# Creating an Othello player based on Artificial Intelligence Theory - Initial Plan
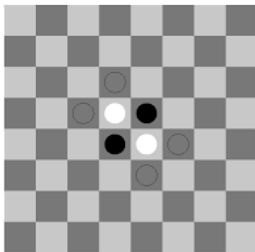
**Module:**     2021-CM3203 - 40 credits

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## Project Description



Othello, also known as Reversi, is a game played by two players on an 8×8 board. The pieces in this game are called "disks", which are white on one side and black on the other. Players flip the opponents' disks to their colours by placing a disk next to an opponent's disk and forming a line, this can be done horizontally, vertically or diagonally. The players' goal is to have the majority of disks turned to display one's colour when the last playable empty square is filled.

Artificial intelligence as an innovative field of Computer Science, is applied in many areas, such as maps navigation, facial detection, recommendation algorithms, and playing board games. The board game AIs such as AlphaGo, are designed and trained to play board games against masters, they play and analyse the games, evaluating the possible moves and therefore choosing the optimal solution.

The topic of my project is to create an Othello AI player that is capable to make sensible moves in Othello games. The development stages involve investigating current existing Othello AI algorithms, designing UI to track the Othello game state, and the systems to customize the AI, including operations for utilising deep neural networks.

## Project Aims and Objectives

The aim of this project is to explore possible approaches of creating and designing an AI player for playing the Othello games. In order to achieving the aim, different existing algorithms invented for Othello AI need to be evaluated, such as Monte Carlo Tree and Minimax search. An Othello game GUI also need to be designed to visualise the process of AI playing the game.

The project should also discuss available approaches to create an evaluation function powered by Deep Learning methods that an AI player can use to accurately determine the worth of a game state. Combining the researches, develop a system with a customisable AI that is able to generate complete Othello games, and possibly find a database of games to create neural networks.

List of Objectives:

1. Research on concepts of Othello and Othello AI

   - such as what moves to play in each phase, recognising patterns of counters and how to best play around them, potential traps, etc.

   1.1. Advanced concepts of Othello, history and rules

   1.2. Game theory, strategies and tactics

2. Design the User Interfaces

   - to ensure the users of the final program will understand how to operate the Othello game and its parameters


3. Investigate existing algorithms and design the AI

   - find out what form of innovation can be involved in my proejct, in comparsion with existing solutions

   3.1. Minimax, α-β Pruning

      - method used when evaluating a game's decision tree to ensure that the move chosen by the player maximises the chance of a favourable outcome for them, discuss how it could be used in building an Othello AI

3.2.    Monte Carlo tree searching

- "a broad class of computational algorithms that rely on repeated random sampling to obtain numerical results. Their essential idea is using randomness to solve problems that might be deterministic in principle." in report, explain why it is an favorable algorithms for Othello AI

3.3.    Deep Learning

- the use of Artificial Neural Networks mimic the human brain's structure by creating a network of neurons (also known as nodes) that are connected by various links, which allows it to be used for learning tasks is that each link's weight can change over time as the deep learning process is run.

- discuss how to approach Deep Learning with Othello

3.4.    UML Class diagrams

- draw the uml diagrams to identifies the key function classes in the implementation.

4.    Programming

4.1.    Choose the programming language

- Python is the my most learned language during my time at Cardiff University. It reads like our everyday English language, thus probably could makes AI development easier and less complex.

