and comparative legal analysis. Empirical findings from existing studies are, however, referred to where they provide context or evidence for specific arguments, as noted in Section 3.3.1.

3.3.4 Public Domain and Individual Domain – Employing A Mixed-Methodology Approach

This thesis also refers to other methodological approaches to support and enrich its primarily doctrinal and comparative analysis, thereby aiming for a more comprehensive and objective research outcome. Content analysis is applied in specific instances to inspect the implications underlying certain data or trends discussed in secondary literature.[189] For example, the advancement and sophistication of software technology is of importance when considering the main question of this thesis. Historical analysis of patent law reveals that patent applications for early computer-implemented inventions were largely unsuccessful during the industrial age.[190] This trend shifted dramatically in the information age by virtue of software's growing pervasiveness and economic importance. Consequently, in some jurisdictions, such claims were more frequently affirmed as patentable subject matter, albeit this typically involved considerable legal debate and doctrinal evolution. This shift is attributable not only to the changing nature of technology itself, but also to evolving legal interpretations of patentability criteria, a greater understanding (though still imperfect) by patent offices and courts of software's technical aspects, and increasing economic pressures to protect software innovation.

Content analysis of secondary sources discussing these historical trends, such as reviewing statistics on patent grant rates or landmark case outcomes over time (as presented in Chapter 5), can help to reflect the influence of the changing level of technology development and legal understanding on patent practices. It also assists in understanding, through review of scholarly analyses and reports, issues such as disparities in patent grant rates between

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[189] Paul Chynoweth, A*dvanced research methods in the built environment* (edited by Andrew Knight and Les Ruddock, first published, Wiley-Blackwell, 2008) 28-35; Adilah Abd Razak, 'Understanding legal research' (2009) < chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://download.e-bookshelf.de/download/0000/5990/10/L-G-0000599010-0002363447.pdf > accessed 11 October 2025.

[190] See generally Randal C. Picker, 'The Invention of the Software Patent: A Brief History' (University of Chicago Law School, John M. Olin Law & Economics Working Paper No. 725, 2nd Series, 2015).

jurisdictions like the US and the EU, which can illustrate the results of diverse conditions set to determine patentability. In order to emphasise the growing importance of computer-implemented inventions, it is also vital to understand from existing research how often computer-related infringements focused on them and how many did not.

It is a central contention of this thesis, to be substantiated through the doctrinal and comparative analysis in subsequent chapters (particularly Chapters 5 and 6), that the current patent system is often perceived as applying traditional and sometimes ill-suited criteria to regulate the patentability of a new form of technology like software. Tailoring timely and appropriate intellectual property protection for software requires reference to the social context of the invention so that legal frameworks remain aligned with the mainstream of the innovative society. Therefore, this thesis also incorporates elements of a socio-legal approach.

This approach, in the context of this research, does not involve new empirical sociological data collection, but rather aims at informing the proposed law reform (specifically, the examination model in Chapter 7) by ensuring an adequate understanding of the articulated expectations of various stakeholders like individuals, software developers, and SMEs, as discussed in literature and the broader societal benefit of a well-functioning patent system for software.[191] This helps to prevent the proposed examination model from being a purely abstract and academic exercise disconnected from practical realities and societal needs. It ensures that the suggested framework for what might be considered a more *sui generis* or tailored approach to examining computer-implemented invention patents is grounded in both doctrinal coherence and an appreciation of real-world impacts. However, the research is, as emphasised, primarily concerned with patent law and policies rather than being a sociological project. Where socio-economic data or stakeholder perspectives are introduced, for example, when discussing the challenges faced by SMEs in navigating the patent system (see Chapter 6), this is done with care to ensure that such illustrations support the legal and doctrinal analysis rather than shifting the core focus of the thesis.

3.3.5 Examination Model of Software Inventions – Establishing and

[191] see, e.g., Reza Banakar and Max Travers (eds), Theory and Method in Socio-Legal Research (Hart Publishing 2005).

Potential for Broader Applicability

From the results of the doctrinal and comparative analyses undertaken in the preceding and subsequent chapters, the basis of software patentability in key jurisdictions around the world will be collected and summarised. Exploring the evolution history of the software industry and its intellectual property protection, interpreting the challenges and needs related to software inventions, and identifying potential solutions to issues within the current patent system are central themes pursued throughout this study. To achieve these results, the patentability standards of software in the US, the EU (specifically the EPO framework), and the principles set forth by key international agreements like the WTO's TRIPS Agreement, will be subjected to in-depth exploration to find the hidden problems and inconsistencies. A clearly defined patentable examination model for the application of software inventions will be established in Chapter 7 to address identified issues concerning the patentability assessment and examination of software inventions. The aspects and indicators of the established model will be investigated in detail, especially their conceptual underpinnings and potential application, rather than assigning fixed numerical weights for examination. Some cases or illustrative scenarios will be referred to in Chapter 7 to demonstrate the potential correctness and applicability of the proposed model. Finally, the potential for broader applicability or adaptation of the principles underlying the established model in different legal contexts will be discussed.

3.4 Summary of Methodological Approach, Anticipated Findings, and Limitations

By the application of the doctrinal and comparative methods outlined above, this thesis anticipates identifying the key aspects of the conundrum surrounding the patenting of computer-implemented inventions. This complexity arises not only because of the unique nature of such inventions, but also from the application of potentially out-dated or too general provisions in patent law. It is anticipated that the doctrinal analysis undertaken in this thesis will demonstrate that a significant portion of the computer-implemented inventions patent challenges and litigations filed in court are attributed not solely to inconsistent judicial interpretation of law, but also other factors. For example, the inherent difficulty in applying traditional patentability criteria to software's abstract and functional nature, the challenges in defining clear boundaries for claim scope, and the quality of initially granted patents stemming from examination complexities. Patent law may not always perform its intended optimal effect in

relation to computer-implemented inventions. Nevertheless, doctrinal and comparative analyses also assist in a systematic analysis of the law, enabling the thesis to propose clearer boundaries for granting patents to computer-implemented inventions without harming the underpinning goal of patent law.

A central proposition emerging from this research, to be further developed in subsequent chapters and reflected in the proposed examination model in Chapter 7, is that the assessment of computer-implemented invention patentability requires a nuanced approach. This approach should consider both traditional patentability criteria and the broader implications of granting exclusive rights; especially concerning access to foundational technologies and the potential for hindering cumulative innovation. For example, when determining patentability, a key consideration could involve evaluating whether the granting of a particular computer-implemented invention patent might unduly restrict future inevitable access to essential technological building blocks. Even if an invention demonstrates a significant technical contribution, general patentability criteria might need to be applied with specific conditions or a heightened inventive step threshold in certain contexts to ensure that the patent grant remains rational and serves the public interest. This perspective informs the development of a more tailored approach to examining computer-implemented inventions, moving beyond simply fitting them into pre-existing patent categories without sufficient regard for their unique impact.

Comparative analysis is expected to confirm that an ambiguous patent provision or its inconsistent application can result in harm to competition within industries heavily reliant on software, such as the smartphone industry. According to cases and statistics referred to in this thesis (particularly in Chapters 5 and 6), antitrust/anti-competition issues can occur if patents with overly broad or ill-defined claims are granted and subsequently asserted aggressively. This research concurs with the view that patentability should be construed sufficiently broadly to encompass genuine technological advancements, but this is only sustainable in the premise that the law and its application provide precise and consistently applied criteria. Only in exceptional circumstances, should such inventions be excluded from patentability or granted only with carefully considered conditions that mitigate such negative impacts.

Due to the length of this thesis and the integrity of the entire research, a detailed empirical analysis of patent law's direct causal influences on specific metrics of smartphone sales is not provided in this thesis. The research concentrates on

solving the uncertainty surrounding the application of patent law to computer-implemented inventions, which is considered a major factor contributing to many computer-implemented invention patent disputes. It would be an interesting avenue for future empirical research to observe more directly whether evolving patent law interpretations and practices for software demonstrably facilitate the distribution of technology and also stimulate economic growth, or, alternatively, act as a regulation that is perceived to be at variance with the needs of the market in reality.

Chapter 4

Intellectual property and smartphone software

Intellectual property (IP) rights are predominantly safeguarded by legal frameworks that regulate copyrights, patents, industrial designs, trade secrets, trademarks, and geographical indications, as recognised under international and domestic legal instruments.[192] Such protections have been evaluated by international bodies as having a considerable impact on a country's economy. In response to the pervasive and instantaneous flow of information in current society, the protection of new products, technologies, and other forms of innovation by an appropriate way is more crucial than it used to be. As far as a business entity is concern, if the protection for intellectual property does not exert effectively, it may lose its competitive advantages and even face the risk of being ousted from the market. This is especially important to small start-up businesses.[193] The protection of intellectual property affects a country's economies strongly. In this context, many national governments seek to enhance the legal protection of intellectual property in order to promote economic activity. Intellectual property can be divided into two major categories: one of them are conducive to production (copyrights, patents, industrial designs, and trade secrets) and the other promote consumption (trademarks and geographic indications). Both categories play distinct roles in promoting and sustaining economic development.

Software related invention is one of the properties that can be protected in many forms of intellectual property rights, including copyright, patent, trade secrets, or industrial design. It had been argued by some scholars that the effective

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[192] Ann Marie Sullivan, 'Cultural Heritage & New Media: A Future for the Past' (2016), 15 J. MARSHALL REV. INTELL. PROP. L. 604.

[193] A. Caplanova, 'Intellectual property, Start-Up Creation', (2016) 105-126.

lifespan of software patents is often curtailed by the rapid pace of technological change in the software industry.[194] From this standpoint, the availability of protection under copyright or trade secret law is considered adequate by some, potentially reducing the perceived importance of patent protection in the context of software innovation.[195] However, intellectual property rights like copyright primarily protect the literal expression, it does not extend to the underlying functional ideas or operational principles of software inventions[196]. On the other hand, while trade secret protection is valuable for safeguarding confidential algorithms and unpublished source code, it cannot encompass all elements of a software invention; particularly those aspects that become publicly accessible upon commercial release. In other words, although copyright and trade secret laws play a critical role in protecting proprietary information, they do not offer comprehensive or optimal protection for all dimensions of software inventions, especially with respect to functionality and operational principles.

Despite ongoing debates and inconsistent jurisprudence surrounding the eligibility of software for patent protection, major jurisdictions such as the US and the EU have implemented legal frameworks that, under specific criteria, allow for the patenting of software-related innovations. These jurisdictions remain influential in shaping international standards due to their central role in global technological advancement. The patent offices in these jurisdictions have set relatively clearer criteria to examine the patent applications for software inventions. Over recent years, the grant rate for software-related inventions has demonstrated a consistent upward trajectory. For instance, in 2023, approximately 62.7% of granted US patents were identified as software-related, maintaining a level similar to the 63.5% recorded in 2022.[197] This trend is indicative of the growing recognition of software as a core component of technological innovation (further analysis of this development is provided in Chapters 5 and 6.)

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[194] See, for example, Mark A. Lemley, 'Software Patents and the Return of Functional Claiming' (2014) Stanford Law Review 66(2) 365.

[195] This viewpoint often suggests that the speed of software development means patents may become obsolete before they expire or can be effectively enforced, and that copyright and trade secrets offer more immediate and flexible protection.

[196] See Article 10(2) of the TRIPS Agreement.

[197] Raymond Millien, 'U.S., EPO and Chinese Software-Related Patent Grants Remained Steady in 2023 ' (2024)IPWatchdog, https://ipwatchdog.com/2024/02/29/us-epo-chinese-software-related-patent-grants-steady-2023/id=173853/ accessed 20 May 2025.

The aforementioned trend reveals that software inventions have been accepted for patenting in most developed countries, albeit often under specific conditions such as demonstrating a technical character or solving a technical problem. Nevertheless, the explicit patentability of "software as such" remains a nuanced legal question and ongoing judicial interpretations continuing to shape the landscape.[198]

Leading jurisdictions like the US, the European Patent Office (EPO), as well as Japan, South Korea, and increasingly, China, all provide avenues for patenting software-related innovations, though the specific criteria and examination practices differ significantly. For instance, the US focuses on whether the software is an application of an abstract idea with an inventive concept, while the EPO requires a "further technical effect".[199] In parallel, other forms of IP, notably copyright for the code itself and trade secret protection for confidential algorithms, also play crucial roles in safeguarding software inventions on a global scale.

Smartphone software can be kinds of typical computer software or any advanced forms. A smartphone contains or combines a variety of software in its mobile operating system to satisfy the user's creativity and various uses. The well-documented "patent wars" in the smartphone market,[200] which primarily involved disputes over smartphone software and underlying technologies, saw major corporations engage in extensive litigation to assert their intellectual property rights and gain competitive advantages. The major performance characteristics of a smartphone derive from its software in combination with hardware components, such as sensors or cameras. Today the imaging and sensing technologies of smartphones are the key elements that determine their market acceptance rates.

Moreover, in recent years the adoption of artificial intelligence (AI) technologies, such as Apple's Siri virtual assistant, [6] has significantly influenced the features and sales volume of smartphones. Such developments have demonstrated the

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[198] Pamela Samuelson, 'Why Copyright Law Excludes Systems and Processes ' (1993) University of Pittsburgh Law Review, 56(3), 587-603.

[199] See *Alice Corp. v. CLS Bank Int'l*, 573 U.S. 208 (2014) and *T 1173/97 – Computer program product/IBM*. TBA Decision of 1 July 1998.

[200] The term 'smartphone patent wars' generally refers to the period of intense legal battles primarily from the late 2000s to the mid-2010s involving major technology companies like Apple, Samsung, Google, and Nokia, who filed numerous lawsuits and counter-suits against each other over patents related to smartphone technology, design, and software functionalities. These disputes were aimed at protecting market share and leveraging IP portfolios.

growing sophistication and functional depth of such technologies. For example, Google's Gemini Live, introduced in 2025, enables real-time multimodal interaction by combining voice, camera input, and screen sharing.[201] This allows users to engage in context-aware assistance, such as object recognition through the camera or in-app guidance via screen sharing. It offers a more personalised and intuitive user experience. Such advancements illustrate how AI not only enhances device capabilities but also increasingly shapes consumer expectations and market dynamics in the smartphone industry.

It can be expected that more AI technologies will be used in smartphones in the future. The ever-innovative smartphone software is developed to fulfil consumer demands, which are also continuously evolving. Software has also contributed to the dissemination of information and the development of the economy. Smartphone software has transformed mobile phones from mere communication devices into indispensable tools in our daily life. Rather than aiming to end such technological competition, it seems wiser to expect more valuable inventions to be introduced if such intellectual property is properly protected and utilised.

While the general principles of intellectual property are well-established, their application within the specific context of smartphone software requires a tailored re-examination. This chapter begins by delineating the distinct characteristics of copyright, patent, industrial design, and trade secret not merely as a general overview, but as a necessary foundational framework. By explicitly defining the scope and limitations of these regimes here, this structure aims to bring into sharp relief the specific tensions and strategic trade-offs—particularly the dichotomy between copyright and patent protection—that are critically analysed in Section 4.3 and beyond. Establishing this specific context immediately prior to the analysis ensures a coherent understanding of why traditional IP distinctions often blur in the face of modern software functionality and AI challenges.

4.1. Intellectual Property

The protection to the intellectual property like software is mainly in for forms of

[201] Rajesh Pandey, 'Gemini Live's real-time camera mode gets a wider release' (2025) Yahoo!tech, https://tech.yahoo.com/articles/gemini-lives-real-time-camera-050229552.html?utm_source=chatgpt.com&guccounter=1&guce_referrer=aHR0cHM6Ly9jaGF0Z3B0LmNvbS8&guce_referrer_sig=AQAAAN6CzWlFNTu398UCiaDFSPLPiE-Qqb6MkElwasgmDIWpCCi2Ad9TXacUcXq-20Tq_qOy8Oowx0yMUCETHDRJcfkFjH5ETQBy6ap0-Q6eAwlMr4TwYnFNeWRGc1FdgmSi-SYWblnFWhhnVw_nklvKDol5kGD6XHLaA0jd9hjFenr9 accessed 20 May 2025.

copyright, patent, industrial design, and trade secret. The extent to which these forms of protection apply is a significant consideration for a rights holder when choosing among them. The following outlines their backgrounds and key characteristics:

4.1.1. Copyright

Copyright originated from early printing controls and the printers' monopoly in Britain. Prior to modern copyright, the Stationers' Company, which received a Royal Charter in 1557, held a significant monopoly over the publishing industry and was responsible for enforcing regulations.[202] This system, however, primarily benefited the printers and booksellers rather than the authors. A pivotal shift occurred with the enactment of the Statute of Anne in 1710, widely regarded as the first true copyright statute.[203] This legislation shifted the focus of protection from publishers to authors and granting them exclusive rights to their works for a limited term. It aimed to encourage learning and the dissemination of knowledge. Prior to that, the Licensing of the Press Act 1662 had attempted to curb unregulated book reproduction through censorship and licensing controls.[204]

Today copyright has evolved into a legal concept that has important influence on almost all modern industries. It focuses on the protecting of published or unpublished original works and render exclusive rights to the author so long as they are fixed in a tangible medium of expression. Eligible subject-matter includes, but is not limited to, literary works, musical compositions, films, paintings, technical drawings, computer software, industrial designs, and architectural works which allow the use and distribution of such work. However, copyright does not extend to abstract ideas, methods, or concepts. Its protection is different from patent protection as copyright only protects the expression of intellectual creation; the ideas or methods proposed in the title can be copied freely.

Currently, the protection of computer software is mainly based on copyright.[205] According to the fundamental international agreements, the TRIPS Agreement, in its wording in Article 10.1 computer programs, whether in source or object

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[202] Copyright in Historical Perspective, p. 136-137, Patterson, 1968, Vanderbilt Univ. Press.

[203] See, e.g., 'Statute of Anne', Britannica, <https://www.britannica.com/topic/Statute-of-Anne> accessed 14 May 2025.

[204] Copyright in Historical Perspective, p. 136-137, Patterson, 1968, Vanderbilt Univ. Press.

[205] John C. Phillips, '*Sui generis* intellectual property protection for computer software', (1992) George Washington Law Review April, 1992 Note.

code, are to be protected as literary works under the Berne Convention.[206] This means that the specific code written by programmers is protected against unauthorised reproduction and distribution. Moreover, copyright protection extends to certain non-literal elements of software, such as its structure, sequence, and organisation (SSO), albeit the scope of protection afforded to SSO varies significantly across jurisdictions and has been the subject of extensive legal debate. However, copyright does not protect the underlying algorithms, functionalities, operational methods, or ideas embodied in the software if they can be expressed in different code. The functional elements of software, such as algorithms or methods of operation, are not safeguarded by copyright. They may only be protected, where eligible, under alternative legal frameworks such as patent law or trade secret doctrines.

Contemporary copyright law in general does not provide sufficient guidance for consistent or strong judicial application in all software-related scenarios. With the advent of the big data era, the volume of digital information captured and processed has grown exponentially, driven by new digital technologies. Data mining, which involves the use of software techniques to analyse large-scale datasets and extract meaningful patterns or insights, has become an essential tool for efficient information retrieval. However, this practice raises important concerns under copyright law, especially when protected works are included in the data being mined. Data mining involves the reproduction of databases, which will raise copyright issues.[207] On the other hand, in the artificial intelligence (AI) era, technology also encounters the similar challenges in relation to copyright. One possible controversy as example is the techniques through facial recognition systems which may involve not only personal privacy but also copyright concerns. Copyright issues is getting more complex than in the era which literature works are simply shown on a piece of paper.[208]

The copyright laws in most of countries have been standardised through

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[206] TRIPS Agreement, Art. 10(1) states: "Computer programs, whether in source or object code, shall be protected as literary works under the Berne Convention (1971)." See World Trade Organization, Agreement on Trade-Related Aspects of Intellectual Property Rights (15 April 1994) Marrakesh Agreement Establishing the World Trade Organization, Annex 1C, 1869 U.N.T.S. 299.

[207] Pek San Tay and Cheng Peng Sik, ‘Data mining and copyright: A bittersweet technology gift for copyright owners and the Malaysian public?’ (2016) Computer law & security review 32 898–906.

[208] See e.g., Jane C. Ginsburg, 'People, Not Machines: Authorship and What It Means for Copyright' (2024) 48 Columbia Journal of Law & the Arts 159; and Annemarie Levendowski, 'How Copyright Law Can Fix Artificial Intelligence's Implicit Bias Problem' (2018) 93 Washington Law Review 579

international copyright agreements although the definition of copyrightable works or the scope of rights may vary in each country.[209] Generally speaking, the term of a copyright spans the author's life plus 50 to 100 years depending on the particular provision in each jurisdiction individually. The American Copyright Act 1976 mainly focuses on the protection of literature with little consideration on the economic aspect. It has received a certain level of consideration by economists in early days; however, it is quite the contrary now.[210] To give an example, video games have high market output value and mainly relies on the protection of copyright. With respect to the EU, the Directive on Copyright in the Digital Single Market, effective from 2019, is a significant legislative act modernising copyright for the digital age by amending prior directives (its 2019 entry into force should be distinguished from any prior mention of 2016 concerning a "new" directive, the latter year pertaining to this Directive's proposal). The European Commission had stressed in the process leading to this reform "the importance to enhance cross border access to copyright-protected content services, facilitate new uses in the fields of research and education, and clarify the role of online services in the distribution of works and other subject-matter."[211] In addition, the TRIPS Agreement sets minimum standards of protection for intellectual property including copyright, which is a key feature distinguishing it from most other international agreements that lacked robust enforcement mechanisms. The copyright protection provided by the TRIPS Agreement includes requirements for enforcement procedures, evidence processing, injunctive relief, damages, and other measures.

4.1.2. Patent

A patent is a set of exclusive rights granted to an inventor or assignee, enabling them to control the commercial use of an invention for a limited period of time. The exclusive right prevents others in commercially making, using, selling, importing, or distributing a patented invention without permission.[212] The patent must be granted by a sovereign state or an intergovernmental organisation like the EPO. The patentability requirements in most of countries are similar, that is, an invention must meet the requirements of

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[209] Mincov Law Corporation, 'International Copyright Law Survey', <http://worldcopyrightlaw.com/copyrightsurvey> accessed 14 May 2025.

[210] Michael Karas and Roland Kirstein, 'Efficient contracting under the U.S. copyright termination law' (218) International Review of Law and Economics 54 39–48.

[211] Sophie Stalla-Bourdillon *et al*., An academic perspective on the copyright reform. Computer law & security review 33 (2017) 3–13.

[212] World Intellectual Property Organization, 'Patents: Frequently Asked Questions' (2015).

novelty, usefulness, and non-obviousness to be deemed patentable. Patent protection is available to an invention, which can be a product or a process, rather than the mere idea of a machine or process being implemented.[213] Patent protection is usually sought as a strategy by inventors to reward their efforts and thus promotes creativity incentives and innovation.

The first formal patent system can be traced back to the Venetian Patent Statute 1450.[214] The idea of such patent system was spread to other countries by the Venetian immigrants.[215] The first modern patent system evolved from the early English patent system, which build up some crucial legal concepts to deal with the problems of production at the first industrial revolution.[216] In the 18th century, the patent law emerged important developments that applicant were required to provide open review to its operation principles and complete specifications for a new patent application.[217]

In the US, a patented invention must meet Title 35 Section 101 of the US Code. According to this provision, an invention is patentable to "whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title". In addition, the patents must also possess have novelty as stated in Section 102 and non-obviousness in Section 103.

In the EU, on the other hand, in article 52(2) of the European Patent Convention (EPC) the provision indicates what constitutes patentable inventions. The provision states that "European patents shall be granted for any inventions, in all fields of technology, provided that they are new, involve an inventive step and are susceptible of industrial application"[218]. However, same provision also

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[213] Economic Report of the President, Chapter 10 The Role of Intellectual Property in the Economy. PP 211–230. chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.presidency.ucsb.edu/sites/default/files/books/presidential-documents-archive-guidebook/the-economic-report-of-the-president-truman-1947-obama-2017/2006.pdf.

[214] Phylarchus of Naucratis, 'The Deipnosophists, or, Banquet of the Learned of Athenæus', Translated from Ancient Greek by H. Bohn 12:20, p.835.

[215] M. Frumkin, 'The Origin of Patents', Journal of the Patent Office Society, March 1945, Vol. 27, Issue 3, pp 143.

[216] Leaffer, Marshall A. (1990). 'Inventing the Industrial Revolution: The English Patent System', 1660-1800, Cambridge University Press.

[217] The 18th century'. Intellectual Property Office. Archived from https://www.copyright.gov/timeline/timeline_18th_century.html on 2014-04-22.

[218] European Patent Convention (EPC) Art 52(1). The full text of the EPC is available at the

indicates that certain subject-matter, including “scientific theories and mathematical methods, aesthetic creations, schemes, rules and methods for performing mental acts, playing games or doing business, and programs for computers, presentations of information” shall not be regarded as inventions. to the extent that the patent application or patent relates to such subject-matter as such (Article 52(3) EPC).

In the WTO, the TRIPS Agreement sets various minimum standards to protect all forms of intellectual property including patents. Furthermore, the term of protection available for a patent should be a minimum of twenty years under the TRIPS Agreement.[219] What should be noticed is that, the TRIPS Agreement in 1994 set different transitional periods for compliance with its obligations, particularly for developing and least-developed countries. This reveals a recognition within international intellectual property law that consideration should be given to the varying capacities and development needs of all practitioners and beneficiaries, regardless of whether they are in developing or developed countries. For instance, TRIPS flexibilities can be particularly relevant for access to, and development of, software-based technologies in developing nations, allowing for policy space in areas such as limitations on patent scope or the use of compulsory licenses, provided these are consistent with the Agreement's overall framework.[220]

4.1.3. Industrial Design

The term "industrial design" in intellectual property law primarily refers to the ornamental or aesthetic aspects of an article, rather than its utilitarian features.[221] Globalisation has brought about more severe global economic competition. A firm with strong product design capabilities in terms of aesthetics and user appeal can gain a sustainable competitive advantage in highly competitive markets. A successful company is considered to have the ability to

European Patent Office website: https://www.epo.org/en/legal/epc accessed 15 May 2025.

[219] Article 33 of the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS).

[220] See, e.g., Carlos M. Correa, Trade Related Aspects of Intellectual Property Rights: A Commentary on the TRIPS Agreement (Oxford University Press 2020) Ch 7. See also World Intellectual Property Organization (WIPO), Advice on Flexibilities under the TRIPS Agreement <https://www.wipo.int/ip-development/en/policy_legislative_assistance/advice_trips.html> accessed 15 May 2025.

[221] See World Intellectual Property Organization (WIPO), About Industrial Designs <https://www.wipo.int/designs/en/> accessed 15 May 2025. The term 'product design' may sometimes be used more broadly in business or engineering contexts to encompass functional considerations as well, but in intellectual property law, 'industrial design' specifically refers to the aesthetic appearance.

constantly modify and adjust changes in new technologies, new products, and new demands.[222] Therefore, maintaining continuous innovation in product design can increase the competitiveness of firms.[223] Industrial design is very important because it provides product differentiation through the innovative development of its appearance, which can significantly add to the value and desirability of a product. The link between industrial design and innovation explains why some companies can become industry leaders and occupy a larger market share.[224] With the advent of the era of Industrial 4.0, industrial design will become even more important. Industrial designers must have new skills to have the opportunity to succeed in the new era. At the same time, it is indispensable to seek for the protection of intellectual property right. On the other hand, the sustainability/sustainable development (S/SD) concepts in industrial design are required.[225] Currently, industrial design must contain the S/SD concepts in order to cope with the challenges in terms of economic, social, and environmental issues.

Industrial design right becomes increasingly significant in the protection given by intellectual property laws. In the US, the appearance of an object or article of manufacture may be protected by three regimes of intellectual property right: design patents, trade dress, and copyright.[226] These three rights only protect the appearance of the product and do not protect any of its functions, quality, or characteristic. In the EU, the industrial design is defined as "the appearance of the whole or a part of a product resulting from the features of, in particular, the lines, contours, colours, shape, texture and/or materials of the product itself and/or its ornamentation".[227] An industrial design may be protected if it is novel and has individual character. The TRIPS Agreement, at the WTO level, also mandates protection for independently created industrial designs that are new

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[222] Walsh, V. (1996). Design, innovation and the boundaries of the firm. Research Policy, 25(4), 509–529.

[223] C.H. Noble, K. Kumar, Exploring the appeal of product design: a grounded, value based model of key design elements and relationships, J. Prod. Innovat. Manag. 27 (5) (2010) 640–657.

[224] Fernando M. Graña *et al.*, 'Determinants of silent and explicit industrial design'. Journal of Business Research, (2018) in press.

[225] Ibrahim H. Garbie, 'Incorporating Sustainability/Sustainable Development Concepts in Teaching Industrial Systems Design courses', Procedia Manufacturing 8 (2017) 417 – 423.

[226] Christopher V Carani, Dunstan H Barnes, 'Protecting and enforcing design rights: United States', McAndrews Held & Malloy, Ltd, 24 Nov. 2016.

[227] Industrial design protection- European Commission, https://single-market-economy.ec.europa.eu/industry/strategy/intellectual-property/protection-designs_en accessed 15 Oct 2025;

or original.[228] Owners of protected industrial designs have the right to prevent third parties from making, selling, or importing articles bearing or embodying a design which is a copy, or substantially a copy, of the protected design, when such acts are undertaken for commercial purposes

While industrial design has traditionally been associated with the aesthetic features of physical products, its principles are increasingly applied to digital products. In the context of software, industrial design protection can extend to the visual appearance of graphical user interfaces (GUIs), including screen layouts, menu structures, the design of icons, and the overall "look and feel" that a user experiences.[229] These aesthetic elements of software are significant for usability, user engagement, and brand identity. Thus, while utility patents may protect the underlying functional innovations of software, industrial design rights can offer complementary protection for its unique visual presentation, preventing competitors from closely imitating a successful software product's distinctive appearance.

4.1.4. Trade Secret

Trade secrets constitute a crucial form of IP, encompassing confidential or sensitive information not generally known or unascertainable by others. This confidentiality is maintained to ensure that a business can obtain economic advantages over competitors or customers.[230] The confidential protected as a trade secret can relate to a wide array of business and technical knowledge, including a company's distributions, productions, business, personnel, finances, strategies, cost, firm's customers, future commercial plans. In the context of computer-implemented inventions, trade secrets are particularly pertinent for protecting elements such as proprietary algorithms, source code, object code, unreleased software versions, specific "know-how" in software development methodologies, non-public Application Programming Interfaces (APIs), curated datasets used for training AI models, and other valuable technical or business information that derives its value from not being publicly known.

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[228] WTO, Industrial Design Law; Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS Agreement) Arts 25 and 26. The TRIPS Agreement is available at https://www.wto.org/english/docs_e/legal_e/27-trips.pdf accessed 15 May 2025.

[229] See, e.g., WIPO, Standing Committee on the Law of Trademarks, Industrial Designs and Geographical Indications, Forty-Sixth Session, Document SCT/46/5: Replies to the Questionnaire on Industrial Design Protection for New Technological Designs (2 November 2022). See also Michael Risch, 'Functionality and Graphical User Interface Design Patents' (2013) 2013(1) Stanford Technology Law Review 5.

[230] Lin, Tom C. W., 'Executive Trade Secrets', SSRN 2047462, 28 April 2012,– via papers.ssrn.com.

Companies often choose to fully protects its trade secrets so they can avoid the appropriation by opportunistic rivals. Trade secrets are very pervasive and high valuable in all industry sectors where there is the risk of predation by rivals at any time. Furthermore, trade secrets exist universally in all major firm's departments, so the fully protection of trade secrets must require to be observed by all employees to reduce the risks stemming from its competitive environments and potential breaches of confidence. For many technology firms, particularly in the fast-moving software industry, trade secrets can be among their most important intellectual property assets, sometimes considered even more critical than patents or trademarks for maintaining a competitive edge,[231] especially when an innovation is difficult to patent or when a company prefers not to disclose the invention publicly through the patent system. This is because divulging trade secrets may undermine the competitive advantage and cause serious economic losses to the firm.

In the most legal cases involving trade secrets today, a significant source of trade secret misappropriation is former employees.[232] In the US, the Inevitable Disclosure Doctrine (IDD) has been, in some jurisdictions and circumstances, invoked as a means of legal protection for trade secrets, albeit its application is not universally accepted and has been subject to considerable debate and varying judicial interpretations. According to this doctrine, under specific factual scenarios, an employer might seek to prevent a former employee, who has knowledge of sensitive trade secrets, from working for a direct competitor in a role where the employee would inevitably rely on or disclose those trade secrets, even without direct evidence of actual misappropriation. If a former employee has or intends to take a job that arguably cannot be performed without an extremely high risk of using or disclosing the former employer's trade secrets, the IDD might, in limited cases, be applied by employers to request an injunction. Employers can ask for an injunction to limit or prohibit the former employee from working in such a specific role for a competitor for a certain period. However, courts are generally cautious in applying the IDD due to concerns about employee mobility and the potential for it to act as a *de facto* non-compete agreement where one does not formally exist or is unenforceable.[233]

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[231] See, e.g., David S. Levine and Ted Sichelman, 'Why Do Startups Use Trade Secrets?' (2017) 94 Notre Dame Law Review 751

[232] Almeling, D.S. *et al*., J., 'A statistical analysis of trade secret litigation in state courts'. Gonzaga Law Rev. 46, 2011, 57–101.

[233] Practical Law - A Thomson Reuters Solution, 'The Inevitable Disclosure Doctrine: A

If a trade secret is presented in a tangible form, the IDD is usually not applied because it has property rights whereas most intangible assets are protected by trade secrets.[234] To clarify, trade secrets receive protection provided they meet the standard definition; namely, being secret, valuable due to that secrecy, and subject to reasonable efforts to maintain confidentiality; regardless of whether they are tangible (e.g., a documented formula) or intangible (e.g., memorised know-how). Consequently, the applicability of the IDD primarily depends on the nature of the information and the employee's new role, not solely on the trade secret's tangible form. Indeed, many valuable software trade secrets, such as algorithmic concepts or architectural designs, are intangible yet represent precisely the type of information the IDD is often invoked to protect.

On 8 June 2016, the European Parliament and the Council adopted the Directive 2016/943. The directive standardised the national laws for protecting trade secrets to resist trade secrets misappropriation. By the introducing of this directive, a more common and clear and balanced legal framework was built to prevent unfair competition and facilitate collaborative innovation. Moreover, Article 39.2 of the TRIPS Agreement of WTO obligates members to protect undisclosed information that is secret, has commercial value because it is secret, and has been subject to reasonable steps under the circumstances, by the person lawfully in control of the information, to keep it secret. It further requires members to provide legal means to prevent such information from being disclosed to, acquired by, or used by others without the consent of the trade secret holder in a manner contrary to honest commercial practices. This is linked to protection against unfair competition, which also draws from Article 10bis of the Paris Convention for the Protection of Industrial Property.[235] While TRIPS sets out the conditions for information to be protected as a trade secret and the types of acts that constitute misappropriation, it does not provide detailed procedural guidance for protecting trade secrets in national laws.

For software companies, trade secret protection is a vital tool. Algorithms, source code, specific programming techniques, datasets used for machine learning, and even user interface designs before public release can all qualify as trade secrets if kept confidential and providing a competitive edge. Choosing between patent and trade secret protection for software often involves a

Necessary And Precise Tool For Trade Secret Law'.

[234] Halligan, R., 2008. Protection of US trade secret assets: critical amendments to the economic Espionage Act of 1996. J. Marshall Rev. Intell. Prop. L. 7, 656–681.

[235] Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS Agreement), Art 39(2).

strategic decision: patents offer strong, publicly registered exclusive rights for a limited time but require full disclosure, whereas trade secrets can last indefinitely as long as secrecy is maintained, but offer no protection against independent discovery or reverse engineering.

4.2. Smartphone Software

The number of people using smartphones has steadily increased across the globe over the past two decades, becoming an indispensable tool for a significant portion of the world's population[236] (as noted in Chapter 3, Figure 3). It is already an important tool for most people in their work and life. With the interaction between individuals and their smartphones, people can get wealth of information in their daily lives. Smartphone is no longer just a communication handset, because its powerful features have changed our living habits. Along with the processor, the smartphone also has a computer chip that can provide much functionality by various hardware and software integrations. Smartphone chips that integrate multiple functions have been developed by many manufacturers, leading to much cheaper and more powerful smartphone functions.

Recently, the popularity of smartphones promotes the rapid development of the software industry. In the meantime, the rapid development of the software industry also enhances the sales of smartphones. Modern smartphone software can directly interact with millions of users on smartphones, tablets, and laptops. With the independence from the landline networks, smartphones allow the users in rural areas of developing countries to communication and access internet and thus enhance the technology and economic developments in rural areas.[237] As a result, more intense competition in the smartphone market emerges continually. The manufacturers must constantly propose new smartphones with stronger features, usually within a product cycle of two to three years, in order to maintain their market share.

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[236] Statistics from various market research firms consistently show this trend. For example, according to Statista, the number of smartphone users worldwide was estimated to be around 6.92 billion in 2023 and is projected to reach approximately 7.33 billion by 2025 and 7.69 billion by 2027. See Statista, Number of smartphone users worldwide from 2016 to 2027 (February 2024) <https://www.statista.com/statistics/330695/number-of-smartphone-users-worldwide/> accessed 15 May 2025.

[237] Michael Hubler and R. Hartje, Are smartphones smart for economic development? Economics Letters 141 (2016) 130–133.

4.2.1 Commercial Values of Smartphone Software

The interaction between an individual and its smartphone can generate a large amount of usage data which is remarkably valuable in commerce. Smartphones software can provide many features such as web browsing, general social networking, gaming, watching television and films, taking photos and videos, and making voice and video calls.[238] The trend of browsing web pages through smartphone browsers has appeared to be popular since the first smartphone was introduced to the public. Likewise, many websites are customised for smartphone browsing purposes.[239] With the rapid development and use of the Internet of Things (IoT), almost all our everyday objects are connected to IoT.[240] The users will share and collect data with their interconnected to other objects by IoT. Therefore, it can be expected that the IoT also has great potential business opportunities. Advertisers insert large amounts of commercials to promote commercial brands and their opportunities during the execution of these functions. These advertisings on smartphones are increasing dramatically; accordingly, smartphones are changing our consuming behaviours as well.

Due to the accessibility of internet connection and ubiquitous mobility of smartphones, the way consumers interact with brands has changed with factors such as advertising value, web page and app interface quality, and brand awareness all influencing their purchase intention.[241] With the rapid development of smartphone technology, the creation of a large number of mobile applications (apps) to meet a wide range of uses has been a key factor in making our daily lives more comfortable. When using these apps, a data log is usually generated, and the context of the user's interaction is recorded, forming a rich data source of the behavior of smartphone users.[242] Most of apps are free while others must be bought. Generally, approximately 20 to 30

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[238] Petros Spachos *et al*., Power tradeoffs in mobile video transmission for smartphones. Computer Communications 118 (2018) 163–170.

[239] Fazal-e-Amin, Characterization of web browser usage on smartphones. Computers in Human Behavior 51 (2015) 896–902.

[240] G. Aloi *et al*., Enabling IoT interoperability through opportunistic smartphone-based mobile gateways. Journal of Network and Computer Applications 81 (2017) 74–84.

[241] José Martins et al., 'How smartphone advertising influences consumers' purchase intention' (2019) 94 Journal of Business Research 378.

[242] Hong Cao and Miao Lin, Mining smartphone data for app usage prediction and recommendations: A survey. Pervasive and Mobile Computing 37 (2017) 1–22.

% of these payment goes to the distribution provider.[243] Because apps make the buying process easier and faster, they can establish a long-lasting relationship with consumers. Thus, mobile apps have become a basic but essential part of any business, especially in home shopping.[244] The analyst report estimates that the mobile apps economy generates more than 10 billion Euros of revenue each year in the EU while the mobile apps market has grown and create more than 529,000 jobs in 28 EU states (by 2013).[245] Europe's app-economy now generates roughly 210 billion Euros in direct and indirect revenue per year, with direct developer earnings alone reaching 95.7 billion Euros in 2021.[246]

Mobile apps also play an ever-increasing important role within healthcare, and bring commercial and healthy benefits. Many healthcare mobile apps are introduced and successfully used in medical technology. For example, a smartphone-based point-of-care urinalysis device was developed to detect chronic kidney disease via rapid and reliable quantitative urinalysis of human serum albumin.[247] The smartphone-based reusable glucose usually includes a permanent bare sensor strip, a stylus with enzyme-carbon composite pellets, and sensor instrumentation circuits.[248] Non-invasive optical glucose biosensor using saliva samples and a smartphone is using in the routine analysis of prediabetic and diabetic patients.[249] Smartphone based handheld optical biosensor for determination of urea in saliva can use in the daily monitoring for providing essential information of renal function without procuring a dedicated instrument.[250] Moreover, smartphones are suitable for recording and digitsing

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[243] Siegler, MG (June 11, 2008). 'Analyst: There's a great future in iPhone apps'. *Venture Beat*.

[244] PHIDEV, 'The Importance of Mobile Apps for Businesses', Feb. 2017, https://phidevinc.com/marketing-tips/ importance-mobile-apps-businesses-today.

[245] Vision Mobile, Plum Consulting, 'European App Economy" analyst report', Sep. 2013.

[246] Europe's app-economy now generates roughly €210 billion in direct and indirect revenue per year, with direct developer earnings alone reaching €95.7 billion in 2021. See also Michael Mandel, EU App Economy: Skills for the Digital Age 3 (Progressive Policy Inst. 2023).

[247] Shaymaa Akraa *et al*., A smartphone-based point-of-care quantitative urinalysis device for chronic kidney disease patients. Journal of Network and Computer Applications, 2018, in press.

[248] Amay J. Bandodkar *et al.*, Re-usable electrochemical glucose sensors integrated into a smartphone platform. Biosensors and Bioelectronics 101 (2018) 181–187.

[249] Anuradha Sonib and Sandeep Kumar Jha. Smartphone based non-invasive salivary glucose biosensor. Analytica Chimica Acta 996 (2017) 54–63.

[250] Anuradha Soni and Sandeep Kumar Jha, Smartphone based optical biosensor for the detection of urea in saliva. Sensors and Actuators B, 2018, in press.

pathological sounds (mainly periodic perturbations and noise) without significant distortion.[251] According to the these benefits of using smartphones in medical technology, it can be affirmed that the commercial values of smartphones combining with software and medical sensors are very high.

Another commercial value of smartphone software is its use in the mobile payments ecosystem. Today, the mobile payments ecosystem, characterised by secure, fast, and convenient transactions, has grown mature. Global mobile payment transaction values demonstrated significant growth from the early 2010s. For instance, while some market analyses indicated values around USD 200 to 300 billion in 2013,[252] this figure had surged dramatically. By 2023, the global mobile payments market was valued at several trillion USD, with projections indicating continued strong growth towards USD 15 to 20 trillion by 2028 to 2030.[253] In the US, for example, proximity mobile payment transaction values were estimated at approximately USD 550 billion in 2023, and were projected to exceed USD 670 billion in 2024 and potentially surpass USD 1.2 trillion by 2028.[254] "Similarly, the European mobile payment market was valued at over USD 640 billion in 2024, with forecasts predicting growth to over USD 3 trillion by 2033".[255]

4.2.2 Patent Wars in the Smartphone Market

Patent wars occurred in the smartphone industry because smartphones involved hundreds of thousands of patents and huge market share can be generated through the exploitation of these patents. The pattern of suing and countersuing in the smartphone market really began in 2009 where Nokia sued Apple over ten patents related to fundamental mobile communication technologies, including wireless data transmission, speech coding, security,

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[251] C. Manfredi *et al.,* Smartphones Offer New Opportunities in Clinical Voice Research. Journal of Voice, Vol. 31, No. 1, 2017, 111.

[252] Early estimates varied; for example, Gartner reported that global mobile payment transaction values reached USD 235.4 billion in 2013. See Gartner, Gartner Says Worldwide Mobile Payment Transaction Value to Surpass.

[253] More recent data shows substantial growth. Forinstance, A stute Analytic are ported. 712.14 Billion by 2033 (13 March 2025) <https://www.globenewswire.com/news-release/2025/03/13/3042185/0/en/Digital-Payment-Market-Hit-Valuation-of-US-712-14-Billion-by-2033-Astute-Analytica.html> accessed 15 May 2025.

[254] See Oberlo, US Mobile Payment Market (2020–2028) (Updated August 2024) https://www.oberlo.com/statistics/us-mobile-payment-market accessed 15 May 2025.

[255] The European mobile payment market was valued at USD 643.8 billion in 2024 and is forecast to reach USD 3,080.9 billion by 2033. See IMARC Group, Europe Mobile Payment Market Size and Share Report, 2033 https://www.imarcgroup.com/europe-mobile-payment-market accessed 15 May 2025.

and encryption, alleging these were essential for the iPhone's operation.[256] Since 2010 the numbers of smartphone-related patent lawsuits and trade complaints have increased significantly. Well-known in the years of 2009 through to 2015, all of major technology firms were in the midst of patent battles relating to smartphone technologies. These companies often expended substantial financial resources for lawyers rather than research and development during this period. Patent litigation became a method by which patent-holding companies sought to prevent competitors from using their patented technologies, or to extract licensing revenues.[257] At times, the purpose of such patent disputes appeared to slow down the development of competitors by asserting patent rights and initiating enforcement actions. When patents are used as a means of anti-competitive behaviour and create market barriers, the innovation of small firms may be compromised by the lack of market access and excessive litigation costs.[258]

Patent pools, which are agreements between two or more patent owners to license one or more of their patents to one another or to third parties, often used for complex technologies requiring multiple patented inventions to implement a standard[259], and cross-licensing are used to access the essential components that are reused in next-generation smartphones designs. As patent wars intensified, some commentators and academic studies suggested that certain smartphone manufacturers might strategically shift parts of their business or focus sales towards markets with perceived weaker intellectual property protection in order to gain "certain advantages or mitigate litigation risks, although such strategies are complex and influenced by multiple factors beyond just intellectual property enforcement."[260] Smartphone companies ensured their investment with a large number of patent applications, which at the same time contributed to a dramatic increase in both the number and cost of patent

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256 *'Nokia sues Apple over iPhone's use of patented wireless standards'. Appleinsider.com. October 22, 2009.* Retrieved January 5, 2012.

257 Yongwook Paik and Feng Zhu, 'The Impact of Patent Wars on Firm Strategy: Evidence from the Global Smartphone Industry' (2016) 27(6) Organization Science 1397.

258 Charles V. Trappey *et al.*, Are patent trade wars impeding innovation and development? World Patent Information 46 (2016) 64–72.

259 See, e.g., World Intellectual Property Organization (WIPO), Patent Pools and Antitrust – A Comparative Analysis (WIPO, March 2014) p. 3, available at <https://www.wipo.int/export/sites/www/competition-policy/en/docs/patent_pools_report.pdf> accessed 15 May 2025.

260 Yongwook Paik, Feng Zhu, The Impact of Patent Wars on Firm Strategy: Evidence from the Global Smartphone Market, Harvard Business School, March 14, 2016.

litigation.[261] In the US, damages awarded or settlements in a single major patent litigation case could potentially exceed 1 billion dollars.[262]

In this regard, the creation of combative patent barriers is obviously contrary to the aim of intellectual property protection and the enforcement agreed by the TRIPs Agreement.[263] Intense patent warfare could mean less smartphone production, poor device features, or slowing innovation. Notably, the intensity of these high-profile patent wars began to subside after approximately 2016, partly due to the increased adoption of settlements, patent pools, and cross-licensing agreements, which became more widely adopted by these companies.

4.2.3. Market Demands and the Expectation of Society

The global smartphone market, a key arena for software innovation, has experienced evolving trends in recent years. While early growth was explosive, the market has matured, with sales volumes showing fluctuations and upgrade cycles lengthening. For example, after a period of growth, global smartphone shipments saw some decline; however, by the fourth quarter of 2024, shipments increased by 1.4% year-over-year, and the full year 2024 saw 6.1% growth, reaching 1.24 billion units, indicating a recovery after previous challenging years.[264] Projections for 2025 suggest continued, albeit slower, growth, with an estimated 1.26 billion units to be shipped.[265] This contrasts with earlier periods, such as 2004, when worldwide mobile phone sales (including feature phones) were estimated at around 643 million units.[266]

The lengthening of consumer upgrade cycles, meaning consumers are not

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[261] 'The great patent battle'. Economist.com, 21 October 2010, https://www.economist.com/business/2010/10/21/the-great-patent-battle.

[262] Humpries, M., 'Your guide to who is suing who in mobile'. Geek.com, 5 Oct. 2010, http://tinyurl.com/ 38tm24d on 17 January 2010.

[263] The Agreement on Trade-related Aspects of Intellectual Property Rights, Annex 1C to the Marrakesh Agreement Establishing the World Trade Organization, 1994.

[264] International Data Corporation (IDC), Worldwide Quarterly Mobile Phone Tracker (February 11, 2025) (reporting 1.24 billion smartphone shipments in 2024, a 6.1% YoY growth). Available at <https://www.idc.com/promo/smartphone-market-share> accessed 15 May 2025.

[265] International Data Corporation (IDC), Worldwide Smartphone Market Forecast to Grow 2.3% in 2025, (Press Release, 25 February 2025) (forecasting 1.26 billion units in 2025). Available at <https://www.idc.com/getdoc.jsp?containerId=prAP53217825> accessed 15 May 2025. (Source 7.1)

[266] According to Nokia's 2004 annual report, the estimated global mobile device market volume for 2004 was 643 million units. See Nokia, Nokia 4Q and 2004 Results (27 January 2005) p. 1. Available at <https://www.nokia.com/system/files/files/q4-2004-earnings-release-pdf.pdf> accessed 15 May 2025. (Source 2.2)

upgrading as quickly to the newest generation of flagship smartphones, has been a notable trend. The quest for dramatically novel flagship smartphone features appears to have somewhat diminished compared to the initial years of rapid innovation. Many high-priced flagship smartphones' new features are sometimes perceived by consumers as offering incremental improvements rather than essential upgrades, potentially making them appear a luxury more than a necessity for all users. Market analysts in the late 2010s noted that in the presence of ultra-high-end flagships, the still high-priced flagships from the previous generation often seemed far more palatable to consumers.[267] This sentiment continues to influence purchasing decisions into the mid-2020s as value-consciousness remains significant. The incremental benefits of the very latest flagship smartphones sometimes make it difficult for some consumers to justify the premium purchase price. However, consumer demand for advanced features such as 5G connectivity (which has become a standard expectation), and continually improving camera functionality remains strong.[268] Furthermore, emerging software-driven innovations, particularly in areas like on-device AI capabilities, are becoming significant differentiators and demand drivers.[269] These evolving consumer expectations and technological advancements are key reasons why the smartphone market continues to be a dynamic field for software development and, consequently, for software patenting, as companies strive to protect their innovations in these demanded areas.

The distinctive characters of smartphone reflected by the facts that it changes people’s business behaviours and social patterns in the daily life. Some people may not aware the changes of social activity pattern made by smartphone; however, in fact it is happening in worldwide. This effect was dramatic especially to young people who appear to be more acceptable to such

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[267] This observation regarding consumer preference for value and slightly older flagship models due to high prices and incremental innovation in new flagships was noted by analysts around 2017 and continues to be a relevant market dynamic. For current context on high-end segment trends and consumer upgrades, see, e.g., Canalys, Mainland China's smartphone market records 4% full-year growth in 2024, led by vivo (Press Release, 16 January 2025) (discussing shifts in the high-end market and competitive pressures). <Available at https://www.canalys.com/newsroom/china-smartphone-market-q4-2024> accessed 15 May 2025.

[268] See Global Smartphone Market Share: Quarterly (19 November 2025). Available at < https://counterpointresearch.com/en/insights/global-smartphone-share> accessed 15 Nov 2025.

[269] See, e.g., ‘Smartphone industry to thrive in 2025 as 5G and AI drive demand’ AI-Impact.co.za (citing IDC forecasts, 2025). Available at <https://ai-impact.co.za/smartphone-industry-to-thrive-in-2025-as-5g-and-ai-drive-demand/> accessed 15 May 2025. (Source 4.3)

changes.[270] Young people are using their smartphone all the time for texting, searching the web, checking email, taking pictures, tweeting, and scheduling face-to-face time. People are expecting a relatively quick response in their social life, and smartphone helped them do so.

The factors influencing the intention to pay for a smartphone vary and depend on various consumer segments, including different age groups. Research indicates that product features, brand name, and social influence are often three major factors influencing the purchasing intention of young people, among others.[271] The perceived value derived from the software-enabled user experience, application ecosystem, and feature set plays a vital role in these decisions.

While global average smartphone sales prices fluctuate, with a forecast around 434 USD for 2025, the market continues to see innovation at both the premium and more affordable ends, much of it driven by software advancements.[272] This accessibility, coupled with powerful software capabilities, is good news and can help meet the expectations of society. As the popularity of smartphones in developing countries has increased, it offering new opportunities. It can be expected that smartphones, through innovative software applications, can contribute to improving access to services like mobile health and information in remote corners of the world, where people might previously have faced significant barriers to accessing; such as medical care or educational resources.[273] The ongoing development and patenting of such software are thus intrinsically linked to these broader societal impacts and market demands.

4.3. Seeking Robust Protection and Development – Copyright

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[270] Ira Hyman, Cell Phones are Changing Social Interaction, Psychology Today, Jan 26, 2014

[271] See, e.g., A. Rai, S. Alsmadi and H. Al-Gasawneh, 'Factors Influencing Smart Phone Buying Behavior of Consumers: Implications for Building a Marketing Strategy' (2024) 3(2) Business and Economic Letter, pp. 60-71. Available at < chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://armgpublishing.com/wp-content/uploads/2024/10/BEL_3_2024_5.pdf> accessed 15 Nov 2025.

[272] See International Data Corporation (IDC), Worldwide Smartphone Market Forecast to Grow 2.3% in 2025 (Press Release, 25 February 2025). Available at <https://www.idc.com/getdoc.jsp?containerId=prAP53217825> accessed 15 May 2025. (Source 7.1).

[273] See, e.g., A. A. Ali and S. A. A. Termizi, 'Mobile Health (mHealth) in the Developing World: Two Decades of Progress or Retrogression?' (2023) JMIR mHealth and uHealth 11:e42180. Available at <https://www.researchgate.net/publication/367885194_Mobile_Health_mHealth_in_the_Developing_World_Two_Decades_of_Progress_or_Retrogression> accessed 15 May 2025.

or Patent?

As mentioned in Chapter 2, the patentability of software has been a subject of ongoing controversy. Following significant legal developments, such as the US Supreme Court's decision i*n Alice Corp. Pty. Ltd. v. CLS Bank International et al.* (often referred to as the "*Alice*" decision or its aftermath, the "Alice Storm"), [274] which introduced a more rigorous two-step framework for assessing the patent eligibility of claims involving abstract ideas, some of the guidelines and judicial interpretations concerning the patentability of software are becoming somewhat more defined, though challenges persist. Nevertheless, there are still many vague parts in examination practices across jurisdictions. A software invention that amounts to nothing more than an abstract idea without a specific technical character or practical application providing a technical solution to a technical problem is, of course, not patentable. Software inventions can be protected by patent legislation rather than solely by copyright, particularly when it is the underlying concept and functional aspects of the software, rather than just the literal code, that require protection.

A software patent must claim an invention that exhibits novelty, inventive step and industrial applicability and, in doing so, often demonstrates a useful, concrete and tangible result. The basic concept to determine these characters is that the identification criteria must be precisely established to assess technical effects and thus satisfy the requirements of the above elements of software patentability. Generally speaking, software provides a variety of distinctive functions and plays the most important role in a computerised device. Therefore, it is often necessary, yet sometimes challenging, to distinguish between the kinds of software innovations that may be patented versus those aspects protectable primarily by copyright. This distinction is vital to the economy because the traditional scope of copyright protection, which safeguards the literal expression of code, may not adequately cover the functional particularity of many software-based inventions that are essential in today’s digital economy model.

However, the rapid growth of software patents has also caused many worries

[274] *Alice Corp. Pty. Ltd. v. CLS Bank Int'l*, 573 U.S. 208 (2014). This US Supreme Court decision established a two-part test for determining patent eligibility under 35 USC Section 101, significantly impacting software and business method patents by making it more difficult to patent inventions deemed to be directed to abstract ideas without an inventive concept transforming them into a patent-eligible application. The period following this decision is often referred to as the "Alice Storm" due to the increased invalidation of such patents.

among practitioners and policymakers, particularly when patents are granted for inventions perceived to have only a trivial contribution to the state of the art, or that broadly claim common computing functionalities without a specific, inventive technical application.[275] Software patents of this nature may make it difficult for firms to access or build upon critical technology they need.[276] Some commentators, like Westermann, have suggested that the software patent term should be decreased to solve many of the practical problems of software patenting, arguing that the typical 20-year term is misaligned with the rapid pace of software innovation.[277]

Since software is often not treated as an ordinary kind of invention, as its inventive aspects are not always easily incarnated as a physically examinable entity in the traditional sense, a set of commonly accepted guidelines or approaches for applying tests like the "useful, concrete and tangible result" standard (particularly in the US context post-*State Street Bank* but pre-*Alice*) or for assessing technical character (as in Europe) is needed to determine the patentability of computer software with greater consistency. By doing this, attention must be paid to the peculiar structure of various patent systems in the world. It is the reason for this thesis to seek to establish an examination model of software inventions and therefore facilitate the avoidance of low-quality software patent problems.

4.4. The Ascent of Artificial Intelligence and Its Implications for Software Intellectual Property

The rapid proliferation of AI, particularly its sub-fields of machine learning (ML), deep learning (DL), and most recently, sophisticated generative AI models, represents a technological shift comparable in impact to previous industrial revolutions. As detailed in Chapter 5 (see Section 5.1.1), AI is no longer a nascent concept but a pervasive force reshaping industries by enabling software to perform tasks that traditionally required human intelligence, such as

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[275] See, e.g., Robert M. Hunt and James Bessen, 'The Problem of Patent Trolls and the Alleged Low Quality of Software Patents' in The Cambridge Handbook of the Law of the Sharing Economy (Nestor M. Davidson, Michèle Finck and John J. Infranca eds., Cambridge University Press 2018) pp. 523-538. See also Organisation for Economic Co-operation and Development (OECD), Patent Quality, OECD Science, Technology and Industry Policy Papers, No. 108 (OECD Publishing 2021).

[276] Josh Lerner and Feng Zhu, 'What is the impact of software patent shifts? Evidence from Lotus v. Borland' (2007) 25(3) International Journal of Industrial Organization 511.

[277] Hannes Westermann, How to treat software in the intellectual property framework (Master Thesis, Lund University, Faculty of Law 2016) available at <https://lup.lub.lu.se/student-papers/record/8874398> accessed 15 May 2025.

learning, problem-solving, and content creation (see Section 5.1.2.3). Software has long been an object of intellectual property protection. However, AI possesses unique characteristics that present novel and intricate challenges. These include its capacity for autonomous or near-autonomous generation of creative and functional outputs, its often complex and sometimes opaque algorithmic underpinnings (the “black box” problem, referring to the difficulty in interpreting the internal decision-making processes of complex AI models),[278] and its profound reliance on vast datasets for training, all of which impact existing frameworks of copyright, patent, trade secret, and industrial design law.

The following sub-sections will explore some of these critical implications, focusing on how AI intersects with and tests the boundaries of traditional intellectual property protections for software-related innovations. The discussion here mainly focuses on the issues of patenting AI-related inventions and briefly introduces to other alternative intellectual property protections available to AI.

4.4.1. Navigating Copyright in the Age of AI-Generated Content

AI, particularly generative AI systems, can produce a wide array of outputs traditionally falling under the scope of copyright, such as software code, literary texts, musical compositions, and visual artworks. This capacity has precipitated a fundamental re-examination of copyright law's core tenets.[279] Central to this debate is the principle of human authorship, a long-standing prerequisite for copyright protection in most legal traditions.[280] Copyright law has historically been anthropocentric, designed to incentivise and reward human creativity by granting exclusive rights to authors for their original expressions. The question of whether works generated autonomously or with substantial input from AI systems can qualify for such protection is thus a critical threshold issue.

The prevailing view, as articulated by key copyright offices and evolving case law, maintains a strong emphasis on human creativity as indispensable for copyright to subsist. For instance, the US Copyright Office (USCO) has issued guidance clarifying that it will register works containing AI-generated material

[278] Li & Chen, ‘Explainable Artificial Intelligence Applications in Cyber Security: State-of-the-Art in Research’ (2024) 4(2) J Cybersecurity L 101.

[279] See, e.g., World Intellectual Property Organization (WIPO), WIPO Conversation on Intellectual Property (IP) and Artificial Intelligence (AI), <https://www.wipo.int/about-ip/en/artificial_intelligence/conversation.html> accessed 15 May 2025.

[280] Jane C. Ginsburg, 'People, Not Machines: Authorship and What It Means for Copyright' (2024) 48 Columbia Journal of Law & the Arts 159.

only if the work as a whole is the product of human authorship. Material generated solely by an AI system, without sufficient creative input or intervention from a human author, is not eligible for copyright protection.[281]

This position underscores that AI, in its current state, is generally viewed as a sophisticated tool that can assist human creators, rather than an author in its own right. The USCO's approach often involves a case-by-case analysis, assessing the degree of human control and creative contribution in the final work. Where AI-generated elements are "the result of “mechanical reproduction'" or where the "traditional elements of authorship were produced by a machine," copyright will not protect the AI-generated output.[282] This means that while a human author can certainly use AI as a tool to create a copyrighted work, the copyright will only extend to the human author's original contributions, not to the parts solely generated by the AI.

Beyond authorship, the criterion of originality also presents challenges. For a work to be copyrightable, it must typically exhibit a "modicum of creativity."[283] Whether the output of a generative AI model, which is derived from patterns learned from vast datasets of existing works, can truly be considered "original" in the copyright sense, as opposed to being a sophisticated derivative or recombination, is a subject of ongoing academic and legal discussion.[284] If an AI's output is merely a predictable result based on its training and prompts without further creative modification by a human, its claim to originality may be tenuous.

A further significant and contentious area concerns the use of existing copyrighted works as training data for AI models. The development of capable AI, especially large language models (LLMs) and generative image models, often requires ingesting and processing massive quantities of text, images, code, and other data, much of which may be protected by copyright.[285] This practice raises substantial questions regarding copyright infringement. AI

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[281] Copyright Office, 'Copyright Registration Guidance: Works Containing Material Generated by Artificial Intelligence', 88 Fed. Reg. 16190 (March 16, 2023). See also U.S. Copyright Office, Copyright and Artificial Intelligence – Part 2: Copyrightability (Report, January 29, 2025), available at https://www.copyright.gov/ai/ accessed 15 May 2025.

[282] U.S. Copyright Office, 'Copyright Registration Guidance: Works Containing Material Generated by Artificial Intelligence', 88 Fed. Reg. 16190, 16192 (March 16, 2023).

[283] Feist Publications, Inc. v. Rural Telephone Service Co., 499 U.S. 340, 345 (1991)

[284] See, e.g., Ryan Abbott, The Reasonable Robot: Artificial Intelligence and the Law (Cambridge University Press 2020) pp. 60-87.

[285] Mark A. Lemley and Bryan Casey, 'Fair Learning' (2021) 99 Texas Law Review 743

developers have, in some instances, argued that such use constitutes fair use (in the US) or falls under exceptions like text and data mining available in certain jurisdictions (e.g., the EU and the UK, albeit with varying conditions and scopes).[286] The fair use defence, for example, involves a multi-factor analysis considering the purpose and character of the use, the nature of the copyrighted work, the amount and substantiality of the portion used, and the effect of the use upon the potential market for or value of the copyrighted work.[287] The application of these factors to AI training is highly fact-specific and is currently being tested in numerous high-profile litigation cases globally.[288] Concerns exist that widespread, uncompensated ingestion of copyrighted works could undermine the markets for original creative works and devalue the rights of human authors and creators.[289] Consequently, discussions around licensing models for AI training data are gaining prominence, alongside calls for greater transparency regarding the datasets used to train AI systems.[290] The legal landscape in this area is rapidly evolving, with courts and legislators worldwide beginning to grapple with these complex issues, aiming to strike a balance between fostering AI innovation and upholding the fundamental principles of copyright protection.[291]

4.4.2. Patenting AI-Implemented Inventions: New Frontiers and Hurdles

The patent system, designed to protect functional inventions, faces distinct and arguably more complex challenges with the rise of AI compared to copyright.

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[286] See UK Intellectual Property Office, Artificial Intelligence and Intellectual Property: copyright and patents: Government response to consultation (June 2022, updated February 2024) < https://www.gov.uk/government/consultations/artificial-intelligence-and-ip-copyright-and-patents> accessed 15 May 2025.

[287] 17 USC Section 107.

[288] See, e.g., The New York Times Co. v. Microsoft Corp. and OpenAI, Inc., No. 1:23-cv-11195 (S.D.N.Y. filed Dec. 27, 2023); Andersen v. Stability AI Ltd., No. 3:23-cv-00201 (N.D. Cal. filed Jan. 13, 2023).

[289] See also Miriam Lord (US Copyright Office), 'US Copyright Office on AI: Human creativity still matters, legally', WIPO Magazine (24 April 2025) < https://www.wipo.int/en/web/wipo-magazine/articles/us-copyright-office-on-ai-human-creativity-still-matters-legally-73696> accessed 15 Nov 2025.

[290] See, e.g., European Parliament, AI and copyright: The training of general-purpose AI (Briefing, EPRS_ATA(2025)769585, February 2025) (discussing TDM exceptions and the debate around licensing for AI training in the EU). Available at < https://www.europarl.europa.eu/thinktank/en/document/EPRS_ATA(2025)769585 > accessed 15 Nov 2025.

[291] The legal and policy discussions are dynamic. For example, WIPO continues to host conversations and gather stakeholder input on these topics. See WIPO, WIPO Conversation on IP and AI – Eleventh Session (April 2025) <https://www.wipo.int/meetings/en/details.jsp?meeting_id=87587? accessed 15 May 2025.

While software inventions have long been a subject of debate within patent law (as discussed throughout Chapters 5 and 6), the specific characteristics of AI technologies introduce new layers of difficulty concerning patent eligibility, inventorship, non-obviousness, and disclosure requirements, particularly in major jurisdictions like the US and EU.

Patent Eligibility of AI Inventions:

A primary hurdle for AI inventions is navigating subject matter eligibility. In the US, AI algorithms, particularly foundational machine learning models, risk being categorised as abstract mathematical methods or mental processes. These are judicial exceptions to patentable subject matter under 35 USC Section 101, especially following the *Alice/Mayo* framework.[292] To overcome this, AI-related claims must demonstrate an inventive concept that transforms the abstract idea into a patent eligible application; for example, by being integrated into a specific practical application that improves a technological process or the functioning of a computer itself.[293] The US Patent and Trademark Office (USPTO) has issued guidance indicating that claims reciting AI should be evaluated for whether they are directed to an abstract idea and, if so, whether they integrate the abstract idea into a practical application; for example by specifying a particular hardware implementation or how the AI's output is used to effect a specific action or result.[294]

In Europe, the EPC explicitly excludes "programs for computers" and "mathematical methods" from patentability "as such" (Article 52(2)(c) and (3) EPC). However, the EPO has established that AI and machine learning inventions can be patentable if they are applied to solve a specific technical problem or achieve a "further technical effect" beyond the normal physical interactions within a computer.[295] The EPO Guidelines for Examination clarify

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[292] *Alice Corp. Pty. Ltd. v. CLS Bank Int'l*, 573 U.S. 208 (2014); *Mayo Collaborative Services v. Prometheus Laboratories, Inc.*, 566 U.S. 66 (2012).

