Intelligent Systems Engineering Project

Simulation for the Management of an Autonomous Warehouse

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Brief introduction to the project

- Multi-agent system based on Jason
- Dynamic and realistic simulation for the management of an autonomous warehouse
- Agent operations: cargo management, navigation system, battery charging, random breakdowns
- GUI for real-time viewing

Purpose and main objectives

- System development
- Definition of autonomous behaviors
- Creation of a realistic navigation system:
- Goods Management
- Warehouse modeling and implementation of a GUI

Brief description of the main features

- Load transportation
- Fault management
- Charging needs
- Dynamic navigation
- Warehouse dynamics

Main components

- Infrastructure
- Environment
  - Update agents' perceptions
  - Handle agents' actions
  - Provides auxiliary methods
- Warehouse model
  - Grid representation
  - State variables and constants

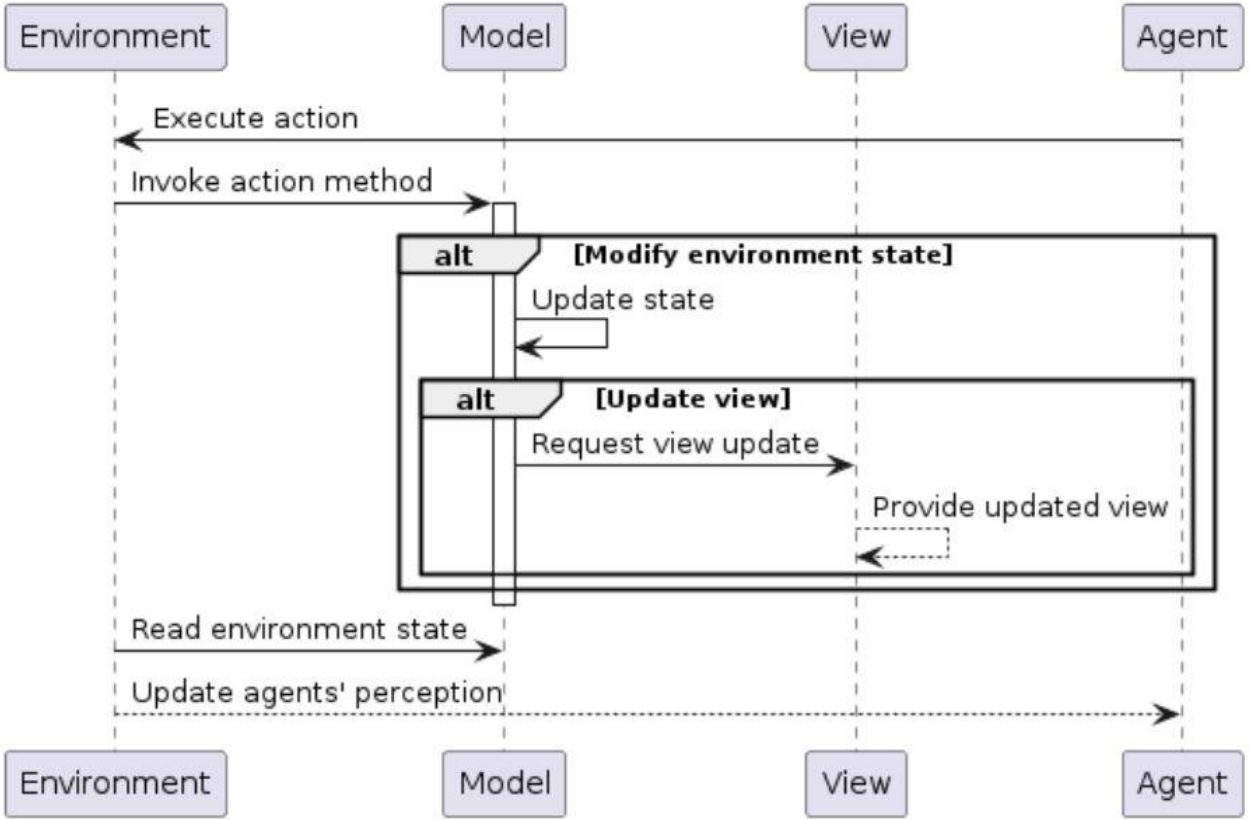
Main components

- Warehouse model
  - Initial placement of agents and environment objects
  - Methods for managing agent actions
  - Provide support methods
- GUI
  - Represents the environment
  - Sets the view attributes
  - Draws environment objects
  - Draws the agents

