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UMR CNRS 7253

Handling Inconsistent Preferences using Possibilities and Information Fusion

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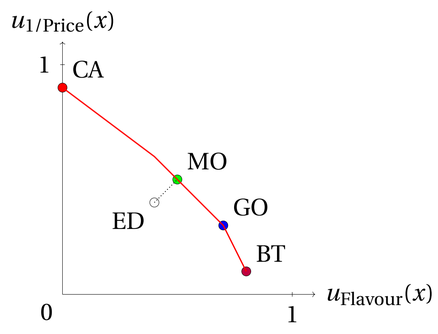
Multiple-Criteria Decision Analysis (MCDA)

Objective: find the best alternative x to recommand. Here $f_\omega = 0.6$ flavour $+ 0.4$ 1/Price.

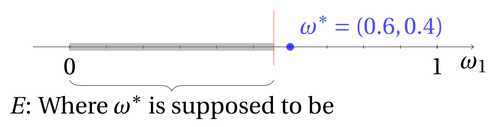
Name	Flavour	1/Price
American Cheddar	0	9
Mozzarella	5	5
Gorgonzola	7	3
Truffle Brie	8	1
Edam	4	4



Can you show Gorgonzola is the best ($f_\omega = 5.4$)? Why Edam is never taken?

Problem in reality: ω is unknown. Solution: preference elicitation.

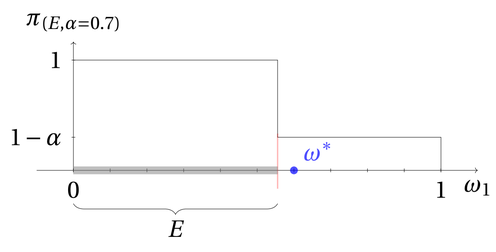
Rubust Elicitation (sets) [1]



E: Where ω^* is supposed to be

- Idea: find all models $\omega \in \Omega$ coherent with user's preferences = set E.
- Problem: with an error, ω^* can be outside of $E \Rightarrow$ converge to a wrong model.

Possibilist Elicitation (possibility distribution) [2]



- Our solution: preference = possibility π.
  A confidence level α with each interaction.
- Even with a wrong answer, we can still converge to ω^* ($\pi(\omega^*) \neq 0$).
- Detection of incoherence: subnormalised π.

Evaluation of the Quality of a Recommendation: Minimax regret

Minimax regret for robust approaches

$$\text{PMR}(x, y, E) = \max_{\omega \in E} \text{R}_\omega(x, y)$$

$$\text{MR}(x, E) = \max_{y \in \mathbb{X}} \text{PMR}(x, y, E)$$

$$\text{mMR}(E) = \min_{x \in \mathbb{X}} \text{MR}(x, E)$$

Regret: $\text{R}_\omega(x, y) = f_\omega(y) - f_\omega(x)$.

Regret extension for possibilist approaches

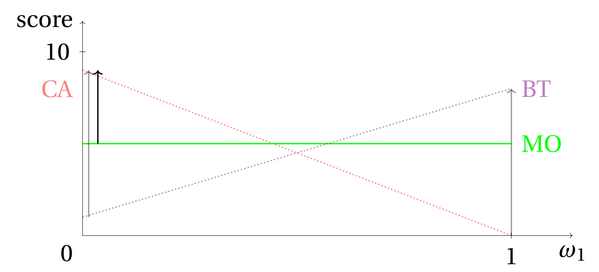
$$\text{EPMR}(x, y, \pi) = \sum_{i=1}^{n} (\alpha_i - \alpha_{i+1}) \text{PMR}(x, y, \pi^\alpha)$$

$$\text{EMR}(x, \pi) = \sum_{i=1}^{n} (\alpha_i - \alpha_{i+1}) \max_{y \in \mathbb{X}} \text{PMR}(x, y, \pi^\alpha)$$

$$\text{mEMR}(\pi) = \min_{x \in \mathbb{X}} \text{EMR}(x, \pi)$$

α-cut: $\pi^\alpha = \{\omega \in \Omega : \pi(\omega) \geq \alpha\}$.

Illustration of Minimax regret



MR(CA) = MR(BT) = 8. MR(MO) = 4 $\Rightarrow$ mMR({CA, BT, MO}) = 4.
MO is the alternative to recommand.

User Error and Information Fusion

Method	$f(x^*) - f(x)$
Robust elicitation	0.125
Possibility elicitation	0.0373
Naive correction	0.233
Fusion 1 (ℓ-out-of-k)	0.130
Fusion 2 (heuristics MCS)	0.0459
Fusion 2 (best MCS)	0.00695

x^*: user prefered. x: recommanded.
Low difference = Good.

- Detection of inconsistency from the user after multiple interactions.
- Possibilist elicitation alone better than set-based elicitation.
- Fusion methods: can potentially improve the quality of the recommendation.
  Provide information on the answers (determine wrong answers).

Wrong Model and Model Change

Method	$\overline{x}$	σ_x
Wrong detected	.0948	.0817
Wrong corrected	.0678	.0741
Wrong not detected	.00866	.0217

Method	$\overline{x}$	σ_x
Wrong detected	.103	.0841
Wrong corrected	.00649	.0140
Wrong not detected	.0238	.0331

- Real model : complex interactions between criteria. Supposed model: no interactions.
  Changing model = recommendations barely improve $\Rightarrow$ Too many new parameters to estimate (from $p-1$ to 2^p-2) + elicitation strategy not optimal for complex model?
- Two different models but without interactions + same number of parameters.
  Changing model = better recommandations (still not perfect?).

References for Elicitation

[1] Nawal Benabbou, Patrice Perny, and Paolo Viappiani. Incremental elicitation of choquet capacities for multicriteria choice, ranking and sorting problems. *Artificial Intelligence*, 246:152–180, 2017.

[2] Loïc Adam and Sébastien Destercke. Possibilistic preference elicitation by minimax regret. In *Uncertainty in Artificial Intelligence*, pages 718–727. PMLR, 2021.

What to do now?

Differentiate incoherence from user and model errors (difficult problem).

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