Decision Analysis - Project 2

1 Introduction

Project 2 is about proposing and solving a selected decision problem using methods from the UTA and AHP. Use the problem definition prepared for the project 1. If you want to use a different data set, a detailed description should be placed at the beginning of the report, following the requirements of Project 1.

As a reminder, include the entire data set along with a description of the criteria. If they are discrete or continuous? Note in the case of continuous domains, specify the range of the criterion's variability, in the case of others: the ordered list of the values. What is the nature (gain/cost) of the individual criteria?

Note: Do not include the entire report 1.

- The entire project must be done **individually or in pairs**.
- The report can be made in a jupyter notebook (**.ipynb + HTML**) or as a **python project + report in PDF**.
- The code with the report should be sent by **18/04/2024 23.59**

2 UTA

2.1

Prepare a program implementing the UTA method that resolves inconsistency by finding a minimal subset of constraints that need to be removed from the constraint set. Use a solver e.g. GLPK in the pulp library.

- As preferential information, consider pairwise comparisons prepared in the previous project, enriched with additional pairwise comparisons.
- Add the constraint that there can be no criterion whose weight is greater than 0.5 and less than a preset threshold (dependent on the number of criteria).
- At least one constraint resulting from the preferential information should be inconsistent with the rest and be rejected by the solver. (The easiest way to do this is by creating a cycle of $A \succ B$, $B \succ C$, $C \succ A$.)

- Find all subsets of consistent preference information by iteratively adding new constraints derived from previously found inconsistencies.
- Discuss the results.

2.2

- For the largest set of consistent preference information, define and solve a problem with an objective function that minimizes the sum of over- and under-estimation errors.
- List all the equations in the model and all the variables with their values obtained during the optimization.
- Print the value of the objective function.
- Draw plots of marginal value functions. All plots should be scaled to the same maximum utility value. All axes should be described.
- Discuss the results.

3 AHP

For the AHP method, it is necessary to create a hierarchy. Therefore, it is necessary to propose a hierarchy that corresponds to the problem under consideration. At the lowest level are alternatives, above them, are criteria, and at the highest level can be:

- criteria categories,
- multiple DMs,
- multiple goals,
- several time periods,
- ...

In this case, you can create additional new criteria describing the data.

- The hierarchy should have at least 3 levels, not all branches have to have the same amount of levels.
- This hierarchy should also be presented in the report along with the weights obtained.
- You can use the original preference scale from 1-9 for pairwise comparisons.
- At least one matrix should be inconsistent.

- The weights should be calculated by the method of eigenvectors and eigenvalues.
- Calculate the relative consistency index for each level and check that the consistency of the preferential information is maintained.
- For inconsistent matrices, recreate matrix A from the final weights. Show where the biggest difference is between what DM provided and the reconstructed matrix.
- Describe the obtained results and confront the matrices of pairwise comparisons with those obtained from the weights.

4 Compare method results

In this section, the obtained ranking from UTA should be compared with the results from the PROMETHEE II (Project 1) and AHP methods, using Kendall's τ coefficient.

The comparison should also include comparing the best and worst alternatives across all methods and a description of what in your opinion had the greatest impact on the obtained ranking.

5 Grading

- 3 – UTA 2.1 with plots of marginal value functions for the selected consistent set of preference information.
- 4 – UTA 2.1, 2.2 and comparison of the results of the UTA method with PROMETHEE II
- 5 – UTA 2.1, 2.2, AHP and comparison of results of UTA, AHP and PROMETHEE methods.