On the constructive and other approaches in Decision Aiding

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Abstract: This paper was motivated by the discussion held at the 2nd YMCDA meeting on the theme "What is a constructive approach in MCDA?". On the one hand, it intends to organise some thoughts on the differences between normative, descriptive, prescriptive and constructive approaches, as well as their relation (or lack of relation) with MCDA methods. On the other hand, it intends to discuss many of the questions that occur to MCDA researchers (not necessarily the younger ones!) about such issues.

1. Introduction

The second YMCDA (Young MCDA Researchers Meeting) was held in Coimbra on October 3rd, 2002, associated to the 56th Meeting of the EURO Working Group on MCDA. The authors of this paper and ten young researchers on MCDA gathered to discuss the theme "What is a constructive approach in MCDA?". Later, the Editors of this volume incited us to submit a text based on the discussion held during the 2nd YMCDA. This text reflects to a large extent the introductions, questions and answers of the meeting, complemented by some of our personal views on this subject.

The traditional dichotomy in decision theory among normative and descriptive approaches has been complemented by the ideas of prescriptive (e.g. (Bell et al., 1988) and constructive approaches (e.g. (Roy, 1993)). The resulting picture is not crystal clear, and the difference among the meanings attached to the same terms by different authors does not help either. Furthermore, it is easy to confuse approaches with MCDA methods or MCDA schools.

To make sense of this mess, we shall start by clarifying what we mean by normative, descriptive, prescriptive and constructive approaches, stressing the differences and interactions among them (Section 2). We then focus on the methods used in decision aiding and argue that methods are independent from

the type of approach and vice-versa (Section 3). After that we discuss some frequently asked questions about approaches and their relation with decision aiding methods and practice (Section 4). A concluding section ends the paper.

2. Different approaches

In the literature (Bell et al., 1988; Bouyssou et al., 2000; French, 1988; Keeney and Raiffa, 1976; Roy, 1996; Roy and Bouyssou, 1993) on decision theory and decision aiding we may find reference to four types of possible approaches (although some authors omit the last one or two): normative, descriptive, prescriptive and constructive. We next clarify what we mean by each of these approaches, noting that different authors may attach different meanings to the same words.

We are concerned here with decision aiding based on formal models of the Decision Maker's (DM) preferences and values. The preference models, which are going to be used to draw answers to the decision problem, contain therefore a model of rationality. The different approaches diverge in the meaning attached to the DM's rationality model, the process of obtaining this model, and the interpretation of the answers that are provided to the DM based on the model. We will mainly consider the case of a single DM, although much of what follows also applies to group decision-making contexts.

Normative approaches

Normative approaches derive rationality models from norms established a priori. Such norms are postulated as necessary for rational behaviour. Deviations from these norms reflect mistakes or shortcomings of the DM who should be aided in learning to decide in a rational way. These models are intended to be universal, in that they should apply to all DMs who want to behave rationally. As an analogy, we may consider ethical norms, laws and religious norms. For more details the reader can see the following classics: (Fishburn, 1970; Fishburn, 1982; Von Neumann and Morgenstern, 1947; Luce and Raiffa, 1957; Raiffa, 1970; Savage, 1954; Wakker, 1989).

Descriptive approaches

Descriptive approaches derive rationality models from observing how DMs make decisions. In particular, these approaches may link the way decisions are made with the quality of the outcomes. Such models are general, in that they should apply to a wide range of DMs facing similar decision problems. As an analogy, we may consider scientists trying to derive laws from observed

phenomena. For more details the reader can see: (Allais, 1979; Humphreys et al., 1983; Kahneman et al., 1981; Kahneman and Tversky, 1979; Montgomery, 1983; Montgomery and Svenson, 1976; Poulton, 1994; Svenson, 1996; Tversky, 1969; Tversky, 1972; von Winterfeldt and Edwards, 1986)

Prescriptive approaches

Prescriptive approaches *discover* rationality models for a given DM from his/her answers to preference-related questions. Modelling consists in discovering the model of the person being aided to decide, i.e. unveiling his/her system of values. Therefore, the models do not intend to be general, but only to be suitable for the contingent DM in a particular context. Indeed the DM can be in difficulty trying to reply to the analyst's questions and/or unable to provide a complete description of the problem situation and his/her values. Nevertheless, a prescriptive approach aims to be able to provide an answer fitting at the best the DM's information *here and now*. As an analogy, we may consider a physician asking questions to a patient, in order to discover his illness and prescribe a treatment. For more details the reader can see: (Belton and Stewart, 2002; Keeney, 1992; Larichev and Moshkovich, 1995; Roy, 1996; Tversky, 1977; Vanderpooten, 2002; Vincke, 1992; Weber and Coskunoglu, 1990).

