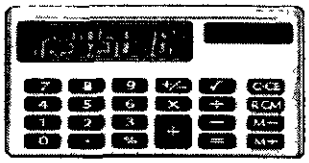
UNIVERSITY EXAMINATIONS



UNIVERSITEITSEKSAMENS

UNISA university of south africa

DSC3704

May/June 2013

MODELS FOR STRATEGIC DECISION-MAKING
DEPARTMENT OF DECISION SCIENCES

Duration 2 Hours

80 Marks

EXAMINERS

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Programmable pocket calculator is permissible

Closed book examination.

This examination question paper remains the property of the University of South Africa and may not be removed from the examination venue

This paper consists of 4 pages

Answer ALL the questions fully but concisely in your answer book
Show all workings with the necessary annotations or explanations
Where relevant in calculations, work with fractions or to an accuracy of three decimal places

Question 1

What is a well-known name for this field of decision theory specialising in the quantification of human preferences and the ensuing applications? (2)

[2]

Question 2

Suppose a facilitator asks a participant to compare three items with each other Assume that this participant is perfectly consistent (errorless) in his judgements of his pairwise comparisons

The participant feels that Item A is twice as important as Item B, and that Item B is three times as important as Item C

2 1 Complete the pairwise comparison judgement matrix of the participant and determine his preference and weights vector (9)

2 2 What ranking order does the participant allocate to the items? (1)

[10]

Question 3

Let $A = [a_{ij}] = [c_{ij} f_{ij}] = \left[\frac{u_i}{u_j} f_{ij}\right]$ be the $n \times n$ matrix of pairwise comparisons or ratios containing a factor error f_{ij} on each element c_{ij} of the errorless matrix C, where $\mathbf{u} = (u_1, \quad, u_n)$ is the preference vector before normalisation

3 1 Write down the formula for

3 1 1 the arithmetic mean

3 1 2 the geometric mean

of the errors in the i-th row of the A matrix (4)

3 2 What must the value of the error f_{ij} be for the matrix A to be errorless? (1)

3 3 Express f_{ij} in terms of a_{ij}, u_i and u_j (1)

3 4 Derive the formula for the aggregate error S of the log least squares (LLS) method (4)

[10]

Question 4

In order to solve the system of equations $D\mathbf{b} = \mathbf{d}$ of the LLS method, an algorithm has been developed that initially sets all the elements d_{ij} of the matrix D and all the elements d_i of the vector $\mathbf{d}$ equal to zero If an observation a_{ij} occurs in the A matrix, the following overwrites take place in the table $D|\mathbf{d}$

$$d_{ii} \leftarrow d_{ii} + 1, \qquad d_{jj} \leftarrow d_{jj} + 1$$

$$d_{ij} \leftarrow d_{ij} - 1, \qquad d_{ji} \leftarrow d_{ji} - 1$$

$$d_i \leftarrow d_i + \ln a_{ij}, \qquad d_j \leftarrow d_j - \ln a_{ij}$$

4 1 What is the usefulness of this algorithm to the facilitator? (3)

4 2 After application of the algorithm on a matrix A, the table containing the elements of D and $\mathbf{d}$ is as follows

2	−1	−1	ln1,5 + ln3
−1	1	0	−ln1,5
−1	0	1	−ln3

Write down the system of equations $D\mathbf{b} = \mathbf{d}$ and solve for $\mathbf{b}$
Determine the implied preference vector and the weights vector (7)

[10]

Question 5

Describe three advantages of applying scientifically acceptable decision-making procedures (6)

[6]

Question 6

Consider the following example in which Saaty reported that a PhD student assessed the relative importance of six criteria for job selection, namely research, growth, benefits, colleagues, location and reputation, in that order The judgement matrix is the following

$$A = [a_{ij}] = \begin{bmatrix} 1 & 1 & 1 & 4 & 1 & \frac{1}{2} \\ 1 & 1 & 2 & 4 & 1 & \frac{1}{2} \\ 1 & \frac{1}{2} & 1 & 5 & 3 & \frac{1}{2} \\ \frac{1}{4} & \frac{1}{4} & \frac{1}{5} & 1 & \frac{1}{3} & \frac{1}{3} \\ 1 & 1 & \frac{1}{3} & 3 & 1 & 1 \\ 2 & 2 & 2 & 3 & 1 & 1 \end{bmatrix}$$

6 1 Use the geometric means method to calculate the implied preference and weights vector Round off final answers to three decimals

According to this preference vector, which criterion is the most important and which one is the least important in the job selection process? (7)

6 2 Normalise the fourth column of the A matrix Use it as the initial vector $\mathbf{v}_0$ and perform one iteration of the iterative method Round off final answers to three decimals

According to this preference vector, which criterion is the second most important in the job selection process? (9)

6 3 Which method did Saaty suggest for calculating the weights vector? Briefly explain how it works (4)

6 4 What must the value of the inconsistency index OI be for the A matrix to be consistent enough to be used?
Refer to the random index in the table below

n	2	3	4	5	6	7	8	9	10
EI	0	0,58	0,90	1,12	1,24	1,32	1,41	1,45	1,51

(3)

6 5 Saaty's fundamental scale allocate the following values

A's importance against that of B	**Numerical value**
Equal	1
Moderately more important	3
Strongly more important	5
Very strongly more important	7
Extremely more important	9

Write down the numerical values that Lootsma allocates to this semantic scale Assume that $\alpha = 3$ (5)

[28]

Question 7

Tennis players are ranked according to the number of tournaments in which they have participated, as well as the number of matches, the number of sets, and the number of games they have won The scores of four players for the four criteria are as follows

Name	Tournaments	Matches	Sets	Games
Wendy	1	4	12	72
Xoliwe	2	3	6	72
Yvonne	3	2	6	72
Zahara	4	1	6	144

7 1 What is their ranking according to

7 1 1 the number of tournaments in which they have participated?

7 1 2 the number of matches they have won? (2)

7 2 Set up the matrix of pairwise comparisons of the tennis players according to the number of sets won Complete the matrix Calculate the corresponding weights vector (5)

7 3 Determine the score of each player based on the number of games they have won relative to the other players (2)

7 4 Design a sensible scoring function for each criterion so that a SMART model can be compiled from the scores
What is the main characteristic of such functions? (5)
[14]

TOTAL: 80