

# UCL Computer Science Exam Practice Paper

## Paper Details

<b>Academic Year:</b>	2023/24
<b>Module Title:</b>	Real-world Multi-agent Systems
<b>Module Code:</b>	COMP0182
<b>Exam Period:</b>	Central Assessment Period: Late Summer
<b>Duration:</b>	Practice paper
<b>Deliveries for which suitable:</b>	A7P (Postgraduate Taught, Level 7)
<b>Cohorts for which suitable:</b>	2023-24

## Instructions

Answer ALL questions from the sections below. Please note that you do not need to perform the exact calculation for obtaining the exact number in the exam questions; rather, you only need to give equations or formula for doing the calculation.

Note: in this practice, the allocated marks are indicative for each question, and the total sum of marks do not reflect that of the real exam.

## Section A

In multi-agent systems, emergent behaviour plays a crucial role in achieving complex tasks through the collective interactions of individual agents.

1. Explain how emergent behaviour arises in multi-agent systems and its significance in achieving complex tasks. Provide one real-world example illustrating emergent behaviour. [4 marks]

Adaptive control strategies and navigation techniques are fundamental components of robot systems, enabling them to navigate through dynamic environments, avoid obstacles, and achieve their objectives efficiently. Effective control and navigation algorithms are essential for ensuring safe and reliable robot operations in diverse scenarios.

2. Propose an adaptive control strategy for coordinating movements in a swarm of robots navigating dynamic environments. Discuss how the strategy enables responsive coordination. [4 marks]
3. Propose an algorithm for dynamic obstacle avoidance in robot navigation, explaining how it adjusts the robot's path in real-time to avoid collisions with moving obstacles. [4 marks]

Sensing technologies, such as Lidar, sonar, and infrared sensors, play a vital role in providing robots with environmental perception for navigation. Additionally, signal processing techniques enhance the reliability of sensor data, enabling robots to make informed decisions and navigate effectively in complex environments.

4. Evaluate the effectiveness of Lidar, sonar, and infrared sensors in robot navigation. Compare their advantages and limitations. [6 marks]
5. Describe the role of signal processing in interpreting sensor feedback for robot control systems. Explain how filtering and noise reduction techniques improve feedback reliability. [4 marks]

## Section B

Consider 3x3 grid world, which is an environment represented as a grid where agents can move. There are two agents, Agent A and Agent B, each with their unique starting position

and goal. The grid also contains two static obstacles that the agents cannot move through. The objective is to find a path for each agent from their starting position to their goal, using the Priority Based Search algorithm, considering that Agent A has higher priority over Agent B.

### 3x3 Grid World Layout

- Empty cells are represented as "E"
- Obstacle cells are represented as "O"
- Agent A's start (S\_A) and goal (G\_A) positions
- Agent B's start (S\_B) and goal (G\_B) positions

2	O	E	G_A
1	S_B	E	O
0	S_A	E	G_B
	0	1	2

### Rules

1. Agents can move up, down, left, or right, but not diagonally.
2. An agent cannot move through obstacles or outside the grid.
3. Agents must reach their goal positions with the minimum number of moves.
4. Agent A has priority over Agent B, meaning Agent B's path must not interfere with the optimal path of Agent A. If necessary, Agent B might need to wait or take a longer path to avoid interference.

### Task

For the provided 3x3 grid world and considering the rules:

- a) Using the Priority Based Search algorithm, calculate the path for Agent A from S\_A to G\_A. Show each step of the decision process and the resulting path.

- b) Next, calculate the path for Agent B from S\_B to G\_B, considering Agent A's optimal path as a static obstacle if it crosses any cell. Show each step of the decision process and the resulting path.
- c) Discuss the potential limitations or challenges of using the Priority Based Search algorithm in scenarios with multiple agents and obstacles.

Ensure to elaborate on your decision process and provide the paths in the form of grid coordinates from start to goal (e.g., [(0,0), (0,1), ...]).

END OF PAPER