Constructive approaches

Constructive approaches *build* rationality models for a given DM from his/her answers to preference-related questions. However, the "discussion" between the DM and the analyst is not "neutral" in such an approach. Actually such a discussion is part of the decision aiding process since it constructs the representation of the DM's problem and anticipates, to some extent, its solution.

If, while talking on what to do tonight, we ask the question "*where to go this night?*" we implicitly do not consider all options implying staying at home. If we ask *"who to meet?"* we implicitly do not consider all options involving staying alone.

Structuring and formulating a problem becomes as important as trying to "solve" it in such an approach. Recent real world applications (see for instance (Bana e Costa et al., 1999; Paschetta and Tsoukiàs, 2000; Stamelos and Tsoukiàs, 2003)) do emphasise the importance of supporting the whole decision aiding process and not just the construction of the evaluation model.

Modelling under this approach consists in constructing a model for the person being aided to decide, suitable for that contingent DM and his/her particular context. As an analogy, we may consider a designer or an engineer tentatively developing a new car. For details the reader might see: (Checkland,

1981; Genard and Pirlot, 2002; Habermas, 1990; Landry et al., 1996; Landry et al., 1983; Landry et al., 1983b; Rosenhead, 1989; Roy, 1996; Schaffer, 1988; Watzlawick et al., 1967).

Important differences

Table 1 summarises the differences among the approaches. We may start by dividing these in two groups. On the one hand, normative and descriptive approaches use general models of rationality, established independently from the DM and the decision process, intended to model the rationality of DMs in general. On the other hand, prescriptive and constructive approaches derive a model for the rationality of the contingent DM, and only that particular DM, emphasising his/her subjectivity (on the importance of subjectivity see (Munda, 1993)).

Table 1. Differences among approaches

Approach	Characteristics	Process to obtain the model
Normative	Exogenous rationality, ideal economic behaviour	To postulate
Descriptive	Exogenous rationality, empirical behaviour models	To observe
Prescriptive	Endogenous rationality, coherence with the decision situation	To unveil
Constructive	Learning process, coherence with the decision process	To reach a consensus

The difference between normative and descriptive models lays mostly in the process of obtaining the model. Normative models are grounded on economic considerations, whereas descriptive models are grounded on empirical observation. The former focus on how DMs ought to decide, whereas the latter focus on how DMs actually make decisions.

The difference between prescriptive and constructive models lays also to a great extent on how the model is obtained. Prescriptive models intend to unveil a system of values that pre-exists before the decision aiding process starts, hidden somewhere inside the DM's mind. Constructive models do not assume that preferences pre-exist, but let the DM construct his/her system of values as the model is being constructed, recognising that one construct cannot be isolated from the other. Indeed, the final model is expected to be validated through a consensus reached between the DM and the analyst. Such a “consensual” model

is expected to satisfy both the DM's perception of his/her problem and the analyst's methodological requirements of meaningfulness and formal coherence (on this point see (Genard and Pirlot, 2002; Landry et al., 1996; Landry et al., 1983; Landry et al., 1983b).

Interactions

It should be noted that quite often (usually in practice) it does not happen that an analyst follows any of the above approaches as if (s)he followed a decision theory manual. Normative approaches might be used with weaker versions of their axiomatics or adopting a more qualitative version (see for instance (Dubois and Prade, 1995; Dubois et al., 2001)) knowing that this is empirically grounded. At the same time one adopting a prescriptive or a constructive approach might decide to introduce and fix a dimension of rationality in order to ease the dialogue with the DM and "force him/her" to accept a certain point of view (see for instance (Keeney, 1992)). Such interactions between the approaches can be better understood when decision support tools come into practice (see also (Belton and Stewart, 2002)).

3. Methods versus Approaches

The number of decision support tools and methods available today in literature and more or less applied is incredible high (see (Bouyssou et al., 2000)). They range from optimisation techniques to cognitive approaches, from artificial intelligence tools to multiple criteria decision analysis methods, from extremely sophisticated tools (such as logic argumentation and ordered sets) to more "soft", natural language and user friendly ones. We are not going to present such tools here. Each of such tools however, has been created with a more or less precise "philosophical" background (see (Genard and Pirlot, 2002)) and with a more or less precise decision aiding approach in mind.

