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Characterisation of multi-criteria methods for dynamic decision-making situations

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ABSTRACT

This paper is concerned with the following question: How to choose among Multi-Criteria Decision Aid (MCDA) methods to solve dynamic decision making problems under uncertainty? To address this question, a methodology has been proposed, which is based on a characterization of the MCDA methods. The MCDA methods are characterized according to 1) sufficient conditions that allow their use to solve dynamic decision-making situations and 2) different other desired properties (neutrality, anonymous, fidelity, dominance, independence, compensatory level, conviviality, transparency, etc.). These properties might be seen as overall quality of the MCDA methods. This paper shows the characterization results for the following MCDA methods: dominance, weighted sum, lexicographical screening, TOPSIS, ELECTRE III, and PROMETHEE II.

KEYWORDS

Dynamic decision-making problems, decomposition, multi-Criteria decision aid (MCDA) methods, properties, and uncertainty.

1. INTRODUCTION

Dynamic and multi-criteria decision-making problems under uncertainty involve a sequence of interdependent decisions to be made at different periods of time in order to achieve an overall goal. Consequences of each decision at each period of time are uncertain due to unknown future and non forecasted changes, which could occur both spontaneously and as a consequence of earlier decisions. These interdependent decisions are evaluated in a multi-criteria context considering multiple and conflicting criteria as well as subjective information like the preferences of the decision maker. In practice, several real-world applications such as tasks scheduling and resources allocation, choice of portfolio and management of financial assets, production regulation, investment project might be modeled as dynamic and multi-criteria decision-making problems under uncertainty.

In this paper, we have chosen to use decision trees (see figure 1) to model dynamic and multi-criteria decision-making problems. The decision tree is composed of strategies; each of them is defined as the sub-tree presenting decisions to be made at each period and for each observable outcome of previous decisions. In a multi-criteria context, optimal strategy
generally does not exist and we look rather for best compromise strategies. A **best compromise strategy** is a strategy that achieves the best compromise between the conflicting criteria. Usually, the best compromise solution is given by Multi-Criteria Decision Aid (MCDA) methods. Therefore, solving the dynamic and multi-criteria decision making problem will consist of identifying the best compromise strategies in the decision tree.

To solve dynamic and multi-criteria decision-making problems, one might think naturally to apply one multi-criteria decision aid method. However, the literature review shows that there is a wide variety of MCDA methods but all of them were proposed to solve static decision-making problems and were not used in dynamic (multi-period) situations. In this paper, we consider basically two main MCDA operational approaches: the single synthesizing criterion approach and the synthesis by outranking approach.

Conversely, dynamic mathematical programming is another alternative that could be considered to solve dynamic and multi-criteria decision-making problems. This approach is generally based on Bellman’s principle of optimality (Bellman, 1957, Bellman and Dreyfus, 1965); under monotonicity and separability conditions, dynamic programming gives optimal solution based on the Bellman’s principle of optimality. However in multi-criteria context, the optimal solution usually does not exist. To be used, the decomposition idea behind the dynamic programming approach should be extended to the multi-criteria context where best compromise solutions are looked for rather than the optimal ones.

To solve such decision-making problems, the literature review shows that the common used approach to solve multi-criteria decision trees consists of generating the set of non-dominated solutions (Haimes et al., 1990; Haimes 1998). In the discrete case, Haimes *et al.* (1990) proposed to use the decision-maker’s preferences to choose among the non-dominated strategies. Nevertheless, the non-dominated set may be very large and consequently very hard to generate. Recently, Frini (2006) proposed a solving methodology which combines the use of MCDA method with the concept of decomposition. The idea is to find the set of best compromise strategies of the multi-criteria decision tree without generating all non-dominated solutions. This work extended the Bellman’s principle of decomposition to the multi-criteria context and proposed a theorem of decomposition, which specifies sufficient conditions under which the decomposition principle could be applied.

