Relating Land Use to the Landscape Character: Toward an Ontological Inference Tool

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1. Introduction and Context

The latest buzzing notion in geographic information science draws from cognitive science, an offspring from psychology, philosophy, linguistics, computer science, neuroscience and anthropology dating back to the 1950s (Miller, 2003). The notion relates to the spatial characteristics of an environment which determine a human's conceptualisation of that environment. In that context it sounds reasonable to posit that the understanding of space is anchored in the experience of people's perception of space, and spatial cognition and behaviour. However, there is a gap between the widely deployed models of space and what research in cognitive science and related fields identified as being important for human interaction with and conceptualisation of space (Mark *et al.*, 1999). This gap still needs to be bridged in order to establish realistic representations of space that correspond with human conceptualisations allowing more efficient spatial information processing (Mennis *et al*., 2000).

In the present work this bridge will be formed by relating human spatial perception of land use to the landscape characteristics in order to build an ontology that is capable of representing the acquired knowledge and to allow inference of land use information from Ordnance Survey's MasterMap topographic database. The relevant material is to be provided by a survey aiming to derive consistent cognitive information from human experience of geographical space.

2. Interviewing for Ontology Engineering

Knowledge can be modelled by an ontology, which explicitly states how relevant concepts and their constituting objects relate to each other and manifest themselves in their physical existency both in reality and that of their representing geography. After all, it is the physical environment that provides the most basic examples of geographical phenomena with which we all are familiar. As stated by Lowenthal (1961, pp. 241-242) "*geography observes and analyzes aspects of the milieu on the scale and in the categories that they are usually apprehended in everyday life*", and "*like geography, however, the wider universe of discourse centers on knowledge and ideas about man and milieu; anyone who inspects the world around him is in some measure a geographer*". Accordingly, the universe of geographical discourse is shared by billions of amateurs all over the globe, allowing us to take a much broader approach instead of founding the ontology on a single domain expert. Moreover, a study of ways non-experts conceptualise

a given domain of reality might help efforts to maximise future usability of the ontology, let alone through its empirical testing (Smith and Mark, 2001).

3. A Spatial Knowledge Questionnaire to investigate the 'Map in the Head'

The 'map in the head' is a metaphorical description of how people process and recall spatial knowledge according to conglomerations of information drawn from different sources and modalities pulled together for a particular purpose (Mark *et al*., 1999). Indeed, a picture is worth a thousand words (Pinker, 1997) enabling cognitive economy (Rosch, 1978), but as a visual object it may or may not convey univocal meaning (Peuquet, 1988). Nevertheless, knowledge can be captured and translated into a machine readable knowledge base if one can account for the ways in which people represent and combine geographical information, categorise common properties for the instances of a land use concept and its spatial structure, and reason to derive new knowledge. These ways can be described by the 'map in the head' metaphor, which, being inspected by the 'mind's eye', is functionally identical to a graphical map inspected by a 'physical eye' (Kuipers, 1982). This implies a direct relationship between the map's depicted reality and that of a map reader, as illustrated in figure 1 derived from Koláčný's (1969) communication model about cognitive aspects of cartography. Both the map and the person inspecting the map carry a representation of reality determined by a variety of factors, which will be mapped onto an ontology.

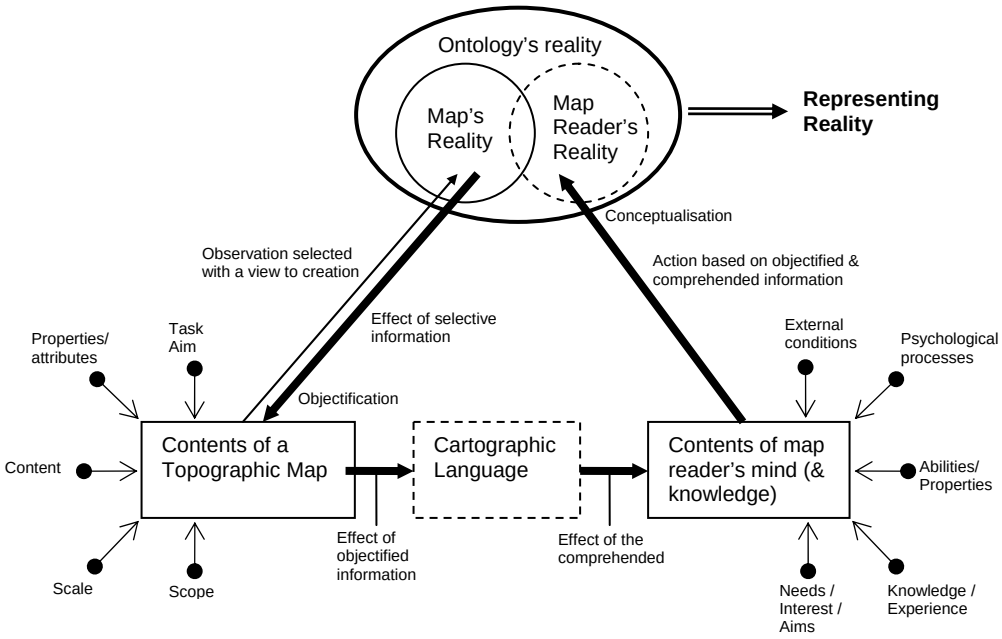

Figure 1. A unified representation that combines both detailed, spatial information from the map data as well as human-acceptable concepts that are intrinsically tied to their underlying geography, and thus to the data itself.

