Session 03
Classes and Objects

(http://docs.oracle.com/javase/tutorial/java/javaOO/index.html)

Objectives

1-Programming Paradigms

2-OOP basic concepts

3-How to identify classes

4-How to declare/use a class

5-Common modifiers (a way to hide some members in a class)

6-Cotrolling access to members of a class using modifiers

7-Overriding methods in sub-classes

8-Nested classes

9-Benefits of OO implementation: inheritance, polymorphism

10-Working with interfaces

11-Working with Abstract methods and classes

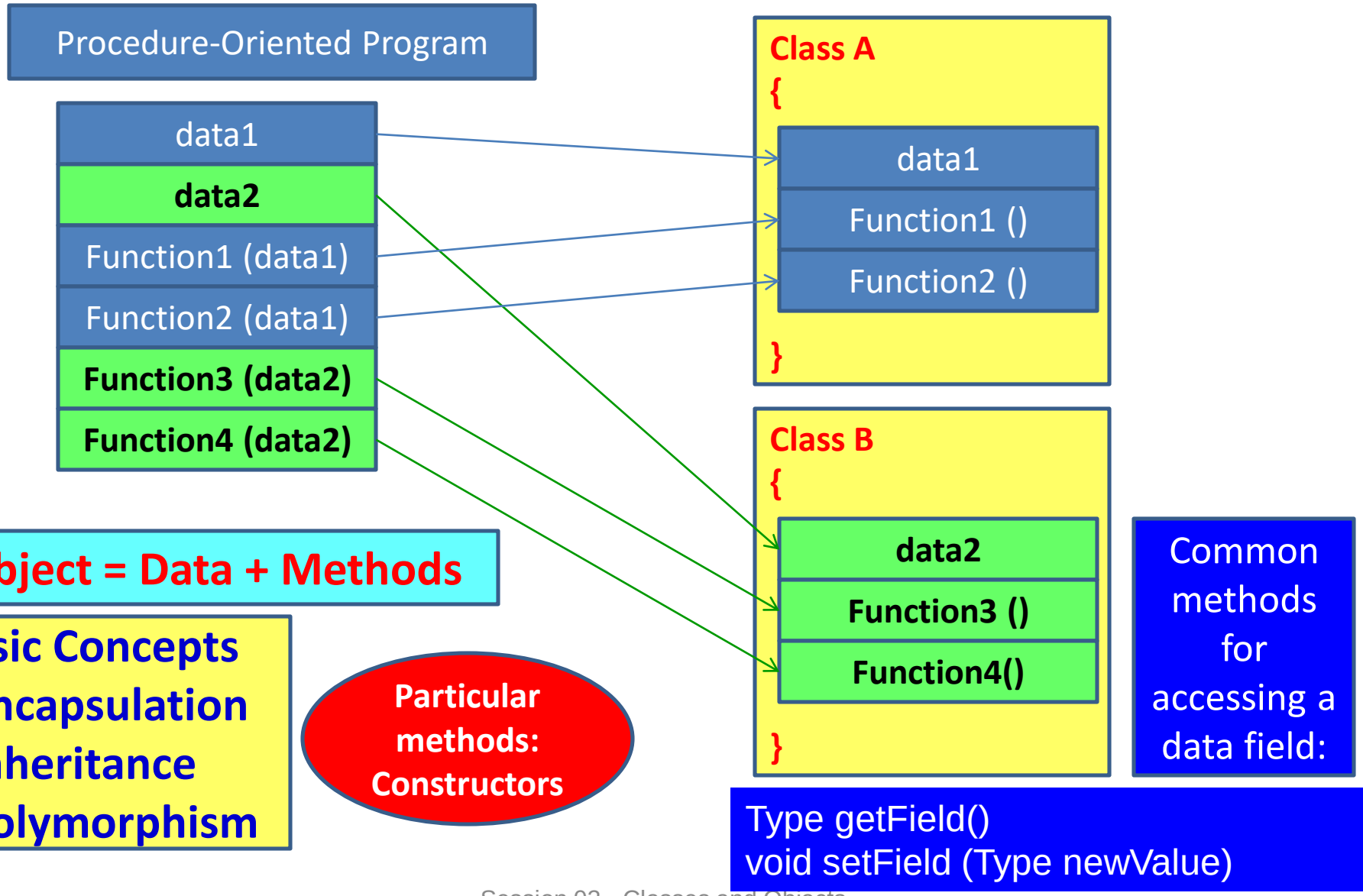
12-Enum type

Programming Paradigms

- High-level programming languages (from 3rd generation languages) are divided into (Wikipedia):

Paradigm	Description
Procedural-oriented (imperative) paradigm-POP (3rd generation language)	Program= data + algorithms. Each algorithm is implemented as a function (group of statements) and data are it's parameters (C-language)
Object-oriented paradigm (OOP) (3rd generation language)	Programs = actions of some objects. Object = data + behaviors. Each behavior is implemented as a method (C++, Java, C#,…)
Functional paradigm (4th generation language)	Domain-specific languages. Basic functions were implemented. Programs = a set of functions (SQL)
Declarative/Logic paradigm (5th generation language)	Program = declarations + inference rules (Prolog, CLISP, …)

Programming Paradigms: POP vs. OOP



OOP Concepts

- Enc**a**psulation
- Inh**e**ritance
- Polym**o**rphism

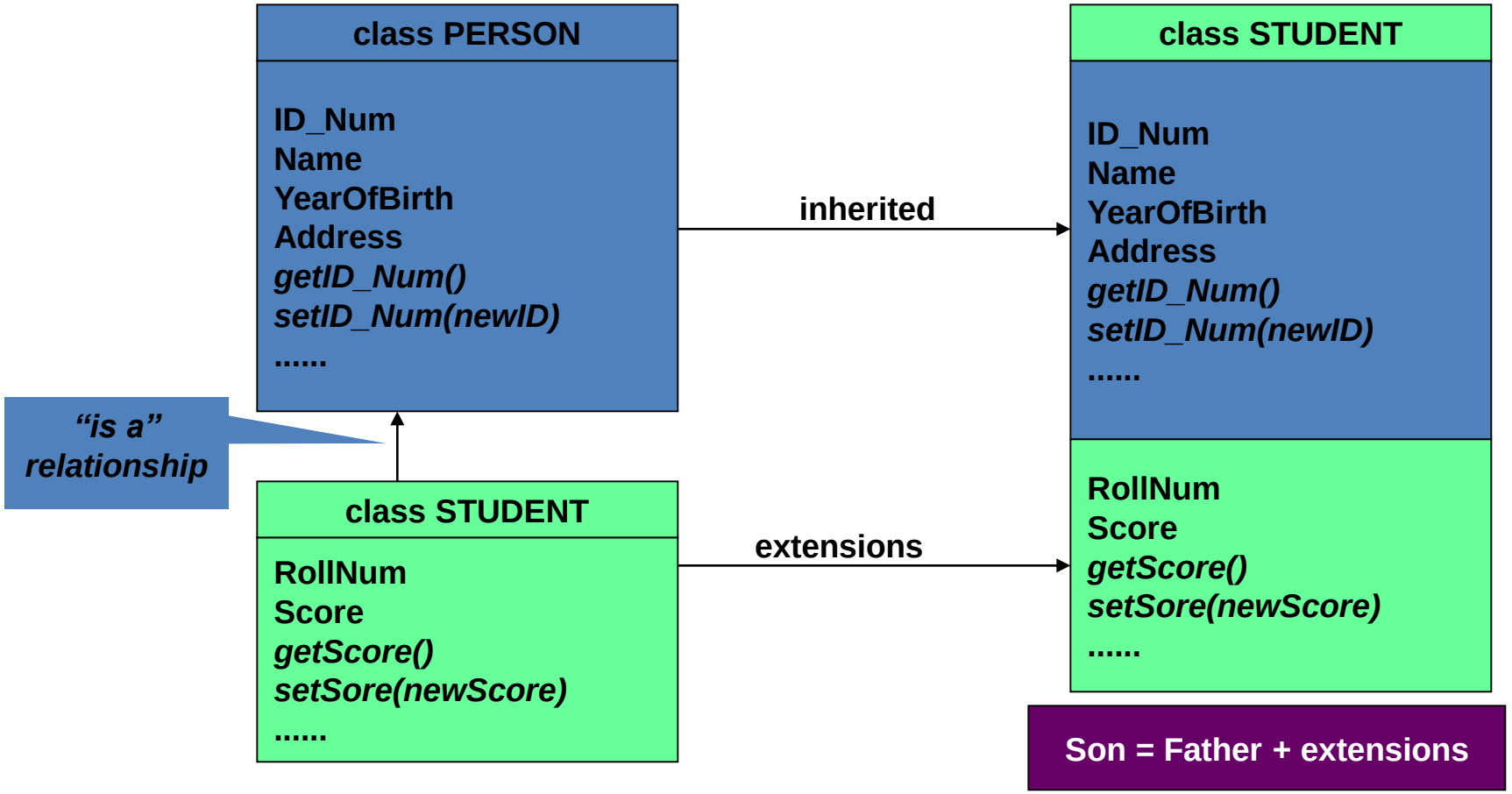
OOP Concepts: Encapsulation

Aggregation of data and behavior.

- Class = Data (fields/properties) + Methods
- Data of a class should be hidden from the outside.
- All behaviors should be accessed only via methods.
- A method should have a *boundary condition:* Parameters must be checked (use if statement) in order to assure that data of an object are always valid.
- **Constructor**: A special method it's code will execute when an object of this class is initialized.

