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Abstract This is a summary of the author's Ph.D. thesis, defended on 8 October 2007 at the University of Luxembourg and the Faculté Polytechnique de Mons, under the joint supervision of Raymond Bisdorff and Marc Pirlot. The thesis is written in English and is available from the author upon request. The work is situated in the field of multiple criteria decision analysis. It mostly deals with what we call *progressive methods*, i.e., iterative procedures presenting partial conclusions to the decision maker that can be refined at further steps of the analysis. Such progressive methods have been studied in the context of multiattribute value theory and outranking methods.

Keywords Multiple criteria decision analysis · Progressive methods · Choquet integral · Multiattribute value theory · Bipolar-valued outranking relation

MSC classification (2000) 05C20 · 90B50

1 Introduction and structure of the doctoral dissertation

Our work mainly focusses on the study and the development of progressive methods in the field of multiple criteria decision analysis (MCDA), i.e., iterative procedures presenting partial conclusions to the decision maker (DM) that can be refined at further steps of the analysis. The thesis is divided into three parts. The first one is intended to be a general analysis of the concept of progressiveness. The last two parts develop progressive methods related first to multiattribute value theory (MAVT) and second to outranking methods. In the following sections, we briefly present our main contributions to these subjects.

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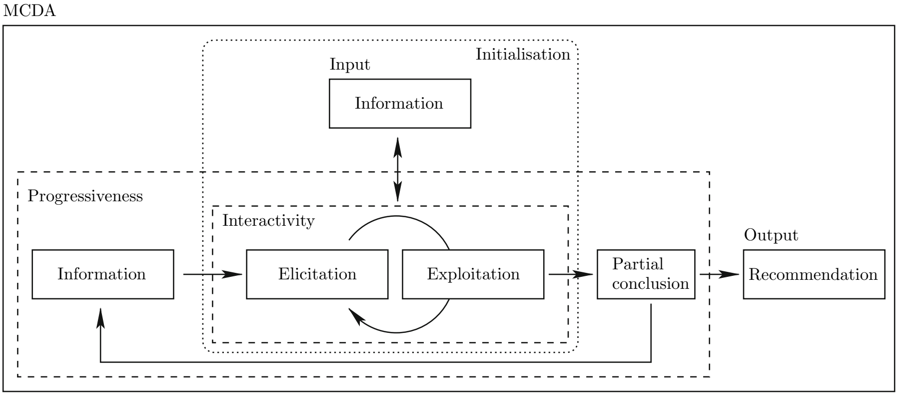

Fig. 1 General scheme of a progressive MCDA process

2 On the concept of progressiveness in MCDA

A *progressive* MCDA method is an iterative procedure which presents intermediate recommendations to the DM which have to be refined at further steps of the MCDA. The concept of progressiveness therefore intervenes in practice in the determination of the recommendation, rather than in the elicitation of a DM's preferences.

Figure 1 represents progressiveness in an MCDA method. As one can see, it is a framework around interactivity, that controls the construction of a final recommendation via intermediate *partial conclusions*.

The entry point to a progressive method is an initialisation phase which generates a first recommendation in accordance with the DM preferences, via an interactive questioning. If the DM is not completely satisfied with this output, a progressive process can then be initiated to further refine the partial conclusion. This can be done by enriching the currently available data by further information, by solving issues related to missing data or by focussing on a subset of alternatives to refine the recommendation.

These iterations are continued until the DM accepts the current recommendation as the final one. In practice this means that he is satisfied with it or that he can get along with it on his own to elaborate his final decision.

The necessity of such methods in real-world applications can be illustrated via a short example. Consider a recruitment procedure in a company. At different steps of this process, new information is collected from the applicants and inappropriate candidates are rejected on the basis of the currently available information. Consequently the final *best* applicant is determined in a progressive manner.

The use of a progressive decision analysis method can be motivated by (at least) three reasons. First, it can be justified by *prudence*, as the ultimate recommendation does not necessarily have to be reached in one step. Second, progressiveness is also motivated by *economic constraints*. Indeed, at a given moment, only limited financial or temporal resources may be available. Third, as the DM's preferences, as well as the final recommendation, are actively constructed via small steps, such methods are motivated by a *constructive approach* (Dias and Tsoukiàs 2004) to the problem.

3 On the choice problematique in an outranking framework

The second part of our thesis deals with the choice problematique, which is the typology of decision problems dealing with the determination of a single alternative which can be considered as the best one.

Our research is based on the so-called bipolar-valued outranking relation representing the credibility of the validation of outranking situations between all pairs of alternatives. We introduce and discuss a set of five pragmatic principles which should guide a progressive search for a single best alternative:

- $\mathcal{P}_\mathbf{1}$: Non-retainment for well motivated reasons;
- $\mathcal{P}_\mathbf{2}$: Minimal size;
- $\mathcal{P}_\mathbf{3}$: Efficient and informative refinement;
- $\mathcal{P}_\mathbf{4}$: Effective recommendation;
- $\mathcal{P}_\mathbf{5}$: Maximal credibility.

These principles are thoroughly discussed and translated into properties in a bipolar-valued outranking digraph. These then lead to the new graph theory-related object of *maximally determined strict outranking hyperkernel*, which is considered as an appropriate choice recommendation in a progressive MCDA context. Note that the Rubis choice method (Bisdorff et al. 2008) implements this concept and allows to determine the choice recommendation.

In our work we also study the *k-choice* problematique, which is the typology of decision problems dealing with the choice of $k > 1$ best alternatives (Meyer and Bisdorff 2007). We show that different definitions of the k-choice problematique can be given:

- Search for the first k best alternatives (k first-ranked);
- Search for a set of k alternatives better than any other coalition of k alternatives (best k-team);
- Search for a set of k alternatives better than all the other alternatives (best k-committee).

In the dissertation each of these definitions is detailed and their resolution is presented via extensions of the Rubis method.

4 On Choquet integral-based MAVT and Kappalab

The last part of our thesis deals with Choquet integral-based MAVT. In this context, we studied the extension of the Choquet integral to take fuzzy partial evaluations into account to produce a fuzzy output. In particular, we show how the overall fuzzy evaluations obtained via this aggregation operator can be used in MCDA to solve the choice and the ranking problematiques.

An important issue in Choquet integral-based MAVT concerns the determination of the parameters of the underlying *capacity*. In our work we present these so-called *capacity identification methods* from a common general point of view and discuss our proposal, which allows to find an approximate solution, even if the Choquet integral is too poor to model the DM's preferences (Grabisch et al. 2008).

A further achievement of our doctoral work is our collaboration to the Kappalab package (Grabisch et al. 2006) for the GNU R statistical system. It allows to solve MCDA problems via Choquet integral-based MAVT and contains all the identification methods proposed in the literature as well as our personal contributions (see also Grabisch and Labreuche 2008).

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