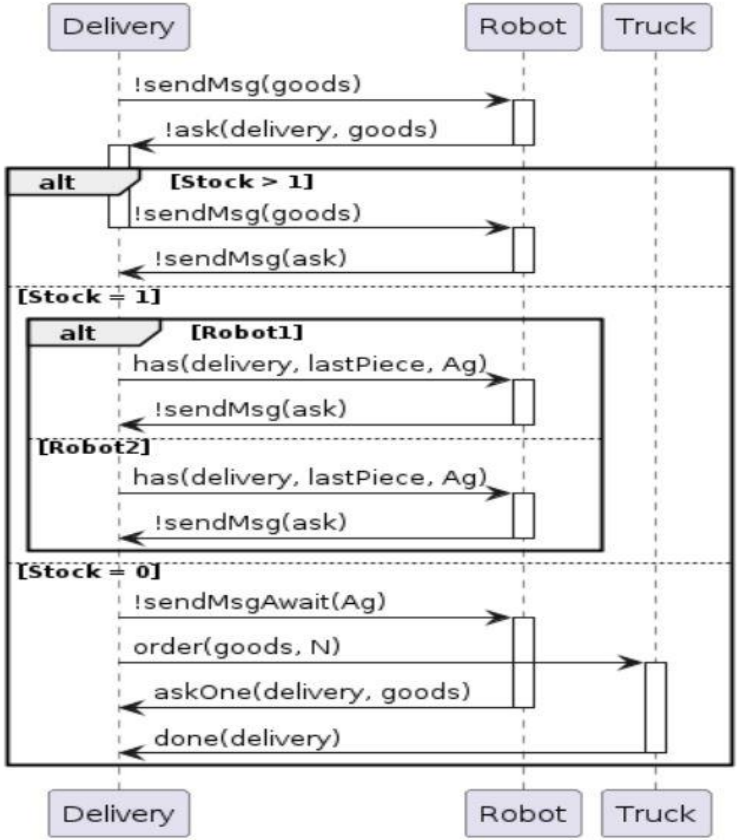
Main components

- Types of agents
  - Robot
  - Delivery
  - Truck
- Communication through messages
  - Use of semaphores

