CS1020: Data Structures and Algorithms I

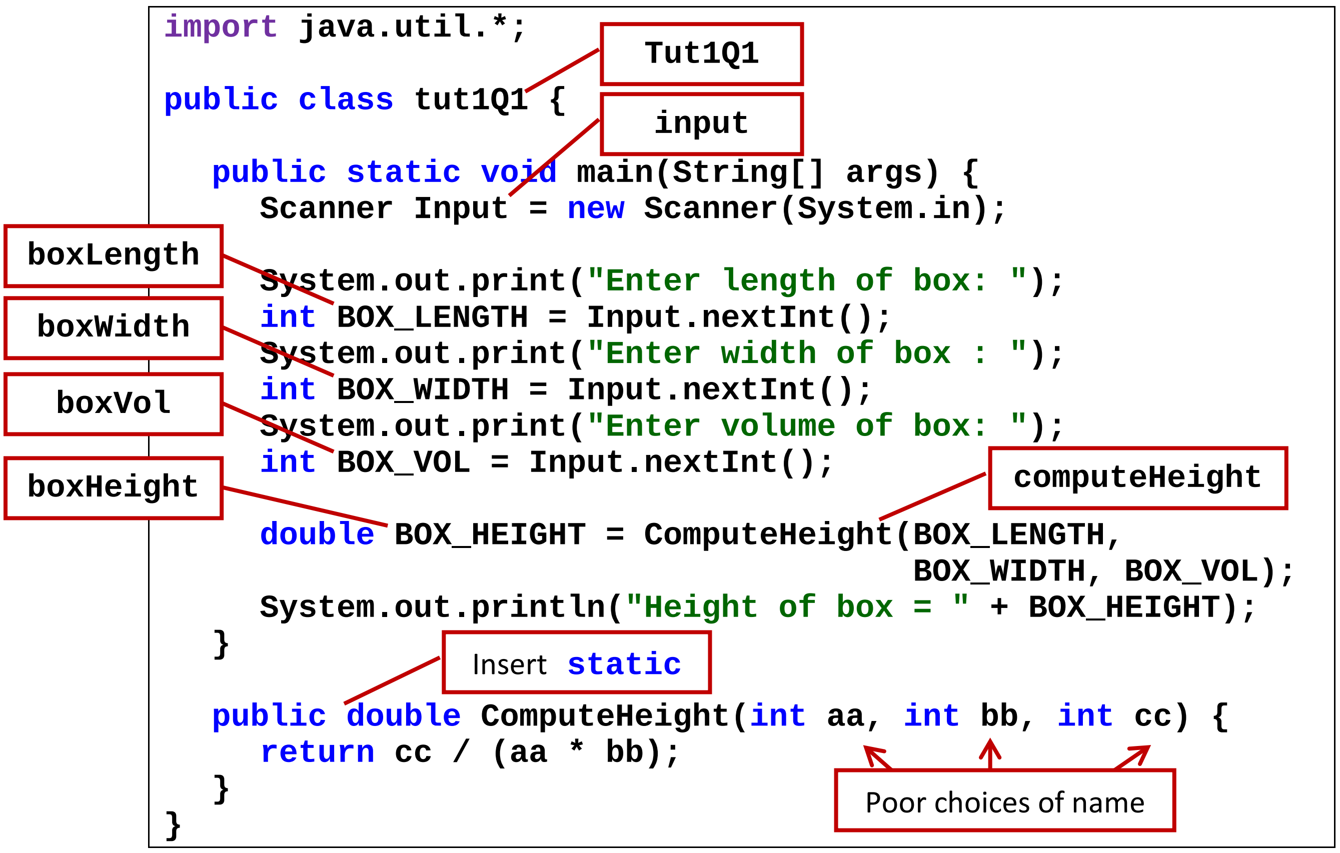
Tutorial 1 – Java and Simple OOP (Suggested Solutions)

(For week 3, starting 27 January 2014)

<u>There are no tutorials in week 3</u>. This tutorial is meant for you to attempt on your own. You may discuss your answers or seek clarification in the IVLE forum.

This tutorial covers topics taught in weeks 1 and 2.

