# BBM 102 – Introduction to Programming II

*Spring 2017*

## Abstract Classes and Interfaces

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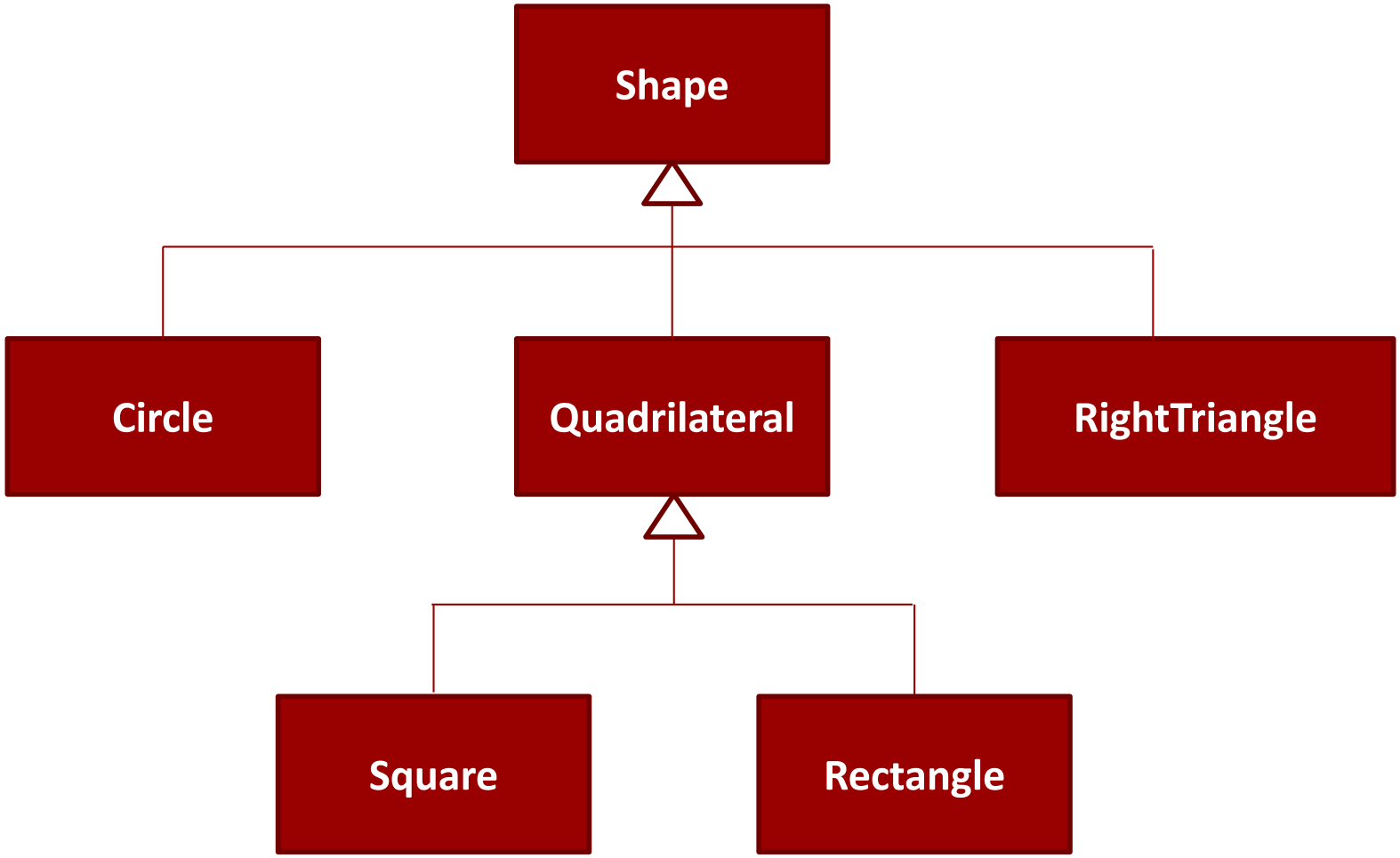
# Today

- Abstract Classes
  - Abstract methods
  - Polymorphism with abstract classes
  - Example project: Payroll System
- Interfaces
  - What is an Interface?
  - Defining an Interface
  - Implementing an Interface
  - Implementing Multiple Interfaces
  - Extending a Class and Implementing Interface(s)
  - Extending an Interface
  - Interfaces as Types
- Interfaces vs Abstract Classes

# Abstract Classes

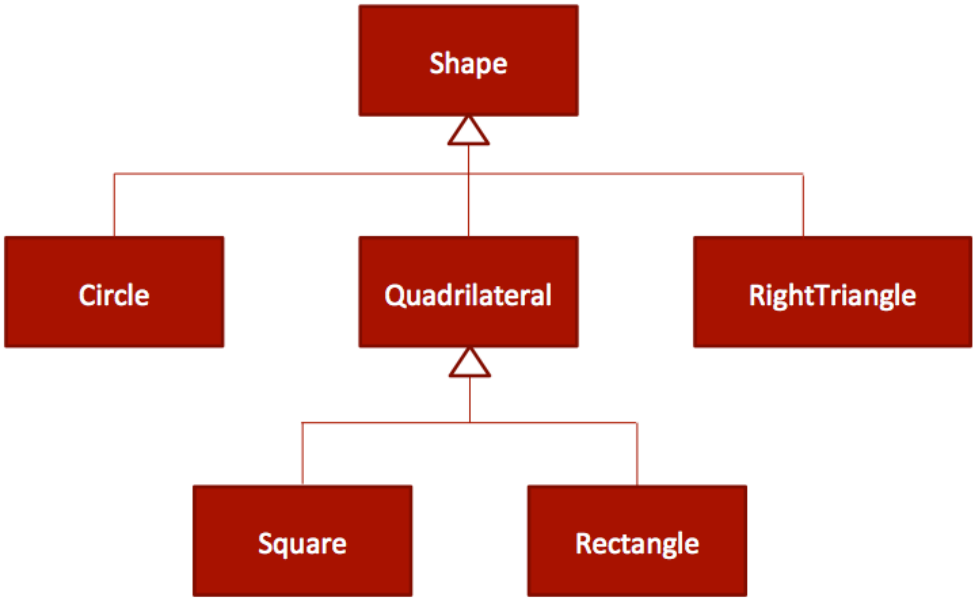
- An *abstract class* is a class that is declared **abstract**
- An *abstract class* may or may not include abstract methods.
- Abstract classes cannot be instantiated, but they can be subclassed.

