Preference Elicitation with Uncertainty: Extending Regret Based Methods through Belief Functions

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Preference elicitation is one of the most crucial aspects of multi-criteria decision analysis (MCDA). Multi-criteria decision making usually starts with the choice of a set Ω of possible decision models by an expert with regards to a decision maker's (DM) needs as well as computational aspects. Preference elicitation refers to the step in which she collects the DM's preferences by asking her to answer questions, such as for instance the ranking of a set of alternatives or the choice of the best alternative within a group. The answers to those questions will imply preferential information that can be used to restrict the set of decision models to the subset consistent with the given information, and provide robust decisions. An efficient elicitation method should try to gain as much information as possible with a small enough number of questions. A lot of work has been specifically directed towards active elicitation methods, in which the set of questions to ask the DM is not given in advance but determined on the fly.

In many methods, and particularly robust ones, preferential information provided by the user is assumed to be given with full certainty, which leads to at least two issues. The first one is that elicitation methods thus do not account for the fact that the DM might doubt her own answers, and that they might not reflect her actual preferences. Such uncertainty will be completely ignored in robust processes. The second one, that somehow follows from the first, is that most robust active elicitation methods will never put the DM in a position where she could contradict herself or assumptions made by the expert, meaning that answers to new questions will never conflict with either previous answers or model assumptions. This is especially problematic when inaccurate preferences are given early on.

Our work intends to tackle these issues by associating uncertainty to each piece of preferential information provided by the DM. To model this uncertainty, we consider the belief function framework developed by Destercke [3]. In this framework, the DM provides with her answer a degree of confidence reflecting how certain she is that it reflects her actual preference. The resulting information is modelled as a so-called simple support belief function. Belief functions are well-suited to account for both uncertainty and inconsistencies, but the initial work does not specify how to efficiently elicit preferences within this setting. The main idea behind our work is to extend one of the existing preference elicitation methods based on regret minimization [2] for the specific case where the set Ω corresponds to weighted sums [1]. At step k of our process, preferential information will be represented by a combined mass function m_k whose focal elements will be polytopes restricting the set of possible weights, and the mass of the empty set will be used to detect inconsistencies. The work we will present includes the following:

- a well-justified extension of Benabbou et al. [1] that represents preferential information through belief functions. In particular, we will explain our choices for extending the different elements of the method – such as Pairwise Max Regret or Max Regret – the way we did;
- results showing that our extension addresses the mentioned issues (in particular that the DM can be exposed to contradiction), and is at least as conservative in terms of guarantees as the deterministic method in the case of consistent DM answers;
- first simulation results comparing on the one hand our method to the deterministic one and studying on the other hand the behaviours that are specific to our approach, such as the value of inconsistency.

References

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[2] Craig Boutilier, Relu Patrascu, Pascal Poupart, and Dale Schuurmans. Constraint-based optimization and utility elicitation using the minimax decision criterion. *Artificial Intelligence*, 170, 2006.

[3] Sebastien Destercke. A generic framework to include belief functions in preference handling and multi-criteria decision. *International Journal of Approximate Reasoning*, 98, 2018.