



# PORTFOLIO OF GAME ENGINE COMPONENTS — AI

Version 3.0  
BSc Computing for Games  
COMP250

Dr Ed Powley

This assignment is formed of **two** separate tasks.

For details of the **game component** task, worth 30% of the marks, please see pages 2–6 of this document.

For details of the **MicroRTS bot** task, worth 70% of the marks, please see pages 7–11 of this document.

# PORTFOLIO OF GAME ENGINE COMPONENTS — AI (TASK 1)

Version 3.0  
BSc Computing for Games  
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## Introduction

In this assignment, you are required to **design** and **implement** a game component implementing one or more artificial intelligence (AI) techniques. Note that “component” here may also include tools to help game designers to author AI behaviours or systems.

It is strongly recommended that your component is integrated into your COMP240 group game development project, however if this is not appropriate you may integrate it into another of your current or previous development projects. You may use any programming language and game engine you deem appropriate, including visual scripting languages such as Blueprints; this choice will probably be dictated by your choice of game.

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*“To be enjoyable, an AI must put up a good fight but lose more often than win. It must make the player feel clever, sly, cunning, and powerful. It must make the player jump from his seat shouting, ‘Take that, you little s\*\*t!’”*

— Mat Buckland

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Almost all types of games use AI in some capacity, and many genres rely on advanced AI techniques. Control of non-player characters is an important application of AI, and a wide-ranging one: enemy AI in a realistic stealth game is very different from in an arcade shooter, which in turn differs from a racing game. Other applications of AI can include adversaries in board, card or strategy games, procedural content generators, procedural narrative engines, assistive technologies, AI “directors”, and many others. Your final product will be a portfolio piece, which you can use in future to demonstrate your mastery of these techniques.

This assignment is formed of several parts:

- (A) **Write** a 2-page handout that will:
  - (i) **outline** the concept of your component;
  - (ii) **identify** the game into which your component will be integrated, and how it will fit into the overall game concept;
  - (iii) **describe** the key requirements of your component.
- (B) **Implement** a draft versions of your component that will:
  - (i) **implement** the user stories from your Trello board.
- (C) **Implement** a final version of your component that will:
  - (i) **revise** any issues raised by your tutor and/or your peers.
- (D) **Present** a practical demo of the computer program to your tutor that will:
  - (i) **demonstrate** your academic integrity;
  - (ii) **demonstrate** your individual programming knowledge and communication skills.



Not all video games portray AI in a positive light. However, many games rely on AI to create a satisfying gameplay experience.

## Assignment Setup

This assignment is a **programming** task. There is no template GitHub repository for this assignment; you should work within the existing source control repository for your game or create a new GitHub repository as appropriate. Either way, remember to modify the `.gitignore` file (or equivalent on other version control systems) to exclude temporary build files from the repository.

## Part A

Part A consists of a **single formative submission**. This work is **individual** and will be assessed on a **threshold** basis. Answer the following questions to pass:

- What is the title and high concept of the game or demo into which your component will be integrated?
- What functionality will your component include?
- How does your component fit into the overall concept of the game or demo?
- What are the key requirements?
- Is the scope appropriate for the product development time-frame?

To complete Part A, prepare the handout using any word processing tool. Your handout may include images and/or links to online videos.

Show the handout to the **tutor** for immediate **informal feedback**.

## Part B

Part B is a **single formative submission**. This work is **individual** and will be assessed on a **threshold** basis. The following criteria are used to determine a pass or fail:

- (a) Submission is timely;
- (b) Enough work is available to conduct a meaningful review;
- (c) A broadly appropriate review of a peer's work is submitted.

To complete Part B, prepare a draft version of your component. Upload the game project to the peer review section on LearningSpace prior to the timetabled peer review session; if it is too large to upload, bring it to the session on a USB flash drive. Include a `readme.md` file detailing which parts of the project constitute your component for this assignment.

You will receive immediate **informal feedback** from your **peers**.

