Project 1: Promethee/Electre

March 25, 2025

1 Description

1.1 Dataset

Your task is to prepare a dataset that will be used in the process of Multi-Criteria Decision Analysis (MCDA).

The dataset should relate to a real-world problem that is relevant or interesting to you. Please avoid datasets generated using various types of generators. Keep in mind that in MCDA problems, there is usually no single optimal solution. Therefore, it is crucial to consider decision-makers' preferences to effectively differentiate between available options.

Think about possible evaluation criteria that are relevant to the analyzed problem and define their appropriate scales and preference directions. Each criterion should be expressed on an initial or any numerical scale. Then, assess all decision alternatives based on the selected criteria.

Your dataset should include between 12 and 50 decision alternatives and between 4 and 9 evaluation criteria.

As part of the solution, you must submit:

- the dataset in .csv format,
- answers to the questions defined in Criterion section as a part of a report in .pdf file.

1.2 Promethee

Prepare the implementation of methods from PROMETHEE family based on the description provided during the lectures and laboratories. Your task is to provide an implementation of missing function in the provided template.

Missing fragments of the implementation:

- `calculate_marginal_preference_index`- Function that calculates the marginal preference index for the given pair of alternatives, according to the following formula:

$$\pi_k(a_i, a_j) = \begin{cases} 1, & \text{if } d_k(a_i, a_j) \geq p_k, \\ 0, & \text{if } d_k(a_i, a_j) \leq q_k, \\ \frac{d_k(a_i, a_j) - q_k}{p_k - q_k}, & \text{if } q_k < d_k(a_i, a_j) < p_k. \end{cases}$$

- `calculate_marginal_preference_matrix`- Function that calculates the marginal preference matrix for all alternatives pairs and criterion available in dataset

- `calculate_comprehensive_preference_index`- Function that calculates comprehensive preference index for the given dataset
- `calculate_positive_flow`- Function that calculates the positive flow value for the given preference matrix and corresponding index
- `calculate_negative_flow`- Function that calculates the negative flow value for the given preference matrix and corresponding index
- `calculate_net_flow`- Function that calculates the net flow value for the given positive and negative flow
- `create_partial_ranking`- Function that aggregates positive and negative flow to a partial ranking (from Promethee I)
- `create_complete_ranking`- Function that aggregates positive and negative flow to a complete ranking (from Promethee II)

As the solution, you must submit:

- the preference information in .csv format, where row corresponds to criterion and column to indifference threshold (q), preference threshold (p), weight (k) and criterion type (either gain or cost)
- implementation of the method in .py file
- answers to the questions defined in Criterion section as a part of a report in .pdf file.

All required packages needed to run the script are defined in `requirements.txt` and could be installed with pip package manager (`pip install -r requirements.txt`).

The scripts are working under python >3.12, the other versions could also so work, but hasn't been tested.

To test your solution you could use the following commands:

```
python -m promethee.main <dataset_path>
python -m promethee.main promethee/data/lecture
```

1.3 Electre TRI-B

Prepare the implementation of ELECTRE TRI-B based on the description provided during the lectures and laboratories. Your task is to provide an implementation of missing function in the provided template.

Missing fragments of the implementation:

- `calculate_marginal_concordance_index`- Function that calculates the marginal concordance index for the given pair of alternatives, according to the following formula:

$$d_j(a,b) = \begin{cases} g_j(a) - g_j(b), & \text{for } \textit{gain} \text{ criterion,} \\ g_j(b) - g_j(a), & \text{for } \textit{cost} \text{ criterion,} \end{cases}$$

$$c_j(a_i,b_h) = \begin{cases} 1, & \text{if } d_k(a_i,b_h) \geq -q_j^h), \\ 0, & \text{if } d_k(a_i,b_h) \leq -p_j^h), \\ \frac{p_j^h + d_k(a_i,b_h)}{p_j^h - q_j^h}, & \text{if } -q_j^h > d_k(a_i,b_h) > -p_j^h). \end{cases}$$

- `calculate_marginal_concordance_matrix`- Function that calculates the marginal concordance matrix for all alternatives pairs and criterion available in dataset
- `calculate_comprehensive_concordance_matrix`- Function that calculates comprehensive concordance matrix for the given dataset
- `calculate_marginal_discordance_index`- Function that calculates the marginal concordance index for the given pair of alternatives, according to the formula presented during classes.

$$D_j(a_i, b_h) = \begin{cases} 1, & \text{if } d_k(a_i, b_h) \leq -v_j^h), \\ 0, & \text{if } d_k(a_i, b_h) \geq -p_j^h), \\ \frac{-d_k(a_i,b_h)-p_j^h}{v_j^h-p_j^h}, & \text{if } -p_j^h > d_k(a_i, b_h) > -v_j^h). \end{cases}$$

- `calculate_marginal_discordance_matrix`- Function that calculates the marginal discordance matrix for all alternatives pairs and criterion available in dataset
- `calculate_credibility_index`- Function that calculates the credibility index for the given comprehensive concordance matrix and marginal discordance matrix
- `calculate_outranking_relation_matrix`- Function that calculates boolean matrix with information if outranking holds for a given pair
- `calculate_relation`- Function that determine relation between alternatives and boundary profiles
- `calculate_pessimistic_assigment`- Function that calculates pessimistic assigment for given relation between alternatives and boundary profiles
- `calculate_optimistic_assigment`- Function that calculates optimistic assigment for given relation between alternatives and boundary profiles

