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# Autonomous Software Agents project

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# 1 Agent

In the field of *Computer Science* an *agent* is an individual situated in some environment, and capable of flexible autonomous action in that environment in order to meet its design objectives. With respect to a more traditional algorithm, there is no need of defining every edge case, a well defined agent should have a reasoning component capable of taking decisions even in unknown situations. The flexibility of an agent can be quantified across two main scales:

- reactive: delay required to respond to a change in the environment;
- proactive: ability of taking action in advance for the maximization of future goals.

Based on the environment and the agent itself there are different communication models but generally the agent perceives observations from the environment using sensors and performs actions against the environment employing actuators.

Another fundamental characteristic of an agent is its autonomy, the internal “brain” should handle the decision process with or without collected information, it should also evolve with respect to possible requirement changes.

Finally an agent can be designed to solve tasks or goals. When we talk about tasks we mean small objectives that must be completed to achieve the final bigger goal. On the other hand we have a goal agent, it takes the goal and it has to define autonomously a list of tasks to fulfill the assigned goal.

## 1.1 Multi-agent system

A multi-agent system, as suggested by the name, is a group of agents placed in same environment. There are two main type of interactions: cooperative and competitive. During this project we will focus on both of them in several stages of the development.

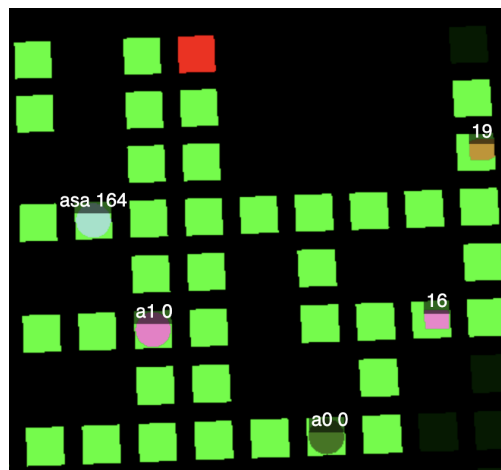
A competitive system is composed of many agents acting against each other, the goal can be divided into sub-goals, maximizing the personal reward and minimize the opponents' ones.

A cooperative system is composed of many agents acting to maximize the shared reward, each agent must be capable of cooperate, coordinate and negotiate as much as possible.

## 2 Deliveroo

*Deliveroo* is the environment provided to test the developed agents of the project, it is composed of a grid of tiles divided into two main categories: walkable (green and red) and not walkable (black). A walkable tile can be a delivery zone (red).

Several parcels, represented by cubes, are scattered around the map, the goal of the agent is to move across it collecting the largest number of parcels. The final objective is to deliver collected elements in one delivery zone.



**Figure 1:** An example of grid map with different parcels and agents.

The agent has can move up, down, left, and right. It can pass through parcels and delivery zones but it is blocked by other agents that can be play the game at the same time.

Multiple parcels can be carried by one agent, and the value of them continues to decrease

The agent can sense other agents and parcels, respectively within two well defined radiuses.

There are several parameters associated to the environment:

- *parcel tick*: frequency of parcels' values decrease;
- *movement speed*: time required for an agent's move;
- *parcel value and density*: maximum number of parcels allowed in the map and associated starting value amplitude.
- qui in generale aggiungerei principalmente quelli che poi sono piu' interessanti per la nostra spiegazione nelle pagine dopo.

Given all the customizable parameters and the size of the map, the number of different game scenarios are huge. An agent must be well developed in order to be able to act in all of them, both alone or cooperating with other agents.

There are two main strategies that can be employed for the solution of the game:

- *single-agent*: the agent acts alone;

- *multi-agent*: the agent communicates with other mates to share information for the maximization of the summation of all the rewards;

### 3 Problem Analysis

Qui spiegherei le varie macroaree su cui abbiamo operato (senza spiegare le soluzioni adottate):

- decay stimato
- probabilistic model
- parcel value discounted
- replan
- cache

### 4 Solutions

Qui spieghiamo le varie soluzioni presentate

## **5 Benchmarking**

## **6 Conclusion**



## 7 References