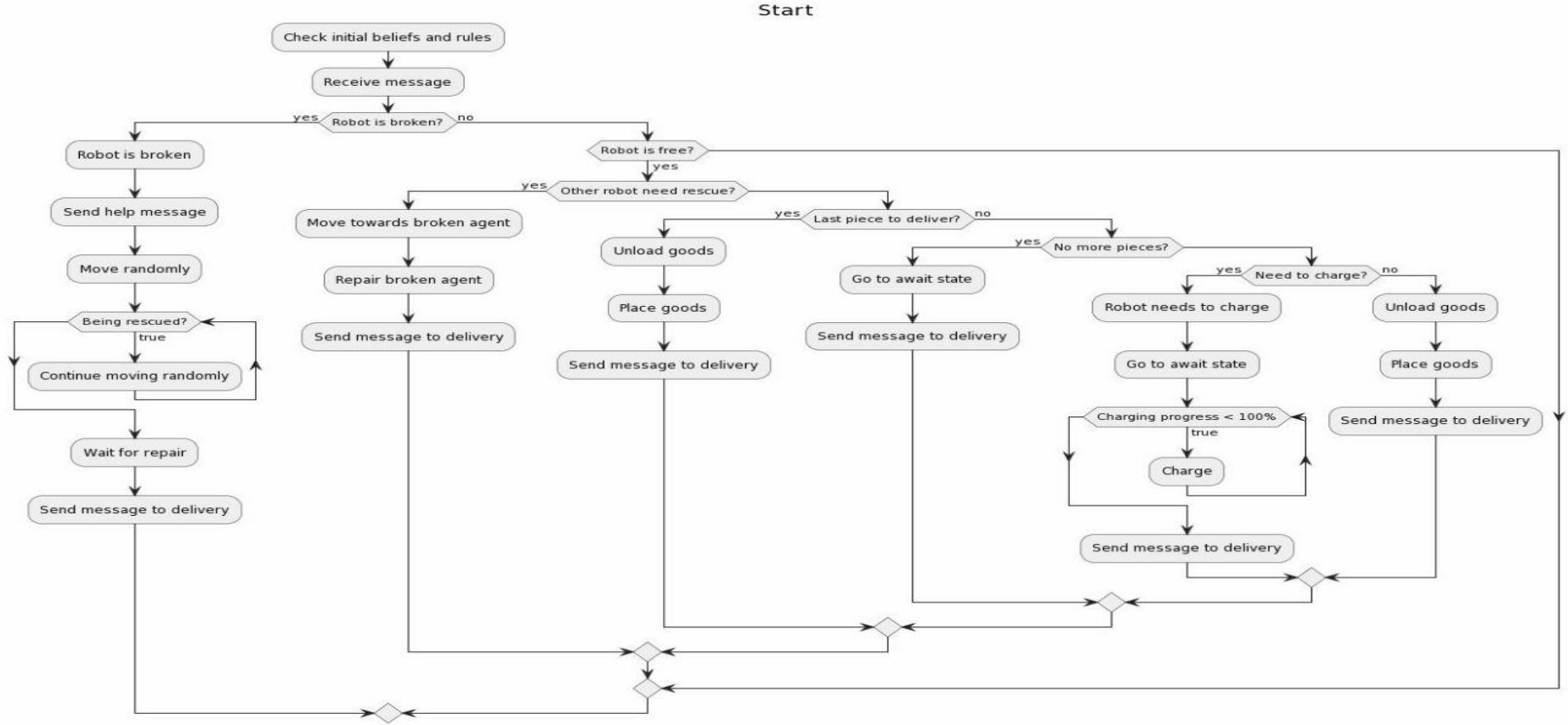
High-level diagrams



Interactions between agents



Behavior of the agents



Implementation of main features: cargo management

```
+!sendMsg(ask)
        : true
        <- .send(delivery, achieve, ask(delivery, goods)).

+!has(delivery, goods, Agent)
        : semaphore(free) & not need_charge(Agent) & not broken(_) & not rescuing(_)
    <- .print("Goal recived"); -semaphore(free); !at(Agent, delivery);
        unload(goods);
        utils.rand_int(R, 1, 4);
        !at(Agent, R);
        access(rack); place(R); free(rack); +semaphore(free); !sendMsg(ask);
        .date(YY, MM, DD);
        .time(HH, NN, SS);
        +consumed(YY, MM, DD, HH, NN, SS, Agent).
```

Implementation of main features: wait and movement

```
+!go(await, Agent)
   : semaphore(free) & not at(waitingZone) & not broken(_) & not rescuing(_)
   <- .print("I'm going to wait"); -rackType(0); -semaphore(free); !at(Agent, waitingZone).

+!at(Agent, P)
        : at(Agent, P)
        <- .wait(200).

+!at(Agent, P)
        : not at(Agent, P)
        <- move_towards(P); !at(Agent, P).
```

Implementation of main features: battery charging

```
limit(goods, 5).

need_charge(Ag) :-
        .date(YY, MM, DD) &
        .count(consumed(YY, MM, DD, _, _, _, B), QtdB) & limit(B, Limit) & QtdB > Limit.

+!has(delivery, goods, Agent)
   : semaphore(free) & need_charge(Agent) & not broken(_) & not rescuing(_)
   <- .print("I need to recharge");
      -consumed(_, _, _, _, _, _, Agent);
      -consumed(_, _, _, _, _, _, Agent);
      -consumed(_, _, _, _, _, _, Agent);
      -consumed(_, _, _, _, _, _, Agent);
      -consumed(_, _, _, _, _, _, Agent);
```

Implementation of main features: battery charging

```
!go(await, Agent); -semaphore(free);
charge(0); .wait(800);
charge(20); .wait(800);
charge(40); .wait(800);
charge(60); .wait(800);
charge(80); .wait(800);
charge(100); .wait(400);
charge(-1);
+semaphore(free);
!sendMsg(ask).
```

