

**CS 416, Artificial Intelligence**  
**Midterm Examination**  
Spring 2003

Name: \_\_\_\_\_

This is a closed book, closed note exam. The standard problem is worth 3 points and problems 7, 10, 13, 14, 23, and 27 are worth double points.

**Introductory Material**

1) When did artificial intelligence begin as a pursuit of computer science?

- a) 1930s
- b) 1950s
- c) 1970s
- d) 1990s

2) What is a satisficing solution?

3) Who was greatly involved with British efforts to build computers and crack codes during WWII?

4) We can view an agent as a function that maps one thing to another. What terms could be used to describe the inputs and the outputs of the agent function,  $f(x) = y$

x =

y =

5) If the state at the next instant in time depends *\*only\** on the state at the current time, the task environment is said to be \_\_\_\_\_?

- a) episodic
- b) stochastic
- c) Markovian
- d) linear
- e) dynamic

6) Who won the most recent human vs. computer chess competition?

- a) the human
- b) the computer
- c) it finished in a draw

## Uniformed Search

7) Route planning: A network of roads connects  $n$  cities. You must find a path from a given start city to a given goal city along these roads.

- *state*: current location (city)
- *goal test*: are we at the goal city?
- *operator*: traveling from one city to another along a road in the network
- *path cost*: total distance traveled

(a) Depth-limited search

a. Can this search be used on this problem? \_\_\_\_\_ If not, why not?

b. If so, what is an appropriate depth limit? \_\_\_\_\_

c. Is this search complete for this problem? \_\_\_\_\_

d. Is this search optimal for this problem? \_\_\_\_\_

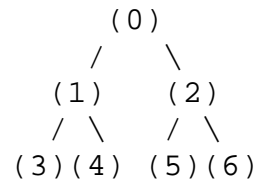
(b) Breadth-first search:

a. Can this search be used on this problem? \_\_\_\_\_ If not, why not?

b. Is this search complete for this problem? \_\_\_\_\_

c. Is this search optimal for this problem? \_\_\_\_\_

8) Given the following state tree:



i.e., state (0) expands to (1) & (2), state (1) to (3) & (4), and state (2) to (5) & (6). And the BFS and DFS implementation are such that the fringe would look like {(1), (2)} after expanding (0). \*Note the fringe is an ordered list\*

If a search problem starts at state (0), after expanding the first (and only) search node, the fringe looks like {(1), (2)}, implying that (1) will be the next search state expanded.

(a) For BFS, what would the fringe look like after expanding state (1)?

(b) For DFS, what would the fringe look like after expanding state (1)?

9) Why would iterative-deepening search be preferred over breadth-first search? Circle the one most appropriate: completeness, optimality, time complexity, space complexity.

10) For each of the problem descriptions below, state one search procedure that should be used and one that should be avoided: depth-first, breadth-first, depth-limited, and iterative deepening. Very briefly explain your answers:

a) There are loops (cycles) in the state-space description

Use:

Avoid:

b) The depth of the solution is unknown.

Use:

Avoid:

c) Very limited memory is available

Use:

Avoid:

## Informed Search

11) What is an admissible heuristic?

12) What is a consistent heuristic?

13) Consider the 15-puzzle problem. Is the following heuristic admissible, yes or no: The MisplacedTiles heuristic using only the first 15 tiles (potentially including the blank). Stated another way, the MisplacedTiles heuristic ignores the state of the bottom, right tile.

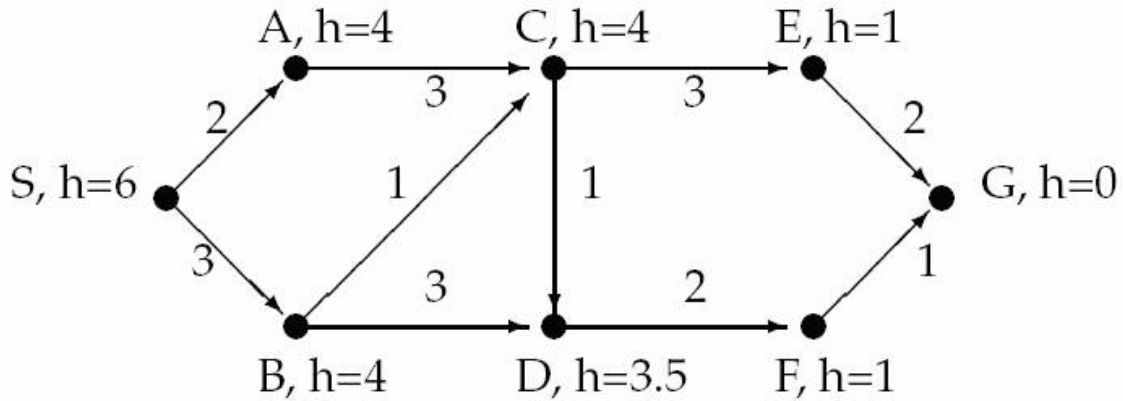
14) Answer True or False and provide a one-sentence explanation: The “Manhattan Distance” is in fact an admissible heuristic for finding the shortest path through Manhattan. (Hint: Broadway crosses Manhattan on a diagonal.)

15) Why is local beam search not simply parallel hill-climbing search?

16) Simulated annealing relies on a temperature,  $T$ , to be correctly set in order to find a global optimum with a probability approaching 1.0. What effect does  $T$  have on the actions of simulated annealing?

17) What are the two primary operations in genetic algorithms that are used to create a new generation of samples?

18) Suppose we want to use the A\* algorithm on the graph below to find the shortest path from node S to node G. Each node is labeled by a capital letter and the value of a heuristic function. Each edge is labeled by the cost to traverse that edge.



