CONSTRUCTING A MULTICRITERIA HIERARCHICAL EVALUATION MODEL USING AN AGGREGATION-DISAGGREGATION APPROACH

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Abstract

This paper presents a new approach to support evaluating a set of objects on a hierarchy of qualitative criteria. Evaluating an object on a node with respect to its evaluations on the sub-nodes is formulated as a multicriteria classification problem where the levels of the node's scale correspond to the ordered classes. Different multicriteria classification methods can be used. Selection of the adequate method(s) depends on many criteria or attributes involving context factors, characteristics of the methods and performances of the models.

keywords:
Multiple criteria decision aid, Hierarchical qualitative evaluation, aggregation-disaggregation approach

1. Introduction

The problem we interested in involves a group of decision makers (DMs) involved in a repetitive decision problem that aim at constructing a common tool for evaluating objects. The DMs can have different value systems and interests, however the tool is intended to favor communication and consensus between DMs, to allow "transparent" judgements and to perform argumentation and documentation the decision problem which is repetitive.

Structuring objectives or values in a hierarchy has been proven to be of great help to the analyst and decision makers structuring and understanding complex decision problems (Keeney 1992, Rasmussen 1985). One advantage of structuring objectives hierarchy is that it is a simple structure for decision makers to understand and use.

Such hierarchical structure is then commonly used in order to define a set of criteria which is assumed to be operational, coherent and exhaustive (Roy, 1996 Keeney and Raïffa, 1976, Edwards and Von Winterfeldt, 1986]. The choice of the level(s) to which we cut the value tree to obtain a set of criteria is not an easy task for the analyst.

On the higher levels of the hierarchy, criteria are of qualitative nature and take into account more than one aspect of the complex problem. These criteria are "constructed attributes", i.e, criteria for which an evaluation model do not pre-exist. This task is difficult to handle in practical decision situations not only because it is problematic to communicate about consequences using a constructed attribute but also because inaccurate determination, uncertainty and ill determination can hold at this level of aggregation.

Saaty (1980) suggested to explain evaluation on the whole criteria hierarchy and then formally modeling a hierarchy of criteria then a set of criteria. He used pairwise comparison between alternatives to assess their priorities on the criteria and pairwise comparison between criteria to assess their relative importance by solving an eingen-value matrix of ratio comparisons.

In this paper we propose to construct ordinal criteria on the hierarchy. Since we can assume that ordinal evaluation is a case of absolute evaluation and evaluation on a node is an aggregation of evaluation on the sub-nodes, we can use classification models to evaluate alternatives on the node taking into account their evaluations on the sub-nodes. We propose to infer evaluation models by an aggregation-disaggregation approach.

2. The proposed approach

Formally, a hierarchy of criteria is defined by a tree in which each node represent a criterion to which an evaluation scale associated. In such a hierarchy, $C_{i1},C_{i2},...,C_{in}$ are «sub-criteria» of criterion C_i means that C_i take into account all viewpoints formalised by $C_{i1},C_{i2},...,C_{in}$ and that the evaluation of an alternative on C_i is grounded on its evaluations on $C_{i1},C_{i2},...,C_{in}$. The levels of the ordinal scale on each criterion is defined both linguistically and by typical alternatives described by their evaluations on sub-criteria. The problem of how to evaluate an alternative on C_i according to its evaluation on $C_{i1},C_{i2},...,C_{in}$ is then formulated through an assignment model in which categories represent the levels of the ordinal scale.

Evaluation on node criteria is formulated as a multicriteria assignment problem

Constructed criteria are meant to measure more than one facet of a complex problem. Constructed attributes or qualitative criteria take into account, in general, more

than one dimension of preference. A very useful technique to deal with the hardness of constructing qualitative criteria consists of

(1) splitting them down into more specific attributes,
(2) construct value functions for each sub-attribute,
(3) aggregate the value functions of sub-attributes into one value function for the overall one.

We propose an alternative way to consider this problem which consist in formulating the problem of constructing qualitative criteria as a multiple criteria classification problem where the set of criteria is the set of qualitative criterion sub-criteria and the classes are the ordered levels of the qualitative criteria scale.

So that multiple criteria ordered classification models, such as ELECTRE TRI, N-Tomnic, UTADIS, ORCLASS, etc. can be used to construct the qualitative criterion from evaluation on its sub-criteria.

Use an aggregation-disaggregation approach to assess model's parameters on qualitative nodes on the hierarchy

Facing such a problem of classification, we can adopt one of two basic attitudes:

1. choose an aggregation procedure and construct its parameter in a decomposed approach,
2. use an aggregation-desaggregation approach to infer classification models from a set of evaluated alternatives.

The ordinal scales we construct are obtained first from evaluation of a reference set of objects. This evaluation allow us to obtain scales fragments which are completed through an interaction protocol using fictitious alternatives constructed on the basis of available real objects and primary ordinal information inferred about the relative importance of criteria.

Infer model's parameters from a reference set of evaluated alternatives

Model's parameters may be not only importance parameters especially when we use outranking methods. These methods use also veto , indifference and preference thresholds. For additive models, criterion value functions need to be assessed.

We propose, in our approach, to use what Lagreze et Siskos [1982] called aggregation-disaggregation approach to infer model's parameters from a set of evaluated objects. This can be done by several manners. Particularly we propose to use one or more of four approaches. These approaches are UTADIS which allows to establish piecewise linear value functions from a reference set of assigned examples

This approach is interactive but also adequate when the problem involves many decision makers. It's more easy to agree on the basis of realist cases than to discuss about values for the model parameter. Also, it allows to obtain parameters which corresponds to their interpretation in the used model.

This aggregation-disaggregation approach can be implemented within the ELECTRE TRI method using ELECTRE TRI Assistant which aims at inferring an ELECTRE TRI model from assignment examples

Choose the method relevant to the construction of the considered qualitative criteria

The choice of a particular multicriteria model and then the aggregation-disaggregation method to be applied is a complex problem. There are many factors to take into account when choosing a particular model to apply on a node of the hierarchy.

Comparison of different models should be based on the acceptability of their qualitative principles which are, in the essence, related to compensation degree they allow, to the acceptability of preference independence they suppose between criteria and to their capacity to take into account uncertainty, arbitrariness and inaccurate determination if it occurs.

Comparison can be also based on their capacity to restore the set of reference objects to their initial evaluations, to detect potential incoherence in the reference set of evaluated alternatives and to assist decision makers treating this incoherence, on their capacity to generate rules that cover all possible cases, to its ease of use and appropriateness to the context of decision problem.

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