Implementation of main features: breakdown and rescue

```
+!has(delivery, goods, Agent)
    : semaphore(free) & broken(Rescuer)
    <- -semaphore(free); .print("BREAKDOWN"); show_broken(Agent);
       .send(Rescuer, achieve, provide_help(Agent)); !fault_resolved(Rescuer).

+!go(await, Agent)
    : semaphore(free) & broken(Rescuer)
    <- -rackType(0); -semaphore(free); .print("BREAKDOWN") show_broken(Agent);
       .send(Rescuer, achieve, provide_help(Agent)); !fault_resolved(Rescuer).

+!has(delivery, lastPiece, Agent)
    : semaphore(free) & broken(Rescuer)
    <- -semaphore(free); !unmanaged(last_piece); .print("BREAKDOWN"); show_broken(Agent);
       .send(Rescuer, achieve, provide_help(Agent)); !fault_resolved(Rescuer).
```

Implementation of main features: breakdown and rescue

```
+!has(delivery, goods, Agent)
    : semaphore(free) & need_charge(Agent) & broken(Rescuer)
    <- -semaphore(free); .print("BREAKDOWN"); show_broken(Agent); .send(Rescuer, achieve,
provide_help(Agent)); !fault_resolved(Rescuer).

+!fault_resolved(Rescuer)
        : not fault_resolved(Rescuer)
        <- move_towards(broken); .wait(500); !fault_resolved(Rescuer).

+!fault_resolved(Rescuer)
        : fault_resolved(Rescuer)
        <- .print("I have been reached for rescue"); .wait(4500); restore(env);
            +semaphore(free); !sendMsg(ask).
```

Implementation of main features: breakdown and rescue

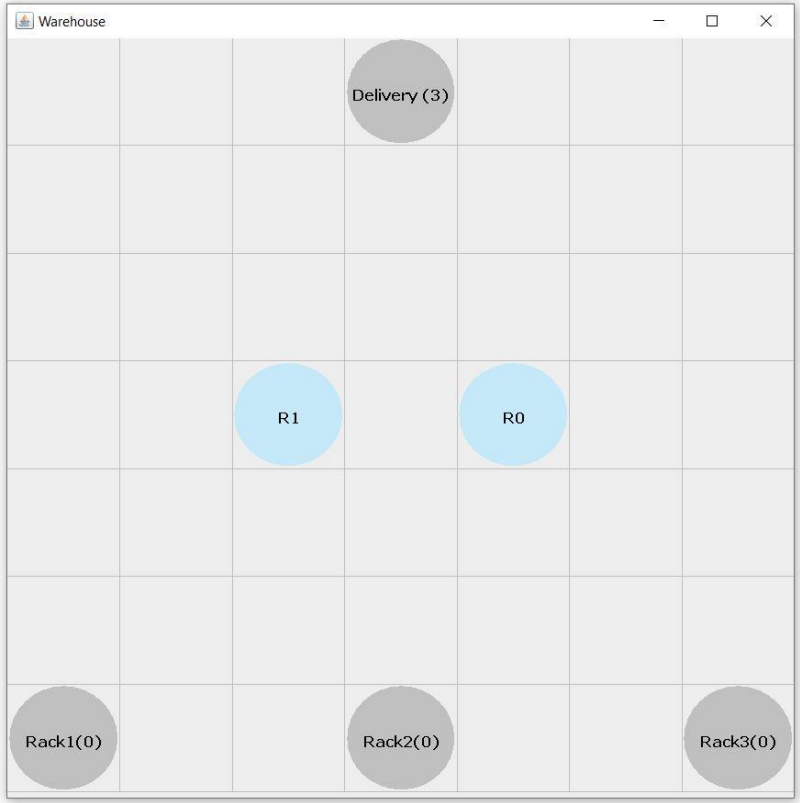
```
+!has(delivery, goods, Ag)
    : semaphore(free) & rescuing(Agent)
    <- -semaphore(free); .print("I go to help"); !reach_robot(Agent).

. . .

+!reach_robot(Agent)
        : not reach_robot(Agent)
        <- catch(Agent); move_towards(Agent); !reach_robot(Agent).

+!reach_robot(Agent)
        : reach_robot(Agent)
        <- .print("Broken agent reached"); show_recovery(Agent); .wait(4500);
            -rescuing(Agent); restore(env); +semaphore(free); !sendMsg(ask).
```

