

Université libre de Bruxelles

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**ANALYZING MARL ALGORITHMS IN  
DYNAMIC ENVIRONMENTS:  
EVALUATING PERFORMANCE WITH AN  
ADDITIONAL UNKNOWN ELEMENT**

Preparatory work for the master thesis -- MEMO-F-403

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## **ABSTRACT**

#todo{Abstract}

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# **I Introduction**

## **I.1 Background and Objectives**

A Multi-Agent Reinforcement Learning (MARL) is a subfield of the Reinforcement Learning domain which focuses on the interaction between multiple agents in a shared environment. Through the recent years, an increasingly amount of research has been conducted in this field to resolve issue that has arisen in the real world. However, most of the research are done through simulations on environments which does not involve unknown elements in existing environment. This thesis aims to evaluate the learning performance of MARL algorithms from a known environment to a slightly modified one by adding an unknown elements. Under the supervision of Prof. Tom Lenaerts, and advisor Yannick Molinghen, from the Machine Learning Group (MLG) of the Université Libre de Bruxelles (ULB).

Currently, the research is focused on the the environment of LLE (Laser Learning Reinforcement) which is a environment created by Yannick Molinghen based on the original game . The environment is a 2D world also known as grid world where a single or multiple agents will be interacting. The goal of the agent is to reach an exit point while acquiring rewards (under the form of Gems) and avoiding obstacles.

The objective of the Master thesis is to develop a new feature in the LLE environment that was also includes in the original Game moreover this feature has also a other objective which is to add a new element in the environment which are not included in the agents learning process.

## **I.2 Notations and Definitions**

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## II State of the Art

### II.1 Distributed artificial intelligence

!!(this section has content from the article “Cooperative Multi-Agent Learning The State of the Art” by [ref to article])!!

Distributed artificial intelligence (DAI) is the a field of study which is rising in the last two decades. which is mainly focused on the domain of distributed systems. A distributed system by the definition of [ref to book] is a (quote)“where a number of entities work together to cooperatively solve problems”(endquote). this kind of study is not new, it has been studied for a long time. But what is new is the rise of the internet and the multiple electronic devices that we have today. Which bring the need of a new field of study which is the DAI that simply is the study of the interaction between multiple artificial intelligence (AI) or agents in a distributed system.

#### II.1.1 Multi-Agent Systems vs. Distributed problems Solving

In the field of DAI, we can find two main subfields a more traditional one which is the Distributed Problem Solving (DPS) which us the paradigm of a divide and conquer. The DPS is a field which is focused on distributing the problem to independent slaves which are solving the problem independently. On the other hand, the Multi-Agent Systems (MAS) emphasizes on the interaction between the agents.

#### II.1.2 Multi-Agent Systems

In MAS there are few constraints that are imposed on the agents. such as even though the agents are working together to solve a problem in a same environment they are not able to share their knowledge of the envirement with each other they may only acces to the information that they have, in RL we often refer this as a local obsevation. This is a important point because if they were able to share their knowledge this would be able to simply synchronize their knowledge and solve this problem as a DPS problem if the problem need no interaction between the agents (todo may be more ).

### II.2 Multi-Agent Learning

The Multi-Agent Learning (MAL)

### II.3 Multi-Agent Reinforcement Learning