FINAL EXAMINATION – DECEMBER 2006
CSC 112
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This is a closed-book exam. You may use two double-sided 8.5x11 sheets of notes.

All answers to this exam should be written in your exam booklet(s). Start with the questions that you know how to do, and try not to spend too long on any one question. Partial credit will be granted where appropriate. You will have two hours and twenty minutes. Good luck!

Data Structures (8 points)

1.) We have used a number of data structures from the Java collections framework, including `LinkedList`, `ArrayList`, and `HashMap`. Of these three, indicate which would be most appropriate for the following uses, and why. If two seem equally appropriate, then explain why as well.

a.) We need to buffer requests to a particular service. The requests should be handled in the order they are made. Although many requests will be handled over time, the number waiting at any one instant is expected to be small.

b.) We are implementing a password-protected database. Since every access to the database will include a user account and a password that must be checked, and we are expecting many people to use our system, we require a data structure that will let us quickly match an account to the right password.

c.) We are simulating genetic drift on a piece of DNA. Our algorithm scans over a sequence of base pairs (which may be quite long), randomly inserting mutations as it goes. A mutation may consist of eliminating a base bair, replacing it with a different base pair, or inserting a base pair.

d.) We are implementing a digital jukebox, and need a data structure to keep track of our song data. Users of our software will have the option of playing a song specified by number, or of playing all songs in sequence.

Trees (12 points)

2.) The following questions review several concepts related to trees.

a.) Create a balanced binary search tree from the following array:

17	22	39	56	70	86	99

b.) Print the elements of the tree you just drew in **preorder**.

c.) Compute the numeric value of the postfix expression: 99.0 3.0 3.0 2.0 + 8.0 2.0 - * + /

Heaps (10 points)

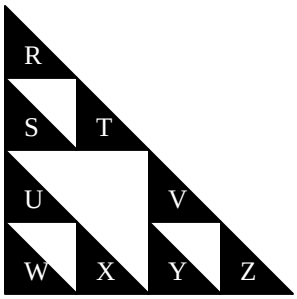
3.) Demonstrate the heap sort algorithm on the array below. You should show the contents of the array after each swap performed. (Assume that the heap is grown from left to right, with the root at 0, and the sorted portion is grown from right to left.) Indicate the configuration at the midpoint of the algorithm, when the entire array has been heapified. (Hint: it may be helpful to draw the heap as a tree, before writing your answer down as an array.)

3	8	6	1	4

Recursion (12 points)

4.) The following code, when called with rank = 2 and appropriate values for r and g, will produce the image at right (minus the alphabetic labels).

```
private void sierpinskiTriangle(int rank, Rectangle r, Graphics g) {
   if (rank <= 0) {
       Polygon p = new Polygon();
       p.addPoint(r.x,r.y);
       p.addPoint(r.x,r.y+r.height);
       p.addPoint(r.x+r.width,r.y+r.height);
       g.fillPolygon(p);
   } else {
       int hw = r.width/2;
       int hh = r.height/2;
       Rectangle r1 = new Rectangle(r.x,r.y,hw,hh);
       Rectangle r2 = new Rectangle(r.x,r.y+hh,hw,hh);
       Rectangle r3 = new Rectangle(r.x+hw,r.y+hh,hw,hh);
       sierpinskiTriangle(rank-1,r1,g);  // line A
       sierpinskiTriangle(rank-1,r2,g);  // line B
       sierpinskiTriangle(rank-1,r3,g);  // line C
   }
}
```



a.) Suppose that line B is removed from the program. What portion of the image will still be drawn? (Indicate by letter.)

b.) If lines A and C are both removed, what portion will be drawn?

c.) What would be the effect of reversing the order of lines A, B, and C?

Programming Style (12 points)

5.) Programming languages contain many features designed to eliminate the need for redundant code (i.e., code that is essentially the same except for minor differences). Give three examples of such mechanisms in Java, explaining exactly how they help avoid redundant code. Give three advantages that result from using such techniques.

Hash Tables (10 points)

6.) Suppose that you create a hash table with five entries, and use **k mod 5** as your hash function. Your table will use open adressing with linear probing. Draw the state of the table after **each** of the following operations, assuming it begins empty:

a.) Insert **Bermuda** under key 441.

b.) Insert M**ontserrat** under key 664.

c.) Insert **Jamaica** under key 809.

d.) Insert **Jamaica** under key 876.

e.) Insert **Dominican Republic** under key 809.

Programming Style (14 points)

7.) For each of the following situations, decide whether the datum described would be best implemented as a local variable, an argument to a method, a class field, or a static class field.

a.) In a GUI, each object present in the window has an associated position that must be stored.

b.) In the constructor for a class, a loop will step through the elements of an array to process them. The loop needs a counter to keep track of the current index.

c.) A ticket-issuing program must keep track of how many tickets have already been issued, so that each time a `Ticket` object is constructed it can be given a unique serial number.

d.) A recursive function must keep track of the number of times it has been called, so that it can return when this number exceeds a predefined threshold.

e.) A program needs to create a `BufferedReader` to read from the standard input. All the reading will take place within `main()`.

f.) A program needs to create a `BufferedReader` to read from a file. Depending upon factors that are unpredictable when the program is written, various different objects may need to read input from the file at various times.

g.) A program will read a data structure from a `BufferedReader`. Depending on the circumstances, the `BufferedReader` may get its data either from the standard input or from a file.

Graphs (12 points)

8.) These two questions deal with graph representation.

a.) Draw the graph represented by the following adjacency matrix:

0	1	1	0	0
1	0	0	1	0
0	0	0	0	0
0	0	0	0	1
0	1	0	0	0

b.) Convert this to an edge-primary representation.

Exceptions (10 points)

9.) Write one or two paragraphs descibing the purpose of exceptions in programming languages. Under what circumstances should they be used, and when should they be avoided?