COS30002 AI for Games

Semester 1, 2019  
Learning Summary Report

Sam Huffer (101633177)

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Self-Assessment Details

The following checklists provide an overview of my self-assessment for this unit.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Pass (P) | Credit (C) | Distinction (D) | High Distinction (Low HD) | (High HD) | |
| Self-Assessment (please tick) |  |  | ✔ |  |  |

*Self-assessment Statement*

|  |  |
| --- | --- |
|  | Included? (tick) |
| Learning Summary Report | ✔ |
| Time-boxed Demonstration Activity (Lab Test) in Doubtfire | ✔ |
| Complete Pass (“core”) task work, approved in Doubtfire | ✔ |

*Minimum Pass Checklist*

|  |  |
| --- | --- |
|  | Included? (tick) |
| Additional non-core task work (or equivalent) in a private repository and accessible to staff account. | ✔ |
| Spike Extension Report (for spike extensions) in Doubtfire | ✔ |
| Custom Project plan (for D and/or low HD), and/or High HD Research Plan document in Doubtfire (optional) | ✔ |

*Credit Checklist, in addition to Pass Checklist*

|  |  |
| --- | --- |
|  | Included? (tick) |
| Custom Project Distinction Plan document, approved in Doubtfire | ✔ |
| All associated work (code, data etc.) available to staff (private repository), for non-trivial custom program(s) of own design | ✔ |
| Custom Project “D” level documents in Doubtfire, to document the program(s) (structure chart etc) including links to repository areas | ✔ |

*Distinction Checklist, in addition to Credit Checklist*

|  |  |
| --- | --- |
|  | Included? (tick) |
| Custom Project “HD” level documents in Doubtfire, to document the program(s) (structure chart etc) including links to repository areas |  |

*Low High Distinction Checklist, in addition to Distinction Checklist*

|  |  |
| --- | --- |
|  | Included? (tick) |
| High Distinction Plan document, approved in Doubtfire |  |
| High Distinction Report document, in Doubtfire, which includes links to repository assets |  |
| All associated work (code, data etc.) available to staff (private repository) for your research work |  |

*High High Distinction (Research) Checklist, in addition to D/Low HD Checklist*

# Introduction

This report summarises what I learnt in COS30002 AI for Games. It includes a self-assessment against the criteria described in the unit outline, a justification of the pieces included, details of the coverage of the unit intended learning outcomes, and a reflection on my learning.

