Lab 06

Inheritance

Objective:

The objective of this lab is to familiarize the students with various concepts and terminologies of inheritance using Java.

Activity Outcomes:

This lab teaches you the following topics:

- Declaration of the derived classes along with the way to access of base class members.
- Protected Access modifier and working with derived class constructors.

Instructor Note:

As pre-lab activity, read Chapter 11 from the text book “Introduction to Java Programming”, Y. Daniel Liang, Pearson, 2019.

1) Useful Concepts

a. Inheritance

Inheritance is a way of creating a new class by starting with an existing class and adding new members. The new class can replace or extend the functionality of the existing class. The existing class is called the base class and the new class is called the derived class.

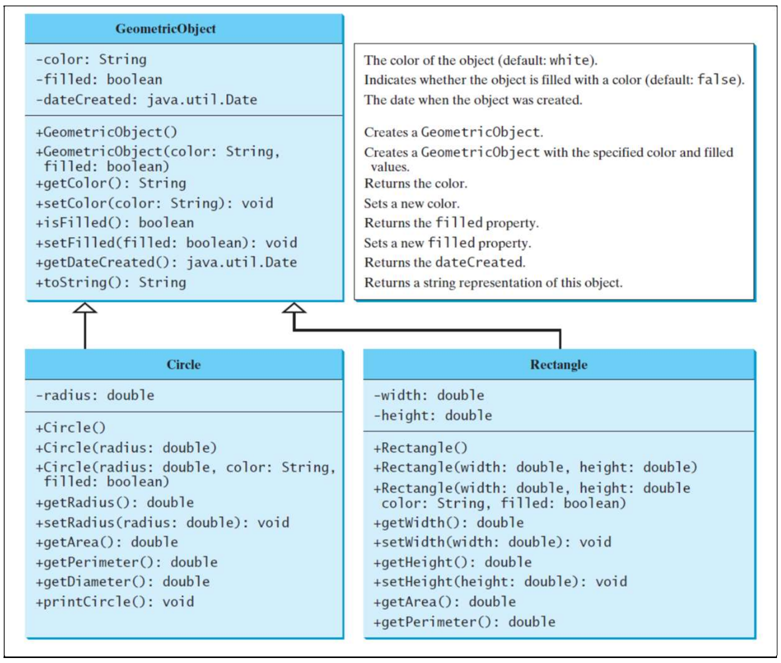
b. Protected Access Specifier

Protected members are directly accessible by derived classes but not by other users.

A class member labeled **protected** is accessible to member functions of derived classes as well as to member functions of the same class.

c. Derived class constructor

Constructors are not inherited, even though they have public visibility. However, the super reference can be used within the child's constructor to call the parent's constructor. In that case, the call to parent's constructor must be the first statement.


GeometricObject
-color: String
-filled: boolean
-dateCreated: java.util.Date
+GeometricObject()
+GeometricObject(color: String, filled: boolean)
+getColor(): String
+setColor(color: String): void
+isFilled(): boolean
+setFilled(filled: boolean): void
+getDateCreated(): java.util.Date
+toString(): String
The color of the object (default: white).
Indicates whether the object is filled with a color (default: false).
The date when the object was created.
Creates a GeometricObject.
Creates a GeometricObject with the specified color and filled values.
Returns the color.
Sets a new color.
Returns the filled property.
Sets a new filled property.
Returns the dateCreated.
Returns a string representation of this object.
Circle
-radius: double
+Circle()
+Circle(radius: double)
+Circle(radius: double, color: String, filled: boolean)
+getRadius(): double
+setRadius(radius: double): void
+getArea(): double
+getPerimeter(): double
+getDiameter(): double
+printCircle(): void
Rectangle
-width: double
-height: double
+Rectangle()
+Rectangle(width: double, height: double)
+Rectangle(width: double, height: double color: String, filled: boolean)
+getWidth(): double
+setWidth(width: double): void
+getHeight(): double
+setHeight(height: double): void
+getArea(): double
+getPerimeter(): double

2) Solved Lab Activities (Allocated Time 50 min.)