# Abstract Classes: Revisiting the Shapes



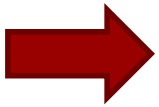
# Abstract Classes

- Shapes all have certain states (for example: position, orientation, line color, fill color) and behaviors (for example: moveTo, rotate, resize, draw) in common.
- Some of these states and behaviors are the same for all shapes (for example: position, fill color, and moveTo).
- Others require different implementations (for example, resize or draw).
- All Shapes must be able to draw or resize themselves; they just differ in how they do it.



# Abstract Classes

```
public class Shape {
        private String name;

        public Shape(String name) {
                this.name = name;
        }

        public String getName() {
                return name;
        }

        public void draw() {
                // what is the shape?
                // Code...?! Nothing!
        }
}
```



```
public abstract class Shape {
        private String name;

        public Shape(String name) {
                this.name = name;
        }

        public String getName() {
                return name;
        }

        public abstract void draw();
}
```

# Abstract Methods

- An *abstract method* is a method that is declared without an implementation
  - without braces, and followed by a semicolon, like this:

```
public abstract void draw();
```

- When an abstract class is subclassed, the subclass usually provides implementations for all of the abstract methods in its parent class.
  - However, if it does not, then the subclass must also be declared abstract.

# Abstract Classes

```
public class RightTriangle extends Shape {
	private int a;

	public RightTriangle(String name, int a) {
		super(name);
		this.a = a;
	}

	public int getA() {
		return a;
	}
	// override abstract method
	public void draw() {
		for (int line = 1; line <= a; line++) {
			for (int i = 0; i < line; i++) {
				System.out.print("*");
			}
			System.out.println();
		}
	}
}
```

# Abstract Classes

```
public abstract class Quadrilateral
                    extends Shape {

    public Quadrilateral(String name) {
        super(name);
    }

    // still nothing to draw!
    public abstract void draw();
}
```

```
public class Square extends Quadrilateral {
    private int a;

    public Square(String name, int a) {
        super(name);
        this.a = a;
    }
    public int getA() {
        return a;
    }

    // override abstract method
    public void draw() {
        for (int line = 0; line < a; line++) {
            for (int col = 0; col < a; col++) {
                System.out.print("*");
            }
            System.out.println();
        }
    }
}
```

# Abstract Classes

```
public class Program {

    public static void main(String[] args) {
        // compilation error!: "Cannot instantiate the type Shape"
        Shape shape = new Shape("Shape");

        // compilation error!: "Cannot instantiate the type Quadrilateral"
        Quadrilateral quadrilateral = new Quadrilateral("Quadrilateral");

        Square s = new Square("Square", 4);
        s.draw();

        Rectangle r = new Rectangle("Rectangle", 3, 7);
        r.draw();

        RightTriangle t = new RightTriangle("RightTriangle", 5);
        t.draw();
    }
}
```

