checker Game

1. Project idea in details
2. Main functionalities
3. Similar applications in the market
4. An initial literature review of academic publications (papers) relevant to the idea
5. Details of Alpha Beta algorithm

1- Project idea in details

checkers, also called draughts, board game, one of the world's oldest games.

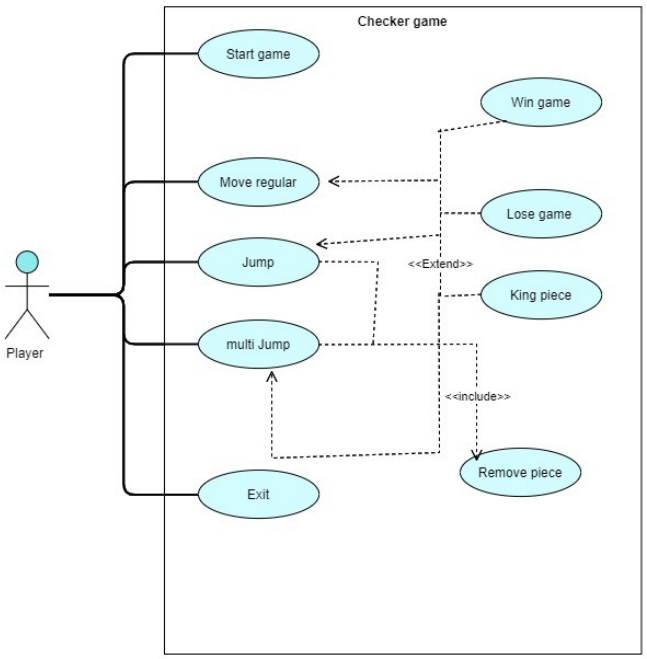
Checkers is played by two persons who oppose each other across a board of 64 light and dark squares, the same as a chessboard. The 24 playing pieces are disk-shaped and of contrasting colours (whatever their colours, they are identified as black and white). At the start of the game, each contestant has 12 pieces arranged on the board.

While the actual playing is always done on the dark squares, the board is often shown in reverse for clarity. The notation used in describing the game is based on numbering the squares on the board. The black pieces always occupy squares 1 to 12, .and the white pieces invariably rest on squares 21 to 32 Play consists of advancing a piece diagonally forward to an adjoining vacant square.

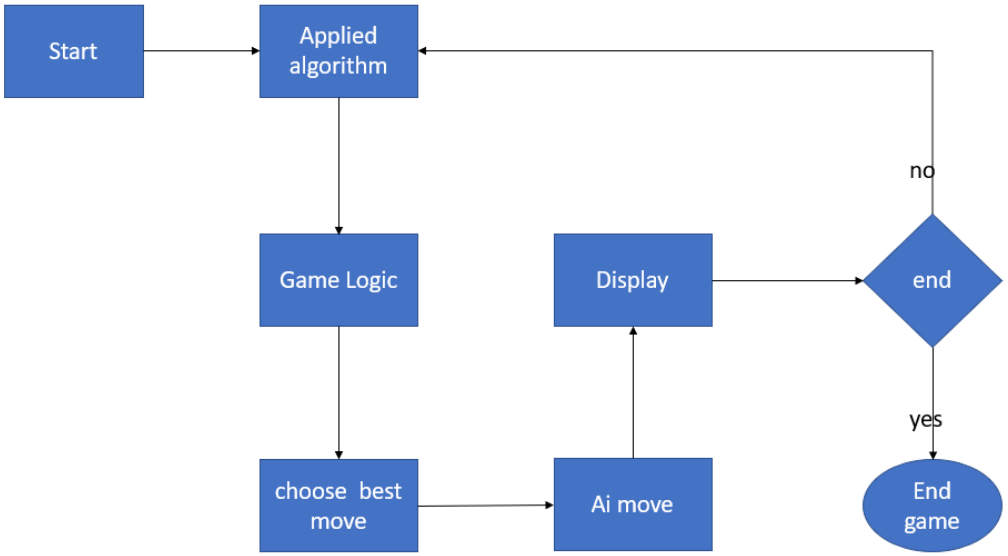
Black moves first. If an opponent's piece is in such an adjoining vacant square, with a vacant space beyond, it must be captured and removed by

jumping over it to the empty square. If this square presents the same situation, successive jumps forward in a straight or zigzag direction must be completed in the same play. When there is more than one way to jump, the player has a choice. When a piece first enters the king row, the opponent's back row, it must be crowned by the opponent, who places another piece of the same colour on it. The piece, now called a king, has the added privilege of moving and jumping backward; if it moved to the last row with a capture, it must continue capturing backward if possible. A win is scored when an opponent's pieces are all captured or blocked so that they cannot move. When neither side can.force a victory and the trend of play becomes repetitious, a draw game is declared

