CS472

Foundations of Artificial Intelligence

Prelim I
October 4, 2004

Name:

Netid:

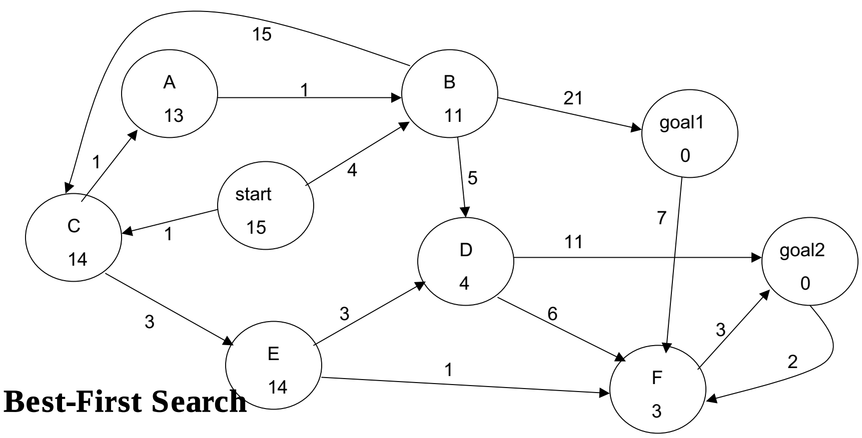
Instructions: You have 50 minutes to complete this exam. The exam is a closed-book exam.

#	description	score		max score
1	state space search	____	/	25
2	adversarial search	____	/	20
3	local search and GAs	____	/	35
4	constraint satisfaction problems	____	/	20
Total score:		______	/	100

State Space Search: (25 points total)

1. (20 pts) Consider the graph drawn below; the start and goal states are labeled. *Note that arcs are directed.* For each of the search strategies listed below, indicate which goal state is reached (if any) and list, in order, the states as they are *removed* from the fringe / open list. *When all else is equal, nodes should be expanded in alphabetical order.* Finally, do not handle *repeated states* in any special manner.

   Arcs are labeled with the cost of traversal. Nodes contain an estimate of the distance to the closest goal.



Greedy Best-First Search

Goal state reached: _____ States expanded:

Iterative Deepening

Goal state reached: _____ States expanded:

Hill Climbing

Goal state reached: _____ States expanded:

Uniform Cost Search

Goal state reached: _____ States expanded:

2. (5 pts) Would the h function in this graph lead to an admissible search? Explain your answer.

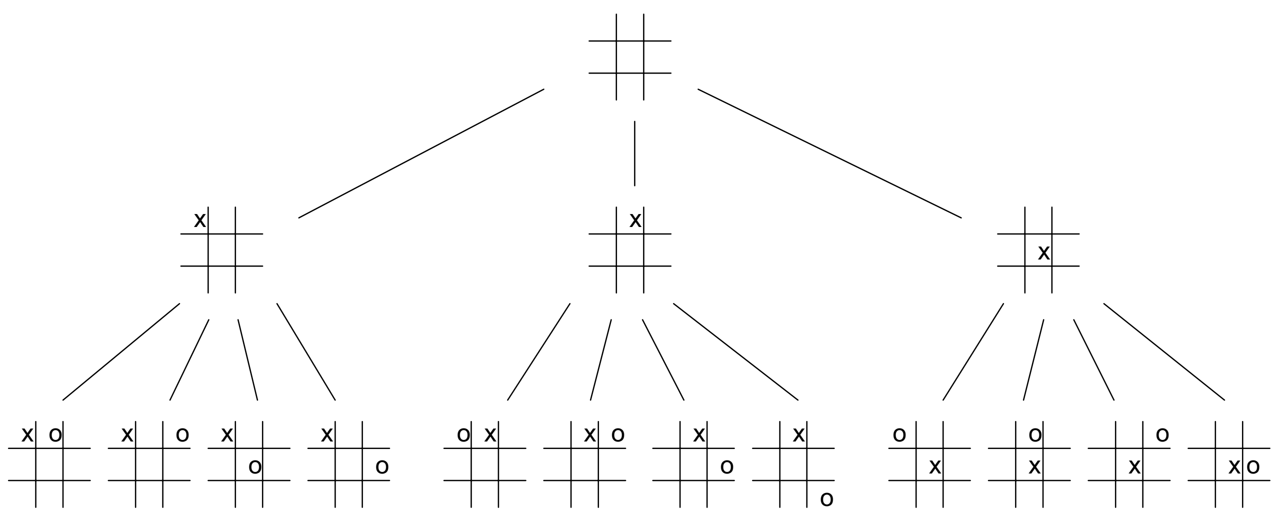
Adversarial Search: (20 points total)

