

**Honours Project - MHW225671**

**INTERIM REPORT**

**2023-2024**

**Department of Computing**

**Submitted for the Degree of: BSc Computer Games (Software Development)**

**Project Title: Development of an AI agent using Reinforcement Learning to play Rocket League with a focus on team behaviours.**

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**Second Marker:**

**Word Count:**(***excluding contents pages, figures, tables, references and Appendices***)

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**Signed by Student: Ektor Zoidis                     Date: 20/11/2023**

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# Introduction

This section will outline the project along with its scope and objectives. It will describe what Reinforcement Learning (RL) is, how it is being used and explain how it can be applied in this project with the goal of creating an effective AI agent at learning to play Rocket League with a focus on team behaviours. It will also delve into a brief history of previous projects that used RL and present the achievements this technology has been able to achieve. Additionally, it will explain the general gameplay and concept of Rocket League and how the game works.

## Background

Reinforcement Learning (RL) is one of the three fundamental pillars of machine learning which centres on the improvement of performance through reinforcement. This is the iterative process of actions and rewards obtained from an environment to reach a set of goals (Barto, 1997). The basic idea is that with each action taken by the agent its state changes and a reward is given to it for that given action, positive or negative, it is with this method that we are able to communicate what is right and wrong and train it to choose the most effective action for a given state (Kaelbling, Littman, & Moore, 1996).

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Figure 1 - The relation between the agent and its environment (Kaelbling, Littman, & Moore, 1996)

Figure 1 (Kaelbling, Littman, & Moore, 1996) shows an intuitive example of how the agent and the environment communicate with one another. The agent’s goal is to maximise the total amount of positive reward it receives and with a well-defined reward system we can lead the agent into completing the objectives we want it to.

Previously RL has been used to master many board games such as TD-Gammon (Tesauro, 1994), Go (Silver, et al., 2018), Shogi (Silver, et al., 2018) and Chess (Silver, et al., 2018), as well as many older Atari games (Kaiser, et al., 2013). In more recent years, however, RL has been used for more complicated games where it managed to defeated the world champions in Dota 2 (OpenAI, et al., 2019), achieve grandmaster levels in StarCraft 2 (Vinyals, et al., 2019) and play Minecraft (Guss, et al., 2021). All these games present unique challenges with lengthy game durations, complex rules and large number of actions and states which proves how effective RL is at solving challenging and complicated problems.

Rocket League is a fast-paced, physics, online multiplayer, vehicular soccer video game made by Psyonix in 2015. It uses rocket-powered cars to play soccer and score goals and features unique mechanics that require high precision and fast reflexes like aerial manoeuvres, wall and ceiling plays, realistic ball physics and many more that add a layer of complexity and dynamism to the gameplay making it unpredictable. These complexities make it a challenging and distinctive title for AI to excel in, yet there have been attempts already made to achieve superhuman performance. The most notable ones are the agents Necto and its newer and improved version Nexto which are considered the best Rocket League bots, being able to win against top ranked players and in bot championships. Part of why these bots are so successful is due to their reward shaping functions, well-defined action spaces and the vast number of network parameters (Moschopoulos, Kyriakidis, & Lazaridis, 2023). There are more recent attempts that have been made, however, and one of them was able to outperform and surpass Nexto: Lucy-SKG (Moschopoulos, Kyriakidis, & Lazaridis, 2023) proving yet again how effective RL can be for training any agent.

While an API with a number of different bots exists and there has been a lot of engagement from the community to create the best possible bot for Rocket League the existing bots do not show sophisticated team behaviour, particularly intentional passing behaviour which is one of the most basic forms of teamwork in any ball game (Verhoeven & Preuss, 2020). This creates a notable gap for research and arises the question of how this can be achieved.

## Project Overview

The purpose of this section is to identify the project outline and present the research question, as well as the hypothesis this project will attempt to answer. It will also list all the objectives that are aimed to be achieved in this project.

### Project Outline

Due to the lack of studies on achieving bots that perform team behaviour in Rocket League, this project aims to investigate the development of an AI agent that will learn to collaborate and perform team interactions. Therefore, the research question for this project is:

**How effectively can an AI agent trained through Reinforcement Learning perform team behaviours and interactions in Rocket League.**

### Project Objectives

The primary aim of the project is to develop an AI that will be able to perform team behaviours and interactions effectively using Reinforcement Learning in Rocket League. In order to develop the AI agent a list of Literature and Primary Objectives have been defined and listed below.

#### Literature Objectives

* Investigate into Reinforcement Learning algorithms

Look into existing algorithms/methods used in Reinforcement Learning and investigate which ones would be most beneficial for this project. As RL is a complicated subject this will be performed by defining a basis algorithm and then adding potential improvements to it to improve its overall performance.

* Look into the tools that will be required to achieve this project

Identifying which tools have been previously used for related projects and learning how to use them effectively is vital for the success of this project.

* Examine how Rocket League works as a game

As Rocket League is a complicated game understanding the elements that make it and breaking them down is a crucial part that must be performed to develop the AI and create a well structure reward system.

* Define what teamwork is in Rocket League

As this project focuses on teamwork and team behaviours recognising which parts make up teamwork in Rocket League and the strategies used is an important goal for the literature.

#### Primary Objectives

* Prototype the AI

As a starting point the AI must first learn to play the game in general to then be able to focus on the goals of this project. A prototype will be made that will create the basic framework to begin working on.

* Develop the AI

As soon as the AI is able to perform the very basic functionalities of the game the full development will begin using the knowledge gained from the literature review to ensure that the agent is as effective it can be.

* Train the AI

Once the AI has been successfully developed time must be arranged for it to train. Training is a very important part of RL that takes time so having time after its development is essential.

* Carry out testing

When the AI has been developed and trained for some time testing will be conducted in a suitable method to gather results.

* Evaluate performance

When the results are out the evaluation will be undertaken to assess the AI’s effectiveness at performing team behaviours and interactions. The results will be analysed and a conclusion will be drawn.

### Hypothesis

To make sure that the AI can be tested and that a conclusion can be drawn Given this the proposed hypothesis of the project is:

# Contextual Review

# Methods

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