6.034 Quiz 2
October 23, 2007

Name	
EMail	

Circle your TA and recitation time, if any, so that we can enter your score in our records and return your quiz to you promptly.

TAs	
Mike Klein	
Tom Kollar	
Akua Nti	
Mark Seifter	
A. M Lestier	

Thu	
Time	Instructor
11-12	Kimberle Koile
12-1	Kimberle Koile
1-2	Kimberle Koile

Fri	
Time	Instructor
12-1	Howard Shrobe
1-2	Howard Shrobe
2-3	Howard Shrobe

Problem number	Maximum	Score	Grader
1	50		
2	50		
Total	100		

There are 10 pages in this quiz, including this one. A tear-off sheet is provided at the end with duplicate drawings and data.

As always, open book, open notes, open just about everything.

Problem 1: Games (50 points)

In the game tree below, the value below each node is the static evaluation at that node. MAX next to a horizontal line of nodes means that the maximizer is choosing on that turn, and MIN means that the minimizer is choosing on that turn.
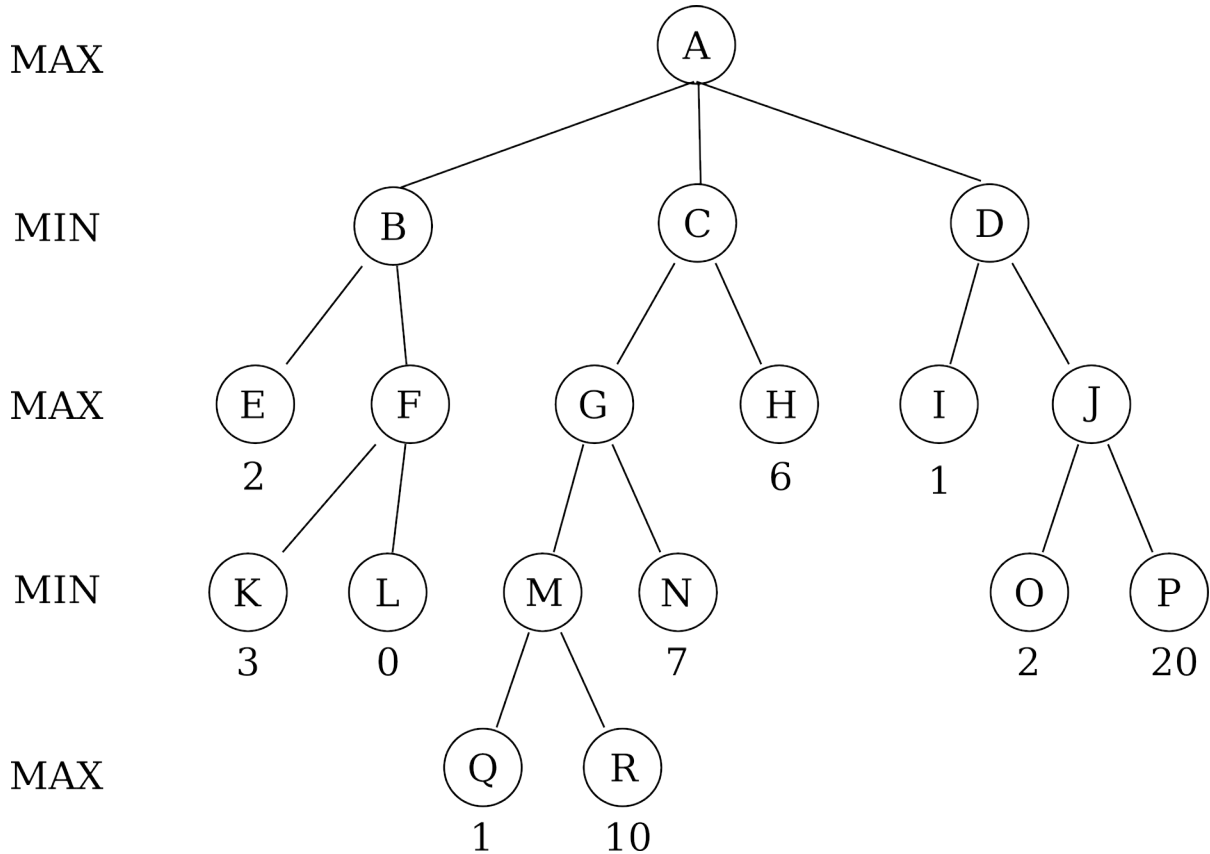
Part A (10 points)

