COGNITIVE CARTOGRAPHY AND GEOGRAPHIC INFORMATION SPATIALIZATION

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ABSTRACT

The Science of Cognitive Cartography uses concepts and procedures of Cognitive Psychology to recover mental images, in order to evaluate them for extracting geographic information considered by persons, having specific methods to evaluate the space knowledge. The establishment of methodologies which propose to meet this set of ratings in Cognitive Cartography learning, is considered one step to understand the functional structure of mental cognitive mapping from spatial information, namely the processing of information to its formalization as a knowledge in cognitive map. These purposes help to draw a user or producer profile of geographic information, allowing their participation in the structuring of this information. The purpose of this research focuses on building a methodological procedure for examining the level of space knowledge of a group of individuals, who have experience in cartography, using methods of knowledge representations based on meaning. This procedure aims to enable a greater understanding of cognitive processes related to geographic information, providing another alternative in analysis and assessment of individuals geographic knowledge, and the enrichment and contribution to the research on Cognitive Cartography.

1. INTRODUCTION

A Cognitive Mapping is a line of research that uses concepts and procedures of cognitive psychology to recover the mental images and to evaluate them, in order to extract the geographic information considered by individuals (Blades & Spencer, 1986).

According Archela (2000), this line of research has emerged as one of the currents of Cartographic Communication, where the author questioned why the individual or user not involved with their perceptual and cognitive considerations in the construction of the maps.

This cognitive theory uses logical mental operations and the map is regarded as a variable source of geographic information, which directly depends on the characteristics of the individual (user). And in consequence, the cartographer has to have a greater concern with the characteristics of the individual (user).

In a cognitive perspective, Information Science, in which according Peuquet (2002), the Cartography is included, believe that the construction of the situations meaning is performed by the individual, ie, the individual is the active agent. The individual is active in the interaction between information structure and its own conceptual framework (Borges et al., 2003).

This interaction is done, for the Cognitive Cartography, between representation models of geographic information, like the map, and the stored knowledge structure of the individual. This interaction provides to individual the modification or amendment of its knowledge stock, because information gained from the environment is the element that generates knowledge.

This author consider the map as a set of geographic information cartographically represented, ie, presented as a land model for a particular purpose.

Also, there may be other models that have some form of spatial information presentation. Each model has its uniqueness and purpose, a way of presenting information according to predefined rules.

A spatial data model such as class diagram is a conceptual model that is concerned with the information structuring, with the attributes representation and spatial relationships and topology between the classes of geographic objects. These are different abstractions of spatial objects and phenomena, but which refer to the same information type: the geographical.

All these models can be used by the techniques of Cognitive Cartographic for the spatial knowledge representation, recovered from the memory of an individual.

2. COGNITIVE PSYCOLOGY, COGNITIVE MAP AND SPATIAL ABILITIES

Cognitive Psychology is a set of psychological concepts whose primary mission is to study the processes of knowledge acquisition and information processing (Doron & Parot, 2002).

Cognitive Psychology is interested in understanding the human processing of information, so designing the structure of data storage in memory and in addition, studying the methods for retrieving this information to provide knowledge, that can be used in various lines of research on the cognition study.

In this sense, is part of the goal of Cognitive Cartographic field. In the definition of Cognitive Cartographic, in citing the mental imagery, refers to a set of records stored in permanent memory that is acquired through learning and creating knowledge about the experienced environment.

The acquisition of this knowledge can be realized through direct experience (directly in the environment) or indirectly (by reading documents, maps, satellite images, among others). The experience involves the ability to learn from the experience itself. Experience is learning, it means acting on the information and build on it (TUAN, 1983).

These retrieved images from the cognitive psychology calls cognitive map. The cognitive map is the set of all spatial knowledge acquired through learning by the individual and that has meaning. According PEUQUET (2002), the cognitive map is the term often used to describe the denomination of the "individual spatial knowledge".

This term refers to the cognitive representation of geographic space and spatial relationships between known objects, and its qualification.