[293] See 35 USC Section 101. The Alice/Mayo framework requires a two-step analysis: first, determine if the claim is directed to a patent-ineligible concept (law of nature, natural phenomenon, or abstract idea); if so, second, determine if the claim's elements, considered both individually and as an ordered combination, transform the nature of the claim into a patent-eligible application by reciting an "inventive concept" that is significantly more than the ineligible concept itself.

[294] See US Patent and Trademark Office, 2024 Guidance Update on Patent Subject Matter Eligibility, Including on Artificial Intelligence (July 2024), available at <https://www.uspto.gov/sites/default/files/documents/ai-sme-update-2024.pdf> accessed 15 May 2025.

[295] European Patent Office (EPO), Guidelines for Examination in the European Patent Office (March 2025), G-II, 3.3 ("Mathematical methods") and G-II, 3.3.1 ("Artificial intelligence and machine learning"). The EPO assesses whether the claimed subject-matter has a "technical

that if an AI or ML invention is directed to a method involving technical means (e.g., a computer) or to a device, its subject matter has technical character and is not excluded from patentability *per se*. The key then lies in assessing inventive step based on features contributing to this technical character.[296] This often involves demonstrating a technical application in a specific field of technology or an improvement in the internal functioning of the computer system itself.[297]

Inventorship and AI:

The traditional patent law requirement for human inventorship presents another significant challenge. As will be explored in Chapter 5, current legal frameworks in both the US and Europe and indeed, globally, do not recognise AI systems as inventors.[298] Patent applications must name human individuals who have made a significant contribution to the conception of the claimed invention.[299] While AI can be a powerful tool assisting human inventors in identifying problems, generating potential solutions, or analysing data, the inventive contribution must ultimately be attributable to human intellect. Determining the precise threshold of human contribution required when AI plays a substantial role in the inventive process is an evolving area of legal interpretation and policy discussion.

Inventive Step / Non-Obviousness in AI-Assisted Inventions:

The assessment of inventive step (EPO) or non-obviousness (US) is also complicated by AI. This standard requires that an invention not be obvious to a "person skilled in the art" (PSITA) at the time of invention. If AI tools capable of synthesising vast amounts of information and generating solutions become

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character" as a whole.

[296] EPO Guidelines (March 2025), G-II, 3.3.1. It states: "if a claim of an invention related to artificial intelligence or machine learning is directed either to a method involving the use of technical means (e.g. a computer) or to a device, its subject-matter has technical character as a whole and is thus not excluded from patentability under Art. 52(2) or (3)."

[297] See, e.g., T 0136/08 (*Circuit simulation/INFINEON TECHNOLOGIES*) of 23.3.2010; T 1227/05 *(Circuit simulation I/INFINEON TECHNOLOGIES*) of 12.9.2006 (relating to simulation having technical purpose). For AI, the application to a field of technology or specific technical implementation is key.

[298] For the US, see *Thaler v. Vida*l, 43 F.4th 1207 (Fed. Cir. 2022), cert. denied, 143 S. Ct. 1783 (2023) (confirming an inventor must be a human being). For Europe, the EPO has consistently rejected applications naming an AI (DABUS) as inventor (e.g., J 8/20 and J 9/20). For Japan, see 'AI Update – AI Inventorship: IP High Court in Japan Rules AI Cannot Be Listed as Inventor' Legal 500 (12 May 2025) <https://www.legal500.com/developments/thought-leadership/ai-update-ai-inventorship-ip-high-court-in-japan-rules-ai-cannot-be-listed-as-inventor/> accessed 15 May 2025.

[299] See USPTO, Inventorship Guidance for AI-Assisted Inventions, 89 Fed. Reg. 10043

commonplace within a particular technical field, the benchmark for what is considered "obvious" to a PSITA equipped with such tools may effectively be raised.[300] Discerning genuine human inventive insight from what an AI could routinely achieve poses a considerable challenge for patent examiners. The EPO, for example, assesses inventive step using the problem-solution approach, considering whether the claimed invention, in light of the closest prior art, would have been obvious to a skilled person seeking to solve an objective technical problem.[301] How the capabilities of AI factor into this hypothetical skilled person's knowledge and abilities is a critical question.

Disclosure and Enablement Requirements:

AI inventions, particularly those involving complex "black box" models like deep neural networks, face significant hurdles in meeting the patent law's disclosure and enablement requirements (will discuss in Chapter 5). Patent applicants must describe their invention in sufficient detail to enable a PSITA to make and use the invention without undue experimentation. For many AI models, performance is critically dependent on specific architectures, vast and often proprietary training datasets, and intricate hyperparameter tuning. [302] Adequately disclosing these details, especially the training data or the precise methodology for its curation and use, can be commercially sensitive and technically challenging within a patent specification.[303] Both the USPTO and EPO require that if the technical effect of an AI invention is dependent on particular characteristics of the training data, those characteristics essential for reproducing the technical effect must be disclosed, unless the skilled person can determine them without undue burden.[304] Striking a balance between fulfilling these disclosure obligations and protecting valuable trade secrets related to AI models and data remains a significant concern for innovators.

Prior Art Searches:

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[300] Ryan Abbott, 'Everything is Obvious' (2019) 66 UCLA Law Review 2

[301] EPO Guidelines (March 2025), G-VII (Inventive Step).

[302] See, e.g., W. Michael Schuster, 'Artificial Intelligence and Patent Ownership' (2019) 75 Washington and Lee Law Review 1945

[303] Mintz Levin, 'Patenting AI/ML Life Sciences and TechBio Innovations – How Much Disclosure is Sufficient?' (24 February 2025) https://www.mintz.com/insights-center/viewpoints/2231/2025-02-24-patenting-aiml-life-sciences-and-techbio-innovations-how accessed 15 May 2025

[304] EPO Guidelines (March 2025), F-III, 3 and G-II, 3.3.1 (clarifying that if the technical effect is dependent on particular characteristics of the training dataset, those characteristics must be disclosed if not determinable by the skilled person without undue burden). USPTO guidance also emphasizes adequate written description and enablement under 35 USC Section 112.

Finally, the rapid pace of AI development and the dissemination of relevant technical information across diverse platforms beyond traditional patent databases complicate comprehensive prior art searches for AI-related inventions.[305] This increases the risk of inadvertently granting patents on inventions that are not truly novel or non-obvious, an issue that patent offices are increasingly acknowledging and seeking to address through updated search strategies and tools.[306]

In conclusion, while AI-implemented inventions offer immense innovative potential, their unique characteristics necessitate careful navigation of established patent law principles. Patent offices and courts are continually adapting their approaches to address these new frontiers, striving to foster innovation while maintaining the integrity and aims of the patent system.

4.4.3. Trade Secrets in the Age of AI: Protecting Algorithms, Models, and Data

Alongside copyright and patent, trade secret protection has emerged as a particularly vital, and often preferred, means of safeguarding valuable innovations within the rapidly advancing field of AI.[307] As previously discussed (see Section 4.1.4), a trade secret encompasses information that (a) is secret, (b) has commercial value because it is secret, and (c) has been subject to reasonable steps by the rightful holder to keep it secret. For AI-driven software and computer-implemented inventions, these trade secrets can include a wide spectrum of assets; such as proprietary algorithms, the specific architecture of machine learning models, trained model weights and parameters, curated and annotated training datasets, as well as specialised data pre-processing techniques and development know-how.[308] Given the potential challenges in

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[305] World Intellectual Property Organization (WIPO), Patent Landscape Report: Generative Artificial Intelligence (WIPO 2024) p. 20 (noting the rapid growth of GenAI patent families and scientific publications since 2017, indicating a broad landscape of prior art). Available at <https://www.wipo.int/edocs/pubdocs/en/wipo_pub_1063.pdf> accessed 15 May 2025

[306] See, e.g., Rothwell Figg, 'Reviewing 2024's AI Patent And Copyright Developments' (9 January 2025) <https://www.rothwellfigg.com/publication-reviewing-2024s-ai-patent-and-copyright-developments> accessed 15 May 2025

[307] See, e.g., John Villasenor, Protecting our Edge: Trade Secrets and the Global AI Arms Race, Testimony before the U.S. House of Representatives Committee on the Judiciary, Subcommittee on Courts, Intellectual Property, and the Internet (7 May 2025) (discussing the vital role of trade secrets for U.S. AI companies). Available at https://judiciary.house.gov/sites/evo-subsites/republicans-judiciary.house.gov/files/evo-media-document/villasenor-testimony.pdf accessed 15 May 2025.

[308] Under the U.S. Defend Trade Secrets Act (DTSA) of 2016, a trade secret is defined broadly to include "all forms and types of financial, business, scientific, technical, economic, or engineering information, including patterns, plans, compilations, program devices,

securing patent protection for certain AI algorithms due to abstract idea concerns and the mandatory public disclosure inherent in the patent system, trade secrets offers an alternative path for protecting the "crown jewels" of AI innovation indefinitely, provided secrecy can be maintained.[309]

However, the nature of AI development and deployment also introduces unique and significant challenges to maintaining the requisite secrecy. The complexity of AI models, while a barrier to understanding for some, does not render them immune to misappropriation. Once the underlying code or model weights are accessed, digital replication can be straightforward. The intense competition for AI talent means that employee mobility poses a heightened risk of trade secret leakage, as individuals may carry valuable, unpatented knowledge of algorithms, model architectures, or data handling techniques to new employers.[310] Furthermore, sophisticated techniques such as model extraction attacks, membership inference, and property inference aim to reverse-engineer or deduce sensitive information about AI models or their training data through querying publicly accessible application programming Interfaces (APIs) or analysing model outputs, thereby potentially compromising their trade secret status if not adequately defended against.[311] The increasing trend towards collaborative research and the use of open-source AI frameworks also requires careful delineation and protection of any proprietary elements integrated with or developed alongside these shared resources.[312] Moreover, the reliance on cloud computing platforms for training and deploying large-scale AI models introduces further complexities in managing data security and access controls

formulas, designs, prototypes, methods, techniques, processes, procedures, programs, or codes..." 18 USC Section 1839(3). Similar definitions exist in other jurisdictions, e.g., Article 2(1) of the EU Trade Secrets Directive (Directive (EU) 2016/943).

309 Jeffry M. Hrdy, 'Keeping ChatGPT a Trade Secret (While Selling It Too)' (2025) 40(1) Berkeley Technology Law Journal. Pre-print available at https://btlj.org/wp-content/uploads/2025/03/40-1_Hrdy.pdf accessed 15 May 2025.

310 Mayer Brown LLP, The Rise of Trade Secret Litigation in the Age of Artificial Intelligence (Client Presentation Slides, April 2025) p. 16. Available at https://www.mayerbrown.com/-/media/files/perspectives-events/events/2025/04/the-rise-of-trade-secret-litigation-in-the-age-of-artificial-intelligence-slides.pdf?rev=4834ae28193343f696a4260e26a78232 accessed 15 May 2025

311 Florian Tramèr, *et al.*, 'Stealing Machine Learning Models via Prediction APIs' (Paper presented at the 25th USENIX Security Symposium, August 2016). See also Patently-O, 'OpenEvidence v. Pathway: The Legal Battle Over AI Reverse Engineering' (3 March 2025) https://patentlyo.com/patent/2025/03/openevidence-pathway-engineering.html accessed 15 May 2025

312 While open-source AI models promote innovation and transparency, companies building proprietary features on top of or alongside such models must clearly define and segregate their trade secrets and implement measures to prevent inadvertent disclosure through open-source contributions or collaborations.

to prevent unauthorised access by third parties or even by the cloud service providers themselves. It necessitating robust contractual safeguards and technical measures.[313]

Companies that protect their AI assets as trade secrets must take proactive steps. They need to diligently implement and enforce reasonable steps to guard against the increasing risks to AI. Beyond standard protections like non-disclosure agreements, access controls, and physical security, specific safeguards for AI are essential. These may include robust cybersecurity for model and data storage, along with data minimisation and anonymisation techniques for training data when practical. Moreover, measures such as differential privacy, technical barriers to prevent model attacks, and comprehensive logging of model access are crucial. Strict internal data governance policies and regular employee training on intellectual property protection and confidentiality also play a vital role.[314] It's important to remember that the definition of "reasonable measures" in the digital and AI context is constantly changing, shaped by new technologies and legal interpretations.[315]

Finally, it is important to recognise that trade secret protection for AI innovations does not exist in a vacuum. It often operates in synergy with other forms of IP. For instance, a company might protect the core, highly sensitive aspects of its AI algorithm or a unique training dataset as a trade secret, while seeking patent protection for specific, inventive applications of that AI in a particular technological field, or copyright protection for the literal expression of the software code implementing the AI. This strategic layering of different intellectual property rights can provide a more comprehensive and resilient

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[313] Centre for Information Policy Leadership (CIPL), Privacy-Enhancing and Privacy-Preserving Technologies in AI: Enabling Responsible Data Use and Innovation whilst Protecting Individual Rights (Report, March 2025) pp. 5-7 (discussing how PETs can help protect confidential information and trade secrets when training AI, particularly in shared or cloud environments). Available at https://www.informationpolicycentre.com/uploads/5/7/1/0/57104281/cipl_pets_and_ppts_in_ai_mar25.pdf accessed 15 May 2025.

[314] Orrick, Herrington & Sutcliffe LLP, 'Protecting Trade Secrets: Tips for AI Companies' (January 2025) https://www.orrick.com/en/insights/2025/01/protecting-trade-secrets-tips-for-ai-companies accessed 15 May 2025.

[315] See, e.g., Victoria A. Cundiff and Jonathan L. Shapiro, '"Reasonable [Cybersecurity] Measures" for Digital Trade Secrets: Lessons from Marketing' (2025) 66 IDEA: The Law Review of the Franklin Pierce Center for Intellectual Property 40 (discussing the evolving nature of "reasonable measures" in a digital environment). Available at <https://scholars.unh.edu/cgi/viewcontent.cgi?article=1511&context=law_facpub> accessed 15 May 2025.

framework for safeguarding the multifaceted innovations emerging from the AI domain.[316]

4.4.4 Systemic Challenges and the Evolving Intellectual Property Landscape in the AI Era

The preceding discussions have highlighted the multifaceted ways in which AI, in its various forms, is compelling a re-evaluation of established intellectual property doctrines. The challenges posed by AI to copyright in terms of authorship and originality. To patent law it concerning eligibility, inventorship, and non-obviousness while to trade secret protection regarding the maintenance of secrecy for dynamic AI models and vast datasets. These are not merely isolated legal puzzles. Rather, they represent interconnected components of a larger, systemic challenge to the entire intellectual property framework, particularly as it applies to the rapidly evolving domain of software, including the complex software ecosystems that power modern smartphones and mobile applications.[317]

One of the most significant systemic impacts of AI is the blurring of traditional intellectual property boundaries, especially for software. AI systems can now generate not only functional software code (traditionally a matter for copyright and potentially patent) but also user interface designs (implicating industrial designs/design patents and copyright), textual content, and even suggest novel algorithmic approaches. [318] For example, a sophisticated smartphone application increasingly relies on AI for core functionalities, from on-device machine learning for image processing and voice assistance to predictive text input and personalised user experiences. Determining how to dissect such an AI-driven software product into its constituent intellectual property elements, copyright for the human-written and potentially parts of AI-assisted code, patent protection for novel AI-driven functionalities or system architectures, trade secrets for the underlying models and training data, and design rights for the user interface, becomes an increasingly complex strategic imperative for software developers and technology companies. This complexity is particularly acute in the smartphone sector, where rapid innovation cycles and feature-rich

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[316] Upadhye Tang LLP, 'Intellectual Property Issues Related to Artificial Intelligence: A Deeper Dive into Patent, Copyright, & Trade Secrets Challenges' (13 March 2025) <https://ipfdalaw.com/intellectual-property-issues-related-to-artificial-intelligence-a-deeper-dive-into-patent-copyright-trade-secrets-challenges/> accessed 15 May 2025.

[317] See, e.g., Daniel Gervais, 'The Machine as Author' (2020) 105 Iowa Law Review 2053

[318] Ryan Abbott, The Reasonable Robot: Artificial Intelligence and the Law (Cambridge University Press 2020) pp. 58-115

applications are the norm.

This technological dynamism exerts considerable pressure on existing legal tools and intellectual property institutions. As AI algorithms and their software implementations evolve at an unprecedented pace, patent offices face significant challenges in conducting thorough prior art searches and examining the novelty and inventive step of AI-related software patents (an issue foreshadowed in Chapter 5.) The "black box" nature of some AI models further complicates the assessment of patent disclosure and enablement requirements. Similarly, courts are increasingly confronted with novel questions of copyright infringement related to AI training data and the authorship of AI-assisted software code, requiring nuanced interpretations of existing legal doctrines.[319] The very speed of AI development in software risks outpacing the ability of legislatures and courts to provide timely and clear guidance, potentially leading to periods of legal uncertainty that can impact investment and innovation in critical software sectors like mobile technology.

Crucially, navigating the intellectual property landscape in the AI era necessitates a careful balancing of innovation incentives with broader public interests. For AI-driven software, particularly in the smartphone ecosystem which affects billions of users, this balance is paramount. On one hand, robust intellectual property protection is argued as necessary to incentivise the substantial investment required for developing cutting-edge AI software, new algorithms, and beneficial applications.[320] On the other hand, overly broad or improperly granted intellectual property rights for foundational AI models or common AI-driven software functionalities could stifle competition, and hinder interoperability within the app ecosystem As a result, it limits access to essential technologies, potentially creating new forms of "patent thickets" built around AI components. The rise of open-source AI models and their impact on innovation and competition in the software landscape further complicates this equation. It presenting both opportunities for wider access and challenges for proprietary intellectual property strategies.[321]

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[319] See, e.g., Mark A. Lemley, 'IP in a World Without Scarcity' (2020) 90 George Washington Law Review 1591

[320] See, e.g., World Intellectual Property Organization (WIPO), WIPO Technology Trends 2019: Artificial Intelligence (WIPO 2019)

[321] Amanda Levendowski, 'How Copyright Law Can Fix Artificial Intelligence's Implicit Bias Problem' (2018) 93 Washington Law Review 579. For a discussion on open source AI and IP, see also Linux Foundation Research, Open Source AI: Opportunities and Challenges (Report, December 2023) available at <https://www.linuxfoundation.org/blog/open-source-ai-opportunities-and-challenges> accessed 15 May 2025.

Looking ahead, the international intellectual property landscape for AI-driven software is in a state of dynamic flux. Major intellectual property offices in the US and Europe are actively developing examination guidelines for AI-related inventions, and international bodies like the World Intellectual Property Organization (WIPO) are facilitating global discussions to explore these complex issues.[322] However, as noted in various contexts throughout this thesis, achieving global harmonisation on such rapidly evolving technological and legal questions is a significant undertaking. For the smartphone software industry, which is inherently global, this period of legal evolution underscores the need for clarity and predictability in intellectual property protection. The systemic challenges introduced by AI reinforce the central argument of this thesis: that a well-defined, consistently applied, and robust framework for assessing the intellectual property rights in software and computer implemented inventions, such as the examination model proposed in Chapter 7, is more critical than ever. Ensuring that the intellectual property system can effectively support and channel the transformative potential of AI within software, while upholding principles of fairness and public access, will be a defining task for intellectual property law and policy in the coming years.

[322] See, e.g., U.S. Copyright Office, Copyright and Artificial Intelligence Initiative <https://www.copyright.gov/ai/> accessed 15 May 2025; European Patent Office, Guidelines for Examination (March 2025), particularly sections pertaining to AI and computer-implemented inventions. WIPO also regularly convenes sessions on IP and AI, e.g., WIPO Conversation on IP and AI, details at <https://www.wipo.int/about-ip/en/artificial_intelligence/conversation.html> accessed 15 May 2025.

Chapter 5

The evolution of technology, computer-implemented inventions and patent law

5.1. The Shifting Economic and Technological Context for Software Innovation

5.1.1. Economic & Technological Backdrop

While steam and electrification are regarded as the first and the second industrial revolutions respectively, writing at the cusp of the 21st century identified the rise of the knowledge-based economy as the third industrial revolution, ushering in a new phase of global economic interconnectedness.[323] This paradigm, rooted in digital technologies and computerised processes, laid the essential groundwork for what is now widely recognised as the fourth industrial revolution. This current revolution is characterised by a fusion of technologies blurring the lines between the physical, digital, and biological spheres, and is overwhelmingly driven by advancements in Artificial Intelligence (AI), machine learning, big data analytics, and ubiquitous connectivity. Indeed, as of 2025, the transformative impact of AI is no longer a future prospect but a present reality, fundamentally reshaping industries, labour markets, and societal structures at an unprecedented pace, presenting both immense opportunities and profound challenges that patent law and intellectual property systems are actively grappling with.

With the continuous and rapid development of this knowledge-based and AI-driven industry, applications for computers, smartphones, and a plethora of other interconnected devices have become truly pervasive, undergoing enhancement at an accelerated pace. By 2025, the capabilities of digital personal assistants and conversational AI have evolved significantly beyond earlier examples. Services such as OpenAI's ChatGPT, Meta's Llama, and Google's Gemini have become prominent, demonstrating increasingly sophisticated natural language understanding, content generation, and

[323] Lester C. Thurow, 'Globalisation: The products of knowledge-based economy' (2000) Vol.570 ANNALS, AAPSS 20.

problem-solving abilities, further integrating AI into the fabric of daily information access and personal productivity.

The knowledge-based economy manifests the demands of the society and thus leads to an even more sophisticated industry that which the products and services are provided by the applications with high complexity. The fourth industrial revolution is in progress and it is the elaborate programs applied in the computer devices to enable this development. One of the famous examples is the driverless car which is controlled by computer programs.

The generation of the new economy model can be traced back to late 1970s to early 1980s where hardware and software started being taken as separate products. Software became an individual product both technologically and commercially under such so-called personal computer revolution (PC revolution)[324]. The initial idea of operation system was introduced at this time - the operational platform for computer programs performing any tasks. More sophisticated programs like the word processing program that is heavily applied today soon been commercialised to the market.[325] It established the value of software in the knowledge-based economy as consumers are seeking for the particular function that performed by certain software.

Professor Thurow in the US took Bill Gates as the symbol of such transition of economic formation.[326] In contrary to the traditional capitalist in the stem and electrification industry age which requires factories or equipment to generate profits, Bill Gates owned no land and other material resources. He established his Microsoft empire by controlling a knowledge process and selling the functional value of products which was a shift to knowledge-based economy and became the richest man of the time.[327] Bill Gates's story demonstrated that wealth accumulation is faster in knowledge-based economy than in traditional capitalist. It is also evidenced by other well-known billionaires. As of the first quarter of 2025, Elon Musk holds the top position on the Forbes World's Billionaires List, with an estimated net worth of USD 342 billion.[328] This reflects a significant increase, over 75% from the prior year, primarily attributed to the

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[324] Adam Mossoff, 'A brief history of software patents (and why they're valid)' (2014) No.14-41 George Mason Law & Economics Research Paper 8-9.

[325] *Ibid*.

[326] Lester C. Thurow, 'Globalisation: The products of knowledge-based economy' (2000) Vol.570 ANNALS, AAPSS 20.

[327] *Ibid.*

[328] Forbes, Forbes 2025 Billionaires List - The Richest People In The World Ranked (2025).

surging valuations of Tesla, SpaceX, and his AI company xAI.[329] Musk surpassed other leading tech billionaires such as Mark Zuckerberg (ranked second with USD 216 billion) and Jeff Bezos (third with USD 215 billion), reaffirming the dominance of knowledge-based innovation sectors in wealth accumulation. His holdings span not only electric vehicles and aerospace but also AI and infrastructure, consolidating his influence across multiple frontier industries.[330]

Computer-implemented Inventions (CIIs) become a driven factor in commercial activities is also reflected in the revenue of technology companies. Five technology giants including Google, Apple, Facebook, Amazon and Microsoft collectively filed 52,000 patents during eight years since 2009.[331] Although the number contains various types of patent, the following figure 4 shows the average royalty rate by major technology types in 2011. Software is the type of technology that generates higher royalty rates than most other types.[332] It only lag behind aerospace technology which normally requires huge investments for research and development. Accordingly, software is not only a selling point to attract consumers, it also helps corporations to immense wealth due to its high investment return. This strategic importance of IP, particularly patents, for leading technology corporations has remained a consistent feature of the knowledge-based economy into the 2020s. Major technology firms, including those previously mentioned (Google, Apple, Meta (formerly Facebook), Amazon, and Microsoft), continue to be among the most prolific patent applicants and holders globally. Their sustained, large-scale patenting activities, extending well into the current decade up to 2024/2025, are regularly highlighted in annual reports from intellectual property organisations and patent analytics firms. These activities underscore an ongoing strategic emphasis on amassing significant intellectual property portfolios to drive innovation, secure dominant market positions, manage complex licensing landscapes, and navigate the competitive dynamics of rapidly evolving high-technology sectors such as artificial intelligence, cloud computing, and next-generation

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[329] Forbes Press Releases, ' Elon Musk Tops Forbes' 39th Annual Billionaires List' (2025) Forbes https://www.forbes.com/sites/forbespr/2025/04/01/elon-musk-tops-forbes-39th-annual-billionaires-list/ accessed 15 May 2025.

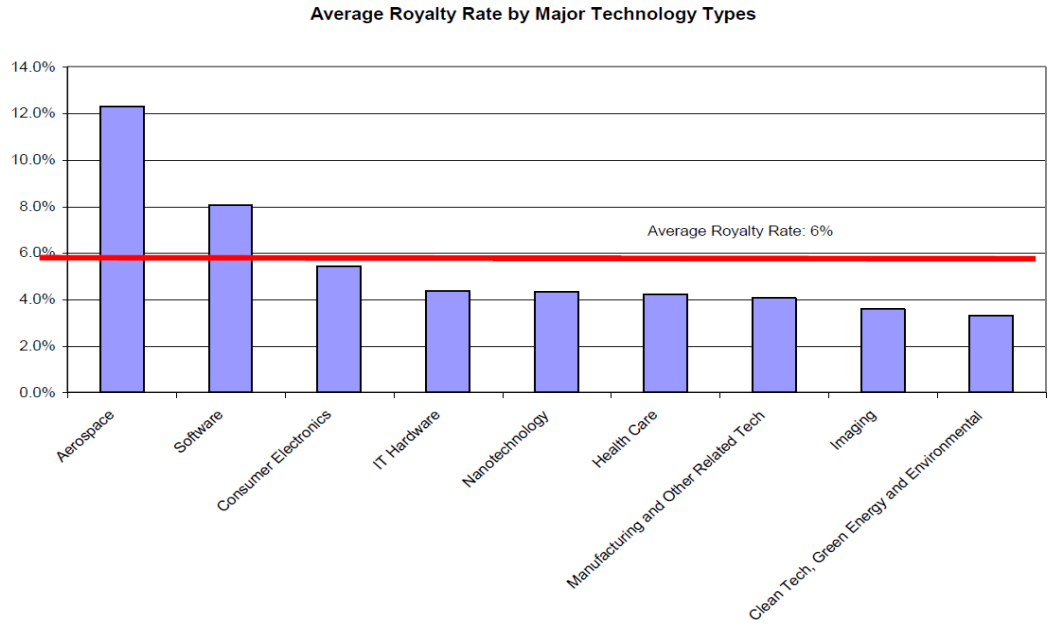
[330] *Ibid.*.

[331] 'The 'big 5' patents report: Google, Apple, Face Book, Amazon & Microsoft' CBINSIGHT https://www.cbinsights.com/research/report/top-tech-patents/ accessed on 15 June 2017.

[332] Figure cited from David Smith, *Dollar value: the valuation of patents, starups, software & other intellectual property assets"* (Cambridge Manhattan Group, LLC 2016) 64. https://tynax.com/dollarvalue.php accessed on 17 June 2017.

communication technologies.[333]

Figure 4. Average royalty rate by major technology types



5.1.2. Emerging Technology and Patent Law Development

5.1.2.1. The Borderless Transmission of Software

The software perceived today is the modern aspect of software. The meaning of software was a different idea in the past where software needed to be physically installed and distributed. Software was designed for particular computers and was not interoperable to other computers. For example, the software designed to IBM computer did not applicable on the product of Digital Equipment Corporation which the size of its computer was as large as refrigerator at that time.[334] Software users went to a store to purchase computer program, took it out from the package and install it in the chosen

[333] Recent trends in patenting by major technology companies can be observed in annual reports and analyses from various sources. For instance, 'IFI Claims Patent Services' typically publishes an annual "Top 50 US Patent Assignees" list, which consistently features these technology giants. (See, e.g., their reports covering patent grants for the years 2022, 2023, and anticipated for 2024, usually accessible via the IFI Claims website). Additionally, the 'World Intellectual Property Organization (WIPO)', in its annual 'World Intellectual Property Indicators' report (e.g., the 2024 edition covering 2023 data), provides insights into top PCT applicants and patenting trends by company and technology field. These reports are generally available on the respective organizations' websites. For WIPO, consult <https://www.wipo.int/ipstats/en/> accessed 03 May 2025.

[334] Adam Mossoff, 'A brief history of software patents (and why they're valid)' (2014) No.14-41 George Mason Law & Economics Research Paper 7.

computer device until 1990s.[335]

Today the way of accessing software and circulating software is diversified in contrast to the early ages. With the technology shift of telecommunication especially the ubiquity of internet, users can sit at home and obtain software from online retailers or software providers available on an internet page or network. Users download a program on their computers or similar devices and can electronically transfer it to any other users on the internet. Consequently, a user in New York can have software transferred to London almost instantaneously, irrespective of physical location.[336]

The borderless transmission of technology becomes even more convenient with the introduction of digital cloud. It allows software to be accessed from any computer devices not limited to a certain one which has the given software downloaded in the hardware. Normally the software provider hosts the application of cloud-based software in its data centre and make it available to thousands of users at the same time.[337] Proponents also argue that accessing software via the cloud, particularly through Software-as-a-Service (SaaS) models where the core application resides on the provider's servers, can offer certain security advantages. For example, it may reduce the risk of a user's local computer being directly infected by viruses or malware traditionally bundled with downloaded and installed software, as the primary processing occurs remotely and updates are managed centrally by the provider.[338]

5.1.2.2 The Contemporary Landscape of Artificial Intelligence (AI) and Generative AI

The trajectory of technological advancement, particularly within the sphere of computer-implemented inventions, has been profoundly shaped by the advent and rapid proliferation of AI. As of 2025, AI is no longer a nascent concept but a pervasive force, underpinning innovations across diverse sectors from

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[335] *Ibid*., at 9.

[336] Keith E. Witek, 'Software patent infringement on the internet and on modern computer system – Who is liable for damages?' (1998) Vol. 14 Issue 2 Santa Clara High Technology Law Journal 311-312.

[337] Peter Mell and Timothy Grance, 'The NIST Definition of Cloud Computing' (NIST Special Publication 800-145, September 2011) 2-3, available at <https://nvlpubs.nist.gov/nistpubs/Legacy/SP/nistspecialpublication800-145.pdf> accessed 30 April 2025.

[338] However, it is also important to acknowledge that cloud-based systems introduce their own set of security considerations, such as the risks associated with data breaches on the provider's side, account security, service availability, and the security of the transmission channels and client-side interfaces.

autonomous vehicles and medical diagnostics to financial modelling and creative industries.[339] At its core, AI encompasses systems designed to perform tasks that typically require human intelligence, including learning, problem-solving, perception, and decision-making[340] Machine Learning (ML) and Deep Learning (DL), key subsets of AI, have driven much of this progress through their ability to identify patterns in vast datasets and improve performance without explicit programming for every function.[341]

A particularly transformative development in recent years has been the emergence of Generative AI.[342] Unlike earlier AI systems primarily focused on analysis or prediction, generative models are capable of creating novel content, such as text, images, code, music, and synthetic data.[343] Large Language Models (LLMs), exemplified by models like those in OpenAI's GPT series or Google's Gemini, have become prominent, demonstrating sophisticated natural language understanding and generation capabilities.[344] These advancements signal a significant leap in the sophistication and potential applications of AI, blurring the lines between human and machine creativity and challenging established notions of authorship and invention.

The rapid evolution and deployment of AI, especially generative AI, introduces unique technical characteristics and capabilities that have profound implications for the legal frameworks governing IP, particularly patent law. The ability of these systems to generate novel outputs, their often complex and sometimes opaque internal workings ("black box" problem), and their reliance on vast and diverse datasets for training necessitate a careful re-evaluation of

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[339]See, for example, 'Generative AI Landscape 2025: Complete Guide to Industry Trends & Implementation', Magai.co (7 March 2025) <https://magai.co/generative-ai-landscape/>, accessed 14 May 2025; 'AI in 2025: Five Defining Themes', SAP News Center (16 January 2025) <https://news.sap.com/2025/01/ai-in-2025-defining-themes/>, accessed 14 May 2025.

[340] See 'What is Machine Learning | 2025 Latest Definition, Types and Examples', SAP <https://www.sap.com/taiwan/products/artificial-intelligence/what-is-machine-learning.html>, accessed 14 May 2025.

[341] *Ibid.*

[342] See 'Generative AI in 2025: What Is GenAI?', Splunk (13 December 2024) <https://www.splunk.com/en_us/blog/learn/generative-ai.html>, accessed 14 May 2025.

[343] *Ibid.* (defining Generative AI and its creative output); 'Generative AI glossary: Key AI terms for 2025 and beyond', Zendesk (3 December 2024) <https://www.zendesk.com/blog/generative-ai-glossary/>, accessed 14 May 2025.

[344] See sources discussing specific prominent LLMs. OpenAI, GPT-4 <https://openai.com/index/gpt-4/> accessed 15 May 2025; Google DeepMind, Introducing Gemini: Our Largest and Most Capable AI Model <https://blog.google/technology/ai/google-gemini-ai/> accessed 15 May 2025; Meta AI, Introducing Meta Llama 3: The Most Capable Openly Available LLM <https://ai.meta.com/blog/meta-llama-3/> accessed 15 May 2025.

traditional patentability criteria and examination practices.

5.2. Emerging Technologies and the Challenges for Patent Law

The fundamental requirements for an invention to be deemed patentable are largely harmonised at an international level, primarily through agreements such as the TRIPS Agreement. These essential criteria typically include newness (novelty), the presence of an inventive step (non-obviousness), and the capability of industrial application (or usefulness).[345] Additionally, a core principle in patent law is that an invention must be sufficiently disclosed to the public in the patent application, enabling others skilled in the art to understand and reproduce it.[346]

The World Intellectual Property Organisation (WIPO), in its efforts to promote the protection of intellectual property worldwide, often encapsulates these ideas by describing a patent as an exclusive right available for an invention that is “a product or a process” offering “a new way of doing something or offers a new solution to a problem.'[347] This inherently implies that the invention must involve “technical information” which is disclosed through the application process.[348]

Doctrinally, novelty requires a patent claim to provide new characteristics that do not exist in the “prior art”[349] in its technical field; non-obviousness is satisfied when the patent claim is not obvious to a person ordinarily skilled in the technical field whereas usefulness requires the claim must be applied for practical purpose.[350] Accordingly, hypothetical ideas without demonstrating concrete results are not eligible for patent protection. However, these general terms in the TRIPS Agreement leave room for interpretation.[351] It is argued that,

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[345] Article27(1) of the TRIPS Agreement.; see of Noes 5 of the Agreement.

[346] See, e.g., Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS Agreement), Article 29(1), which states: "Members shall require that an applicant for a patent shall disclose the invention in a manner sufficiently clear and complete for the invention to be carried out by a person skilled in the art and may require the applicant to indicate the best mode for carrying out the invention known to the inventor at the filing date or, where priority is claimed, at the priority date of the application."

[347] WIPO, at https://www.wipo.int/en/web/patents accessed on 26 Oct 2025.

[348] *Ibid.*.

[349] Novelty is to be met if the invention provides some new characteristics not known in the body of existing knowledge; the existing knowledge is the so called” prior art”.

[350] Vaibhav Choudhary, 'The patentability of software under intellectual property rights: an analysis of US, European and Indian intellectual property right' (2011) 33(7) E.I.P.R. 347.

[351] Carole Deschamps, ‘Patenting computer-related inventions in the US and Europe: the need for domestic and international legal harmony’ (2011) 33(2) E.I.P.R. 107.

according to Hashim, the language in the agreement is deliberately vague. It reflects the resistance of developing countries who stand for allowing accessing patented inventions for further research.[352] Moreover, it is also the political consideration to address new technologies which the legislator was not able to anticipate.[353] Member countries are thus afforded a degree of flexibility to determine the precise scope and mechanisms of patent protection ensured by their domestic law within the TRIPS Agreement framework. Indeed, as an international treaty designed for widespread adoption across diverse legal and economic systems, the principles articulated in TRIPS Agreement are, to some extent by their very nature, framed in general terms to allow for such national tailoring and to be broadly acceptable to the largest number of countries across the globe. In this regard, such inherent generality, coupled with national policy choices, inevitably leads to the variations in the application of these principles in different jurisdictions.

5.2.1 General Difficulties in Patenting Software Innovations

Social, economy, and legal demands

As emphasised in previous chapters, the aim of patent is to provide incentives to innovation and reward the investments of research as well as prevent others' unauthorised utilisation of the patented work[354] (see Chapter 2 Literature for the sceptical innovation incentives function of patent commended by scholars). It can be argued that it is the legislator's intention to provide stimulating function via patent law to facilitate technology development. As at the time patent law was drafted patent was a device for inventors to ensure the patented work could be legally utilised by the holder and therefore reward his brain efforts. In earlier industrial eras where software was not yet prevalently implemented in the majority of inventions, patenting a creation was relatively simple than today as the innovative features of conventional products can be told easily; especially comparing with patenting the complicated construction of computer-implemented inventions. The inventive step of a patent claim was invested based on the straightforward criteria applied in the patent offices. A clear example can be seen from chemical patents where the chemical formula can

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[352] Mohamed R. Hashim, 'International influence – TRIPS and patent subject-matter' (2013) 44(6) IIC 658-659.

[353] *Ibid.*, at 659.

[354] Vaibhav Choudhary, 'The patentability of software under intellectual property rights: an analysis of US, European and Indian intellectual property right' (2011) 33(7) E.I.P.R. 445.

be recorded and found explicitly by inventors.[355] It allows efficient retrieval of patent details not only for inventors at the stage of research and development, but also for patent offices during the examination process.

However, such clarity is not the case in software industry. In the information technology sector, software is one of the vital elements for later essential enhancement of a service or product. Thus, if a software programmer intends to improve, for instance, the accuracy of pedometer software for smartphone handsets, it may be unavoidable to refer to or build upon other existing functional patents to provide such enhanced accuracy. While this characteristic of cumulative innovation, where new developments often rely on pre-existing patented technologies, is present in many technological fields, it can be argued that its impact is particularly pronounced in the software industry. This is often attributed to factors such as the typically high degree of interoperability required between different software components, the common practice of building software using numerous modular elements, the rapid iteration cycles, and the often less clearly demarcated boundaries of software patent claims which can create extensive patent thickets. Just like many other types of IP, such as copyright where a contemporary pop song might implicitly or explicitly draw upon melodies from older classic music, producing a patentable software innovation that enhances an existing product often necessitates applying or building upon patented information embedded in those prior products. It is an ineluctable process to achieve superior quality and further advancements. This principle of cumulative innovation, where new discoveries and inventions systematically build upon previous knowledge and achievements, is a well-recognised dynamic in technological progress and is extensively discussed in innovation studies.[356]

As with all other types of patents, inventors who need to access patent that already exists and are necessary for certain technology meet difficulties on both time and cost. The prior difficulty occurs because they need to search whether there is any patent that the research has to apply. If yes, it takes time to acquire consent of patent holder for lawful application and the negotiation may require considerable time. This process is especially hard to be practiced in software industry due to the absence of standardised and comprehensive scheme to

[355] Christina Mulligan and Timothy B. Lee, 'Scaling the patent system' (2012) Vol.68 NYU Annual Survey of America Law 8-9.

[356] See, e.g., Suzanne Scotchmer, 'Innovation and Incentives' (MIT Press 2004) Chs 2 and 5 (discussing the challenges of incentivizing both foundational and sequential innovation).

classify software inventions.[357] Needless to say a mechanism for investors to discover relevant patents. It is a long-standing argument. Some jurisdictions like the US have tried to minimise the problem it incurs; such as set out standards to software patent in examination guidelines and train software specialised examiner. The number of patent disputes do not seem to decrease as the current criteria is not able to cope with the problem that led by obscure software patent scope. It is the reason for this thesis seek to clarify patentable software and therefore facilitate to lawfully circulate it.

As regards the latter difficulty, inventors need to pay fees to be licensed for applying pre-existing patented works. Although the need to license existing patented works poses a general challenge across various technological fields, the perceived innovation cost dynamics in certain segments of the software field can present unique considerations. While the development of highly complex, enterprise-scale software systems or cutting-edge AI models can undoubtedly entail substantial investment in skilled personnel, data resources, and research, it is also true that for some types of software, particularly smaller applications or incremental improvements, the initial tools for creation (computers and development environments) are widely accessible, potentially leading to lower initial capital outlay compared to industries requiring significant physical infrastructure or laboratory work. However, this perceived lower entry barrier for development does not necessarily equate to low overall innovation costs when factoring in aspects like high-value talent acquisition, extensive testing, marketing, and crucially, the potential costs associated with navigating a dense patent landscape and securing necessary licenses. Moreover, such software products may indeed be replaced anytime by other analogous products. Licensing fees increase the innovation cost and may result in the failure of recovering investments. It is especially true when a later product is introduced to replace the invention. Even if the inventor is licensed to apply existing patents with reasonable conditions and is awarded a patent, it is necessary to pay renewal fees; otherwise, the patent lapses and everyone is free to access it. Furthermore, due to the nature that the innovative contents of software are not always readily obvious or easy to be seen from the outside, there is also a risk that developers may infringe others' patents and be subsequently ruled to pay for the infringement, regardless of whether they were intentional or not.[358]

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[357] *Ibid*.. 9-10.

[358] Elizabeth Siew Kuan Ng, 'Patent trolling; innovation at risk' (2009) 31(12) E.I.P.R. 594 and 607.

Given the aforementioned characteristics of software patents and the associated challenges, it is worth considering critically whether or not the current patent system effectively carries out its incentive function in the software industry. Gauging such effectiveness is a complex task, but it can be approached by investigating several interconnected factors. These may include analysing trends in patent filing and grant rates for software inventions, examining the behaviour of patent holders (including assertion and licensing practices), assessing the revenue generated from patented software versus the costs incurred, studying the impact of the patent system on market entry and competition (especially for SMEs), and understanding the various factors that might lead inventors or companies in the software field to either pursue patent protection actively or, conversely, to hesitate or opt for alternative protection strategies. It should be kept in mind that, despite the well-known smartphone patent wars reported in the press or other media, there are other players apart from the familiar large companies in reality. Individual software developers, small start-ups and small and medium enterprises (SMEs) also make significant contribution to software technology. A conspicuous example is the open-source programmers. While the large companies are keen on setting up patent portfolio, such independent programmers often tend to oppose against the extension of software patentability.

The founder of Free Software Foundation, Richard M. Stallman, a prominent advocate for free software, argues that oppose the patenting of software.[359] He took algorithms as a method of solving problems and viewed them as fundamental tools necessary for software research and development. From this perspective, Stallman and many proponents of the Free Software movement argue that patenting software and its underlying algorithms imposes detrimental restrictions on these essential building blocks of innovation. They contend that such patents can hinder programmers' freedom to write and improve software, create legal risks for developers who might unknowingly infringe upon broadly defined algorithmic patents, and ultimately slow down technological progress by privatising what they consider to be mathematical truths or fundamental computational methods that should remain in the public domain for all to use and build upon. The concern is that allowing patents on algorithms effectively grants monopolies on ideas or problem-solving techniques, which contradicts the open, collaborative ethos often prevalent in software development,

[359] Giovanna Massarotto, ‘Open source paradigm: Beyond the solution to the software patentability debate’ (2016) 15:647 The John Marshall Review of Intellectual Property Law 658-659.

particularly within the open-source community, and can impede the free circulation and incremental improvement of software knowledge.

To compare with certain traditional types of inventions, particularly those in fields requiring substantial physical infrastructure, laboratory equipment, or complex manufacturing processes (such as in heavy industry or biotechnology research), producing some forms of new computer programs and software can appear to require less initial capital cost[360]. For instance, an individual developer or a small team can often begin creating a mobile application or a web-based service using readily available computing hardware and widely accessible (sometimes open source) development tools, without the immediate need for large factories or specialised physical laboratories. This perceived lower barrier to entry for initiating development in some software domains is then sometimes argued as a reason why patent-based rewards might seem less critical as an initial stimulus for innovation for every type of programmer, especially when contrasted with the high upfront R&D investments in other sectors. This fact is especially true to open-source programmers and thus may be the reason of objection to software patent in this sector. Despite the limited reliance on patents, the open-source software ecosystem continues to thrive, benefiting from strong community governance and peer-reviewed development processes, which often translate into high stability and robust performance.[361]

Since portable computerised devices like tablet and smartphones have become essential equipment to our daily life, Apple's iTunes App Store launched in 2008 to provide apps with more varieties and better convenience.[362] By March 2017, there were 2.2 billion apps available in Apple's App Store whereas 2.8 million apps were available in the Google Play store.[363] However, the landscape of mobile application distribution has undergone significant changes over the years. As of May 2025, the Apple App Store hosts approximately 1,937,882 applications, with 95.4% of them offered for free and 4.6% as paid apps. The platform sees an average of 1,396 new apps added daily, totalling over 47,000

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[360] Reto M. Hilty and Christophe Geiger, 'Patent software? A judicial and socio economic analysis' (2005) 36(6) IIC 633.

[361] *Ibid.*

[362] David Curry, 'App Downloads Data' (2025) Business of Apps http://www.businessofapps.com/app-usage-statistics-2015/ accessed 15 Nov 2025.

[363] 'Android vs. IOS App Development: A comparison & Decision Guide' IntellegentBee https://intelligentbee.com/blog/android-vs-ios-app-development-comparison-decision-guide-infographic/ accessed on 15 Nov 2025.

new entries each month[364]. In comparison, the Google Play Store lists approximately 1,543,215 apps, reflecting a net growth of around 4,700 applications monthly due to both new submissions and regular removals[365].

These figures not only reflect the dynamic nature of digital marketplaces but also underscore the ongoing evolution in developer participation, platform governance, and user engagement patterns. The above information evidence is the flourishing of software business. However, software patent seems bring about risks of patent infringement and costs like licensing fees and infringement compensation. From the stance of small player, patent seems not able to perform its innovation incentives function as it results in more restraints.

Software patent has been granted for years, *de facto*, in most developed countries albeit most of the patent court decisions have often evaded explicitly confirming "software" as a patent eligible subject-matter and frequently were circuitous in clarifying its patentability.[366] Without a definite and universally accepted patent scheme for software, many relevant patent claims or patents were written in various terms.[367] This intensifies the difficulties of patent examination and increases the possibility of granting patents to those not truly patentable. Hence, it gives opportunistic patentees an avenue to expand the scope of the patent beyond its actual technical contribution. This circumstance is particularly evident when applicants strategically employ ambiguous or artfully chosen terminology in their claims and descriptions. The aim of such drafting can be to characterise an invention in a way that emphasises any potential technical aspects while obscuring elements that might otherwise lead to its classification as explicitly unpatentable subject matter, such as a mere abstract idea or a "program for a computer as such" under certain exclusionary provisions.

Furthermore, the historical ambiguity surrounding whether software, in its

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[364] 42matters, 'https://42matters.com/ios-apple-app-store-statistics-and-trends' (2025) 42matters https://42matters.com/ios-apple-app-store-statistics-and-trends accessed 20 May 2025.

[365] AppBrain, 'Number of Android apps on Google Play (May 2025)' (2025) https://www.appbrain.com/stats/number-of-android-apps accessed 20 May 2025.

[366] Jack T. Carroll *et al.*, 'Alice Patent Eligibility Analysis Divergence Before USPTO and District Court'(2024) IP Litigation Current, Foley & Landner LLP https://www.foley.com/insights/publications/2024/09/alice-patent-eligibility-analysis-divergance-before-uspto-and-district-court/?utm_source=chatgpt.com accessed 20 April 2025.

[367] Christina Mulligan and Timothy B. Lee, 'Scaling the patent system' (2012) Vol.68 NYU Annual Survey of America Law 9-10.

various manifestations, constitutes patentable subject matter in many jurisdictions has had a lasting impact on the development and comprehensiveness of dedicated prior art databases for this field. While patent databases do exist and contain numerous software-related patents, especially from more recent decades, the systematic cataloguing and searching of software prior art (particularly non-patent literature and earlier commercial software not widely patented) remains notably more challenging compared to more traditional technological areas. With the ubiquity of software and the massive number of patents that can potentially be relevant to or encompassed within a complex device like a smartphone, it becomes exceptionally challenging, if not practically unfeasible for many innovators, to discover and analyse all existing patents pertinent to a new software invention.[368] The most common way to do so is to "guess" what the patents may look like in any possible way, such as searching by key words and patent classification.[369] While searching for prior art to avoid potential patent infringement always carries an element of diligence and inherent challenge in any field, the aforementioned difficulties in software, such as the nature of software prior art often residing in non-patent literature or undocumented product features, the lack of universally standardised terminology, and the sheer volume and overlapping nature of software patents—can make this process seem particularly reliant on serendipity or "an inventor's luck" to uncover all truly relevant references. Current patent systems often fail to provide sufficient clarity to potential patentees. This makes the result of a patent application more unpredictable and heightens legal uncertainty. It again manifests the problem of the patent system in this sector, and it is not hard to imagine why small players tend to ignore patents rather than take part in the patent game without clear rules to enjoy the benefits associated with patents.

On the other hand, the difficulty of searching for existing patent may be, at some level, an advantage to other players in software industry; namely, the big player like the famous companies who develop advanced programs and make profits by virtue of their patents. It is certainly true that patent holder is entitled to earn money by circulating its patent including manufacturing and selling products that implements the patent and licensing or transferring its patent to others. This is the financial reward that ensured by patent protection. In addition, patent as a kind of immaterial assets can enhance the value of a company regardless it

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[368] *Ibid*., at 18.

[369] *Ibid*. at 10.

is exploited by the company or not.[370] Nonetheless, with the increase of patent applications related to computer programs which resulted in patent troll and competition concerns in the US, its patent system seems provide a system opposite to the patent aim of innovation incentives. This phenomenon has been proved by an economic study : companies, who made efforts to build up patent portfolios in the 1990s, to a large extent moved their investments from software research and development to patent application and defending existing patents.[371] In other words, patent portfolio owing companies no longer tend to do research and development for profits making purposes; rather they tend to obtain more patent for and file patent litigation for consolidating its market share and increase the difficulties of innovation to competitors.

In fact, the Federal Trade Commission (FTC) in the US had released a report in the early 2000s which addressed the problem of defensive patenting, where patents are not utilised for research and development purposes but rather for strategic leverage,[372] just a few years before this circumstance was further highlighted by economic studies. In other words, the competition problem of entities inadvertently asserting patents to hinder competitors as a method to create market power has been found arguable and is detrimental to innovation much earlier than the smartphone patent wars launched in 2010s. It is true that the intensity of the smartphone patent war appears to have become quieter than it was several years ago. Some leading handset providers tend to use other strategies to maintain their business. For example, after a period of renewed patent litigation initiated by Nokia against Apple in late 2016 concerning numerous technology patents, the two companies announced in May 2017 that they had settled all disputes and entered into a multi-year patent license agreement, alongside a new business collaboration. Now co-operation has become another prominent choice to utilise patents for business opportunities.[373] However, this shift does not completely rule out the possibility of what might be perceived as *de facto* joint monopolies or oligopolistic coordination, which may cause even worse competition problems than those

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[370] Reto M. Hilty and Christophe Geiger, 'Patent software? A judicial and socio economic analysis' (2005) 36(6) IIC 638.

[371] *Ibid*., 632.

[372] The report 'To promote innovation: The proper balance of competition and patent law and policy' was released in 2003 by the Federal Trade Commission. Cited from Thomas A. Hemphill, 'The telecommunication and information industries: US patent policy and the criterion of non-obviousness' (2009) 26 Telematics and Informatics 6.

[373] 'Apple Nokia to 'co-operate' after settling patent row' (2017) BBC news http://www.bbc.co.uk/news/technology-40012987 accessed 23 May 2017.

posed by a single technology giant. While robust competition laws exist in major jurisdictions precisely to prevent or remedy such anti-competitive situations, the application of these laws to complex technology ecosystems, intertwined patent cross-licenses, and platform-based markets can be intricate and face significant challenges. Concerns may arise, for instance, if broad cross-licensing agreements among dominant players effectively create high barriers to entry for smaller innovators or limit consumer choice, even if such arrangements do not meet the traditional definitions of illegal collusion under competition law scrutiny.

Not like the small players, big companies have legal departments with expertise to deal with patent issues including search prior art and drafting patent claims. Moreover, in contrast to the small players who are normally short of financial resource, patent application fees are affordable to big companies with a certain amount of fund for such investment. If a patent infringement claim is filed against a company, its patent portfolio enables it to file a counter suit or negotiate for settlement and cross licensing. For these large entities, individual patents may function less as direct incentives for initial invention and more as strategic tools within a broader competitive landscape.

According to the investigation on software industry participants and an analysis of prevailing patent statutes and examination guidelines, a fact can be shown that, when viewed from the perspective of achieving the ostensible legislative aims of patent law; namely, to incentivise broad-based innovation and facilitate the dissemination of useful knowledge; the current patent system often appears to fall short of achieving its full potential for stimulating innovation within the unique context of the software industry; nor does it always optimally encourage the circulation and accessibility of useful technical information in this domain. The individual and small programmers and the big companies represent two different economic sectors in the software industry who have different demands for patent protection. They both play significant roles in the knowledge-based economy but, on the other hand, also cause potential problems to the software industry. Exploiting useful information without patent protection causes what is commonly referred to as the “free-rider problem”, where third parties can benefit from an innovator's investment in research and development without incurring similar costs or obtaining authorisation. A robust patent system is necessary to provide a legitimate and systematic regulation against such practices. However, the big companies’ competition strategies seemingly often prioritise benefits only to the company rather than to broader innovation and common welfare. It

also reveals the risk that the vague scope of some software patents can indeed perplex an inventor who is genuinely keen on research and development. When the boundaries of existing patents are unclear, innovators face considerable uncertainty in determining whether their own independent developments might inadvertently infringe, leading to a chilling effect on R&D activities or compelling them to engage in costly and time-consuming clearance searches and legal consultations.

Global market – from the perspectives of developed and developing countries

It is demonstrated in this thesis that people from different social groups have diverse demands for a comprehensive and robust patent system. The tension between freedom to access useful information and protection to immaterial assets is not only the dilemma within different economic sectors. Same concern is also reflected in the various levels of technology and economy development in the Globe. In the knowledge-based economy, new technologies have been developed into different forms of inventions. In contrary to the inventions in steam and electrification industry ages where inventions were utilised in a straightforward way and circulated to particular markets, one of the distinctive characters of knowledge-based economy is that it changes people's economic and social patterns in the globalisation environment.[374]

Smartphone is a typical example that demonstrates the globalisation in the knowledge-based economy. To produce a smartphone handset, the user interface is designed in A country, available to install the applied programs developed in B country. Its accessories are produced in C, D and more countries whereas they are assembled in country E. Finally, the handsets are commercialised, distributed and sold across many countries with consumer demand. Smartphone companies seek places which require minimised costs to produce products and the market where they can maximise profits. This leads to complex interdependencies and often a form of *de facto* cooperation between developed countries and developing countries within global value chains.

In developed countries, the major taxpaying industries, such as pharmaceutical, microelectronics and computer software industries rely on strong intellectual property protection measures and enforcement to ensure profit-making and

[374] Lester C. Thurow, 'Globalisation: The products of knowledge-based economy' (2000) Vol.570 ANNALS, AAPSS 20.

their competitiveness on the market.[375] Not only advocating strong intellectual property protection, leading developed countries like the US, the EU, Canada and Japan also persuaded developed countries to sign TRIPS Agreement in 1994 to strengthen intellectual property protection.[376] Such countries' main concern is the expansion of intellectual property rights scope and mechanism for enforcement. As far as developed countries are concerned, the provision of TRIPS Agreement provides merely the minimum obligations to intellectual property protection. In order to pursue even stronger intellectual property protection than that mandated by TRIPS Agreement, the leading developed countries have frequently sought to include intellectual property provisions in bilateral or regional trade agreements with developing countries. These provisions often aim to establish protection levels that go beyond the basic minimums set by the TRIPS Agreement, sometimes referred to as "TRIPS-Plus" standards (details of the bilateral agreements is peripheral to the core discussion in this thesis and is therefore not discussed here).

On the other hand, in developing countries, the strong intellectual property protection becomes an obstacle for accessing knowledge and culture, thus bringing disadvantage to research and development. It increases the difficulties for developing countries to catch up with developed countries. However, globalisation is an unstoppable trend, it changes the ways of transmission of know-how. A piece of codified knowledge can be transformed with low costs from place to place in the world. While the main products of core innovation companies have moved from "embodied innovation" to "disembodied innovation", intellectual property rights is of importance to the companies with managerial, financial, and technological advantages as international trade and contracting out the invention are their primary income.[377] As a result, how this knowledge is protected and how easy to access it is one of the vital factors for developing countries to benefit from innovative activities.

Such an economy model has taken up the traditional productivity and the cross-border gains; it has also become the significant factor to technology convergence in industrial economies as well as of importance of innovation for

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[375] Ezieddin Elmahjub, 'A case for flexible intellectual property protection in developing countries: brief lessons from history, psychology and economics' (2016) 38(1) E.I.P.R. 31.

[376] *Ibid.*.

[377] Daniele Archibugi and Carlo Pietrobelli, 'The globalisation of technology and its implications for developing countries. Windows of opportunity or further burden?' (2003) 70 Technological Forecasting & Social Change 864-865.

technical and economic progress.[378] This concept is now widespread and developing countries have triggered innovative research and development to be a participator in the global market. Indeed, TRIPS Agreement aims to promote innovative activities by eliminating the barrier to international trade. Nevertheless, this goal seems still dragging due to the inequality positions among different players in the global market.

It is worthnoting that, despite the inequality of technology resource and development between developed and developing countries, they are not necessarily antagonistic to each other. In fact, developing countries are deemed as attractive offshore production bases for multinational corporation that is happening in the global market.[379] Such corporation allows the transformation of technologies necessary for production between offshore subsidiaries and suppliers under certain conditions[380]; it also enhances their chances of market linkage to participate the global market.

In the knowledge-based economy, new forms of technology have brought about new economic pattern. Seeking for intellectual property protection is no longer for the sole purpose of rewarding right holder's effort. As aforementioned, the enforcement of intellectual property right is also taken for strategic reasons in global market.[381] Not like the steam and electrification economies where government controlled the polices that drove economy growth, in knowledge-based economy companies' policies and their corporations are more predominant. Since the dismantling of limits to international trade in the mid-20th century, companies are able to expand cross-border economic opportunities.[382] This trend is not likely to be stopped or manipulated by the government as considerable number of citizens' livelihood relies on such opportunities, also people have enjoyed the convenience from international

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[378] Jin Guo, 'TRIPS and ICT developments in developing countries: Do 'one-size-fits-all' standards work?' (School of Economics and Management, Lund University, August 2015) 3-4. < http://lup.lub.lu.se/luur/download?func=downloadFile&recordOId=8034444&fileOId=8034445 > accessed 20 April 2017.

[379] Lester C. Thurow, 'Globalisation: The products of knowledge-based economy' (2000) Vol.570 ANNALS, AAPSS 20.

[380] According to Thurow, the conditions require developing countries to provide relatively well-education workforces, good infrastructure, political stability, a willingness to play by market rules.

[381] Reto M. Hilty and Christophe Geiger, 'Patent software? A judicial and socio economic analysis' (2005) 36(6) IIC 638.

[382] Lester C. Thurow, 'Globalisation: The products of knowledge-based economy' (2000) Vol.570 ANNALS, AAPSS 30.

trade and is not like to turn back. Developed countries have no option but continue investing global economy.[383]

The contents of traditional intellectual property protections did not cover the particularity of today's economy model, the different ways of presentation of the invention, and the different participants' needs. It is true that considering the protection to new technologies in this background and to expand intellectual property protection, mainly patent here, is necessary and urge. There is a fundamental principle to be followed; namely, to encourage innovation as well as common welfare is the major premise as intellectual property laws are "socially rooted" laws[384]. Expanding patent protection to software should, rather than as an exception, follow this principle and not to lose its legitimacy.

5.2.2 Specific Challenges Posed by Artificial Intelligence to Patent Law

The distinctive attributes of AI and generative AI technologies inherently intersect with fundamental principles of patent law, raising novel and complex questions regarding patent eligibility, inventorship, disclosure, and the assessment of novelty and inventive step.[385] Traditionally, patent law is predicated on human ingenuity, requiring a discernible technical contribution and a detailed public disclosure enabling a skilled person to replicate the invention.[386] However, AI's capacity for autonomous problem-solving and content generation challenges this human-centric model. Questions arise, for instance, as to whether an invention conceived or significantly developed by an AI system can be patented, and who would be named as the inventor.[387] Recent court rulings have reinforced that judicial interpretation alone cannot

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[383] *Ibid*.

[384] Reto M. Hilty and Christophe Geiger, 'Patent software? A judicial and socio economic analysis' (2005) 36(6) IIC 638.

[385] See 'AI and IP: 2024's legal cliffhangers and 2025's potential plot twists', Dentons (10 January 2025) <https://www.dentons.com/en/insights/articles/2025/january/10/ai-and-ip-2024s-legal-cliffhangers>, accessed 14 May 2025; 'AI trends for 2025: IP protection and enforcement', Dentons (10 January 2025) <https://www.dentons.com/en/insights/articles/2025/january/10/ai-trends-for-2025-ip-protection-and-enforcement>, accessed 14 May 2025.

[386] See general patent law principles as discussed elsewhere in this thesis (e.g., Chapter 5.2).

[387] See 'AI IP Year in Review - Patent Law and Generative AI 101', Sterne Kessler (16 January 2025) <https://www.sternekessler.com/news-insights/publications/ai-ip-year-in-review-patent-law-and-generative-ai-101/?, accessed 14 May 2025; 'AI Update – AI Inventorship: IP High Court in Japan Rules AI Cannot Be Listed as Inventor', Legal500.com (12 May 2025) <https://www.legal500.com/developments/thought-leadership/ai-update-ai-inventorship-ip-high-court-in-japan-rules-ai-cannot-be-listed-as-inventor/>, accessed 14 May 2025.

extend inventorship to AI systems under existing patent law.[388]

Furthermore, the inherent complexity and "black box" nature of certain advanced AI models pose significant hurdles for satisfying the patent law requirement of sufficient disclosure and enablement.[389] Adequately describing a complex neural network or the intricate process and data used to train a large generative model in a manner that enables a skilled person to reproduce the claimed invention without undue experimentation is technically challenging and may involve disclosing commercially sensitive information.[390]

The rapid pace of AI innovation and the often-distributed nature of relevant prior art (found not only in patents but also in research papers, code repositories, and online forums) complicate the assessment of novelty and inventive step.[391] Determining what constitutes "obvious" to a person skilled in an art that increasingly utilises powerful AI tools is a dynamic question.[392] Moreover, the vast output potential of generative AI could, in theory, rapidly create material that could qualify as prior art, potentially shortening the effective lifespan of certain types of patents.[393]

These challenges are not merely theoretical; they are actively being debated and addressed by patent offices and courts worldwide, shaping examination guidelines and influencing jurisprudence in major jurisdictions like the US and Europe.[394] While AI is often implemented through software, its unique

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[388] See Legal500.com (12 May 2025) <https://www.legal500.com/developments/thought-leadership/ai-update-ai-inventorship-ip-high-court-in-japan-rules-ai-cannot-be-listed-as-inventor/>, accessed 14 May 2025.

[389] See 'How will AI affect patent disclosures?', ResearchGate (Last Updated 17 February 2025) <https://www.researchgate.net/publication/388113515_How_will_AI_affect_patent_disclosures>, accessed 14 May 2025.

[390] *Ibid.*.

[391] See Sterne Kessler (16 January 2025) <https://www.sternekessler.com/news-insights/publications/ai-ip-year-in-review-patent-law-and-generative-ai-101/>, accessed 14 May 2025 .

[392] See 'AI innovation and a 'person skilled in the art'', Journal of Intellectual Property Law & Practice (Published 6 February 2025) <https://academic.oup.com/jiplp/advance-article-abstract/doi/10.1093/jiplp/jpaf003/8003605>, accessed 14 May 2025

[393] See Sterne Kessler (16 January 2025) <https://www.sternekessler.com/news-insights/publications/ai-ip-year-in-review-patent-law-and-generative-ai-101/>, accessed 14 May 2025

[394] See WIPO, 'Intellectual Property for Frontier Technologies', WIPO.int <https://www.wipo.int/en/web/frontier-technologies>, accessed 14 May 2025; 'Guidelines 2025 enter into force', EPO.org (24 March 2025) <https://www.epo.org/en/news-events/news/guidelines-2025-enter-force>, accessed 14 May 2025 ; 'Understanding the USPTO's Updated AI Strategy for 2025', Foresight Valuation Group (11 February 2025)

characteristics necessitate a focused examination of how existing patent law principles can or should be applied, and whether adjustments are needed to effectively incentivise and disseminate AI-driven innovation while mitigating risks of over-patenting abstract concepts or hindering cumulative development.

5.2.3. The US Approach to Software Patentability: Evolution and Enduring Issues

5.2.3.1. US Patent Law Framework

Historically, and which clearly does not resemble the patent system of today, the purpose of patent law was to attracting artisans and craftsmen to create new industries; they were an important resource in the American colonies with high demand.[395] In the US, federal patent law was first available in 1790 to "useful and important inventions" that were working or could be made working by an appropriately skilled craftsman[396]. The US patent law gave its indication to patentability subject-matter as any new and useful art, machine, manufacture or composition of matter, or any new useful improvement thereof.[397] In the 21st century, inventors are not working for same purpose as the 18th century or earlier, the term "art" in patent law was replaced by "process" in 1952 which provide the basis for patenting software patent later on.[398]

Today the US substantive patent law is found in Title 35 of the USC which embodies the same statement to govern patentability. The early criterion of "flash of genius"[399] during patent examination in the USPTO met its end after the passage of the federal Patent Act 1952 and was replaced by the "preponderance of evidence". Under such new criteria, the submitted patent plan to the patent examiners must reveal that the invention is useful, novel, and

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<https://foresightvaluation.com/blog_media/understanding-usptos-updated-ai-strategy-2025-key-takeaways-and-changes-2024/>, accessed 14 May 2025

[395] Talya Poncheck, 'The emergence of the innovative entity: Is the patent system left behind?' (2016) 16 J. Marshall Rev. Intell Prop. L. 66 68 and 79.

[396] M. Barry Dumas, Diving on to the bitstream (1st ed., Routledge) 113. Patent Act of 1790 was the first US federal patent law published by the US Congress.

[397] The US Patent Act 1793 which equals to Title 35 Section 101 of the USC. Cited *Ibid.*, at 114. The statement was followed by the USPTO.

[398] M. Barry Dumas, Diving on to the bitstream (1st ed., Routledge) 114.

