

Introduction to Computer Programming (Java A)

Lab 7

(The source code and document description are designed by ZHU Yueming and Wang Wei)

[Objective]

- Learn how to define a Java class and create its object
- Learn how to define and use instance variables
- Learn how to define and use instance methods
- Learn how to use get and set methods
- Learn how to use ArrayList and make the object as its element.

[Before Exercises]

Step1: How to define a circle on a 2D plane?

A circle has three attributes including the **radius**, the **x coordinate** and the **y coordinate**.

We can define a class named Circle, in which there are three private attributes.

```
public class Circle {  
    private double radius;  
    private double x;  
    private double y;  
}
```

Step2: Define the methods of a circle.

Define three public methods for computing the area, perimeter and print position of the circle.

```
public class Circle {  
    private double radius;  
    private double x;  
    private double y;  
  
    public double area() {  
        return radius*radius*Math.PI;  
    }  
    public double perimeter () {  
        return 2*Math.PI*radius;  
    }  
    public void position() {  
        System.out.printf("Position of the cricle is (%.1f,%.1f)\n",x,y);  
    }  
}
```

Step3: How to use the class Circle?

Create another class named CircleTest in the same package, in which there is a main method to be used.

In the main method, we can create an object of Circle by using the statement as follows:

```
Circle c1=new Circle();
```

After that, we want to know the perimeter, area and position about the `c1`, so we need to invoke the method of `c1`.

```
public class CircleTest {  
    public static void main(String[] args) {  
        Circle c1=new Circle();  
        System.out.printf("The area of c1 is %.2f\n", c1.area());  
        System.out.printf("The perimeter of c1 is %.2f\n", c1.perimeter());  
        c1.position();  
    }  
}
```

When we run the program, the result would as follows:

```
The area of c1 is 0.00  
The perimeter of c1 is 0.00  
Position of the cricle is (0.0,0.0)
```

Step4: Set and get the values of the attributes

If we set or get the radius of a circle object in main method directly, it would lead to an error because of its private privilege.

In addition, the radius of a circle should not contain a negative number, how can we set the restriction?

```
public static void main(String[] args) {  
    Circle c1=new Circle();  
    System.out.printf("The area of c1 is %.2f\n", c1.area());  
    System.out.printf("The perimeter of c1 is %.2f\n", c1.perimeter());  
    c1.position();  
    c1.radius=-1;  
    System.out.println(c1.radius);  
}
```

We can define several public methods in class Circle for getting or setting the class variables, and we can check the validity of input value in the set method.

```
public class Circle {  
    private double radius;  
    private double x;  
    private double y;  
  
    public double area() {  
        return radius*radius*Math.PI;  
    }  
    public double perimeter () {  
        return 2*Math.PI*radius;  
    }  
    public void position() {  
        System.out.printf("Position of the cricle is (%.1f,%.1f)\n",x,y);  
    }  
}
```

```
public double getRadius() {  
    return radius;  
}  
public void setRadius(double radius) {  
    if (radius > 0) {  
        this.radius = radius;  
    }  
}  
public double getX() {  
    return x;  
}  
public void setX(double x) {  
    this.x = x;  
}  
public double getY() {  
    return y;  
}  
public void setY(double y) {  
    this.y = y;  
}  
}
```

After that, we can access the attributes by the get and set methods.

```
public static void main(String[] args) {  
    Circle c1=new Circle();  
    c1.setRadius(5);  
    System.out.println(c1.getRadius());  
    System.out.printf("The area of c1 is %.2f\n", c1.area());  
    System.out.printf("The perimeter of c1 is %.2f\n", c1.perimeter());  
    c1.position();  
}
```

Sample output:

```
5.0  
The area of c1 is 78.54  
The perimeter of c1 is 31.42  
Position of the cricle is (0.0,0.0)
```

Step5: How to manage multiple circle objects ?

We can use an array or an ArrayList to manage them.

In the main method, create an arrayList with a Circle type, to store many objects of Circle. Add the following code at the end of main method.

```
ArrayList<Circle> circleList=new ArrayList<Circle>();  
circleList.add(c1);  
System.out.printf("Radius of %d circle is %.2f: \n",1,circleList.get(0).getRadius());
```

Sample output:

```
5.0
The area of c1 is 78.54
The perimeter of c1 is 31.42
Position of the cricle is (0.0,0.0)
Radius of 1 circle is 5.00:
```

Step5: Add more circles in the ArrayList.