The cognitive map stores information on the locations (WHERE knowledge system), objects (WHAT knowledge system) and the time ans events (WHEN knowledge system) (Peuquet, 2002).

It is noteworthy that each individual has different skills and capabilities to store information of geographical space. Individuals have different levels of ability in logical reasoning, visual memory or experience in certain types of information and, consequently, play mental activities related to cognitive processes differently (Allen, 1991).

3. THE SPATIAL KNOWLEDGE AND METHODS FOR SPATIAL REPRESENTATION OF KNOWLEDGE

The knowledge related to geographic information captured from the cognitive map of an individual can be represented in models, through specific methods considered in Cognitive Cartography. To perform analysis on the spatial knowledge level of the individual or group of individuals, there is a need to retrieve it and externalize it.

When referring to the concept of knowledge, is referring to the information fully processed and stored in the cognitive map, ie, after the occurrence at all stages of cognitive mapping, since the perception (the first seizure, which is stored in temporary memory) until final processing of information (cognitive process, where there is storage in permanent memory).

The structure of stored knowledge related to geographic information is organized similarly to a set of categories at the hierarchy level, where attributes are stored, that qualify it and spatial relationships between these information.

There are methods for knowledge representation in cognitive psychology that are compatible for use in structures such as geographic information. For this specific application, the literature recommends methods to deal with the structures of knowledge based on meaning (Anderson, 2004).

The meaning is attributed to the knowledge of the object observed, through previous experience with similar objects and in this case, there was a store that information in long-term memory. This concept is linked to understanding, which from a signifiable object, there is an integrative conceptual structure, i.e., an integration of elements of the environment in relation to the observable object (PEUQUET, 2002).

Anderson (2004) addresses the issue of significance, comparing the messages conveyed by verbal information and visual information. The author explains that, after processing a verbal message, people usually only remember the meaning and not words. While the individuals to see a picture or an image, tend to remember a meaning interpretation of it.

Anderson (2004) explains that there is evidence that individuals initially encode many of the perceptual details of a phrase/text or a picture/image, but are prone to forget that information quickly. Once the perceptual information is forgotten, individuals retain the memory of his interpretation.

Some ideas are represented in a better and more easily in images/pictures and other texts/words.

Propositional representations and schemes are examples of the kind of representation method based on meaning. The main feature of these representations of knowledge and that imply in some meaningful abstractions of the experiences that gave origin to knowledge.

The concept of proposition, borrowed from the logic and linguistics, is fundamental to this analysis. According to Anderson (2004), a proposition is the smallest unit of knowledge that can sustain in an

assertive, i.e. is the smallest unit on which it makes sense to conduct a trial of True-False. It is the meaning behind a particular relationship between concepts.

Both the images and words are represented in a propositional form. The propositional form of mental representation is not in words or in images, but certainly in an abstract way of representing the underlying meanings of knowledge.

Propositions can be used to represent any kind of relationship, including actions, attributes, spatial positions, classificatory categories or virtually any other conceptual relationship.

And the schema concept was articulated in Artificial Intelligence (AI) and Computer Science, where professionals who have experience with database recognize its similarity to several types of data structures. Because of this, the very geographic data modeling is based in essence on schemas (Anderson, 2004).

The question for psychologists, that should be a concern of cartographers, in relation to geographic data, is which aspects of the scheme concept are suitable to understand how individuals reason about concepts. This form of reasoning is presented as an indicator for psychology professionals and cartographers in the way in how to structure geographic data, for example, compose a database of cartographic production, in how to structure interoperability environments, such as spatial data infrastructures etc.

The schemes represent knowledge in categories according to the structure of slots. The notion of this term refers to computing, on the opening of the hardware for fitting a second motherboard, which is the same memory. The slots specify values that members of a category have in several attributes. These members of the categories in data modeling are called object classes.

