Evaluating Geographic Visualization Tools and Learning about User Tasks

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Complex goal and task definition in geographic visualization

Computer environments for visual data exploration are commonly developed to investigate plausible scenarios or questions that prompt the discovery of relations or patterns that are useful. The goal of simultaneously representing data (geospatial or otherwise) in a number of graphical forms is typically to support a process of hypothesis formation and knowledge construction (Gahegan 2001). However, a clear definition of users' goals and tasks that facilitates the evaluation of software tools or concepts is not always possible due to the exploratory nature of visualization. In addition, visualization techniques can be pertinent for a wide range of applications, users and data types. At present, this implies that evaluations must be custom tailored to each system and the domain dependent tasks it is designed to support, which makes the generalization of results about (geo)visualization techniques difficult in many cases.

Refining task typologies

A series of three evaluations have been conducted on a visualization system suitable for exploring area-based geographic data for two main purposes. First, to investigate the nature of the tasks that users of these systems attempt. This has allowed determining some necessary system's functionality for supporting user requirements. More importantly, it has permitted the refinement of available task typologies (such as Zhou and Feiner 1998; Knapp 1995) that better characterize the visual exploration of spatial data. The second main aim has been to generate guidelines for designing experiments with which to evaluate the usability and usefulness of geovisualization systems.

Usability evaluations and experiments design

The first evaluation was designed to detect usability problems with the tool and to elicit users' views about the types of tasks they would need to support. The findings were incorporated as improvements in the systems interface design. They were also followed up in the subsequent evaluations with post-test interviews and questionnaires that obtained information about perceived usefulness and ease of use of the tool.

The second and third evaluations were aimed at tackling the first aim described above, which was accomplished by designing experiments where the tasks were defined in terms of three factors (each whith a number of levels): the visual cognitive operation preformed, the spatial extent of the area explored and the number of attributes investigated. This design made it possible to establish the marginal effect of each factor upon the outcome of a response variable, or in other words, provided a detailed description and measure of the impact of a given factor on the response variable at varying levels of other factors.

Relevance of findings and way forward

It is well known in geography that with spatial data "everything is related to everything else, but near things are more related than distant things" (Tobler 1970: 236). Hence, spatial relations and relative positions between geographic entities are not due to the semantics of a visual graphic designed to facilitate perception as in the case of Information Visualization displays, but are due to spatial processes that may exist in actual physical space. Geovisualization tools should allow users to discover such patterns and hence support tasks where the relative position or location of geographical entities may have a meaning in itself over and above facilitating perception.

Research in cognitive psychology on spatial cognition (Richardson *et al*. 1999), the representation in memory of geographical knowledge and its effects on geographic judgments and biases in geographical knowledge (Friedman *et al*. 2002), have profound implications on the building of solid theoretical principles for geovisualization and the design of computer based tools that support hypothesis formation and knowledge construction. On the other hand, evaluations in the lines of those briefly described above may contribute to the research in these fields by obtaining information about user tasks which support their work processes. In addition, the techniques discussed are an effective means to evaluate whether the tools we develop are usable and fit for purpose.

References

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