The University Consortium for Geographic Information Science

Research Priorities

SPATIALIZATION: SPATIAL METAPHORS AND METHODS FOR HANDLING NON-SPATIAL DATA

THE PRIORITY

This research priority deals with the need to develop a theoretical framework, supported by empirical evidence and large-scale implementation, for the construction of cognitively adequate and computationally efficient spatializations for knowledge discovery in large, distributed repositories of non-georeferenced data.

DESCRIPTION OF RESEARCH CHALLENGE

We define spatialization as the systematic transformation of high-dimensional (non-geographic) data into lower-dimensional spatial representations to facilitate knowledge discovery from very large databases. Spatialization involves a two step process including: (1) mathematical transformations to re-arrange data items based on their content and functional relationships into a logically defined coordinate system, and (2) graphic depiction of the spatialized data for information exploration and knowledge construction.

A spatialized representation differs from ordinary data visualization and geographic visualization in that it may be treated as if it represented spatial information, thus making possible the use of spatial metaphors and spatial analysis techniques for general data exploration. Spatialization capitalizes on people's familiarity with space in everyday life to produce information spaces that are both intuitive and internally coherent. Semantically sound information space design is called for when effective and unambiguous communication between information providers and information seekers is required as well as when knowledge from heterogeneous sources is to be analyzed as part of a knowledge discovery strategy. In either case, there is a need to derive generalization through semantic abstraction from data archives. A sound spatialization framework enables information designers to construct conceptually robust and usable information spaces and allow information seekers to more efficiently extract knowledge buried in large digital data achives.

Such a framework can be substantially supported through two major strands of work: (1) research into the cognitive and ontological

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foundations and implications of how people interact with non-spatial data on the basis of familiar spatial metaphors, and (2) work on the computational techniques that can produce meaningful spatialized geometries, visualizations, and methods of analysis.

IMPORTANCE OF RESEARCH CHALLENGE

There is a growing need for novel approaches to discovering and extracting information and knowledge from non-georeferenced data archives. While recent events have underscored the need to better analyze text, sound, and image records in counter-terrorism work, this is only one of many areas of relevance for this line of research. Visualization-based methods are seen as particularly relevant, as evidenced by the growth of information visualization as a cross-disciplinary field, including a distinct academic infrastructure. A look at various national funding programs reveals a similar picture, particularly at NSF and NIMA.

Awareness of spatialization within GIScience is growing, as indicated by dedicated sessions at the Annual AAG meetings and the GIScience conference series. Recent spatialization efforts of GIScientists have received enthusiastic reception by the information science and computer science communities. Recognition of spatialization as a GIScience priority will encourage the further infusion of GIScience expertise into spatialization research, reduce the redundancy that is still observed in many information visualization efforts, and raise the recognition of our community beyond the realm of geospatial data.

EMINENT RESEARCH QUESTIONS

Can we build an ontology of semantic information spaces? What will be its semantic primitives? For example, what kinds of proximities translate into semantic proximity in a (navigable) information space? Do people employ proximity strategies accordingly? Which visual variables are useful when dealing with the visualization of an information space, such as a collection of news stories? To what degree does the comprehension of a metaphor (e.g. map metaphor) depend on a user's background and training? What is the empirical evidence regarding the relative advantages and problems of 2D versus 3D visualizations?

Which computational techniques are most suitable for preserving characteristics of an information space during its projection into a representational space? In other words, once we know users' spatial cognitive strategies, how do we ensure that geometric configurations are created which actually justify the employment of these strategies? Can the notion of map projections and their inherent distortions help us in this matter? To what degree will it help us to reinterpret such techniques as multidimensional scaling and self-organizing maps in the light of the object-field debate? How does insight gained from spatializations compare to traditional statistical inference?

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