## Part C

Part C is a **single summative submission**. This work is **individual** and will be assessed on a **criterion-referenced** basis. Please refer to the marking rubric at the end of this document for further detail.

To complete Part C, revise your component based on the feedback you have received. Then, upload your game project to the LearningSpace. Include a `readme.md` file detailing which parts of the project constitute your component for this assignment. If your project exceeds the 1GB limit for LearningSpace uploads, you are advised to remove unnecessary assets — you need only include enough content (e.g. one level) to allow your AI component to be assessed.

Please note, the LearningSpace will only accept a single `.zip` file, which must include your submissions for **both** Task 1 (Game Component) **and** Task 2 (MicroRTS Bot).

You will receive **formal feedback** from your **tutor** three weeks after the final submission deadline.

## Part D

Part D is a **single summative submission**. This work is **individual** and will be assessed on a **threshold** basis. The following criteria are used to determine a pass or fail:

- (a) Enough work is available to hold a meaningful discussion;
- (b) Clear evidence of programming knowledge **and** communication skills;
- (c) No breaches of academic integrity.

To complete Part D, prepare a practical demonstration of the computer program. Ensure that the source code and related assets are pushed to GitHub and a pull request is made prior to the scheduled viva session. Then, attend the scheduled viva session.

## Additional Guidance

As always, avoid underestimating the effort required to implement even simple software; always consider scope. From the proposal stage, you should consider very carefully what is feasible.

Your code will be assessed on **functional coherence**: how well the finished product corresponds to the user stories, and whether it has any obvious bugs. Correspondence to user stories runs both ways: implementing features that were not present in the design (“feature creep”) is just as bad as neglecting to implement features.

Your code will also be assessed on **sophistication**. To succeed on a project of this size and complexity, you will need to make use of appropriate algorithms, data structures, libraries, and object oriented programming concepts. Appropriateness to the task at hand is key: you will **not** receive credit for complexity where something simpler would have sufficed. Likewise, if you are using an engine such as Unity or Unreal, you should make use of (and build upon) the AI functionality included therein; you will **not** receive extra credit for “rolling your own” without good reason to do so.

**Maintainability** is important in all programming projects, but doubly so when working in a team. Use **comments** liberally to improve code comprehension, and carefully choose the **names** for your files, classes, functions and variables. Use a well-established commenting convention for **high-level documentation**. The open-source tool Doxygen supports several such conventions. Also ensure that all code corresponds to a sensible and consistent **formatting style**: indentation, whitespace, placement of curly braces, etc. Hard-coded **literals** (numbers and strings) within the source should be avoided, with values instead defined as constants together in a single place. Where appropriate, values should be exposed as properties or variables in the Unity or Unreal editor so that they can easily be “**tinkered**” without changing the source code.

Maintainability is also important when using **visual scripting** systems such as **Blueprints**. Pay special attention to the **layout** of your Blueprints, which should be tidy and should make clear the flow of control and data. Use **grouping, macros, functions, routing nodes** etc. to achieve this. Blueprints which resemble bowls of spaghetti will not achieve high marks!

As with all assignments on this course, you are expected to display a level of **innovation and creative flair** befitting Falmouth University’s reputation as a world-leading arts institution. One approach to promoting creativity is **divergent thinking**: generating ideas by exploring many possible solutions. Often the most interesting ideas are **subversive**: they deliberately go against convention or obvious solutions.

## 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. For informal feedback,

make a pull request on GitHub.

- **Is this a mistake?**

If you have discovered an issue with the brief itself, the source files are available at:

<https://github.com/Falmouth-Games-Academy/bsc-assignment-briefs>.

Please make a pull request and comment accordingly.