Short demo of the simulation in action



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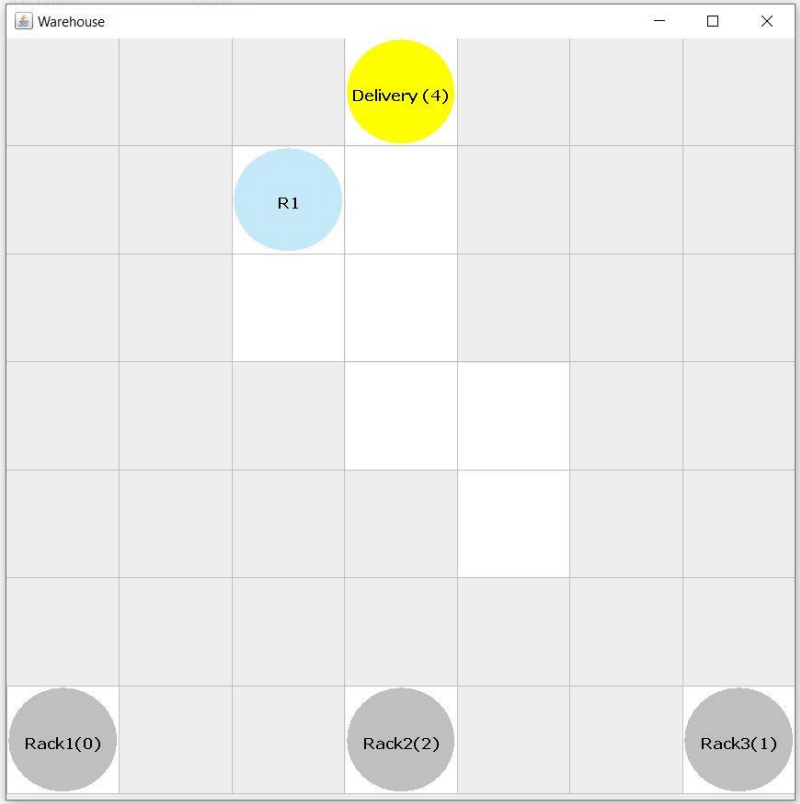

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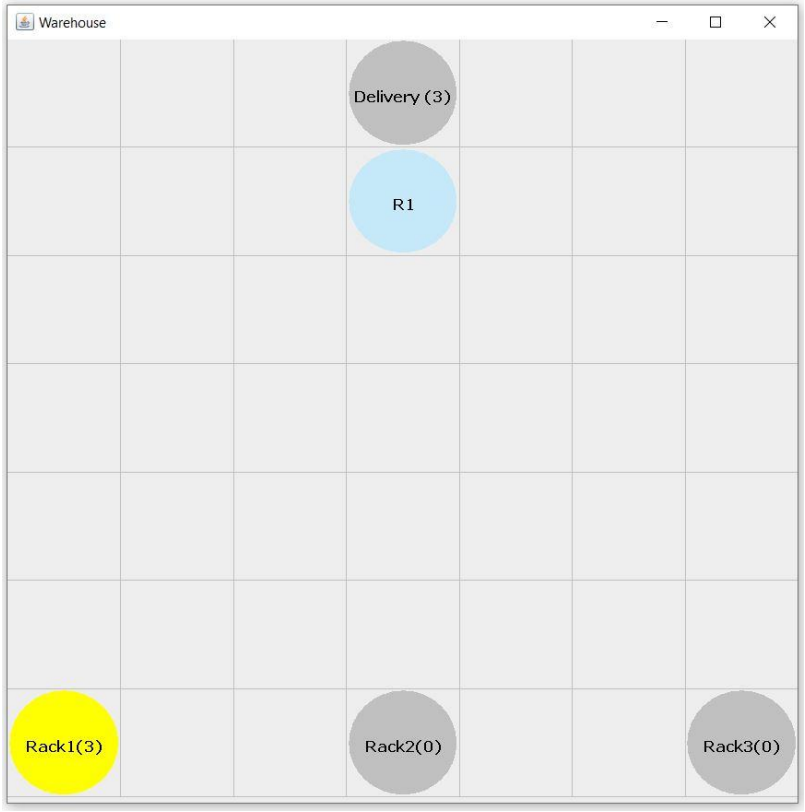

