

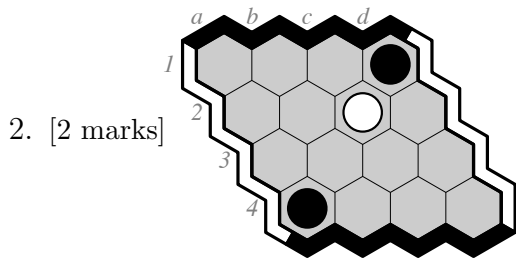
1. [2 marks] For hex played on a 100x100 board (with no swap-rule), (**circle one**)

a) it is known that the 1st player can win, but no winning move is known

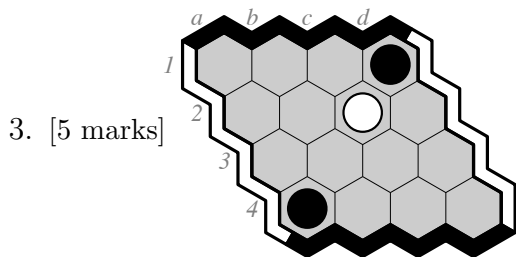
b) it is known that the 1st player wins by playing first in the centre,

c) it is known that if the 1st player could win, then so could the second player, which is impossible, so the 2nd player wins

d) it is not yet known which player wins



In this hex puzzle, assume black plays next. After black plays at b2, black has a top-bottom virtual connection using only these four other cells: _____.

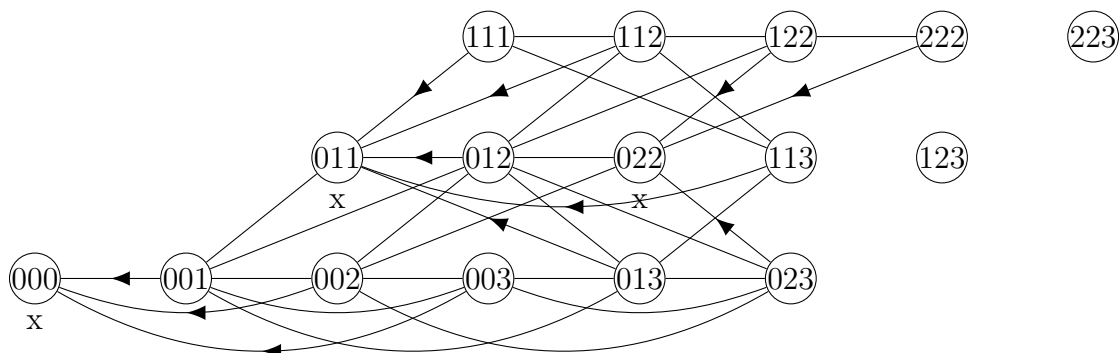


In this hex puzzle, assume white plays next. Using mustplay analysis and the previous question, white can reduce the search space for a winning move from 13 cells to this set of cells: _____. On the diagram, draw a winning white move, and then draw a picture of a winning virtual connection.

4. [5 marks] This is part of the nim state transition diagram, starting from state (2 2 3): each x shows

_____, and each arrow shows

_____. Finish the diagram: add missing lines/arrows/x's.



5. [4 marks] A minimax search of the empty tic-tac-toe board examines $s = 340\,858$ nodes; s is close to $9! = 362\,880$, because (**circle one**) a) there are $9!$ nodes in the state space b) each path from the initial position to a full board corresponds to a permutation of the 9 board cells c) in the search tree, after pruning transpositions, about $9!$ nodes remain d) in the search tree, after pruning transpositions and isomorphisms, about $9!$ nodes remain . Explain briefly why $s < 9!$:
-
-

6. [4 marks]

```
def minimax(state, depth):          *** fill in the blanks ***
    if is_terminal(state):
        return eval(state)
    if is_even(depth):
        return _____(for all c in state.children(): _____)
    if is_odd(depth):
        return _____(for all c in state.children(): _____)
```

