UC Santa Barbara

NCGIA Closing Reports on Research Initiatives and Projects

Title

Short Summaries of Key NCGIA Research Results

Permalink

https://escholarship.org/uc/item/2rt2243f

Author

National Center for Geographic Information and Analysis

Publication Date

1998-02-01

eScholarship.org Powered by the California Digital Library
University of California

Short summaries of key NCGIA research results

February 1998

Covering the period 1 December 1988–30 December 1997

- In a study of how humans request information from a geographic information system, NCGIA researchers found that a finite number of mathematical relations can be used to describe the full range of qualitative spatial (topological) relations between items in a geographic database. The formalism developed is easy to understand and applies to the most common types of geometric objects in geographic databases. As a result of this work, we can now develop better software that allows users to query geographic databases about arbitrarily complex spatial relations. Through close cooperation with U.S. industry partners, this model was quickly integrated into commercial products.

- All geographic information is subject to error and uncertainty, because of the limitations of mapping and surveying instruments, census data collection methods, the effects of map generalization to coarse scales, and endless other factors. NCGIA has developed and published the first comprehensive set of error models for geographic information, implemented them in techniques for estimating confidence bands on the results of analysis of geographic information, and made them available in the form of software for use in conjunction with GIS. It is now possible for the first time to evaluate objectively the effects of data uncertainty on the results of research and decision-making using geographic data.

- Searching for ways to standardize access to geographic databases, NCGIA developed a comprehensive extension to the standard database query language SQL for large spatial databases. This database language features such innovative components as map-like presentations of query results, modifications of the presentation upon user request, and selection of items based on conditions among spatial objects. Most commercial products of geographic information systems have adopted such an approach and efforts led by the Open GIS Consortium used such concepts as a basis to finalize an industry-wide standard.

- Geographic information systems were adopted widely in government agencies at all levels shortly after their commercial introduction in the early 1980s. On the other hand their high cost kept them out of the hands of grass-roots community groups until comparatively recently. A number of aspects of GIS design also work against their adoption by all stakeholders in planning debates: it is difficult, for example, to represent more than one point of view about an issue in GIS. NCGIA's project on Public Participation GIS has developed designs for a new type of GIS aimed specifically at this application, with input from community planning groups, and the designs have been tested in several applications.

- In an interdisciplinary effort, NCGIA gained new insight into a better understanding of spatial relations as used in natural language. Combining formal methods from mathematics with human subjects testing methods from psychology and linguistics, they have established rules for determining when people would be likely to consider that, for example, a road "crosses" a park, when it would "enter" the park, etc. The formal model is more powerful than models currently in use in cognitive science, and will lead to better natural-language user interfaces of public geographic information systems, enabling a wide range of citizens to use complex new technologies.

- Early generations of GIS software were notoriously difficult to use, in part because of crude user interface design, and in part because of limited understanding of how people think and reason with geographic information. NCGIA's Research Initiative 2 brought cognitive scientists together with GIS designers for the first time, and led to the development at the University of Maine site of NCGIA of novel techniques of user interface design for GIS. These methods are now implemented in several commercial systems, and have led to a marked improvement in recent years in GIS ease of use.

- In principle, the content of coarse-scale maps should be derivable from more detailed maps through a series of systematic procedures. In practice, national mapping agencies produce map series at one scale largely independently of mapping at other scales, with consequent redundancy of effort and substantial cost. NCGIA's research on the multiple representation problem has led to the first systematic collection of map generalization techniques, the development of several new ones, and their implementation in the first commercially available procedures for automated generalization.

- Maps and atlases have traditionally presented geographic information as if it were free of uncertainty, and techniques for displaying map uncertainty are now of purely historical interest. Yet map uncertainty still exists, and is reflected in lawsuits over uncertain property boundaries, arguments over the accuracy of wetland delineation, or debates over old growth forest as wildlife habitat. NCGIA's Research Initiative 7 has made use of the new potential offered by computerized geographic information to communicate knowledge of uncertainty through newly developed techniques of animation, three-dimensional simulation, and use of sound.

- Many types of geographic information have long been known to violate the assumptions commonly made in statistical analysis of independence, stationarity, and random sampling. Techniques to overcome these problems have been available, but lack of suitable software and readily implemented methods has kept them out of widespread use. As part of its research initiative on GIS and spatial analysis, NCGIA has developed and distributed a suite of software packages for easy integration of analysis with GIS, and for management of various forms of spatial dependence and heterogeneity. With these tools, researchers performing empirical quantitative research in social science now have ready access to methods for dealing with what were previously substantial statistical problems.

NCGIA education results

- NCGIA's contributions to education began with the development of the "NCGIA Core Curriculum in GIS", a set of teaching materials that has been adopted as the basis for university-level GIS courses in over 1,000 institutions worldwide and translated into several different languages including Russian, Chinese, Japanese, French, and Hungarian. NCGIA has also developed similar materials for use in K-12 education. These education materials act as curriculum aids in many different disciplines. For example, a chemistry teacher has found GIS to be an excellent tool for motivating students through a discussion of problems of storage and transportation of hazardous materials. In other cases GIS is used as a base for problem solving studies on issues in the local community, or as an interesting, interactive way of learning about other parts of the world.