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Visualizing and Animating Large-scale Spatiotemporal Data with ELBAR Explorer

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Abstract. Visual exploration of data enables users and analysts observe interesting patterns that can trigger new research for further investigation. With the increasing availability of Linked Data, facilitating support for making sense of the data via visual exploration tools for hypothesis generation is critical. Time and space play important roles in this because of their ability to illustrate dynamicity, from a spatial context. Yet, Linked Data visualization approaches typically have not made efficient use of time and space together, apart from typical rather static multivisualization approaches and mashups. In this paper we demonstrate ELBAR explorer that visualizes a vast amount of scientific observational data about the Brazilian Amazon Rainforest. Our core contribution is a novel mechanism for animating between the different observed values, thus illustrating the observed changes themselves.

Keywords: Visual Analytics, Information Visualization, Linked Data

1 Introduction

Making sense of spatiotemporal data is a crucial step in providing insight for critical actionable decisions. Linked Data is no exception in this. With the increased availability of potentially interesting information the task is to support decision makers by illustrating significant patterns of data. This way data becomes narrative and can share a story [3].

In this paper we demonstrate the combined use of spatial and temporal aspects of Linked Data and illustrate how very heterogeneous phenomena can be illustrated over time and space. Our contribution is an explorer that takes spatiotemporal Linked Data as an input via SPARQL queries and enables exploration of variables via animations. To evaluate and illustrate the use of the tool we make use of openly published data about the Brazilian Amazon Rainforest. This data, including its economical, social and ecological dimensions, serves to show the potential of visualizing Linked Data by animations over time.

Section 2 explains both the ELBAR explorer and the spatiotemporal data we used for evaluation. Section 3 discusses the use of ELBAR explorer with a

concrete scenario. Section finishes the paper with concluding remarks and future work ideas.

2   Animating Large-scale Temporal Data with ELBAR

In this demonstration, ELBAR[4] makes use of the openly available Linked Brazilian Amazon Rainforest Data[5] [2] which captures and shares environmental observations (like deforestation) together with information about social phenomena (like amount of population) and economical phenomena (like market prices of products). The data has been aggregated to 25 km x 25 km grid cells [1] and extended with open governmental data and linked to DBPedia. ELBAR uses the paradigm of visual animations to illustrate changes over time on maps. The core idea is that employing such means to navigate multiple dimensions of data supports analysts in generating hypotheses for further investigation.
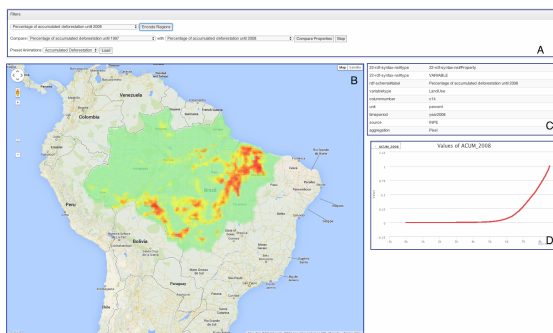

Fig. 1. Explorer for Linked Brazilian Amazon Rainforest (ELBAR). The interface contains four sections: A – Filters, B – Map, C – Info window, D – Graph

Fig. 1 presents a screenshot of the ELBAR explorer. The filters (Section A) provide mechanisms for selecting variables (e.g. deforestation rates) for further inspection. SPARQL queries are built from the interactions done by the users and sent to SPARQL endpoints. Results from the endpoint are processed and converted to visual elements on maps (Section B) and graphs (Section D)[6]. The relevant observations (as retrieved from a triple store) are then visually encoded and overlaid on a map, based on their spatial positions. The information window (Section C) is then updated with further information regarding the filter being selected. Clicking on visual elements of the graph (Section D) highlights the individual sections on the map.