# Overview of Pieces Included

|  |  |  |
| --- | --- | --- |
| **Task** | **Included?** | **Justification** |
| Task 1: Bitbucket Setup | Y | Illustrates competence with tools used in software and game development, and therefore somewhat related to ILO 1. |
| Task 2: FSM and Python | Y | Illustrates learning regarding FSMs and state diagrams, which relate to ILO 1. |
| Task 3: Tic Tac Toe | Y | Illustrates learning regarding FSMs, state diagrams, and competing game AIs, which relate to ILO 1. |
| Task 4 (Spike): Goal-Oriented Behaviour | Y | Illustrates learning regarding GOB and SGI, which relate to ILO 4. |
| Task 5: PlanetWars Bots | Y | Illustrates learning regarding GOB, which relates to ILO 4. |
| Task 6: Graphs, Search and Rules | Y | Illustrates learning regarding graphs, searches, and path planning, which relate to ILO 2; with GOB, which relates to ILO 4; and regarding combining the above, relating to ILO 5. |
| Task 7 (Spike): Tactical Analysis with PlanetWars | Y | Illustrates learning regarding tactical analysis for GOB, which relates to ILO 4. |
| Task 8: Autonomous Steering: Seek, Arrive, Flee | Y | Illustrates learning regarding force-based agent movement (ILO 3). |
| Task 9: Autonomous Steering: Wander and Paths | Y | Illustrates learning regarding force-based agent movement (ILO 3) and combining AI techniques for more complex behaviour (ILO 5). |
| Task 10 (Spike): Tactical Steering | Y | Illustrates learning with force-based agent movement (ILO 3), tactical analysis for GOB, which relates to ILO 4, and combining AI techniques for more complex behaviour (ILO 5). |
| Task 11 (Spike): Emergent Group Behaviour | Y | Illustrates learning with force-based agent movement (ILO 3), tactical analysis for GOB, which relates to ILO 4, and combining AI techniques for more complex behaviour (ILO 5). |
| Task 12: Test | Y | Answered questions 2 and 6, which illustrate learning regarding the concepts of game balance, bias, strategy and tactics, which relate to ILOs 1 and 4. |
| Task 13: Test Response | N | Not attempted; consulted with Tien, who figured my test responses were sufficient, and suggested I only do it if I had time, which I ran out of. |
| Task 14 (Spike): Agent Marksmanship | Y | 1 4 5 |
| Task 15 (Spike): Soldier on Patrol | Y | 1 3 4 5 |
| Task 16 (Spike): Goal-Oriented Action Planning | Y | 4 |
| Task 17: Graphs, Paths and Search | Y | 2 4 5 |
| Task 18 (Spike): Navigation with Graphs | Y | 2 4 5 |
| Task 19 (Credit): Spike Extension Report | Y | \* |
| Task 20 (Credit): Custom Project Plan | Y | \* |
| Task 21 (Distinction): Distinction-Level Custom Project | Y | \* Tactical analysis for GOB |
| Task 22 (Credit): Research Plan | Y | \* |
| Task 23 (High Distinction): High Distinction-Level Custom Project | N | Not attempted; not going for HD. |
| Task 24 (High Distinction): Research Report | N | Not attempted; not going for HD. |
| Task 25: Portfolio | Y | \* |

# Coverage of the Intended Learning Outcomes

This section outlines how the pieces I have included demonstrate the depth of my understanding in relation to each of the unit’s intended learning outcomes.

## ILO 1: Software Development for Game AI

*“Discuss and implement software development techniques to support the creation of AI behaviour in games”*

Describe what you have included in your portfolio that demonstrates your ability in relation to this outcome.

 Pass: Identify where in your lab work, lab tests or core spike work that the topics that need to be discussed and implemented have been covered.

 Credit: Descriptions much contain depth and relate the concepts to each other, and implementations must demonstrate practical application.

 Distinction, High Distinction: relate to your project and/or research

To demonstrate my pass-level learning and achievement regarding ILO 1: Software Development for Game AI, I have included in my portfolio the following tasks:

* Task 1: Bitbucket Setup. The Task Summary PDF on Canvas lists this task – setting up a Bitbucket repository to store all work done for this unit – as pertaining to this outcome at a pass level; I suppose setting up a repository demonstrates familiarity with the tools required for game development, and allows for the examination of other tasks by assessors. Beyond that, it doesn’t particularly relate to AI for games specifically.
* Task 2: FSM and Python. In this task’s pass-level content, I demonstrate my learning regarding AI states, basic finite state machines (FSMs), and state diagrams outlining the states and state transitions of FSMs, by drawing up a state diagram for a simple FSM, and implementing that FSM.
* Task 3: Tic Tac Toe. In this task’s pass-level content, I demonstrate my learning regarding basic finite state machines, state diagrams, and competing game AIs pitted against one another by creating several bots to play games of Tic Tac Toe.
* Task 12: Test. In this task’s pass-level content, I demonstrate my learning and understanding regarding the concepts of game balance and player bias, answering question 2 and outlining the aforementioned concepts and discussing the suitability of different levels of game balance and AI bias for different players. I also demonstrate my learning regarding the concepts of strategy and tactics, answering question 6 and outlining the difference between the two, and providing examples of each in existing games.
* Task 14 (Spike)
* Task 15 (Spike)
* Task 25

To demonstrate my credit-level learning and proficiency with ILO 1: Software Development for Game AI, I have included in my portfolio the following tasks:

* Task 19 (Credit)
* Task 20 (Credit)
* Task 22 (Credit)

To demonstrate my distinction-level learning and achievement regarding ILO 1: Software Development for Game AI, I have included in my portfolio the following tasks:

* Task 21 (Distinction)

## ILO 2: Graphs and Path Planning

*“Understand and utilize a variety of graph and path planning techniques*.”