Using minimax without Alpha-Beta pruning, which of the three possible moves should the maximizer take at node A?

What will be the final minimax value of node A?

Part B (10 points)

Mark suggests that Alpha-Beta pruning might help speed things up. Perform a minimax search with alpha-beta pruning, traversing the tree, and list the order in which you **statically evaluate** the nodes (that is, you would start with E). Write your answer below. **Note that there is, at the end of this quiz, a tear-off sheet with copies of the tree.**

Part C (10 points)

Tom thinks that he might save some trouble by calculating static values at depth 2 and then using those static values to reorder the tree for the alpha-beta search that goes all the way to the leaf nodes. Thus, Tom is attempting to deploy alpha-beta search in a way that will improve pruning.

Suppose the static evaluator Tom uses at depth 2 produces exactly the minimax values you found in Part A. Tom uses those numbers to reorder BC&D, EF, GH, and IJ. Note that Tom knows nothing about how the tree branches below depth 2 at this point. Draw the reordered tree down to depth 2, the EFGHIJ level.

Explain the reasoning behind your choices:

Part D (10 points)

Suppose that Tom uses a static evaluator at the second level to reorder the nodes. Circle the set of evaluations that would lead to the reordering in part C:

E=5 F=8 G=6 H=7 I=1 J=3

E=5 F=7 G=3 H=2 I=8 J=9

E=3 F=9 G=8 H=5 I=1 J=10

E=5 F=7 G=9 H=2 I=3 J=4

Part E (10 points)

Tom uses the 6 static evaluations from part D to reorder the nodes at the first and second level, but leaves the order of the nodes below the second level alone. Then he runs alpha-beta search. How many nodes has he statically evaluated (**including** the nodes he already evaluated at the second level) when his search finishes?

Problem 2: Constraint Satisfaction (50 points)

Alessandro has been hired by the advertising firm Jingles 'R Us. For his first assignment, he is asked to come up with a jingle for a new product. The new jingle must have eight measures, with one chord per measure. Alessandro, having forgotten everything he learned in music class, is panicked, and calls his friend Joyatee. Joyatee gives him the following advice:

"Well, Western music is governed by rules about which chords sound good together, so you can think of this as a constraint satisfaction problem. You're writing pop music, which means the constraints are stricter than they would otherwise be, so you'll have even less work to do.

"You can make each measure a variable, with the possible values being chords. You'll then have rules about which chords can go next to each other. This should get you started."

Joyatee scribbles down a set of rules as Alessandro watches. The possible chords for each measure are labeled A, B, C, D, E, and F.

Part A: Domains and Constraints (10 points)

These are the constraints that establish **initial domain values** for a jingle containing eight measures. (Note that the jingle starts at measure one).

1. The jingle must start with chord A

2. The jingle must end with chord A or chord F

3. Measure 7 must have chord E

4. Chord A cannot appear at any position other than the first and last measures

5. Measure 4 must have chord E

In the table below, show the initial domain values for each measure, as determined by the constraints on specific measures. Use only the constraints that establish initial domain values. **Do not use the rules for chord transitions**.

Measure	Initial Domain
1	
2	
3	
4	
5	
6	
7	
8	

There are also constraints on chord transitions; that is, these are the **constraints between variables**.