OOP Concepts: Inheritance - 1

Ability allows a class having members of an existed class ➔ Re-used code, save time

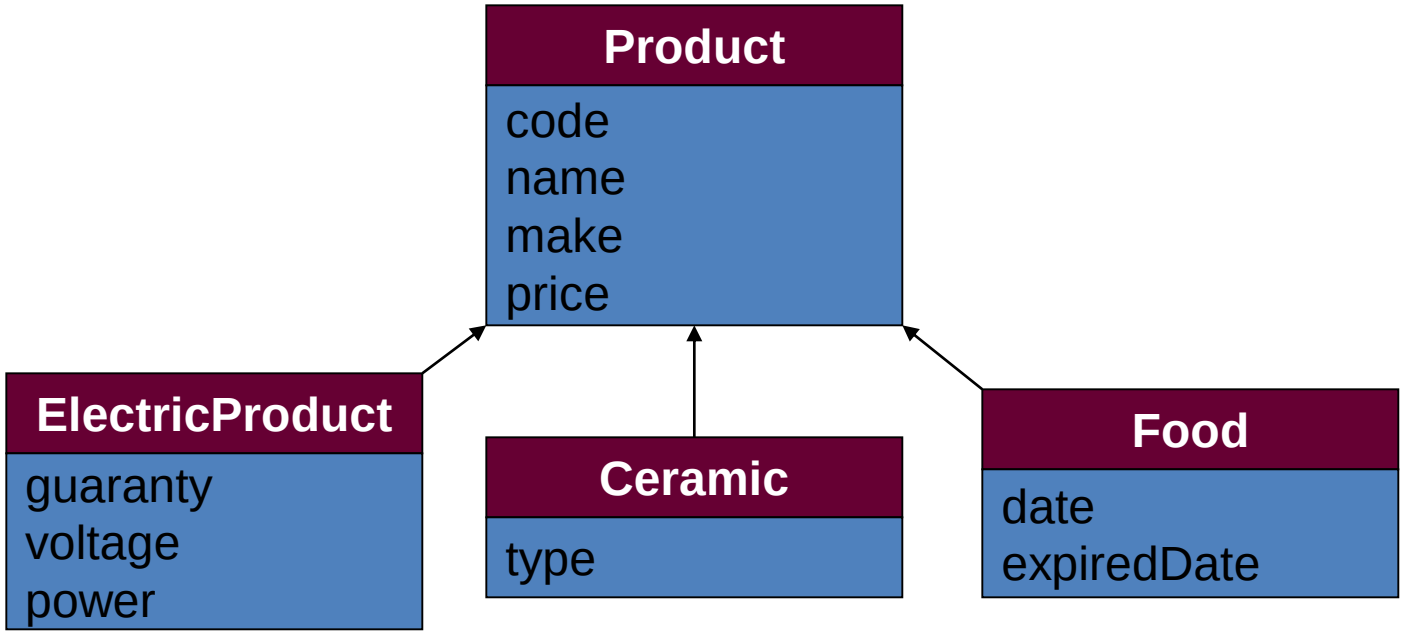


OOP Concepts: Inheritance - 2

How to detect father class?

Finding the intersection of concerned classes.

- Electric Products< code, name, make, price, guaranty, voltage, power>
- Ceramic Products < code, name, make, price, type >
- Food Products < code, name, make, price , date, expiredDate >



OOP Concepts: Polymorphism

Ability allows many versions of a method based on overloading and overriding methods techniques.

Overloading: A class can have some methods which have the same name but their parameter types are different.

Overriding: A method in father class can be overridden in it's derived classes (body of a method can be replaced in derived classes).

How to Identity a Class

- Main noun: Class
- Nouns as modifiers of main noun: Fields
- Verbs related to main noun: Methods

Vehicle has attributes of manufacturer, manufacture year, cost, color
Write a Java program that will allow **input** a Vehicle, **output** its.

```
class Vehicle {
    String manufacturer;
    int manufacture year;
    double cost;
    String color;
    Vehicle input() {
        <code>
    }
    void output() {
        <code>
    }
}
```

Declaring/Using a Java Class

```
[public] class ClassName [extends FatherClass] {
    [modifier] Type field1 [= value];
    [modifier] Type field2 [= value];
    // constructor
    [modifier] ClassName (Type var1,…) {
        <code>
    }
    [modifier] methodName (Type var1,…) {
        <code>
    }
    …….
}
```

Modifiers will be introduced later.

How many constructors should be implemented? ➔ Number of needed ways to initialize an object.

What should we will write in constructor's body? ➔ They usually are codes for initializing values to descriptive variables

Defining Constructors

- Constructors that are invoked to create objects from the class blueprint.
- Constructor declarations look like method declarations—except that they use the **name of the class** and have **no return type**.
- The compiler automatically provides a no-argument, default constructor for any class without constructors.

Defining Methods

- Typical method declaration:

```
[modifier] ReturnType methodName (params) {
  <code>
}
```

- Signature: data help identifying something
- Method Signature:

  name + order of parameter types

Passing Arguments a Constructor/Method

- Java uses the mechanism passing by value. Arguments can be:
  - Primitive Data Type Arguments
  - Reference Data Type Arguments (objects)

Vehicle Management System

- Code a class named **Car**, **Motor**, **Truck** are directly derived from base class **Vehicle** object.

```
public class Vehicle { //super class
    private String manufacturer;
    private int year;
    private double cost;
    private String color;
    public Vehicle(){}
    public Vehicle(String manufacturer, int
  year,double cost, String color){
        this.manufacturer=manufacturer;
        this.year=year;
        this.cost=cost;
        this.color=color;
    }
```

```
public String getManufacturer() {
        return manufacturer;}
    public void setManufacturer(String
  manufacturer) {
        this.manufacturer = manufacturer;}
    public int getYear() {
        return year;}
    public void setYear(int year) {
        this.year = year;}
    public double getCost() {
        return cost;}
    public void setCost(double cost) {
        this.cost = cost;}
```

```
public String getColor() {
        return color;
    }
    public void setColor(String color) {
        this.color = color;
    }
    public String toString(){
        return
  manufacturer+"\t"+year+"\t"+cost+"\t"+colo
  r;
    }
}
```

Creating Objects

- Class provides the blueprint for objects; you create an object from a class.
  - `Point p = new Point(23, 94);`
- Statement has three parts:
  - **Declaration**: are all variable declarations that associate a variable name with an object type.
  - **Instantiation**: The new keyword is a Java operator that creates the object (memory is allocated).
  - **Initialization**: The new operator is followed by a call to a constructor, which initializes the new object (values are assigned to fields).

Type of Constructors
Create/Use an object of a class

- ***Default constructor***: Constructor with no parameter.
- ***Parametric constructor***: Constructor with at least one parameter.
- **Create an object**

  ClassName obj1=new ClassName();

  ClassName obj2=new ClassName(params);
- **Accessing a field of the object**

  object.field
- **Calling a method of an object**

  object.method(params)

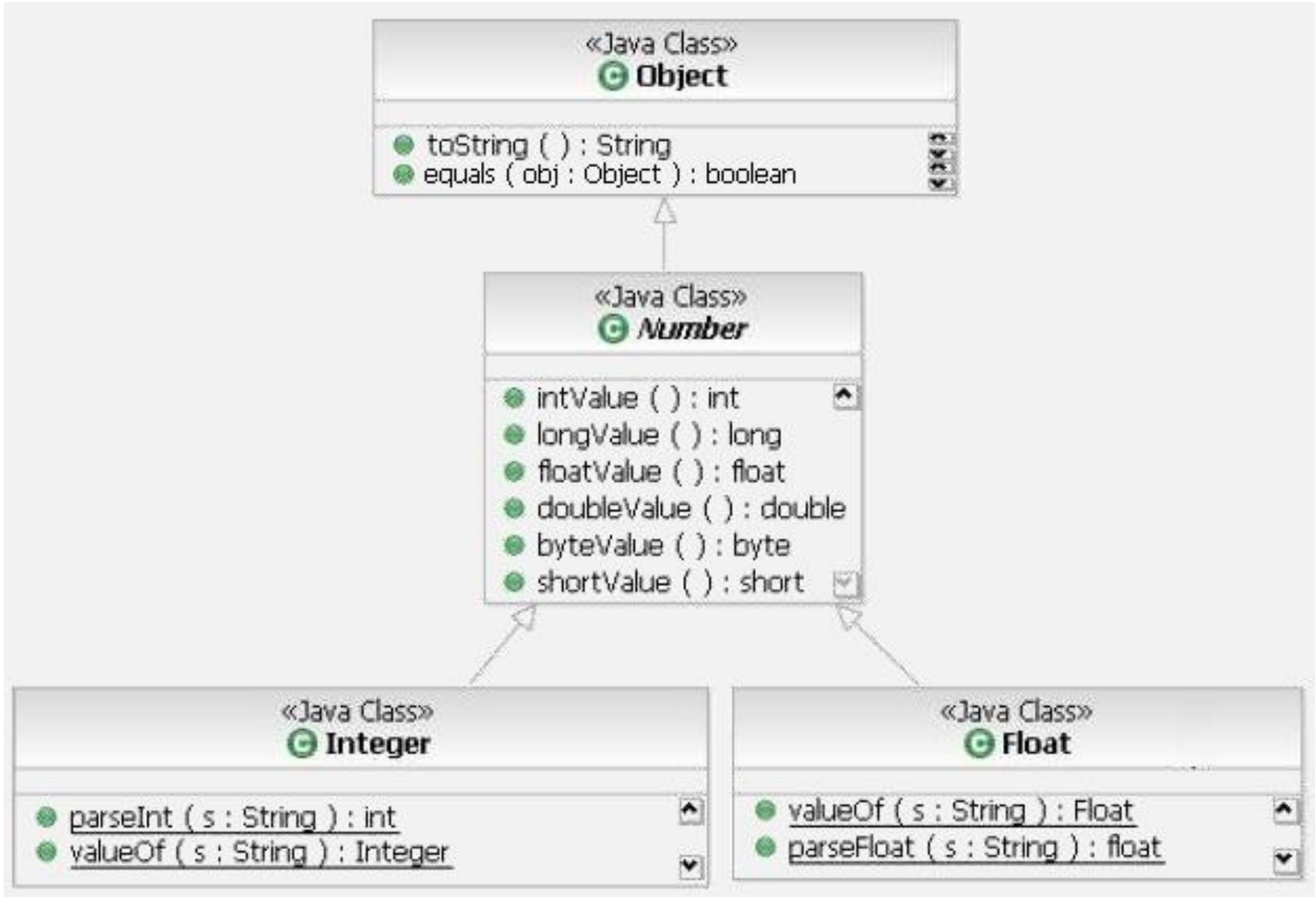
Notes about Constructors

- If we do not implement any constructor, compiler will insert to the class a system default constructor.
- If we implement **a** constructor, compiler does **not** insert default constructor.