[399] Fordham Law Review, 'The "flash of genius" standard of patentable invention' (1944) Issue 1 Volume 13 Fordham Law Review 85. The early criterion of "flash of genius" requires patent claim to NOT be "…merely the work of a skilful mechanic, to involve merely ordinary mechanical or engineering skill, or constitute a display of experienced skill of the calling involving only the exercise of the ordinary faculties of ….material supplied by a special knowledge and facility of manipulation resulting from habitual and intelligent…, which were deemed lack of ingenuity that is necessary for a patentable invention.

non-obvious.[400] The result of business investment in organised research and development activities, rather than invention by individual, started being protected since then.[401] Accordingly, patentees must experience a period of inspiration that exceeds ordinary skill or ingenuity to be granted a patent.[402] Currently, all industrial countries in the world follow this approach to improve their competitiveness in international trade.

The US Congress is authorised to ensure the progress of science and the useful arts.[403] Patent is one of the exclusive rights that is granted to protect an inventor's writings and discoveries. Just as the general statements by the international treaties, US patent law does not in its articles indicate the patentability of software patents. Under the US patent law, software, as other patent subject-matter, was slotted in to the current structure and is patentable as long as it meets the patent requirements expressed in law. It relies on the courts to conduct substantial evaluation and provide systematic criteria to be followed by patent offices and patentees.

As evidenced in figures 1 and 2 (Chapter 3), the number of software patents granted by the USPTO increased stably from 25,000 in 1991 to approximately 125,000 in 2011. Nevertheless, they also demonstrate that within the six months after the decision made in *Alice Corp.* in 2014, nearly two-third of the software patents challenged in front of in the US Federal Courts were considered invalid. Until early 2017, the high rate of invalid software patent in front of the Federal Court remained the same.[404] A striking figure also highlighted by observers indicated a dramatic surge in district court decisions addressing Section 101 eligibility post-*Alice*: the number of such decisions leaped from a mere 37 in the 32-month period preceding *Alice* to 359 in the equivalent period following the decision—an increase of nearly tenfold.[405]

The statistics mentioned here reveal that the patents granted by the USPTO

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[400] Thomas A. Hemphill, 'The telecommunication and information industries: US patent policy and the criterion of non-obviousness' (2009) 26 Telematics and Informatics 3.

[401] *Ibid.*, at note 3.

[402] *Ibid.*, at 3. See also footnote no. 3.

[403] Article I, Section 8 of the US Congress "The Congress shall have power… To promote the progress of science and useful arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries."

[404] JDSUPRA, 'SHzoom requests the Federal Circuit reissue trading technologies as precedential opinion' (Fenwick & West LLP, 23 March 2017) < https://www.jdsupra.com/legalnews/shzoom-requests-the-federal-circuit-39695? > accessed 15 Nov 2025.

[405] *Ibid.*

were not necessarily affirmed at the US court. The US patent examination process is conducted based on the patent claim provided by patentee. The USPTO, as abided by the US Constitution indication of promoting science, useful art and innovative activities, broadly granted software patent. Nevertheless, the Federal Court has a tendency to deny a wide definition of patentable invention, especially computer programs after the *Alice Corp.* decision, to ensure the quality of the patent.[406]

The US patent issuance authority, the USPTO, and US patent enforcement authority, the Federal Court, seem to apply different standards in dealing with software patents. The current status of the US patent system may lead to an inevitable problem of litigation exhaustion. Namely, patent examiner grants patents with overly broad scope based on the plausible patent claims, but they are easily being challenged by others in the Federal court. The following section shows that, despite embracing the constitutional principle of promoting science, the standards governing the patentability of computer-implemented inventions began to tighten significantly.

5.2.3.2. Key Case Law and Doctrinal Shifts - from *Diamond* to *Alice corp*.

The US courts are not always amenable to computer-implemented inventions patent like software in order not to offend against the principle that mathematical algorithms and laws of nature are not patentable. These judicially created exceptions to Title 35 of the USC are fundamental in identifying patentable subject-matter. Patent claims that tend to monopolise laws of nature, nature phenomena or abstract ideas should be excluded in order to ensure that "basic tools of scientific and technological work" are free for all to use and profit.[407] Section 101 of Title 35 of the USC provides four statuary categories of patent including process, machine, manufacture and composition of matter. Despite being allowable in the US patent law, applicants for patents were not able to get patent protection for the process of using a mathematical formula on a computer.

In *Gottschalk* v. *Benson* (1972)[408] and later in *Parker* v. *Flook* (1978)[409], the US Supreme Court held that algorithms and mathematical formulae, when claimed

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[406] Richard H. Stern, '*Alice v CLS*: US business method and software patents marching toward oblivion?' (2014) 36(10) E.I.P.R. 629.

[407] Eddy D. Ventose and Terry Harris, 'Managing the "risky" business of patenting in the United States' (2014) 36(12) E.I.P.R. 746.

[408] *Gottschalk v. Benson*, 409 U.S. 63 (1972).

[409] *Parker v. Flook*, 437 U.S. 584 (1978).

in the abstract, are not patentable subject matter as they are akin to laws of nature or natural phenomena. Moreover, the US Supreme Court in the aforementioned case, defined a process as a mode of treatment of certain materials that leads to certain results "It is an act, or a series of acts, performed upon the subject-matter to be transformed and reduced to a different state or thing"[410]

However, computer-implemented inventions had been giving a different review in the court since the 1980s and relevant application started springing up. The Supreme Court in *Diamond v Diehr* focused its inspection on the results produced by the claimed invention rather than how it performs the results.[411] Although the patent claim using a mathematical equation and a computer, the court reasoned that the invention turned raw, uncured rubber into synthetic rubber therefore it was the transformation of an article into a different state of thing.[412] Patents for computer-implemented inventions moved to a liberal trend especially after a Federal Court decision in *State Street Bank & Trust Co* in 1998.[413]

The patent involved in *State Street Bank* was a computerised processing system designed for efficiently managing multiple mutual funds to save costs and avoid taxes.[414] The decision established the 'useful, concrete, and tangible result' test (a standard subsequently abrogated by the Supreme Court in *Bilski and Alice*). While this test historically broadened software patentability, it is no longer the governing standard for subject-matter eligibility. Accordingly, an invention providing it is reduced to some form of practical application, and meet all other substantial and procedural requirements, is patent eligible.[415] In this regard, there were relatively few limits imposed on the patentability of software. Whereas this decision provided the opportunity for software patent, it also removed all the barrier included in Title 35 Section 101 of the USC. It incurred a flood on patent applications where many of the patent scope were overly

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[410] *Gottschalk v Benson* 409 U.S. 63 (1972). See also 71.

[411] *Diamond v Deihr* 450 U.S. (1981).

[412] *Ibid.* at 184 and 187.

[413] *State Street Bank & Trust Co v Signature Financial Group* 149 F 3d 1368 (Fed. Cir.1998).

[414] *Ibid.*, cited from Yinliang Liu, 'Patenting business method in the United State and beyond – globalisation of intellectual property protection is not always easy game to play' (2011) 42(4) IIC 397.

[415] David I. Bainbridge , *Information Technology and Intellectual Property Law* (6th ed., Bloomsbury Professional 2014) 456 and 457.

broad and uncertain.[416] This leads to a risk that most of the information contained in software are patentable and not free to be applied regardless they are trivial or useful, simply algorithm or inventive ideas.

While software patent issuance seemed to have been loosened in the US as it moved into the 21st century, the Federal Circuit in *In re Bilski* overturned the uncertain useful, concrete and tangible result requirements and rejected the patent based on the machine-or-transformation test set up in the early cases.[417] (Refer to *Diamond* and Chapter 2 for the details of the test) The court took it as an effective way for rejecting overreaching patent claim. However, the Supreme Court rejected the patentability of the invention in concern based on different reasons from the Federal Circuit.

In its reasoning, the Supreme Court explained the requirements for a computer-implemented patent which remains and is referred by the USPTO today.[418] The court confirmed the patentability of a business method. It pointed out that Section 101 does not exclude the patentability of business method because it is a kind of "method"; but it excludes a claim that merely describes the method of doing business because the claimed process is an abstract idea.[419] Another considerable indication made by the Supreme Court in this case is that even though the machine-or-transformation test is a useful and important indicator determining patentability, it should not be the sole consideration. One of the judges in the case doubted the test's usefulness in the information age where "new technologies may call for new inquiries" to the unforeseen inventions.[420] Hence, the Supreme Court did not ratify the Federal Circuit's attempt to curtail business methods patent, nor did it clarify a standard to do so. Rather, it carefully referred to the *Benson*, *Flook*, and *Deiher* decisions and denied the patent claim as an abstract idea. However, the Supreme Court's ruling significantly turned on the patentability of abstract ideas.[421] At least it revealed that not all methods are necessarily ineligible for patent albeit the court

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[416] David I. Bainbridge , *Information Technology and Intellectual Property Law* (6th ed., Bloomsbury Professional 2014) 457-458.

[417] *In re Bilski* 545 F 3d 959 (Fed. Cir. 2008).

[418] Patent subject matter eligibility, USPTO available at https://www.uspto.gov/web/offices/pac/mpep/s2106.html accessed on 16 November 2025.

[419] *Bilski v Kapppos* 130 S. Ct. 3218-3230 (2010).

[420] *Ibid*. at 3227. Cited from Susan Marsnik and Robert E. Thomas 'Drawing a line in the patent subject-matter sands, Does Europe provide a solution to business method and software patent problem?' (2011) Boston College International and Comparative Law Review 40.

[421] *Ibid*., at 3231.

attempted to clarify the exclusion to relevant inventions.[422]

Since *Diamond*, the patentability of software patent in the US has been debated with changeable arguments for decades. At least the courts in *Bilski* has implied the possibilities for business method and software patents. However, the absence of a new test or standards made by the US courts to articulate a consistent doctrine remains.[423] The *Bilski* decision clarifies the use of machine-or-transformation test but failed to indicate what other criteria should be taken into account in the court, therefore leaves the "abstract idea" abstract. In the middle 2010s, a milestone case *Alice Corp Pty Ltd v CLS Bank International* went to the Supreme Court concerning abstract idea.[424]

The Supreme Court in *Alice Corp* suggested a test to inspect patentability of process and method which, according to Burk, attempted to define a parameter of patentable subject-matter and was expected to give a conclusion to the changing opinions since *Benson* and *Flook*.[425] In *Alice,* the claimed invention uses a computer system as intermediary between two transaction parties to mirror their bank balance. This business idea is for mitigating settlement risk which is akin to a computerised escrow.[426] The Federal Circuit deemed Alice's patent is invalid based on the reason that they were directed to an abstract idea.[427] It revisits the Supreme Court's indication in *In re Alappat* that "… Not only has the world of technology changed, but the legal world has changed….. Abstract methods do not become patent-eligible machines by being clothed in computer language."[428] However, the Federal Circuit's en banc decision in *CLS Bank v. Alice Corp*. was widely regarded as a particularly stark demonstration of the prevailing inconsistency and uncertainty surrounding patent eligibility under US patent law for computer-implemented inventions.[429] While dissenting or concurring opinions reflecting differing judicial philosophies are a regular and often healthy feature of appellate jurisprudence, the sheer range of divergent

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[422] Simon Stokes, 'Intellectual property and technology issues' (2016) 134(Mar) C.O.B.7.

[423] *Ibid*..

[424] *Alice Corp Pty Ltd v CLS Bank International* 134 S. Ct. 2347 (2014) (Sup. Ct.).

[425] Dan L. Burk, 'The inventive concept in *Alice Corp Pty Ltd v CLS Bank International*' (2014) 45(8) IIC 865.

[426] Richard H. Stern, '*Alice v CLS*: US business method and software patents marching toward oblivion?' (2014) 36(10) E.I.P.R. 620.

[427] CLS Bank International v Alice Corp Pty Ltd 717 F.3d 1269 (2013) (Fed. Cir.).

[428] I*n re Alappat* 33F. 3d 1526, 1545 (1994) (Fed Cir.).

[429] Eddy D. Ventose and Terry Harris, 'Managing the "risky" business of patenting in the United States' (2014) 36(12) E.I.P.R. 776.

views expressed by the judges in this specific case, with no single approach commanding a clear majority for how to determine the patent eligibility of such software-related claims, underscored the deep divisions and the lack of a settled, predictable legal standard at that time.

The *Alice* decision went to Supreme Court where the instructions for mitigating risk were deemed patent ineligible on the ground of abstract idea.[430] Despite giving the two-step approach in *Alice* case (details in Section 5.2.3.3.1) for determining the patentability of business method, the Supreme Court again refused to rule categorically that business methods or software could not be patented.[431] Rather, Judge Moore in her dissenting opinion warned that if the claims in concern were held not patent eligible, "this case is the death of hundreds of thousands of patents, including all business method, financial system, and software patents as well as many computer implemented and telecommunication patents".[432] This stark warning vividly illustrates a major policy consideration often faced by judges in such pivotal patent eligibility cases: the potential far-reaching impact of their decisions on vast numbers of existing patents, settled industry expectations, and the broader incentives for innovation in critical technology sectors. It is not surprising that the *Alice* decision is regarded as leading to the demise of numerous patents in the US.[433]

5.2.3.3. Observation on the US System

There is no statutory exception in US patent law that excludes software as a patentable subject-matter. The courts have to cautiously apply the general exception to reject such patent. It can be told from the US case law that in defining the patentability of an invention that involves computer, the biggest challenge to the US court is to identify both abstract ideas which is not protected by patent and an invention which adds valuable improvement to the abstract idea. The balance is needed to be found to clarify the lawful objectives of patent law. Namely, to what extent the idea is too abstract to be a patentable subject-matter. Despite not denying software and business method patent, none of the cases clarified the boundaries in its decision albeit exception of abstract idea is usually applied to refuse patentability of computer-implemented inventions.

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[430] *Alice Corp Pty Ltd v CLS Bank International* 134 S. Ct. 2347 (2014) (Sup. Ct.).

[431] Richard H. Stern, 'Alice v CLS: US business method and software patents marching toward oblivion?' (2014) 36(10) E.I.P.R. 619.

[432] Dissenting opinion at 133-1314. Cited from Richard H. Stern, 'Alice v CLS: US business method and software patents marching toward oblivion?' (2014) 36(10) E.I.P.R. at note 81.

[433] Simon Stokes, 'Intellectual property and technology issues' (2016) 134(Mar) C.O.B.7.

5.2.3.3.1 The Inherent Problem of the US Patent System

The machine-or-transformation test is a principle that has been well accepted in the US patent system for examining in what circumstances a machine-implemented invention is eligible for patent; but it is also emphasised by the Supreme Court as merely one of the useful inquiries rather than the only clue to determine CII's patentability. The idea that an invention might simply give command to the machine and drive its work, on the other hand, should also be taken into consideration when assessing its patent eligibility beyond mere abstraction. The two-step analysis test made by the court in *Alice* followed the framework set forth in the decision in *Mayo* which concerned a medical diagnostic test.[434] The Supreme Court in *Mayo* was regarded as displaying considerable ambition[435] as it attempted to harmonise the historically at times inconstant application of patent law by indicating that a process invention essentially relies on the use of a natural law must "also contain other elements or a combination of elements, sometimes referred to as an "inventive concept," " sufficient to ensure that the patent in practice amounts to significantly more than a patent upon the natural law itself.[436]"

Given the Supreme Court's indications in cases like *Mayo* and *Alice* regarding the need for an "inventive concept" that transforms an abstract idea into something "significantly more," it seems that one potential path to alleviating some of the confusion surrounding software patent eligibility might involve a renewed emphasis on the underpinning principles of patent law. That is, the rigorous application of the requirements of novelty and non-obviousness (an inventive step). The doctrinal justification for such an emphasis lies in the traditional understanding that while Section 101 defines the general categories of patentable subject matter and its judicial exceptions act as a preliminary filter, the core substantive examination of whether an invention truly merits patent protection hinges on its novelty and non-obviousness over the prior art. Relying more heavily on these established, universally applicable criteria to assess the inventive contribution of software-related claims, rather than becoming overly entangled in defining elusive concepts like "abstractness" at the Section 101 stage, could potentially offer a more consistent and technologically neutral

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[434] *Mayo Collaborative Service v Prometheus Laboratories Inc* 132 S. Ct. 1289 (Sup Ct 2012).

[435] Richard H. Stern, '*Alice v CLS Bank*: US business method and software patent marching oblivion?' (2014)36(10)E.I.P.R. 621 and 622.

[436] *Mayo Collaborative Service v Prometheus Laboratories Inc* 132 S. Ct. 1289 and 1284.

approach to patent examination. This would shift the focus from what the invention is (e.g., software) to what inventive technical contribution it makes to the art.

Computer-implemented inventions are relatively less concrete to compare with those in the industrial age. Patent claims related to computer operation like business method frequently contain significant abstract description and therefore increases the difficulties during the patent examination in the USPTO of the actual scope of the patent.[437] Although the US Supreme Court gave clues regarding, while not broadly promoting, software and business method patents, it appears that eligibility is often found when claims are clearly directed to software as a technological implementation rather than merely to abstract business processes to which a computer is generically applied. In consequence, it has been observed by some studies and commentators that the rate of patent litigation concerning computer-implemented inventions, particularly involving software patents, experienced periods of significant increase; especially during times of legal uncertainty or when new technological paradigms (like smartphones or e-commerce) spurred intense competition and patenting activity.[438]

Despite the expectation on the *Alice Corp* decision for concluding harmonised criteria and ensuring the intellectual property protection for software, an investigation showed that there were no significant immediate overall changes to the issuance of software related inventions in 2014, the year when the ruling was made. If anything, patenting in certain areas, such as business methods, had noticeably fallen after the decision in 2014 (see Figure 5)[439]. This observed trend in patent issuance post-*Alice* whereby business method patents experienced a noticeable decline while the overall numbers for software inventions did not show an immediate, drastic downturn is likely attributable to a confluence of factors rather than a single cause. While one interpretation points towards the possibility that more explicit (albeit still debated) software patentability standards emerging from *Alice* and subsequent USPTO guidance, coupled with sustained market demand for software innovation, might have

[437] Yanling Liu, 'Patenting business methods in the United States and beyond – globalisation of intellectual property protection is not always an easy game to play' (2011) 42(4) IIC 401 and 402.

[438] See, e.g., Lex Machina, 'Lex Machina Releases 2024 Patent Litigation Report' < https://www.lexisnexis.com/community/pressroom/b/news/posts/lex-machina-releases-2024-patent-litigation-report > accessed 07 May 2025.

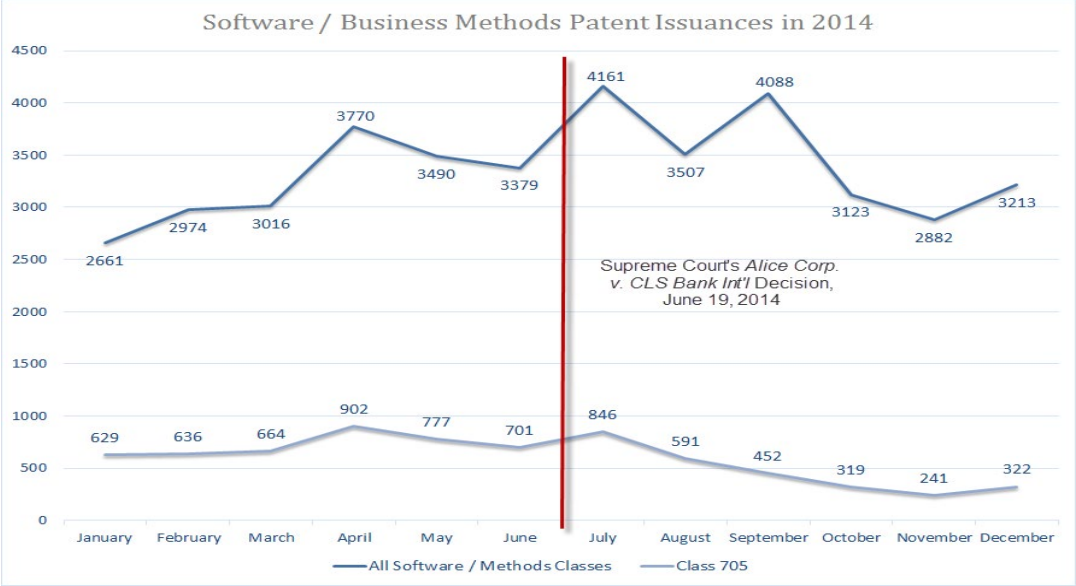
[439] Robert Sachs "AliceStorm: The Impact on Software Patent Issuance." *IPWatchdog*, 2015, ipwatchdog.com/2015/01/15/alicestorm-the-impact-on-software-patent-issuance/.

played a role in maintaining a certain level of patenting activity for software that could demonstrate an “inventive concept” beyond the abstract idea, it is also crucial to consider other contemporaneous influences. For instance, broader economic conditions during that period, shifts in R&D investment strategies by major technology companies in response to the new legal landscape, the specific types of software innovations being pursued, and the evolving examination practices at the USPTO could all have contributed to these statistical patterns. Isolating the precise impact of “more explicit standards” or “market demand” from these other complex variables requires nuanced econometric analysis; however, the data does suggest that the *Alice* decision did not uniformly halt patenting in all software-related areas; even as it significantly impacted claims perceived as purely abstract business methods. Accordingly, all the situations discussed here lead to a conclusion that the most considerable hurdle to software patents is not solely the examination procedure in the USPTO. As demonstrated through case law, despite this sometimes leading to the problem of low-quality patents, patent examination at a pre-grant stage has legal criteria to follow. Rather, the litigation of patent validity, at a post-grant stage, filed by other parties in front of the courts, is often more intractable and fraught with uncertainty. Since a consistently applied and universally clear effective conclusion on patent eligibility for all types of software has not yet been definitively and comprehensively made by the US Supreme Court, leaving considerable room for interpretation by lower courts. The more cases of the US beyond *Alice* discussed in Chapter 6.

The US patent system often seems liberal and open-minded to computer-implemented inventions like software and business methods, at least at the patent examination stage. Nevertheless, the patentability verification in patent courts often narrows down the opportunities for such patents with ambiguous tests and an apparent reluctance at times by the Supreme Court to neither explicitly confirming nor denying broad categories wholesale. The application of multiple, sometimes overlapping or inconsistently interpreted, judicial tests and standards in different cases (such as the machine-or-transformation test historically, and the evolving two-step *Alice*/*Mayo* framework) has led to perceptions of the US patent system as being exceptionally complex and, at times, lacking a single, universally predictable approach for determining the patent eligibility of computer-implemented inventions. To reposition software patents firmly within the law, the primary task is arguably to define the non-obviousness to be found in software inventions and to provide clearer criteria for distinguishing them from unpatentable abstract ideas.

Given such a rigorous determination of non-obviousness in the context of software, including a thorough justification against it being merely an abstract idea, an idea might be suggested here that there should ideally be carried out more definitively at the patent examination stage, which could potentially avoid some measure of later litigation exhaustion. However, implementing such a heightened scrutiny at the examination stage itself presents significant challenges. These include the aforementioned difficulties in establishing comprehensive software prior art databases, the high level of technical expertise required by examiners to assess complex software inventions accurately, the time constraints on individual examiners, and the inherent difficulty in prospectively defining the precise boundaries of “abstractness” or “non-obviousness” for all future software innovations without inadvertently stifling legitimate invention. Furthermore, a more stringent examination upfront could increase the initial costs and duration of patent prosecution for applicants. In this regard, a clearly defined patentable examination model for the application of software inventions was established and is presented in Chapter 7 by this thesis.

Figure 5. Number of software and business method patent issued pre and post *Alice* case



5.2.3.3.2. Economy and Political Factors to the US Patent System

Patent wars have historically involved substantial costs for the parties involved in them. While based on 2012 data, these figures illustrate the historical financial stakes. For example, a study considering data from 2012 indicated

that the average cost of US patent litigation for cases with stakes over 25 million USD was exceptionally high during that period.[440] The median damages awarded for US patent holders in the telecom industry between 1995 and 2012 were over 50 million USD. According to 35 U.S. Code Section 284, the court may increase damages up to three times the amount found or assessed.[441] While these figures reflect an earlier period often associated with intense patent disputes, more recent data on litigation costs, particularly concerning software and high-technology sectors, would be valuable to illustrate current trends. However, the 2012 data serves to highlight the significant financial stakes involved in major patent confrontations.

More recent analyses leading up to the mid-2020s indicate that while the landscape of patent litigation continues to evolve, substantial costs remain a defining feature, particularly in high-stakes technology sectors. For instance, annual reports from legal analytics firms like Lex Machina have consistently tracked patent litigation trends, often noting shifts in filing numbers, the types of patents being asserted, and the significant role played by Non-Practicing Entities (NPEs), especially in software and high-tech fields.[442] Furthermore, studies on patent litigation costs, such as those periodically published by organisations like the American Intellectual Property Law Association (AIPLA) in its Report of the Economic Survey, continue to show that defending against or asserting a patent through trial can involve expenditures running into millions of dollars, depending on the amount at risk.[443] The introduction of post-grant proceedings like *Inter Partes* Review (IPR) under the America Invents Act (AIA) has offered an alternative, often less expensive, venue for challenging patent validity, which has, in turn, influenced overall litigation dynamics and costs, though complex cases involving substantial discovery and expert testimony still command high legal fees.[444] In order to avoid the risk of patent infringement,

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[440] Heli Koski and Juha Luukkonen, 'Technology giants in patent wars: competition, litigations and innovation', Building Expertise for Innovation –conference. 26 April.2017

[441] David Long , Supreme Court ruling increases patent owners' ability to get enhanced damages (Halo v. Pulse). Essential Patent LLC, 13 June 2016.

[442] See, e.g., Lex Machina, 'Lex Machina Releases 2024 Patent Litigation Report' < https://www.lexisnexis.com/community/pressroom/b/news/posts/lex-machina-releases-2024-patent-litigation-report > accessed 07 May 2025.

[443] For data on litigation costs, see American Intellectual Property Law Association (AIPLA), 'Report of the Economic Survey' (2023 edition). This survey typically details the costs associated with IP litigation based on amounts at risk. Information is usually available via the AIPLA website. Accessed 28 April 2025.

[444] John R. Allison and et al., 'Understanding the Realities of Modern Patent Litigation' (2016) 92 Texas Law Review 1769.

more and more companies are taking into account the formation of supply chains when negotiating contractual relationships.[445]

On the other hand, the imposition of such patent litigation risks on suppliers may induce those suppliers who are diligent in respecting intellectual property rights to make careful design and manufacturing choices. This is not only to avoid infringement, but also potentially to assist them in obtaining their own patents for their innovations. Hughes and Mina,[446] investigating the impact of the patent system on SMEs drawing on UK, EU and US data sources, indicated that the use of patents as a means of protecting their investment is less likely for SMEs than other means. Due to cost and capacity pressures, many SMEs license more patents to other companies rather than enforcing them directly or investing heavily in their own patent portfolios. The patent legal aid for SMEs is still considered by many observers to be insufficient in many parts of the world. Given the inherent complexity and substantial cost of navigating the patent system, as highlighted by findings such as those by Hughes and Mina regarding SMEs' lower propensity to utilise patents due to cost and capacity pressures, more accessible and affordable legal support is widely advocated. Such support is often seen as crucial for enabling these smaller entities to effectively protect their innovations, participate more equitably in the patent system, and thereby contribute more fully to broader technological progress and economic development.

5.2.4. The EU Approach to Software Patentability - The "Technical Character" Paradigm

5.2.4.1. The European Patent Law and Legal Basis for Software Patent

As has been established earlier in this thesis, the EPC forms the primary legal basis for patent protection in Europe. Articles 52(2)(c) and 52(3), famously excludes “programs for computers... as such” from patentability, a principle that has been extensively interpreted by the EPO Boards of Appeal to mean that software possessing “technical character” and producing a “further technical

[445] Michael J. Meurer, ‘Allocating Patent Litigation Risk across the Supply Chain’, Patent Litigation Indemnification, (2018) Texas Intellectual Property Law Journal. Accessed 16 Nov 2025.

[446] Alan Hughes, Andrea Mina, ‘The impact of the patent system on SMEs’, Intellectual Property Office, 8 November 2008.

effect" can indeed be patentable.[447],[448],[449] Nevertheless, the prevailing view, reflected in EPO practice and its Guidelines for Examination (hereafter the "EPO Guidelines"), is that computer programs are not categorically excluded if they are part of a computer-implemented invention that provides a technical solution to a technical problem.[450] Accordingly, patent claims that involve computers, computer networks or other programmable apparatus "whereby *prima facie* one or more of the features of the claimed invention are realised by means of a program or programs" can be considered as CII.[451] The Guidelines further indicates that if the claimed invention involving computer programs as a patent subject-matter has a "technical character" it does not constitute the patentability exclusion listed in article 52(2) and (3) of the EPC.

What is also noticeable is, in the wording of Article 52(2) EPC, patent is available for inventions "in all fields of technology". This has been arguably referred to as providing a general leaning that does not inherently disfavour software patents if they meet the criteria of an invention.[452] The EPO's assessment of computer-implemented inventions operates under a strict two-hurdle test. The first hurdle, governed by Article 52(2) and (3), requires the claim to possess 'technical character' to avoid exclusion. Should this technical threshold be met, the second hurdle involves assessing the claimed subject matter for novelty (Art 54) and inventive step (Art 56), typically using the Problem-Solution Approach. Thus, a European patent is available only if the invention clears both hurdles.[453]

The eligibility of software patent in Europe is not merely a presumption from the statute of the EPC and the EPO Guidelines. The decisions issued from the Board of the Appeal of the EPO in the following section demonstrates that relevant authorities attempted to set up boundaries to such patent in order to draw a line between patentable computer-implemented inventions and those merely algorithm and formula. In other words, while the EPC itself does not

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[447] Article 52(2)(a) to (d) of the EPC.

[448] Article 52(2)(c) of the EPC.

[449] Article 52(3) of the EPC.

[450] The EPO Guidelines G-II, 3.6 < https://www.epo.org/en/legal/guidelines-epc/2025/g_ii_3_6.html > accessed 16 Nov 2025.

[451] *Ibid.*.

[452] David I. Bainbridge , *Information Technology and Intellectual Property Law* (6th ed., Bloomsbury Professional 2014) 459 and 460.

[453] Bernard Perbal, "Focus on the patentability of computer programs" (2014) 8 J. Cell Commum. Signal. 69.

explicitly confirm the patentability of software as a standalone category in all circumstances, the extensive case law from the EPO Boards of Appeal (as will be demonstrated in the following section) has established a clear, albeit conditional, pathway for patenting computer-implemented inventions. Such inventions are effectively approved when they demonstrate the requisite technical character and meet all other patentability requirements, subject to cautious examination by the EPO and potential scrutiny by national courts if challenged.

5.2.4.2. Key Case Law and Doctrines of the EPO Boards of Appeal

The first significant decision related to computer software made by the Board of Appeal of the EPO was *Vicom/Computer-related invention.*[454] The claimed method of digitally processing an image was initially rejected granting patent at the EPO because it was considered as a mathematical method and computer program as such. The Board of Appeal overturned this decision and pointed out that the patent claim directed to "a technical process which process is carried out under the control of program"; whether implemented in the hardware or software, it cannot be regarded as the computer programs as such excluded by the EPC.[455] Rather, it was the "application of the program for determining the sequence of steps in the process for which in effect protection is sought". The Board clarified that a patentable invention should not be excluded from protection because of its implementation modern technical means in the form of a computer program are used; it emphasised that the "technical contribution" defined in the claimed is the decisive concern.[456]

The Board of Appeal's reaction to *Vicom* resulted in a watershed to computer programs issues and was followed by later decision for decades. It opened the door for computer-implemented invention related patent. However, there was no definition of "technical character" given in this decision. In late 1990s, approaches to determining the patentability of computer programs started a gradual process of change.

In *IBM/Computer program Product I*, the Board of Appeal forwarded a "further technical effect" doctrine to determine whether a computer program has technical effect or not. The patent application in this case included a method claim and claims that concerning computer program products directed loaded

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[454] Case T208/84 *VICOM/Computer-related invention* [1987] EPOR 74.

[455] *Ibid*., at paragraph 12 of the Reasons for the Decision.

[456] *Ibid.*, at paragraph 16.

into the memory of the computer and those stored on a computer usable medium[457]. The examination division rejected the patent claim directed to computer program products in order to prevent a program written on a sheet of paper being patentable.[458] The Board of Appeal disagreed and pointed out that while a program is run on a computer brings about or is capable of bring about "a technical effect which goes beyond the "normal" physical interactions between the program (software) and the computer (hardware on which it is run)."[459]

Europe's approach to dealing with the patentability of computer programs continued changing when it entered 21st century. The Board of Appeal in case *PBS Partnership/Controlling Pension Benefits Systems* considered a method and an apparatus to control pension benefit programs.[460] On the one hand, the Board rejected the method claims in this case reasoning that, just as the stand of previous EPO cases, the method merely had "purely administrative actuarial and/or financial character" therefore did not confer technical character to such method.[461] On the other hand, the Board pointed the claimed apparatus was an invention within the meaning of the EPC albeit the claim was eventually rejected for the reason of lack of inventive step. It reasoned that the apparatus as "a computer system suitably programmed for use in a particular field, even if that is the field of business and economy, has the character of a concrete apparatus in the sense of a physical entity, man-made for utilitarian purpose."[462] This approach concerning whether there is any physical entity is difficult from the considerations in previous decisions, is thus referred as the "any hardware" doctrine.[463]

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[457] Case T1173/97 *IBM/Computer Program Product I* [1999] OJEPO 690.

[458] Case T935/97 *IBM/Computer Program Product II* [1999] EPOR 301. Cited from Susan Marsnik and Robert E. Thomas 'Drawing a line in the patent subject-matter sands, Does Europe provide a solution to business method and software patent problem?' (2011) Boston College International and Comparative Law Review 62-63. <available: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1676898 > accessed 16 Nov 2025.

[459] Case T1173/97 *IBM/Computer Program Product I* [1999] OJEPO 690, at paragraph 13 of the Reasons for the Decision.

[460] Case T931/95 *Pension Benefits System Partnership/Controlling Pension Benefit Systems* [2001] OJEPO 441.

[461] *Ibid.*, at point 3 of the Reasons for the Decision.

[462] *Ibid.*, at point 5.

[463] Susan Marsnik and Robert E. Thomas 'Drawing a line in the patent subject-matter sands, Does Europe provide a solution to business method and software patent problem?' (2011) Boston College International and Comparative Law Review 65-68. <available: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1676898 > accessed 16 Nov 2025.

A few years after the decision in *PBS Pension*, in *Hitachi/Auction Method* the Board of Appeal took a different view from the reasons of prior decision and accepted that a method claim can be an invention.[464] The claimed method in this case using the Dutch auction system to overcome the delay problem when persons placed bids to on-line auction. The Board stressed that, in concerning the "invention" within the EPC is the presence of technical character "which may be implied by the physical features of an entity or the nature of an activity, or may be conferred to a non-technical activity by the use of technical means."[465] Despite providing a very wide definition to invention, the Board rejected the patentability of the invention (the auction method) on the ground of lack of inventive step. The Board reasoned that the claim did not provide a non-obvious technical solution to an identified technical problem by technical means; rather, the implementation of the Dutch auction system, in this context, was considered merely the automation of a known business scheme using conventional computer technology, without adding any further inventive technical insight or effect beyond this straightforward computerisation. Thus, it effectively circumvented the technical problem rather than solving it in an inventive technical manner.[466]

The Board in *Hitachi* reinforced the notion of inventive step of an invention. An invention involving computer programs can avoid being excluded from patentability by the simple recitation of technical means in the patent claim thereby making eligible the subject-matter within the meaning of the EPC. The claimed category and prior is not considered at this stage.[467] With regard to the determination of technicality, however, "inventive step" is the key assessment based on the requirements in Article 56 of the EPC. In line with the *COMVIK* approach, only features contributing to the technical character are considered for inventive step. Crucially, non-technical features (e.g., business rules or administrative schemes) are disregarded in this assessment or are treated as part of the constraints given to the skilled person for formulating the objective technical problem. They cannot contribute to the inventive step. These technical features are then evaluated against "the state of the art" (also a fundamental concept in patent law, encompassing all publicly available knowledge) to

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[464] Case T258/03 *Hitachi/Auction Method* [2004] 575.

[465] *Ibid*., at point 4.4 of the Reasons for the Decision.

[466] *Ibid.*, at point 5.7.

[467] Yuko Matsuya, 'Legal Protection of Software-Copyright, Patent and Open Source-Challenges for Business in a Mixed Environment' (2012) MIPLC 20-21. Available at < https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2244216 > accessed 16 Nov 2025.

determine if the claimed solution would have been “not obvious to a person skilled in the art.” This strict separation of technical and non-technical features has been further reinforced in recent jurisprudence, notably in G 1/19 (Pedestrian Simulation), which confirmed that even computer simulations must produce a 'technical effect' going beyond the simulation itself to be patentable, a principle now central to examining AI-related inventions.

5.2.4.3. Observations on the EU System

The patentability for computer programs has attracted discussion in Europe since *Vicom* case in 1980s. The case law emerging from the EPO Boards of Appeal over several decades has shown a continuous effort to interpret and apply the criteria framed in the EPC in a manner that attempts to keep pace with rapid technological advancements, particularly in the field of computer-implemented inventions. While this evolution is often driven by the specific facts and legal questions presented in individual appeal cases, the EPO also periodically updates its Guidelines for Examination to reflect these key developments, providing a more structured (though still evolving) framework for examiners and applicants. After thirty something years computer-implemented invention technology has been moving toward to a new era. Advancement of information technology and globalisation result in transnational movements of goods, services, technologies and capital.[468] Smartphones are an essential information technology communication device today, and companies with interests in this industry are keen on broadening software patents globally to boost market share.[469]

As far as the EU is concerned, the EPO provides a patent system with a centralised EPC to be followed and grants European patent in this integrated internal market. However, it relies on the national patent office and court to deal with the patent maintenance and enforcement.[470] Today, a computer program usually carries many ideas. A statistic was once made by an observer that an

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[468] Mark Summerfield, ’The limitations of patents in a globalised economy’ (Patentology, 04 September 2016) < http://blog.patentology.com.au/2016/09/the-limitations-of-patents-in.html> accessed 17 March 2017.

[469] Richard Stallman, ’Beware: Europe’s ‘unitary patent’ could mean unlimited software patents’ (The Guardian, 22 August 2011) < https://www.theguardian.com/technology/2011/aug/22/european-unitary-patent-software-warning> accessed 17 March 2017.

[470] Mark Summerfield, ’The limitations of patents in a globalised economy’ (Patentology, 04 September 2016) < http://blog.patentology.com.au/2016/09/the-limitations-of-patents-in.html> accessed 17 March 2017.

operating system implemented around 100,000 patented ideas.[471] This result makes it more convincible that, according to Google's estimation, a smartphone might contain 250,000 patented ideas.[472] Patent enforcement in the digital era, particularly for software inventions, is no longer always like it was perceived to be in the traditional industrial age, where the patent infringer might often have been a more easily identifiable particular individual or competing manufacturing entity, and the nature of infringement (e.g., unauthorised making or selling of a physical product) could sometimes appear more obvious. Today, in the context of complex software systems and global digital distribution, potential infringers can range from large multinational corporations and sophisticated software developers to smaller entities, or even in some debated scenarios concerning distributed systems or user actions, end-users. Infringement itself can be harder to detect and prove. It often occurring through the use of complex algorithms embedded deep within software products, the provision of cloud-based services that perform patented methods, or the interaction of multiple components across different systems and even jurisdictions. The "obviousness" of infringement is further complicated by vague patent claim boundaries, the difficulty in reverse-engineering software to ascertain its internal workings, and the global scale at which software can be deployed and accessed. In this section, the challenges of granting software patent in EU patent system is analysed from the aspect economic concern, political factors and the inherent problem of the EU patent system.

5.2.4.3.1. Economic Concern and Policy Debates

The EPO grants software patents by declaring them as "computer implemented inventions".[473] In 2005, the Karlsruhe Memorandum argues that software patents in Europe will hurt jobs and innovation.[474] The signatories to this memorandum, representing various academics, software developers, and businesses, primarily contended that software patents could stifle innovation by creating legal uncertainties and barriers for programmers, particularly for SMEs and individual developers. They raised concerns that such patents might lead

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[471] Richard Stallman, 'Beware: Europe's 'unitary patent' could mean unlimited software patents' (The Guardian, 22 August 2011) < https://www.theguardian.com/technology/2011/aug/22/european-unitary-patent-software-warning> accessed 17 March 2017.

[472] *Ibid.*

[473] Free Software Foundation Europe, 'Software Patents in Europe'. < https://fsfe.org/campaigns/swpat/swpat.en.html

[474] Karlsruhe Memorandum on Software Patentability, < https://fsfe.org/campaigns/swpat/memorandum.en.html

to monopolies on fundamental software functionalities, hinder interoperability, discourage collaborative and open-source development, and divert resources towards litigation rather than productive research and development, thereby negatively impacting employment and economic dynamism in the software sector. Although the patentability requirements for software inventions in the EU are often perceived as stricter than that in the US, the demand for European patents has shown a consistent upward trend over many years, reflecting Europe's standing as a significant technology market.

For instance, while the EPO received nearly 166,000 patent applications in 2017, an increase of 3.9% and an all-time high at that time, more recent data continues to illustrate this growth. According to the EPO Patent Index 2024 European patent applications reached approximately199,275 in 2023 (an increase of approximately 2.9% compared to 2022), with fields such as digital communication and computer technology consistently ranking among the top areas for filings.[475] The top three patent applications were following by medical technology (13090, increase 6.2%), digital communication (11694, increase 5.7%) and computer technology (11174, increase 4.1%). [476] The EPO published some 106,000 granted European patents in 2017, up 10.1% on the previous year, due to sustained efforts to boost both patent quality and examination efficiency. Of these granted patents, applications originating from the EPO's 38 member states accounted for 47% of the total (up 2.8%).

EPO President Benoît Battistelli stated "The growing demand for European patents confirms Europe's attractiveness as a leading technology market. European companies filed for more patents than ever before...” Since both digital communications and computer technology patents are often closely related to software inventions, it has been confirmed that innovations in computer programs can help to increase the competitiveness of European industries within the EU's internal market and on a global scale. This perceived stricter approach to software patentability in the EU, as compared to some other jurisdictions at certain times, did not appear to significantly affect inventors’ willingness to file patents with the EPO, as evidenced by the aforementioned growth in applications.

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[475] European Patent Office. Patent Index 2023. 2024. European Patent Office, https://www.epo.org/en/about-us/statistics/patent-index-2023. Accessed 13 May 2025.

[476] EPO, ‘EPO reports growing demand; Europe's attractiveness as leading tech market confirmed’

5.2.4.3.2. Political Factors and Harmonisation Efforts

The EPO published the Unitary Patent on 14 November 2017 to enhance technology transfer in the EU through more trade and foreign direct investment.[477] The unitary patent is a single patent that valid across the territory of the participating EU states. Generally, the granting of software patents increases with increasing both trade and foreign direct investment. The implementation of the Unitary Patent will amount to a 31% saving on the cost of a classic European Patent,[478] which will help the access to the markets of innovation and technology for SMEs and research centres in the EU. Even taking account of a new requirement for the patents worth renewing, the cost structure of Unitary Patent will present a saving for most of users.[479]

The BBC News on 11 January 2018 reported that "Of all the questions hanging over world trade this year, none loom bigger than President Trump… President Trump sees the deficits as evidence that the other country concerned is trading unfairly or that US policy in the past has been weak". Although the US president then threatened in March 2018 to impose tariffs on European steel and aluminium products, the trade tensions between both the US and the EU had seen periods of heightened activity and subsequent de-escalation. While specific tariffs were imposed and debated, the broader trade relationship, particularly concerning technology and digital economy, has evolved significantly since 2018, involving ongoing negotiations and occasional friction over issues such as digital taxation, data flows, and technology standards. Evaluating the precise state of these tensions in the period leading up to 2025 requires consideration of these multifaceted dynamics.[480] Contrary to a simple assertion that there is no threat, the relationship between US political and trade policies and the European patent system is complex and subject to potential influence. While direct threats to the EPC or the EPO's operational independence are unlikely, broader US trade postures, particularly concerning technology and intellectual property enforcement on a global scale, can create

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[477] EPO, 'Unitary Patent expected to boost trade and investment in the EU, new study shows', https://www.epo.org/en/news-events/press-centre/press-release/2017/451504 accessed 16 Nov 2025.

[478] EPO, 'Cost of a Unitary Patent', < https://www.epo.org/en/applying/european/unitary/unitary-patent/cost >accessed 16 Nov 2025.

[479] *Ibid*..

[480] Silvia Amaro, EUROPE NEWS, 'President Trump's trade policy is 'difficult to follow,' top EU official says' CNBC 2018, available at < https://www.cnbc.com/2018/04/07/trade-tensions-between-eu-and-the-us-have-calmed-down-katainen.html > accessed 16 Nov 2025.

indirect pressures or shape the international intellectual property landscape within which the European system operates. The potential for such influence should not be entirely dismissed.

As mentioned, the Unitary Patent entry into force was expected in November 2017 that was later than the time when the British citizens opted for a Brexit on 23 June 2016. The new Unitary Patent has suffered substantial impact.[481] France, Germany and the UK are the three countries with the highest number of patent applications in Europe. Their languages are the only three designated official languages in which a Unitary Patent may be dealt with or validated. And London is one of the three locations of the UPC central division. Without the UK, the Unitary Patent will lose substantial value. Brexit brings unpredictable changes to the Unitary Patent in the EU. One notable past event related to the development of the Unitary Patent system was the UK government's announcement on 26 April 2018 that the UPC would allow European patents to be litigated in a single court proceeding within the signatory states. While this announcement marked a step towards the UPC's eventual establishment, the UK's subsequent decision not to participate following Brexit.[482] It fundamentally altered the system's geographical scope. As a result, the UPC commenced operations on 1 June 2023 for the participating EU member states, but without the involvement of the UK.

These political developments and shifts in international trade relations, particularly those involving key partners like the US and the complexities introduced by Brexit, underscore the dynamic external environment within which the European patent system for computer-implemented inventions must operate and adapt. Their ongoing evolution represents a factor that continues to shape the policy landscape and practical implementation of patent protection in Europe.

5.2.4.3.3. The Inherent Problem of the EU Patent System

As mentioned in earlier sections, the EU patent law does not explicitly confirm computer software as patentable subject-matter. The legal justifications by the

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[481] Boris Upho and Laura Morelli, 'Brexit: Will it stop the European Unitary Patent before it starts?' IPWatchdog 2016 < https://ipwatchdog.com/2016/04/28/brexit-will-stop-european-unitary-patent-started/ > access Nov 16 2025.

[482] European Union, United Kingdom, April 26 2018, 'Unified Patent Court one step away from reality following UK ratification'. See also Marks & Clerk < https://www.lexology.com/library/detail.aspx?g=008e6a39-e117-4235-bb6b-bd70475dbe8d > Accessed 15 Nov 2025.

EPO for the granting of software patents under the EPC, while evolving through case law, have been argued to lack sufficient clarity or consistency, posing challenges for stakeholders.[483] Strengthening these legal justifications to provide a more solid and predictable framework is indeed a key objective for enhancing legal certainty in this field. However, software is a strategic tool for the European economy to compete at a global market and becomes a key enabler for economic growth.[484] The US statute remains silent on content that does not constitute a patentable subject, while the EPC adopts a more formal approach.[485] The disagreement between the US and the EU are taken separately "subject matter eligibility" and "the invention requirement" in their law, respectively. A more detailed comparative analysis of these distinct approaches and the problems they entail will be undertaken in Chapter 6.

5.2.5 Specific Patentability Challenges in the Era of AI and Generative AI

Building upon the general overview of AI and generative AI technologies and their interface with patent law, it is crucial to examine how these emerging technologies specifically impact the application of core patentability criteria within major jurisdictions. While the fundamental requirements of patentability remain constant, their interpretation and application in the context of complex AI systems present distinct challenges that exacerbate existing ambiguities in software patenting.

5.2.5.1 Subject Matter Eligibility of AI and Generative AI

One of the most significant hurdles for AI inventions lies in navigating subject matter eligibility requirements; particularly in jurisdictions that exclude abstract ideas or non-technical subject matter. In the US, the *Alice/Mayo* framework requires claims directed to abstract ideas to include an "inventive concept" that transforms the idea into a patent-eligible application.[486] AI algorithms, especially foundational machine learning models, often risk being characterised as unpatentable abstract mathematical methods or mental processes under this test unless they are integrated into a specific technical solution or improve

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[483] European Patent Convention (EPC), Art 52(2)(c).

[484] Digital Single Market, Report on the trends and current practices in the area of patentability of computer implemented inventions within the EU and the US.

[485] Siva Thambisetty, *Alice* and 'something more': the drift towards European patent jurisprudence. *Journal of Law and the Biosciences*, 3(3) (2016) 691–696.

[486] See *Alice Corp. v. CLS Bank International,* 573 U.S. 208 (2014); Mayo Collaborative Services v. Prometheus Laboratories, Inc., 566 U.S. 66 (2012). (Note: Refer back to the discussion in 5.2.1.2).

the functioning of a computer or other technical system.[487] The increasing sophistication of generative AI, capable of producing creative outputs, further complicates this, raising questions about whether the patentable invention lies in the model itself, the training data, the training process, or a specific technical application of the model's output.[488]

Similarly, in Europe, the exclusion of "programs for computers as such" and mathematical methods under the EPC necessitates demonstrating "technical character" or a "further technical effect" for computer-implemented inventions to be patentable.[489] For AI, the EPO generally considers AI inventions patentable if they serve a technical purpose by solving a technical problem or operate within a technical system, such as controlling a technical process or improving the internal functioning of a computer system.[490] However, applying this "technical purpose" test to increasingly general-purpose AI models, particularly generative AI capable of diverse outputs, requires nuanced analysis to distinguish between technical applications and non-technical uses. The ongoing development of case law at the EPO, reflected in recent guidelines, provides some guidance, but the boundaries remain subject to interpretation.[491]

5.2.5.2 Assessing Novelty and Inventive Step for AI-Driven Innovations

Beyond subject-matter eligibility, determining the novelty and inventive step of AI inventions presents unique difficulties. The rapid pace of research and development in AI, coupled with the proliferation of information across various platforms, makes conducting comprehensive prior art searches challenging.[492]

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[487] See 'USPTO answers FAQs on Inventorship Guidance for AI-Assisted Inventions', Nixonpeabody.com (27 January 2025) <https://www.nixonpeabody.com/insights/alerts/2025/01/27/uspto-answers-faqs-on-inventorship-guidance-for-ai-assisted-inventions>, accessed 14 May 2025; 'Practical Strategies for Patent Protecting AI and Machine Learning Inventions', Caldwelllaw.com (July 2024)< https://caldwelllaw.com/news/ai-patent-strategies-uspto-2024/>, accessed 14 May 2025.

[488] See Todd M. Hopfinger and Lestin L. Kenton Jr.,' AI IP Year in Review – Patent Law and Generative AI 101' Sterne Kessler (16 January 2025) <https://www.sternekessler.com/news-insights/publications/ai-ip-year-in-review-patent-law-and-generative-ai-101/>, accessed 14 May 2025.

[489] See European Patent Convention (EPC) Art. 52(2)(c) and (3); EPO Guidelines for Examination, A-II, 3.6 and G-II, 3.3 (2025). (Note: Refer back to the discussion in 5.2.2.1/2).

[490] See EPO Guidelines for Examination, G-II, 3.3 (2025) < https://www.epo.org/en/legal/guidelines-epc/2025/ >, accessed 14 May 2025.

[491] See EPO.org (24 March 2025) <https://www.epo.org/en/news-events/news/guidelines-2025-enter-force >, accessed 14 May 2025

[492] See Sterne Kessler (16 January 2025) <https://www.sternekessler.com/news-insights/publications/ai-ip-year-in-review-patent-law-and-generative-ai-101/>, accessed 14 May 2025; 'The Role of Artificial Intelligence in Enhancing Patent Lifecycle Management',

Relevant prior art may exist not only in traditional patent databases and academic journals but also in open-source code repositories, pre-print servers, technical blogs, and online forums, sources that may not be systematically indexed or easily searchable by patent examiners.[493] This fragmentation increases the risk of inadvertently granting patents on inventions that are not truly new or non-obvious in light of existing, publicly available knowledge.

Furthermore, the involvement of AI systems in the inventive process itself complicates the assessment of inventive step. While current patent laws primarily recognise human inventors, the use of advanced AI tools by human inventors raises questions about the standard of the "person skilled in the art." If skilled practitioners routinely use powerful AI to assist in generating solutions or analysing data, what would be considered "obvious" to such a person in the context of an AI-assisted invention?[494] Distinguishing between a human inventor's inventive contribution and the capabilities of the AI tool they employed is a complex task that requires careful consideration during the examination process.

5.2.5.3 Disclosure and Enablement in the Context of Complex AI Models

The patent law requirement for sufficient disclosure and enablement mandates that a patent application must describe the invention in enough detail to allow a person skilled in the art to make and use the invention without undue experimentation. For complex AI models, particularly deep learning systems and large generative models, fulfilling this requirement can be challenging.[495] The performance of these models often depends critically on specific architectural choices, vast and often proprietary training datasets, and fine-tuned hyperparameters.

Adequately disclosing the details of a large training dataset or the intricate

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ijsrcseit.com (25 March 2025) <https://ijsrcseit.com/index.php/home/article/view/CSEIT23112582>, accessed 14 May 2025.

[493] *Ibid..*

[494] See Roberto Dini, 'AI innovation and a 'person skilled in the art'', Journal of Intellectual Property Law & Practice (Published 6 February 2025) < https://academic.oup.com/jiplp/article/20/10/643/8003605 >, accessed 14 May 2025 (discussing AI and the person skilled in the art); Nixonpeabody.com (27 January 2025) <https://www.nixonpeabody.com/insights/alerts/2025/01/27/uspto-answers-faqs-on-inventorship-guidance-for-ai-assisted-inventions>, accessed 14 May 2025.

[495] See Lisa Larrimore Ouellettee, 'How will AI affect patent disclosures?', (2025) ResearchGate (Last Updated 17 February 2025) <https://www.researchgate.net/publication/388113515_How_will_AI_affect_patent_disclosures>, accessed 14 May 2025.

process by which a model was trained may be commercially prohibitive or technically infeasible within the confines of a standard patent application. Conversely, failing to provide such details might render the patent invalid for lack of enablement, as a skilled person may not be able to replicate the claimed invention based solely on the patent specification. Finding an appropriate balance between providing sufficient information for enablement and protecting commercially sensitive aspects of AI technology remains a significant unresolved issue in patent law.

5.3. Comparative Perspectives on Software Patentability: US, EU, and Other Key Jurisdictions

There are roughly, but not limited to, two major patent approaches with different levels of estimation between promoting innovative activities and guarding the patentability indicated by patent law. The discussion in this section is to give general ideas of the US approach and EU approach, which are regarded as the different mainstreams to determine software patents, and then extended to other jurisdictions that adopt similar approaches. In-depth analysis is given in section 5.2 and its subsections for the two mainstream approaches.

5.3.1. Jurisdictions Emphasising Technological Progress and Broader Eligibility: The US and Influenced Systems

The US – A Model of Loose Patent Policies to Software

Patent is a form of intellectual property right that regarded as an integral component of the commercial innovative activities and economic growth in the US.[496] While historically, a general understanding was that an invention should fall "within the technological arts" to be patentable,[497] the practical application of patent eligibility criteria to software, particularly in the late 20th and early 21st centuries, evolved significantly through landmark court decisions. Generally speaking, the functionality of software came to be widely considered patent eligible in the US. Despite the patent exclusion of mathematical formula and algorithms, software was often taken as a predictable art as it was frequently "directed towards novel configurations and arrangement of pre-existing technology."[498] This reveals that the traditional exclusions appeared to have

[496] Thomas A. Hemphill, 'The telecommunication and information industries: US patent policy and the criterion of non-obviousness' (2009) 26 Telematics and Informatics 2.

[497] Bernard Perbal, "Focus on the patentability of computer programs" (2014) 8 J. Cell Commum. Signal. 68.

[498] Georgios I. Zekos, 'Intellectual property rights: a legal and economic investigation' (2016)

been softened in the US.

Figure 6 below shows the number of software related patents and all other patents granted annually in the US respectively in the past twenty-five years.[499] In the beginning of the 1990s, software related patents in the US were less than half of all other patents in number. The number of software related patents grew gradually with a dramatic increase in the late 1990s after the landmark *State Street Bank & Trust Co. v. Signature Financial Group* decision made by the Federal Circuit.[500] In this pivotal 1998 case, the court effectively opened the door to the patentability of many computer programs and business methods by establishing the "useful, concrete and tangible result" test. This test posited that as long as an invention, even one implementing a business method or mathematical algorithm, produced such a practical result, it could be considered patent-eligible subject matter under Title 35 Section 101 USC, significantly broadening the perceived scope of patentable software. Overall, in 2010 when the knowledge-based economy had come to dominate the global market, the two categories of patents in the US first reached a similar number and then the number of software patents started grew with accelerating pace than it was before. In 2012 the number of software related patent in the US has exceeded all other patents. It remained on a growth trajectory for some time, albeit experiencing a slight drop in 2014 where a high-profile decision was made by the Supreme Court. [501] (See sections 5.2.3.2. for further details regarding the High-profile case *Alice Corp.* as well as sections 5.2.3.3.1 for discussion about software patent after this case.)

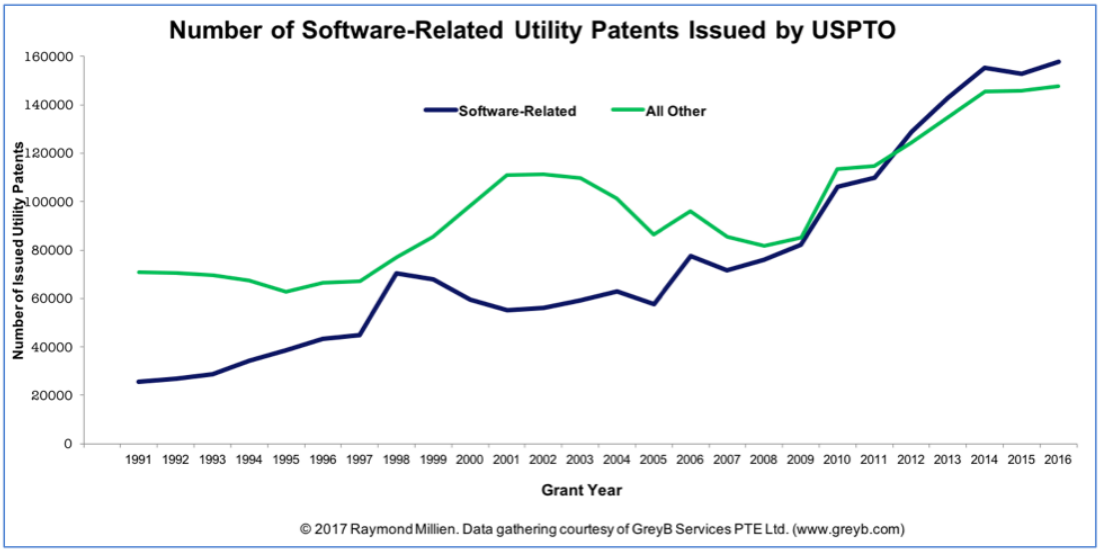
Figure 6. Numbers of software relate patents and all other type patents in the US (industry analysis)

Vol.14, No.3 IUP Journal of Knowledge Management 62.

[499] Figure cited from Raymond Millien, "Alice who? "Over half the US utility patents issued annually are software related!" (IPWatchdog 2017) < https://ipwatchdog.com/2017/05/21/alice-over-half-u-s-utility-patents-issued-annually-software/ > accessed 16 Nov 2025.

[500] *State Street Bank & Trust Co v Signature Financial Group* 149 F 3d 1368 (Fed. Cir.1998).

[501] *Alice Corp Pty Ltd v CLS Bank International* 134 S. Ct. 2347 (2014) (Sup. Ct.).



It is self-evident that software related inventions are patentable in the US in principle. As shown in the figure, it has become the main force in the innovative activities. Most of the holders of such patents are information technology companies such as IBM, Samsung, Microsoft and more which are the familiar names involved in the smartphone patent wars.[502] Two facts can be confirmed from the US status at this stage. One of those is that information companies' amassing of patents may be seen as encouraged by certain aspects of US patent policies and market dynamics, it does not necessarily mean all of their innovative activities are primarily or solely motivated by the patent system itself. In the global market, the ultimate goal of companies is profits making. This may explain why most of the software patents are held by big companies, not small players. The other facts reflected here is that, particularly evident during the era of the smartphone patent wars, the sheer volume of patent lawsuits filed in US courts suggested that the then-current US patent law framework presented significant challenges. It appeared neither robust enough for right holders to effectively and predictably prevent others' infringement, nor did it seem capable of ensuring the availability of sufficient and readily accessible information, such as a truly comprehensive and systematically organized software prior art database or clear delineations of "free applicable useful knowledge", to reliably assist innovators and businesses in avoiding unintentional infringement of others' patents.

This systemic deficiency concerning software prior art and claim clarity is

[502] Donald M. Cameron and R. Scott Mackendrick, 'Patents for computer-implemented inventions and business method' (2015) 17 < http://www.jurisdiction.com/itpatents.pdf > accessed 22 March 2017.

particularly acute for several reasons. Firstly, as discussed earlier, much relevant prior art for software often resides in diverse, non-patent literature (NPL), open-source code repositories, or as functionalities embedded within myriad commercial products, making exhaustive and reliable searches by both patent examiners and the public exceptionally challenging. Secondly, the frequently abstract and functionally-defined nature of many software patent claims can lead to ambiguous or overly broad interpretations of their scope. This ambiguity makes it difficult for developers to ascertain with reasonable certainty whether their independent innovations might inadvertently fall within the ambit of numerous existing, vaguely delineated patents, thereby creating a "minefield" where the risk of unintentional infringement becomes a significant operational and legal hazard. The substantial costs and protracted nature of patent litigation in the US further compound this problem, as even the threat of suit over a potentially weak or overly broad software patent can compel entities, especially smaller ones, to abandon innovative paths or agree to unwarranted licensing terms. Consequently, these interconnected issues can inadvertently create significant barriers to entry, heighten legal uncertainty, and impose considerable transaction costs on the software industry, particularly for startups and SMEs that lack the resources to navigate such a complex patent landscape effectively.

Japan

Japan is another developed country that seeks for strong intellectual property protection to ensure technology development and profits making. Its policies to protect new type of inventions frequently follow the US's step.[503] Not like most of the jurisdictions where patent claims tend to avoid the term "law of nature" in order not to be reject patentability, the Japanese patent law, "Patent Act" of Japan, defined that invention "… means the highly advanced creation of technical ideas utilising the laws of nature."[504] Besides, according to the Examination Guidelines for Patent and Utility Model in Japan, software is considered a creation of technological ideas utilising a law of nature when the "information processing by software is concretely realised by using hardware resources."[505]

The Japanese patent law further lists the acts that regarded as "working" in its

[503] Yanling Liu, 'Patenting business methods in the United States and beyond – globalisation of intellectual property protection is not always an easy game to play' (2011) 42(4) IIC 407.

[504] Article 2(1) of the Patent Act (of Japan) 1959.

[505] Chapter 1, Part VII of the Examination Guidelines for Patent and Utility Model in Japan.

provision; it explicitly indicates computer program as an invention of product.[506] In other words, software inventions are patentable in the form of computer program. With regard to the term "computer program", a legal definition is also stated in the Japanese patent law as "a set of instructions given to an electronic computer which are combined in order to produce a specific result."[507]

The Japanese patent law seems literally provides clarifications to the legal terminologies that causes confusion and debates. However, the term "utilising the laws of nature" leads to challenges when determining the patentability of software patent.[508] This provision is interpreted as excluding matters like mere mental activities, pure academic theories, artificial arrangement from being patentable; laws of nature is also not patentable as itself does not utilise laws of nature.[509] Software is normally regarded as a set of instruction to computer rather than using law of nature and it is proven by the consideration in Japanese court - the most common reason to lead to an unpatentable software is that the patent claim failed to demonstrate the exercise of ordinary creative activity expected of a person having ordinary programming skills.[510] In other words, subject-matter eligibility seems not a troublesome issue in Japan, as the statutory framework explicitly recognises computer programs as product inventions and provides a definition for them. Consequently, the primary hurdles for software inventions often lie in meeting the requirements of novelty and, particularly, inventive step, rather than overcoming an initial subject-matter exclusion akin to that for "programs for computers as such" in Europe or navigating the "abstract idea" doctrine in the US. The assessment of inventive step for software in Japan is conducted similarly to other types of inventions, focusing on whether the invention would have been obvious to a person having ordinary skill in the art, which in this context often translates to a person with ordinary programming skills and knowledge of the relevant technical field.[511]

However, the core requirement that an invention must be "a highly advanced

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[506] Article 29(1)(i) of the Patent Act (of Japan) 1959.

[507] Article 29(4) of the Patent Act (of Japan) 1959.

[508] Yuko Matsuya, 'Legal Protection of Software-Copyright, Patent and Open Source-Challenges for Business in a Mixed Environment' (2012) MIPLC 26.

[509] Yuko Matsuya, 'Legal Protection of Software-Copyright, Patent and Open Source-Challenges for Business in a Mixed Environment' (2012) MIPLC 26.

[510] Appeals Department of the Japan Patent Office, 'Major judicial precedents of business method-related inventions'(2006). Cited from < https://rimonlaw.com/images/general/Availability%20of%20Software%20Patents%20Internationally.pdf > 11 accessed 17 Nov 2025.

[511] *Ibid.*, at 27.

creation of technical ideas utilising the laws of nature" still necessitates careful consideration for software patents. While the Examination Guidelines clarify that "information processing by software concretely realised by using hardware resources" can meet this criterion, challenges can arise in demonstrating how specific software, especially that which might appear to be primarily algorithmic or involve business methods, truly "utilises laws of nature" beyond the general operation of a computer. Japanese case law, as indicated by some analyses of business method-related inventions, suggests that rejections for lack of inventive step often occur when the claimed software merely automates a known manual process using conventional programming techniques, or when the purported novelty lies in non-technical business rules rather than in a technical implementation that leverages natural laws in a non-obvious way. For instance, a claim might fail if it does not demonstrate how the software achieves a specific technical effect or improvement that goes beyond what would be expected from a skilled programmer tasked with computerising a given problem.

This approach, while differing in its foundational terminology from the EPO's direct "technical character" and "further technical effect" inquiries, shares a common underlying goal: to distinguish patentable technical innovations involving software from non-patentable abstract schemes or mere computerisation of non-technical processes. The explicit inclusion of computer programs as product inventions in the Japanese Patent Act, and the provision of a statutory definition for "computer program" might be seen as an attempt to provide greater initial legal clarity compared to jurisdictions that rely more heavily on evolving case law to define the boundaries of software patentability. Nevertheless, the interpretation of "utilising the laws of nature" in the context of sophisticated software, including AI-driven inventions, remains an area where examiners and courts must continually adapt existing principles to new technological realities, a challenge noted by commentators like Matsuya regarding the broader legal protection of software.[512] Ultimately, Japan's framework seeks to foster its strong technology sector by providing a pathway for software patents, provided they represent genuine technical advancements that are both novel and non-obvious within the context of established programming knowledge and technical capabilities.

