AI

Assignment 2

Connect 4 Game

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Problem Statement :

It's required to implement a smart agent to play connect-4 against a real player using MinMax algorithm and another variant of it which uses alpha-beta pruning.
The game is different from the usual connect 4 in a way that it doesn't end by a player connecting 4 pieces but continues on until the board is full.

Data structure used :

- **State Class** : contains 2D char array representing the board and the corresponding utility for this board to be evaluated when it's terminal.

Algorithms used :

- **MinMax Algorithm** : As discussed in lecture.
- **MinMax with AlphaBeta pruning Algorithm :**
- **Heuristic function :** Count the number of 4 consecutive pieces of each player and assigns a relatively big multiplier (negative in case of player, positive in case of AI), then does the same for each 3 and 2 consecutive pieces but the multiplier is much smaller(note that to actually consider a 3 piece there must be an empty space on the same line, same for 2 consecutive pieces).

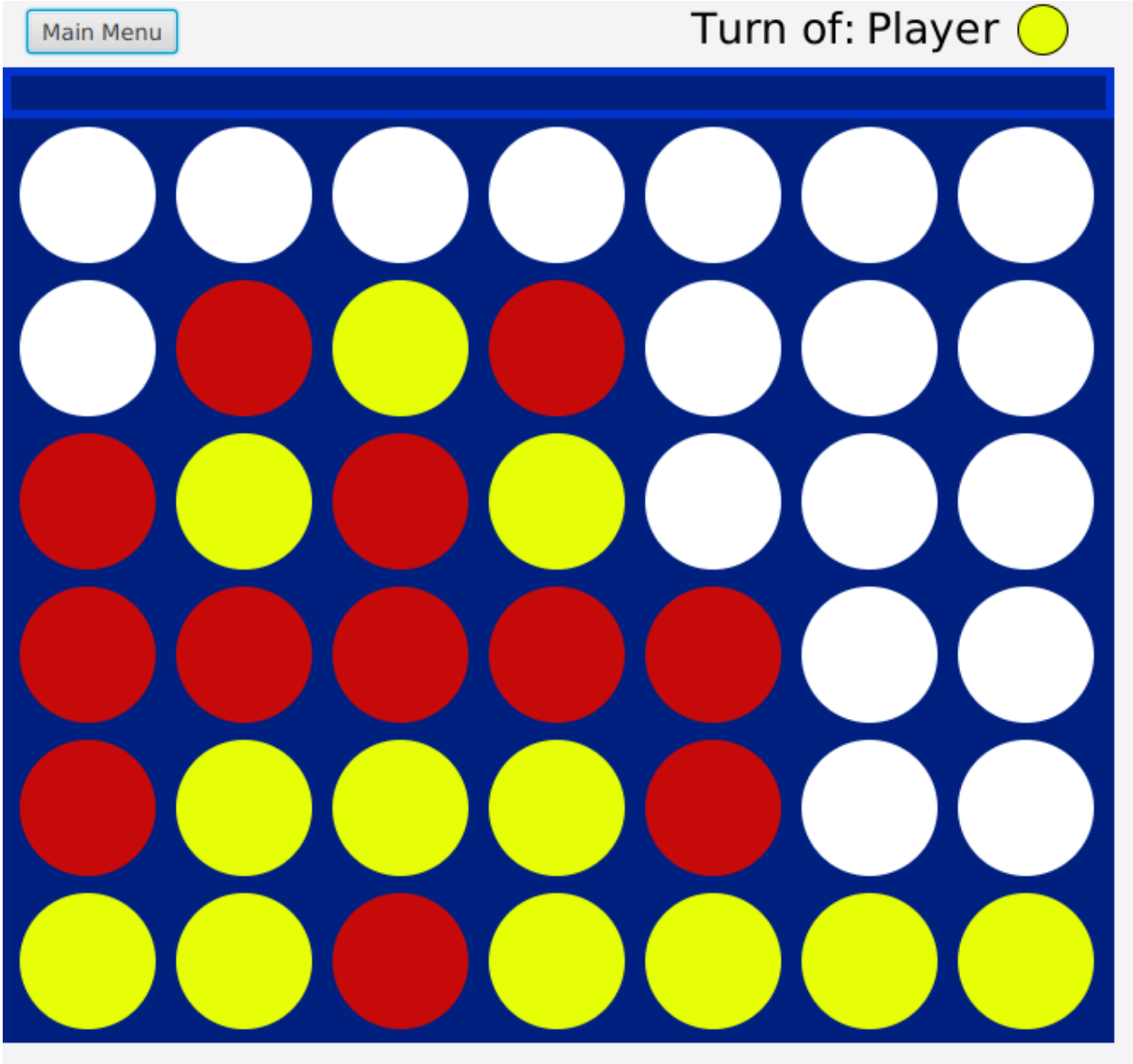
Assumptions and Details :