It is clear for instance that traditional Operational Research techniques such as linear programming, combinatorial optimisation and queuing theory reflect a normative idea of rationality as well as expected utility theory and game theory (see the discussion in (Moscarola, 1984)). On the other hand several decision heuristics as well as some early artificial intelligence knowledge representation techniques reflect a descriptive approach: capture the way by which decision makers and/or experts do it and generalise it. Much cognitive analysis can be associated to such an effort.

At the same time several multiple criteria decision support methods have been developed under a prescriptive approach as well as several artificial

intelligence tools make explicitly or implicitly reference to such an approach. Note for instance the common argumentation concerning intransitive preferences in decision analysis and non-monotonic reasoning in logic (see for instance (Doyle and Wellman, 1991; Tsoukiàs, 1991)). It should be also noted that the seminal work of Simon (Simon, 1954; Simon, 1979) on the concept of bounded rationality can be viewed as the background of both several decision support methods (developed under a descriptive or a prescriptive approach) and of several artificial intelligence achievements.

Finally, several "soft" OR methods implicitly and several MCDA methods explicitly refer to a constructive approach. Indeed Roy (Roy, 1996) explicitly claims that the philosophical justification for the methods developed by himself and his group is "constructivism", while the description of the Soft Systems Methodology (Checkland, 1981) clearly focuses on the decision aiding process and the structuring issue although it does not explicitly talk about a constructive approach.

However, despite the fact that each decision support method can be more or less associated to a decision aiding approach, we claim that such an association is misleading since it reduces such approaches just to a collection of methods.

Our thesis is that decision aiding approaches do not imply the use of an exclusive set of methods and that at the same time the use of a precise method does not imply the adoption of a decision aiding approach. To be extreme: we consider possible to use a constructive approach and adopt at a certain point a combinatorial optimisation technique as well as using an outranking based preference aggregation procedure within a normative approach.

In order to explain our idea we are going to use a descriptive model of the decision aiding approach derived from decision aiding practice (see (Bouyssoy et al., 2000; Morisio and Tsoukiàs, 1997; Paschetta and Tsoukiàs, 2000; Stamelos and Tsoukiàs, 2003). Within such a frame the decision aiding process is seen through its products, that is:

- a representation of the problem situation;
- a problem formulation;
- an evaluation model;
- a final recommendation.

Within such a model, what is called a decision support method is part of what is defined as an evaluation model, that is a collection of formal tools aimed to produce a possible answer to a formally well established problem (the problem formulation). Indeed an evaluation model M is defined as the t-uple:

$$\langle \mathbf{A}; \mathbf{D}; \mathbf{G}; \Omega; R \rangle$$

where:

- $\mathbf{A}$ is the set of alternatives or decision variables;
- $\mathbf{D}$ is the set of dimensions under which the elements of $\mathbf{A}$ are modelled;
- $\mathbf{G}$ is the set of criteria used to elaborate the solution;
- Ω is the set of uncertainty distributions associated to the information;
- R is the algorithm used to elaborate the information.

The reader may notice that such a model accommodates large part of well-known OR and decision support methods. What makes the difference among the four decision aiding approaches is how the decision aiding process is conceived, what is considered as given (and therefore fixed) and what is expected to be modelled.

A normative approach will concentrate its efforts only to the definition of the evaluation model since the representation of the problem situation is useless and the problem formulation is already established: maximise the economic function representing the decision maker's values.

A descriptive approach will allow for at least some alternative problem formulations, but only within a limited range of possibilities. Actually it should take care to identify the DM's cognitive profile and find the model that better fits the DM's behaviour.

A prescriptive approach will allow to take in consideration the whole decision aiding process, but again will concentrate its efforts to the evaluation model since the principal question is how to fix such a model with respect to the DM's contingent behaviour and values.

A constructive approach considers the four outcomes of the decision aiding process as equally important, none being fixed a priori. Moreover, the learning dimension of the process is such that any of the above outcomes can be re-discussed at any time of the process. Last, but not least, the possible inconsistencies of the decision maker are not to be considered as “trouble” for the analyst, but a source of discussion and knowledge for the whole process.

