CS4040

THE UNIVERSITY OF WARWICK

Fourth Year Examinations: Summer 2011

Agent Based Systems

Time allowed: 2 hours.

Answer **FOUR** questions.

Read carefully the instructions on the answer book and make sure that the particulars required are entered on each answer book.

Approved calculators may be used.

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1. (a) Given the following definition of action selection in a subsumption architecture, explain the purpose of the following components:

   i. Tuples of the form (c, a). [2]

   ii. The variables R and $fired$. [4]

   iii. The "$\prec$" comparison. [2]

   1. function $action(p : P) : A$
   2. var $fired : \wp(R)$; $selected : A$
   3. begin
   4. $fired \leftarrow \{(c, a) | (c, a) \in R$ and $p \in c\}$
   5. for each $(c, a) \in fired$ do
   6. if $\neg(\exists(c', a') \in fired$ such that $(c', a') \prec (c, a))$ then
   7. return (a)
   8. end-if
   9. end-for
   10. return $null$
   11. end function $action$

   (b) The notion of intention is commonly used when considering practical reasoning. Explain the roles of intentions in achieving practical reasoning. [6]

   (c) Explain what you understand to be a commitment strategy and give examples. [4]

   (d) What are hybrid architectures? Describe and explain the implications of the alternative layering approaches for hybrid agents. [5]

   (e) Explain, with the aid of examples, what is meant by the terms task sharing and result sharing in the context of cooperative distributed problem solving. [2]

Continued

2. (a) Define the notions of

   i. A Nash equilibrium. [2]

   ii. A Pareto optimal outcome. [2]

   (b) Given the following payoff matrices explain which (if any) strategies are in Nash equilibrium, where A_i means player i selects strategy A. [6]

   i.

	A_i	B_i
A_j	7 8	3 5
B_j	5 2	1 8

   ii.

	A_i	B_i	C_i	D_i
A_j	4 4	18 3	9 8	6 1
B_j	4 12	19 8	17 1	1 4
C_j	12 13	3 7	4 12	21 6
D_j	10 14	10 1	18 15	3 2

   (c) Consider the following set of Dung-style arguments:

$$\langle \{a, b, c, d, e\}, \{(a, c), (b, c), (c, d), (d, e)\} \rangle$$

   i. Explain the meaning of this set of arguments. [4]

   ii. Draw the diagrammatic representation of this set of arguments. [2]

   iii. List the mutually defensible positions in this set of arguments. [3]

   (d) Letting $R(Ag, Env)$ denote the set of all possible runs of agent Ag in environment Env, $u(r)$ denote the utility of run r, and $P(r|Ag, Env)$ denote the probability that run r occurs given agent Ag is situated in environment Env, write an equation that defines the properties of the *optimal* agent given u and Env. [3]

   (e) The notion of bounded optimality is generally a more useful measure than pure optimality. Describe the arguments for using the notion of bounded optimality, and formally define the notion of a bounded optimal agent. [3]

Continued

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3. (a) Using an example application of your choosing, describe the analysis and design phases of the GAIA methodology, along with their key components. [8]

   (b) Explain what is meant by system-level and individual-level trust in multi-agent systems. [4]

   (c) Consider a website that enables users to buy and sell secondhand computer components. Using this setting, describe the desirable properties of a reputation mechanism, and explain how and why reputation might be incorporated into the website. [7]

   (d) Suppose that you are designing a multi-agent system for monitoring city traffic using a collection of agents that are geographically distributed across the area. Describe how this task relates to the stages of cooperative distributed problem solving, and how you might use generalised partial global planning to achieving this task. [6]

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4. (a) Describe the semantics of the *inform* and *request* FIPA performatives, in terms of preconditions and rational effects. [6]

   (b) Describe the structure of FIPA messages, illustrating your answer with an example of your choice. [4]

   (c) Discuss the stages of the Contract Net protocol, and illustrate how the protocol might be implemented using FIPA performatives. (You may use any FIPA performatives, and are not restricted to inform and request.) [6]

   (d) Using an example application of your choice, briefly describe the stages of the AAII methodology. [5]

   (e) Explain what is meant by a social norm in the context of multi-agent systems and describe two alternative strategies through which social norms might emerge. [4]

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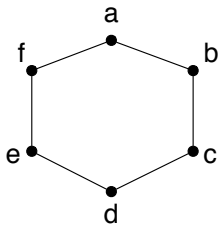
5. (a) Define the *monotonic concession protocol* for negotiation and the *Zeuthen strategy*. Discuss how they relate to the desirable properties of negotiation protocols. [7]

   (b) Consider the delivery task illustrated by the following map, such that agents A and B must both start from a and return to a. Agent A must deliver to b and e and B to d. Suppose that A claims to have to deliver only to e.



   i. Explain what is meant by a pure deal and state the pure deal that will be agreed in this case? Does A benefit by claiming to have to deliver only to e? [3]

   ii. Explain what is meant by a mixed deal and state what mixed deal would be agreed in this case? Does A benefit by claiming to have to deliver only to e? [5]

   (c) Suppose that an auction agent submits the following XOR bid:

   bid = ({bread, cheese}, 10) XOR ({tea, milk}, 4)

   i. What is meant by this bid? [2]

   ii. What valuations are associated with the following bundles? [3]

   - {bread, cheese}
   - {bread, tea}
   - {bread, tea, cheese, milk}

   (d) Agents have been proposed as a useful technique for certain kinds of distributed system. Discuss the typical characteristics of agents, and the potential pitfalls of agent development. [5]

Continued

6. (a) Given the the voter preferences below, describe and demonstrate the operation of:
   i. Linear sequential pairwise voting using the agendas "abcde" and "aedcb". [6]
   ii. Plurality voting. [2]
   iii. The Borda count voting method. [4]

Voter 1	*Voter 2*	*Voter 3*	*Voter 4*	*Voter 5*	*Voter 6*	*Voter 7*
c	a	c	a	c	b	d
b	e	d	d	b	a	b
d	c	e	b	e	e	e
a	b	a	e	a	c	a
e	d	b	c	d	d	c

   (b) In the context of voting protocols:
   i. explain what is meant by the independence of irrelevant alternatives, the Condorcet winner criterion, and the Pareto criterion, and [3]
   ii. describe how these criteria relate to linear sequential pairwise voting, plurality voting, and the Borda count method. [3]
   (c) Suppose we know that the following holds in a pairwise election: a beats b and c, b is beaten by c and d, c is beaten by d, and d beats a.
   i. Draw a majority graph to illustrate this situation. [3]
   ii. With reference to the majority graph, explain whether a or d is a Condorcet winner. [4]

End