EXAM I | **Name:**

CSC 440 – ARTIFICIAL INTELLIGENCE – SPRING 1994

Please print your name at the top of every page.
This is an open book/notes exam.
This exam consists of 8 questions.
Write all answers in the space provided. You may continue at the back of the page if more space is required.
Be as precise and concise as possible.
If you do not understand a question, ask me about it.
The exam will end exactly 75 minutes after it begins.
Good Luck.

Question	**Points**	**Out of**
1		15
2		15
3		15
4		10
5		10
6		20
7		5
8		10
Total		100
Grade		

Question (15 points) Answer all the below.

(a) (5 points) Which of the following state-space search methods are guaranteed to find a optimal cost solution whenever any solution exists? Indicate your answers by writing **yes** or **no** in the box provided.

a) ☐ Depth-first search
b) ☐ Hill Climbing
c) ☐ Breadth-first search
d) ☐ Best-first search
e) ☐ A^*

(b) (5 points) Identify each search method described by writing its name in the box provided. Assume $\hat{g}(n)$ is the cost incurred in getting from the start node to n, $\hat{h}(n)$ is an estimate of the minimal cost to get from n to a goal, $\hat{f}(n) = \hat{g}(n) + \hat{h}(n)$, and **OPEN** is the *queue* of the nodes to be expanded.

Treats **OPEN** as a simple queue	
Treats **OPEN** as a simple stack	
Keeps **OPEN** ordered by $\hat{g}$	
Keeps **OPEN** ordered by $\hat{h}$	
Keeps **OPEN** ordered by $\hat{f}$	

(c) (5 points) Answer **true** or **false** to each of the following statements:

a) ☐ A heuristic is a technique that allows the search process to efficiently find the optimal solution.

b) ☐ Knowledge may reduce search.

c) ☐ Decomposable problems can always be solved by AND-OR graphs.

d) ☐ Constraint satisfaction is a breadth-first procedure.

e) ☐ Means-ends analysis is a strong method.

Question 2 (15 points) Consider the following sentences:

1. *If the maid stole the jewelery, then the butler wasn't guilty.*
2. *Either the maid stole the jewelery or she milked the cows.*
3. *If the maid milked the cows, then the butler got his cream.*
4. *Therefore, if the butler was guilty, then he got his cream.*

(a) (5 points) Letting

M = The maid stole the jewelery

B = The butler was guilty

C = The maid milked the cows

G = The butler got his cream

express these statements in propositional logic.

(b) (5 points) Express their clause form equivalents (don't forget to negate the conclusion).

(c) (5 points) Demonstrate using resolution that the conclusion (statement 4) follows validly from the premises.

