

HOW CAN THEORETICAL CARTOGRAPHY CONTRIBUTE TO GISCIENCE: A PHILOSOPHY PERSPECTIVE

DU Q.

Wuhan University, WUHAN, CHINA

INTRODUCTION

Theory issue behind map and GIS has been always a tough and controversial theme which is critical for them to become sciences in multi-disciplinary circle. To build a theoretical framework for modern Cartography and GIS discipline from different approaches is certainly beneficial to the further development of the two disciplines. Cartography and GIS are relatively separate disciplines; however, they have inherent correlation. By looking back to the development of theoretical Cartography, we can borrow something for on-going GIS theory development effort.

Philosophy has been evolving for hundred years. Among numerous schools of them it is noted that two main turns have generally taken place, i.e., Epistemological turn from Ontology (or Metaphysics) and Linguistic Turn from Epistemology (Robert Greene,1980, Richard Rorty,1967). The three phases of philosophy development reflect the focus shift from reality itself to its representation both in our mind and language.

1 FROM COMPUTER CARTOGRAPHY TO GISCIENCE

Cartography as a long historical science deals with representing, communicating and exploring spatial knowledge. Cartography is primarily about map making and map use, where map making is a process from reality to map via conception and map use from map back to reality again. Cartography has been evolving a lot as introduction of computation technology. GIS took its place in 1960's and develop further to Giscience. Characteristics of information integration make GIS go far beyond map even pure spatial knowledge. However Cartography is still important because of spatial knowledge play an exclusive role in GIS

In Cartography, map is the integration of human plus their spatial thinking (map maker, map user, society), where in GIS, GIS is map data (digital map, image, attribute, multimedia etc) plus machine(computer, network, software) and human(GIS designer, GIS user, society). Here we can see machine (hardware + software) replaces part of the function of paper's recording and human's spatial thinking ability. Machine along with its computation technology prevail and are rapidly developed for the last decades, however the rest of the components has lagged far behind.

2 WHAT IS GISCIENCE ABOUT

Geographic Information Science (GIScience) is the basic research field that seeks to redefine geographic concepts and their use in the context of geographic information systems. GIScience also examines the impacts of GIS on individuals and society, and the influences of society on GIS. GIScience re-examines some of the most fundamental themes in traditional spatially oriented fields such as geography, cartography, and geodesy, while incorporating more recent developments in cognitive and information science. It also overlaps with and draws from more specialized research fields such as computer science, statistics, mathematics, and psychology, and contributes to progress in those fields (David Mark, 2000). According to Mark,(2003) , GIScience should include at least following issues:

- Ontology and representation
- Ontology of the geographic domain
- Formal representation of geographic phenomena
- Computation
- Qualitative spatial reasoning
- Computational geometry
- Efficient indexing, retrieval, and search in geographic databases
- Spatial statistics
- Other geo-computation topics
- Cognition
- Cognitive Models of Geographic Phenomena
- Human interaction with geographic information and technology

- Applications, institutions, and society
- Acquisition of geographic data
- Quality of geographic information
- Spatial analysis
- Geographic information, institutions, and society
- Crosscutting Research Themes
- Time
- Scale

If we look closer to the components arising, they roughly fall into two categories: science and technology or theory and method. Computation issue is basically technology or method oriented such as database, some has strong property of cognition and thinking such as spatial reasoning. Ontology and cognition are explicitly listed out here. Some are implicitly theoretical concern, for example, time and scale could be part of furniture of the universe, which is subordinate to fluxism, one school of Ontology. It can be included that philosophy should play a key role in GIScience construction

3 PHILOSOPHY ISSUE IN THEORETICAL CARTOGRAPHY

Traditionally, Theoretical Cartography has been closely related to different school of Philosophy. It is difficult to exhaust all philosophical approaches in Theoretical Cartography, Epistemology and Semiotics are main two of them. Epistemology is concerned with cognitive and aesthetic aspect of human to map symbol, color, pattern and layout, while semiotics with conceptual model of map and its surroundings. Metaphysics is also adopted to build theory of Cartography (e.g. Meta-Cartography), where Ontology plays a role.

Up to now Semiotics seems prevail in Theoretical Cartography community for at least two reasons: its ability for explanation and value for methodology. On the other side, ontology is getting popular in GIScience via information science and knowledge engineering.

4 CONTRIBUTION OF THEORETICAL CARTOGRAPHY TO GISCIENCE

Map is as old as human beings. GIS exists only for several decades. GIScience is even shorter in history. GIScience has the necessity to learn from the effort of theoretical Cartography

To some extent, we can compare map to GIS as well as Theoretical Cartography to GIScience. The comparison is meaningful and significant. Cartography deals with not only map, but map maker and map user with their mind and cognition. GIScience deal with spatial data and associated geographic meaning and knowledge, capability to handle them and interpret them. The comparison can still extend to the comparison of social space of map to cyberspace of geographic information service.

