Journée de la Recherche du LAMSADE

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LAMSADE

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Who am I?

1. **Functions:**
   - **Since 09/2011:** Maitre de conférences Université Paris Dauphine
   - **09/2010- 08/2011:** Post-doctorant École Centrale Paris (V. Mousseau)
   - **09/2009- 08/2010:** A.T.E.R Université Paris 1
   - **01/2007- 01/2010:** CIFRE Research engineer THALES R & T.

2. **Academic:**
   - **05/2010:** PhD Université Paris 1/ THALES (M. Grabisch et C. Labreuche)
   - **06/2006:** M2 in applied sciences (Decision) Faculté Polytechnique de Mons-Belgique
   - **Before . . .**
The domain: MultiCriteria Decision Aid (MCDA)

**Aim:** to help a decision-maker (DM) to select one or more alternatives among several alternatives evaluated on criteria often contradictory.

⇒ We need to construct a preference relation $\succeq_X$ over the set of all alternatives $X$

**Example (Evaluation of students)**

<table>
<thead>
<tr>
<th>Candidates</th>
<th>Collective Activities</th>
<th>2 : Song</th>
<th>3 : Musical instruments</th>
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<tbody>
<tr>
<td>$a$ : Yvanessa</td>
<td>●●●</td>
<td>17</td>
<td>70 %</td>
</tr>
<tr>
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How to solve a MCDA problem?

Two approaches:

1. **Building and exploiting an outranking relation:**
   
   ⇒ **Objective:** To build a relation on the alternatives, based on pairwise comparisons, and to exploit it in order to solve the problem. (ELECTRE methods)

2. **Building and exploiting an overall value function (MultiAttribute Utility Theory (MAUT))**

   ⇒ **Objective:** To build a numerical representation of the preferences of the DM on the set of alternatives.

   \[ x \succsim x \iff u(x) \geq u(y) \]
MAUT in practice

⇒ **Objective:** To build a numerical representation of the preferences of the DM on the set of alternatives.

In practice:

1. People ask to the DM some preferential information over a subset of alternatives;

2. A model is chosen in order to represent it;

3. If the preferential information given is compatible with the model chosen, then compute the parameters of the model;

4. Finally compute the numerical values of all alternatives by using an automatic extension of the model.
MAUT in practice with an additive model: the weighted sum

⇒ **Objective:** To build a numerical representation of the preferences of the DM on the set of alternatives.

In practice:

1. People ask to the DM some preferential information over a subset of alternatives;

2. A model is chosen in order to represent it: **The weighted sum**

\[ \forall (x_1, \ldots, x_n) \in \mathbb{R}^+_n \quad u(x_1, \ldots, x_n) := \sum_{i \in N} w_i x_i \]

3. If the preferential information given is compatible with the model chosen, then compute the parameters of the model: **The weight** \( w_i \) **of each criterion**

4. Finally compute the numerical values of all alternatives by using an automatic extension of the model.
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If DM says: $b \succ_x a$ and $c \succ_x d$

Then his preferential information is not representable by a weighted sum.
\[\sum_{i=1}^{n} V_i \times x_i\]

"Weighted sum"
\[ \sum_{i=1}^{n} v_i \cdot x_i \quad \text{"Weighted sum"} \quad \frac{-1}{2} \sum_{\{i,j\} \subseteq N} l_{ij} |x_i - x_j| \quad \text{a penalization term} \]
A non-additive model: The 2-additive Choquet integral

\[ C_\mu(x_1, \ldots, x_n) = \sum_{i=1}^{n} v_i x_i - \frac{1}{2} \sum_{\{i,j\} \subseteq N} I_{ij} |x_i - x_j| \] (1)

Where

- \( I_{ij} \) = the interaction index between criteria \( i \) and \( j \).
- \( v_i \) = the importance of the criterion \( i \) (\( \equiv \) Shapley index).
Title

Elaboration of an interactive approach taking into account interaction between criteria in MCDA.

Objective

Develop a MAUT approach by using the 2-additive Choquet integral:

1. Study the theoretical and algorithmic aspects when intensities of preferences are allowed (small, medium …)

2. Implementation in MYRIAD (THALES’s MCDA software)

3. Test in real THALES’s applications: F.O.B (Forward Operating Base) and Airport C.D.M. (Airport Collaborative Decision Making)

⇒ We obtained the 2-additive MACBETH approach
Theoretical contributions (characterization of the 2-additive model)

1. Ordinal case: a characterization theorem (Th & Dec (2010))
2. Cardinal case: a characterization theorem (FSS (2010))

Algorithmic contributions (dealing with inconsistencies)

1. Ordinal case: by using directly the characterization theorem (EUSFLAT 2011);
2. Cardinal case: by using algorithms based on linear programming (IPMU 2010).

Dempster-Shafer theory

A link between Choquet integral and belief functions (Th & Dec (2010), EUSFLAT 2009).
My contributions during the Postdoc

- **Valorization of Decision-Deck project** [www.decision-deck.org](http://www.decision-deck.org)

- **Continue to work on the 2-additive MACBETH** (MCDM 2011, ADT 2011, EUSFLAT 2011) (C. Labreuche et M. Grabisch)

- **Argument Strength Assessment procedure (ASA):** Elicitation of sorting models by using value assignments (V. Mousseau et O. Cailloux)
Research topic 1: Choquet integral

With Denis Bouyssou and Christophe Labreuche (THALES)

1. Find necessary and sufficient conditions to represent a preferences by Choquet integral in MCDA without any assumption (like in additive models)

2. Elicitation of capacities and utility functions simultaneously with Choquet integral

3. Thinking about the concept of commensurability between criteria
Research topic 2: Comparing decision maps

With Marc Pirlot and Valerie Brison (University of Mons Belgium)

Find a characterization of the 2-additive model in this context
Research topic 3: bipolar Choquet integral

With Antoine Rolland and Julien Ah-Pine (University of Lyon 2)

- Find a characterization of Choquet integral w.r.t. a 2-additive bi-capacity
- An algorithm to identify a 2-additive bi-capacity.
- First Contribution: Elicitation of a 2-additive bi-capacity through trinary actions (IPMU2012, Paper accepted).
Research topic 4: Preference Learning

With Meltem Oztürk, Gabriella Pigozzi, Vincent Mousseau (ECP), Wassila Ouerdane (ECP), Marc Pirlot (University of Mons, Belgium) and Antoine Rolland (University of Lyon 2)

- How to interact with machine learning community?
- First meeting: Last January (Vincent, Marc, Wassila, Antoine)
- Future event: Organization of a workshop during the autumn at Mons (Belgium).
Research topic 5: Decision Deck Project (http://www.decision-deck.org/)

- D2 aims at collaboratively developing Open Source software tools implementing Multiple Criteria Decision Aid (MCDA).
- LAMSADE is a founding member of D2.
- **next meeting:** 10th Decision Deck Workshop in Tarragona (Spain)
- **Future event:** In autumn, the next workshop at LAMSADE?
Publications

- 2 articles in Journals (Th & D 2010 and FSS 2010)
- 7 international conferences with proceedings (3 IPMU, 2 EUSFLAT, 1 ESREL, 1 ADT)
- 1 national conference with proceedings (LFA)
- 2 international conferences with abstract (1 EURO, 1 MCDM)
- 9 workshops and invited seminar (MCDA-EWG, …)
- Patent FR 09 0366 : “Procédé pour le paramétrage d’un calculateur utilisant des modèles basés sur la connaissance”