Describe what you have included in your portfolio that demonstrates your ability in relation to this outcome.

 Pass: Identify where in your lab tests and/or spike work where you have explained or utilised this ILO.

 Credit: Evidence of depth in the portfolio work and explanations provided.

 Distinction, High Distinction: relate to your project and/or research

To demonstrate my pass-level learning, proficiency and achievement regarding ILO 2: Graphs and Path Planning, I have included in my portfolio the following tasks:

* Task 6: Graphs, Search and Rules. In this task’s pass-level content, I demonstrate my learning regarding graphs, searches and path planning by completing and running simulations of the Towers of Hanoi and Water Jugs problems, broadening my understanding of how searches can be applied to graphs to plan sequences of actions.
* Task 17
* Task 18
* Task 25

To demonstrate my credit-level learning, proficiency and achievement regarding ILO 2: Graphs and Path Planning, I have included in my portfolio the following tasks:

* Task 19 (Credit)
* Task 20 (Credit)
* Task 22 (Credit)

To demonstrate my distinction-level learning, proficiency and achievement regarding ILO 2: Graphs and Path Planning, I have included in my portfolio the following tasks:

* Task 21 (Distinction)

## ILO 3: Force-Based Agent Movement

*“Create realistic movement for agents using steering force models*.”

Describe what you have included in your portfolio that demonstrates your ability in relation to this outcome.

 Pass: Working implementations / demonstrations from the spike work.

 Credit. Additional work that extends the core spike work features

 Distinction, High Distinction: relate to your project and/or research

To demonstrate my pass-level learning, proficiency and achievement regarding ILO 3: Force-Based Agent Movement, I have included in my portfolio the following tasks:

* Task 8: Autonomous Steering: Seek, Arrive, Flee. In this task’s pass-level content, I demonstrate my learning and proficiency regarding force-based agent movement by drawing a UML class diagram of the existing classes provided for this task, and fully implementing basic force-based seeking, arriving and fleeing behaviours, and then developing pursuit behaviour, varying the shapes of agents, and attempting to limit different steering forces separately.
* Task 9: Autonomous Steering: Wander and Paths. In this task’s pass-level content, I demonstrate my learning and proficiency regarding force-based agent movement by implementing further basic force-based behaviours of wandering and following a path.
* Task 10 (Spike): Tactical Steering. In this task’s pass-level content, I demonstrate my learning and proficiency regarding force-based movement by implementing hiding behaviour for prey agents.
* Task 11 (Spike): Emergent Group Behaviour. In this task’s pass-level content, I demonstrate my learning and proficiency regarding force-based movement by implementing cohesion, separation and alignment steering behaviours.
* Task 15
* Task 16
* Task 25

To demonstrate my credit-level learning, proficiency and achievement regarding ILO 3: Force-Based Agent Movement, I have included in my portfolio the following tasks:

* Task 10 (Spike): Tactical Steering. In this task’s credit-level content, I demonstrate my learning and proficiency regarding force-based movement by implementing the ability for agents to avoid obstacles.
* Task 11 (Spike): Emergent Group Behaviour. In this task’s credit-level content, I demonstrate my learning and proficiency regarding force-based movement by implementing walls, agent- and wall-avoidance behaviours, and attempting to balance group movement behaviours to get aesthetically-pleasing group movement amongst the prey agents.
* Task 19 (Credit)
* Task 20 (Credit)
* Task 22 (Credit)

To demonstrate my distinction-level learning, proficiency and achievement regarding ILO 3: Force-Based Agent Movement, I have included in my portfolio the following tasks:

* Task 21 (Distinction)

## ILO 4: Goals and Planning Actions

*“Create agents that are capable of planning actions in order to achieve goals*.”

Describe what you have included in your portfolio that demonstrates your ability in relation to this outcome.

