6.034 Quiz 1
26 September 2012

Name	
email	

Circle your TA **(for 1 extra credit point)**, so that we can more easily enter your score in our records and return your quiz to you promptly.

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This semester I am taking ☐ **subjects with substantial final projects or papers.**

Problem number	Maximum	Score	Grader
		+1	
1	50	50	AB
2	50	50	IM
Total	100	101	IM

There are 11 pages in this quiz, including this one, but not including blank pages and tear-off sheets. Tear-off sheets are provided at the end with duplicate drawings and data. As always, open book, open notes, open just about everything, including a calculator, but no computers.

Problem 1: Rule Based Systems (50 points)

Now that you are taking 6.034, you are the source of all wisdom among your friends. That's why your friends come to you with tough questions about life and career decisions. One such question is: "Should I become a rockstar or pursue another job?"

You decide to write a Rule Based System to help figure out which of your friends should indeed become rockstars.

For your convenience, a copy of the following rules and assertions is provided on a tear-off sheet at the end of the quiz.

Rules:

```
P0  IF    '(?x) is in 6.034'
    THEN  '(?x) is charismatic'

P1  IF     (OR '(?x) is nimble',
               '(?x) takes dance lessons')
    THEN  '(?x) can dance like Mick Jagger'

P2  IF     (OR '(?x) is a rebel',
              (AND '(?x) has money',
                   '(?x) chooses style over comfort'))
    THEN  '(?x) wears leather'

P3  IF    (AND '(?x) is related to Lady Gaga',
               (NOT '(?x) goes to MIT'))
    THEN '(?x) chooses style over comfort'

P4  IF    (OR (AND '(?x) wears leather',
                   '(?x) can dance like Mick Jagger'),
              (AND '(?x) is musically gifted',
                   '(?x) is charismatic'))
    THEN '(?x) should become a rockstar'
```

Assertions:

A0: (Alison is in 6.034)
A1: (Brad is in 6.034)
A2: (Alison is musically gifted)
A3: (Chris is a rebel)
A4: (Chris takes dance lessons)

Backward-chaining assumptions

Make the following assumptions about backward chaining:

- When working on a hypothesis, the backward chainer tries to find a matching assertion in the list of assertions. If no matching assertion is found, the backward chainer tries to find a rule with a matching consequent. If no matching consequent is found, then the backward chainer assumes the hypothesis is false.
- The backward chainer never alters the list of assertions, so it can derive the same result multiple times.
- Rules are tried in the order they appear.
- Antecedents are tried in the order they appear.
- Lazy evaluation/short circuiting is in effect (e.g., if the first part of an AND clause is false, the rest does not need to be evaluated to determine that the whole clause is false).

Part A: Backward Chaining (25 points)

First, determine whether Chris should become a rockstar by simulating backward chaining with the hypothesis

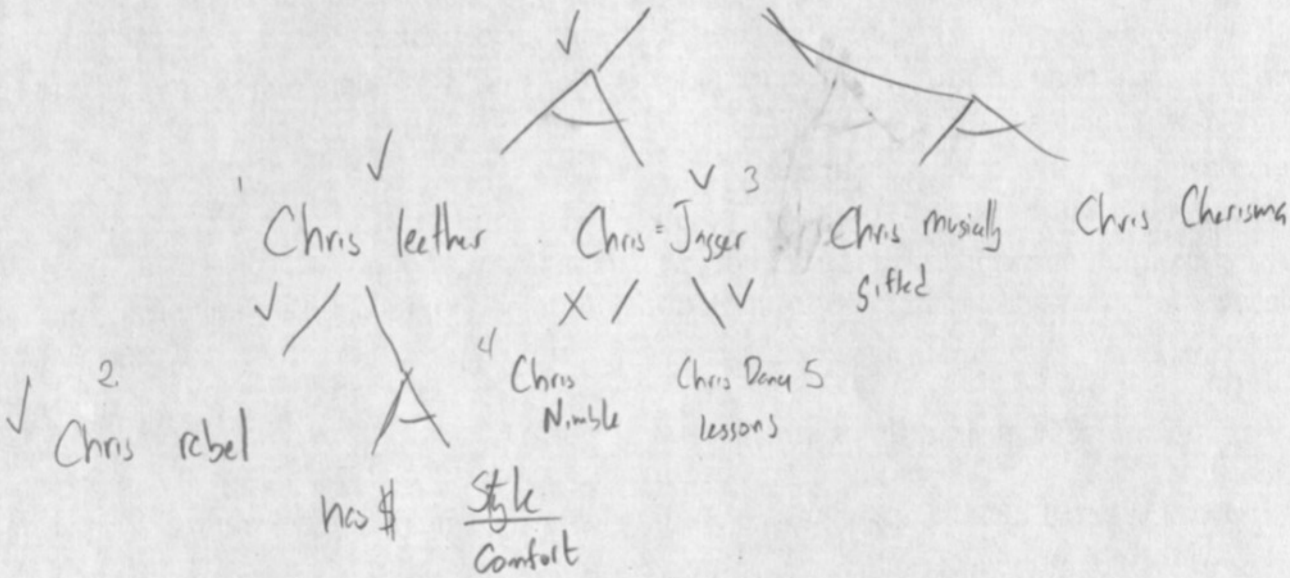
(Chris should become a rockstar)