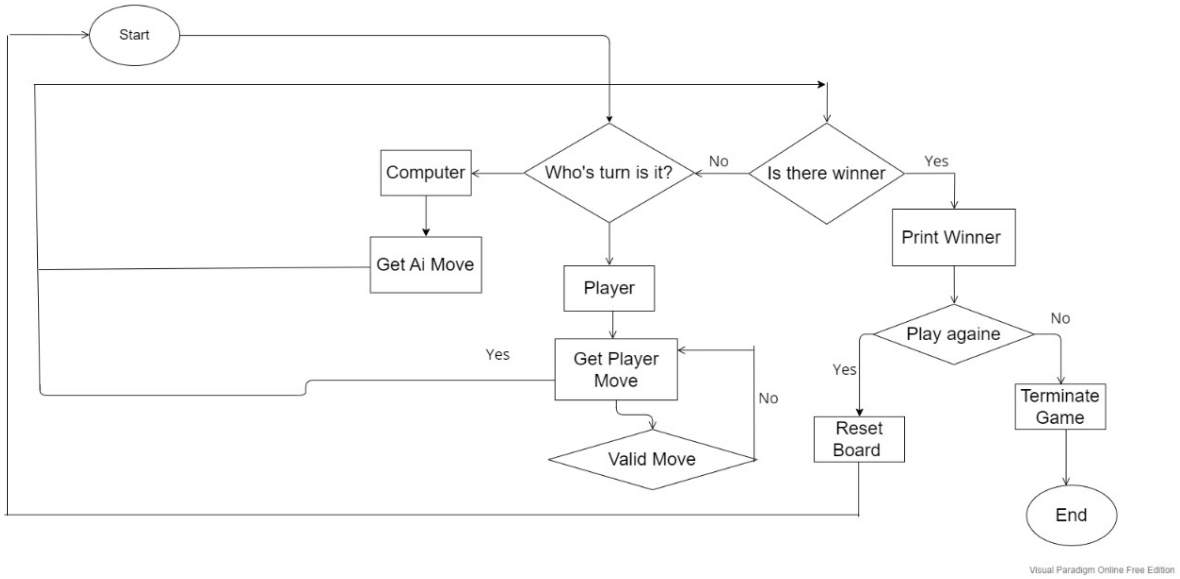
2 - Main functionalities



Block diagram for checkers



Checkers Player Game Flowchart



3 -Heuristic Function

Heuristic Function 1

```
return self.blue_left - self.white_left
```

For our implementation, it was evident that we would need to use an adversarial search. Additionally, we are planning on implementing an Alpha-Beta Depth-First algorithm into our artificial intelligence since this is a turn-based game. Now that we decided on those two elements of our AI, we needed to think of a good approach to our heuristic function. For this, we initially will use a simple function that will take the total count of the AI's chips minus the total amount of the opponent chips (i.e.: (# my pieces) - (# opponents' pieces)).

Heuristic Function (2)

```
return self.blue_left - self.white_left + (self.blue_kings * 0.5 -
self.white_kings * 0.5)
```

We quickly realized that we would eventually have to modify our heuristic function to add weight to acquiring a king since that is a very advantageous move for the player.
The "evaluation" of our project is simply how well it plays (against other AI and against humans). Obviously, we would like to maximize the number of games that our AI wins. To do this, we are going to modify our heuristic to include a weight for a king piece, as having a king makes more states available with one move and thus allows for more chances to take the opponent's pieces. (i.e.: (# my pieces) - (# opponents' pieces) + (# my king pieces * 0.5 - # opponents' king pieces * 0.5)). In the function we multiply the number of kings * 0.5 to make the result of all function a small number to treat with it easily.

The algorithms use different heuristics to form various evaluation functions. Here we will describe our attempts at creating several fine heuristics..

1: Eval l – Piece to value

Our most basic function counts for the player who builds the tree the value of his pieces and subtracts from it the value of opponent's pieces. Since Kings are considered more powerful than regular pawn.