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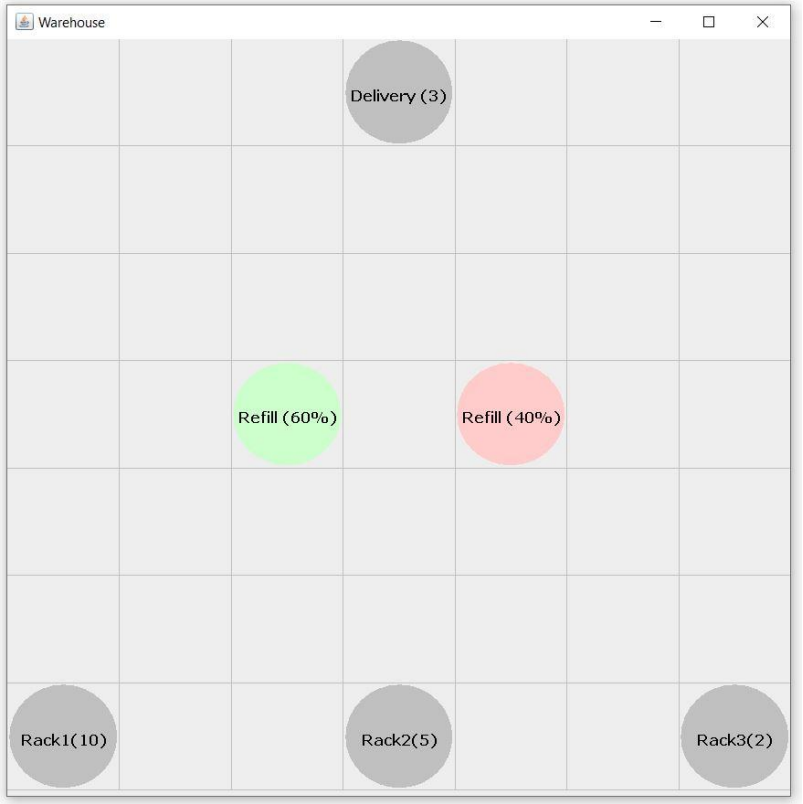

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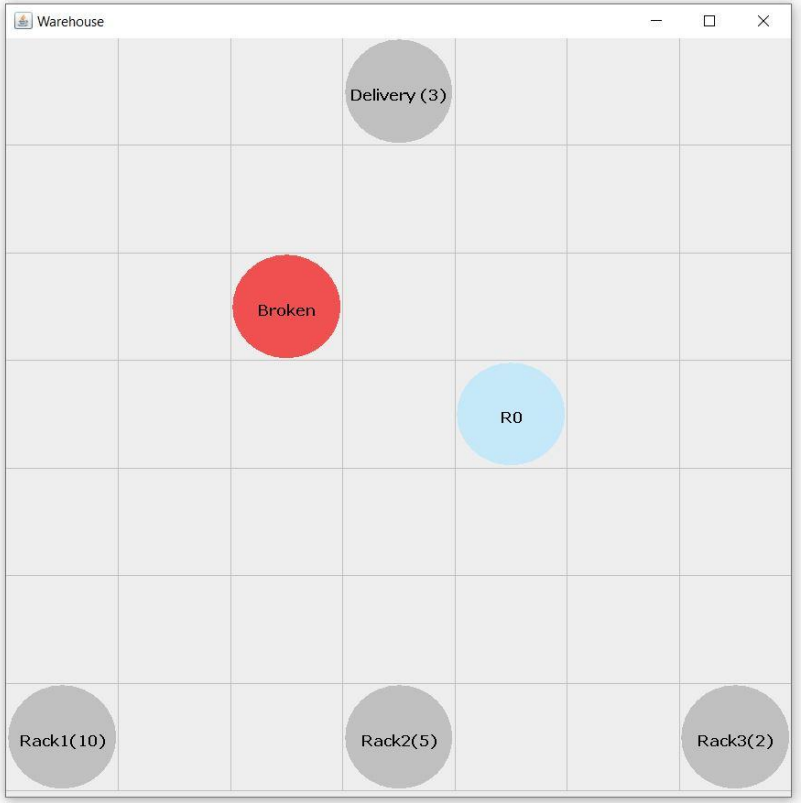

