GROUP DECISION MAKING UNDER MULTIPLE CRITERIA

MIDTERM EXAM

Assoc. Prof. Özgür Kabak **April 28, 2020**

Due date: April 28, 2020, 17:00
Please submit your files to ninova before 17:00.
All questions related to the questions are welcomed via e-mail (ozgurkabak@gmail.com), via WhatsApp (0532-4274535) or by direct phone call (0532-4274535).

This is an individual exam. Do not cheat! Academic misconduct or cheating will not be tolerated!

- *You may use printed lecture notes and other related sources and related files in your own computer. You may use excel for calculations.*
- *Do not communicate or share files with your peers.*

Instructions:

- You may answer the questions on word file or handwritten on a paper, and use excel for calculations.
- You have to convert the word file or handwritten papers to a pdf file to upload on ninova.
- If you use excel, please prepare a single excel file. Each question should be in a separate sheet.
- Please upload your answers on ninova as a single pdf file and an excel file.

QUESTIONS

1. (15 pts.) Distribution of the valid votes in Muğla province in the year 2018's Parliament Elections is given as follows. Only the parties that have the right to send deputies to the parliament according to the overall results are listed (i.e., the parties that have more than 10% in overall votes). Muğla has 7 seats in the parliament.

Parties	Number of votes
Party A	182,679
Party B	42,033
Party C	43,648
Party D	264,842
Party E	106,862

a) Find the number of seats allocated to parties using Highest average method - d'Hondt's rule.
b) Find the number of seats allocated to parties using Greatest remainder method with Hare quota.
c) Discuss the properties of these two methods based on the results you find in part a) and b).

2. (15 pts.) In which part of a Multi Attribute Group Decision Making (MAGDM) process can voting methods be used? Explain based on the conceptual framework for MAGDM in Kabak and Ervural (2017).

3. (15 pts.) Please classify the following papers based on the classification scheme for MAGDM literature defined in Kabak and Ervural (2017).

- Safarzadeh, S., Khansefid, S., & Rasti-Barzoki, M. (2018). A group multi-criteria decision-making based on best-worst method. Computers & Industrial Engineering, 126, 111-121. https://doi.org/10.1016/j.cie.2018.09.011
- Fan, Z.-P., Ma, J., Jiang, Y.-P., Sun, Y.-H., & Ma, L. (2006). A goal programming approach to group decision making based on multiplicative preference relations and fuzzy preference relations. European Journal of Operational Research, 174(1), 311–321. http://doi.org/10.1016/j.ejor.2005.03.026

4. (20 pts.) Suppose there are 16 voters whose rankings of six candidates, *a–f* , are as follows (the notation $a \succ b$ means that the voter referred to rank candidate *a* ahead of candidate *b*.)

Voter No.	Ranking
1	$a \succ b \succ d \succ c \succ e \succ f$
2	$a \succ d \succ c \succ f \succ b \succ e$
3	$b \succ d \succ c \succ e \succ a \succ f$
4	$b \succ d \succ e \succ c \succ a \succ f$
5	$b \succ e \succ a \succ f \succ d \succ c$
6	$c \succ b \succ e \succ a \succ d \succ f$
7	$c \succ d \succ a \succ f \succ b \succ e$
8	$d \succ a \succ c \succ b \succ e \succ f$
9	$d \succ c \succ b \succ e \succ a \succ f$
10	$e \succ a \succ b \succ d \succ c \succ f$
11	$e \succ f \succ b \succ d \succ c \succ a$
12	$f \succ a \succ c \succ e \succ b \succ d$
13	$f \succ c \succ a \succ b \succ d \succ e$
14	$f \succ e \succ a \succ d \succ c \succ b$
15	$f \succ e \succ b \succ c \succ a \succ d$
16	$f \succ e \succ d \succ c \succ a \succ b$

a) Find the winner using the Coombs method.
b) Find the winner using the Schulze method (Schulze, 2011).
c) Discuss the properties of Coombs and Schulze methods in terms of reversal symmetry, monotonicity, and majority criteria.