## **Additional Resources**

- <http://aigamedev.com>
- <https://docs.unity3d.com/Manual/Navigation.html>
- <https://docs.unrealengine.com/latest/INT/Gameplay/AI/>
- <https://google.github.io/styleguide/cppguide.html>

# Marking Rubric

Criterion	Weight	Refer for Resubmission	Basic Proficiency	Novice Competency	Novice Proficiency	Professional Competency	Professional Proficiency
Basic Competency Threshold	40%	At least one part is missing or is unsatisfactory.	Submission of all parts is timely and satisfactory. Enough work is available to hold a meaningful discussion. Clear evidence of programming knowledge and communication skills. No breaches of academic integrity.				
Functional Coherence	15%	Few requirements have been implemented and/or the code fails to compile or run.  Many obvious and serious bugs are detected.	Some requirements have been implemented.  Some obvious bugs are detected.	Many requirements have been implemented.  There is some evidence of feature creep.  Few obvious bugs are detected.	Almost all requirements have been implemented.  There is little evidence of feature creep.  Some minor bugs are detected.	All requirements have been implemented.  There is almost no evidence of feature creep.  Some bugs, purely cosmetic and/or superficial in nature, are detected.	All requirements have been implemented.  There is no evidence of feature creep.  Few to no bugs are detected.
Sophistication	15%	Little insight into the appropriate use of programming constructs is evident from the source code.  The program structure is poor or non-existent.	Some insight into the appropriate use of programming constructs is evident from the source code.  The program structure is adequate.	Much insight into the appropriate use of programming constructs is evident from the source code.  The program structure is appropriate.	Considerable insight into the appropriate use of programming constructs is evident from the source code.  The program structure is effective. There is high cohesion and low coupling.	Significant insight into the appropriate use of programming constructs is evident from the source code.  The program structure is very effective. There is high cohesion and low coupling.	Extensive insight into the appropriate use of programming constructs is evident from the source code.  The program structure is extremely effective. There is very high cohesion and very low coupling.
Maintainability	15%	The code is only sporadically commented, if at all, or comments are unclear.  Few identifier names are clear or inappropriate.  Code formatting hinders readability.	The code is well commented.  Some identifier names are descriptive and appropriate.  An attempt has been made to adhere to a consistent formatting style.  There is little obvious duplication of code or of literal values.	The code is reasonably well commented.  Most identifier names are descriptive and appropriate.  Most code adheres to a sensible formatting style.  There is almost no obvious duplication of code or of literal values.	The code is reasonably well commented, with appropriate high-level documentation.  Almost all identifier names are descriptive and appropriate.  Almost all code adheres to a sensible formatting style.  There is no obvious duplication of code or of literal values. Some literal values can be easily "tinkered".	The code is very well commented, with comprehensive appropriate high-level documentation.  All identifier names are descriptive and appropriate.  All code adheres to a sensible formatting style.  There is no obvious duplication of code or of literal values. Most literal values are, where appropriate, easily "tinkered" outside of the source.	The code is commented extremely well, with comprehensive appropriate high-level documentation.  All identifier names are descriptive and appropriate.  All code adheres to a sensible formatting style.  There is no duplication of code or of literal values. Nearly all literal values are, where appropriate, easily "tinkered" outside of the source.
Creative Flair	15%	Little or no creativity.  The work is a clone of an existing work with mere cosmetic alterations.  The work delivers little or no fun and/or engagement.	Some creativity.  The work is derivative of existing works, with only minor alterations.  The work delivers some fun and/or engagement.	Much creativity.  The work is derivative of existing works, demonstrating little divergent and/or subversive thinking.  The work delivers much fun and/or engagement.	Considerable creativity.  The work is somewhat novel, demonstrating some divergent and/or subversive thinking.  The work delivers considerable fun and/or engagement.	Significant creativity.  The work is novel, demonstrating significant divergent and/or subversive thinking.  The work delivers significant fun and/or engagement.	Extensive creativity.  The work is highly original, with strong evidence of divergent and/or subversive thinking.  The work delivers extensive fun and/or engagement.