![Decision Tree](image-url)

**Figure 1:** Illustration of decision
This paper proposes a methodology of choice to answer the following question: Which MCDA methods could be used, conjointly with decomposition, to solve dynamic and multi-criteria decision-making problems under uncertainty? Section 2 reports the main results of the work of Frini (2006). Then, the methodology of choice is presented in section 3. Finally, section 4 presents the results of the characterization of the following MCDA methods: dominance, weighted sum, lexicographical screening, TOPSIS, ELECTRE III, and PROMETHEE II. Conclusions and research perspectives are discussed in section 5.

2. DECOMPOSITION OF MULTI-CRITERIA DECISION TREES

To solve multi-criteria decision trees, Frini (2006) suggested extending the Bellman’s principle of optimality. The proposed principle of decomposition is thought of in the perspective of best-compromise solutions.

**Principle of decomposition**: Each best compromise strategy has the property that all its partial strategies must also constitute best compromise strategies (Frini, 2006).

If this principle of decomposition is true, then best compromise strategy obtained at each decision node of the tree will be necessary composed of partial strategies of best compromise. Consequently, only the strategies of partial best compromise strategies shall be considered in the analysis. However, applying the principle of decomposition does not guarantee in all cases the best compromise solutions. Frini (2006) stated four sufficient conditions to guarantee the validity of the principle of decomposition which are summarized by theorem 1.

**C1. Condition 1**: The relational preference system of the multi-criteria decision aid (MCDA) method is a total preorder \((P, I)\) or a partial preorder \((P, I, R)\). \(P, I\) and \(R\) refer respectively to preference relation, indifference relation and incomparability.

**C2. Condition 2**: The relational preference system verifies the temporal consistence (strong and weak version). The strong version (resp. weak) of temporal consistence means that if at a given period, the result of the multi-criteria decision aid method indicates a strict preference of a given partial strategy compared to another (resp. indifference between two strategies), this result remains the same if we prolong the two strategies by the same action at a previous period.

**C3. Condition 3**: Preference and indifference relations \(P\) and \(I\) given by the MCDA (after exploitation) are transitive.

**C4. Condition 4**: The set of best compromise solutions is not empty at each decision node.

**Theorem 1**: If conditions 1, 2, 3 and 4 are verified, then each best compromise strategy has the property that all its partial strategies are also best compromise strategies. See Frini (2006) for proof.

Under sufficient conditions of theorem 1, a solving method of the decision tree will consist of the following steps:

**Step 1**: Model the decision problem by a multi-criteria decision tree.

**Step 2**: Assign probabilities to states of the nature at each uncertainty node of the decision tree. Evaluate according to the criteria all alternatives emerging from each decision node.

**Step 3**: Assign the path evaluation to every terminal branch.

**Step 4**: Choose the MCDA method that will be used at decision nodes. Ensure that it verifies conditions of theorem 1.
Step 5: For each period \( t = T, T-1, \ldots, 1 \) and starting by last period,

- At each uncertainty node, the expected value (by criterion) is used to evaluate partial strategies.
- At each decision node of period \( t \), apply the MCDA method on the set of partial strategies leaving this node. These strategies are composed of an immediate alternative prolonged by a partial strategy of best compromise in period \( t+1 \) for each state.
- Eliminate from further analysis the partial strategies that are not retained by the MCDA method.
  - At period \( t+1 \), if the MCDA method conclude that partial strategies \( s_k^t \) is strictly preferred to \( r_k^t \), then \( r_k^t \) is eliminated from further analysis.
  - At period \( t+1 \), if the MCDA method concludes that partial strategies \( s_k^t \) and \( r_k^t \) are indifferent, then both of them are retained for the next period.
  - At period \( t+1 \), if the MCDA method concludes that partial strategies \( s_k^t \) and \( r_k^t \) are incomparable, then both of them are retained for the next period.

Step 5 is repeated until the set of best compromise solutions at the starting point of the tree is obtained. The strategies obtained at period 1 are all of best compromise and constitute “the solution” of the problem.

3. METHODOLOGY OF CHOICE BASED ON CHARACTERIZATION OF MCDA METHODS

This paper addresses specifically Step 4 of the solving approach of multi-criteria-decision trees (presented above). This section aims at providing answers to the following question: How to choose among MCDA methods to solve dynamic decision making problems under uncertainty? The proposed methodology of choice is based on theoretical and pragmatic characterization of the MCDA methods.