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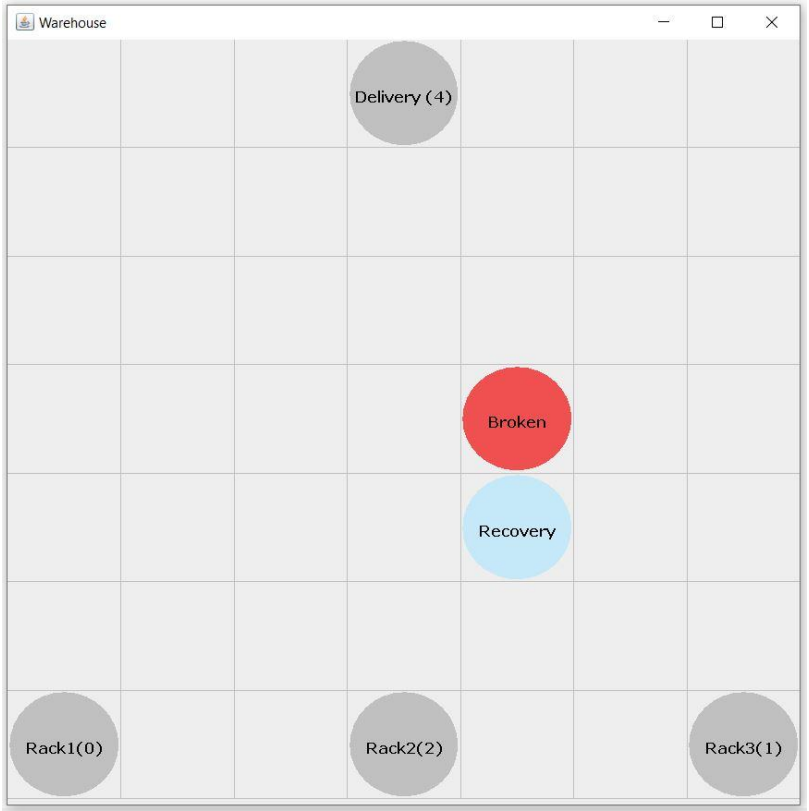

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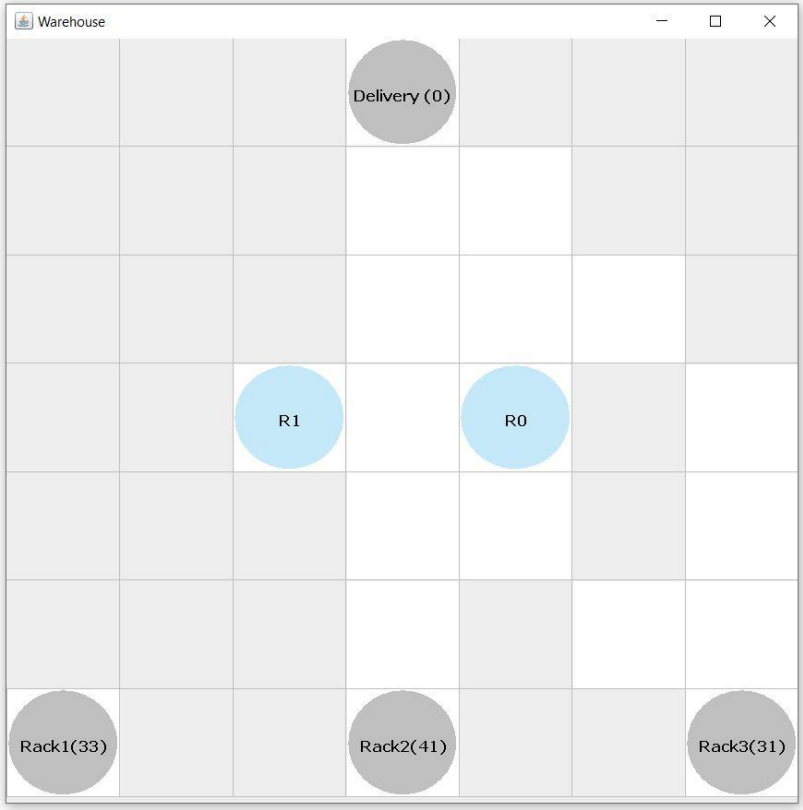

Main results, reflections and conclusions

- Main results:
  Analysis on the achievement of objectives
- Reflections
  - Difficulty detecting and correcting some problems
  - Some things could have been done better
- Conclusions
  - New skills were learned
  - Some features simple but effective
  - Learning took time and dedication

Thank you!