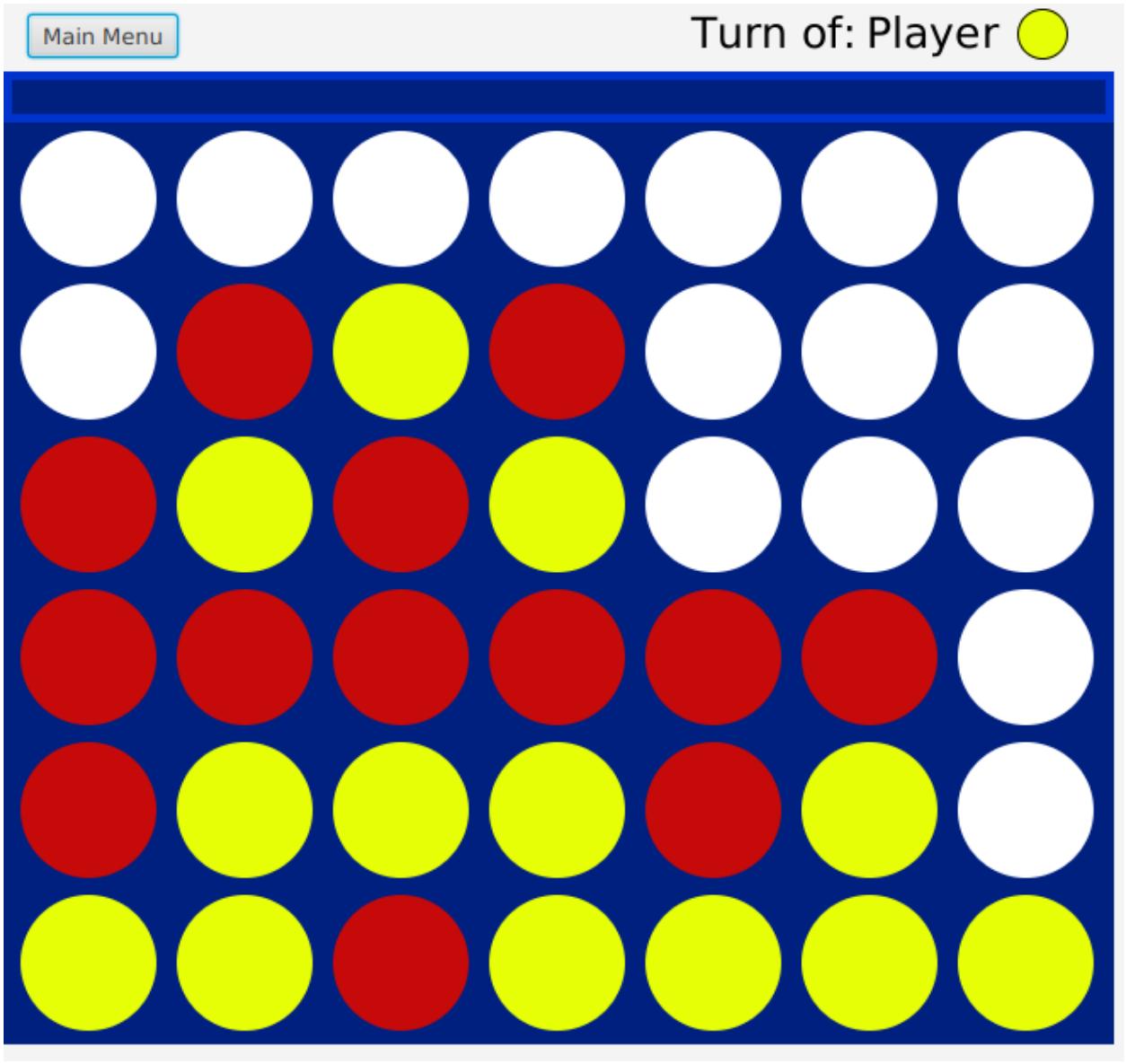
- **MinMax Searching using K-values bigger than 8 takes excessively long to the point where the game isn't fun anymore..**
- **Player always starts the game.**
- **Game board has a fixed length and width of 6,7 respectively.**
- **Tree printing is optional, a checkbox is marked in the GUI to print the tree of each play into a file.**
- **Only one tree is stored at a time as each play has a new tree which overrides the old tree**

