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Agent-based modelling: a tool for supporting disaster-rescue tasks

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Agent-Based Modeling
A Tool for Supporting Disaster-Rescue Tasks

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Outline

Agent-Based Simulations

Disaster Rescue Simulations

The development of Disaster-rescue (DR) simulations is a very active field with many research and technical conferences, either from:

- Pure computational purposes, or
- As an *in silico* tool helping to determine actual policies of action for emergency recovering and management in real life[3]

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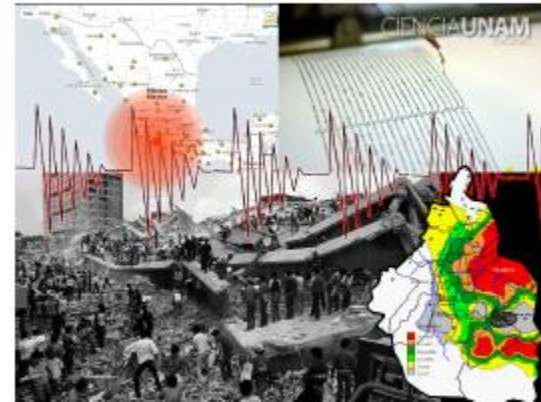
[1] http://ciencia.unam.mx/uploads/textos/rp_sismo1985_17092015.jpg

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Agent-Based Simulations

Agent-Based Modeling in DR

Agent-Based Modeling (ABM) are becoming the *de facto* tool to develop simulations applied to a wide range of domains, like the Disaster-rescue.

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2 http://www.jornada.unam.mx/ultimas/2015/09/18/
el-terremoto-cambio-el-rostro-de-la-ciudad-4790.html/700_p251985Terremoto2alta.png

Agents

An **agent** can be conceived as a purpose-driven entity which interacts with its environment through perceptions and actions[4][2].

- Relevant features: persistence, rationality, autonomy, learning, and social ability.

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**Agents and Multi-Agent Systems**
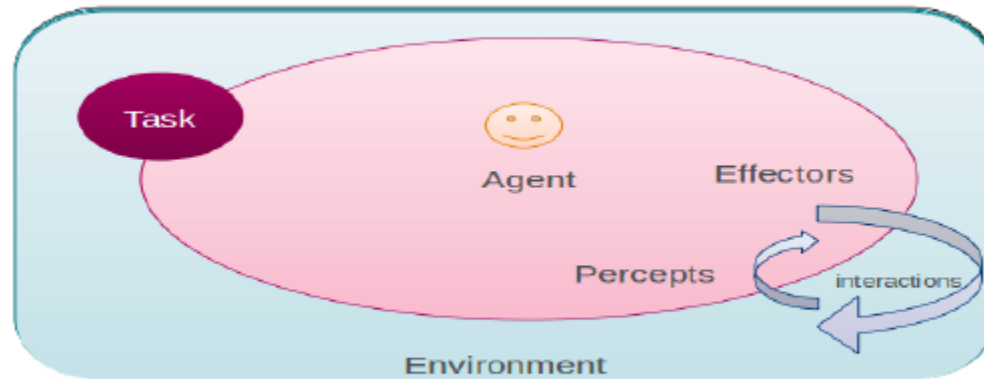
Types of Agents

Different types of agents have been used to build ABM:

- **Reactive agents** offer noteworthy results due to their simplicity in construction and characteristics such as: autonomy, pro-activeness, reactiveness, and social ability.
- **Cognitive agents** are designed under a more robust architecture that enables them to reach a goal-driven behaviour with additional features such as mobility, veracity, benevolence, and rationality.
    - Belief-Desire-Intention (BDI) architecture[7][6]: offers several advantages when modeling cognitive agents that can help in representing some aspects of human behaviour[1].

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Developing ABM

Multi-Agent System

Assembles of several agents having either an homogeneous or heterogeneous architecture[2].

