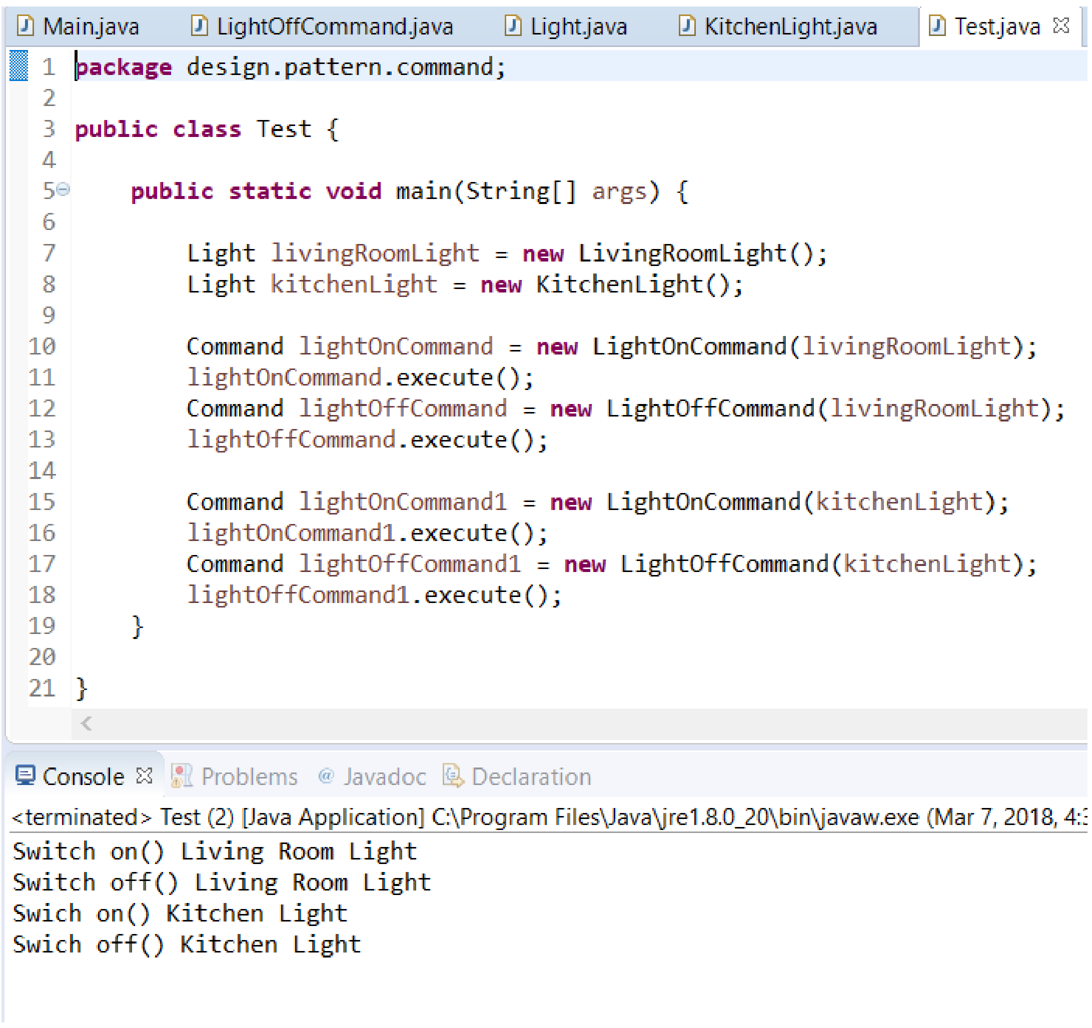
BSc (Hons) in Information Technology
Year 3 - Semester 1, 2018

Lab Exercise – Design Patterns

SE3030 – Software Architecture (SA)

