

Autonomous Agents and Multiagent Systems

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LEARNING AGENTS IN WOLF PACK

Group 01 - Alameda

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# Abstract

In the areas of multi agent system we try to solve several problems from the beginning without using previous knowledge. But with the complexity rising exponentially this is becomes impossible and we can’t solve real world problems, only small and simple.

One of this problems is the Pursuit Problem, this one was introduce by Benda et al. [1] and it has been study due to is simplicity to understand and difficulty to solve with a high number of success.

In this project it was applied several solutions to test different implementations to get better results. It was started we the most simplistic architecture, **Reactive**, this one only relies in is sensors and actuators and has no memory. After that we implemented the **Deliberative** approach, in this case it the agent had memory and communicate with each other and in each step create a plan to achieve theirs goals. By last we implemented the **Learning** and this one consisted in use several test cases until all agents learning the best method. This one uses the **Q-learning** algorithm to save which are the best choices and uses also the **e-greedy** to select is action.

This last approach was used to solve this problem in the comparative study [2].

\*\*\* TODO last steps TODO \*\*\*\*\* (3) Results, *i.e.*, what is the proposed solution to the problem and the main results of the comparative study; (4) Conclusions, *i.e.*, what are the implications of the solution.

**Keywords:** Reactive, Deliberative, Learning, Q-Learning, e-greedy.

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# Introduction

This project appear due to the necessity of apply the general knowledge acquired in the classes of AASMA.

In the case of this project the environment and the way the agents interact with this change, existing several architectures that we already talked like reactive, deliberative and Learning. The main objective is to represent a scenery in netlogo to simulate the interactions between the behaviors of the agents with the different approaches.

The approach adopted for the realization of this objectives, is start by choosing what are the agents and what they represent, followed of the environment, the objectives of the agents and how they relate.

This report is divided in six sections, where we start by explaining the scenario to describe the environment, the actuators, sensors, actions and features of the agents. After that a section dedicated to the different architectures and several results to explain why and what are the results obtained. Before we take conclusions we compare our solution to the comparative solution described in the paper [2]. In the end we explain our results in general and future modifications that could had been implemented.

# The Scenario

The agents we conceive consist in four agents with the role hunters, that will chase and capture a other agent designed as prey. The environment chosen is a field represented by a matrix which is a toroidal environment.

In this case our hunters will be represented by four wolves and their objective is to surround the prey which is the sheep, who is alone in this world. Which wolf will have a field of vision to try seek the sheep and it is limited by the expression 2d +1 < n. Besides this limitation each agent only can move in four or eight directions and only one step at the time.

The proprieties of the environment, are inaccessible, this is happens because there is not any agent who can get the full state of the environment, non-deterministic, since each action might have more than one effect, dynamic, because every agent moves at the same instant of time, discrete due to exist a finite number of possible actions and percepts, and for none episodic, the agent can take decisions which will affect the decisions the other agents will take and change the outcome.

# Agent Architectures / Algorithms

In this section you should describe the several architectures and algorithms according to what is required in the project’s description, *e.g.*, reactive, deliberative / BDI, hybrid, etc. The text should present a conceptual description mentioning aspects of implementation only if necessary for the understanding of the concepts. Some of the aspects to describe in each subsection are:

## Reactive Architecture

* The *<perception> \* → <actuator>* rules developed for each type of agent;
* The description of the arbitration mechanism of rules, *i.e.*, how they are ordered;
* The justification for any internal state variable that was used.

## Deliberative / BDI Architecture

* The beliefs of each type of agent;
* The desires of each type of agent;
* The intentions of each type of agent;
* How do beliefs originate desires and, lastly, the intentions;
* The kind of plans the agents create and follow in order to implement the intentions;
* Description of possible changes to the original BDI algorithm, justifying them.

## Hybrid Architecture

* Description of the hybrid architecture, if implemented;
* How the mediation between the deliberative layer and the reaction was made.

## Coordination, Cooperation, Negotiation

In this section it should be described all coordination and/or cooperation algorithms and communication protocols used to create cooperative agents, if implemented in the project.

**Note:** This section is especially important for the project “*Warehouse Delivery”*. In this project, it should also be explained the algorithms for coalition formation (one subsection each) that were implemented.

## Emotions Component

In this section it should be described the emotions component that was incorporated into the architecture, if any. You should provide a conceptual description that focuses on the modeled emotional mechanisms, how they were used to influence behavior and how they were integrated into the architecture.

**Note:** This section is especially important for the project “*Extreme Scuba”*. In this project, it should also be explained the emotional contagion mechanisms implemented, if any.

## Learning Component

If learning techniques were used in the project, detail the aspects on which learning was incorporated, what learning algorithms were used and how they were implemented in the specific case of the project.

**Note:** This section is especially important for the project “*Wolf Pack”*.

# Comparative Study

In this section you should present the comparative study made between the several approaches explored in the creation of agents. In particular, the study should be able to provide conclusions about which of the approaches explored contributed more to the "success" of the agents.

Some of the aspects to describe this section are:

* The approaches that will be compared in the tests;
* The metrics used to determine the "success" of each agent / team;
* The tests that were designed;
* The results obtained in each studied condition (charts, tables, etc.);
* A statistical analysis of the results;
* Conclusions (limitations / advantages of each approach, etc.).

**Notes:**

* Any conclusions must be substantiated by the results of the experiments;
* This section applies to all projects, *i.e.*, even if the requested comparative study does not refer to the several architectures used, the general indications described above remain valid, only the object of the comparative study changes.

# Conclusions

This section should summarize the proposed solution to the problem presented in the Introduction. In particular, you should present an interpretation of the results described in the Comparative Study section.

**Note:** It is also expected in this section to describe how the work presented could be extended in order to motivate future work.

# References

This section should list all the references considered relevant to the understanding of the work presented. Here are some examples of reference formatting for several types of publication:

**For a book:**

1. D. Patterson and J. Hennessy, *Computer Organization and Design: The Hardware/Software Interface*, San Francisco, CA, USA: Morgan Kaufmann Publishers, 1997.

**For a journal article:**

1. B. Kernighan and S. Lin., An Efficient Heuristic Procedure for Partitioning Graphs. *The Bell System Technical Journal*, Vol. 49, No. 2, pp. 291-307, February 1970.

**For a paper included in the proceedings of a conference:**

1. F. Fallah, S. Devadas, and K. Keutzer. OCCOM: Efficient Computation of Observability-Based Code Coverage Metrics for Functional Simulation. In *Proceedings of the Design Automation Conference*, pp. 152–157, June 1998.

**For a dissertation:**

1. D. Cheng. *Power Estimation of Digital CMOS Circuits and the Application to Logic Synthesis for Low Power*. PhD thesis, University of California at Santa Barbara, December 1995.

**For a technical report:**

1. E. Sentovich. *SIS: A System for Sequential Circuit Synthesis.* University of California, Berkeley, April 1992.

**For a webpage:**

1. *Instituto Superior Técnico, Official webpage*. Retrieved from: <http://tecnico.ulisboa.pt/>. Last accessed April 2016.