AI-701: Artificial Intelligence | **Assignment # 02**

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1 Search & CSPs (8+20+4) = 32

1. Define in your own words the following terms: state, state space, search tree, search node, goal, action, transition model, and branching factor.

2. Consider the search tree below. The initial state is at the top, and the goal states are represented by the double circles. Note that the edges are directed.

   In the circle, at the top is the name of the node N, and at the bottom is the heuristic function's estimate $h(N)$ of the cost to the nearest goal. On the edge is the actual cost of traversing an edge.

   (a) For each of the search strategies listed below, (1) form an ordered list of the states explored and (2) indicate which goal state is reached (if any). Also (3) specify the final contents of the frontier at the time the search terminates. When the states are expanded, new nodes are generated in ascending alphabetical order. Assume the sort is stable (i.e., ties are left as initially ordered).

   i. Depth First Search
   ii. Breadth First Search
   iii. Uniform Cost Search
   iv. Greedy/Best First
   v. A^* Search

   (b) In this example, is h(N) admissible? Briefly explain your answer.

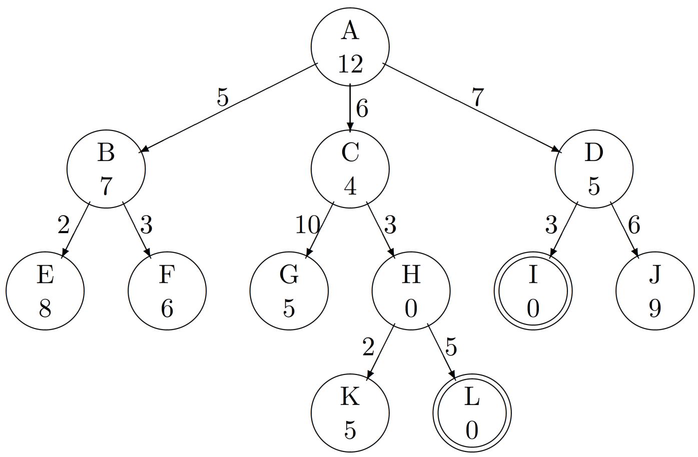

Figure 1:

3. Which of the following are true and which are false? Explain your answers.

   (a) Depth-first search always expands at least as many nodes as A^* search with an admissible heuristic.
   (b) h(n) = 0 is an admissible heuristic for the 8-puzzle.
   (c) A^* is of no use in robotics because percepts, states, and actions are continuous.
   (d) Breadth-first search is complete even if zero step costs are allowed.

(e) Assume that a rook can move on a chessboard any number of squares in a straight line, vertically or horizontally, but cannot jump over other pieces. Manhattan distance is an admissible heuristic for the problem of moving the rook from square A to square B in the smallest number of moves.

(a) Define the Constraint Satisfaction Problems. Also, describe the elements in the definition.

(b) What are search trees for Constraint Satisfaction Problems? Describe what do nodes and branches in a search tree represent for CSP.

(c) Explain why depth-first search is used in the search tree for Constraint Satisfaction Problems. Compare it with breath-first search.

2 Logic (4+6)=10

1. Translate the following English sentences to Propositional Logic.
   Propositions: (R)aining, Liron is (Sick), Liron is (H)ungry, Liron is (HA)appy, Liron owns a (C)at, Liron owns a (D)og

   (a) It is raining if and only if Liron is sick

   (b) If Liron is sick then it is raining, and vice versa

   (c) Liron is hungry but happy

   (d) Liron either owns a cat or a dog

2. For each sentence below, write V=Valid if the sentence is valid, U=Unsatisfiable if the sentence is unsatisfiable, and S=Satisfiable if the sentence is satisfiable but is neither valid nor unsatisfiable.

   (a) $A \vee (\neg A)$

   (b) $A \wedge (\neg A)$

   (c) $A \wedge (\neg B)$

   (d) $(A \wedge (\neg A)) \rightarrow B$

   (e) $(A \vee (\neg A)) \rightarrow B$

   (f) $(A \vee (\neg A)) \rightarrow (A \wedge (\neg A))$

3 Game Playing (5+10)=15

(a) Use the Minimax algorithm to compute the minimax value at each node for the game tree in the fig. 2.

