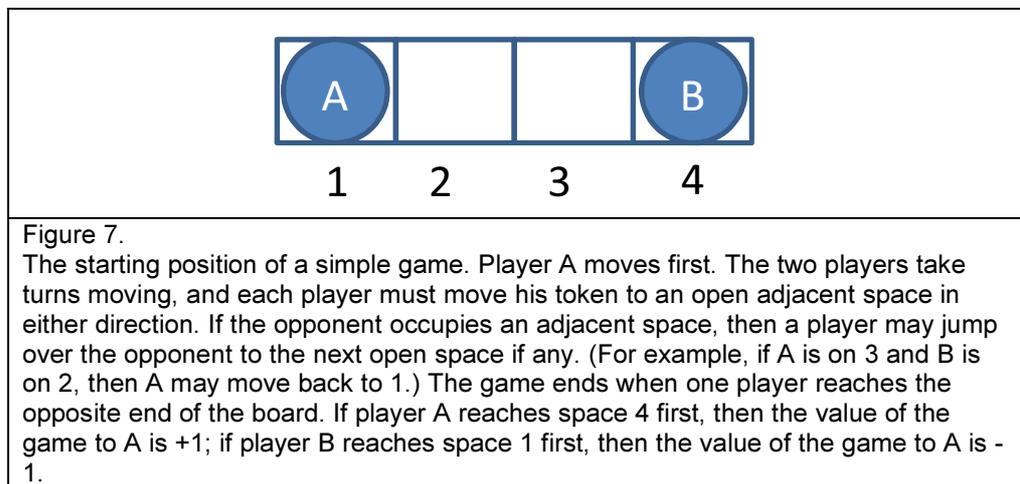


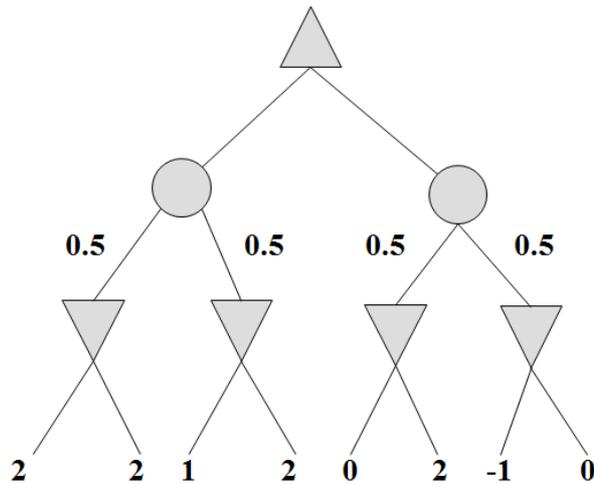
Intelligent Autonomous Agents and Cognitive Robotics Exercise Sheet 2

1. Consider the two-player game described in Figure 7.
 - a. Draw the complete game tree, using the following conventions:
 - i. Write each state as (s_A, s_B) where s_A and s_B denote the token locations.
 - ii. Put each terminal state in a square boxes and write its game value in a circle.
 - iii. Put loop states (states that already appear on the path to the root) in double square boxes. Since it is not clear how to assign values to loop states, annotate each with a "?" in a circle.
 - b. Now mark each node with its backed-up minimax value (also in a circle). Explain how you handled the "?" values and why.
 - c. Explain why the standard minimax algorithm would fail on this game tree and briefly sketch how you might fix it, drawing on your answer to (b). Does your modified algorithm give optimal decisions for all games with loops?



2. The minimax algorithm assumes that players take turns moving, but in card games such as bridge, the winner of the previous trick plays first on the next trick. Modify the algorithm to work properly for these games.
3. Proof for a positive linear transformation of leaf values (transforming value x to $ax+b$ with $a>0$), the choice of moves remains unchanged in a game tree with chance nodes.
4. This question considers pruning in games with chance nodes. The following figure shows the complete game tree for a trivial game. Assume that the leaf nodes are to be evaluated in left- to-right order, and that before a leaf node is evaluated, we know nothing about its value—the range of possible values is $-\infty$ to ∞ .
 - a. Compute the value of all nodes, and indicate the best move at the root with an arrow.
 - b. Given the values of the first six leaves, do we need to evaluate the seventh and eighth leaves? Given the values of the first seven leaves, do we need to evaluate the eighth leaf? Explain your answers.
 - c. Suppose the leaf node values are known to lie between -2 and 2 inclusive. After the first two leaves are evaluated, what is the value range for the left-hand chance node?

d. Circle all the leaves that need not be evaluated under the assumption in (c).



5. Which of the following are true and which are false? Give brief explanations.
 - a. In a fully observable, turn-taking, zero-sum game between two perfectly rational players, it does not help the first player to know what strategy the second player is using— that is, what move the second player will make, given the first player's move.
 - b. In a partially observable, turn-taking, zero-sum game between two perfectly rational players, it does not help the first player to know what move the second player will make, given the first player's move.
 - c. A perfectly rational backgammon agent never loses.
6. Consider the problem of placing k knights on an $n \times n$ chessboard such that no two knights are attacking each other, where k is given and $k \leq n$
 - a. Choose a CSP formulation. In your formulation, what are the variables?
 - b. What are the possible values of each variable?
 - c. What sets of variables are constrained, and how?
7. Explain the difference of depth first search for non CSP problems and basic backtracking search for CSP problems.
8. Explain what can be done to reduce the state space exploration of standard backtracking search.
9. How many solutions are there for the map-colouring problem from the lecture?
10. Show how a single ternary constraint such as " $A + B = C$ " can be turned into three binary constraints by using an auxiliary variable