What Can GISciences Learn from Vision and Pattern Research?

What Can GIScience Contribute?

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Abstract

Geographical Information Systems (GIS) save and process data that describe the surface of the earth and objects that are on it; GIS deals with "large" amount of data (GB to TB), including raster and vector data with highly structured semantics (Frank 2001). From such data different information systems are derived, e.g., car navigation systems, Google Earth, regional and city planning, etc., etc.

The processes of vision and pattern recognition are potentially useful to recognizes objects as data (especially raster data that have been collected by remote sensing). The segmentation methods in vision are generally applicable for raster data: the transfer to vector data is somewhat more difficult. GIScience tries to integrate geometric and semantic criteria. In our current research we start with the assumption that the form observed is the result of processes shaping the object. The geometric rules to recognize object classes must therefore be linked to the underlying process. We attempt to describe these processes by algebras and expect that these process descriptions will be helpful in recognizing objects. We assume that humans are recognizing objects by what they afford us to do with them (Gibson 1986).

For a long time GIScience scrutinizes spatial relations and how humans experience and describe them. Metric and topological relations are analyzed and methods are described to recognize them as raster and vector data. Research is focused under the heading of "qualitative spatial reasoning". Several authors have addressed *qualitative metric* (Frank 1996) and *topological* relations and link them to human cognition (Mark et al. 1991; Egenhofer et al. 1995) with connections to qualitative reasoning in other fields (Hayes 1985). For example, it was possible to define the same topological relations (RCC or Egenhofer relations) for vector as well as for raster data (Winter et al. 2000). Vector data in GIS are most of the time stored as "winged edge" structures, at times quad edges that depict simplicial complexes are used. Efficient mapping of relations, such as Lienhard has described, appear applicable but are hardly known to GIScience researchers.

GIS processes data of different level of detail; pyramids seem useful and thus transfer of research results to GIScience are possible. Not only should pyramids in GIS give a gradually

more detailed access to data, but we expect to integrate in the pyramid also data quality information (Frank 1998; Bulbul et al. draft 2009), which is then used to limit the amount of data that needs to be processed when making decisions (Frank 2008). Data and decisions have a scale or level of detail that describes what part of the data is relevant; these scales we expect to describe by spatial and temporal frequencies of the processes involved (Frank submitted 2009). Different studies show geographically applied relations between levels of detail; still missing are formal description methods and accordingly efficient algorithms.

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