CS 540: Introduction to Artificial Intelligence

Mid Exam: 7:15-9:15 pm, October 25, 2000
Room 1240 CS & Stats

CLOSED BOOK
(one sheet of notes and a calculator allowed)

Write your answers on these pages and show your work. If you feel that a question is not fully specified, state any assumptions you need to make in order to solve the problem. You may use the backs of these sheets for scratch work.

Write your name on this and all other pages of this exam. Make sure your exam contains ***six*** problems on ***ten*** pages.

Name ____

Student ID ____

Problem	Score	Max Score
1	______	22
2	______	22
3	______	10
4	______	21
5	______	10
6	______	15
TOTAL	______	100

Name: ______________________________

Problem 1 – Decision Trees (22 points)

Imagine you wish to recognize good art given some features of it. You've written a program that is able to measure two numeric properties of each piece of art: *F1* and *F2*, plus your code is able to determine the most-used primary color (*red=R*, *blue=B*, and *yellow=Y*). A set of *training examples* appears below.

F1	*F2*	*Color*	*Result*
0	*4*	*R*	*good*
3	*2*	*B*	*bad*
7	*5*	*B*	*good*
1	*4*	*B*	*bad*
8	*1*	*R*	*good*

a) Using a method like the one that you used in HW 1, first discretize the continuous features, *but only divide into two (2) bins* (*low=L* and *high=H*). Complete the reformulated table below and briefly explain your work to the right of the table.

F1	*F2*	*Color*	*Result*	*Explanation of Reformulation*
		R	*good*	
		B	*bad*	
		B	*good*	
		B	*bad*	
		R	*good*	

b) What score would the *information gain* calculation assign to each of the features?
Be sure to show all your work (use the back of this or the previous sheet if needed).

c) Which feature would be chosen as the root of the decision tree being built? ____________
(Break ties in favor of *F1* over *F2* over *Color.)*

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d) Show the *next* interior node, if any, that the C5 algorithm would add to the decision tree. Again, be sure to show all your work. (Even if this secod interior node does not completely separate the training data, stop after adding this second node.)

Be sure to label all the leaf nodes in the decision tree that you have created.

e) Assuming you have the following *tuning set*, which pruned tree would HW 1's pruning algorithm produce *AFTER THE FIRST ROUND OF PRUNING*? Justify your answer.

F1	*F2*	*Color*	*Result*
1	*4*	*R*	*good*
2	*0*	*B*	*bad*
0	*7*	*Y*	*bad*

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Problem 2 – Search (22 points)

Consider the search space below, where *S* is the start node and *G1* and *G2* satisfy the goal test. Arcs are labeled with the cost of traversing them and the estimated cost to a goal is reported inside nodes.

For each of the following search strategies, indicate which goal state is reached (if any) and list, *in order*, all the states *popped off of the OPEN list*. When all else is equal, nodes should be removed from OPEN in alphabetical order.

Uniform Cost

Goal state reached: ________ States popped off OPEN: ______________________________

Iterative Deepening

Goal state reached: ________ States popped off OPEN: ______________________________

Best First (using the *h* function only)

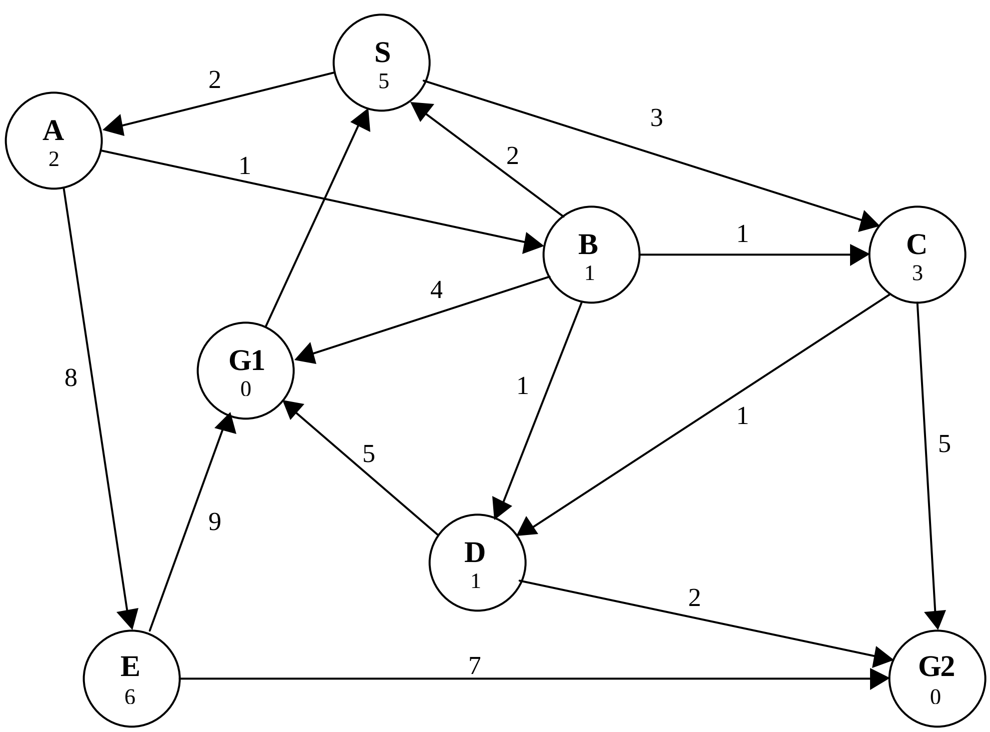
Goal state reached: ________ States popped off OPEN: ______________________________

Beam (with beam width = 2 and using the *h* function only)

Goal state reached: ________ States popped off OPEN: ______________________________

A*

Goal state reached: ________ States popped off OPEN: ______________________________



Name: ______________________________

Problem 3 – Representation using Logic (10 points)

Convert each of the following English sentences into first-order predicate calculus (FOPC), using reasonably named predicates, functions, and constants. If you feel a sentence is ambiguous, clarify which meaning you're representing in logic. (Write your answers in the space *below* the English sentence.)