4. A PROPOSED METHODOLOGY TO EVALUATE THE SPACE KNOWLEDGE THROUGH REPRESENTATIONS BASED ON MEANING

4.1 INITIAL CONSIDERATIONS

The guidelines to construct a mechanism for assessing the spatial knowledge level of a group of people can take multiple paths. Depending on the stage of cognitive mapping to be evaluated. It can grasp the content acquired from the environment through perception (first seizure) until the final phase, which is the consolidated knowledge (cognitive map) (PEUQUET, 2002).

When evaluating the consolidated knowledge, which fills the individual's cognitive map, the literature of cognitive psychology directed to the application of methods that use the representations of this knowledge based on meaning. It is noteworthy that these methods of psychology are mostly empirical and experimental observation on the result of natural or controlled conditions or through indirect tasks of trial, for example, a trial of the proximity of perception by the individual that allows the specification an information structure of the environment (GOLLEDGE & STIMSON, 1997).

The structure of spatial information and their relationships are captured and stored in the human mind through categories of information. Some types of experiments are applications of cognitive categorization methods. These experiments mostly work trying to identify how the geographical concepts are stored and structured. In these experiments, studied by Mark et al. (1999) (in BATTING & MONTAGUE, 1968, LLOYD et al., 1996, and TVERSKY & HEMENWAY, 1983) mechanisms of stimulation were used as phrases containing geographic concepts, extracts images (aerial photos or satellite), concepts related to the same information to raise the level of categorization done by the group (categories of information, attributes and recognized topological or spatial relationships), and learn how this group builds its spatial knowledge through these categories and relationships. The knowledge gained can be represented by schemes and data models.

At the search of representations of knowledge based on meaning, it can also test the individual's ability to capture formal knowledge through association with concepts that, in principle, already been experienced. The literature indicates propositional representations to check the ease of playing certain phrases that has meaning, that for this research, it will be bundled with geographical concepts. Typically, each hit the meaning of concepts, even though phrased differently presented, and also recognize when there is a significant difference and change the concept presented (ANDERSON, 2004).

The evaluation of this methodology was constructed based on experiments found in the research, consistent with the policy and objective of this thesis. We selected experiments, some of which were reproduced in full, for the assessment of spatial knowledge of a group of individuals.

The experiments were directed to a profile group formed by individuals who have some working experience with cartographic production. The discrepancy of the answers will be assessed according to subgroups that were made from the total group of individuals. Such subgroups were organized according to academic background, length of experience in working with Cartography, and finally, age.

In these experiments presented in the literature, there are publications that formalize new methodologies for assessment of spatial knowledge through the meaning-based representations in the area of Cognitive Cartography as that of Mark et al. (1999). It could say that there is a shortage of these. The author explains that this problem exists because it can not build a single specification of tasks and individuals, given the dynamic and comprehensive nature of spatial knowledge. It creates endless types of experiments to achieve an closed objective, and this makes it difficult to identify what is most appropriate for each group.

