Case-based Reasoning applied to Environmental Modeling with GIS

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Abstract

Spatial Decision Support Systems (SDSS) extend traditional Decision Support Systems by providing adequate tools for spatial analysis and interactive cartographic interfaces. Experts develop their decision strategies based on building alternative "what-if"scenarios to solve a given problem. This requires building several models of relevant aspects of the world. The appropriate choice of models, and of data to instantiate them, demands considerable expertise in the problem domain. Furthermore, model suitability often depends on the geographic area for which the scenarios are being built. Model sensitivity to location is particularly relevant in the case of environmental planning, where the number of variables is very large, and highly dependent on regional/cultural factors. Solutions are reached only after intensive collaboration of groups of experts, who contribute to final model development.

The goal of our research is to design a software framework to support collaborative model construction and management, in the domain of environmental planning. This framework, under development, is based on a SDSS called WOODSS (WOrkflOw-based spatial Decision Support System) developed at UNICAMP, Brazil. WOODSS supports the construction and management of environmental planning models implemented using a GIS, storing them in a database.

Decision makers can query this modelbase, retrieve models based on keyword matching, and use them as a basis to build a new model. However, WOODSS is not able to effectively help users in solution construction. The approach we are investigating to solve this shortcoming is to integrate Case Based Reasoning (CBR) mechanisms into the SDSS.

CBR is a paradigm of Artificial Intelligence which consists in developing solutions to new problems by remembering old similar situations, adapting their solution to the new context. The basic processing cycle of CBR is: given a problem specification, retrieve all cases which are most similar to it, reuse their solutions by adapting and adjusting them, revise the correctness and usefulness of the new case and retain it for future utilization. The purpose of inserting CBR into WOODSS is to help users on choosing the most useful models (or parts of them) at the right time.

Identifying the most relevant models is a huge task, because similarity is highly domain dependent. Humans can deal naturally with similarity matching but this task is not a simple computational task, demanding several simplifying assumptions. The same case can be "remembered"in several different ways. This requires establishing as many indexing schemes as there are ways in which a case can be remembered. Similarity analysis is very costly and knowledge-intensive because different characteristics of a case can be more or less important according to the situation. In addition, the correct interpretation of the relationships

among features of the input problem and the stored cases is fundamental to similarity evaluation. Moreover, the system is supposed to grow in competence with time, and thus model management structures must be dynamic.

All these open problems in CBR are even more critical in spatial-sensitive problems, as is our context. Thus, this work can provide a basis for future applications and research not only on the combination of GIS and CBR, but also on wider fields.