GROUP DECISION MAKING UNDER MULTIPLE CRITERIA

FINAL EXAM

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You may use lecture notes and other related printed sources as well as your computer.
Allowed programs are **pdf readers** for reading pdf files, and **MS Excel** for mathematical calculations. Other programs are strictly forbidden to use. Please turn of Internet property of your computer.

Duration: 2.5 hours

QUESTIONS

1. (20 Points) Suppose a hypothetical city, Yiretuk, where 1,193,145 votes are cast for five party lists contesting six seats and suppose the distribution of votes is as follows:

Journey Party	180,551
Bribe Lovers Party	332,191
June Party	444,697
Burglar Party	152,342
Jobs and Powers Party	83,364

Allocate seats to party lists by using D'Hondt's rule, Greatest remainder method with Hare quota, and Single Transferable vote with droop quota. Compare the results based on the characteristic of the methods.

2. (20 points) A software company desires to hire a system analysis engineer among five candidates A1, A2, A3, A4, and A5 who are evaluated through against five benefit criteria; i.e. emotional steadiness, oral communication skills, personality, experience, and education background.
Human Resources manger utilized ELECRE method to find the appropriate candidates. She has calculated concordance and discordance measures as follows:

Concordance Matrix

	A1	A2	A3	A4	A5
A1		0,8	1	0,8	1
A2	0,65		0,8	0,9	0,67
A3	0,55	0,65		0,5	0,8
A4	0,8	0,82	0,82		0,85
A5	0,67	0,82	0,8	0,82	

Discordance Matrix

	A1	A2	A3	A4	A5
A1		0,3	1	0,8	0,3
A2	0,4		0,5	0,9	0,67
A3	0,55	0,5		0,55	0,75
A4	0,3	0,8	0,67		0,85
A5	0,67	0	0,8	0,8	

a) Use ELECTREE 1 and find the Kernel.
b) Use ELECTRE II to rank the alternatives. Assume concordance and discordance thresholds $C^* = 0.75$, $D^* = 0.60$ for the strong outranking relation and $C^- = 0.60$, $D^- = 0.70$ for the weak outranking relation.

3. (20 points) Consider the following case related to the Deep Cove Project. How can group decision making (GDM) approaches be used to this problem situation? Which GDM methods can be used for which purposes?

"**Environmental and economic considerations: The Deep Cove project**

The water discharged in Deep Cove from the Manapouri Power Station in Fiordland National Park at the bottom of New Zealand's South Island is so pure that it does not need any chemicals to neutralize harmful bacteria or other contaminants. Several years ago, a US firm applied for the rights to capture this water and transport it with large ocean-going tankers to the US West Coast and Middle East. It would have entailed building a floating dock close to the tail race of the power station, where up to two tankers could berth simultaneously. The project would provide employment for about 30 people in an economically depressed area of NZ, and the NZ Government would collect a water royalty. It would thus make a substantial contribution to both the local and national economies.

The firm showed considerable responsibility in planning the whole operation to keep the environmental impact in the fiord as low as economically feasible. For instance, all staff would be flown into Deep Cove daily, allowing no permanent residence. All rubbish would be removed. No permanent structures would be erected. Tanker speed in the fiords would be reduced to keep swells low. There would be extensive safety measures to avoid oil spills, etc.

Not surprisingly, environmental groups were opposed to this project. Here are some of their reasons: First, it would introduce non-tourist commercial activities in the waters of a national park, which is against the charter of national parks. They feared that the removal of up to 60% of the tail race water for extended periods would alter the balance between fresh water and salt water and affect the sound's unique flora and fauna that have evolved over millions of years. The big tankers would speed up the mixing of the fresh water layer on top of the salt water base, affecting the ecological balance even further. Due to the severe weather conditions in that part of NZ, accidents resulting in oil spills would be difficult to prevent, even with the best of intentions, with potentially disastrous consequences. It could introduce rats, endangering rare birds. It would make poaching of rare birds easier.

The NZ Government had the final say. What should it do? Given the potential environmental impact, a decision for or against it could not be made on economic grounds alone. It required a careful balancing of important economic, political, and environmental factors. There were conflicting objectives, i.e. maximizing the economic welfare of NZ versus minimizing irreversible environmental impacts to preserve a unique wilderness area for the enjoyment of future generations, as well as limiting the intrusion of commercial activities into a national park."

4. (25 Points) Consider the case study in Ölçer and Odabaşı (2005)* and assume the problem with four attributes: A_1: investment cost (IC), A_2: operating cost (OC), including handling, repair and maintenance costs, A_3: manoeuvrability (MV), A4: vibration and noise (VN).

Propose an appropriate fuzzy group decision making approach which depends on OWA operator and PROMETHEE Approach to solve the given problem. Write the steps of the proposed approach clearly. (You may use an existing method analyzed in the class different from Ölçer and Odabaşı (2005) or create a new one)

* A.İ. Ölçer, A.Y. Odabaşi, A new fuzzy multiple attributive group decision making methodology and its application to propulsion/manoeuvring system selection problem, European Journal of Operational Research, Volume 166, Issue 1, 1 October 2005, Pages 93-114,

5. (20 points) Consider the illustrative example in Xu (2006)'s study, where university faculty are evaluated for tenure and promotion. The attributes are G_1: teaching, G_2: research, and G_3: service (whose weight vector $\omega = (0.14, 0.26, 0.60)^T$). Five faculty candidates (alternatives) x_j (j = 1, 2, 3, 4, 5) are to be evaluated using the label set S = {s_{-3} = none, s_{-2} = very low, s_{-1} = low, s_0 = medium, s_1 = high, s_2 = very high, s_3 = perfect} by three DMs d_k (k = 1, 2, 3) (whose weight vector is $\lambda = (0.2, 0.5, 0.3)^T$) under these three attributes.
The individual preference values and the collective overall preference values given in following table.

	Individual Preference Values			Collective Overall Preference Values
	DM 1	DM 2	DM 3	
Weight→	0.20	0.50	0.30	
x_1	1.06	0.34	0.54	0.535
x_2	1.18	0.94	0.46	0.807
x_3	0.54	0.26	0.92	0.480
x_4	-0.06	0.28	0.74	0.369
x_5	0.40	1.12	-0.08	0.514

a) In order to evaluate Xu's proposed method and quantify the level of the decision-making effect of each DM in linguistic MAGDM, calculate consistency, closeness and uniformity indices defined in Pang and Liang (2012)'s study.
b) Briefly interpret the results you have obtained in part (a).

- Jifang Pang, Jiye Liang, Evaluation of the results of multi-attribute group decision-making with linguistic information, Omega, 40 (3) 2012, 294-301
- Zeshui Xu, 2006, A Note on Linguistic Hybrid Arithmetic Averaging Operator in Multiple Attribute Group Decision Making with Linguistic Information, Group Decision and Negotiation, Volume 15, Issue 6, pp 593-604.