The literature review shows a wide variety of MCDA methods that are different on many aspects (assumptions, concepts used, type of aggregation, compensatory level). These MCDA methods were used to solve mono-period decision-making problems without considering any dynamical aspect. For those static decision-making problems, the issue of choice between these methods was considered crucial by many researchers. Many authors proposed different ways of choice between MCDA methods. Hwang and Yoon (1981) and Teghem and Kunch (1989) provided a classification of these methods. Tecle (1988) and Al-Shemmeri et al. (1997) proposed to choose between the MCDA methods by using a multi-criteria approach. Ozernoy (1992), Laaribi et al. (1996) and Guitouni (1998) proposed methodologies of choice that take into consideration both the characteristics of the MCDA method and those of the decision-making situation. Other authors (Vincke, 1992, 1994; Pérez, 1994; Pirlot, 1997; Guitouni, 1998) proposed to choose between the MCDA methods based on theoretical characterization.

For dynamic decision-making situations, the problematic of choice among MCDA methods is also a challenge for the decision-maker/analyst. The choice among the MCDA methods should take into consideration the theoretical results presented in section 2. We propose in this work to consider simultaneously all the following aspects.
A) **Characterization of the decision-making situation**

The first step for the choice of the MCDA method will be based on the results of Guitouni (1998). It consists of characterizing the decision-making situation and confronting his input/output with those of the MCDA method. The input consists of the local relational preference systems (local utility function, preorder, pseudo-order, semi-order, etc.). The output is the result of the MCDA method (global evaluation, choice of the best compromise strategy or a subset of strategies, ranking of strategies, etc.). Only the MCDA methods having the same couple of input and output than the decision-making situation will be considered for further analysis.

B) **Verification of decomposition conditions**

To be applied for the solving of dynamic decision-making problems, The MCDA methods considered in A) have to verify the four conditions of theorem 1. In fact, these conditions are sufficient to guarantee that applying the decomposition principle will give the best compromise strategies. Only MCDA methods verifying conditions 1 to 4 of theorem 1 are considered for further analysis.

C) **Characterization of the MCDA method**

Because of the large number of MCDA methods, many of them could verify steps A) and B) of this methodology and we can have still to do a choice among them. In order to clarify the choice, we propose to consider other properties that don’t appear as requirements of the decomposition but which are desirable to insure a good quality of the obtained results. The literature review reveals a series of properties, which characterize MCDA methods (Vincke, 1992; Pérez, 1994; Pirlot, 1997; Al-Shemmeri, Al-Kloub and Pearman 1997; Ozernoy, 1992; Bouyssou, 1986; Guitouni, 1998). Some of these properties could be judged objectively whereas others could only be judged subjectively. From this literature, we consider a list of desirable properties in order to characterize MCDA methods. These properties are drawn from the list of properties proposed by Guitouni (1998) as a comparison basis for MCDA methods. We propose to check first properties that could be judged objectively: neutrality, anonymous, fidelity, dominance and independence.

**P1. Neutrality:** The MCDA method is neutral if the final result is not influenced by the denomination of the strategies.

**P2. Anonymous:** The MCDA method is anonymous if the final result is not influenced by the denomination of the criteria.

**P3. Fidelity:** Fidelity means that the result given by the MCDA method reproduces the partial results on which all the criteria are unanimous on.

**P4. Dominance:** The MCDA method respect the dominance principle if it concludes that strategy \( s_k^i \) is preferred to strategy \( r_k^i \) when the strategy \( s_k^i \) dominates strategy \( r_k^i \).

**P5. Independence:** The MCDA method verify the independence property if the preference relation between two strategies \( s_k^i \) and \( r_k^i \) depends only on preferential information relative to compared strategies \( s_k^i \) and \( r_k^i \).

These properties are important for the quality of results. In fact, the set of best compromise solutions is given by the MCDA method and its quality depends on the quality of the method used at decision nodes. For example, if the MCDA method doesn’t verify neutrality, the solution given by our methodology will depend on the nomination of the alternatives.
An analysis of the results of this characterization will be done and some MCDA methods could be eliminated from further analysis if they don’t verify the required desirable properties.