Specifically:

Pawn's value = 1 King's value = 1.5

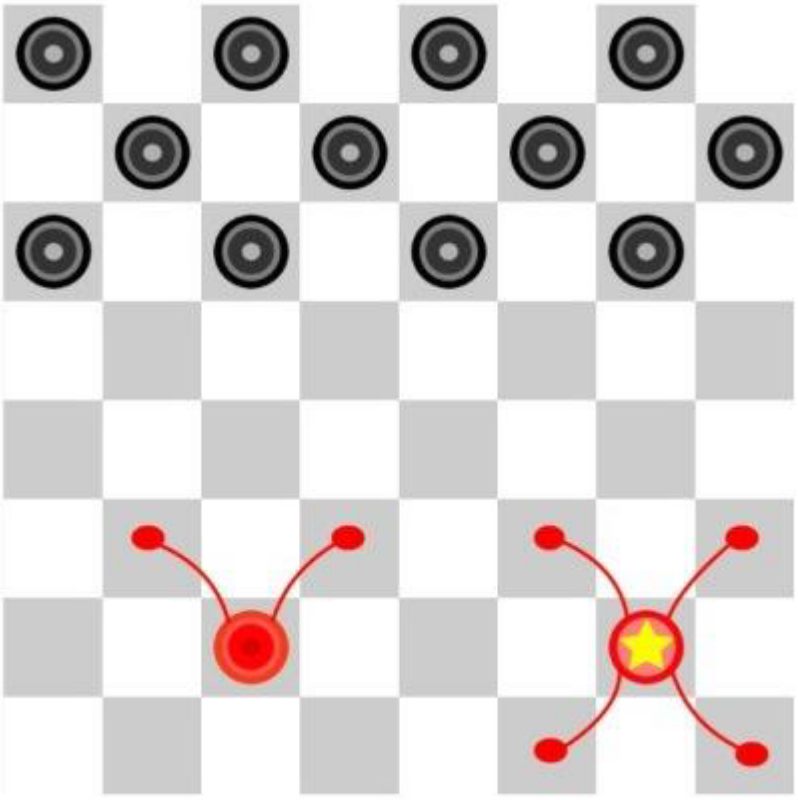


Figure 1.1: Move of a man and move of a king.

2: Eval lll – Piece & Row to value

This function is a small modification to the previous function in a sense that this function gives specific value of row to heuristic.

Pawn's value: 5 + row number

King's value = 5 + # of rows + 2

Similar Apps In Checker

1-Draughts

2-Halma

3-Konane

4- An initial literature review of academic publications (papers) relevant to the idea

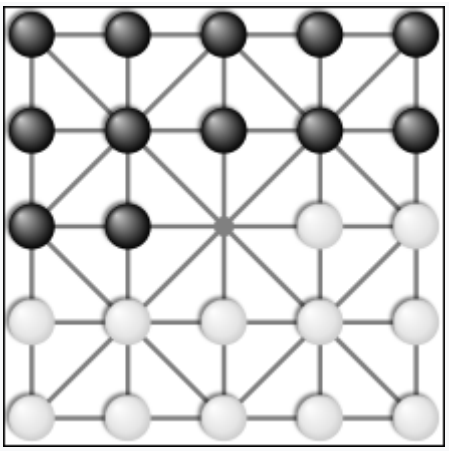
The history of the checker games:

Ancient games:

Similar games have been played for millennia. A board resembling a checkers board was found in Ur dating from 3000 BC. In the British Museum are specimens of ancient Egyptian checkerboards, found with their pieces in burial chambers, and the game was played by the pharaoh Hatshepsut. Plato mentioned a game, as being of Egyptian origin, and Homer also mentions it. The method of capture was placing two pieces on either side of the opponent's piece. It was said to have been played during the Trojan War. The Romans played a derivation of petteia called or the game of the Little Soldiers.

Alquerque

Main article: Alquerque



Alquerque board and setup

An Arabic game called *Quirkat* or *al-qirq*, with similar play to modern checkers, was played on a 5×5 board.

It is mentioned in the tenth-century work Kitab al-Aghani. Al qirq was also the name for the game that is now called nine men's morris. Al qirq was brought to Spain by the Moors, where it became known as *Alquerque*, the Spanish derivation of the Arabic name.

The rules are given in the 13th-century book *Libro de los juegos*. In about 1100, probably in the south of France, the game of Alquerque was adapted using backgammon(طاولة الزهر) pieces on a chessboard. Each piece was called a "fers", the same name as the chess queen, as the move of the two pieces was the same at the time.