# Abstract Classes

- Are part of the inheritance hierarchy

  **Circle extends Shape**

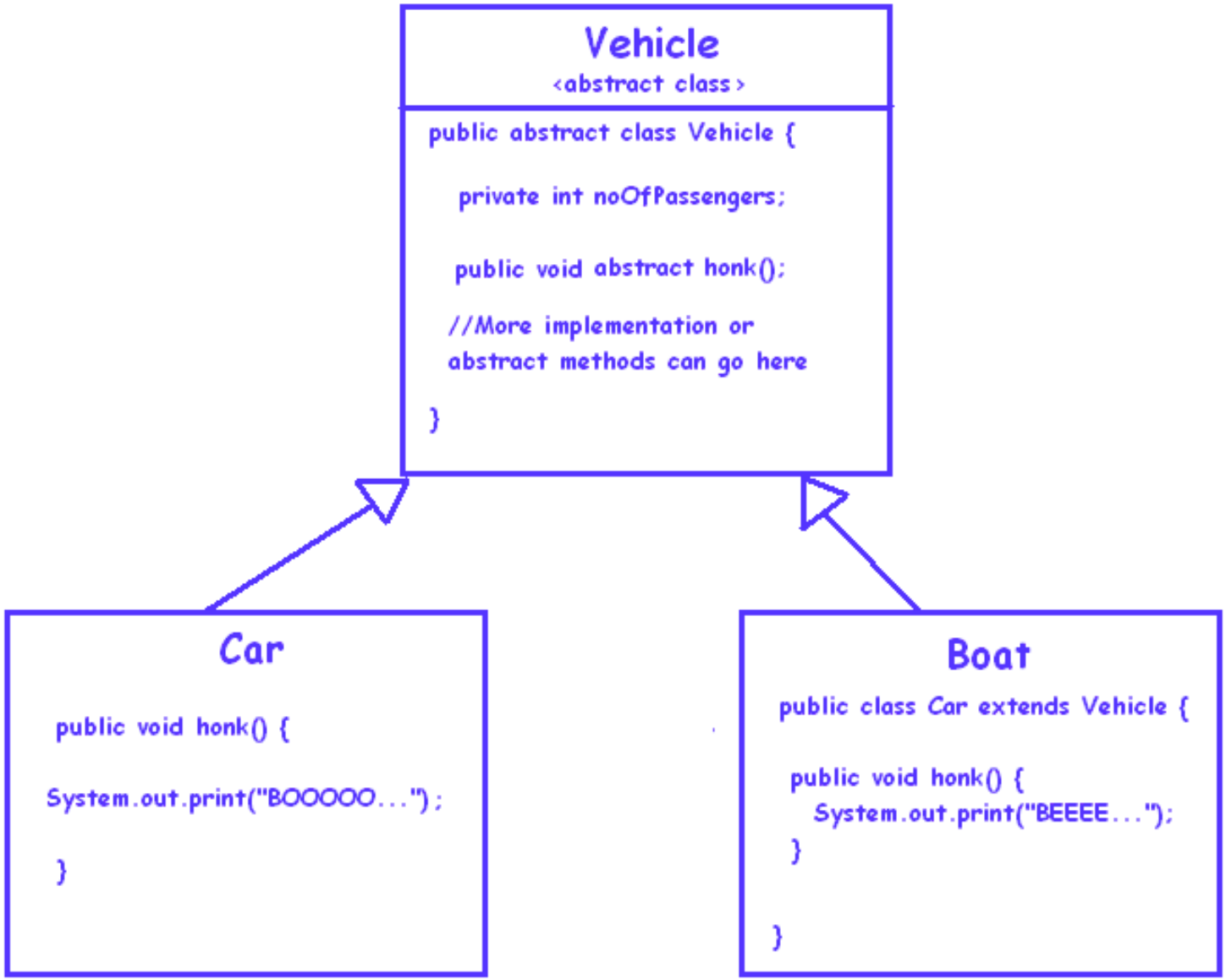
  **Square extends Quadrilateral**

- Can have constructor(s), but no objects of these classes can be created

  ```
  Shape shape = new Shape("Shape");
  // compilation error!: "Cannot instantiate the type Shape“
  ```

- Classes that can be used to instantiate objects are called **concrete classes**.

# Example-1


Vehicle
<abstract class>
public abstract class Vehicle {
private int noOfPassengers;
public void abstract honk();
//More implementation or
abstract methods can go here
}
Car
public void honk() {
System.out.print("BOOOOO...");
}
Boat
public class Car extends Vehicle {
public void honk() {
System.out.print("BEEEE...");
}
}

# Example-2

- Imagine there are several instruments, either stringed or wind.
- Design a class hierarchy for only two types of instruments, guitars and flutes.
- You have to design your model in a way that new instruments can be added in the hierarchy later on.
- Imagine there is only one feature for each instrument at the moment, which is the play feature.

# Example-2

Abstract class

```
public abstract class Instrument {

    protected String name;
    abstract public void play();
}
```

Still abstract

```
abstract class StringedInstrument extends Instrument {
    protected int numberOfStrings;
}
```

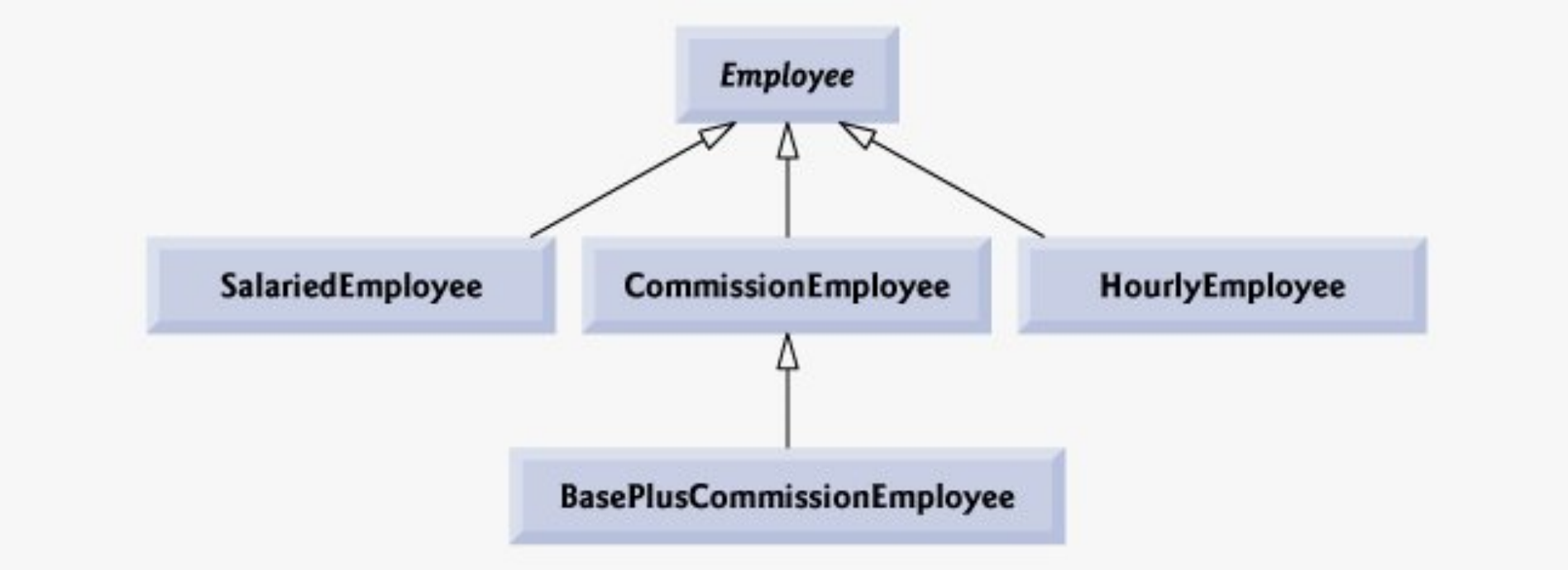
```
public class Guitar extends StringedInstrument{

    public void play(){
       System.out.println("Guitar is rocking!");
    }
}
```