Exercise 01 – Command Pattern

1. Create an Interface called **Command** with a method signature **execute()**
2. Create an Interface called **Light** with method signatures **on()** and **off()**
3. Implement 2 concrete classes named (**KitchenLight**, **LivingRoomLight**) and use **Light** interface with overriding methods **on()** and **off()** in each class.
4. Similarly use **Command interface** and implement 2 concrete classes named (**LightOnCommand**, **LightOffCommand**) and override **execute()** methods in each class.
5. Create **Test** class as below to check each light **on** and **off** commands with respect to the provided location.
6. Method **execute()** will run the given object for command class as below. Follow all above steps and execute relevant method.
7. Run this **Test** class and check the output should be as below.



```java
package design.pattern.command;

public class Test {

    public static void main(String[] args) {

        Light livingRoomLight = new LivingRoomLight();
        Light kitchenLight = new KitchenLight();

        Command lightOnCommand = new LightOnCommand(livingRoomLight);
        lightOnCommand.execute();
        Command lightOffCommand = new LightOffCommand(livingRoomLight);
        lightOffCommand.execute();

        Command lightOnCommand1 = new LightOnCommand(kitchenLight);
        lightOnCommand1.execute();
        Command lightOffCommand1 = new LightOffCommand(kitchenLight);
        lightOffCommand1.execute();
    }

}
```

```
<terminated> Test (2) [Java Application] C:\Program Files\Java\jre1.8.0_20\bin\javaw.exe (Mar 7, 2018, 4:
Switch on() Living Room Light
Switch off() Living Room Light
Swich on() Kitchen Light
Swich off() Kitchen Light
```

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Exercise 02 – Template-method pattern

1. Create an abstract class called **Beverages** and extends that class using **Tea** and **Coffee** concrete classes
2. Within **Tea** and **Coffee** classes override both abstract methods **addCondiments()** and **brew()**
3. Now modify the **Beverage** class to implement **boilWater()** and **pourInCup()** methods. As per the below.

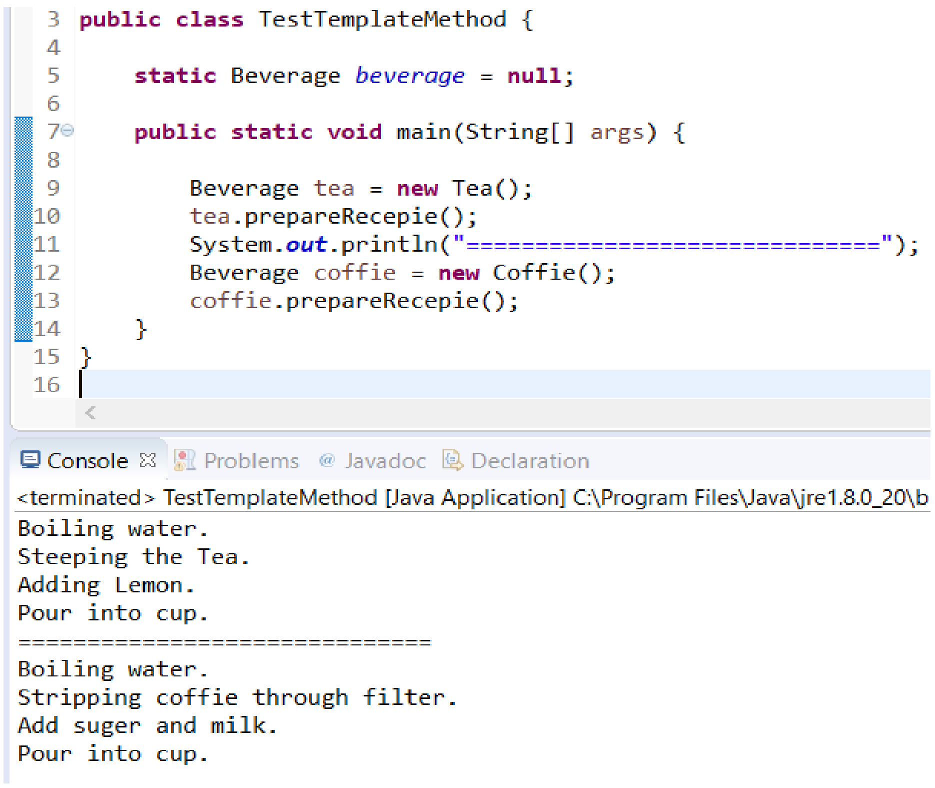
```java
abstract void brew();

abstract void addCondiments();

void boilWater(){
    System.out.println("Boiling water.");
}

void pourInCup(){
    System.out.println("Pour into cup.");
}
```

