cmput396 **asn4** **do not hand in** **0 marks**

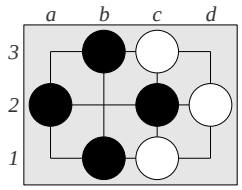
1. For the game of go, there are three common rules that prevent the repetition of a state in a game. Recall that the Trump-Taylor rules use positional superko (so a move is illegal if it would recreate a position that occurred earlier in the game).

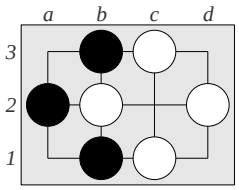
   ko rule: from a position P, a non-pass move is illegal if it leaves the position P' that occurred just before P;

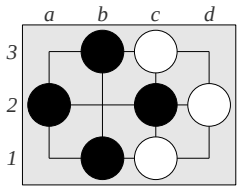
   positional superko rule: from a position P, a non-pass move is illegal if it leaves a position P' that occurred at any point previously in the game;

   situational superko rule: from a position P, a non-pass move is illegal if it leaves a situation that has previously occurred in the game, where a situation is defined by the position and player whose move created that position.

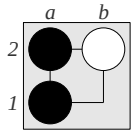
   Example. Assume, from the empty 3×4 board, `1.a2 2.d2 3.b3 4.c3 5.b1 6.c1 7.c2`, leaving position P' (below left). Next white plays at b2, leaving position P (middle). Next black wants to play at c2, which would create position R (right). Does this black move violate the ko rule? the superko rule? the situational superko rule?

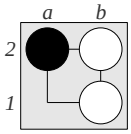


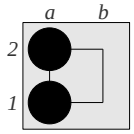




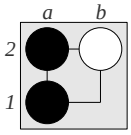
2. Consider the 2×2 go game `1.a1 2.b2 3.a2` (below left) `4.b1 5.a2` (middle) `6.pass 7.a1` (right). Now white wants to play `8.b2`. Would this move violate the ko rule? psk rule? ssk rule?







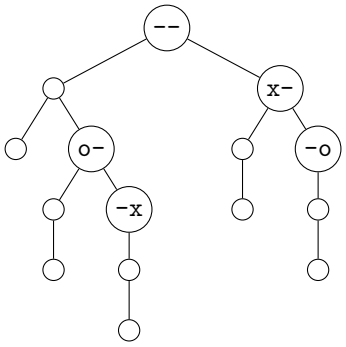
3. Consider a 2×2 go game, using ssk (situational superko rule). The sequence `1.a1 2.b2 3.a2 4.b1` leads to a black win by +1. Here, consider instead the sequence `1.a1 2.b2 3.a2 4.pass` (below). Give all legal black moves here. For each move, give the minimax final game score.



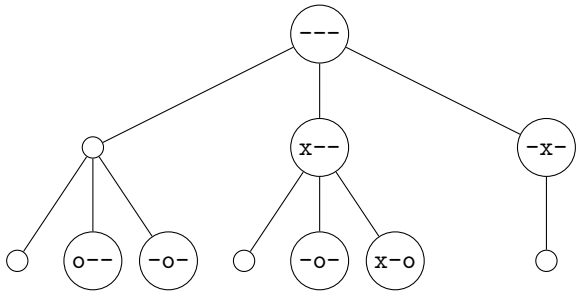
4. **Linear go** is go on a 1×n board, for some n. Explain why the minimax first-player score for 1×1 go is 0.

5. In go, because of the superko rule, using a dag instead of a tree is complicated (the algorithm is beyond the scope of this course. if you are interested, see the papers by Kishimoto and Müller on the **graph history interaction problem**). So, we will consider only the game tree and accept the fact that there may be different nodes in our tree that could be grouped together for algorithmic purposes (we will not group them together).

   Here is the game tree for 1x2 go with, at each node, isomorphic children pruned. An empty dot shows a node reached by the pass move. On the diagram, label each node with the first-player minimax score.



6. Here is the game tree (top 3 levels only) for 1x3 go with, at each node, isomorphic children pruned. On the diagram, draw the next level of the tree. Then, on the diagram, label each node with the first-player minimax score of that node (ie. assume that you know the complete tree).



7. Draw the first three levels of the minimax tree for 1×4 go. Prune isomorphic children. Label each node with its first-player minimax score (assume that you know the complete tree).

   Do the same for 1×5 go, first two levels of the minimax tree.