1. Consider the game of tic-tac-toe (also sometimes called noughts and crosses). We define X_n as the number of rows, columns, or diagonals with exactly n X's and no O's. Similarly, O_n is the number of rows, columns, or diagonals with exactly n O's and no X's. The utility function assigns +1 to any position with $X_3 = 1$ and -1 to any position with $O_3 = 1$. All other terminal positions have utility 0. For nonterminal positions, we use a linear evaluation function defined as *Eval(s)*= $3X_2(s) + X_1(s) - (3O_2(s) + O_1(s))$.

   The figure below shows a partial game tree to depth 2.

   (a) (10 pts) Given the partial game tree, use the minimax algorithm to choose the best starting move. Mark on the tree the minimax value associated with **every** node in the tree.

   (b) (10 pts) Circle the nodes that would **not** be evaluated if alpha-beta pruning were applied, assuming the nodes are generated **in the optimal order for alpha-beta pruning**. (This means that it's ok to (virtually) reorder the leaves and associated internal nodes if they are not in the optimal order.)



Local Search and Genetic Algorithms: (35 points total)

1. Short answer questions

   - (2 pts) Give the name of the algorithm that results from the following special case: Simulated annealing with $T = 0$ at all times.

   - (3 pts) In what sense is a genetic algorithm a local search algorithm?

2. (15 pts) In order to describe and solve a problem via a **genetic algorithm**, one must normally specify a number of elements of the GA (e.g., the *crossover* operator). List and **very briefly** describe 5 of the most critical such elements (excluding crossover, of course).

   (a)

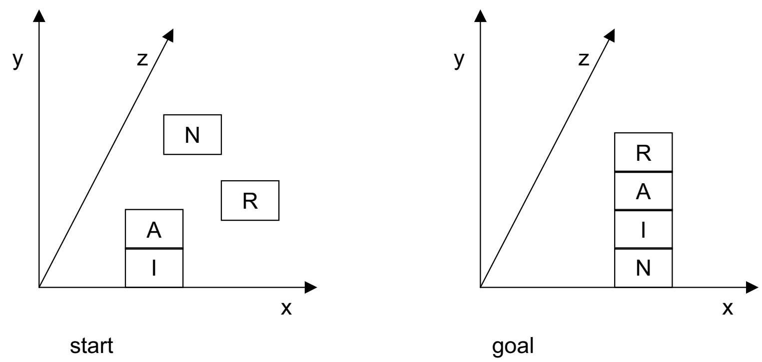
   (b)

   (c)

   (d)

   (e)

3. (15 pts) Genetic programming is another form of evolutionary computing where programs are evolved instead of bit strings. Consider the block stacking problem discussed in class in which an agent operates in a simulated "blocks world" environment. Given an arbitrary starting configuration of the blocks, the goal of the agent is to stack the blocks according to some arbitrary goal state (see figure). Your job is to design a GA to evolve a program that can perform the above task.



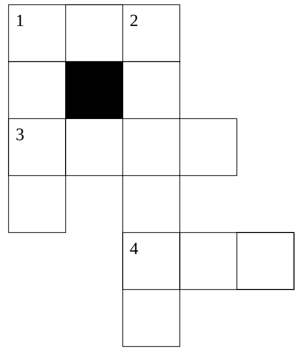
- (5 pts) Describe **two** *terminals* and **two** *primitive functions* that you would use.

- (5 pts) Explain how crossover works in the gentic programming context.

- (5 pts) In genetic programming, how is the quality of an evolving program typically determined?

Constraint Satisfaction Problems (20 points total)

Consider the crossword puzzle given below:



Suppose we have the following words in our dictionary: {ant, ape, big, bus, car, has, bard, book, buys, hold, lane, year, rank, browns, ginger, symbol, syntax}. The goal is to fill the puzzle with words from the dictionary.

1. (10 pts) Formalize the problem as a constraint satisfaction problem.

2. (5 pts) Show the resulting constraint network.

3. (5 pts) The resulting constraint network is not arc-consistent. Give one domain value that can be pruned. Explain which constraint arc can be used to prune it, and why.