Sample Runs :

Main Menu:

- **K = 2 , MinMax**

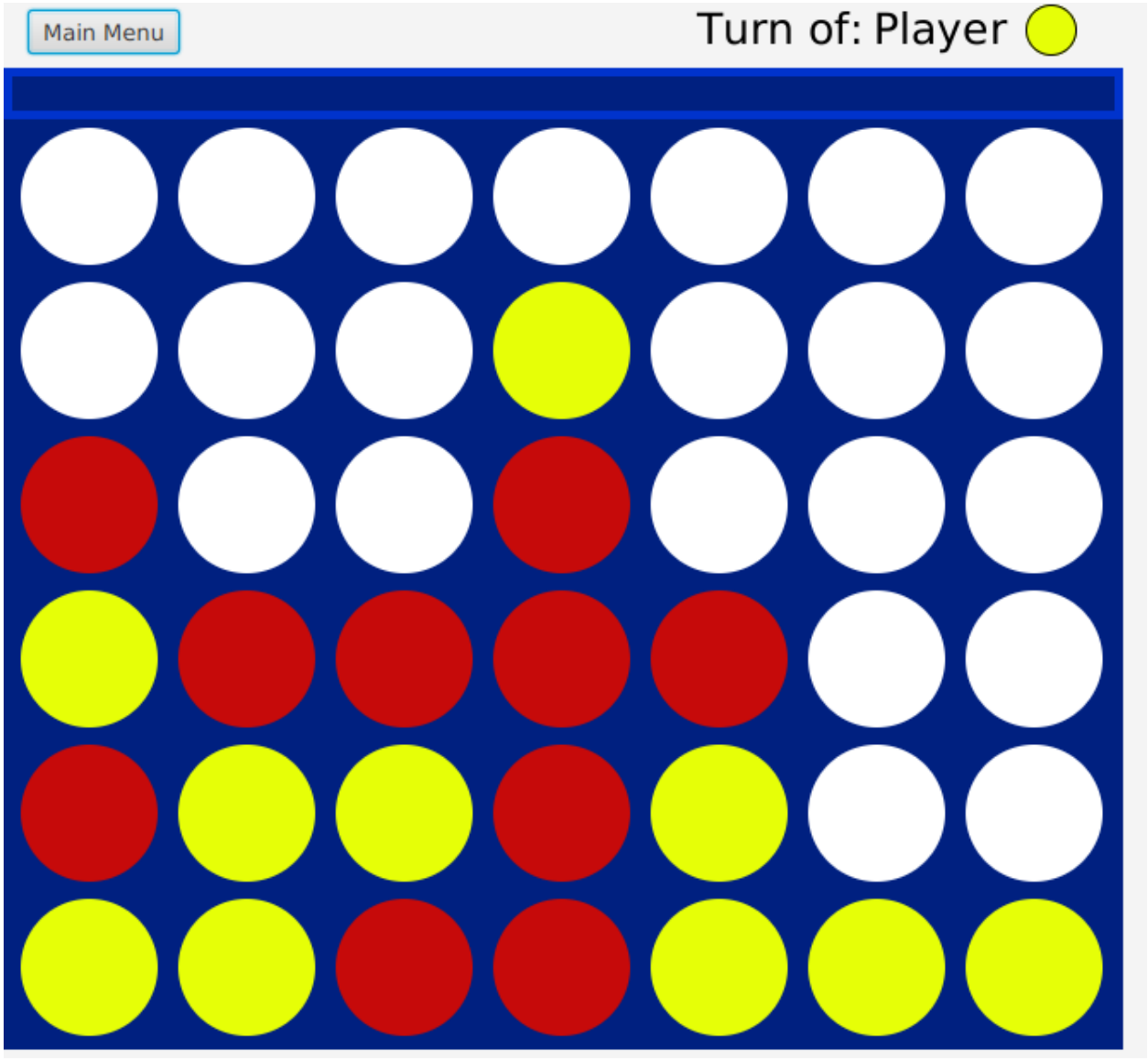


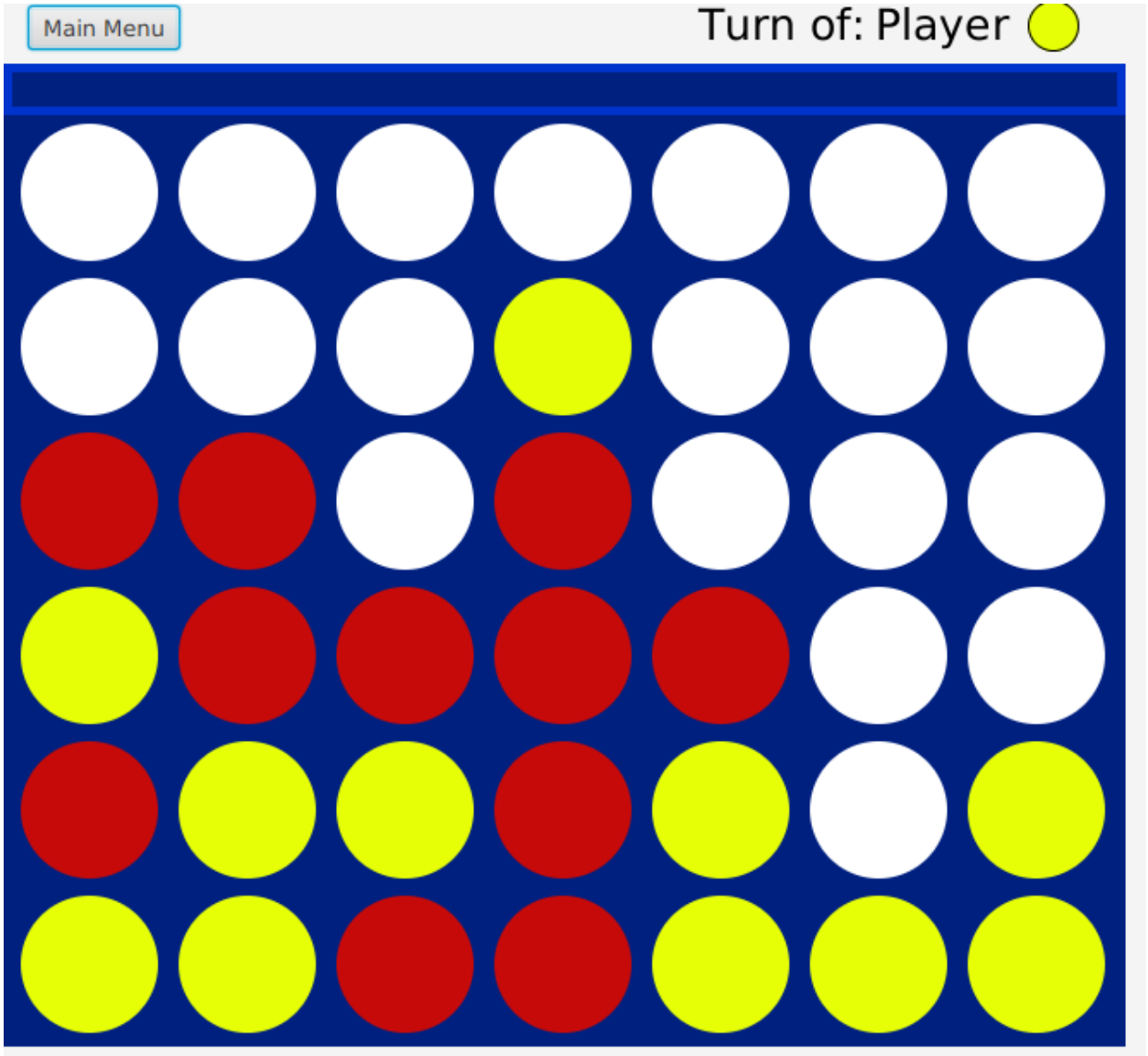


