**Computer Science Final Project: Connect 4**

**Requirements and planning**

* The connect 4 project that I am trying to create is a game that can be either multiplayer or vs computer (I will be implementing both). The game is played using the standard 6x7 board, where each opponent can place a ‘piece’ into one of the 7 columns (each player has a distinct piece). The goal of the game is to build a row consisting of 4 pieces of the same piece (horizontal, vertical or diagonal).

**Methodology:**

* The first step to creating this game is to design and print the board. This is a fairly easy step as it only requires for loops to build the board. However an array must also be used to treat the board as a grid with coordinates, so that each move will take a certain position.
* The next step is to check for a connect 4 after each move. This requires using  a loop to check all surrounding positions and if for consecutive pieces of the same type are met, then we have a win.
* There are certain aspects that must be controlled in connect 4. For example, we must ensure that an error message loads when a column is filled so that no more pieces are added to it (max number of pieces in a column is 6). We must also ensure the inputs are between 1-7 as that is the column range.
* For implementing the game such that we are versing the computer, an algorithm must be followed where the computer responds properly to each move the user makes.

**4 Upcoming Weeks**

* Week 1: planning
* Week 2: create base board and implement the adding of pieces
* Week 3: create multiplayer version
* Week 3: create vs computer version

**Design:**

**For multiplayer…**

***Functions to include:***

3 main functions form the basis of connect 4.

1. First function will be used to print and display the board.
2. Second function will input the pieces to the corresponding positions on the board.
3. Third function will check to see if a connect 4 has been made, indicating a win.

First function just requires two nested for loops, one counting to 6 (the rows) and the other counting to 7 (the columns).

For the second function, we need to be able to store and keep track of each piece position, otherwise it would be impossible to determine a  win. To do this, we use a 2D array.. Each time the user inputs a piece to a certain column, the 2D array will store the row and column ([row] [col]) similar to a coordinate system.

For the third function we will simply be using multiple for loop that run and check the pieces in the surrounding (up, down, left, right) of a given position and would count how many identical pieces there are consecutively. If there are 4 or higher, it will return a true (indicate win) and otherwise it would return a false (indicating that game has not ended yet, or a draw is being made). It is possible for a draw to occur and that would mean that all the positions in the board are filled with no connect 4 made. This requires us to build another function that checks if the board is full, allowing us to print the proper “draw” message.

**For vs Computer…**

I was not able to successfully  implement this concept into my code and so I’ve only completed a multiplayer version. However, I do understand some of the procedures and ideas that must be taken into account to create a working artificial intelligent algorithm.

The best algorithm to use for creating an artificial connect 4 game is the MiniMax algorithm. It uses a recursion function that checks the 7 possible plays that the computer can make. Inside each one of them it checks the 7 possible plays that the player could make after. Then inside each one of those plays, it checks again for the next 7 possible plays the computer could make it and this goes on for usually about 3 or 5 levels.

Next, a score is calculated based on the possible winning opportunities for both the computer and the user. The score is returned in each level to the upper level until it reaches the very first level where there is a score for every possible move the computer could make. Based off the score, the computer will be able to make the move that would lead to winning.

For assigning a score, the winning opportunities are read and the one requiring the least number of moves to winning is given the highest score and vice versa. For example if there is an empty position that has around it, a row of 3 identical pieces (horizontal, vertical or diagonal), then a high score is assigned. If  there were 2 pieces around it, then a lower score is assigned.

By applying more recursion levels to the algorithm, we can better predict the best move for the computer.

I ran into trouble for implementing the score system and the computer was not able to make correct decisions. Another type of artificial intelligence could have been implemented and that is a random system. It would assign random column choices for the computer. The line of code below is what could have been used for a random system.

**“int column = rand() % 7;”**

**Post Mortem**

* Although my connect 4 project works in the case of multiplayer, it does not work as an artificial system. This contradicts my initial plans for this project and shows that I was somewhat unsuccessful. However, I still learned to a high degree about the theory required for implementing such a program and hopefully I could complete the project sometime in the future.
* My multiplayer project went really well as everything went according to plan. It took some time for me to completely understand the 2D array system (very crucial to program) but once understood, the functions merged well together and the program ran. Initially, I spent quite a bit of time trying to create a more professional looking board and that wasted valuable time. In the future I would personally go for the hard portion of the program first and get as much of it done as possible, then go and complete the easier portions (eg. nice board).

**Weekly Status**

**Week 1**

**Done:**

* Time was spent choosing a topic
* I looked at ideas such as inverse matrices, a snake game and lastly connect 4
* After I chose connect 4, I began researching into 2D array systems and winning methods of connect 4

**In the Way:**

* + Focusing in class

**Next Week:**

* + Finish base board for connect 4

**Week 2**

**Done:**

* Base board of connect 4 completed
* 2D array system was in development (didn’t quite work perfectly)

**In the Way:**

* + Focusing in class
  + Too much time spent on trying to make the board look nice (adding ‘cls’ clear screen)

**Next Week:**

* + Be able to store positions from inputs

**Week 3**

**Done:**

* Working 2D array system
* Values stored
* Multiplayer system where two users input distinct pieces
* Researched into the minimax algorithm

**In the Way:**

* + Focusing in class

**Next Week:**

* + Create a function that checks for a win
  + Ensure that max row and full table controls are made

**Week 4**

**Done:**

* Tried to implement minimax algorithm (failed miserably)
* Check for win function completed
* Controls made
* Multiplayer works
* Still trying to get artificial intelligence system to work

**In the Way:**

* + procrastination

**Testing**

This program is a multiplayer connect 4 game!

