UNIVERSITY OF LONDON
IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE

EXAMINATIONS 2001

BEng Honours Degree in Computing Part III
MSc in Computing Science
BSc Honours Degree in Mathematics and Computer Science Part III
MSci Honours Degree in Mathematics and Computer Science Part III
for Internal Students of the Imperial College of Science, Technology and Medicine

This paper is also taken for the relevant examinations for the
Associateship of the City and Guilds of London Institute
This paper is also taken for the relevant examinations for the
Associateship of the Royal College of Science

PAPER C344

INFORMATION AND DECISION SUPPORT SYSTEMS

Monday 14 May 2001, 10:00
Duration: 120 minutes

Answer THREE questions

Paper contains 4 questions
Calculators required

1   Making movies is an expensive business and Peckham Productions can only afford to make one new film next year. Should it be "Gladiator2 - The Christians and the Lions", "Terminator3" or "Halloween103"?

"Haloween103" is pretty much risk-free and the company would be sure to get £10 million profit.

"Terminator3" is a far riskier proposition. Box office takings may be high, with a profit of £80 million, medium with a profit of £40 million or low, in which case the company will just break even. The probabilities of high, medium and low takings are 0.38, 0.12 and 0.50, respectively.

"Gladiator2 - The Christians and the Lions" is more problematic. The main character of the previous Gladiator film died at the end of the movie, so they would need to choose a new star. There's really only one other actor for the role: "Ross Raven" He is currently filming "Nero's Revenge - The Roman Empire Fight Back", but there's a 5% chance of it taking longer than expected. In that case, the starting of filming "Gladiator2 - The Christians and the Lions" would have to be delayed, which would have an impact on ultimate takings.

Another issue is how to market "Gladiator2 - The Christians and the Lions". Do the company pitch it as a religious film or as a wildlife movie? They only need to make a decision just before the film is released, but it will affect profits.

Takings for "Gladiator2" may either be high or low. If Peckham productions put the film forward as a wildlife film, then low takings are just as likely as high takings. If they present it as a religious film, the likelihood of low takings would depend on whether its production was delayed. If there is no delay and the film is presented as a religious movie (just in time for a large evangelical festival to be held in the US), the probability is 0.4 that takings, and so ultimate profits, will be high. However, if there is a delay and the film is presented as a religious movie, the probability is only 0.3 that takings will be high.

Here are estimated the profit figures for "Gladiator2"

Profits in £millions	Marketing	High Takings	Low Takings
Filming Delayed	Religious	50	-5
	Wildlife	35	10
Filming Not Delayed	Religious	80	0
	Wildlife	45	15

a   Draw a complete decision tree for Peckham Productions. Solve the decision tree on the basis of the expected monetary value criterion. What should Peckham Productions do?

b   Create cumulative risk profiles for the three films and plot all three profiles in a single graph. What conclusions can you draw from these?

c   One of the executives, Peter Peckham, has his doubts about the prospects for "Terminator3". He assesses the probability of medium takings as 0.3 and of low takings as 0.4. Based on the expected monetary value criterion, what should Peter Peckham do?

The three parts carry, respectively, 30%, 50%, 20% of the marks.

2a   A decision maker faces a risky gamble in which he may obtain one of five different cars as a prize: a Rolls-Royce, a BMW, a Honda, a Rover or a Ford. The Rolls-Royce is the one he prefers the most and the Ford the least.

He has made the following three assessments:

- He is indifferent between having the Honda for sure and a 50:50 lottery with the Rolls-Royce and Ford as prizes.

- He is indifferent between having the BMW for sure and a 40:60 lottery with the Rolls-Royce and Honda as prizes.

- He is indifferent between a 50:50 lottery with the BMW and Rover as prizes and a 50:50 lottery with the Rolls-Royce and Ford as prizes.

What are the utility values of the five cars?

b   Carefully explain why most people are keen to ensure their house against fire, and why large insurance companies are usually happy to insure them.

c   A person's utility function for total wealth W (in £K) is:

$$U(W) = \frac{W}{500} - \frac{W^2}{1,000,000} \quad \text{for } 0 \le W \le 1,000$$

i   Sketch a graph of this function. How would you classify this person with regard to his attitude to risk?

ii   If the person's assets are currently £100K, should she take a bet in which she will win £100K with probability 0.6 and lose £100K with probability 0.4 ?

iii   If the person's assets are currently £900K, should she take the bet described in subpart ii ?

iv   Does the person's betting behaviour as exemplified by your answers to subparts   ii and iii seem reasonable? How could you explain such behaviour?

The three parts carry, respectively, 30%, 30%, 40% of the marks.

3   Sprockets International intends to purchase a new robotic manufacturing system for its factory in South Wales. Four suppliers have been short-listed: Albion Automatons, Blinkey Bots, Carbusa Controls and Denton Droids.

In addition to cost, the technical director thinks that the two most important attributes to consider when making a choice are environmental impact and reliability. He has assessed how well each of the robotic systems performs along the two benefit attribute dimensions, on a scale from 0 (worst) to 100 (best). These scores are given in the following table, together with costs:

Robotic System	Costs (in £m)	Environmental Impact	Reliability
Albion	0.4	0	80
Blinkey	1.1	30	100
Carbusa	0.8	90	0
Denton	0.7	100	50

a   The technical director is having difficulty in allocating weights to the two benefit attributes. Assuming that the two weights sum to 100 and that the attributes are mutually preference independent, perform a sensitivity analysis to show how the robotic system offering the highest value for aggregate benefits will vary depending on the weight which has been allocated to environmental impact.

b   The technical director eventually decides to allocate a weight of 10 to environmental impact. Identify the robotic systems that lie on the efficient frontier.

c   The technical director believes that, if he was offered a hypothetical robotic system with the lowest reliability and worst environmental impact, he would be willing to pay £0.15m to convert the system to one which had the best environmental impact but still the lowest reliability. Out of the four systems then available, which system should the manager choose?

The three parts carry, respectively, 35%, 30%, 35% of the marks.

4   Queen's Gate IT Institute is a private college offering courses in computing. It relies mainly on word-of-mouth recommendations to attract new students, but sometimes advertises in local newspapers too.

Each year the college assesses whether it has been successful (State 1) or unsuccessful (State 2), in terms of student intake, and then decides whether or not it needs to advertise its courses for the next session. The following transition matrices $\mathbf{P}_1$ and $\mathbf{P}_2$ provide the transition probabilities (between states 1 and 2) with and without advertising during any year:

With advertising: Without advertising:

$$\mathbf{P}_1 = \begin{bmatrix} .9 & .1 \\ .6 & .4 \end{bmatrix} \qquad \mathbf{P}_2 = \begin{bmatrix} .7 & .3 \\ .2 & .8 \end{bmatrix}$$

The profit the school expects to make each year depends whether or not they advertise and on the transition between that year's state and the following year's state. Levels of profit (in £100K) are given by the following return matrices $\mathbf{R}_1$ and $\mathbf{R}_2$:

With advertising: Without advertising:

$$\mathbf{R}_1 = \begin{bmatrix} 2 & -1 \\ 1 & -3 \end{bmatrix} \qquad \mathbf{R}_2 = \begin{bmatrix} 4 & 1 \\ 2 & -1 \end{bmatrix}$$

The school wishes to come up with a policy to produce optimal profits over a three year planning horizon.

a   Show how this problem can be expressed using a finite-stage dynamic programming model. Include specifications of:

- the stages
- the states
- the policy decision
- the reward
- the maximum total expected reward
- the boundary conditions

b   Solve the problem and find the optimal policy over three years.

The two parts carry, respectively, 60%, 40%, of the marks.