Decision Class Analysis with Incomplete Information

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Abstract

The decision analysts have observed that a constructed decision model such as an influence diagram (ID) is usually applicable to only one specific problem even if the formulation of real decision problem needs much time, efforts, and cost. They often investigate that some prior knowledge from the experience to model IDs can be utilized to resolve other similar domain problems. From this investigation, we considered a decision analysis to combine the prior knowledge so that we handle a set of similar decision problems simultaneously (Kim and Park, 1997).

Decision class analysis (DCA) 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 (Holtzman, 1989). Our previous study used a neural network for analyzing a class of decisions which results in the generation of IDs in the topological level (Kim and Park, 1997). We considered DCA as a classification problem where a set of input data (situation-specific knowledge) and output data (a topological leveled ID). So the quality of resulting ID is dependent on the input data given from decision maker. But it is not easy for the decision maker to know to the situation-specific knowledge of a decision problem exactly. Their input data may be imprecise, vague or incomplete.

In this paper, we examine the sensitivity analysis for DCA. Sensitivity analysis identifies those input parameters to which perturbations of the base-case value causes the greatest impact on the output measure. The input parameters of DCA are situation frames (i.e., the decision maker's circumstances) of an individual specific decision problem, and output parameters are abstracted corresponding specific decision variables (i.e., chance nodes and arcs in influence diagram) for solving that problem.

When given the situation-specific information of the decision maker, the DCA should abstract the corresponding specific decision variables for solving the individual problem. Analyzing a class of decisions is composed of three steps: First, the decision maker decides decision node(s) to represent the decision-making purpose of a given problem. Second, the decision maker suggests

knowledge of specific situations occurred at current circumstance and situation. Third, to obtain a single decision analysis, an influence diagram (ID) is built based on the decision and the situation-specific knowledge. The third step is made of two phases: Phase I is to search for relevant chance and value nodes of the individual ID from the given decision nodes and specific situations. Phase II elicits arcs among the nodes.

In second step, the well-represented situation-specific knowledge plays a major role to elicit a single decision analysis through the DCA. However, it is not easy for the decision maker to know the situation-specific knowledge exactly. Let s1 and s2 are situation frames, for example, and s1 is variation of domestic economy, and s2 is variation of foreign economy. It will be incorrect if we use an ID based on imprecise information like s1 and s2 is important, when we dont have precise knowledge about the value of s1 and s2. Instead, it is more realistic to derive IDs from each possible value of s1 and s2, then aggregate the derived IDs considering DMs additional knowledge and preferences. In this example, we can get four IDs from the four situations, like only s1 is important, only s2 is important, both s1 and s2 are important, and both s1 and s2 are unimportant. Therefore, having situation frames to get value 0 or 1 instead of any one value makes it possible to identify that current situation frames are important or not. When the decision maker does not have a complete information, it is another burden for him (her) to know exactly the situation-specific knowledge, i.e., the degree of relative importance or relevance to the current problem. This makes analyzing sensitivity in DCA to be useful and convenient for the decision maker. Compared to decision analysis, the primary purpose of sensitivity analysis in decision class analysis is to identify the imprecise situation-specific variables whose uncertainty affects the presence of each variable or whose uncertainty affects the deletion of variables. So limited resources will be focused on modeling, quantifying and analyzing the uncertainty in these situation-specific sensitive variables. Furthermore, the result of sensitivity analysis in DCA can be used in sensitivity analysis in decision analysis.

The properties of our suggested procedure are as follows: First, it is possible to model an exact ID for the specific decision problem with less time and efforts. Second, domain experts easily append their additional information and knowledge to the ID in the modeling process. Third, as a result, the sensitiveness of each variable of a resulting ID can be also known. So little resources will be focused on analyzing the sensitive variables, i.e., robust variables of an ID. We applied our procedure to a real world decision class problem, a land development and conservation problem (Kim, 1997; Kim et. al., 1999).

References

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