# PORTFOLIO OF GAME ENGINE COMPONENTS — AI (TASK 2)

Version 3.0  
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## Introduction

In this assignment, you are required to design and implement an **AI bot** for the **MicroRTS** game.

In most games, the role of AI agents is to provide an enjoyable experience for the player. However, creating agents that instead try to win the game is an important area of research: in some genres of games there is demand for such AI, and it allows games to be used as a testbed for AI techniques that can be applied to real-world decision problems. Real-time strategy (RTS) games are particularly challenging for AI to play well, involving complex tactical and strategic decisions. MicroRTS is a simplified RTS which was developed for benchmarking AI techniques against each other. In this assignment you will develop a “bot” (an AI agent) that plays MicroRTS. Your bot will compete in a tournament against your classmates’ bots.

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*“Real stupidity beats artificial intelligence every time.”*

— Terry Pratchett

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This assignment is formed of several parts:

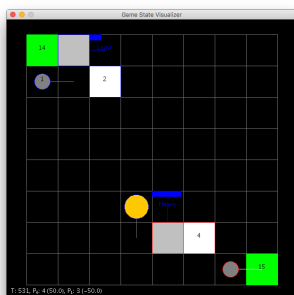
- (A) **Implement**, over a course of several sprints, draft versions of your bot:
  - (i) **research** and **devise** appropriate AI methods;
  - (ii) **implement** these methods in your bot;
  - (iii) **upload** your bot to the tournament server;
  - (iv) **revise** your bot based on results from the tournament server;
  - (v) **repeat** iteratively.
- (B) **Implement** a final version of your bot that will:
  - (i) **revise** any issues raised by your tutor and/or your peers.
- (C) **Present** a practical demo of your bot that will:
  - (i) **demonstrate** your academic integrity;
  - (ii) **demonstrate** your individual programming knowledge and communication skills.

## Assignment Setup

This assignment is a **programming** task. Begin by forking the following GitHub repository:

<https://github.com/Falmouth-Games-Academy/comp250-bot>

Modify the provided template code to implement your bot. The base repository’s `readme.md` file contains important instructions for submitting your bot to the tournament server; be sure to read and follow these instructions carefully.



MicroRTS, originally developed by Santiago Ontañón at Drexel University, is an open-source software environment designed for benchmarking AI techniques for real-time strategy games.

## Part A

Part A is a **single formative submission**. This work is **individual** and will be assessed on a **threshold** basis. The following criteria are used to determine a pass or fail:

- (a) Submission is timely;
- (b) Enough work is available to conduct a meaningful review;
- (c) A broadly appropriate review of a peer’s work is submitted.



To complete Part A, develop your bot in an iterative fashion. Push your code to GitHub regularly; if you have forked the base repository correctly, every push to the `master` branch will automatically submit your bot to the tournament server. Use the results from the tournament server to refine your bot design.

Ensure that a sufficiently advanced draft is uploaded to GitHub, and attend the scheduled peer review session.

## Part B

Part B is a **single summative submission**. This work is **individual** and will be assessed on a **criterion-referenced** basis. Please refer to the marking rubric at the end of this document for further detail.

To complete Part B, revise your bot based on the feedback you have received. Then, upload it to the LearningSpace. Please note, the LearningSpace will only accept a single `.zip` file, which must include your submissions for **both** Task 1 (Game Component) **and** Task 2 (MicroRTS Bot).

You will receive **formal feedback** from your **tutor** three weeks after the final submission deadline.

## Part C

Part C is a **single summative submission**. This work is **individual** and will be assessed on a **threshold** basis. The following criteria are used to determine a pass or fail:

- (a) Enough work is available to hold a meaningful discussion;
- (b) Clear evidence of programming knowledge **and** communication skills;
- (c) No breaches of academic integrity.

To complete Part C, prepare a practical demonstration of your bot. Ensure that the source code and related assets are pushed to GitHub and a pull request is made prior to the scheduled viva session. Then, attend the scheduled viva session.