- A → any other chord
- B → E
- C → F
- D → A or E
- E → A or F
- F → D
- Two consecutive measures cannot have the same chords

Fill out the following graph with directed arrows showing the allowed chord transitions. Note that this graph is merely another way of representing the constraints between adjacent measures.
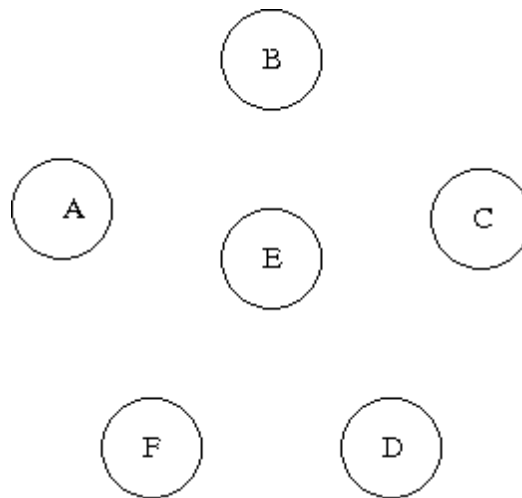
Part B: Backtracking (10 points)

Fill in the tree for a backtracking search that finds a set of assignments of chords to measures that satisfies all the constraints.

- Search proceeds, as shown by then numbered levels, from measure 1 to measure 8.
- You try chords in lexical order, from A to F
- Paths are extended using the initial domains you found in part A.
- You are **not to use any constraint propagation** in this part of the problem.
- As usual, any path whose last node violates any constraint is terminated.

○

1
_____

2
_____

3
_____

4
_____

5
_____

6
_____

7
_____

8
_____

Part C: Backtracking with Forward-Checking (10 points)

Fill in the tree for a backtracking search with forward-checking. That is, check the domains of the neighbors of the just-assigned variable. You are to start with the domain values you found in Part B, except the prohibition on constraint propagation.

○

1
_____

2
_____

3
_____

4
_____

5
_____

6
_____

7
_____

8
_____

Part D: Backtracking with Forward-Checking and Constraint Propagation (10 points)

Fill in the tree for a backtracking search with forward-checking and propagation through singleton domains. You are to start with the domain values you found in Part B, except the prohibition on constraint propagation..

