CS472

Foundations of Artificial Intelligence

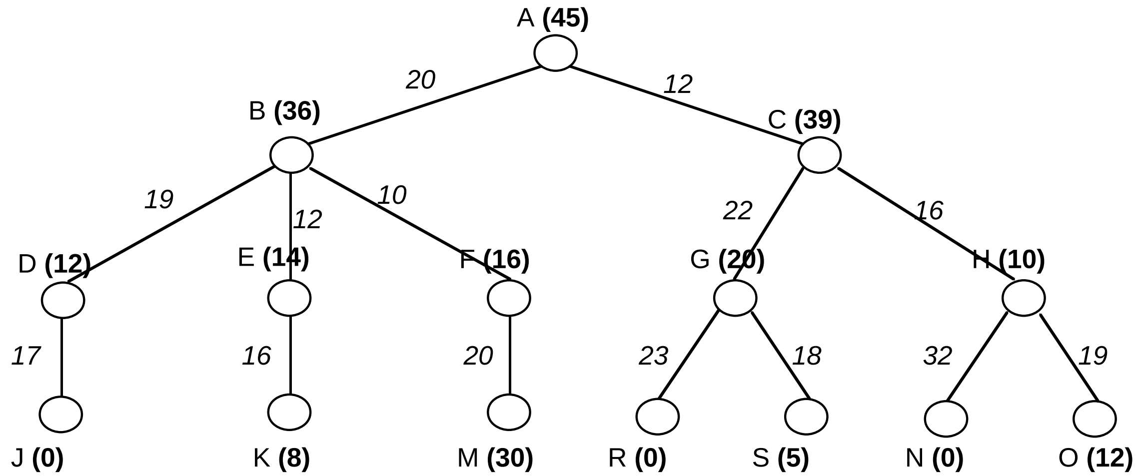
Prelim I
October 1, 2003

Name:

Netid:

Instructions: You have 50 minutes to complete this exam. The exam is a closed-book exam. There are 5 questions.

#	description	score		max score
1	state space search basics	____	/	20
2	problem-solving as search	____	/	25
3	adversarial search	____	/	20
4	local search	____	/	15
5	constraint satisfaction problems	____	/	10
Total score:		______	/	90



State Space Search: (20 points total)

The Figure above shows a search tree. Node **A** is the start state and nodes **J**, **R**, and **N** are goal states. Each arc is labeled with the actual cost of traversing it. The parenthesized value in boldface next to each node indicates the value that is returned by a heuristic evaluation function for the node.

For each of the search strategies named below, (a) list the nodes in the order they would be explored (i.e. in the order they would be removed from the fringe/open list); and (b) list the nodes that lie along the final correct path to the goal. Assume that the successors of each node are searched left-to-right. (In the case of ties, choose the node that has been on the fringe (i.e. the open list; the list of nodes to be expanded) the longest.

1. (5 pts.) uniform-cost search

2. (5 pts.) iterative deepening

3. (5 pts.) A* search

4. (5 pts.) hill-climbing search

Problem-Solving as Search: (25 points total)

1. Indicate whether each statement below is **true** or **false**; and provide a brief explanation for your answer.

   (a) (5 pts.) Breadth-first search is a special case of uniform-cost search.

   (b) (5 pts.) Uniform-cost search is a special case of A* search.

2. Briefly describe each of the following concepts and explain each's significance:

   - (5 pts.) Heuristic functions

   - (5 pts.) Alpha-beta pruning

   - (5 pts.) Local search methods

Adversarial Search: (20 points total)

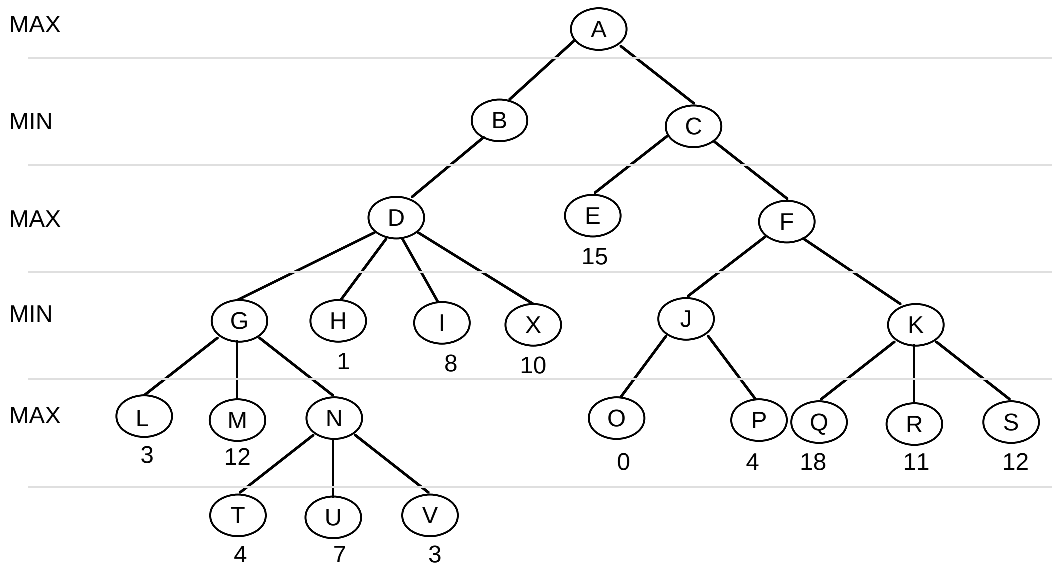


Figure 1: A minimax game tree.

Use the game tree from Figure 1 above for the following questions. Leaves of the tree are labeled with the value returned by a static evaluation function.

1. (5 pts.) Show how the values get propagated up through the tree using minimax. (You should indicate these values **directly** on the tree.) Assume that there is no depth cutoff for the search — the minimax algorithm searches until it reaches a leaf and then propagates the values upward. What should the next move be for the Maximizing player?

2. (5 pts.) Indicate **one** example of $\alpha - \beta$ pruning in this tree. Assume left-to-right evaluation of nodes.

3. (3 pts.) Does $\alpha - \beta$ pruning always select the same line of play as standard minimax? Choose one of: yes no

4. (2 pts.) What is the worst case search space size for alpha-beta pruning? In your answer, assume that b is the branching factor and d is the depth at which the static evaluation function is applied.

5. (5 pts.) What is the best case search space size for alpha-beta pruning? Briefly explain your answer. As above, assume that b is the branching factor and d is the depth at which the static evaluation function is applied.

Local Search: (15 points total)

1. (10 pts.) Provide high-level pseudocode for **random-restart hill-climbing**.

2. (5 pts.) Is random-restart hill-climbing a complete search? Explain.

Constraint Satisfaction Problems (CSPs): (10 points total)

1. (5 pts.) Explain why it is a good heuristic for a CSP search to choose the *variable* that is *most* constrained.

2. (5 pts.) Explain why it is a good heuristic for a CSP search to choose the *value* that is *least* constraining.