4. Now you should impose the order of execution of these methods as below. This order of execution **should not be changed** implicitly or explicitly in any of these sub classes and it should work as life cycle methods.
5. Your modification should satisfy **step 4**
6. Now Implement **Test class** to test **above template method pattern** and you should be able to display the output below.



```java
public class TestTemplateMethod {

    static Beverage beverage = null;

    public static void main(String[] args) {

        Beverage tea = new Tea();
        tea.prepareRecepie();
        System.out.println("==============================");
        Beverage coffie = new Coffie();
        coffie.prepareRecepie();
    }
}

```

```
<terminated> TestTemplateMethod [Java Application] C:\Program Files\Java\jre1.8.0_20\b
Boiling water.
Steeping the Tea.
Adding Lemon.
Pour into cup.
==============================
Boiling water.
Stripping coffie through filter.
Add suger and milk.
Pour into cup.
```

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Exercise 03 – Builder Pattern

1. Create a **Query** class with SELECT, FROM WHERE and ORDER BY as properties
   a. Implement a method to print the complete query

2. Create a **QueryBuilder** class with a property to hold a **Query** object
   a. Create the Query object inside the constructor of **QueryBuilder**
   b. Implement methods to set SELECT, FROM WHERE and ORDER to the Query object
   c. Each method should return a **QueryBuilder** object

3. Implement a method called **build()** in **QueryBuilder** that returns the **Query** object
   a. Check if the Query contains at least SELECT and FROM properties, if not it is not a valid query and prevent building the query by throwing an exception

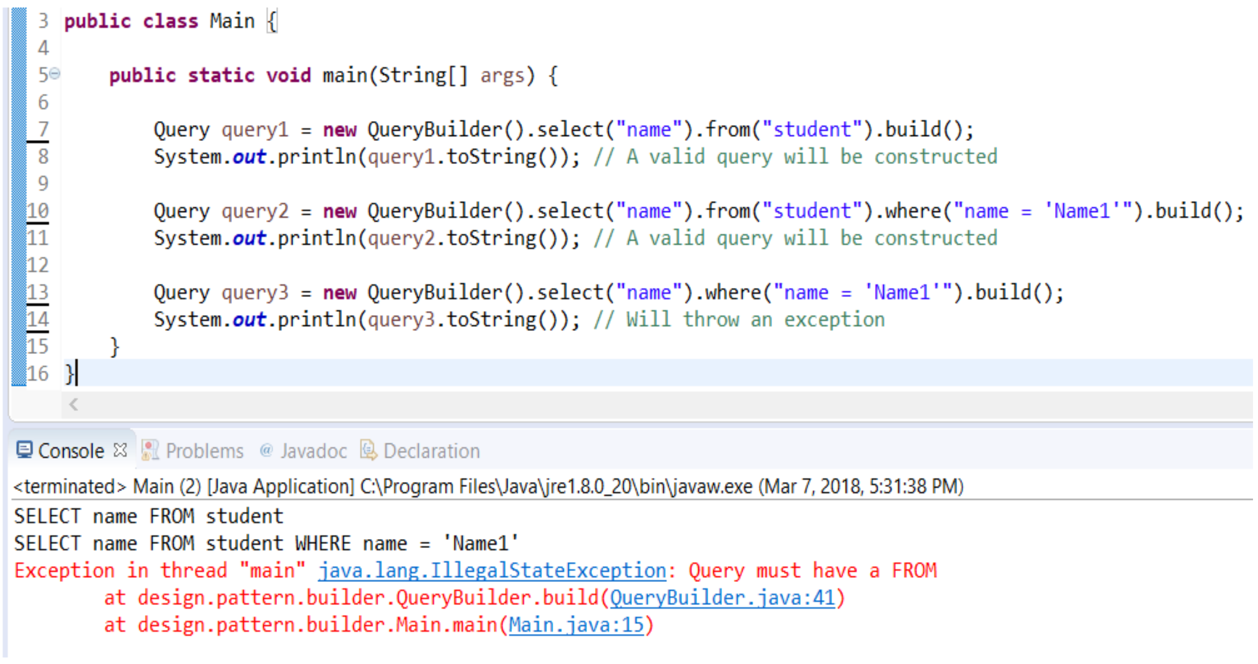
4. Create a Test class to test out the pattern functionality

```
Query query1 = new QueryBuilder().select("name").from("student").build();
System.out.println(query1.toString()); // A valid query will be constructed

Query query2 = new QueryBuilder().select("name").from("student").where("name =
'Name1'").build();
System.out.println(query2.toString()); // A valid query will be constructed

Query query3 = new QueryBuilder().select("name").where("name = 'Name1'").build();
System.out.println(query3.toString()); // Will throw an exception
```