4.2.    Implementing the UI

- current thought is to use pygame somehow to create a basic UI first

4.3.    Implementing the AI

- create AI algorithms according the previously discussed approaches (Minimax, Monte Carlo, Deep Learning)

5.    Neural network development

- acquire enough data for the artificial neural networks to analyse and train itself

6. Testing and experimentation

- examine the AI and extract the results to test it's capabilities

6.1. AI vs AI

- use AI with different logic to against each other, investigates the winrates and patterns

6.2. AI vs Human

- find some volunteered participants to play with AI with different Logic, investigates the winrates and patterns

7. Evaluation - final report

- discussion of overall project performance, approach, results, findings and achievements

7.1. Evaluate performance of the implementation

- analysis results obtained from experiments, talk about expectations and the actual system, corresponding to initial plan. What are the limitations recongnized

7.2. Future possible improvements

- identify any improvements could be made, such as adding new features and optimizing the algorithms

7.3. Conclusions

- to have the final say on the issues that have raised in the project, to synthesize  thoughts

7.4. Reflection on Learning

- describe the outcome of the project, reflect on concept, idea and theory. Identify challenges and lesson learned

# Work Plan

| END Date 13th May / Tasks MUST (milestones) | February 14th | February 21st | February 28th | March 7th | March 14th | March 21st | March 28th | April 4th | April 11th | April 18th | April 25th | May 2nd | May 9th | May 13th |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Weekly meeting | ▓ | ▓ | ▓ | ▓ | ▓ | ▓ | ▓ | ▓ | ▓ | ▓ | ▓ | ▓ | ▓ | ▓ |
| Complete project with functional code | ▓ | ▓ | ▓ | ▓ | ▓ | ▓ | ▓ | ▓ | ▓ | ▓ | ▒ | ▒ | ▒ | |
| Research on concepts of Othello and Othello AI | ▓ | ▓ | ▒ | | | | | | | | | | | |
| Design the game UI | ▓ | ▓ | ▒ | | | | | | | | | | | |
| Investigate existing algorithms and design the AI | ▓ | ▓ | ▓ | ▒ | ▒ | | | | | | | | | |
| Programming | | | | ▓ | ▓ | ▓ | ▓ | ▓ | ▒ | | | | | |
| Neural network development | | | | | ▓ | ▓ | ▓ | ▓ | ▒ | | | | | |
| Testing and experimentation | | | | | | | | ▓ | ▓ | ▒ | | | | |
| Run tests on system and debug | | | | | | | | ▓ | ▓ | ▒ | ▒ | ▒ | | |
| Evaluation and write the Final report | | | | | | | | | ▓ | ▓ | ▓ | ▓ | ▓ | ▒ |
| Review meeting | | | | | | | | ▓ | ▓ | ▓ | ▓ | ▓ | ▓ | |
| **Tasks COULD** | | | | | | | | | | | | | | |
| Not yet come up with one | | | | | | | | ▓ | ▓ | ▓ | ▓ | ▓ | ▨ | |

The Gantt chart will be used as a plan for me to follow and ensure that I do not fall far behind on finishing the project. It has two sections, the first being a must complete section, where all the tasks must be completed. The second is a could complete section, where if I have spare time I will attempt to try to complete.

To allow for more flexibility in case extra time is needed to complete one or more of the tasks, red boxes are filled in the Gantt chart to show that there is spare time to finish tasks if an issue or a problem occurs. The red boxes were included to ensure the highest rate of success for this project. Note that the chart above is the initial version, which could be easily adjustable as I deepened my understanding of the project.

The first phase would be searching and planning, expected to be done before the 28th of February, including the summarization of existing algorithms and initial design of my own project. The programming phase is expected to be the longest, which is also the phase that I most uncertain about. For the test and experimentation section real participants will be involved thus ethics documents need to be prepared and signed, participants would be other students from Cardiff University. The final report is planned to start from April, and it will also be progressed during the development of other phase.

The initial plan for the review meetings to be done is after the most important milestones have been reached. The first review meeting expecting to be the start of April(4th-11th) when I'm about to finish the programming phase, and the second review meeting expecting to be the start of May(2nd-9th) when I'm about to finish the final report. The weekly meeting could be done once a week for a shorter time or once every two weeks for a longer time.

## Planning for Final Report

The final report should cover all the design, implementation and evaluation stages in detail, provides justifications on why and how certain decision was made towards the final design. One of the key parts of the final report is to assess how this project could be continued and further developed. The code will be analysed with suggestions and a statement of future work that is needed to be done if the project is to be continued.