Ontology, Epistemology and Linguistics are three main phases in philosophy development. They represent different approaches for human to understand the universe and ourselves, where Ontology is concerned about the existence, Epistemology the knowledge and Linguistics the existence via our knowledge. Philosophical perspective always dominate in Cartography and GIScience research

5 GISCIENCE ADVANCE IN PHILOSOPHICAL ASPECT

To build a framework of theory for GIS from the perspective of Philosophy is a task of challenge. Following the thread of focus of philosopher from Ontology, Epistemology to Linguistics, we can understand better how we could define the field and boundary of GIScience which may be conceptually coincident with human's worldview and way of thinking.

5.1 Ontology

Ontology is the earliest philosophy branch about the being and existence, the general rules or furniture of the universe. The science of what is, of the kinds and structures of objects, properties, events, processes, and relations in every area of reality.

Ontology reflect the interest of philosopher to the reality itself. Different schools of Ontology focus on the reality from different angles such as substantialism (thing), fluxism (event or process), and adequatism (taxonomy). This Ontology in the sense of philosophy seeks the understanding of the reality, and then evolves to the reality representation in our mind, i.e., the conceptualization of the world, in the sense of information science. Which ever ontology is, it draws our attention back to the reality and also the representation of reality, especially from the viewpoint of computation, where algorithm design was once primary concern of computer scientist.

In GIScience, Ontology is turning to a spatial knowledge framework. Ontology can help to build a better model of the geographic space, i.e., spatial data model and other semantic representation are confronted with a great leap with the help of ontological base.

Apart from universal ontology, there are more than one ontology which change from time to time, place to place, domain to domain and task to task. Ontology can be seen as common part of community's conceptualization. Generally ontology can also be defined in a hierarchical manner as following:

- Upper level ontology: structure of time, space, attribute, event, process etc
- Domain ontology: for a specific domain
- Task ontology: for a specific task.

Cartography can help build a better geographic ontology because map itself is a conceptual system which covers human cognition of the geographic space in different history, culture, location and domain, and for different purpose. This map spectrum is a sole geographic ontological base which represented with map language. To mine geographic ontology from maps could be a feasible way to build a more intelligent GIS.

5.2 Epistemology

Epistemology deals with the nature, origin and scope of knowledge, our cognitive ability and our knowledge system. Mental map is the best result of epistemological process. Epistemology turn reflects the difficulty of understanding the existence leaving our cognition ability aside. We look inward to ourselves about what we can understand, how we represent and organize the reality in our mental world. Epistemology is strongly connected with aesthetic and psychological process. In GIScience, it has close relation to algorithm and analytical model.

Epistemology is important because we need to understand how our cognitive system runs and what the result is by cognitive process, presumed any our knowledge about the reality come through our cognition of the reality. For information system, to possess both knowledge about the reality and capability to handle the knowledge is critical. In a broader sense, building and using GIS are also cognitive process just like map making and map use. Human-computer-reality real-time interaction has become on-going operating model for GIS, here spatial cognition as the interested branch of both psychologist and geographer is apparently relevant.

Cartography has long history to research the perception and cognition of human to map symbol and color, and further the spatial pattern. Map making and map reading are two inverse cognitive processes to encode and decode spatial knowledge mediating by cartographic representation. Interaction between human and map, incorporated with geographic circumstance in which map are made and used, is a perfect knowledge communication model, among which cognition plays a key role.

5.3 Linguistics (Semiotics)

In information science, Linguistic paradigm plays a main role to connect Ontology and Epistemology, for Ontology comes from conceptualization which is by epistemological process and need some kind of language to formalize or represent it. i.e. Language represents the observation result of the reality (Ontology) through the filter of our mind (Epistemology).

Map as a kind of spatial language or semiotics system has dual function, recording our knowledge about the world and providing the knowledge about the world. Map as cognitive model, as communication channel, as spatial index tool, as spatial analytical tool reflects its linguistic function perfectly. Syntactics, semantics and pragmatics are three aspects of language system which provide us different methodological approaches to look in depth the structure of our spatial language system. Map archive itself is a knowledge base which can provide us with not only descriptive knowledge, but also declarative and procedural knowledge.

GIS as linguistic system can help it more than a database or set of geographic objects. With the help of linguistic paradigm of GIScience, GIS will become more structural, meaningful and useful. There will be plenty of linguistic approaches from more than 100 year development of modern linguistics to apply on geographic data. Some of the branch of linguistics include:

- Phonetics, Phonology, Morphology
- Syntax, Semantics
- Psycho-linguistics
- Socio-linguistics
- Historical linguistics
- Mathematical linguistics
- Applied linguistics
- Visual linguistics

Even merely from the microcosmical and technological approach, Linguistic paradigm of geographic information has at least four aspects of significance for the development of GIScience, i.e., its paradigm potential, its ontological concern, its methodological guidance and its qualitative approach

6 CONCLUSION

So far most GISs depend heavily on Euclidean Geometry. However, much research reveals that the structure of geographic information is not merely a geometric matter, instead, more an ontological, epistemic and linguistic matter.

Both Theoretical Cartography and GIScience are confronted with the demand of theory and paradigm development. Theoretical Cartography can contribute to GIScience for its predating concern with some essential issue of geographic knowledge system. Two significant turns in philosophy give us hint to investigate the development of geographic knowledge system from outside and yet higher perspective. To make GIScience a real science we need common effort of Cartography and GIS community.

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