Computer Science 235
Test 2
Nov 17, 2006

Based on the code found at the end of the test:

1. Give an example of a local variable, with a line number. (2 points)

`cages, 74`

2. Give an example of an instance variable, with a line number. (2 points)

`weight, 10`

3. Give an example of a formal parameter, with a line number. (2 points)

`food, 16`

4. Give an example, in line numbers, of a constructor (not a contructor *call*). (2 points)

`12-14`

5. Give an example of subtyping. Name a type and say what other type it is a subtype of. (2 point)

`Carp, a subtype of Animal`

6. Which of the following are found on line 13? (Circle all that apply). (4 points)

Declaration [Assignment] [Initialization] Instantiation

7. Which of the following are found on line 74? (Circle all that apply). (4 points)

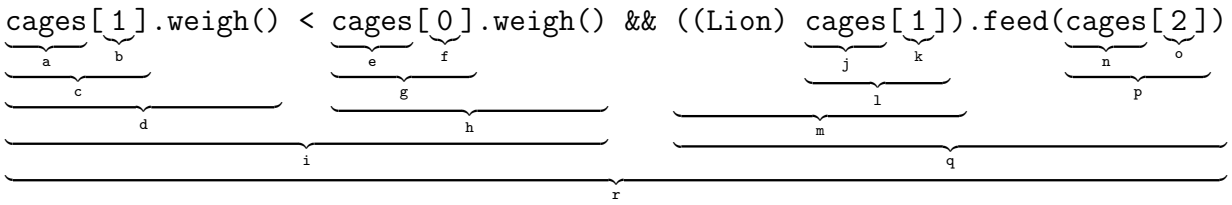
[Declaration] [Assignment] [Initialization] Instantiation

8. Which of the following are found on line 75? (Circle all that apply). (4 points)

Declaration [Assignment] [Instantiation]

9. In the invocation of the method `equals` on line 81, `cages[j]` is the `receiver` and `"worms"` is the `actual parameter`. (2 points)

10. Give the static type of each labelled expression from line 87-88. (1 point each)



a. `Animal[]`

b. `int`

c. `Animal`

d. `int`

e. `Animal[]`

f. `int`

g. `Animal`

h. `int`

i. `boolean`

j. `Animal[]`

k. `int`

l. `Animal`

m. `Lion`

n. `Animal[]`

o. `int`

p. `Animal`

q. `boolean`

r. `boolean`

11. A *queue* is a data structure similar to a stack except that elements are extracted in the same order they are put in, so you extract the *earliest inserted* element instead of the *most recently inserted*. Queues exhibit First-In-First-Out order, whereas stacks exhibit Last-In-First-Out order. Write a class that implements the following interface. Using a `String` is recommended. (20 points)

```
public interface Queue {
     void pushBack(char c);      // add a char to the back of the queue
     char front();                    // return the char at the front
     char popFront();              // return and remove the char at the front
     boolean isEmpty();        // is this queue empty?
}
```

```
public class StringQ implements Queue {
     private String internal;
     public StringQ() { internal = ""; }
     public void pushBack(char c) { internal += c; }
     public char front() { return internal.charAt(0); }
     public char popFront() {
            char toReturn = internal.charAt(0);
            internal = internal.substring(0);
            return toReturn;
      }
      boolean isEmpty() { return internal.length() == 0; }
}
```

12. a. Given the following `Node` class, write an iterative method `deleteEveryNth()` in the `List` which, given n, deletes every nth element from the list. For example, if the list is $1 \rightarrow 2 \rightarrow 3 \rightarrow 4 \rightarrow 5 \rightarrow 6 \rightarrow 7 \rightarrow 8 \rightarrow$ `null`, then `deleteEveryNth(3)` will result in $1 \rightarrow 2 \rightarrow 4 \rightarrow 5 \rightarrow 7 \rightarrow 8 \rightarrow$ `null`. (You may assume that n is positive. Note that if $n = 1$, then this deletes the entire list; note also that $n = 1$ is the only occasion when the head is deleted). (12 points)

```
public class Node {
     private int datum;
     private Node next;
     public int datum() { return datum; }
     public Node next() { return next; }
     public void setNext(Node next) { this.next = next; }
}

public class List {
     Node head;
     public void deleteEveryNth(int n) {


     if (n == 1)  head = null;
     else {
       int counter = 1;
       for (Node current = 0; current != null; current = current.next())
             if((counter + 1) % n == 0) {
                 current.setNext(current.next().next());
                 counter += 2;
             }
             else counter++;
     }









     }
}
```

b. Now do the same thing recursively. You may decide the return t ype and parameters for the `deleteEveryNth` in the `Node` class; accordingly, you should fill-in the method in the `List` class as well. This time you may assume $n > 1$ (and so the head will never be deleted by this). (12 points)

```
public class List {
     private Node head;
     public void deleteEveryNth(int n) {

         head.deleteEveryNth(n, 1);

     }
}

public class Node {
       private int datum;
       private Node next;

       public   void deleteEveryNth( int n, int i) {

               if (i + 1 % n == 0) {
                  next = next.next;
                  next.deleteEveryNth(n, i + 2);
               }
               else
                  next.deleteEveryNth(n, i+1);

       }
 }
```

13. You are writing a program for a college library to keep track of checked out books, compute fines, etc. In this library, students are fined 10 cents per day for a late book; faculty are not fined until a book is at least 5 days late, after which they are fined 5 cents per day.

Assume your system will have an interface `Book` (with several classes implementing it, representing various kinds of books), an interface `Patron` (as a supertype for classes representing students and faculty), and a program `Library` which contains (among other things) an array of `Book`s and a method which, given a `Patron`, computes the total fines for all of that patron's late books.

Given the following interfaces for `Book` and `Patron`, write (1) a class `Student` implementing `Patron`, (2) a class `Faculty` implementing `Patron`, and (3) the method `computeFine()` in class `Library`.

Do not do any more than you are asked to do. You do not need to write any `Book` classes, nor anything else in the `Patron` classes besides the method `computeFineOnBook()`. (10 points)

```
public interface Book {
  /**
     * Is this book checked out by the given
     * patron?
     * @param p The patron who may have
     *checked out this book
     * @return true if p holds this book, false
     * otherwise.
     */
     boolean isCheckedOutBy(Patron p);

     /**
      * How many days are left until this book
      * is due?
      * @return The number of days until the
      * book is due, a negative number if the
      * book is late.
      */
      int daysUntilDue();
}
```

```
public interface Patron {
    /**
     * How much fine should this patron pay on
     * account of the given book?
     * @param b The book this patron may have
     * a fine for
     * @return The amount of money this patron
     * owes for this book, which would be 0 if this
     * patron does not hold this book, the book is
     * not late, or the book is in grace period.
     */
     int computeFineOnBook(Book b);
}
```

```
public class Library {
    public static Book[] shelf;

    public static int computeFine(Patron p) {

        int toReturn = 0;
        for (int i = 0; i < shelf.length; i++)
            if (shelf[i].isCheckedOutBy(p))
                toReturn += p.computeFineOnBook(shelf[i]);
     return toReturn;

    }
}
```

```
class Student implements Patron {
   int computeFineOnBook(Book b) {
       if (b.daysUntilDue() < 0)
            return b.daysUntilDue() * 10;
       else return 0;
   }
}

class Faculty implements Patron {
   int computeFineOnBook(Book b) {
       if (b.daysUntilDue() < -5)
          return (- b.daysUntilDue() + 5) * 5;
       else
          return 0;
   }
}
```