



Ain shams university Faculty of Engineering
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Course: Artificial Intelligence

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1- GitHub link:

https://github.com/moaz152/Othello_AI_Player

2-The YouTube video :

<https://drive.google.com/drive/folders/1MM52Oaxc1EuHYSaYemCL5sL3aUbRnuy4>

3- The chosen programming language :

For our project, we decided to use the **Java** programming language. since Java is an Object-Oriented programming language, I was easily able to create and manage the various classes that will make up the game and AI, including how they interface with one another, which was important for allowing the AI to interact with the Othello game, and for allowing the AI's decider and evaluator classes to be chosen at runtime. Finally, Java provides numerous packages and classes for easy UI creation, such as Swing. By creating an interface using these packages, I was able to quickly create the necessary graphical interface to easily show the game state.

4-UML diagrams:

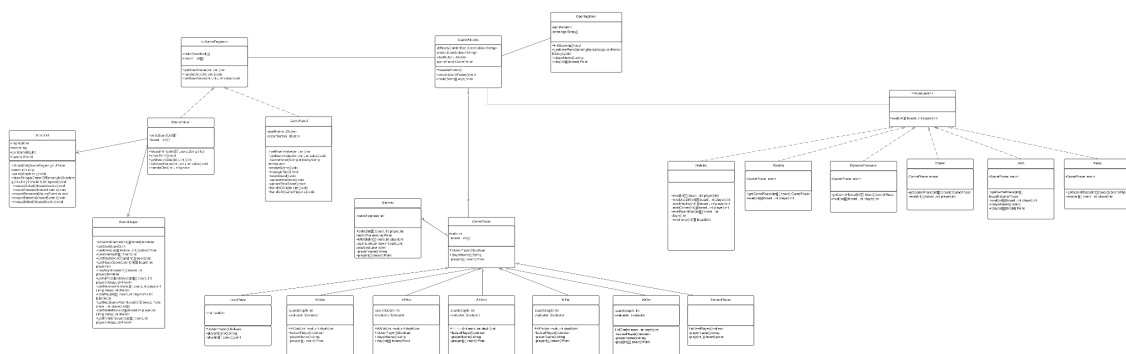
UML Class Diagram

To provide myself with a clear class structure to follow in the development stage, we created a UML Class Diagram to outline the functionality of the most important classes in the implementation.

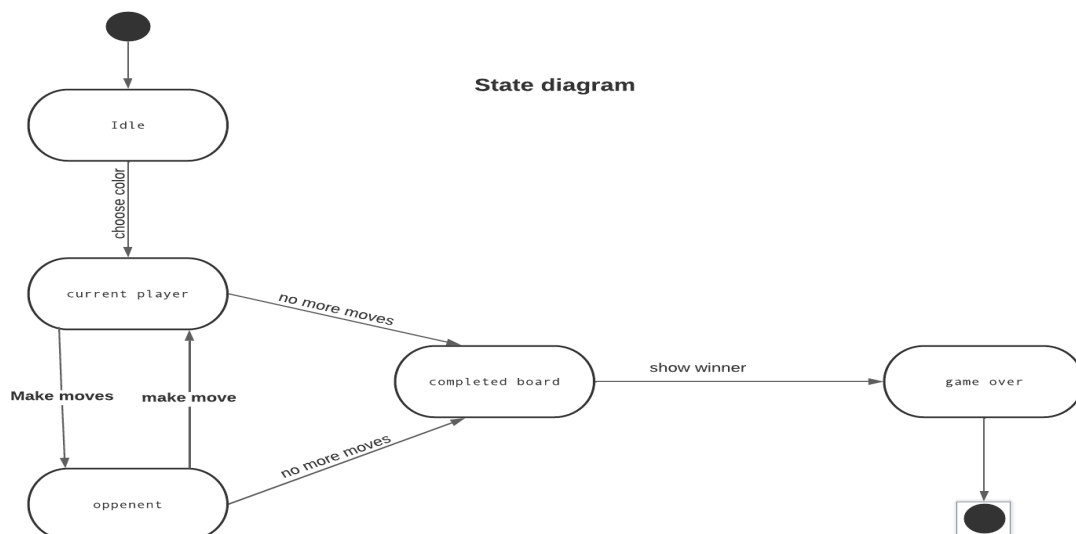
Overall Structure

Classes associated with the Othello game logic are outlined in blue, classes associated with the UI are outlined in green, and classes that will contain AI routines are outlined in red. Though the diagram does not list every class included in the final program, the classes shown are the most important to the Othello game's logic and display, and the AI program's operation. Each class has a name, example methods and fields, and connections to related classes.

a)Class diagram



b)State diagram



5- Game playing supported algorithms:

Minimax Search

The search algorithm is a minimax search with alpha-beta pruning.