## Additional Guidance

As always, avoid underestimating the effort required to implement even simple software; always consider scope. From the proposal stage, you should consider very carefully what is feasible.

Your code will be assessed on **functional coherence**: how well the finished product corresponds to the user stories, and whether it has any obvious bugs. Correspondence to user stories runs both ways: implementing features that were not present in the design (“feature creep”) is just as bad as neglecting to implement features.

Your code will also be assessed on **sophistication**. To succeed on a project of this size and complexity, you will need to make use of appropriate algorithms, data structures, libraries, and object oriented programming concepts. Appropriateness to the task at hand is key: you will **not** receive credit for complexity where something simpler would have sufficed. Likewise, if you are using an engine such as Unity or Unreal, you should make use of (and build upon) the AI functionality included therein; you will **not** receive extra credit for “rolling your own” without good reason to do so.

**Maintainability** is important in all programming projects, but doubly so when working in a team. Use **comments** liberally to improve code comprehension, and carefully choose the **names** for your files, classes, functions and variables. Use a well-established commenting convention for **high-level documentation**.



The open-source tool Doxygen supports several such conventions. Also ensure that all code corresponds to a sensible and consistent **formatting style**: indentation, whitespace, placement of curly braces, etc. Hard-coded **literals** (numbers and strings) within the source should be avoided, with values instead defined as constants together in a single place. Consider allowing some literal values, where appropriate, to be “tinkered” without changing the source code, e.g. by defining them in an external file read at startup.

As with all assignments on this course, you are expected to display a level of **innovation and creative flair** befitting Falmouth University’s reputation as a world-leading arts institution. One approach to promoting creativity is **divergent thinking**: generating ideas by exploring many possible solutions. Often the most interesting ideas are **subversive**: they deliberately go against convention or obvious solutions.

## FAQ

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- **What should I do to seek help?**

You can email your tutor for informal clarifications. For informal feedback, make a pull request on GitHub.

- **Is this a mistake?**

If you have discovered an issue with the brief itself, the source files are available at:

<https://github.com/Falmouth-Games-Academy/bsc-assignment-briefs>.  
Please make a pull request and comment accordingly.

## Additional Resources

- <https://github.com/santiontanon/microrts/wiki>
- <https://sites.google.com/site/micrortsaicompetition/home>
- <https://docs.oracle.com/javase/tutorial/>
- <https://google.github.io/styleguide/javaguide.html>

