CS4041/CS4042

THE UNIVERSITY OF WARWICK

Fourth Year Examinations: Summer 2012

Agent Based Systems

Time allowed: 2 hours.

Answer **FOUR** questions.

Read carefully the instructions on the answer book and ensure that the particulars required are entered on the front cover of EACH answer book you use.

Approved calculators may be used.

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1. (a) Given the following set of voter preferences, describe and demonstrate the operation of:

    i. Plurality voting. [2]

    ii. The Borda count voting method. [4]

    iii. Linear sequential pairwise voting using the agendas "cadbe' and "ecadb". [6]

Voter 1	*Voter 2*	*Voter 3*	*Voter 4*	*Voter 5*	*Voter 6*	*Voter 7*
c	c	e	a	b	c	a
b	a	c	b	a	b	d
a	d	a	e	e	d	b
e	b	b	c	c	e	e
d	e	d	d	d	a	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 d, b is beaten by c, c is beaten by d and a, and b beats d.

    i. Draw a majority graph to illustrate this situation. [3]

    ii. With reference to the majority graph explain which, if any, of the candidates is a Condorcet winner. [4]

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2. (a) Consider the following partial pseudo-code of the control loop of a BDI-based agent.

$B := B_0$;
$I := I_0$;
while true do
    get next percept ρ through $see(\ldots)$ function;
    $B := brf(B, \rho)$;
    $D := options(B, I)$;
    $I := filter(B, D, I)$;
    $\pi := plan(B, I)$;
    while not ($empty(\pi)$ or $succeeded(I, B)$ or $impossible(I, B)$) do
    .
    .
    .
    end-while
end-while

Given this partial pseudo-code:

i. Explain the meaning of the variables B, D and I. [3]

ii. Describe the purpose of the functions $brf(\ldots)$, $options(\ldots)$, and $filter(\ldots)$. [3]

iii. Give suitable pseudo-code for the missing section to complete the BDI control loop. [3]

(b) Explain what is meant by a hybrid agent architecture, and briefly describe the different layering approaches. [4]

(c) The notion of intention is commonly used in practical reasoning agents. Explain its roles. [4]

(d) Explain what is meant by a commitment strategy and give examples. [4]

(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]

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, giving examples to support your answer. [6]

(c) Discuss the stages of the Contract Net protocol, and illustrate how the protocol might be implemented using FIPA performatives. [6]

(d) Consider the environment $\langle E, e_0, \tau \rangle$ defined as:

$$E = \{e_0, e_1, e_2, e_3, e_4, e_5, e_6, e_7, e_8\}$$
$$\tau(e_0 \xrightarrow{\alpha_0}) = \{e_1, e_2, e_3, e_4\}$$
$$\tau(e_0 \xrightarrow{\alpha_1}) = \{e_5, e_6, e_7, e_8\}$$

Suppose that there are two agents possible with respect to this environment:

$$Ag_1(e_0) = \alpha_0$$
$$Ag_2(e_0) = \alpha_1$$

Assume that the probabilities of the various runs are as follows:

$$P(e_0 \xrightarrow{\alpha_0} e_1 | Ag_1, E) = 0.4 \qquad P(e_0 \xrightarrow{\alpha_1} e_5 | Ag_2, E) = 0.2$$
$$P(e_0 \xrightarrow{\alpha_0} e_2 | Ag_1, E) = 0.2 \qquad P(e_0 \xrightarrow{\alpha_1} e_6 | Ag_2, E) = 0.1$$
$$P(e_0 \xrightarrow{\alpha_0} e_3 | Ag_1, E) = 0.1 \qquad P(e_0 \xrightarrow{\alpha_1} e_7 | Ag_2, E) = 0.5$$
$$P(e_0 \xrightarrow{\alpha_0} e_4 | Ag_1, E) = 0.3 \qquad P(e_0 \xrightarrow{\alpha_1} e_8 | Ag_2, E) = 0.2$$

Assume the utility function u_1 is defined as follows:

$$u_1(e_0 \xrightarrow{\alpha_0} e_1) = 8 \qquad u_1(e_0 \xrightarrow{\alpha_1} e_5) = 6$$
$$u_1(e_0 \xrightarrow{\alpha_0} e_2) = 17 \qquad u_1(e_0 \xrightarrow{\alpha_1} e_6) = 21$$
$$u_1(e_0 \xrightarrow{\alpha_0} e_3) = 3 \qquad u_1(e_0 \xrightarrow{\alpha_1} e_7) = 4$$
$$u_1(e_0 \xrightarrow{\alpha_0} e_4) = 14 \qquad u_1(e_0 \xrightarrow{\alpha_1} e_8) = 7$$

Given these definitions, what is the expected utility of the agents Ag_1 and Ag_2 with respect to E and u_1 and state, with explanation, which agent is optimal [3]

(e) What is meant by bounded optimality, and why is it a useful concept? [2]

4. (a) Consider the following set of Dung-style arguments:

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

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

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

iii. Explain what is meant by a mutually defensive position and a preferred extension in the context of argumentation. [2]

iv. List the preferred extensions for this set of arguments. [3]

v. For each argument in the set, say whether it is sceptically accepted, credulously accepted, or neither. [3]

(b) Suppose that (ϕ_1, Γ_1) and (ϕ_2, Γ_2) are arguments from some database Δ in a deductive argumentation system. Explain the different ways that (ϕ_1, Γ_1) could be attacked by (ϕ_2, Γ_2). [4]

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

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5. (a) Define the notions of

   i. a pure Nash equilibrium, and [2]

   ii. a Pareto optimal outcome. [2]

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

   i. [2]

	A_i	B_i
A_j	0 0	0 -1
B_j	-1 0	1 1

   ii. [2]

	A_i	B_i
A_j	1 -1	-1 1
B_j	-1 1	1 -1

   iii. [2]

	A_i	B_i	C_i
A_j	1 3	3 4	4 3
B_j	1 1	7 5	5 4
C_j	3 4	1 4	2 5

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

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

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

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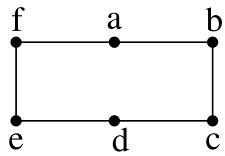
6. (a) Define the *monotonic concession protocol* for negotiation and the *Zeuthen strategy*. Discuss how they relate to the desirable properties of negotiation protocols. [7]

   (b) Given the following map, assume that agents A_1 and A_2 have a delivery task, such that both agents must start from a and return to a. Agent A_1 must deliver to b and e and A_2 to d. Suppose that A_1 claims to only have to deliver to e.



   i. What is a pure deal and what pure deal will be agreed in this case? Does A_1 benefit by claiming to only have to deliver to e? [3]

   ii. What is a mixed deal and what mixed deal would be agreed in this case? Does A_1 benefit by claiming to only have to deliver to e? [5]

   (c) Consider the following pseudo-code for the action selection loop in a logic-based agent.

for each $\alpha \in Ac$ do
    if $\Delta \vdash_\rho Do(\alpha)$ then
        return α
    end-if
end-for
for each $\alpha \in Ac$ do
    if $\Delta \nvdash_\rho \neg Do(\alpha)$ then
        return α
    end-if
end-for
return `null`

   Describe how this loop works, explaining the role of ρ, Δ, $\vdash_\rho$ and $Do(\alpha)$, and the limitations of such an approach for run-time decision-making. [8]

   (d) With reference to the logic-based agent outlined above, explain what you understand by the term calculative rationality. [2]