Crowning[edit]

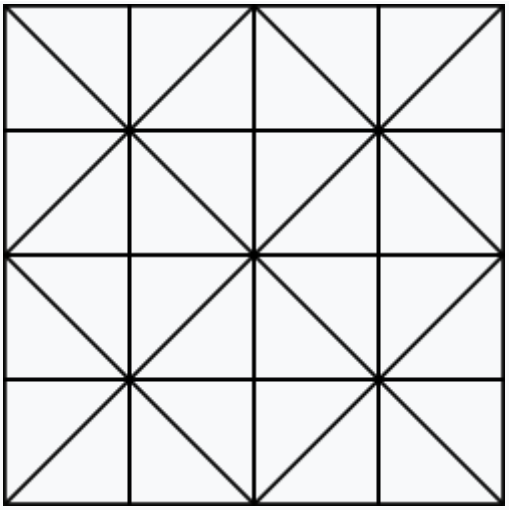
Men in medieval clothing playing checkers

The rule of crowning was used by the 13th century, as it is mentioned in the Philippe Mouskés's *Chronique* in 1243 when the game was known as *Fierges*, the name used for the chess queen (derived from the Persian *ferz(*الفارس الفارسي*)*, meaning royal counsellor or vizier(الوزير)).

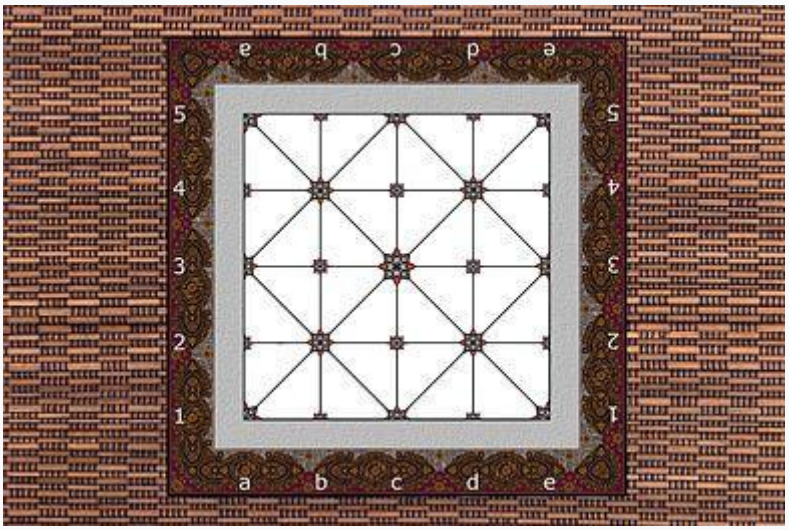
The pieces became known as "dames" when that name was also adopted for the chess queen. The rule forcing players to take whenever possible was introduced in France in around 1535, at which point the game became known as *Jeu forcé*, identical to modern American checkers." The game without forced capture became known as *Le jeu plaisant de dames*, the precursor of international checkers.

The 18th-century English author Samuel Johnson wrote a foreword to a 1756 book about checkers by William Payne, the earliest book in English about the game.[5]

Rules:



An empty abstract Alquerque board



This board graphic displays Moorish design elements relating to the origin of Alquerque. The algebraic notation facilitates move annotation and gameplay discussion.

Before starting, each player places their twelve pieces in the two rows closest to them and in the two rightmost spaces in the center row. The game is played in turns, with one player taking white and the other black.

- A piece can move from its point to any empty adjacent point that is connected by a line.
- A piece can jump over an opposing piece and remove it from the game, if that opposing piece is adjacent and the point beyond it is empty.
- Multiple capturing jumps are permitted, and indeed compulsory if possible.
- If a capture is possible it must be made, or else the piece is removed (or huffed).

The goal of the game is to eliminate the opponent's pieces.

Additional rules

R. C. Bell developed additional rules, saying those given by Alfonso X "are not sufficient to play a game". These extra rules are:

- A piece cannot move backward (e.g., a piece in the middle of an empty board would have five available moves).
- No piece can return to a point it has previously occupied.
- Once a piece has reached the opponent's back row it can only move to capture opposing pieces.
- The game is won when either:
    - The opponent has lost all of their pieces.
    - None of the opponent's pieces are able to move.

Bell also includes a scoring system for rating games.