South Korea

[512] See also Robert Plotkin, 'Commentary: How AI is affecting the patent system' (2023) Reuters https://www.reuters.com/legal/litigation/how-ai-is-affecting-patent-system-2023-06-28/ accessed 11 May 2025.

South Korea has been one of the countries whose information technology sector and corresponding intellectual property policies have been largely influenced by the changing of global economic environment.[513] The sharp rising of Samsung in the technology industry in past decades symbolises the rising of South Korea as a major technological power. While playing a remarkable role in international trade, this has prompted South Korea to adjust its intellectual property policies; especially under the pressure from its biggest counterpart in international trade, such as the US.[514] It is in the background that the enactment of the early Computer Program Protection Act in South Korea occurred which explicitly covering computer software.[515]

The general definition of an "invention" is given in the Korean patent law, the Korean Patent Act, where the term is defined essentially similar to Japanese patent law[516]: an invention is "the highly advanced creation of a technical idea using the law of nature." computer-implemented inventions like software are generally treated no differently from other types of inventions under Korean patent law. They are examined with the same statutory requirements due to the absence of specialised provisions specifically targeting computer-related inventions in the Act itself. In 2014, the Korean Intellectual Property Office (the "KIPO") enacted a revised version of its examination guidelines in response to the economic environment change. In this Examination Guidelines for Computer-Related Inventions, an invention is understood to implement a concrete means involving a combination of software and hardware (or device implementation) to achieve a specific purpose.[517] Consequently, under this framework, a computer-implemented invention that integrates software with hardware resources to perform specific information processing for a defined purpose can indeed constitute an invention that is the "creation of technical ideas using the laws of nature," as stipulated by the Korean Patent Act. The KIPO Guidelines further elaborate that for software to be recognised as part of such a patentable invention, it must be more than an abstract algorithm; its

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513 Paul Goldstein and Joseph Straus, Intellectual property in Asia: Law, Economics, History and Politics (Springer, 2009) 262.

514 *Ibid*.

515 Compute Programs Protection Act 1986 in South Korean.

516 See Article 2(i) of the Korean Patent Act 1990, an invention is "the highly advanced creation of a technical idea using the law of nature."

517 Refer to Section of the Examination Guidelines for Computer-Related Inventions. Cited from Ho Yeon Lee and Stephen T. Bang, 'Patent protection of computer program inventions' (2016) < http://www.internationallawoffice.com/Newsletters/Intellectual-Property/South-Korea/Kim-Chang/Patent-protection-of-computer-program-inventions > accessed 17 March 2017.

interaction with hardware to achieve a specific outcome is key. For instance, software that controls a physical process, optimises the functioning of the computer itself, or processes data in a way that is intrinsically linked to a specific technical field is generally considered to fulfil this requirement. This approach aims to ensure that patent protection is directed towards software that provides a concrete technical solution or application, rather than abstract computational methods divorced from any specific technical context. The emphasis is on the "concrete means" and the "specific purpose" achieved through the software-hardware combination, thereby grounding the software in a technical reality that can be seen as "utilising laws of nature" through its interaction with physical hardware components.

Different countries have different policies for dealing with software patents. The US has shown its liberal mind to software related patent, and this has been reflected in the growth of the number of software patents there in the past decades; Japan and South Korea appear to be following up this trend to a certain extent.[518] Computer programs were once often viewed primarily as an idea of a series of steps or instruction to perform a method. In the knowledge-based economy, jurisdictions have no choice but to face the truth regarding the enhancement, sophistication and value of computer programs like software. Despite there not yet being a uniformed consensus in the world to explicitly take software inventions as a statutory patent subject-matter without qualification,[519] jurisdictions like the US, Japan, and South Korea have demonstrated clear attempts to accommodate software inventions within their patent systems, primarily by establishing specific criteria through examination guidelines and evolving case law that interpret general patentability requirements in the context of software. For instance, while the US employs a judicial exceptions framework (notably the *Alice*/*Mayo* test focusing on abstract ideas and inventive concepts), both Japan and South Korea, with patent laws defining inventions as “highly advanced creations of technical ideas utilising laws of nature,” have developed guidelines clarifying how software, through concrete realisation via hardware resources, can meet this definition. These approaches, though distinct in their doctrinal language, share a common trajectory of finding pathways to patent software that exhibits more than mere abstract computation. This contrasts with other jurisdictions that may have historically shown, or continue to show, greater

[518] Donald M. Cameron and R. Scott Mackendrick, ‘Patents for computer-implemented inventions and business method’ (2015) 62 < http://www.jurisdiction.com/itpatents.pdf > accessed 22 March 2017.

[519] *Ibid*. at 15.

reluctance or apply more stringent interpretations regarding the patentability of mathematical formulas and algorithms when embodied in software, although, as the examples discussed in the following section for Europe might reveal, even such traditionally restrictive approaches have seen considerable evolution and a degree of convergence towards recognising the patentability of technically inventive software..

5.3.2 Jurisdictions Adhering to More Formal Limitations on Software Patent Scope: The EU and Other Approaches

The EU – A Model That Applies Rigorous Examination to Software

The patent system in Europe is unique when compared with other jurisdictions in the world. The EPO is an intergovernmental organisation for Europe countries inside or outside of the European Union which aim to support innovation, competitiveness and economic growth across Europe. Inventors are able to seek patent protection in up to 44 countries, including EPC contracting states, extension states, and validation states as of 2025 under a single procedure provided by the EPO under the legal framework of the EPC, as referenced earlier in this thesis.[520]

The EPC is not only the legal basis for granting European patents, it also provides single procedure to the subsequent registration in the contracting states and provides standard rules for governing such patents.[521] Decisions of the EPO can be appealed to the Boards of Appeal which are bound by the EPC. Generally speaking, national courts of the contracting states often look to the decisions settled by the EPO and its Boards of Appeal for guidance; however, historically, they were not strictly bound to identically do so in all matters of interpretation or enforcement.[522] This has led the European patent system to a unique problem that was perhaps not as acutely likely to be seen in more centralised jurisdictions. Namely, a regional system (such as that governed by the EPC) that applies the same patent granting criteria through a central body like the EPO, can still lead to situations where national courts in different contracting states do not necessarily put a same construction on the scope or

[520] European Patent Office, at https://www.epo.org/about-us/governance.html accessed on 10 May 2025. The term “EPC” is the abbreviation of the Convention on the Grant of European Patents which also known as the European Patent Convention.

[521] Donald M. Cameron and R. Scott Mackendrick, ‘Patents for computer-implemented inventions and business method’ (2015) 31 < http://www.jurisdiction.com/itpatents.pdf > accessed 22 March 2017.

[522] Nicolas Fox and William Corbett, ‘UK and EPO approaches to excluded subject-matter and inventive step: are Aerotel and Pozzoli heading for the rocks?’ 36(9) E.I.P.R. 569.

validity of granted European patents when disputes arise at the national level; the intendedly uniform patent system in Europe under the EPC has thus, at least prior to the full effect of recent reforms like the Unified Patent Court (UPC), often been described by commentators as being, in practice, fragmented.[523] As a result, it is not surprised to see the inconsistent decisions on similar patent disputes being rendered by the EPO's adjudicative bodies and various national courts respectively.

As indicated in the EPC articles, the European patent shall be regarded as national patent in each of the contracting states where it is granted[524]; Any infringement shall be subject to be dealt with by national law.[525] Patent granted based on the EPC shall be enforced and invalidated in each national court separately. Recent research demonstrated the different outcomes, concerning a same claim, made by different national courts across the EPC jurisdictions.[526] The statistics, mainly referring to the patent litigations between 2000 and 2008, indicated that only small percentage of the parallel litigation across the EPC jurisdictions reached to a same ruling. Around 28.6 % of cases file in Germany and in the UK had same outcome. On the other hand, there were only 22.7 % of parallel litigations in the Germany and the Netherlands reached to consistent outcomes.[527] Accordingly, there was an inherent difficulty for patent holders to enforce patents around the European territory.

This very fragmentation and the associated costs and legal uncertainties were, of course, primary drivers behind the long-standing efforts to establish a more unified patent system in Europe, culminating in the creation of the Unitary Patent and the UPC. Following the entry into force of the UPC Agreement on 1 June 2023, a new supranational forum has emerged to adjudicate European patents and unitary patents across participating EU member states. Within its first 18 months of operation, the UPC registered over 500 filings, reflecting

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[523] The assertion that the European patent system, prior to the full implementation of the Unified Patent Court, was *de facto* fragmented due to divergent national court practices in patent enforcement and litigation, despite the EPC, is a well-established critique. This fragmentation was seen as leading to legal uncertainty, forum shopping, and increased costs for litigants. For an analysis of these systemic issues, see, for example, 'Bruno van Pottelsberghe de la Potterie, 'Lost property: the European patent system and why it doesn't work' (Bruegel Blueprint Series Vol. IX, 2009) particularly Chapter 3 discussing litigation and enforcement challenges. This report is available at <https://aei.pitt.edu/11263/1/patents_BP_050609.pdf> accessed 01 May 2025.

[524] Article 2(2) of the EPC.

[525] Article 64(3) of the EPC.

[526] Katrin Cremers *et al.*, 'Patent litigation in Europe' (2017) 44 Eur J Law Econ 29.

[527] *Ibid.*, at 31.

strong demand and user confidence. Although comprehensive statistics on outcome alignment between the UPC and national courts are not yet publicly available, the establishment of the UPC represents a deliberate policy response to previous inconsistencies and aims to improve legal certainty and reduce forum shopping within Europe.[528]

After a European patent is grated in accordance with the EPC, it is put into effect within the contracting states that the right holder assigned. Therefore, the patent is performed in the form of a bundle of European patents. An invention may be considered in various way in different national courts as the bundle of European patents are subject to national legislation of the contract states.[529] Given the inconsistency of EPC interpretations and the complex procedure of enforcing the European patent, the idea of European unitary patent has been introduced and was expected to be put into force in the first quarter of 2018.[530] It is for the purpose of providing effective protection and ensuring the legal certainty in European territory; besides, it also aims to respond to the challenge to the European internal market brought its economic counterpart like the US, Japan and other emerging markets like China.

Under the unitary patent system in the EU, patent applicants are able to obtain protection in member states after the UK leave the EU, with a single application to the EPO.[531] Although Brexit leads to several changes after the UK general election held in June 2016 (details is discussed in section 6.12b), still the unitary patent system is expected to provide a forum for centralised enforcement of European patent and an efficient mechanism for a challenger to invalidate a European patent.[532] The UPC that proposed with this new system allows participating member states to file infringement and validity disputes at the unified supranational court.[533] The effectiveness of the unitary patent remains

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[528] Antje Brambrink and Nikita Alymov, 'Key Trends and Takeaways from the First 18 Months of the UPC'(2024) Finnegan https://www.finnegan.com/en/insights/articles/key-trends-and-takeaways-from-the-first-18-months-of-the-upc.html accessed 10 May 2025.

[529] Avgi Kaisi, 'Finally a single right for the EU? An analysis of the substantive provisions of the European patent with unitary effect' (2014) 36(3) E.I.P.R. 171.

[530] European Patent Office, at http://www.epo.org/law-practice/unitary.html accessed on 12 June 2017.

[531] At the time of writing, Croatia, Poland and Spain do not sign the Unified Patent Court Agreement which was signed by most of the EU countries in 2013.

[532] Hazel Ford and Leythem A. Wall, '7 reasons revocation in EU could be as popular as IPR in United States' (2016) Finnegan at https://www.law360.com/articles/775865/7-reasons-revocation-in-eu-could-be-as-popular-as-ipr-in-us accessed 15 Nov 2025.

[533] European Patent Office, at https://www.epo.org/en/applying/european/unitary/upc accessed 15 Nov 2025.

to be seen. What is concerned here is the influence it may cause to software patents in Europe. The possible influences are examined from two perspectives: one is its impact to the software industry; the other is its intervention to the domestic patent law and national court of member states.

It cannot be denied that the conception of a unitary patent aims to set up a centralised system which facilitates the harmonisation of European patents. Apart from obtaining a Pan-Europe patent by a single request, the UPC also boosts the efficiency of patent litigation procedure. It will comprise of a court of first instance, a Court of Appeal and registry that aims to save the costs of procedure (including time and financial costs) and increase legal certainty.[534] To carry out this aim, the UPC is designed to harmonise the scope and limitation of patent in substantive patent law in the EU and remedies when infringement occurs.[535]

The new system intends to ease the cumbersome procedure when a patent proprietor wishes to enforce his patents in multiple European countries or when a third party wishes to challenge the validity of a European patent. With the introduction of the UPC, these can be done in the European patent court with single action. Moreover, enforcing and challenging European patent in multiple countries allows patent holders and third parties to choose national courts and procedures that is in favour of their benefits.[536] For example, patent holding companies are likely to enforce patents in the markets which have strong institutions with strong intellectual property protection.[537] The UPC also helps to prevent forum shopping.

As discussed in Chapter 4. Despite the intended harmonization, large corporations in smartphone patent war are keen on building up patent portfolios for dominant and defensive purposes. A unitary patent could arguably make it easier for them to reach this goal, as obtaining geographically broad protection via a single patent might appear procedurally less complex than managing a bundle of national patents, while still providing extensive European coverage. In other words, if a European patent with unitary effect is granted to a big company, the company's ability to assert its rights or leverage the patent strategically across numerous participating states could be enhanced,

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[534] *Ibid*..

[535] *Ibid*..

[536] *Ibid*.

[537] Yongwook Paik and Feng Zhu, 'The impact of patent wars o firm strategy: Evidence from global smartphone market' (2016) Working Paper 14-015 Harvard Business School 6.

potentially facilitating the company to monopolise useful information more easily or further enhance its business opportunities in the market.

It is also a concern raised by some commentators that similar perceived advantages of broader, more easily asserted rights under the unitary system might also inadvertently benefit patent trolls that purchase patents primarily to demand licensing fees by threatening litigation, rather than to circulate or practice the patented technology.[538] Such patent abuse is particularly a recognised underlying risk to individuals and start-up businesses who may not afford to pay for licensing or defend against potentially unfounded infringement claims. In regard to SMEs, it has been repeatedly emphasised that SMEs is the target of unitary patent and its UPC's goal of a cost-effective and simplified European patent application and enforcement.[539] Request has been made by the member states that participated the Select Committee on the Unitary Patent to minimise the cost of patent protection for SMEs.[540] The European Commission, in response, declared to help SMEs on requesting and managing unitary patent; including affordable litigation fees in Europe, mediation and arbitration service specialised for the needs of SMEs, local intellectual property experts that provide SMEs guidance for their portfolio, and preventive intellectual property infringing schemes that prevent or disincentives infringement behaviours.[541] However, the actual statistics of European patent disputes from 2011 shows a different trend rather than the ideal picture envisaged by the EPO.[542] The unitary patent system does not appear to alleviate the financial burdens associated with filing patent applications, negotiating cross-licensing agreements, or affording patent litigation.[543]

According to the statistics of the Commission, only 10% of the European patent

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[538] Chris Hamer and Andreas Wietzke, 'New Unified Patent Court may tilt playing field in favour of 'patent trolls' ' (2022) Mathys &Squire https://www.mathys-squire.com/insights-and-events/news/new-unified-patent-court-may-tilt-playing-field-in-favour-of-patent-trolls/?utm_source=chatgpt.com accessed 10 May 2025.

[539] Ingve Björn Stjerna, 'The European Unified Patent Court: what can still go wrong' (2017) Foss Patents at http://www.fosspatents.com/2017/01/the-european-unified-patent-court-what.html accessed on 13 June 2017.

[540] European Commissions, 'Unitary patent' at https://www.epo.org/en/applying/european/unitary/unitary-patent accessed on 17 Nov 2025.

[541] *Ibid.*

[542] Ingve Björn Stjerna, '"Unitary patent" and court system – A poisoned gift for SMEs '(2016) at https://www.stjerna.de/files/Unipat-SMEs.pdf accessed 17 Nov 2025.

[543] Ingve Björn Stjerna, 'The European Unified Patent Court: what can still go wrong' (2017) Foss Patents at http://www.fosspatents.com/2017/01/the-european-unified-patent-court-what.html accessed on 13 June 2017.

litigations were parallel litigation; the rest 90 % of litigations were filed to single member states only.[544] Besides, it was pointed out by Dr. Jochen Pagenberg in Germany that the large majority of European parallel litigation was not filed by SMEs.[545] In other words, the SMEs are not the group that could benefit from the unitary patent system. Even if they enforce patent at the new system, the amount of reimbursed payment by the losing party to the winning party can up to more than five times as much than the payment of current patent litigation filed at German courts.[546]

The statistics cited by some critics therefore raise concerns that, despite the stated goals of promoting an efficient and accessible patent package beneficial to SMEs, the unitary patent and UPC might, in practice, still disproportionately favour litigants with substantial financial resources, potentially perpetuating some of the very problems of access and cost it envisaged to solve if not carefully managed.[547] A primary aim of the new system is indeed to enhance legal certainty, reduce litigation costs, and simplify patent enforcement across Europe, thereby strengthening the internal market and potentially bolstering Europe's overall competitiveness against economic counterparts like the US and China. It's ultimate impact on SMEs and the balance of interests within the patent ecosystem remains a subject of ongoing observation and debate. Therefore, proper adjustment of the patentability standards and careful attention to procedural fairness and cost control within the UPC system are considered by many to be very important for SMEs. This thesis will discuss the patentability and examination model in Chapter 7.

The patent legislation in each contracting state must be based on the consideration of its particular legal history, technology development, economic needs and a myriad other factors. Once the unitary patent system is adopted, contacting states have to accept the EPO approach. However, it should be bear in mind that the EPO is an organisation outside of the EU albeit the majority of its members are EU countries. After the unitary patent and UPC put into force, EPO is entitled to grant or refuse an EU-wide patents and its Courts' decision

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544 *Ibid.*, at 4.

545 *Ibid,* at 4-5.

546 Ingve Björn Stjerna, 'The European Unified Patent Court: what can still go wrong' (2017) Foss Patents at http://www.fosspatents.com/2017/01/the-european-unified-patent-court-what.html accessed on 13 June 2017.

547 Kluwer Patent blogger, 'Entry in to force of the Unitary Patent package appears as a risky bet' (2023) https://patentblog.kluweriplaw.com/2023/05/29/entry-into-force-of-the-unitary-patent-package-appears-as-a-risky-bet/ accessed 13 May 2025.

has EU-wide bounding force. Furthermore, as Moody at Ars Technica argued, the EPO in the new patent system will receive 50 % of the patent renewal fees and the other EU countries will share the rest 50 %. It may be an incentive to the EPO to grant as many patent as possible, including computer-implemented inventions that remain controversial in some court opinions.[548]

Software is one of the inventions that the EPO may considerably change the landscape of the inconsistent national patent courts' decisions in contracting countries. Either the EPO rule out or accept software patent, no contacting countries is able to escape it regardless the flexibility needed according to the individual legislation history and technology development in each country. If the decision is challenged or appealed, it will be considered based on the EPO's rules. Concerns have been raised by some, such as Stallman,[549] that the software business and computer users could effectively be "tied in knots" by the EPO's interpretations and decisions under such a centralised system, particularly if these decisions are perceived as overly broad or difficult to challenge effectively at the national level for participating states. The unitary patent might be seen by some critics as conferring the EPO unchecked power to decide software patents, potentially leading to an increase in patent disputes within the EU similar to those that have taken place in the US, and raising fears among some about the possible emergence of litigation patterns akin to "US-style patent trolling" if not carefully managed.[550] Let alone the US-style patent trolls that resulted in the US patenting system. EU case law from the EPO Boards of Appeal has demonstrated an acceptance of software patents (details of significant decisions see section 5.2.2.) using the term computer implemented invention rather than the ambiguous idea of software. Since the door has thus effectively been opened to software patents in the EU through this evolving jurisprudence, commentators such as Zammit and Aquilina[551]

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[548] Glyn Moody, 'Welcome to EPOnia, the strange land of European patents that is outside the law ' (2016) Ars Technica UK at https://arstechnica.co.uk/tech-policy/2016/02/welcome-to-eponia-the-strange-land-of-european-patents-that-is-outside-the-law/6/ accessed on 22 August 2017.

[549] Richard Stallman, 'Beware: European's "unitary patent" could mean unlimited software patents' (2011) The Guardian at https://www.theguardian.com/technology/2011/aug/22/european-unitary-patent-software-warning accessed 13 June 2017.

[550] Richard Stallman, 'Beware: European's "unitary patent" could mean unlimited software patents' (2011) The Guardian at https://www.theguardian.com/technology/2011/aug/22/european-unitary-patent-software-warning accessed 13 June 2017.

[551] Andrew J. Zammit and Yasmine Aquilina, 'European Union: The murky water of software patents' (2015) at

have expressed concerns that the unitary patent system could potentially lead to an increase or "flooding" of software patent applications and grants across the participating EU member states, particularly if the harmonisation efforts within the UPC do not lead to a consistently rigorous application of patentability standards, or if perceived variations in national approaches persist or influence UPC divisions.

Although the states of the US do not necessarily have identical rules in determining patent issues in each district court, the centralised federal court in the US is in charge of the finalising patent disputes that controversial in different states according to the principles indicated in the US Constitution. As for the EU is not an integral country and the EPC in the EU is not in the position same as the supremacy of US Constitution in the US. Once a confliction occurs among the EPO court and national court of contacting states, it is hard to expect the patent disputes to be settled in a way the fulfils the national laws of all EPC contracting states. However, once a software patent is affirmed by the EPO under the unitary system, the unitary software patent will automatically be recognised by all the participating contracting states. Nevertheless, given the EU's multi-jurisdictional legal traditions, the historical divergence in national court interpretations even under the EPC framework, and the inherent complexities in harmonising approaches to rapidly evolving subject matter like software across numerous member states with distinct legal and economic priorities (as discussed throughout this chapter), it arguably appears more difficult to form a truly uniform and controversy-free software patent category in such a heterogeneous background as the EU than in the more centralised federal patent system of the US, despite the latter's own significant challenges with software patent clarity.

Brexit and its Consequences for the Unified Patent Court System

The implementation of the European Unitary Patent and the associated UPC system was historically contingent upon ratification by a specific number of EU member states, with France, Germany, and the UK initially envisaged as three key mandatory ratifying states crucial for the system's entry into force under its original framework.[552] The UK was thus expected to play a pivotal role, not only

http://www.mondaq.com/x/422988/Patent/The+Murky+Waters+Of+Software+Patents accessed 15 June 2017.

[552] The Agreement on a Unified Patent Court (UPCA) originally stipulated specific ratification requirements involving the UK, France, and Germany for its entry into force. See, e.g., Article 89(1) of the Agreement on a Unified Patent Court (2013/C 175/01) OJ C 175/1, 20.6.2013. For early discussions on ratification, see also European Patent Office, 'Unitary Patent &

as a ratifying member but also as one of the three locations for the UPC's central division, with a branch planned for London.[553] However, the United Kingdom's 2016 referendum decision to leave the European Union (Brexit), which formally occurred on January 31, 2020, fundamentally altered this landscape and introduced significant political and legal complexities regarding UK participation.[554] Following an initial period of uncertainty where the UK government had, at one point, signalled its intention to proceed with ratification despite Brexit,[555] the UK ultimately confirmed in February 2020 that it would not be participating in the Unitary Patent system or the UPC.[556]

This definitive withdrawal of the UK from the UPC project had several direct consequences for the then-nascent system:

- Restructuring of the UPC's Central Division: The planned London branch of the UPC's central division, which was to handle patents in specific technological fields (such as life sciences and pharmaceuticals), had to be reallocated. These responsibilities were subsequently divided, with Milan, Italy, being chosen to host the part of the central division previously assigned to London, alongside the existing seats in Paris and Munich.[557]
- Geographical Scope of the Unitary Patent: The Unitary Patent, by its nature an EU instrument intertwined with participation in the UPC, does not cover the territory of the UK. Patentees seeking protection in the UK must continue to utilise the national UK patent system or validate their granted

Unified Patent Court'.

[553] Article 7(2) of the Agreement on a Unified Patent Court (2013/C 175/01) originally designated London as one of the seats of the central division, alongside Paris and Munich, with responsibilities for specific technological fields. See also early official communications from the UPC Preparatory Committee, e.g., Unified Patent Court, 'Locations' <https://www.unified-patent-court.org/court/locations> accessed 06 May 2025.

[554] Luke McDonagh, ' UK Patent Law and Copyright Law after Brexit Potential Consequences' (November 2017) <https://www.cigionline.org/static/documents/documents/Brexit%20Series%20Paper%20no.3_0.pdf> accessed 06 May 2025.

[555] See, e.g., UK Intellectual Property Office, 'UK signals intention to ratify the Unified Patent Court Agreement' (Press release, 28 November 2016). This press release, though now historical, reflected the government's position at that specific juncture.

[556] See, e.g., 'UK formally withdraws from Unified Patent Courtt', 'simmons-simmons, 31 July 2020 <https://www.simmons-simmons.com/en/publications/ckda3v1mmk7120926aq8ts61b/uk-formally-withdraws-from-unified-patent-court> accessed 06 May 2025.

[557] See, e.g., Unified Patent Court, 'Signature of the Headquarters Agreement between Italy and the Unified Patent Court' 08 February 2024 https://www.unified-patent-court.org/en/news/signature-headquarters-agreement-between-italy-and-unified-patent-court accessed 06 May 2025.

European patents nationally in the UK, separate from the Unitary Patent which offers protection in the participating EU member states.

- Impact on European Patent Harmonisation: The UK's non-participation, given its historical significance and volume of patent litigation within Europe, meant that the goal of a fully harmonised patent litigation landscape across all major European economies via the UPC could not be completely realised. While the UPC Agreement eventually entered into force and the court commenced operations in June, 2023, for its contracting EU member states,[558] creating a unified jurisdiction for patent disputes within that bloc, the European patent system now operates with a clear divergence concerning the UK.

The UK's decision, while providing certainty regarding its own stance, has reshaped the European patent landscape. Businesses and innovators must now adapt their European patent strategies to this bifurcated reality: leveraging the UPC and Unitary Patent system for protection and enforcement within the participating EU states, while continuing to engage with the separate UK national patent system for protection in that key market. The long-term implications of this divergence for patent enforcement strategies, legal certainty, and innovation incentives across the broader European continent remain an active area of analysis and adaptation for patent practitioners and policymakers.

UK and other countries in Europe

The major patent systems in the EU are based on the EPC. The substantial provisions of the EPC are transposed into the national patent law of the contracting states. However, the transformation is not necessarily to be perfect and identical.[559] The relevant law in the UK, the Patent Act 1977, is no exception. Corresponding to Articles 52(1) and (2) EPC, the UK patent law in Sections1(1) and (2) states the requirements of patentable invention and patent exclusion respectively. They both preclude computer programs as such to be protected by patent. The UK patent law is substantially similar to the EPC provisions at this point albeit the statutory language is different from the EPC. Historically, UK courts have occasionally adopted a cautious stance towards

[558] See, e.g., Unified Patent Court, 'The Unified Patent Court opens its doors' (1 June 2023) <https://www.unified-patent-court.org/news/unified-patent-court-opens-its-doors> accessed 06 May 2025.

[559] Justine Pila, 'Software patents, separation of powers, and failed syllogisms: A cornucopia from the Enlarged Board of Appeal of the European Patent Office' (2010) 48/2010 Oxford Legal Studies Research Paper 2-3.

certain EPO approaches in determining patent exclusions and their exceptions. However, over time, particularly following the *Symbian* case in 2008[560], there has been a trend towards greater alignment between UK and EPO practices. This evolution reflects a balance between adhering to domestic legal principles. Nevertheless, the UK courts have, at times, appeared to sceptically refer to certain EPO approaches for determining patent exclusions and their exceptions, rather than always utterly following the EPO's footsteps.[561] This cautious or independent stance can be attributed to several factors, including the binding nature of UK domestic precedents (*stare decisis*), a distinct judicial philosophy regarding statutory interpretation and the role of technical contribution in patentability, and perhaps a perception by some UK judges that certain lines of EPO Board of Appeal case law might have been sparsely reasoned or led to overly broad interpretations of patent eligibility for software-related inventions, as will be discussed with reference to specific cases like *Aerotel*.

In UK patent practice, the courts tend to bypass the UK patent law moving straight to an interpretation of the EPC provision.[562] In the case of determining the patentability of an invention, the UK court emphasise on the substance of the claim rather than its form. Consequently, it is often argued by commentators that the UK patent system, particularly as interpreted by its higher courts, applies a more rigorous approach when assessing the patentability of software-related inventions compared to, for instance, certain lines of case law from the EPO Boards of Appeal or the historical practices in some other European jurisdictions.[563] Moreover, the UK jurisdiction is constrained by the *stare decisis* principle but so do other countries, e.g. Ireland and Cyprus. Patent examiners must comply with the decision of the UK court. Since the EPO board's decision has no binding force to contracting states, it merely has persuasive effect to the UK patent examination procedure. It is legally binding only when Technical Board of Appeal's decision is expressly approved by the UK court.[564] Although the UK court intend to defer the EPO decisions, inevitable divergence has shown between the EPO and the UK on granting software patents.

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[560] *Symbian Ltd v Comptroller General of Patents* [2008] EWCA Civ 1066.

[561] Justine Pila, 'Software patents, separation of powers, and failed syllogisms: A cornucopia from the Enlarged Board of Appeal of the European Patent Office' (2010) 48/2010 Oxford Legal Studies Research Paper 2-3, at 7.

[562] Susan Marsnik and Robert E. Thomas 'Drawing a line in the patent subject-matter sands, Does Europe provide a solution to business method and software patent problem?' (2011) Boston College International and Comparative Law Review 84.

[563] see, e.g., Gary Slapper and David Kelly, 'The English Legal System' 20th edn, 2024.

[564] *Ibid*., at 85.

Some decisions that made by the EPO and UK courts after entering the 21st century may demonstrate such divergence in contemporary patent practices between the two jurisdictions. Justice Jacob manifested the divergence in his acknowledgement of the weight of the EPO board decision in *Aerotel* decision which was brought to the UK Court of Appeal.[565] The EPO case law had set up a series of doctrines to decide whether an invention constitutes computer program as such and should be excluded from patentability (see section 5.2.2. for the doctrines set up by EPO case laws), including the "any hardware approach" which departed from taking technical contribution as the key element that established by the EPO.[566] The any hardware doctrine was applied in early 2000s and its core concept was to investigate whether the computer program for use in a particular field involve a physical entity or not.[567] If yes, it is an invention within the meaning of EPC. Justice Jacob in *Aerotel* refused to follow this EPO board approach even though he directly referred to the EPC not the UK patent law. Rather, as stated in the *Aerotel* judgment itself, he declared that the UK court was bound by its own precedents and the approaches approved by UK courts over time. This included, in this instance, a specific interpretation of the technical contribution approach (originating from cases like *Vicom* at the EPO) as it had been received and interpreted by the UK Court of Appeal in its own line of authority.[568]

However, Justice Jacob did not completely follow the technical contribution approach; rather he synthesised a UK approach, a "technical contributions approach with rider" he labelled, and indicated four steps for investigating patent claim.[569] Namely, to require a properly construed claim, identify the actual contribution, ask whether the invention falls solely within the excluded subject-matter, and inspect whether the contribution is actually technical in nature.[570] It is revealed in the *Aerotel* case that UK patent law and practice no

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[565] *Aerotel Ltd v Telco Holdings Ltd; Macrossan v Comptroller-General of Patents* [2006] EWCA Civ 1371; [2007] 1 All E.R. at 225.

[566] Case T931/95 *Pension Benefits System Partnership/Controlling Pension Benefit Systems* [2001] OJEPO 441.

[567] See Case T258/03 *Hitachi/Auction Method* [2004] 575 for similar application.

[568] *Aerotel Ltd v Telco Holdings Ltd; Macrossan v Comptroller-General of Patents* [2006] EWCA Civ 1371; [2007] 1 All E.R. at 225 at [38].

[569] *Ibid*., at [31]. Cited from Susan Marsnik and Robert E. Thomas 'Drawing a line in the patent subject-matter sands, Does Europe provide a solution to business method and software patent problem?' (2011) Boston College International and Comparative Law Review 93.

[570] *Aerotel Ltd v Telco Holdings Ltd; Macrossan v Comptroller-General of Patents* [2006] EWCA Civ 1371; [2007] 1 All E.R. at 225 at [40].

longer fully corresponded with the EPO's steps on the issues of software patents.[571] It was the sparsely reasoned cases and the absences of consonant approaches to be followed in the EPO that discourage the UK court for a harmonised EU patent system.[572] In addition, UK approach seems more logic with consistence than the EPO.

The divergence of the two jurisdictions continues into the 2010s where the UK and EPO decisions appeared to be taking different points of view again. The *Aerotel* four-step test was then applied by later courts with certain amendments.[573] In the UK case *HTC v Apple* where the claimed invention was a method for responding to more than one touch at a time on a touch-sensitive computer device, the Court of Appeal found that the High court mistakenly ruled out the claimed patent by reasoning it as computer program as such.[574] The Court of Appeal based on the four-step test with slightly modification to find the technical contribution. It held the claim patentable, reasoning that the invention, as defined in the claim, constituted a solution to a specific technical problem and enabled the computer device to operate in a better way, thereby demonstrating the requisite technical contribution.

Other the other hand, a later EPO decision in *Nokia/Shopping with mobile device* took an approach in contrast to the UK Court of Appeal in *HTC v Apple*.[575] The claimed invention was a program of mobile device to display an itinerary, as a function of user profile, for shopper to visit group of vendors and obtain what they need by setting up conditions, such as shorter distances and cheapest prices. A point of contrast emerges when comparing the UK court's emphasis in *HTC v Apple* on the technical contribution provided by the claimed invention. While the UK approach, following *Aerotel*, scrutinises the substance of the contribution for its technical nature, the EPO's methodology in cases like *Nokia/Shopping* with mobile device, while also hinging on "technicality", often

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[571] David Bainbridge, 'Court of Appeal parts company with the EPO on software patents' (20007) 23 Computer Law & Security Report 199.

[572] Justine Pila, 'Software patents, separation of powers, and failed syllogisms: A cornucopia from the Enlarged Board of Appeal of the European Patent Office' (2010) 48/2010 Oxford Legal Studies Research Paper 10.

[573] Nicolas Fox and William Corbett, 'UK and EPO approaches to excluded subject-matter and inventive step: are Aerotel and Pozzoli heading for the rocks?' 36(9) E.I.P.R. 570.

[574] *HTC Europe Co Ltd v Apple Inc* [2013] EWCA Civ 451; [2013] R.P.C. 30 (CA (Civ Div)).

[575] Case T1670/07) *NOKIA/Method and system of shopping with a mobile device* Unreported July 11, 2013 (EPO (Technical Bd App)). Cited from Nicolas Fox and William Corbett, 'UK and EPO approaches to excluded subject-matter and inventive step: are Aerotel and Pozzoli heading for the rocks?' 36(9) E.I.P.R. 570-573.

appears to integrate this assessment more directly within its established problem-and-solution framework for determining inventive step. The EPO tends to first ensure the claim as a whole has technical character to overcome Articles 52(2) and (3) EPC, and then assesses whether the features contributing to this technical character solve an objective technical problem in a non-obvious manner.

The Board of Appeal in *Nokia* applied the problem-and-solution approach which it has expressly stated in the EPO Guidelines.[576] According to the approach, the Board investigated Nokia's claim by determining the closest prior art, identifying the benefits that flows from the difference of between the claimed invention and the closest prior art, formulating the objective technical problem, finding out whether it would be obvious to a person skilled in the art to how to solve the objective technical problem in the way that taught by the claim.[577] The Board finally held that the claimed invention is not patentable on the ground that the feature providing by the program did not have any technical effect.

In spite of rejecting patentability based on the reason of absence of technical contribution, the starting point of the UK court and EPO board were different. The UK approach concerns whether the claim is capable for patentable subject-matter whereas the EPO's focus is on whether the claim encompass an inventive step. Applying different approaches may lead to different results. It is hard to tell which one is more accurate for determining patentability. What can be concluded from this historical analysis of case law is that the rift in jurisprudential approach between the UK courts and the EPO regarding certain aspects of software patentability persisted for a significant period. There were concerns that this divergence may widen as long as the EPO was perceived by some in the UK judiciary as being content with what they considered a less rigorous or overly formalistic status quo, or if it failed to provide a policy framework and consistently reasoned decisions deemed sufficiently logical and aligned with UK legal principles to convince the UK courts.

Historically, addressing such divergences within a multinational patent system like the EPC might have involved seeking clarifying opinions from the EPO's Enlarged Board of Appeal on fundamental issues, fostering greater judicial dialogue, or, though rare, potential clarifications in the EPO's Guidelines or

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[576] Guidelines for Examination in the European Patent Office (2012), Part G, Chapter VII, 3.5; Which is now Part G, Chapter VII, 5.

[577] Nicolas Fox and William Corbett, 'UK and EPO approaches to excluded subject-matter and inventive step: are Aerotel and Pozzoli heading for the rocks?' 36(9) E.I.P.R. 571.

even amendments to the EPC itself. However, with the UK's departure from the EU and its subsequent decision not to participate in the UPC system, the dynamic of this "rift" has fundamentally changed. UK courts now operate with greater autonomy in interpreting national patent law (albeit derived from the EPC), while the UPC develops its own jurisprudence for participating EU member states. The "solution" to past divergences now largely lies in how each system evolves independently while still observing developments in the other as persuasive, though not binding, authority.

To compare with the UK which takes an uncompromising stance to deal with software patents, other EU countries tend to apply approaches that relatively more flexible to be in line with the EPO's decision. In Germany, its patent law in general also reflects in its provisions to pursuant to the patentability under EPC. According to Section 1(1) of the Patentgesetz, the German patent law, an invention must satisfy the requirement of new, inventive step, and susceptible of industrial application[578]; Section 1(3) also lists the exclusions to patentability which, as a matter of course includes computer program. As for the exception to computer program, the German Federal Patent Court gave definition to "software as such" as a program "not directly associated with its functional execution" in connection with hardware.[579] The German Federal Court of Justice also indicated that patent is available to a method that "describing a methodical action using of controllable physical forces to attain an obvious success without interposition of human intellectual activity.[580]" It can be seen from the indication of the federal court that, despite asserted to be following the EPO case law, the interpretation of law may differ.

Technicality is also the vital factor for patentability in Germany. Claimed invention must fulfil the requirements of novelty and inventive step to generate technical character; moreover, it must provide objective technical contribution to prior art and a solution to technical problem.[581] However, the assessment

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[578] Available at http://www.wipo.int/wipolex/en/text.jsp?file_id=401424 accessed on 25 May 2025.

[579] Bundespatentgericht [1989] GRUR 42 – *Rollandensteuerung*. Cited from Paolo Guarda, 'Looking for a feasible form of software protection: copyright or patent, is that the question?' (2013) 35(8) E.I.P.R. 451.

[580] Bundesgerichtshof [1969] GRUR 672 – Rote Taube. Cited from Paolo Guarda, 'Looking for a feasible form of software protection: copyright or patent, is that the question?' (2013) 35(8) E.I.P.R. 451.

[581] Susan Marsnik and Robert E. Thomas 'Drawing a line in the patent subject-matter sands, Does Europe provide a solution to business method and software patent problem?' (2011) Boston College International and Comparative Law Review 103.

"technical" in German changes over time. It is indicated by the Federal Court that there is no objective definition to technical.[582] Technical has dynamic meaning which should be assessed depends on the development of technology. Generally speaking, the German patent system takes the approach to software patent analogous to the EPO. In the 2010s the Federal Court brought Germany software patent to a new dimension that goes against the EPO strict policy. It approved the patent to *Siemens* for a client-server for the automatic generation of structured documents (such as XML or HTML).[583] In its ruling, the Federal Court stated that a method concerning the direct interaction between the components of a data processing data is always of technical nature.[584]

This ruling is apparently viewed by some commentators as establishing a low barrier to software patents in Germany. It suggests that almost any interaction between software-controlled components within a data processing system could be deemed "technical" by its very nature, potentially sidestepping a more rigorous inquiry into whether the software provides a further technical effect beyond the normal operation of the computer or solves a non-obvious technical problem in a specific field of technology. This might be more stringently required, for instance, under the EPO's problem-and-solution approach. If this interpretation were broadly applied, it could indeed imply that Germany, at least following this specific line of Federal Court jurisprudence, might adopt a more software-patent-friendly stance for certain types of computer-implemented inventions compared to the EPO's more nuanced assessment of "technical contribution" and inventive step for all features, including those involving software. Since the computer is a technical device *per se*, software is patentable by virtue of taking in to consideration the characteristics of the technical device. In other words, almost all software implementing direct interactions within a data processing system could, under this specific German Federal Court reasoning, be argued to possess technical nature and be potentially patentable. While this particular decision raised discussions at the time about a potentially more lenient approach to software patentability in Germany for certain types of claims, its long-term impact and alignment with the evolving jurisprudence of the EPO and now the UPC requires ongoing

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582 *Ibid.*, cited in *Symbian Limited v Comptroller General of Patents* [2008] EWCA Giv 1066 at [31].

583 Bundesgerichtshof [2010] Xa ZB 20/08.

584 Cited from Florian Mueller, 'German high court declared all software potentially patentable' (2010) FOSSpatent http://www.fosspatents.com/2010/05/german-high-court-declares-all-software.html accessed 17 June 2017.

assessment.

The varying national interpretations and judicial approaches within Europe, as exemplified by some of the UK and German case law discussed, highlight the historical complexities that contributed to a somewhat fragmented European patent landscape, despite the centralising role of the EPO. While the UPC now aims to foster greater harmonisation among its participating member states, the broader challenge of achieving consistent and predictable standards for rapidly evolving technologies like software remains a significant undertaking for all patent systems. The subsequent sections of this thesis (particularly Section 5.2) will delve deeper into the specific patentability criteria, and Chapter 7 will propose a model aimed at addressing some of these enduring challenges.

China

China patent law came into force in 1985. Initially, during the period from 1985 to 1999, the patent law was more oriented towards promoting technology diffusion rather than primarily protecting the exclusive rights of inventors.[585] The majority of foreign patents belonged to the category of inventions, whereas most Chinese domestic patents were utility models and industrial designs. During this period, a notable pattern emerged where foreign patents were predominantly granted to established overseas organisations, likely reflecting their greater resources and experience in international patenting, while Chinese domestic patents were more frequently sought by and granted to individuals and smaller local entities. It possibly indicating a nascent stage of domestic intellectual property engagement often focused on utility models and industrial designs which typically have lower application thresholds. Foreign patents were concentrated in a few technology firms, mostly in the information technology sector.[586] The values of domestic patents were much lower than that of foreign patents.[587] As the ability of Chinese firms to imitate foreign technologies had increased and foreign firms had become more competitive in the Chinese market, this situation was seen by some as posing a threat to the protection of intellectual property for those foreign firms in this period.[588]

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[585] Yifei Sun, Determinants of foreign patents in China. World Patent Information 25 (2003) 27–37.

[586] SachaWunsch-Vincent, Mila Kashcheeva, Hao Zhou, International patenting by Chinese residents: Constructing a database of Chinese foreign-oriented patent families. China Economic Review 36 (2015) 198–219.

[587] Zhang Gupeng, Chen Xiangdong, The value of invention patents in China: Country origin and technology field differences. China Economic Review 23 (2012) 357–370.

[588] Albert Guangzhou Hu, Propensity to patent, competition and China's foreign patenting

China surpassed the US in 2011 to become the country with the largest number of patent applications, a surge that may be partly attributed to the motivation for acquiring patents related to innovation playing an important role in national and regional development strategies.[589] However, the technological substance of the rapid growth has since become increasingly doubted by some observers. Both politically induced factors (such as government subsidies and targets) and technologically substantial growth in applications may be the reason.[590] Although patent count was correlated with R&D input and financial output, Chinas' patent subsidy programs increased patent counts more than 30%.[591] In 2016, the number of patent applications in China was higher than the combined total for the US, EU, Japan, and South Korea, which received about 236,600 patent applications.[592] Due to the enhancement by Chinese government policy, the patent filings and grants experienced growth that reflects China's economic system undergoing a strategic shift from a labour-intensive model to an innovation-driven incentives orientation.[593] Fisch *et al.* examining China's patents as a proxy of patent value in comparison with patents from the US, EU, Japan, and South Korea indicated the phenomenon of "citation lag" for China's patents.[594] "Citation lag" generally refers to the average time difference between when a patent is published and when it begins to be cited by subsequent patents or scientific literature. A longer citation lag for a country's patents, when compared to those from leading innovative nations, can be significant. It may suggest that these patents, on average, take longer to be recognised as technologically important or foundational by the broader global innovation community. It potentially reflecting differences in perceived technological novelty, market impact, or accessibility of the disclosed information. But their results also suggested that the gap in perceived value or

surge. Research Policy 39 (2010) 985–993.

589 Albert G.Z. and *et al*., China as number one? Evidence from China's most recent patenting surge. Journal of Development Economics 124 (2017) 107–119.

590 Henning Kroll, Exploring pathways of regional technological development in China through patent analysis. World Patent Information 46 (2016) 74–86.

591 Jianwei Dang, Kazuyuki Motohashi, Patent statistics: A good indicator for innovation in China? Patent subsidy program impacts on patent quality. China Economic Review 35 (2015) 137–155.

592 WIPO, 'China Tops Patent, Trademark, Design Filings in 2016', Geneva, December 6, 2017, http://www.wipo.int/pressroom/en/articles/2017/article_0013.html

593 Demetris Christodoulou, Baruch Lev, Le Ma, The productivity of Chinese patents: The role of business area and ownership type. International Journal of Production Economics 199 (2018) 107–124.

594 *Christian Fisch et al.,* The value of Chinese patents: An empirical investigation of citation lags. China Economic Review 45 (2017) 22–34.

technological impact (as indicated by citation patterns) between China's patents and those from leading international jurisdictions might narrow down in the near future.

Chapter 6

Patents for computer-implemented invention and potential problems

6.1. Software – A Patentable Subject-Matter?

As emphasised throughout this thesis, a patentable claim has to fall within the criteria of being new; involves an inventive step (i.e. non-obvious); and is one which is capable of industrial application (i.e. is useful).[595] An invention has to fulfil these requirements to constitute legitimate subject-matter in patent law and thus being eligible for a patent. Crucially, an inspection must be completed as to whether a patent claim provides sufficient technical information to demonstrate that the invention is a patentable subject-matter or not. However, inventors and other patent applicants must be clear as to what extent is the patent claim to be considered a patent eligible subject-matter. With regard to the functionality of computer programs that are not covered by, and protected by, the Directive, a 2008 Report - the "Study of the Effects of Allowing Patent Claims for Computer-implemented Inventions" (CIIs) (hereafter the "2008 Report") - outlined the problems in the current patent system, along with possible solutions.[596] It also revealed the legal practice adopted by the European Patent Office (EPO) in the early 21st century was relatively conservative and elusive.[597]

It should be noted that the term "computer-implemented invention" adopted in the 2008 Report refers to "any invention the performance of which involves the use of a computer, computer network or other programmable apparatus and having one or more *prima facie* novel features which are realised wholly or

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[595] Article 27(1) of the TRIPS Agreement.

[596] Reinier Bakels *et al.*, 'Study of the effects of allowing patent claims for computer-implemented inventions – Final reports and recommendations'(2008) < https://publications.europa.eu/en/publication-detail/-/publication/90421535-ff72-46f3-b09e-a4bb8e0e711b/language-en > accessed on 27 March 2018.

[597] Reinier Bakels *et al.* (n 1). For example, the report's Executive Summary discusses how the legal practice for CIIs developed gradually through EPO case law, leading to legal uncertainty regarding concepts such as 'technical contribution' or 'technical character' in the period leading up to 2008; see e.g. p 5 of the report accessed via the link in footnote 1.

partly by means of a computer program or computer programs[598].” On the other hand, the 2008 Report also pointed out that software patents are “programs for computers …” and thus is excluded from patentability based on Articles 52(2)(c) and 52(3) of the EPC. Accordingly, it provides computer-implemented invention patents and software patents as two separate ideas that are neither synonyms nor opposites – “if only computer-implemented invention patents are granted, not all software patents are excluded”.[599]

Subsequent to the 2008 Report's observations on terminology and the prevailing discourse at that time, the EPO’s legal framework for the patentability of computer programs has been more definitively articulated, primarily through landmark decisions by its Enlarged Board of Appeal and as consistently reflected in the EPO “Guidelines for Examination”. A pivotal clarification was provided by the Enlarged Board of Appeal in its opinion in G 3/08 (*Programs for computers*)[600]. This opinion established that a computer program claimed “as such” is not barred from patentability under Article 52(2)(c) and (3) EPC if, when running on a computer, it produces a “further technical effect” that extends beyond the normal physical interactions between the program and the computer. This principle effectively means that software can contribute to the technical character of an invention and form part of a patentable subject-matter, provided it serves a technical purpose. The EPO’s current practice, detailed in its regularly updated Guidelines for Examination, consistently applies this “further technical effect” criterion and the overall “*COMVIK* approach” to assess whether a CII, including those realised by software, solves a technical problem in a non-obvious way using technical means[601]. Therefore, the crucial determinant for patentability at the EPO is the presence of technical character in the claimed invention as a whole, rather than a blanket exclusion based merely on the involvement of software.

As explained in the 2008 Report, the recommendation was made in order to

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[598] The term “computer-implemented invention” in the 2008 Report follows the definition of the 2002 Proposal for a Directive of the European Parliament and of the Council on the patentability of computer-implemented inventions (which was rejected in 2005).

[599] Reinier Bakels *et al.*, ‘Study of the effects of allowing patent claims for computer-implemented inventions – Final reports and recommendations’(2008) < https://publications.europa.eu/en/publication-detail/-/publication/90421535-ff72-46f3-b09e-a4bb8e0e711b/language-en > p5; accessed on 27 March 2018.

[600] G 3/08, *Programs for computers*, Opinion of the Enlarged Board of Appeal of 12 May 2010.

[601] See, for example, EPO Guidelines for Examination (as of March 2025), Part G, Chapter II,

provide a regime to further optimal innovation across the world economy.[602] It noted that it is not realistic to expect the EPO to have a comprehensive economic view,[603] given it dominated the "inner circle" where patent policy was made. Policy making in the EPO, like other jurisdictions in the world, is a complex process which involves various factors and participants. It is especially significant in the EPO where the policy makers, members of Administrative Council as well as Boards of Appeal, and even the President are from different backgrounds and jurisdictions. The subject of patent policy and its implications are too complex to be necessarily understood by politicians.

In addition, the language used by patent experts can be considered as not intelligible; even lawyers, those not well versed in the speciality of software patents, frequently are unable to construe it easily.[604] Moreover, the 2008 Report provided a critical demonstration of the potential risks associated with granting computer-implemented invention patents, cautioning that they might ultimately inflict more harm on the innovation ecosystem than generate benefits. The identified potential forms of harm were multifaceted:

- The risk of creating a "legal minefield" for programmers. This stems from the sheer volume and often vaguely defined boundaries of software-related patents, making it exceptionally challenging for developers, especially individuals and small to medium-sized enterprises, to innovate and write new code without the constant threat of inadvertently infringing on existing patents and facing potentially crippling litigation costs. This uncertainty can, in turn, produce a chilling effect on software development.
- The danger of establishing monopolies on interface standards, a problem significantly amplified by network effects. When essential interface standards are patented, it can lock users and developers into proprietary ecosystems, stifle competition by raising barriers to entry for alternative solutions, and critically hinder interoperability between different products and services, thereby limiting consumer choice and technological advancement.
- A substantial jeopardy to open-source software was identified. The core tenets of open-source software, collaborative development, free access to source code, and the liberty to modify and distribute software, can be

602 *Ibid*.. at 21.

603 *Ibid.*

604 I*bid*.

fundamentally undermined by the assertion of patent rights. Patent holders might demand licensing fees or initiate infringement lawsuits against open-source software projects or their users, thereby threatening the viability and continued development of valuable open-source resources.

- Finally, the 2008 Report warned of the potential for a "tragedy of the anti-commons." This scenario arises when a complex technology is covered by a multitude of overlapping patents held by different entities (often referred to as a "patent thicket"). The resulting difficulty and expense in negotiating licenses with all necessary patent holders can become so prohibitive that it effectively stalls or prevents further innovation and the creation of new, integrated products, particularly in fields like software where cumulative innovation is common.

Consequently, the report underscored that product applying technology with a high level of complexity, which are typically reliant on large network systems and multiple technological components, are particularly vulnerable to these interconnected problems and the ensuing high transaction costs associated with navigating such a challenging patent landscape.[605]

Accordingly, the 2008 Report reaffirms several inherent problems within the EPO patent system. While a comprehensive analysis of how EPO patent policies have since evolved, particularly through the lens of significant case law (as will be discussed in detail later in section 6.1 of this chapter, specifically under the heading "Case law in the technology era – The EPO practice"), provides a crucial contemporary perspective, the specific challenges highlighted or reinforced by the 2008 Report include the following:

The minefield facing software inventors

As repeatedly accentuated by the EPO, technical character is a crucial element of patent eligible software. It is necessary that the software provides a technical solution to a technical problem. Nevertheless, software inventions normally carry out its valuable contribution by means of processing data and executing business methods. The difficulty is twofold. On the one hand, the inventor has to demonstrate that their invention is more than merely computerised algorithms which simply process data. It must have a technical character which

[605] *Ibid.,* at p11-p12. See also Sinan Utku and Alain Strowel, 'Developments regarding the patentability of computer implemented inventions within the EU and the US: Part 1 – introduction and the legal problem of patenting computer-implemented inventions'(2017) 39(8) E.I.P.R. 491.

adds value to existing technology. On the other hand, there is a paucity of direction as to the significance the valuable enhancement should provide. Failure to demonstrate the contribution to technology means no patent will be granted; which may include the actual missing contribution, a poorly drafted patent claim, or because of changing patent examination principles in different courts of different jurisdictions.

Moreover, a patent invention must satisfy the requirements of novelty and inventive step. Software inventors have to ensure the invention is not any form of prior art (which is already available to the public); even if the prior art does not exist physically or is commercially available.[606] This is especially difficult in the technology era where many inventions are invented under a patent thicket. Extra care must be paid when conducting prior art research to avoid infringing existing patents and engaging in works which defeat the requirement of novelty.

Inventive step is another requisite element of a patentable invention. Inventors have to demonstrate that the software invention is not obvious to a person skilled in the art. Software continues as an industry which is rapidly developing and changing, increasing the hurdle of defining the non-obviousness of an invention. This problem is aggravated by the easily disseminated nature of software by virtue of the borderless internet. Software may be innovative in the moment, but be widely known in the next minute. Patenting software is not only competing with other inventors, but also competing with time to some extent.

The current patent practice of the EPO established an environment which is replete with pitfalls and is, perhaps, disfavoured to software inventors. It is more likely a minefield into which inventors fall easily rather than one which provides the necessary protection to stimulate innovative activities.

Network effect and monopolies

Network effect is a concept that is widely applied in economics and business. In the software industry especially, in respect of those applied to smartphones and similar portable devices, it refers to the phenomenon that the value of a product or service is increased by virtue of the wide use of this product/service. For example, Apple encourages software developers to create more interesting and useful apps that can be installed on its iOS operating system. These apps attract more users to use Apple iPhone, thus increasing the iPhone's market

[606] European Patent Office, 'Novelty and prior art', Inventor's Handbook, https://www.epo.org/en/learning/learning-resources-profile/business-and-ip-managers/inventors-handbook/novelty-and-prior-art accessed 28 April 2025

share.[607] Examples can also be seen in the popular social media platforms Instagram and X (Twitter). The more users who join these social media means the more user connections and interactions available on these platforms; therefore, bringing more profits to the provider.

Network effect allows the minority to control most of the sources on the market. In the software industry, it leads to the monopoly of essential patents that is necessary to innovative activities and hence blocks the entry of new invention on the market. The problem is even worse if the monopolised patented technology is interface standards. The monopoly of such a type of technology not only significantly impedes the interoperability of the products/services that provide same functions, it also limits consumers' choices and results in inconvenience if they want to connect with others that applied different products/services. The costs and risks of innovation are hence increased, and as a matter of course, software development is negatively affected.

The risks to open-source software and anti-commons tragedy

The purpose of open-source software is to encourage the collaborative development of software. The source code of such software is publicly available and anyone can inspect, modify, and distribute the software as long as the users comply with the criteria listed by the open-source organisation.[608] Software patents raise the hurdle for accessing software, and inventors may have to pay for licensing fees to ultilise the software that is needed.

As previously noted, inventions normally encompass hundreds of (and perhaps even more) patents. Software is an especially sophisticated type of invention and is the accumulation of various existing patents. If software inventors have to negotiate for the authorised ultilisation, it requires considerable time and fees to have every patented software to be licensed. This does not even include the wasting of time and investments when the patent holder refuses the licensing of their work. Software patents, to this end, overly limit the circulation of useful information and further leads to an anti-commons tragedy.

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[607] Lea Shaver, 'Illuminating innovation: From patent racing to patent war'(2012) 69 Wash. & Lee L. Rev. 1891 at note 187.

[608] For example, Open Source Initiate listed ten criteria to be followed; they are related to free redistribution, source code, derived works, integrity of the author's source code, no discrimination against persons or groups, no discrimination against fields of endeavour, distribution of license, license must not be specific to a product, license mut not restrict other software, and license must be technology-nature. See https://opensource.org/osd/ last accessed on 19 Jun 2023.

Given the three-step progression as recommended in the 2008 Report, perhaps most considerable problem of the European patent system and the low-quality patents in caused by the uncertainty of European patent law.

According to the 2008 Report, as highlighted in the first step, is improving disclosure (and possibly improving patent quality from a technical perspective) through procedural and regulatory measures,[609] and further increasing the level of specification required that leads to a patent eligible invention.[610] Although aware the problems that computer-implemented invention patent may cause, it however also pointed out that the subject-matter requirement in general is not coherent and causes legal uncertainty. Therefore, the EPC provision does not entirely prevent the patentability of computer-implemented inventions as well as software inventions.[611]

In the case of the computer-implemented invention patent in the EPO, the approaches for determining patent subject-matter which had been applied in the EPO and patents courts were succinctly introduced, with relevant case law authority, in Chapter 5. While earlier interpretations of case law might have suggested that inventions involving software were primarily "*de facto* tacitly accepted" in Europe rather than being openly or formally approved, the EPO's stance has since been significantly clarified and solidified. Following landmark decisions, notably *G 3/08* by the Enlarged Board of Appeal, it is now explicitly recognised that a computer program itself can be patented if, when run on a computer, it produces a "further technical effect" going beyond the normal physical interactions between the program and the computer, thereby endowing it with the requisite technical character. Thus, although the statutory exclusion for "programs for computers as such" under Article 52(2)(c) and (3) EPC remains firmly in place, there is a well-defined and judicially endorsed pathway for patenting technically inventive software. This represents a more formal and conditional approval framework by the EPO and its Boards of Appeal than what might have previously been characterised as mere tacit acceptance. Generally speaking, European patent employs a low threshold to patent eligible subject-

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609 Reinier Bakels *et al.*, 'Study of the effects of allowing patent claims for computer-implemented inventions – Final reports and recommendations'(2008) < https://publications.europa.eu/en/publication-detail/-/publication/90421535-ff72-46f3-b09e-a4bb8e0e711b/language-en > p30; accessed on 27 March 2018.

610 *Ibid.,* at p5.

611 *Ibid.*, at p21-p22. See also Sinan Utku and Alain Strowel, 'Developments regarding the patentability of computer implemented inventions within the EU and the US: Part 1 – introduction and the legal problem of patenting computer-implemented inventions'(2017) 39(8) E.I.P.R. 491.

matter. According to case law and doctrine, it is not hard to tell that the EPO and patent court approaches embraced the concept of technical character despite various terms being used to describe similar ideas and inquiries.[612]

Most recently, software patents has been developing toward a more delicate issue and its cumulative nature is even stronger than it was in the past half century. To what extent is an invention to be regarded as having "technical character" is vital to embody a patent eligible subject-matter. The decisions made by the Enlarged Board of Appeal of the EPO in the past decade may give indications on how the EPO interprets Article 52 EPC in response to the overwhelming trend of technology.

Case law in the technology era – The EPO practice

After entering the 21st century in which software inventions had been flourishing with the development of portable communication devices, several landmark decisions made by the Technical Boards of Appeal of the EPO helped to define the boundaries of what constitutes a patentable CII. These decisions form a line of "case law" authority that influences how the EPO assesses computer-implemented inventions. Examples can be seen from some of the notable cases that have been discussed earlier in this thesis.

T 0641/00 (the *COMVIK* case): Defining the Technical Contribution

In T0641/00 (the *COMVIK* case) and T1173/97 (the *IBM* case), the Technical Board of Appeal of the EPO stressed the assessment of inventive step as well as the importance of technical contribution.

Despite being listed in the patent exclusion of the EPC, the *COMVIK* case clarified the patent eligibility of computer-implemented inventions in the early 2000s. It is especially important because it assures the patentability of inventions with the combination of technical and non-technical features. The patent claim in concern was related to digital mobile telephone systems which applied a single-user multi-identity IC card for a subscriber identity module. Therefore, the subscriber's identity could be changed.[613] Thus, the functioning of a mobile telephone in this case was regarded as technical. It solved technical problems such as signal strength and data transmission. On the contrary,

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[612] Alain Strowel and Sinan Utku, 'The trends and current practices in the area of patentability of computer implemented inventions within the EU and the US'(2016) pdf. accessed via < https://ec.europa.eu/digital-single-market/en/news/report-trends-and-current-practices-area-patentability-computer-implemented-inventions-within > 30 March 2018. At p15.

[613] T 0641/00 (*Two identities/COMVIK*) of 26.9.2002.

features that were merely commercial and administrative considerations were held as non-technical.[614] Examples like data processing tasks that check the validity of subscribers did not provide a technical solution to a technical problem. Hence it did not contribute to the inventive step assessment and was a not patentable subject-matter.

As mentioned earlier in this Chapter, the Board of Appeal in *COMVIK* indicated a framework for evaluating such inventions. With its so called “two hurdle” test, the first hurdle observes whether the claim includes at least one technical means, regardless whether it is computer software or hardware. This hurdle is to exclude the inventions that are abstract ideas, algorithms and similar concepts that are indicated in Article 52 of the EPC. Hence, the invention is not obvious to a person skilled in the art. Compared with this step, which purely requires the patent claim to show its non-obviousness, the second hurdle can only be satisfied when proving the patent claim is not excluded subject-matter, as such, identified in Article 52(3) of the EPC. In other words, it must be a patentable subject-matter on the basis of the provision. A patent claim must successfully navigate both hurdles to be considered patent eligible.

The *COMVIK* case established a sensible framework where, in a mix-type invention, only the technical features are entitled for inventive step assessment. This long-waited clarification enhanced the consistency of computer-implemented invention patents in the EPO. Software inventions, providing they have technical contributions to solve technical problems, are not excluded for patentability merely because the application encompasses a non-technical aspect.

The *COMVIK* case and its two-hurdle test was a milestone for the investigation of computer-implemented inventions and other mix-type inventions. It also ensured that only the inventions that have technical contribution are eligible for patent protection. This case is influential to later EPO examination and cases. A further example can be seen from one of the significant cases regarding computer-implemented invention patent.

T 154/04 (*Duns Licensing*): The Concept of "Further Technical Effect"

[614] Nick Reeve, ‘Changes to the European Patent Office Guidelines for assessing the patentability of computer implemented inventions following the Enlarge Board of Appeal Decision in G1/19’ (Reddie & Grose, May 2022) < https://www.reddie.co.uk/2022/05/11/changes-to-the-european-patent-office-guidelines-for-assessing-the-patentability-of-computer-implemented-inventions-following-the-enlarged-board-of-appeal-decision-in-g1-19/ > accessed 20 August 2023.

Following *COMVIK*, the Board of Appeal in T154/04 (*Duns Licensing*) clarified that a computer-implemented invention can be patentable if it has a further technical effect.[615] This case also considered the inventive step of mix-type computer-implemented inventions. The patent claim under consideration was related to a computer-implemented method of retrieving data from a relational database. This case echoed the technical and non-technical features when investigating inventive step. It should be noticed that in this case the Board of Appeal pointed out that a technical feature does not necessarily depend on novelty. A feature, such as a well-known network, can still be a technical feature. It can be assessed for inventive step and can be regarded as a patentable subject-matter as long as it does not fall foul of Article 52 EPC. Moreover, the Board clarified that the acknowledgement of an inventive step is predicated on the invention solving a technical problem. Consequently, if an invention's contribution lies solely in addressing a non-technical problem, even if technical means are employed for its implementation, it would typically not be considered to involve an inventive step.

G 3/08 (*Programs for Computers*): Affirming the Approach

After the cases that entrenched the importance of technical features and how they should be identified, *COMVIK* and its progeny of cases established a robust approach to protect computer-implemented inventions. Computer-implemented inventions including software patents kept growing in Europe in the 2000s and their development continued into the 2010s. At the beginning of this decade, the Enlarge Board of Appeal in G3/08 (*Programs for Computers*) confirmed the decision of the above cases. The Board indicated that the approach applied on computer-implemented inventions at the EPO is appropriate and complies with the provisions of EPC.[616] The Board's opinions are crucial as it elucidates the patentability of computer-implemented inventions. Computer programmes "as such" are not patentable in accordance with Article 52(2)(c) and (3); however, the provision does not preclude the patentability of an invention that has technical character. Despite not providing the definition of the term "technical", the Board, based on the decision of previous case law, established a stable framework for the patentability of computer-implemented inventions including software related inventions. It also made such patent applications more predictable and therefore beneficial to the programmers and patent applicants as well as patent lawyers.

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[615] T 154/04 (*Estimating sales activity/DUNS LICENSING ASSOCIATES*) 15 November 2006.

[616] G 3/08 (*Programs for computers*) 12 May 2010.

The significance of the Enlarged Board of Appeal's opinion in the *Programs for Computers* case also reflects the revision of the EPO Guidelines and the later EPO cases. The 2018 revision of the Guidelines was one of the examples. Part G of the Guidelines clarified how the non-technical feature of a computer-implemented invention should be treated and the principles to assess inventive step. In its Chapter II, sections 3.3 to 3.6, the revision moved a step forward on the question of what is "technical", albeit this often-asked question was not quite completely answered.[617] The revision named a list of examples of technical and non-technical features. For instance, machine learning algorithms are able to contribute to technical character if they serve a technical purpose. The 2018 revision also revealed a clue that computer-implemented inventions are entering the era of AI and the EPO has started setting to work with this emerging technology.

T 1227/05 (*Infineon*): Patenting Computer-Implemented Simulations

Later in the mid 2000's, the EPO's decision T 1227/05 (the *Infeneon* case) led the EPO approach to deal with a new type of technology, the computer-implemented inventions which is particularly related to simulating techniques.[618] The patent claim in this case was a method that stimulates the noise performance of a mixed-signal circuit. *Infeneon* emphasised its technical character; namely, it was directly associated with the noise interference in mixed-signal circuits - which was a specific technical issue. According to the opinion of the Technical Board of Appeal, the method in concern directed to the application of a technical problem, the noise in mix-signal circuits, therefore was eligible for patentability. The Board's decision in *Infeneon* recognised the technical character generated by simulation methods and set the scene for the patentability of computer-implemented simulation hereafter.

