NANYANG TECHNOLOGICAL UNIVERSITY

SEMESTER 2 EXAMINATION 2015-2016

CZ4046/CSC416 – INTELLIGENT AGENTS

Apr/May 2016 Time Allowed: 2 hours

INSTRUCTIONS

1. This paper contains 4 questions and comprises 4 pages.
2. Answer **ALL** questions.
3. This is a closed-book examination.
4. All questions carry equal marks.

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1. (a) Explain why an intelligent agent should be *reactive*, *pro-active* and *social*.

(6 marks)

(b) What are the two main steps involved in the *policy iteration* algorithm? Elaborate the purpose of each step.

(8 marks)

(c) Give two benefits of *reactive architectures*.

(2 marks)

(d) Consider the environment $Env_1 = \langle E, e_0, \tau \rangle$ defined as follows:

$E = \{e_0, e_1, e_2, e_3, e_4, e_5, e_6\}$ $\tau(e_0, \alpha_0) = \{e_1, e_2\}$
$\tau(e_0, \alpha_1) = \{e_2, e_3\}$ $\tau(e_1, \alpha_2) = \{e_3\}$
$\tau(e_2, \alpha_3) = \{e_4, e_5\}$ $\tau(e_3, \alpha_4) = \{e_2, e_6\}$

Note: Question No. 1 continues on Page 2

$\tau(e_i, \alpha_i)$ defines the state transition for the environment in state e_i, given action α_i. Assume that there are two possible agents for this environment Ag_1 and Ag_2, which are defined as follows:

$Ag_1(e_0) = \alpha_0$	$Ag_2(e_0) = \alpha_1$
$Ag_1(e_1) = \alpha_2$	$Ag_2(e_2) = \alpha_3$
$Ag_1(e_2) = \alpha_3$	$Ag_2(e_3) = \alpha_4$

Assume $|r|$ gives the total number of states in a particular run r. For example, $|r_1| = 3$ if $r_1 = (e_0, \alpha_0, e_3, \alpha_2, e_5 \mid Ag_1, \text{Env}_1)$. The probability P and utility U of each run are given as follows:

$P(r \mid Ag_1, \text{Env}_1) = 4/(|r| + |r|)$ $\qquad$ $U(r) = 10 - |r|$

$P(r \mid Ag_2, \text{Env}_1) = |r|/9$

(i) Write down all possible runs for Ag_1 and Ag_2.

(4 marks)

(ii) Calculate the expected utility for Ag_1 and Ag_2. Which one of the two agents is optimal with respect to Env_1 and U?

(5 marks)

2. A person visits the doctor because he believes that he has the flu. At this particular time of the year, the doctor estimates that 1 out of 1000 persons suffers from the flu. The first thing the doctor examines is whether the person appears to have the standard symptoms of the flu. If the person suffers from the flu, then he will exhibit the symptoms with probability of 0.9, but if he does not have the flu he may still have these symptoms with probability of 0.05. Then, the doctor can decide to administer a drug that has probability of 0.6 to shorten the sickness period if the person suffers from the flu (if he has not got the flu, the drug has no effect). The cost of administering the drug is \$100. If the sickness period is shortened, the doctor estimates that this is worth \$1000. If the sickness period is not shortened, it is worthy nothing.

(a) What are the three types of nodes in a decision network for this problem?

(3 marks)

(b) Draw the decision network for this problem.

(8 marks)

Note: Question No. 2 continues on Page 3

(c) Compute the expected utility of administering the drug and of not administering the drug, if the person appears to have the standard symptoms of the flu. Note that you may need to apply the Bayes' theorem: $P(A \mid B) = \dfrac{P(B \mid A)P(A)}{P(B)}$.

(12 marks)

(d) Should the doctor administer the drug to the person?

(2 marks)

3. (a) Use a real world example to explain the need to design a coordination or cooperation protocol while building a multi-agent system.

(5 marks)

(b) The CONTRACT NET protocol is one of the most widely used cooperation protocol in the multi-agent systems world. Briefly describe the operation of the protocol.

(5 marks)

(c) Explain why "incentive compatibility" is an important property of an auction mechanism.

(5 marks)

(d) Explain Pareto property in voting theory.

(5 marks)

(e) Consider the coalitional game with agents $Ag=\{1,2\}$ and characteristic function v defined by $v(\{1\})=5$, $v(\{2\})=5$, $v(\{1,2\})=20$. With reference to this example, explain the meaning of the core of a coalitional game.

(5 marks)

4. Consider the following two payoff matrices A and B as shown in Table Q4a and Table Q4b respectively. The first number in each entry is the payoff received by the row player *i*; while the second number is the payoff received by the column player *j*.

Payoff matrix A:

Table Q4a

	***j* defect**	***j* cooperate**
***i* defect**	**(2, 6)**	**(1, 5)**
***i* cooperate**	**(3, 4)**	**(2, 4)**

Payoff matrix B:

Table Q4b

	***j* defect**	***j* cooperate**
***i* defect**	**(2, 3)**	**(3, 4)**
***i* cooperate**	**(3, 5)**	**(2, 4)**

(a) Identify which strategy pairs (if any) in these two payoff matrices are in dominant strategy equilibrium. Briefly explain your answer.

(5 marks)

(b) Identify which strategy pairs (if any) in these two payoff matrices are in Nash equilibrium. Briefly explain your answer.

(8 marks)

(c) Identify which outcomes in these two payoff matrices are Pareto optimal. Briefly explain your answer.

(7 marks)

(d) Identify which outcomes in these two payoff matrices maximize social welfare. Briefly explain your answer.

(5 marks)

END OF PAPER

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Please read the following instructions carefully:

1. **Please do not turn over the question paper until you are told to do so. Disciplinary action may be taken against you if you do so.**

2. You are not allowed to leave the examination hall unless accompanied by an invigilator. You may raise your hand if you need to communicate with the invigilator.

3. Please write your Matriculation Number on the front of the answer book.

4. Please indicate clearly in the answer book (at the appropriate place) if you are continuing the answer to a question elsewhere in the book.