1. [Week 1 topics: Java naming convention, syntax error, logic error]
   The program below has several issues. Study the program and try to compile and run it.



```
import java.util.*;

public class tut1Q1 {

   public static void main(String[] args) {
      Scanner Input = new Scanner(System.in);

      System.out.print("Enter length of box: ");
      int BOX_LENGTH = Input.nextInt();
      System.out.print("Enter width of box : ");
      int BOX_WIDTH = Input.nextInt();
      System.out.print("Enter volume of box: ");
      int BOX_VOL = Input.nextInt();

      double BOX_HEIGHT = ComputeHeight(BOX_LENGTH,
                                        BOX_WIDTH, BOX_VOL);
      System.out.println("Height of box = " + BOX_HEIGHT);
   }

   public double ComputeHeight(int aa, int bb, int cc) {
      return cc / (aa * bb);
   }
}
```

(a) The names of the class, method and variables in this program do not follow Java Naming Conventions. (There are several sites on Java naming conventions. One is http://www.javacodegeeks.com/2011/08/java-naming-conventions.html)
Replace all inappropriate names with those that follow the naming conventions.

(b) The names of the parameters of the **ComputeHeight()** method are poorly chosen. Replace them with more descriptive names.

(c) There is a compilation error:

```
non-static method ComputeHeight(int,int,int) cannot be
referenced from a static context
         double BOX_HEIGHT = ComputeHeight(…)
```

Correct the error.

(d) There is a logic error in the computation of the height in the **ComputeHeight()** method. Correct the error.

After all corrections are made, the program should give the correct output. A sample run is shown below:

```
Enter length of box: 8
Enter width of box : 5
Enter volume of box: 60
Height of box = 1.5
```

Answer:

```java
// Tut1Q1.java
// Corrected version of tut1Q1.java
import java.util.*;

public class Tut1Q1 {

   public static void main(String[] args) {
      Scanner input = new Scanner(System.in);

      System.out.print("Enter length of box: ");
      int boxLength = input.nextInt();
      System.out.print("Enter width of box : ");
      int boxWidth = input.nextInt();
      System.out.print("Enter volume of box: ");
      int boxVol = input.nextInt();

      double boxHeight = computeHeight(boxLength, boxWidth,
                                       boxVol);
      System.out.println("Height of box = " + boxHeight);
   }

   // Compute height of a box given its length, width and volume
   public static double computeHeight(int len, int wid, int vol) {
      return (double) vol / (len * wid);
   }
}
```

2. [Weeks 1 and 2: **Math** class, writing method]
   The area of a triangle can be computed given the lengths of its sides ***a***, ***b*** and ***c*** with **Heron's Formula**:

   $$area = \sqrt{s(s-a)(s-b)(s-c)}$$

   Where ***s*** is half the triangle's perimeter:

   $$s = \frac{a+b+c}{2}$$

   Write a program **TriangleArea.java** that reads 3 positive values of type **double** representing the lengths of the sides of a triangle, and computes the area of the triangle. The program should include a method **area()** to compute the triangle's area. You are to determine what parameters the method should have. Print the area in 2 decimal places.

Answer:

```
// TriangleArea.java
import java.util.*;

public class TriangleArea {

   public static void main(String[] args) {
      Scanner sc = new Scanner(System.in);

      System.out.print("Enter lengths of 3 sides: ");
      double side1 = sc.nextDouble();
      double side2 = sc.nextDouble();
      double side3 = sc.nextDouble();

      System.out.printf("Area of triangle = %.2f\n",
                        area(side1, side2, side3));
   }

   // Compute area of triangle using Heron's formula
   public static double area(double a, double b, double c) {
      double s = (a + b + c)/2; // half perimeter
      return Math.sqrt(s * (s-a) * (s-b) * (s-c));
   }

}
```

3. [Weeks 1 and 2: **String** class]
   The **String** class is a rather special and interesting class. Try to explore on your own and read up more about it as strings are used extensively.

   (a) The following code:

```
String str = "one-" + "two" + " buckle my shoe";
System.out.println(str);
```

   produces this output:

```
one-two buckle my shoe
```

   If the assignment statement above is replaced by the following, what would be the output?

   (i) `String str = 1 + 2 + " buckle my shoe";`

   Answer:

```
3 buckle my shoe
```

   (ii) `String str = "" + 1 + 2 + " buckle my shoe";`

   Answer:

```
12 buckle my shoe
```

   (iii) `String str = '1' + 2 + " buckle my shoe";`

   Answer:

```
51 buckle my shoe
```

   (iv) `String str = 1 + "-2" + " buckle my shoe";`

   Answer:

```
1-2 buckle my shoe
```

   The **+** operator is associative from left to right. In (i), 1 + 2 results in 3. In (ii), the first operand "" is a string, hence the + operator is interpreted as the **string concatenation** operator instead of addition operator, therefore subsequent operands (1 and 2) are converted to strings. In (iii), the character '1' has an ASCII/Unicode value of 49, which is used in the addition operation of '1' + 2 (49 + 2). In (iv) 1 + "-2" results in a string concatenation, since one of the operands is a string, hence 1 + "-2" gives "1-2".