The tree for this play : tree.txt

Nodes Expanded = 54 Time taken = 25 ms

- **K =2 , Alpha Beta Pruning**

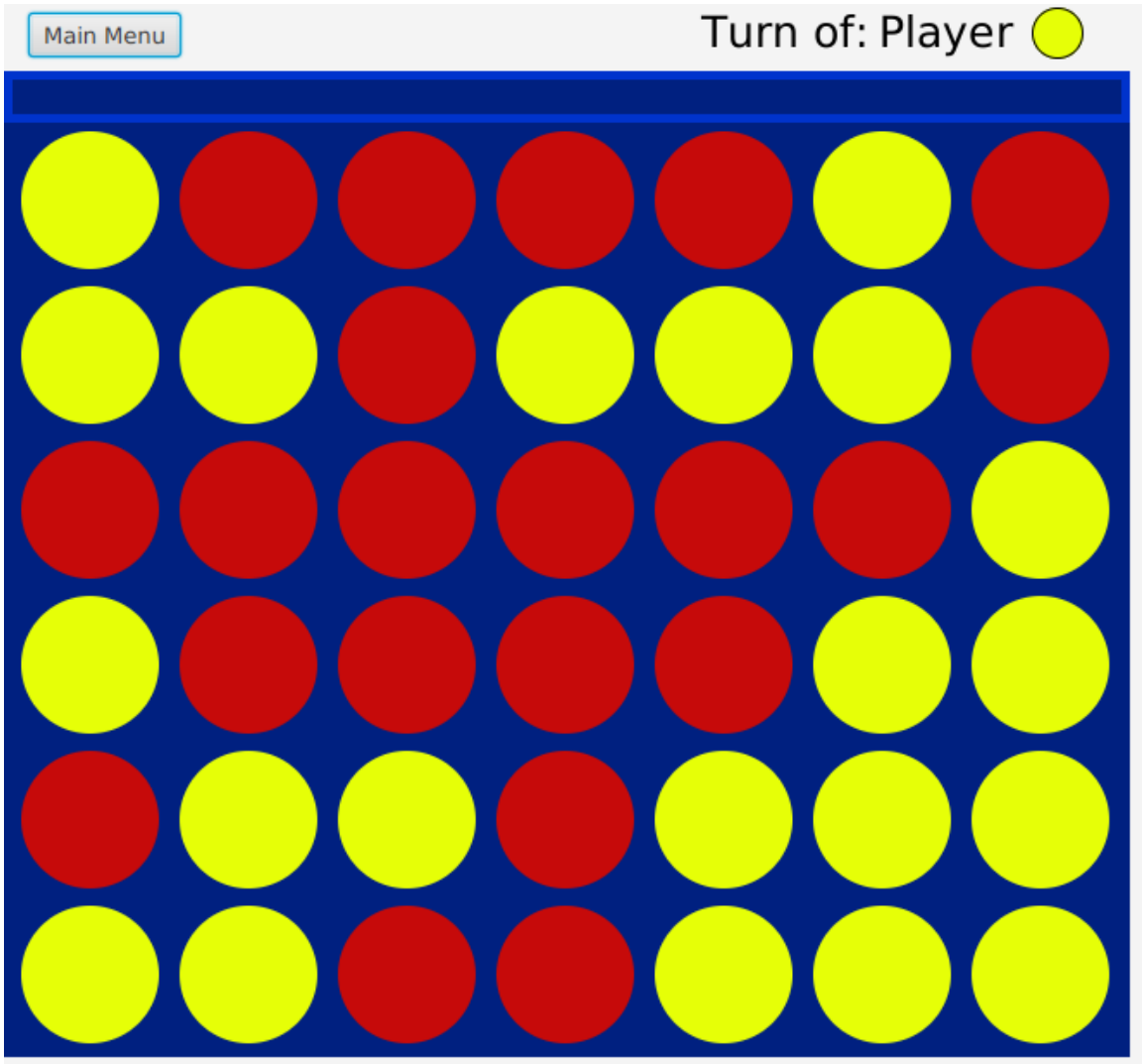




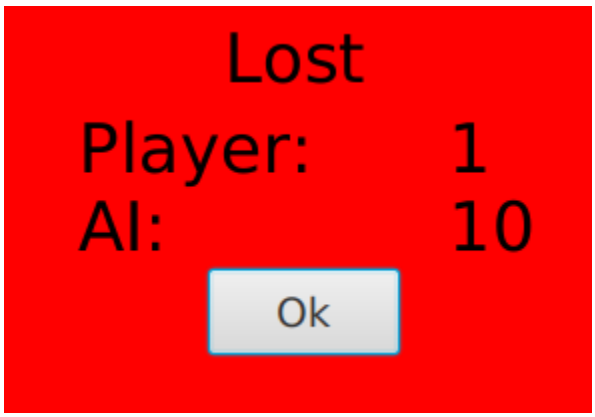
The tree for this play : [tree.txt]

