A TOPSIS-based Multi-objective Model for Crowd Judgment Analysis

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Traditional Judgment Analysis

Crowdsourcing service can be utilized very efficiently based on the available vast human resources to label data at a larger scale. Collecting independent opinions from them can solve the large annotation task in very time and cost-effective manner.

	Question 1	Question 2	Question 3	Question 4
Annotator 1	Y	—	Y	Y
Annotator 2	N	Y	Y	Y
Annotator 3	Y	U	—	N
Annotator 4	—	—	U	—
Annotator 5	Y	U	N	—

Figure 1. Snapshot of traditional response matrix.

	O1	O2	O3	O4	O5
Q1	1.5	1.9	0	0	0.81
Q2	1.7	0	0	0	1.5
Q3	1.3	1	0	0	0.68
Q4	0	0	1	0.1	1.76
Q5	0	0	1.66	1.8	0.51

Figure 2. Snapshot of judgment matrix.

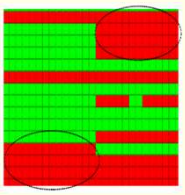

Figure 3. Response matrix after scaling.

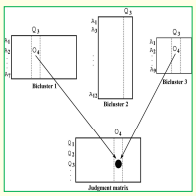

Figure 4. Overlapping biclusters.

❖ Probabilistic Model for Group Decision Making

$$\gamma_j(z) = \prod_{i \in \partial_j} P(z)^{I(R_{ij}=Z)} (1 - P(z))^{I(R_{ij} \neq Z)}$$

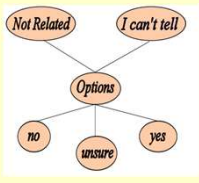

Figure 5. Multi Opinion option set.

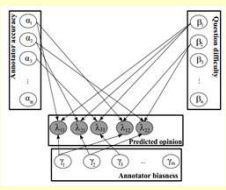

Figure 6. Graphical Model for Group Decision Making.

Constrained Judgment Analysis

	Question 1	Question 2
Annotator 1	{(10, 20), (22, 33), (42, 30)}	{(10, 20), (20, 30), (40, 30)}
Annotator 2	{(10, 21), (20, 30), (44, 35)}	{(40, 30), (20, 30), (10, 20)}
Annotator 3	{(10, 12), (21, 27), (27, 23)}	{(11, 20), (2, 30), (43, 33)}
Annotator 4	{(11, 22), (20, 30), (29, 50)}	{(12, 22), (20, 30), (30, 30)}
Annotator 5	{(11, 23), (20, 30), (50, 30)}	{(10, 10), (20, 30), (40, 30)}

Figure 7. Response Matrix (Constrained).

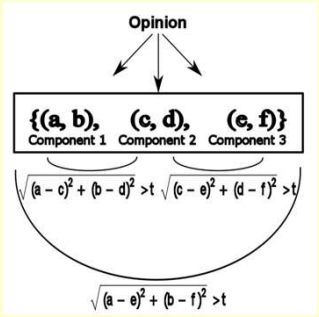

Figure 8. Component of a question.

Challenges

❖ As it is unknown to us what are the possible options (only starting and ending coordinates are known), therefore, it is hard to find the posterior distribution of each option.

❖ If the range of opinions are large, then it becomes more difficult to aggregate the decisions.

❖ One solution can be to use binning, but it needs multiple threshold values that is a problem and there is a chance of loosing the exact information due to the merging of similar opinion in same bins.

Motivations

❖ We are motivated that defining the option set is not necessary when it is not available.

❖ Ranking of crowd from constrained opinions from them cannot be performed easily as no ground truth label is present.

❖ TOPSIS method for ranking can be a probable solution for ranking to reward them.

❖ However, the ideal solution in traditional TOPSIS for multiple objectives cannot be optimal in the presence of conflicting objectives.

Multi-objective Formulation

❖ The aggregated judgment from multiple crowd opinions are derived by optimizing two conflicting criteria simultaneously.

❖ The first objective is the coverage area enclosed by K points and the second objective is the deviation of the solution from the mean.

❖ The optimized solutions obtained from the multi-objective optimization algorithm is utilized as the ideal solution of the TOPSIS model to rank the crowd.

Dataset and Analysis

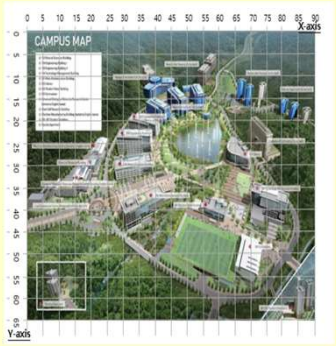

Figure 9. Grid map of UNIST Campus.

Results

Solutions	Objective 1	Objective 2
Solution 1	1.9502	0.0569
Solution 2	1.8234	0.0546
Solution 3	1.7754	0.0537
Solution 4	1.6846	0.0519

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