ALFIE EDWARDS

CM3203: ONE SEMESTER INDIVIDUAL PROJECT

SUPERVISED BY DR RICHARD BOOTH

Initial Plan

February 5, 2018

Contents

1   Project Title

Training Multiple Machine Learning Agents to Complete Cooperative Tasks Under Varying Conditions

2   Project Description

I plan to design systems of multiple machine learning agents with limited means of communication. In particular, I am interested in utilising neural networks. These systems will be trained using standard machine learning techniques to complete cooperative tasks framed as simple games. I hope to be able to analyse the ways in which the systems learn to communicate, and draw conclusions about how language can allow independent agents to optimise in cooperation.

3   Overall Goals

- I aim to gain knowledge and experience regarding neural networks, and machine learning in general.

- I aim to draw conclusions about how communication can allow independent agents to optimise as a single system.

- I aim to draw conclusions about how the means of communication influences the effectiveness of employing multiple agents to solve a problem.

- I plan to design and implement two different multi-player games which require cooperation and communication between players to achieve success.

- I plan to design and implement two systems of communicating machine learning agents which can be trained to succeed in those games.

- I plan to train those machine learning agents to play the games using varying parameters.

- I plan to collect data about how efficiently the machine learning agents can be trained given different parameters.

- I plan to collect data about how the machine learning agents utilise communication given different parameters.

4 Ethical Considerations

I do not believe that this project has any ethical issues that would require ethical approval. The project does not deal with people, or data relating to people.

5 Deliverables

I will submit the following items at the end of the project:

1. Final Report

2. All source code produced

3. Implementations of both games

4. Implementations of both machine learning systems

5. Datasets from both Experiments

6. All data visualisations produced

6 Work Plan

6.1 Practical Work

6.1.1 Research and Preparation

Before attempting any design or implementation work, I will need to do some research and other preparation. I will research similar projects that have been undertaken by others, and see if I can gain any insight from their methodology and results. I plan on using a software framework to implement my machine learning agents, as I do not want to focus on low-level implementation details. I plan on researching popular frameworks, and choose an appropriate option for my needs. I will also have to install any related software such as compilers and software libraries.

6.1.2 Design

Before starting the design, I plan to practice implementing a basic machine learning system using my chosen framework, so I can make sure I understand

the process and available functionality. Hopefully this will allow me to create a more informed design for my first experiment.

Firstly, the design will detail a two-player game in which the players must cooperate using some form of communication channel in order to succeed. I want to limit my first experiment to two players to minimise its complexity. I want this experiment to demonstrate a basic case of cooperating agents. Keeping this experiment simple should also help minimise technical complications, which I am expecting because of my lack of experience with machine learning.

The design will also describe the machine learning agents which will participate in the game. It must detail how they how they will be implemented and trained within my chosen framework, and how they will communicate.

Finally, the design needs to describe what parameters will be varied for the experiment, and what data will be collected for analysis. These details could depend on the nature of the game.

6.1.3   Implementation

After completing the design, I want to start by implementing the game, as this should be quite straightforward. The game should include a real-time graphical display, to allow me to visualise the system, and to enable the possibility of including screen-shots in my Final Report. Next, I will implement the machine learning agents, and ensure they can properly interface with the game. Finally, I will carry out the experiment by training the machine learning agents to play the game with varying parameters. During this I will collect the appropriate data, as specified in the design.

6.1.4   Second Experiment

In the second half of my project, I plan to complete a second experiment. I want to complete this experiment before the Easter recess, so that I have ample time to work on my Final Report, and will have to do programming work during the break. I will base the details of this second experiment on the results of the first. The planning and implementation phases should be similar to those of the first experiment.

I am intentionally leaving the details of this experiment vague, because I do not know what aspects of my results will be most interesting. I believe I am more

likely to reach interesting and inciteful conclusions if I design this experiment based on my findings, rather than pre-empting the nature of the system I am experimenting with.

6.2 Final Report

I plan to keep simple records of work I have completed to avoid forgetting important details.

After completing the first experiment, I plan to create the basic structure of my Final Report, and write up my progress so far. I want to do this before starting the second experiment because I will be able to write a more detailed account when I have just completed the work. This also allows me to split up the writing and implementation work somewhat, which will help prevent me getting fatigued with one particular type of work.

I am aiming to complete the second experiment by start of the Easter recess, to allow me ample time to complete the Final Report.

6.3 Supervisor Meetings

In addition to practical and written work, I have scheduled weekly meetings with my project supervisor, Professor Richard Booth. I plan to use this time to keep him up-to date with my work, and seek guidance on any project-related issues I encounter. These meetings will also allow me to consult him on design decisions I make (such as details of my experiments), and allow him to voice any concerns he might have about the project.

6.4 Milestones

In the following timeline I refer to weeks by number. On this scale, Week 1 starts on Monday the 29th of January. This is the start of the second semester. Easter recess will take place on Weeks 9, 10, and 11. I have accounted for this period in my milestones by minimising the amount of work expected, and limiting that work to writing. The hand-in date for my final report is the Friday of Week 15.

Milestones listed against a week are intended to be completed by the end of that week. The associated work could be started in prior weeks.

Week 1	• Complete the Initial Plan. • Research related projects. • Research machine learning frameworks. • Choose a machine learning framework to use for my implementation.
Week 2	• Research machine learning techniques. • Implement a basic machine learning system (for practice). • Design the game for the first experiment.

Week 3	• Design the machine learning system for the first experiment.
	• Decide what parameters will be varied and what data will be collected in the first experiment.
	• Implement the game. The implementation must:
	  – Include a real-time graphical display.
	  – Allow for easy interfacing with my chosen machine learning framework.

Week 4	• Implement the machine learning system based on the design. • Carry out the first experiment and collect the relevant data.
Week 5	• Create a basic structure for the Final Report. • Write up progress so far, including results and analysis.
Week 6	• Design a second experiment based on the previous results.

Week 7	• Implement the second game. The implementation must:
	  – Include a real-time graphical display.
	  – Allow for easy interfacing with the chosen machine learning framework.

Week 8	• Implement the second machine learning system. • Carry out the second experiment and collect the relevant data.
Week 11	• Write up progress so far, including results and analysis.
Week 12	• Refine and finalise the structure of the Final Report. • Have all Final Report sections drafted.
Week 14	• Complete and hand in the Final Report.