4.2 PROPOSED METHODOLOGY

Based on the conceptual foundations of knowledge representation methods based on meaning, as well as in experiments on assessments of knowledge, built up a procedure for evaluating the spatial knowledge of a group of individuals with expertise in cartography. This procedure involves three stages: evaluation of the profile of individual group; the experiments thenselves and the analysis of the results (Figure 1).
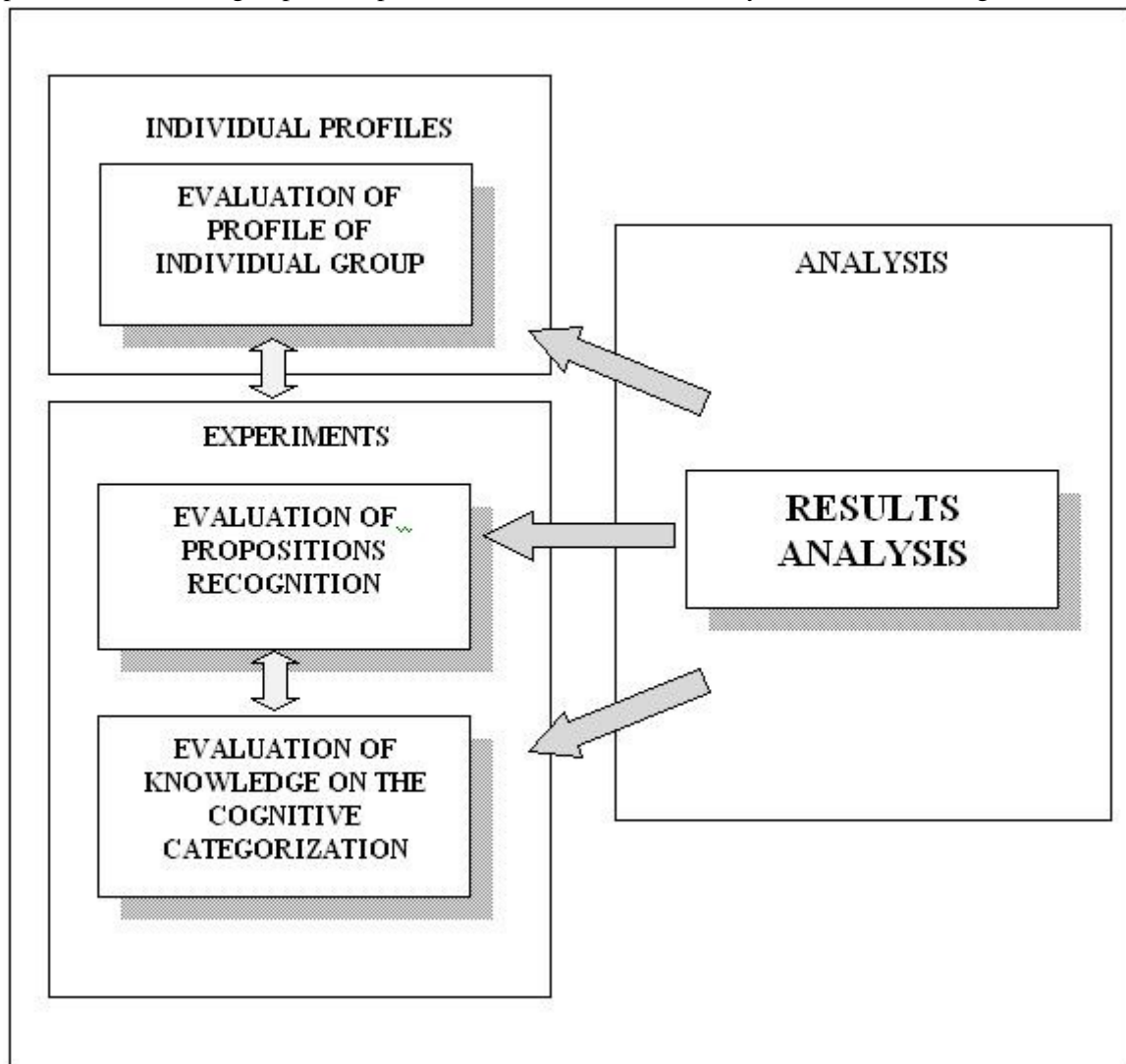

Figure 1 – Schematics of the procedures of the methodology.

The first stage of the evaluation process is to define the profile of the individuals who participated in the experiments. The following parameters were taken into consideration: the academic level, length of experience in cartography and age. Like all individuals who participated in the experiment are male, the gender parameter was not considered. It searched for potential subjects, who have or have had involvement with the area of cartographic production, both in academic (formal knowledge) or in the practice (practical knowledge), or both, because the constructed experiments for this methodology content technical targeted to this audience. Of the 44 individuals who participated in the experiments, it can see that the majority (43%) belong to the category of those with technical course in Surveying and may or may not have degrees in other areas such as Accounting, Mathematics, Foreign International, Psychology, Business Administration, Law or Chemistry, and have 10 years experience in cartography (map production work -

the average is around 5 years experience). This group is considered young, because most are aged between 20 and 25 years.