For this problem:

- Perform the A\* algorithm on this graph, filling in the table below. You should not need all the lines in the table. Indicate the  $f$ ,  $g$ , and  $h$  values of each node on the queue as shown in the first two rows of the table. You need not write the contents of the (priority) queue in order in the table.

Assume that if you find a path to a node already on the queue that you update its cost (using the lower  $f$  value) instead of adding another copy of that node to the queue.

- Show the path found by the A\* algorithm on the graph above.

iteration	node expanded	Priority queue at end of this iteration
0		$S = 0 + 6 = 6$ (i.e. $S = g(S) + h(S) = f(S)$ )
1	S	$A = 2 + 4 = 6$ ; $B = 3 + 4 = 7$
2		
3		
4		
5		
6		
7		
8		
9		
10		

19) Suppose we run the A\* algorithm using a heuristic that is admissible but not consistent.

a) Is A\* still going to return the shortest path of all successful paths? \_\_\_\_\_

b) Why?

c) If it is still going to return the shortest path of all successful paths, then why do we care about consistent heuristics?

20) Assume heuristic A dominates heuristic B.

a) Why is it better to use A with A\*? Include a definition of what domination means in this context.

(extra credit) If A is admissible, is B admissible as well?

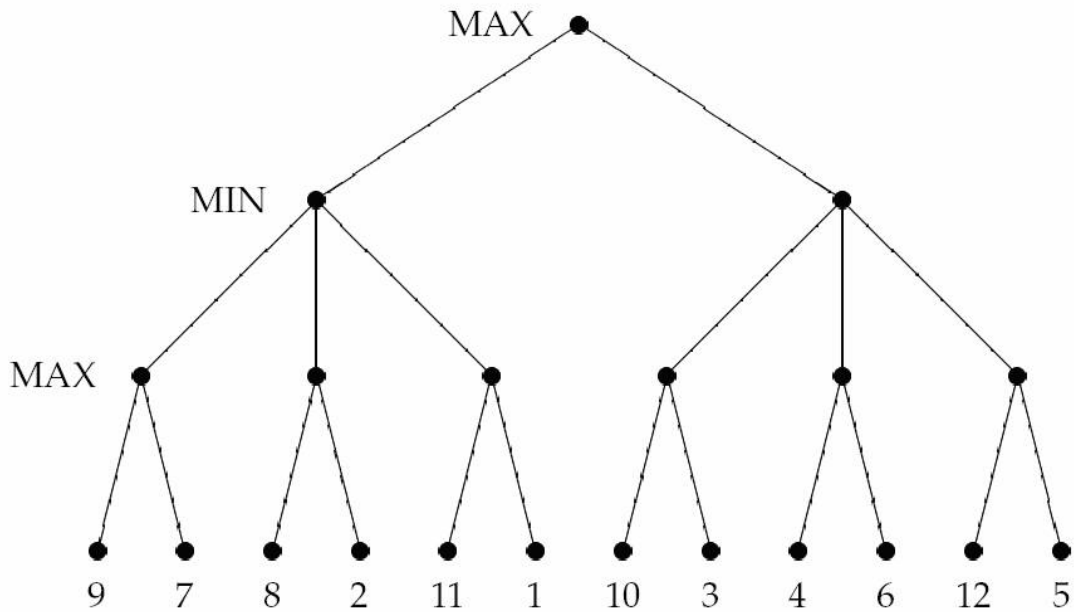
## **Adversarial Search**

21) How does your game playing change if you know you are playing against a suboptimal opponent?

22) The horizon effect is a challenge for game playing algorithms. What is it and how would you take advantage of this weakness in an opponent?

23) Perform alpha-beta minimax search on the tree below. The player making the first move wishes to maximize the game outcome.

- Use the cutoff test  $a \geq \beta$
- Indicate which leaf nodes are evaluated by circling the value of the leaf node.
- What is the value of this tree?
- Which is the best move from the root node?



## Logical Agents

24) Convert  $(L \wedge G) \Rightarrow M$  to a Horn Clause:

25) What is the Modus Ponens rule?

26)  $\alpha$  entails  $\beta$  if and only if the sentence ( \_\_\_\_\_ ) is unsatisfiable?

27) A knowledge base (KB) contains the following sentences:

Red	Blue $\Rightarrow$ Silver	Pink $\Rightarrow$ Red
$\neg$ Pink $\vee$ Blue	Pink $\Rightarrow$ Tan	Blue $\Rightarrow$ Orange
Tan $\vee$ Orange	Silver	
$\neg$ Pink	$\neg$ (Violet $\vee$ White)	

Using the standard inference rules for propositional logic, does this KB entail the following sentences? For each answer, state which sentences and rule(s) you are using, if any.

$\neg$ Orange

Silver  $\wedge$  Red

Silver  $\vee$  White

Extra Credit:

Some heuristics which are not admissible can still be guaranteed to provide an optimal answer (i.e., to return the lowest cost path) for A\*. Give an example of one.

What does meta reasoning mean?

Circle the word YES if any of these sentences apply to you:

- YES Are you taking any of the following courses: APMA 111, APMA 212, CS 120, ITAL 102, LATI 201, LATI 202, SPAN 101, 102, 201, 202A
- YES Are you taking any of the following courses: COMM 201, FREN 101, 102, 201, 202, 232, 331
- YES Are you taking any of the following courses: ECON 202 (sections 100 and 200 only), MATH 114
- YES Are you taking any of the following courses: APMA 213, MATH 131, 132, STAT 112
- YES Are you taking any of the following courses: APMA 310, CS 101, MATH 111, Math 121, Math 122, STAT 110