Object class

- The **java.lang.Object** class is the root of the class hierarchy. Every class has Object as a superclass. All objects, including arrays, implement the methods of this class.
- **Class constructors: Object()** This is the Single Constructor.

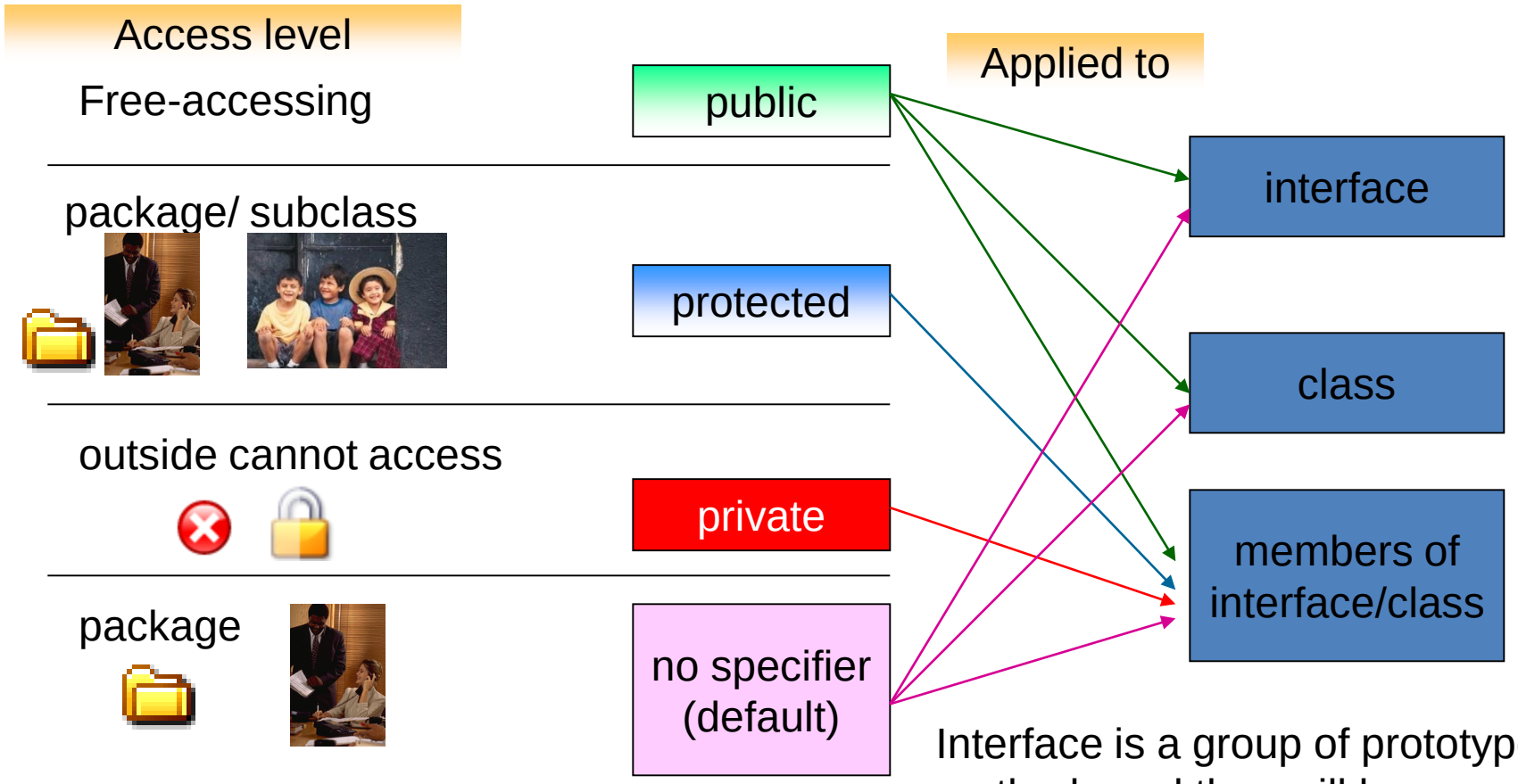
- String **toString()** This method returns a string representation of the object.
- boolean **equals**(Object obj) This method indicates whether some other object is "equal to" this one.
- int **hashCode()** This method returns a hash code value for the object.
- Class **getClass()** This method returns the runtime class of this Object.


«Java Class»
Object
toString ( ) : String
equals (obj : Object) : boolean
«Java Class»
Number
intValue ( ) : int
longValue ( ) : long
floatValue ( ) : float
doubleValue ( ) : double
byteValue ( ) : byte
shortValue ( ) : short
«Java Class»
Integer
parseInt (s : String) : int
valueOf (s : String) : Integer
«Java Class»
Float
valueOf (s : String) : Float
parseFloat (s : String) : float

Common Modifiers - 1

- Modifier (linguistics) is a word which can bring out the meaning of other word (adjective →noun, adverb → verb)
- Modifiers (OOP) are keywords that give the compiler information about the nature of code (methods), data, classes.
- Java supports some modifiers in which some of them are common and they are called as **access modifiers** (public, protected, default, private).
- Common modifiers will impose level of accessing on
  - class (where it can be used?)
  - methods (whether they can be called or not)
  - fields (whether they may be read/written or not)

Common Modifiers - 2



Order:
public > protected > default > private

Interface is a group of prototyped methods and they will be implemented in a class afterward. It will be introduced later.

Access Level

Modifier	Class	Same Package	Subclass-Outside package	World
private	Y	N	N	N
No (default)	Y	Y	N	N
protected	Y	Y	Y	N
public	Y	Y	Y	Y

Tips on Choosing an Access Level

- Use the most restrictive access level that makes sense for a particular member. Use private unless you have a good reason not to.
- Avoid public fields except for constants. Public fields tend to link you to a particular implementation and limit your flexibility in changing your code.

Overloading Method

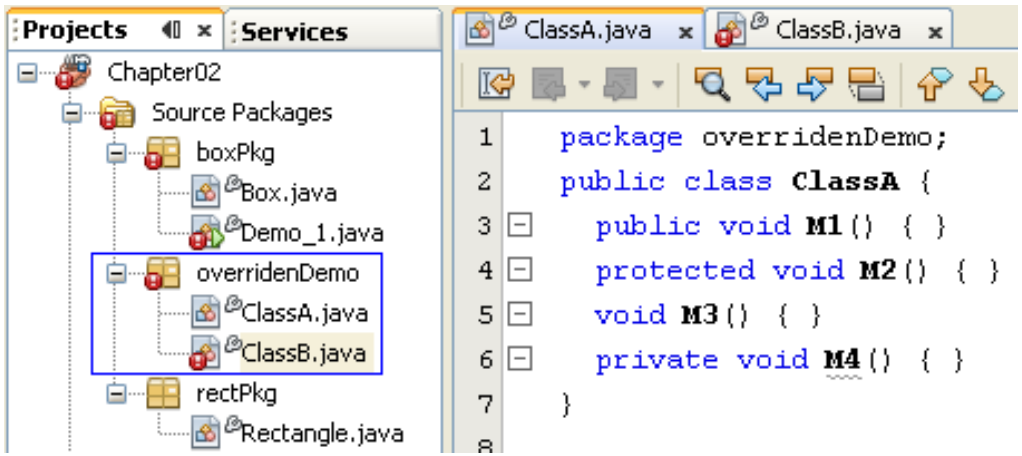
```
/* Overloading methods Demo. */
public class Box {
   int length=0;
   int width=0;
   int depth=0;
   // Overloading constructors
   public Box(){
   }
   public Box(int l){
       length = l>0? l: 0; // safe state
   }
   public Box(int l, int w){
       length = l>0? l: 0; // safe state
       width = w>0? w: 0;
   }
   public Box(int l, int w, int d){
       length = l>0? l: 0; // safe state
       width = w>0? w: 0;
       depth = d>0? d: 0;
   }
   // Overloading methods
   public void setEdge (int l,int w){
       length = l>0? l: 0; // safe state
       width = w>0? w: 0;
   }
   public void setEdge (int l,int w,int d){
       length = l>0? l: 0; // safe state
       width = w>0? w: 0;
       depth = d>0? d: 0;
   }
   public void output(){
      String S= "[" + length + "," + width
                + "," + depth + "]";
      System.out.println(S);
   }
}
```