A further characterization of the remaining MCDA methods will be done considering subjective properties such as: \( P6 \): compensatory level, \( P7 \): conviviality, \( P8 \): transparency, \( P9 \): handling of missing data.

Figure 2 illustrates the steps of the methodology of choice.
4. RESULTS OF CHARACTERIZATION OF SOME MCDA METHODS

In this section, we consider six MCDA methods: dominance, lexicographical screening, multi-attribute utility, TOPSIS, ELECTRE III and PROMETHEE II. We try to characterize them toward the previous discussed properties (C1 to C4 and P1 to P5). Table 3 and 4 presented in the appendices summarize the main characteristics of these MCDA methods. We present here briefly these methods:

**Dominance**

\[ s'_k \succ r'_k \Rightarrow s'_k \mathbf{D} r'_k \rightarrow g_m(s'_k) \geq g_m(r'_k) \quad \forall m \in \{1...M\} \text{ and } \exists m_0 \text{ such as } g_{m_0}(s'_k) > g_{m_0}(r'_k). \]

**Lexicographical screening**

Let \( \{g_{(1)}, \ldots, g_{(m_0)}, \ldots, g_{(M)}\} \) be the ordered list of criteria according to their weight. \( s'_k \succ r'_k \Rightarrow \exists m_0 \text{ such as } g_{(m_0)}(s'_k) \succ g_{(m_0)}(r'_k) \text{ and } g_{(m)}(s'_k) = g_{(m)}(r'_k) \) for each criteria \( m \) more important than \( m_0 \).

**Weighted sum**

\[ s'_k \succ r'_k \Rightarrow V(s'_k) > V(s'_k) \text{ where } V \text{ is the aggregative function defined by } V(s'_k) = \sum_{m=1}^{M} \pi_m g_m(s'_k). \]

**TOPSIS**

\[ s'_k \succ r'_k \Rightarrow C^*(s'_k) \succ C^*(r'_k) \text{ where } C^*(s'_k) = \frac{D_v(s'_k)}{D_v(s'_k) + D_v(r'_k)}, D_v(s'_k) \text{ is the Euclidian distance of } s'_k \text{ to the anti-ideal strategy, } D_v(s'_k) \text{ is the Euclidian distance of } s'_k \text{ to the ideal strategy.} \]

**ELECTRE III**

ELECTRE III is based on pair-wise comparison. It starts by computing for each pair of alternatives \( (a_i, a_k) \) a concordance index \( C(a_i, a_k) \) and discordance indexes \( D_j(a_i, a_k) \). The concordance index is computed by equation (1).

\[
C(a_i, a_k) = \sum_{j=1}^{n} \pi_j \delta_j(a_i, a_k) \tag{1}
\]

where

\[
\delta_j(a_i, a_k) = \begin{cases} 
1 & -q_j \leq \Delta_j \\
\frac{\Delta_j + p_j}{p_j - q_j} & -p_j \leq \Delta_j \leq -q_j \\
0 & -p_j > \Delta_j
\end{cases}
\]

and \( \Delta_j = g_j(a_i) - g_j(a_k), \ q_j \) and \( p_j \) are respectively indifference and preference threshold for criteria \( j \).
The concordance index is computed by equation (2).

\[
D_j(a_i, a_k) = \begin{cases} 
0 & \text{if } -p_j \leq \Delta_j \\
\frac{-(\Delta_i + p_j)}{v_j - p_j} & \text{if } -v_j \leq \Delta_j \leq -p_j \\
1 & \text{if } -v_j > \Delta_j 
\end{cases}
\]

(2)

where \( v_j \) is a veto threshold.

Then, a valued outranking relation \( \sigma(a_i, a_k) \) is built by equation (3)

\[
\sigma(a_i, a_k) = C(a_i, a_k) \prod_{j \in J} \frac{1 - D_j(a_i, a_k)}{1 - C(a_i, a_k)}
\]

(3)

if \( J = \{ j : D_j(a_i, a_k) > C(a_i, a_k) \} \neq \emptyset \) and \( \sigma(a_i, a_k) = C(a_i, a_k) \) if \( J = \emptyset \)

An outranking graph will result from the valued outranking relation. Then, a distillation procedure is applied in order to obtain a partial preorder of the alternatives.

