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F-SD301 – Assignment – Decision Theory

Context:

In this analysis, I will address the questions related to the Decision Theory assignment, F-SD301. The assignment focuses on formulating a linear program (LP) to infer criteria weights for the Human Development Index (HDI) and using Data Envelopment Analysis to identify efficient countries. Two datasets, HDI and HCI, are merged, and data cleaning is performed to align country names. Below are the responses to the questions:

Part I: Linear Program (LP) for Criteria Weights

1. What value(s) did you use for the constraint RHS δ_{ik}?

I utilized a constant δ for each pair of countries to establish the constraints. After experimenting with different values, I determined that $\delta = 0.06$ yielded the best results by minimizing the average rank difference between the HCI rank and the inferred rank by the model.

2. Did your optimal solution exhibit any inconsistencies with respect to the pairwise comparisons provided? If yes, which ones?

I applied the linear system to the entire set of countries and found that, among the provided pairwise comparisons:

[("Vietnam","Kazakhstan"), ("Slovenia","Spain"), ("Turkey","Argentina"), ("Nepal","Ghana"), ("Zimbabwe","Iraq"), ("Japan","Switzerland"), ("Kenya","Honduras"), ("Peru","Kuwait")],

only the pair (Nepal, Ghana) was assigned incorrectly. The remaining comparisons aligned with the linear program's results. Among all pairwise comparison (=13861) on the 166 countries, 913 were assigned incorrectly.

3. What were the optimal criteria weight values wj that you obtained?

The optimal criteria weight values obtained were as follows:

Weight for Schooling (weights_0) = 0.25974118

Weight for Life Expectancy (weights_1) = 0.74025882

Weight for Income (weights_2) = 0.0

4. What is Croatia's ranking out of all countries, applying your optimal weights? How does this compare with its HDI ranking?

Under the optimal weights, Croatia's new ranking among the 166 countries used in the modeling is 37. This ranking differs slightly from Croatia's HDI ranking, which is 30. The difference between the two rankings is 7 places.

Part II: Data Envelopment Analysis (DEA) for Efficient Countries

1. Which countries lie on this efficient frontier?

The countries that lie on the efficient frontier according to Data Envelopment Analysis are:

Australia, Hong Kong, Iceland, Ireland, Lesotho, New Zealand, Nigeria, Palau, Singapore, South Africa, and the United States.

2. What is Estonia's efficiency rating (ϑ)? If Estonia is not efficient, (a) what are its target values for each criterion? and (b) what is the convex combination of ERS members used to generate these target values?

Estonia's efficiency rating (θ) found is 0.51789541. Since Estonia is not efficient, we can calculate its target values for each criterion and identify the convex combination of efficient countries used to generate these target values.

The target values per criteria for Estonia are determined by a convex combination [Iran, St. Kitts and Nevis, Senegal] (ERS countries for Estonia) and their respective weight: [0.24321174, 0.48355169, 0.27323657] by (1-criteria) with criteria being in (Schooling, Life expectancy, Income)

Target_schooling_Estonia = 0.6229005300120373
Target_expectancy_Estonia = 0.8302166968978185
Target_income_Estonia = 0.1690596579733825

Value for each criterion for Estonia:

Value_schooling_Estonia = 0.872592
Value_expectancy_Estonia = 0.902545
Value_income_Estonia = 0.418487

The target values and the convex combination provide insights into how Estonia could improve its performance. By looking at which countries are heavily weighted in the convex combination, policymakers can identify which countries Estonia should look to as benchmarks.