Nodes Expanded = 28 Time taken = 4 ms

End of the game:



Score :



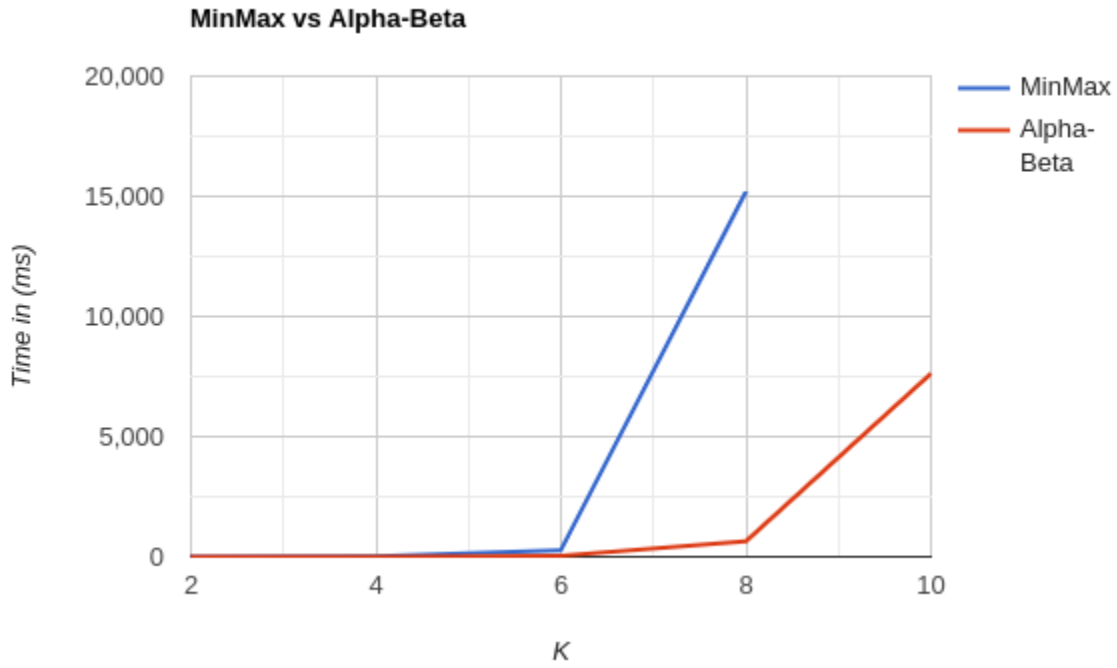
Analysis of Algorithms : (average)

