Incremental preference elicitation of the simple ranking method using reference profiles

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1 Introduction

The Simple Ranking Method using Reference Profiles (or SRMP) is a Multi-Criteria Decision Aiding (MCDA) technique based on the outranking paradigm, which allows to rank decision alternatives according to the preferences of a decision maker (DM). It is very useful in real-world applications as it is easy to explain to a normal user, it handles naturally heterogeneous evaluation scales and the decision recommendation can be easily justified. A direct elicitation of the preference parameters of such a model is generally difficult to implement in practice and so indirect elicitation approaches, requiring the DM to evaluate pairwise comparisons of a subset of decision alternatives, is often used. This latter approach also holds a number of limitations, for instance in a live elicitation process, especially if the number of questions is large. In this work we propose an incremental preference elicitation process, where the DM provides preferential statements on pairs of alternatives that have been selected using multiple heuristics in such a way as to maximize the convergence towards a "good enough" preference model.

2 State of the art and problem statement

The majority of outranking-based preference models suffer from the fact that the resulting preference relations are not transitive. This is particularly disruptive when a preorder on alternatives is needed. In order to deal with this issue, Rolland [4] has proposed to use so-called reference points in the comparison of two alternatives through an outranking relation : a is considered as strictly preferred to b if and only if the outranking relation between a and the reference point is stronger than the outranking relation between b and the reference point. Let us show how this is implemented more formally.

We denote with $\mathcal{A}$ a set of n alternatives and with $M = \{1, \ldots, m\}$ the indexes of m criteria. The evaluation of an alternative $a \in \mathcal{A}$ on criterion $j \in M$ is denoted with a_j, and with each criterion is associated a preorder $\succsim_j$, s.t. if the DM considers that a is at least as good as b on j then $a_j \succsim_j b_j$.

The SRMP method is defined by several parameters, whose values may differ from one DM to another and which need to be identified beforehand, either directly, or through indirect inference. These parameters are (1) the reference profiles : $\mathcal{P} = \{p^h, h = 1..k\}$ which dominate each other ; (2) the lexicographic order of the profiles : σ, which corresponds to a permutation on $1..k$ and which represents the order of the profiles that will be used for the comparisons of the alternatives ; (3) the criteria weights : $w_1, w_2, \ldots, w_m$, where $w_j \geq 0$ and $\sum_{j \in M} w_j = 1$.

When comparing two alternatives $a, b \in \mathcal{A}$ with respect to a profile p^h, $h \in \{1..k\}$, two situations can arise :

- a is strictly preferred to b with respect to p^h, i.e., $a \succ_{p^h} b \Leftrightarrow \sum_{j \in C(a_i, p^h)} w_j > \sum_{j \in C(b, p^h)} w_j$
- a is indifferent to b with respect to p^h, i.e., $a \sim_{p^h} b \Leftrightarrow \sum_{j \in C(a_i, p^h)} w_j = \sum_{j \in C(b, p^h)} w_j$

where $C(a,p^h) = \{j \in M : a_j \succsim_j p^h_j\}$ is the set of criteria on which alternative $a \in \mathcal{A}$ is at least as good as profile p^h.

To rank $a, b \in \mathcal{A}$ using the SRMP procedure, we sequentially consider the profiles $p^{\sigma(1)}, \ldots, p^{\sigma(k)}$ according to the lexicographic order as follows :

— a is strictly preferred to b iff $(a \succ_{p^{\sigma(1)}} b)$ or $(a \sim_{p^{\sigma(1)}} b$ and $a \succ_{p^{\sigma(2)}} b)$ or ... or $(a \sim_{p^{\sigma(1)}} b$ and ... and $a \sim_{p^{\sigma(k-1)}} b$ and $a \succ_{p^{\sigma(k)}} b)$

— a is indifferent to b iff $(a \sim_{p^{\sigma(1)}} b$ and ... and $a \sim_{p^{\sigma(k)}} b)$

Recent contributions propose indirect elicitation approaches for SRMP models where the DM expresses his/her preference through pair-wise comparisons of alternatives. In [3], Olteanu et al. formulate the SRMP preference elicitation as a mixed integer linear optimization problem (MIP). Belahcène et al. [1] propose another approach using the Boolean satisfiability approach (SAT). Liu et al. [2] propose a metaheuristic to elicit the parameters of an SRMP model which is faster than the MIP approach but it does not guarantee finding the *optimal model*.

In order to limit the cognitive effort of the DM during the preference elicitation process, in this work, our goal is to reduce the number of pairwise comparisons theat are presented to him/her, while guaranteeing at the same time that the learned preference model represents well-enough his/her real preferences. We therefore propose an incremental preference elicitation process. At each iteration a heuristic selects a pair of alternatives from a database of pairs of alternatives that will be proposed to the DM. He/she then expresses his/her preferences on this pair of alternatives (either indifference or strict preference), which in turn generates a new binary comparison which is added to the previous ones. These comparisons are used as constraints in the MIP, which we use to construct a new SRMP model. This procedure is repeated until a "good enough" preference model is obtained. It is obvious that "good enough" might have different definitions, depending on the context of the application, or the decision maker. In this work we also give some advice on how to determine when to stop the process in practice. Our conclusions are based on an empirical validation through artificially generated data-sets.

3 Conclusions and future work

Different heuristics and MIP configurations have been studied in order to choose the combination providing the best inferred model from as few DM interactions as possible. The results lead us in choosing a heuristic that selects that pair requiring the most possible profiles in distinguishing between two alternatives. The experiments also show the limits of our proposal in terms of execution time, which increases significantly with the number of learning examples. For a real-word use of this elicitation process, computing time is an important factor, therefore we propose to explore metaheuristic approaches to infer a SRMP model in the future. Additional heuristics will also be explored as the SRMP model inference becomes more tractable as a consequence.

Références

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