UNIVERSITY OF LONDON
IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE

EXAMINATIONS 2002

MEng Honours Degree in Information Systems Engineering Part IV
MSci Honours Degree in Mathematics and Computer Science 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
This paper is also taken for the relevant examinations for the Associateship of the Royal College of Science

PAPER C474=I4.8

MULTI-AGENT SYSTEMS

Monday 22 April 2002, 10:00
Duration: 120 minutes

Answer THREE questions

Paper contains 4 questions
Calculators not required

1a Briefly explain Russell and Norvig's four feature classification of intelligent agents.

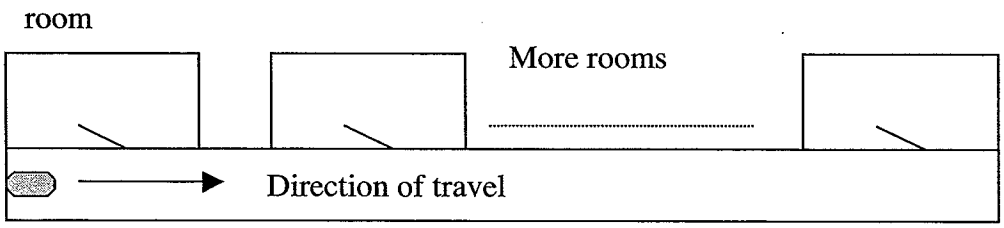
b What is a partly accessible, dynamic agent environment?

c If S is the set of all environment states, P is the set of percepts of the state of the environment available to an agent, and A is the set of the actions it can perform on the environment, give functional characterisations of:

(i) a purely reactive, tropistic agent,
(ii) an hysterectic agent with an internal set of memory states M

d Give the execution cycle of an hysterectic agent using your characterisation of part c(ii).

e A garbage collecting agent has to move down a corridor on the left of which there are a series of rooms as depicted in the following picture. The agent does not know how many rooms there are. It always starts in the left end of the corridor . Its task is to move down the corridor in the direction indicated by the arrow



looking for doors into these rooms. When it detects a door it moves into the room to check if there are any bags of rubbish in the room for it to collect. If there are, it picks them up one by one. When it no longer detects a bag of rubbish to pick up it moves out of the room into the corridor. It continues down the corridor repeating the above for each room with a door off the corridor. It stops when it comes to the end of the corridor.

Assume that the agent has the following set of perceptual tests:

wall-front	there is (or not) a wall immediately in front of it
door-left	there is (or not) a door immediately on its left
rubbish-bag-in-room	there is (or not) a bag of rubbish in a room

And the following action repertoire:

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move-forward	move a short distance down the corridor
move-into-room	move through a door on its left into a room
pick-up	pick up a detected bag of rubbish
move-out-of-room	move out of a room into the corridor and down the corridor a short distance
stop	stop wherever it is

You can assume that its actions always succeed. The agent also has two internal states: in_corridor, in_room. Define the required behaviour of this agent by:

either defining a suitable response function which, for each internal state, and each possible set of percept values for that state, returns the next internal state and the required action,
or by drawing a finite state machine for the agent.

Indicate a negative value for a percept test, such as door-left, by not(door-left).

The five parts of this question carry respectively 10%, 10%, 20%, 10%, 50% of the marks.

2a AGENT0 implements a simple model of a communicating agent.

i) What are the memory components of an AGENT0 agent?

ii) How is an AGENT0 agent programmed?

iii) What are the types of messages that such an agent can accept?

iv) What are the types of action that it can be requested to do?

v) *Summarise* the execution cycle of the agent.

b What extra functionality, and what, if any, extra internal components would an AGENT0 agent need, in order to be able to handle ACHIEVE messages. Assume that such messages contain a goal that the sending agent wants the receiving agent to achieve on its behalf. This goal is represented as a belief that the receiving agent should hold at a future time. Also assume that such a future belief cannot always be achieved by execution of just one private action.

The two parts of this question carry, respectively, 70%, 30% of the marks.

Turn over.....

3a Briefly explain the role of a *matchmaker* or *facilitator* in a distributed information system.

b Briefly explain the role of the KQML capability related performatives:

i) *advertise*

ii) *recommend-one*

iii) *recruit-all*

iv) *subscribe*

c Give the KQML messages that would be used when:

i) a buyer agent, **buyer-ag,** wants to be obtain from a car dealer agent, **car dealer-ag,** all solutions to a **Prolog** query:

"price(citroen,picasso,M,X)"

which uses the ontology **car-data,** as a stream of messages,

ii) the **car-dealer-ag** responds to the message of part i), assuming it answers the query using the following two facts:

price_of(citroen,picasso,'GX1.6',11000)
price_of(citroen,picasso,'GX1.8',12000)

iii) the agent **car-dealer-ag** wants a facilitator agent **fac-ag** to know that it can respond to KQML messages that ask it to return, as a stream, all answers to queries expressed in Prolog using the **car-data** ontology

iv) **buyer-ag** wants **fac-ag** to send it the identity of one agent it knows about which can be asked to return, as a stream, all answers to queries expressed in Prolog using the **car-data** ontology

v) the agent **buyer-ag** wants the facilitator **fac-ag** to let it know the identity of any agent **A** that, in the future, advertises to the faciliator that it can be asked to find all answers to queries expressed in KIF using the **car-data** ontology.

d Using a finite state machine, specify the message interaction protocol that will take place between the **car-dealer-ag** and the **buyer-ag** when the latter wants to get the answers to some query one at a time, *on demand.* Only the performatives that will appear in the messages need be given.

The four parts of this question carry respectively 15%, 30%, 35%, 20% of the marks

4a

i) Briefly describe the key features of the Contract Net protocol for distributing tasks over a network of agents or problem solvers. Pay particular attention to:

the roles of a manager and a contractor
the structure of a task announcement,
the structure of a bid

ii) What are the shortcomings of the protocol for real time distribution of tasks where task completion time is important?

b

i) What are the main infrastructure components needed to support mobile agents?

ii) Give three ways in which a mobile agent's program might be transferred

iii) Describe how a mobile agent infrastructure might be implemented in the Qu-Prolog programming language. You do not need to give any programs, just specify what the programs would do. Describe how the agent's state can be represented and updated, and how security measures can be enforced.

The two parts of this question carry equal marks

[End of paper

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