7. [4 marks]

```

      a b c
1 . . .
2 . . x
3 . o .
```

For this tic-tac-toe position with x to move, the minimax value is

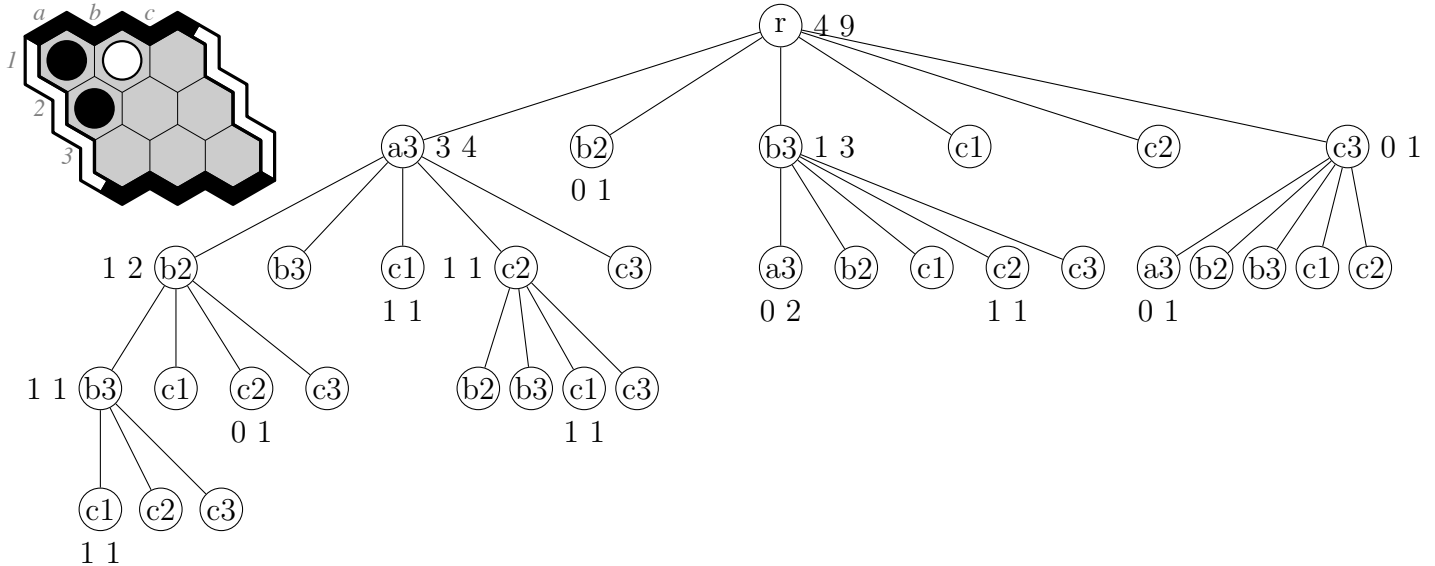
(**circle one**) x-win draw o-win.

A best move for x is _____and a best reply for o is

_____.

for your
rough
work

8. [10 marks] For this Hex position with white to move, here is a pure Monte Carlo search tree. Each node with no label shown has label 0 0.



If mcts terminates now (so, after iteration 9), then the move returned by the search will be _____.

Assume that pure mcts executes one more time (so, for iteration number 10). **On the above diagram,** draw a path to each leaf node that might be picked in the selection phase of iteration 10.

Now assume that (in iteration 10) that node r-a3-c3 is expanded. **On the above diagram,** make changes so that it shows the tree after iteration 10.

9. [4 marks] The number of correct answers to the last part of the previous question (the tree after iteration 10) is _____.

Assume that the mcts continues after iteration 10 for a total of 1000 iterations, and that the final number of visits to node r-b3 is 23. Then the final number of wins at node r-b3 will be **(circle one)**

- exactly 1 exactly 6 exactly 17 exactly 21 about 1 about 6 about 17 about 21