TÉCNICO LISBOA

AUTONOMOUS AGENTS AND MULTIAGENT SYSTEMS

2ND SEMESTER - 2016/2017

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PROJECT

1. THE AGENTS

The project will consider the development of and intelligent system in one of the lines a) Autonomous Agents or b) Autonomous MultiAgent Systems.

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 projects needs to include several of the following (to go 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:

- 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: an RTS game is not acceptable if each player / agent controls all the units of its own team, *i.e.*, each unit / squad must be an agent! Otherwise it is a AI projet.

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 (examples using advanced methods from ADI or methods such MCTS)
3. **An architecture for decision making and execution** : rective, hybrid, deliverative, …
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.).

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.

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** according to the provided template of the conference AAMAS http://www.aamas2017.org/submission-instructions_aamas2017.php

3. A **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 of some 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 or 3.

Project proposals need to be defined and discussed on the week 3 – 7 April.

Deadline 19 May for the project report.

The mark is individual and not by group if equal effort was not made.

Individual discussions will be made if needed (Week of 29 May).

The evaluation of the project will consider:

15%	Introduction to the topic
20%	Formalization and Modelling
15%	Algorithmic Description
30%	Implementation
20%	2Min Video Presentation

6. Project Examples (to be updated)

Below we show several examples of possible projects. Students can also propose some new projects (deadline week 3 – 7 April).

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 Efficient Real-World AI

In this project we would consider the development of an AI for a computer game. We could base the work on Monte-Carlo Tree Search, or Deep Q-Learning for instance. The environment needs to be stochastic and/or partial observable.

6.1.3 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

6.1.4 Propose yours

6.2 Multi-Agent Systems

6.2.1 Traffic with Autonomous Vehicles

This project considers what will happen to the traffic in towns when a majority of vehicles become autonomous. Here we are not interest in the robotic problem of how to control the vehicles we want to understand how to improve traffic when a majority of cars are autonomous. See for instance https://www.youtube.com/watch?v=iHzzSao6ypE&t=148s or http://www.am-lisboa.pt/101000/1/004072,012016/index.htm

We consider several steps:

- model a complex enough circulation network including vehicles, traffic lights, autonomous cars and non-autonomous cars.
- research and implement the human factors that affect driving, e.g. reaction time, limitation on the communication
- study different forms of control architectures and its impact, e.g. local vs global
- study the impact of automatic coordination between vehicles
- study the impact of the percentage of autonomous cars in the circulation
- study other parameters such as the existence or not of traffic lights, the size and interconnection of the network, among others
- include prioritary vehicles and see if they can go fast
- study also different cost/payment system
- measure and compare under the different conditions : the number of accidents, traffic jams, average and maximum times, …

You can use as initial model the Traffic Grid Netlogo example and extend it to include human factors such as the reaction time shown in the video and try to see if it possible to remove the traffic lights.

6.2.2 Logistics

This project consider the transport 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, the side-payment schemes that can emerge.

We consider several steps:

- model a complex enough circulation network, 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, …

6.2.3 Participate in Microsoft challenge: Build a collaborative AI in Minecraft (RECOMMENDED)

https://www.microsoft.com/en-us/research/academic-program/collaborative-ai-challenge/

6.2.4 Language Games and the Evolution of Language

Reimplement some papers on these topics, e.g.

http://www.nature.com/nature/journal/v417/n6889/abs/nature00771.html

http://ieeexplore.ieee.org/abstract/document/956077/

6.2.5 Werewolf

In the game of werewolf you can start by modelling how each character should perform different actions. From the observed actions you should be able to infer a belief over the identities of the different characters. Actions can be accuse, deny, silence, … The agent should also plan the actions to make.

6.2.6 Propose yours