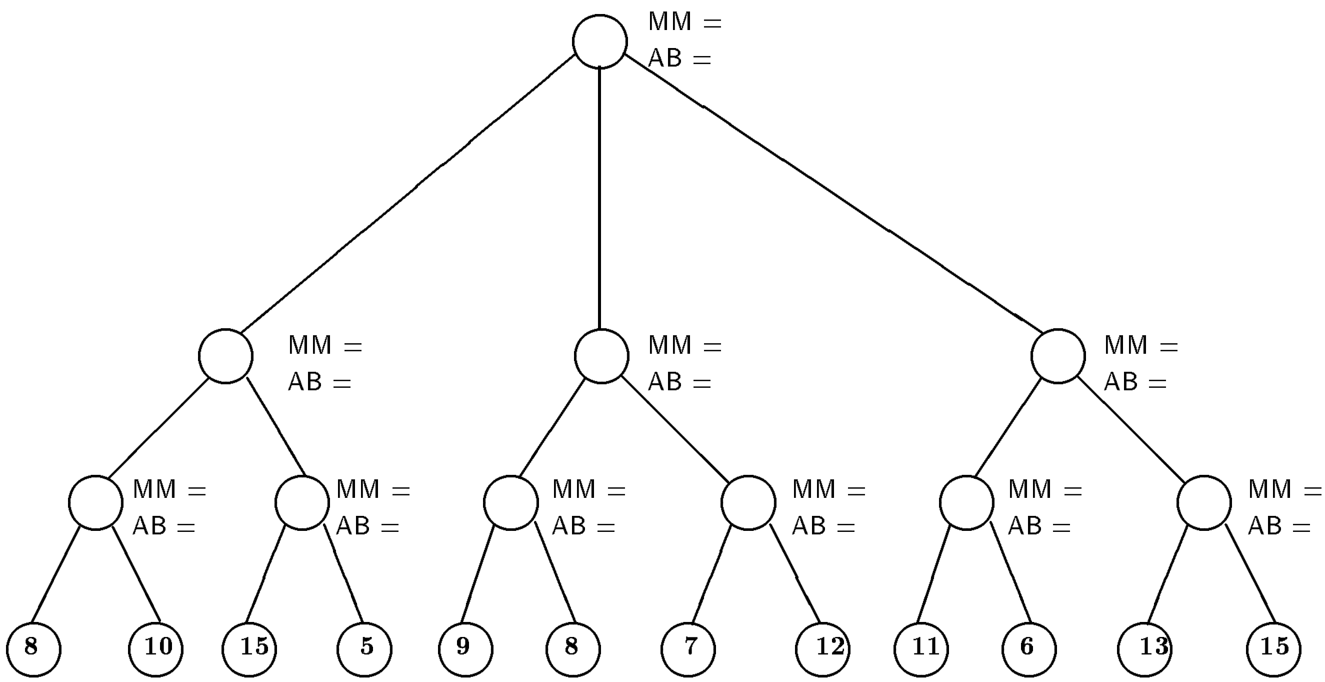
Question 3 (15 points) Consider the following sentences:
1. *All computer scientists are rational.*
2. *Anyone who understands a rational person is rational.*
3. *There is a psychotic who understands a computer scientist.*
4. *Therefore, some rational person is a psychotic.*

(a) (5 points) Express these statements in first-order predicate logic. Be sure to provide a clear syntax and semantics for your predicates.

Question 3. (continued) (b) (10 points) Demonstrate, using resolution, that the conclusion (statement 4) follows validly from the premises.

Question 4 (10 points) For the following state space (root node is a maximizing state), indicate *both* of the following:

- The backed-up MINMAX value at each node.
- The backed-up alpha/beta values at each node, as well as indicating any alpha or beta cutoffs by putting an X thru the arc connecting to unevaluated states. Assume the leaf states have no applicable operators.



Question 5 (10 points) Represent the following information in a generalization hierarchy:

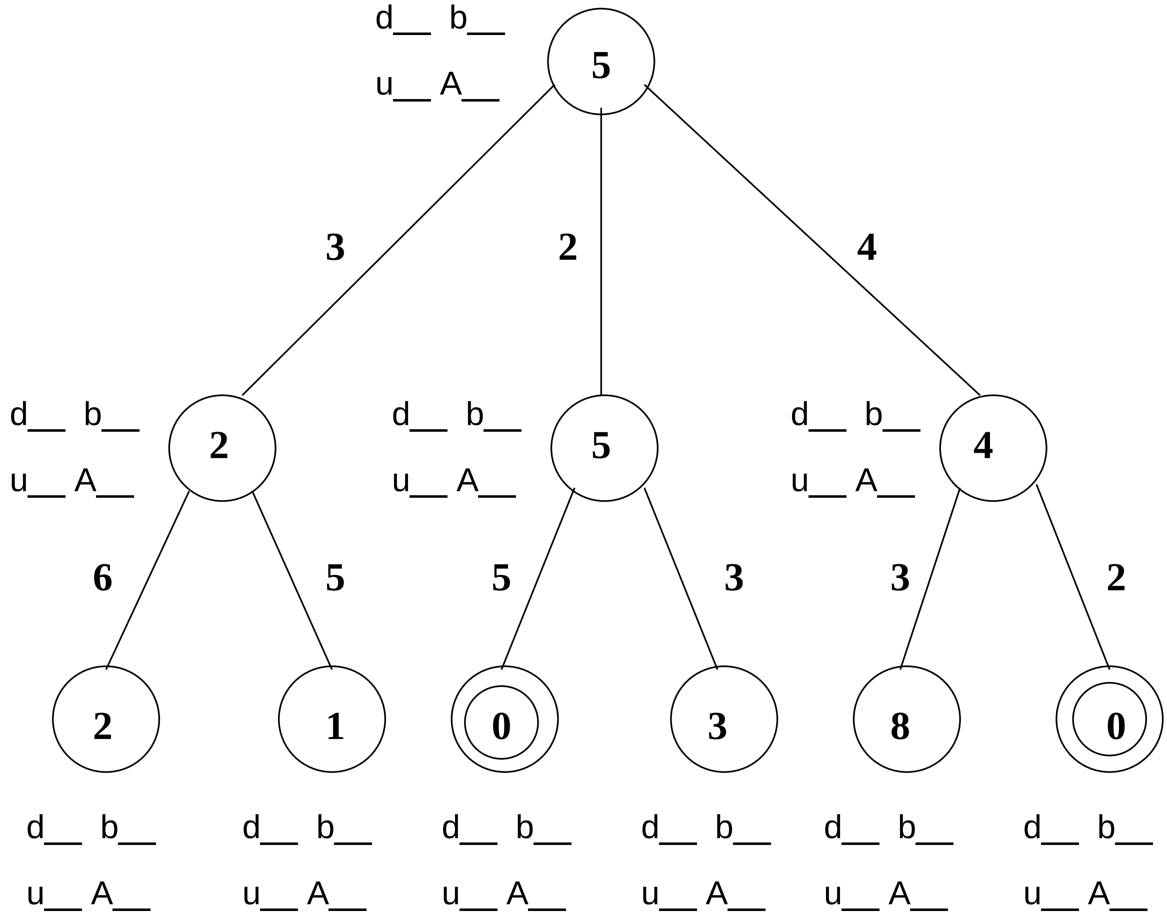
- Bill is an Fine Arts major.
- Jill is a CS major.
- Fine Arts majors and CS majors are students.
- Students are people and have 2.0 GPAs.
- Arts majors have 3.0 GPAs.
- People are right-handed.
- CS majors type with however they are handed (left or right).

and answer the questions, using the property inheritance algorithm, *What are Bill and Jill's GPAs?*, *Is Jill left-handed?*.

Question 6 (20 points) The tree below is a state-space tree in which the root is the start node, the double circled leaves (marked **0**) are goal nodes, the other leaves are unsolvable (no operators apply to them), arcs are marked with the cost of the operators, and nodes are marked with the value of **h** (estimated remaining cost to a solution). Cost is to be minimized.

On the lines next to each node, write a number indicating the order in which the node is chosen for expansion during the indicated kind of search. If a node is never chosen for expansion in some search, put an **X** on the appropiate line. The kinds of search are:

d: depth first **b:** breadth-first
u: branch-and-bound **A:** A*



Question 7 (5 points) A problem-solving search can proceed either forward (from a known start state to a desired goal state) or backward (from a goal state to a start state). What factors determine the choice of direction for a particular problem? Justify.

Question 8 (10 points) Show results of applying the unification algorithm given in class to the following pairs of terms. In particular, clearly indicate the disagreement sets (D_k), partial unifiers (σ_k), set of (partially unified) terms (S_k), and iteration of the algorithm (k). Indicate, clearly, what is happening at each iteration of the algorithm, stating why (if that is the case) unification fails. Note that x, y, u are variables, and b, c are constants.

a) $S = \{F(x, x, g(x)),\ F(g(y), g(h(u)), g(g(g(b))))\}$ **(5 points)**

Question 8 (continued)

b) $S = \{F(g(h(w)), u, x, x, g(u)),\ F(y, h(c), g(b), g(b), y)\}$ **(5 points)**