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[4] A demo of ELBAR is presented at `http://linkedscience.org/demos/elbar`

[5] `http://linkedscience.org/data/linked-brazilian-amazon-rainforest/`

[6] Users are also presented with Preset Animations, that can be previously defined or extracted from the data

3   Scenario for the Use of ELBAR

3.1   Visualizing the Phenomena

Assuming a user would like to understand a certain phenomena over time (like deforestation) she/he will select a property (like deforestation rate) to visualise it on the map. The explorer then presents the corresponding values of the property, color-coded and overlaid on the map as well as a distribution of the values of the property as a graph. The graph (see the the bottom right of Figure 1) is interactive and supports mouse events such as zoom (by clicking and dragging to select a section in the graph) or left clicks.
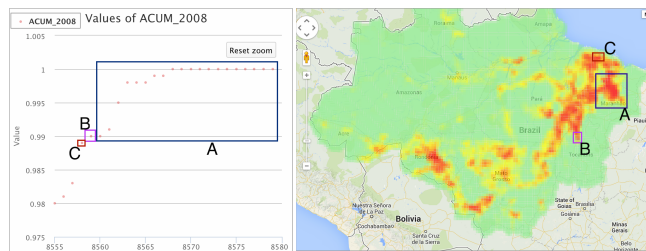

Fig. 2. User interactions on graphs translate to highlight visual elements on the map, aiding in providing context

Zooming the graph provides a finer grained view of the distribution to facilitating selection of individual data points. Clicking on the graph selects the respective section on the map and highlights it. Such interactions support understanding of how different phenomena are distributed. They also potentially illustrate their spatial proximity and patterns they form. The example illustrated in Figure 2 shows the distribution of a property (ACUM_2008 - accumulated percentage of deforestation in The Brazilian Amazon Rainforest until 2008) on the graph (left) and the map (right). The graph is then zoomed to the highest few points and then explored using mouse clicks. Clicking on individual datapoints indicate their spatial references by marking up the respective section on the map. Clicking on all the points (with a high value of ACUM_2008) on Section A (middle) highlights the respective section A on the map (right). However, with almost similar high values, the section B and C highlight sections in other areas.

3.2   Animating the Phenomena over Time

Comparing two properties for example (selected in Section A), accumulated deforestation in 1997 (ACUM_1997) and accumulated deforestation in 2008 (ACUM_2008) in such cases is a helpful feature that provides animated transitions to assist users observe change. The result is then parsed and the values are visually encoded into the relevant sections on the map, with a transition[7] defined that

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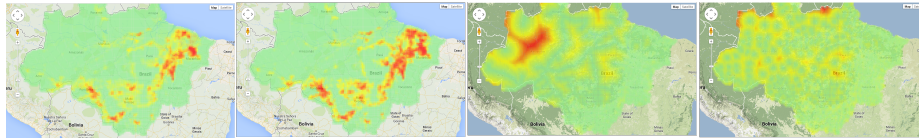[7] https://github.com/mbostock/d3/wiki/Transitions

Fig. 3. Generating hypothesis for the high deforetation in the North East Amazon. 1: accumulated deforestation in 1997, 2: accumulated deforestation in 2008, 3: distance from the nearest road, 4: distance from nearest municipality.

iterates between the two visual encodings, thereby creating an animated effect. Since no other visual feature is altered in the user's field of view apart from color encoding, the user can easily observe the evolution of deforestation. The analyst then attempts to understand why the North East Amazon contains the highest amount of deforestation. Different properties such as distance from nearest road (bottom left, Fig. 3) and distance from the nearest municipality (bottom right, Fig. 3) indicate the clear segregation of the North Eastern region, which could support an analyst to hypothesise that the remoteness of these areas help in illegal deforestation activities.

4   Conclusions

In this paper, we presented ELBAR explorer that employs generic visualization and animation techniques to support analysts and decision makers explore spatial and temporal data. We demonstrate the system and the architecture, along with a description of the data. This will be accompanied with a guided example of how such techniques can be used, and we also invite our demonstration attendees, both online and onsite, to build custom transitions.

Future work will include development and evaluation of ELBAR with different kinds of spatiotemporal data. Moreover, we investigate other novel mechanisms for exploring the spatiotemporal and topical aspects of Linked Data. We foresee the potential for the use of the community is the expansion of the background data, such as census data from individual municipalities and other authorities could support for gaining insight of social, economical and ecological processes.

References

1. de Espindola, G.M.: Spatiotemporal trends of land use change in the Brazilian Amazon. Ph.D. thesis, National Institute for Space Research (INPE), São José dos Campos, Brazil (2012)
2. Kauppinen, T., de Espindola, G., Jones, J., Sanchez, A., Gräler, B., Bartoschek, T.: Linked Brazilian Amazon Rainforest Data. Semantic Web Journal 5(2) (2014)
3. Segel, E., Heer, J.: Narrative visualization: Telling stories with data. Visualization and Computer Graphics, IEEE Transactions on 16(6), 1139–1148 (2010)