UNIVERSITY OF SOUTHAMPTON COMP6203W1

SEMESTER 1 EXAMINATION 2017 - 2018

INTELLIGENT AGENTS

DURATION 90 MINS (1.5 Hours)

This paper contains 4 questions.

Answer THREE out of FOUR questions.

An outline marking scheme is shown in brackets to the right of each question.

This examination is worth 60%. The coursework was worth 40%.

University approved calculators MAY be used.

A foreign language dictionary is permitted ONLY IF it is a paper version of a direct 'Word to Word' translation dictionary AND it contains no notes, additions or annotations.

11 page examination paper.

Question 1.

(a) Suppose we have the following definitons in an abstract agent architecture:

- An environment is a tuple $\langle E, e_0, \tau \rangle$, where E is a finite set of environmental states, e_0 is the initial state and τ is a state transformer function;
- An agent can select from a finite set of actions, Ac;
- The set R is the set of all possible runs, where a run is a sequence of interleaved actions (from Ac) and states (from E); and
- R^{Ac} is the set of runs ending in an action, and R^{E} is the set of runs ending in an environmental state.

Give functional definitions for the following:

(i) The state transformer function for a non-deterministic environment.

[3 marks]

(ii) A reactive agent. [3 marks]

(iii) A task for an agent. You are free to specify a task in any way you wish, but you must give an explanation for your definition.

[4 marks]

(b) The utilities for players i and j engaging in an encounter are given below, where $\tau(\mathcal{D}, \mathcal{C})$ is the environmental state that results from agent i playing $\mathcal{D}$ and agent j playing $\mathcal{C}$.

$$u_i(\tau(\mathcal{D}, \mathcal{D})) = 5 \quad u_i(\tau(\mathcal{D}, \mathcal{C})) = 4$$
$$u_i(\tau(\mathcal{C}, \mathcal{D})) = 3 \quad u_i(\tau(\mathcal{C}, \mathcal{C})) = 5$$

$$u_j(\tau(\mathcal{D}, \mathcal{D})) = 5 \quad u_j(\tau(\mathcal{D}, \mathcal{C})) = 4$$
$$u_j(\tau(\mathcal{C}, \mathcal{D})) = 8 \quad u_j(\tau(\mathcal{C}, \mathcal{C})) = 9$$

(i) Draw the payoff matrix for this encounter. [2 marks]

(ii) Define the concept of *social welfare* and identify the solutions (if any) that maximise social welfare in this encounter. [5 marks]

(iii) Define the concept of a *pure strategy Nash equilibrium* and identify the solutions (if any) that are pure strategy Nash equilibria in this encounter. [7 marks]

(iv) Define what we mean by a *mixed strategy Nash equilibrium*, and compute this equilibrium for i and j in this game. [9 marks]

TURN OVER

Question 2.

Consider a bilateral two-issue negotiation setting where agents A and B are negotiating about the division of two pies with the following multi-issue utility functions:

$$U_A(\vec{o}) = 0.25 * o_1 + 0.75 * o_2$$

$$U_B(\vec{o}) = 0.5 * (1 - o_1) + 0.5 * (1 - o_2)$$

Where $\vec{o}$ is a vector specifying the offer, where $o_1 \in [0, 1]$ and $o_2 \in [0, 1]$ are the proportions of pies 1 and 2 respectively going to agent A, and the remaining pie goes to agent B. As can be seen, agent A prefers pie 2, whereas agent B is indifferent between them.

Now consider the table below containing 7 offers, showing the share of each pie going to agent A.

Offer Number	Pie 1	Pie 2
1	1.0	1.0
2	1.0	0.0
3	0.0	1.0
4	0.5	0.5
5	0.0	0.0
6	0.8	0.0
7	0.0	0.8

For example, offer 2 means that agent A gets pie 1 and agent B gets pie 2, whereas offer 4 means that each agent gets half a pie.

(a) Which offer(s) from the table above is (are) Pareto efficient? Explain. [6 marks]

(b) Which offer(s) from the table satisfies (satisfy) the utilitarian welfare condition (also known as maximising social welfare). Explain. [4 marks]

(c) Which offer(s) from the table satisfies (satisfy) the egalitarian welfare condition? Explain. [4 marks]

(d) Which offer(s) from the table is (are) envy free? Explain. [6 marks]

(e) Compare and contrast the alternating offers protocol and the monotonic concession protocol for bilateral negotiation. In doing so, describe the protocols, discuss sensible strategies, and discuss the advantages and disadvantages.