And now:

Checkers (American English), also known as **draughts** ,is a group of strategy board games for two players which involve diagonal moves of uniform game pieces and mandatory captures by jumping over opponent pieces. Checkers is developed from alquerque. The term "checkers" derives from the checkered board which the game is played on, whereas "draughts" derives from the verb "to draw" or "to move".

The most popular forms of checkers in Anglophone countries are American checkers (also called English draughts), which is played on an 8×8 checkerboard; Russian draughts, Turkish draughts both on an 8x8 board, and International draughts, played on a 10×10 board – the latter is widely played in many countries worldwide. There are many other variants played on 8×8 boards. Canadian checkers and Singaporean/Malaysian checkers (also locally known as *dum*) are played on a 12×12 board.

American checkers was weakly solved in 2007 by a team of Canadian computer scientists led by Jonathan Schaeffer. From the standard starting position, perfect play by each side would result in a draw.

General rules

- Checkers is played by two opponents on opposite sides of the game board. One player has dark pieces (usually black).the other has light pieces (usually white or red).
- Players alternate turns.
- A player cannot move an opponent's pieces.
- A move consists of moving a piece diagonally to an adjacent unoccupied square.
- If the adjacent square contains an opponent's piece, and the square immediately beyond it is vacant, the piece may be captured (and removed from the game) by jumping over it.
- Only the dark squares of the checkerboard are used.
- A piece can only move diagonally into an unoccupied square.
- When capturing an opponent's piece is possible, capturing is mandatory in most official rules.
- If the player does not capture, the other player can remove the opponent's piece as a penalty (or muffin), and where there are two or more such positions the player forfeits pieces that cannot be moved (although some rule variations make capturing optional).
- In almost all variants, the player without pieces remaining, or who cannot move due to being blocked, loses the game.

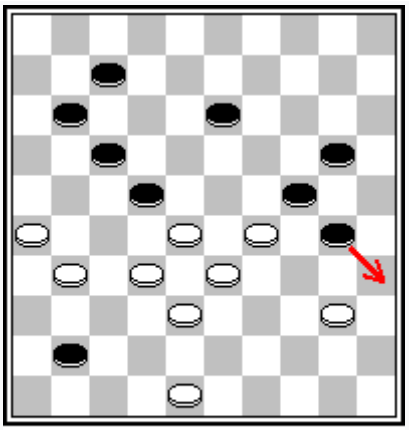
Pieces

Man:

An uncrowned piece (*man*) moves one step diagonally forwards and captures an adjacent opponent's piece by jumping over it and landing on the next square.

Multiple enemy pieces can be captured in a single turn provided this is done by successive jumps made by a single piece; the jumps do not need to be in the same line and may "zigzag" (change diagonal direction). In American checkers, men can jump only forwards; in international draughts and Russian draughts, men can jump both forwards and backwards.

King :



A game in international draughts (10×10 board), featuring a flying king (the move "Les Blancs prennent 6 pions...")

When a man reaches the farthest row forward, known as the *kings row* or *crown head*, it becomes a *king*. It is marked by placing an additional piece on top of, or *crowning*, the first man. The king has additional powers, including the ability to move backwards and, in variants where men cannot already do so, capture backwards. Like a man, a king can make successive jumps in a single turn, provided that each jump captures an enemy piece.

In international draughts, kings (also called *flying kings*) move any distance along unblocked diagonals. They may capture an opposing man any distance away by jumping to any of the unoccupied squares immediately beyond it. Because jumped pieces remain on the board until the turn is complete, it is possible to reach a position in a multi-jump move where the flying king is blocked from capturing further by a piece already jumped.

Flying kings are not used in American checkers; a king's only advantage over a man is the additional ability to move and capture backwards.

The American checkers :

- Man can move one step diagonally forwards
- When man become king ,he has the ability to move and capture backwards.

The international checkers :

- Man can move forwards and backwards.
- King and move any diagonal distance

5. Details of Alpha Beta algorithm

Alpha Beta pruning algorithm is a modified version of minimax algorithm ,It can be applied at any depth of a tree and returns the same result as minimax .

It is an adversarial search algorithm used commonly for machine playing of two-player games.

It seeks to decrease the number of nodes that are evaluated by minimax algorithms by applying a technique called pruning . This technique prunes away the branches that have no influence in the final decision.

