CUHK(SZ)-CSC1003 Final Exam

Feb. 2, 2023

Name:

Student ID:

Note:

a. This is a closed exam. No notes, calculators, or dictionaries are allowed.
b. This exam paper has nine pages in single-sided printing, including the cover page.
c. Answer all questions within 120 minutes.

Example Question:

Read the following Java program, and write down your answer(s).

```
public class HelloWorld {
    public static void main(String[] args) {
        System.out.println("Hello World!");
    }
}
```

What is the output of the program when running "java HelloWorld"?

Hello World!

1. (10 points) Circle **ONE** solution that best suits each question. (2 points each)

A (1) Is Java an object-oriented, procedural, or functional programming language?

A. object-oriented

B. procedural

C. functional

D. None of the above

B (2) How many **distinct** values can be represented by a 7-bit value?

A. 64

B. 128

C. 256

D. 1024

A (3) A _____ is a program that executes compiled Java code on a specific platform.

A. Java Virtual Machine

B. Java Compiler

C. Java Source Code Editor

D. Java Docs

D (4) Which of the following Java statements declares and allocates a 2-dimensional array of integers with five columns and four rows:

A. int array[5][4];

B. int array[4][5];

C. int[ ][ ] array = new int[5][4];

D. int[ ][ ] array = new int[4][5];

A (5) Comparing with Java, a Python program

A. is directly interpreted into machine instructions.

B. needs to be compiled into machine instructions before execution.

C. runs as a standalone application without a virtual machine.

D. is suitable for developing large-scale system applications.

2. (20 points) Answer the following short questions. (4 points each)

(1) For two integer variables "i" and "j", assume "i = 1" and "j = 2". What is the difference between two Java statements "(double) (i / j)" and "((double) i) / j"?

0.0 0.5

(2) Declare and allocate a double array with 1003 elements. Write down the Java code.

```
double[] a = new double[1003];
```

(3) Write one line of Java code that declares, allocates, and initializes an array of type integer with exactly 4 elements whose values are 97, 33, 44, and 12, in that order.

```
int[] a = {97, 33, 44, 12};
```

(4) Write a Java conditional statement that tests if a given integer variable named "grade" is no less than 50 or not. If its value is 50 or above, output "passed" on the screen; otherwise, output "failed".

```
if (grade >= 50) { System.out.print("passed"); }
else { System.out.print("failed"); }
```

(5) Read the following Java code, and estimate the order of growth of operations as a function of input "N". Is it $\log N$, N, $N \log N$, N^2, N^3, 2^N, or ...?

```
public static int f(int N) {
    if (N == 0) return 1;
    int sum = f(N/2) + f((N-1)/2);
    for (int i = 0; i < N; i++) {
        sum = sum + i;
    }
    return sum;
}
```

$N \log N$

3. (5 points) Write a Java loop that computes the average of an array of integers called "iArray" that has been previously declared and initialized. Store the result in a variable of type integer called "iAverage" that has been previously declared and initialized to zero.

```
for (int i=0 ; i < iArray.length ; i++) {
    iAverage += iArray[i];
}
iAverage = iAverage / iArray.length;
```

4. (5 points) Read the following Python code and write down the output.

```
sum = 0
for i in range(1, 10):
    sum = sum + (i * i)
    if (sum > 100): break
print("sum = ", sum)
```

1 + 4 + 9 + 16 + 25 + 36 + 49

5 14 30 55 91 140

Sum = 140

5. (5 points) What will happen when running the following Python code?

```
balance = 10
while True:
    if (balance < 10): continue
    balance = balance - 1
    print("balance = ", balance)
```

Output: balance = 9

It meets an infinite loop and will never end.

6. (10 points) Write down the outputs when running the following Java program:

```
public class Question6 {
    public static void main(String[] args) {
        String S1 = new String("CSC1003");
        String S2 = new String(" is taught");
        String S3 = new String(" at CUHK-SZ");

        int iSize1 = S1.length() + 3;
        System.out.println(iSize1);

        String S123 = S1 + S2 + S3;
        System.out.println(S123);

        boolean bEquals1 = S1 == "CSC1003";
        System.out.println(bEquals1);

        boolean bEquals2 = S1.equals("CSC1003");
        System.out.println(bEquals2);

        boolean bEquals3 = S123 == S1 + S2 + S3;
        System.out.println(bEquals3);
    }
}
```

1st line of output: 10

2nd line of output: CSC1003 is taught at CUHK-SZ

3rd line of output: false

4th line of output: true

5th line of output: false

7. (5 points) Consider the following Java methods.

```
static String r(int m) {
    if (m > 0) return "+" + r(m-1);
    else return "";
}
static String s(int m, int n) {
    if (n > 0) return "-" + s(m,n-1) + "-";
    else return r(2*m);
}
```

Write down the output of "System.out.println(s(3,2));"

