Introduction to Computer Programming (Java A)
Lab 8

[Objective]

- Learn to declare constructors and use them to construct objects
- Learn to declare and use of static data field and toString( )method.
- Learn to use various String methods

Part 1: Constructors and instance methods

The Circle class defined in the previous lab does not contain any explicitly declared constructor. The Java compiler will provide a default constructor that would initialize all three fields (radius, x, y) to 0.0 when called. If we want to create a circle object, of which the three fields have the following values: radius = 2.0, x = 1.0, y = 1.0, we can write a main method like the one below.

```
public static void main(String[] args) {
   Circle c = new Circle();
   c.setRadius(2.0);
   c.setX(1.0);
   c.setY(1.0);
}
```

However, this is quite troublesome. A better solution is to declare constructors so that they can be called to construct objects with certain radius values and center positions. The following code declares two such constructors. The first constructor takes one argument to initialize the radius field (the fields x and y will be initialized to 0.0). The second constructor takes three arguments to initialize all three fields.

```
public Circle(double radius) {
    this.radius = radius;
}

public Circle(double radius, double x, double y) {
    this.radius = radius;
    this.x = x;
    this.y = y;
}
```

Note that in the constructors, “this” keyword is needed to differentiate the field access from method argument access. Now we can simply create the circle (radius = 2.0, x = 1.0, y = 1.0) with a constructor call. Much easier, right?

```
public static void main(String[] args) {
   Circle c = new Circle(2.0, 1.0, 1.0);
}
```

Continue to type the following code in the main method and see what happens.

```
Circle c = new Circle();
```

The code would not compile. Do you know why? If not, please go check our lecture notes.

[Exercises]

Exercise 1: Add a public method distanceToOrigin() to the Circle class. The method returns the distance between the circle's center point and the origin point (0.0, 0.0). Then write a Java program to perform the following tasks:

(1) Generate a random number N in the range [5, 10).
(2) Create N circles. Each circle has a random radius in the range [1.0, 3.0) and a random center position: x and y are in the range [2.0, 5.0).
(3) Among the generated circles, find the one with the smallest area and the one whose center is the farthest from the origin point.

For random number generation, you may use the following two methods of the Random class:
(1) public int nextInt(int bound)
(2) public double nextDouble()
See https://docs.oracle.com/javase/8/docs/api/java/util/Random.html for more details.

A sample run:

```
Circle #1: radius = 2.14, x = 2.00, y = 4.04
Circle #2: radius = 1.45, x = 3.33, y = 4.16
Circle #3: radius = 1.89, x = 4.68, y = 4.87
Circle #4: radius = 1.59, x = 4.97, y = 4.47
Circle #5: radius = 2.71, x = 2.66, y = 4.83
Circle #6: radius = 2.42, x = 2.18, y = 3.34
Circle #7: radius = 2.72, x = 4.60, y = 2.46
Circle #2 is the smallest circle, area = 6.62
Circle #3 is the farthest circle, distance to origin = 6.75
```

Part 2: static data field and instance method toString( )

1. Static data field belongs to class instead of object.

```
public class Circle {
  private double radius;
  private double x;
  private double y;
  private static int cnt = 0;
 }
```

`cnt` is the static data field, it got a inital value 0. In the class static method could access a static data field.

```
public static int getCnt(){
  return cnt;
 }
```

How about constructor ?

```
public Circle(double radius) {
  this.radius = radius;
  cnt++;
}
```

Instance data field belongs to object while static data field belongs to class, static data field is shared with all the objects of the class.

2. A special instance method **toString( )** which return a string composed with all the instance field of the object.

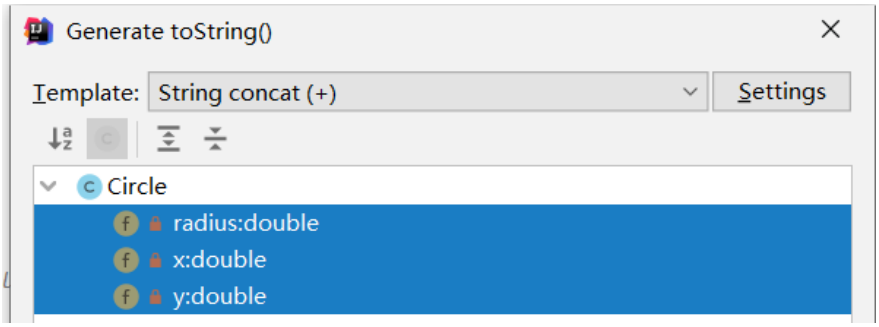
While the object is used as a string, the toString( ) is invoked by default. For example:

1) Create a Circle object c : `Circle c = new Circle(1.0, 1.0, 1.0);`

2) Use "`System.out.print(c)`" to print the c, what's the output?