G 1/19 (*Pedestrian Simulation*): Refining the Simulation Patentability Test

As simulation software continues to be applied and developed in the 2020's,

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[617] The actual contents of the EPO Guidelines 2018 version were no longer available on the EPO website. Relevant information referred to Johnathan Turnbull *et al.*, 'EPO publishes 2018 revision of Guidelines for examination directed to computer-implemented inventions' (*Herbert Smith Freehills*, October 2018) < https://hsfnotes.com/ip/2018/10/10/epo-publishes-2018-revision-of-guidelines-for-examination-directed-to-computer-implemented-inventions/ > accessed 20 August 2023. See also Laurence Lai, 'Top 6 changes to the 2018 EPO Guidelines for examination' (*Kluwer Patent Blog*, October 2018) < https://patentblog.kluweriplaw.com/2018/10/01/top-9-changes-2018-epo-guidelines-examination/> accessed 20 August 2023.

[618] T 1227/05 (*Circuit simulation/ Infineon Technologies*) 13 December 2006.

the Enlarged Board of Appeal issued a substantial decision in G1/19 (*Pedestrian simulation*) which its subject-matter concerned computer simulations.[619] This case revealed the increasing importance of simulation in modern science and engineering.[620] The concept of simulation refers to:

> "the imitation of the operation of a real-world process or system over time…"

The model usually takes the form of assumptions concerning the operation of the system. These assumptions are expressed in mathematical, logical, and symbolic relations between the *entities*, or objects of interests of the system… a model can be used to investigate a wide variety of "what if" questions about the real-world system." [621] In the field of modern computer-implemented technologies, simulation technology can be employed to, for example, improve the accuracy of a measurement, control a system, or to improve a system.[622]

The Board in *Pedestrian Simulation* continued the essence of the *Infeneon* decision and extended it; it also reaffirmed the principle set up in the *COVIK* case. In *Infeneon*, the patent claim was regarded patentable based on the reason that the simulation was inherently technical. On the other hand, however, in *Pedestrian Simulation*, the Board narrowed the scope for determining the patentability of such invention.

In *Pedestrian Simulation*, the patent claim at issue was software for a computer-implemented simulation concerning a pedestrian crowd's movement in architectural designs through an environment such as a building. Such a process was also based on mathematical methods. While *Infeneon* approved the possibility of computer simulation where the patent claim addresses a technical problem and fulfils the requirement of technical character, the Enlarged Board of Appeal in *Pedestrian Simulation* provided more comprehensive criteria for the examination of computer simulation within the European patent framework.

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[619] G 0001/19 (*Pedestrian simulation*) 10 March 2021.

[620] Philip Martin, 'Simulations and models – what can be patented at the EPO?' (*Marks & Clerk*, March 2021) < https://www.marks-clerk.com/insights/articles/simulations-and-models-what-can-be-patented-at-the-epo/ > accessed 11 October 2023.

[621] Jerry Banks, *et al.*, *Discrete-event system simulation* (5th edition, Pearson Prentice Hall, 2005) p3.

[622] Philip Martin, 'Simulations and models – what can be patented at the EPO?' (*Marks & Clerk*, March 2021) < https://www.marks-clerk.com/insights/articles/simulations-and-models-what-can-be-pate nted-at-the-epo/ > accessed 11 October 2023.

Generally speaking, there is no physical reality in computer simulations except for a computer. Computer simulations exist in in the computational architecture of a computer system. They are created by software models and are able to simulate physical process, systems, or virtual environments. In other words, they are more like digital constructs that do not possess physical substance in the way that the objects do in the real world.

Due to this nature of simulation, the core issue to be taken into consideration is whether a simulation which is not directly linked to a physical reality has technical contribution or not. The Enlarged Board of Appeal not only reaffirmed the application of the *COMVIK* approach in computer simulation cases, but also clarified what should be taken in to account when determining the patentability of such inventions. In this decision, technicality was emphasised again to satisfy the two hurdles inspection. However, the Enlarged Board indicated that assessing the technicality of the computer simulation underlying processes or systems is not sufficient. Rather, the crucial factor is whether the computer simulation concerned contributes to the solution of a technical problem.[623]

In this regard, the patent examination of computer simulation seems slightly different from the examination of AI and machine learning inventions. The latter mainly concentrate on the technicality of inventions where the arguments normally caused on the mathematical algorisms or relevant models, or whether the adoption of such model is based on the technical considerations "relation to the internal functioning of the computer itself." [624] The clarification on technicality made by the Enlarged Board of Appeal in *Pedestrian Simulation* still apply to such arguments and is also applicable to such type inventions.

As far as smartphone and similar portable computer devices are concerned, simulation technology allows such devices to provide real-time and even personalised functions. From casual and an entertaining point of view, "Pokemon Go" is one of the famous examples that is carried out by augmented reality simulations through the user's mobile phone camera. It simulates creatures in the real environment and the users are able to visualise the image

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[623] G 1/19 Pedestrian simulation, OJ EPO 2021, A77. See also Richard Kennedy, 'G1/19 – what does it mean for AI?' (Venner Shipley, June 2021) https://www.vennershipley.com/insights-events/g1-19-what-does-it-mean-for-ai/ accessed 22 January 2024..

[624] Richard Kennedy, 'G1/09 – what does it mean for AI?' (*Venner Shipley*, June 2021) https://www.vennershipley.com/insights-events/g1-19-what-does-it-mean-for-ai/ > accessed 22 January 2024.

on their own screens. This technology also provides practicality that facilities the conveniences of daily life. For instance, certain mobile applications employ augmented reality to superimpose navigational instructions directly onto the user's camera view of the physical streetscape, thereby simplifying wayfinding in unfamiliar locales. Other applications enable users to virtually preview how items of furniture or home decoration might look within their own living spaces before committing to a purchase, aiding in practical decision-making for interior arrangements. Furthermore, real-time language translation tools can utilise the device's camera to capture foreign text, such as on signs or menus, and then overlay the translated text onto the screen, offering significant convenience for travellers or when engaging with foreign-language content.

From a wider perspective, simulation technology can also be applied for professional purposes. For example, people who intend to renovate a building or space can apply simulation to visualise architectural structures and interior designs. It helps property owners and builders/ designers to reduce the risks of disagreement on the final work, thus reducing both parties' costs of time and money. Advanced simulation technology is also observed in our daily lives as it improves the techniques of health care. It provides surgical procedures or anatomy and other relevant scenarios for medical professionals. They are able to be trained in a more realistic environment without inherent risks of the actual practice of surgery[625].

The EPO Guidelines relating the patentability of computer-implemented inventions was amended after the publication of the G1/19 decision. The Guidelines includes not only the "two hurdle" concept from the *COMVIK* decision, but also its application on artificial intelligence.[626] Moreover, computer simulation technology invention is another issue that the

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[625] For discussions on the application of simulation (such as Building Information Modelling - BIM) in architecture and design for visualization, risk reduction, and cost management, see for example, B. Succar, 'Building information modelling framework: A research and delivery foundation for industry stakeholders' (2009) 18(3) Automation in Construction 357. Regarding the use of advanced simulation technology in healthcare for improving medical techniques and training, particularly for surgical procedures and anatomy education in risk-free environments, see for instance, S. B. Issenberg *et al.*, 'Features and uses of high-fidelity medical simulations that lead to effective learning: A BEME systematic review' (2005) 27(1) Medical Teacher 10.

[626] Nick Reeve, 'Changes to the European Patent Office Guidelines for assessing the patentability of computer implemented inventions following the Enlarge Board of Appeal Decision in G1/19' (Reddie & Grose, May 2022) < https://www.reddie.co.uk/2022/05/11/changes-to-the-european-patent-office-guidelines-for-assessing-the-patentability-of-computer-implemented-inventions-following-the-enlarged-board-of-appeal-decision-in-g1-19/ > accessed 20 August 2023.

amendments took in to consideration. The practical application of these updated Guideline provisions, particularly in the evolving field of AI, will be further illustrated through case law analysis later in this chapter (see, for instance, the discussion under the heading “The Impact of AI Patents', which includes an analysis of T 1615/17). First is to inspect whether or not the patent claim exhibits any technical features carried out by virtue of the computer implementation. Normally inventions that involves a computer, computer network or any tangible physical concrete apparatus will not be challenged at this step. Nevertheless, the subject-matter inspection does not make much sense without the second step - the inventive step assessment.[627] In fact, the latter is considered to be the substance of patentability examination as the core inspection. In other words, it is to find out whether the claimed invention identifies technical problems or not. If yes, further, whether the claimed patent helps to provide a solution, which in not obvious to the nominal person of ordinary skill in the art, to solve the problem.

It is clear that the EPO approach takes technical features as the essential element for patentability. With the progress of technology development and the enhancement of computer-implemented inventions where defining non-obviousness became harder than it used to be, inventive step inspection has increasingly importance. Recently the technical feature inspection for determining subject-matter proceeds mainly focusing on the inventive step in patent court decisions.[628]

A study prepared for the European Commission found that the EPO has partially conflated the requirements of subject-matter as well as inventive step. Before one can identify the technical feature in an invention, it should be noted that if an invention is excluded from patentability according to Article 52(2) and (3) EPC, there is no need to conduct an inventive step assessment.[629] That is, unless the solution is led by the interaction between technical and non-technical features. Hence, it can be concluded that patentability subject-matter and inventive step inspection are supplementary to each other. Before one can

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[627] *Ibid.*

[628] Nicholas Fox and William Corbett, ‘UK and EPO approaches to excluded subject-matter and inventive step: are *Aerotel* and *Pozzoli* heading for the rocks?’ (2014) 36(9) E.I.P.R. 571.

[629] Alain Strowel and Sinan Utku, ‘The trends and current practices in the area of patentability of computer implemented inventions within the EU and the US’(2016) pdf. accessed via < https://ec.europa.eu/digital-single-market/en/news/report-trends-and-current-practices-area-patentability-computer-implemented-inventions-within > at p17, accessed on 30 March 2018.

identify the technical feature in an invention, the first question to ask is how the patent claim is evaluated in the EPO.

The EPO Guidelines in 2017 demonstrated a problem-and-solution approach to determining the inventive step in an objective and predictable manner.[630] The approach is divided into three main stages: first, determining the "closest prior art"; secondly, establishing the "objective technical problem" which is to be solved; finally, starting from the closest prior art and objective problem defined in previous two steps, consider whether the claimed invention is obvious to a skilled person or not. This is also correspondence to article 56 of the EPC which indicates an invention shall be considered as involving an inventive step if it is not obvious to a person skill in the art.[631]

In spite of the fact that the patent system in the EU is stricter than the US, especially considering computer programs which are expressly excluded by the EPC, the low threshold seems not able to play the proper role of "gatekeeper" as it may be expected. Moreover, although the EPO Guidelines set up lists of steps for considering inventive step, it is commented in an earlier study commissioned by the European Parliament, based on the 2001 EPO Guidelines, that the non-obviousness test in the EPO leaves room for interpretation.[632] The report pointed out that the test "will present an obstacle only in exceptional cases"; an example was given that a new but trivial combination of known techniques would be considered obvious.[633] Accordingly, the report suggested that non-obviousness is not sufficient for high technical invention like computer programs.

To address this challenge, the report itself pointed towards specific complexities inherent in software that necessitate a more nuanced assessment beyond a simple non-obviousness test. Specifically, as far as computer programs are concerned, more specifically software and business methods, it is not easy to find such techniques and knowledge in such a document; even if they are common knowledge. This intensifies the difficulties to the examiners in patent offices in defining prior art and determining patentability. Inventiveness must

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630 5, Ch.VII, Part G of the EPO Guidelines (2017 version).

631 Article 56 of the EPC.

632 Reinier Bakels and P. Bernt Hugenholtz, 'The patentability of computer programmes: Discussion of European-level legislation in the Field of Patents for software' (2002) < http://www.europarl.europa.eu/meetdocs/committees/juri/20020619/SoftwarePatent.pub.pdf >p31, accessed 29 March 2018.

633 *Ibid.*

also be taken into consideration when inspecting the requirement of non-obviousness.[634] The report therefore emphasised that genuine inventiveness must be taken into consideration when inspecting the requirement of non-obviousness[635]. These long-standing complexities in patenting software-related inventions, particularly concerning the assessment of inventiveness and the definition of prior art, have taken on new dimensions and are further intensified with the rapid advancement of AI.

The Impact of AI Patents

The difficulty in defining technical character, the rapidly changing landscape impacting novelty and inventive step, the potential for broad monopolies via network effects, and the complexities introduced by cumulative innovation are further exacerbated by the rise of AI. AI, often implemented through complex software algorithms, introduces unique issues for patent examination.

Determining the "technical character" of an AI invention can be particularly challenging. While some AI applications clearly control physical processes or improve the internal functioning of a computer system (potentially meeting the "further technical effect" criterion established in cases like *Duns Licensing* and refined for simulations in *Infineon* and *G 1/19*), others may primarily involve abstract mathematical methods or business schemes. Distinguishing a patentable technical application of AI from a mere algorithm or business logic operating on a computer remains a key difficulty, echoing the struggles seen in earlier cases.

The assessment of novelty and inventive step are also complicated by AI. The rapid pace of AI research and development, coupled with the vast amount of potentially relevant prior art in diverse formats; including code repositories and research papers outside traditional patent databases, make comprehensive prior art searches difficult. Furthermore, assessing whether an AI invention would have been "obvious" to a person skilled in the art (as required by Article 56 EPC and examined via the problem-solution approach) becomes complex when considering the capabilities of modern AI tools available to practitioners. What is obvious to a human assisted by powerful AI may be different from what is obvious to a human working alone.

Moreover, the "black box" (internal decision-making processes are not easily

634 *Ibid.*

635 *Ibid.*

understood or interpretable by humans. While these models can produce highly accurate results, it's often unclear how or why a specific output was generated from a given input.) nature of some complex AI models can pose challenges for disclosure and enablement requirements. Adequately describing an AI invention such that a skilled person can reproduce it without undue burden can be difficult if the invention relies heavily on vast, proprietary training datasets or intricate, non-transparent algorithmic structures. The cumulative nature of AI development, where new models and applications often build upon existing frameworks, intensifies the risk of "patent thickets" and the "tragedy of the anti-commons" previously discussed. Broad AI patents could stifle innovation by making it difficult and costly for subsequent developers to build upon foundational AI techniques.

In conclusion, while EPO case law has evolved to address the patentability of computer-implemented inventions and simulations by emphasizing technical character and inventive step, the advent of AI introduces new layers of complexity. The existing framework, while adaptable, faces significant pressure in consistently and predictably handling AI inventions, particularly concerning the definition of technical contribution, the assessment of inventive step in an AI-assisted world, and the potential for overly broad protection hindering future innovation. Addressing these emerging challenges will require continued refinement of both patent law principles and examination practices.

AI patent example in Europe: T 1615/17 (*Classification/HUAWEI*).

While *G 1/19* provided crucial clarifications regarding computer-implemented simulations, the broader question of how machine learning algorithms, often performing complex data processing or classification, satisfy the requirement for technical character remains a key aspect of EPO practice concerning AI inventions. In this regard, decisions from the Technical Boards of Appeal continue to shape the understanding of what constitutes a patentable technical application of AI. A noteworthy example illustrating the application of the technicality test to a core machine learning task is found in **T 1615/17 (*Classification/HUAWEI*)**.[636]

This case concerned an invention related to a classification method utilising machine learning algorithms to classify data. More specifically, the invention provided techniques for identifying classes associated with certain data, such

[636] T 1615/17 (*Classification method/HUAWEI TECHNOLOGIES ET AL.*) of 12 May 2020, Technical Board of Appeal 3.5.07.

as classifying Quality of Service (QoS) data within a communication system. The heart of the dispute lay in whether such a classification method, fundamentally based on a machine learning algorithm, possessed the requisite "technical character" and "inventive step". The Examining Division had initially taken the view that the invention merely amounted to an abstract mathematical method without a patentable technical contribution. However, the Technical Board of Appeal overturned this decision. The Board reaffirmed the established EPO principle that mathematical methods, including machine learning algorithms, can be patentable if they are applied to solve a technical problem or produce a technical effect within a technical context.[637] In the specific circumstances of this case, the Board reasoned that despite the classification algorithm itself being inherently mathematical, its application to classify QoS data within a communication system, and its use for improving the performance of that communication system (e.g., in resource management), endowed the invention with technical character. The Board underscored that the decisive factor is whether the mathematical method serves a "technical purpose".[638] Here, the classification of QoS was seen as directly addressing a technical problem within the technical field of communication systems.

The *T 1615/17* case demonstrated how a seemingly abstract machine learning task, like data classification, can be deemed patentable at the EPO when it is firmly rooted in a technical application. This case serves as a valuable illustration following the principles reiterated in *G 1/19*, reinforcing that the focus for AI inventions, like other computer-implemented inventions, must be on their contribution to the solution of a technical problem within a technical domain. While not from the Enlarged Board, this decision has been referenced in subsequent practice,[639] providing guidance on how machine learning applications in specific technical fields can overcome the initial hurdle of being perceived as merely abstract methods, thus contributing to the evolving landscape of AI patentability in Europe.

Case law in the technology era – the US practice

On the other hand, the other, internationally, important patent system, the USPTO, has applied patent policies, especially when compared with the EPO.

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[637] See T 1615/17, Reasons, point 1.2.3 (citing G 3/08, OJ EPO 2011, 10 and Case Law of the Boards of Appeal, I.A.1.4.2). See also EPO Guidelines for Examination (as of March 2025), Part G, Chapter II, section 3.3.

[638] T 1615/17, Reasons, point 1.2.4.

[639] T 1615/17 (Linking place information based on position/RAKUTEN) 21-10-2022 | epo.org.

The patent policies of the USPTO, the other important patent system discussed in this chapter, differ in key respects from those of the EPO, particularly concerning inventions implemented by computer. Notably, the approach of the United States to the patent eligibility of such inventions, especially software and business methods, has been significantly shaped by the Supreme Court's 2014 decision in *Alice Corp. v. CLS Bank International*. Consequently, a comprehensive understanding of US practice in this technological era necessitates a consideration of the distinct legal landscapes both before and after this pivotal ruling.

In the new era in which knowledge-based technology is becoming the leading industry and occupying a dominant position in the economy, the popularization of the internet fosters the widespread technology information swap. This phenomenon causes concerns that the number of software patent application will keep ramping up.[640] The EPC in the EU has in its provision acknowledged the exclusion to computer programs as such despite the patentability of software inventions remain a topic for legitimate debate. With regard to the US, the practice of software patent is stormier. While patent authorities, inventors, and those in relevant legal professions anticipated seeing certain breakthroughs brought on by the milestone decision made by the US Supreme Court in *Alice Corp*, the decision does not seem to help to ease the disputes with software patents. Nonetheless, there is one thing that can be confirmed – both the EU and the US are facing a pivotal but intractable problem. Namely, the lower courts and patent practitioners are struggling with applying the tests for patent subject-matter eligibility; however, the highest court has not yet concluded a standard to investigate software patent subject-matter nor confirm whether software is a patent eligible subject-matter or not.[641]

It had been expressly interpreted by the US Supreme Court in early case law in *Diamond v Dieher* that, in accordance with the meaning of Section 101 of title 35 of the USC, laws of nature, nature phenomena, and abstract ideas are not patentable subject-matter (a concise description *Diamond v Dieher* has been given in Chapter 5)[642]. The court left the door ajar for computer software as it reasoned that the patent claim was not to monopolise a well-known formula but

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[640] Guido Noto La Diega, 'Software patents and the internet of things in Europe, the United States, and India' (2017) 39(3) E.I.P.R. 173.

[641] Rupert A. Knights and Craig A. Redinger, 'Patent eligibility of software patents in the US and Europe: A post-Alice consideration' (2015) No.1 Vol.8 Landslide (ABA Section on Intellectual Property Law) at p2.

[642] *Diamond v. Diehr*, 450 U.S. 175 (1981).

applied the formula as a step to carry out something new in the art.[643] Therefore, it deserves patent protection. The US approach to the patentability of computer programs including software left almost no trail to be followed at this time; at least it opened the door for attention and heated debates to fit the new type of intelligent product into the existing legislative framework.

On the other hand, according to the USPTO, laws of nature and abstract ideas are used to explain judicial exceptions and are usually employed by the US courts to describe the basic tools of scientific and technological work, including mathematical algorithms[644]. The US patent law explicitly stated four categories of statutory subject-matter, including process, machine, manufacture, and composition of matter in Section 101. However, the USPTO in its guidance to Section 101 also illuminates that patent claims are not automatically eligible for patentability when it falls within any particular category of these four.[645] As a patent system that welcomes all aspects of technology innovation, the USPTO analyse patent claims based on their broadest reasonable interpretation[646].

Following up the machine-or-transformation test set up in *In re Bilski* (see Chapter 5 for case details) which the US Federal Circuit opened up the possibility of patenting abstract ideas and software patents[647], the Supreme Court in *Mayo Collaborative Services v Prometheus Laboratories Inc.*, on the other hand, indicated the patentability of natural phenomena.[648] The patent claim in *Mayo* was a method which correlates the relationship between blood metabolite levels and the effectiveness of drug dosage. In its decision the Supreme Court denied the patentability and reasoned that the claim at issue was a law of nature which merely directed to a more effective utilisation by treating doctors. In this case the Supreme Court declared fundamental concepts regarding the patentability of laws of nature, one of which is that a process which recites laws of nature is not patentable in principle; but it may be patent eligible in certain cases if it "has additional features that provide practical assurance that the process is more than a drafting effort designed to

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643 *Ibid.* 101 S. Ct 1048, 1057 (1981).

644 USPTO, '35 USC Section 101: Statutory requirements and four categories of invention' (2015) < https://www.uspto.gov/sites/default/files/101_step1_refresher.pdf > at p8.

645 *Ibid.,* at p12.

646 *Ibid*.

647 *In re Bilshi* 545 F. 3d (Fed. Cir. 2008)(en banc) 943, 945, 1010.

648 *Mayo Collaborative Services v Prometheus Laboratories Inc.* 132 S. Ct. (2012) 1289.

monopolise the law of nature itself." [649] Furthermore, as the Supreme Court's precedent pointed out, if a patent claim is reflected as an inventive step independent of the newly discovered law of nature that "ensure that the patent in practice amounts to significantly more than a patent upon the natural law itself." Despite the patent claim in *Mayo* was related to the field of biological science, the Supreme Court's construction to the nature phenomena is influential to future court decisions in determining the patentability of claims includes laws of nature, and of course raises calls for same scrutiny to other abstract ideas including software patent[650].

The US Supreme Court has long avoided answering or defining what is an abstract idea. The Federal Circuit's decision in *Alice Corp* was criticised as a "created significant legal uncertainty" due to the perplexity caused by its divided opinions and the uncertainty of patentable invention remains[651]. The Supreme Court was urged to clarify the patentability of software in *Alice Corp* by the *amicus curiae* briefs put forward by software related enterprises including Google, Amazon and IBM, industry association like the Institute of Electrical and Electronics Engineers (known as IEEE-USA), and the USPTO[652]. However, this reliance on judicial intervention to delineate clear and adaptable rules for software patentability in such a complex and rapidly evolving technological field was not without its own inherent challenges, including the risk that any resulting test might prove difficult to apply consistently or fail to resolve the underlying ambiguities comprehensively.

6.1.1. Legal Basis – Patent Exclusion

6.1.1.a. Did The *Alice Corp.* Ruling Change the Fate of Software and Business Method Patents In The US?

Even though the US patent system tends to analyse patent claims based on its broadest reasonable interpretation, the USPTO also emphasises that even if a patent claim satisfies any of the four statutory patentable subject-matter, it

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[649] *Ibid.,* at 1297.

[650] Pheh Hoon Lim and Louise Longdin, 'The smartphone wars: patents and copyright as swords and shields' (2016) 38(5) E.I.P.R. 286-287.

[651] Stuart P. Meyer *et al*., 'Intellectual property alert: Supreme Court rules against broadly claimed software patents, but offers no clear test for abstract idea' (2014) < https://www.lexology.com/library/detail.aspx?g=9ad4c7ee-a6e0-448d-9ca9-4d3b4f3c3e91 > accessed 17 Nov 2025.

[652] *Ibid.*

"must still avoid" falling with the patent exclusion listed by patent law.[653] As discussed in Chapter 5, in response to the call for determination regarding the patent eligible subject-matter, especially software patent, the US Supreme Court finally provided a two-step standard by means of the patent claim in *Alice Corp v CLS Bank* which is concerned with computer-implemented methods for business.[654]

Alice Corporation's patents were about a scheme which was to mitigate settlement risks in finance exchange. Its computerised trading platform was designed to facilitate the exchanging of financial obligations between both parties by employing a computer system as an intermediary. Alice's patent claims in suit included: "a method for exchanging financial obligations; a computer system configured to carry out the method for exchanging obligation; and a computer-readable medium containing program code for performing the method of exchanging obligations."[655] The patents were challenged by CLS Bank, asserting they were invalid. Alice Corp counterclaimed infringement against CLS Bank. The case initially came before the district court where Alice's patents were held invalid. The patents were deemed as merely reciting abstract ideas and they were not a patent eligible subject-matter under Section 101 of the US patent law.[656] The case was appealed to the Federal Circuit and the patents remained invalid with the court's reasoning: "…. Abstract methods do not become patent eligible machines by being clothed in computer language."[657]

Alice Corp then appealed to the Supreme Court in 2014. The Supreme Court referred to the two-step test which was pointed out in the *Mayo* and elucidated that the *Mayo* test is the standard for determining patent eligibility in all claims.[658] Accordingly, in the first step of the framework the court must

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[653] USPTO, '35 USC Section 101: Statutory requirements and four categories of invention' (2015) < https://www.uspto.gov/sites/default/files/101_step1_refresher.pdf > at p12 accessed 27 March 2018.

[654] *Alice Corp v CLS Bank* 134 S. Ct 2347 (2014).

[655] Supreme Court of the United States (syllabus) (2014) <https://www.supremecourt.gov/opinions/13pdf/13-298_7lh8.pdf > accessed 1 February 2018.

[656] Stuart P. Meyer *et al.*, 'Intellectual property alert: Supreme Court rules against broadly claimed software patents, but offers no clear test for abstract idea' (2014) < https://www.lexology.com/library/detail.aspx?g=9ad4c7ee-a6e0-448d-9ca9-4d3b4f3c3e91 > accessed 17 Nov 2025.

[657] *Alice Corp. Pty Ltd v CLS Bank Int* 717 F. 3d. *(Fed. Cir. 2013)*1269,1292.

[658] Rupert A. Knights and Craig A. Redinger, 'Patent eligibility of software patents in the US and Europe: A post-Alice consideration' (2015) No.1 Vol.8 Landslide (ABA Section on Intellectual Property Law) at p2.

determine is whether or not the claims at issue are directed to a patent-eligible concept. Namely, in the case of Alice Corp's patents, the court had to consider if the claimed patents involved abstract ideas. If the answer to the first step is yes, the second step of the framework is that the court must consider whether or not the claimed abstract idea merely requires generic computer implementation without transforming the abstract idea into further inventive contribution.[659] In other words, the claim must include an 'inventive concept' sufficient to transform the abstract idea into a patent-eligible application. This concept must amount to 'significantly more' than the abstract idea itself, ensuring the claim does more than merely instruct the practitioner to implement the abstract idea on a generic computer.

Considering Alice Corp's patents fail to transform the abstract idea into a patentable invention, the Supreme Court therefore affirmed Federal Circuit's judgement and rejected Alice Corp's patents. What is worth noting is that while Alice Corp's patents were sophisticated business ideas that prevent financial settlement risks, the failure of the patents demonstrates the patent ineligibility of simply abstract methods. Indeed, this outcome, highlighting the inability of such methods to secure patent protection despite their business sophistication, could be seen as largely consistent with the Supreme Court's established jurisprudence. The Court has historically excluded fundamental concepts, including abstract ideas, from patentability, and its decision in *Alice* built upon the framework previously articulated in cases such as *Mayo Collaborative Services v. Prometheus Laboratories, Inc.*, which had already signalled a rigorous approach to such subject matter. It did not, therefore, result in a blanket invalidation of all software patents across the board; rather, the *Alice* decision reinforced that the patent eligibility of such inventions would henceforth be heavily scrutinized on a case-by-case basis, depending on the specific nature of the claims and whether they added a sufficient inventive concept to an underlying abstract idea.[660] Rather, to summarise the different courts' opinions in the case, an abstract idea is not patent eligible if an invention is related to a simple idea and such invention merely to implement this idea by using conventional computer or similar hardware. Regardless it is in the form of computer system, method or any other similar forms.

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[659] Supreme Court of the United States (Syllabus) (2014) <https://www.supremecourt.gov/opinions/13pdf/13-298_7lh8.pdf > accessed 1 February 2018.

[660] Pheh Hoon Lim and Louise Longdin, 'The smartphone wars: patents and copyright as swords and shields' (2016) 38(5) E.I.P.R. 287.

As mentioned in Chapter 5, Judge Moore in the Federal Circuit stated in his dissenting opinion that if Alice Corp's patents are affirmed patent ineligible, it would lead to "the death of hundreds of thousands of patents"[661] including business methods and software patents. In addition, some people may argue the *Alice Corp* decision as the end of software and business methods patent.[662] However, the courts in this case did not pronounce any prohibition on software patent in general; rather it more likely provides a legitimate justification to software patents in the US as software invention will be considered patentable if it provides it does more than an abstract idea applied via computer devices and it transforms the idea into a patent eligible invention. This judicial approach appears to be significantly influenced by underlying public policy objectives. These include preventing the undue pre-emption of fundamental scientific and economic building blocks, ensuring the patent system incentivizes genuine technological advancements rather than broad abstract concepts, and addressing concerns over patent quality and litigation burdens often associated with patents on mere computerized abstract ideas. Consequently, while seeking to curb overly broad claims, the courts have aimed to preserve patent protection for software that demonstrably improves computer functionality or provides specific, inventive technical solutions.

Subsequent Federal Circuit decisions have indeed provided clearer examples of this demarcation. For instance, in *DDR Holdings, LLC v. Hotels.com, L.P.*[663], claims directed to a system for generating a composite web page that solved a specific problem rooted in internet technology itself (rather than merely using the internet as a tool for an abstract idea) were found patent-eligible. Crucially, the Federal Circuit in *Enfish, LLC v. Microsoft Corp*[664] provided a vital clarification: claims directed to a specific improvement in the functioning of the computer itself (e.g., a self-referential database) are not abstract under first step. This distinction is pivotal, separating patent-eligible technical improvements from claims that merely invoke computers as tools.

Applying for software and business method patent in the US is not impossible. In fact, many of this type of patents were granted even after *Alice Corp* decision albeit there are studies notice that the rate to rejected computer program related

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[661] *Bank v Alice Corp* 717 F. 3d 1269, 3(2013).

[662] Robert Stoll, "Federal Circuit cases to watch on software patentability – Planet Blue" (2017) < https://www.shermanip.com/federal-circuit-cases-to-watch-on-software-patentability-planet-blue/ >

[663] DDR Holdings, LLC v. Hotels.com, L.P., 773 F.3d 1245 (Fed. Cir. 2014).

[664] Enfish, LLC v. Microsoft Corp., 822 F.3d 1327 (Fed. Cir. 2016).

patents has increased thereafter.[665] Figure 7 below is the data collected by Essig and Howard describing the percentage of patent issued pre- and post-the *Alice Corp* decision. The chart shows the percentage of e-commerce related patents issued with a rejection based on Section101 during examination before and after *Alice Corp* and after Examination Guidelines was updated between 2014 to 2016. It can be seen from the graph that there was tiny difference between the pre-*Alice* period and the period when *Alice Corp* was just made. There was less than 55 percent patent issuance when facing a Section 101 challenge. However, when the 2014 Guidelines was introduced after the *Alice Corp* decision was made, the rate rose to nearly 70 percent. Furthermore, in the period between the introduction of 2015 Guidelines and 2016 Guidelines, the rate went up to more than 80 percent.

The information in the study demonstrates that e-commerce patents have been facing stricter inspection in the post-Alice era than it used to be. It is also pointed out in the study that, with the updating of the Guidelines, the examiners of the USPTO faced greater burdens when reviewing patent applications in relevant categories.[666] The information reveals that the US approach to software and business method patent is gradually moving into a stricter sense, similar to the European approach. This notable convergence in the examination standards for software-related inventions between two of the world's most influential patent systems, the USPTO and the EPO, understandably prompts consideration of whether a broader international consensus is beginning to emerge. While achieving a fully harmonized global standard for patent eligibility in this complex technological field may still be a considerable way off, with various jurisdictions retaining their own specific legal nuances and tests, such a parallel shift towards requiring a more discernible technical contribution beyond the mere computer implementation of an abstract idea could indeed signal a developing international inclination. This trend, if sustained, might influence patent practices in other regions and shape future discussions on international patent law harmonization for computer-implemented inventions. However, it does not mean such patents are facing a dead end. Rather, according to Essig and Howard's study, their findings suggest that the Alice Corp.'s impact on software and business method patents has gradually

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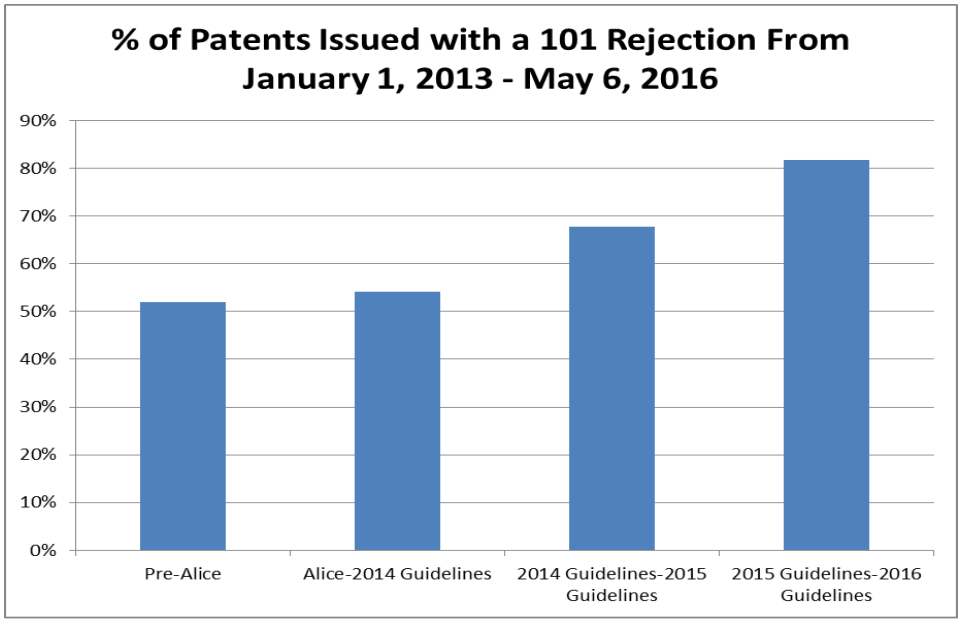
[665] Lincoln S. Essig and Damien Howard, 'Impact of the USPTO Examination Guidelines on software patents post-Alice' (2016) < https://www.lexology.com/library/detail.aspx?g=0a9d2dcc-808b-4d56-af17-b91c4d03f659 > accessed 18 Nov 2025.

[666] *Ibid*..

stabilised, and importantly, that the number of such patents being issued has even started growing again. It turns out *Alice Corp* resulted in a more rigorous patent examination like Europe. However, as far as patent practitioners are concerned, applying software and business method patent is somewhat left to chance. It looks like the Supreme Court indicated a two-step test as a guide, but it leaves nothing to explain what are the standards to apply such test.

Figure 7. Percentage of Patents Issued Pre- and Post-Alice Corp Decision



Source: Lincoln S. Essig and Damien Howard, "Impact of the USPTO Examination Guidelines on software patentspost-Alice' (2016) <https://www.knobbe.com/news/2016/09/impact-uspto-examination-guidelines-software-patents-post-alice >

6.1.1.b. What About the Patent Exclusion in Europe?

When addressing the patentability of computer programs, the European patent system under the EPC offers a distinct statutory framework, contrasting with the US approach that relies heavily on judicially created exceptions to 35 USC Section 101, such as for "abstract ideas".[667] Article 52(2)(c) EPC explicitly lists "programs for computers" among subject matter that shall not be regarded as inventions. However, this initial statement of exclusion is critically qualified by Article 52(3) EPC, which clarifies that this provision applies only "to the extent to which a European patent application or European patent relates to such subject-matter or activities as such." The interpretation and application of this

[667] USPTO, '35 USC Section 101: Statutory requirements and four categories of invention' (2015) < https://www.uspto.gov/sites/default/files/101_step1_refresher.pdf > 3, accessed 09 December 2024

"as such" qualifier by the EPO and its Boards of Appeal have been central to delineating the boundary for patent eligibility of computer-implemented inventions in Europe.

The journey of interpreting "as such" effectively began with early efforts by the EPO Boards of Appeal to prevent the wholesale exclusion of valuable technical innovations merely because they were implemented using software. A ground-breaking decision in this developmental phase was T1173/97 (*Computer program product/IBM*)[668], which established that a computer program product is not excluded from patentability if, when run on a computer, it produces a "further technical effect which goes beyond the normal physical interactions" between the program and the computer[669]. This ruling was pivotal in signalling that software contributing to a technical solution and possessing this "further technical effect" could indeed be patented. Complementing this perspective, decisions such as T931/95 (*Pension Benefits System Partnershi*p) [670] highlighted another crucial aspect: even if the subject-matter of a claim (for example, a computer-implemented method with business-related aspects) is deemed not to fall under the exclusions of Article 52(2) EPC "as such", it must still independently satisfy all other fundamental patentability requirements. These include novelty, and significantly for computer-implemented inventions, an inventive step (Article 56 EPC) that must be based on technical features contributing to the solution of a technical problem. This underscores that overcoming the Article 52(2) and (3) exclusions are merely the first hurdle in a comprehensive patentability assessment.

Indeed, the consistent focus of EPO patentability examination for computer-implemented inventions, as often highlighted by commentators like Kenrick and Robinson, is squarely on the identification and assessment of "technical features" and the overall "technical character" of the claimed invention; the mere involvement or presence of a computer does not automatically confer patentable subject-matter status if that essential technical character is absent [671]. The term "as such", in this context, has been interpreted by practitioners and scholars, such as Brunner *et al.*, not as a complete bar, but as a means to limit the scope of the exclusions, thereby permitting patents for

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[668] T1173/97 *Computer program product/IBM* (1998).

[669] Ibid., at headnote

[670] T931/95 *Pension Benefits System Partnership* C-IV 1.1 to 1.2.

[671] Mark Kenrick and David Robinson, 'Securing software patents through the EPO' (2014) < https://www.iam-media.com/article/securing-software-patents-through-the-european-patent-office > accessed 17 Nov 2025.

inventions that are fundamentally technical in nature, even when realised or delivered by software[672]. While the initial threshold for demonstrating some technical means (and thus avoiding exclusion “as such”) might appear relatively accommodating, often satisfied by the claim involving a computer or a computer-readable medium, the subsequent substantive examination for inventive step remains rigorous. This involves applying the problem-solution approach where only features contributing to the technical character of the invention are considered for assessing non-obviousness. Furthermore, this emphasis on technicality is embedded within the EPC Implementing Regulations, which mandate, for instance, that the patent description "specify the technical field to which the invention relates" (Rule 42(1)(a) EPC) and that the claims define "the technical features of the invention" (Rule 43(1) EPC).

Despite this established framework, which has been significantly consolidated and clarified by later Enlarged Board of Appeal decisions such as G 3/08 (as discussed in detail in the earlier section before), the precise delimitation of what constitutes “technical character” or a “further technical effect” can still present challenges and be a subject of ongoing debate, particularly for newer and more abstract forms of software technologies, including aspects of artificial intelligence. The EPC itself does not provide a definition for “technical”, leaving its interpretation to the evolving body of case law. This reliance on jurisprudential development, while allowing for adaptability, can also introduce a degree of uncertainty for applicants attempting to navigate the boundaries of patentable subject matter. Nevertheless, through this purposive and dynamic interpretation of Article 52(2) and (3) EPC, the European patent system has long established a clear, albeit conditional and technically focused, pathway for patenting inventions that are either implemented by or intrinsically involve computer programs. This represents a structured system of approval for software that provides a genuine technical contribution, moving far beyond what might have been perceived in much earlier stages as merely a “*de facto* tacit acceptance”.

6.1.2. Legal Basis – Justifications for Software Patent

6.1.2.a. The US Patent System – What is Missing?

It has long been a point of contention, with significant segments of the US

[672] John Brunner *et al.*, ‘Software and business method patents in Europe and the UK’ (2015) Carpmaels &Ransford < https://www.carpmaels.com/software-and-business-method-patents-in-europe-and-the-uk/ > accessed 2 March 2017.

technology industry—particularly software developers, startups, and larger tech companies frequently targeted by patent assertions—arguing that, prior to pivotal Supreme Court clarifications like *Alice Corp.*, US courts tended to grant overly broad or indiscriminate patent protection to software when compared with other jurisdictions.[673] Critics contended that such an expansive approach did not necessarily equate to better or more effective protection for genuine innovation. Instead, they argued that it often led to a proliferation of low-quality patents on abstract software concepts or routine business methods merely implemented on a computer. The reasons for this criticism were multifaceted: such patents were seen to stifle innovation by creating "patent thickets" that made new developments difficult and costly; they empowered non-practicing entities (NPEs or "patent trolls") to engage in widespread litigation, imposing substantial legal expenses and uncertainty on operating companies; and the unclear boundaries of these broad software patents made it challenging for developers to ascertain freedom to operate, thereby chilling new technological exploration. The *Alice Corp* decision evokes worries that the courts' general guidance on determining software patent may extend protection to software to an unreasonable and overbroad scope.[674] The doubts were not incurred without reason. Indeed, the Supreme Court decision was desirably anticipated to guide the parameters for patent exclusion, namely abstract ideas like computer programs which is expressly foreclosed by patent law, and patentable inventive functions that constitutes patentable subject-matter.[675] Another reason why *Alice Corp* attracts so much attention was because the court, as shown in case law, avoided answering the question of whether software and business methods are patent eligible.

Case law shows that the US Supreme Court tended to avoiding answering this controversial question and very often it left its lower court to face the queries raised by patentees. An example can be seen in *Bilski v Kappos* in which the Supreme Court gave its ruling a decade ago.[676] The patent claim in concern were methods for hedging risks for commodities trading. The claim was rejected by the Patent Office based on the reason that the invention convers abstract

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[673] Richard Waters, 'Software patents survive US Supreme Court test' (2014) Financial Times < https://www.ft.com/content/ff6516a2-f7c3-11e3-90fa-00144feabdc0 > accessed 27 March 2018.

[674] *Ibid.*

[675] Eddy D. Ventose and Terry Harris, 'Managing the "risky" business of patenting in the United States' (2014) 36(12) E.I.P.R. 762.

[676] *Bilski v Kappos* 130 S. Ct. 3218 (2010).

ideas. This rejection by the Patent Office was subsequently affirmed on appeal by the U.S. Court of Appeal for the Federal Circuit (CAFC). In this appellate decision, the CAFC applied the machine-or-transformation test and rejected the claim according to Section 101 of US Patent Act.[677] Regrettably, the Supreme Court did not take this chance to draw lines for patenting business method. It neither ratified the lower court's attempt to clarify subject-matter issues; nor establish a definitive standard or test for this problem.[678] On the contrary, the court indicated to the lower courts to develop a test that is less extreme than machine-or-transformation to decide the scope of business method patent.

It cannot be denied there were some times that the US Supreme Court put effort to reach this arguable topic since the software patent issue stared sprouting up in the 1980s. *Diamond v Diehr*[679] is one of the examples where the Supreme Court notably recognised the possibility of patenting computer programs. However, the booming software industry has led to more intricate and equivocal patent claims. The Supreme Court's approach to applying patent eligibility criteria, originally developed for industrial-age inventions, to the complexities of the information age, has often been characterised by legal commentators as cautious and incremental, particularly in its handling of software-related patent claims. This ongoing jurisprudential challenge has arguably contributed to a degree of persistent uncertainty and a measured pace in the Court's development of definitive doctrines for these rapidly evolving technological fields. While it is true that, unlike the EPC, the US Patent Act's Section 101 broadly defines categories of invention without explicit statutory exclusions for specific fields like computer programs, it is crucial to recognize that US patent law, through long-standing judicial precedent, firmly precludes from patent eligibility fundamental concepts such as "laws of nature, natural phenomena, and abstract ideas." These judicial exceptions thus serve as significant gatekeepers for patentable subject matter, much like the explicit exclusions in other systems. Consequently, the Supreme Court's guidance in interpreting these principles is of paramount importance for patent practitioners, often carrying more immediate practical weight for defence purposes than the general text of the Patent Act itself.

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[677] Michael Barclay, '*Bilski v Kappos*: The Supreme Court declines to prohibit business method patents' (2010) < https://www.eff.org/deeplinks/2010/06/bilski-v-kappos-supreme-court-declines-prohibit > accessed 18 Nov 2025.

[678] Susan Marsnik and Robert E. Thomas 'Drawing a line in the patent subject-matter sands, Does Europe provide a solution to business method and software patent problem?' (2011) Boston College International and Comparative Law Review 39-40.

[679] *Diamond v. Diehr*, 450 U.S. 175 (1981).

6.1.2.b. The European Patent System – Does the Law Make the Position on Software Patents Clear?

The disputes of software patents in the US are surrounded by whether abstract ideas are patent eligible. In other words, how to decide a software invention is or is more than an abstract idea is the determinative process of software patent. On the other hand, the European patent offices and patent courts have an emphasis on the technical character that the claimed invention provides. Despite the fact that the patentability of software related inventions has been approved in European case law, the technical effect consideration causes argument that its significance as the cornerstone of the EPO approach when deciding subject-matter has ceased.[680] Rather, since the patentability in European patent still embraces technical character as determination, the technicality consideration is now focused on the observation of inventive step.[681]

As mentioned earlier (see section 6.1.1.b.), even though the EPC excludes patentability of computer programs, the term “as such” in Article 52(3) leaves room for possibilities to software inventions and has made the exclusion less absolute. Whether a patent claim comprising computer software is patentable or not ultimately depends on the interpretation of this EPC provision. For patent granting purposes, this interpretation is primarily carried out by the EPO during its examination and opposition procedures, and critically, by its Boards of Appeal, whose extensive case law provides the authoritative guidance on how EPO practice evolves. Post-grant, the validity and infringement of European patents are determined by national courts of the contracting States, and increasingly, by the UPC in participating EU Member States. While the CJEU may have a role where matters of EU law intersect with patent law (particularly concerning the Unitary Patent system), it does not directly interpret the EPC for the EPO's granting procedure. Thus, for the initial determination of patentability and the development of applicable legal principles followed by the EPO, the interpretations by the EPO's Examining/Opposition Divisions and its Boards of Appeal are most directly pertinent. This increases the importance of the “technical character” in an invention although this term is not presented in the EPC articles. The Guidelines for Examination of the EPC, in this concern, may provide a preliminary clue of the legal ground to this decisive requirement

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[680] Nicholas Fox and William Corbett, ‘UK and EPO approaches to excluded subject-matter and inventive step: are *Aerotel* and *Pozzoli* heading for the rocks?’ (2014) 36(9) E.I.P.R. 571.

[681] *Ibid.*

especially to the patent examiners and patent applicants in Europe.

With reference to the EPO Guidelines, inventions that contain computer programs can be protected as "computer-implemented invention".[682] The claimed subject-matter is not excluded from patentability as stated in Article 52(2) of the EPC if has a technical character. On the other hand, the EPO Guideline also indicate that computer-implemented inventions are often the inventions that have the mix of technical and non-technical features.[683] Technical character is particularly of significance in the claim of such an invention as it is necessary to demonstrate that the claimed invention contains an inventive step. The assessment inspected all the features that contribute to the character of the invention, including the features which is non-technical when isolated but contribute to the technical character of the invention.[684] In other words, if the non-technical features do not contribute to the technical character or merely contribute to solve a non-technical problem, they do not provide an inventive step. This problem-solution approach is the main criterion that EPO applies at the moment when observing the technical character of an invention with mixed features like CII.

In light of the EPO case law and Guidelines, the observation on computer-implemented inventions patent eligibility mainly lies in the inventive step and technical character of the invention. The patent exclusions listed in Article 52(2) EPC are construed in a narrow way. The inventive step assessment is fundamentally conducted on the basis of observation of technical character of the invention. Only one technical feature is sufficient to identify a patentable invention.[685] However, there is not yet a commonly accepted definition for the term "technical". To be more realistic it is not easy to establish a simple and workable criterion to define this term. It relies on the positive and negative examples given by the Boards of Appeal in similar cases to reflect whether the patent claim has technical features or not.[686] This reliance on a case-by-case progression for demarcating the boundaries of "technical character" inevitably invites reflection on its overall efficacy and desirability. On one hand, such a

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[682] PartG, Chapter II, 3.6 of the EPO Guidelines.

[683] Part G, Chapter VII, 5.4 of the EPO Guidelines.

[684] *Ibid.*

[685] José Santacroce, 'Patent of computer-implemented inventions: The View of the EPO' (2014) < http://www.oepm.es/export/sites/oepm/comun/documentos_relacionados/Ponencias/70_Ponencia_2.pdf > accessed on 27May 2018.

[686] *Ibid.*

jurisprudential approach inherently offers valuable flexibility, allowing the understanding of "technical" to evolve in tandem with rapid technological advancements, a particularly crucial attribute in dynamic fields like software and computer-implemented inventions. It permits nuanced assessments tailored to specific factual contexts, which a rigid statutory definition might fail to accommodate. On the other hand, this method can contribute to periods of legal uncertainty and increase the complexity for applicants and practitioners who must navigate an ever-expanding body of case law to discern applicable principles. Formulating a universally applicable, abstract definition of "technical" that remains robust across diverse technological domains and resilient over time presents a profound, perhaps even intractable, legislative or regulatory challenge. Therefore, while not without its inherent difficulties in ensuring consistent predictability, the EPO's practice of refining the concept of "technical character" through the reasoned decisions of its Boards of Appeal may represent a pragmatic, albeit continually evolving, mechanism for mediating the complex interface between patent law and dynamic technological innovation. It reflects an ongoing endeavour to strike a balance between fostering legal certainty and adapting to the relentless pace of technological change in order to appropriately incentivize meaningful invention.

Problem-solution approach that currently applied in the EPO was developed along with the decision of EPO case law. The thriving of software knowledge, the borderless transmission of internet, and the demand of enhancement of portable communication devices like smartphones have led to the cumulating of patent disputes in the 21st century across many jurisdictions. While specific Europe-wide litigation statistics for this precise period and focus can be complex to consolidate, trends observed in other major technological economies like the United States offer a pertinent illustration of the scale of this issue. For example, a study made by the Government Accountability Office in the US found that, when concerning the number of defendants in patent lawsuit, the number was twice up between 2007 to 2011.[687] Among which 89 percent of them were related to software patents. It was just the period of time that such portable devices started to come to the fore.

It is noteworthy that the EPO case law approaches adopted for patentability scrutiny is gradually moving toward a more mature legal basis for patent

[687] James Bessen, 'The patent troll crisis is really a software patent crisis' (2013) The Washington Pot < https://www.washingtonpost.com/news/the-switch/wp/2013/09/03/the-patent-troll-crisis-is-really-a-software-patent-crisis/?noredirect=on&utm_term=.7f8e74369176 > accessed 01 September 2018.

practitioners to refer to. The implementation of problem-and-solution approach can be seen in the Technical Board of Appeal in *Hitachi* which explained about technical character. It stated that "…the purely abstract concepts devoid of any technical implications" is falling within the non-invention "as such" in article 52(3) of the EPC.[688] This approach can also be found in other cases which pointed out the same notion. In *COMVIK*, the Technical Board of Appeal followed the idea of problem-and-solution approach stated that "… taking into account of all those features which contribute to said technical character whereas features making no such contribution cannot support the presence of an inventive step."[689]

In spite of the various tests/doctrines established in the EPO case law at the early stage of the interest in software, the indications made by the EPO Boards of Appeal in the new century give more pertinent criteria for the assessment of technical character to fit in this new era. The doctrinal justification for this refined approach primarily stems from a purposive interpretation of the EPC itself. The fundamental aim of the EPC, as articulated in Article 52(1), is to grant patents for "inventions" across "all fields of technology," provided they are new, involve an inventive step, and are susceptible of industrial application. This implies an overarching emphasis on rewarding tangible technical contributions. Crucially, while Article 52(2)(c) EPC lists "programs for computers" as subject matter not to be regarded as inventions, this exclusion is qualified by Article 52(3) EPC, which limits its application to such programs "as such". The consistent interpretation by the Boards of Appeal has been that this "as such" provision means that if a computer-implemented invention, through its software, exhibits a technical character—for instance, by producing a "further technical effect" beyond the mere execution of the program, or by providing a technical solution to a specific technical problem—it transcends the scope of the exclusion. This purposive interpretation ensures that patentability is determined by the substantive technical contribution of an invention rather than being precluded solely due to its implementation in software. Such an approach aligns with the broader objective of the patent system to promote genuine technological progress, while also adhering to the EPC's framework that seeks to avoid the patenting of non-technical abstract concepts or schemes in isolation.

These decisions appear to be timelier as they take into account the background where software has been more sophisticated in structure and borderless when

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[688] T 258/03 *Auction method/ HITACHI* of 21.04.2004; at paragraph 4.5.

[689] T 641/00 *Two identities/COMVIC* of 26.09.2002, at headnote I.

transmitted. In 2010, the Enlarged Board of Appeal issued an opinion in response to the referral submitted by the President of the European Patent Office regarding the patentability of computer programs under the EPC.[690] In its response, the Enlarge Board Appeal illustrated that the approach adopted by *Hitachi* and *COMVIK* begins its inspection on whether the claimed subject-matter has technical character or not with the consideration on all the features. Only this step is done the Boards can then move on to the step of inspecting whether the features contribute to that technical character. If yes, the assessment of inventive step should take this technical character in to consideration.[691]

The approach is obviously improved by building on the previous doctrines set by the EPO Boards of Appeal and updating the criteria to be a better fit for the needs of contemporary technology patterns. Under the problem-and-solution approach, a computer-implemented invention is patent eligible as long as its technical implementation helps to solve a technical problem. The European approach in accordance with Article 52(2) and (3) of the EPC which has long been regarded as strict in respect of computer-implemented invention patents has now been loosen and its software patent policy can be considered analogous to that of the US. Namely, computer-implemented inventions can easily satisfy the requirement that the claimed invention must be implemented on a computer; then demonstrate their technical character and inventive step of the invention afterwards based on the problem-and–solution principles.

Although the EPO case law and Guidelines have made progress to keep abreast of the times, there is something that remains not clarified; or it is fair to say not able to the settled. The requirement of “technicality” has not yet been expounded hence the hurdle to software patent states in Article 52(3) of the EPC is not eased; especially to software patent practitioners like software developers. Since an invention has to be unique and distinguishable from others, and thus is patentable, its technical character must be distinctive, too. It is, as a matter of fact, not possible to give one definition to decide the various technical character of the different attributes of different inventions.

This problem gets even worse because each jurisdiction in Europe has its own culture, economic background, and national law. An ideal software patent policy has to take into account those circumstances and allow flexibility when being

690 G 0003/08 *Programs for computers* of 12.05.2010.

691 *Ibid*., at paragraph 12.2.1.

applied, especially considering that patent law is often regarded as being the least harmonised among the major branches of intellectual property law. Moreover, software is widely applied in many industries especially information and communication technology. Its technical contribution may be identified based on the particular industry's demands. Such invention needs an adjustable examination standard which allows the claimed invention to be patented or rejected according to the industrial demands in order to benefits the industry and the society. Indeed, this call for an "adjustable" or "flexible" examination standard ideally extends beyond purely industrial or commercial considerations to also encompass a responsiveness to broader, evolving societal demands and public interest concerns. However, the challenge lies in how to effectively and consistently integrate these often multifaceted and dynamic societal values—which might include ethical, social, or environmental considerations—into the predominantly technical framework of patent examination. This remains a significant subject of ongoing discussion and debate within patent law and policy, as striking the right balance is crucial for ensuring the patent system truly serves the long-term welfare of society as a whole.

6.1.2.c. Software Patent in Danger and so is the Industry

Being aware of current US patent practice, which has seen the "inventiveness" concept emerging from the *Alice* framework significantly influence the statutory concept of subject-matter eligibility, Judge Rader of the US Court of Appeals for the Federal Circuit, in *Alice Corp*, cited the intriguing comments made by a scholar in 1960. By referring to Rich's wording, the judge expressed his worry that the subject-matter of the patentability for software inventions makes the doctrine "the plaything of judges, who, as they became initiated into its mysteries, delighted to devise and expound their own ideas of what it meant; some very lovely prose resulting."[692] While inventors and other researchers are looking for patent protection to secure their investments to innovation and creative technology, the empty terms like "inventive step", "non-obviousness" and "technical contribution" can be perceived by those striving for legal certainty as a challenging aspect of the system. Although judicial interpretation is a fundamental characteristic of legal development in common law jurisdictions and not unique to patent law, the inherent ambiguities associated with these

[692] *Bank v Alice Corp* 717 F. 3d 1269, 3(2013) *1269, 1335* (Rader J citing Giles S. Rich, "Principles of Patentability" (1960) 28 Geo. Wash. L. Rev. 393, 404). See also Pheh Hoon Lim and Louise Longdin, 'The smartphone wars: patents and copyright as swords and shields' (2016) 38(5) E.I.P.R. 286.

patentability standards, particularly when applied to rapidly evolving fields such as software technology can lead to significant unpredictability for innovators and practitioners. Greater predictability in the application of patentability standards would arguably enable patent practitioners and innovators to make more informed strategic decisions, potentially fostering more consistent societal benefits derived from software enhancements and their broader circulation.

This is not to say that the courts and legislators have to create a series of criteria that fit every single type of invention. Rather, as it has been shown in the patent practice, the doctrines and tests established in different courts in different jurisdictions appear to be unsettled, and their application turned to be the subjective affirmation of the judges. Formulating a set of criteria that fits to every occasion is not practical and is impossible in reality. Computer software is one of the many life-changing products of time, but people are expecting further enhancement that brings more convenience and makes more profits. Of concern is that patent law has to be applied in changeable legal practices and must get involved in another interminable debate every time a new type of product is introduced. A flexible standard may be ideal if it is designed to weigh each significant factor of patentability and give a reasonable appreciation to the dedication that the invention offers.

6.2. Current Patent System and its Problems

Software patent is more susceptible to problems when compared with other types of subject-matter patents. The 2008 Report in the EU suggested that it is more practical to focus on the problems than on the legal definition of precise limits to software patents.[693] Nevertheless, this research believes that a clear legal definition provides the primary/basic foundation of protection that the law confers to interested parties such as patentees and unintentional infringers. Hence it can further carry out the aim of incentivising innovation. It is available to any kind of patentable inventions. Software patent is more controversial and sometimes more blurred than other inventions as it is usually identified as ideas and not patent-eligible. Consequently, effectively addressing the challenges stemming from the peculiar nature of software inventions represents a critical imperative in this knowledge-based era. Otherwise, patent law would not only fail to accomplish its basic function but also make the mainstream technology

[693] Reinier Bakels *et al.*, 'Study of the effects of allowing patent claims for computer-implemented inventions – Final reports and recommendations'(2008) < https://publications.europa.eu/en/publication-detail/-/publication/90421535-ff72-46f3-b09e-a4bb8e0e711b/language-en > p5; accessed on 27 March 2018.

be confronted with more risks when doing research and more challenges when circulating advanced technology. Therefore, achieving a clear and well-calibrated legal framework for software patents is crucial not merely to resolve ambiguities, but fundamentally to strike the appropriate balance: one that effectively stimulates genuine innovation while simultaneously safeguarding against undue restrictions that could impede broader technological progress and public access. Accordingly, the following section focuses on the inevitable and urgent problems which the current patent system is facing. Then a proposed patent system, tailored to alleviate the weaknesses of current system, is presented in the next chapter.

6.2.1 Legal Uncertainty

As discussed throughout this study, it is evident that the scope of software patent is not easy to define otherwise the patent legislation and patent courts would have settled the issue. What have learnt so far can merely be taken as conceptual foundation that guides in what circumstances computer-implemented inventions like software can be deemed as patent eligible. This reliance on a slowly accumulating body of legal authorities for more definitive guidance may be partly attributed to the inherent nature of judicial decision-making itself; courts typically deliver rulings based on the specific facts and particular claims of each individual patent presented before them. While this case-by-case progression is a fundamental mechanism through which legal principles are developed and refined across most areas of law, in a field as rapidly evolving and diverse as software, it often means that broad, universally applicable rules emerge only incrementally. Consequently, for extended periods, practitioners and innovators may primarily derive a conceptual foundation for understanding patent eligibility rather than obtaining definitive, predictive tests. In reality, however, software is the product of the combination of various functional instructions. Each function can represent a specialist's unique brainchild. It is hard to apply one single principle to cover the boundless and unforeseeable software development. This leads to uncertainties for inventors, patentees, as well as other members of society such as software users. It is undeniable that a certain degree of uncertainty is inherent in many, if not all, legal domains, as legal frameworks must continually adapt to novel circumstances and evolving interpretations. However, a critical question arises specifically within the context of software patents: does the prevailing level and nature of uncertainty in this field exceed what might be deemed an acceptable or functional threshold for fostering innovation, encouraging investment, and

providing clear operational guidance to all stakeholders? The particular challenges in defining patentable subject matter for software, coupled with its rapid technological churn, arguably exacerbate these uncertainties beyond typical levels observed elsewhere. The specific manifestations of these amplified uncertainties can indeed be observed from many perspectives.

(1) Hard to set up prior art database for software increases the challenge of patent claim drafting as well as examination procedure

Inventive step is one of the vital elements of a patent eligible invention. The EPC states in its provision that an invention is regarded as involving an inventive step if "having regard to the state of the art, it is not obvious to a person skilled in the art."[694] The term "the state of the art" as used in this EPC provision is also widely known by its synonym, "prior art".[695] In addition, the EPC provision indicates that the patent requirement of novelty and states that an invention must not from part of the state of the art.[696] Similar provisions can be also found in US patent law.[697] In patent law, prior art is any evidence that shows the inventor's invention already exists and is known.[698]

Prior art research is essential to both patentees and patent examiners. As far as patentees are concerned, the patent applicant is obliged to disclose prior art that is relevant to patentability. For example, Title 37 of the Code of Federal Regulations (known as the "CFR") in the US, which states the principles to the rules and regulations regarding patents, trademarks, and copyrights, stipulated that the applicant has a duty of candour and good faith in dealing with patent office.[699] Accordingly, the applicant must disclose all the information known to that individual to be material to patentability.[700] Moreover, prior art research is also important to patentees as it is the way to assure that the claimed invention had not be done before. In order to fulfil the fundamental requirements of patentability, it is also necessary for patentee to demonstrate that his invention

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694 Article 56 of the EPC.

695 This synonymy is explicitly stated in the EPO Guidelines for Examination (as of March 2025), Part G, Chapter VI, section 1, which begins: "Prior art (also known as 'state of the art')...".

696 Article 54(1) of the EPC.

697 Section 102(a)(1) and (2) of the US Patent Act (Title 35 of the US Code).

698 EPO, 'Novelty and prior art' < https://www.epo.org/en/learning/learning-resources-profile/business-and-ip-managers/inventors-handbook/novelty-and-prior-art > accessed on 17 Nov 2025.

699 Section 1.56(a) of Title 37 of the CFR.

700 *Ibid.*

has contribution to prior art.

With regard to patent examiners, prior art is the major consideration for identifying invalid patents.[701] It is especially significant during the examination of software patent, as such invention is usually the accumulation or advancement of a new functional idea to previously exists patent. Furthermore, some jurisdictions, like the approaches adopted in the EPO as discussed in this research, now relies on the problem-and-solution test to verify the validity of a patent. Reflecting the characteristic incremental evolution of legal doctrines, this problem-and-solution test, as applied by the EPO, can be seen as formalising and building upon earlier general considerations of an invention's "technical contribution" to the state of the art. It thereby establishes a more structured and methodical framework for determining whether a claimed invention meets the crucial non-obviousness requirement for patentability. Thus, clarifying the closest prior art is the primary step that enables the following observation on inventive step as well as technical character of the invention.

Software patent application is, in principle, examined on the basis of prior art and publications including previous patent claims. However, unlike conventional types of inventions where prior art research normally relies on the databases made of granted patents, several historical and practical factors make it challenging to expect similarly comprehensive databases specifically for software-related prior art in any jurisdiction. Primarily, as the software industry began to thrive in the late 20th century, an era when patent law was already systematically implemented for other technologies, many early computer-implemented inventions were not patented. This was often because they were deemed to be unpatentable mathematical algorithms or abstract business methods under the prevailing interpretations of patent law at the time.[702] Consequently, a significant body of early software innovation and technical knowledge was never captured in formal patent databases, forming a crucial gap in the documented prior art. From the perspective of the ways that computer-implemented inventions were applied, most of such inventions were not documented in scholarly publications or online databases. They were normally embedded in the products and placed on the market with limited public disclosure of their specific internal algorithms or inventive operational

[701] Susan Graf, 'Improving patent quality through identification of relevant prior art: Approaches to increase information flow to the patent office' (2007) 11 Lewis & Clark L. Rew. 490, at 501.

[702] BITLAW, 'Bad software patents' < https://www.bitlaw.com/software-patent/bad-patents.html > accessed 15 May 2018.

methods.[703] While it is true that software made available to the public through use or sale (for instance, as part of a commercial product) does form part of the "state of the art" for patentability purposes, this public availability does not automatically translate into easily discoverable or verifiable prior art for patent examiners and applicants. The specific inventive software techniques within such publicly available products often remain undocumented in searchable formats. As commentators like Schulman have pointed out, uncovering these non-obvious or non-documented technical details to a level sufficient to serve as prior art in an examination or invalidation proceeding can require considerable effort, such as complex reverse engineering, which is a far cry from searching through indexed patent databases or academic publications. This inherent difficulty in accessing, documenting, and verifying the specific inventive aspects of publicly used but poorly disclosed software functionalities significantly complicate the prior art verification process during patent examination.

With the advance of computer-implemented inventions technology especially software products and the raise of patent awareness, the number of software patents has considerably increased in comparison with the 20th century. Technical information can be found in written forms in patent claims and patents awarded by patent offices. Despite the fact that software prior art today is searchable, some intrinsic problems remain intractable due to the abstract nature of software patent and its patent claims. Software technology is out of the ordinary as one single invention may be presented in multiple representations. It is difficult to demarcate alleged different inventions according to their patent claims.[704] However, to distinguish different inventions is the essential step of assessing an invention in the consideration of prior art. Such characteristic intensifies the level of confusion that the examiners in patent officers struggle with. Similarly, patentees have to take extra effort to search for identifying prior art in order to make the claimed invention to be patent eligible.

(2) Vague wording in statutory, judgments and even patent examination guidelines

[703] Andrew Schulman, 'Open to inspection: Using reverse engineering to uncover software prior art, part 1' (2016) < http://www.softwarelitigationconsulting.com/articles/open-to-inspection-using-reverse-engineering-to-uncover-software-prior-art-part-1/#_edn7 > accessed 17 May 2018.

[704] Rosa M. Ballardini, 'The software patent thicket: A matter of disclosure' (2009) Volume 6, Issue 2 Scripted 212.