Sr.No	*Allocated Time*	*Level of Complexity*	*CLO Mapping*
Activity 1	*25 mins*	*Medium*	*CLO-4*
Activity 2	*25 mins*	*Medium*	*CLO-4*

Activity 1:

This example will explain the method to specify the derived class. It explains the syntax for writing the constructor of derived class.

Solution:

```
public class person {

protected String name ; protected String id ; protected int phone ;

public person() {
name = "NaginaNazar" ; id = "sp14bcs039" ; phone = 12345 ;
}

public person(String a , String b , int c)
{ name = a ; id = b ; phone = c ;}

 public void setName(String a){ name = a ;}

public void setId(String j){id = j ;}

public void setPhone(int a) { phone = a ;}

public String getName() {return name ;}

public String getid() {return id ;}

public int getPhone() {return phone ;}
public void display( )
{
System.out.println("Name : " + name + "ID : " + id + "Phone : " +
phone ) ;}}
-------------------------------------------------------------------
public class student extends person {
private String rollNo;
private int marks ;

public student() {
super() ;
rollNo = "sp14bcs039" ; marks = 345 ;
}
public student(String a , String b , int c , String d , int e)
{ super(a,b,c) ;
rollNo = d ; marks = e ;
}

public void setRollNo(String a){ rollNo = a ;}

public void setMarks(int a ){ marks = a ;}

public String getRollNo() { return rollNo ;}

public int getMarks() {return marks ;}

public void display( )
{
super.display();
System.out.println("Roll # : " + rollNo + "\nMarks : " + marks) ;
}
}

-------------------------------------------------------------------
public class Runner
{
public static void main(String []args)
```

```
{
student s = new student ("Ahmed", "s-09", 123, "sp16-bcs-98",50);
s.display();
} }
```

Output

```
Name : Ahmed

ID : s-09

Phone : 123

Roll # : sp16-bcs-98

Marks : 50
```

Activity 2:

This example demonstrates another scenario of inheritance. The super class can be extended by more than one class.

```
public class Employee {

protected String name;
protected String phone;
protected String address;
protected int allowance;

public Employee(String name, String phone, String address, int
allowance)
{
this.name = name; this.phone = phone; this.address = address;
this.allowance = allowance;
}
}
--------------------------------------------------------------------
public class Regular extends Employee
{
private int basicPay;
public Regular(String name, String phone, String address, int
allowance, int basicPay)
{
super(name, phone, address, allowance);
this.basicPay = basicPay;
}

public void Display(){
System.out.println("Name: " + name + "Phone Number: " + phone
+"Address: " + address + "Allowance:  " + allowance + "Basic Pay:  "
+ basicPay);
}
}
----------------------------------------------------------------------
public class Adhoc extends Employee
{
private int numberOfWorkingDays; private int wage;

public Adhoc(String   name, String     phone,     String     address,
int   allowance, int numberOfWorkingDays, int wage)
{
super(name, phone, address, allowance);
this.numberOfWorkingDays = numberOfWorkingDays;
this.wage = wage;
}

public void Display()
{
System.out.println("Name: " + name + "Phone Number: " + phone
+"Address: " + address +   "Allowance:     "    +   allowance   +
"Number    Of   Working   Days: " + numberOfWorkingDays + "Wage: " +
wage);
}
}
----------------------------------------------------------------------
public class Runner
```

```
{
public static void main(String []args){
Regular regularObj = new
Regular("Ahmed","090078601","Islamabad",15000,60000);
regularObj.Display();
Adhoc adhocObj = new
Adhoc("Ali","03333333333","Rawalpindi",500,23,1500);
adhocObj.Display();
}
}
```

Output

```
Name: Ahmed Phone Number: 090078601 Address: Islamabad
Allowance:  15000Basic Pay:  60000

Name: Ali Phone Number: 03333333333 Address: Rawalpindi
Allowance:      500 Number Of Working Days: 23 Wage: 1500
```

3) Graded Lab Tasks(Allocated Time 2 Hr 10 Min.)

Note: The instructor can design graded lab activities according to the level of difficulty and complexity of the solved lab activities. The lab tasks assigned by the instructor should be evaluated in the same lab.

