Chapter 3.3
Flexible Spatial Decision-Making and Support:
Processes and Systems

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ABSTRACT

Spatial decision-making is a key aspect of human behaviour. Spatial decision support systems support spatial decision-making processes by integrating required information, tools, models, and technology in a user-friendly manner. While current spatial decision support systems fulfill their specific objectives, they fail to address many of the requirements for effective spatial problem solving, as they are inflexible, complex to use, and often domain-specific. This research blends together several relevant disciplines to overcome the problems identified in various areas of spatial decision support. We proposed a generic spatial decision-making process and a domain-independent spatial decision support system (SDSS) framework and architecture to support the process. We also developed a flexible SDSS to demonstrate an environment in which decision-makers can utilize various tools and explore different scenarios to derive a decision. The use of the system is demonstrated in a number of real scenarios across location, allocation, routing, layout, and spatio-temporal problems.

INTRODUCTION

Decision-making is an essential element of our lives and critical for business success, because many natural phenomena and socio-economic activities take place in a spatial context. Spatial decision-making (SDM) becomes one of the important aspects of human behaviour. SDM activities are either dependent or influenced by geographical information. They are based on spatial problems that are normally semi-structured or ill-defined. Spatial problems are also multi-dimensional as they contain both spatial and non-spatial aspects.

It is not easy to measure or model all the aspects of a spatial problem in a single step. Therefore, a sophisticated modelling process is needed for solving these spatial problems.

Spatial decision-making usually involves a large number of alternative solutions, and these alternatives need to be managed using an appropriate scenario management facility. The multi-criteria decision-making (MCDM) method helps the decision-maker to select a solution from the many competitive alternatives. It facilitates the evaluation and ranking of the alternative solutions based on the decision- maker's knowledge or preference with respect to a set of evaluation criteria.

Decision support systems (DSS) have been proposed to support decision-making. Silver (1991) broadly defines a decision support system as a computer-based information system that affects or is intended to affect the way people make decisions. A focused DSS definition given by Sprague and Carlson (1982) states that a decision support system is an interactive computer-based system that helps decision-makers to solve unstructured problems by utilising data and models. To support spatial decision-making, a variety of systems have been developed: These include geographic information systems (GIS) and spatial decision support systems (SDSS). Our focus is on SDSS in this research. Peterson (1998) defines a spatial decision support system as an interactive and computer-based system designed to support a user or a group of users in achieving higher effectiveness for solving semi-structured or non-structured spatial decision problems.

As technology progresses, there is increasing opportunity to use SDSS in a variety of domains. Flexible support of decision-making processes to solve complex, semi-structured or unstructured spatial problems can offer advantages to individuals and organisations. We synthesise ideas, frameworks, and architectures from GIS, DSS, and SDSS. In addition, concepts from spatial modelling, model life cycle management, scenario life cycle management, knowledge management, and MCDM methodology are explored and leveraged in the implementation of a flexible spatial decision support system using object-oriented methodology and technology.

BACKGROUND

Moloney, Lea, and Kowalchek (1993) observe that about ninety percent of business information are geographically related and cover diverse domains, for example, resource management, environmental modelling, transportation planning, and geo-marketing. Spatial problems are normally categorised into allocation, location, routing, and layout problems based on their geographical features. The primary goal of SDSS is to support decision-making activities using its flexible modelling capabilities and spatial data manipulation functions. SDSS encompass spatial analytical techniques and enable system output in a variety of spatial forms. The characteristics of the spatial data, models, and operations as well as the integration processes of non-spatial systems with spatial systems make SDSS more complex. Currently- available SDSS frameworks and architectures are suitable for their specific objectives. However, they fail to properly address many of the requirements of a generic, flexible, and easy-to-use SDSS. As we have noted earlier, incorporating a GIS with a DSS develops some of SDSS frameworks and architectures. However, the existing SDSS frameworks and architectures are neither comprised of all the DSS components, nor are they generic. Fedra's (1995) framework is good for analytical modelling, but the solver is tightly integrated within the model, which does not provide flexibility in using a solver with different models. It does not provide any mapping instrument for flexible integration of model and data; rather it uses a pre-customised integration system that is limited to a specific domain. The model management framework of Yeh and Qiao (1999) supports the modelling life cycle but over-

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