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Multi-agent systems based solution for Pickup-and-delivery

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KU Leuven - Multi-agent systems

0 Outline

1 Outline

1 Problem definition - Setting

- Pizzeria chain RoboPizza
- Pizza delivery using robots (AGVs)
- RoboPizza receives pizza delivery requests (tasks), robots deliver the pizzas
- Manhattan style city blocks

1 Problem definition - Robots

- Can move from and to any location in the city
- Have maps and can compute paths between locations
- Can carry up to 5 pizzas at once
- Can only communicate with entities that are close to them

1 Problem definition - Tasks

- Consist of pickup up (multiple) pizzas and deliver them to a location before a certain timepoint.
- If there are more than 5 pizzas in a task, it will have to be split up.
- Will be created every time step with low probability.
  - Delivery time window based on distance from pizzeria + randomness.
  - Amount of pizzas from Gaussian distribution.
  - Delivery location uniformly random in city.

1 Problem definition - World

Dynamism

- Streets can become closed off due to road works
- Amount of pizerrias

Potential AGV crashes

- Running out of battery
- ?

Efficiency measure

- Total waiting time for task

Charging

- Happens on one location.
- Charging station can only serve a limited amount of robots.

2 Outline

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2 Objectives

- Analyze performance of BDI & delegate MAS algorithm in a city setting

3 Outline

1. Problem definition
2. Objectives
3. Research questions
4. Hypotheses
5. Variables
6. Plan

3 Research questions (1)

- What is the relation between the amount of requests that RoboPizza receives and the waiting time for customers?
- Are robots on the road more when there are more requests in the system?
- Does increasing the amount of robots decrease the customer waiting time when there are many requests?
- How does the amount of robots impact the workload (occupancy rate) of the charging station?

3 Research questions (2)

- What is the relation between the amount of charging robots and the amount of clients we have to decline?
- How do waiting times change as the amount of road works change (dynamism)?
- How do waiting times change as the amount of pickup locations change (dynamism)?

4 Outline

4 Hypotheses (1)

- What is the relation between the amount of requests that RoboPizza receives and the waiting time for customers?
  - H_1: The waiting time increases with the amount of requests.
  - H_0: The waiting time does **not** increase with the amount of requests.

- Are robots on the road more when there are more requests in the system?
  - H_1: Robots are on the road more when there are more requests in the system.
  - H_0: Robots are **not** on the road more when there are more requests in the system.

4 Hypotheses (2)

- Does increasing the amount of robots decrease the customer waiting time when there are many requests?
  - H_1: Increasing the amount of robots decreases the customer waiting time when there are many requests.
  - H_0: Increasing the amount of robots does **not** decrease the customer waiting time when there are many requests.

- How does the amount of robots impact the workload (occupancy rate) of the charging station?
  - H_1: A larger amount of robots increases the workload of the charging station.
  - H_0: A larger amount of robots does **not** increase the workload of the charging station.

4 Hypotheses (3)

- What is the relation between the amount of charging robots and the amount of clients we have to decline?
  - H_1: The amount of charging robots has no influence on the amount of clients that have to be declined.
  - H_0: The amount of charging robots **influences** on the amount of clients that have to be declined.

- How do waiting times change as the amount of road works change (dynamism)?
  - H_1: Waiting times increase as the amount of road works increase.
  - H_0: Waiting times do **not** increase as the amount of road works increase.

4 Hypotheses (4)

- How do waiting times change as the amount of pickup locations change (dynamism)?
  - H_1: Waiting times decrease as the amount of pickup locations increase.
  - H_0: Waiting times do **not** decrease as the amount of pickup locations increase.

5 Outline

5 Independent variables

- n_{robots} = amount of delivery robots
- $p_{request}$ = probability for a new request
- $\mu_{pizza}, \sigma_{pizza}$ = Gaussian distribution parameters for amount of pizzas
- $p_{pizzeria\_closes}$ = probability for a pickup location to close
- $p_{pizzeria\_opens}$ = probability for a pickup location to open
- $p_{road\_works\_start}$ = probability for road works to start
- $p_{road\_works\_finish}$ = probability for existing road works to finish

5 Dependent variables

- t_{wait} = cumulative waiting time for customers
- $t_{robots\_driving}$ = time robots spent driving
- t_{idle_time} = time where robots are idle
- $n_{deliveries}$ = amount of finished deliveries
- n_{road_works} = amount of road works
- $n_{requests}$ = cumulative amount of requests in the system
- $n_{robots\_charging}$ = workload of the charging station
- avg_{pizzas} = average amount of pizzas carried by robots
- $avg_{pizzeria}$ = average amount of pizzeria open
- $avg_{requests}$ = average amount of requests in the system

5 Other variables

- speed = moving speed of the robots
- baking time = how fast can a pizzeria cook a pizza
- battery size = the capacity of a battery
- charging time = the amount of time it takes to recharge a battery

6 Outline

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6 Plan

1. Create a map
2. Generate pizzeria and charging station
3. Create random delivery tasks
4. Implement task-allocation & route planning
5. Calculate statistics
6. Report results

Questions?