The purpose of this study is (a) to study a plain topographic map according to the processes that operate on it when it is being inspected by the map reader; (b) to study the nature of the input, or stimulus, perception and analytic processes and the nature of similarity judgement; (c) to study a person's conceptualisation according to the principles and structure of categorisation; and (d) to study the respondent's demographic characteristics as an influenceable factor in all of the above. For example, the study of a person's conceptualisation is based on people's inner knowledge representation and principles of categorisation (Rosch, 1978). Therefore, questions are structured according to a horizontal dimension, where separate categories describe a land use spatially, and to a vertical dimension, where those categories are further described in detail by a further set of questions. The information gathered from this process will look similar to the representation given in figure 2, starting with functional concepts that make up a specific land use category, which are then further described according to their purpose, role, affordance (i.e. words), physical property and spatial relations. Hence, the land use is represented and defined based on its underlying land cover, taking a top-down approach from the general to the specific.

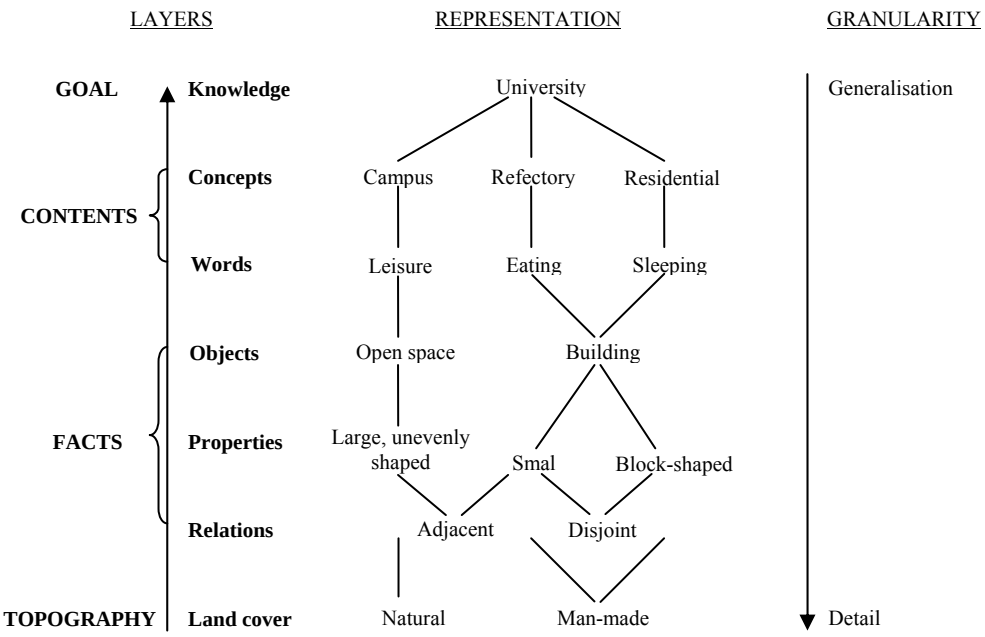

Figure 2. A top-down approach for capturing a person's inner conceptualisation

4. Preliminary Results

Some preliminary conclusions can be drawn from results of a small pilot study, based on PhD colleagues from the Department of Geomatic Engineering, UCL. The results suggest that people are capable of inferring land use information from a plain topographic map, despite not necessarily being very familiar with this type of data. The most accurate interpretations were achieved with respect to residential areas, such as terraced houses, and recreational areas, such as parks and sports grounds, which have quite distinct features. More difficult proved to be the interpretation of larger features and buildings, which could either be industrial or educational buildings, retail outlets, hospitals, or

offices. Most respondents approached the interpretation task by looking for the road network, shapes and sizes of objects, whose similarity as well as their overall shape determined the perception of groups. The greatest difficulty in the interpretation was caused by misinterpreting objects based on the inability to correctly understand an object's meaning, while the fuzziness of where one land use starts and the other ends was not a major obstacle. None of the respondents recognised the depicted area's location in reality.

The conceptualisation of a land use category seems more difficult than expected. Nevertheless, results indicate that conceptualisations are similar across respondents despite small variations depending on what was felt is important in describing a particular land use at that moment in time. Further, conceptualisations resemble much of the real environment due to the factual information about a land use's spatial organisation. However, respondents did not differentiate much between a member category's purpose, role or affordance, showing that there is a very fine distinction among those concepts, which people are not always aware of. Results from the conceptualisation of industrial area and educational institution seem to fortify the observation of Smith and Mark (2001) that the number of instances given by respondents per title category appears to reflect some combination of the familiarity of the category itself and the richness and diversity of familiar category members.

A further approach to capturing people's mental representation of land uses was tested in the form of sketch maps. Despite existing analytical methods used with sketch maps (Okamoto *et al*., 2005), the results are impossible to analyse, since the sketch maps do not relate to a specific known geographical location in the real world. Furthermore, Downs and Stea (1977) defy such a pursuit, as sketch maps vary greatly due to personal variations in age, experiences, and skills, and a one-to-one correspondence to the real world is apparently absurd due to people's limited storage capacity of information and its selective cognitive processes.

5. Conclusion

Land use information is readily available from various commercial sources. However, the methods with which such information is created are time consuming and still require considerable amount of human interaction. Ordnance Survey's strategy is to capture and maintain once, but to use many times. Hence, the aim is to infer additional information from existing data repositories in order to tailor future products according to customer needs. Such an inference, especially from a topographic database, is not easy. In this research the use of ontologies for such a purpose is investigated using human knowledge and their map interpretation abilities as a starting point. Whilst we are trying to embrace elusive measures such as human values, attitudes, beliefs, judgement, trust and understanding of a land use domain, the information captured is specific but objective in its contents, yet it is general across people's knowledge but subjective in its nature. One pitfall may indeed be the infiltration of human knowledge with erroneous beliefs (Smith, 2004).

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Biography

Marie-Kristina Thomson is a PhD student in the department of Geomatic Engineering at UCL researching ways to infer information from a topographic database. She holds a BSc

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