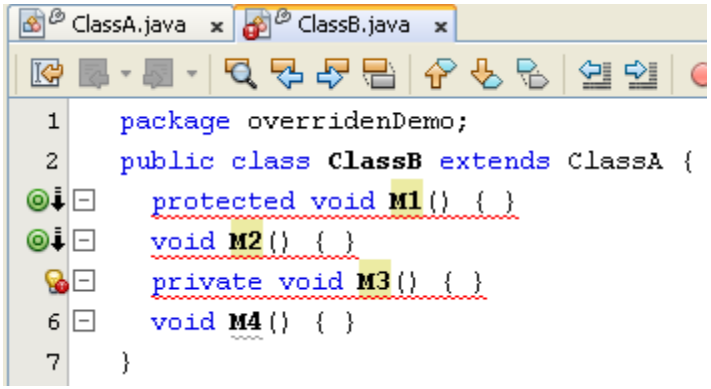
```
/* Use the class Box */
public class BoxUse {
   public static void main(String[] args){
       Box b= new Box();
       b.output();
       b.setEdge(7,3);
       b.output();
       b.setEdge(90,100,75);
       b.output();
   }
}
```

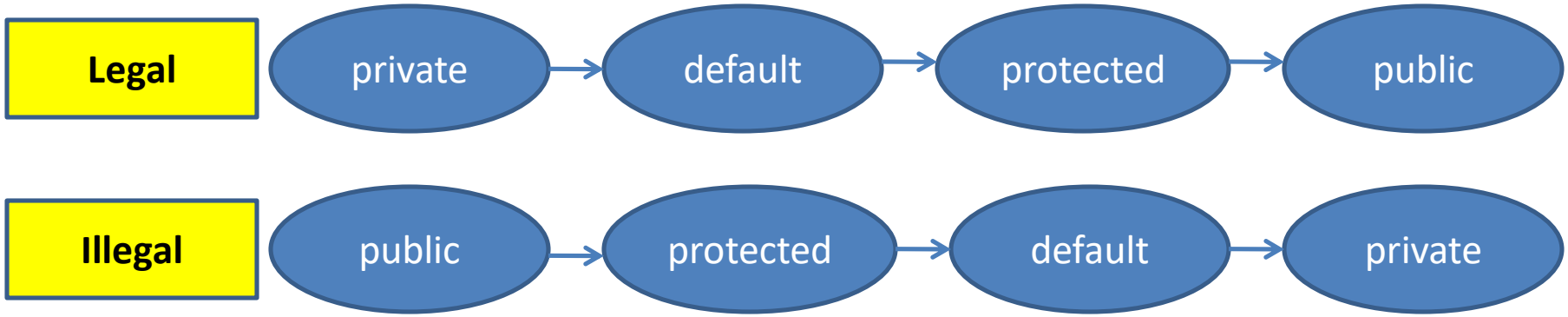
Output - FirstPrj (run)

```
run:
[0,0,0]
[7,3,0]
[90,100,75]
```

Access Modifier Overridden







The sub-class must be more opened than it's father

Modifier *final*

- Final class: Class can not have sub-class
- Final data is a constant.
- Final method: a method can not be overridden.

OtherModifierDemo.java *

```
1
2   public class OtherModifierDemo extends java.lang.Math {
3   }
```

```
2   public class OtherModifierDemo{
3       final public int MAXN = 5;
4       public static void main(String[] args)
5       { OtherModifierDemo obj= new OtherModifierDemo();
6         obj.MAXN = 1000;
7         final int N=7;
8         N=10;
9       }
10  }
```

```
1   class A{
2     final void M() { System.out.println("MA");
3   }
4   class B extends A {
5     void M() { System.out.println("MB");
6   }
7   public class FinalMethodDemo {
8
9   }
```

Modifier *static*
Class variable/ Object variable

- Object variable: Variable of each object
- Class Variable: A variable is shared in all objects of class. It is stored separately. It is declared with the modifier ***static***
- Class variable is stored separately. So, it can be accessed as:

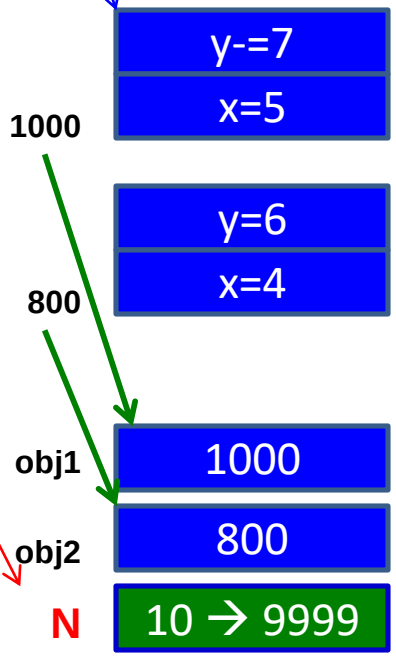
  object.staticVar

  ClassName.staticVar

Modifier *static*: Class variable/ Object variable

```
public class StaticVarDemo {
    static int N=10; // class variable
    int x, y; // object variable
    public StaticVarDemo(int xx, int yy){
        x= xx; y=yy;
    }
    public void setN( int nn){
        N= nn;
    }
    public void output(){
      System.out.println(N + "," + x + "," + y);
    }
}
```

```
public class StaticVarDemoUse {
    public static void main(String args[]){
        StaticVarDemo obj1= new StaticVarDemo(5,7);
        StaticVarDemo obj2= new StaticVarDemo(4,6);
        obj1.output();
        obj2.output();
        obj1.setN(9999);
        obj1.output();
        obj2.output();
        System.out.println(StaticVarDemo.N);
    }
}
```




```
Output - FirstPrj (run)
run:
10,5,7
10,4,6
9999,5,7
9999,4,6
9999
```

Modifier *static*: static code – Free Floating Block

```
public class StaticCodeDemo {
    public static int N=10;
    int x=5, y=7;
    static {
        System.out.println("Static code:" + N);
    }
    int sum(){
        return x+y;
    }
    static {
        System.out.println("Static code: Hello");
    }
}
```

All static code run only one time when the first time the class containing them is accesses

```
public class StaticCodeDemoUse {
    public static void main(String args[]){
        System.out.println(StaticCodeDemo.N);
        StaticCodeDemo obj= new StaticCodeDemo();
        System.out.println(obj.sum());
    }
}
```

The second access

```
Output - FirstPrj (run)
run:
Static code:10
Static code: Hello
10
12
```

Modifier *static*: Static method

- It is called as class method/global method and it is called although no object of this class is created.
- Entry point of Java program is a static method
- Syntax for calling it: ClassName.staticMethod(args)
- ***Static methods***:
  - can access class variables and class methods directly **only**.
  - ***cannot*** access instance variables or instance methods directly—they must use an object reference.
  - cannot use the this keyword as there is no instance for this to refer to

What should be static in a class?

- Constants:
  - The static modifier, in combination with the final modifier, is also used to define constants. The final modifier indicates that the value of this field cannot change.

  static final double PI = 3.141592653589793;

Methods with Arbitrary Number of Arguments

A group is treated as an array
group.length →number of elements
group[i]: The element at the position i

```
1   public class ArbitraryDemo {
2       public double sum(double... group){
3           double S=0;
4           for (double x: group) S+=x;
5           return S;
6       }
7       public String concate(String... group){
8           String S="";
9           for (String x: group) S+=x + " ";
10          return S;
11      }
12      public static void main(String[] args){
13          ArbitraryDemo obj= new ArbitraryDemo();
14          double total= obj.sum(5.4, 3.2, 9.08, 4);
15          System.out.println(total);
16          String line = obj.concate("I", "love", "you", "!");
17          System.out.println(line);
18      }
19  }
```

```
Output - FirstPrj (run)
run:
21.68
I love you !
```

Exanple: a vehicle

```
public class SingleVehicle {
    public Vehicle input(){
        Vehicle v;
        String manufacturer;
        int year;
        double cost;
        String color;
        Scanner in=new Scanner(System.in);
        System.out.print("Manufacturer:");
        manufacturer=in.nextLine();
        System.out.print("Manufacture
  year:");
```

```
year=Integer.parseInt(in.nextLine());
System.out.print("Cost:");
cost=Double.parseDouble(in.nextLine());
System.out.print("Color:");
color=in.nextLine();
v=new Vehicle(manufacturer, year, cost,
  color);
return v;
    }
public void output(Vehicle v){
        System.out.println(v.toString());
    }}
```

Example: Array of vehicles

```
public class ArrayVehicle {
    public Vehicle[] input(int n){
        Vehicle[] v=new Vehicle[n];
        String manufacturer;
        int year;
        double cost;
        String color;
        Scanner in=new Scanner(System.in);
        for(int i=0;i<n;i++){
          System.out.print("Manufacturer:");
          manufacturer=in.nextLine();
```

```
System.out.print("Manufacture year:");
year=Integer.parseInt(in.nextLine());
System.out.print("Cost:");
cost=Double.parseDouble(in.nextLine());
System.out.print("Color:");
color=in.nextLine();
v[i]=new Vehicle(manufacturer, year, cost,
  color);}
return v;    }
public void output(Vehicle[] v){
  System.out.println("Manufacturer  Year   Cost
  Color");
        for(int i=0;i<v.length;i++)
          System.out.println(v[i].toString());
    }}
```