**PROMETHEE II**

PROMETHEE II is also based on pair-wise comparison. It consists of computing for each pair of alternatives \( (a_i, a_k) \), a global preference index given by equation (4):

\[
P(a_i, a_k) = \sum_{j=1}^{n} \pi_j F_j(a_i, a_k)
\]

(4)

where \( F_j(a_i, a_k) \) represents the results of the comparison of \( a_i \) and \( a_k \).

An outranking graph will result from the valued outranking relation \( P \). The exploitation phase consists of computing the positive and negative flows: \( \Phi^+(a_i) = \sum_{a_k : a_k \neq a_i} P(a_i, a_k) \) and \( \Phi^-(a_i) = \sum_{a_k : a_k \neq a_i} P(a_k, a_i) \). Then a total preorder results from \( \Phi^+(a_i) - \Phi^-(a_i) \).

Tables 1 and 2 present the results of the verification of the decomposition conditions C1 to C4 (Frini, 2006) as well as the desired properties P1 to P5 (Guitouni, 1998; Frini, 2006) presented earlier. We try in this section to analyze these results in order to identify which MCDA methods could be used in dynamic situations and to explain why the other MCDA methods could not be used.

**Table 1:** Results of the verification of decomposition conditions on the MCDA methods

<table>
<thead>
<tr>
<th>MCDA</th>
<th>C 1</th>
<th>C 2</th>
<th>C 3</th>
<th>C 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dominance</td>
<td>Partial</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Lexicographical screening</td>
<td>Total</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Weighted sum</td>
<td>Total</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>TOPSIS</td>
<td>Total</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>ELECTRE III</td>
<td>Partial</td>
<td>No</td>
<td>Yes(^1)</td>
<td>Yes</td>
</tr>
<tr>
<td>PROMETHEE II</td>
<td>Total</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

\(^1\) Transitivity is verified on the final results (after distillation) of the ELECTRE III method, which in this case is the partial preorder produced by the distillation phase.
The results in table 1 show that only the first three MCDA methods could be applied for dynamic decision-making problems. TOPSIS, ELECTRE III and PROMETHEE II don’t verify the temporal consistence condition C2 and consequently could not be applied conjointly with the decomposition of the dynamic decision-making problem. In the following, we analyze the results in table 2 in order to better explore the relation-ship between the temporal consistence and the independence property.

### Table 2: Results of the verification of properties P1 to P5 on the MCDA methods

<table>
<thead>
<tr>
<th>MCDA</th>
<th>P1</th>
<th>P2</th>
<th>P3</th>
<th>P4</th>
<th>P5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dominance</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Lexicographical screening</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Weighted sum</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes²</td>
</tr>
<tr>
<td>TOPSIS</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>ELECTRE III</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>PROMETHEE II</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

The results in table 2 show that all methods that verify the temporal consistence verify the independence property. We can assert that if one MCDA method verifies the independence, it doesn’t guarantee that it verifies the temporal consistence (see TOPSIS method). However, the results of ELECTRE III and PROMETHEE II support the following relation: temporal consistence $\Rightarrow$ independence, which lead us to propose conjecture 1:

**Conjecture 1:** If the MCDA method verifies the temporal consistence, then it verifies the independence.

Results of tables 1 and 2 show that the outranking MCDA methods that are considered in this study (ELECTRE III and PROMETHEE II) don’t verify the temporal consistence property. This could result from the fact that these methods don’t verify the independence property and also because of their use of thresholds and pair-wise comparisons. For all these reasons, we think that there is a good chance that the results obtained here for ELECTRE III and PROMETHEE II are generalized to all outranking methods. Thus, we propose conjecture 2:

**Conjecture 2:** The outranking MCDA methods didn’t verify the temporal consistence.

### 5. CONCLUSIONS

Solving dynamic multi-criteria decision-making problems is a very challenging endeavor. Recognizing that importance, this paper proposes a methodology to answer the following question: Which MCDA methods could be used to solve dynamic and multi-criteria decision-making problems under uncertainty?

