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COSC 211 : Object Oriented Programming I - LAB04

Objectives:

- Learn how to create classes that can be used in creating objects
- Understand the purpose of constructors and how they differ from methods
- Differentiate between static and instant variables (and methods)
- Differentiate between accessor and mutator methods

1. Classes as factory of objects

So far, all the classes we have been written are applications containing the main method.
Another type of class is that which is written not necessarily to be executed as an application, but to be used in creating objects. Such type of classes are designed such that they describe the state and methods for a set of objects. This is achieved by using instant variables, instant methods and constructors.

Instant Variables: These are variables declared without using the **static** keyword. Such variables are only accessed through an object of the class and each object has its own copy of the variables – hence the name instant. Instant variables are used to store the state of an object and are usually declared as **private** so that they cannot be accessed directly by other objects.

Instant methods: These are methods declared without using the **static** keyword. They are normally used to describe the behavior of objects of a particular class. Instant methods are normally declared as **public** so that they could be accessed by other objects.

Constructor: These are used to initialize the fields (variables) of an object at the time the object is being created. Constructors must have the same name as the class, they have no return type and they are implicitly public.

Example 1: The following shows two classes. A class, Box, which specify the fields, a constructor and methods of a box object, and a class, BoxDemo, which creates two Box objects and called their methods.

```
public class Box {

   private double length , width , height;   //instance variables

   public Box(double boxLength , double boxWidth , double boxHeight) { //constructor
      length = boxLength;
      width = boxWidth;
      height = boxHeight;
   }

   public double volume() {      //instant methods
      return length * width * height;
   }

   public double surfaceArea() {
      return 2*(length*width + length*height + width*height);
   }
}
```

```
public class BoxDemo {
   public static void main(String[] args) {
      // Create two Box objects
      Box box1 = new Box(20.0, 10.0, 15.0);
      Box box2 = new Box(6.0, 4.0, 2.0);

      double volume, area;
```

```
      // Get and display volume and surface area of box1
      volume = box1.volume();
      area = box1.surfaceArea();
      System.out.println("The volume of box1 is " + volume + " cubic cm");
      System.out.println("The surface area of box1 is "+area+" square cm\n");

      // Get and display volume of surface area box2
      System.out.println("The volume of box2 is " + box2.volume() + " cubic cm");
      System.out.println("The surface area of box2 is "+area+" square cm\n");
   }
}
```

2. Difference between static and instance variables

If a variable is declared as **static** then there will be only one copy of the variable, which can be access though the class name, even without creating any object of the class. Thus, such variables are sometimes called **class variables**. Such a variable cannot be used to store the state of an object since each object has its own state.

Example 2: The following example shows the difference between static and non-static variables. Notice that both the class Circle and the class CircleDemo are stored in the same file. In this case, only one of the classes should be declared as public – the one containing the main method. The file should also have the same name as this public class.

```
// Demonstrating the use of static variables.

class Circle {
   private static int numberOfCircles = 0;    //a static variable

   private double radius;            //instance variables

   public Circle(double circleRadius) {
      numberOfCircles++;
      radius = circleRadius;
   }

   public double area() {
      return Math.PI * radius * radius;
   }

   public double circumference() {
      return 2.0 * Math.PI * radius;
   }

   public static int getNumberOfCircles() {
      return numberOfCircles;
   }
}

public class CircleDemo {
   public static void main(String[] args) {

      // The static method getNumberOfCircles can be called before creating any
circle object
      System.out.println("The number of circles is " + Circle.getNumberOfCircles());

      Circle circle1 = new Circle(8.5);
      System.out.println("The number of circles is " + Circle.getNumberOfCircles());

      Circle circle2 = new Circle(5.0);
      System.out.println("The number of circles is " + Circle.getNumberOfCircles());

      System.out.println("The area of the first circle is \t" + circle1.area() + "
square cm");
      System.out.println("The circumference of the first circle is\t" +
circle1.circumference() + " cm");

      System.out.println("The area of the second circle is\t" + circle2.area() + "
square cm");
      System.out.println("The circumference of the second circle is\t" +
circle2.circumference() + " cm\n\n");
```

```
    }
}
```

3. Accessor and Mutator methods

It is a good programming principle to always declare instance variables as private. However, it is O.K. to allow indirect access to these variables by providing public methods. Some of these method only access but do not change the variables, hence they are called **accesor** methods. Those that do not only access, but also make changes to these variables are called **mutator** methods.