Simple Uses of Inner Classes

- **Inner classes** are classes defined within other classes
  - The class that includes the inner class is called the **outer class**
  - There is no particular location where the definition of the inner class (or classes) must be place within the outer class
  - Placing it first or last, however, will guarantee that it is easy to find

Simple Uses of Inner Classes

- An inner class definition is a member of the outer class in the same way that the instance variables and methods of the outer class are members
  - An inner class is local to the outer class definition
  - The name of an inner class may be reused for something else outside the outer class definition
  - If the inner class is private, then the inner class cannot be accessed by name outside the definition of the outer class

Inner/Outer Classes

```
public class Outer
{
        private class Inner
        {
                // inner class instance variables
                // inner class methods

        } // end of inner class definition

        // outer class instance variables
        // outer class methods
}
```

Simple Uses of Inner Classes

- There are two main advantages to inner classes
  - They can make the outer class more self-contained since they are defined inside a class
  - Both of their methods have access to each other's private methods and instance variables
- Using an inner class as a helping class is one of the most useful applications of inner classes
  - If used as a helping class, an inner class should be marked private

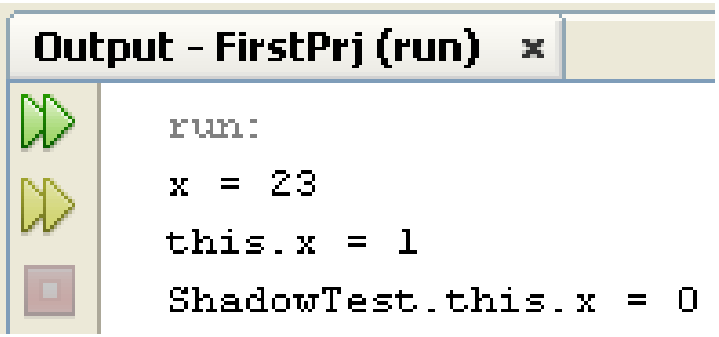
Shadowing (1)

- Declaration of a type in a particular scope has the same name as another declaration in the enclosing scope, then the declaration ***shadows*** the declaration of the enclosing scope.

Shadowing Variable (2)

```
public class ShadowTest {
    public int x = 0;
    class FirstLevel {
        public int x = 1; // shadowing

        void methodInFirstLevel(int x) {
            System.out.println("x = " + x);
            System.out.println("this.x = " + this.x);
            System.out.println("ShadowTest.this.x = " + ShadowTest.this.x);
        }
    }
    public static void main(String... args) {
        ShadowTest st = new ShadowTest();
        ShadowTest.FirstLevel fl = st.new FirstLevel();
        fl.methodInFirstLevel(23);
    }
}
```



Mechanism: Local data is treated first

Implementing Object-Oriented Relationships

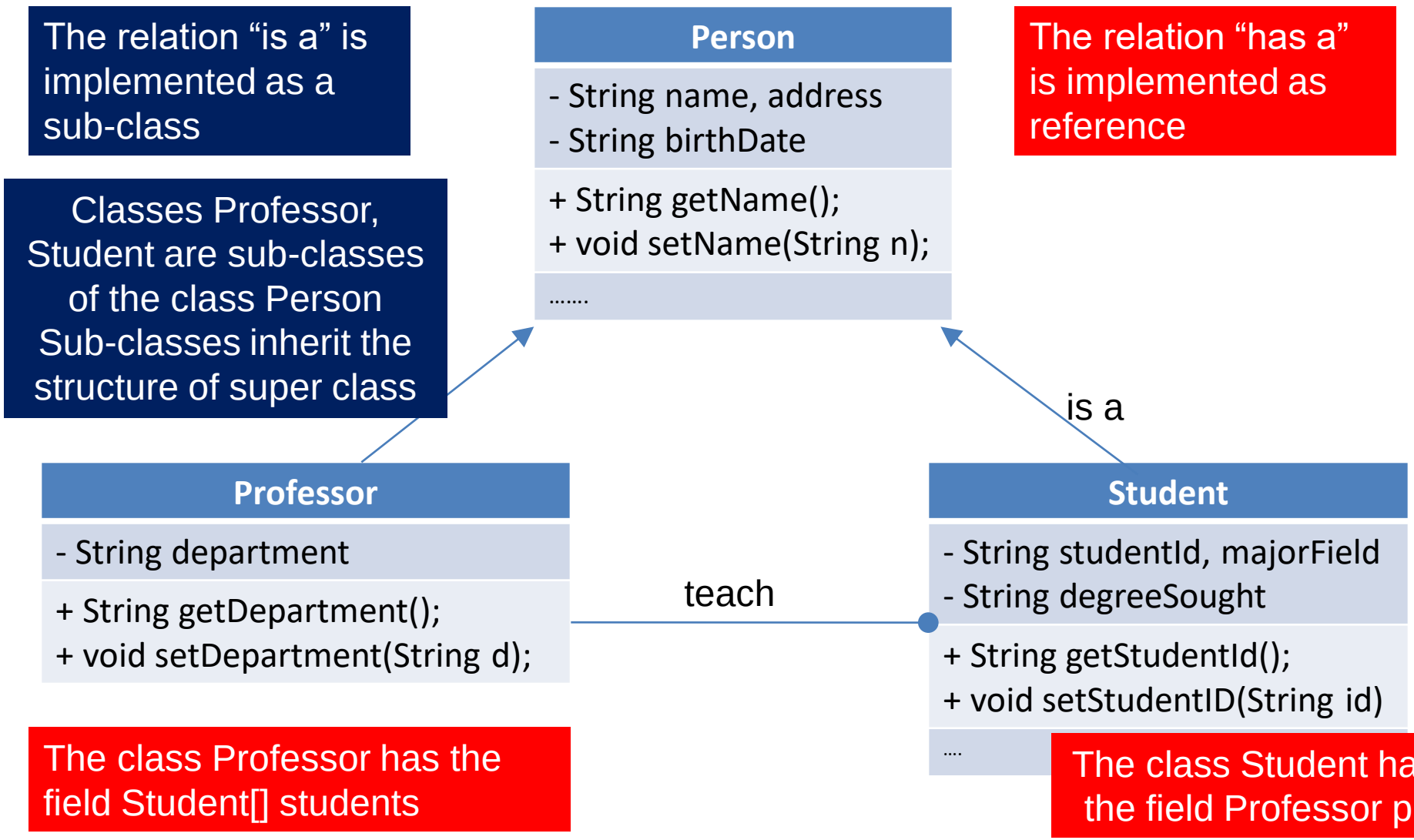
- 3 common relations in classes:
  - “is a/ a kind of”
  - “has a”
  - association
- Examples:
  - Student **is a** person
  - “A home is a house that **has a** family and a pet.”
  - A Professor has some students and a professor can be contained in one Student

Implementing Object-Oriented Relationships…

The relation “is a” is implemented as a sub-class

The relation “has a” is implemented as reference

Classes Professor, Student are sub-classes of the class Person
Sub-classes inherit the structure of super class



The class Professor has the field Student[] students

The class Student has the field Professor pr

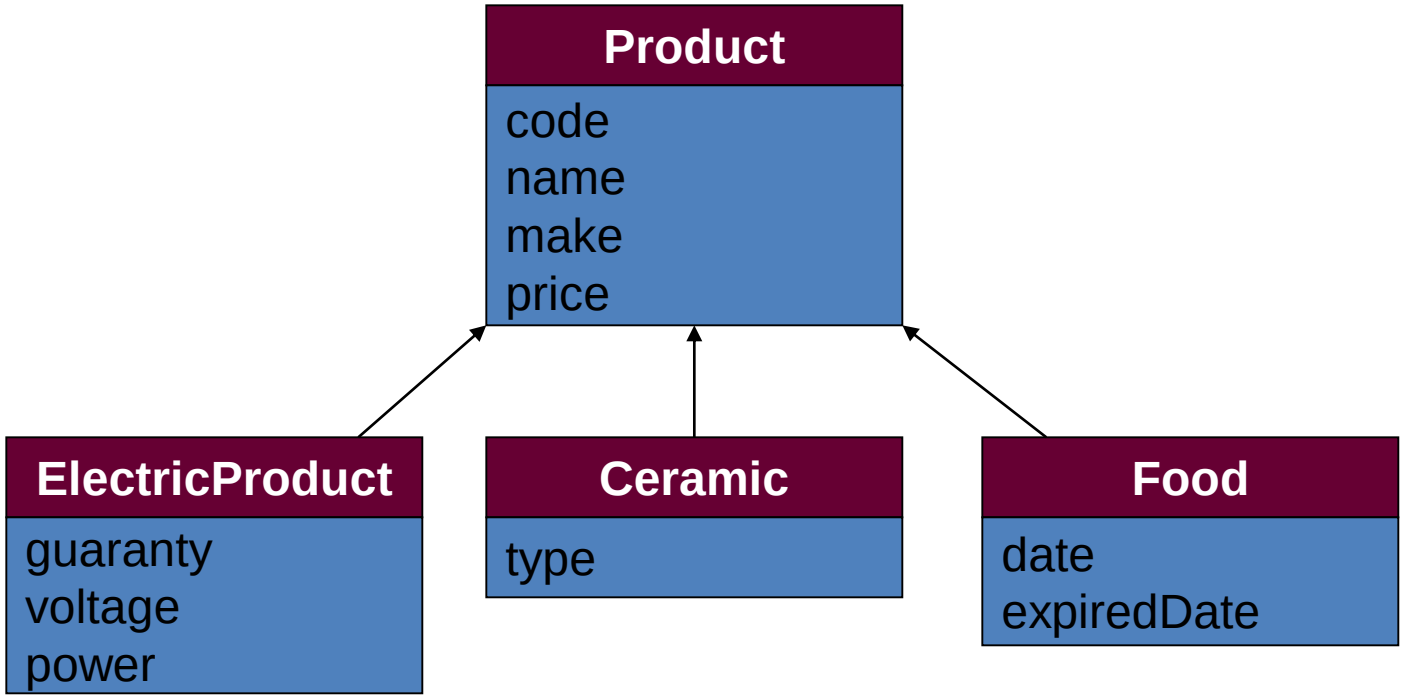
Inheritance

- There are some sub-classes from **one** super class ➔ An inheritance is a relationship where objects **share a common structure**: the structure of one object is a sub-structure of another object.
- The **extends** keyword is used to create sub-class.
- A class can be directly derived from **only one** class (Java is a **single-inherited** OOP language).
- If a class does not have any super class, then it is implicitly derived from Object class.
- Unlike other members, constructor **cannot be inherited** (constructor of super class can not initialize sub-class objects)