○

1
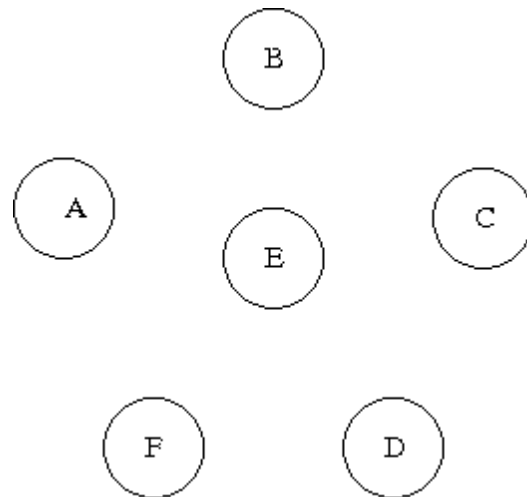_____

2
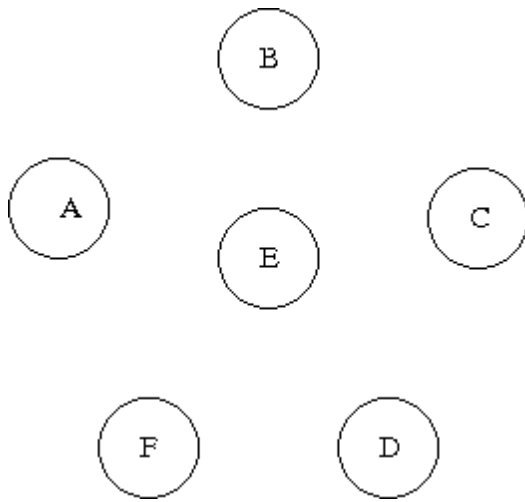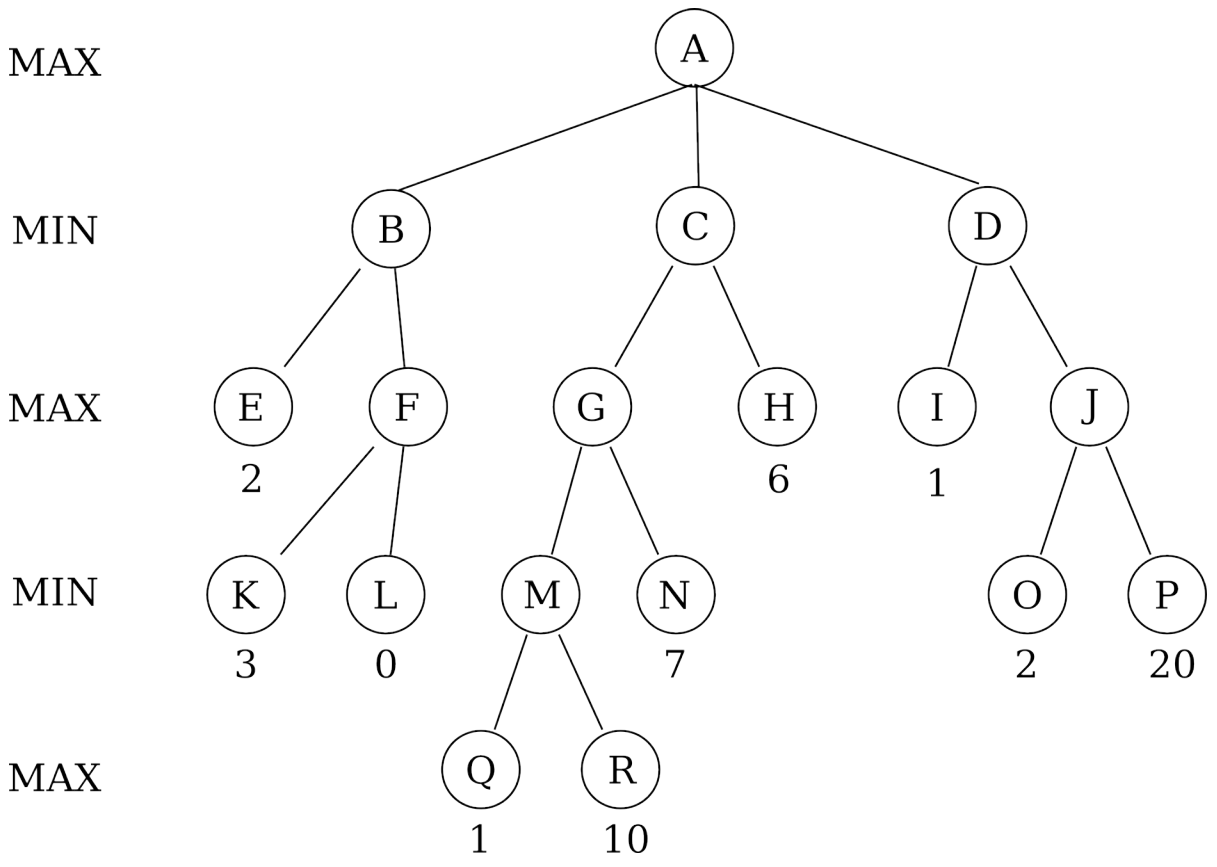_____