Lab Task 1

(The Person, Student, Employee, Faculty, and Staff classes)
Design a class named Person and its two subclasses named Student and Employee. Design two more classes; Faculty and Staff and extend them from Employee. The detail of classes is as under:

A person has a name, address, phone number, and email address.
A student has a status (String)
An employee has an office, salary, and date hired. Use the Date class to create an object for date hired.
A faculty member has office hours and a rank.
A staff member has a title.
Create display method in each class

Lab Task 2

Imagine a publishing company that markets both book and audio-cassette versions of its works. Create a class publication that stores the title and price of a publication. From this class derive two classes:
i. book, which adds a page count and
ii. tape, which adds a playing time in minutes.
Each of these three classes should have set() and get() functions and a display() function to display its data. Write a main() program to test the book and tape class by creating instances of them, asking the user to fill in their data and then displaying the data with display().

Lab Task 3

Write a base class Computer that contains data members of wordsize(in bits), memorysize (in megabytes), storagesize (in megabytes) and speed (in megahertz). Derive a Laptop class that is a kind of computer but also specifies the object's length, width, height, and weight. Member functions for both classes should include a default constructor, a constructor to inialize all components and a function to display data members.r.

Lab 07

Method Overriding and Abstract Classes

Objective:

The objective of this lab is to familiarize the students with various concepts and terminologies of method overriding and concept of abstract classes.

Activity Outcomes:

This lab teaches you the following topics:

- Method overriding where a base class method version is redefined in the child class with exact method signatures.
- Abstract classes along with the access of base class members.

Instructor Note:

As pre-lab activity, read Chapter 11 from the text book “Introduction to Java Programming”, Y. Daniel Liang, Pearson, 2019.

1) Useful Concepts

a. Method Overriding

The definition of an inherited method can be changed in the definition of a derived class so that it has a meaning in the derived class that is different from what it is in the base class. This is called overriding the definition of the inherited method.

For example, the methods toString and equals are overridden (redefined) in the definition of the derived class HourlyEmployee. They are also overridden in the class SalariedEmployee. To override a method definition, simply give the new definition of the method in the class definition, just as you would with a method that is added in the derived class.

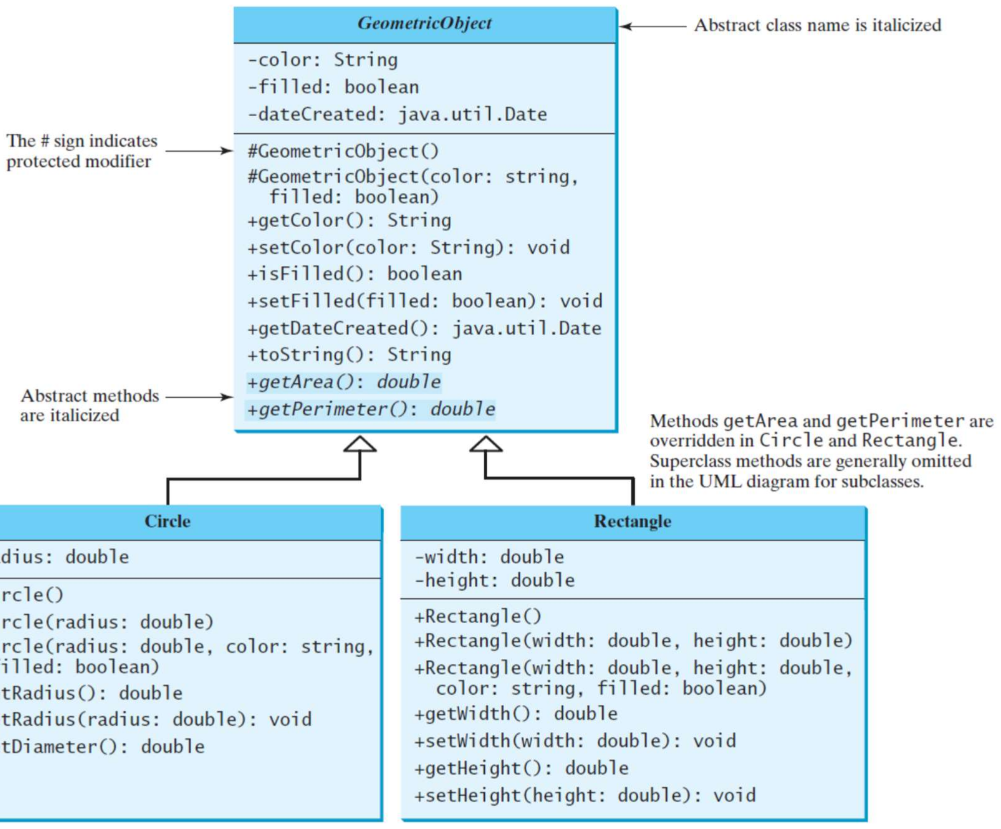
In a derived class, you can override (change) the definition of a method from the base class. As a general rule, when overriding a method definition, you may not change the type returned by the method, and you may not change a void method to a method that returns a value, nor a method that returns a value to a void method. The one exception to this rule is if the returned type is a class type, then you may change the returned type to that of any descendent class of the returned type. For example, if a function returns the type Employee, when you override the function definition in a derived class, you may change the returned type to HourlyEmployee, SalariedEmployee, or any other descendent class of the class Employee. This sort of changed return type is known as a covariant return type and is new in Java version 5.0; it was not allowed in earlier versions of Java.