Write all the hypotheses the backward chainer looks for in the database in the order that the hypotheses are looked for. The table has more lines than you need. We recommend that you use the space provided on the next page to draw the goal tree that would be created by backward chaining from this hypothesis. The goal tree will help us to assign partial credit in the event you have mistakes on the list.

1 Chris should become a rockstar	11
2 Chris wears leather	12
3 Chris is a rebel	13
4 Chris can dance like Mick Jagger	14
5 Chris is nimble	15
6 Chris takes dance lessons	16
7	17
8	18
9	19
10	20

Space provided to draw the goal tree.

Chris should become a rockstar



Part B: Forward Chaining (25 points)

Make the following assumptions about forward chaining:

- Rules fire in the order listed (rule-ordering conflict resolution).
- New assertions are added to the bottom of the list of assertions.
- If a particular rule matches assertions in the list of assertions in more than one way, the matches are considered in the order corresponding to the top-to-bottom order of the matched assertions. Thus, if a particular rule has an antecedent that matches both Assertion 1 and Assertion 2, the match with Assertion 1 is considered first.

B1 (20 points)

Now you want to use a forward-chaining system to determine who among your friends should become rockstars.

Run forward chaining on the list of assertions, showing your work in the table on the next page. For the first three iterations, fill out the first three rows of the table on the next page. In the first column, list all the rules that match during that iteration. In the second column, write down the rule that fires. In the third, write down the assertion that is added when the rule fires. For the rest of the iterations, simply write down the rule that fires and the assertion that is added.

Iteration	Rules Matched	Rule Fired	New Assertion Added
1	P0, P1, P2	P0	Alison is charismatic
2	P0, P1, P2, P4	P0	Brad is charismatic
3	P0, P1, P2, P4	P1	Chris can dance like Jagger
4		P2	Chris wears leather
5		P4	Alison should become Rockstar
6		P4	Chris should become Rockstar
7			
8			
9			
10			
11			
12			
13			
14			

Using your forward-chaining system, how many of your friends should become a rockstar? 2

B2 (5 points)

If you moved P4 to the top of the list of rules, would your forward chaining have taken less, same, or more number of iterations to complete?

Circle one: **LESS** **SAME** **MORE**

Explain: Since there are no OR clauses in P4 that are processable w/o getting assertions from P0-P3, the chain would take the same amount of steps as P4 deletes nothing.

Problem 2: Search and Games (50 points)

Odysseus hopes to travel from Troy to Ithaca. Unfortunately, there are many possible paths, and most of them lead to catastrophe. Odysseus has drawn up the following map of possibilities, provided on the tear off sheet at the end of the exam, and Athena has told him how many of his men die if he chooses to travel along a given connection in the map. Athena also gives Odysseus heuristic values for each node, located in parentheses, which she indicates are consistent estimates for the number of men who will die in traveling from that node to Ithaca.