 Pass: Working implementations / demonstrations from the spike work.

 Credit. Additional work that extends the core spike work features

 Distinction, High Distinction: relate to your project and/or research

To demonstrate my learning, proficiency and achievement regarding ILO 4: Goals and Planning Actions, I have included in my portfolio the following tasks:

* Task 4 (Spike): Goal-Oriented Behaviour. In this spike’s pass-level content, I demonstrate my learning regarding goal-oriented behaviour (GOB) achieved through simple goal insistence (SGI) by implementing basic GOB and SGI, and discussing some limits of SGI.
* Task 5: PlanetWars Bots. In this task’s pass-level content, I demonstrate my learning and growing proficiency regarding GOB, writing pseudocode for and implementing several simple bots to compete in PlanetWars simulations.
* Task 6: Graphs, Search and Rules. In this task’s pass-level content, I demonstrate my learning regarding GOB by completing and running simulations of the Towers of Hanoi and Water Jugs problems, searching graphs to plan a sequence of actions to achieve a desired goal.
* Task 7 (Spike): Tactical Analysis with PlanetWars. In this task’s pass-level content, I demonstrate my learning and proficiency with GOB achieved through tactical analysis, by developing GOB bots for the PlanetWars simulation, that use simple and complex tactical analysis to inform their decisions, and comparing their success rates across a number of PlanetWars maps.
* Task 10 (Spike): Tactical Steering. In this task’s pass-level content, I demonstrate my learning and proficiency regarding GOB by having prey agents use tactical analysis to further their goal of evading the predator agent.
* Task 11 (Spike): Emergent Group Behaviour. In this task’s pass-level content, I demonstrate my learning and proficiency regarding GOB by implementing force-based movement behaviours that facilitate the goal of agents moving in groups, and using tactical analysis while prioritising and weighting those movement behaviours to best address the agent’s (prioritised) goals.
* Task 14
* Task 15
* Task 16
* Task 17
* Task 18

To demonstrate my credit-level learning, proficiency and achievement regarding ILO 4: Goals and Planning Actions, I have included in my portfolio the following tasks:

* Task 4 (Spike): Goal-Oriented Behaviour. In this spike’s credit-level content, I demonstrate my learning regarding GOB and SGI by converting the procedural, pass-level version of this program into an object-oriented (OO) version, and discussing the pros and cons OO programming affords in this context.
* Task 7 (Spike): Tactical Analysis with PlanetWars. In this task’s credit-level content, I demonstrate my learning and understanding regarding GOB and tactical analysis by discussing further information that could be used for tactical analysis in the simulation, and the implications of PlanetWars’ fog of war regarding tactical analysis, and of symmetrical versus asymmetrical maps regarding game bias and balance.
* Task 10 (Spike): Tactical Steering. In this task’s credit-level content, I demonstrate my learning and proficiency regarding GOB by having prey agents use tactical analysis to choose hiding spots from multiple predator agents intelligently, furthering their goal of evading the predator agents and not being eaten.
* Task 11 (Spike): Emergent Group Behaviour. In this task’s credit-level content, I demonstrate my learning and proficiency regarding GOB by implementing force-based movement behaviour that facilitate the goals of agents not overlapping and avoiding walls, and regarding tactical analysis by adding a predator agent that prey agents have to use tactical analysis to evade.
* Task 12: Test. In this task’s pass-level content, I demonstrate my learning and understanding regarding GOB by discussing the concepts of game balance and player bias, answering question 2 and discussing biases players will have for particular strategies in pursuit of in-game goals. I also discuss the concepts of strategy and tactics, answering question 6 and outlining the difference between the two, providing examples of each in existing games of how tactics are used to meet the underlying goals of a strategy in a given environment.
* Task 19 (Credit)
* Task 20 (Credit)
* Task 22 (Credit)

To demonstrate my distinction-level learning, proficiency and achievement regarding ILO 4: Goals and Planning Actions, I have included in my portfolio the following tasks:

* Task 21 (Distinction)

## ILO 5: Combine AI Techniques

*“Combine AI techniques to create more advanced game AI*.”

