

Connect Four

Changelog

✓ Apr 7, 2024

- Start project
- Hash out the data structure design



Apr 8, 2024 Create a terminal game without any visual

- Hash out Four in a Row algorithm
- Implementation



Apr 9, 2024 Print the game as players make moves



Apr 10, 2024 Generalize to m-n-k

Features

Build a [connect-four game](#) for the terminal. The game should support two players (X, O) until there is one winner. An [m,n,k-game](#) is an abstract board game in which two players take turns in placing a stone of their color on an m-by-n board, the winner being the player who first gets k stones of their own color in a row, horizontally, vertically, or diagonally.

For classic Connect Four played on a 7-column-wide, 6-row-high grid, there are 4,531,985,219,092 (about 4½ trillion) positions[12] for all game boards populated with 0 to 42 pieces.

✓ 6x7 Board

Represent the board as a 6x7 matrix.

- 6x7 matrix
- Map of key, value pair where the key is the column and the value is the last available position

Going with the map of columns to the last valid position. The last available increment as players play in that column, so we can keep track of valid moves in $O(N)$ space.

✓ Two players

There will be two players represented, each time a player plays, update the moves and the next player up.

1. 'X' - represents player 1
2. 'O' - represents player 2

Each player X, O can make at moves $(6 \times 7)/2$ moves which will be store as

✓ Move

Each move can be denoted by an x coordinate $[0,6]$ representing any of the columns with a valid move. Each piece falls straight down, occupying the lowest available space within the column. Valid moves are any columns that are not yet filled.

Store moves make by each player

- Dict of key, value pair where the key is the player [X, O] and the value is a list of coordinates (x,y) for each move made
- Use a matrix where the value at (x,y) is updated to either X,O

Going with the dict of key, value pair where the key is the player [X, O] and the value is a list of coordinates (x,y) for each move made. Each player X, O can make at moves $(6 \times 7)/2$ moves which will be stored as a list of (x,y) coordinates in the dict value.

✓ Four in a Row

Find 4 in a row if one exist

- Run DFS from each coordinate
- Run BFS from each coordinate
- Run a horizontal, diagonal and vertical k,search from the last played coordinate. The assumption here is that the last played move will create a winning row, column or diagonal of length k. Walk in all directions and measure the width

Going with a horizontal, diagonal and vertical k-search from the last played coordinate (x,y)

- vertical k-search
 - in the dictionary of moves, find all (x,y) coordinates with the same x - $O(N)$
 - if all qualifying points less than k - no four in a row
 - sort by y - $O(N\log N)$
 - iterate on the qualifying points
 - measure ranges that increment by (x,y+1) indicating the same player move
 - return true if a range is k-length
- horizontal k-search
 - in the dictionary of moves, find all (x,y) coordinates with the same y - $O(N)$
 - if all qualifying points less than k - no four in a row
 - sort by x - $O(N\log N)$
 - iterate on the qualifying points
 - measure ranges that increment by (x+1,y) indicating the same player move
 - return true if a range is k-length
- diagonally k-search
 - all points in the same diagonal will have slope of 1. $(y_i - y_j) / (x_i - x_j) = 1$
OR $x_i - x_j == y_i - y_j$
 - if all qualifying points less than k - no four in a row
 - sort by x,y - $O(N\log N)$
 - iterate on the qualifying points
 - measure ranges that increment by (x+1,y+1) indicating the same player move
 - return true if a range is k-length

Game Over

The game ends when a player has 4 in a row or there are no more available moves.

- No more available moves
- Found four in a row

Game ends on either of the two conditions above.

Display the game

Print the board with all moves on the terminal.

- TBD

M-N-K

Generalize connect4 to a game of m-n-k, an m,n,k -game is an abstract board game in which two players take turns in placing a stone of their color on an m -by- n board, the winner being the player who first gets k stones of their own color in a row, horizontally, vertically, or diagonally.