Inheritance…

- **How to construct a class hierarchy? → Intersection**

- Electric Products< code, name, make, price, guaranty, voltage, power>
- Ceramic Products < code, name, make, price, type >
- Food Products < code, name, make, price , date, expiredDate >



Inheritance…: “super” Keyword

- Constructors Are **Not** Inherited
- super(...) for Constructor Reuse
  - super(arguments); *//invoke a super class constructor*
  - The call ***must*** **be the *first* statement in the subclass constructor**
- Replacing the Default Parameterless Constructor

Inheritance…: “super” Keyword

- We use the Java keyword super as the qualifier for a method call:
  super. methodName(arguments);
- Whenever we wish to invoke the version of method methodName that was defined by our superclass.
- **super()** is used to access the superclass's constructor. And It must be the first statement in the constructor of the subclass.

Inheritance…

```
1   public class Rectangle {
2        private int length = 0;
3        private int width = 0;
4       // Overloading constructors
5       public Rectangle() // Default constructor
6       {    }
7       public Rectangle(int l, int w)
8       {  length = l>0? l: 0;    width= w>0? w: 0;
9       }
10      // Overriding the toString method of the java.lang.Object class
        public String toString()
12      {  return "[" + getLength() + "," + getWidth() + "]}";
13      }
14      // Getters, Setters
15       public int getLength() { return length;  }
16       public void setLength(int length) { this.length = length;  }
17       public int getWidth() {  return width;  }
18       public void setWidth(int width) { this.width = width;  }
19       public int area() {  return length*width;    }
20  }
```

Inheritance…

```
1   public class Box extends Rectangle {
2     private int height=0; // additional data
3     public Box()   {  super(); }
4     public Box (int l, int w, int h)
5     {  super(l, w); // Try swapping these statements
6        height = h>0? h: 0;
7     }
8     // Additional Getter, Setter
9     public int getHeight() { return height; }
10    public void setHeight(int height)
11          {  this.height = height; }
12    // Overriding methods
      public String toString()
14    { return "[" + getLength() + "," +
15          getWidth() + "," + getHeight() + "]";
16    }
      public int area(){
18        int l = this.getLength();
19        int w = this.getWidth();
20        int h = this.getHeight();
21        return 2*(l*w + w*h + h*l);
22    }
23    // additional method
24    public int volumn(){
25        return this.getLength()*this.getWidth()*height;
26    }
27  }
```

```
1   public class Demo_1 {
2     public static void main  (String[] args)
3     {  Rectangle r= new Rectangle(2,5);
4        System.out.println("Rectangle: " + r.toString());
5        System.out.println("   Area: " + r.area());
6        Box b= new Box(2,2,2);
7        System.out.println("Box " + b.toString());
8        System.out.println("  Area: " + b.area());
9        System.out.println("  Volumn: " + b.volumn());
10    }
11  }
```

Output - Chapter06 (run)

```
run:
Rectangle: [2,5]}
   Area: 10
Box [2,2,2]
  Area: 24
  Volumn: 8
BUILD SUCCESSFUL (total time: 0 seconds)
```

```
public class Point {
    private int x,y;
    public Point(int x,int y){
        this.x=x;  this.y=y;}
    …..//getter & setter }
public class Polygon {
    protected Point d1, d2, d3, d4;
    public void setD1(Point d1) {this.d1=d1;}
    public Point getD1(){return d1;}
    @Override
    public String toString(){
      return
  d1.getX()+"\t"+d1.getY()+"\t"+d2.getX()+"\t"+d2.ge
  tY()+
  "\t"+d3.getX()+"\t"+d3.getY()+"\t"+d4.getX()+"\t"+
  d4.getY(); }}
```

```
public class  Square extends Polygon{
  public Square(){
     d1 = new Point(0,0); d2 = new Point(0,1);
     d3 = new Point (1,0);d4 = new Point(1,1);
    }
}
public class Main {
    public static void main(String args[]){
        Square sq = new Square();
        System.out.println(sq.toString());
    }
}
```

```
public class Person {
    private String name;
    private String bithday;
    public Person() {
    }  // getter & setter }
public class Employee extends Person {
    private double salary;
    public double getSalary() { return salary; }
    public void setSalary(double salary){
        this.salary = salary;    }
    @Override
    public String toString() {
 //return name + "\t" + birthday + "\t" + salary;
      return super.getName() + "\t" +
  super.getBithday() + "\t" + salary;
    }}
```

```
public class Main {
    public static void main(String
  args[]){
        Employee e = new Employee();
        e.setName("To Ngoc Van");
        e.setBithday("3/4/1994");
        e.setSalary(4.4);
  System.out.println(e.toString());
    }
}
```

Output???

```
1. public class Polygon {
     protected Point d1, d2, d3, d4;
     public Polygon() {
      System.out.println("Polygon class");
     }……}
2. public class Square extends Polygon{
   public Square(){
      System.out.println("Square class");
     }}
3. public class Main {
     public static void main(String args[]){
         Square hv = new Square();
     }}
```

```
1. public class Polygon {
     protected Point d1, d2, d3, d4;
     //no constructor
     ……}
2. public class Square extends Polygon{
   public Square(){
      System.out.println(“Square class");
     }}
3. public class Main {
     public static void main(String args[]){
         Square hv = new Square();
     }}
```

Why Error???

Overriding and Hiding Methods (1)

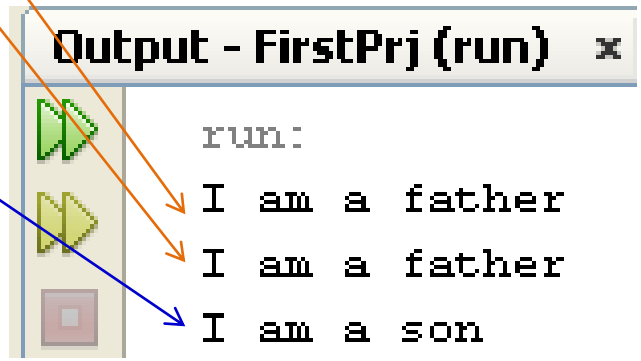
- **Overriding a method**: An instance method in a subclass with the same signature (name, plus the number and the type of its parameters) and return type as an instance method in the superclass overrides the superclass's method.
  - Use the **@Override** annotation that instructs the compiler that you intend to override a method in the superclass (you may not use it because overriding is default in Java).
- **Hiding a method**: Re-implementing a static method implemented in super class

Overriding and Hiding Methods (2)

```
class Father1 {
    public static void m(){
        System.out.println("I am a father");
    }
}
class Son1 extends Father1{
    public static void m(){
        System.out.println("I am a son");
    }
}
public class HidingMethodDemo {
    public static void main(String args[]){
        Father1 obj= new Father1();
        obj.m();
        obj= new Son1();
        obj.m();
        Son1 obj2= new Son1();
        obj2.m();

    }
}
```