b. Abstract Class

A class that has at least one abstract method is called an abstract class and, in Java, must have the modifier abstract added to the class heading. An abstract class can have any number of abstract methods. In addition, it can have, and typically does have, other regular (fully defined) methods. If a derived class of an abstract class does not give full definitions to all the abstract methods, or if the derived class adds an abstract method, then the derived class is also an abstract class and must include the modifier abstract in its heading.

In contrast with the term abstract class, a class with no abstract methods is called a concrete class.

```
public abstract class GeometricObject
{
private instanceVariables;
. . .
public abstract double getArea();
public abstract double getPerimeter();
. . .
}
```


GeometricObject
Abstract class name is italicized
-color: String
-filled: boolean
-dateCreated: java.util.Date
The # sign indicates protected modifier
#GeometricObject()
#GeometricObject(color: string, filled: boolean)
+getColor(): String
+setColor(color: String): void
+isFilled(): boolean
+setFilled(filled: boolean): void
+getDateCreated(): java.util.Date
+toString(): String
+getArea(): double
+getPerimeter(): double
Abstract methods are italicized
Methods getArea and getPerimeter are overridden in Circle and Rectangle. Superclass methods are generally omitted in the UML diagram for subclasses.
Circle
-radius: double
+Circle()
+Circle(radius: double)
+Circle(radius: double, color: string, filled: boolean)
+getRadius(): double
+setRadius(radius: double): void
+getDiameter(): double
Rectangle
-width: double
-height: double
+Rectangle()
+Rectangle(width: double, height: double)
+Rectangle(width: double, height: double, color: string, filled: boolean)
+getWidth(): double
+setWidth(width: double): void
+getHeight(): double
+setHeight(height: double): void

2) Solved Lab Activities (Allocated Time 1 Hr.)

Sr.No	*Allocated Time*	*Level of Complexity*	*CLO Mapping*
Activity 1	*10 mins*	*Medium*	*CLO-4*
Activity 2	*20 mins*	*Medium*	*CLO-4*
Activity 2	*20 mins*	*Medium*	*CLO-4*

Activity 1:

The following activity demonstrates the creation of overridden methods.

Solution:

```
class A
{
int i, j;

A(int a, int b) { i = a; j = b; }

// display i and j
void show() {
System.out.println("i and j: " + i + " " + j);
}
}
--------------------------------------------------------------------
class B extends A
{
int k;
B(int a, int b, int c) { super(a, b); k = c; }

// display k - this overrides show() in A
void show() {
System.out.println("k: " + k);
}
}
---------------------------------------------------------------------
Public class OverrideRunner
{
public static void main(String args[])
{
B subOb = new B(1, 2, 3); subOb.show(); // this calls show() in B
}}
```

Output

k: 3

Activity 2:

