UNIVERSITY OF TORONTO

FACULTY OF APPLIED SCIENCE AND ENGINEERING

FINAL EXAMINATION, DECEMBER 1998

Fourth Year - Program 4

Exam Type: C

MIE566F - Decision Analysis

Examiner: Eddie Hsu

Total marks of examination 100
This will count for 40% of the final grade.
Non-programmable calculators permitted

***10*** 1. Brainstorming is a group creativity method consisting of two phases. In the first phase, everyone involved spends some time proposing various ideas, regardless of how odd they may sound. No criticism or judgment is permitted at this point. In the second phase, the various ideas are discussed and a solution is formed based on these ideas. The final solution may be a combination of ideas or may be derived from the ideas presented.

Name two types of blocks that the brainstorming method overcomes and briefly explain how it does this.

2. When one is trying to sell something to another, it is best to segregate the benefits and to integrate the losses. In this way, the perceived utility of the object to the buyer is maximized.

***5*** a) Briefly explain what is meant by segregating the benefits and integrating the losses.

***5*** b) What kind of utility function must the buyer have in order for this type of selling strategy to work?

3. George has a motorcycle that is extremely fast, but not too dependable. At any rate, it often quits on him. When this happens, he must determine to which of two mechanics to take it. He knows from past experience that one of three things might be wrong with his bike:

E1: Distributor trouble
E2: Carburetor trouble
E3: Fuel pump trouble

One of the mechanics specializes in electrical troubles, and the other in fuel system troubles. Consequently, George knows that the repair will cost him:

| | M1 | M2 |
|---|---|---|
| E1 | 60 | 30 |
| E2 | 60 | 90 |
| E3 | 90 | 105 |

In addition to taking his cycle directly to a mechanic, George has the option of having the trouble electronically diagnosed. There are two possible outcomes:

O1: Electrical trouble is indicated
O2: Fuel trouble is indicated

The test is not perfect of course, and the conditional probabilities are:

| | O1 | O2 |
|---|---|---|
| E1 | .8 | .2 |
| E2 | .4 | .6 |
| E3 | .1 | .9 |

(e.g. P(O1 | E1) = .8)

***10*** a) Based on his past experience with the bike, George estimates that the probabilities for the states are:

$$P(E1) = .6 \quad P(E2) = .1 \quad P(E3) = .3$$

If George is risk-neutral, what is the maximum that he would be willing to pay for perfect information?

***15*** b) What is the maximum that he should be willing to pay for the electrical diagnosis?

***5*** c) Suppose the diagnosis costs $10. What is George's optimal decision, and what is the expected cost?

***10*** 4. Briefly explain why observability and credibility are crucial to the making of a strategic move.

5. The administrator of a courier service is investigating planning options. The two attributes of interest are:

$x_1$ Revenue (5 - 25 in millions of dollars)

$x_2$ Service Level (0 – 100% of "next-day" deliveries)

Observe that these two attributes are in conflict, since a high service level requires a larger staff and reduces revenue.

Preliminary testing has shown these to be mutually utility independent. Utility functions $U_1(x_1)$ and $U_2(x_2)$ were derived by asking the following questions:

With $x_2$ held fixed at 80%, the administrator determined that:

- $x_1 = 10$ is equivalent to a lottery with a 40% chance of $x_1 = 5$ and a 60% chance of $x_1 = 25$
- $x_1 = 7$ is equivalent to a lottery with a 50% chance of $x_1 = 5$ and a 50% chance of $x_1 = 10$
- $x_1 = 14$ is equivalent to a lottery with a 25% chance of $x_1 = 10$ and a 75% chance of $x_1 = 25$

Similarly, with $x_1$ held fixed at $15 million, the administrator determined that:

- $x_2 = 20$ is equivalent to a lottery with a 50% chance of $x_2 = 0$ and a 50% chance of $x_2 = 100$
- $x_2 = 8$ is equivalent to a lottery with a 50% chance of $x_2 = 0$ and a 50% chance of $x_2 = 20$
- $x_2 = 45$ is equivalent to a lottery with a 50% chance of $x_2 = 20$ and a 50% chance of $x_2 = 100$

In comparing options involving both of the attributes, the administrator was found to be indifferent between:

i) $(x_1 = 25, x_2 = 0)$ for certain or a lottery with a 40% chance of $(x_1 = 25, x_2 = 100)$ and a 60% chance of $(x_1 = 5, x_2 = 0)$
ii) $(x_1 = 5, x_2 = 100)$ for certain or a lottery with a 30% chance of $(x_1 = 25, x_2 = 100)$ and a 70% chance of $(x_1 = 5, x_2 = 0)$

***10*** a) Determine the appropriate weights and write out the full two-attribute function.

***5*** b) Suppose the administrator must choose between three possible plans. These plans will produce the following revenues and service levels:

| | | **x1** | **x2** |
|---|---|---|---|
| | | Revenue | Service Level |
| Plan | I | 15 | 90 |
| | II | 17 | 80 |
| | III | 19 | 70 |

Compute the utility of each plan and give your recommendations.

6. Strenlar Exploration Corporation (SEC), a mineral exploration company founded by George Wallace using funds derived from production of a polymer he developed, finds what they believe to be a huge ore deposit in a small Eurasian country. They are not equipped to handle the extraction of the ore, however. They must, therefore, decide what to do with their find. While there are several criteria

of interest that should be considered, the company has narrowed the scope down to three main concerns:

1) Financial standing of the company(f)
2) Future opportunities for growth (g)
3) Operational standing (o)

As they see it, they have three options:

1) Set up a subsidiary company to handle the extraction (C)
2) Enter into a joint venture with another company that is able to handle the extraction and share the profits (J)
3) Sell the ore rights to the country in which they are operating (S)

**5** a) The Analytical Hierarchy Procedure (AHP) is similar in some ways to using a multi-attribute utility function. If the company is to use AHP to decide what course of action to take, what type of independence among the criteria must they assume? Briefly explain why this assumption is necessary in order to use AHP.

**12** b) Let's say that after some discussion with a decision analyst, the board of SEC has come up with the following matrices, which show the results of the pairwise comparisons they made:

*Comparison of Criteria*

| | f | g | o |
|---|---|---|---|
| f | 1 | 5 | 2 |
| g | 1/5 | 1 | 1 |
| o | 1/2 | 1 | 1 |

*On the basis of Financial Standing (f)*

| | C | J | S |
|---|---|---|---|
| C | 1 | 1 | 1/3 |
| J | 1 | 1 | 1/2 |
| S | 3 | 2 | 1 |

*On the basis of Opportunities for Growth (g)*

| | C | J | S |
|---|---|---|---|
| C | 1 | 1/3 | 3 |
| J | 3 | 1 | 8 |
| S | 1/3 | 1/8 | 1 |

*On the basis of Operational Standing (o)*

| | C | J | S |
|---|---|---|---|
| C | 1 | 3 | 7 |
| J | 1/3 | 1 | 3 |
| S | 1/7 | 1/3 | 1 |

(Note that the numbers in the matrices are always read as your degree of preference for the Row element over the Column element. Thus in the last matrix, judging the different options on the basis of operational standing, you would prefer option C to option J with a preference rating of 3.)

Determine the weights for each matrix. There should be three criteria weights and one weight for each combination of option and criteria.

**8** c) Calculate the consistency indices (CI) for each matrix given the weights in the table above and your answer in part b). Based on the CI values would you say any of the matrices are inconsistent?