UNIVERSITY OF SOUTHAMPTON COMP6203W1

SEMESTER 1 EXAMINATION 2016 - 2017

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.

6 page examination paper.

Question 1.

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

[8 marks]

(b) Explain the difference between intelligent agents and objects. Explain the difference between purely reactive agents and agents with state.

[8 marks]

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

[10 marks]

(d) Define a multi-agent system (MAS). Explain the relation of MAS to other fields of research.

[7 marks]

Question 2.

(a) The Vickrey auction is said to be *strategyproof* or, equivalently, *incentive compatible in dominant strategies*. Explain what this property means in terms of the bidding behaviour. [2 marks]

(b) Demonstrate that the property holds by considering different cases. [6 marks]

(c) Suppose you are selling multiple items, each using a separate Vickrey auction. Is the auction still strategyproof? Motivate your answer. What other auction can be used for selling multiple items? [5 marks]

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

(e) Describe 5 main players in display (a.k.a. banner) advertising, and their role. [10 marks]

(f) The Vickrey auction is now the predominant auction used by ad exchanges. Give two advantages of this auction compared to some of the other main auctions. For each advantage, discuss why this is especially relevant for online advertising. [6 marks]

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Question 3.

Consider three firms operating in an oligopolistic market.

Each firm i simultaneously makes an independent choice of a price, choosing either $p_i = 2$ (cheap) or $p_i = 3$ (expensive). Assume there are no production costs.

There are 12 customers, each buying one unit of the product. If all firms charge the same price, each attracts 4 customers. If one firm is cheap and two are expensive, the cheap one attracts 6 customers, and expensive firms attract 3 customers each. If two firms are cheap, they attract 5 customers each, and the expensive firm attracts the remaining 2 customers.

Each firm aims at maximising its profits – i.e., the product of its own price and the number of customers it has attracted.

(a) Represent this situation as a three-player non-cooperative game. Use two matrices, one corresponding to the choice of $p_3 = 2$, the other – to $p_3 = 3$, with Firm 1 as a row player and Firm 2 as a column player. (Note that each matrix should contain payoffs for all three players!) Find ALL pure strategy Nash equilibria. [11 marks]

(b) Turn this game into a coalitional game where the value of each coalition is determined by the profits that the coalition can *guarantee* to itself, no matter what the other firms do. [11 marks]

(c) Write down the system of inequalities defining the core of this coalitional game. Is the core empty? If yes, prove so; if not, find an element in the core. [11 marks]

Question 4.

(a) The school board is voting whether to award the contract for building a new elementary school to Ants (A), Bees (B), Centipedes (C), Dragonflies (D) or Earthworms (E).

There are 14 members of the board, whose preferences over the candidates are distributed as follows:

# 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	
		C	D
Player 1	A	12,12	3,9
	B	9,3	9,9

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

TURN OVER

		Player 2	
		C	D
Player 1	A	12,12	3,9
	B	9,**6**	9,9

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