UNIVERSITY OF LONDON

IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE

EXAMINATIONS 1999

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

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

PAPER 3.44

INFORMATION AND DECISION SUPPORT SYSTEMS

Friday, May 7th 1999, 10.00 – 12.00

Answer THREE questions

For admin. only:
paper contains 4 questions

1 Metallica Traders, a UK metals broker, has acquired an option to purchase 1,000,000 kilograms of partially refined polykryptonite ore from the Poldovian Government for £5.00 per kilogram. Polykryptonite can be processed into several different products which are used in hi-tech manufacturing, and Clark Kent, the MD of Metallica Traders, estimates that he would be able to sell the ore for about £8.00 per kilogram after importing it. However, the EU is currently negotiating with Poldovia over alleged "dumping" of certain manufactured goods which that country exports into the EU. As part of these negotiations, the EU has threatened to ban the import of a class of materials, which includes polykryptonite, from Poldovia. If the UK government refuses to issue an import license (on consultation with Brussels), Metallica will have to pay a penalty of £1.00 per kilogram to annul the purchase of the polykryptonite.

The chances are estimated to be fifty-fifty that the Poldovian government will agree to stop dumping their manufactured goods and that consequently Metallica will be awarded an import license.

Metallica could always apply for an import license and wait until they know it's approved before closing the deal with Poldovia. However, it may take some time to find out whether they will be granted the license, and if they do not act promptly there is a 70% probability that a bigger competitor will step in and take up Metallica's offer, despite the risk of a possible loss.

Metallica adopts the Expected Monetary Value Criterion whenever involved in decision analysis.

a Draw a decision tree and find what should Metallica do in the absence of any extra information.

b What is the expected value of perfect information (regarding issuing of an import license) in the above problem?

Lois Lane is a London-based business consultant with good connections in the import licensing authority. For a fee she would feel out her contacts and see if they think that the licence would be granted. Of course, her assessment of the situation is not foolproof. In the past, in cases where the import license was ultimately issued, she was right 90% of the time. In cases where license requests were turned down, she was correct 60% of the time.

c What should Metallica be willing to pay Lois Lane for her opinion?

d Suppose that after some turbulence on the Metals Exchange, Clark Kent can no longer rely on a definite £8.00 per kilogram selling price for partially refined polykryptonite ore. Instead, he now believes that the selling price could equally likely be anywhere in the range £5.00 to £10.00 per kilogram. Should this price change affect Metallica's decision?

The four parts carry, respectively, 20%, 20%, 40%, 20% of the marks.

2a Describe the axioms underlying the Expected Utility Value criterion for decision making, including simple examples to clarify their meaning.

b A British soldier on peace-keeping duties in the Balkans sustained a severe injury to his right hand while attempting to defuse a mine. He was flown back to hospital in the UK, but the wound has become badly infected and a prompt decision must be taken.

The consultant responsible for this case believes that it may not be possible to save the hand. Moreover, if the infection spreads it could threaten the arm or even the life of the soldier. Based on his experience, the consultant believes that if high-dose intravenous antibiotics are administered, combined with surgery to remove the dead tissue and debris from the surface of the wound, there is:

- a 60% chance of successfully saving the hand,
- a 35% probability of having to amputate at the elbow in order to successfully stop the infection spreading to the rest of the body, and
- a 5% probability of the soldier eventually dying through infection.

On the other hand, a clean amputation at the wrist, carried out immediately, would be safe, stop infection spreading and lead the no further consequences.

One of the consultant's colleagues tells him of an experimental hand transplant technique, which could be carried out in the hospital. The surgery team is ready to proceed and an accident victim is willing to donate a hand that appears to be a good match. The soldier's infected hand would be amputated at the wrist, and during the long transplant procedure, there is a 1% chance of complications leading to death. If the soldier survives, a long course of anti-rejection therapy would be instituted after the operation, and there is then still a 50-50 chance that the transplant will be rejected. In that case, the transplanted hand would itself have to be amputated, and the soldier would have to live with both the loss of the hand and the discomfort and inconvenience associated with the unsuccessful transplant operation and follow-up therapy. Even a successful transplant would have involved quite an ordeal on the part of the soldier.

The consultant has been on a course in decision analysis and helps his patient carefully assign utilities to the various possible outcomes:

U(medical treatment leads to infection being eradicated and hand being saved) = **1**

U(damaged hand successfully replaced by transplant, which is not rejected) = **0.9**

U(hand immediately and safely amputated - no transplant attempted) = **0.7**

U(transplant carried out, but transplanted hand later rejected and amputated) = **0.6**

U(medical treatment unsuccessful, infection spreads and arm amputated at elbow) = **0.5**

U(soldier loses life) = **0**

i) How could the utilities have been elicited from the soldier?

ii) With the help of a decision tree, suggest what action should be taken.

[Turn over ...

iii) After reviewing the literature, the consultant is no longer happy with the probability of 60% that he assigned to saving the hand through medical treatment. He now thinks that this probability, p*, might lie anywhere between 50% and 75%, but is sure that the probability of the soldier losing his life through infection, after unsuccessful medical treatment, is 5%, regardless. Perform a sensitivity analysis to check whether and how the recommended action changes with p*.

Part a and the three subparts of part b carry, respectively, 30%, 20%, 25%, 25% of the marks.

3a Describe the purpose and characteristics of an OLAP system.

b Why is it ***not*** considered a good idea to send OLAP queries directly to the transaction processing databases?

c Draw and label a suitable architecture for a comprehensive enterprise-wide decision support system capable of handling OLAP queries efficiently.

d What are the advantages and disadvantages of employing a relational database as against specialised multidimensional database technology for the core OLAP database?

The four parts each carry 25% of the marks.

4a What is an intelligent agent?

b Describe with examples how the following aspects of agent behaviour could have relevance to decision support:

mobility,

advanced information gathering and

knowledge transfer among agents.

c What roles might there be for agents to be used in conjunction with an Executive Information System serving the senior managers of a City firm.

The three parts carry, respectively, 20%, 40%, 40% of the marks.

[End of paper