Semiotics of Addressing Systems in Urban Environments

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Abstract Addressing systems are primarily designed for enabling computers to match an address to its corresponding location on a map. However, humans also frequently use addresses to find locations in the environment without any machine aid. This paper discusses cognitive issues of addressing systems, by examining what types of spatial knowledge can be provided by different addressing systems.

An address is a specification that refers to a unique location on Earth (Longley et al. 2011). It is usually expressed in the form of an addressing system, i.e. as a combination of certain components (e.g. spatial features and their relations, postal codes, etc.). Addressing systems can be distinguished depending on their structure, as well as the types of the components used, which often correspond to social and cultural aspects (Davis et al. 2003). For example, in China and most of Europe, roads and consecutive building numbers are among the standard addressing components. However, there are other places, like Istanbul in Turkey, Salvador in Brazil, as well as Iran, where a name assigned to a building can have addressing value. Japanese and Korean are quite different; (most) streets have no name, and blocks are coded instead. In addition, building numbers are not ordered along a road, but based on the date the buildings were constructed (Kim U.N 2001).

Geocoding (or address matching) refers to the process of relating an address to its corresponding location on a map (Longley et al. 2011). Today, most spatial information systems are equipped with automated geocoding engines, which is one of the prerequisites for providing meaningful location-based services (Dru M.A. & Saada S. 2001, Schmidt M. & Weiser P. 2012).

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Research on evaluating (Davis et al. 2003, Cayo M.R. & Talbot T.O. 2003, Karimi H.A. et al. 2004, Goldberg D. & Cockburn M. 2010 a) and improving (Goldberg D. & Cockburn M. 2010 b, Wu J. et al. 2005, Yang D.H. 2004) the accuracy of geocoding generally agrees that the accuracy factor mainly depends on the syntactic structure of the corresponding addressing system, as well as the richness of the database (cf. gazetteers) used (Davis et al. 2003).

While GIScience's goal is to formally model the interaction of humans with their environment (Frank A.U 2000), the interaction of humans with addresses (as verbal descriptions of locations in the environment) has been less explored. People are a major (if not the largest) user group of addresses. They frequently use addresses to find locations in the environment without any machine aid. In addition, an address provides people with an interpretation of their surroundings, which is a different mental representation of space compared to the one resulting from manipulating and acting in the external environment (Golledge R.G. and Stimson R.J. 1997).

To investigate these differences, this paper introduces the idea of semiotics of addressing systems. If an address is thought of as a symbol or *sign* referring to a place, then according to the science of signs or *"Semiotics"*, three different aspects of it (i.e. syntax, semantics, and pragmatics) should be studied in order to discover the differences/similarities between this sign (an address) and the object that the sign is referring to (a location on the Earth). This paper particularly intend to answer the following questions:

- How much is an addressing system structured? How can it be formally defined? How complicated is its formal definition?
- How much is an address interpretable by humans? How much can it relate to humans' spatial mental representations?
- How much is an addressing system spatially informative? What spatial knowledge does it provide to humans? How much can it help humans to perform spatial tasks, such as wayfinding?

To answer these questions, three different addressing systems with different structures and types of components (Austrian, Japanese, and Iranian addressing systems) have already been considered. The syntax of each addressing system has been discussed through its formal description; and its semantics and pragmatics have been evaluated based on the types and relations of their addressing components.

The initial results indicate that the differences in structure of different addressing systems lead to different complexities in their formal definitions as well as different levels of detail. Addresses are conceived, interpreted, and integrated into human spatial mental representations differently, depending on the form of the address. From the spatial knowledge acquisition point of view, an address provides people with an interpretation of their surroundings: An address that only contains spatial features helps to acquire declarative components of spatial knowledge (which includes knowledge of objects and/or places together with meaning and significance attached to them); whereas ad-

dresses with spatial relation components also contribute to acquiring configurational components of spatial knowledge (i.e. information about spatial relationships among objects or places).

Empirical tests are required to verify the above initial theoretical results. There are many linguistic, cultural, and cognitive issues to be taken into account, which may thoroughly affect the findings. However, it is still unclear how to impart differences in spatial cognition caused by external factors in empirical studies. Therefore, in addition to empirical tests, an agent-based simulation can help to confirm the hypothesis in an isolated environment in order to demonstrate the humans' spatial knowledge acquisition and growth in the course of long time interaction with different addresses.

On the other hand, studying different addressing systems can lead to a better understanding of the way different people around the world think about their space. A Japanese person who has been exposed to an addressing system with no names for streets, but (temporally-ordered) codes for blocks and buildings may perceive space differently than an Iranian person who has been interacting with a route-description-based addressing system full of spatial elements as well as metric and topological relations. This might have considerable effect on different aspects related to spatial thinking, such as route planning, verbal and non-verbal spatial communications, etc.

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