

UNIVERSITY OF LONDON
IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE

EXAMINATIONS 2000

MEng Honours Degree in Information Systems Engineering Part IV
MEng Honours Degrees in Computing Part IV
MSc in Advanced Computing
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*

PAPER C474=I4.8

MULTI-AGENT SYSTEMS

Friday 5 May 2000, 14:30
Duration: 120 minutes

Answer THREE questions

Paper contains 4 questions

1a Suppose we want to have an information-gathering mobile agent that:

- (1) will be sent directly by its parent agent to the first mobile agent station at which it is to gather information,
- (2) when it is launched by the station it discovers the identity the local directory server by querying the agent station,
- (3) when it has obtained all the information it requires from agents registered with the local directory server it queries its parent agent to find out what to do next. The reply is either a string naming the next station to visit, in which case it moves to this next station, or the reply is a message telling it that it should finish. In this case it sends a message to its parent agent containing the information it has gathered, and then terminates.

Briefly describe how such a mobile agent could be implemented in the April language. Describe the functionality of the agent station and the local directory agent and briefly describe some message protocols that the mobile agent might use to communicate with these agents.

- b Based on your answer to part a, give the April program for the mobile agent described below which gathers details of prices for a set of music CDs. Also give the message send statement that the parent agent uses to send the mobile agent to its first station.

The mobile agent is provided with:

- a list of names of CDs
- the identity of the parent agent that launches it

At each station it visits, it first consults the local directory agent to find the identities of the local agents that sell CDs.

It then queries each such agent by sending it a message of the form:

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('prices_for, CDNames)
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where CDNames is the list of CDs for which it has to obtain prices. Assume that the answer to such a query, if one is given, is of the form:

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('my_prices-are, CDPrices)
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where CDPrices is a list of pairs giving a CD name and a price. The agent waits for replies for at most 10 seconds.

The information sent by the mobile agent to its parent agent when it is told to finish will include each CDPrices price list it has received paired with the identity of the agent that supplied the price list.

The two parts of this question carry equal marks.

- 2 a Describe the key features of the *contract net protocol* for allocating tasks to agents, paying particular attention to:
- i) the roles of manager and contractor,
 - ii) the contents of a task announcement,
 - iii) the use of node available messages.
- b If bids had to include a task completion time, and a contractor were able to execute more than one task at a time:
- i) What extra capabilities and knowledge would a contractor need?
 - ii) What modifications would be needed in the content of the messages?
- c Suppose a manager M divides a task T into subtasks T1 and T2 which are awarded to contractors C1, C2. Suppose that C1 and C2 have to cooperate in solving C1 and C2. Suggest how this might be achieved within the standard contract net protocol.

Parts a,b and c respectively carry 50%, 30% and 20% of the marks .

- 3a Briefly explain the ideas of bounded rationality and practical reasoning which underpin so-called BDI agents. How does the mechanism for action in a BDI agent differ from that of purely reactive agent? Under what circumstances does this appear to be advantageous?
- b Briefly describe the function of the main data and process components of a skeletal BDI interpreter, and how they may interrelate in a changing environment. Illustrate your answer by considering how a BDI agent might proceed to hang a picture on a wall with hammer, screwdriver, nails and screws available.
- c Give the reasons why more heuristic adaptations of bounded rationality depart from the skeletal BDI interpreter. Illustrate your answer by providing a critical description of one alternative layered architecture.

The three parts of this question carry approximately equal marks.

- 4a KQML was designed as a Knowledge Query and Manipulation Language, but it has also been described as a communication language for intelligent information agents. Briefly explain how the following aspects of agent communication are supported in KQML:

- i) knowledge sharing,
- ii) communication protocol,
- iii) communication facilitators.

Illustrate each answer with a KQML-style message pertaining to the price of IBM stock on the New York Stock Exchange.

- b KQML has been criticised as lacking adequate semantics.
- i) How does KQML avoid the main semantic issues in the content of messages?
 - ii) In which way does the FIPA agent Communication Language seek to give meaning to performatives?
 - iii) Briefly discuss the extent to which each of these languages supports the communication of commitment by one agent to another.
- c
- i) Suggest a representation of a KQML performative as an April message.
 - ii) Briefly describe the operational semantics of commitment in Agent0. Indicate the fields of a performative requesting commitment when represented in April and the ancillary performatives that would be needed.

The three parts of this question carry approximately equal marks.