Alpha Beta pruning algorithm uses two parameters :

- Alpha
  Alpha is the highest value choice that we have found so far and it's initial value is $-\infty$

- Beta
  Beta is the lowest value choice that we have found so far and it's initial value is $+\infty$

Alpha-beta pruning primary prerequisite is : $\alpha >= \beta$

Alpha-Beta Pruning Key Concepts :

Alpha-Beta depends in two players (Max and Min)

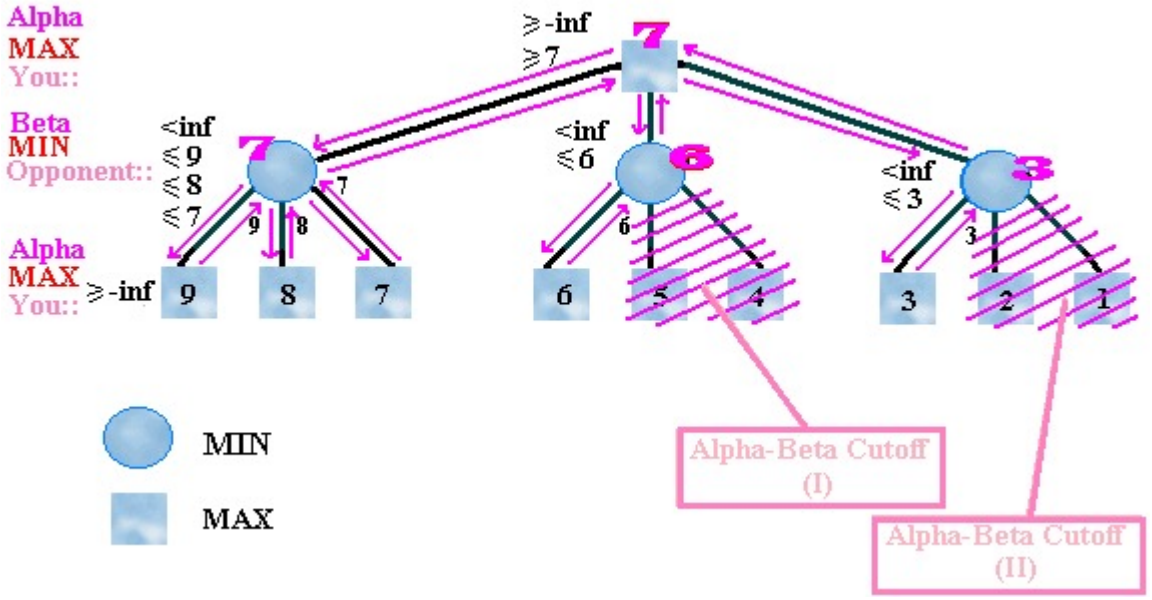
Max player updates only the alpha value and tries to maximize his opportunity to win .
Min player updates only the beta values and tries to minimize Max's opportunity to win .

Algorithm pseudocode :

```
function alphaBeta(position, depth, alpha, beta,
isMaxPlayer )
     if depth == 0 or game over in position
          return static evaluation of position

     if isMaxPlayer
          maxEvaluation = - infinity
          for each child of position
               evaluation = alphaBeta(child, depth - 1,
alpha, beta, false)
               maxEvaluation = max(maxEvalution ,
evaluation)
               alpha = max(alpha, evaluation)
               if beta  <= alpha
                    break
          return maxEvaluation

     else
          minEvaluation = + infinity
          for each child of position
               evaluation = alphaBeta(child, depth - 1,
alpha, beta, true)
               minEvaluation = min(minEvaluation,
evalution)
               beta = min(beta, evalution)
               if beta <= alpha
                    break
          return minEvaluation
```



- What are the advantages / disadvantages?

- Advantages

- Great graphics
- Advanced checkers engine
- Perfect for a quick break or a few hours of fun
- Aim to get a checker to the end of the board

- Disadvantages

- Do not play only defensively
- Be willing to sacrifice pieces

Development platform:

a. Visual Studio , pycharm

b. Python 3.11.0 version

c. Pygame Library -> to develop checkers 2D game.

d. GitHub Repo ->

https://github.com/nadaalaa22/checker-game-in-python

Resources

1- https://www.javatpoint.com/ai-alpha-beta-pruning

2-https://en.wikipedia.org/wiki/Alpha%E2%80%93beta_pruning#:~:text=Alpha%E2%80%93beta%20pruning%20is%20a,%2C%20Go%2C%20etc.).