Under the above description the use of a combinatorial optimisation algorithm within the evaluation model does not preclude that the whole decision aiding process has been conducted using a constructive approach. It simply shows that the precise DM's problem can be formulated as a combinatorial optimisation one. On the other hand the use of a fuzzy preference aggregation procedure based on a concordance-discordance principle can be well seen as the result of a normative approach in the case the analyst imposes the axioms of such a model as “the model” of rationality.

It is sure that different approaches are more or less flexible and allow using a more or less large variety of methods. At the same time is true that different methods fit better within a certain approach. For instance the typical protocol used in order to obtain a value or a utility function of the decision maker's preferences is based on normative grounds. But this should not allow the confusion of claiming all utility functions being "normative" (see for instance (Keeney, 1992)).

Before concluding this discussion we should also like to emphasise the necessity of using well established and characterised methods whatever is the approach used (see (Bouyssou et al., 1993)). An axiomatic characterisation of a method does not imply imposition of these axioms as models of rationality. It just allows to know what a method can and cannot do. The use of a decision support method lacking a sound axiomatic characterisation should not be justified evoking constructiveness, while at the same time the existence of axioms should not be considered as establishing models of rationality.

4. Frequently Asked Questions

Question: "Are interactive methods constructive?"

Answer: As already mentioned above it makes little sense to call a method "constructive". Interactive methods can be used in a constructive way. Nevertheless, it should be mentioned that some methods (for instance see (Vanderpooten, 1989; Wierzbicki, 1980)) are designed in such a way that a constructive approach in using them is easier. At the same time it should also be mentioned that such algorithms do not necessarily guarantee convergence.

Q: "What would you say if someone shows intransitive preferences, namely a cycle?"

A: There might be several reasons for that: existence of several criteria which when aggregated result in an intransitive comprehensive preference relation, an hesitation of the decision maker, partial information or ambiguous statements. From a normative point of view intransitive preferences are a "mistake". From a constructive point of view they are a source of knowledge.

Q: "Why can't preferences form a cycle?"

A: Cyclic preferences are a problem only if we give to them an economic interpretation (see (Fishburn, 1991) and the very interesting discussion in (Mongin, 2000)). In other terms if "*x* is preferred to *y*" is interpreted as "*I am*

willing to pay for x more than I am willing to pay for y" then the usual money pump argument applies and cyclicity is a problem. But if we interpret the same sentence as "*there are more arguments in favour of x that in favour of y*" (see (Tsoukiàs et al., 2002) and also the discussion in (Schaffer, 1988)) then a cyclic preference only indicates a cyclic structure of arguments. This can be a source for discussion and a way to better understand the nature of the DM's problem.

Q: "If we choose the method in advance (e.g. because of the availability of software), are we being normative?"

A: Most likely yes. Indeed, since any method is followed by a model of rationality, if the method is chosen without any discussion with the DM we finish by imposing to him/her such a model. This is a "normative" behaviour.

Q: "Can a very flexible method be designed so that we can choose it in advance and still be constructive?"

A: See the reply at the question just before. All methods are based on some hypotheses including a rationality model (possibly a very weak one). Making such hypotheses without any discussion with the DM, without analysing the problem situation, results in imposing a rationality model. This is rather normative.

Q: "Are some methods more flexible than others, thus encouraging a constructive approach?"

A: Yes, some methods are more flexible than others since they require fewer hypotheses. Furthermore, some methods are particular cases of more general methods. However, we would not say that this encourages a constructive approach. Being constructive implies beginning the decision aiding process with no preconceived idea about the methods to use.

Q: "If we want to be "maximally" constructive, do we need to invent a method for each particular occasion? For instance, practically all the Electre methods were invented as a response to a particular problem."

A: We do not necessarily need to invent a new method for each occasion. We can be constructive using existing methods if we are prepared to work with different types of methods and if we are prepared to give up (or adapt) a chosen method whenever it shows to be unsuitable for the situation. Moreover, methods are usually composed of specific procedures (how to obtain preferential information, how to model preferences, how to aggregate them, how to use the comprehensive preference relation, how to handle uncertainty, how to obtain a

robust result etc.) and there might be a certain degree of freedom in choosing such procedures. In other terms we might define a new method just combining in a different way already known procedures. This is the reason for which is necessary to know well what each procedure can do and cannot do (necessity of axiomatic characterisation).

Q: "Is there any relation between research on theoretical issues (such as representation theorems, characterisation of procedures etc.) and the different approaches?"

