STSM Scientific Report: User profiling and geovisual analytics process modeling for maritime data exploration

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Context & Objectives of STSM

Geovisual analytics have been widely used by the GI community for developing new methods of visualizing, exploring and analyzing geographic information [1], [2], [3], [4]. These visualization and exploration methods have been of major interest for the analysis of moving objects, such as pedestrians, cars, ships or animals [5], [6], [7]. However, the diversity of these visual solutions can cause difficulties when it comes to choosing the appropriate tool for a given task.

The GI community recognizes the importance of knowing the user, its context and the tasks (geographical questions) that have to be performed, before developing or proposing adequate solutions [8]. Our research on maritime traffic analysis required an accurate model for the process of geovisual analytics and for the potential users.

In this context, the objective of this STSM was to lead a task analysis for exploring geographic information regarding specific events at sea, allowing us to identify characteristics of interest for the use of geovisual analytics. This way, a profile of users for geovisual analytics of maritime traffic would be developed. The second point of this mission was to improve our model of geovisual analytics solutions. We designed ontological models for user profile and geovisual analytics solutions.

Achieved work

From our scientific point of view, we developed exploration and analysis question to be investigated for specific scenarios of interest in maritime traffic (stop at sea, parallel fishing). Successive questions (tasks) have been listed and classified in 4 main groups of questions: *General identification*, *Spatio-temporal analysis*, *Context analysis* and *Risk analysis*. These groups correspond to successive investigation in the use of maps and visual analytics. Identified questions have been matched to corresponding geovisual analytics uses, such as m*easure time*, *characterize an area*, *Summarize trajectories*, etc. This step identified map-use primitives, which should be completed later with further interviews.

Taken into account various types of actors involved in traffic data analysis, we identified several characteristics of the user, which could affect their comfort and comprehension with geovisual analytics, regarding the task to perform. These characteristics would describe experience the user has with analyzed data (data knowledge), interest for the task, education regarding mathematics or statistics, technological abilities (for more or less complex visualization environments), context for the use of visualization, profession and time available for performing the task. Time available gathers both time of the data (real-time of historical time) or time of the task, and stands for the pressure the user can experience. Time pressure is indeed of major influence in map use [9]. Figure 1 illustrates the chosen model for user profiling.

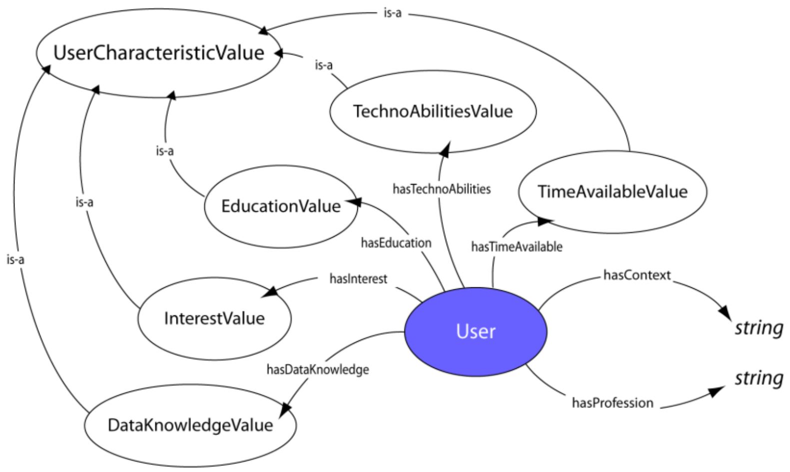

Figure 1. Ontological model for user profiling

Comparing the very definition of (geo) visual analytics [4], we proposed a formal model of this type of data exploration solution. Raw data (from the field) will be displayed with a particular visual shape (visual projection), which can be manipulated by the user with interactions (symbolization interaction, or more global view manipulation) [10]. For our purpose, we need to identify what kind of time is visualized (real-time of historical), and the data used as background information (*e.g.*, base map or meteorology). The dimensions of the visual space also have to be specified (*e.g.*, 2D or 3D map), for they will affect the complexity of use. Figure 2 illustrates our model for geovisual analytics solutions.

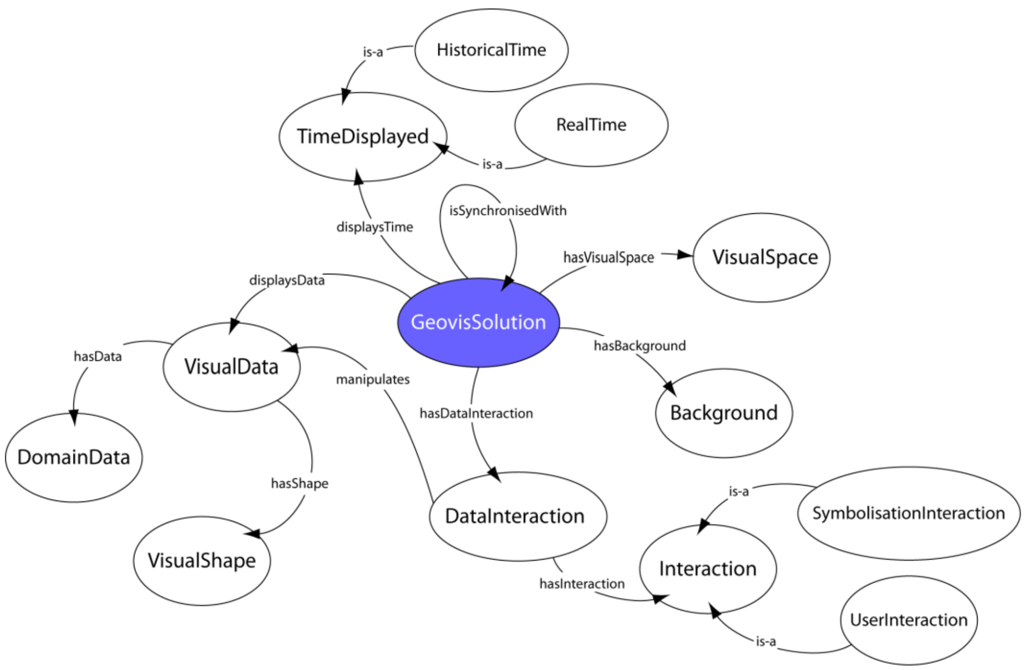

Figure 2. Ontological model for geovisual analytics solutions

These two models have been developed in the ontology software Protégé 4.1. Some examples of users and geovisual analytics solutions have been implemented in the same software, creating the basis of a catalogue for further investigation of rules.

Communication & Publication perspectives

This STSM work has been presented in Brest (France) at the MOVE workshop on *Moving Objects at Sea*, as a short abstract and oral presentation. We are also currently working on two extended papers with logical publication order.

The first paper will extend an abstract presented at Geoprocessing conference (February 2013, Nice, France) and will be submitted to the *International Journal on Advances in Intelligent Systems*, by the end of September. This paper will cover the need of geovisual analytics, the description of visual exploration tasks and the description of users involved in this exploration.

The second paper will present further use of these tasks into geovisual analytics environments, their formal description and the chosen methodology for rules development between tasks and visual solutions. This paper could be submitted to the *Cartographic Journal* or to the *Journal of Spatial Information Science*, depending on further decisions of passed MOVE workshop.

Both papers will be co-authored with the STSM supervisors (Menno-Jan Kraak and Corné van Elzakker) and MINES ParisTech research supervisor (Aldo Napoli).

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