Interactive Transitions for Map Applications

1 Description

Professional geographical information systems serve many different purposes, such as emergency response & management activities, landscape planning, and natural resource management. Beyond these, Web-based mapping service applications such as Google Maps[1], OpenStreetMap[2] or the French Géoportail[3] are used by millions of people, mainly for identifying points of interest and planning itineraries. Using any of these geovisualization systems typically involves navigating large maps by panning & zooming, switching between different views on the geographical area (e.g., traditional road map, topographical map, satellite imagery, as well as many other types of maps in geoportals: thematic maps, collaborative geo-data, etc.). It also involves adding or removing specific data layers on-demand, depending on what users are looking for. Beyond performing the above basic mapping tasks, advanced scenarios involving subject-matter experts reveal even more navigation issues that need to be addressed. For instance, in the context of natural disaster risk reduction, public authorities need to combine knowledge from different representations (facilities and infrastructures at stake) at different scales (regional to local), periods of time, and levels of detail, in order to identify vulnerable areas, forecast scenarios of impacts and reduce potential risk.

There have been significant advances on the graphics rendering aspects of geovisualization applications recently, such as the gradual switch, for some types of maps, from bitmap-tile-based rendering to vector-graphics rendering. However, the user interface aspects of those applications have received little attention and remain quite similar to what they were ten years ago. In this thesis, we will explore novel ways of combining different maps and data layers into a single cartographic representation, and investigate novel interaction techniques for driving the transition and navigating in the resulting representation. Based on the motivating scenarios mentioned above, we plan to design techniques for three transition types:

- *scale*: getting more or less details on a given geographical area,
- *data type*: changing the map semantics, e.g., traditional road map, topographical map, satellite imagery, etc.,
- *time*: observing the historical evolution of a given geographical area.

We will investigate two main ways of achieving such transitions:

- *space multiplexing*: displaying the two representations *at the same time* (side by side on the same display surface or on distributed display surfaces, integration of one representation on top of the other either locally or globally, etc.) – interaction may drive spatial arrangement ;
- *time multiplexing*: displaying the two representations *in sequence* (smooth global animation, progressive introduction of different elements that belong to either different categories or different local areas, etc.) – interaction may drive the speed and pace of a single animation or the arrangement between several animations.

[1] `maps.google.com` [2] `openstreetmap.org` [3] `geoportail.gouv.fr`

This PhD work consists of exploring this design space for achieving map transitions, implementing the most promising solutions and evaluating them. The perceptual and cognitive evaluation of visualization and interaction techniques in the context of this project is a scientific challenge and will be a contribution *per se*. Experimental tasks for testing will depend on users' expectations, which vary according to the type of transition considered. For example:

- When achieving a scale transition, users have to be able to figure out the spatial relationship between the two representations.
- When achieving a data type transition, users must be able to keep track of a given map objet and to identify which graphical attributes have changed (introduction of elements of legend, textures, etc.).
- When achieving a time transition, users want to integrate how a map object has evolved (outline deformation, introduction/removal of associated elements of legend, etc.).

All these concepts ("spatial relationship", "map object", "element of legend", etc.) will have to be operationalized into experimental tasks that can be run in a controlled lab environment.

2 Skills/Interests

- graphics rendering (most of the developments will rely on Java2D-based libraries) ;
- good knowledge of the foundations of Human Computer Interaction ;
- Geographical Information Systems.

3 Supervisors

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