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Developing ABM
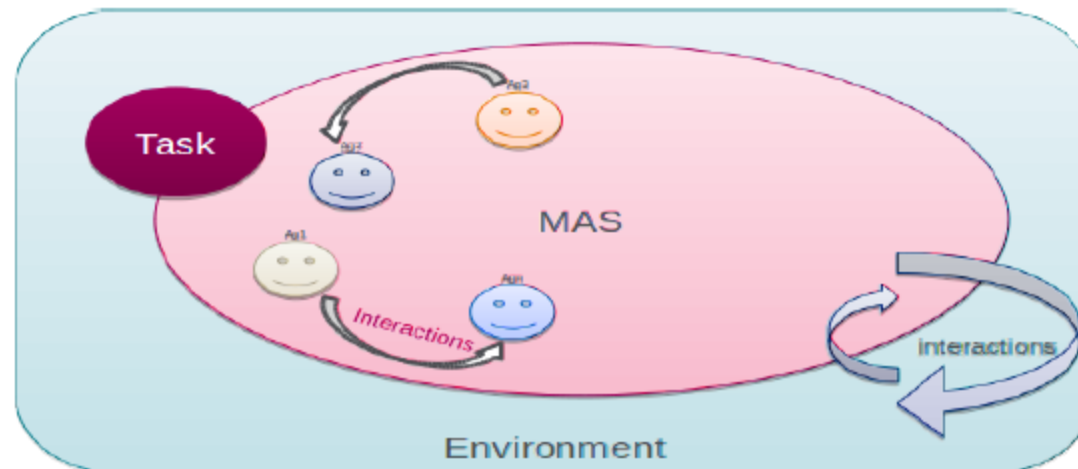
ABM in Social Simulation

Benefits of using ABM in social simulation:

- Is a **microscope** as long as it allows the analysis of the most representative details of social entities or individuals and their relationships.

- Is a **telescope** as long as it allows to observe the aforementioned features within the crowd/social setting and observe their evolution in time.

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Developing ABM

ABM Development

Layout of ABM development:

- **Specification and Formalization**: using a language either logic-based, mathematical or algorithmic.

- **Implementation**: translating the formal specification to a runnable piece of software.

- **Verification and Debugging**: using validation tools from both Software Engineering and Social Sciences.

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Developing ABM

ABM Benefits in Developing Countries

ABM are helpful in Developing Countries:

- Provide a digital tool for planning and testing rescue, salvation and recovery strategies.

- Make possible the study of diverse social phenomena.

- Does not require very specialized infrastructure or large budgets.

[3]http://static.obrasweb.mx/media/2015/15/09/
terremoto-85-coleccion-villasana-torres-220150915165640.jpg

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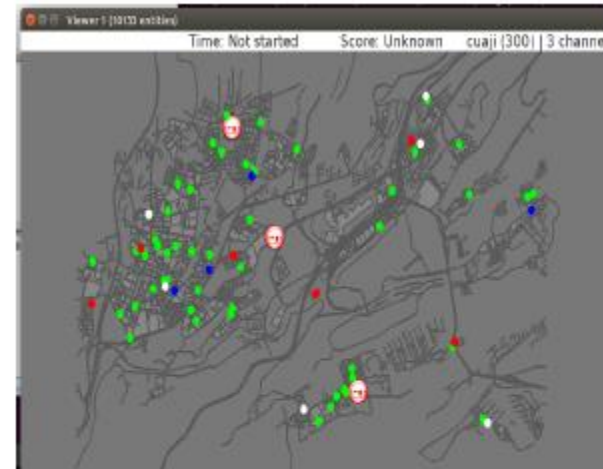Frameworks for ABM development

Open Software Tools

Open Software can help in developing ABM customized simulations:

- Represent the actual natural and social conditions of the target territory and population.
- Use the available data and knowledge about them.
- Reflect the level of realism needed in a particular circumstance.

