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## Chapter 18 Check Point Questions

### Section 18.2

#### ▼ 18.2.1

What is a recursive method? What is an infinite recursion?

A recursive method is the one that calls itself. An infinite recursion is the one that never stops.

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#### ▼ 18.2.2

How many times is the factorial method in Listing 18.1 invoked for factorial(6)?

six times. (base case factorial(0))

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[Read Answer](#)

#### ▼ 18.2.3

Show the output of the following programs and identify base cases and recursive calls.

(a)

```
public class Test {
    public static void main(String[] args) {
        System.out.println(
            "Sum is " + xMethod(5));
    }

    public static int xMethod(int n) {
        if (n == 1)
            return 1;
        else
            return n + xMethod(n - 1);
    }
}
```

(b)

```
public class Test {
    public static void main(String[] args) {
        xMethod(1234567);
    }

    public static void xMethod(int n) {
        if (n > 0) {
            System.out.print(n % 10);
            xMethod(n / 10);
        }
    }
}
```

```
}  
}
```

(a) Sum is 15 ( $5 + 4 + 3 + 2 + 1 = 15$ )

(b) 7654321

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#### ▼ 18.2.4

Write a recursive mathematical definition for computing  $2^n$  for a positive integer  $n$ .

$f(n) = 2$  if  $n = 1$

$f(n) = 2 * 2^{(n-1)}$  for  $(n > 1)$

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#### ▼ 18.2.5

Write a recursive mathematical definition for computing  $x^n$  for a positive integer  $n$  and a real number  $x$ .

$f(n) = x$  if  $n = 1$

$f(n) = x * x^{(n-1)}$  for  $(n > 1)$

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#### ▼ 18.2.6

Write a recursive mathematical definition for computing  $1 + 2 + 3 + \dots + n$  for a positive integer  $n$ .

$f(n) = 1$  if  $n = 1$

$f(n) = f(n-1) + n$  for  $(n > 1)$

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### Section 18.3

#### ▼ 18.3.1

Show the output of the following two programs:

(a)

```
public class Test {  
    public static void main(String[] args) {  
        xMethod(5);  
    }  
  
    public static void xMethod(int n) {  
        if (n > 0) {  
            System.out.print(n + " ");  
            xMethod(n - 1);  
        }  
    }  
}
```

(b)

```
public class Test {
```

```

public static void main(String[] args) {
    xMethod(5);
}

public static void xMethod(int n) {
    if (n > 0) {
        xMethod(n - 1);
        System.out.print(n + " ");
    }
}
}

```

(a) The output is 5 4 3 2 1

(b) The output is 1 2 3 4 5

[Hide Answer](#)

[Read Answer](#)

### ▼ 18.3.2

What is wrong in the following method?

(a)

```

public class Test {
    public static void main(String[] args) {
        xMethod(1234567);
    }

    public static void xMethod(double n) {
        if (n != 0) {
            System.out.print(n);
            xMethod(n / 10);
        }
    }
}

```

(b)

```

public class Test {
    public static void main(String[] args) {
        Test test = new Test();
        System.out.println(test.toString());
    }

    public Test() {
        Test test = new Test();
    }
}

```

(a) n is double. There is no guarantee that  $n \neq 0$  will be eventually false.

(b) Infinite recursion due to `new Test()` inside the constructor `Test()`.

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### ▼ 18.3.3

How many times is the fib method in Listing 18.2 invoked for `fib(6)`?

25 times (Why?)

number of time fib is invoked in `fib(0)` =

1

number of time fib is invoked in fib(1) =

1

number of time fib is invoked in fib(2) =

1+ number of time fib is invoked in fib(1)+number of time fib is invoked in fib(2)  
=1+1+1=3

number of time fib is invoked in fib(3) =

1+ number of time fib is invoked in fib(1)+number of time fib is invoked in fib(2) =  
1+1+3=5

number of time fib is invoked in fib(4) =

1+ number of time fib is invoked in fib(2)+number of time fib is invoked in fib(3) =  
1+3+5=9

number of time fib is invoked in fib(5) =

1+ number of time fib is invoked in fib(3)+number of time fib is invoked in fib(4) =  
1+5+9=15

number of time fib is invoked in fib(6) =

1+ number of time fib is invoked in fib(4)+number of time fib is invoked in fib(5) =  
1+9+15=25

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## Section 18.4

### ▼ 18.4.1

Describe the characteristics of recursive methods.

One or more base cases (the simplest case) are used to stop recursion. Every recursive call reduces the original problem, bringing it increasingly close to a base case until it becomes that case.

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### ▼ 18.4.2

For the isPalindrome method in Listing 18.3, what are the base cases? How many times is this method called when invoking isPalindrome("abdxcdba")?

The base cases are (1) s.length() <= 1 and (2) s.charAt(0) != s.charAt(s.length - 1)  
When invoking isPalindrome("abdxcdba"), the isPalindrome method is called 5 times.

