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Enhancing retail location decision support: The development and application of geovisualization

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Abstract

Geovisualization refers to the *visual* exploration, analysis, synthesis and presentation of geospatial data. This paper presents findings from research that has focused on developing and applying geovisualization techniques and technologies for use within retail location decision support. To date, retailers represent a major user group of geographic information system (GIS) -based decision support technologies, with applications ranging from trade area mapping to store portfolio planning. However, the ability to handle spatial–temporal data, visualize change, and explore the temporal dimension of spatial data is limited within conventional GIS. The paper details the development of a prototype geovisualization system that has been designed to enable visualization of spatial–temporal change of retail-related data. From this explicitly visual paradigm, a number of examples of potential analysis are examined at four different scales of analysis: national, regional, market and micro-level. The paper highlights both the challenges and potential to enhance retail decision support by integrating geovisualization techniques and technology within decision support activities.

Keywords: Retail location decision support; Geovisualization; Geographic information systems (GIS)

1. Introduction

Geovisualization research has gained considerable momentum over recent years within the fields of GIS, cartography and spatial statistics. The aim of geovisualisation is to turn large heterogeneous data into information (interpreted data) and subsequently, into knowledge (understanding derived from information). As MacEachren and Kraak (2001, p.3) define, '*geovisualisation integrates approaches from visualization in scientific computing, cartography, image analysis, information visualization, exploratory data analysis and geographic information systems to provide theory, methods and tools for visual exploration, analysis, synthesis and presentation of geospatial data*'. Fig. 1 provides a conceptual framework for geovisualization system use, defined along three axis: (i) the nature of the tasks performed—from knowledge construction to the sharing and dissemination of information; (ii) the type of users—ranging from domain experts to the general public; and, (iii) the level of interaction with the data—referring to the extent to which the user will have control over the system and the underlying geospatial data (i.e., open source versus black-box). The four primary functions of geovisualization can be placed along the central diagonal of the geovisualization use space: explore, analyse, synthesis and present (MacEachren et al., 2003; MacEachren, 1994). A defining element of geovisualization is the role and emphasis placed on human cognitive visual processing. Geovisualization techniques are geared to exploit visual-cognitive abilities: such as, pattern recognition, ordering, and interpretation of visual cues. Based on the contentious premise that humans learn more effectively and efficiently within a visual as opposed to textual or numerical setting (Tufte, 1997, 1990; Lloyd, 1997; Bertin, 1981), geovisualization aims to transform decision support from static uni- or bi-dimensional space into a highly dynamic and visual environment that facilitates interactive exploration of multi-dimensional space.

The traditional focus of visualization research has been within the hard sciences, in fields such as biotechnology, engineering and medical science. Interest amongst

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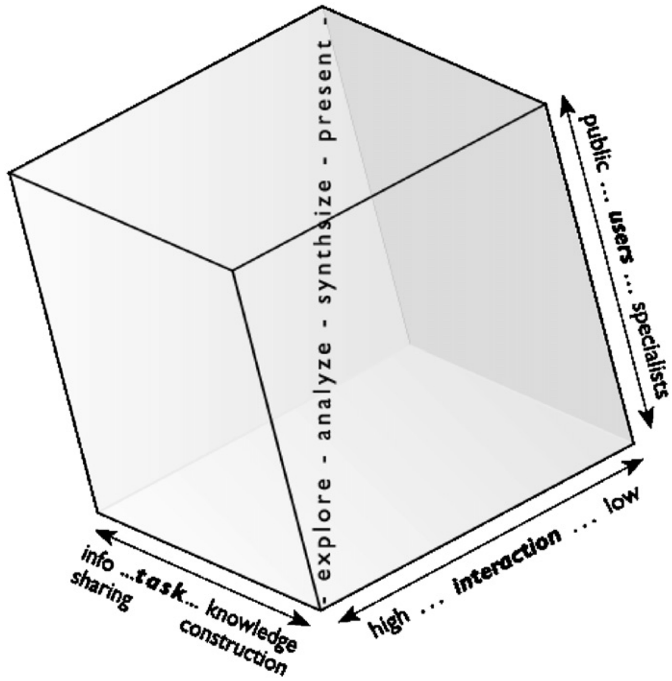