5. You should display the following outputs. If you missed key word of the query, you should throw an exception as below.



```
public class Main {

    public static void main(String[] args) {

        Query query1 = new QueryBuilder().select("name").from("student").build();
        System.out.println(query1.toString()); // A valid query will be constructed

        Query query2 = new QueryBuilder().select("name").from("student").where("name = 'Name1'").build();
        System.out.println(query2.toString()); // A valid query will be constructed

        Query query3 = new QueryBuilder().select("name").where("name = 'Name1'").build();
        System.out.println(query3.toString()); // Will throw an exception
    }
}
```

```
<terminated> Main (2) [Java Application] C:\Program Files\Java\jre1.8.0_20\bin\javaw.exe (Mar 7, 2018, 5:31:38 PM)
SELECT name FROM student
SELECT name FROM student WHERE name = 'Name1'
Exception in thread "main" java.lang.IllegalStateException: Query must have a FROM
	at design.pattern.builder.QueryBuilder.build(QueryBuilder.java:41)
	at design.pattern.builder.Main.main(Main.java:15)
```

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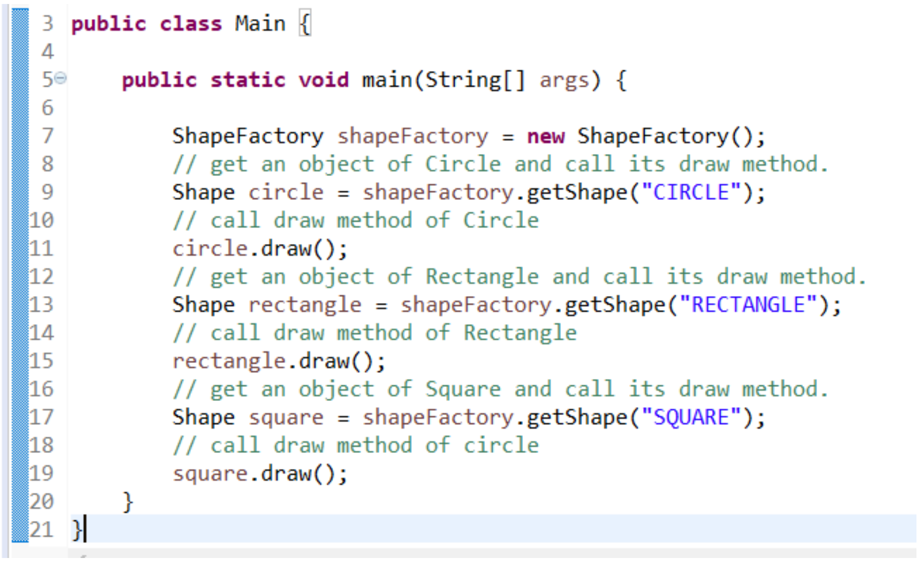
Exercise 04 – Abstract Factory Pattern

