Decision Problem Formulation Using Case-Based Reasoning

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Abstract

The process of decision analysis can be viewed as three steps: the formulation of real decision problem, the evaluation of the formulation by a primarily computational process in order to give the decision maker a recommendation, and the appraisal of the analysis to gain insight into the recommendation. The formulation process has been accomplished manually, through lengthy interviews between decision maker(s), decision analyst(s), and domain experts. The formulation of real decision problems needs much time, efforts, and cost, but the main difficulty is that a constructed decision model such as influence diagrams (IDs) are usually applicable to only one specific problem. Decision participants found that some prior knowledge from the experience to model IDs can be utilized to resolve other similar domain problems. Holtzman suggests a decision class analysis (DCA) which regards a decision analysis as an integrator of decision knowledge and treats a set of decisions having some degree of similarity as a single unit. To analyze a class of decisions, rule-based system, and neural network based approach have been used. Even though the use of neural networks to generate IDs in the topological level results in a good performance, the generated ID is usually not a well-formed ID. Especially as the size of decision class grows larger and larger, the generated ID deviates from a well-formed ID. To build a decision class, neural networks require a lot of cases belong to same domain. Neural networks have to be retrained whenever a new case is added. Furthermore, no defined methodology as yet exists for guiding the design of neural networks to the needs of a given problem domain. Rule-based approaches are known to be computationally expensive for the real-world decision problems. Knowledge acquisition is usually known to be a difficult and time-consuming process in rule-based systems, and it is hard to organize (or systematize) a domain knowledge in real world decision problems. However, case based reasoning (CBR) approach c

In this research, we suggest the use of a CBR approach for analyzing a class of decisions which results in the building of IDs in the topological level. In a closed world, a case is regarded as a model of decision problem represented with ID and decision situations. To formulate a new decision

problem with circumstance and situations, this research retrieves one or more cases using the case retrieval mechanism by the suggested fitness and garbage ratio. An ID for the given problem is built through combining the retrieved IDs and modifying the combined ID using prepared node classification trees and decision makers preference. In this paper, a case-based reasoning approach to build an influence diagram is described. Building an influence diagram in decision analysis is known to be a most complicated and burdensome process. To overcome such a difficulty, decision class analysis is suggested, which treats a set of decisions having some degree of similarity as a single unit.

The methodology needs a case base, and two kinds of knowledge bases, and four major functions. The case-base is a set of cases for similar decision problem. A case consists of situations and an ID of a specific decision problem, which are represented using frame type. The knowledge bases consist of two knowledge: domain-specific knowledge and decision-analytic knowledge. The major functions the methodology are a user interfacing, a case base managing, a ID building, and a knowledge bases managing function. The user interfacing function provides an interactive question-answering capability. It takes the problem situations for decision modeling, presents super ID, core ID, and alternatives of modification, asks the DMs preference for modification of ID, accepts the answer, shows the resulting ID of the decision problem. The interaction between the system and decision maker is performed by through formed layout and diagram. The case managing function performs following works: retrieves the relevant cases by a case retrieval mechanism and stores the resulting case as a new case. The ID building function takes the candidate IDs and builds an ID. A super ID and a core ID are generated by the combination of the retrieved candidate IDs, and the super ID is modified by decision maker. Also, domain-specific knowledge is used to modify the super ID and decision-analytic knowledge is used to check the constraints of ID. The knowledge base managing function performs following works: selects the relevant node classification trees and adds a new node classification tree to domain-specific knowledge.

To formulate a decision model of a new decision problem using CBR, first, the DM gives the situation information of a new problem. The proper cases are retrieved and selected through the given retrieval procedure and the fitness and the garbage ratio. The ID of selected case is defined as candidate ID. Candidate IDs are combined to generate the core ID and the super ID. To fit them into the specific situation of a given problem, the super ID is modified using domain-specific knowledge and considering the characteristics of the problem and preference. Also, decision-analytic knowledge is used to check whether the resulting ID is well-formed ID or not. These processes are repeated until the DM is satisfied at the resulting ID.

The basic concept of decision class analysis and case-based reasoning is very similar so case-based reasoning approach is believed to be a better methodology to implement a decision class analysis. A decision class refers decision problems having common characteristics among the problems, i.e., the decision problems in the same class share common domain-specific knowledge. So decision class analysis tries to model a decision problem conveniently and cost effectively using previous experience of modeling problems having some degree of similarity. Therefore, CBR approach is believed to be more appropriate methodology to implement DCA than previous approaches such as rule-based and neural-network approaches.