

Mapping Understanding: Transforming Topographic Maps into Cognitive Maps

The amount of information available for any geospatial location is often overwhelming; we have access to detailed maps of slope, vegetation, road systems, infrastructure systems (above and below ground), right of way and property line descriptions, census data, and land uses. There are two related issues with this plethora of information: how to relate information across categories (e.g. maps and census data) and how to reduce the complexity of data to make it more easily understood by a user.

Our current work focuses on methods of developing maps to better fit the cognition of users (we have previous work that deals with cross-categorical information). In this discussion, we begin with a theoretical distinction between **topographically projected maps** and **cognitive maps** that people remember as a simplified graphic representation of the environment. Topographic maps aim to preserve accurate measure of lengths, angles, and areas (putting aside for a moment the problems of projecting a spherical earth onto a flat surface). While there is always a selection process to decide what to represent, projections always preserve a good measure of the geometric complexity. The term cognitive map, first used by Tolman in 1948, described the ability of rats (and men) to remember an environment as an overview from above. This term is widely used in urban design (Lynch 1960) and is extended to include the ways in which we encode, store, and decode information about an environment. Cognitive maps can be understood as simplifications and topological transformations of topographic maps.

Most studies begin with cognitive maps and focus on the degree of accuracy relative to topographic maps (e.g. how accurately were landmarks placed). In contrast, we set out to understand the relationship of these map forms to generate a method, which translates topographic maps into cognitive maps. Our goal is to define principles to integrate into an algorithm that would automatically generate cognitive maps. There has been some work on the translation of topographic maps into a linear direction that have cognitive (perceived time distortion) properties (Agrawala 2001). In this work, we are interested in two-dimensional networks rather than in a linear system.

We have studied cognitive maps in three settings. First, as part of a larger study of GPS and road map navigation, we gathered data comparing plotted GPS tracks with the sketch maps drawn by subjects. Second, we gathered sketch maps drawn by 60 students after their first, four-day, visit to a new city. Third, we gathered sketch maps drawn by 14 graduate students one week, four weeks, and three months after their arrival in a new city. Our methods of studying the difference between topographic maps and cognitive maps involve bidimensional regression, geometric comparison, and topological comparison. The principles from this work are important both as cognitive validation of cartography, as well as, in the design of navigational interfaces for mobile devices.