1. Create an Interface called **Shape** with a method signature **draw()**
2. Implement 3-4 Concrete Classes of Shape
   a. Create classes for **Square**, **Circle**, **Triangle**, **Rectangle**, etc.
   b. Implement the **draw()** method
      e.g. Print the name of the shape inside the draw method of each class

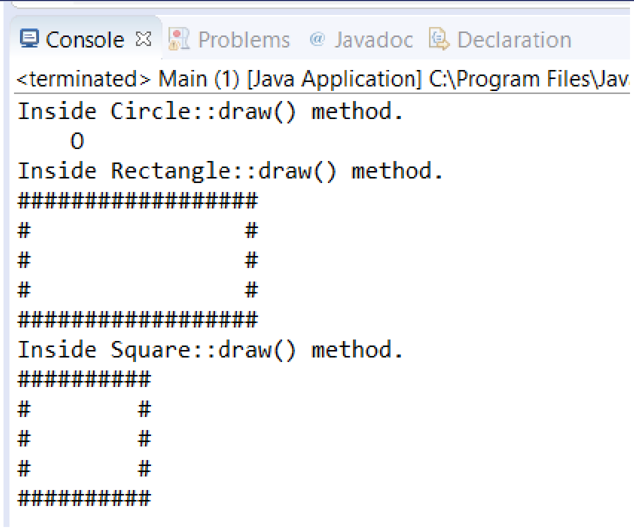
3. Create a **ShapeFactory** class
   a. Add a method called **getShape()** that accepts a **String** as a parameter and returns a **Shape**
   b. Implement **getShape()** method to create the concrete shapes
      e.g. Check if the parameter is "SQUARE" and create an instance of Square class and return it
4. Create a Test class to test out the pattern functionality

```
ShapeFactory shapeFactory = new ShapeFactory();
// get an object of Circle and call its draw method.
Shape shape1 = shapeFactory.getShape("SQUARE");
// call draw method of Circle
shape1.draw();
```

5. Complete the rest of the parts in design You should display the following output.
6. Create a Test class to test out the pattern functionality as below



```
public class Main {

    public static void main(String[] args) {

        ShapeFactory shapeFactory = new ShapeFactory();
        // get an object of Circle and call its draw method.
        Shape circle = shapeFactory.getShape("CIRCLE");
        // call draw method of Circle
        circle.draw();
        // get an object of Rectangle and call its draw method.
        Shape rectangle = shapeFactory.getShape("RECTANGLE");
        // call draw method of Rectangle
        rectangle.draw();
        // get an object of Square and call its draw method.
        Shape square = shapeFactory.getShape("SQUARE");
        // call draw method of circle
        square.draw();
    }
}
```



```
<terminated> Main (1) [Java Application] C:\Program Files\Jav
Inside Circle::draw() method.
    O
Inside Rectangle::draw() method.
##################
#                #
#                #
#                #
##################
Inside Square::draw() method.
##########
#        #
#        #
#        #
##########
```

Exercise 05 – Strategy Pattern

Add 2 behaviors for Student class (**IFestival** and **IPRograms**) and add these behaviors are loosely coupled for the **Student** class. Each specific behavior may have its own way of **implementing algorithm** and it would not affect for the **adding** or **removing** behaviors.

