NANYANG TECHNOLOGICAL UNIVERSITY

SEMESTER 2 EXAMINATION 2020-2021

CE4046/CZ4046 – INTELLIGENT AGENTS

Apr/May 2021 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) The question 'Isn't Multi-Agent System all just Social Science?' is an objection to the multi-agent system field. Provide an argument against this objection.

(4 marks)

(b) What is an *optimal agent*? What is a *bounded optimal agent*? Explain the difference between them.

(5 marks)

(c) Clearly list the 5 steps of the Agent Control Loop.

(10 marks)

(d) Agent synthesis is a program that takes a task environment, and from this task environment automatically generates an agent that succeeds in this environment. What are the **TWO** properties that an agent synthesis algorithm should have? Clearly explain each of the two properties.

(6 marks)

2. Assume that you want to purchase a flat and have two options: Flat A or Flat B. You want to resell the flat in a few years. So, you are interested in whether the flat's value will increase. Depending on the place you choose, there is some probability of increase in the value of the property. You go to work by taking a bus. So, you are also interested in the distance from the bus stop to the flat.

If you purchase Flat A, you will have a probability of 0.5 to find a bus stop that is near to the flat. If you purchase Flat B, you will also have a probability of 0.5 to find a bus stop that is near to the flat. The probability that the value of Flat A will increase in a few years is 0.6, and the probability that the value of Flat B will increase in a few years is 0.4.

The utilities of different cases are given in Table Q2 below.

Table Q2

Which flat to buy	Whether can find a bus stop nearby	Whether the value of the flat will increase	Utility
A	T	T	0.8
A	T	F	0.4
A	F	T	0.6
A	F	F	0.1
B	T	T	0.8
B	T	F	0.3
B	F	T	0.5
B	F	F	0.05

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

(10 marks)

(b) What is the expected utility of buying each flat? Which flat should you buy? Show clearly the detailed steps of deriving your answers.

(15 marks)

3. (a) Novel coronavirus (COVID-19) is very contagious. Robots might be useful to help combat the spread of the deadly coronavirus, e.g., using robots to deliver medicine, food, disinfect rooms, or even perform surgeries. List and briefly explain a few key ideas in multi-agent systems which can be used to build such a system in which many robots interact with humans including patients, doctors, and nurses.

(5 marks)

(b) During the COVID-19 crisis, masks are in short supply in many countries including Singapore. Assume that Singapore is starting its own mask production lines to meet the increasing demand. Building a mask production line involves many activities such as getting the equipment, getting raw materials, and hiring workers. Briefly describe how you can use CONTRACT NET to allocate tasks to build a mask production line.

(5 marks)

(c) Vickrey auctions are one-shot second-price sealed-bid auctions. We have seen the advantages of second-price auctions over first-price auctions in class: truth telling is a dominant strategy in a Vickrey auction. Now we introduce a third-price auction in which the winner is the highest bidder, and he pays the third highest bid. Is truth telling still a dominant strategy? Briefly explain your answer.

(5 marks)

(d) Consider a coalitional game with agents Ag={1,2} and a characteristic function v defined by v({1})=7, v({2})=13, v({1,2})=25. With reference to this example, explain the meaning of the core of a coalitional game.

(5 marks)

(e) Does the Borda count satisfy the Pareto property? Explain your answer.

(5 marks)

4. Consider the payoff matrix in Table Q4. The first number in each entry is the payoff received by the row player **A**, while the second number is the payoff received by the column player **B**.

Table Q4

	B: left	**B: middle**	**B: right**
A: up	**4, 2**	**4, 3**	**5, 2**
A: middle	**2, 4**	**2, 4**	**3, 5**
A: down	**4, 1**	**5, 0**	**4, 1**

(a) Identify the dominant strategies (if any) of each player in the payoff matrix. Briefly explain your answer.

(5 marks)

(b) Identify which strategy pairs (if any) in the payoff matrix are in Nash equilibrium. Briefly explain your answer.

(8 marks)

(c) Identify which outcomes in the payoff matrix are Pareto optimal. Briefly explain your answer.

(7 marks)

(d) Identify which outcomes in the payoff matrix 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.