Player 1, please type in your name: Hossein

Player 2, please type in your name: Hossein2

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Hossein, it's your turn, Choose one of the labelled columns (1-7): 34

Hossein, it's your turn, Choose one of the labelled columns (1-7): -45

Hossein, it's your turn, Choose one of the labelled columns (1-7): 3

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Hossein2, it's your turn, Choose one of the labelled columns (1-7): 0

Hossein2, it's your turn, Choose one of the labelled columns (1-7): 4

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Hossein, it's your turn, Choose one of the labelled columns (1-7): 1

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Hossein2, it's your turn, Choose one of the labelled columns (1-7): 2

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Hossein, it's your turn, Choose one of the labelled columns (1-7): 7

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Hossein2, it's your turn, Choose one of the labelled columns (1-7): 7

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Hossein, it's your turn, Choose one of the labelled columns (1-7): 6

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Hossein2, it's your turn, Choose one of the labelled columns (1-7): 5

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Hossein, it's your turn, Choose one of the labelled columns (1-7): 1

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Hossein2, it's your turn, Choose one of the labelled columns (1-7): 3

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Hossein, it's your turn, Choose one of the labelled columns (1-7): 3

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Hossein2, it's your turn, Choose one of the labelled columns (1-7): 1

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Hossein, it's your turn, Choose one of the labelled columns (1-7): 2

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Hossein2, it's your turn, Choose one of the labelled columns (1-7): 2

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Hossein, it's your turn, Choose one of the labelled columns (1-7): 1

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Hossein2, it's your turn, Choose one of the labelled columns (1-7): 5

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Hossein, it's your turn, Choose one of the labelled columns (1-7): 3

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Hossein2, it's your turn, Choose one of the labelled columns (1-7): 6

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Hossein, it's your turn, Choose one of the labelled columns (1-7): 4

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Hossein2, it's your turn, Choose one of the labelled columns (1-7): 6

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Hossein, it's your turn, Choose one of the labelled columns (1-7): 4

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Hossein2, it's your turn, Choose one of the labelled columns (1-7): 2

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Hossein, it's your turn, Choose one of the labelled columns (1-7): 3

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Hossein2, it's your turn, Choose one of the labelled columns (1-7): 3

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Hossein, it's your turn, Choose one of the labelled columns (1-7): 4

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Hossein, YOU JUST WON!

Would you like to play again? Enter 1 for yes and 2 for No: 1

Hossein2, it's your turn, Choose one of the labelled columns (1-7): 5

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Hossein, it's your turn, Choose one of the labelled columns (1-7): 4

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Hossein2, it's your turn, Choose one of the labelled columns (1-7): 3

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Hossein, it's your turn, Choose one of the labelled columns (1-7): 2

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Hossein2, it's your turn, Choose one of the labelled columns (1-7): 1

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|OYOYO~~|

Hossein, it's your turn, Choose one of the labelled columns (1-7): 5

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|OYOYO~~|

Hossein2, it's your turn, Choose one of the labelled columns (1-7): 6

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|OYOYOO~|

Hossein, it's your turn, Choose one of the labelled columns (1-7): 7

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|OYOYOOY|

Hossein2, it's your turn, Choose one of the labelled columns (1-7): 7

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|OYOYOOY|

Hossein, it's your turn, Choose one of the labelled columns (1-7): 7

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|OYOYOOY|

Hossein2, it's your turn, Choose one of the labelled columns (1-7): 7

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|OYOYOOY|

Hossein, it's your turn, Choose one of the labelled columns (1-7): 7

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|OYOYOOY|

Hossein2, it's your turn, Choose one of the labelled columns (1-7): 7

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|OYOYOOY|

Hossein, it's your turn, Choose one of the labelled columns (1-7): 7

That column is full, please choose another column: 7

That column is full, please choose another column: 7

That column is full, please choose another column: 7

That column is full, please choose another column: 6

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|OYOYOOY|

Hossein2, it's your turn, Choose one of the labelled columns (1-7): 5

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|OYOYOOY|

Hossein, it's your turn, Choose one of the labelled columns (1-7): 1

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|OYOYOOY|

Hossein2, it's your turn, Choose one of the labelled columns (1-7): 2

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|OYOYOOY|

Hossein, it's your turn, Choose one of the labelled columns (1-7): 3

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|OYOYOOY|

Hossein2, it's your turn, Choose one of the labelled columns (1-7): 4

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Hossein, it's your turn, Choose one of the labelled columns (1-7): 2

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Hossein2, it's your turn, Choose one of the labelled columns (1-7): 1

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|OYOYOOY|

Hossein, it's your turn, Choose one of the labelled columns (1-7): 4

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Hossein2, it's your turn, Choose one of the labelled columns (1-7): 5

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Hossein, it's your turn, Choose one of the labelled columns (1-7): 6

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Hossein2, it's your turn, Choose one of the labelled columns (1-7): 2

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Hossein, it's your turn, Choose one of the labelled columns (1-7): 3

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Hossein2, it's your turn, Choose one of the labelled columns (1-7): 4

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Hossein, it's your turn, Choose one of the labelled columns (1-7): 2

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|OYOYOOY|

Hossein2, it's your turn, Choose one of the labelled columns (1-7): 3

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|YOYOYYO|

|OYOYOOY|

Hossein2, YOU JUST WON!

Would you like to play again? Enter 1 for yes and 2 for No: 2

Game Ended

Process returned 0 (0x0)   execution time : 139.370 s

Press any key to continue.