Iran University of Science & Technology

School of Computer Engineering

Assignment #1

Multi-agent system

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Teaching Assistants:

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Due: 1404/01/16

Contents

Notes:

1. Submit the answers in a complete PDF file and the code for the questions in the .ipynb format (including the notebook cell outputs) in a compressed file named HW_StudentID.zip by the specified deadline.
2. A total of 72 hours of delay in submitting the answers is allowed across all projects. After that, for each additional day of delay, 10% of the score will be deducted.
3. If a student submits the project earlier than the deadline and achieves 75% of the score, up to 24 hours will be added to their allowable delay time.
4. The maximum delay for submitting each assignment is 5 days, and after 5 days, submission will not be accepted.
5. The exercises must be performed individually, and group participation is not allowed.
6. It is important to note that the explanation of the code and the obtained results must be included in the PDF file. Code without a report will result in a score deduction.
7. The evaluation of the assignment will be based on the correctness of the solution and the completeness and accuracy of the report.
8. Assignments must be completed individually, and group work on assignments is not allowed.
9. Please allocate sufficient time for the assignment and avoid leaving it until the last days.
10. You can ask your questions in the relevant group.

good luck.

Setting Up the Environment and a Random Agent (City in Flames)

Scenario Description:

In this exercise, a 15×15 grid-based city is designed, containing fires, houses, emergency stations, and civilians. The primary goal is to evaluate the performance of a simple, non-intelligent agent in a dynamic environment where it has no prior knowledge of its surroundings. The agent moves randomly through the city and encounters fire spread and civilian rescues along its path.

The agent can move to any of the four adjacent cells (right, left, up, down). Cells containing fires must be extinguished, and civilians must be evacuated. If a civilian's cell catches fire, the civilian is killed, and the agent receives a penalty of -100 points.

Emergency Stations are located at two specific points:

- Top-left corner (cell [0,0])
- Bottom-right corner (cell [14,14])

These stations do not catch fire, and rescued civilians must be transported there.

Fires, buildings, civilians, and the agent are randomly distributed across the environment. Each cell can contain only one entity (fire, building, civilian, or agent).

Environment Details and Game Rules:

Environment Components:

- Buildings: 7 buildings are randomly placed in the environment, blocking the agent's movement. The agent cannot enter building cells.
- Emergency Stations: 2 stations where rescued civilians are delivered.
- Civilians: 8 individuals in need of rescue, randomly distributed.
- Fires:
    - Type 1 Fire: 5 small fires that can be independently extinguished.
- Agent: A single agent placed randomly in one of the cells.

Movement and Interaction Rules:

- At each step, the agent can move to adjacent cells (right, left, up, down) and may revisit cells it has previously visited.
- To extinguish a fire, the agent must enter a fire-containing cell and execute a special action. Simply entering the cell does not automatically extinguish the fire.
- To rescue a civilian, the agent must enter the civilian's cell, execute the rescue action, and then transport the civilian to an emergency station.
- The agent can carry only one civilian at a time and should prioritize transporting the civilian to the emergency station.

Fire Spread:

- Every 5 consecutive agent moves, the fire spreads randomly to an adjacent cell (right, left, up, down).
- Fire cannot spread to a cell containing an emergency station and buildings.
- If all surrounding cells of a fire are already burning, it will not spread further.
- The agent can pass through burning cells.
- If the agent carries a civilian and moves through fire, the civilian is not harmed.

Perception and Exploration:

- At the start, the agent has no knowledge of the fire locations, buildings, or civilians.
- The environment is completely unknown, and the agent must explore to discover it.
- The agent only has knowledge of the emergency station's location.
- The agent has sensors that allow it to perceive only a 5×5 area around itself.
- To uncover the rest of the map, the agent must move and explore gradually.
- If fire spreads beyond the agent’s sensor range, the agent will not be aware of the change.

Scoring System:

- +10 points for extinguishing each Type 1 Fire.
- +50 points for rescuing and delivering a civilian to an emergency station.
- -100 points if a civilian dies due to fire spread.

Game End Conditions:

- The game ends after 50 time steps.
- If all fires are extinguished and all civilians are rescued within this limit, the game is successfully completed.
- If fires remain or not all civilians are rescued, the agent fails.

Additional Notes:

- All components (fires, buildings, civilians, emergency stations) are randomly and unpredictably placed.
- To extinguish fires or rescue civilians, the agent must perform specific actions—simply entering the cell is not enough.
- The agent must explore and observe the environment to gather information for decision-making.
- Use the Python programming language.
- Display the city map and the map discovered by the agent from its surroundings, and print them on the .ipynb output.

Objective of the Exercise:

This exercise helps you understand the fundamental concepts of multi-agent systems and interactions in dynamic environments. After implementing this basic model, you can design intelligent agents and optimize movement and actions to improve performance.