   In summary, **+** is an overloaded operator which could mean either addition or string concatenation, depending on its operands. If both its operands are numerical values (or associates of numerical values such as characters), then addition is performed; if one of its operands is a string, then string concatenation is performed.

   The following program illustrates the relation between a character and its associated integer value (Unicode value).

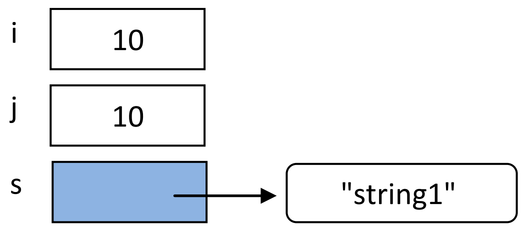
Try out the following program Snippet.java:

```
public class Snippet {

  public static void main(String[] args) {

    int i = 65;
    System.out.println("i = " + i);
    System.out.println("(char) i = " + (char) i);
    System.out.println();

    char ch = 'a';
    System.out.println("ch = " + ch);
    System.out.println("(int) ch = " + (int) ch);
    System.out.println();

    ch = '1';
    System.out.println("ch = " + ch);
    System.out.println("(int) ch = " + (int) ch);
  }

}
```

(b) Given the following code fragment:

```
int i = 10;
int j = i;
String s = new String("string1");
```

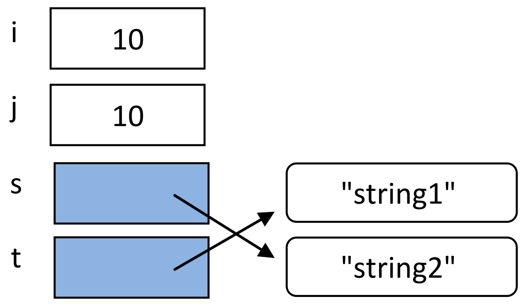
the memory can be depicted as below:



Give a depiction of the memory if the following statements are added to the code above and executed:

```
String t = s;
s = new String("string2");
```

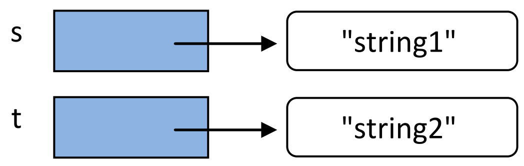
Answer:



(c) Given the following code fragment:

```
String s = new String("string1");
String t = new String("string2");
```

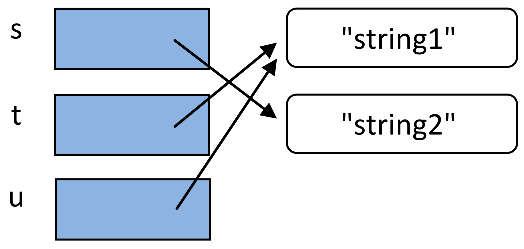
the memory can be depicted as below:



Give a depiction of the memory if the following statements are added to the code above and executed:

```
String u = s;
s = t;
t = u;
```

Answer:



(d) For primitive types, the equality operator **==** is used to compare two values to determine if they are equal. For example, given two **int** variables *a* and *b*, the condition (*a* == *b*) checks if *a* and *b* have the same value.

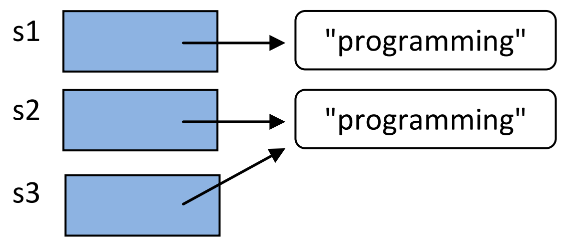
For objects, **==** is a ***reference equality operator*** to compare two references to determine if they refer to the same object. To compare two (distinct) objects to determine if they store the same values, use the **equals()** method instead.

Given the following code fragment:

```
String s1 = new String("programming");
String s2 = new String("programming");
String s3 = s2;
System.out.println("s1 == s2: " + (s1 == s2));
System.out.println("s2 == s3: " + (s2 == s3));
System.out.println("s1 == s3: " + (s1 == s3));
System.out.println("s1.equals(2): " + (s1.equals(s2)));
System.out.println("s2.equals(3): " + (s2.equals(s3)));
System.out.println("s1.equals(3): " + (s1.equals(s3)));
```

Give a depiction of the memory after the above code is executed, and hence determine the output of the above code.