3
_____

4
_____

5
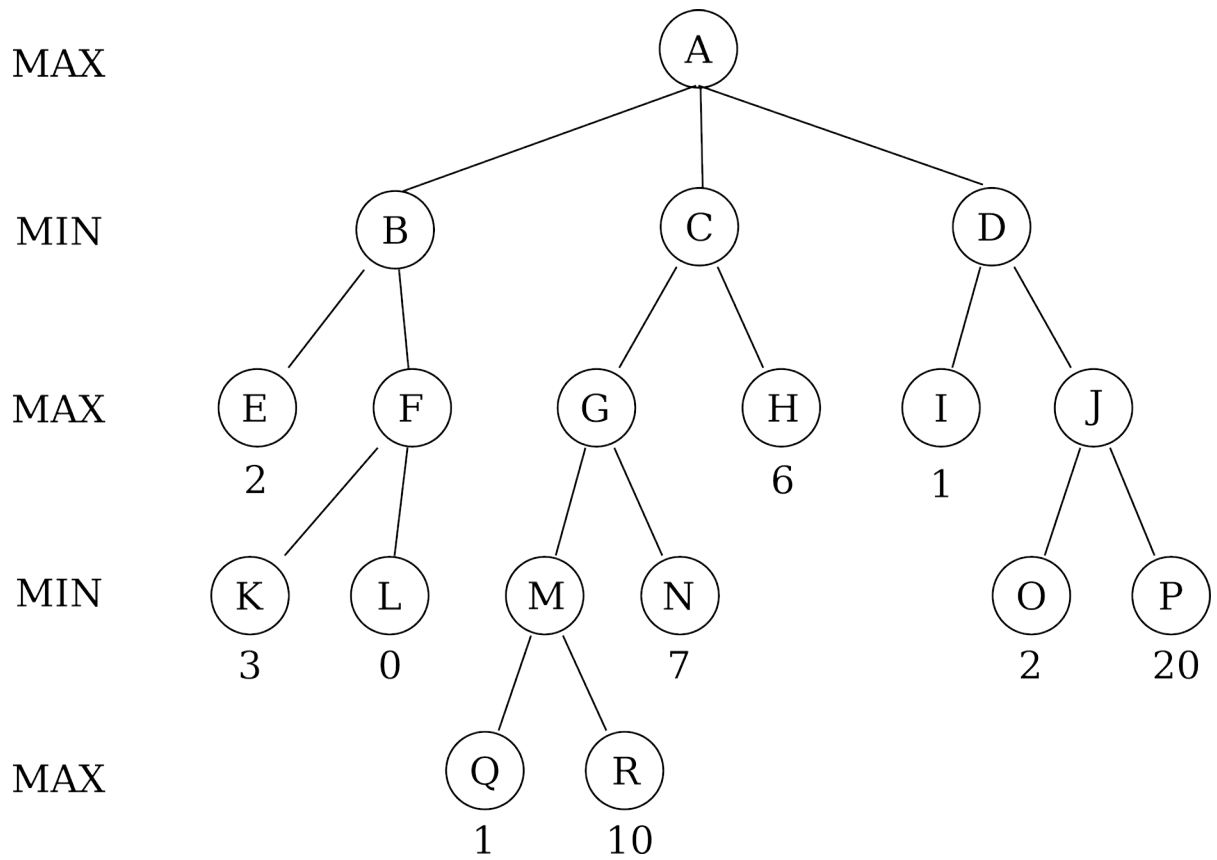_____

6
_____

7
_____

8
_____

Part E (10 points)

What sequence or sequences of chords are found in Parts B, C, and D?

_____

This pages is a tear off sheet provided for your convenience; you need not hand it in.

MAX   A

MIN   B   C   D

MAX   E   F   G   H   I   J
   2   6   1

MIN   K   L   M   N   O   P
   3   0   7   2   20

MAX   Q   R
   1   10

MAX   A

MIN   B   C   D

MAX   E   F   G   H   I   J
   2   6   1

MIN   K   L   M   N   O   P
   3   0   7   2   20

MAX   Q   R
   1   10

12

MIT OpenCourseWare

6.034 Artificial Intelligence

Fall 2010