Describe what you have included in your portfolio that demonstrates your ability in relation to this outcome.

 Pass: Working implementations / demonstrations from the spike work.

 Credit. Additional work that extends the core spike work features

 Distinction, High Distinction: relate to your project and/or research

To demonstrate my pass-level learning, proficiency and achievement regarding ILO 5: Combine AI Techniques, I have included in my portfolio the following tasks:

* Task 6: Graphs, Search and Rules. In this task’s pass-level content, I demonstrate my learning regarding combining AI techniques by completing and running simulations of the Towers of Hanoi and Water Jugs problems, using graphs and searching to plan the sequence of actions necessary to achieve a particular goal, combining graphs, searching and path planning with GOB.
* Task 9: Autonomous Steering: Wander and Paths. In this task’s pass-level content, I demonstrate my learning and proficiency regarding combining AI techniques by applying force-based movement to following the nodes of a path.
* Task 10 (Spike): Tactical Steering. In this task’s pass-level content, I demonstrate my learning and proficiency combining AI techniques by having prey agents use tactical analysis to further their goal of evading the predator agent using force-based movement behaviours.
* Task 11 (Spike): Emergent Group Behaviour. In this task’s pass-level content, I demonstrate my learning and proficiency regarding combining AI techniques by combining cohesion, separation and alignment movement behaviours to generate emergent group behaviours amongst prey agents, and tactical analysis while prioritising and weighting agents’ goals.
* Task 11
* Task 14
* Task 15
* Task 17
* Task 18

To demonstrate my credit-level learning, proficiency and achievement regarding ILO 5: Combine AI Techniques, I have included in my portfolio the following tasks:

* Task 10 (Spike): Tactical Steering. In this task’s credit-level content, I demonstrate my learning and proficiency combining AI techniques by having prey agents use force-based obstacle avoidance to further the goal of not colliding with obstacles, balanced against the use of other force-based movement behaviours to move to locations to hide from multiple predators, locations chosen using tactical analysis.
* Task 11 (Spike): Emergent Group Behaviour. In this task’s pass-level content, I demonstrate my learning and proficiency regarding combining AI techniques by modifying and comparing weightings of cohesion, separation and alignment steering behaviours to generate different emergent behaviours, while investigating circling behaviour, and useing force-based movement to further the agents’ goals of avoiding walls and each other.
* Task 19 (Credit)
* Task 20 (Credit)
* Task 22 (Credit)

To demonstrate my distinction-level learning, proficiency and achievement regarding ILO 5: Combine AI Techniques, I have included in my portfolio the following tasks:

* Task 21 (Distinction)

# Reflection

## The most important things I learnt:

* The underlying logic behind a number of force-based AI movement behaviours that can be combined and modified to form more complex behaviours (i.e. alignment, cohesion and separation).
* How search algorithms and networks can be applied in AI movement to make decisions about where to go, and follow paths to get to one’s destination in a graph-based world.
* Pros and cons of different ways of having AIs move in a boxed, graph-based environment in relation to customizability of the simulation space by the user.

## The things that helped me most were:

* The lecture notes that outlined the logic required for particular movement behaviours, as they gave me a basis for the implementation of those behaviours and gave me ideas to work with in case that implementation ran into issues and I needed to devise an alternative.
* The lab and spike work, as it allowed me to explore the topic and build my understanding of it and competencies it required by working through each requirement of the task.
* Google search results for specific questions related to programming in python.

## I found the following topics particularly challenging:

None of the topics were especially challenging conceptually; I found they were all reasonably straightforward. The challenges came from the implementation, such as:

* Implementing the detection of objects using feelers as outlined in the lecture slides: there were one or two aspects of how to implement it that didn’t click in my mind until after the submission of the task, resulting in me improvising an alternative obstacle-avoidance method using two detection circles.
* Balancing the group steering behaviours in Task 11 to create functional and nice-looking steering behaviours: getting the magnitudes of the different forces and combining them all was tricky to do. I managed it somewhat, but not to the point of replicating the smoothness of the behaviours as demonstrated in the lecture, nor to the point of getting the prey agents circling around the simulation space.