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8. (5 points) Read the following Java program which converts a positive integer to binary. Modify the program with minimum effort so that it also works for the input of an integer "0". Show your modification in the box provided below.

```
public class Question8 {
    public static String convert(int N) {
        if (N == 1) return "1";
        return convert(N / 2) + (N % 2);
    }
    public static void main(String[] args) {
        int N = Integer.parseInt(args[0]);
        System.out.println(convert(N));
    }
}
```

```
public class Question8 {
    public static String convert(int N) {
        if (N == 0) return "0";
        if (N == 1) return "1";
        return convert(N / 2) + (N % 2);
    }
    public static void main(String[] args) {
        int N = Integer.parseInt(args[0]);
        System.out.println(convert(N));
    }
}
```

9. (15 points) Read the following Java program which tries to compute the Fibonacci numbers, and answer the following questions.

```
public class Question9 {
    public static long fib(int n) {
        if (n == 0) return 0;
        if (n == 1) return 1;
        return fib(n-1) + fib(n-2);
    }
    public static void main(String[] args) {
        int n = Integer.parseInt(args[0]);
        System.out.println(fib(n));
    }
}
```

What problem would you expect to happen when running "java Question9 80" on a desktop computer? Why? Write down a short answer. (5 points)

The program will take a long time to output the answer (some computers will crash and never give the answer). Each time we use the "fib" method, we will again use fib(n-1) and fib(n-2), which is time-consuming.

Modify the program to fix the problem. (10 points)

Use an array to record the value of each fib(int n).

```
public class Question9 {
    static long[] f = new long[100];
    public static long fib(int n) {
        if (n == 0) return 0;
        if (n == 1) return 1;
        if (f[n] != 0) return f[n];
        f[n] = fib(n-1) + fib(n-2);
        return f[n];
    }
    public static void main(String[] args) {
        int n = Integer.parseInt(args[0]);
        System.out.println(fib(n));
    }
}
```

10. (20 points) The following Java code defines a "MyRectangle" class with four public data members representing the x- and y-coordinates of the bottom-left vertex and top-right vertex of a rectangle, whose sides are parallel to the x- or y-axis.

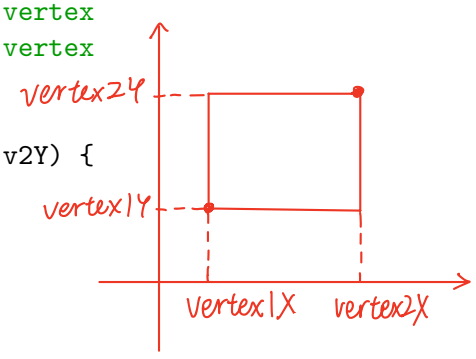
```
public class MyRectangle {
    // Data members
    public int vertex1X; // x-coordinate of bottom-left vertex
    public int vertex1Y; // y-coordinate of bottom-left vertex
    public int vertex2X; // x-coordinate of top-right vertex
    public int vertex2Y; // y-coordinate of top-right vertex

    // Constructor
    public MyRectangle(int v1X, int v1Y, int v2X, int v2Y) {
        vertex1X = v1X;
        vertex1Y = v1Y;
        vertex2X = v2X;
        vertex2Y = v2Y;
    }

    // Returns area of rectangle
    public int area() {
        /****** to be completed -- refer to part (a) ******/
    }

    // Returns the overlap region of this and rect
    public MyRectangle overlap(MyRectangle rect) {
        /****** to be completed -- refer to part (b) ******/
    }

    // Returns the overlap region of all rectangles in the array
    public static MyRectangle overlapAll(MyRectangle[] rectangles) {
        /****** to be completed -- refer to part (c) ******/
    }
}
```



vertex1X < vertex2X

vertex1Y < vertex2Y

For example, the statement "new MyRectangle(20,80,30,90)" creates a rectangle with bottom-left vertex at position (20,80), and top-right vertex at (30,90).

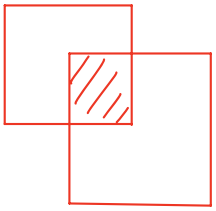
10. (continued...)

(a) Complete the "area()" method, which computes the area of a rectangle. (5 points)

```
return (vertex2X-vertex1X)*(vertex2Y-vertex1Y)
```

(b) Complete the "overlap(MyRectangle rect)" method. This method returns a rectangle which is the overlapped region of two rectangles. In the event that there is no overlap, it should return a rectangle with both bottom-left vertex and top-right vertex at position (0,0). (10 points)

```
int X1 = Math.max(vertex1X, rect.vertex1X);
int X2 = Math.min(vertex2X, rect.vertex2X);
int Y1 = Math.max(vertex1Y, rect.vertex1Y);
int Y2 = Math.min(vertex2Y, rect.vertex2Y);
if (X1>X2||Y1>Y2) return new MyRectangle(0,0,0,0);
return new MyRectangle(X1,Y1,X2,Y2);
```



(c) Using the "overlap(MyRectangle rect)" method written above in part (b), complete the "overlapAll(MyRectangle[ ] rectangles)" method which returns the overlapped region of all the rectangles in the array. You may assume that there is at least one element in the array. (5 points)

```
MyRectangle ans = rectangles[0];
for (int i=1; i<rectangles.length; i++){
    ans = ans.overlap(rectangles[i];
}
return ans;
```