Four connect

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**Overview**

To develop the Four Connect game c11 programming language is used with console based interface. The console displays the game state after each move. There are four versions are implemented 1. MinMax vs Random (Disk Removal), 2. MinMax vs Random (Without Disk Removal), 3. MinMax vs Human and 4. Player vs Player. At the start of the game, it asks the user to select the type of the game. The game is played between two users 1. Computer (MinMax), Computer (Random Move). It is allowed to MinMax player to remove its disk at the bottom after each 3rd turns and due to disk removal all the disks are moved to below one row to bottom. The MinMax player is depicted with character ‘O’ while Random player is depicted with character ‘X’. The game continue till it doesn’t find sequence of (four) ‘O’ or ‘X’ characters at horizontally, vertically or diagonally. The Depth of the game is defined as 2, it denotes the how the state is deep in the search, although depth may increase but the computation time increase too.

**Heuristic Function**

The goodness or state’s score depends on how much the current state is good for every player. In other words, score depends the number of possible ways or the number of possible moves that leads to win the game for a player. Therefore, to calculate state’s score the state is explored for both players. The heuristic function returns the score for each state and the maximum score is select at the end as favorable move for max (O) player as explained above the player ‘O’ is plays the game as minmax agent while player ‘X’ plays random move. In the start, the player max get its possible moves and then evaluate them by getting score for each move using successor state. It recursively call itself till depth limit and increase/decrease score by checking other player disks. If a row or column contains ‘X’ the score increase because this move will favorable for player ‘O’ to stop winning the game to player ‘X’.

**Winners**

I have played the game several times, the ratio of winner game for MinMax player is high as compared to Random move. In conclusion, if I played this game 10 times, the 7 time MinMax player won the game while 3 times other player won the game.

**Improvement**

To improve pruning, the machine learning techniques are may involve. Such as apply q-learning algorithm that stores the each move with it rewards either this move was good or not. Next time, in alpha beta pruning graph we can avoid those moves that are resulted as negative rewards. In this way, the time and space both will reduce.

**Output**

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Welcome to Four Connect Game

Game Depth: 4

Game Dimensions: 6,7

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1. MinMax vs Human

2. MinMax vs Random (Disk Removal)

3. MinMax vs Random (Without Disk Removal)

4. Player vs Player

5. Exit

Enter Option: 2

Player X Turn's

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- - - - - - -

- - - X - - -

Player O Turn's (MinMax)

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- - - - - - -

- - - - - - -

- - - - - - -

- - - - - - -

- - - X O - -

Player X Turn's

- - - - - - -

- - - - - - -

- - - - - - -

- - - - - - -

- - - - X - -

- - - X O - -

Player O Turn's (MinMax)

- - - - - - -

- - - - - - -

- - - - - - -

- - - - - - -

- - - - X - -

- - - X O - O

Player X Turn's

- - - - - - -

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- - - - - - -

- - - - - - -

- - - - X - X

- - - X O - O

Player O Turn's (MinMax)

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- - - - X - X

- - - X O - O

Player X Turn's

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- - - X X - X

- - - X O - O

Game State After Disk Removal

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- - - X X - O

Player O Turn's (MinMax)

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Player X Turn's

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X - - X X O O

Player O Turn's (MinMax)

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X - - X X O O

Player X Turn's

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X - - X X O O

Player O Turn's (MinMax)

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Player X Turn's

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Game State After Disk Removal

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X - X X X O O

Player O Turn's (MinMax)

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Player X Turn's

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Player O Turn's (MinMax)

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Player O Turn's (MinMax)

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Player X Turn's

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Game State After Disk Removal

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Player O Turn's (MinMax)

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Player X Turn's

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X X X X X O O

Player X won