Add the following code at the end of main method.

```
for(int i=1;i<5;i++) {
    circleList.add(new Circle());
    circleList.get(i).setRadius(i);
    circleList.get(i).setX(Math.random()*5);
    circleList.get(i).setY(Math.random()*5);
}

System.out.println("---Begin to print the circle list---");
for(int i=0;i<5;i++) {
    System.out.printf("The area of %d circle is %.2fn",
        i+1, circleList.get(i).area());
    System.out.printf("The perimeter is %.2fn",
        circleList.get(i).perimeter());
}
```

Sample output:

```
5.0
The area of c1 is 78.54
The perimeter of c1 is 31.42
Position of the cricle is (0.0,0.0)
Radius of 1 circle is 5.00:
---Begin to print the circle list---
The area of 1 circle is 78.54
The perimeter is 31.42
The area of 2 circle is 3.14
The perimeter is 6.28
The area of 3 circle is 12.57
The perimeter is 12.57
The area of 4 circle is 28.27
The perimeter is 18.85
The area of 5 circle is 50.27
The perimeter is 25.13
```

[Exercises]

1. Declare a class named **User**. The class contains:
 - a. Private data fields:
 - i. String **account**;
 - ii. String **password**;
 - iii. double **money**;
 - b. Implement a public method named **introduce()** to print the user account and his account balance.
 - c. Implement a public method **expense(double value,Scanner in)**. It withdraws the money from the user account if the password is correct.

- d. Implement a public method **income(double value)**. It deposits the money to the user account.
- e. Implement the **getter** and **setter** methods for each private field of the class User.

In the same package, we create a class named **UserTest**, which has a main method.

Statements in main method:

```
User user =new User();
Scanner in = new Scanner(System.in);
user.setUser("Lucy");
user.setPassword("123456");
user.setMoney(1000);
user.introduce();
user.expense(2000,in);
user.expense(500,in);
user.income(1000);
user.introduce();
in.close();
```

Sample output:

```
Lucy's account has a balance of 1000.00 dollar
Plan to expense 2000.00 dollar but no sufficient funds
Plan to expense 500.00 dollar
Please input your password:
123456
Expense 500.00 dollar and balance 500.00 dollar
Got 1000.00 as income,balance is 1500.00 dollar
Lucy's account has a balance of 1500.00 dollar
```

2. Design a class named **Food**. The class contains:

- a. Private data fields:
 - i. int **id**;
 - ii. String **name**;
 - iii. String **type**;
 - iv. int **size**;
 - v. double **price**;

Implement a public method named **showInformation()** to print all the information of this food object.

- b. Implement the **getter** and **setter** method for each private field of Food.

In **FoodTest** class, create four objects of Food as follows:

Object Name	id	name	type	size	price
pizza1	1	pizza	Seafood	11	12
pizza2	2	pizza	Beef	9	10
Fried rice	3	fried rice	Seafood	5	12
Noodles	4	noodles	Beef	6	14

Create an `ArrayList<Food>` to add those four Food objects, and then show the information of them as follows by iterating the `ArrayList<Food>` we created.

Sample output:

```
-----welcome,this is Start of the Menu-----
[id] 1  [type] Seafood    [name] pizza    [size] 11 (Inches) 12.00 $
[id] 2  [type] Beef      [name] pizza    [size] 9 (Inches) 10.00 $
[id] 3  [type] Seafood    [name] fried rice [size] 5 (Inches) 12.00 $
[id] 4  [type] Beef      [name] noodles   [size] 6 (Inches) 14.00 $
-----welcome,this is End of the Menu-----
```

3. Design a class named **softOpen**. The class contains no data fields but:
 - a. Implement a public static method named **generateMenu()** to generate 4 object of Food and add them to the `ArrayList<Food>`.
 - b. Implement a public static method named **getMenu(ArrayList<Food>)** to print the items in the `ArrayList<Food>` as designed.
 - c. Implement a public static method named to generateUser(Scanner in) to generated a user whose account and money is get by using the Scanner object 'in'.
 - d. Implement a public static method named **UserConsume(ArrayList<Food>,User user,Scanner in)** to invoke the **getMenu**, ask user to select the foods in the Menu, count the cost and invoke the expense of the user.
 - e. Invoke the method **introduce()** of the User object to show his/hers balance.

Statements in main method:

```
Scanner in = new Scanner(System.in);
ArrayList<Food> foodList = generateMenu(); //generate a Menu
User user = generateUser(in);             //generate a user
user.introduce();                         //show the account of the user
user.consume(foodList,user,in);           //user consume
user.introduce();                         //show the account of the user
in.close();
```

Sample output:

```
Generate a user,please input name:Bob
balance($):2000
Bob's account has a balance of 2000.00 dollar
-----welcome,this is Start of the Menu-----
[id] 1  [type] Seafood    [name] pizza      [size] 11 (Inches) 12.00 $
[id] 2  [type] Beef      [name] pizza      [size] 9 (Inches) 10.00 $
[id] 3  [type] Seafood    [name] fried rice [size] 5 (Inches) 12.00 $
[id] 4  [type] Beef      [name] noodles    [size] 6 (Inches) 14.00 $
-----welcome,this is End of the Menu-----
please input the foodID and the number you want,to exit input 0 as foodID
food id(input 0 to end select):2
number of this food:10
food id(input 0 to end select):4
number of this food:1
food id(input 0 to end select):0
select end
Plan to expense 114.00 dollar
Please input your password:
123456
Expense 114.00 dollar and balance 1886.00 dollar
Bob's account has a balance of 1886.00 dollar
```