Centre of Excellence in Artificial Intelligence, IIT Kharagpur
AI Foundations & Applications (AI61005)
Class Test 1
Sept 12, 2022
Time: 1 hour, Marks: 40
Answer All Questions
Write your name and roll number on every sheet.

1. Consider a 15 node implicit state space for a minimization problem, which is a binary tree with a start node, 8 leaf nodes and 6 other internal non-leaf nodes. Each leaf node is a goal node. Each node is numbered from 1 to 15, starting from the start with node number 1, every child of a node numbered k is 2k (left child) and 2k+1 (right child). The edge costs and heuristics are related to your roll number as follows: If your roll number is even, then every left edge is of cost 3, every right edge is of cost 4 and the heuristic value at all non-goal nodes is the last 2 digits of your roll number mod 3. If your roll number is odd, then every left edge is of cost 5, every right edge is of cost 4 and the heuristic value at all non-goal nodes is the last 2 digits of your roll number mod 4. All goal nodes have heuristic values 0. We wish to find the minimum cost path using Algorithms A* and Depth-first branch-and-bound (DFBB). Now answer the following questions:
   a. In a Tabular form, show the working of Algorithm A* in a step by step fashion, showing the nodes in OPEN and CLOSED, each with their g, and f values. Indicate which node is expanded in every step.
   b. If DFBB is executed by ordering the children to be inserted into OPEN from left to right, draw the Search Tree to show which nodes will be expanded and which node will be pruned by DFBB, indicating their g, h and f values. Also, list which nodes expanded by DFBB will not be expanded by A*, giving, for every such node, the node number and its g, h and f value.
   c. State whether the following sentence is True or False and justify by a short proof sketch or counter-example: Given that the state space for a minimization problem is a tree with positive edge costs, non-negative underestimating heuristics which may not be consistent and at least one goal at finite depth, then algorithm A* guarantees to find the optimal cost solution.

[8+ (5+2) +5 = 20 marks]

2. Let us have a 2-player Game Tree with 16 goal nodes starting with a MIN node and alternating MIN and MAX nodes, as usual. Assign evaluation function values between 1 to 99 at the leaf nodes using only the digits of your roll number to ensure maximum

pruning if the alpha-beta pruning algorithm uses a left to right ordering. All evaluation function values at leaf nodes cannot be identical. Draw the game tree with the pruning and the computed min-max and alpha-beta values. Clearly justify your answer for maximum pruning.

[10 marks]

3. Use Propositional Logic Based Modelling to resolve the following Puzzle by listing the Boolean variables, the encoded propositional formula from the statements, the answer and a clear proof / solution for your answer:

Three boxes are presented to you. One contains gold, the other two are empty. Each box has imprinted on it a clue as to its contents; the clues are:

- Box 1 "The gold is not here"
- Box 2 "The gold is not here"
- Box 3 "The gold is in Box 2"

Only one message is true; the other two are false. Which box has the gold?

[10 marks]