

**1st Midterm Exam**  
**Thursday February 26**  
**75 minutes == 75 points**  
**Open book and notes**

1. *15 points*

Consider a block world problem, in which you are given a number of blocks, all of the same size. The blocks can be on the table or on top of other blocks. You are allowed to pick up one block at a time if nothing is on top of it. A block can be moved either to the table or on top of another block.

1. Describe the state space representation of the problem.
2. Propose a non trivial (i.e. not  $h(n)=\text{constant}$ ) heuristic. Is your heuristic admissible?

2. *10 points*

Suppose you decide to remove the CLOSED list from the A\* algorithm. Will the algorithm still work? Will it still have the same properties, specifically completeness and optimality of the solution if the heuristic is admissible? Explain.

3. *10 points*

A drawback of A\* is its memory requirement since the OPEN list might get very large. Suppose you modify A\* as follows: You keep in OPEN only the best N nodes (with  $N > 1$ ). When the OPEN list is full and a new node has to be stored, the worst node is deleted from OPEN and removed from consideration.

1. If an admissible heuristic is used, is the modified algorithm admissible?
2. If a perfect heuristic is used (i.e.  $\forall n h(n) = \text{cost of optimal path from } n \text{ to goal}$ ), is the modified algorithm admissible?

4. *5 points*

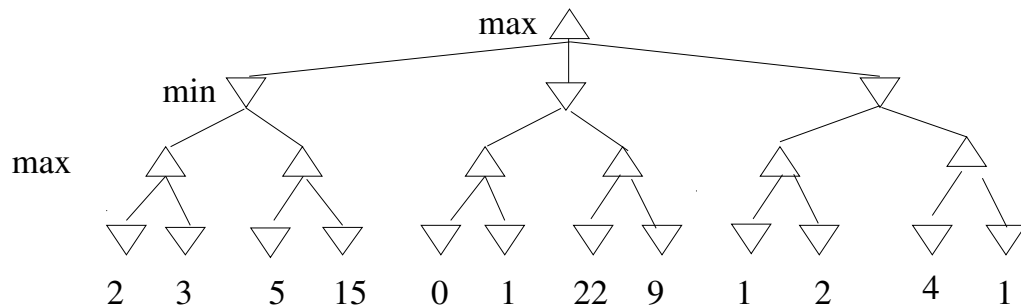
Suppose you write a program to perform A\* search for your class programming assignment. You use an admissible heuristic and you obtain a solution. You are pleased with your solution and you show it to your best friend who is taking the same class. To your dismay you discover that his A\* search program has found a different solution. He swears that he also used an admissible heuristic. You know that both you and your friend are excellent programmers and that there are no mistakes in your programs.

TURN TO THE NEXT PAGE FOR MORE QUESTIONS

1. What can you say about the two different solutions that your programs have found?
2. Can you explain why your programs have found two different solutions?

5. *15 points*

Show the backed-up values for the nodes in the following game tree and show the branches that are pruned by alpha-beta pruning. For each branch pruned, write down the condition that is used to do the pruning. Follow the convention used in the textbook to examine the branches in the tree from left to right.



6. *20 points*

Answer these questions briefly but precisely.

1. Under what conditions is breadth-first search guaranteed to find an optimal path? Why?
2. Suppose you solve the Traveling Salesman Problem using an algorithm that at each step goes to the closest city not yet visited. Will the algorithm find the optimal solution? If yes, why? If not, why not?
3. Give an example of a problem domain for which a solution that requires the minimum amount of search is more appropriate than a solution that is optimal. Motivate your answer.
4. Can a genetic algorithm work if there is no fitness function? Explain briefly what is the role of the fitness function.