Evaluation Function

- **Real Time Evaluation** : Evaluation function changes as you move from early-game to end-game with each move , using linear interpolation between static values.
- **Machine-Learning-Tuned Evaluation** : we've used Hill-Climbing algorithm to train weights on each heuristic function based on game progress.

Heuristic Functions

One of the most critical components of the search algorithm is the heuristic function, which evaluates the strength and overall desirability of a given board position. It is implemented as a linear combination of the following statistics, with the weights adapting as the game progresses

- **Corner Grab** (Measures if the current player can take a corner with its next move, Weighted highly at all times.)
- **Stability** (Measures the number of discs that cannot be flipped for the rest of the game. Weighted highly at all times.)
- **Mobility** (Measures the number of moves the player is currently able to make. Has significant weight in the opening game, but

diminishes to zero weight towards the endgame.)

- **Placement** (piece placement score of the current player minus the piece placement score of the opponent.)
- **Frontier Discs** (number of spaces adjacent to opponent pieces minus the the number of spaces adjacent to the current player's pieces.)
- **Disc difference** (Measures the difference in the number of discs on the board. Has zero weight in the opening, but increases to a moderate weight in the midgame, and to a significant weight in the endgame.)
- **Parity** (Measures who is expected to make the last move of the game. Has zero weight in the opening, but increases to a very large weight in the midgame and endgame.) (currently unused feature)

Used heuristics, their description and the benefits of using them:

heuristics are strategies or approaches that players can use to guide their decision-making and improve their chances of winning the game. Here are some examples of heuristics that can be used in the Othello game:

1. Control the center of the board: In Othello, the four center squares are considered to be the most valuable squares. Players can use this heuristic to guide their early game strategy by focusing on controlling the center of the board.
2. Focus on mobility: Mobility is an important factor in the Othello game, as it allows players to move and capture pieces more easily. Players can use this heuristic to guide their gameplay by prioritizing moves that increase their mobility and limit their opponent's mobility.
3. Look for potential flips: In Othello, a player can flip their opponent's pieces by surrounding them on two opposite sides. Players can use this heuristic to identify potential flips on the board and prioritize moves that create these opportunities.
4. Avoid corner squares: The corner squares in Othello are considered to be less valuable than other squares, as they limit a player's mobility and make it more difficult to flip pieces. Players can use this heuristic to guide their gameplay by avoiding moves that place their pieces in the corner squares.

The benefits of using heuristics in the Othello game include:

1. Improved decision-making: Heuristics can help players make better decisions by providing a framework for evaluating moves and strategies.

2. Increased efficiency: By using heuristics to guide their gameplay, players can work more efficiently and make more effective use of their time.
3. Improved performance: Heuristics can help players improve their performance in the game by providing a structure for learning and improving their gameplay.
4. Increased enjoyment: By using heuristics to guide their gameplay, players can enjoy the game more by feeling more confident and in control of their moves and strategies.

Supported features:

1. Interactive game board: Digital versions of the Othello game provide an interactive game board that allows players to place their pieces and see the current state of the game.
2. AI opponents: Many digital versions of the Othello game include AI opponents that can provide a challenging single-player experience.
3. Multiplayer support: Digital versions of the Othello game often include multiplayer support, allowing players to compete against other players online.
4. Tutorial and practice modes: Some digital versions of the Othello game include tutorial and practice modes that can help players learn the game and improve their skills.
5. Customization options: Some digital versions of the Othello game provide customization options, allowing players to choose different board configurations, piece sets, and rules variations.

6- Evaluation:

	Coins	Corners	Stability	Mobility
Coins		45-19	59-5	54-9
Corners			5-59	29-35
Stability	24-40	38-26		
Mobility	20-44	45-19	30-34	