CS4041/CS4042

THE UNIVERSITY OF WARWICK

Summer Examinations 2012/13

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) Consider the following example of a Dung-style argumentation system:

$$\langle \{x, y, z\}, \{(x, y), (y, z), (z, x)\} \rangle$$

Explain the meaning of this set of arguments. [2]

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

(c) State the preferred extension of the argumentation system in part (a). [2]

(d) Now consider the following argumentation system:

$$\langle \{a, b, c, d, e, f, g, h, i\}, \\ \{(a, b), (a, c), (a, h), (b, e), (h, e), (d, e), (f, g), (g, f), (f, i), (g, i)\} \rangle$$

i. Draw the diagrammatic representation of this set of arguments. [4]

ii. Explain the status of arguments a, b, e and i. [4]

(e) Explain what is meant by a grounded extension, and how it can be determined. [3]

(f) Describe the analysis and design phases of the GAIA methodology and their key components, using an example MAS application to illustrate your answer. [8]

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2. (a) Explain the roles played by intentions in supporting practical reasoning. [4]

   (b) Give examples of commitment strategies and explain how they related to reasoning. [4]

   (c) 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]

   (d) Using FIPA performatives, describe the stages of the Contract Net protocol. [6]

   (e) Consider an environment $\langle E, e_0, \tau \rangle$ defined as:

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

   in which there are two possible agents:

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

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

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

   and that a utility function u_1 is given as:

   $$u_1(e_0 \xrightarrow{\alpha_0} e_1) = 9 \qquad u_1(e_0 \xrightarrow{\alpha_1} e_4) = 5$$
   $$u_1(e_0 \xrightarrow{\alpha_0} e_2) = 7 \qquad u_1(e_0 \xrightarrow{\alpha_1} e_5) = 12$$
   $$u_1(e_0 \xrightarrow{\alpha_0} e_3) = 18 \qquad u_1(e_0 \xrightarrow{\alpha_1} e_6) = 1$$

   State the expected utility of Ag_1 and Ag_2 in E with respect to u_1 given the above probabilities, and explain which agent is optimal. [3]

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

   (g) 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]

3. (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.

	A_i	B_i
A_j	3 1	1 3
B_j	1 3	3 1

   [2]

   ii.

	A_i	B_i	C_i
A_j	2 1	5 1	3 0
B_j	3 7	5 1	6 2
C_j	0 0	5 0	7 3

   [2]

   (c) Describe the stages of the AAII methodology, illustrating your answer with an example application of your choice. [5]

   (d) Describe the action selection loop of a logic-based agent, and give pseudo-code for how it could be implemented. [5]

   (e) Explain the limitations of logic-based agents for run-time decision-making. [3]

   (f) Explain how social norms are useful in multi-agent systems and describe two alternative strategies through which social norms might emerge. [4]

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4. (a) Suppose that two agents, A_1 and A_2, have a delivery task in an environment of 6 locations, a, b, c, d, e, f, that are arranged in a circle. Both agents must start from location a and return to a. 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 from its deception? [3]

   ii. What is a mixed deal and what mixed deal would be agreed in this case? Does A_1 benefit from its deception? [5]

   (b) i. The FIPA language is based on the $inform$ and $request$ performatives. Describe their semantics in terms of preconditions and rational effects. [6]

   ii. Describe the structure of FIPA messages, illustrating your answer with an example of your choice. [3]

   (c) Briefly discuss the differences between logic-based argumentation and negotiation as ways of achieving agreement in MAS, and identify the kind of application for which each is best suited. [4]

   (d) Discuss how generalised partial global planning can be used for cooperative distributed problem solving. [4]

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5. (a) i. In the context of the BDI architecture, explain what is meant by the B, D and I concepts and how they fit within the architecture. [3]

   ii. Explain, using pseudo-code, the control loop for a BDI-based agent. [5]

   iii. Explain the purpose of the $reconsider()$ and $filter()$ functions, in the context of a BDI architecture. [2]

   (b) Describe the different layering approaches that are used in hybrid agent architectures, and explain how they operate. [4]

   (c) Explain what is meant by system-level and individual-level trust in multi-agent systems, giving examples to support your answer. [4]

   (d) Suppose that you are creating an online marketplace for buying and selling second-hand goods, and intend to use reputation to improve the marketplace. In this context, describe the desirable properties of a reputation mechanism, and explain how and why reputation might be used. [7]

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6. (a) Given the following 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 'ebcda' and 'badec'. [6]

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

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

End