Patent examination is conducted based on the claimed drafts for the application. Patentees have to be very careful when drafting claims, aiming to delineate an inventive scope that is broad enough to provide meaningful protection yet sufficiently precise and well-supported to avoid being deemed patent ineligible or invalidated for overbreadth—effectively seeking an optimal balance. The lack of a substantial prior art database, particularly for software, can, it is argued by some commentators, create situations where claims might be drafted using indirect or overly complex language (periphrastically).[705] For instance, in an environment with scarce or poorly indexed prior art, claims may be formulated using broad functional terms or by describing known concepts in novel terminology, making it challenging for examiners to identify relevant pre-existing technology and potentially leading to the grant of patents whose claims might inadvertently overlap with poorly documented existing solutions. This is certainly one of the factors contributing to the problem of ambiguous patent claims. Such ambiguity, by obscuring the precise boundaries of the claimed invention, directly impedes a thorough investigation of novelty as it becomes challenging for examiners to effectively search for and compare the claim against the existing body of prior art. Furthermore, the use of overly complex, vague, or persuasive rather than strictly technical language in claims, such as defining features by their desired outcome instead of their specific technical implementation, or employing non-standard or self-serving terminology, is another factor that can create significant difficulties during examination. What is worse is that this issue of claim indeterminacy is not the only cause of ambiguous patent boundaries. The problem of ambiguity is also escalated by abstruse or unclearly drafted statutory provisions (often termed “recondite provisions”) and by ambivalent or conflicting court decisions; for example, those offering differing interpretations of key patentability criteria or establishing tests that prove difficult to apply consistently across various technologies.

It can be said that drawing from examples like the TRIPS Agreement, the EPC, and the US Patent Act, that specific, forthright statutory wording explicitly tailored for software patents is largely absent. The primary target for most foundational patent laws were tangible inventions. Software, it appears, represents a distinct category of invention, novel in many aspects and differing significantly from the traditional tangible inventions for which these patent laws were initially conceived. In other words, existing patent law often merely

[705] Paul Leaves, ‘Filing software patents: Can you do it? Why do it? Is it worth it?’ (2010) Comms. L. 15(3) 75.

provides general principles to be followed when determining software patent eligibility, rather than specific rules. It is true that most inventions today are not entirely new creations; rather, many build upon existing patents and achieve functional enhancement by leveraging prior art.[706] Software patents, however, present particular intractability in assessment, partly due to the historical absence of comprehensive technical documentation for early software, which was often not considered patentable subject matter at the time of its creation.

In recent decades, various key jurisdictions have initiated or debated patent reforms aimed at addressing the challenges posed by the rapid growth of computer-implemented inventions in the new century, though these efforts have yielded mixed results and varying degrees of what might be termed “successful implementation”. For the purpose of this discussion, “successful implementation” can refer to instances where proposed legislative changes were formally enacted and began to shape patent practice, or conversely, where significant reform initiatives failed to achieve adoption despite extensive debate. While a comprehensive global survey of all such reforms is beyond the scope of this chapter, prominent examples from Europe and the United States serve to illustrate the inherent complexities and the often contentious nature of these endeavours, which in turn impact the legal uncertainty surrounding software patents.

In Europe, a significant attempt to create specific Union-level legislative instrument for software-related inventions, the proposed Directive on the patentability of computer-implemented inventions ultimately failed to gain approval. The draft Directive was rejected by the European Parliament in 2005, largely due to deeply divided opinions among stakeholders, including significant opposition from parts of the software industry and open-source advocates concerned about its potential to broaden software patentability excessively. This failure meant that the determination of software patentability in Europe continued to rely heavily on the general provisions of the European Patent Convention (EPC) and the evolving case law of the EPO's Boards of Appeal, leaving the precise scope of the exclusion for “programs for computers as such” (Article 52 EPC) to ongoing judicial interpretation rather than specific legislative harmonization at that level. This outcome underscored the difficulty in achieving a unified legislative approach and arguably contributed to sustained debates over legal certainty in this area.

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[706] Justus Baron and Henry Delcamp, ‘The private and social value in discrete and cumulative innovation’ (2011) Cerna Working Paper 2010-07 6.

Turning to the United States, patent reform initiatives have often been driven by different, though sometimes related, pressures. For instance, the Innovation Act, which saw various iterations including a reintroduction in 2015, was largely aimed at curbing perceived abuses within the patent system, particularly concerning the activities of non-practising entities (NPEs or “patent trolls”) and the high volume of patent litigation, issues that disproportionately affected the software and technology sectors. While the Innovation Act in its comprehensive form did not ultimately become law, certain of its underlying goals and some proposed measures have resonated in other legislative actions or judicial developments. The divergent experiences and mixed outcomes of these reform attempts in both Europe and the US highlight the profound challenges in establishing clear, stable, and broadly accepted legal frameworks for software patents, thereby often perpetuating rather than alleviating the legal uncertainty that characterises this field.

Software, however, is contentious because its substance is just between a patentable invention that is new, non-obvious and useful and the patent exclusion of computer programs as such. Given the explicit provisions that preclude software from being patent eligible, patentees and lawyers who draft patent claims shall have to seek language and a supporting description that not only accurately define the invention but also strategically frames it to meet the prevailing patentability criteria, particularly by emphasizing its technical character and inventive contribution. The patent provisions are, as a matter of course, the primary legislative guidance to be followed. On the other hand, decisions made by patent courts also constitute a significant and dynamic basis of law, demonstrating the evolving trends in patent legal practice. Such judicial precedents are especially important and influential in rapidly evolving technological sectors, such as the software development industry itself and the broader information and communication technology (ICT) domain, where the dynamic development of new products and methods often outpaces the ability of formal patent regulations to provide specific, up-to-date guidance.

This study has highlighted the significant challenges encountered when applying foundational patent criteria to software patents. While these criteria are fundamental across all fields of technology, their application to the unique characteristics of software (including its often-abstract nature, functional aspects, and rapid evolution) has historically presented considerable difficulties, necessitating extensive interpretative development through case law and guidelines. The study has also examined the often evolving, and at times

seemingly inconsistent, application of tests developed by the courts for determining software patent eligibility. This perceived instability or lack of consistent predictability in judicial tests can arise as courts grapple with the novel technological issues presented by software, leading to periods where patentability standards may appear to shift or be applied with varying outcomes until more settled jurisprudence emerges.

It is evident from these two circumstances that, as far as software patents are concerned, neither a fixed set of statutory patent provisions alone nor an accumulation of timely court decisions (which were timely at least at the time they were made) has perfectly resolved all debates surrounding software patent eligibility. Software inventions possess unique attributes: their patentability assessment relies on an analysis of statutory provisions to ensure their legal basis on the one hand, and also demands a set of understandable criteria that enable the assessment of all possible types of software. In this regard, case law plays a role that is strategically important because, while the provisions in patent law are the benchmark to be followed, court decisions can actually reflect the practical application and interpretation of these statutes to specific claims at a given time, thereby demonstrating how patent law is construed and evolves in practice.

Apart from case law, how the patent examiners review a patent claim is also important for patentees when drafting a cogent claim.[707] As far as an ordinary inventor who is not familiar with law and cannot afford a patent counsel are concerned, to draft a convincible claim and be awarded a patent is the first task that they are facing. They have to search for prior art and make sure the claim fulfils the four basic requirements of patentability. Examiners can be deemed as the first person (people) that may “challenge” their invention and refuse granting patents. Leading patent-granting authorities globally, such as the EPO, the USPTO, and those in other prominent technological jurisdictions like Japan, South Korea, and China, have introduced comprehensive guidelines. These guidelines state the instructions on the practice and procedure to be followed in the various aspects of patent examination in accordance with their respective national or regional patent laws.[708] It is, therefore, a crucial reference for

[707] Reto M. Hilty and Christophe Geiger, ‘Patenting software? A judicial and socio economic analysis’ (2005) IIC 16(6) 634.

[708] Patent guidelines for examination, according to the statement of the EPO, is to give instruction on the practice and procedure to be followed in the various aspects of the examination, of patent s applications according to patent law. < https://www.epo.org/en/legal/guidelines-epc > accessed on 18 Nov 2025.

inventors before they can have their invention circulated. However, while patent examination guidelines are intended to enhance clarity and consistency, they are not immune to criticism and can, in some respects, contribute to the very uncertainties they seek to mitigate, particularly in rapidly evolving technological fields such as software and computer-implemented inventions. For instance, despite regular updates, guidelines may inevitably lag behind the most current jurisprudential developments emerging from appeal boards or courts, or they might struggle to offer definitive instructions for entirely novel technological scenarios not yet fully contemplated by established case law. The sheer volume and intricate detail of these guidelines can also prove daunting for many applicants, especially individual inventors or small enterprises lacking specialized legal counsel, making effective navigation challenging. Furthermore, the language within the guidelines, though crafted to be instructive, can itself become a subject of differing interpretations or be perceived as not fully resolving underlying ambiguities present in the statutory provisions or leading judicial precedents. These inherent limitations mean that even with comprehensive guidelines in place, a degree of uncertainty can persist in predicting examination outcomes, particularly for cutting-edge or borderline inventions that test the established boundaries of patentability.

(3) patentees have to follow the patent criteria in different countries, even if they want to gain patent protection for the same product

A significant factor compounding the legal uncertainty surrounding software patents is the fundamental principle of territoriality inherent in patent law. While it is a general axiom that patentees seeking international protection must navigate disparate national patent criteria—a challenge common to innovators in all technological fields—this requirement is acutely exacerbated for software inventions. The reasons for this heightened difficulty are multifaceted and deeply rooted in the unique characteristics of software itself and the current state of its patentability jurisprudence.[709] These include the often ill-defined and inconsistently applied standards for determining software patent eligibility across various jurisdictions (as discussed throughout this chapter), the rapid obsolescence cycles typical of software technologies, the pervasive challenges in conducting comprehensive global prior art searches specific to software, and the consequently unpredictable outcomes of software patent applications in

[709] Roberto Romandini and Alexander Klicznik, 'The territoriality principle and transnational use of panted inventions – the wide reach of a unitary patent and the role of the CJEU' (2013) IIC 44(5) 530

different national systems. Therefore, innovators in the software field confront not merely the administrative burden of multiple filings, but a multiplied and intensified uncertainty when attempting to secure, maintain, and enforce their rights across diverse legal landscapes.

The fundamental issue—that a patent grant is effective only within the territory of the jurisdiction that awarded it, thus necessitating separate patent applications in each country where protection is desired—is indeed a long-standing characteristic of the international patent system, prompting extensive discussion among scholars and commentators across all technological domains.[710] However, for software patents, this "bundle of patents" challenge transcends mere administrative inconvenience or increased transactional costs; it fundamentally acts as a critical multiplier of the already pervasive legal uncertainty inherent in this field. Given that the very definition of what constitutes a patentable software invention often varies significantly and remains in flux across different legal systems (as explored in discussions of "technical character", "abstract ideas", and other eligibility doctrines), software innovators are compelled to confront these foundational ambiguities repeatedly, under diverse interpretative lenses and examination practices, in each jurisdiction where protection is sought. This compounding of substantive uncertainty due to territoriality is arguably a core problem impacting the software industry, rendering strategic research and development investments, as well as global market entry, particularly fraught with unpredictable legal risks and potentially disproportionate costs.

The problem should not be underestimated, especially given the rapid pace at which software techniques are updated or replaced, potentially rendering a lengthy and costly multi-jurisdictional patenting effort fruitless even before it concludes. As aforementioned, the fundamental patentability of many software concepts awaits consistent global confirmation. Furthermore, the acknowledged difficulties in systematically recording and searching for software prior art are significantly magnified when attempting to do so across numerous national systems with varying database qualities and search capabilities. Consequently, it is often argued by observers that pursuing software patents across multiple jurisdictions can be an arduous process with highly

[710] E.g. Robert M. Schwartz and Timo Minssen, 'Life after Myriad: the uncertain future of patenting biomedical innovation and personalised medicine in an international context' (2015) I.P.O. 3 and Vaibhav Choudhary, 'The patentability of software under intellectual property rights: an analysis of US, European and Indian intellectual property rights' (2011) E.I.P.R. 33(7) and many more.

unpredictable returns, where the value of the claimed work may diminish rapidly during the protracted prosecution periods, compelling patentees to decipher and navigate disparate patent practices often for speculative rather than assured gain.

The current patent system can create an environment that is particularly challenging for individual inventors as well as start-ups. In contrast to large companies who establish extensive patent portfolios to maintain their market share, individual inventors are typically less keen on patenting. It does not mean that they do not need patent protection. Rather software patent could, in principle, be an effective way to protect inventor's ideas from being "free-ridden" upon and to generate a competitive business advantage.[711]

Nevertheless, not only the significant cost of time and money can deter individual inventors; it can also be predicted that such inventors, who are not familiar with analysing legal provisions, would be reluctant to engage with the uncertain application of patent law. Filing a patent is often a risky undertaking for individual software developers because the fragmentary prior art database makes it hard for them to avoid unintended infringing existing patents. The difficulty of searching prior art is certainly amplified when they have to find out existing patents in multiple countries. There is a considerable possibility that the patent application is refused for not having novelty.

With regard to start-ups, even if they are willing to embark on establishing a patent portfolio and using patents for business strategy purposes, they undeniably face the conventional challenge common to any globally-minded enterprise: the necessity of seeking patent protection in every country where their product might be circulated. However, while this principle of territoriality in patent rights presents a universal hurdle, for software start-ups, this "normal risk" is often significantly magnified by factors particularly acute in their domain. These include the pervasive uncertainty surrounding the patent eligibility of software innovations across different jurisdictions (as previously discussed in this chapter), the rapid pace of technological obsolescence that can devalue a patent even before it is granted in multiple territories, the substantial costs and complexities associated with conducting thorough multi-jurisdictional prior art searches specifically for software, and the inherently digital nature of their products, which often implies immediate global reach and vulnerability from day

[711] Lee Davis, 'Patents and the internet' (2002) LEFIC Working Paper 2002-02 23-24. Available at < http://euro.ecom.cmu.edu/program/law/08-732/Patents/PatentsAndTheInternet.pdf > accessed 11 November 2017.

one. These compounded challenges can render the strategic decision to pursue widespread international patent protection an especially daunting and resource-intensive endeavour for emerging software companies.

In the era where the internet connects nearly every country in the world and helps to transmit information with only few clicks, it is possible that the valuable work has already been utilised before the inventors can realise and thus greatly reduce the value of the product. Moreover, most software is developed by building up on existing patents.[712] (Some of these patents may be standardised and can be applied with approachable cost. This is not the concern in this thesis.) The inventors not only need to make sure their invention is not patented, if it is, they will also have to negotiate for legally utilising the patents. Filing patents in multiple countries means that the inventors will need to be authorised to use the existing patents in many countries. The price will be higher than being authorised in a single country regardless if the authorisation is made in one single or many agreements. While rapid product obsolescence is indeed a challenge faced by various dynamic sectors, this issue presents particularly acute difficulties in the context of software patenting. The often extremely short product lifecycles prevalent in the software industry—where new versions, updates, or entirely new applications can supersede existing ones globally with remarkable speed—mean that by the time a patent is granted after a potentially multi-year examination process (especially if pursued across several jurisdictions), the specific software it protects may already be outdated, its market relevance significantly diminished, or its core functionalities absorbed into newer, more advanced offerings. This rapid turnover, particularly when juxtaposed with the cumulative nature of software development which often requires licensing multiple existing patented components, profoundly impacts the economic viability and strategic calculus of seeking extensive patent protection for many software innovations. Consequently, the cost of requiring such authorisations is often not justifiable if the product is quickly superseded in the market.

(4) Strategic Jurisdictional Choices: Forum Shopping and its Implications for Software Patents[713]

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[712] Justus Baron and Henry Delcamp, 'The private and social value in discrete and cumulative innovation' (2011) Cerna Working Paper 2010-07 6.

[713] See, e.g., Sinan Utku and Alain Strowel, 'Developments regarding the patentability of computer implemented inventions within the EU and the US: Part 1 – introduction and the legal problem of patenting computer-implemented inventions' (2017) 39(8) European Intellectual Property Review 491.

The ability of patentees to select jurisdictions for filing patents or initiating litigation based on perceptions of favourability, a practice often termed “forum shopping”, is a recognized element of international patent strategy. While seeking advantageous legal environments is not unique to any particular field, this phenomenon can manifest with particular acuity and give rise to distinct concerns in the context of software patents. The significant global variations in how different legal systems assess the patent eligibility and scope of computer-implemented inventions, combined with the inherently borderless nature of digital products and the software market, means that such strategic jurisdictional choices can have pronounced effects. For instance, a perceived “generosity” or predictability in one jurisdiction might attract a disproportionate number of software patent filings, potentially impacting global innovation dynamics and market competition, especially if patents granted under more lenient standards are asserted or licensed internationally. Conversely, jurisdictions with stricter or less predictable standards for software patents might be strategically bypassed by applicants, potentially affecting local innovation ecosystems and the development of domestic technology sectors.

Beyond the issue of forum shopping, other challenges may arise from the territorial nature of patent rights, which often compels patentees to secure what can be termed a “bundle” of individual national patents to achieve widespread geographical protection for a single invention. Patentees must indeed file multiple applications in different countries to obtain patent protection for their work globally. Consequently, when patent disputes and infringement actions occur, these must typically be litigated before the national courts of the specific country where the patent in question was issued and is allegedly being infringed. This necessity of engaging with multiple national court systems, each possessing its own distinct procedural rules and potentially offering varying interpretations of substantive patent law (even when such laws are based on ostensibly harmonised conventions like the EPC), further compounds the complexities, costs, and uncertainties faced by patentees, particularly in technically nuanced and rapidly evolving fields like software.

Patent law and its associated case law leave considerable room for interpretation regarding software patents, with precise boundaries often remaining ill-defined due to the unlimited possibilities inherent in software development. The application of current patent regulations to software-related inventions in many key jurisdictions is often still perceived as lacking definitive clarity or uniform predictability. Evaluating whether a patent claim is patent-

eligible or not is therefore a significant undertaking for the patentee during the drafting process. In this regard, attempting to anticipate the assessment approach of a particular patent office also becomes a vital, yet challenging, step for the patentee.

The patent systems in different jurisdictions reflect distinct considerations rooted in their unique cultural, historical, and policy backgrounds. For example, the historically strong emphasis in the United States on fostering commerce and technological innovation, coupled with a more expansive view of inventor rights, for many years contributed to a generally broader interpretation of patentable subject matter, which included, for a significant period, many types of business methods and software with limited technical underpinnings. In contrast, the EPC, with its explicit (though qualified by the "as such" provison) exclusion of "programs for computers" and its consistent demand for "technical character", can be seen as reflecting Europe's robust engineering traditions, a cautious approach to extending patentability to non-traditional fields, or specific policy decisions aimed at maintaining a particular standard of patent quality and scope.

Similarly, when disputes occur, patentees or relevant third party may choose to file litigation at the patent court that is in favour of their benefits. This circumstance is especially rigorous to the unintentional infringers because they may be accused and deemed as liable in a patent law suits. It has been noticed that, with the continuing development of technology, intellectual property has risen in quantities and rates and so does the global litigation frequency.[714] Data calculated in the US showing that, with the booming of portable handset and its application software, the number of patent lawsuit defendants over non-software and software inventions was about the same in 2007; but in 2011 the latter was almost three times as many as the prior type of inventions.[715] Several interconnected factors likely contributed to this notable surge in software patent litigation during that period. These included the rapid proliferation of software patents themselves, many of which were granted under earlier, arguably more lenient standards and were later criticised for being overly broad or of questionable quality. Additionally, this era coincided with

[714] Willis Towers Watson, 'Intellectual property litigation risk report' (2018) 2. Available at < file:///C:/Users/Ya%20Fang/Downloads/global-intellectual-property-litigation-risk-research-report.pdf > accessed 18 Nov 2025.

[715] James Bessen, 'The case against software patents, in 9 charts' (2014). Available at < https://www.vox.com/2014/7/7/5862284/9-charts-that-show-patents-are-bad-for-the-software-industry > accessed on 19 September 2018.

intense competition and extensive cross-licensing disputes in burgeoning technology sectors, most famously the “smartphone wars,” which heavily involved software patents. The increasing activity of NPEs acquiring and asserting software patents against operating companies, coupled with the significant economic value tied to software innovations, also played a crucial role, all unfolding against a backdrop of evolving and sometimes uncertain legal standards for software patent eligibility prior to more recent judicial clarifications.

(5) Navigating Patent Infringement Risks: Uncertainty for Software Developers

The uncertainty surrounding software patents extends significantly to the ever-present risk of alleged infringement, leaving many developers questioning the predictability of their legal standing and whether they might inadvertently face accusations. From one perspective, while a patent system that readily grants software patents might seem initially attractive to some applicants, it can paradoxically create a more adverse and uncertain environment for subsequent innovators and the industry at large. A “wide open door” to software patents, especially if not accompanied by rigorous examination and clear definitions of scope, can increase the difficulty for later inventors for several reasons.

A primary challenge stems from the nature of software itself. Often, the core inventive value of software lies in its underlying algorithms, operational methods, or functional enhancements, which are expressed in code but are not visibly apparent from the external operation of the product into which the software is implemented. In other words, the crucial functional improvement is often “hidden” within the product and not readily discernible through mere observation. While copyright law undoubtedly provides crucial protection for the literal expression of the software code (the source code and object code), it does not extend to protect the underlying operational principles, algorithms, or the functionality itself if that functionality can be achieved through independently created, different code. It is precisely these inventive functional aspects that inventors often seek to protect through the patent system, aiming for a broader scope of protection than copyright alone can offer. However, this “hidden” nature of software functionality, while not precluding patentability if other criteria are met, makes it exceptionally difficult for other inventors and businesses to conduct thorough prior art searches to ascertain their freedom to operate with confidence. Consequently, this characteristic means that not only do inventors find it hard to research prior art effectively, but they also face a heightened likelihood of unintentionally infringing existing patents, even when acting in

good faith.

In a patent system where precise definitions for software patent eligibility and claim scope remain elusive, it is exceedingly difficult for patentees or applicants to predict the outcome of their patent applications. Similarly, it becomes challenging for them, as well as for third-party developers, to confidently avoid infringement because the boundaries of existing software patents can be unclear and hard to distinguish. Thus, an inventor or company pursuing software patents not only takes the risk of the application being rejected but also faces the possibility of being prosecuted for infringing others' patents with their own product, or even being countersued upon asserting their own patent. Both outcomes represent significant costs and deterrents. For many individual software developers and start-ups, the investment in filing patents in such an environment may not yield a return; instead, there is a considerable possibility that they will incur substantial expenses for little or no tangible benefit.

6.2.2. Patent Quality and Patent Trolling

Impact of Vague Provisions on Claim Drafting, Patent Quality, and Examination Burden

Vague patent provisions can indeed contribute to a lowering of the quality of patents granted by patent offices. In an effort to secure broad patent protection, applicants may sometimes be incentivised to draft claims in an overly expansive manner. For example, claims might be formulated using broad functional language that defines an invention primarily by its desired result rather than its specific technical implementation, or they might attempt to cover general concepts with minimal disclosure of concrete enabling embodiments. When such broadly drafted claims are granted without sufficient scrutiny to ensure a clear and commensurate technical contribution, they risk inadvertently encompassing future, unforeseen technological enhancements or contributing to "patent thickets" that hinder subsequent inventors who are making genuine advancements upon existing art. Furthermore, while professional ethics and rules of practice generally require patent lawyers to act with candour, the use of ambiguous, overly complex, or non-standard technical terminology in patent claims can, even if not intentionally misleading, inadvertently obscure the true scope and technical contribution of an invention. This lack of clarity can present significant challenges for examiners in accurately assessing crucial patentability criteria such as novelty and inventive step, potentially leading to erroneous assessments or the grant of patents with ill-defined boundaries.

Moreover, such vague statutory provisions and the resulting claim ambiguities also intensify the difficulty for examiners in patent offices during the substantive examination process. Examiners will likely need to expend more time and resources deciphering claims and inspecting whether the invention fulfils all the requirements stipulated in patent law. This inevitably makes the already time-consuming patent examination process even longer and, of course, increases the workload and pressure on patent office staff. While allocating more resources to patent offices for hiring and training additional highly qualified examiners could undoubtedly help alleviate some of these pressures and potentially improve examination consistency and quality, this measure alone may not fully resolve the underlying difficulties. If the foundational legal provisions themselves remain inherently vague, or if judicial interpretations lack consistent clarity for rapidly evolving technologies like software, then even the most skilled and diligent examiners will continue to face fundamental challenges in applying the law predictably and efficiently. Addressing these deep-seated issues may therefore necessitate a multi-faceted approach, encompassing not only resource allocation for examination but also ongoing efforts towards achieving clearer legislative frameworks or more definitive jurisprudential guidance.

Resulting in over broad patents and patents with low quality which facilitates the rampant patent trolls

The uncertain provisions can make the boundaries of a software patent vague, too. An advanced software product may perform multiple functions, many of which might build up on existing patents that the claimed patent has to work with them to be carried out. This complexity could make it difficult for the examiners to distinguish the individual inventive value of the various claimed functions, potentially leading to the boundaries of such a granted patent being broader than what is genuinely justified by the invention's technical contribution.

Moreover, it is a recognised concern within patent discourse that under certain challenging conditions—such as high examiner workloads, difficulties in accessing comprehensive prior art specific to rapidly evolving software technologies, or the inherent complexities in definitively assessing the scope of broadly drafted functional claims—, examiners may sometimes grant patent protection that covers claims which are arguably overly broad or ambiguous. Examples often cited in commentary include patents with claims attempting to monopolize general business processes merely implemented on a generic computer without detailing a specific inventive technical solution, or software

functionalities described at a very high level of abstraction that lack sufficient disclosure of concrete technical embodiments. It is contended that such patents may also be granted for, or be interpreted to cover, conceptual aspects that lack clear practical, technical functions beyond generic data processing. While the patent examination process is designed to filter out non-functional or trivial subject matter, claims drafted with artful, highly abstract, or even obfuscatory language can sometimes obscure a genuine lack of concrete technical utility or substantive inventive contribution. This can make it challenging for examiners, who often operate under significant time constraints and with imperfect or asymmetric information regarding the alleged invention, to definitively reject such claims at an early stage, especially if no directly refuting prior art is readily apparent or if the claimed subject matter hovers in a grey area of eligibility. The same problem of accurately assessing software patents has also been observed in patent courts. It has been noted, for example, that a significant percentage of district court judgments regarding software patents in the US were subsequently found to be faulty upon review by the Court of Appeals for the Federal Circuit.[716]

Needless to say, uncertain statutory provisions and their evolving judicial interpretations can create an environment where it may be possible for patentees to obtain patents by drafting claims that, while perhaps appearing novel or complex on their surface, may lack substantial inventive merit. For instance, commentators and studies have pointed to patents being granted for inventions that arguably represent only trivial modifications of known concepts or fairly obvious applications of existing technology to new, but analogous, digital contexts. This is particularly a risk if these inventions are presented within lengthy and elaborate patent specifications, replete with detailed but often standard technical descriptions that can create an illusion of complexity and inventiveness where little of genuine substance truly exists. Indeed, the study by Miller, for example, suggests that a notable portion of patents held by patent licensing firms, entities often associated with “patent trolling” activities, may contain one or more claims that are arguably invalid due to anticipation or obviousness based on a thorough prior art analysis.[717] These types of patents, whether overly broad or of low intrinsic quality, do not provide an essential

[716] James Bessen, ‘The case against software patents, in 9 charts’ (2014). Available at < https://www.vox.com/2014/7/7/5862284/9-charts-that-show-patents-are-bad-for-the-software-industry > accessed on 19 September 2018.

[717] *Ibid*. See also Shawn P. Miller, ‘Where’s the innovation? An analysis of the quantity and qualities of anticipated and obvious patents’ (2015) Stanford Law School 26-27.

contribution to technology and are often characterized as being of low quality. They instead increase the difficulties for software developers, as the latter will have to either attempt to design around these questionable patents or acquire costly authorisations from patent holders in order to legally draft an entirely new patent claim, even if their asserted patents do not necessarily represent significant innovative value.

Patent trolls buying patents instead of engaging in innovation activities, and then ask for licensing fees which hedges inventors and researchers who actually devoting time and effort in research

Low-quality patents can act as significant hurdles across many technological fields, but they are often argued to present particularly acute and widespread challenges within the software industry. This perceived heightened impact is attributed to several factors unique to or more pronounced in software: the inherently abstract nature of many software concepts can complicate precise claim drafting and rigorous examination, potentially leading to overly broad or vague patents; historical difficulties in establishing comprehensive and easily searchable prior art databases for software may result in the grant of patents on ideas that are not genuinely novel or inventive; and the highly cumulative nature of software innovation means that a single low-quality patent on a foundational component or common functionality can disproportionately hinder numerous subsequent developments and create extensive legal uncertainty. With the high-speed development of software, developers may need to spend considerable extra time and resources seeking licenses and paying for the use of existing patents in the form of licensing fees or royalties. Apart from the time involved in licensing negotiations, that may lead to delays in product introduction, the rapid obsolescence cycle characteristic of the software market presents a further and significant complication. While many industries face product obsolescence, for software, this cycle can be exceptionally short, with new versions, updates, or entirely different applications emerging and being distributed globally at an accelerated pace. This often means that a software product, and consequently any patents tied to its specific features, can lose substantial market value or become functionally outdated very quickly—sometimes well within the lengthy period required to prosecute a patent application to grant in multiple jurisdictions, or during protracted licensing negotiations. In addition, some software applications, such as certain types of entertaining apps or niche utilities, may inherently possess limited or transient financial value from their inception. In such scenarios, particularly given the

cumulative nature of software development which often necessitates licensing multiple underlying patented technologies, the substantial upfront and ongoing costs of obtaining patent protection or authorising the use of existing patents can become economically unviable when weighed against the product's short lifespan or low profit margins. This makes it an unattractive or impractical proposition for developers to invest heavily in patenting or licensing for such products.

On the other hand, there is some essential software that holds considerable financial value to a technology; such as the services once popularly provided by Dropbox which allows users to store entire files or individual documents.[718] Patents covering such foundational technologies are certainly considered worth investing in to protect. However, this concentration of value also allows some speculators to control the price to pay for utilising such patents. It can be seen in the software industry that some big companies who own such patents earn much profit by selling or licensing their patents. An example can be seen from the deal between Nokia Corp. and Vringo Inc. in 2012. Nokia sold a collection of patents regarding wireless network technology to Vringo which is a company that is known for generating revenue by filing patent infringement lawsuits against technology companies.[719] These companies may not generate substantial sales revenue from their mobile phones, but the considerable profits earned from licensing their patent portfolios can be sufficient to sustain the company and fund other investments. Individual developers and start-ups may not afford to pay the fees for research purposes. What is worse is, there are some non-practising entities who do not concentrate on inventive activities.[720] They hold essential patents or even some trivial but unavoidable patents and ask for high amounts of fees from inventors.

The vague provisions in patent law may also benefit the so called “patent trolls” because some patents they assert are overly broad or unnecessary. It seems that the current patent law brings more obstacles to software developers than advantages.

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[718] American Bar Association, ‘Essential software and apps’ (2017). Available at < https://www.americanbar.org/groups/gpsolo/publications/gp_solo/2011/december/essential_software_apps/ > accessed on 19 September 2018.

[719] Yahoo Finance, ‘Nokia to sell 500 patents to licensing firm Vringo’ (2012) Available at < https://finance.yahoo.com/news/nokia-sell-500-patents-licensing-193248944.html > accessed on 19 September 2018.

[720] Kelli Larson, ‘The exploitation and enforcement of patents by non-practicing entities: practices, developments and future challenges’ Economics and Society No. 315 23.

6.2.3. Innovation Incentives

Inventors hesitate to apply for a patent

Despite the aim of patent law being to encourage inventive activities, it is often argued by observers that vague or inconsistently applied patentability standards can render the process of obtaining a patent, particularly for software-related inventions, highly unpredictable. This unpredictability can foster a perception among inventors that the success of an application may hinge less on the intrinsic technical merit of the invention itself and more on extraneous factors, such as the specific examiner assigned, the prevailing (yet perhaps uncodified) interpretative leanings of the patent office at a given time, or the artfulness of claim drafting in navigating ambiguous legal criteria, rather than being purely a matter of “luck”. As an inventor, the patentee would not want to get involved in the uncertain game which requires time and money to apply for it but rewarded for nothing. Besides, due to patent trolls and patent thickets, inventors would infringe others’ patents and need to pay for licensing or infringement. These are the potential extra cost that make a patent more unapproachable.

Furthermore, a software invention may lose its value rapidly as new software is published and market demands shift; in such a fast-paced environment, pursuing patent protection, with its often-lengthy prosecution times, can appear to be an unwise option from both a temporal and financial perspective. It might seem a more pragmatic option for an inventor to introduce their invention to the market quickly and attempt to monetize it through other means, without patent protection, before it is superseded. Therefore, a pertinent question arises: does the core value proposition of the patent system genuinely facilitate or inadvertently hinder innovation in the software context? In line with the underlying problems discussed concerning this system, it is reasonable to entertain doubts as to whether patents, in their current application to software, still represent the most robust or economically viable protection for all innovative efforts in this field. Given these challenges, it is understandable that innovators may explore alternatives. Indeed, other forms of intellectual property protection are frequently utilized for software inventions, serving either as alternatives or as complements to patent protection. Key among these are copyright, which safeguards the literal expression of the software code (both source and object) as well as certain non-literal structural elements; trade secret law, which can protect confidential algorithms, business logic, or unreleased source code from misappropriation, provided reasonable secrecy

measures are maintained; trademark law, for protecting brand names, logos, and other identifiers associated with the software; and various contractual mechanisms, such as licensing agreements, non-disclosure agreements (NDAs), and terms of service. The prevailing uncertainty within the patent system, particularly concerning software, may thus encourage innovators to place greater reliance on these alternative strategies, viewing them as potentially more predictable or cost-effective means of safeguarding their software-related innovations than patenting.

6.2.4. Competition Issues

Lessons from the Smartphone Patent Wars and their Impact on the Software Industry

The smartphone is undoubtedly one of the most fascinating inventions of the early 21st century; or perhaps more accurately, it represents a complex combination of numerous fascinating inventions spanning both hardware and software. The intense patent disputes among smartphone companies, often dubbed the "smartphone patent wars," demonstrated how distinctive components and functionalities could become crucial selling points to attract consumers. This field was fiercely contested in the market for years, and consequently, a vast number of patents were granted. Illustrating the intensity of patenting activity during that era, data from 2012 indicated that while approximately 70,000 mobile device-related patents had been granted in the US in 2000, this number had surged, with roughly 250,000 active patents in this domain by that year.[721] Notably, smartphone patents reportedly accounted for one in six active US patents in 2012.[722] (It is acknowledged that this data reflects the situation over a decade ago, during a peak period of the "smartphone wars". More recent statistics, if available and integrated, would offer an updated perspective on the current patent landscape in this sector. However, this earlier data effectively highlights the significant proliferation of patents that characterised the height of these industry-wide disputes.)

Today, it is widely observed that the intensity of the high-profile "smartphone patent wars" has substantially cooled down[723]. Relevant news coverage and

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[721] Daniel O'connor, 'One in six active US patents pertain to the smartphone' (2012) < http://www.project-disco.org/intellectual-property/one-in-six-active-u-s-patents-pertain-to-the-smartphone/#.W8w3p2hKhPY> accessed on 19 September 2018.

[722] *Ibid*.

[723] This de-escalation trend has been widely noted by industry observers. See, for example, Brian Fung, 'The smartphone patent wars are mostly over. Here's what that means for you',

high-profile litigation announcements concerning this topic have markedly diminished in the press over approximately the past half-decade. Does this signify that patents are no longer important to the software industry?

Since the hardware of mobile devices has arguably reached a mature stage of development, software has increasingly become the main battlefield for differentiation and competition among major companies. Furthermore, software features and the overall user experience are widely considered to be key factors that motivate consumer decisions when purchasing new handsets.[724] Large companies often establish patent portfolios as strategic assets in their competition with other firms. However, filing lawsuits is a lengthy and complicated process, carrying the risk of countersuits that could result not only in substantial fines but also in injunctions to remove products from the market. Recently, smartphone companies have generally shifted their policies towards a more peaceful direction, frequently seeking cross-licensing agreements with competitors to acquire access to useful technology and information. For example, Google and Samsung, two dominant forces in the Android operating system ecosystem, reached a broad cross-licensing agreement in 2014 covering existing patents and those to be filed in subsequent years.[725] Such strategies can help avoid mutual obstruction while facilitating the circulation of valuable information, leading to win-win outcomes for the involved parties and benefiting the overall development of the industry. Hence, the answer to the earlier question is no: patents remain critically important to the smartphone and broader software industry. Large companies have merely found alternative pathways, beyond persistent litigation, to manage their IP. Without valuable patents, a company lacks the necessary leverage to negotiate favourable cross-licensing deals or maintain its competitive standing. But what then, is the situation for other, perhaps smaller, players in this industry?

'The Washington Post' (25 April 2017); and Ian Mansfield, 'The Smartphone Patent Wars Are Over - So Who Won?', 'IAM Magazine' (1 September 2016) https://www.iam-media.com/article/the-smartphone-patent-wars-are-over-so-who-won accessed 28 April 2025.

[724] The strategic shift in the mature smartphone market, from hardware-centric competition to a greater emphasis on software ecosystems, user experience (UX), AI-driven features, and services as key differentiators, is a widely discussed trend in technology industry analysis. Similarly, consumer research often highlights the significant influence of operating systems, app availability, and unique software functionalities on purchasing decisions. For an overview and analysis of these trends, see, e.g., Ben Thompson, 'The End of the Beginning', Stratechery (24 September 2018) https://stratechery.com/2018/the-end-of-the-beginning/ accessed 29 April 2025.

[725] Eric Pfanner, 'Google and Samsung sign broad cross-licensing agreement' (2014) < https://www.nytimes.com/2014/01/28/technology/google-and-samsung-sign-broad-cross-licensing-agreement.html > accessed on 22 September 2018.

The Correlation Between Essential Software Patents and Market Monopolies

Patent is a legal protection that allows patentees the lawful monopoly for a limited period of time and asks for the disclosure of patent information in return. This theory has been applied in patent law and was well practiced in an earlier industrial era where an essential invention's value could remain relatively stable and irreplaceable for extended periods. However, today the software industry is characterized by its extreme dynamism. Consequently, the limited time of monopoly afforded by a patent, normally for 20 years, while a standard duration across technologies, arguably holds a different and often diminished practical significance compared to its impact in slower-moving traditional industries. Software is a fast-changing technology that progresses with each passing day. Indeed, a new software application or feature may rapidly lose its distinct market value or become technologically superseded long before the patentee can fully benefit from the entire two-decade period of exclusivity. This accelerated obsolescence, driven by constant updates and swift global dissemination of new alternatives, can significantly curtail the effective monopoly period and thereby lessen the perceived upfront incentive of seeking patent protection for certain types of fast-iterating software innovations.

Software development, as a technological endeavour, often does not necessitate the same high levels of capital investment in cumbersome, specialized equipment that are typically associated with research and development in some other scientific or engineering fields. The widespread availability of powerful personal computers and sophisticated software development kits means that, in principle, individuals or small teams possessing the requisite programming skills and insight can potentially create software that performs novel or advanced functions without massive upfront infrastructure costs. This lower barrier to initiating software development and experimentation, however, does not imply that all software thus produced will meet the stringent patentability criteria of novelty and, particularly, non-obviousness; indeed, only genuinely inventive contributions that provide a non-obvious technical solution qualify for patent protection. The challenge, rather, arises when this relative ease of creating numerous software variations or alternative implementations of functionalities intersects with a patent system that itself faces difficulties in areas such as comprehensive prior art searching and precise claim scope definition for software-related inventions.

Unlike big companies which may have already started establishing patent

portfolios before they became major players in the smartphone sector, software developers can be young in the field and work individually without extensive resources. Even if an individual software developer is granted a patent, it does not mean he is necessarily able to afford to engage in or demand cross-licensing. Despite not being overtly targeted to be blocked from entering the market, it is often inherently hard for individual software developers as well as small software companies to expand their business in the software market[726]. The main players in the software industry seem to remain big companies. Therefore, it can be argued that in some segments of the software industry, the manifestation of monopoly-related concerns has evolved. While direct competition among large patent-holding companies persists, the challenges encountered by small entities and individual developers can be significantly amplified in an environment where established industry players might form strategic alliances, exert control over essential platforms or APIs, or amass large defensive patent portfolios. Although such market dynamics, where dominant firms create high barriers to entry or significant competitive disadvantages for smaller players, are not entirely unique to the software industry, they can be particularly impactful in this sector. This is often attributed to compounding factors such as strong network effects inherent in many software platforms, the disproportionate burden of high-cost patent litigation on SMEs, and the often-cited density of “patent thickets” surrounding key software functionalities and standards. These elements can make it exceedingly difficult for individual developers and small software companies, despite their innovative potential, to effectively compete, innovate freely, or even enter certain markets dominated by these entrenched interests and their consolidated intellectual property positions.

Trivial patents increase the cost of software innovation activities

The current patent system can also be averse to individual software developers because it may inadvertently encourage speculation. Patent trolls represent another threat to them because they may be asked to pay for access to arguably useful information (or to avoid litigation over questionable patents) at unreasonable prices. In the ideal world, patentees are supposed to disclose

[726] Data illustrating the significant market concentration in mobile operating systems, dominated by Google's Android and Apple's iOS, can be found in reports from market analysis firms. See, for example, Statista, ‘Market share held by the leading mobile operating systems worldwide from 2012 to 2024’ (Data typically updated periodically, specific chart title and latest year may vary) <https://www.statista.com/statistics/272698/global-market-share-held-by-mobile-operating-systems/ > accessed 28 April 2025.

useful information in return for the monopoly right, but individual software developers are exposed to an environment where prior art databases may be missing and they are surrounded by patent trolls. Indeed, studies have consistently shown that NPEs are responsible for a substantial portion of patent infringement lawsuits filed in jurisdictions like the US, with software and high-technology sectors being particularly affected.[727] In other words, the current patent system can make it easier for them to fall into patent troll's traps and exacerbate the difficulties and cost of circulating their inventions. Sometimes unreasonable circumstances may occur where software developers need to pay considerable fees for asserted patents that may appear trivial or even for lawsuits filed over alleged unintentional infringement.

It is obvious that the problems of the current patent system are all interconnected. In spite of the fact that the smartphone patent war is cooling down, the disadvantages to individual developers and small entities does not ease. They are struggling with the obscurity of patent law provisions and the perceived pendulum made by patent courts. Let alone the shortage of funds to cope with cross-licensing and patent trolls. It is fair to say that, although it is not evident whether the current patent system reaches the aim of accelerating innovation incentives or not, one thing can be sure is that the law as currently applied in this domain often seems to create more disadvantages than benefits for these inventors. In an industry that is characterized by constantly changing conditions, software developers are more likely to avoid applying for patents or to shun involvement in this complexity.

It is true that patent awareness has significantly resurfaced in recent years, particularly in rapidly developing economies such as China, as evidenced by the sharp growth in both domestic patent grants processed by the China National Intellectual Property Administration and international patent filings originating from Chinese inventors[728]. Patents serve as a significant strategic instrument for economic growth for a country. However, a crucial premise (or "a major prerequisite') for patents to effectively fulfil this role, particularly in

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[727] See, e.g., Colleen V. Chien, 'Startups and Patent Trolls' (2013) 17 Stanford Technology Law Review 461 (discussing the impact of NPE litigation on technology companies, particularly startups). More recent data and trends are often available from patent litigation analytics firms such as RPX Corporation or Unified Patents.

[728] Detailed statistics and trend analyses illustrating the substantial increase in patent applications filed with the China National Intellectual Property Administration (CNIPA) and by Chinese applicants abroad (e.g., through the PCT system or directly in other major patent offices) are presented in the annual editions of the World Intellectual Property Organization (WIPO), "World Intellectual Property Indicators" report.

fostering a vibrant software industry and encouraging widespread innovation, is that the governing legal framework—essentially, the “rules of the game” for obtaining, interpreting, and enforcing patent rights—must be clear, predictable, and straightforward in its application. The sharply growing number of patents in some developing countries does not necessarily equate to fostering genuine software development, nor does the strategic cooperation of giant smartphone companies inherently resolve the underlying issues for smaller innovators. Rather, without a clear and balanced system, such trends may inadvertently create further hurdles for those with truly valuable ideas that could facilitate daily convenience and reduce societal costs.

The sharply growing number of patents in some developing countries does not necessarily equate to fostering genuine software development, nor does the strategic cooperation of giant smartphone companies inherently resolve the underlying issues for smaller innovators. Rather, without a clear and balanced system, such trends may inadvertently create further hurdles for those with truly valuable ideas that could facilitate daily convenience and reduce societal costs. The foregoing discussion in this chapter has underscored a range of persistent and interconnected problems plaguing the current patent system as it applies to software inventions—from fundamental legal uncertainties regarding patent eligibility and scope, to issues of patent quality that can facilitate patent trolling, and the significant systemic hurdles these create for genuine innovators, particularly individual developers and SMEs. These challenges suggest that merely reactive adjustments or isolated legislative efforts may prove insufficient. To effectively address these multifaceted shortcomings or “omissions” within the current legal and examination frameworks, and to better align the patent system with the goal of fostering sustainable software innovation in a clear, predictable, and equitable manner, a more comprehensive, principled, and forward-looking approach appears necessary. Building upon the problems diagnosed in this chapter, the next chapter will therefore transition from critique to construction by proposing one such potential solution: a structured multi-dimensional examination model specifically designed to enhance consistency, predictability, and quality in the assessment of software-related patents.

Chapter 7

A Proposed Examination Model for Software Patents: Structure, Application, and Implications

This chapter builds upon the previous discussion, particularly as presented in Chapter 6, which highlighted the inconsistencies and inadequacies in the current legal practices concerning computer-implemented inventions (CIIs) across major jurisdictions such as the United States and Europe. It begins by revisiting the unique nature of software-related inventions and the rationale for their protection, followed by the identification of key challenges within existing patent examination systems. In light of these findings, this chapter proposes a structured examination framework designed to address these deficiencies. The aim is to deduce timely and practical policies that promote technological development. In so doing, the objective is to offer a viable and adaptable model that might guide patent examiners, applicants, and judicial bodies in evaluating software-related inventions with greater consistency, predictability, and fairness than currently exists between the courts across the various jurisdictions where the case is heard.

This chapter is structured as follows: Section 7.1 revisits the *sui generis* nature of software patents and identifies current examination challenges; Section 7.2 introduces the conceptual framework of the proposed multi-factor patent examination model; Section 7.3 details the model's operationalisation, including its scoring and weighting methodology; Section 7.4 demonstrates the efficacy and reliability of the model when applied to significant case authorities; Section 7.5 discusses the potential benefits for various stakeholders; Section 7.6 acknowledges the model's limitations and suggests areas for future refinement; and Section 7.7 considers the model’s ultimate potential for globalisation.

7.1 The Unique Nature of Software Patents and Current

Challenges

7.1.1 The Rationale for Patenting Software-Related Inventions

In many countries, computer programs are classified as being patent exclusion, in principle, and are only deemed patentable after being reviewed in accordance with the criteria established in patent law, including jurisprudence. However, hardware would essentially be meaningless without software providing instructions on the data treatment, process operation, information transmission, logical judgement and so on. Software facilitates hardware to work effectively and/or to solve the problem of hardware operation. Like the other types of inventions, software-related invention is entitled to intellectual property (IP) rights protection. This applies especially to functional software which includes functionality, languages, and interfaces which are more than mere "literature'. However, one primary prerequisite is, like other types of inventions, under the current patent law and practice, software-related inventions seeking patent protection must be novel, non-obvious, and industrially applicable.

The importance of software patents can be easily equated to hardware patents. Global positioning systems (known as GPS) is one such example. GPS technology involves many software inventions combined with satellite systems to calculate accurate location, speed, and time information for users.[729] GPS has been widely used, such as in mobile phones and vehicle navigation. More powerful software can provide temporal and spatial information more precisely in GPS, hence the users can enjoy a better experience. Another example can be seen in the fast-developing industry of wearable devices, for example the Apple watch, used for tracking vital signs or pieces of data related to users' health and fitness. In general, a wearable device is worn on the body / placed in belongings to collect and deliver information about its targets. Such types of devices contain delicate software and sensor technologies and have become common products in our lives, especially for healthcare.[730]

The devices and innovations noted above are examples of precision instruments that can be easily installed in a small portable device. These are

[729] Joe Bird, 'A virtual analog rule for software patent eligibility' (2015) Landslide Magazine < https://www.mondaq.com/unitedstates/patent/445260/a-virtual-analog-rule-for-software-patent-eligibility > accessed 17 Nov 2025.

[730] Brain E. Ferguson and Anish Desai, 'The coming patent war over wearable technologies' (2015) < https://www.weil.com/articles/the-coming-patent-war-over-wearable-technologies > accessed 17 April 2018.

only two of the numerous ways that software is applied to hardware and used in our daily lives. When examining the essence of such devices, software provides a variety of distinctive functions and plays an increasingly important role.

Contemporary approaches to software patentability have increasingly relied less on the historic rigid definitional boundaries. Rather, they rely more on whether the invention, as claimed, contributes a discernible technical effect in a manner that is novel, non-obvious, and industrially applicable. These criteria, though applied differently across jurisdictions, reflect a converging tendency to evaluate software claims in light of their functional and systemic contributions rather than formalistic distinctions. This shift towards functional evaluation, however, does not fully resolve the inherent tension within patent law concerning software. On one hand, strong protection is argued to provide necessary ex-ante incentives for the significant investment often required in software development[731]. On the other hand, overly broad software patents risk hindering ex-post cumulative innovation, where subsequent developers build upon existing platforms and code[732]. Balancing these competing concerns, namely incentivising initial creation without unduly restricting future development, remains a central challenge in tailoring patent law for the unique characteristics of software innovation, which often involves incremental improvements and network effects[733].

The rapid advancement of software-driven technologies has intensified debates over the patentability of software. Notably, in the US Supreme Court's decision in *Alice Corp. v. CLS Bank International*[734], the courts introduced a two-step framework for determining patent eligibility, focusing on whether claims are directed to abstract ideas and, if so, whether they contain an “inventive concept” sufficient to transform the abstract idea into a patent-eligible application[735].

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[731] See generally arguments supporting patent incentives, e.g., discussion in Calvin Wai Loon Ho, ‘Utilitarianism and Patents: Justification and Change’ (2012) 2012 Singapore Journal of Legal Studies 357.

[732] See Suzanne Scotchmer, ‘Standing on the Shoulders of Giants: Cumulative Research and the Patent Law’ (1991) 5(1) Journal of Economic Perspectives 29; Robert P. Merges and Richard R. Nelson, ‘On the Complex Economics of Patent Scope’ (1990) 90(4) Columbia Law Review 839.

[733] Jerry R. Green and Suzanne Scotchmer, ‘On the Division of Profit in Sequential Innovation’ (1995) 26(1) The RAND Journal of Economics 20.

[734] *Alice Corp. Pty. Ltd. v. CLS Bank Int'l, 573 U.S. 208 (2014).*

[735] Rupert A. Knights and Craig A. Redinger, ‘Patent Eligibility of Software Patents in the U.S. and Europe: A Post-Alice Consideration’ (2015) 8(1) Landslide Magazine 1.

Similarly, in the EPO's decision in *Computer program product/IBM*, the court established that a computer program product is not excluded from patentability if, when run on a computer, it produces a further technical effect beyond the normal physical interactions between the program and the computer[736],[737],[738]. These developments underscore the evolving nature of software patentability criteria.

Software patent is often considered a unique type of patent, potentially different from other patents when determining patentability.[739] The main procedure for implementing patent law provisions on software patentability resides within the examination systems of patent offices. After the "*Alice* storm" in US courts,[740] some of the patentability tests for software are getting more explicit at some levels. Nevertheless, there remain some vague parts in examination. According to the observation and discussion of patent law and case laws in the EPO and US patent courts previously in this thesis (Sections 5.3.1), software inventions that have only abstract ideas without technical character are not patentable. The principle for software patentability is, and must, as a matter of course, meet the statutory requirements of novelty, inventive step, and industrial applicability. What is more important is, despite differing doctrinal terminology, both the EPO and US patent systems converge on the principle that software-related inventions must achieve a concrete technical effect or contribute a technical solution to a technical problem to be patentable.

During the evolution of software patents, there have been many statements that indicate the fundamental elements in various software related patents. In light of contemporary legal standards and evolving jurisprudence, the eligibility of software-related inventions are no longer determined by a singular conceptual rule, but rather through a set of jurisdiction-specific criteria shaped by both

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[736] T 1173/97 *(Computer program product/IBM*) EPO, 1 July 1998

[737] Mewburn Ellis, 'Patentability of Software and Business Method Inventions in Europe' (Mewburn Ellis LLP) http://mewburn.com/resource/patentability-of-business-method-and-software-inventions-in-europe-2/ accessed [Date of access, e.g., 27 April 2025].

[738] 'Examination of computer-implemented inventions at the European Patent Office with particular attention to computer-implemented business methods' [2007] EPO Official Journal 594.

[739] See sections 2.2.2, 2.2.4, and 2.2.5 in Chapter 2.

[740] As discussed in Section2.5. Alice Corp. Pty. Ltd. v. CLS Bank Int'l, 573 U.S. 208 (2014); See also USPTO, 2024 Guidance Update on Patent Subject Matter Eligibility, Including on Artificial Intelligence (July 2024), available at <https://www.uspto.gov/sites/default/files/documents/ai-sme-update-2024.pdf> accessed 15 May 2025

statutory provisions and case law[741]. At present, the basis for recognising a software-related invention as patentable may be characterised along the following lines:

(1) It must solve a technical problem using technical means (technical contribution);[742]

(2) It must not be directed to an abstract idea without an inventive implementation;[743]

(3) It must produce a further technical effect beyond mere data processing;[744]

(4) It must be capable of industrial application;[745] and

(5) Its novelty and inventive step must be demonstrable in relation to prior art.[746]

7.1.2 Challenges in Current Software Patent Examination

Whether a software invention is patentable or not should be conceived under commonly acceptable definitions and also take into consideration the constantly changing technology. Such ideal definitions should be expected to help avoid the existence of low-quality software patent problems which are the obstacles to later research. From the inventors' perspective, especially to those without strong resources or financial funds, the more useful the information available to support their research, the more opportunities they have to achieve unique and valuable research advancements.

According to the observation on the patent systems in the mainstream jurisdictions in this study, the underlying argument of whether software inventions are patent eligible or not appears to be less contentious than it used to be. (as discussed in Section 6.1.1) However, other hidden problems remain. There is a lack of clear software patentability assessment-approach in the US or EU patent law systems, especially regarding the standards and consistency in the examination process. The law does not specifically define the terms

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741 Hannes Westermann, 'How to treat software in the intellectual property framework' (Lund University Faculty of Law Master Thesis 2016).

742 Examples can be seen in EPO cases T1173/97 and T258/03.

743 US case *Alice Corp. v. CLS Bank* U.S. 208 (2014).

744 The EPO Guidelines for Examination G-II, 3.6.

745 Article 57 of the EPC and Section 101 of USPTO 35 USC (US Patent Act).

746 Articles 54 to 56 of the EPC and Sections 102 and 103 of the US Patent Act.

"novel," "obvious," and "invention" in the context of software (e.g., Article 52(2) of the EPC and Sections 101 to 103 of the US Patent Act). Furthermore, as revealed in Chapter 2, there are still procedural issues or difficulties for determining a patentable software invention.

Historically, the US courts did loosen the exceptions for software-related inventions after the Supreme Court decision in *Diamond v Diehr* in 1981[747], making it easier to obtain software patents[748]. This change considerably promoted the swift growth of software patents in the US, seeing growth roughly two and a half to four times larger than that of patents in general.[749] However, lower patentability standards also meant fewer hurdles when trying to obtain a software patent. As a result, problems with low-quality software patents emerged[750][751]. The existence of low-quality software patents goes against the purpose of inspiring inventions and can hinder the development of industry and economy.

This study has identified that many of these problems need to be confronted promptly by relevant authorities as the legislative intents in the past are no longer apt to the needs of highly developed industries today. Rather, it becomes an obstacle to technology advancement in some respects. The problems/questions that need to be reassessed are summarised here[752]; including:

1. **Classification Ambiguity:** In the US, where the USPTO applied the Cooperative Patent Classification (CPC) as a patent classification system,[753] software patents are not treated as exclusive patent classes;

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[747] *Diamond v Diehr* 450 U.S. 175 (1981).

[748] Josh Lerner and Feng Zhu, 'What is the Impact of Software Patent Shifts? Evidence from Lotus v. Borland' (2005) NBER Working Paper No. 11168.

[749] James Bessen and Robert M. Hunt, 'An Empirical Look at Software Patents' (2007) 16(1) Journal of Economics & Management Strategy 157.

[750] Dan L. Burk and Mark A. Lemley, The Patent Crisis and How the Courts Can Solve It (University of Chicago Press 2009); James Bessen and Michael J. Meurer, Patent Failure: How Judges, Bureaucrats, and Lawyers Put Innovators at Risk (Princeton University Press 2008).

[751] Robert Hunt and James Bessen, 'The Software Patent Experiment' (2004) Federal Reserve Bank of Philadelphia Business Review Q3 2004, 22.

[752] Wesley M. Cohen, Richard R. Nelson and John P. Walsh, 'Protecting Their Intellectual Assets: Appropriability Conditions and Why U.S. Manufacturing Firms Patent (or Not)' (2000) NBER Working Paper No. 7552.

[753] The Cooperative Patent Classification (CPC) system was launched by partnership between the EPO and the USPTO to establish a common, internationally compatible classification system for patent documents. [cite: 392, 393] Class G06F (Electric Digital Data Processing) is a primary class, but software related inventions may fall into various classes

rather they fall under the functional categories of "data processing'[754]. Current patent classification systems (like the CPC) often categorise software under broad functional headings (e.g., "data processing'), which may not adequately capture the nuances required for effective prior art searching and examination, especially with the rise of AI and complex algorithms. For instance, classifying an AI invention often requires understanding not just its function (e.g., image recognition) but also its underlying algorithmic structure and training data dependencies, aspects poorly captured by traditional classification schemes focused on industrial application fields.

2. **Differing Standards and Uncertainty (US and EU):** In the EU, patenting software-related inventions is often considered more difficult than in the US. As identified in Chapter 2, the peculiar structure of the European patent system can make the European patent law obscure[755]. This can cause uncertainty regarding the patentability of software patents. The definition of software and software patent subject-matter have not been explicitly recognised. Furthermore, the courts in some member states are not bound to obey the EPO's indications and decisions; essentially independent national courts can decline patents which are enforced or asserted to be revocable[7]. Such configuration causes uncertainty for software inventions in Europe as there is not yet a harmonised approach to be followed.

3. This divergence is evident, for example, in the differing treatments of graphical user interfaces (GUIs) or information modelling, where the EPO may find "technical character" if the presentation facilitates specific technical operations under certain conditions[756], while US courts might analyse similar claims under the "abstract idea" doctrine post-*Alice*[757]. The EPC does not specifically define the term "invention" and Article 52(2) of

depending on application field.

[754] Class 717 of the CPC is the classed of data processing. In this class it is for 'software program development and techniques including processes and apparatus for controlling data processing operations pertaining to the development, maintenance, and installation of software programs…..'.

[755] Susan Marsnik and Robert E. Thomas 'Drawing a line in the patent subject-matter sands, Does Europe provide a solution to business method and software patent problem?' (2011) 32 Boston College International and Comparative Law Review 221, 44-49.

[756] See EPO, Guidelines for Examination, G-II, 3.7 ('Presentations of information').

[757] See, e.g., discussions on the application of Alice to software interfaces, often requiring an 'inventive concept' beyond conventional computer implementation.

the EPC, while stating that European patents shall be granted for inventions that are new, involve an inventive step, and are susceptible of industrial application, also indicates that terms such as "mathematical methods, programs for computers, and presentations of information" shall not be regarded as inventions;[758] namely, elements often related to software. Thus, although software is *de facto* patentable in both jurisdictions[759], the patentability standards in the US and EU continue to exhibit substantial grey areas.

4. **International Context (TRIPS Agreement):** The TRIPS Agreement, as one of three pillar agreements of the WTO[760], considerably influences the patent policies of WTO member states regarding software (the other two pillars, the Multilateral Agreement on Trade in Goods and the General Agreement on Trade in Services, are less relevant to the patentability of software and are therefore not discussed here). The TRIPS Agreement sets various minimum standards for intellectual property protection and established basic measures in the protection of intellectual property rights between the WTO members. The TRIPS Agreement is applicable to, and binding upon, all 164 members of the WTO[761]. After trade negotiations in 1994, the main provisions for developing countries are that they are entitled to a four-year transition period in relation to intellectual property rights and an additional five-year transitional period for technical product patents[762]. These transitional periods have since expired, and developing countries are now generally required to fully implement all TRIPS obligations. For least-developed countries, they are entitled to a 10-year transitional period which may be extended upon request[763]. (The initial 10-year transitional period has been extended multiple times, with the current exemption from most TRIPS obligations set to last until July 1, 2034, and subject to further extensions upon request.) The TRIPS Agreement can be deemed as the

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[758] Article 52(2) of the EPC.

[759] World Trade Organization, 'Understanding the WTO: The Organization - Members and Observers' https://www.wto.org/english/thewto_e/whatis_e/tif_e/org6_e.htm accessed 4 April 2018.

[760] Carsten Fink, 'Intellectual Property and the WTO' (2004) Working paper, Open Knowledge Repository, World Bank Group, < https://openknowledge.worldbank.org/handle/10986/25931 > accessed 29 March 2018.

[761] At the date of this thesis is drafting, there are 164 members of the WTO since July 2016.

[762] Agreement on Trade-Related Aspects of Intellectual Property Rights, Article 65 of the TRIPS Agreement.

[763] TRIPS Agreement art 66.

most comprehensive multilateral agreement on IP. However, even with TRIPS, inconsistencies remain.

5. **Consequences of Inconsistency:** The inconsistency in the patentability standards of software patents across the US, EU, and influenced by WTO/TRIPS Agreement, leads to uncertainty in the marketplace and potentially more litigation. It can even inhibit new software inventions from entering the market as some patent developers might rather maintain the status quo and easy accessibility to software rather than introduce the legal uncertainty to such patents.

6. **Defining Novelty and Contribution:** Does a patented software-containing system need to have novel aspects of the invention in its software? What is the threshold for the software's contribution to be considered primary rather than merely incidental? The lack of clear guidance makes assessment in these regards difficult.

7. **Deficient Eligibility Criteria:** The legal tests for eligibility (e.g., the *Alice* two-step test in the US) and functional claiming remain ambiguous, lacking concrete definitions of what constitutes an "abstract idea" versus a patentable implementation, or a sufficient "inventive concept.'[764]

8. **Understanding "Technical Effect":** What constitutes a "further technical effect" or sufficient "technical character" remains elusive. Whether a software patent should be granted or not is based on the physical feature of the entity or the nature of the activity which performs its technical character. The term "technical character" should be defined clearly in the patent legislation to confirm a software patent as it is the vital determination to a patentable invention. Clearer parameters are needed, especially for software managing industrial processes or controlling machinery. The challenge intensifies with inventions claiming improvements within the computer itself (e.g., faster processing, more efficient memory management, etc.). Distinguishing a patentable technical solution from a mere algorithm operating on data requires examiners to assess whether the claimed effect transcends the "normal" physical interactions between program and computer[765], achieving a specific technical improvement in

[764] Rupert A. Knights and Craig A. Redinger, 'Patent Eligibility of Software Patents in the U.S. and Europe: A Post-Alice Consideration' (2015) Vol. 8, Number 1, Landslide 1.

[765] See EPO, Guidelines for Examination, G-II, 3.6 ('Programs for computers'); T 1173/97 (*Computer program product/IBM*) (EPO BA 1 July 1998).

the computer's functioning[766].

9. **Business Method Patentability:** How can the “useful, concrete, and tangible” requirement be consistently applied to software implementing business methods, especially when they resemble mathematical models? Identifying the patentable technical contribution beyond the business logic is challenging.

10. **Quality Metrics:** Evaluating the societal contribution of software patents lacks standardised metrics. How should benefits like economic impact, job creation, public health improvements, or industry reform be weighted in assessing patent quality?

11. **Defensive Patenting:** Looser standards can encourage the accumulation of patents for strategic/defensive purposes (negotiation leverage, blocking competitors) rather than for active innovation, potentially harming competition and raising entry barriers[767]. This phenomenon, often termed “patent thicket” creation, can particularly disadvantage SMEs lacking the resources for extensive patent litigation or cross-licensing negotiations, thereby potentially stifling competition from newer entrants[768].

12. **Arbitrary Granting & Prior Art Gaps:** Inconsistent application of standards and incomplete prior art databases (especially for older or non-traditionally documented software techniques) can lead to arbitrary patent grants and deter innovators due to marketplace uncertainty[769].

13. **Re-examination Efficiency:** While useful, re-examination processes can be slow. Faster, more decisive mechanisms for handling challenges, perhaps involving market participant input, could improve efficiency.

14. **Terminology Confusion:** The use of varied and sometimes archaic terminology for software concepts creates confusion during examination

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[766] Cf. USPTO, Manual of Patent Examining Procedure (MPEP), Section 2106.05(a) ('Improvements to the Functioning of a Computer or To Any Other Technology or Technical Field').

[767] Stuart J. H. Graham *et al.*, ‘High Technology Entrepreneurs and the Patent System: Results of the 2008 Berkeley Patent Survey’ (2009) 24(4) Berkeley Technology Law Journal 1255.

[768] See James Bessen, ‘Patent Thickets: Strategic Patenting of Complex Technologies’ (Research on Innovation Working Paper 2003); Carl Shapiro, ‘Patent System Reform: Economic Analysis And Critique’ (2004) 19(1) Berkeley Technology Law Journal 1017.

[769] James Bessen, ‘Patent Thickets: Strategic Patenting of Complex Technologies’ (Research on Innovation Working Paper 2003).

and prior art searches; demanding clearer and unified guidelines in needed.

15. **Claim Verification:** Confirming that a software patent claim truly meets all requirements, especially inventive step and functional enablement, is complex. Verifying the described outcomes and distinguishing true technical solutions from abstract ideas remains a core challenge.

16. **Procedural Burdens:** A low cost and easy patent application environment, including a short and simple patent application procedure and affordable enforcement fees, is needed, especially for small entities. If the result of patent application and enforcement is not predictable, it causes more risks to inventors, potentially leading to hesitation in seeking patent protection as the benefits may not offset the costs.

These highlighted problems underscore the pressing need for a more structured, transparent, and doctrinally grounded approach to software patent examination. While it remains clear that abstract ideas are not patentable and software inventions must possess novelty, inventive step, and industrial applicability to produce a useful, concrete, and tangible result, the unique nature of software presents challenges. Standardised examination methods, including specific identification criteria, are essential to consistently assess technical effects and determine if the patent claims satisfy the requirements for novelty and non-obviousness in the context of software.

Perhaps software is not the ordinary kind of invention produced in the industrial age, given the difficulties in substantiating it as a physically examinable entity. Therefore, establishing a set of commonly accepted guidelines or approaches for the “concrete and tangible result” test, adaptable to the peculiar structures of various patent systems, becomes necessary. While creating such guidelines is admittedly difficult and time-consuming, it represents a crucial step forward, potentially building upon existing precedents from patent courts worldwide. Furthermore, the very nature of software prior art poses a significant challenge. Unlike traditional inventions often documented in patents and scientific literature, much software innovation resides in code repositories, technical blogs, open-source projects, and product documentation. These sources often difficult for patent examiners to systematically search and evaluate[770]. This “prior art gap,” compounded by the sheer volume of patent and non-patent

[770] See, e.g., Stephen R. Tate, 'Debugging the Patent Process: Improving Software Patent Quality by Promoting Non-Patent Prior Art' (2014) 8(1) Washington Journal of Law, Technology & Arts 29.

literature, increases the risk of inadvertently granting patents on inventions that are not truly novel or non-obvious over existing, albeit less formally documented, techniques[771].