# Example-2

```
abstract class WindInstrument extends Instrument {
    //features
}
```

```
public class Flute extends WindInstrument{

    public void play(){
       System.out.println("Flute is rocking!");
    }
}
```

# Example Project: Payroll System



# Overview of the classes

| | earnings | toString |
|---|---|---|
| Employee | abstract | *firstName lastName*<br>social security number: *SSN* |
| Salaried-Employee | weeklySalary | salaried employee: *firstName lastName*<br>social security number: *SSN*<br>weekly salary: *weeklysalary* |
| Hourly-Employee | *If hours <= 40*<br>wage * hours<br>*If hours > 40*<br>40 * wage +<br>( hours - 40 ) *<br>wage * 1.5 | hourly employee: *firstName lastName*<br>social security number: *SSN*<br>hourly wage: *wage*; hours worked: *hours* |
| Commission-Employee | commissionRate * grossSales | commission employee: *firstName lastName*<br>social security number: *SSN*<br>gross sales: *grossSales*;<br>commission rate: *commissionRate* |
| BasePlus-Commission-Employee | ( commissionRate * grossSales ) + baseSalary | base salaried commission employee: *firstName lastName*<br>social security number: *SSN*<br>gross sales: *grossSales*;<br>commission rate: *commissionRate*;<br>base salary: *baseSalary* |

# Employee.java (1)

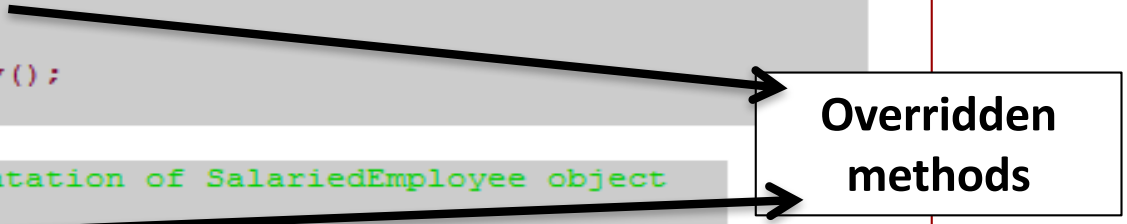
```
1  // Fig. 10.4: Employee.java
2  // Employee abstract superclass.
3
4  public abstract class Employee
5  {
6     private String firstName;
7     private String lastName;
8     private String socialSecurityNumber;
9
10    // three-argument constructor
11    public Employee( String first, String last, String ssn )
12    {
13       firstName = first;
14       lastName = last;
15       socialSecurityNumber = ssn;
16    } // end three-argument Employee constructor
17
18    // set first name
19    public void setFirstName( String first )
20    {
21       firstName = first;
22    } // end method setFirstName
23
24    // return first name
25    public String getFirstName()
26    {
27       return firstName;
28    } // end method getFirstName
29
30    // set last name
31    public void setLastName( String last )
32    {
33       lastName = last;
34    } // end method setLastName
35
```

# Employee.java (2)

```
36     // return last name
37     public String getLastName()
38     {
39        return lastName;
40     } // end method getLastName
41
42     // set social security number
43     public void setSocialSecurityNumber( String ssn )
44     {
45        socialSecurityNumber = ssn; // should validate
46     } // end method setSocialSecurityNumber
47
48     // return social security number
49     public String getSocialSecurityNumber()
50     {
51        return socialSecurityNumber;
52     } // end method getSocialSecurityNumber
53
54     // return String representation of Employee object
55     public String toString()
56     {
57        return String.format( "%s %s\nsocial security number: %s",
58           getFirstName(), getLastName(), getSocialSecurityNumber()
59     } // end method toString
60
61     // abstract method overridden by subclasses
62     public abstract double earnings(); // no implementation here
63  } // end abstract class Employee
```

# SalariedEmployee.java

```
 4  public class SalariedEmployee extends Employee
 5  {
 6     private double weeklySalary;
 7
 8     // four-argument constructor
 9     public SalariedEmployee( String first, String last, String ssn,
10        double salary )
11     {
12        super( first, last, ssn ); // pass to Employee constructor
13        setWeeklySalary( salary ); // validate and store salary
14     } // end four-argument SalariedEmployee constructor
15
16     // set salary
17     public void setWeeklySalary( double salary )
18     {
19        weeklySalary = salary < 0.0 ? 0.0 : salary;
20     } // end method setWeeklySalary
21
22     // return salary
23     public double getWeeklySalary()
24     {
25        return weeklySalary;
26     } // end method getWeeklySalary
27
28     // calculate earnings; override abstract method earnings in Employee
29     public double earnings()
30     {
31        return getWeeklySalary();
32     } // end method earnings
33
34     // return String representation of SalariedEmployee object
35     public String toString()
36     {
37        return String.format( "salaried employee: %s\n%s: $%,.2f",
38           super.toString(), "weekly salary", getWeeklySalary() );
39     } // end method toString
40  } // end class SalariedEmployee
```



# HourlyEmployee.java (1)

```
 4  public class HourlyEmployee extends Employee
 5  {
 6     private double wage; // wage per hour
 7     private double hours; // hours worked for week
 8
 9     // five-argument constructor
10     public HourlyEmployee( String first, String last, String ssn,
11        double hourlyWage, double hoursWorked )
12     {
13        super( first, last, ssn );
14        setWage( hourlyWage ); // validate hourly wage
15        setHours( hoursWorked ); // validate hours worked
16     } // end five-argument HourlyEmployee constructor
17
18     // set wage
19     public void setWage( double hourlyWage )
20     {
21        wage = ( hourlyWage < 0.0 ) ? 0.0 : hourlyWage;
22     } // end method setWage
23
24     // return wage
25     public double getWage()
26     {
27        return wage;
28     } // end method getWage
29
30     // set hours worked
31     public void setHours( double hoursWorked )
32     {
33        hours = ( ( hoursWorked >= 0.0 ) && ( hoursWorked <= 168.0 ) ) ?
34           hoursWorked : 0.0;
35     } // end method setHours
```