Mary is tall and Bill is not.

Some dogs are tiny.

All of Picasso's paintings are valuable.

All the houses near Sue's house are either large or old (or both).

Name: ______________________________

Problem 4 – Reasoning using Logic (21 points)

a) Is the following WFF *valid*? Justify your answer

[(P Þ Q) Ù (Q Þ R)]   Þ   (P Þ R)

b) Provide and justify a (formal) *interpretation* that makes the following WFF *true*:

(P Ú Q Ú R) Ù (ØQÚ R) Ù (ØPÚ ØR)

Name: ______________________________

c) Formally show that *S Ú R* follows from the "given's" below.
(Don't deduce more than 10 additional WFF's.)

Number	***WFF***	***Justification***
1	*Ø (ØQ) Ù Z*	*given*
2	*ØW*	*given*
3	*(ØW Ù Q) Þ (ØP)*	*given*
4	*(W Ù Z) Þ S*	*given*
5	*Q Þ (S Ú P)*	*given*
6	*(P Ù Q) Þ R*	*given*
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		

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Problem 5 – Miscellaneous Short Answers (10 points)

Briefly describe each of the following AI concepts and explain each's significance.
(Write your answers *below* the phrases.)

Heuristic Functions

Occam's Razor

Quantifiers

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*A**

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a-b Pruning

Name: ______________________________

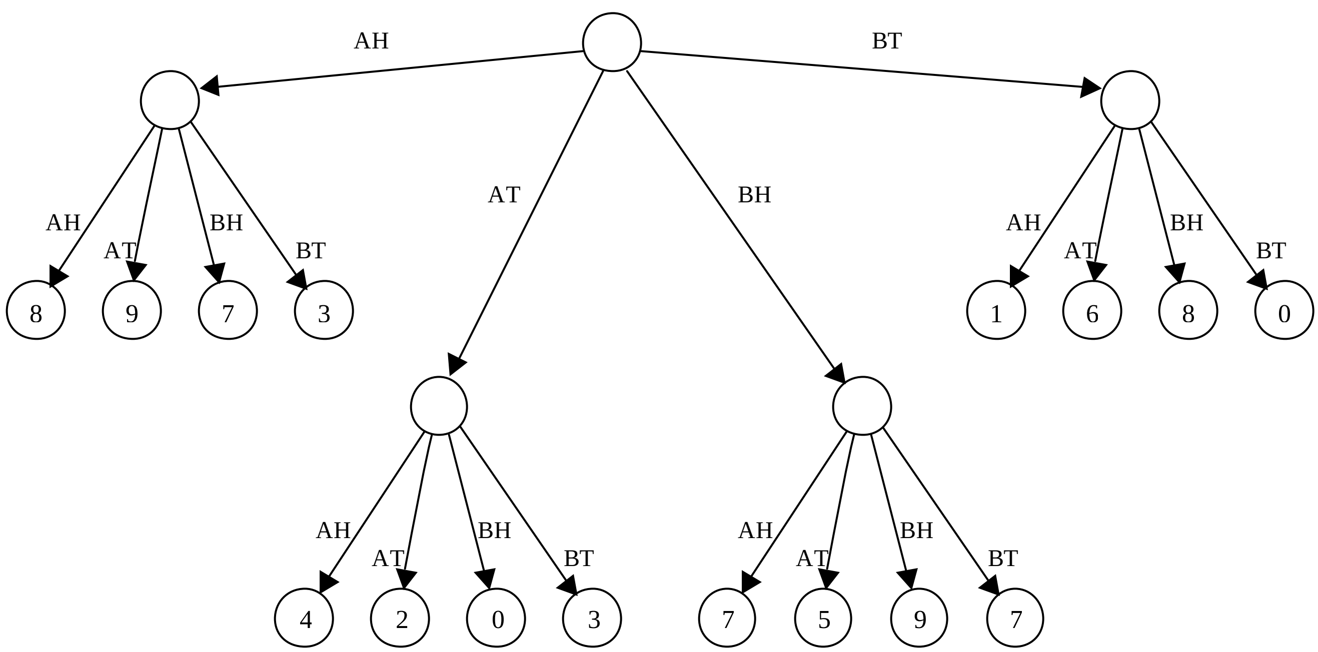
Problem 6 – Game Playing (15 points)

Consider the following game:

> When it is their turn to move, players must first *choose which of two weighted coins, A and B, to flip.*
>
> Coin *A* comes up heads 75% of the time and tails the other 25%.
> If heads, the player *must* make move *AH* and if tails he or she (or it) *must* make move *AT*.
> (To do this problem, you needn't know exactly what each move means.)
>
> Coin *B* comes up heads 10% of the time and tails the other 90%.
> If heads, players *must* make move *BH* and if tails they *must* make move *BT*.

Assume it is the *computer's* turn to play, and the game tree looks like the one below, where the values at the leaf nodes are the results of calls to the *SBE* (higher scores are better for the *computer*).

a) Explain what move the *computer* should make.
(Hint: think about *expected-value* calculations. Also, you might want to do parts *b* and *c* first.)



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b) Now assume that *there is no randomness* and the players simply can choose *any* of the four moves (*AH, AT, BH,* or *BT*). Apply the *minimax* algorithm to the tree below and explain which move the computer should make. As in part (a), assume it is the computer's turn to play.

c) Assuming leaf nodes are visited left-to-right, identify *the first* unnecessary call to the *SBE* (for the *no randomness* case). Explain your answer.