Gareth Lewis

"Machine learning will automate jobs that most people thought could only be done by people."

- Dave Waters

"Artificial Intelligence, deep learning, machine learning — whatever you're doing if you don't understand it — learn it. Because otherwise you're going to be a dinosaur within 3 years."

- Mark Cuban

Introduction

For this assignment, you will undertake a research project into Machine Learning (ML) for creating video game AI. This will allow you to experiment with the ML frameworks that we will explore in the lecture and workshop sessions to create a small game that uses ML, rather than symbolic AI, to control non-player behaviour.
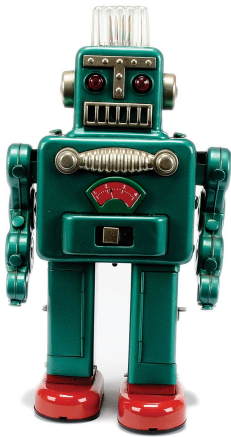
The choice of game you look to develop is up to you, but it is recommended that you look to minimise the scope of the game to something that you can experiment with in the time available (12 weeks). You will need to look for a game that has fairly limited AI behaviours and scope.

This project seeks to answer two key ML questions for game baddie AI:
>Can ML successfully be used to model baddies in a game?
>Can ML baddies be 'tuned' to respond to player behaviours?

The goal of this assignment is to create an artefact that will demonstrate machine learning based AI within a small video game

The assignment consists of the following parts:

(A) Game Design & implementation

The first stage of the project is to choose a suitable game to develop, creating a traditional symbolic AI sub-system which will provide your training data for your Machine Learning experiments. It is worth looking at making homages to 'old' arcade and console games, given their relative simplicity and simplicity in re-creating them in modern languages and frameworks.

Whilst you have a free reign on technology platforms, it's worth remembering that the module is taught using Python and Scikit-Learn, however ML.Net is also available and has a similar level of functionality to Scikit-Learn. This may provide you with a suitable development route if you prefer C# over Python.

For Python development, I would recommend PyGame and for C# development, I would recommend MonoGame. These are both lightweight and easy to use frameworks that are geared around creating small games quickly.

To develop your game's symbolic AI, you can leverage all you have learnt from COMP710. Remember, the symbolic AI will be used to create suitable training data for your ML-based training solutions. Having simple AI that is easy to modify and instrument will be of great help.

(B) Instrument your game

In this stage of the project, you will look to instrument your game such that you can collect meaningful test data for your machine leaning experiments.

To help with automated data collection, it may help to create your game so that it can play itself (through player and baddie AI). It's also worth remembering that data collection, experimentation and interpretation are the key stages of the data science learning loop, so expect to go through this stage multiple time during the assignment.

(C) Fundamental Machine Learning experiments

This stage of the assignment is concerned with answering the first of the two research questions 'Can ML successfully be used to model baddies in a game?' How you will engage with this question will depend on what data you are collecting from your instrumented game (player inputs, screen capture etc) and what outputs your baddie characters will require.

A core part of ML is to experiment both with data and the computation processes that are applied to it. This is where you will spend much of your time, trying and refining your data and processing models to create working solutions.

(D) Extended Machine Learning experiments

This stage of the assignment is concerned with answering the second of the research questions 'Can ML baddies be 'tuned' to respond to player behaviours?' and will look to build on your experiments from the second stage of the project.

The precise nature of the terms 'tuned', 'respond' and 'player behaviour' are dependent on the game you are going to make, so some consideration should be given to this before starting your project. However, it is worth thinking about the relationships between the player and the baddies, in terms of what responses you would expect to see and how and when the baddie should make them relative to the player. In some cases, this may be realised as a baddie that will play at the player's level, i.e. will get worse when the player is playing badly and improve as the player improves. Alternatively, this might be using different strategies.

The assignment consists of the following parts:

Part A – Project outline

This is a single formative submission. To complete this part of the assignment, attend the workshop in week 4 and give a short presentation which outlines your research plan. You should include material covering what game you are planning to use as a testbed and why, the key AI that you are looking to capture with ML and an outline to the data and ML processing that you are looking to use.

You will receive informal feedback during the session.