# HourlyEmployee.java (2)

```
36
37      // return hours worked
38      public double getHours()
39      {
40         return hours;
41      } // end method getHours
42
43      // calculate earnings; override abstract method earnings in Employee
44      public double earnings()
45      {
46         if ( getHours() <= 40 ) // no overtime
47            return getWage() * getHours();
48         else
49            return 40 * getWage() + ( gethours() - 40 ) * getWage() * 1.5;
50      } // end method earnings
51
52      // return String representation of HourlyEmployee object
53      public String toString()
54      {
55         return String.format( "hourly employee: %s\n%s: $%,.2f; %s: %,.2f",
56            super.toString(), "hourly wage", getWage(),
57            "hours worked", getHours() );
58      } // end method toString
59   } // end class HourlyEmployee
```

# CommissionEmployee.java (1)

```
4  public class CommissionEmployee extends Employee
5  {
6     private double grossSales; // gross weekly sales
7     private double commissionRate; // commission percentage
8
9     // five-argument constructor
10    public CommissionEmployee( String first, String last, String ssn,
11       double sales, double rate )
12    {
13       super( first, last, ssn );
14       setGrossSales( sales );
15       setCommissionRate( rate );
16    } // end five-argument CommissionEmployee constructor
17
18    // set commission rate
19    public void setCommissionRate( double rate )
20    {
21       commissionRate = ( rate > 0.0 && rate < 1.0 ) ? rate : 0.0;
22    } // end method setCommissionRate
23
24    // return commission rate
25    public double getCommissionRate()
26    {
27       return commissionRate;
28    } // end method getCommissionRate
29
30    // set gross sales amount
31    public void setGrossSales( double sales )
32    {
33       grossSales = ( sales < 0.0 ) ? 0.0 : sales;
34    } // end method setGrossSales
```

# CommissionEmployee.java (2)

```
36     // return gross sales amount
37     public double getGrossSales()
38     {
39        return grossSales;
40     } // end method getGrossSales
41
42     // calculate earnings; override abstract method earnings in Employee
43     public double earnings()
44     {
45        return getCommissionRate() * getGrossSales();
46     } // end method earnings
47
48     // return String representation of CommissionEmployee object
49     public String toString()
50     {
51        return String.format( "%s: %s\n%s: $%,.2f; %s: %.2f",
52           "commission employee", super.toString(),
53           "gross sales", getGrossSales(),
54           "commission rate", getCommissionRate() );
55     } // end method toString
56  } // end class CommissionEmployee
```

# BasePlusCommissionEmployee.java

```
 4  public class BasePlusCommissionEmployee extends CommissionEmployee
 5  {
 6     private double baseSalary; // base salary per week
 7
 8     // six-argument constructor
 9     public BasePlusCommissionEmployee( String first, String last,
10        String ssn, double sales, double rate, double salary )
11     {
12        super( first, last, ssn, sales, rate );
13        setBaseSalary( salary ); // validate and store base salary
14     } // end six-argument BasePlusCommissionEmployee constructor
15
16     // set base salary
17     public void setBaseSalary( double salary )
18     {
19        baseSalary = ( salary < 0.0 ) ? 0.0 : salary; // non-negative
20     } // end method setBaseSalary
21
22     // return base salary
23     public double getBaseSalary()
24     {
25        return baseSalary;
26     } // end method getBaseSalary
27
28     // calculate earnings; override method earnings in CommissionEmployee
29     public double earnings()
30     {
31        return getBaseSalary() + super.earnings();
32     } // end method earnings
33
34     // return String representation of BasePlusCommissionEmployee object
35     public String toString()
36     {
37        return String.format( "%s %s; %s: $%,.2f",
38           "base-salaried", super.toString(),
39           "base salary", getBaseSalary() );
40     } // end method toString
41  } // end class BasePlusCommissionEmployee
```

# PayrollSystemTest.java (1)

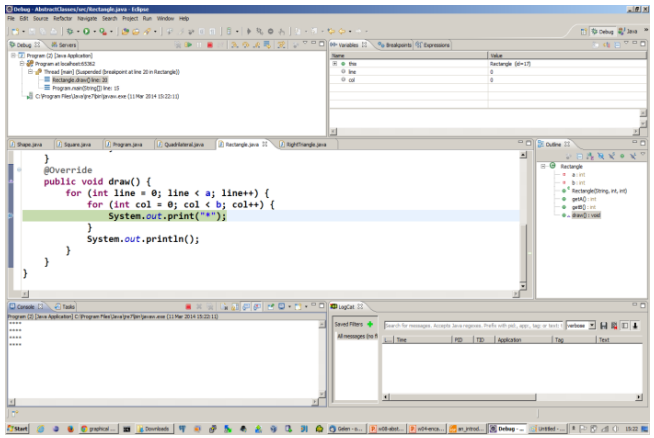
```
 4  public class PayrollSystemTest
 5  {
 6     public static void main( String args[] )
 7     {
 8        // create subclass objects
 9        SalariedEmployee salariedEmployee =
10           new SalariedEmployee( "John", "Smith", "111-11-1111", 800.00 );
11        HourlyEmployee hourlyEmployee =
12           new HourlyEmployee( "Karen", "Price", "222-22-2222", 16.75, 40 );
13        CommissionEmployee commissionEmployee =
14           new CommissionEmployee(
15           "Sue", "Jones", "333-33-3333", 10000, .06 );
16        BasePlusCommissionEmployee basePlusCommissionEmployee =
17           new BasePlusCommissionEmployee(
18           "Bob", "Lewis", "444-44-4444", 5000, .04, 300 );
19
20        System.out.println( "Employees processed individually:\n" );
21
22        System.out.printf( "%s\n%s: $%,.2f\n\n",
23           salariedEmployee, "earned", salariedEmployee.earnings() );
24        System.out.printf( "%s\n%s: $%,.2f\n\n",
25           hourlyEmployee, "earned", hourlyEmployee.earnings() );
26        System.out.printf( "%s\n%s: $%,.2f\n\n",
27           commissionEmployee, "earned", commissionEmployee.earnings() );
28        System.out.printf( "%s\n%s: $%,.2f\n\n",
29           basePlusCommissionEmployee,
30           "earned", basePlusCommissionEmployee.earnings() );
31
32        // create four-element Employee array
33        Employee employees[] = new Employee[ 4 ];
34
35        // initialize array with Employees
36        employees[ 0 ] = salariedEmployee;
37        employees[ 1 ] = hourlyEmployee;
38        employees[ 2 ] = commissionEmployee;
39        employees[ 3 ] = basePlusCommissionEmployee;
```