The following activity explains the use of overriding for customizing the method of super class. The classes below include a CommisionEmployee class that has attributes of firstname, lastName, SSN, grossSales, CommisionRate. It has a constructor to initialize, set and get functions, and a function to display data members.
The other class BasePlusCommisionEmployee is inherited from CommisionEmployee. It has additional attributes of Salary. It also has set and get functions and display function.
The Earning method is overridden in this example.

```
public class commissionEmployee
{
protected String FirstName; protected String LastName; protected
String SSN; protected double grossSales; protected double commonRate;

public commissionEmployee()
{
FirstName="Nagina"; LastName="Nazar"; SSN="S003";
grossSales=1234.1; commonRate=12.5;
}

public commissionEmployee (String a,String e,String b, double c,
double d){ FirstName=a;
LastName=e; SSN=b;
grossSales=c; commonRate=d;
}

public void setFN(String a){ FirstName=a;}
public void setLN(String e){ LastName=e;}
public void setSSN(String b){ SSN=b;}
public void setGS(double c){ grossSales=c;}
public void setCR(double d){ commonRate=d;}
public String getFN(){return FirstName;}
public String getSSN(){return SSN;}
public double getGS(){return grossSales;}
public double getCR(){return commonRate;}

public double earnings(){
return grossSales*commonRate;
}

public void display(){
System.out.println("first name:"+FirstName+"last name:"
+LastName+"SSN:"+SSN+" Gross Sale:"+grossSales+" and
commonRate:"+commonRate);
}
}
----------------------------------------------------------------------
public class BasePlusCommEmployee extends commissionEmployee
{
private double salary;

BasePlusCommEmployee(){ salary=48000; }

BasePlusCommEmployee(String A,String E,String B, double C, double D,
double S)
{
super(A,E,B,C,D);
salary=S;
}
//overridden method
public double earnings()
{
return super.earnings()+salary;
}

public void display(){
super.display();
System.out.println("Salary : "+salary);
}
```

```
}

Public class OverrideRunner
{
public static void main(String args[])
{
BasePlusCommEmployee b = new BasePlusCommEmployee("ali", "ahmed",
"25-kkn", 100, 5.2, 25000);
double earn = b.earnings();

System.out.println("Earning of employee is " + earn);
}
}
```

Output

```
Earning of employee is 25520.0
```

Activity 3:

A Simple demonstration of abstract.

```
public abstract class A {
abstract void callme();
// concrete methods are still allowed in abstract classes
void callmetoo() {
System.out.println("This is a concrete method.");
} }
--------------------------------------------------------------------
public  class B extends A {
void callme() {
System.out.println("B's implementation of callme.");
} }
--------------------------------------------------------------------
public class AbstractDemo {
public static void main(String[] args) {
B b = new B();
b.callme(); b.callmetoo(); } }
```

Output

```
B's implementation of Call me. This is a concrete method
```

Graded Lab Tasks(Allocated Time 2 Hr.)

Note: The instructor can design graded lab activities according to the level of difficulty and complexity of the solved lab activities. The lab tasks assigned by the instructor should be evaluated in the same lab.

Lab Task 1

Create a class named Movie that can be used with your video rental business. The Movie class should track the Motion Picture Association of America (MPAA) rating (e.g., Rated G, PG-13, R), ID Number, and movie title with appropriate accessor and mutator methods. Also create an equals() method that overrides Object 's equals() method, where two movies are equal if their ID number is identical. Next, create three additional classes named Action , Comedy , and Drama that are derived from Movie . Finally, create an overridden method named calcLateFees that takes as input the number of days a movie is late and returns the late fee for that movie. The default late fee is $2/day. Action movies have a late fee of $3/day, comedies are $2.50/day, and dramas are $2/day. Test your classes from a main method.

Lab Task 2

Write a program that declares two classes. The parent class is called Simple that has two data members num1 and num2 to store two numbers. It also has four member functions.

The add() function adds two numbers and displays the result. The sub() function subtracts two numbers and displays the result.
The mul() function multiplies two numbers and displays the result. The div() function divides two numbers and displays the result.

The child class is called VerifiedSimple that overrides all four functions. Each function in the child class checks the value of data members. It calls the corresponding member function in the parent class if the values are greater than 0. Otherwise it displays error message.

Lab Task 3

Create an abstract class that stores data about the shapes e.g. Number of Lines in a Shape, Pen Color, Fill Color and an abstract method draw. Implement the method draw for Circle, Square and Triangle subclasses, the better approach is to draw these figures on screen, if you can't then just use a display message in the draw function.