NANYANG TECHNOLOGICAL UNIVERSITY

SEMESTER 2 EXAMINATION 2016-2017

CE4046/CZ4046 – INTELLIGENT AGENTS

Apr/May 2017 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 the **TWO** aspects that make the Multi-Agent System field different from the Artificial Intelligence field.

(4 marks)

(b) Environments can be characterized as *static* vs. *dynamic*. Briefly describe these environment properties, and indicate the nice property an intelligent agent needs to achieve in a dynamic environment.

(6 marks)

(c) Figure **Q1** shows a simple decision network for a decision of whether Tom should take an umbrella when he goes out.

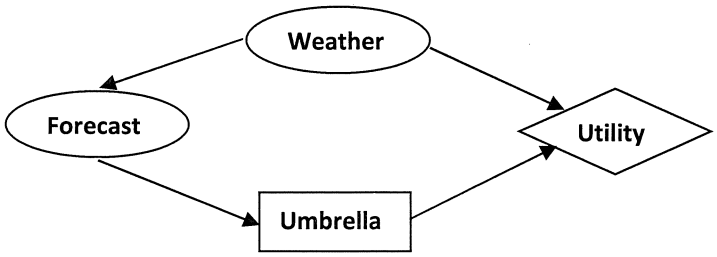

Figure Q1

Note: Question No. 1 continues on Page 2

The node **Forecast** indicates the weather forecast in the morning (sunny, cloudy or rainy), and the node **Weather** indicates whether or not it actually rains during the day (rain or no_rain). Tom estimates that the probability of raining during the day is 0.3. The probability of weather forecast given the actual weather, P(Forecast | Weather), is given below:

P(sunny | no_rain) = 0.7
P(cloudy | no_rain) = 0.2
P(sunny | rain) = 0.15
P(cloudy | rain) = 0.25

Tom is the most happy when it is not raining and he does not take an umbrella (utility = 100), next most happy when it is raining and he takes an umbrella (utility = 70). Tom hates carrying an umbrella when it is not raining (utility = 20), but is the most unhappy if it is raining and he does not have an umbrella (utility = 0).

(i) For each node in the decision network, indicate its type.

(4 marks)

(ii) Given the forecast that it will be cloudy, compute the expected utility of taking an umbrella and of not taking an umbrella. Should Tom take an umbrella? Note that you may need to apply the Bayes' theorem: $P(A \mid B) = \frac{P(B \mid A)P(A)}{P(B)}$.

(11 marks)

2. An agent inhabits a world with two states, namely, *S* and *S'*. It can perform one of the two actions, namely, *a* and *b*. Action *a* does nothing, and action *b* flips from one state to the other state. Consider this world as an MDP. The reward of each state is as follows: $R(S) = 3$, and $R(S') = 2$. The discount factor $\gamma = 0.5$.

Apply the policy iteration algorithm to determine the optimal policy. Assume that the initial policy has action *a* in both states.

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

(6 marks)

(b) Show each step completely during each iteration. What is the optimal policy?

(19 marks)

3. (a) When building a team of fighter jet agents for fighting with another team of fighter jet agents, what are the additional issues we have to consider compared with designing a single fighter jet agent?

(5 marks)

(b) Briefly describe the five stages included in the CONTRACT NET protocol.

(5 marks)

(c) Anyone who wishes to register a new vehicle in Singapore must first obtain a Certificate of Entitlement (COE). COEs are bid through the COE Open Bidding System. The number of successful bidders is limited by the COEs available for each particular COE category. Each successful bidder pays the price of the highest unsuccessful bid. Assume that each bidder wants only one COE. Is the bidding mechanism truthful? Justify your answer.

(5 marks)

(d) Explain manipulation in voting theory.

(5 marks)

(e) Consider the coalitional game with agents Ag={1,2} and characteristic function v defined by v({1})=9, v({2})=6, v({1,2})=17. With reference to this example, explain the meaning of the core of a coalitional game.

(5 marks)

4. Consider the two payoff matrices A and B 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**	**(7, 7)**	**(6, 7)**
***i* cooperate**	**(7, 7)**	**(7, 8)**

Note: Question No. 4 continues on Page 4

Payoff matrix B:

Table Q4b

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

(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.