# PayrollSystemTest.java (2)

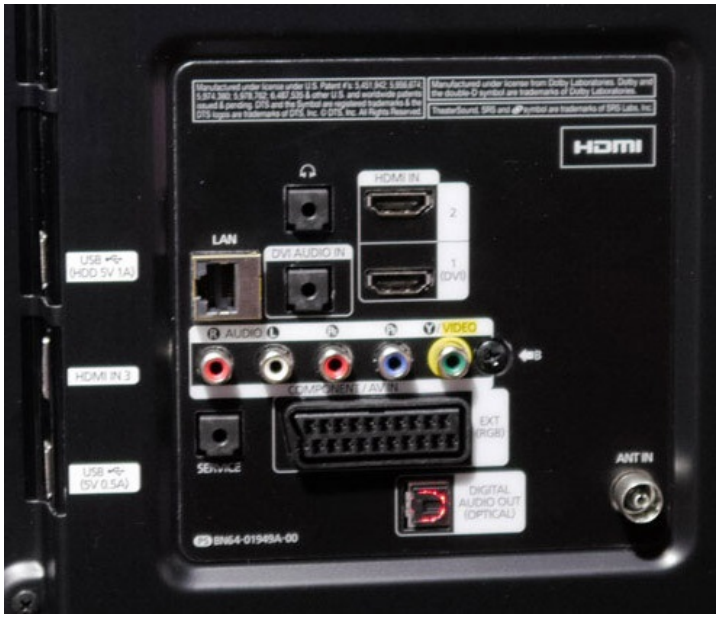
```
41         System.out.println( "Employees processed polymorphically:\n" );
42
43         // generically process each element in array employees
44         for ( Employee currentEmployee : employees )
45         {
46            System.out.println( currentEmployee ); // invokes toString
47
48            // determine whether element is a BasePlusCommissionEmployee
49            if ( currentEmployee instanceof BasePlusCommissionEmployee )
50            {
51               // downcast Employee reference to
52               // BasePlusCommissionEmployee reference
53               BasePlusCommissionEmployee employee =
54                  ( BasePlusCommissionEmployee ) currentEmployee;
55
56               double oldBaseSalary = employee.getBaseSalary();
57               employee.setBaseSalary( 1.10 * oldBaseSalary );
58               System.out.printf(
59                  "new base salary with 10%% increase is: $%,.2f\n",
60                  employee.getBaseSalary() );
61            } // end if
62
63            System.out.printf(
64               "earned $%,.2f\n\n", currentEmployee.earnings() );
65         } // end for
66
67         // get type name of each object in employees array
68         for ( int j = 0; j < employees.length; j++ )
69            System.out.printf( "Employee %d is a %s\n", j,
70               employees[ j ].getClass().getName() );
71      } // end main
72   } // end class PayrollSystemTest
```

# Interfaces

## GUI




## LCD/LED TV




## Laptop

# Concept of Interface

- An interface is a contract. It guarantees that the system will have certain functionalities.
- An interface is an integration point between two systems.
- A system can have many interfaces, so it can be integrated to many other systems.

# Defining an Interface

- Keyword `interface` is used to define an interface
- Methods in an interface must be `public` and `abstract`, these keywords are commonly omitted
- Interfaces can include `public static final` variables (constants), these keywords are commonly omitted

```
public interface Shape {
    public abstract void draw();
    public static final double PI = 3.14;
}
```

No need to write

# Implementing an Interface

- An interface is implemented by the keyword `implements`
- Any class implementing an interface must either implement all methods of it, or be declared abstract

```
public class RightTriangle implements Shape {
    // .....
    public void draw() {
        for (int line = 1; line <= a; line++) {
            for (int i = 0; i < line; i++) {
                System.out.print("*");
            }
            System.out.println();
        }
    }
}
```

# Implementing Multiple Interfaces

- More than one interface can be implemented by a class.
- Names of interfaces are separated by comma

```
public class LedTv implements Usb, Hdmi, Scart, Vga {

    // .....

}
```

*Question: What if at least two interfaces include the same method definition?*

# Extending a Class and Implementing Interface(s)

```
public class Car extends Vehicle
                        implements Shape {


        public void draw() {
            // ....
        }
}
```

# Extending an Interface

- It is possible for an interface to extend another interface

```
public interface I1 {
        void m1();
}
```

```
public interface I2 extends I1 {
        void m2();
}
```

```
public class C1 implements I1 {

        public void m1() {
                // ...
        }
}
```

```
public class C2 implements I2 {
        public void m1() {
                // ...
        }
        public void m2() {
                // ...
        }
}
```

