ncgia

a cognitive retrospective

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Retrospective on the background, programs, and results of NCGIA

- Workshops, conferences, research initiatives, edited volumes, …
- Engaged a **wider community from Day 1**
- Looked towards what is working and what needs to be added
  - COSIT series supported strongly by NCGIA
  - GIScience created to complement existing conferences
  - Pushed foundational issues in the field

    94-9: Time in Geographic Space: Report on the Specialist Meeting of Research Initiative 10, edited by Max J. Egenhofer, U. Maine, and Reginald G. Golledge, UCSB, describes the Specialist Meeting of the NCGIA Research Initiative on "Spatio-Temporal Reasoning in GIS" which addresses space and time as it relates to objects and people in geographic space
  - Pushed the field to consider alternative frameworks

NCGIA and Varenius Workshops

- Multiple Modalities & Multiple Frames of Reference for Spatial Knowledge
  Santa Barbara, California
  February 18-20, 1999

- Cognitive Models of Dynamic Geographic Phenomena & Representations
  Pittsburgh, Pennsylvania
  October 29-31, 1998

- Scale & Detail in the Cognition of Geographic Information
  Santa Barbara, California
  May 14-16, 1998

Project Varenius aims to foster research in the following areas of geographic information science:

– computational implementation of geographic concepts

– cognitive models of geographic space

– geographies of the information society

Mark, D. M., Freksa, C., Hirtle, S. C., Lloyd, R., & Tversky, B. (1999). Cognitive models of geographical space. *International Journal of Geographical Information Science, 13*, 747-774.

FOUNDATIONAL ISSUES

- The research over the past twenty years has highlighted the importance of cognitive maps in geographic communication, acquisition and use of geographic information, wayfinding, planning, and urban design.
- From constructing user-centered in-car navigation systems that impose a minimum of attentional demands on a driver to constructing urban parks that encourage public use, research on cognitive mapping can suggest appropriate parameters to consider in the design process.

Knowledge Acquisition

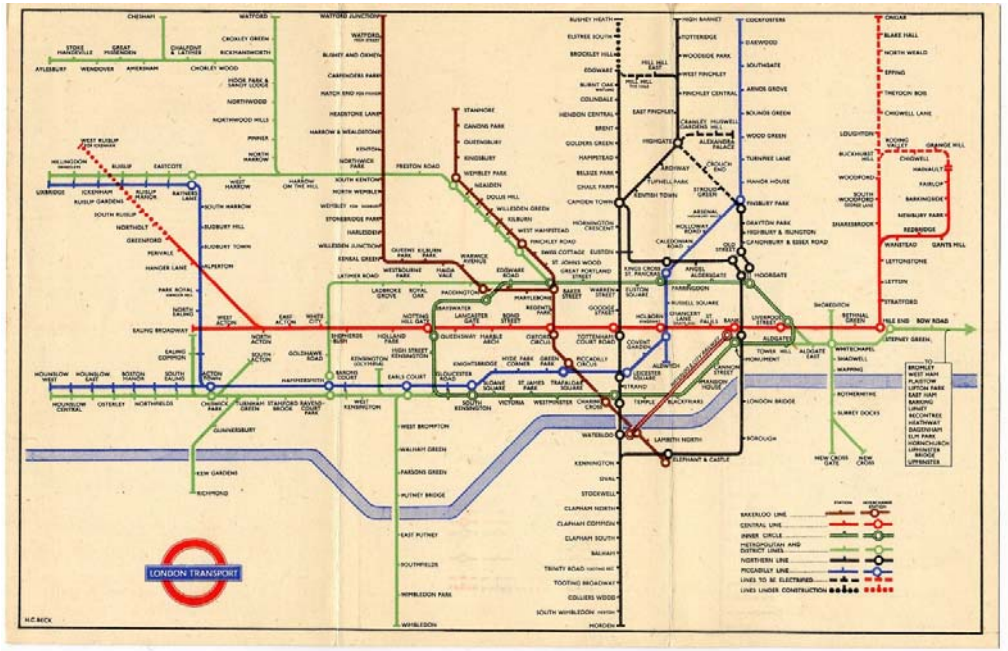
- Knowledge acquisition is a messy business. The classical view of [Landmark Recognition → Route Knowledge → Survey Knowledge] does not hold under careful scrutiny.
- It clear that the acquisition sequence is not strictly linear (Allen, 1999).
- Accurate metric knowledge was either gained in the first session or never learned, calling into question the learning parameters in the original conceptualization (Ishikawa & Montello, 2006).

Hierarchical Structuring

- While automated navigation systems often provide directions using street nodes (*turn left at Main St; Go 3.4 km*), humans often talk in terms of neighborhoods and landmarks (*when you get to downtown, turn left at the Starbucks*).
- Neighborhoods form one of the basic organizing principles of cognitive maps, nested in a semi-lattice (Hirtle, 1995), which leads to hierarchical clustering like effects on judgments of distance and orientation.
- There is a symbiotic relationship between landmarks and neighborhoods provides two distinct ways of structuring space into regions, which in turn influences the perception of that space.

Schematization of Geographic Knowledge

- The London Underground map designed in 1931 by Harry Beck is seen as ideal communicator as it extracts useful information, organizes that information in a colorful and pleasing display, while keeping relative directional information intact (e.g., northern stations are at the top of the map), as well as the critical linear ordering of stations along a specific route.