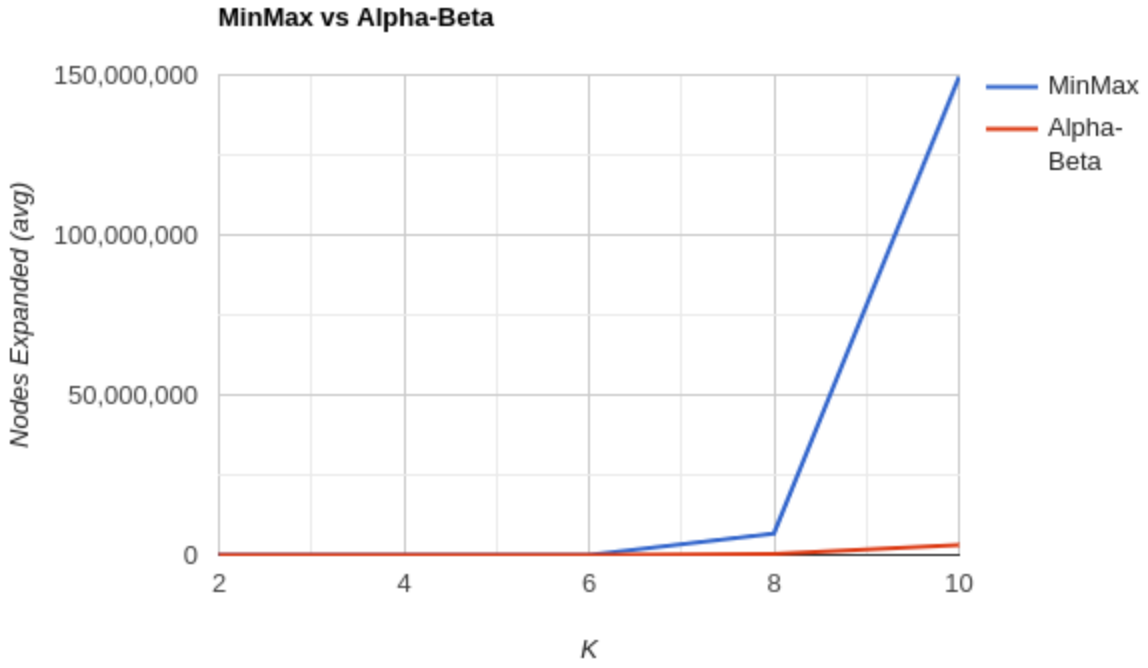
- **Nodes Expanded :**

K	2	4	6	8	10
MinMax	57	2745	13345	6719996	149330164
Alpha Beta	30	700	8256	254399	3078963

- **Time taken : in ms**

K	2	4	6	8	10
MinMax	0	15	275	15196	532669
Alpha Beta	0	5	40	650	7632




MinMax vs Alpha-Beta
150,000,000
100,000,000
50,000,000
0
Nodes Expanded (avg)
2
4
6
8
10
K
MinMax
Alpha-Beta