# Interfaces as Types

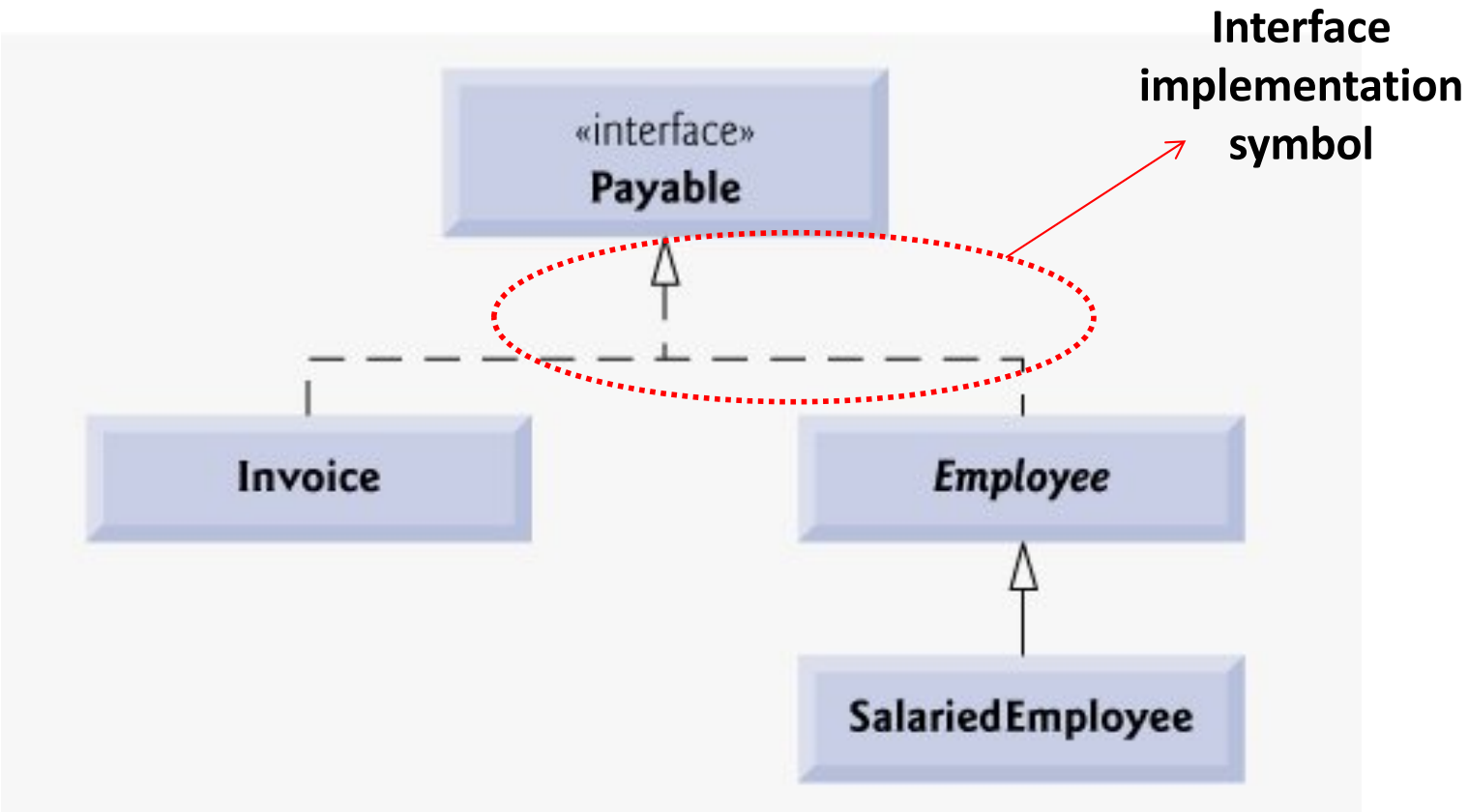
- When you define a new interface, you are defining a new reference data type.
- You can use interface names anywhere you can use any other data type name.
- If you define a reference variable whose type is an interface, any object you assign to it must be an instance of a class that implements the interface.

# Interfaces as Types

```
public class Program {
    public static void main(String[] args) {
        Shape shape;

        shape = new Square(4);
        shape.draw();

        shape = new Rectangle(3, 7);
        shape.draw();

        shape = new RightTriangle(5);
        shape.draw();
    }
}
```

```
public class Program {
    public static void main(String[] args) {
        Shape[] shapes = new Shape[3];
        shapes[0] = new Square(5);
        shapes[1] = new Rectangle(2, 8);
        shapes[2] = new RightTriangle(3);
        for (Shape s : shapes) {
            drawIt(s);
        }
    }

    public static void drawIt(Shape s) {
        s.draw();
    }
}
```

# Example Project: Payroll System Revisited



# Payable.java

```
1  // Fig. 10.11: Payable.java
2  // Payable interface declaration.
3
4  public interface Payable
5  {
6     double getPaymentAmount(); // calculate payment; no implementation
7  } // end interface Payable
```

# Invoice.java (1)

```
 4  public class Invoice implements Payable
 5  {
 6     private String partNumber;
 7     private String partDescription;
 8     private int quantity;
 9     private double pricePerItem;
10
11     // four-argument constructor
12     public Invoice( String part, String description, int count,
13        double price )
14     {
15        partNumber = part;
16        partDescription = description;
17        setQuantity( count ); // validate and store quantity
18        setPricePerItem( price ); // validate and store price per item
19     } // end four-argument Invoice constructor
20
21     // set part number
22     public void setPartNumber( String part )
23     {
24        partNumber = part;
25     } // end method setPartNumber
26
27     // get part number
28     public String getPartNumber()
29     {
30        return partNumber;
31     } // end method getPartNumber
32
33     // set description
34     public void setPartDescription( String description )
35     {
36        partDescription = description;
37     } // end method setPartDescription
38
39     // get description
40     public String getPartDescription()
41     {
42        return partDescription;
43     } // end method getPartDescription
```