Given the incomplete patent protection and varying standards currently observed at both domestic and international levels, an effective examination system is vital. Such a system is needed to prevent the granting of patents for vague claims with trivial contributions, thereby minimizing uncertainty within patent law and ensuring the integrity of the examination process. Furthermore, the rapid growth of software patents has caused concern among practitioners and policymakers, particularly regarding the granting of numerous patents for trivial ideas, which can hinder access to critical technology[772]. Recognising the evolving landscape of law and technology, Webbink proposed considering a new schema for protecting software in the mid-2000s[773]. More recent research has also suggested that decreasing the software patent term could potentially solve many practical problems associated with software patenting. Establishing a set of commonly accepted guidelines or approaches for the “concrete and tangible result” test, adaptable to various patent systems, is necessary. While creating such guidelines is difficult, it represents a crucial step forward, potentially building upon existing precedents.

As discussed elsewhere (e.g., Chapter 6), the issuance of low-quality software patents and the unequal benefits they confer can harm competition. Consequently, any new system must aim to reduce uncertainty in patentability standards to become broadly acceptable and effectively recognised and enforced across more jurisdictions.

7.1.3 Limitations of Existing Patent Quality Models

Several prior models have addressed patent quality and examination efficiency. Before the establishing of a specialised standard for software patent examination, attempts to solve the problems which are obvious in patent

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[771] See challenges discussed in 'How is AI Solving the Biggest Headaches in Prior Art Search?' (XLSCOUT) https://xlscout.ai/how-is-ai-solving-the-biggest-headaches-in-prior-art-search/; 'Understanding Prior Art Search in 2025' (Lumenci) https://lumenci.com/blogs/prior-art-search-guide-patent-non-patent-literature/ accessed 27 April 2025.

[772] Dan L. Burk and Mark A. Lemley, The Patent Crisis and How the Courts Can Solve It (University of Chicago Press 2009); James Bessen and Michael J. Meurer, Patent Failure: How Judges, Bureaucrats, and Lawyers Put Innovators at Risk (Princeton University Press 2008).

[773] Mark H. Webbink, ‘A New Paradigm for Intellectual Property Rights in Software’ (2005) 2005(5) Duke Law & Technology Review 1.

practice have been undertaken. While these existing models offer valuable insights, they do not directly satisfy the contemporary needs of software patent examination, especially when considering the nuances required at the claim level.

One prominent example is Lanjouw and Schankerman's multi-indicator model developed in 2004.[774] This model utilised metrics such as forward citations, backward citations, and family size to measure innovation and patent quality, analysing determinants of research productivity using a large dataset of patent applications. They employed a composite index, constructed using a minimum-variance estimator with parameter estimates based on observable characteristics, arguing it could provide more information than individual indicators alone. This approach sought to differentiate real and apparent changes in patent productivity by considering three main factors: level of demand, quality of patents, and technological exhaustion. Their findings indicated that patent quality is positively associated with the stock market value of firms, that rises in patent quality can account for some time series variation in R&D research productivity, and that there exists an inverse relationship between patent quality and the level of demand. While suitable for assessing macro-level research output and providing valuable insights into innovation dynamics, the original aim of this model was not the examination of newly applied-for patents. Its design is retrospective, best suited for analysing granted patents rather than guiding the examination of new applications. Consequently, the model fails to account for the specific doctrinal and technical particularities inherent in software patents.

Moreover, in 2012, Hido *et al.*[775] developed a system applying machine learning and text mining techniques for large-scale patentability analysis, aiming to reduce evaluation time for new patent applications. Their study used a statistical prediction model to estimate the examination results of approximately 0.3 million patent applications filed in Japan between 1993 and 2007. They formalised a Patent Quality Index (PQI) for each application based on its specification document and examination result, employing supervised classification methods. Two primary feature sets, word age and syntactic complexity, were introduced to evaluate the text of patent applications. The

[774] Jean O. Lanjouw and Mark Schankerman, 'Patent quality and research productivity: measuring innovation with multiple indicators', (2004) Vol, 114, The Economic Journal, 441-465.

[775] Shohei Hido *et al.*, 'Modeling Patent Quality: A System for Large-scale Patentability Analysis using Text Mining', (2012) Vol.20 No.3 Journal of Information Processing 1–12

output threshold for patentability was defined such that an average PQI score must be ≥ 0.5 for an application to be predicted as approvable. While representing a valuable early attempt to automate examination prediction, the results showed limitations in accuracy and inherent uncertainties; specifically, only 40.6% of the applications that were eventually granted achieved an average PQI score of 0.568. As the authors themselves believed, this work could be considered a first step in quantifying the quality of patent applications. Critically, however, the PQI demonstrated limited predictive accuracy and lacked sufficient legal interpretability. Furthermore, the linguistic indicators chosen, such as word age and syntactic complexity, while potentially useful for information retrieval or text analysis, do not map clearly onto the required statutory criteria for patentability, such as novelty or inventive step (non-obviousness).

A third example comes from Song and Li in 2014,[776] who constructed a multi-dimensional indicator system designed to compare patent quality among China's 31 provinces/municipalities and 8 selected countries. Their framework categorised the measurement of patent quality into four distinct indicator aspects: invention characteristics, application document quality, under examination performance, and commercialisation potential. Each of these four indicators was assigned its own coefficients and indexes within a comprehensive assessment equation. The data used for these four indicator aspects were obtained from calculation results generated by weighted equations specific to each aspect. This model successfully highlighted regional and national disparities in patent strength and encouraged a quantitative assessment extending beyond simple patent counts. However, a significant drawback lies in the methodology for determining the weights and coefficients within the equations. These values were assigned by the authors, and the underlying basis or source for these assigned values lacked sufficient acceptable justification or transparency, making the system difficult to use widely or replicate reliably. This lack of empirical transparency and clear doctrinal foundation severely limits the model's overall reliability and, crucially, its applicability to the nuanced legal and technical calibration required for examining software inventions.

[776] Hefa Song and Zhenxing Li, 'Patent quality and the measuring indicator system: Comparison among China provinces and key countries', (2014) Institute of Policy and Management, Chinese Academy of Sciences.

Another relevant example is Boeing and Mueller's 2016 model,[777] which utilised data from international search reports (ISRs) issued under the Patent Cooperation Treaty (PCT) framework to measure and compare patent quality across different countries. Their approach allowed for technology-specific cross-country comparisons. In their model, the dependent variable, termed the ISR index, was defined as the ratio of the average quality level of PCT applications between two countries. This methodology revealed findings such as a widening gap between the technological capacities of China and the leading US. Their framework proves valuable for benchmarking national innovation systems and identifying international technological gaps. Nevertheless, although helpful for macro-level benchmarking and policy analysis, their model offers no practical support for assessing the eligibility or technical merit of individual patent applications, especially those concerning complex software inventions. It was explicitly designed for cross-country comparison and was never intended to guide the day-to-day work of patent examiners or facilitate the assessment of claim-level eligibility and patentability.

It cannot be denied that these previous models, representing significant efforts undertaken before and alongside the establishment of more specialised standards, are valuable for understanding broader trends in patent quality and overall innovation output. They collectively underscore the importance and potential of employing empirical and data-driven approaches within the realm of patent policy. However, they are generally not aligned with the specific doctrinal requirements or the procedural necessities inherent in modern software patent examination, particularly at the granular claim level. This thesis, therefore, proposes a doctrinally grounded, examination-oriented model designed specifically for practical application within institutional patent review systems, aiming to address the limitations identified in prior work.

7.1.4 Historical Evolution of Software and Intellectual Property Protection

'The evolution of industrial patterns in each era has been described in Chapter 5. Before continuing tailoring a rational patentability requirement and examination process for software inventions, it is necessary to define how software was regarded in each era so as to make out the differences between the computer-implemented software today and in previous years. While such

[777] Philipp Boeing and Elisabeth Mueller, 'Measuring patent quality in cross-country comparison', (2016) Vol. 149, Economics Letters 145–147.

differences and intellectual property protection to software to them are approved or even acquiesced, it justifies why intellectual property protection for software needs evolutionary improvement to accommodate the changing world, too. This thesis roughly divides software development into four phases according to the level of development and different intellectual property protection available in each phase.

With the proliferation of computers and the tremendous amounts of computer sales in the early 1960s, the software industry equally began to see rapid expansion. In this regard, the years between mid-1950s to 1960s is therefore taken as the first phase of the software industry. The prices of software and hardware were expensive in this first phase. Small firms and individual consumers found the associated prices prohibitive. In this period, trade secrets were considered as the best means of protecting software from unauthorised copying and infringement. The reliance on trade secrecy, while effective for maintaining confidentiality, inherently limited knowledge dissemination and collaborative development within the burgeoning industry.

In the mid-1970s, the rise of personal computers (PC) led to a flourishing of the software industry. The years between the mid-1970s to 2000s can be defined as the second phase of the software industry. The industry had been growing steadily during this period and met a moderation at the end of the 20th century. Computer programs were explicitly embodied into the protection of national copyright law in most countries during this period. Under the protection of copyright, software was sold to general customers via a wide range of channels. However, the copyright protection to software is weak. Software can be easily copied thus piracy issues strongly affected the development of the software industry in this phase[778].

After entering this millennium, the software industry moved on to its third phase. The patentability requirements and standards for software inventions started establishing rapidly in the US and EU; albeit the controversies of whether software should or should not be the objective of patent protection remains. Generally speaking, in the software industry practitioners tend to seek patents for the stronger protection to their invention. Hence software is mainly protected by patent law during this phase. Nevertheless, the protection from copyright law

[778] European IPR Helpdesk, 'Copyright or Patent? How to protect my software?' (European Union 2018) https://www.google.com/search?q=https://intellectual-property-helpdesk.ec.europa.eu/news-documents/documents/copyright-or-patent-how-protect-my-software_en accessed [Date of access, e.g., 27 April 2025].

also co-exists. In this phase, the internet had opened up new commercial opportunities. More small and medium software companies emerged and created very high turnover. The worldwide software revenue in 2012 and 2013 was 388.5 billion US dollars and 407.3 billion US dollars respectively[779]. The packaged software industry revenue, between the years of 2000 to 2009 in the US, was estimated to range between 102 to 151.7 billion US dollars[780]. In the 2000s, companies in the software industry actively pursued mergers, acquisitions, partnerships or strategic alliances to increase their market share.

With both cloud computing and its predecessors expanding in recent years, the using of hosted software, called software-as-a-service (SaaS), possibly demonstrates a safer model for intellectual property protection on software applications. SaaS can reduce the risks, yet not completely eliminate, unauthorised copying, since no client software is loaded onto the computer of end user[781]. The SaaS model will be forecast for continuous growth. This model may be taken as that the software industry enters its fourth phase[782]. This fourth phase is also characterised by the increasing integration of software across diverse industries, moving beyond traditional IT sectors into areas like manufacturing (Industry 4.0), automotive technology, biotechnology, and finance (FinTech). This cross-sectoral permeation further complicates intellectual property protection strategies, as software becomes deeply embedded within larger technological systems, raising questions about system-level patentability and infringement.

Currently, the industrial revolution of AI, which is taken as the fourth industrial revolution, is in progress by virtue of the elaborate programs applied in the computer devices that enable this development. A contemporary example is the automated vehicles controlled through computer programs. Its advanced computer control system allows such vehicles to sense the environment and

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[779] Anne Shields, 'Must-know: An overview of the software industry' (Market Realist, 19 August 2014) https://www.google.com/search?q=https://marketrealist.com/2014/08/must-know-overview-software-industry/ accessed [Date of access, e.g., 27 April 2025].

[780] Statista, 'Packaged software industry revenue in the U.S. from 2000 to 2009 (in billion U.S. dollars)' (Statista 2018) https://www.google.com/search?q=https://www.statista.com/statistics/195320/packaged-software-industry-revenue-in-the-us-since-2000/ accessed [Date of access, e.g., 27 April 2025].

[781] Richards Patent Law, 'Software as a Service (SaaS) Protection' https://www.richardspatentlaw.com/industries/software/saas/ accessed 23 April 2018.

[782] Business Sweden Research, 'The U.S. software industry: A brief overview' (Business Sweden USA 2014).

further identify appropriate navigation paths without the needs of human input. On the other hand, the borderless transmission of technology provides even greater convenience with the introduction of digital cloud. The knowledge-based economy in the fourth industrial revolution will be more complex and more changeable, especially in the software industry. The industrial revolution of artificial intelligence is significant evidence that the software industry has entered the fourth phase.

Today the software industry has been playing the role of one of the most important industries due to the quick evolution of the software market. Software industry has already been one of the most vibrant segments of the global economy. As mentioned above, the intellectual property protections to software inventions have been different in each phase. The protections for software industry in the first, second, and third phases were reliant, primarily, on trade secrets and general contract law, copyright law, and patent law, respectively. In the fourth phase the development and availability of SaaS technology helps to avoid software downloaded to the client server end. Nevertheless, not all the software is eligible to come into play via this mechanism. That is to say, patents remain an important protection to most of the software that are applied at the moment. For years, intellectual property law and software patents have provided a legal protection for software industry and its participators to invest in developing and marketing. However, most of the software products can be replaced due to the constant improvement of technology, and consequently the threat of substitutes is strong. Software industry has changed the model and strategy of business, industrial production and capacity, and people's life and work.'

7.1.5 Emerging Challenges: Artificial Intelligence and Patent Examination

The accelerating development and deployment of AI, encompassing machine learning (ML) and increasingly sophisticated generative AI models, introduce a distinct set of challenges that overlay and often intensify the difficulties already present in software patent examination [783]. While AI is fundamentally implemented through software, its unique characteristics, such as adaptive learning, complex algorithms often opaque even to their creators ("black box" problem), and the ability to generate novel outputs autonomously – strain

[783] WIPO, WIPO Technology Trends 2019: Artificial Intelligence (WIPO 2019) https://www.wipo.int/publications/en/details.jsp?id=4386.

traditional patent doctrines and examination procedures[784]. Several key areas require specific attention[785]:

1. **Patentable Subject Matter (Eligibility):** AI algorithms, particularly foundational models, frequently risk being classified as abstract mathematical methods or mental processes, ineligible for patent protection under frameworks like EPC Article 52 or the US *Alice* test. Patent offices globally are grappling with how to apply the "technical effect" or "inventive concept" requirements to AI. For instance, the EPO guidelines suggest focusing on the application of AI to solve a technical problem or its role in a technical system,[786] while the USPTO examines whether the AI constitutes an improvement to computer functionality or another technical field[787]. Generative AI adds further complexity: is the patentable invention the model architecture, the training process, a specific application using the model, or potentially even novel outputs generated by the AI itself? The latter raises profound questions about whether AI-generated creations meet the criteria for patentable inventions if human contribution is minimal[788].

2. **Inventorship and Obviousness:** The role of AI in the inventive process challenges the human-centric definition of inventorship embedded in most patent laws[789]. High-profile cases attempting to list AI systems like DABUS as inventors have been largely unsuccessful to date, reaffirming the requirement for human inventors[790] [791]. However, the use of AI as a

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[784] Ryan Abbott, The Reasonable Robot: Artificial Intelligence and the Law (Cambridge University Press 2020).

[785] USPTO, Public Views on Artificial Intelligence and Intellectual Property Policy (USPTO October 2020) https://www.uspto.gov/sites/default/files/documents/USPTO_AI-Report_2020-10-07.pdf.

[786] European Patent Office, Guidelines for Examination, G-II, 3.3 'Mathematical methods' & 3.3.1 'Artificial intelligence and machine learning'. See also USPTO, Patent Eligibility Guidance Update (January 2019) and subsequent memos regarding application of 35 USC Section 101 to AI inventions.

[787] European Patent Office, Guidelines for Examination, G-II, 3.3.1.

[788] USPTO, Manual of Patent Examining Procedure (MPEP), Section 2106.04(a)(1) ('Examples of abstract ideas [...] Mathematical concepts') & Section 2106.05(a) ('Improvements to the Functioning of a Computer or To Any Other Technology or Technical Field').

[789] Mark A. Lemley, 'Coding Ontology' (2021) 97 Notre Dame Law Review 175.

[790] Shlomit Yanisky-Ravid and Xiaoqiong (Jackie) Liu, 'When Artificial Intelligence Systems Produce Inventions: The 3A Era and the Patent Law' (2018) 35 Cardozo Arts & Entertainment Law Journal 659.

[791] See Thaler v Comptroller General of Patents Trade Marks And Designs [2021] EWCA Civ 1374 (UK Court of Appeal); Thaler v. Vidal, 43 F.4th 1207 (Fed. Cir. 2022) (US Federal

sophisticated tool by human inventors complicates the assessment of inventive step (non-obviousness). How should the standard of the "person skilled in the art" be interpreted when that person has access to powerful AI tools capable of synthesising information, suggesting solutions, or even generating code? Determining whether an AI-assisted invention would have been obvious requires new considerations regarding the capabilities routinely available to practitioners in the relevant field[792].

3. **Disclosure and Enablement:** Adequately disclosing an AI invention to meet the enablement requirement (allowing a skilled person to replicate the invention without undue burden) poses significant difficulties[793]. This is particularly true for complex deep learning models where performance depends heavily on specific architectures, vast training datasets, and intricate hyperparameters. Disclosing proprietary training data may be commercially infeasible, yet withholding it might render the patent non-enabled. Striking a balance between sufficient disclosure and protecting trade secrets related to data and model specifics is a critical unresolved issue[794].

4. **Prior Art and Novelty:** The potential for AI, especially generative AI, to produce vast quantities of code, designs, text, and other potentially relevant material complicates prior art searches. Identifying and accessing relevant prior art, which may exist in non-traditional forms like code repositories or pre-print servers, becomes more challenging for examiners. Furthermore, assessing the novelty of an invention claimed to be generated by AI requires careful consideration of the AI's inputs, training, and the human guidance involved.

These AI-specific challenges interact with the broader issues discussed in this chapter, such as classification ambiguity, defining technical contribution, and ensuring examination consistency. Any proposed examination model, including the five-dimensional framework presented herein, must ultimately be adaptable enough to accommodate the unique technical and legal questions raised by AI

Circuit).

[792] European Patent Office, 'EPO refuses DABUS patent applications designating AI system as inventor' (EPO Press Release, 27 January 2020) https://www.epo.org/en/news-events/news/epo-refuses-dabus-patent-applications-designating-machine-inventor.

[793]. Peter S. Menell, 'Tailoring Intellectual Property Rights to Artificial Intelligence' (2020) Ohio State Law Journal 1329.

[794] Brenda M. Simon and Xuan-Thao Nguyen, 'Artificial Intelligence and Patent Disclosure' (2021) 74 SMU Law Review 595.

inventions if it is to remain relevant and effective in promoting technological progress in this rapidly evolving domain.

7.2 The Proposed Five-Dimensional Examination Model: Conceptual Framework

In response to the inconsistencies and shortcomings observed in software patent examinations across jurisdictions, and the limitations of existing models, this section introduces a unified and structured Five-Dimensional Examination Model. The aim is to assist patent offices, courts, and stakeholders in consistently evaluating computer-implemented inventions (CIIs), especially those involving software components. This model is designed to offer patent offices, applicants, courts, and other stakeholders a more coherent and predictable framework when evaluating the patentability of computer-implemented inventions. It seeks to provide a systematic, transparent, adaptable, and scalable patent examination process as patent systems struggle to keep up with the accelerating technological change.

7.2.1. The five core dimensions

This model is designed to offer patent offices, applicants, courts, and other stakeholders a more coherent and predictable framework when evaluating the patentability of computer-implemented inventions (CIIs). It seeks to provide a systematic, transparent, adaptable, and scalable patent examination process as current patent systems, as noted above, struggle to keep up with the accelerating technological change. In respect of the discussion presented in the previous section, the five core dimensions are grounded in established legal standards and interpreted in light of technological practicality. They are:

(1) Novelty,

(2) Inventive Step / Non-obviousness,

(3) Technical Character / Technical Effect,

(4) Industrial Applicability, and

(5) Economic Significance (policy-oriented).

While the first four dimensions of this model correspond directly to established legal criteria for patentability, primarily derived from statutory instruments such as Articles 52 to 57 of the European Patent Convention (EPC) and 35 USC Section101 to 103, as well as their interpretation through significant case law

including *Alice, Bilski*[795]*, T 1173/97*[796]*, T 258/03*[797], and *G 1/19*[798], the fifth dimension operates differently.

The fifth dimension, Economic Significance, serves as a policy-enhancing layer. Though not a strict legal requirement for patentability in all jurisdictions, this dimension considers the broader impact of the invention. It evaluates factors relevant to encouraging innovation, particularly for Small and Medium Enterprises (SMEs), individual inventors, or within the context of emerging economies. Recognizing that many software programmers are individual developers or operate small-scale businesses, the model explicitly incorporates this dimension to promote equitable access and try to make sure patent protection is available to everyone as equally as possible.

The inclusion of "Economic Significance" as a distinct dimension, albeit policy-oriented, represents a departure from purely legal-technical assessments prevalent in traditional patent examination. It implicitly acknowledges the perspective that patent systems function not only to reward invention but also as instruments of industrial policy and economic development, aiming for utilitarian goals[799]. This dimension invites examiners to consider, within the bounds permitted by law, the potential impact of an invention on market structure, competition, and access, particularly for resource-constrained innovators. Critiques of such an approach often highlight the potential for subjectivity and the difficulty in predicting economic impacts accurately at the examination stage, potentially diverting focus from objective technical merit[800].

Importantly, this five-dimensional model is not intended to override national or regional patent law. Instead, it is designed to act as an interpretive and evaluative scaffold, providing a structured framework for both applicants

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795 Bilski v. Kappos, 561 U.S. 593 (2010).

796 T 1173/97 (*Computer program product/IBM*) supra n 5.

797 T 0258/03 (*Auction method/HITACHI*) [2004] OJ EPO 575.

798 Decision G 1/19 (Pedestrian simulation) of 10 March 2021.

799 See Calvin Wai Loon Ho, 'Utilitarianism and Patents: Justification and Change' (2012) 2012 Singapore Journal of Legal Studies 357 (discussing utilitarian justifications); cf. arguments linking patent policy to economic goals in Mohd Zulkhairi Bin Mohd Yusoff *et al.*, 'Intellectual Property and Innovation: A Critical Assessment of Patent Law and Economic Growth' (ResearchGate January 2024) https://www.researchgate.net/publication/388677256_Intellectual_Property_and_Innovation_A_Critical_Assessment_of_Patent_Law_and_Economic_Growth.

800 See, e.g., criticisms regarding patent quality and effects on competition in Carl Shapiro, 'Patent System Reform: Economic Analysis And Critique' (2004) 19(1) Berkeley Technology Law Journal 1017.

seeking patents and examiners assessing applications, particularly those operating within software-intensive technological domains.

For practical application, each dimension encompasses specific sub-criteria. National patent offices or regional courts could adopt an optional weighted scorecard system based on these criteria to help benchmark quality and ensure consistency in evaluations. For instance, a claim might receive a "pass/fail" assessment or a numerical rating (e.g., on a scale of 0–5) under each criterion, facilitating an aggregate evaluation of its overall patentability profile. While such numerical assessments would not be legally binding in themselves, they offer examiners and courts a structured rationale to support their decision-making process. On the other hand, patentees can leverage this model proactively to estimate the patentability of their computer-implemented inventions. It helps them to either create a computer-implemented invention that satisfies the requirements of patent laws or to have clear clues (guidance) when drafting patent claims so the claims can be done in a more effective and economical way.

7.2.2 Conceptual Workflow

The model operates through a step-by-step evaluative approach, ideally applied sequentially but also allowing for interaction across dimensions:

Step 1: Prior Art Review (Novelty) - Is the invention previously disclosed in the prior art?

The first threshold is whether the software invention discloses any elements already existing in known technology. Publicly available disclosures, patent databases, and academic papers are scanned. Tools including WIPO Patentscope[18] or EPO Espacenet[19] support this process.

Step 2: Inventive Step Assessment – Would it be obvious to a skilled person in the field?

Once novelty is established, the examiner asks: "Given the prior art, would this have been obvious to a skilled person in the relevant technical field?" Techniques such as the "problem-solution approach" (EPO)[801] or "teaching-suggestion-motivation" test (USPTO)[802] are applied here[803].

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[801] EPO Guidelines for Examination, Part G, Chapter VII, 5.

[802] See MPEP Section 2143 concerning the KSR standard replacing the rigid TSM test.

[803] See KSR Int'l Co. v. Teleflex Inc., 550 U.S. 398 (2007) (Regarding the TSM test).

Step 3: Technical Character Determination - Does it produce a further technical effect or solve a technical problem?

This is the most complex dimension in software cases. Here, the invention must demonstrate a "further technical effect" (EPO standard) or embody an "inventive concept" tied to a technical implementation (US standard), such as improving system performance, securing communication, or optimising machine behaviour. For example, according to T 641/00 *COMVIK*[804], merely automating a business method using a computer is insufficient; but a program controlling an anti-lock braking system or improving vehicle safety, clearly has technical character.

Step 4: Industrial Applicability Validation - Can it be made or used in any kind of industry?

The invention should be capable of being manufactured or used in a tangible industry; for example, manufacturing, logistics, IT, or services.

Step 5: Evaluation of Economic Significance - Does it contribute to market utility or economic advancement?

While not a strict patentability criterion under current law, this dimension reflects emerging policy discussions (e.g., WIPO SME reports)[805], evaluating whether the invention could lower market entry barriers, offer strategic advantage to under-resourced developers, and promote national/regional innovation goals.

7.3 The Proposed Five-Dimensional Examination Model: Operationalisation

As mentioned in Section 7.1.3, many published related-models exhibit limitations, particularly concerning assigned weights and indexes that often lack a widely acceptable basis or source, making those systems difficult to apply broadly. Hence, this research attempts to describe in detail how the weights or indices are estimated and applied within the established model. This section details the quantitative aspects of the proposed model, including the scoring system and weighting methodology.

7.3.1 Scoring Matrix and Indicators

Each dimension is assessed on a 0–5 scale, allowing for qualitative discretion

[804] T 0641/00 (*Two identities/COMVIK*) [2003] OJ EPO 352.

[805] See e.g., WIPO, 'Making Intellectual Property Work for SMEs'

while offering a semi-quantitative basis for decision-making. The matrix can be adapted for internal examiner use, pre-filing applicant tools, or training benchmarks. The following chart (Table 1) is a demonstration of suggested patent examination based on the model:

Based on foundational patentability requirements outlined in frameworks such as Article 52 of the EPC and Title 35 of the USC, an improved weight grading method with normalised variable weights was developed for the examination of software patentability. In this method, the patentability of a software invention is examined across five dimensions: Novelty, Inventive Step, Technical Character, Industrial Applicability, and Economic Significance.

Each dimension is assessed using specific indicators, which are graded on a 5-point scale to provide a semi-quantitative basis for evaluation. In order to express and evaluate each aspect equally, two indicators were selected per dimension in the examination. These indicators were selected under the consideration of being equally representative for each aspect and designed to fit with the patent laws of most countries:

- Novelty: Concrete, Specialty
- Inventive Step: Innovate, Difficulty
- Technical Character: Tangible, Intensity
- Industrial Applicability: Useful, Feasible
- Economic Significance: Job Creation, Benefit

The score for each indicator is graded on a 5-point scale as follows:

- Excellently (Score: 9–10)
- Highly (Score: 7–8)
- Moderately (Score: 5–6)
- Mildly (Score: 3–4)
- Lowly (Score: 1–2)

The examiner uses this grading system to meet standardised measurements when assessing the patentability of a software invention. Table 1 provides the detailed score template for examiners, which includes the five aspects, their ten corresponding indicators, the grading scale (letter grade), and the grade point

range for each scale.

Table 1. The score table of examination for examiners.

Aspects	Indicators	Excellently score: 9~10	Highly score: 7~8	Moderately score: 5~6	Mildly score: 3~4	Lowly score: 1~2
Novelty	Concrete, a_1					
	Specialty, a_2					
Inventive	Innovate, a_3					
	Difficulty, a_4					
Technical character	Tangible, a_5					
	Intensity, a_6					
Industrial applicability	Useful, a_7					
	Feasible, a_8					
Economic	Job creation, a_9					
	Benefit, a_{10}					

In this study, an improved weight grading method with normalised variable weights was developed for the examination of software patentability. The score of *i* indicator, ES_i, obtains from the equation:

$$ES_i = Nw_i \cdot a_{avg,i}, \text{ where } i = 1, 2, \ldots, 10 \qquad (1)$$

where Nw_i and $a_{avg,i}$ are the normalised weight and average scores from examiners of *i* indicator. The formula of normalised weight is

$$Nw_i = \frac{w_i}{\sum_{j=1}^{10} w_j} \qquad (2)$$

where w_i is the weight of *i* indicator. There are three kinds of methods for obtaining weight; they are unit, statistical, and measurement weightings. The unit weighting means to consider the weight of indicators individually. Each indicator is of equal importance in the examination. The statistical weighting sets the weight inversely proportional to the score. Its purpose is to retain information on low-level indicators. The measurement weighting is applicable when the measurement error is inconsistent to reduce the importance of measuring the return of larger error indicators (lowly consensus examination).

Therefore, the indicators with smaller measurement error have greater weight. The formula of measurement weighting is

$$w_i = \frac{1}{\sigma_i^2} \tag{3}$$

where σ_i is the standard deviation, which can be calculation using the following equation:

$$\sigma_i = \sqrt{\frac{1}{m-1}\sum_{j=1}^{m}(a_{i,j} - a_{avg,i})^2} \tag{4}$$

Table 2 shows the data of k_m at different amount of examiners (m), where k_m and s_i are the coefficient between s and σ at amount of examiners (m) is small and sample standard deviation of i indicator, respectively. Note that this model allows different numbers of examiners on various indicators, which is due to the fact that can correct their errors by using k_m.

Table 2. Summary of the values of k_m at different amount of examiners (m).

Number of examiners	*m*								
	2	3	**4**	5	6	7	8	9	10
k_m	1.2533	1.1284	1.0854	1.0638	1.0509	1.0424	1.0362	1.0317	1.0281

Sources: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://iopscience.iop.org/article/10.1088/1742-6596/1912/1/012005/pdf

Each indicator in the examination of software invention is a sufficiency condition rather than a necessity condition. Furthermore, standard deviation is used to quantify the variational amount of a set of data, which is applicable when apparent disagreements between examiners appear. Therefore, the measurement weighting is recommended by this study.

It is important to acknowledge the inherent subjectivity remaining even within this structured scoring system. While the indicators provide specific points of focus, the assignment of scores (1-10) necessarily involves examiner judgment based on their technical expertise and interpretation of the prior art and legal standards. The model aims to channel this judgment through defined criteria and mitigate outlier scores via the weighting mechanism, rather than eliminating

subjectivity entirely. The use of multiple examiners, reflected in the calculation of average scores and standard deviations, further serves as a mechanism to moderate individual biases.

As the enhancing of normalised weight for low error indicator (highly consensus examination) is too strong, it will result in better results than that of unit weighting. Therefore, the increment needs to be halved when the normalised weight is higher than 0.1. A modification equation was adopted to achieve this work, that is

$$Mw_i = \begin{cases} (Nw_i + 0.1)/2, & \text{if } Nw_i > 0.1 \\ Nw_i, & \text{if } Nw_i \le 0.1 \end{cases} \quad (5)$$

where Mw_i is the modification weight, and 0.1 is normalised weight of unit weighting for ten indicators system. Likewise, the score equation of *i* indicator is modified as

$$ES_i = Mw_i \cdot a_{avg,i} \quad (6)$$

The total score of examination (ES_{total}) can be calculated by the following equation:

$$ES_{total} = \sum_{i=1}^{10} ES_i = \sum_{i=1}^{10} Mw_i \cdot a_{avg,i} \quad (7)$$

Table 3 shows a total table of indicator scores and average, modification weights, and total score of the examination. Finally, the output of the examination result for patentability of software invention is defined as

$$\text{Examination result} = \begin{cases} \text{Approve}, & \text{if } ES_{total} \ge 7 \\ \text{Reject}, & \text{if } ES_{total} < 7 \end{cases} \quad (8)$$

In which, 7 is a recommended threshold value by this study which can be changed for the Patent and Trademark Office.

Table 3. Total table of indicator scores and weights of the examination.

Indicators	Examiner-1	Examiner-2	Examiner-3	Examiner-4	Examiner-5	$a_{ave,i}$	Modification weight, Mw_i
Concrete, a_1							
Specialty, a_2							
Innovate, a_3							
Difficulty, a_4							

Tangible, a_5							
Intensity, a_6							
Useful, a_7							
Feasible, a_8							
Job creation, a_9							
Benefit, a_{10}							
Average of a_1–a_{10}							
Total score, ES_{total}							

7.3.3 Situation Analysis and Examiner Consensus

The consensus among examiners regarding examination results across different aspects or indicators is crucial. Discrepancies or controversial results may lead to potential disputes in the future. In this study, the levels of consensus—high, moderate, and low—are defined based on the number of normalized weights below 0.05. Specifically, high consensus corresponds to 1–2 such instances, moderate consensus to 3–4, and low consensus to 5–6. The following section presents an analysis of various scenarios involving different levels of consensus and the number of examiners across multiple indicators.

Situation-1: High Consensus Examination

A dataset containing two normalized weights (Mw) less than 0.05 (highlighted in bold in Table 4) was used to investigate the case of a high consensus examination. The total score was calculated using Equations (2) to (7). Since the result, ES_{total}=7.09, exceeds the threshold value defined in Equation (8), the software invention corresponding to this dataset is deemed approved.

Additionally, the average score of indicators a_1-a_{10} is shown in Table 4, with a value of 7.52. This average is higher than ES_{total}, which is due to the model assigning lower importance to indicators with larger errors.

Furthermore, because the sum of all modification weights is less than 1, as determined by Equation (5), the evaluation process under this model is considered more rigorous.

Table 4. Total table of indicator scores at high consensus examination.

Indicators	Examiner-1	Examiner-2	Examiner-3	Examiner-4	Examiner-5	a_{ave}	Modification weight, Mw_i
Concrete, a_1	**8**	**6**	**7**	**5**	**4**	**6.00**	**0.0123**

Specialty, a_2	**7**	**8**	**8**	**4**	**4**	**6.20**	**0.0073**
Innovate, a_3	6	7	6	6	5	6.00	0.0614
Difficulty, a_4	8	8	8	8	7	7.80	0.1267
Tangible, a_5	8	7	8	8	8	7.80	0.1267
Intensity, a_6	7	8	8	8	8	7.80	0.1267
Useful, a_7	8	8	9	8	8	8.20	0.1267
Feasible, a_8	8	9	8	9	8	8.40	0.1023
Job creation, a_9	9	9	8	8	9	8.60	0.1023
Benefit, a_{10}	9	8	9	8	8	8.40	0.1023
Average of a_1–a_{10}		7.52					
Total score, ES_{total}		7.09					

Situation-2: Moderate consensus examination

Table 5 shows virtual examination results of 5 examiners. The data set includes three *Mw* less than 0.05 that is a virtual examination result at moderate consensus situation. The difference of data sets in Table 4 and 5 is the change of the score of Examiner-5 in indicator a_3. It can be seen that all the *Mw* values are obviously different from those in Table 3, even though the change of average of a_1–a_{10} is small (7.52→7.48). The value of ES_{total} reduces from 7.09 to 6.95, which would result in a rejection for a patent application. Therefore, the variance of score in the same indicator plays an important role. An approved patent having a high consensus result in examination is reasonable and necessary, especially for an approved software patent. An approved patent that does not receive the results of a high consensus examination may trigger litigation in the future as the examiners' conflicting opinions on the invention reveal how challengeable it might be.

Table 5. Total table of indicator scores at moderate consensus examination.

Indicators	Examiner-1	Examiner-2	Examiner-3	Examiner-4	Examiner-5	a_{ave}	Modification weight, Mw_i
Concrete, a_1	**8**	**6**	**7**	**5**	**4**	**6.00**	**0.0129**
Specialty, a_2	**7**	**8**	**8**	**4**	**4**	**6.20**	**0.0077**
Innovate, a_3	**6**	**7**	**6**	**6**	3	**5.60**	**0.0140**
Difficulty, a_4	8	8	8	8	7	7.80	0.1303
Tangible, a_5	8	7	8	8	8	7.80	0.1303

Intensity, a_6	7	8	8	8	8	7.80	0.1303
Useful, a_7	8	8	9	8	8	8.20	0.1303
Feasible, a_8	8	9	8	9	8	8.40	0.1036
Job creation, a_9	9	9	8	8	9	8.60	0.1036
Benefit, a_{10}	9	8	9	8	8	8.40	0.1036
Average of a_1–a_{10}		7.48					
Total score, ES_{total}		6.95					

Situation-3: Low consensus examination

The data of indicators a_3–a_5 from Examiner-5 in Table 4 are changed to fit a virtual situation of low consensus examination. Table 6 includes the data of five *Mw* less than 0.05. The changes of *Mw* values are obviously different from in Table 3 that is same as in Table 5. Compared with the results from the high consensus examination (Table 3), the average of a_3–a_{10} decreases to 0.12 while reducing the ES_{total} value of 0.55. The results indicate that the value of ES_{total} decreases with increasing the amount of *Mw* less than 0.05. It is believed that the grant ratio is very low for a low consensus examination. Consequently, the professional training and quality of examiners are very important.

Table 6. Total table of indicator scores at lowly consensus examination.

Indicators	Examiner-1	Examiner-2	Examiner-3	Examiner-4	Examiner-5	a_{ave}	Modification weight, Mw_i
Concrete, a_1	**8**	**6**	**7**	**5**	**4**	**6.00**	**0.0182**
Specialty, a_2	**7**	**8**	**8**	**4**	**4**	**6.20**	**0.0108**
Innovate, a_3	**6**	**7**	**6**	**6**	**3**	**5.60**	**0.0198**
Difficulty, a_4	**8**	**8**	**8**	**8**	**4**	**7.20**	**0.0142**
Tangible, a_5	**8**	**7**	**8**	**8**	**5**	**7.20**	**0.0268**
Intensity, a_6	7	8	8	8	8	7.80	0.1639
Useful, a_7	8	8	9	8	8	8.20	0.1639
Feasible, a_8	8	9	8	9	8	8.40	0.1259
Job creation, a_9	9	9	8	8	9	8.60	0.1259
Benefit, a_{10}	9	8	9	8	8	8.40	0.1259
Average of a_1–a_{10}		7.36					
Total score, ES_{total}		6.40					

7.4 Application of the Proposed Model in Leading Patent Cases

To validate the robustness and practical utility of the proposed examination model, this section applies the framework to two landmark software patent cases — one from the United States and another from Europe. The objective is to assess how the model aligns with judicial reasoning and to illustrate its practical effectiveness in improving consistency and transparency in software patent evaluations.

It has been mentioned in the Step 2 inventive step assessment that, in the context of substantive examination, both the EPO and the USPTO have adopted systematic analytical frameworks to assess patentability. The EPO applies the so-called “problem-solution approach,” which requires the identification of a technical problem, the closest prior art, and the inventive step based on what would have been obvious to a person skilled in the art. This approach is formalised in the EPO’s Guidelines for Examination, Part G-VII, 5. The USPTO, on the other hand, employs the “teaching-suggestion-motivation” test in evaluating whether an invention is obvious under 35 USC Section 103. This test seeks to determine whether the prior art provides a teaching, suggestion, or motivation to combine references to arrive at the claimed invention. Though its mandatory application has been narrowed post-*KSR Int'l Co. v. Teleflex Inc.*, it remains a guiding principle for consistency in obviousness determinations.

7.4.1 Europe: EPO Enlarged Board of Appeal *G 1/19*

This pivotal case, *G 1/19* (Pedestrian Simulation), was decided by the EPO Enlarged Board of Appeal in 2021 and provided significant clarification on the patentability of computer-implemented simulations.[806]. The Enlarged Board affirmed the established EPO approach that computer-implemented simulations can be patentable if they are used for a technical purpose and contribute to solving a technical problem, thereby possessing the requisite technical character. The specific subject matter involved a computer-implemented method for simulating the movement of a pedestrian crowd through an environment such as a building or railway station, which was claimed to aid in decisions regarding the design or modification of the venue's structure (e.g., positioning of walls or staircases).

[806] G 1/19 (*Pedestrian simulation/CONNOR*) (EPO EBA 10 March 2021).

Application of the Proposed Five-Dimensional Examination Model:

The application of the proposed examination model to the *G 1/19* case, based on the exemplar scores assigned in Table 7 below, illustrates how the model can systematically evaluate such an invention:

Table 7. Illustrative Scoring of *G 1/19* (Pedestrian Simulation) using the Proposed Five-Dimensional Examination Model)

Aspect	**Indicators**	**Assigned Score (Exemplar)**
Novelty	Concrete, Specialty	7, 8
Inventive Step	Innovate, Difficulty	7, 6
Technical Character	Tangible, Intensity	7, 7
Industrial Applicability	Useful, Feasible	8, 7
Economic Contribution	Job Creation, Benefit	6, 5

- Novelty (Exemplar Scores: Concrete 7, Specialty 8):

The simulation method, while potentially using known mathematical modeling techniques, was applied to a specific scenario (pedestrian flow in a venue for design purposes). The "Concrete" indicator might receive a high score if the simulation involved specific, well-defined inputs and parameters directly relevant to the venue's physical layout and pedestrian characteristics, going beyond a mere abstract simulation. The "Specialty" indicator could also score highly if the particular combination and application of simulation techniques for structural design represented a novel approach in that specific context, not readily found in prior art. The EPO in *G 1/19* did not focus primarily on novelty in its broadest sense, but rather on eligibility and inventive step assuming novelty could be established for a specific application.

- Inventive Step / Non-obviousness (Exemplar Scores: Innovate 7, Difficulty 6):

The "Innovate" indicator would assess whether the claimed simulation method, as a whole, provided a non-obvious solution to the technical problem of optimizing venue design for pedestrian movement. This would involve considering whether the simulation's outputs (e.g., predictions of crowd density or bottlenecks) offered insights that a person skilled in architectural design and

crowd simulation would not have routinely achieved. The "Difficulty" indicator reflects the complexity or non-triviality of developing and implementing such a simulation effectively for the stated technical purpose. The Enlarged Board in *G 1/19* emphasized that for a simulation to involve an inventive step, its technical purpose and the features achieving that purpose must be non-obvious.

- Technical Character / Technical Effect (Exemplar Scores: Tangible 7, Intensity 7):

This dimension is central to the *G 1/19* decision. The "Tangible" indicator here relates to the simulation producing a tangible technical outcome or being linked to a physical reality. The Enlarged Board clarified that a simulation contributes to solving a technical problem if it forms the basis for a further technical use of the outcomes of the simulation (e.g., designing a building with improved pedestrian flow). Thus, the simulation of pedestrian movement for structural design decisions clearly addresses a concrete technical problem (optimizing a physical layout for safety or efficiency), satisfying the "technical character" requirement. The "Intensity" of the technical effect could be high if the simulation provides significant, reliable, and actionable insights that directly influence the technical design of the venue. The EPO's nuanced appreciation of technical contribution, hinging on the purpose and application of the simulation, aligns well with the model's ability to capture these technical aspects.

- Industrial Applicability (Exemplar Scores: Useful 8, Feasible 7):

The simulation method is clearly "Useful" as it aids in practical architectural and engineering design decisions. Its "Feasibility" would depend on whether the simulation can be reliably implemented using known computing resources and modeling techniques to produce meaningful results for its stated purpose. The *G 1/19* decision implicitly accepts industrial applicability for simulations that serve a technical purpose.

- Economic Significance (Policy-Oriented) (Exemplar Scores: Job Creation 6, Benefit 5):

While not a direct patentability criterion in *G 1/19*, this dimension considers broader impacts. Such simulation tools could lead to more efficient building designs ("Benefit"), potentially reducing construction costs or improving public safety. While direct "Job Creation" might be moderate, the enabling of better design processes contributes to the construction and urban planning industries. The EPO framework does not explicitly include such economic considerations

in its patentability assessment, but this dimension in the proposed model allows for a policy-oriented perspective.

Overall Assessment using the Model:

The exemplar scores assigned across the dimensions, particularly the strong scores in Novelty, Inventive Step, Technical Character, and Industrial Applicability, would likely yield an ES_{total} (as calculated by equation 7) above the approval threshold (e.g., >7.0, as per equation 8). This outcome, indicating a positive examination result under the proposed model, aligns with the Enlarged Board of Appeal's affirmation in *G 1/19* that computer-implemented simulations can be patentable when they are used for a specific technical purpose and provide a technical contribution to the art. Rather than dismissing simulations outright due to their computational nature, the matrix scoring within the proposed model allows for a structured recognition of inventive implementations that are demonstrably tied to achieving concrete technical objectives, reflecting the nuanced approach favoured by the EPO.

7.4.2 United States: *Alice Corp. v. CLS Bank International*, 573 U.S. 208 (2014)

This landmark case involved Alice Corporation's patent claims directed to a computer-implemented scheme for mitigating settlement risk in financial transactions by using a computer system as a third-party intermediary to manage escrow. The US Supreme Court ultimately ruled the patent claims invalid under 35 USC Section 101, finding them to be directed to an unpatentable abstract idea (the fundamental concept of intermediated settlement) without an "inventive concept" sufficient to transform that abstract idea into a patent-eligible application.

Application of the Proposed Five-Dimensional Examination Model:

The application of the proposed examination model to the Alice Corp. case, utilizing the exemplar scores assigned in Table 8 below, demonstrates how the model systematically reaches an outcome consistent with the Supreme Court's ruling:

Table 8. Illustrative Scoring of *Alice Corp. v. CLS Bank International* using the Proposed Five-Dimensional Examination Model

Aspect	Indicators	Assigned Score (Exemplar)

Novelty	Concrete, Specialty	4, 4
Inventive Step	Innovate, Difficulty	3, 3
Technical Character	Tangible, Intensity	2, 2
Industrial Applicability	Useful, Feasible	5, 5
Economic Contribution	Job Creation, Benefit	3, 3

- Novelty (Exemplar Scores: Concrete 4, Specialty 4):

The underlying concept of intermediated settlement or escrow was found by the Court to be a long-standing commercial practice, a fundamental economic principle. Thus, the "Concrete" novelty of the core idea itself was low. While the specific application via a computer system might have possessed some "Specialty" in its particular arrangement at the time, the fundamental concept lacked novelty. The model's moderate scores here reflect that while a computerized implementation might present some new features, the core idea was not new.

- Inventive Step / Non-obviousness (Exemplar Scores: Innovate 3, Difficulty 3):

The Supreme Court determined that the claims merely recited the abstract idea of intermediated settlement implemented using generic computer functionalities (e.g., a data processing system, a communications controller). There was no inventive step found in the how of the computer implementation beyond conventional computer activity. Thus, the "Innovate" score would be low, as the invention did not provide a non-obvious solution beyond the abstract idea. The "Difficulty" in implementing such a known commercial practice on a generic computer was also not deemed to be significant in an inventive sense.

- Technical Character / Technical Effect (Exemplar Scores: Tangible 2, Intensity 2):

This is a critical dimension where the Alice claims scored poorly, aligning with the Supreme Court's reasoning. The Court found that the claims did not improve the functioning of the computer itself, nor did they effect a technical improvement in any other field of technology. The computer was used merely as a tool to perform an abstract economic concept. Therefore, the "Tangible" technical contribution was minimal, and the "Intensity" of any specific technical

effect beyond generic data processing was very low. The model's low scores here directly reflect the absence of a technical solution to a technical problem.

- Industrial Applicability (Exemplar Scores: Useful 5, Feasible 5):

The claimed method was certainly "Useful" in a commercial or economic sense for managing settlement risk, and its implementation on a computer was "Feasible." However, under Section 101 analysis, mere utility in a business context, without an inventive technical application, is insufficient to confer patent eligibility for an abstract idea. The model reflects this by potentially assigning moderate scores here, but these are insufficient to overcome very low scores in Technical Character and Inventive Step.

- Economic Significance (Policy-Oriented) (Exemplar Scores: Job Creation 3, Benefit 3):

While a system for mitigating settlement risk could have some economic "Benefit" by reducing counterparty risk in financial markets, the patenting of such a fundamental concept implemented generically on computers could also stifle competition and innovation in financial software if overly broad. The potential for widespread "Job Creation" directly from this specific patented method (as opposed to the broader financial industry) might also be assessed as moderate to low. The low scores here reflect a policy concern that patenting abstract ideas with generic computer implementation could have negative net economic effects by preempting basic commercial practices.

Overall Assessment using the Model:

Given the lack of substantial technical implementation beyond generic computing elements, and the claims being directed to a fundamental economic practice, the indicators under the "Technical Character" and "Inventive Step" dimensions scored particularly poorly. Consequently, the model would generate an overall score (ES_{total}) well below the approval threshold (e.g., ES_{total} l < 7.0), aligning with the Supreme Court's decision to invalidate the patent claims. The proposed model thus mirrors the Supreme Court's two-step approach by first identifying the abstract nature of the underlying concept and then finding an absence of a sufficient "inventive concept" that would transform it into a patent-eligible technical application. It reinforces the critical need for demonstrating technical specificity and an inventive application of an idea in the context of software patents, rather than merely claiming abstract processes performed by a general-purpose computer.

7.5 Benefits and Stakeholder Implications

The proposed five-dimensional examination model offers tangible benefits by directly addressing the challenges identified in current software patent examination practices. While fundamental legal reforms can be complex and time-consuming, implementing adjustments in examination procedures provides a more immediate and practical path towards improvement. This model, integrating aspects of novelty, inventive step, technical character, industrial applicability, and economic significance, systematically provides solutions to the previously identified problems:

1. **Addressing novelty and technical contribution:** The model utilises specific indicators like “Concrete” and “Specialty” under the Novelty dimension. This encourages examiners to assess not just whether the invention exists, but the nature of its newness – is it a tangible, well-defined advancement? Is it specialised beyond common knowledge? This structured assessment helps ensure the software component itself possesses genuine novelty, implicitly requiring it to play a primary, rather than merely incidental, role in the claimed invention.

2. **Clarifying invention efficacy:** Particularly relevant in the era of complex AI, the model's structure with five distinct aspects and ten specific indicators provides a clearer framework for identifying and evaluating the efficacy of software inventions. It moves beyond a simple yes/no to a more nuanced evaluation across dimensions critical to a valuable invention.

3. **Improving eligibility criteria and functional claiming:** The model's weighted scoring, specifically designed to reduce the impact of high-variance (low consensus) examiner scores, offers a more rational and robust criterion for assessing eligibility and functional claiming. By giving less weight to outlier opinions, it bases the outcome on points of stronger agreement, mitigating deficiencies in current practices where ambiguity can lead to inconsistent results. Achieving high consensus among examiners under this model thus becomes a strong indicator of a well-supported and less challengeable patent grant.

4. **Defining technical effect and character:** The “Tangible” and “Intensity” indicators within the Technical Character dimension provide concrete points for evaluation. Examiners are prompted to assess if the technical effect is real and substantial, addressing the persistent uncertainty surrounding what constitutes sufficient technical contribution, especially for

software managing industrial processes or controlling machinery where a clear technical outcome is paramount.

5. **Determination of the requirement of useful and concrete:** While case law offers guidance, the model provides practical tools. The “Useful” and “Feasible” indicators (Industrial Applicability) assess practical implementation, while “Job Creation” and “Benefit” (Economic Significance) consider real-world impact. Together, these help examiners identify and weigh the useful, concrete, and tangible characteristics required, especially in commercial or business method applications.

6. **Establishing quality metrics:** The model's five aspects and ten indicators serve as pertinent quality metrics, moving beyond mere technical function. They explicitly incorporate considerations like economic benefits, job creation, potential social welfare impacts, and industry reforms, providing a standardised basis for evaluating the broader contribution and overall quality of the software patent.

7. **Discouraging defensive patenting:** The inherent rigor of the model's scoring mechanism, particularly the modified weighting (Equation 5) where the sum of modification weights is less than 1, naturally raises the bar for patentability. This increased stringency helps filter out trivial patents, making it less attractive to accumulate patents solely for strategic or defensive purposes (like negotiation leverage or blocking competitors) rather than for genuine innovation.

8. **Enhancing precision and consistency:** By providing a definitive set of criteria and indicators, the model reduces the potential for arbitrary decisions and improves consistency among examiners. This is especially crucial in complex, cross-industry areas (like smartphones or IoT) where software patents are increasingly prevalent and clear standards are vital. For applicants, particularly SMEs, this increased predictability could reduce the uncertainty and costs associated with prosecuting software patent applications, allowing for more informed decisions about pursuing patent protection or other strategies like trade secret or open-source release.

9. **Improving re-examination efficiency:** The structured nature of the model makes it equally applicable to re-examination processes, ensuring consistency between initial review and subsequent challenges. Its framework allows for integrating results from different stages, and the clear

scoring threshold offers a potentially faster, more objective basis for handling challenges from market participants.

10. **Unifying terminology interpretation:** The explicitly defined aspects (novelty, inventive Step, etc.) and indicators (concrete, innovate, tangible, etc.) provide a structured vocabulary. This common language reduces confusion arising from synonyms or ambiguous terms during examination and subsequent prior art searches, facilitating clearer communication and evaluation.

11. **Strengthening patent claim inspection:** When a patent evaluated using this model is enforced or litigated, the detailed scores across all indicators provide a comprehensive and rigorous foundation for the grant decision. This transparent and structured reasoning makes the basis for the patent grant more convincing and defensible.

In summary, the proposed model assists patent examiners in more consistently and transparently determining patentability by systematically inspecting novelty, inventive step, industrial applicability, and technical character, ultimately ensuring the claimed invention produces a useful, concrete, and tangible result that meets robust quality standards.

7.6 Limitations and Future Refinements

While the proposed examination model aims to improve consistency and rigor within the existing framework, it is acknowledged that addressing the full spectrum of challenges in software patenting may ultimately require broader legal and statutory refinements. Adjusting examination procedures, as this model facilitates, is often more feasible in the short term than enacting legislative changes. However, for long-term coherence and effectiveness, the following legal aspects warrant consideration for future refinement[807]:

1. **Novel aspects and technical contribution:** Future legislation or guidelines should explicitly state that a patented software-containing system requires novel aspects within the software invention itself. Clear definitions for terms like “unprecedented” novelty and “indispensable” contribution proportion are needed, acknowledging the difficulty in establishing comprehensive software prior art databases. The line for software patent eligibility, especially in industrial or life science applications, needs explicit

[807] Mark H. Webbink, ‘A New Paradigm for Intellectual Property Rights in Software’ (2005) 2005(5) Duke Law & Technology Review 1.

demarcation based on novelty and contribution. In Europe, while the basic requirement is that an invention must be “new’, the EPO Guidelines for Examination (e.g., Part G, Chapter VI, referencing F-IV, 4.5-4.21) provide detailed guidance on assessing novelty in relation to technical problems, solutions, and computer programs, although these provisions can sometimes be seen as broad or vague. Future legislation or guidelines should explicitly state that a patented software-containing system requires novel aspects within the software invention itself. Clear definitions for terms like “unprecedented” novelty are needed.

2. **Identification of invention efficacy:** The rise of AI and complex algorithms necessitates clearer legal classification approaches. Future rules could better address the role of software (major or minor contributor), the specific treatment of machine learning components (perhaps guiding whether the system or just the algorithm is patentable), and firmer boundaries for business method patents. Developing standardised quantification methods or benchmarks for software efficacy could significantly aid examiners in making consistent judgments.

3. **Criteria of eligibility and functional claiming:** Building upon case law like *Alice*, legal standards could further clarify eligibility criteria. Consideration might be given to requiring demonstrated tested results for functional claims in software patents, proving sufficient efficacy in relevant applications, potentially differentiating them from past practices.

4. **Technical effect and character**: Patent legislation should be reconsidered to provide a more exhaustive definition or guidance on what constitutes a sufficient “technical effect” or “technical character,” especially for software managing industrial processes or controlling machinery.

5. **Determination of the requirement of useful and concrete:** While US and EPO practices offer guidance (e.g., *Alice* test, machine-or-transformation, technical problem/solution approach), further legislative clarification or harmonisation could reduce ambiguities for software and business method patents.

6. **Quality metrics:** Legislation could formally recognise or encourage the consideration of broader quality metrics based on societal benefits (economic impact, job creation, public health, etc.) when assessing patentability or inventive step, possibly by requiring such benefits to be stated in the description (akin to EPO Rule 42(1)(c) regarding advantages

for inventive step). In Europe, while the EPC does not explicitly require useful effects, advantageous technical effects stated in the description (as suggested by Rule 42(1)(c)) are often significant in determining the inventive step (as assessed under Guidelines Part G, Chapter VII, 5), potentially serving as implicit quality or technical character metrics.

7. **Elimination of patents used for defensive purposes:** To curb the proliferation of patents acquired mainly for strategic leverage, legal changes should aim to disincentivse purely defensive patenting. Establishing stricter, clearer patenting criteria across the board inherently increases the costs and effort associated with obtaining and maintaining patents, making low-quality or purely strategic patenting less attractive.

8. **Precise patentable criteria & examiner training:** To combat inconsistency, more definitive statutory criteria or binding judicial guidelines are essential. Crucially, this must be supported by mandatory, ongoing technical training for examiners to ensure they remain abreast of rapid technological developments and can apply criteria accurately to emerging software fields. Such training should ideally include exposure not only to new technologies but also to evolving industry practices, open-source development models, and the specific types of prior art prevalent in the software domain, enabling a more holistic assessment of novelty and inventive step.

9. **A more efficient re-examination process:** Legislative or procedural rules could mandate deadlines for re-examination and establish faster, clearer criteria for deciding challenges. Clarity is vital, especially when a decision might necessitate product removal from the market, requiring efficient and predictable procedures.

10. **Unified interpretation of terminology:** The confusion caused by varied and archaic software terminology hinders effective examination and prior art searching[808]. Developing a comprehensive, unified, and potentially global guideline set for software terminology is needed to overcome confusion caused by synonyms and archaic language, mitigating the impact of incomplete prior art systems. Initiatives like the development of common taxonomies or ontologies for software concepts, potentially through collaboration between patent offices and industry stakeholders, could be instrumental in achieving greater terminological consistency.

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[808] James Bessen and Robert M. Hunt, 'An Empirical Look at Software Patents' (2007) 16(1) Journal of Economics & Management Strategy 157.

11. **Patent claim inspection:** To address the complexity of verifying claims, particularly regarding inventive step for sophisticated software, consideration could be given to formalising the use of independent, third-party technical expertise. Such experts (acting perhaps as neutral assessors or notary agencies) could assist examiners in verifying claimed features and technical outcomes, potentially expediting examination for complex inventions.

These potential refinements highlight that while the proposed examination model offers significant procedural improvements, achieving a fully robust and predictable system for software innovation may require parallel evolution in underlying legal and statutory standards.

7.7 Globalisation Potential

As mentioned previously, adopting adjustments in the examination aspects to improve on the existing problems in patent approval is easier than making modifications in the legal aspects. Nevertheless, it is still necessary to gradually modify the statutes with reference to the proposals in Section 7.1.2, which are conducive to the globalisation of software patents. The model proposed in this thesis takes into account the software-related patent laws of the US and EU to meet all of the requirements for granting a software patent. Moreover, it also considers the problems in practice that they confront. Despite the culture difference between the two jurisdictions, it does not affect the function of the proposed model as the aspects and indicators employed here can be adjusted according to its level of importance. Hence, it can be effectively incorporated into the software patent examination mechanism in these two mainstream jurisdictions.

As mentioned in Section 7.1, the TRIPS Agreement sets out various minimum standards to protect all forms of IP. It established, mainly, the basic measures in the protection of intellectual property rights between the WTO members. The WTO represents the principle at international level to its large number of members. It should be even more cautious when establishing guides to a set of global standardised examination methods and standards to software inventions.The model proposed in this thesis provides a useful framework to WTO members which follow the patentability criteria set up in the TRIPS Agreement provisions.

However, achieving true globalisation faces hurdles beyond doctrinal alignment. Considerations like national interests, differing levels of technological

development, varying common law and civil law approaches to statutory interpretation, and diverse policy priorities regarding access to technology versus incentivising local innovation can all impede the adoption of a single, harmonised examination model[809]. Overcoming these requires not only a technically sound and adaptable model but also significant diplomatic effort and a willingness to accommodate legitimate national differences within a broadly consistent framework, recognising that TRIPS itself represents a baseline rather than complete harmonisation[810].

The globalisation of patentability standards for software patents can thus reduce the uncertainty of the entire trade market and reduce the number litigation, thus further encourage innovative activities by providing a worldwide harmonised patent standard. This model can also minimise the happening of patent trolls and strategic use of patents as it prevents granting trivial patents which hardly have valuable contribution to innovation. The model can be accepted by most countries. Therefore, it will facilitate to ensure a friendly environment for software developers and prevent companies that relies on software from get involved in competition issues. The useful software product will then be promoted to worldwide in the healthy market under the robust protection and circulation of patents.

[809] See, e.g., challenges discussed in 'The Impact of Globalization On Intellectual Property Law' (Lawyers of Distinction, 23 September 2024) https://www.lawyersofdistinction.com/the-impact-of-globalization-on-intellectual-property-law/.

[810] See 'Intellectual Property and the WTO: Understanding the TRIPs Agreement' (Dragotti e Associati, 12 November 2024) https://www.dragotti.com/en/intellectual-property-and-the-wto-understanding-the-trips-agreement/ (noting TRIPS establishes minimum standards).

Chapter 8

Conclusions and Recommendations

8.1 Findings

This thesis identifies that some of the procedural issues, difficulties, and lack of precision for software patentability determinations are linked to several interconnected problems:

(1) Businesses, particularly in the high-tech and software industries, must make careful assessments when formulating their business models and intellectual property strategies to maximize profits and protect innovation in a complex and often uncertain legal environment.

(2) There is a frequently articulated need, especially from the perspective of SMEs, for a patent system environment that offers lower costs, greater accessibility and easier to access, potentially including shorter and simpler patent application procedures and more affordable enforcement mechanisms. However, as discussed in Chapter 1, such reforms must be carefully balanced against the need to maintain patent quality and the integrity of the system.

(3) The determination of whether software should be protected by patent legislation or primarily by copyright must be based on a careful consideration of its substantial functions and the nature of the innovation it embodies, moving beyond its literal expression.

(4) A fundamental principle applicable to all intellectual property is that an inventor's proprietary claim must be precisely defined to be effectively asserted and respected, regardless of whether the asset is tangible or intangible.

(5) There is no compelling economic or social reason to grant a patent monopoly to a software invention if it is predictable that the societal benefits generated by the given software cannot reasonably offset the potential societal costs, such as those arising from restricted access or stifled competition.

(6) The question of whether a software patent should be granted often hinges, particularly in jurisdictions like Europe, on whether the invention, despite being software-implemented, enables a physical feature of an entity or the nature of an activity to perform a technical character or achieve a technical effect, rather than being a mere abstract concept.

(7) Determining whether to grant patent protection for software or not should take into consideration how well the claimed invention can meet demonstrable needs of human activities and contribute to useful technical knowledge.

(8) The current patent system, in its application to software in key jurisdictions, has often been found to lack sufficient clarity for potential patentees, sometimes resulting in unpredictable patent application outcomes and leading to legal uncertainty.

(9) Establishing clearer standards for software patent examination through updated guidelines, and ensuring that patent examiners are adequately trained in software technologies and the specific legal criteria applicable to them, is urgently needed to improve the consistency and quality of patent grants. Moreover, significant improvements in legal certainty might also necessitate broader doctrinal or even legislative clarifications when they are operating in the examination.[811]

Accordingly, this thesis argues that a refined and more tailored patentability criteria must be established and consistently applied to inspect the inventive step and technical effects of software patents and to make sure the claimed invention effectively satisfies the requirements of novelty and non-obviousness (inventive step) as stated in patent law.

The legal basis for assessing software patentability in most major countries was summarised in Chapters 5 and 6. Key principles emerging from this analysis indicate that for software to be considered patent-eligible, it typically must:

(1) produce a useful, concrete, and tangible result, and not be simply an abstract idea, mathematical algorithm, or a general principle without a specific practical application;

(2) if it primarily involves the arrangement of data structures, demonstrate that

[811] See, e.g., USPTO, Patent Examiner Training Program, Available at < https://www.uspto.gov/jobs/become-patent-examiner> accessed 29 May 2025.

this arrangement enables more efficient data processing operations or performs other valuable technical functions;

(3) if it combines with a law of nature or mathematical formula, show that this combination enables a particular technological function, with the invention being assessed as a whole;

(4) if it provides intricate and complex computer programming to achieve specific features (such as applications for the Internet or a cyber-market), demonstrate that these features represent a novel and non-obvious technical solution;

(5) produce a "further technical effect" that goes beyond the normal physical interactions between software and hardware (a key EPO criterion); and

(6) in some conceptualisations, satisfy requirements related to being a specific process, machine, manufacture, or transformation of matter that performs tangible functions.

Despite all these conditions that can lead to patent-eligible software having been concluded from existing jurisprudence and guidelines, it is not always easy for examiners and applicants to assess whether a particular software invention meets the above requirements consistently and predictably or not. An easier and more transparent assessment pathway is demanded for both patentees and the examiners in the patent office.

Software inventions are patentable both in theory and in legal practice in many key jurisdictions, but the patentability criteria for such inventions, when comparing systems like those of the US, EU, and considering principles from the WTO TRIPS Agreement, can still appear to be in a "grey" area or be applied with varying degrees of stringency and interpretation.[812] It is obvious that the assessment of technical features was taken by many countries as an essential element for patentability. With the progress of technology development and the enhancement of computer-implemented inventions, where defining non-obviousness has become harder than it used to be, inventive step inspection has assumed increasing importance.

In general, obtaining patents for certain types of software-related inventions in the EU has often been perceived as more difficult than in the US during certain historical periods, though both systems have faced challenges in achieving

[812] See, e.g., John R. Thomas, Pharmaceutical Patent Law (4th edn, Wolters Kluwer 2020).

consistency. Certainly, the patent provisions in other countries are implemented differently as they have to fit with the different backgrounds of culture, society, and economic needs.

The TRIPS Agreement sets various minimum standards to protect all forms of IP. However, if the patentability threshold applied by national offices is perceived as too low, it may not be able to play the proper role of "gatekeeper" as it is expected to be. Rather, granting too many patents of questionable validity has been argued to contribute to the problem of low-quality patents, particularly in fields like software where prior art can be difficult to locate and assess comprehensively.[813] Besides, the inconsistency of the software patentability standards in the world is also an underlying problem as it causes uncertainty in the marketplace and can result in more litigation. It may even inhibit new software inventions from entering the market. As discussed in Chapter 2, some patent developers or open-source advocates would prefer the status quo of easy accessibility to software rather than facing the legal uncertainty associated with software patents.[814] On the other hand, some software patents perceived to be of low quality are used as tools to gain unequal benefits which can damage fair competition in the market.[815] An effective patent examination system for software is crucial to prevent the granting of patents to vague claims with trivial contribution to knowledge. It is also a necessary regime to minimise uncertainty in patent law.

The analytical model proposed in Chapter 7, which assesses the patentability of software inventions based on several key dimensions, is useful for the evaluation of patent quality and for promoting a more structured examination approach. While, as reviewed in Chapter 7 (Section 7.1.3), previous researchers suggested relevant models correlating patent quality with various parameters such as research productivity in research and development, industrial applicability, economic benefits, examination results of patent applications, and technology-specific cross-country comparisons,[816] most of

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[813] See James Bessen and Michael J. Meurer, Patent Failure: How Judges, Bureaucrats, and Lawyers Put Innovators at Risk (Princeton University Press 2008) pp. 66-71.

