

NANYANG TECHNOLOGICAL UNIVERSITY
SEMESTER 2 EXAMINATION 2023-2024
CE4046/CZ4046/SC4003 – INTELLIGENT AGENTS

Apr/May 2024

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) Clearly list the 5 steps of the Agent Control Loop. (10 marks)
 - (b) When calculating the utility of a state sequence in Markov Decision Processes (MDP), why is it necessary to include a discount factor? What will be the effect if the discount factor is set higher or lower, respectively? (7 marks)
 - (c) One of the properties that an intelligent agent needs to have is “*social*”. What does this property mean? Which of the five trends in the history of computing has made this property possible? (4 marks)
 - (d) The question ‘Isn’t it all just Social Science?’ is an objection to the multi-agent system field. Provide arguments against this objection. (4 marks)

2. John needs to decide whether or not to get coffee for his friend Jenny. Because the floor is slippery, there is a probability of 0.5 that John will drop the coffee when he gets the coffee. If John has dropped the coffee, he has the option to clean up the floor. The utilities of different cases are given in Table Q2 below.

Table Q2

| Whether to get coffee | Whether coffee is dropped | Whether to clean up | Utility |
|-----------------------|---------------------------|---------------------|---------|
| No | No | No | 0 |
| No | No | Yes | -20 |
| Yes | No | No | 80 |
| Yes | No | Yes | -30 |
| Yes | Yes | No | -100 |
| Yes | Yes | Yes | -120 |

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

(10 marks)

- (b) If John gets coffee and drops it, should he clean up? If John gets coffee but does not drop it, should he clean up? If John does not get coffee, should he clean up?

(6 marks)

- (c) Should John go to get coffee for Jenny? Show clearly all the steps of calculation.

(9 marks)

3. (a) Building agents with LLM (large language model) is now a very hot area in AI. In an LLM-powered autonomous agent system, LLM functions as an agent's brain, complemented by several key components such as planning, memory and tool use. List and briefly explain at least three key ideas we discussed in the course which can be used to build a successful LLM-powered multi-agent system.

(6 marks)

Note: Question No. 3 continues on Page 3

- (b) A few major countries will run presidential election (voting) this year. Explain the concept of manipulation in voting. (5 marks)
- (c) Consider a third-price auction where the winner is the bidder who submits the highest bid, but he/she only pays the third highest bid. Is the third-price auction truthful? Explain why. (5 marks)
- (d) One desirable property of a good voting mechanism is Pareto property. Explain the meaning of Pareto property. (5 marks)
- (e) Data pricing is to price data as an asset to promote the healthy development of data sharing, exchange, and reuse. Can Shapley value be applied for data pricing? Explain why. (4 marks)
4. Consider the two payoff matrices 1 and 2 in Table Q4a and Table Q4b, respectively. 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**.

Payoff matrix 1:

Table Q4a

| | B: left | B: right |
|----------------|-----------------|-----------------|
| A: up | (-2, -1) | (2, 0) |
| A: down | (-1, 0) | (1, -1) |

Note: Question No. 4 continues on Page 4

Payoff matrix 2:

Table Q4b

| | B: left | B: right |
|----------------|----------------|-----------------|
| A: up | (0, -2) | (-1, 0) |
| A: down | (-2, 1) | (0, -1) |

- (a) Identify the dominant strategies (if any) of each player in these two payoff matrices. 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.