Student class will be extended as **UndergraduateStudents** and **PostGraduateStudents**

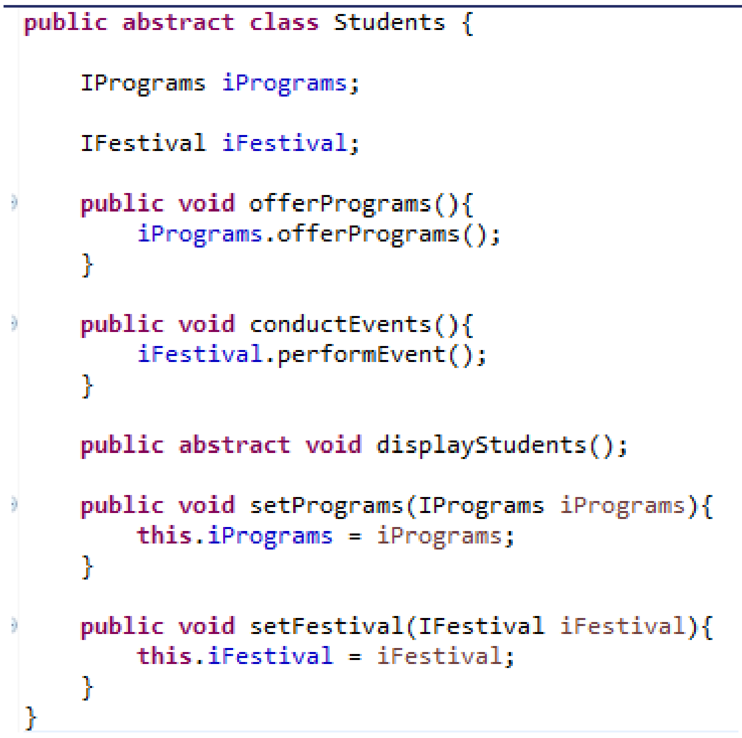
1. Create an interface called **IFestival** and declare method **performEvent()**

2. Create an interface called **IPrograms** and declare method **offerPrograms()**

3. Then create 3 concrete classes (**CodeFest**, **RoboFest** and **GameFest**) and implement the **IFestival** interface and override the **performEvent()** method in each class separately.

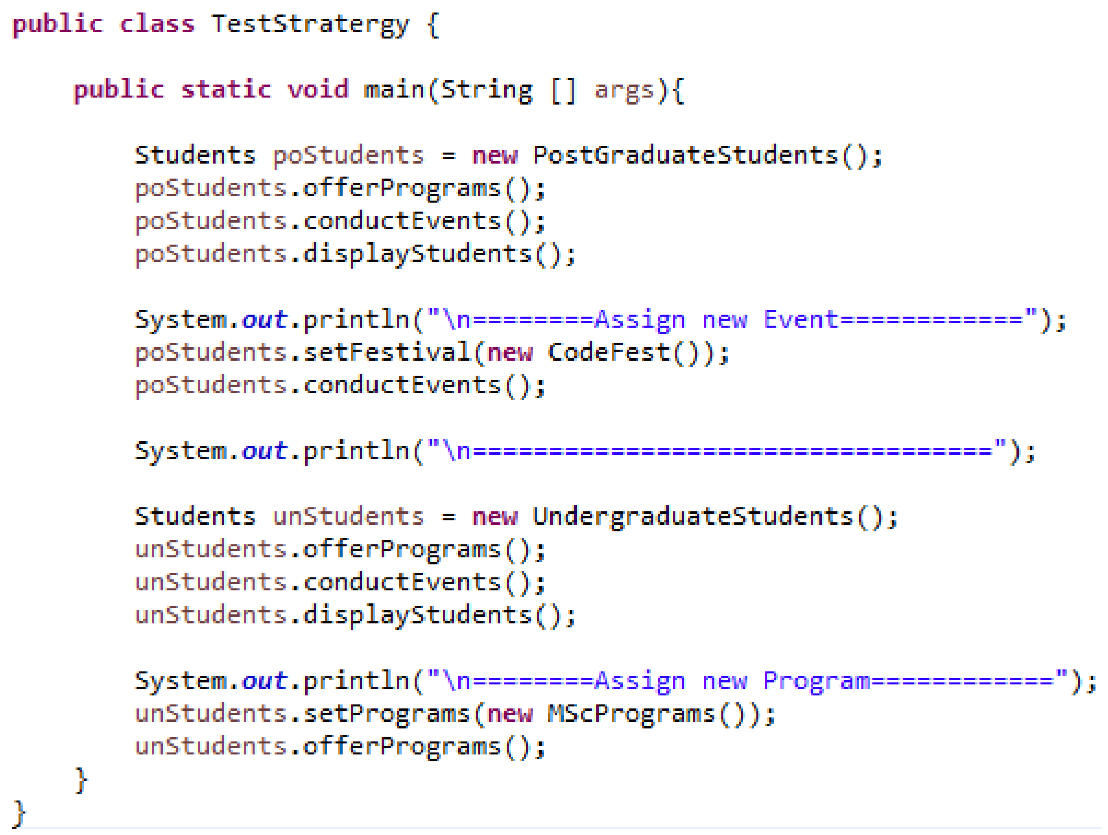
4. Now create another 3 concrete classes (**DoctoralPrograms**, **MScPrograms** and **BScPrograms**) and implement the **IPrograms** interface and override the **offerPrograms()** method in each class separately