Fig. 1. Functions of geovisualization.

geographers and cartographers in visualization since the 1980s has resulted in the emergence of the *geo*visualization field of research (Brown et al., 1995; Hearnshaw and Unwin, 1994). This has provided opportunities for businesses to build on parallel developments in the areas of GIS, data warehousing, data mining and business intelligence, in providing techniques and technologies to unlock through *visual* means previously hidden spatial–temporal dimensions of their datasets. The increasing availability of time-series data within the retail industry coupled with the addition of temporal and spatial elements within data structures has allowed retail analysts and decision makers to move away from simply generating *static* snap-shots to undertaking *dynamic* temporal analysis and visualization of change (e.g., animation of spatially related data over a number of time periods). The application of geovisualization within business geomatics[1] are many and varied, ranging from visualizing retail sales performance metrics (e.g., sales per square foot, market share and penetration) to monitoring changes in commercial structure over time (e.g., the changing ethnic composition of retail businesses in a given urban market).

The paper is divided into four sections. First, the paper provides the research context by focusing on the tradition of retail location decision support, geovisualization is placed within the context of the widespread use and evolution of GIS within the retail industry. The second section details the development of a prototype geovisualization system that has been designed to enable visualization of spatial–temporal change of retail-related data. The third section presents a number of examples of potential analysis, examined at four different scales of analysis: national, regional, market and micro-level. The final section highlights both the challenges and potential to enhance retail decision support by integrating geovisualization techniques and technology within existing decision support activities.

2. Tradition of retail location decision support

GIS are used by the vast majority of major retail chains across North America and Europe to provide decision support for a range of location-based decisions (see Hernandez and Biasiotto, 2001). The widespread adoption of GIS within retail is hardly surprising given the spatial nature of the retail business. Retail demand (customers) and supply (stores), and the interaction between them, is spatially constrained (i.e., the existence of distance decay). Retail organizations typically have access to substantial reserves of spatially related data, with such data ranging from demographic variables, store sales data, customer transaction and loyalty data to competitor store data and land-use planning data (Byrom et al., 2001; Hernandez, 1995). The most common retail GIS applications include customer spotting, trade area analysis (e.g., demographic reporting for given trade areas), customer profiling, competitor analysis, hot-spotting, sales forecasting and consumer behaviour modelling. These can be applied to a number of decision events, from relatively low-risk store openings, renovations and merchandising decisions to major high-risk decisions, such as, corporate acquisition of competing chains or international expansion through merger activities (Hernandez and Biasiotto, 2002).

The vast majority of these decisions are supported by relatively rudimentary GIS-based inventory mapping and analysis, with a smaller number of retailers pursuing more sophisticated and complex modelling applications (Hernandez and Biasiotto, 2001). The prevailing decision style of retail organizations has been characterized by Clarke (1995) as knee-jerk and cavalier, a mix of both 'art' and 'science' (Hernandez and Bennison, 2000). Typically, retail location decisions have been supported by a range of static maps, for example, a trade area demographic map and associated data, such as existing store sales, number of competitors within the trade area. The decision stakeholders (e.g., members of the capital investment board, CEO, CFO) are presented with static views of the retail landscape. Change in markets conditions, such as sales trends, the entry and growth of new competitors, or change in customer demand profiles in a given market have been represented as snap-shots in time (e.g., separate maps for each year) or relative changes (e.g., percentage change between time periods). To date, managing, analyzing and visualizing the most fundamental element of retail—change

[1]Geomatics defined as "…the science and technology of gathering, analyzing, interpreting, distributing and using geographic information. Geomatics encompasses a broad range of disciplines that can be brought together to create a detailed but understandable picture of the [human] and physical world and our place in it." (Geomatics Canada, 2004).