5. Consider the following supplier selection problem.
A supplier management board of a company is evaluating suppliers in order to decide if a change is appropriate. There are four potential suppliers that need to be evaluated. The board decided to ask each of the three sector managers of the company to provide their evaluations of the suppliers. The managers are very busy and they work in different buildings. It would be complicated to get them together to discuss what the important criteria are to evaluate the suppliers. Under these circumstance, the board will let each manager to evaluate the companies independently, according to a set of criteria that they think it is appropriate and to provide their own weight vector.

The first manager, who is a budget manager, is biased to the financial aspects of the decision and considered the price per batch (in thousands) (C_1^1), warranty (in days) (C_2^1) and payment conditions (C_3^1). The second manager is a production manager and is focused on the overall aspects of the suppliers and considered the price (C_1^2), delivery time (in hours) (C_2^2), production capacity (C_3^2), product quality (C_4^2) and the time to respond to a support request (in hours) (C_5^2). The third manager is the commercial manager and is biased to the capacity to advertise and the final satisfaction of the clients. So, she considered the product lifespan (in years) (C_1^3), social and environment responsibility (C_2^3), quality certifications (C_3^3) and the price (C_4^3). The weight vectors of each one of the decision maker are: w^1 = (0.5, 0.25, 0.25), w^2 = (0.2, 0.2, 0.2, 0.2, 0.2) and w^3 = (0.25, 0.12, 0.23, 0.4).

The decision matrices are presented in Tables 1-3. The linguistic evaluations were converted to numerical values as shown in Table 4. For the values given in 0-1 scale, 1 presents the highest performance and 0 is the lowest performance.

Also, the supplier management board provided the following weight vector for the decision makers w_d = (0.3, 0.4, 0.3).

Based on the above given information, the supplier management board of the company want to rank the suppliers.

a) (15 pts.) Write the distinguishing characteristics of the given problem. What kind of multiple attribute group decision making (MAGDM) approach is required to solve such problems? Explain your answers considering The Conceptual Framework for MAGDM introduced in the course.

b) (20 pts.) According to the given information in the Supplier Selection Problem, please rank the alternative suppliers using one of the appropriate method presented in Hwang and Lin (1987).

Table 1. Decision matrix for the first manager

Alternatives	C_1^1 **(in thousand \$)**	C_2^1 **(in days)**	C_3^1 **(linguistic term set)**
A_1	260	90	Good
A_2	250	90	Poor
A_3	350	180	Good
A_4	550	365	Intermediate

Table 2. Decision matrix for the second manager

Alternatives	C_1^2 **(in thousand \$)**	C_2^2 **(in days)**	C_3^2 **(0-1 scale)**	C_4^2 **(linguistic term set)**	C_5^2 **(in hours)**
A_1	260	72	0.9	Intermediate	36
A_2	250	96	0.6	Poor	36
A_3	350	54	0.55	Good	24
A_4	550	68	0.5	Excellent	12

Table 3. Decision matrix for the third manager

Alternatives	C_1^3 **(in years)**	C_2^3 **(linguistic term set)**	C_3^3 **(0-1 scale)**	C_4^3 **(in thousand \$)**
A_1	3.5	Very poor	0.3	260
A_2	3.0	Very poor	0.2	250
A_3	4.5	Poor	0.6	350
A_4	5.0	Intermediate	0.9	550

Table 4. Linguistic variables for the ratings

Linguistic Terms	**Corresponding numerical value**
Very poor	1
Poor	2
Intermediate	3
Good	4
Excellent	5

References

Schulze, M. (2011) “A new monotonic, clone-independent, reversal symmetric, and Condorcet-consistent single-winner election method”, Social Choice and Welfare, 36, pp 267–303.

Hwang, C.L. and Lin, M.J. (1987), «Group Decision Making under Multiple Criteria», Lecture Notes in Economics and Mathematical Systems, Springer-Verlag, Berlin [Related sections can be found in ninova – file named Hwang-Li-MAGDM.pdf.]

GOOD LUCK!