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### ▼ 18.4.3

Show the call stack for isPalindrome("abcba") using the method defined in Listing 18.3.

Omitted

[Hide Answer](#)

[Read Answer](#)

## Section 18.5

### ▼ 18.5.1

Show the call stack for isPalindrome("abcba") using the method defined in Listing 18.4.

Omitted

[Hide Answer](#)

[Read Answer](#)

### ▼ 18.5.2

Show the call stack for `selectionSort(new double[]{2, 3, 5, 1})` using the method defined in Listing 18.5.

Omitted

Hide Answer

Read Answer

### ▼ 18.5.3

What is a recursive helper method?

An overloaded method with additional parameters.

Hide Answer

Read Answer

## Section 18.6

### ▼ 18.6.1

What is the base case for the `getSize` method?

The base case for the `getSize(File d)` method is that `d` is a file.

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### ▼ 18.6.2

How does the program get all files and directories under a given directory?

The program gets all files and directories under the directory `d` using `d.listFiles()`, which returns an array of `File` objects under the directory.

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### ▼ 18.6.3

How many times will the `getSize` method be invoked for a directory if the directory has three subdirectories and each subdirectory has four files?

4 times for the directories and  $4 * 4$  time for all the files. So, the total is 20.

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### ▼ 18.6.4

Will the program work if the directory is empty (i.e., it does not contain any files)?

Yes.

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Read Answer

### ▼ 18.6.5

Will the program work if line 20 is replaced by the following code?

```
for (int i = 0; i < files.length; i++)
```

No. The directory may be empty.

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### ▼ 18.6.6

Will the program work if lines 20-21 is replaced by the following code?

```
for (File file: files)
    size += getSize(file); // Recursive call
```

No. files may be null.

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## Section 18.7

### ▼ 18.7.1

How many times is the moveDisks method in Listing 18.8 invoked for moveDisks(5, 'A', 'B', 'C')?

$2^5 - 1$

Hide Answer

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## Section 18.8

### ▼ 18.8.1

How do you obtain the midpoint between two points?

The midpoint between p1 and p2 is  $((p1.x + p2.x)/2, (p1.y + p2.y)/2)$ , which can be obtained by invoking p1.midpoint(p2).

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### ▼ 18.8.2

What is the base case for the displayTriangles method?

The base case for the displayTriangles method is  $order == 0$ .

Hide Answer

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### ▼ 18.8.3

How many times is the displayTriangles method invoked for a Sierpinski triangle of order 0, order 1, order 2, and order n?

The displayTriangles method is invoked one time for order 1, 4 times for order 1,  $1 + 3 * 3$  times for order 2, and  $1 + 3^n$  for order n.

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### ▼ 18.8.4

What happens if you enter a negative order? How do you fix this problem in the code?

Will be an infinite loop. To fix it, add  $if (order < 0) return$  in the beginning of the method displayTriangle.

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### ▼ 18.8.5

Instead of drawing a triangle using a polygon, rewrite the code to draw a triangle by drawing three lines to connect the points in lines 71-77.

Replace lines 71-77 with the following code:

```
// Draw a triangle to connect three points
Line line1 = new Line(p1.getX(), p1.getY(), p2.getX(), p2.getY());
```

```
Line line2 = new Line(p2.getX(), p2.getY(), p3.getX(), p3.getY());
Line line3 = new Line(p3.getX(), p3.getY(), p1.getX(), p1.getY());
```

```
this.getChildren().addAll(line1, line2, line3);
```

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## Section 18.9

### ▼ 18.9.1

Which of the following statements are true?

- a. Any recursive method can be converted into a nonrecursive method.
- b. Recursive methods take more time and memory to execute than nonrecursive methods.
- c. Recursive methods are always simpler than nonrecursive methods.
- d. There is always a selection statement in a recursive method to check whether a base case is reached.

- a. (TRUE)
- b. (TRUE)
- c. (FALSE)
- d. (TRUE)

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### ▼ 18.9.2

What is a cause for a stack-overflow exception?

When a method is invoked, its contents are placed into a stack. If a method is recursively invoked, it is possible that the stack space is exhausted. This causes stack overflow.

[Hide Answer](#)[Read Answer](#)

## Section 18.10

### ▼ 18.10.1

Identify tail-recursive methods in this chapter.

The `isPalindrome` method in Listing 18.4, `sort` method in Listing 18.5, and `binarySearch` method in Listing 18.6 are tail-recursive.

[Hide Answer](#)[Read Answer](#)

### ▼ 18.10.2

Rewrite the `fib` method in Listing 18.2 using tail recursion.

```
/** Return the Fibonacci number for the specified index */
public static long fib(long index) {
    return fib(index, 1, 0);
}

/** Auxiliary tail-recursive method for fib */
private static int fib(long index, int next, int result) {
    if (index == 0)
        return result;
    else
        return fib(index - 1, next + result, next);
}
```

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