As the solution, you must submit:

- `boundary_profiles.csv`, where row corresponds to boundary profiles and column to criterion
- `indifference_threshold.csv`, where row corresponds to boundary profiles and column to criterion and entry to indifference threshold
- `preference_threshold.csv,` where row corresponds to boundary profiles and column to criterion and entry to preference threshold
- `veto_threshold.csv`, where row corresponds to boundary profiles and column to criterion and entry to veto threshold
- `type.csv`, where row corresponds to criterion and columns 'type' (either gain or cost) and 'k' (weight of criterion)
- `credibility_threshold.csv` with single column and row with credibility threshold
- implementation of the method in .py file

- answers to the questions defined in Criterion section as a part of a report in .pdf file.

All required packages needed to run the script are defined in `requirements.txt` and could be installed with pip package manager (`pip install -r requirements.txt`).

The scripts are working under python >3.12, the other versions could also so work, but hasn't been tested.

To test your solution you could use the following commands:

```
python -m electre_tri_b.main <dataset_path>
python -m electre_tri_b.main electre_tri_b/data/lecture
```

1.4 Comparison

Compare the results received with both implemented methods. Refer among other to the compliance of the results between all method and between your preferences, point out difference that you observed. You can also describe difficulties that you faced when working with them.

2 Criterion

2.1 Dataset

2.1.1 Report

Name	Points
What is the domain of the problem about?	1.0
What is the source of the data?	1.0
What is the point of view of the decision maker?	1.0
What is the number of alternatives considered? Were there more of them in the original data set?	1.0
Describe one of the alternatives considered (give its name, evaluations, specify preferences for this alternative)	1.0
What is the number of criteria considered? Were there more of them in the original data set?	1.0
What are the domains of the individual criteria (discrete / continuous)? Note: in the case of continuous domains, specify the range of the criterion's variability, in the case of others: list the values. What is the nature (gain / cost) of the individual criteria?	1.0
Are all criteria of equal importance (should they have the same "weights")? If not, can the relative importance of the criteria under consideration be expressed in terms of weights? In this case, estimate the weights of each criterion on a scale of 1 to 10. Are there any criteria among the criteria that are completely or almost invalid / irrelevant?	1.0
Are there dominated alternatives among the considered data set? If so, present all of them (dominating and dominated alternative), giving their names and values on the individual criteria.	1.0
What should the theoretically best alternative look like in your opinion? Is it a small advantage on many criteria, or rather a strong advantage on few (but key) criteria? Which?	1.0
Which of the considered alternatives (provide name and values on individual criteria) seems to be the best / definitely better than the others? Is it determined by one reason (e.g. definitely the lowest price) or rather the overall value of the criteria? Does this alternative still have any weaknesses?	1.0
Which of the considered alternatives (provide name and values on individual criteria) seems to be the worst / definitely worse than the others? Is it determined by one reason (e.g. definitely the highest price), or rather the overall value of the criteria? Does this alternative still have any strengths?	1.0
Provide at least 4 pairwise comparison between alternatives in your dataset.	1.0
Total	**13.0**

2.2 Promethee

2.2.1 Method implementation

Name	Points
Calculate marginal preference index	2.0
Calculate comprehensive preference index	2.0
Calculate positive, negative and net flow	2.0
Construct final ranking	2.0
Total	**8.0**

2.2.2 Report

Name	Points
Write the preferential information you provided at the input of the method	2.0
Enter the final result obtained with the method	2.0
Compare the complete and partial ranking	2.0
Compare the results obtained using the implemented method with the alternatives you identified as the best and the worst (in Dataset section)	2.0
Compare the results obtained using the implemented method with a priori believes about the alternatives (pairwise comparisons defined in Dataset section)	2.0
Additional comments on the obtained results. You may refer, among other things, to alternatives that surprised you or to position in the ranking that you believe are incorrect.	*4.0**
Total	**10.0**

2.3 Electre TRI-B

2.3.1 Method implementation

Name	Points
Marginal concordance calculation	2.0
Marginal discordance calculation	2.0
Comprehensive concordance and credibility index calculation	2.0
Optimistic and pessimistic assigment implementation	2.0
Total	**8.0**

2.3.2 Report

Name	Points
Write the preferential information you provided at the input of the method	2.0
Enter the final result obtained with the method	2.0
Compare the optimistic and pessimistic class assignments.	2.0
Compare the results obtained using the implemented method with the alternatives you identified as the best and the worst (in Dataset section)	2.0
Compare the results obtained using the implemented method with a priori believes about the alternatives (pairwise comparisons defined in Dataset section)	2.0
Additional comments on the obtained results. You may refer, among other things, to alternatives that surprised you or to assignments you believe are incorrect.	*4.0**
Total	**10.0**

2.4 Comparison

2.4.1 Report

Name	Points
Compliance between methods	2.0
Differences between methods	2.0
Other comments on results	*2.0**
Total	**4.0**