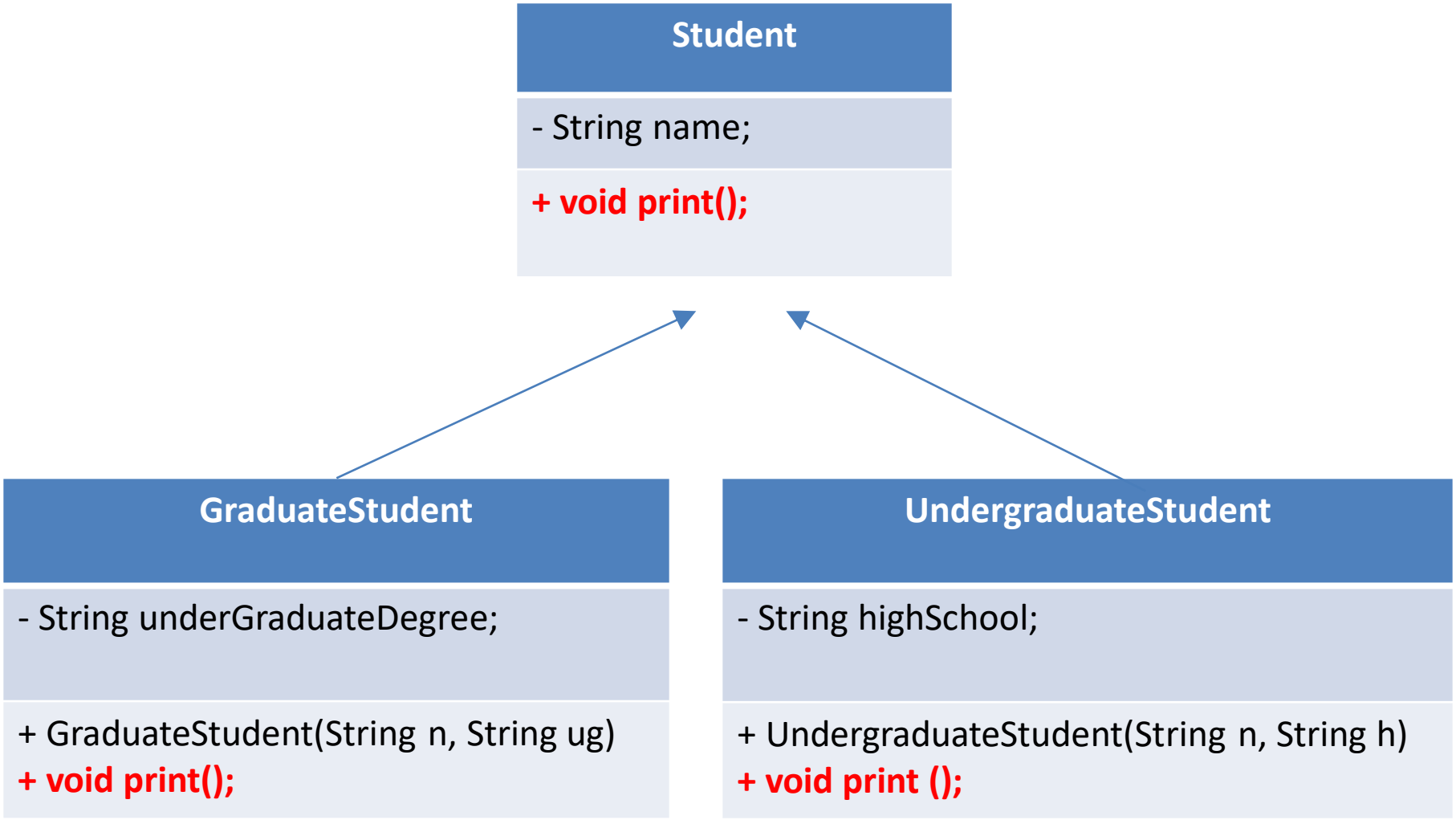
Hiding



Polymorphism

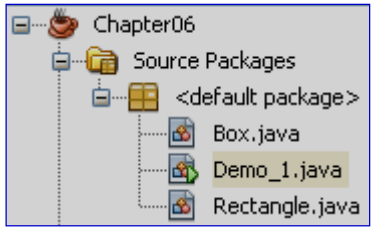
- The ability of two or more objects belonging to ***different*** classes to respond to exactly the ***same*** message (method call) in different class-specific ways**.**
- ***Inheritance combined with overriding facilitates polymorphism*****.**

Polymorphism…



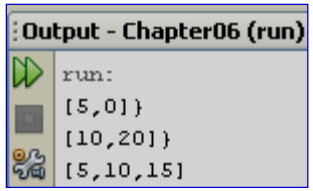
Overriding Inherited Methods

Overridden method: An inherited method is re-written




```
1   public class Box extends Rectangle {
2     int height=0;
3     public void set (int l, int w, int h)
4     {  super.setValue(l, w);
5        height = h>0? h: 0;
6     }
7     // Overriding the toString method
8     // of the Rectangle class
9     public String toString()
10    { return "[" + length + "," + width +
11                 "," + height + "]";
12    }
13  }
```

```
1   public class Rectangle {
2      protected int length=0, width=0;
3      // Overloading methods
4      public void setValue(int l)
5      {  length = l>0?l:0; }
6      public void setValue(int l, int w)
7      {  length = l>0? l: 0;
8         width= w>0? w: 0;
9      }
10     // Overriding the toString method of the java.lang.Object class
11     public String toString()
12     {  return "[" + length + "," + width + "]}";
13     }
14  }
15
```

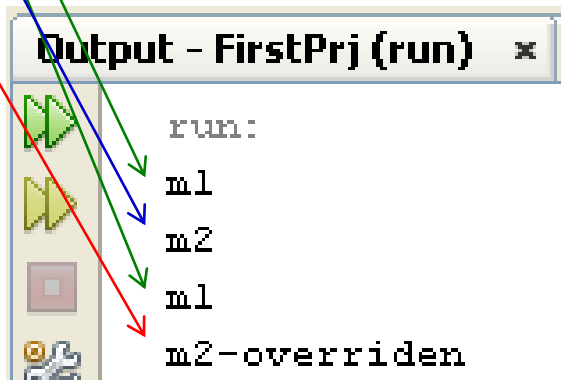



```
public class Demo_1 {
  public static void main  (String[] args)
  {  Rectangle r= new Rectangle();
     r.setValue(5);
     System.out.println(r.toString());
     r.setValue(10,20);
     System.out.println(r.toString());
     Box b= new Box();
     b.set(5,10,15);
     System.out.println(b.toString());
  }
}
```

Overloaded methods: Methods have the same name but their parameters are different in a class

How Can Overridden Method be Determined?

```
class Father{
    int x=0;
    void m1() { System.out.println("m1");}
    void m2() { System.out.println("m2");}
}
class Son extends Father {
    int y=2;
    void m2() { System.out.println("m2-overriden");}
}
public class CallOverriddenMethod {
    public static void main(String[] args){
        Father obj= new Father();
        obj.m1();
        obj.m2();
        obj= new Son();
        obj.m1();
        obj.m2();
    }
}
```



Exampe

- Code a class named **Car**, **Motor**, **Truck** are directly derived from base class **Vehicle** object.

```
public class Car extends Vehicle {
    private String typeofEngine;
    private int seats;
    public Car(){
      super();
    }
```

```
public Car(String manufacturer, int
  year,double cost, String color, String
  typeofEngine, int seats){
    super(manufacturer, year, cost,color);
    this.typeofEngine=typeofEngine;
    this.seats=seats;
}
public String getTypeofEngine() {
   return typeofEngine;
}
public void setTypeofEngine(String
  typeofEngine) {
    this.typeofEngine = typeofEngine;
}
```

```
public int getSeats() {
        return seats;
    }
public void setSeats(int seats) {
        this.seats = seats;
    }
public String toString(){
        return
  super.toString()+"\t"+typeofEngine+"
  \t"+seats;
    }}
```

Example: Array of Car, Motor, Truck

```
public class ArrayVehicles {
    private Vehicle[] list;
    private int n;
    public ArrayVehicles(){
        n=0;
        list=new Vehicle[50];
    }
    public int getNumberofVehicle(){
        return n;
    }
```

```
private Vehicle input(){
        Vehicle v;
        String manufacturer;
        int year;  double cost;
        String color;
        Scanner in=new Scanner(System.in);
        System.out.print("Manufacturer:");
        manufacturer=in.nextLine();
        System.out.print("Manufacture year:");
        year=Integer.parseInt(in.nextLine());
        System.out.print("Cost:");
        cost=Double.parseDouble(in.nextLine());
        System.out.print("Color:");
        color=in.nextLine();
        v=new Vehicle(manufacturer, year, cost,
  color);
        return v;
    }
```

```
public void inputMotor(){
    double power;
    Vehicle v=input();
    Scanner in=new Scanner(System.in);
    System.out.print("Power:");
    power=in.nextDouble();
    list[n++]=new
  Motor(v.getManufacturer(),v.getYear(
  ),v.getCost(),v.getColor(), power);
     }
```

```
public void inputCar(){
   String typeofEngine;
   int seats;
   Vehicle v=input();
   Scanner in=new Scanner(System.in);
   System.out.print("Type of engine:");
   typeofEngine=in.nextLine();
   System.out.print("Number of Seats:");
   seats=in.nextInt();
   list[n++]=new
   Car(v.getManufacturer(),v.getYear(),
   v.getCost(),v.getColor(), typeofEngine,
   seats);
     }
```

```
public int getNumberofCar(){
    int count=0;
    for(int i=0;i<n;i++)
       if(list[i] instanceof Car)
          count++;
    return count; }
public int getNumberofMotor(){
    int count=0;
    for(int i=0;i<n;i++)
      if(list[i] instanceof Motor)
          count++;
    return count;
     }
```

```
public void output(){
  if(getNumberofCar()>0){
    System.out.println("List of Cars");
    System.out.println("Manufacturer  Year
  Cost    Color TypeofEngine
  NumberofSeats");
    for(int i=0;i<n;i++){
      if(list[i] instanceof Car)
  System.out.println(list[i].toString());
       }
  System.out.println("--------------------");
  System.out.println("Number of
  cars:"+getNumberofCar());
     }
```

```
if(getNumberofMotor()>0){
  System.out.println("List of Motors");
  System.out.println("Manufacturer  Year
  Cost    Color Power");
  for(int i=0;i<n;i++){
    if(list[i] instanceof Motor)
  System.out.println(list[i].toString());
        }
  System.out.println("--------------------");
       System.out.println("Number of
  motors:"+getNumberofMotor());
     }
```

```
if(getNumberofTruck()>0){
  System.out.println("List of Trucks");
  System.out.println("Manufacturer  Year
  Cost    Color Load");
  for(int i=0;i<n;i++){
    if(list[i] instanceof Truck)
  System.out.println(list[i].toString());
        }
  System.out.println("--------------------");
  System.out.println("Number of
  trucks:"+getNumberofTruck());
      }
    }
```

Menu

```
public class Main {
   public static void main(String[]
  args) {
      ArrayVehicles a=new
  ArrayVehicles();
      Scanner in=new
  Scanner(System.in);
```

```
while(true){
   System.out.print("\n 1. input a Car");
   System.out.print("\n 2. input a Motor");
   System.out.print("\n 3. input a Truck");
   System.out.print("\n 4. output");
   System.out.print("\n 0. Exit");
   System.out.print("\n Your choice(0->4):
   ");
   int choice;
   choice=in.nextInt();
   switch(choice){
    case 1:a.inputCar();
           break;
```

```
case 2:a.inputMotor();
          break;
   case 3:a.inputTruck();
         break;
   case 4:a.output();
          break;
   case 0:
      System.out.println("Bye!!!!");
      System.exit(0);
          break;
  default:System.out.println("only to
  choose (0->4)");
             }}}}
```

Interfaces

- An *interface* is a reference type, similar to a class, that can contain *only* **constants**, initialized fields, static methods, prototypes (abstract methods, default methods), static methods, and nested types.
- It will be the **core** of some classes
- Interfaces cannot be instantiated because they have **no-body** methods.
- Interfaces can only be *implemented* by classes or *extended* by other interfaces.