3) Use "`System.out.print(c.toString())`" instead of "`System.out.print(c)`", what's the output?

IDEA could generated the toString() of the current class.



The following instance method toString() is generated:

```
public String toString() {
  return "Circle{" +
      "radius=" + radius +
      ", x=" + x +
      ", y=" + y +
      '}';
}
```

Invoke "`System.out.print(c)`" and "`System.out.print(c.toString())`" again, what's the output?

While change the toString( ) as follow code, invoke "`System.out.print(c)`". what's the output, why?

```
public String toString(char z) {
  return "Circle{" +
      "radius=" + radius +
      ", x=" + x +
      ", y=" + y +
```

```
                ", z=" + z +
                '}';
    }
```

Exercise 2: Modify the program in Exercise 1, add a new instance field id and a public method toString() in class Circle. Modify Exercise 1 to keep the same function.

1. The instance data field "id" is the index of the Circle object while object is created. For example, the 1st created Circle object's id is 1,the 2nd created Circle object's id is 2, and so on.

2. The instance method "toString()" returns a String which include all the data field value as desired format.

```
Circle #idValue: radius = radiuValue, x = xValue, y = yValue

Notes: idVaule using %d, radiuValue,xVaulue and yValue using %.2f as
format description.

For example:
Circle #1: radius = 1.71, x = 4.84, y = 4.46
```

A sample run:

```
Circle #1: radius = 2.15, x = 2.48, y = 4.71
Circle #2: radius = 2.52, x = 4.40, y = 2.14
Circle #3: radius = 2.24, x = 2.72, y = 2.61
Circle #4: radius = 2.87, x = 3.53, y = 4.68
Circle #5: radius = 1.45, x = 2.43, y = 2.56
Circle #6: radius = 1.15, x = 2.60, y = 2.90
Circle #6 is the smallest circle, area = 4.13
Circle #4 is the farthest circle, distance to origin = 5.86
```

Part 3: String manipulations

Please use String methods (https://docs.oracle.com/javase/8/docs/api/java/lang/String.html) to finish the tasks below. Methods in the Character class are also helpful: https://docs.oracle.com/javase/8/docs/api/java/lang/Character.html.

Exercise 3: Write a program to check if a string provided by a user is a palindrome or not. A string is a palindrome is the reverse of the string is the same as the string (we do not differentiate upper-case and lower-case letters in this task). For example, "abba" is a palindrome. "#Aa#" and "0" are also palindromes.

Your program should continuously take user inputs for checking and stops when the user types “quit”.

A sample run:

```
Type a string ("quit" to finish): hello
hello is not a palindrome
Type a string ("quit" to finish): many
many is not a palindrome
Type a string ("quit" to finish): 0
0 is a palindrome
Type a string ("quit" to finish): 900
900 is not a palindrome
Type a string ("quit" to finish): #Aa#
#Aa# is a palindrome
Type a string ("quit" to finish): quit

Process finished with exit code 0
```

Exercise 4: Write a program to remove all repeated characters in a string provided by the user and return a new string without any repeating characters or white spaces. Please use StringBuilder to build the new string.

Sample runs:

```
Please type a string: hello
After removing repeating chars and spaces: helo
```

```
Please type a string:
Empty string, exit…
```

```
Please type a string: abcd  bcde cdef
After removing repeating chars and spaces: abcdef
```

Exercise 5: Write a program to count the occurrence of a substring in a string. The program should ask the user to input two strings s1 and s2, and output the number of occurrences of s2 in s1.

Sample runs:

```
s1: JavaExamplesJavaCodeJavaProgram
s2: Java
Found at index: 0
Found at index: 12
Found at index: 20
Total occurrences: 3
```

```
s1: abcd  bcde cdef
s2: bc
Found at index: 1
Found at index: 6
Total occurrences: 2
```

```
s1: abcdefg
s2: xyz
Total occurrences: 0
```

API References:

String methods: https://docs.oracle.com/javase/8/docs/api/java/lang/String.html

- public int length()
- public char charAt(int index)
- public boolean startsWith(String prefix)
- public boolean equals(Object anObject)
- public boolean equalsIgnoreCase(String anotherString)
- public String trim()
- public int indexOf(String str)
- public int indexOf(String str, int fromIndex)
- public String substring(int beginIndex)
- public String substring(int beginIndex, int endIndex)
- public String[] split(String regex)
- public char[] toCharArray()

Character methods:
https://docs.oracle.com/javase/8/docs/api/java/lang/Character.html

- public static char toLowerCase(char ch)
- public static boolean isWhitespace(char ch)

StringBuilder methods:
https://docs.oracle.com/javase/8/docs/api/java/lang/StringBuilder.html

- public StringBuilder append(char c)
- public String toString()