A: Yes, the more we know about the theoretical properties of models and procedures the better we are able to say whether they fit the precise problem situation we are working with. Knowing the axioms under which an expected utility can be established allows us to be able to choose it when appropriate. Unfortunately this is not always the case with all the methods suggested in literature and this is the reason for which more theoretical investigation is required (see (Bouyssou et al., 2000; Bouyssou et al., 1993; Perny and Tsoukiàs, 1996)).

Q: "Do some DMs demand for normative approaches, for instance, to give the idea that the decision was "scientific" or "objective"?"

A: Yes, sometimes this may be true, but on the other hand everyone likes some freedom. The internal conflict may be that more freedom implies more responsibility and accountability, and not everyone feels comfortable with that. Actually, trying to figure what the DM is asking for (justifying, understanding, exploring etc.) already induces us to use a constructive approach.

Q: "Is there a specific approach to use when the decision support is addressed to a group of actors?"

A: A first reply is no. The presence of several actors acting as DMs, cooperating or not, introduces of course several dimensions of rationality (at least one for each DM). Under such a perspective, a prescriptive or a constructive approach might fit better, since it will allow to better take in account such different "rationalities". On the other hand, a normative approach will allow the group to better realise the difference between acting as individuals and acting as a unique rational decision maker. This might be an interesting support to provide.

Q: "What about the use of "expert systems" and other "automatic decision" devices and procedures?"

A: To some extent all such methods prefigure the use of a descriptive approach. Representing an expert's knowledge or a DM's decision heuristic and encode it in a software device allowing it to act on behalf of the DM is one of the aims of the descriptive decision aiding approach. Of course such a device might be able to learn from new situations thus performing an adaptive behaviour. Nevertheless, such a learning will be based on a well established procedure and if preferences are to be learned then a model of rationality has to be associated to such a procedure. Such a model is imported from outside and there is little of constructiveness in that.

5. Conclusion

In this paper we started by organising some thoughts on the differences between normative, descriptive, prescriptive, and constructive approaches in MCDA. To our opinion, two questions are crucial to distinguish these approaches. A first question, *"where the rationality model comes from?"*, separates the approaches where the model is imported and therefore valid for a general DM (normative and descriptive) from the approaches where the model is defined with respect to the decision process and therefore is tailored for a contingent DM (prescriptive and constructive). A second question, *"how is the model obtained?"*, further distinguishes the approaches. To postulate a model (normative) is rather different from deriving it from observation (descriptive), as to unveil preferences considered pre-existing (prescriptive) is rather different from constructing them by a process that originates from a consensus among DM and analyst (constructive).

We have insisted on the thesis that the approach followed is independent from the MCDA method used. Neither the former implies the latter, nor the contrary. Even though proponents of MCDA methods may often have one of these approaches in mind, this does not preclude the use of a method according to a different perspective. Nor does it preclude the creative use of parts of different methods.

Many of the FAQ we encountered during the 2nd YMCDA were related to common concerns, namely the possibility of learning and the choice of an MCDA method. Concerning the first issue, the provided answers reflect that many of the characteristics that make normative approaches appealing (such as solid axiomatics, operationality and effectiveness) lose some of their interest when the DM is allowed to learn about his/her preferences during the decision

process. A characteristic of the constructive approach is to accept this learning dimension and regard it as valuable. Concerning the second issue, this paper argues that to be constructive in the purest form of the approach, the analyst must bring no preconceived idea of which method will be applied. Otherwise, some normativeness is being introduced with the assumptions of the method chosen in advance. First, it is important to devote some effort to understanding and structuring the problem together with the DM. Then, a method or a combination of parts of methods that by their characteristics suit the situation (hence the need to know the method's axioms), may be tentatively used.

In reality, of course, this type of approach much in the line of the “OR spirit” is not followed. More often than not, specially in the past, the analyst is an MCDA scholar and will only employ a method that was developed by him/her. More generally, the MCDA analyst will have been trained to use a particular method, or has experience in using only a couple of methods. It does also happen that the analyst is tempted by the availability of a user-friendly software, or by the advantages of using a simple method, or by the aura of scientificity attached to a method. These are important concerns that may sometimes be in conflict with the spirit of constructing a decision process from scratch in a way that suits the DM's needs. How to deal with this conflict is an issue deserving much research. Familiarising analysts and DMs alike with the four approaches to MCDA, their differences and interactions is probably a good start.

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