FCUP-CC3042-2024/2025-1S

✔ Concluída

A. Multi-Agent Autonomous Waste Collection

Objective:

Design and implement a decentralized waste collection system using Multi-Agent Systems (MAS) with simulate autonomous garbage trucks (agents) that collaborate to efficiently collect waste from various dynamically to changes in waste levels and traffic conditions.

Problem Scenario:

In large urban areas, managing waste collection efficiently is a challenge, especially with varying levels road conditions (e.g., traffic, roadblocks). Instead of a centrally controlled system, autonomous garbag waste collection, where each truck operates as an independent agent. These agents must work togeth redundant collections, and manage limited resources such as fuel or battery levels.

Key Features of the Assignment:

1. **Truck Agents:** Each truck is represented by an agent responsible for collecting waste from assigr of detecting the fill level of waste bins in their vicinity and making decisions on whether to collect capacity, battery/fuel level, and proximity.
2. **Bin Agents:** Waste bins can also be represented by agents that periodically report their fill levels trigger a collection request when they reach a specified threshold.
3. **Decentralized Decision-Making:** The system is decentralized, meaning each truck agent makes i collect waste, where to go next, and how to optimize its route, without relying on a central contro other to avoid overlapping collection areas and ensure city-wide coverage.
4. **Dynamic Environment:** The environment should include dynamic elements like changing traffic c waste production levels. Truck agents need to adjust their routes in real time based on these con
5. **Task Allocation and Collaboration:** Implement a negotiation or task allocation protocol (e.g., Con agents to share responsibilities, hand off tasks to nearby agents when overloaded, and ensure ef
6. **Resource Management:** Each truck has limited resources, such as fuel or battery life and waste c efficient routes to minimize fuel consumption and maximize waste collected per trip. They also ne unload waste or recharge when needed.
7. **Optimization Metrics:** The system should track the following metrics to evaluate performance:
    - Total waste collected
    - Average collection time for each bin
    - Total fuel consumption or battery usage
    - Distance traveled by each truck agent
    - Efficiency of collaboration and task allocation between agents

8. **Fault Tolerance:** The system should be able to handle scenarios where some agents fail or go off Remaining agents should redistribute tasks to ensure uninterrupted waste collection.

Suggested Development Phases:

Week 1-2:

- **System Design:** Define the architecture of the system, including truck and bin agents, communic elements (e.g., traffic and road conditions).
- **Initial Setup:** Implement a basic waste collection simulation with a few truck and bin agents opera

Week 3:

- **Agent Communication:** Implement the communication protocols between truck agents and bin a fill level reports from bin agents and make collection decisions based on the information received
- **Route Planning:** Develop an initial route-planning algorithm that enables truck agents to travel be while managing their fuel or battery levels.

Week 4:

- **Dynamic Adaptation:** Introduce environmental changes like roadblocks or varying traffic conditio Agents should adjust their routes dynamically in response to these changes.
- **Task Allocation Protocol:** Implement a task allocation or collaboration mechanism (e.g., Contract agents to hand off tasks or divide collection areas efficiently.

Week 5:

- **Resource Optimization:** Enhance agents' decision-making algorithms to optimize resource usage consumption and maximizing waste collection per trip.
- **Fault Tolerance:** Implement fault-tolerant behavior in the system. If a truck agent fails or become redistribute its tasks to other agents.

Week 6:

- **User Interface and Visualization:** Create a simple interface that shows the city layout, truck mov metrics (e.g., waste collected, fuel consumed). The interface should allow users to observe agent
- **Testing and Evaluation:** Test the system with various city layouts and dynamic conditions, such a and traffic. Measure system performance using the predefined optimization metrics.