UNIVERSITY OF SOUTHAMPTON COMP6203W1

SEMESTER 1 EXAMINATION 2015 - 2016

INTELLIGENT AGENTS

DURATION 90 MINS (1.5 Hours)

This paper contains 5 questions

Answer THREE out of FIVE 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.

Question 1.

(a) What are the main five trends in the history of computing, as was discussed in the lecture? Briefly describe each of them.

[7 marks]

(b) Define an agent.
What are the main questions addressed in agent design?

[6 marks]

(c) Describe the main properties (or, types of behaviour) of an intelligent agent.

[7 marks]

(d) Describe the difference between purely reactive agents and agents with state.

[7 marks]

(e) Construct a normal form game where a weakly dominated strategy is part of a Nash equilibrium.

[6 marks]

Question 2.

(a) Explain the differences between intelligent agents and objects.

[5 marks]

(b) What are the main five dimensions characterising the environments in which intelligent agents operate? Briefly describe each of them.

[8 marks]

(c) Define a multi-agent system (MAS).
What are the main questions addressed in MAS design?

[6 marks]

(d) Explain the relation of MAS to other fields of research.

[7 marks]

(e) Construct a normal form game where if you iteratively eliminate *weakly* dominated strategies, the order in which you eliminate them can influence which Nash equilibria will remain.

Note: This is not the case for the iterative elimination of *strictly* dominated strategies.

[7 marks]

TURN OVER

Question 3.

(a) Firms Alpha and Beta serve the same market. They have constant average costs of £2 per unit. The firms can choose either a high price (£10) or a low price (£5) for their output. When both firms set a high price, the total demand of 10,000 units is split evenly between the two firms. When both set a low price, the total demand is 18,000, which is again split evenly. If one firm sets a low price and the second a high price, the low priced firm sells 15,000 units, the high priced firm only 2,000 units.

Analyse the pricing policies of the firms as a non-cooperative game.

(i) Construct the payoff matrix, where the elements of each cell of the matrix are the two firms' profits.

(ii) Derive the equilibrium strategy profile.

(iii) Explain why this is an example of the prisoners' dilemma game.

[15 marks]

(b) Consider a Business-to-Consumer (B2C) Internet company that provides some service to end users. The company has an enterprise value, which is a function $f(n)$ of the number n of its users. On the other hand, when people adopt the service provided by the company, each user i derives a non-negative utility $u_i \geq 0$ from using the service.

Let N denote the population of potential users, and let F denote the company. Consider a cooperative game played by $N \cup \{F\}$ – that is, by the company and potential users.

The characteristic function is given as follows. If a coalition $C \subseteq N$ does not include the company, its value $v(C)$ is 0. If a coalition C does include the company, its value $v(C)$ consists of the company enterprise values and the sum of its users' utilities. That is, for any

$C \subseteq N \cup \{F\}$, we have

$$v(C) = \begin{cases} f(|C|-1) + \sum_{i \in C \cap N} u_i & \text{if } \ F \in C \\ 0 & \text{otherwise} \end{cases}$$

The game is superadditive, so the grand coalition forms. Compute the Shapley value ϕ for the company F and each user $i \in N$.

[18 marks]

TURN OVER

Question 4.

(a) Describe the 4 main auction types for selling a single item. [9 marks]

(b) Suppose that an agent i has a private value of v_i for the item. 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. [9 marks]

(c) Which of these auctions is used by most Ad Exchanges? Give two reasons why this type of auction seems suitable for online advertising, compared to other types of auction. [7 marks]

(d) Describe the process and the main players involved in showing a display ad when a user visits a website. [8 marks]

Question 5.

(a) Consider the following voting profile:

# voters	Ranking
5 :	$B \succ E \succ A \succ C \succ D$
5 :	$C \succ E \succ A \succ D \succ B$
3 :	$D \succ A \succ E \succ C \succ B$
1 :	$A \succ C \succ E \succ D \succ B$

(i) Find the winner of the election under Plurality voting rule with lexicographic tie-breaking.

(ii) Is this profile a Nash equilibrium? If yes, provide a proof. If not, show what agents can benefit from changing their strategies and how.

[10 marks]

(b) (i) Find a mixed strategy equilibrium of the game below and compute expected utilities for both players. Show your calculations!

		Player 2	
		Left	Right
Player 1	Up	4,4	1,3
	Down	3,1	3,3

(ii) Now assume that the utility function of player 2 has changed as follows (the change is indicated in bold):

		Player 2	
		Left	Right
Player 1	Up	4,4	1,3
	Down	3,**2**	3,3

TURN OVER

How does this affect the equilibrium strategies (both pure and mixed) of player 1 and/or player 2?

[13 marks]

(c) Consider the sequential-offer bargaining game where two agents, 1 and 2, take turns making offers about how to divide a pie of size one. Time runs from $t = 0, 1, 2, \ldots$.

At time 0, agent 1 proposes a split $(x_0, 1 - x_0)$, which agent 2 can accept or reject. If agent 2 accepts, the game ends and the pie is consumed. If agent 2 rejects, the game continues to time $t = 1$, when agent 2 gets to propose a split $(x_1, 1 - x_1)$. Now, agent 1 can accept or reject, and so on.

If agreement to split the pie $(x, 1 - x)$ is reached at time t, the payoff for agent 1 is $\delta_1^t x$ and the payoff for agent 2 is $\delta_2^t(1 - x)$ for discount factors $\delta_1, \delta_2 \in (0, 1)$.

Assume only a finite number of offers, T, can be made. What are the equilibrium strategies for both agents? When do they reach an agreement? Prove for $T = 2$.

[10 marks]

END OF PAPER