Interfaces…

```
1   public interface InterfaceDemo {
2       final int MAXN=100; // constant
3       int n=0; // Fields in interface must be initialized
4       static public int sqr(int x){ return x*x;}
5       public abstract void m1(); // abstract methods
6       abstract public void m2();
7       void m3(); // default methods
8       void m4();
9   }
10
11  class UseIt{
12      public static void main(String args[]){
13          InterfaceDemo obj= new InterfaceDemo();
14      }
15  }
```

Interfaces…

```
public interface InterfaceDemo {
    final int MAXN=100; // constant
    int n=0; // Fields in interface must be initialized
    static public int sqr(int x){ return x*x;}
    public abstract void m1(); // abstract methods
    abstract public void m2();
    void m3(); // default methods
    void m4();
}
class A implements InterfaceDemo{
    // overriding methods
    public void m1() { System.out.println("M1");}
    public void m2() { System.out.println("M2");}
    void m3() { System.out.println("M3");}
    void m4() { System.out.println("M4");}
}
```

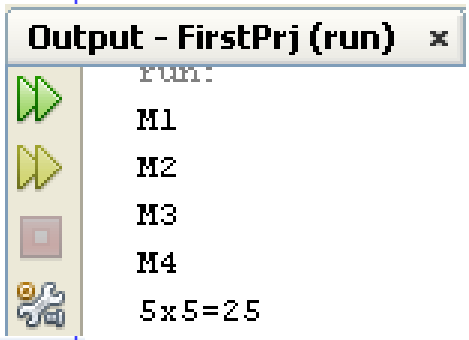
m3(), m4() in A cannot implement m3(), m4() in InterfaceDemo, attempting to assign weaker access privileges, were public

Default methods of an interface must be overridden as public methods in concrete classes.

```java
public interface InterfaceDemo {
    final int MAXN=100; // constant
    int n=0; // Fields in interface must be initialized
    static public int sqr(int x){ return x*x;}
    public abstract void m1(); // abstract methods
    abstract public void m2();
    void m3(); // default methods
    void m4();
}
```

```java
class A implements InterfaceDemo{
    // overriding methods
    public void m1() { System.out.println("M1");}
    public void m2() { System.out.println("M2");}
    public void m3() { System.out.println("M3");}
    public void m4() { System.out.println("M4");}
}
```

```java
class UseIt{
    public static void main(String args[]){
        InterfaceDemo obj= new A();
        obj.m1();
        obj.m2();
        obj.m3();
        obj.m4();
        int s= InterfaceDemo.sqr(5);
        System.out.println("5x5=" + s);
    }
}
```



Abstract Classes

- Used to define ***what*** **behaviors a class is required to perform without having to provide an explicit implementation.**
- **It is the result of so-high generalization**
- **Syntax to define a abstract class**
  - *public abstract class className{ ... }*
- It isn't necessary for all of the methods in an abstract class to be abstract.
- An abstract class can also declare implemented methods.

Abstract Classes…

```
1   package shapes;
2   public abstract class Shape {
3       abstract public double circumstance();
4       abstract public double area();
5   }
6   class Circle extends Shape {
7       double r;
8       public Circle (double rr) { r=rr; }
        public double circumstance() { return 2*Math.PI*r; }
        public double area() { return Math.PI*r*r; }
11  }
12  class Rect extends Shape {
13      double l,w;
14      public Rect(double ll, double ww){
15          l = ll; w = ww;
16      }
        public double circumstance() { return 2*(l+w); }
        public double area() { return l*w; }
19  }
20  class Program {
21      public static void main(String[] args) {
            Shape s = new Shape ();
23      }
24  }
```

```
20  class Program {
21      public static void main(String[] args) {
22          Shape s = new Circle(5);
23          System.out.println(s.area());
24      }
25  }
```

Modified

```
Output - Chapter06 (run)
run:
78.53981633974483
```

Abstract Classes…

```
1   public abstract class AbstractDemo2 {
2       void m1() // It is not abstract class
3       { System.out.println("m1");
4       }
5       void m2() // It is not abstract class
6       { // empty body
7       }
8       public static void main(String[] args)
9       {   AbstractDemo2 obj = new AbstractDemo2();
10      }
11  }
```

This class have no abstract method but it is declared as an abstract class. So, we can not initiate an object of this class.

Abstract Classes…

Error. Why?

```
1  public abstract class AbstractDemo2 {
2      void m1() // It is not abstract class
3      { System.out.println("m1");
4      }
5      abstract void m2();
6  }
   class Derived extends  AbstractDemo2
   {   public void m1() // override
9      { System.out.println("m1");
10     }
11     public static void main(String[] args)
12     {   Derived obj = new Derived();
13     }
14 }
```

Implementing Abstract Methods

- Derive a class from an abstract superclass, the subclass will inherit all of the superclass's features, all of ***abstract* methods** included**.**
- To replace an inherited abstract method with a concrete version, the subclass need merely override it.
- Abstract classes ***cannot be instantiated***

Abstract class	Interface
1) Abstract class can **have abstract and non-abstract** methods.	Interface can have **only abstract** methods. Since Java 8, it can have **default and static methods** also.
2) Abstract class **doesn't support multiple inheritance**.	Interface **supports multiple inheritance**.
3) Abstract class **can have final, non-final, static and non-static variables**.	Interface has **only static and final variables**.
4) Abstract class **can provide the implementation of interface**. 6) An **abstract class**can extend another Java class and implement multiple Java interfaces.	Interface **can't provide the implementation of abstract class**. An **interface** can extend another Java interface only.
7) An **abstract class**can be extended using keyword ?extends?.	An **interface class**can be implemented using keyword ?implements?.
8) A Java**abstract class**can have class members like private, protected, etc.	Members of a Java interface are public by default.

Type Casting in Inheritance

- You can cast an instance of a child class to its parent class. Casting an object of child class to a parent class is called **upcasting**.
- Casting an object of a parent class to its child class is called **downcasting**.
- `class Vehicle { String manufacturer; }`
- `class Car extends Vehicle {String typeofEngine; }`
- `public class TypeCastExample {`

```
public static void main(String[] args) {
    Vehicle v1 = new Vehicle();
    Vehicle v2 = new Car();//upcasting
    Car v3 = (Car) new Vehicle();//downcasting
    Car v4 = new Car(); } }
```

Enum Types

- An *enum type* is a special data type that enables for a variable to be a set of predefined constants.
- We use enum types any time you need to represent a fixed set of named-constants (uppercase).

New/ Java Enum

```
public enum Day {
    SUNDAY, MONDAY, TUESDAY, WEDNESDAY,
    THURSDAY, FRIDAY, SATURDAY;// ; can be missed
}
```

Enum Type simple example

```
enum Season { SPRING, SUMMER, AUTUMN, WINTER  }

class Main {
    static void fun(Season x)
     {switch(x)
        {case SPRING:  System.out.println("It is spring"); break;
         case SUMMER: System.out.println("It is summer"); break;
         case AUTUMN:  System.out.println("It is autumn"); break;
         case WINTER:  System.out.println("It is winter");
}
     }
    public static void main(String[] args) {
     Season x = Season.WINTER;  fun(x);

     for(Season y: Season.values()) {
        System.out.print(y + ": "); fun(y);
      }
     System.out.println();
    }
}
```

```
It is winter
SPRING: It is spring
SUMMER: It is summer
AUTUMN: It is autumn
WINTER: It is winter
```

Enum Type with parameter constructor

```
enum Season {
    SPRING(25, 11), SUMMER(32, 13), AUTUMN(23, 10), WINTER(10, 9);
    private final int avgTemp, dayLength;
    Season(int x, int y) {
       avgTemp = x; dayLength = y;
     }
   public void display() {
     System.out.println(this + " average temperature is " + avgTemp);
     System.out.println(this + " average day's length is " + dayLength);
  }
}

class Main {
    public static void main(String[] args) {
      Season x = Season.WINTER;
      x.display();
      System.out.println();
   }
}
```

```
WINTER average temperature is 10
WINTER average day's length is 9
```

Summary

- The class, how to declare fields, methods, and constructors.
- Hints for class design:
  - Main noun → Class
  - Descriptive nouns → Fields
  - Methods: Constructors, Getters, Setters, Normal methods
- Creating and using objects.
- Use the dot operator to access the object's instance variables and methods.

- Overriding methods in sub-classes
- Controlling Access to Members of a Class using modifiers
- Nested Classes
- Benefits of OO implementation: Inheriatance ans Polymorphism
- Working with Interfaces.
- Working with Abstract Methods and Classes.
- Enum Type