INTRODUCTION

A large number of spatial decision support system (SDSS) related software, algorithms, and tools have been developed to date. With few exceptions, these components have been built independently from scratch for each application, are not easily reusable, and their performance is not independently verifiable. The lack of component modularity contributes to the lack of reusability in these tools (Goodchild and Glennon, 2008). Developing reusable SDSS components depends on a high level of understanding of the domain of spatial decision support (SDS) including the identification of the fundamental granules of the SDS process. Such an understanding is difficult to achieve, given the lack of systematic integration and presentation of knowledge in SDS. In this work, we develop a conceptual framework for SDS with a set of ontologies (Guarino 1998) to organize the body of knowledge and drive information retrieval from it. This “knowledge” includes understanding of the underlying decision processes, selection and application of appropriate methods and tools, and other best practices for making informed decisions.

The ontologies promote semantic clarity by providing a common vocabulary for the essential SDS concepts and the interrelations among them. The ontologies provide specifications for modular SDSS component tools and services, by decomposing the spatial decision process into prototypical
phases and steps, specifying the input and output for each phase and step, and relating them to commonly used methods and techniques, desired systems functionalities for decision support, and so on. The ontology-driven approach provides a better organization and understanding of SDSS tools through a rich set of descriptive properties classified by ontology concepts, to promote interoperability among these tools.

**CONCEPTUAL FRAMEWORK OF SDS**

The knowledge in the field of SDS is vast, including the understanding of spatial decision process and its phases (Malczewski 1999); methods and techniques used during a decision process (Malczewski 1999, Leung 1997, Wu 1998, Aerts et al. 2003, Church et al. 2004, Malczewski 2006), participation and collaboration dimensions of the decision process (Armstrong 1993, Jankowski and Nyerges 2001, Sieber 2006); systems functionality (Densham 1991); and data, data models, and process models needed to solve a decision problem in the application domains (Malczewski 2006).

We analyzed a representative set of SDS literature to identify major knowledge components, including essential concepts and the important relations among these concepts. These concepts are partitioned into faceted ontologies corresponding to the major SDS components, such as spatial decision process, decision context, methods, systems functionalities, participants and roles, data and process models, related resources, and so on. For each concept, the representation includes the commonly used term, any synonyms and abbreviation, descriptions, and description sources. These concepts are further defined by explicitly specified relations among concepts. For example, a method or process model relates to a process phase or step if it is often used in that phase or step, and relates to a decision problem type if it is used to solve that type of problem. The input and output for each process phase and step are specified in terms of facets such as criteria, alternatives, data, data model, process models, etc. Decision processes and methods are also linked to decision participants, levels of participation, and so on.

The ontologies are the organizing glue of the SDS knowledge portal. This portal provides links to commonly used resources for decision support, such as literature, tools, and case studies. The ontology for a resource type
defines for each resource its unique properties (e.g., its source) and its relationships to concepts defined in other ontologies. For example, a tool description might include where in the spatial decision process it is used, which method(s) it implements, which problem type it addresses, which application domain it is used for, its input/output requirements, its functional components, etc. Besides organizing the SDS concepts, the ontologies are used to guide the user to browse or search information within the portal.

The ontologies were designed and populated based on several use cases generated collectively with SDSS and ontology experts at two SDS Workshops. The Workshops and subsequent ontology developments produced a common vocabulary for the field of SDS and a language for shared understanding and organization of its components. The input and output of decision process phases and steps explicitly specified in the ontologies serve as input and output requirement or guidance for the SDSS component tools/services, thus promoting their modularity and reusability. The SDS ontologies are not meant to be rigid or static. They can accommodate “dialect variations” of different user communities, by recording the correspondence between core and community terminologies, and displaying the appropriate set of terms based on the user profile. As SDS usage increases, the ontologies can be easily expanded to accommodate new processes, methods, technologies, applications, decision contexts, and relationships between components.

REFERENCES