[9 marks]

(f) Explain the tit-for-tat concession strategy and how you could generate a multi-issue offer in such a setting. [4 marks]

TURN OVER

Question 3.

(a) Describe the 4 main auction types for selling a single item. [10 marks]

(b) Suppose that an agent i has a private value of $v_i = 10$ for the item being auctioned. Explain how the agent should bid in each of these auctions, and what the main considerations are when bidding. In doing so, identify any (weakly) dominant strategies, and highlight any similarities between the bidding strategies. [10 marks]

(c) Explain the winner's curse and when this might occur. [4 marks]

(d) Describe the process and the main players involved in showing a display ad when a user visits a website. [9 marks]

Question 4.

(a) Using one or two examples, briefly discuss the statement: "in the design of protocols between agents, correctness should not depend on the agents' internal state or reasoning". [6 marks]

(b) Give definitions of the following concepts in the context of a Dung abstract argumentation framework:

(i) An admissible set of arguments. [4 marks]

(ii) Maximal inclusion. [2 marks]

(c) Figure 1 illustrates a graph with 6 abstract arguments, a, b, c, d, e and f, and attacks $\{\langle \mathrm{a}, \mathrm{b}\rangle, \langle \mathrm{b}, \mathrm{c}\rangle, \langle \mathrm{b}, \mathrm{f}\rangle, \langle \mathrm{c}, \mathrm{b}\rangle, \langle \mathrm{c}, \mathrm{e}\rangle, \langle \mathrm{d}, \mathrm{b}\rangle\}$. A preferred extension can be characterised as a set of arguments that satisfies the requirements of admissibility and maximal inclusion. Identify a preferred extension for this graph, and explain your reasoning.

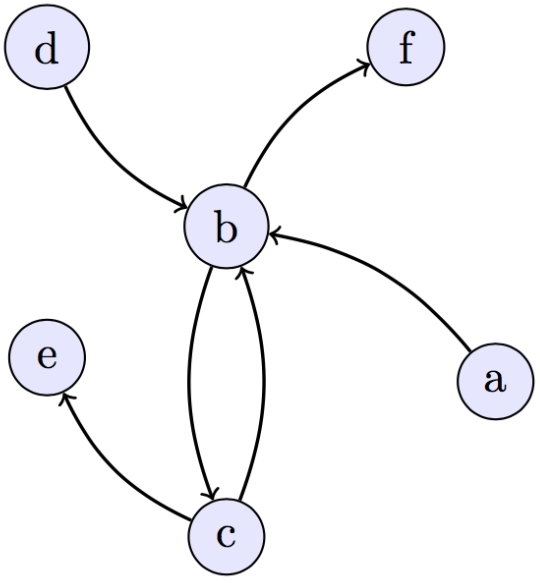

FIGURE 1: A graph with 6 abstract arguments.

[9 marks]

(d) A group of friends want to decide which movie they watch together. There are four options they are considering: The Martian (M), Pan

TURN OVER

(P), Spectre (Sp) and Suffragette (Su). Frank suggests that they vote using a Borda count. He asks them for their preferences and says that he will combine them with his own to make a group decision. The preferences (excluding Frank's) are:

- Alice: $\mathrm{M} >_{\mathrm{A}} \mathrm{Sp} >_{\mathrm{A}} \mathrm{Su} >_{\mathrm{A}} \mathrm{P}$
- Bob: $\mathrm{Sp} >_{\mathrm{B}} \mathrm{M} >_{\mathrm{B}} \mathrm{P} >_{\mathrm{B}} \mathrm{Su}$
- Carol: $\mathrm{P} >_{\mathrm{C}} \mathrm{Su} >_{\mathrm{C}} \mathrm{M} >_{\mathrm{C}} \mathrm{Sp}$
- David: $\mathrm{Su} >_{\mathrm{D}} \mathrm{M} >_{\mathrm{D}} \mathrm{P} >_{\mathrm{D}} \mathrm{Sp}$
- Elizabeth: $\mathrm{Su} >_{\mathrm{E}} \mathrm{Sp} >_{\mathrm{E}} \mathrm{P} >_{\mathrm{E}} \mathrm{M}$

Frank really wants to see Spectre. Can he manipulate the vote by declaring his own preferences such that Spectre is the outcome? Explain your reasoning in detail.

[12 marks]