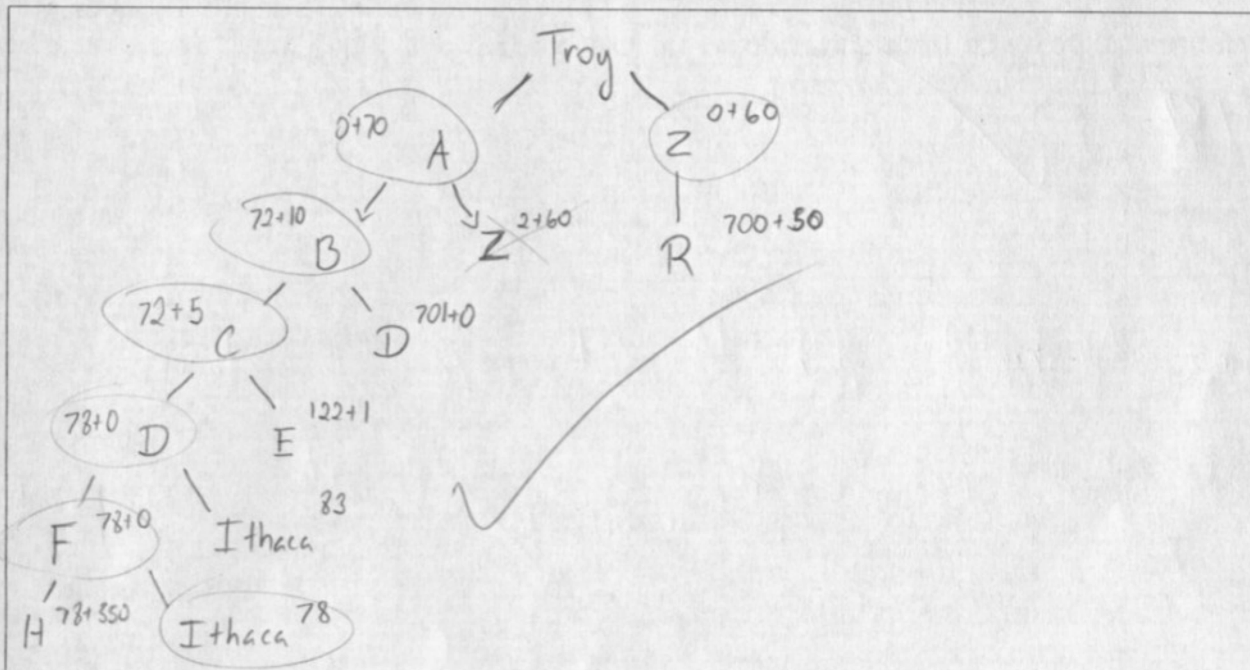
Part A: (26 points)

Part A1: A* (14 points)

You are to do A* search aimed at losing the least men. Assume that the heuristic values are consistent. Break ties alphabetically. List the extended nodes in the order they are extended:

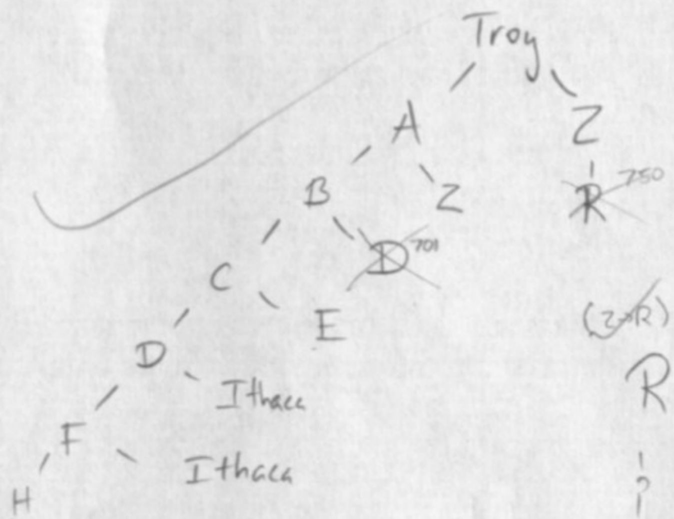
Troy, Z, A, B, C, D, F, Ithaca

Draw the search tree. Order the children of a node alphabetically from left to right.



Part A2: A* modification (6 points)

Suppose Odysseus starts with 701 men. He reasons that he can sometimes eliminate newly extended paths immediately, without bothering to put them on the search queue, with no risk of overlooking any successful trip home. List the paths that can be eliminated immediately.



(Z→R) (A→B→D)

R & D are ≥ 701

∴ thus are immediately eliminated

Part A3: Admissibility (6 points)

By convention, Odysseus has labeled the start node with a heuristic value of 0. What is the largest value he could use that would still be an admissible estimate?