Schematization of Geographic Knowledge

- Beck's map replaced a more geographically accurate, but less useful, rendition of the same information.
- In fact, it is becoming clear that photographs, virtual reality, immersive environments and other photo-realistic settings by themselves may have limited used for navigation aids (Darken & Peterson, 2001; Freksa, 1999).

ALTERNATE FRAMEWORKS

- While traditional approaches have been useful to understanding the nature of cognitive mapping, they are limited in their ability to account for the interactions of multiple criteria. A number of researchers have explored several alternative frameworks for the development of cognitive maps. Three of these approaches are reviewed below.

Naïve Geography

- Naïve Geography is an approach based on the work in artificial intelligence in the 1970's on Naïve Physics to model common-sense knowledge of objects and motions in the world (Hayes, 1979).
- Egenhofer and Mark (1995) introduced the concept of Naïve Geography to capture everyday reasoning about geographical space.
- Naïve Geography include a number of interesting principles from assuming a space is two-dimensional, even though it is not to asserting that boundaries are sometimes entities and some not.

Naïve Geography

- For example, if a boundary is always taken as a mathematical object of having length but no width then the common notion of leaving one's country before entering another country would be impossible.
- Reasoning about boundaries in such situations, including the legal standing, would follow the principles of Naïve Geography and not the underlying mathematical principles.
- Geographical Information Systems that ignore the principles of Naïve Geography might prove difficult to use. These limitations are particularly worth noting for community-based or public participation GIS systems

Naïve Geography Example?

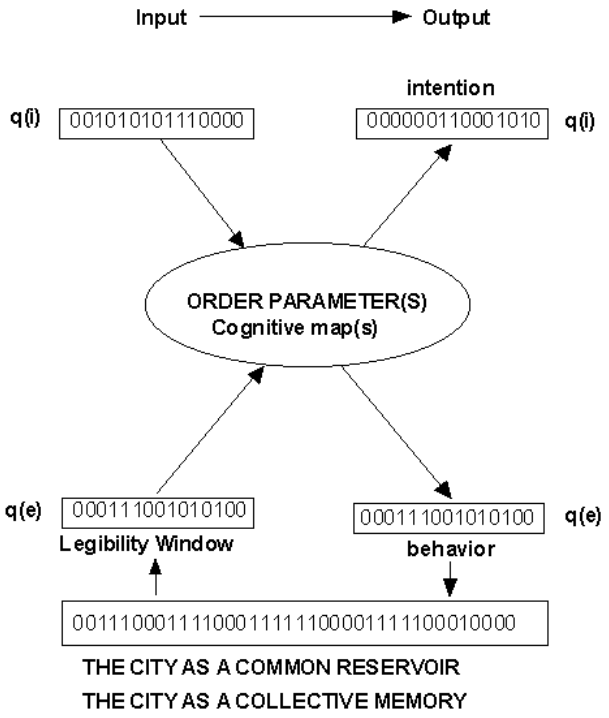
- David Mark: "How big is the pie"?
- Answer: "The size of a triangle … (pause) … only a little larger."

Geocognostics

- At the Naïve Geography Meeting, Geoff Edwards (1997) developed a framework called geocognostics.
  - In this approach, he argues for the need to combine two representational structures, one for views, which is the typical focus of cognitive maps, and another for trajectories, or one's path through the space.
  - The approach of using trajectories through space was also the focus of work by Hutchins (1995) in explaining the representations of Polynesian sailors who could not depend on traditional landmarks in their navigation tasks.
- Geocognostics gets its name from the combination of geometrical and cognitive principles that are needed to account for a rich set of empirical findings.

Synergetic Inter-Representation Network

- Juval Portugali at GIScience and COSIT has argued for the value of considering the links between internal representation and the external environment, which necessarily influence each other.
- Using the mechanics of self-organizing system, he introduces the notion of a Synergetic Inter-Representation Network (SIRN).
- SIRN provides a new underlying theory that can account for acquisition and storage of spatail information.



CONCLUSIONS 1/3

- NCGIA has been at the forefront of applied and theoretical research on cognitive mapping.
- Cognitive mapping is proven to be rich source of both empirical findings and theoretical research. In addition, it is argued that cognitive mapping is important for many areas of geoinformatics.
- The acceptance of public GIS projects, the ability to provide useful feedback to planners, the use of navigation systems, and the modeling of emergency management evacuation plans depend in part on understanding how humans process spatial information.

CONCLUSIONS 2/3

- In part, cognitive mapping provides the framework for developing user-centered GISs.

- A navigation system working only in longitude and latitude would be accurate but worthless as an in-car navigation system.
  - While this example may seem obvious, the reality is that multiple coordinate systems are already in use and emergency call operators are faced with translating from caller's natural language information to a GIS to a rescue vehicle's code, resulting in a large number of possible confusions or miscommunications (Goodchild, 2000).

CONCLUSIONS 3/3

- The NCGIA has
  - fostered leading research through engagement with wider research communities
  - consistently brought multiple voices to the table to address issues of concern
  - manage to examine both theoretically interesting problems and motivated real-world applications, often within the same meeting or research endeavor

- Questions or comments welcomed…