Frini (2006) proposed a methodology for solving dynamic and multi-criteria decision-making situations based on the decomposition principle. The quality of results given by this approach depends on the MCDA method that will be used. Consequently, the choice of the MCDA method to be applied at decision nodes must be made carefully. In order to support this choice, this paper proposes a characterization approach that combines the assessment of MCDA method and the decision-making situation characteristics. The MCDA method is evaluated according to 1) four sufficient conditions (C1 to C4) that allow their use in dynamic decision-making situations and 2) different desired properties (neutrality, anonymous, fidelity, dominance, compensatory level, conviviality, transparency, etc.) that

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² It is assumed that local utility functions are strictly increasing.
assess the overall quality of the MCDA methods. The results of this methodology are given for the following methods: dominance, weighted sum, lexicographical screening, TOPSIS, ELECTRE III, and PROMETHEE II.

The characterization of these MCDA methods shows that TOPSIS, ELECTRE III and PROMETHEE II don’t respect the conditions of decomposition and so could not be used conjointly with the decomposition of the decision-making problem. In addition, by examining the results of this characterization, the example of TOPSIS shows that independence property does not imply temporal consistence. Two conjectures, to be further investigated in future research, are proposed in this paper. The idea behind the first conjecture comes from the results of ELECTRE III and PROMETHEE II, which support that: temporal consistence $\Rightarrow$ independence. The idea behind the second conjecture comes from the fact that ELECTRE III and PROMETHEE II could not be used with decomposition because they don’t verify the independence property and also because of their use of thresholds and pair-wise comparisons. This conclusion leads us to propose the second conjecture, which asserts that outranking MCDA methods don’t verify the temporal consistence condition and consequently they could not be used with decomposition.

REFERENCES


**APPENDICES**

<table>
<thead>
<tr>
<th>MCDA methods</th>
<th>Preferences</th>
<th>Problematic</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mode</td>
<td>Moment</td>
<td>Order</td>
</tr>
<tr>
<td>Dominance</td>
<td>Direct evaluation</td>
<td>a priori</td>
<td>Partial preorder</td>
</tr>
<tr>
<td>Lexicographical screening</td>
<td>Direct evaluation</td>
<td>a priori</td>
<td>Total preorder</td>
</tr>
<tr>
<td>Multi-attribute utility</td>
<td>Direct evaluation</td>
<td>a priori</td>
<td>Total preorder</td>
</tr>
<tr>
<td>TOPSIS</td>
<td>Direct evaluation</td>
<td>a priori</td>
<td>Total preorder</td>
</tr>
<tr>
<td>ELECTRE III</td>
<td>Pairwise comparison</td>
<td>a priori</td>
<td>Partial Preorder</td>
</tr>
<tr>
<td>PROMETHEE II</td>
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<td>a priori</td>
<td>Total Preorder</td>
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</table>

**Table 4**:

<table>
<thead>
<tr>
<th>Discriminatory level of criteria</th>
<th>Compensatory Level</th>
<th>Inter-criteria information</th>
<th>Concepts used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dominance</td>
<td>Absolute</td>
<td>Non compensatory</td>
<td>NA</td>
</tr>
<tr>
<td>Lexicographical screening</td>
<td>Absolute</td>
<td>Non compensatory</td>
<td>Total preorder</td>
</tr>
<tr>
<td>Multi-attribute utility</td>
<td>Absolute</td>
<td>Total</td>
<td>Explicit</td>
</tr>
<tr>
<td>TOPSIS</td>
<td>Absolute</td>
<td>Total</td>
<td>Explicit</td>
</tr>
<tr>
<td>ELECTRE III</td>
<td>Non absolute</td>
<td>Partial</td>
<td>Explicit</td>
</tr>
<tr>
<td>PROMETHEE II</td>
<td>Non absolute</td>
<td>Partial</td>
<td>Explicit</td>
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