78

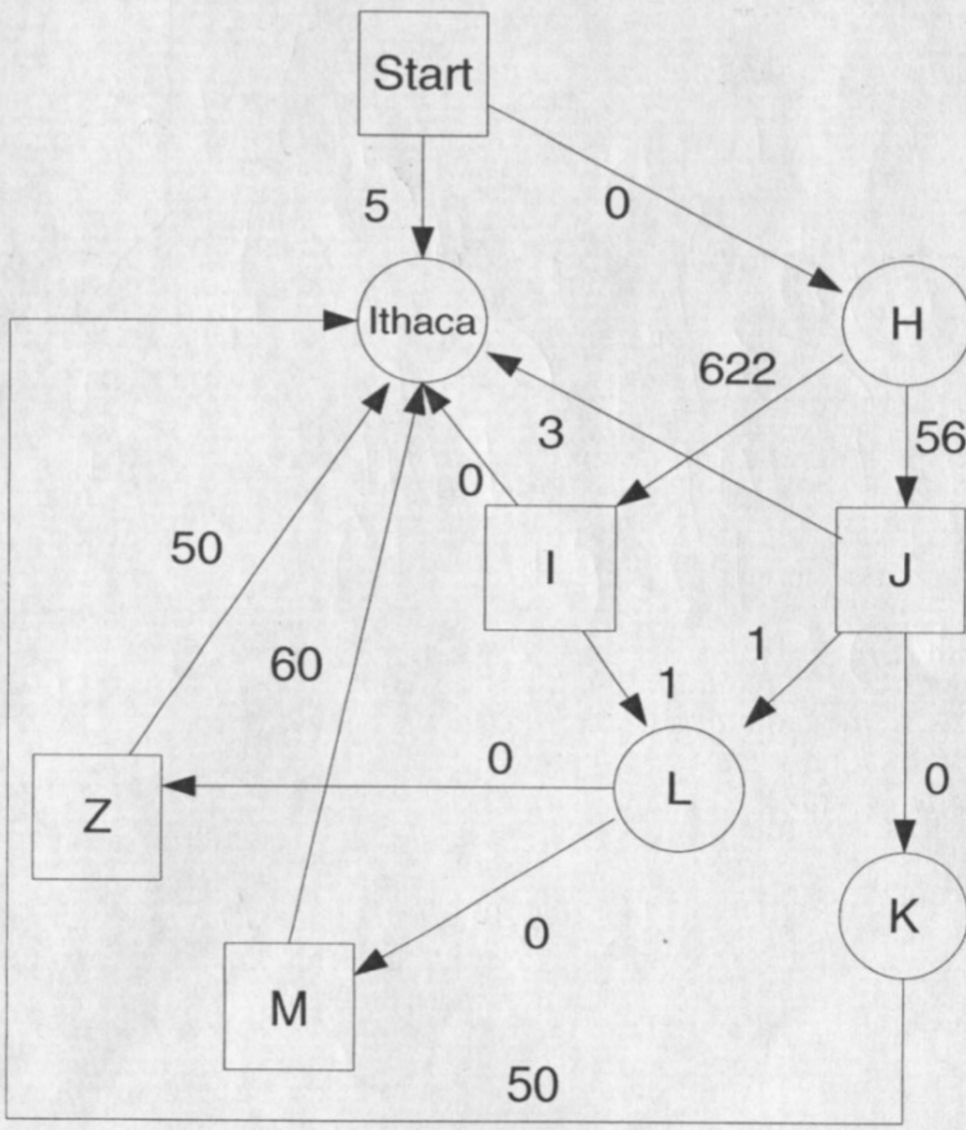
Explain how you arrived at this value.

Since shortest path to goal = 78, the admissible heuristic only needs to be less than or equal to the goal (this isn't a consistent heuristic)

Part B: Games (24 points)