Part B - Attend weekly research progress meetings

This is a single formative submission that is undertaken on a weekly basis during the workshop sessions, where you will be able to discuss your research progress with your peers and with the lecturing staff.

You will receive informal feedback during the session.

Part C - Attend the peer review

This is a single formative submission that will occur after reading week. To complete this part of the assignment, zip up your work to date onto the peer assignment page in learning space prior to the peer review. During the peer review, you can review the work of your colleagues and give suitable support and suggestions for their work.

You will receive informal feedback during the session and formal peer review feedback at the end of the session.

Part D - Submit the assignment to Learning Space

This is a single summative submission. To complete this part, zip up your project work and submit it to learning space. Your submission will be assessed against the rubric at the end of this document.

You will receive formal feedback within 3 weeks

Part E - Attend the Viva

This is a single summative submission. To complete this part, prepare a demonstration of your work and attend the scheduled viva session. Your submission will be assessed against the rubric at the end of this document.

You will receive informal feedback during the viva.

Additional Guidance

This assignment is a research project, therefore it has fairly open goals in comparison to work that you have undertaken as an undergraduate. This means that you need to be far more in control of both what you do and when you do it. From the proposal stage, you should consider very carefully what is feasible. The important aspect about this coursework is the machine learning process; you should approach this like an experiment and document each step and iteration in the process. A common pitfall is poor planning or time management.

Many students underestimate the work involved in designing and implementing games, particularly developing AI using both symbolic and non-symbolic approaches. It simply cannot be crammed into a last-minute deluge just before a deadline. There is a critical and time-consuming phase of testing! It is, therefore, very important that you begin work early and sustain a consistent pace: little and often.

FAQ
- **What is the deadline for this assignment?**
  Falmouth University policy states that deadlines must only be specified on the MyFalmouth system.

- **What should I do to seek help?**
  You can email your tutor for informal clarifications.

Marking Rubric

Learning Outcome Name	Learning Outcome Description	Criteria	Weighting	Fail	Pass	Merit	Distinction
Code/ Process	Deploy working and extensible software systems, appropriately verifying functional coherence and professionally applying core techniques from a specialised field of computing.	Implementation of core game	15%	Weak game with clear issues	Simple game that works well	Complex game with some issues	Complex game with no issues
		Maintainability of training solutions	20%	Code is hard to follow Data processing appears ad hoc and/or difficult to follow	Code is fairly well-written with some comments. Clear approach to data processing	Code is well-written with suitable comments. Clear data processing process Some consideration given to meta-training Some consideration given to robustness Some consideration given to regression	Code is well-written with meaningful comments. Clear data processing process Much consideration given to meta-training Robustness considerations form a core part of training solutions framework Regression considerations form a core part of training solutions framework
		Robustness of ML integration	15%	ML solution implemented but largely non-functional / non-working	ML implements 'mainline' AI of baddies Some scaling to player ability	ML implements 'mainline' AI of baddies and other AI features Clear and demonstrable scaling to player ability / activities	ML implements mainline and other AI features Considerable and demonstrable scaling to player ability / activities
Solve/ Process	Synthesise your knowledge of mathematics and developments in a specialist field of computing to overcome complex technical challenges.	Choice of game domain	10%	Game AI that is really not suited to ML / scope of project or too trivial	Game AI that lends itself well to ML Game scope is suitable for assignment	Game AI this is well-suited to ML approaches Game scope is suitable for assignment Some potential for segmentable /multiple AI solutions	Game AI that incredibly well suited to ML approaches Game scope is suitable for assignment Clear scope for segmentable /multiple AI solutions
		Scope of ML techniques	20%	little consideration of ML techniques within submission	Consideration given to several ML approaches and differential data processing. Some evidence of scalable AI behaviour	Consideration given to several orthogonal ML approaches and differential data processing. Some consideration given to scalable AI behaviour	Consideration given to several orthogonal ML approaches and differential data processing. Significant consideration given to scalable AI behaviour
		Quality / Playability of AI	20%	Game is playable but very buggy	Game is playable and AI is considered 'good' and relatively engaging	Game is playable and AI is engaging	Game is playable and AI is engaging and clearly scales to player