## I found the following topics particularly interesting:

* Force-based steering behaviours and emergent group behaviour (including patrolling): these behaviours appear to form the basis of how enemy AIs move in, for example, first- and third-person shooters and adventure games, and thus struck me as being of particular practical value.
* Predicting the location of a target an AI is shooting at, another fundamental behaviour required of any game involving AIs shooting each other or the player.
* Graph-based locations and movement: this seemed an interesting alternative means of moving around a virtual space besides force-based steering.

## I feel I learnt these topics, concepts, and/or tools really well:

*List and explain. If none, explain why! Refer to your portfolio pieces for evidence to support your claims.*

## I still need to work on the following areas:

* ILO 4, Planning Actions

*List and explain. If none, explain why! Refer to your portfolio pieces.*

## My progress in this unit was . . .:

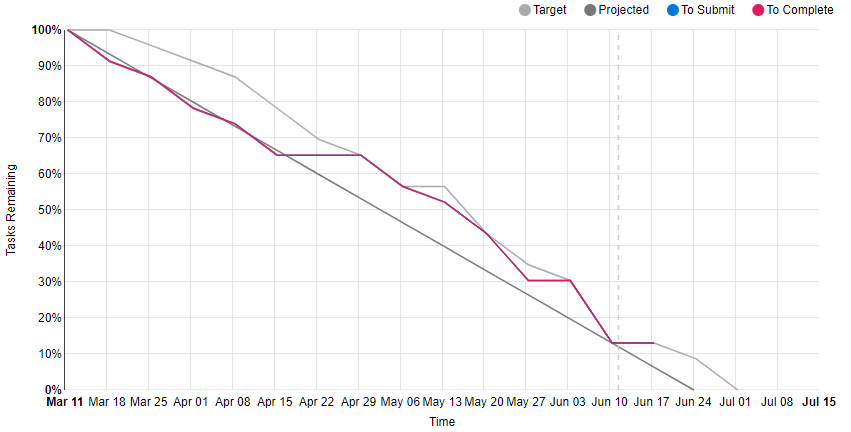
During the semester, I worked consistently on my tasks, handing almost all of the lab and spike work in on time. The only gaps in my progress during the semester according to the burndown chart were during the mid-semester break, when there were no tasks due and I elected to focus on work for my concurrent capstone project, and while I was working on upcoming assignments from other units while waiting for the release of the instructions of Task 18: Navigation with Graphs and the credit tasks. Otherwise, I have worked consistently on each week’s tasks from that week’s tutorial until the tasks’ completion.

Figure : My burndown chart for AI for Games.

## This unit will help me in the future:

This unit has given me a firm basis in the logic and implementation of force- and graph-based AI movement, fundamental types of game AIs, the uses of graphs and searches in games, and AI action planning to achieve goals, all of which are practical and applicable beyond just this unit. Certainly, I’ll be able to take the concepts and logic behind various features and adapt them for future projects in university, and in game development projects generally, particularly since this unit has furthered my desire to specialise in game AI programming.

## If I did this unit again, I would do the following things differently:

* Assuming assignments and deadlines from other units permitted, if I did this unit again, I would like to begin working on the designs and implementation for my custom project earlier in the semester. That would ensure I had more time to complete the custom project if I needed it, and would likely allow me to finish and submit it earlier than I achieved this time around.
* If I had sufficient time while redoing this unit, I wouldn’t mind attempting a HD research report; after doing the research plan credit task, I was genuinely curious about my chosen research matter and wouldn’t have minded looking into it.

# Conclusion

In summary, I believe that I have clearly demonstrate that my portfolio is sufficient to be awarded a distinction grade. I completed all of the core work and credit tasks, and have submitted a distinction-level custom project that combines and extends core concepts in a manner I believe sufficiently demonstrates my learning and proficiency with the unit’s content – sufficient to warrant a distinction grade