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ABSTRACT

In this page we are going to describe the main concepts of our multi-agent system project proposal, that is going to be developed as part of the *Autonomous Agents and Multi-Agent Systems* course.

Categories and Subject Descriptors

We will be using Python to develop this system. Libraries and other sorts of development tools can not be disclaimed so far, as this type of decisions will only be taken once the development process begins.

Notwithstanding, we might use NumPy library as it provides multi-dimensional array processing and high-level mathematical functions. Likewise, Skitik-learn can be useful to process data and to apply supervised and unsupervised learning algorithms. Lastly, we might want to apply Matpoltlib, so it can plot our experimental analysis and infer outcomes from empirical results.

In order to represent the agents we will use an object-oriented programming paradigm as objects, wherein internal state will be represented by attributes, and sensors and actuators by methods.

General Terms

Algorithms, Measurement, Performance, Reliability, Experimentation, Human Factors, Verification.

Keywords

Reasoning, Communication, Coordination, Search, Planning, Interaction, Agent-Oriented Programming, Resources, Decision Making.

1. INTRODUCTION

Multi-agent systems have an enormous range of applications, from optimization to learning problems. Our project is going to focus on optimizing the dealing with emergency requests.

2. PROBLEM

2.1 Definition

Emergency requests are a complex problem, dealing with a network of different variables that interconnect with one another, merging towards the same goal: to answer to emergency situations in the best possible way.

2.2 Relevance

We believe the complexity of the problem as well as for the quotidian situation we are living in - with the Covid-19 pandemic - to impart on the relevance of the project. In addition, the multi-agent system can serve as the application of the contents lectured in this course.

2.3 Requirements

The emergency responses have a set of requirements to fulfill:

- ❖ The type of emergency request has a specific time period for the transportation to respond to it, in accordance with the gravity of the situation.
- ❖ The emergency transportation is electric and needs to have enough energy supplies to respond to the emergency situations.
- ❖ The emergency requests need to be responded by the quickest to arrive emergency responders.

3. PROPOSAL

Our project is going to focus on the implementation of a multi-agent system responsible to respond to emergency situations. These (multi)agents are to effectively distribute ambulances and resources to efficiently respond in accordance with the type, gravity, amount of energy fuel (of the ambulances) and spatiotemporal distribution of emergency requests.

4. PROPERTIES

In order to realize the solution of this problem we are going to define both environmental and agent properties that define how the problem is modeled.

4.1 Environment

4.1.1 Representation

A matrix with **XxY** size given as input parameters once the system starts. Each agent has a (x,y) coordinate pair. Each movimentation within the environment has a cost, discounted in the ambulance's energy fuel.

A representation of an environment is presented in **Figure 1**.

4.1.2 Properties

- **accessible**: the agents can obtain complete perceptions of the environment's state.
- **deterministic**: all actions have guaranteed effects.
- **dynamis**: the environment is constantly being updated with the appearance of new patients.
- **discrete**: the actions and perceptions are of a finite universe and depend solely on the agents.
- **non-episodic**: each emergency request and action happens in a specific time step and depends on the previously chosen decisions.

- There is a **penalty** for each time step the patient isn't at the Hospital once the emergency request is made, accounted for by the internal state of the Hospital.

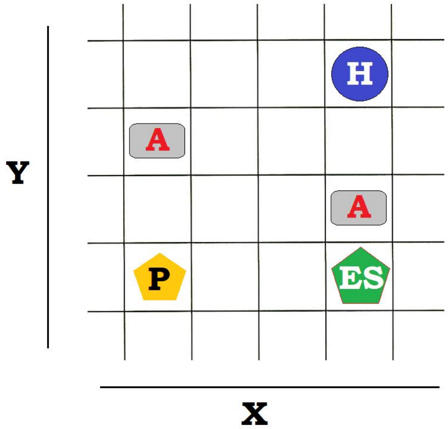

Figure 1: An environment with **XxY** dimensions, with an Hospital agent (**H**), two Ambulance agents (**A**), a Patient (**P**) and an Energy Station agent (**ES**).

4.2 Agents

We model each Agent by defining the architectural properties and the agent's sensors, actuators and internal state. It is important to understand that the nature of the interactions between the agents are of a collaborative nature - they are all contributing towards the same goal (responding to emergency situations).

4.2.1 Ambulances.

4.2.1.1 Architecture

- Mainly Reactive: Ambulances answer to the centralized requests made by the Hospital agent
- Deliberative
- Belief-desire-intention model
- Autonomy and Adaptivity
- Rationality
- Sociability
- Collaboration
- Mobility
- Maintains a State

4.2.1.2 Sensors

- Is available or not (has patient)
- Arrived at destination
- Level energy
- Positioning and direction

4.2.1.3 Actuators

- Delivering patient to Hospital
- Pick up patient
- Respond to emergency (go to next patient)
- Go to energy station
- Charge
- Stop charging

4.2.1.4 Internal State

- Records information about environment state and history
- Tradeoff between available energy and distance travelled
- Routes

4.2.2 Hospital

4.2.2.1 Architecture

- Hybrid (the patients are directly manipulated through system inputs and their emergency requests automatically delivered to the Hospital)
- Autonomy
- Veracity

4.2.2.2 Sensors

- Available ambulances
- Number of patients
- Processing state of each patient

4.2.2.3 Actuators

- Put emergency request in queue
- Solve patient's condition

4.2.2.4 Internal State

- Institutional credits (discounted each time step the patient hasn't arrived to the Hospital and earned each time a patient is well handled)
- Available ambulances

4.2.3 Electric Stations

4.2.3.1 Architecture

- Reactive
- Autonomy
- Veracity

4.2.3.2 Sensors

- Is available or not (already has ambulance charging there)

4.2.3.3 Actuators

- Charge ambulance

4.2.3.4 Internal State

- Has ambulance (is available or not)

4.2.4 Patients

This agent is most probably going to be designed as an external entity whose behavior is sporadic and not relevant to assess as a rational agent. Nevertheless, it needs to have the following characteristics to interact in the environment: a type of emergency situation (from high to low priority), a location to make the emergency request from, and condition progress.

5. REFERENCES

[1] Wooldridge, Michael. 2007. *An Introduction to MultiAgent Systems* (2nd ed.). Chichester, West Sussex.