8. For this 2x2 go state, give all possible next moves by `o` (including pass), and for each move give the final minimax score for 1st player `x`.

```
- -   x -   x -   x x   - -   - x   o -   - x
- -   - -   - o   - o   o o   o o   o o   - -
```

   For this 2x2 go state, give the final minimax score for 1st player `x`.

```
- -   x -   x -   x x   - -   x -
- -   - -   - o   - o   o o   o o
```

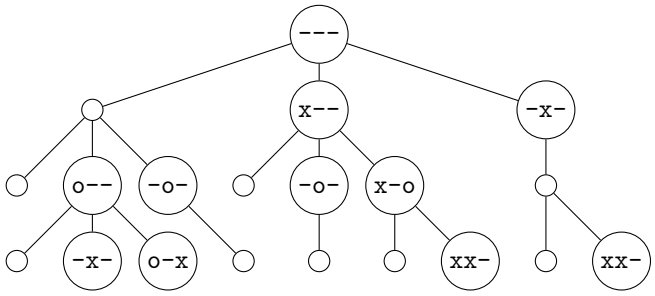
1. Position R is the same as position P', so the move by black to c2 violates all 3 rules. Notice that every ko violation also violates positional superko and situational superko. Also, every positional superko violation also violates situational superko.

2. This does not recreate the previous position, so it does not violate the ko rule. It recreates the position after move 3, so it violates the positional superko rule. But this position earlier was created by a black move, here it is created by a white move, so it does not violate the situational superko rule.

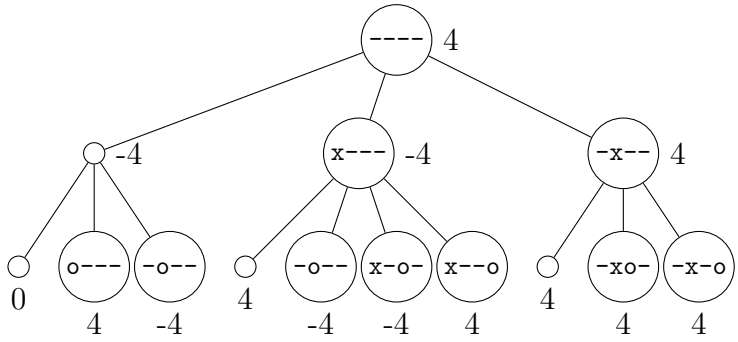
3. There are two possible moves: `5.pass` or `5.b1`. Pass is always legal. Here the other move is also legal (by all 3 ko rules). If black plays `5.pass`, this is the 2nd consecutive pass, so the game ends, black wins by +1. If black plays `5.b1`, then a best line of play starts with `6.b2`, capturing the 3 black stones, and leaving 1 white cell on the board. Now white can play as in the handout (with colors reversed), and white wins by +1.

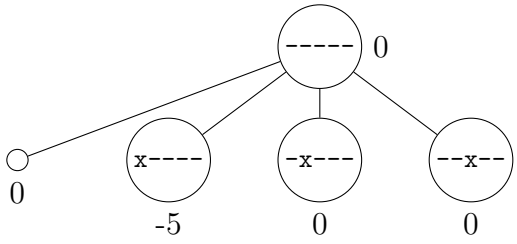
4. There are no legal moves (a stone placed on the only empty cell has no liberties), so the only possible game sequence is 1.pass 2.pass, gameover, each player has 0 territory, so minimax score 0.

5. In postorder, minimax node values are 0 -2 -2 2 2 2 2 2 0 2 2 -2 -2 -2 0

6. 

From the left, the children of the root have minimax values -3, -3, 3, so the root minimax value is 3.

7. 



8. i) `o` has 4 legal moves: pass, or playing beside `x` allows `x` to play diagonally, capturing all 4 cells, minimax score `x` +4. If `o` plays diagonally (below from +) then `x` can play upper-left (below). Now `o` must pass. (`o` cannot play lower right: that captures and creates a position that has already occurred.) Now `x` does not want to capture `o` (below), because then `o` can snap back (below), and eventually `o` wins by 1.

```
- -   x -   x -   x x   - -   - x   o -   - x  +  - x   x x   x x   - -
- -   - -   - o   - o   o o   o o   o o   - -  +  o -   o -   - x   o -
```

So the final minimax score for the diagonal reply by `o` is `x` +1, with principal variation shown.

```
- -   x -   x -   x x   - -   - x   o -   - x  +  - x   x x
- -   - -   - o   - o   o o   o o   o o   - -  +  o -   o -
```

ii) `o` captures. `x` passes (snapback capture creates earlier position). `o` passes, game ends, minimax score `x` −4.