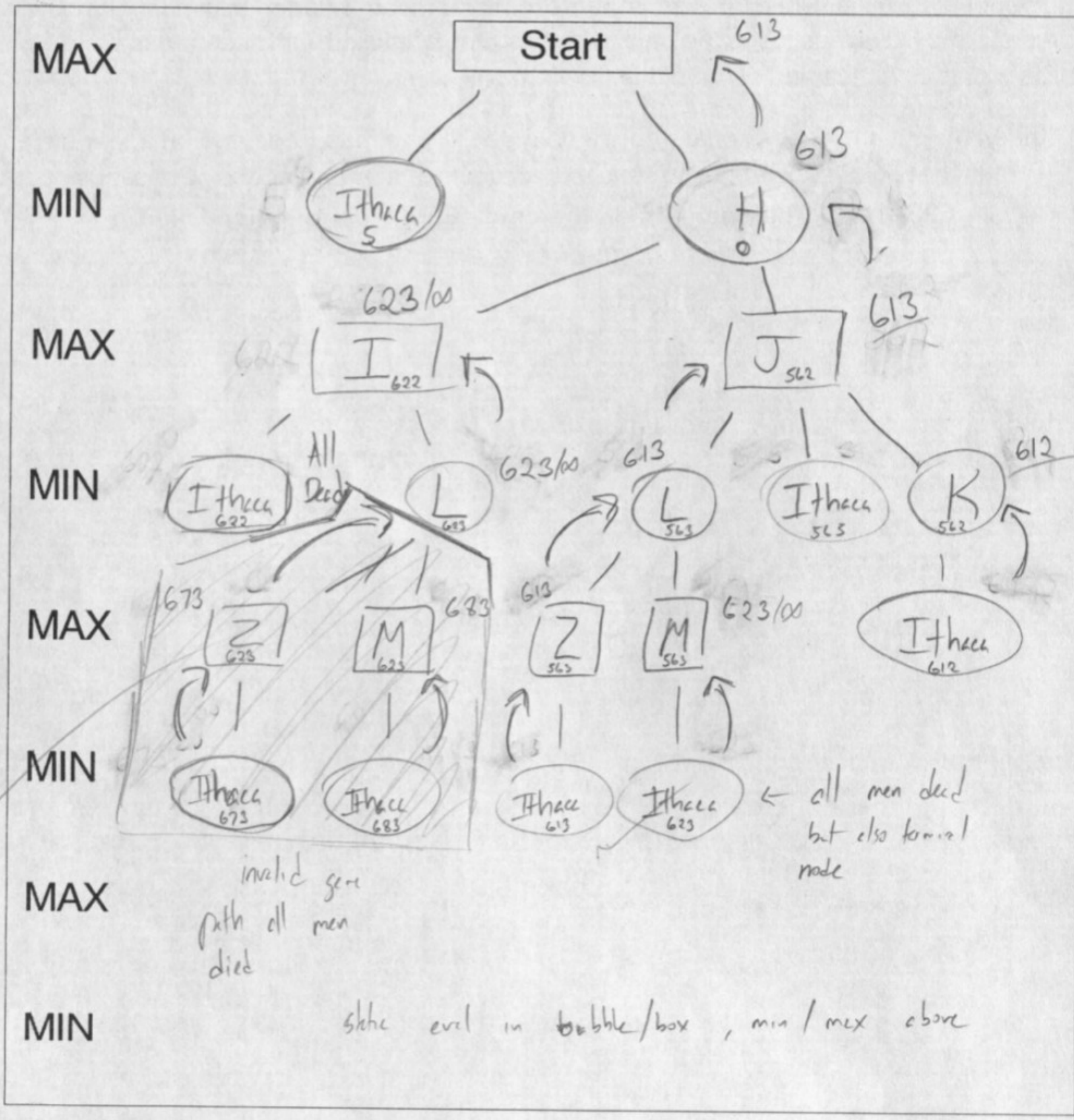
In a modern remake of the Odyssey, finding a path to Ithaca has become a contest. Starting at the Start node, Poseidon and Odysseus take turns choosing which connection Odysseus will follow. Poseidon wants to make a path with the maximum number of men killed, while Odysseus wants to make a path with the minimum number of men killed. Odysseus loses the game if all his men are killed. Odysseus wins if he builds a path to Ithaca and some of his men are still alive.

Poseidon makes choices at square nodes on the following map (repeated on a tear off sheet at the end of the exam). Odysseus makes choices at round nodes. Odysseus starts with **623 men**. **The numbers on the connections denote men killed.**



Part B1 (9 points)

Draw the complete game tree, stopping when the goal is reached or all men are killed.



Part B2 (9 points)

Now, perform minimax on the game tree you drew in Part B1. Write the minimax score at each node. **Note that the value of the static evaluation function is the total number of men killed.**

Part B3 (3 points)

What is the minimax path from the Start?

START -> H -> J -> L -> Z -> Ithaca

Part B4 (3 points)

How many men are left alive at the end of the game?

10