(b) Use the Alpha-Beta pruning algorithm to prune the game tree in the fig. 2 assuming that child nodes are visited from left to right. Show all final alpha and beta values computed at root, each internal node explored, and at the top of pruned branches.

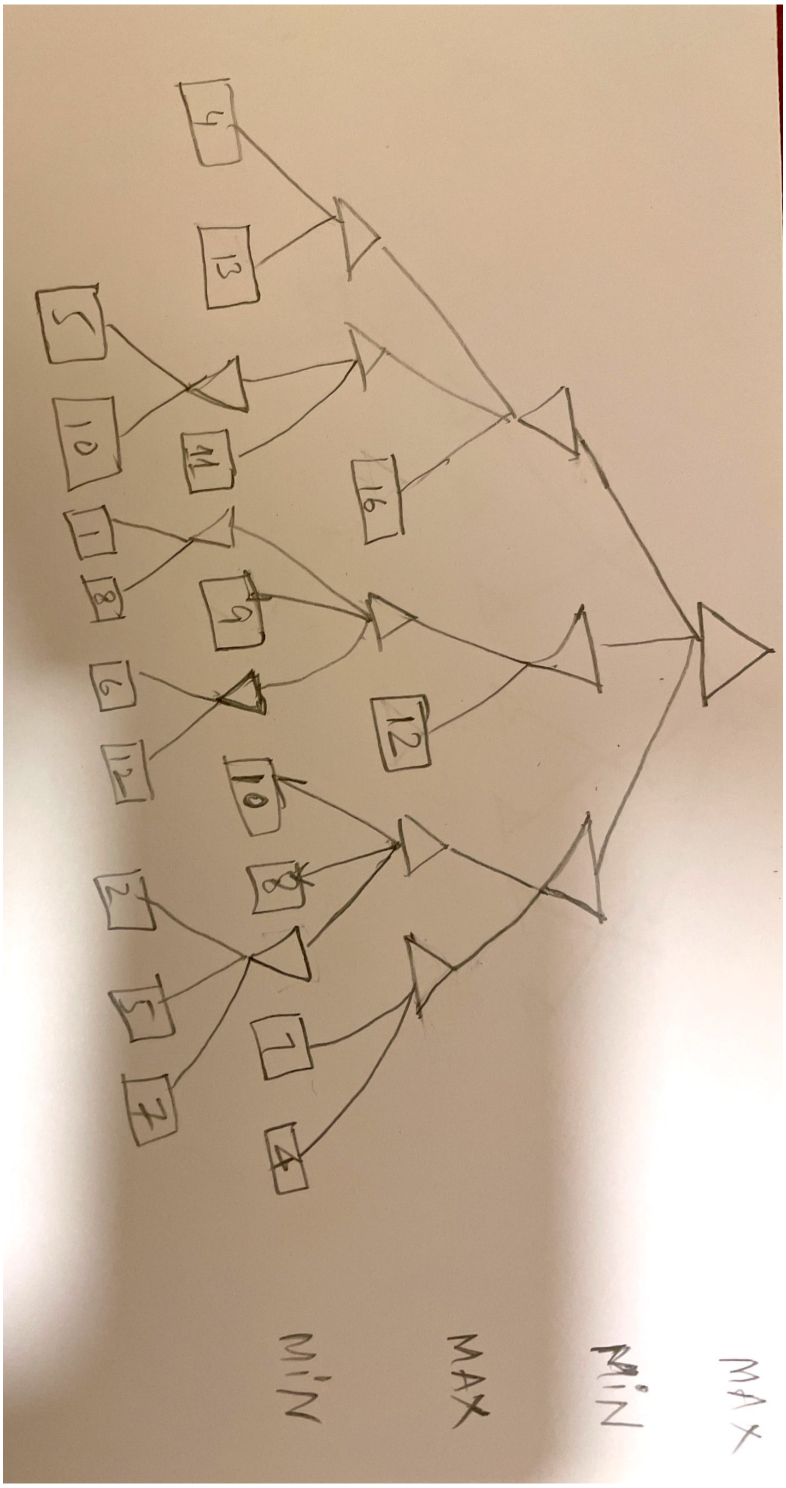

Figure 2: Game Tree