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CS 100J Prelim 2

16 March 2006

Have a good break!!!

This 90-minute exam has 6 questions (numbered 0..5) worth a total of 100 points. Spend a few minutes looking at all questions before beginning. Use the back of the pages, if you need more space.

Question 0 (2 points). Fill in the information, legibly, at the top of each page (Hint: do it now.)

Question 1 (10 points). (a) Consider the call `C.m(5)` on the following static method `m`, declared in class `C`.

```
public static void m(int p) {
    for (int k= 0; k != p; k= k+1) {
        int x= p*k;
        p= p + x;
    }
}
```

(a1) When is `p` created during execution of the call?

(a2) When is `k` created during execution of the call?

(a3) When is `x` created during execution of the call?

(b) Below, fill in the assignment so that the following assertion is true —i.e. if execution starts with assertion `P` true, then after the assignment to `y`, `R` is true. Be careful.

```
// {P: y is the sum of h..100}
```

```
y = _____ ;
```

```
// {R: y is the sum of (h-1)..101}
```

(c) State the four loopy questions used to develop a loop.

0 _____ out of 02

1 _____ out of 10

2 _____ out of 15

3 _____ out of 14

4 _____ out of 22

5 _____ out of 37

Total _____ out of 100

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Question 3 (14 points). Write the bodies of the two methods whose specifications and headers are given below, assuming that these methods are in class Dog.

*/** = ob is a non-null dog with the same fields as this Dog */*

public boolean equals(Object ob) {

}

*/** Constructor: a Dog that is a terrier, has name Spot, and is y years old */*

public Dog(int y) {

}

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Question 4 (22 points). The Ithaca Animal Spa needs your help! They have two separate rooms, one for cats and one for all other animals. But right now, their website just collects one list of all the animals who have been signed up for treatment. We need you to write a function `removeCats` in class `Cats`, whose specification and header is given below. This function removes all the `Cats` from its parameter and returns a new vector of type `Vector<Cat>` that contains all the `Cats` in the original `Vector` (in the same order).

For example, suppose `woof` and `rover` are instances of class `Dog` and `furball` and `meowy` are instances of class `Cat`, and parameter `v` is

[woof, furball, rover, meowy]

Then, execution of the call `removeCats(v)` changes `v` to [woof, rover] and returns a new `Vector` that contains [furball, meowy].

You will probably write a loop; you need not write a loop invariant, but it may help you.

Assume <code>v</code> has type <code>Vector<C></code> for some class <code>C</code>		
Return	Method	Purpose
<code>C</code>	<code>v.get(int k)</code>	<code>= v[k]</code>
<code>void</code>	<code>v.set(int k, C c)</code>	replace <code>v[k]</code> by <code>c</code>
<code>int</code>	<code>v.size()</code>	= the number of elements in <code>v</code> 's list
<code>int</code>	<code>v.indexOf(C c)</code>	= <code>i</code> , where <code>v[i]</code> is <code>c</code> ; <code>-1</code> if <code>c</code> not in <code>v</code>
<code>int</code>	<code>v.add(C c)</code>	Add object <code>c</code> to <code>v</code> and return the index (position) of the newly added object in <code>v</code> .
	<code>v.remove(int k)</code>	Remove element <code>v[k]</code> , changing <code>v</code> so that it contains <code>v[0..k-1]</code> followed by <code>v[k+1..]</code>

```
/** Remove all Cats from v and return a Vector that contains the removed Cats */
```

```
public static Vector<Cat> remCats( Vector<Animal> v ) {
```

```
}
```

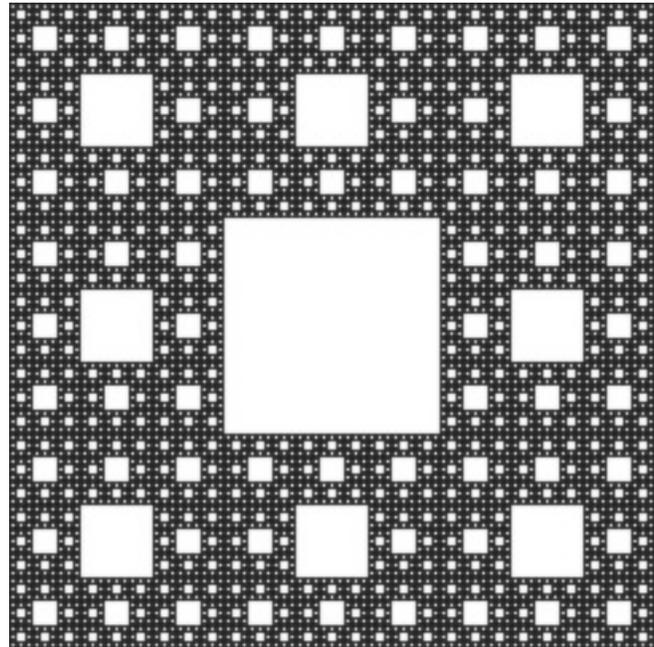
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Question 5 (37 points). Write a **recursive procedure** `scarpet`, which will contain a loop, that draws a “Sierpinski Carpet”, named after the person who conceived of the idea (his last name was Sierpinski, not Carpet). An example appears to the right. The specification and header of `scarpet` appears on the next page. From the spec, you can see that the procedure draws *something* in a square of width and height `w` whose top-left corner is `(x, y)`. Note that `w` is a power of 3.



The square to be drawn is originally black, and the pen color is white. You don't have to do anything to change the pen color.

Here's how procedure `scarpet` should work.

If $w < 3$, `scarpet` draws nothing.

If $w \geq 3$, the square is viewed as a grid of 9 squares, each of width and height `w/3`, as pictured to the right. We describe what goes into each of the 9 squares.

The center square gets a white rectangle. Do this using a procedure call like this:

```
graphics.fillRect(x1, y1, w1, h1);
```

where `(x1, y1)` gives the coordinates of the top-left pixel and the rectangle has width `w1` and height `h1` (you have to figure out what values to use for the arguments).

Each of the other 8 squares (those with “sc” in them) gets a Sierpinski Carpet.

sc 0	sc 1	sc 2
sc 3	4	sc 5
sc 6	sc 7	sc 8

Solving the problem There are three pieces to procedure `scarpet`, and we will attempt to grade you separately on each. How well we are able to do on this depends on *your* ability to write your code in such a way that the three pieces are easily seen. Here are the three pieces.

1. **The recursive concept**, with the idea of base and recursive cases.
2. **One loop that processes each of the 9 squares** of the grid in turn, drawing what it has to in that square. We have numbered the squares in their lower right corners, and the loop should process them in that order.
3. **Getting the coordinates and lengths of the squares in the grid correct.** What is the top-left pixel of each square given that the upper-left corner of the original square is `(x, y)` and that its height and length are `w`? This may help: If `k` is the control variable for the loop that processes the squares, expressions `k/3` and `k%3` may be useful. It may help you to pencil in coordinates and lengths of some of the squares of the grid that appears above and to the right.

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/** Draw a Sierpinski Carpet of width and height w with top left corner (x, y).

Precondition: w is a power of 3.

Precondition: Place to be drawn is black, and the pen color is white. */

public static void scarpet(**int** x, **int** y, **int** w) {

}