# Marking Rubric

Criterion	Weight	Refer for Resubmission	Basic Proficiency	Novice Competency	Novice Proficiency	Professional Competency	Professional Proficiency
Basic Competency Threshold	40%	At least one part is missing or is unsatisfactory.  The work is only a trivial modification of the sample code.  The student is disqualified from the tournament.	Submission is timely.  Enough work is available to hold a meaningful discussion.  The work is clearly diverges from the sample code.  Clear evidence of programming knowledge and communication skills.  No breaches of academic integrity.  Tournament rules have been adhered to.  A bot is pushed to GitHub and submitted to the tournament server at least once per sprint.				
Functional Coherence	10%	The code fails to compile or run.  Many obvious and serious bugs are detected.	Some obvious bugs are detected.	Few obvious bugs are detected.	Some minor bugs are detected.	Some superficial bugs are detected.	Almost no bugs are detected.
Algorithmic Sophistication	10%	Little insight into the appropriate use of AI techniques is evident from the design of the bot.	Some insight into the appropriate use of AI techniques is evident from the design of the bot.	Much insight into the appropriate use of AI techniques is evident from the design of the bot.	Considerable insight into the appropriate use of AI techniques is evident from the design of the bot.	Significant insight into the appropriate use of AI techniques is evident from the design of the bot.	Extensive insight into the appropriate use of AI techniques is evident from the design of the bot.
Sophistication of Implementation	10%	Little insight into the appropriate use of programming constructs is evident from the source code.  The program structure is poor or non-existent.	Some insight into the appropriate use of programming constructs is evident from the source code.  The program structure is adequate.	Much insight into the appropriate use of programming constructs is evident from the source code.  The program structure is appropriate.	Considerable insight into the appropriate use of programming constructs is evident from the source code.  The program structure is effective. There is high cohesion and low coupling.	Significant insight into the appropriate use of programming constructs is evident from the source code.  The program structure is very effective. There is high cohesion and low coupling.	Extensive insight into the appropriate use of programming constructs is evident from the source code.  The program structure is extremely effective. There is very high cohesion and very low coupling.
Maintainability	15%	The code is only sporadically commented, if at all, or comments are unclear.  Few identifier names are clear or inappropriate.  Code formatting hinders readability.	The code is well commented.  Some identifier names are descriptive and appropriate.  An attempt has been made to adhere to a consistent formatting style.  There is little obvious duplication of code or of literal values.	The code is reasonably well commented.  Most identifier names are descriptive and appropriate.  Most code adheres to a sensible formatting style.  There is almost no obvious duplication of code or of literal values.	The code is reasonably well commented, with appropriate Doxygen-compatible documentation.  Almost all identifier names are descriptive and appropriate.  Almost all code adheres to a sensible formatting style.  There is no obvious duplication of code or of literal values. Some literal values can be easily "tinkered".	The code is very well commented, with comprehensive appropriate Doxygen-compatible documentation.  All identifier names are descriptive and appropriate.  All code adheres to a sensible formatting style.  There is no obvious duplication of code or of literal values. Most literal values are, where appropriate, easily "tinkered" outside of the source.	The code is commented extremely well, with comprehensive appropriate Doxygen-compatible documentation.  All identifier names are descriptive and appropriate.  All code adheres to a sensible formatting style.  There is no duplication of code or of literal values. Nearly all literal values are, where appropriate, easily "tinkered" outside of the source.
Performance	15%	No bot is entered into the tournament, or the entered bot is disqualified.	Marks to be allocated according to the bot's Elo score, as measured in a round-robin tournament.				

## Appendix: Tournament Rules

1. Bots will play in a **round-robin** (all-versus-all) tournament.
2. Bots will be ranked by **Elo score**, based on wins and losses.
3. A **rolling tournament** server is available, to which you may upload your bot for testing.
4. However, **final leaderboard position** will be based on the version of your bot that is submitted to LearningSpace.
5. You **may** upload multiple bots to the rolling tournament server, however **only one** submission will be accepted for the final tournament.
6. **All Java source code** for your bot must be provided — pre-compiled files (.class, .jar etc) are **not** permitted. This includes any third-party libraries you use.
7. The bot will **forfeit** the current match if it:
  - (a) Takes longer than 100 milliseconds to choose an action
  - (b) Allocates more than 1GB of memory
  - (c) Crashes by raising an uncaught exceptionForfeiting a match is recorded as a loss.
8. The bot will be **disqualified** from the tournament if it:
  - (a) Fails to compile on the tournament server
  - (b) Creates additional threads or processes
  - (c) Accesses GPU resources
  - (d) Accesses the network
  - (e) Accesses files outside the working directoryDisqualification removes the bot from the tournament, and results in the lowest possible Elo score. If a bot is disqualified from the rolling tournament, you may upload a new version to fix the issue.
9. The bot will be **permanently disqualified** from the tournament if it:
  - (a) **Deliberately** attempts to compromise the security of the tournament server
  - (b) **Deliberately** attempts to interfere with the smooth running of the tournament or the fairness of the resultsPermanent disqualification removes the bot from the tournament, and results in a ban on uploading further bots to the server. Your bot will also not be included in the final tournament. Permanent disqualification will be considered an automatic failure of the Basic Competency Threshold for this assignment.
10. All students are expected to engage with the competition in an **ethical** and **professional** manner. Any perceived breaches of this, as judged by the Module Leader, will be penalised accordingly.