[814] See, e.g., Richard M. Stallman, 'Why Patents Are Bad for Software', available at < https://simson.net/clips/1991/1991.IST.Software_Patents.pdf> accessed 29 May 2025.

[815] See Federal Trade Commission, To Promote Innovation: The Proper Balance of Competition and Patent Law and Policy (October 2003) Chapter 3, pp. 38-53. Available at < https://www.ftc.gov/sites/default/files/documents/reports/promote-innovation-proper-balance-competition-and-patent-law-and-policy/innovationrpt.pdf> accessed 29 May 2025.

[816] The discussion of prior patent quality models by Lanjouw and Schankerman, Hido *et al.*, Song and Li, and Boeing and Mueller is detailed in Chapter 7, Section 7.1.3 of this thesis,

these existing models were not primarily designed for the *ex ante* examination of new patent applications, particularly with the specific nuances of software in mind. The examination model specifically tailored for the patent application of software inventions has remained a developing area. In addition, some of these published models employed weighting methods in their formulae to emphasise the contribution or significance of some aspects of an invention as well as using parameters to estimate a final effect or result. However, some software developers may not be able to easily access the detailed rationale or empirical basis for the acquisition of the weight coefficients used in some prior academic or proprietary study models, where this process is usually the first step for quantifying the quality of patent applications. Indeed, when the assigned values of weights or indexes lack a transparent and broadly acceptable basis or source, it makes the model difficult to be applied widely. Therefore, the model established in this thesis (Chapter 7) aims to provide a more transparent and doctrinally grounded framework, even if the precise "weighting" in its application remains a matter for careful implementation by patent offices.

Further key findings emerging from the comprehensive literature review (Chapter 2) and the doctrinal and comparative analyses undertaken in this thesis (Chapters 4, 5, and 6) highlight persistent challenges and areas of contention within the existing software patent landscape. These findings underscore the complexities that the proposed examination model in Chapter 7 aims to mitigate:

- **The Role and Definition of Software in Patent Claims:** A recurring finding is the difficulty in consistently determining the precise contribution and inventive role of a software element within a broader patented system. Questions persist regarding whether the software component constitutes the primary inventive concept or merely a secondary element implementing a broader (potentially non-novel) idea. This ambiguity affects claim clarity and the assessment of inventive step.
- **The *Sui Generis* Nature of Software and Patentability Assessment:** This thesis confirms the widely held view in the literature that software possesses unique characteristics that differentiate it from traditional patentable subject matter (as discussed in Section 2.7). This study proposes a refined examination model within the existing patent framework rather than a completely new *sui generis* legislative right. The findings

along with their respective citations.

indicate that effectively assessing software requires an approach that is highly sensitive to these unique attributes.

- **Defining "Technical Character," "Further Technical Effect," and "Technical Contribution"**: A significant finding is the enduring challenge in establishing clear, universally applicable definitions and consistent application of terms like "technical character," "further technical effect" (especially in EPO practice), and "technical contribution" when applied to software inventions. While case law provides examples, legal uncertainty remains due to the lack of precise legislative definitions.
- **Criteria for Efficacy and Value in Software Inventions:** The thesis notes that while the technical effect of software in managing industrial processes or controlling machinery is often a key consideration, there is a lack of standardised criteria to evaluate the "efficacy" or "value" and consistently distinguishes patent-eligible inventions from routine or trivial applications.
- **Patentability of Software Implementing Business Methods:** The patentability of software that implements business methods remains a contentious area. A key finding is the difficulty in consistently identifying whether a mathematical algorithm underlying a business method, when implemented in software, achieves a genuinely "useful, concrete, and tangible result" that transcends the abstract business concept itself.
- **Quality Metrics for Software Patents**: The research highlights that assessing the "quality" of software patents is complex and often lacks standardised metrics that go beyond mere technical feasibility. Factors such as broader economic impact, job creation, public health benefits, or societal welfare are not systematically integrated into the patentability assessment in most jurisdictions, though they are relevant to the overall aims of the intellectual property system.
- **Defensive Patenting in the Software Industry:** The literature review and analysis suggest that the phenomenon of acquiring patents primarily for strategic leverage or to deter litigation rather than for active commercialisation is a notable feature in the software industry. However, quantifying whether the rate of purely defensive patenting for software is definitively higher than in other sectors, and fully assessing its net impact on innovation, presents considerable empirical challenges beyond the scope of this doctrinal study.

- **Impact of Patentable Thresholds on Market Dynamics:** A finding, supported by literature, is that perceived lower or ambiguous patentable thresholds can influence market behaviour, potentially enabling the strategic use of patents in ways that affect competition. The relationship between these thresholds and the dynamics of innovation requires careful consideration.
- **Re-examination Processes and Prior Art Challenges:** While re-examination processes exist, this thesis notes the ongoing discussion in the literature regarding their optimal efficiency and whether they fully address the unique challenges of software prior art. The difficulty in finding and applying relevant prior art for software due to its often non-traditional documentation and rapid evolution, as discussed in Chapter 6, remains a fundamental issue impacting both initial examination and post-grant review. The America Invents Act (AIA) introduced mechanisms like *Inter Partes* Review (IPR) in the US, which have been frequently used to challenge software patent validity; however, their optimal effectiveness and interaction with court litigation continue to be analysed and debated.
- **Confirming Efficacy of Claimed Software Inventions:** A persistent challenge identified is how to effectively confirm that a claimed software invention actually performs as described and achieves the purported technical results or efficacy, especially when the underlying mechanisms are complex or opaque ("black box"). This verification is crucial for ensuring that patents are granted for workable and genuinely inventive solutions.

The current classification approaches for software inventions do not always provide sufficient clarity to fully cope with dynamic technological developments. The criteria for eligibility and functional claiming still exhibit deficiencies in consistent application. This thesis has underscored the necessity of establishing more definitive criteria for both examiners and patentees. The increasing distribution of software patents across diverse industries further highlights the need for robust and adaptable patentability assessment.

Software, as this research has consistently argued, should not be treated as an ordinary kind of invention solely because its inventive aspects are not always "incarnated as a physically examinable invention" in the traditional sense, or because its core functions may be "hidden behind an apparatus in the form of a program language." A set of commonly accepted guidelines or approaches for achieving concrete and understandable results when determining the

patentability of computer software must take into account the peculiar structures of various patent systems worldwide, even though establishing such harmonised guidelines is admittedly difficult and time-consuming.

8.2 Conclusions

Software inventions can be legitimately protected by patents, rather than solely by copyright, when the invention embodies a functional result stemming from inventive intellectual efforts and provides a technical solution to a technical problem. It is evident that, according to the patent law in most patent systems worldwide, an abstract idea is not patentable. A software patent must demonstrate the characteristics of novelty, inventive step (non-obviousness), and industrial applicability to produce a useful, concrete, and tangible result. This thesis emphasises the need for a workable and consistent way to investigate these conditions, including the establishment of clearer identification criteria on how to determine the requisite technical effects that would satisfy the requirements of novelty and non-obviousness in software patentability. The literature review (Chapter 2) and analysis of patent system challenges (e.g., Chapter 6) have shown that the rapid growth of software patents has, at times, raised concerns among practitioners and policymakers,[817] particularly regarding the granting of patents for what are perceived as trivial technological advancements, which may make it difficult for subsequent inventors and firms to access or build upon critical technology they need. In response to the above issues, this study conducted a discussion on the legitimacy and appropriate scope of software patenting in the current knowledge age. Furthermore, this study sought to identify a mechanism to address the dual nature of software as both a technology and a form of writing, thus aiming to avoid the cycle of potential overprotection and under-protection.

Whether a software invention satisfies the patentability requirements stated in patent law should be examined prudently. A set of clearer definitions for key legal terms in patent law and more consistent examination practices shall be pursued to avoid the issuance of low-quality software patents, which may become obstacles and create lost opportunities for later researchers. A well-functioning patent system can also ensure protection for inventions that genuinely contribute to technology as well as provide societal benefits. For doing so, software should not necessarily be treated as an ordinary kind of

[817] This observation regarding concerns among practitioners and policymakers about the impact of certain software patents is supported by literature reviewed in Chapter 2

invention that can always be straightforwardly assessed by traditional physical examination, given that its core inventive aspects are often functional and less tangible.

In this thesis, the research has discussed on the legitimacy of software patents in the knowledge age and concluded that appropriately defined software inventions, particularly those demonstrating a clear technical contribution, are indeed worthy of effectively protected by patents. It also analysed the importance and varying approaches to software patents in different jurisdictions around the world, especially in the US and EU. According to the observation of merits and shortcomings in each jurisdiction, the problems remaining for improvement in each individual patent system are often particularly manifest in the context of software patents.

Given that the issuance of patents perceived to be of low quality or that confer unequal benefits to innovation have, as discussed in Chapters 2 and 6, been shown to potentially harm competition, this work started from an examination of the scope of patent protection to identify principles that could prevent the granting of patents to vague claims with trivial contribution to knowledge and thus minimise uncertainty in patent law. In addition, with the aim of ensuring the patent system moves toward a form of intellectual property protection that effectively satisfies the needs of human activities and technological advancement, this thesis embarked on research toward this ongoing, rather than definitively "not-yet-achieved," goal; especially in the investigation of an improved examination mechanism for software inventions. It investigated methods for improving the assessment of such inventions from both doctrinal and comparative legal aspects, and proposed improvement strategies through the development of a structured examination model.

Taking full account of the findings from the preceding chapters, a workable examination model for software inventions was proposed by this study in Chapter 7. Due to the fact that most previously published relevant models addressing patent quality or examination had limitations (as reviewed Section 7.1.3), such as their assigned values of weights and indexes lacking a sufficiently transparent or universally acceptable basis or source, therefore making those systems difficult to use widely for *ex ante* patentability assessment by examiners, the model proposed in this thesis describes in detail its conceptual framework, evaluative dimensions, and specific indicators, emphasising doctrinal grounding and adaptability rather than fixed numerical weights. In inspecting the patentability of a software invention, five core

evaluative aspects were included in the proposed model for examination. They are novelty, inventive step (non-obviousness), technical character, industrial applicability, and economic significance. In order to take each aspect into account systematically, two illustrative indicators are selected under each aspect to guide the patent examination of a software invention. The indicators selected are based on a consideration of their representativeness for each aspect and their potential to fit with the patent laws of most countries. By applying this patent granting system, it assists patent examiners in generating more standardised measurements and reasoned justifications when assessing the patentability of a software invention.

Three illustrative situations were analysed in Chapter 7 to conduct an in-depth exploration of how the proposed model might be applied and to assess its potential impact on determining patentability. The results show that this model can pertinently determine the level of patentability of a software invention. Since this model allows for nuanced assessment rather than relying on overly simplistic metrics, it can help to ensure that the examination is rigorous. In this model, the variance of scores among examiners for the same indicator plays a significant role in highlighting areas of potential ambiguity or disagreement. An approved patent ideally has a highly consensual result (low variance of scores) in examination that is reasonable and necessary. An approved patent that does not receive the results of a highly consensual examination may have a higher possibility of triggering litigation in the future. The grant ratio is expected to be very low in a low consensus examination (among different examiners). Therefore, the professional training and quality of examiners are very important for effectively conducting examination under this or any structured model. Generally speaking, the overall outcome of an examination is less likely to be skewed when the number of examiners is sufficient, though dramatically reducing the number of examiners involved in assessing complex inventions could compromise the robustness of the examination model. Thus, it is important to maintain an adequate number and consistent application by examiners as much as possible on each indicator.

Finally, the results of applying the model to case studies in Chapter 7 show that some insights into the hidden problems in software patent assessment (identified, for example, in Chapter 6) can be addressed or mitigated through the operation of the proposed model. Hence, this model can assist in determining whether claimed software patents have the characteristics required for patenability.

8.3 Limitations and Future work

The patentability of software is not inherently controversial in all its forms; rather, it is the application of existing patent law that has often proven problematic when dealing with it. This thesis has expounded the relationship between the evolution of technology, computer-implemented inventions (mainly concentrating on software inventions), and patent law in Chapter 5, and discussed the problems associated with such inventions and the potential issues within the patent system in Chapter 6. In addition, a *sui generis* approach to the examination model for software inventions was suggested in Chapter 7. However, patent law is an intellectual property field that is highly sophisticated, and some related subjects still warrant further in-depth investigation. The following sections describe the short-term and long-term research plans that could be pursued in the future:

8.3.1 Short-Term Research Plans

In the short-term, the following work could be undertaken to build upon the topics that have been conducted in this thesis. Such subsequent work can make the results of this thesis even more substantial complete:

1. Conducting further empirical analysis and comparative statistics on software patenting trends in different countries. This could involve investigating questions such as what is the future of communication technology patenting in a given country? (Data for this could potentially be drawn from company annual reports, national department of trade statistics, economic databases, and national patent offices); Is patent law demonstrably responsible for any observed decline in sales of computerised devices (e.g., smartphones)? Is any such decline a short-term or long-term phenomenon attributable to patent system effects?

2. Moreover, the inconsistent determination of patent eligibility for software within the current patent system remains a problem. To further address this problem, continued efforts towards greater international cooperation and dialogue, potentially leading to soft-law instruments or shared best practices rather than immediate, binding international legislative changes, could be beneficial. This is to mitigate conflicts among different countries which can lead to laborious and costly parallel patent applications and enforcement actions. Therefore, how to deal with patent law conflict at the international level should be considered seriously.

3. The ongoing development and impact of the Unified Patent Court (UPC) in Europe is also a timely topic to monitor. Can this system bring advantages or disadvantages to patentees who are willing to utilise patents internationally? When compared with the US, where there are specialised patent bar and long-standing Federal Circuit jurisprudence for patent cases, can the UPC contribute to establishing a more robust, coherent patent system in Europe in the coming years, particularly for computer-implemented inventions?

8.3.2 Long-Term Research Plans

With regard to the long-term improvement of patent law and its application to software, the following subjects are particularly worthy of further research:

1. AI will be increasingly important in the future and is beneficial to the convenience of society. The cooperation of enterprises in the AI era is getting important, too. Trading these inventions requires financial funds as well as clear intellectual property frameworks for negotiation and cooperation. If AI-related inventions are not protected properly or are over-protected, creating access barriers, it would be hard to achieve these societal and economic goals. Exploring new beneficial cooperation models and the legal issues, especially intellectual property law, surrounding the creation, ownership, and dissemination of AI-generated or AI-assisted software inventions will be critical.

2. The subject of patent law in the context of the rise of developing countries like China and India is also worth exploring in detail. Will their evolving intellectual property systems and innovation strategies significantly change the pattern of international technology transfer and global innovation dynamics? What are the particular issues or emphases in their approach to software patentability?

Appendix: List of Abbreviations

AIA (America Invents Act)

AI (Artificial Intelligence)

AIPLA (American Intellectual Property Law Association)

APIs (Application Programming Interfaces)

CIIs (Computer-Implemented Inventions)

CJEU (Court of Justice of the European Union)

CPC (Cooperative Patent Classification)

DL (Deep Learning)

EPC (European Patent Convention)

EPO (European Patent Office)

FTC (Federal Trade Commission)

GUIs (Graphical User Interfaces)

IDD (Inevitable Disclosure Doctrine)

IPR (*Inter Partes* Review - US)

ISRs (International Search Reports)

IoT (Internet of Things)

LLMs (Large Language Models)

ML (Machine Learning)

NPE (Non-Practicing Entity)

PCT (Patent Cooperation Treaty)

PHOSITA (Person Skilled in the Art)

PQI (Patent Quality Index)

S/SD (Sustainability/Sustainable Development)

SaaS (Software-as-a-Service)

SMEs (Small and Medium Enterprises)

SSO (Structure, Sequence, and Organisation)

TRIPS Agreement (Agreement on Trade-Related Aspects of Intellectual Property Rights)

UPC (Unified Patent Court)

USCO (US Copyright Office)

USPTO (United States Patent and Trademark Office)

WIPO (World Intellectual Property Organization)

WTO (World Trade Organization)

BIBLIOGRAPHY

Primary Sources:

List of Statutes

International Treaties and Agreements

Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS Agreement), Apr. 15, 1994, Marrakesh Agreement Establishing the World Trade Organization, Annex 1C, 1869 U.N.T.S. 299.

Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS Agreement), Art 39(2).

Berne Convention for the Protection of Literary and Artistic Works, Sept. 9, 1886, as last revised at Paris, July 24, 1971, and amended on Sept. 28, 1979, S. Treaty Doc. No. 99-27, 828 U.N.T.S. 221.

European Patent Convention (EPC) (Convention on the Grant of European Patents), Oct. 5, 1973, 1065 U.N.T.S. 199 (as amended).

Patent Cooperation Treaty (PCT), June 19, 1970, 28 U.S.T. 7645, 1160 U.N.T.S. 231 (as amended).

EU Legislation and Official Documents

Council Regulation (EC) No 6/2002 of 12 December 2001 on Community designs, OJ L 3, 5.1.2002, p. 1–24.

Directive 2006/116/EC of the European Parliament and of the Council of 12 December 2006 on the term of protection of copyright and certain related rights, Article 1.

Directive 2009/24/EC of the European Parliament and of the Council of 23 April 2009 on the legal protection of computer programs (codified version), OJ L 111, 5.5.2009, p. 16–22.

Directive (EU) 2016/943 of the European Parliament and of the Council of 8 June 2016 on the protection of undisclosed know-how and business information (trade secrets) against their unlawful acquisition, use and disclosure, OJ L 157, 15.6.2016, p. 1–18.

Directive (EU) 2019/790 of the European Parliament and of the Council of 17 April 2019 on copyright and related rights in the Digital Single Market and

amending Directives 96/9/EC and 2001/29/EC, OJ L 130, 17.5.2019, p. 92–125.

European Commission, “Copyright in the Digital Single Market” (Proposal for a Directive, COM(2016) 593 final, 14 September 2016).

European Commission, “Industrial design protection” [https://single-market-economy.ec.europa.eu/industry/intellectual-property/industrial-design/industrial-design-protection_en] accessed 15 May 2025.

European Patent Convention (EPC), Art 52(2)(c).

European Patent Office (EPO), *Guidelines for Examination in the European Patent Office* (March 2024). [https://www.epo.org/en/legal/epc/guidelines] accessed 29 May 2025

European Patent Office (EPO), *Patent Index 2023* (EPO March 2024). [https://www.epo.org/en/about-us/annual-reports-statistics/statistics/patent-index-2023] accessed 29 May 2025.

US Legislation and Official Documents

U.S. Const. art. I, Section 8, cl. 8.

35 USC Section 101 (Defininig patentable subject matter).

35 USC Section 102 (Novelty).

35 USC Section 103 (Non-obvious subject matter).

35 USC Section 112 (Specification).

35 USC Section 171 (Patents for designs).

35 USC Section 284 (Damages).

17 USC Section 102(b) (Copyright Act - Subject matter of copyright: In general).

17 USC Section 302.

18 USC Section 1839(3) (Defend Trade Secrets Act - Definitions).

U.S. Copyright Office, *Compendium of U.S. Copyright Office Practices* (3rd edn, 2021). [https://www.copyright.gov/comp3/] accessed 28 May 2025.

U.S. Copyright Office, “Copyright Registration Guidance: Works Containing Material Generated by Artificial Intelligence', 88 Fed. Reg. 16190 (March 16, 2023).

U.S. Patent and Trademark Office (USPTO), *2019 Revised Patent Subject Matter Eligibility Guidance*, 84 Fed. Reg. 50 (Jan. 7, 2019).

U.S. Patent and Trademark Office (USPTO), *General information concerning patents*. [https://www.uspto.gov/patents/basics/general-information-concerning-patents] accessed 15 May 2025.

U.S. Patent and Trademark Office (USPTO), *Inventorship Guidance for AI-Assisted Inventions*, 89 Fed. Reg. 10043 (February 13, 2024).

U.S. Patent and Trademark Office (USPTO), *Patent Examiner Training Program*. [https://www.uspto.gov/jobs/join-us/patent-examiner-training-program] accessed 29 May 2025.

U.S. Patent and Trademark Office (USPTO), *2024 Guidance Update on Patent Subject Matter Eligibility, Including on Artificial Intelligence* (July 2024). [https://www.uspto.gov/sites/default/files/documents/ai-sme-update-2024.pdf] accessed 15 May 2025.

See U.S. Patent and Trademark Office (USPTO), The Artificial Intelligence Patent Dataset — 2023 Update (February 2024)

UK Legislation and Official Documents

Patent Act 1977 (UK).

Trade Secrets (Enforcement, etc.) Regulations 2018 (SI 2018/597) (UK).

UK Intellectual Property Office, *Artificial Intelligence and Intellectual Property: copyright and patents: Government response to consultation* (June 2022, updated February 2024). [https://www.gov.uk/government/consultations/artificial-intelligence-and-intellectual-property-copyright-and-patents/outcome/artificial-intelligence-and-intellectual-property-copyright-and-patents-government-response-to-consultation] accessed 15 May 2025.

UK Intellectual Property Office, *Trade secrets: An overview* (UK IPO Guidance, last updated 10 January 2023). [https://www.gov.uk/government/publications/trade-secrets/trade-secrets-an-overview] accessed 29 May 2025.

Other Countries

Computer Program Protection Act (South Korea).

Patent Act (Japan Patent Act).

Patent Law of the People's Republic of China.

Patentgesetz (PatentG) (German Patent Act), Section 1(1), Section 1(3).

List of Cases

Aerotel Ltd v Telco Holdings Ltd & Ors Rev 1 [2006] EWCA Civ 1371, [2007] RPC 7.

Alice Corp. Pty. Ltd. v. CLS Bank Int'l, 573 U.S. 208 (2014).

Bilski v. Kappos, 561 U.S. 593 (2010).

Case C-406/10 SAS Institute Inc v World Programming Ltd [2012] 3 C.M.L.R. 4.

Computer Associates Int'l, Inc. v. Altai, Inc., 982 F.2d 693 (2d Cir. 1992).

DDR Holdings, LLC v. Hotels.com, L.P., 773 F.3d 1245 (Fed. Cir. 2014).

Diamond v. Chakrabarty, 447 U.S. 303 (1980).

Diamond v. Diehr, 450 U.S. 175 (1981).

Enfish, LLC v. Microsoft Corp., 822 F.3d 1327 (Fed. Cir. 2016).

Feist Publications, Inc. v. Rural Telephone Service Co., 499 U.S. 340 (1991).

Google LLC v Oracle America Inc 593 US 1 (2021).

Gottschalk v. Benson, 409 U.S. 63 (1972).

HTC Europe Co Ltd & Ors v Apple Inc [2013] EWCA Civ 451.

In re Alappat, 33 F.3d 1526 (Fed. Cir. 1994) (en banc).

In re Bilski, 545 F.3d 943 (Fed. Cir. 2008) (en banc).

KSR Int'l Co. v. Teleflex Inc., 550 U.S. 398 (2007).

Mayo Collaborative Services v. Prometheus Laboratories, Inc., 566 U.S. 66 (2012).

Nautilus, Inc. v. Biosig Instruments, Inc., 572 U.S. 898 (2014).

Oracle America, Inc. v. Google Inc., 750 F.3d 1339, 1381 (Fed. Cir. 2014).

Parker v. Flook, 437 U.S. 584 (1978).

Pension Benefits System Partnership, T 0931/95 [2001] O.J. E.P.O. 441.

PepsiCo, Inc. v. Redmond, 72 F.3d 1262 (7th Cir. 1995).

Programs for computers, G 3/08 [2011] O.J. E.P.O. 10.

SAS Institute Inc. v. World Programming Ltd, Case C-406/10, ECLI:EU:C:2012:259, [2012] 3 C.M.L.R. 4.

State Street Bank & Trust Co. v. Signature Financial Group, Inc., 149 F.3d 1368 (Fed. Cir. 1998).

Symbian Ltd's Application [2008] EWCA Civ 1066, [2009] RPC 1.

T 0136/08 (Circuit simulation/INFINEON TECHNOLOGIES) of 23.3.2010 (EPO).

T 0154/04 (Duns Licensing/Esti) [2008] O.J. E.P.O. 46.

T 0208/84 (VICOM/Computer-related invention) [1987] O.J. E.P.O. 14.

T 0258/03 (Hitachi/Auction method) [2004] O.J. E.P.O. 575.

T 0641/00 (Two identities/COMVIK) [2003] O.J. E.P.O. 352.

T 1173/97 (Computer program product/IBM) [1999] O.J. E.P.O. 609.

T 1227/05 (Circuit simulation I/INFINEON TECHNOLOGIES) of 12.9.2006 (EPO).

T 1615/17 (Classification/HUAWEI) of 15.6.2021 (EPO).

Thaler v. Vidal, 43 F.4th 1207 (Fed. Cir. 2022), cert. denied, 143 S. Ct. 1783 (2023).

G 1/19 (Pedestrian simulation) [2021] O.J. E.P.O. A69 (EPO Enlarged Board of Appeal).

Literature Sources:

Abbott, Ryan. The Reasonable Robot: Artificial Intelligence and the Law. Cambridge: Cambridge University Press, 2020.

ACT | The App Association and Deloitte, “The App Economy in Europe” (Report, 2022) 5–6 <https://actonline.org/app-economy-europe-2022>\ accessed 20 May 2025.

Adler, Michael. "The Emperor Julian and the Jews." Jewish Quarterly Review, o.s. 5.4 (July 1893): 591-651.

Al-Adwan, A. A. H., M. A. Al-Adwan, and J. S. S. Al-Adwan. “Heads down, worlds apart: A study of student perceptions and experiences with phone use in social interactions.” European Journal of Investigation in Health, Psychology and Education 14(1) (2024): 130-145. [https://www.ejimed.com/download/heads-down-worlds-apart-a-study-of-

student-perceptions-and-experiences-with-phone-use-in-social-15731.pdf] accessed 28 May 2025.

Allison, John R., Mark A. Lemley, and David L. Schwartz. “Our Divided Patent System.” University of Chicago Law Review 82(6) (2017): 1073-1145.

Almeling, David S., Darin W. Snyder, Michael Sapoznikow, Whitney E. McCollum, and Jill E. Weader. “A Statistical Analysis of Trade Secret Litigation in State Courts.” Gonzaga Law Review 46(1) (2011): 57-101.

Attridge, Daniel J. M. “Challenging Claims! Patenting Computer Programs in Europe and the USA.” Intellectual Property Quarterly (IPQ) 1 (2001): 1-32.

Bainbridge, David I. Intellectual Property. 6th edn. Harlow: Pearson, 2014.

Bainbridge, David. “Court of Appeal parts company with the EPO on software patents.” Computer Law & Security Review 23(3) (2007): 200-206.

Bakels, Reinier B. “Software Patentability: What Are the Right Questions?” European Intellectual Property Review (EIPR) 31(10) (2009): 515-523.

Bakels, Reinier B. “The Patentability of Computer-Implemented Inventions in Europe.” University of Amsterdam, Institute for Information Law (IViR), Working Paper, 18 January 2023. [https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4329030] accessed 22 May 2025.

Banakar, Reza, and Max Travers, eds. Theory and Method in Socio-Legal Research. Oxford: Hart Publishing, 2005.

Baron, Justus, and Henry Delcamp. “The Rationale for Patent Portfolio Races in Standards.” Working Paper, Northwestern University Pritzker School of Law, Searle Center on Law, Regulation, and Economic Growth, April 2020. [https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3584152] accessed 29 May 2025.

Bessen, James, and Michael J. Meurer. Patent Failure: How Judges, Bureaucrats, and Lawyers Put Innovators at Risk. Princeton, NJ: Princeton University Press, 2008.

Bronwyn H. Hall and Rosemarie Ham Ziedonis, 'The Patent Paradox Revisited: An Empirical Study of Patenting in the U.S. Semiconductor Industry, 1979-1995' (2001) 32(1) RAND Journal of Economics 101

Brunner, Alexander, *et al.* “Patentability of Computer-Implemented Inventions in Europe.” Intellectual Property Magazine, 1 October 2012. [https://www.intellectualpropertymagazine.com/patent/patentability-of-

computer-implemented-inventions-in-europe-105066.htm] accessed 29 May 2025.

Burk, Dan L., and Mark A. Lemley. The Patent Crisis and How the Courts Can Solve It. Chicago: University of Chicago Press, 2009.

Carl Shapiro, 'Navigating the Patent Thicket: Cross Licenses, Patent Pools, and Standard Setting' (2001) 1 Innovation Policy and the Economy 119.

Cass, Ronald A. "Lessons from the Smartphone Wars: Patent Litigants, Patent Quality, and Software." Minnesota Journal of Law, Science & Technology 16(1) (2015): 1-68.

Castells, Manuel. The Rise of the Network Society. 2nd edn. Malden, MA: Wiley-Blackwell, 2010.

Charles V. Trappey, Amy J.C. Trappey, and Yu-Hui Wang, 'Are Patent Trade Wars Impeding Innovation and Development?' (2016) 46 World Patent Information 64.

Chesbrough, Henry. Open Innovation: The New Imperative for Creating and Profiting from Technology. Boston, MA: Harvard Business Press, 2003.

Chien, Colleen V., and Michael Risch. "Recalibrating Patent Trolls: An Empirical Study of the Effect of Patent Pledges on NPE Litigation." Iowa Law Review (forthcoming, 2024). (SSRN pre-print version: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4549093 accessed 28 May 2025).

Choudhary, Vaibhav. "The Patentability of Software Under Intellectual Property Rights: An Analysis of US, European and Indian Intellectual Property Right." European Intellectual Property Review (EIPR) 33(7) (2011): 434-446.

Christofides, Antonis. "Software patents in Europe." FFII (2010). [http://swpat.ffii.org/int/intro/index.en.html] accessed 12 September 2015.

Chynoweth, Paul. "Advanced research methods in the built environment." In Advanced Research Methods in the Built Environment. Edited by Andrew Knight and Les Ruddock, 28-35. Chichester: Wiley-Blackwell, 2008.

Cohen, Lauren, Umit G. Gurun, and Scott Duke Kominers. "Patent Trolls: Evidence from Targeted Firms." NBER Working Paper No. w22740, updated January 2024. [https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2843710] accessed 29 May 2025.

Colella, Domenico, and Francesca Besemer. “Patentability of commercial methods and limits on distributing music via internet – the Italian and international situations.” Entertainment Law Review (Ent. L.R.) 22(1) (2011): 44-49.

Cong. Research Serv., Patent-Eligible Subject Matter Reform: Background and Issues for Congress, R45918 (2023).

Cotropia, Christopher A., Jay P. Kesan, and David L. Schwartz. “Unpacking Patent Assertion Entities (PAEs).” Minnesota Law Review 99 (2015): 649-710. Available at: https://scholarship.law.umn.edu/mlr/165/ accessed 29 May 2025.

Cundiff, Victoria A., and Jonathan L. Shapiro. “"Reasonable [Cybersecurity] Measures" for Digital Trade Secrets: Lessons from Marketing.” IDEA: The Law Review of the Franklin Pierce Center for Intellectual Property 66 (2025): 40. Pre-print available at: https://scholars.unh.edu/cgi/viewcontent.cgi?article=1511&context=law_facpub accessed 15 May 2025.

Davies, Simon. “Searching Computer-Implemented Inventions: The Truth Is Out There.” European Intellectual Property Review (EIPR) 29(3) (2007): 89-94.

Drexl, Josef. “Patenting Software-Related Inventions at the European Patent Office—A Review of the Case Law of the Boards of Appeal.” GRUR International 111(12) (2022): 1087-1100. [DOI: https://doi.org/10.1093/grurint/ikac100] accessed 22 May 2025.

Dyson, Esther, George Gilder, George Keyworth, and Alvin Toffler. “Cyberspace and the American Dream: A *Magna Carta* for the Knowledge Age.” Release 1.2. Progress & Freedom Foundation, 22 August 1994. [https://www.eff.org/files/publications/IP/PFF/pff_magna_carta.txt] accessed 28 May 2025.

Essig, Lincoln S., and Damien Howard. “Impact of the USPTO Examination Guidelines on software patents post-Alice.” Knobbe Martens (blog post), 20 September 2016. [https://www.knobbe.com/news/2016/09/impact-uspto-examination-guidelines-software-patents-post-alice] accessed 29 May 2025.

European Commission, 'SMEs and Intellectual Property Rights' (2019).

European Parliament. AI and copyright: The training of general-purpose AI. Briefing, EPRS_ATA(2025)769585, February 2025.

[https://www.europarl.europa.eu/RegData/etudes/ATAG/2025/769585/EPRS_ATA(2025)769585_EN.pdf] accessed 15 May 2025.

Federal Trade Commission (FTC). To Promote Innovation: The Proper Balance of Competition and Patent Law and Policy. Report, October 2003. [https://www.ftc.gov/sites/default/files/documents/reports/promote-innovation-proper-balance-competition-and-patent-law-and-policy/innovationrpt.pdf] accessed 29 May 2025.

Ferrill, Sarah E., Kelly J. Horn, William G. Neer, and Troy L. Viger. "Design patent law in the United States." In Research Handbook on Design Law. Edited by Dana Beldiman, 293-336. Cheltenham: Edward Elgar Publishing, 2024.

Fisch, J. E., *et al.* "An Analysis of China's Citation Lag." Queen Mary Journal of Intellectual Property 5(3) (2015): 294-315.

Forbes, Forbes 2025 Billionaires List - The Richest People In The World Ranked (2025).

Fox, Nicolas, and William Corbett. "UK and EPO Approaches to Excluded Subject-Matter and Inventive Step: Are Aerotel and Pozzoli Heading for the Rocks?" European Intellectual Property Review (EIPR) 31(9) (2009): 463-471.

Frankel, Susy. TRIPS Flexibilities and the TPP: Are Too Many Options a Good Thing? Victoria University of Wellington Legal Research Paper No. 23/2017, 2017. [https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3033792] accessed 28 May 2025.

Frumkin, Maximilian. "The Origin of Patents." Journal of the Patent Office Society 27(3) (March 1945): 143-177.

Garbie, Ibrahim H. "Incorporating Sustainability/Sustainable Development Concepts in Teaching Industrial Systems Design courses." Procedia Manufacturing 8 (2017): 417–423.

Gervais, Daniel J. "(Re)structuring Intellectual Property." UC Irvine Law Review 10(5) (2020): 1345-1386. [https://scholarship.law.uci.edu/ulr/vol10/iss5/4/] accessed 28 May 2025.

Gervais, Daniel. "The Machine as Author." Iowa Law Review 105 (2020): 2053-2104.

Ghidini, Gustavo, and Emanuela Arezzo. "Patent and copyright paradigms vis-à-vis derivative innovation: the case of computer programs." IIC -

International Review of Intellectual Property and Competition Law 36(2) (2005): 159-181.

Ginsburg, Jane C. “People, Not Machines: Authorship and What It Means for Copyright.” Columbia Journal of Law & the Arts 48 (2024): 159-188.

Graham, Stuart J. H., and Saurabh Vishnubhakat. “Of Smart Phone Wars and Software Patents.” Journal of Economic Perspectives 27(1) (Winter 2013): 67-88.

Graña, Fernando M., Maria del Mar Benavides-Espinosa, and Salvador Roig-Dobón. “Determinants of silent and explicit industrial design.” Journal of Business Research 88 (2018): 314–320. DOI: 10.1016/j.jbusres.2017.11.028.

Guarda, Paolo. “Looking for a Feasible Form of Software Protection: Copyright or Patent, Is That the Question?” European Intellectual Property Review (EIPR) 35(8) (2013): 445-454.

Gugliuzza, Paul R. “The Federal Circuit's Patent Eligibility Jurisprudence: A Statistical Study.” George Mason Law Review 29(1) (2024): 1-50.

Haskel & Westlake, 2017

Haunss, Sebastian. Conflicts in the Knowledge Society: The Contentious Politics of Intellectual Property. Cambridge: Cambridge University Press, 2013.

Hage, Jaap. “Comparative law as method and the method of comparative law.” Maastricht European Private Law Institute Working Paper No. 2014/11, 2014. [http://ssrn.com/abstract=2441090] accessed 14 October 2015.

Hall, Bronwyn H., and Rosemarie Ham Ziedonis. “The Patent Paradox Revisited: An Empirical Study of Patenting in the U.S. Semiconductor Industry, 1979-1995.” RAND Journal of Economics 32(1) (Spring 2001): 101-128.

Halligan, Robert G. “Protection of US trade secret assets: critical amendments to the economic Espionage Act of 1996.” John Marshall Review of Intellectual Property Law 7 (2008): 656–681.

Hemphill, Thomas A. “The telecommunication and information industries: US patent policy and the criterion of non-obviousness.” Telematics and Informatics 26(1) (February 2009): 1-12.

Hido, Shohei, *et al.* “Large-scale Patentability Analysis based on Text Mining and Machine Learning.” Proceedings of the 21st International Conference on Computational Linguistics and 44th Annual Meeting of the ACL, Sydney, July 2006, pp. 953-960. [https://aclanthology.org/P06-1120.pdf] accessed 29 May 2025.

Hilty, Reto M., and Christophe Geiger. “Patenting Software? A Judicial and Socio-Economic Analysis.” IIC - International Review of Intellectual Property and Competition Law 36(6) (2005): 615-647.

Hilty, Reto M., Jörg Hoffmann, and Stefan Scheuerer, eds. Artificial Intelligence and Intellectual Property. Cheltenham: Edward Elgar Publishing, 2023.

Hrdy, Jeffry M. “Keeping ChatGPT a Trade Secret (While Selling It Too).” Berkeley Technology Law Journal 40(1) (2025): Pre-print available at: https://btlj.org/wp-content/uploads/2025/03/40-1_Hrdy.pdf accessed 15 May 2025.

Hughes, Alan, and Andrea Mina. The Impact of the Patent System on SMEs. Centre for Business Research, University of Cambridge, April 2010. [https://www.ifm.eng.cam.ac.uk/uploads/Research/CSTI/Hughes__Mina_2010_.pdf] accessed 29 May 2025.

Hunt, Robert M., and James Bessen. “The Problem of Patent Trolls and the Alleged Low Quality of Software Patents.” In The Cambridge Handbook of the Law of the Sharing Economy. Edited by Nestor M. Davidson, Michèle Finck, and John J. Infranca, 523-538. Cambridge: Cambridge University Press, 2018.

Hutchinson, Terry. Researching and Writing in Law. 4th edn. Pyrmont, NSW: Lawbook Co., 2018.

Hyman, Ira. “Cell Phones are Changing Social Interaction.” Psychology Today, 26 January 2014. [https://www.psychologytoday.com/us/blog/mental-mishaps/201401/cell-phones-are-changing-social-interaction] accessed 28 May 2025.

International Data Corporation (IDC). Worldwide Quarterly Mobile Phone Tracker. Report/Data, 11 February 2025. [https://www.idc.com/promo/smartphone-market-share] accessed 15 May 2025.

International Data Corporation (IDC). Worldwide Smartphone Market Forecast to Grow 2.3% in 2025. Press Release, 25 February 2025.

[https://www.idc.com/getdoc.jsp?containerId=prAP53217825] accessed 15 May 2025.

James Bessen and Michael J Meurer, Patent Failure: How Judges, Bureaucrats, and Lawyers Put Innovators at Risk (Princeton University Press 2008).

Karas, Michael, and Roland Kirstein. “Efficient contracting under the U.S. copyright termination law.” International Review of Law and Economics 54 (June 2018): 39–48.

Karjala, Dennis S. “Copyright Protection of Computer Program Structure.” Fordham Law Review 64(2) (1995): 519-588.

Karlsruhe Memorandum on Software Patentability (2005).

Kenrick, John, and Tim Robinson. Patenting Software Inventions: A Practical Guide for Innovators and Business Leaders. London: Ark Group, 2007.

Krippendorff, Klaus. Content Analysis: An Introduction to Its Methodology. 4th edn. Thousand Oaks, CA: SAGE Publications, 2018.

Landes, David S. The Unbound Prometheus: Technological Change and Industrial Development in Western Europe from 1750 to the Present. 2nd edn. Cambridge: Cambridge University Press, 2003.

Landes & Posner, The Economic Structure of Intellectual Property Law

Lane, Christel. “Theorising the firm in a globalised world: A new institutionalist perspective.” Journal of Management Studies 55(1) (2018): 109-130. [https://onlinelibrary.wiley.com/doi/abs/10.1111/joms.12305] accessed 29 May 2025.

Lanjouw, Jean Olson, and Mark Schankerman. “Patent Quality and Research Productivity: Measuring Innovation with Multiple Indicators.” The Economic Journal 114(495) (April 2004): 441-465.

Lashinsky, Adam. Inside Apple: How America's Most Admired and Secretive Company Really Works. London: John Murray Press, 2012.

Laurie, Ronald S. “A Comparison of Patent and Copyright Protection for Computer Software Under US Law.” Computer Law & Security Review 12(2) (1996): 78-85.

Lemley, Mark A. “Software Patents and the Return of Functional Claiming.” Stanford Technology Law Review 2014(1) (January 2014): 365-412. [https://review.law.stanford.edu/wp-

content/uploads/sites/3/2014/01/Lemley-66-Stan.-L.-Rev.-365.pdf] accessed 28 May 2025.

Lemley, Mark A., and A. Douglas Melamed. “Missing the Forest for the Trolls.” Columbia Law Review 113(8) (December 2013): 2117-2189. [https://scholarship.law.columbia.edu/faculty_scholarship/1796/] accessed 28 May 2025.

Lemley, Mark A., and Bhaven Sampat. “Examining Patent Examination.” Stanford Law School, John M. Olin Program in Law and Economics Working Paper No. 422, February 2012. [https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2049092] accessed 29 May 2025.

Lemley, Mark A., and Bryan Casey. “Fair Learning.” Texas Law Review 99(5) (April 2021): 743-794. [https://texaslawreview.org/wp-content/uploads/2021/04/Lemley-Casey.pdf] accessed 15 May 2025.

Lerner, Josh, and Feng Zhu. “What is the impact of software patent shifts? Evidence from Lotus v. Borland.” International Journal of Industrial Organization 25(3) (May 2007): 511-529. [https://doi.org/10.1016/j.ijindorg.2006.06.002] accessed 29 May 2025.

Levendowski, Amanda. “How Copyright Law Can Fix Artificial Intelligence's Implicit Bias Problem.” Washington Law Review 93(2) (June 2018): 579-630. [https://digitalcommons.law.uw.edu/wlr/vol93/iss2/4/] accessed 15 May 2025.

Levine, David S., and Ted Sichelman. “Why Do Startups Use Trade Secrets?” Notre Dame Law Review 94(2) (December 2018): 751-808. [https://scholarship.law.nd.edu/ndlr/vol94/iss2/5/] accessed 29 May 2025.

Li & Chen, ‘Explainable Artificial Intelligence Applications in Cyber Security: State-of-the-Art in Research’ (2024) 4(2) J Cybersecurity L 101.

Lim, Pheh Hoon, and Louise Longdin. “The Smartphone Wars: Patent and Copyright as Swords and Shields.” European Intellectual Property Review (EIPR) 38(5) (2016): 284-294.

Lin, Tom C. W. “Executive Trade Secrets.” Notre Dame Law Review 87(3) (February 2012): 911-976. [https://scholarship.law.nd.edu/ndlr/vol87/iss3/1/] accessed 29 May 2025.

Linux Foundation Research. Open Source AI: Opportunities and Challenges. Report, December 2023. [https://www.linuxfoundation.org/research/open-source-ai-report] accessed 29 May 2025.

Lippoldt, Douglas C., and Mark F. Schultz. Trade Secrets, Innovation and the WTO. E15 Expert Group on Trade and Innovation, International Centre for Trade and Sustainable Development (ICTSD) and World Economic Forum, August 2014. [https://e15initiative.org/wp-content/uploads/2015/09/E15-Innovation-Lippoldt-and-Schultz-Final.pdf] accessed 15 May 2025.

Lisa Larrimore Ouellettee, 'How will AI affect patent disclosures?', (2025) ResearchGate (Last Updated 17 February 2025) <https://www.researchgate.net/publication/388113515_How_will_AI_affect_patent_disclosures>, accessed 14 May 2025.

Lord, Miriam. “US Copyright Office on AI: Human creativity still matters, legally.” WIPO Magazine, 24 April 2025. [https://www.wipo.int/wipo_magazine/en/2025/02/article_0003.html] accessed 15 May 2025.

MacLeod, Christine. Inventing the Industrial Revolution: The English Patent System, 1660-1800. Cambridge: Cambridge University Press, 1988.

Mandich, Giulio. “Venetian Patents (1450–1550).” Journal of the Patent Office Society 30(3) (March 1948): 166-224.

Mark A. Lemley & Bhaven N. Sampat, Does Alice Target Patent Trolls?, 18 J. Empirical Legal Stud. 692 (2021)

Market Intelligence & Consulting Institute (MIC). Global 5G Smartphone Shipments Projected to Surpass 900 Million Units, Exceeding 70% Market Penetration in 2025. Press Release, 14 November 2024. [https://mic.iii.org.tw/english/PressRelease_Detail.aspx?sqno=14773] accessed 15 May 2025.

Marsnik, Susan J., and Robert E. Thomas. “Drawing a Line in the Patent Subject-Matter Sands: Does Europe Provide a Solution to the Business Method and Software Patent Problem?” Boston College International and Comparative Law Review 24(2) (Spring 2001): 227-275.

Matsuya, Yuko. “Legal Protection of Software-Copyright, Patent and Open Source- Challenges for Business in a Mixed Environment.” Munich Intellectual Property Law Center (MIPLC) Master Thesis Series, 2012.

Mazzeo, Michael J., Jonathan H. W. H. Lee, and Calum M. MacGeoch. “Patent Assertion Entities and Investment in Innovation.” Journal of Law and Economics 66(1) (February 2023): 159-190. [https://www.journals.uchicago.edu/doi/abs/10.1086/723983] accessed 29 May 2025.

McDonagh, Luke, and Charleen K.-S. Lee. “Patenting Computer-Implemented Inventions in Europe: Examining the Case Law of the EPO Boards of Appeal on Technical Character and Inventive Step.” European Intellectual Property Review (EIPR) 43(11) (2022): 675-684.

Menell, Peter S. “An Analysis of the Scope of Copyright Protection for Application Programs.” Stanford Law Review 41(5) (May 1989): 1045-1104.

Menell, Peter S., Mark A. Lemley, and Robert P. Merges. Intellectual Property in the New Technological Age: 2023 – Vol. I: Perspectives, Trade Secrets, and Patents. Berkeley, CA: Clause 8 Publishing, 2023.

Merges, Robert P. “Symposium: Software Patents: A Panel Discussion: Software Patents and the Role of the Federal Circuit.” Berkeley Technology Law Journal 13(2) (1998): 267-279.

Michael Mandel, “EU App Economy: Skills for the Digital Age” (Progressive Policy Institute Report, 2023) 3 <https://www.progressivepolicy.org/wp-content/uploads/2023/10/EU-App-Economy-Skills.pdf>\ accessed 2 June 2025.

Millien, Raymond. “Alice who? “Over half the US utility patents issued annually are software related!” IPWatchdog.com, 21 May 2017. [http://www.ipwatchdog.com/2017/05/21/alice-over-half-u-s-utility-patents-issued-annually-software/id=83367/] accessed 28 May 2017.

Miller, Shawn P., and Justyna Z. Miller. “Trends in Patent Litigation: An Empirical Look at Non-Practicing Entity Activity From 2012 Through 2022.” Lewis & Clark Law Review 28(2) (2023): 519-570. [https://law.lclark.edu/live/files/34151-lcb282article2millermillerpdf] accessed 29 May 2025.

Mincov Law Corporation. “International Copyright Law Survey’. [http://worldcopyrightlaw.com/copyrightsurvey] accessed 14 May 2025.

Mintz Levin. “Patenting AI/ML Life Sciences and TechBio Innovations – How Much Disclosure is Sufficient?” Mintz.com, 24 February 2025. [https://www.mintz.com/insights-center/viewpoints/2231/2025-02-24-patenting-aiml-life-sciences-and-techbio-innovations-how] accessed 15 May 2025.

Moir, Hazel V.J. “An inventive step for the patent system?” European Intellectual Property Review (EIPR) 35(3) (2013): 125-136.

Mokyr, Joel. The Lever of Riches: Technological Creativity and Economic Progress. Oxford: Oxford University Press, 1990.

Moody, Glyn. “European Parliament Votes Overwhelmingly To Reject Software Patents Directive.” Ars Technica, 6 July 2005. [https://arstechnica.com/tech-policy/2005/07/5088/] accessed 29 May 2025.

Mueller, Janice M. Patent Law. 7th edn. New York: Wolters Kluwer, 2023.

Mullin, Joe. “Patent troll lawsuit head toward all-time high.” ARS Technica, 15 July 2015. [http://arstechnica.com/tech-policy/2015/07/patent-troll-lawsuits-head-towards-all-time-high/] accessed 5 September 2016.

Mullin, Joe. “Apple awarded $539M from Samsung in long-running patent fight.” Ars Technica, 24 May 2018. [https://arstechnica.com/tech-policy/2018/05/apple-awarded-539m-from-sammsung-in-long-running-patent-fight/] accessed 15 May 2025.

Ng, Elizabeth Siew Kuan. “Patent Trolling: Innovation at Risk.” European Intellectual Property Review (EIPR) 31(12) (2009): 593-603.

Noble, C. H., and K. Kumar. “Exploring the appeal of product design: A grounded, value-based model of key design elements and relationships.” Journal of Product Innovation Management 27(5) (2010): 640–657.

Nokia. Nokia 4Q and 2004 Results. Press Release, 27 January 2005. [https://www.nokia.com/system/files/files/q4-2004-earnings-release-pdf.pdf] accessed 28 May 2025.

Organisation for Economic Co-operation and Development (OECD), SMEs, Entrepreneurship and Innovation (OECD Publishing 2010)

Organisation for Economic Co-operation and Development (OECD). Compendium of Patent Statistics 2023. Paris: OECD Publishing, 2023. [https://www.oecd.org/sti/inno/oecd-patent-statistics.htm] accessed 15 May 2025.

Organisation for Economic Co-operation and Development (OECD). Enabling SMEs to participate more fully in a digitalised and globalised economy. Policy Brief, June 2023. [https://www.oecd.org/industry/smes/Policy-Brief-Enabling-SMEs-to-participate-more-fully-in-a-digitalised-and-globalised-economy.pdf] accessed 29 May 2025.

Organisation for Economic Co-operation and Development (OECD). Patent Quality. OECD Science, Technology and Industry Policy Papers, No. 108.

Paris: OECD Publishing, 2021. [https://doi.org/10.1787/2a2cQuality-en] accessed 29 May 2025.

Organisation for Economic Co-operation and Development (OECD). SMEs, Entrepreneurship and Innovation. Paris: OECD Publishing, 2023.

Orrick, Herrington & Sutcliffe LLP. “Protecting Trade Secrets: Tips for AI Companies.” https://www.google.com/search?q=Orrick.com, January 2025. [https://www.orrick.com/en/insights/2025/01/protecting-trade-secrets-tips-for-ai-companies] accessed 15 May 2025.

Paik, Yongwook, and Feng Zhu. “The Impact of Patent Wars on Firm Strategy: Evidence from the Global Smartphone Industry.” Organization Science 27(6) (November-December 2016): 1397-1414. [https://doi.org/10.1287/orsc.2016.1087] accessed 29 May 2025.

Patterson, Lyman Ray. Copyright in Historical Perspective. Nashville, TN: Vanderbilt University Press, 1968.

Phillips, John C. “*Sui generis* intellectual property protection for computer software.” George Washington Law Review 60(3) (April 1992): 997-1030.

Picker, Randal C. “The Invention of the Software Patent: A Brief History.” University of Chicago Law School, John M. Olin Law & Economics Working Paper No. 725, 2nd Series, 2015. [https://chicagounbound.uchicago.edu/law_and_economics/33/] accessed 28 May 2025.

Porter, Michael E. Competitive Strategy: Techniques for Analyzing Industries and Competitors. New York: Free Press, 1980.

Powell, Walter W., and Kaisa Snellman. “The Knowledge Economy.” Annual Review of Sociology 30 (2004): 199-220.

Prager, Frank D. “A History of Intellectual Property from 1545 to 1787.” Journal of the Patent Office Society 26(11) (November 1944): 711-760.

Quinn, Gene. “Navigating Alice: Patent Eligibility in 2024 and Beyond.” IPWatchdog.com, 15 January 2025. </44>[https://www.ipwatchdog.com/2025/01/15/navigating-alice-patent-eligibility-2024-beyond/id=170123/] accessed 15 May 2025.

Rahim, Azira, Siti Zaharah Safin, Law Kuan Kheng, Nurliyana Abas, and Siti Meriam Ali. “Factors Influencing Purchasing Intention of Smartphone among University Students.” Procedia Economics and Finance 37 (2016): 245–253.

Rai, A., S. Alsmadi, and H. Al-Gasawneh. “Factors Influencing Smart Phone Buying Behavior of Consumers: Implications for Building a Marketing Strategy.” Business and Economic Letter 3(2) (2024): 60-71. [https://armgpublishing.com/wp-content/uploads/2024/10/BEL_3_2024_5.pdf] accessed 28 May 2025.

Randal C. Picker, 'The Invention of the Software Patent: A Brief History' (University of Chicago Law School, John M. Olin Law & Economics Working Paper No. 725, 2nd Series, 2015).

Razak, Adilah Abd. “Understanding legal research.” UPM Research Bulletin 4 (March 2009): 19-24.

Risch, Michael. “Functionality and Graphical User Interface Design Patents.” Stanford Technology Law Review 2013(1) (January 2013): 5. [https://journals.law.stanford.edu/stanford-technology-law-review/online/functionality-and-graphical-user-interface-design-patents/] accessed 29 May 2025.

Roberto Dini, 'AI innovation and a 'person skilled in the art'', Journal of Intellectual Property Law & Practice (Published 6 February 2025) < https://academic.oup.com/jiplp/article/20/10/643/8003605 >, accessed 14 May 2025.

Robert Sachs "AliceStorm: The Impact on Software Patent Issuance." *IPWatchdog*, 2015, ipwatchdog.com/2015/01/15/alicestorm-the-impact-on-software-patent-issuance/.

Ronald A. Cass, 'Lessons from the Smartphone Wars: Patent Litigants, Patent Quality, and Software' (2015) 16(1) Minnesota Journal of Law, Science & Technology 1.

Rothwell Figg. “Reviewing 2024’s AI Patent And Copyright Developments.” RothwellFigg.com, 9 January 2025. [https://www.rothwellfigg.com/publication-reviewing-2024s-ai-patent-and-copyright-developments] accessed 15 May 2025.

Sachs, Robert R. “Looking Back At Ten Years Of Alice And The Algorithmic Revolution.” Bilski Blog, 10 June 2024.

Samuelson, Pamela. “Reconciling Copyright and Patent for Software: A Way Forward.” UC Irvine Law Review 13(4) (2023): 1057-1112. [https://scholarship.law.uci.edu/ulr/vol13/iss4/6/] accessed 28 May 2025.

Samuelson, Pamela. “Why Software Is Different.” SSRN Electronic Journal, 2017.

Samuelson, Pamela, Annemoon Geurts, and Thomas Vinje. “Does Copyright Protection Under the EU Software Directive Extend to Computer Program Behaviour, Language and Interfaces?” European Intellectual Property Review (EIPR) 34(3) (2012): 158-167.

Samuelson, Pamela, Randall Davis, Mitchell D. Kapor, and J. H. Reichman. “A Manifesto Concerning the Legal Protection of Computer Programs.” Columbia Law Review 94(8) (December 1994): 2308-2431.

Sandeen, Sharon K., and Elizabeth A. Rowe. Trade Secrecy and Employees: A State-by-State Survey. 3rd edn. Chicago: American Bar Association, 2021.

Schuster, W. Michael. “Artificial Intelligence and Patent Ownership.” Washington and Lee Law Review 75(4) (2019): 1945-2026. [https://scholarlycommons.law.wlu.edu/wlulr/vol75/iss4/5/] accessed 29 May 2025.

Shemtov, Noam. “Software protection – what can be patented and what can be copyrighted?” In Intellectual Property and Open Source: A Practical Guide to Protecting Code. Edited by Van Lindberg, Chapter 2. Sebastopol, CA: O'Reilly Media, 2008.

Shoemaker, Amanda. “How the FTC Ban On Noncompetes Will Impact Use of the Inevitable Disclosure Doctrine.” Cornell Law Review Online 109 (2025)

Sidak, J. Gregory. “The Meaning of FRAND, Part II: The Case of User-Interface Design Patents for Smartphones.” Journal of Competition Law & Economics 10(1) (March 2014): 133-173. [https://doi.org/10.1093/joclec/nht045] accessed 29 May 2025.

Silvia Amaro, EUROPE NEWS, ‘President Trump's trade policy is 'difficult to follow,' top EU official says’ CNBC 2018, available at < https://www.cnbc.com/2018/04/07/trade-tensions-between-eu-and-the-us-have-calmed-down-katainen.html > accessed 16 Nov 2025.

Sinde Valentin. “The Assessment of Inventive Step for Computer-Implemented Inventions at the European Patent Office: An Analysis of the Problem-Solution Approach in the Field of Artificial Intelligence.” Journal of Intellectual Property, Information Technology and Electronic Commerce Law (JIPITEC) 14(2) (2023): 223-240.

Song, Jianping, and Ning Li. “A Multi-Dimensional Indicator System for Comparing Patent Quality Among Countries.” Scientometrics 98(1)

(January 2014): 357-377. [https://doi.org/10.1007/s11192-013-1030-5] accessed 29 May 2025.

Stallman, Richard M. “Why Patents Are Bad for Software'. GNU Operating System. [https://www.gnu.org/philosophy/software-patents.en.html] accessed 29 May 2025.

Stanford Institute for Human-Centered Artificial Intelligence. Artificial Intelligence Index Report 2024. AI Index Steering Committee, Stanford University, 2024. [https://aiindex.stanford.edu/report/] accessed 29 May 2025.

Stalla-Bourdillon, Sophie, Eleonora Rosati, Karmen Turk, Christina Angelopoulos, Aleksandra Kuczerawy, Miquel Peguera, and Martin Husovec. “An academic perspective on the copyright reform.” Computer Law & Security Review 33(1) (February 2017): 3–13.

Stuart J.H. Graham et al., 'High Technology Entrepreneurs and the Patent System: Results of the 2008 Berkeley Patent Survey' (2009) 24(4) Berkeley Technology Law Journal 1255.

Sullivan, Ann Marie. “Cultural Heritage & New Media: A Future for the Past.” John Marshall Review of Intellectual Property Law 15(3) (Spring 2016): 604-638.

Sunnie Ning, Stabilizing Alice for Abstract Ideas: A Case for the Federal Circuit to Turn to USPTO Guidance, Harv. J.L. & Tech. Digest (Apr. 3, 2021)

Sutter, John D. “How smartphones make us superhuman.” CNN.com, 10 September 2012. [https://edition.cnn.com/2012/09/10/tech/mobile/oms-smartphones-superhuman/index.html] accessed 29 May 2025.

Tay, Pek San, and Cheng Peng Sik. “Data mining and copyright: A bittersweet technology gift for copyright owners and the Malaysian public?” Computer Law & Security Review 32(6) (December 2016): 898–906.

Thomas, Daniel. “Global smartphone sales fall for first time.” Financial Times, 2 May 2016. [https://www.ft.com/content/f432fc88-0d45-11e6-b41f-0beb7e589515] accessed 2 May 2016.

Thurow, Lester C. Fortune Favors the Bold: What We Must Do to Build a New and Lasting Global Prosperity. New York: HarperBusiness, 2003

Tomaselli, Sylvana. "The Enlightenment Debate on Women." History Workshop Journal 20 (Autumn 1985): 101-125. [doi:10.1093/hwj/20.1.101]

Tramèr, Florian, *et al.* “Stealing Machine Learning Models via Prediction APIs.” Paper presented at the 25th USENIX Security Symposium, Austin, TX, August 2016. [https://www.usenix.org/conference/usenixsecurity16/technical-sessions/presentation/tramer] accessed 15 May 2025.

Trappey, Charles V., Amy J.C. Trappey, and Yu-Hui Wang. “Are patent trade wars impeding innovation and development?” World Patent Information 46 (September 2016): 64-72.

Undorf, Stefan, and Tilman Breitenstein. “The "as such" exclusion in European patent law for computer-implemented inventions: Time for a paradigm shift?” IIC - International Review of Intellectual Property and Competition Law 54(5) (2023): 721-751.

Unified Patents. 2023 Patent Dispute Report: Year in Review. Report, January 2024.

Upadhye Tang LLP. “Intellectual Property Issues Related to Artificial Intelligence: A Deeper Dive into Patent, Copyright, & Trade Secrets Challenges.” ipfdalaw.com, 13 March 2025. [https://ipfdalaw.com/intellectual-property-issues-related-to-artificial-intelligence-a-deeper-dive-into-patent-copyright-trade-secrets-challenges/] accessed 15 May 2025.

U.S. Chamber of Commerce. International IP Index. 12th Edition. Washington, DC: U.S. Chamber of Commerce, Global Innovation Policy Center, March 2024. [https://www.theglobalipcenter.com/ipindex2024/] accessed 15 May 2025.

U.S. Patent & Trademark Office, The Artificial Intelligence Patent Dataset — 2023 Update (2024).

Veale, Michael, Lilian Edwards, and Marion Oswald. “When AI Undermines Algorithmic Accountability: The Case of Copyright and Other IP Torts.” In Research Handbook on the Law of Artificial Intelligence. Edited by Woodrow Barfield and Ugo Pagallo, 682-704. Cheltenham: Edward Elgar Publishing, 2021.

Vepachedu, Rao. “Quantity Over Quality at the USPTO?” Cardinal IP, 15 July 2009. [https://cardinal-ip.com/ip-news-strategy/quantity-over-quality-at-the-uspto/] accessed 12 Sep 2016.

Villasenor, John. Protecting our Edge: Trade Secrets and the Global AI Arms Race. Testimony before the U.S. House of Representatives Committee on the Judiciary, Subcommittee on Courts, Intellectual Property, and the

Internet, 7 May 2025. [https://judiciary.house.gov/sites/evo-subsites/republicans-judiciary.house.gov/files/evo-media-document/villasenor-testimony.pdf] accessed 15 May 2025.

Vinje, Thomas C. “Copyright Protection of Computer Software in the European Community.” European Intellectual Property Review (EIPR) 10(2) (1992): 41-47.

Vishnubhakat, Saurabh. “The Commercial Value of Software Patents.” Stanford Technology Law Review 18(2) (2015): 295-345.

Walsh, Jacqueline S. The Future of the Small Software Firm: A Case for the Proper Balance of Laws Protecting Software and Competition. PhD Thesis, University of Leicester, 2013. [https://figshare.le.ac.uk/articles/thesis/The_future_of_the_small_software_firm_a_case_for_the_proper_balance_of_laws_protecting_software_and_competition/10086149] accessed 28 May 2025.

Webbink, D. “A new paradigm for intellectual property rights in software.” Duke Law & Technology Review 2005(5) (2005).

Westermann, Hannes. How to treat software in the intellectual property framework. Master Thesis, Lund University, Faculty of Law, 2016. [https://lup.lub.lu.se/student-papers/record/8874398] accessed 29 May 2025.

William D. Nordhaus, Invention, Growth, and Welfare: A Theoretical Treatment of Technological Change (MIT Press 1969).

William Fisher, ‘Theories of Intellectual Property’ (Cambridge University Press, 2001), 168-199.

William M. Landes and Richard A. Posner, The Economic Structure of Intellectual Property Law (Harvard University Press 2003).

World Intellectual Property Organization (WIPO). Advice on Flexibilities under the TRIPS Agreement. [https://www.wipo.int/ip-development/en/policy_legislative_assistance/advice_trips.html] accessed 15 May 2025.

World Intellectual Property Organization (WIPO). Intellectual Property and Software. WIPO Publication. (Various dates, example link for general topic: https://www.wipo.int/patents/en/topics/software.html) accessed 28 May 2025.

World Intellectual Property Organization (WIPO). Learn from the past, create the future: Inventions and Patents. WIPO Publication No. 941E, 2020.

[https://www.wipo.int/publications/en/details.jsp?id=4536] accessed 28 May 2025.

World Intellectual Property Organization (WIPO). Patent Cooperation Treaty (PCT) Yearly Review 2024: The International Patent System. Geneva: WIPO, 2024. [https://www.wipo.int/edocs/pubdocs/en/wipo-pub-901-2024-en-pct-yearly-review-2024.pdf] accessed 29 May 2025.

World Intellectual Property Organization (WIPO). Patent Landscape Report: Generative Artificial Intelligence. Geneva: WIPO, 2024. [https://www.wipo.int/edocs/pubdocs/en/wipo_pub_1063.pdf] accessed 15 May 2025.

World Intellectual Property Organization (WIPO). Patent Pools and Antitrust – A Comparative Analysis. Report, March 2014. [https://www.wipo.int/export/sites/www/competition-policy/en/docs/patent_pools_report.pdf] accessed 15 May 2025.

World Intellectual Property Organization (WIPO). Standing Committee on the Law of Patents (SCP).

World Intellectual Property Organization. "The Story of Artificial Intelligence in Patents." WIPO, https://www.wipo.int/en/web/technology-trends/artificial_intelligence/story. Accessed 31 May 2025.

World Intellectual Property Organization (WIPO). Understanding Copyright and Related Rights. WIPO Publication No. 909E, 2016. [https://www.wipo.int/publications/en/details.jsp?id=4080] accessed 28 May 2025.

World Intellectual Property Organization (WIPO). WIPO Conversation on Intellectual Property (IP) and Artificial Intelligence (AI). [https://www.wipo.int/about-ip/en/artificial_intelligence/conversation.html] accessed 15 May 2025.

World Intellectual Property Organization (WIPO). WIPO Conversation on IP and AI – Revised Issues Paper on Intellectual Property Policy and Artificial Intelligence. Second Session, WIPO/IP/AI/2/GE/20/1 Rev., 21 May 2020. [https://www.wipo.int/meetings/en/doc_details.jsp?doc_id=509902] accessed 28 May 2025.

World Intellectual Property Organization (WIPO). WIPO Conversation on IP and AI – Eleventh Session. Meeting Document, April 2025. [https://www.wipo.int/meetings/en/details.jsp?meeting_id=87587] accessed 15 May 2025.

World Intellectual Property Organization (WIPO). What is Intellectual Property? WIPO Publication No. 450E, 2020. [https://www.wipo.int/publications/en/details.jsp?id=4520] accessed 28 May 2025.

World Intellectual Property Organization (WIPO). World Intellectual Property Indicators 2024. Geneva: WIPO, 2024.

Wren, J. D. “Theory and reality for software patents: good in concept, not so good in practice.” Bioinformatics 22(13) (1 July 2006): 1543-1547.

Zammit, David, and Ivan Daniel Aquilina. “Software Patents in the European Union: An Unstoppable Flood?” Journal of Intellectual Property Law & Practice 18(3) (March 2023): 207-219. [https://doi.org/10.1093/jiplp/jpad005] accessed 29 May 2025.

Zygmuntowska, Justyna. “Patenting AI Inventions in the EPO—Is the Current Approach "AI-Proof"?” IIC - International Review of Intellectual Property and Competition Law 54(10) (October 2023): 1535-1560. [https://doi.org/10.1007/s40319-023-01400-7] accessed 22 May 2025.