TÉCNICO LISBOA

AUTONOMOUS AGENTS AND MULTIAGENT SYSTEMS

2ND SEMESTER - 2017/2018

PROJECT

Development of an intelligent system in one of the lines: a) autonomous agents or b) autonomous multi-agent systems.

1. THE AGENTS

1.1 AUTONOMOUS AGENTS (AA)

This type of project considers one agent that fulfills a goal, it can consider interaction with a user or not. It cannot be a project similar to the AI course, it needs to include uncertainty or more complicated models. The project needs to include several of the following properties (going beyond what is done in the AI course):

- The variety of sensors and actuators *should not be too limited*;
- Uncertainty and noise in the system;
- Rich interactions.

1.2 MULTI-AGENT SYSTEMS (MAS)

This type of project has to model and simulate a *multiagent system* (MAS), *i.e.*, more than one agent. The agents can be cooperative or not. The projects needs to include several of the following properties:

- The variety of sensors and actuators *should not be too limited*;
- Agents should have either *conflicting goals* or *coordination problems*;
- Agents must, at some moments, be faced with having to choose one goal at the expense of another, *i.e.*, have *non-linear decisions*;
- The agent's decisions must not be straightforward and goals should not have a fixed order of priority.

Note: a RTS game is not acceptable if each player/agent controls all the units of its own team. Each unit/squad must be an agent. Otherwise it is an AI project.

2. OBJECTIVES

The standard objectives for all projects imply the implementation of the following components:

1. **Modeling the (multi) agent system:** sensors, actuators, the environment, the dynamics of the environment;

2. **A decision making algorithm**: depending on the system it can be a simple reactive decision making yet, in this case, should make use of advanced learning principles (e.g. reinforcement learning)
3. **An architecture for decision making and execution**: reactive, deliberative, hybrid…
4. **AA**: decision under uncertainty, complex decision making
5. **MAS:** communication and cooperation (or coordination, negotiation, team formation, etc.);
6. **Comparative analysis**, including a thorough analysis of the (overall) behavior of the agents for each of the implemented approaches (detailed experiments, tables, graphs, conclusions, etc.). Here it is necessary to discuss the suitability of the different approaches in accordance with gathered results.

3. Evaluation Criteria

The project will be evaluated according to the following criteria:

- The description of the problem that is being addressed (especially in the case of proposed projects), the agents' objectives, etc.;
- The conceptual correction of the simulation environment;
- The conceptual correction of the agent architectures, including the definition of all sensors, actuators, internal state, etc.;
- The approach used to address the problem;
- The intelligent, emergent resulting behavior;
- The suitability and correctness of any embedded mechanisms of emotions, team-work, learning, etc.;
- The relevance of conclusions inferred from the undertaken experimental analyzes.

4. Final Delivery

The final delivery of the project must include the following elements:

1. The **source code** (*e.g.*, the NetLogo file) of the implementation of the environments, agents, several architectures and algorithms, etc.;
2. The **final report** with a 4 page limit according to the provided template of the conference AAMAS http://www.aamas2017.org/submission-instructions_aamas2017.php
3. A 3min **video** demonstrating the agents or algorithms "*in action*", e.g.:
   a. The emergence of some social phenomenon in a population;
   b. The effect of learning new behavior (e.g., before and after learning);
   c. The contagion of emotions in the population;
   d. The "team-behavior" exhibited by some group of agents;
   e. A comparison of the agents' behavior between the several approaches.

Note: The deadline for the delivery of all required material will be announced in the course webpage.

5. Evaluation

Projects are to be made in groups of 2.

Project proposals need to be defined and discussed on the week 9 – 13 April.

Deadline June 1st for the project report and accompanying video.

The mark is individual and not by group if equal effort was not made. Students must provide and explanation of the effort and contribution of each member.

Individual discussions will be made if needed (Week of June 4th).

The evaluation of the project will consider:

15%	Introduction to the topic
20%	Formalization and Modelling
15%	Algorithmic Description
30%	Implementation and comparative analysis
20%	3Min Video Presentation

The video presentation is to replace a live presentation of the project by the group. This video must introduce the problem, the implementation and the main results. It does not need to be complex you can do a screen capture of your agent and introduce some subtitles with the introduction, details of the implementation and conclusions.

6. Project Examples (to be updated)

Below we show a few examples of possible projects. We encourage students to propose new projects.

Students are free to use whatever technology, programming language and environment they prefer.

6.1 Autonomous Agents

6.1.1 Collaborative Game with a Person

This project considers the development of an agent that is able to play a collaborative game with a person. Examples include Geometry Friends (http://gaips.inesc-id.pt/geometryfriends/), Fireboy and Watergirl (http://www.fireboynwatergirl.com/), Sueca (http://gaips.inesc-id.pt/parceiro/).

In this project the agent needs to be proactive and adapt to the user. An agent that just reacts is not enough, an agent needs to adapt to the game style of the user, suggest ways to play, and help when needed.

The groups can create a new game if preferred (the visuals and the game engine is not part of this course and will not be evaluated), or use one existing game.

6.1.2 Logic-Geometric Programming

Logic-Geometric Programming, where joint motions of multiple agents are optimized to solve cooperative sequential manipulation tasks which require planning both at the symbolic and motion level.
https://ipvs.informatik.uni-stuttgart.de/mlr/papers/15-toussaint-IJCAI.pdf
https://ipvs.informatik.uni-stuttgart.de/mlr/marc/source-code/16-LGP.tgz

6.1.3 Propose yours
Discuss during the practical sessions your proposal. Deadline 13 April

6.2 Multi-Agent Systems

6.2.1 Logistics
This project considers the transportation of people or goods. We can consider *N* companies that received requests to transport different products from a location to another. Each truck has a limited capacity. We want to study how to improve the overall efficiency of such transport. We want to evaluate the coordination, formation of coalition, monopolies that can arise, and the side-payment schemes that can emerge.

Here, students should pursue some of the following possibilities:

- model a circulation network with enough complexity, as well as the different supplies, clients, orders and fulfilment of orders;
- study different forms of control architectures for each supplier and its impacts, e.g. reactive vs non-reactive;
- study the impact the possibility of forming coalition, side-payments and other in the network;
- study other parameters such as the number of companies and clients, the balance between the size of each company, the transport prices, and others.;
- study also different cost/payment system;
- measure and compare under the different conditions: the number of accidents, traffic jams, average and maximum times.

6.2.2 UAV-based surveillance system for fire prevention
This project considers the collaborative planning of routes for forest surveillance in accordance with risk of fire occurrence. The environment can be model as a heat map with probabilities of fire risk changing along time. A set of drones (UAVs) should be able to autonomously establish efforts to cover areas with higher risk of fire in accordance with a specific utility function.

The project can be further extended to comprise coordinated behavior in the presence of additional constraints, including: 1) kinematic constraints on the speed and rotation of UAVs; 2) number and time-availability constraints of UAVs; 3) UAV autonomy constraints; 4) irregularities on the terrain surface; and 4) visibility constraints.

A project template for the development of such an multi-agent system in Java can be found in the Materials tab of the course's webpage.

6.2.3 Propose yours
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