Example 3: The follows shows example of accessor and mutator methods.

```
// Demonstrating using accessor and mutator methods.
class Rectangle {
   private double length , width;

   public Rectangle(double rectangleLength , double rectangleWidth) {
      length = rectangleLength;
      width = rectangleWidth;
   }
   public double area() {
      return length * width;
   }

   // Accessor methods
   public double getLength() {
      return length;
   }
   public double getWidth() {
      return width;
   }

   // Mutator methods
   public void setLength(double newLength)      {
      length = newLength;
   }
   public void setRectangleWidth(float newWidth) {
      width = newWidth;
   }
}

public class RectangleDemo {
   public static void main(String[] args)       {
      // Create one Rectangle object
      Rectangle rectangle = new Rectangle(20.0, 10.0);

      // Get and display the area of rectangle
      double area = rectangle.area();
      System.out.println("The area of the rectangle is\t" + area + " square cm");

      // Get and display the length of rectangle
      //Note: we cannot use rectangle.length
      System.out.println("The length of the rectangle is\t" + rectangle.getLength() +
" cm");

      // Modify the length of rectangle1 to 12.0
      //We must use a mutator method to change the value of a private instance
variable
      rectangle.setLength(12.0);

      // Get and display the new length of the rectangle
      System.out.println("The new length of the rectangle is " +
rectangle.getLength() + " cm");

      // Get and display the new area of the rectangle
      System.out.println("The new area of the rectangle is   " + rectangle.area() + "
square cm\n\n");
   }
```

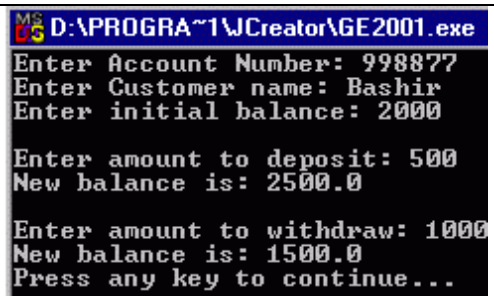
```
}
```

4. Assignment.

1. Open the folder **lab04** , Study, compile, and then execute each of the three demo applications:
   - BoxDemo
   - CircleDemo
   - RectangleDemo

2. Write a java program containing two classes: BankAccount and BankAccountDemo. The class BankAccount must contain the following:
   - an instance variable **accountNumber** of type int.
   - an instance variable **customerName** of type String
   - an instance variable **balance** of type double.
   - a **constructor** that initializes each of the instance variables.
   - a method **deposit**.
   - a method **withdraw**
   - a method **getBalance**.

The class BankAccountDemo must:

· Prompt for and read the account number for the customer. · Prompt for and read the name of the customer. · Prompt for and read the initial balance for the customer. · Create a bankAccount object for the customer. · Prompt for and read an amount to be deposited. · Display the current balance for the customer after the deposit. · Prompt for and read an amount to be withdrawn. · Display the current balance of the customer after the withdrawal.	

3. Write two java classes, **Student** and **StudentDemo** in separate files. The class **Student** should contain the following:

- an instance variable **name** of type String.
- an instance variable **iDNumber** of type int
- three instance variables **quiz1**, **quiz2**, **quiz3** of type double.
- a **constructor** that initializes each of the instance variables.
- a **get method** for each of the instance variables.
- three **set method**, one for each of quiz1, quiz2 and quiz3
- a method **average** to return the average of the three quizzes.
- a method **printDetails** to print the details of a student object in the following format:

  Student Name: ??????????

  Student ID: ???????????

  Quiz Grades: ??????? ????????? ????????

The class StudentDemo must:

· Create an object of type Student, supplying values for name, ID number and three quizzes in the constructor call. · calls the printDetails method to print the details of the student · calls the average method to get the average and print it. · Prompts for and read the new grade for quiz3 · calls the setQuiz3() method to change the value of quiz3 to the value entered by the user. · prints the details and the average again.