5. Now implement an Abstract class of Student and let user to set behavior considering **aggregation relationship** as follows. (**All behaviors should be able to set dynamically**)



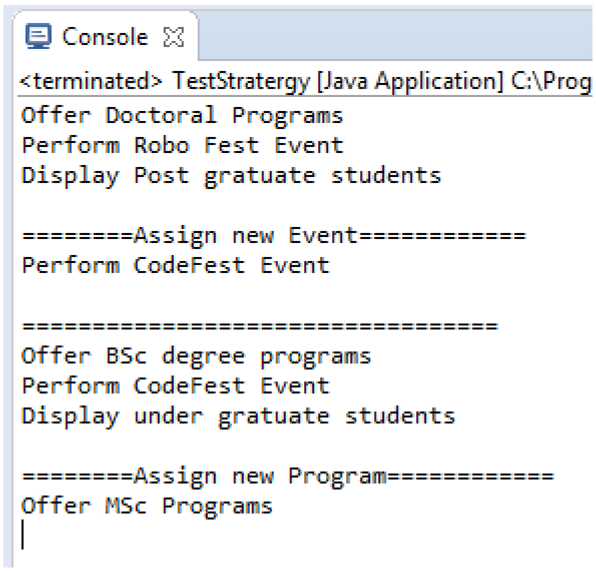
```
public abstract class Students {

    IPrograms iPrograms;

    IFestival iFestival;

    public void offerPrograms(){
        iPrograms.offerPrograms();
    }

    public void conductEvents(){
        iFestival.performEvent();
    }

    public abstract void displayStudents();

    public void setPrograms(IPrograms iPrograms){
        this.iPrograms = iPrograms;
    }

    public void setFestival(IFestival iFestival){
        this.iFestival = iFestival;
    }
}
```

6. Finally, you can implement **StratergyTest** class as follows and you should be able to **add or remove each behavior in dynamic manner using setters**. It should display output as follows.



```
public class TestStratergy {

    public static void main(String [] args){

        Students poStudents = new PostGraduateStudents();
        poStudents.offerPrograms();
        poStudents.conductEvents();
        poStudents.displayStudents();

        System.out.println("\n========Assign new Event===========");
        poStudents.setFestival(new CodeFest());
        poStudents.conductEvents();

        System.out.println("\n==================================");

        Students unStudents = new UndergraduateStudents();
        unStudents.offerPrograms();
        unStudents.conductEvents();
        unStudents.displayStudents();

        System.out.println("\n========Assign new Program===========");
        unStudents.setPrograms(new MScPrograms());
        unStudents.offerPrograms();
    }
}
```

Output of Strategy



Console

```
<terminated> TestStratergy [Java Application] C:\Prog
Offer Doctoral Programs
Perform Robo Fest Event
Display Post gratuate students

========Assign new Event============
Perform CodeFest Event

===================================
Offer BSc degree programs
Perform CodeFest Event
Display under gratuate students

========Assign new Program============
Offer MSc Programs
```

============================END OF THE LAB===