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Frameworks for ABM development

Development Tools

Noteworthy tools for ABM simulation development[5]:

- RoboCup Rescue[4] represent real maps of cities using a variant of the OpenStreetMaps[5] and several simulations of natural disasters like fire, earthquakes and floods.
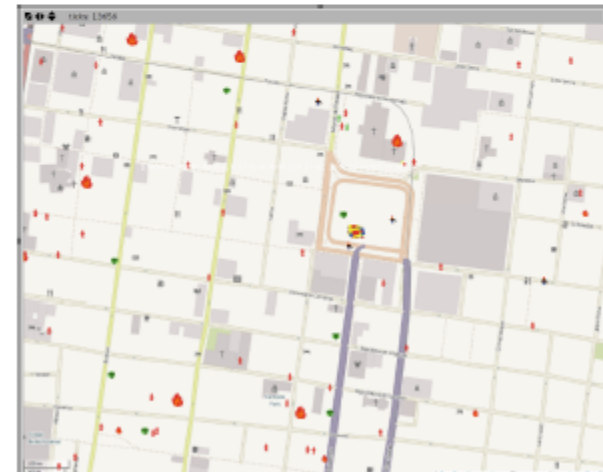

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[4] http://roborescue.sourceforge.net/blog/

[5] https://www.openstreetmap.org

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Frameworks for ABM development

ABM Development Tools

Diverse initiatives to perform ABM and there are many tools for ABM development[5]:

- NetLogo[6] is a flexible tool with a graphical environment and input/output customization, it adopts a rapid prototyping approach.
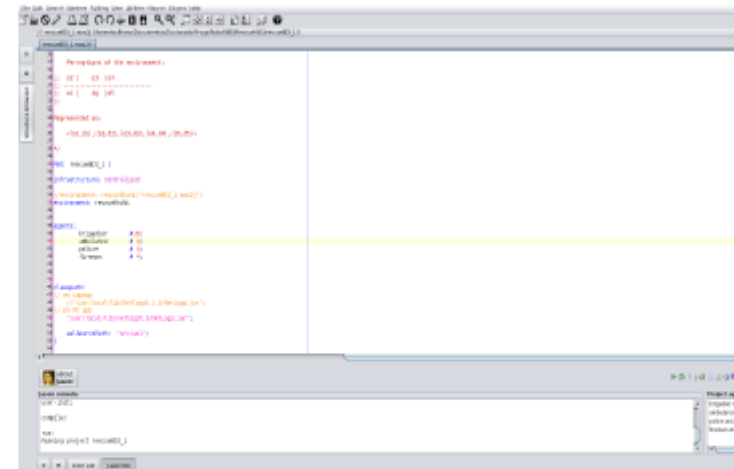

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[6] http://ccl.northwestern.edu/NetLogo/

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Frameworks for ABM development

BDI Development

On the side of Multi-Agent Systems, Jason[7], a fully fledged BDI environment, offers enough flexibility to be integrated with other tools and frameworks, as NetLogo, to easy the development of ABM based on cognitive agents.

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[7] http://jason.sourceforge.net/

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ABM in Developing Countries

MAS in ABM Simulations

Given the features offered by Agents and Multi-Agent Systems (particularly cognitive agents), ABM represents an ideal technique for developing computational simulations with a high level of realism like those required by Disaster-rescue conditions.

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8 http:
//a.abcnews.com/images/International/ap_tsunami_anniversary_4_dm_130311_ssh.jpg

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ABM in Developing Countries

ABM Development

ABM can be developed with some free software tools like those based mainly in the Java programming language conferring a great opportunity to extend and to reuse legacy code by interfacing with their API as NetLogo and Jason.

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ABM in Developing Countries

ABM for DR in Developing Countries

ABM simulations for Disaster-rescue can be highly beneficial for developing countries, where natural disasters, like earthquakes, floods, hurricanes or any other, cause serious damages to the population and the public infrastructure like roads, harbors, hospitals, schools or another buildings.

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9 http://media.gettyimages.com/photos/
rescue-workers-and-volunteers-sift-through-the-rubble-of-a-collapsed-picture-id97653878

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