In the first experiment of second stage of the evaluation process was made a research on the ability of individuals to recognize and reproduce the sentences that contain familiar geographical concepts. Sentences, that have entered propositions, were organized to provide a certain logic in their reproduction. This experiment was based on demonstration of Bransford & Franks (1971) apud Anderson (2004) and has the objective to verify if individuals have the ability to play just as the sentences were presented. We selected 12 (twelve) sentences, 06 (six) on the concept of hypsometric line and 06 (six) for the island concept, applied to the reading of 12 (twelve) sentences at a time 05 (five) minutes. To achieve the goal of the assessment of recognition memory and meaning of the subjects, it were presented six (06) sentences that contained: a) set of propositions that already exist, b) a new set of propositions with new combination of existing and c) a set of non-existent or false propositions. The individuals had 2 and a half minutes to respond whether the sentence was existing, new or false. These times were set by previous tests.

The second experiment of second stage consisted of an assessment of spatial knowledge based on application of cognitive categorization experiments. This part was a reproducyion, on the part of individuals, of concepts, categories of spatial information, object classes, attributes and topological and spatial relationships through the material that served as a stimulus for seizure of this knowledge. This material included sentences with concepts, extract satellite image and extract a model acquisition of geometry objects.

4.3 RESULTS ANALYSIS

The evaluation of the group of individuals was important, because it helped understand some aspects and facets of the results achieved. Associations made, especially regarding the times in which individuals lived and live the analog and digital proceedings of the cartographic production, served as basis for defining how these individuals structure their knowledge in spatial cognitive map.

Has actually been proven that individuals are not sensitive to the combination of propositions that are part of the same concept, and in consequence, easily swap their new sentences by existing, and vice versa, as Anderson (2004) and Bransford & Franks (1971) apud Anderson (2004).

Regarding the categorization of cognitive experiments, some results were found and are listed below:

- Preference specialize in a some more classes of objects or generalize, and leave the typing of these classes in attributes;

- The initiative to perform a categorization at a higher level class of objects, ie, classifying objects in packages, in broad categories of geographic information;

- Depending on the group's profile to be technical, people felt the need to quote attributes related to information about the quality and accuracy of the acquired geometry of the objects;

- The objects considered highly relevant (Road/ Land/ Highway and Building/ Construction/ Built Structure), for the entire group of individuals, were those with high occurrence in the topographic chart, which is a generated product of cartographic production;

- The relationship of spatial aggregation are related to objects of greater importance (buildings and complex buildings and stretches of highways and roads);

- Check it easier to choose objects that maintain spatial relationships considered more simple, such as "cross" ou "match" instead of choosing objects that have more elaborate relations like aggregation;

- Individuals recognized as the most significant concept that was related to a definition already known in the documentation of work used in map production.

5. FINAL CONSIDERATIONS

In the present study was proposed to establish a methodology for conducting an analysis of the level of spatial knowledge of a group of individuals who have experience in cartography, using methods of representations based on the meaning. The main objective of this research was to contribute conceptually to the study of cognitive cartography, given the importance of considering the aspect of knowledge potential of the individual, be it the cartographer or the user himself, in the context of acquisition and structuring of geographic information.

It is suggested that:

- This methodology is applied in other groups of individuals with experience in cartography, combining individuals with other academic backgrounds, such as Geography, Civil Engineering among others, to compare the results the results of this research with others, confirming, or not, so the conclusions performed;

- This methodology is applied in groups of individuals with no experience in cartography or in specific groups like the Indigenous;

- The construction of methodologies using other methods combined, such as building of sketch maps or multi-dimensional maps or semantic networks, among others, to assess other aspects related to spatial knowledge, such as perception of environments by direct or indirect experience or perception of dimension of cognitive distance, among others;

- Carrying out a study on time information retrieval from memory;

- The construction methodology which applies the fundamentals of the studies of geo-ontologies combined with cognitive categorization.

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