Answer:



```
s1 == s2: false
s2 == s3: true
s1 == s3: false
s1.equals(2): true
s2.equals(3): true
s1.equals(3): true
```

(e) In parts (b) – (d) above, we create **String** objects using the **String** constructor.

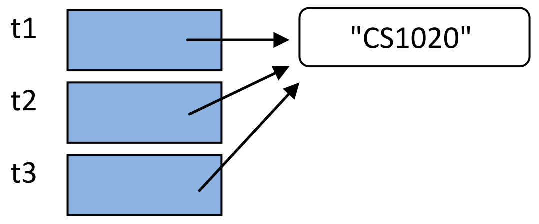
You may also create a **String** object using string literal, for example:

```
String s = "hello";
```

Test out the code below and find out why the output is such.

```
String t1 = "CS1020";
String t2 = "CS1020";
String t3 = "CS" + "1020";
System.out.println("t1 == t2: " + (t1 == t2));
System.out.println("t2 == t3: " + (t2 == t3));
System.out.println("t1 == t3: " + (t1 == t3));
```

Answer:



```
t1 == t2: true
t2 == t3: true
t1 == t3: true
```

String literals (sometimes also called string constants) come from a "string constant pool". At compile time, the compiler is able to determine that all the 3 string literals are the same, and hence **t1**, **t2** and **t3** are made to refer to the same string literal "CS1020" in the string constant pool.

On the other hand, if we use the **String** constructor, for example:

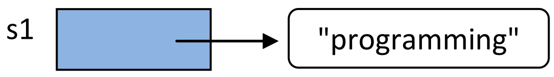
```
String x = new String("CS1020");
String y = new String("CS1020");
```

then it is obliged to create 2 instances of String, and hence **x** and **y** refer to two distinct String objects (both happen to contain the same value "CS1020", as in the case of references **s1** and **s2** in part (d)).

(f) You may have heard that strings in Java are **immutable**. What does it mean?

Answer:
Immutable means that once an object is created it cannot be altered. For example:

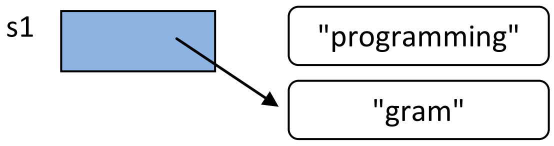
```
String s1 = new String("programming");
```



If we add this statement:

```
s1 = s1.substring(3, 7);
```

The string object "programming" created above is not changed to "prog" (because strings are immutable). Instead, a new string object "prog" is created and s1 now is made to reference this new object. The original string "programming" becomes garbage and inaccessible (such garbage will be removed by the system's garbage collector).



Note that there are mutable string classes in Java, for example: StringBuffer class and StringBuilder class.

4. [Week 2: Overloading]
In Java it is possible to define two or more methods within the same class that share the same name, as long as their parameter declarations are different. When this is the case, the methods are said to be *overloaded,* and the process is referred to as *method overloading.* (From http://www.java-samples.com/showtutorial.php?tutorialid=284)

Conditions for overloading:

- The number of parameters are different; or
- The parameter types are different

There are many overloaded methods (even overloaded constructors) in many classes in the API. For instance, the **Math** class has these overloaded methods to return the absolute value of its parameter a:

- `static double abs(double a)`
- `static float abs(float a)`
- `static int abs(int a)`
- `static long abs(long a)`

For example, **Math.abs(-5)** calls the third method; **Math.abs(-3.7)** calls the first method (because **double** is the default type for real numbers); **Math.abs(-3.7f)** calls the second method (to indicate a **float** value, the number is suffixed with f or F).

Given the following imaginary class C:

```
public class C {

   public static int m() {
      return 123;
   }

   public static int m(int a) {
      return 3 * a;
   }

   public static int m(int a, int b) {
      return a + b;
   }

   public static int m(double a, double b) {
      return (int) (a * b);
   }
}
```

What is the output for each of the following statements?

(a) `System.out.println(C.m());`
(b) `System.out.println(C.m(7));`
(c) `System.out.println(C.m(3.5));`
(d) `System.out.println(C.m(10, 20));`
(e) `System.out.println(C.m(10, 20.0));`

Answers:

(a) 123
(b) 21
(c) Error, no matching method.
(d) 30
(e) 200

- End of Tutorial 1 -