# Invoice.java (2)

```
45      // set quantity
46      public void setQuantity( int count )
47      {
48         quantity = ( count < 0 ) ? 0 : count; // quantity cannot be negative
49      } // end method setQuantity
50
51      // get quantity
52      public int getQuantity()
53      {
54         return quantity;
55      } // end method getQuantity
56
57      // set price per item
58      public void setPricePerItem( double price )
59      {
60         pricePerItem = ( price < 0.0 ) ? 0.0 : price; // validate price
61      } // end method setPricePerItem
62
63      // get price per item
64      public double getPricePerItem()
65      {
66         return pricePerItem;
67      } // end method getPricePerItem
68
69      // return String representation of Invoice object
70      public String toString()
71      {
72         return String.format( "%s: \n%s: %s (%s) \n%s: %d \n%s: $%,.2f",
73            "invoice", "part number", getPartNumber(), getPartDescription(),
74            "quantity", getQuantity(), "price per item", getPricePerItem() );
75      } // end method toString
76
77      // method required to carry out contract with interface Payable
78      public double getPaymentAmount()
79      {
80         return getQuantity() * getPricePerItem(); // calculate total cost
81      } // end method getPaymentAmount
82   } // end class Invoice
```

# Employee.java

`Payable` **interface includes** `getPaymentAmount()` **method, but** `Employee` **class does not implement it!**

```
4  public abstract class Employee implements Payable
5  {
6     private String firstName;
7     private String lastName;
8     private String socialSecurityNumber;
9
10    // three-argument constructor
11    public Employee( String first, String last, String ssn )
12    {
13       firstName = first;
14       lastName = last;
15       socialSecurityNumber = ssn;
16    } // end three-argument Employee constructor
17
18       /* Rest of the class is same as the previous example
19       except there is no earnings() method! */
20
21
22
23
```

# SalariedEmployee.java

```
 4  public class SalariedEmployee extends Employee
 5  {
 6     private double weeklySalary;
 7
 8     // four-argument constructor
 9     public SalariedEmployee( String first, String last, String ssn,
10        double salary )
11     {
12        super( first, last, ssn ); // pass to Employee constructor
13        setWeeklySalary( salary ); // validate and store salary
14     } // end four-argument SalariedEmployee constructor
15
16     // set salary
17     public void setWeeklySalary( double salary )
18     {
19        weeklySalary = salary < 0.0 ? 0.0 : salary;
20     } // end method setWeeklySalary
21
22     // return salary
23     public double getWeeklySalary()
24     {
25        return weeklySalary;
26     } // end method getWeeklySalary
27
28     // calculate earnings; implement interface Payable method that was
29     // abstract in superclass Employee
30     public double getPaymentAmount()
31     {
32        return getWeeklySalary();
33     } // end method getPaymentAmount
34
35     // return String representation of SalariedEmployee object
36     public String toString()
37     {
38        return String.format( "salaried employee: %s\n%s: $%,.2f",
39           super.toString(), "weekly salary", getWeeklySalary() );
40     } // end method toString
41  } // end class SalariedEmployee
```

# PayableInterfaceTest.java

```
 4  public class PayableInterfaceTest
 5  {
 6     public static void main( String args[] )
 7     {
 8        // create four-element Payable array
 9        Payable payableObjects[] = new Payable[ 4 ];
10
11        // populate array with objects that implement Payable
12        payableObjects[ 0 ] = new Invoice( "01234", "seat", 2, 375.00 );
13        payableObjects[ 1 ] = new Invoice( "56789", "tire", 4, 79.95 );
14        payableObjects[ 2 ] =
15           new SalariedEmployee( "John", "Smith", "111-11-1111", 800.00 );
16        payableObjects[ 3 ] =
17           new SalariedEmployee( "Lisa", "Barnes", "888-88-8888", 1200.00 );
18
19        System.out.println(
20           "Invoices and Employees processed polymorphically:\n" );
21
22        // generically process each element in array payableObjects
23        for ( Payable currentPayable : payableObjects )
24        {
25           // output currentPayable and its appropriate payment amount
26           System.out.printf( "%s \n%s: $%,.2f\n\n",
27              currentPayable.toString(),
28              "payment due", currentPayable.getPaymentAmount() );
29        } // end for
30     } // end main
31  } // end class PayableInterfaceTest
```

# Interfaces vs Abstract Classes

| Abstract class | Interface |
|---|---|
| 1) Abstract class can **have abstract and non-abstract** methods. | Interface can have **only abstract** methods. |
| 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 have static methods, main method and constructor**. | Interface **can't have static methods, main method or constructor**. |
| 5) Abstract class **can provide the implementation of interface**. | Interface **can't provide the implementation of abstract class**. |
| 6) The **abstract keyword** is used to declare abstract class. | The **interface keyword** is used to declare interface. |
| 7) **Example:**<br>public abstract class Shape{<br>public abstract void draw();<br>} | **Example:**<br>public interface Drawable{<br>void draw();<br>} |

# Summary

- Abstract class is defined with the keyword `abstract`
- If a class includes an abstract method, it must be declared as abstract
- Objects of abstract classes cannot be created
- Interface is defined with the keyword `interface`
- A class can *implement* an interface, an interface can *extend* an interface
- A class can implement many interfaces
- Objects of interfaces cannot be created

# Acknowledgements


- The course material used to prepare this presentation is mostly taken/adopted from the list below:
  - Java - How to Program, Paul Deitel and Harvey Deitel, Prentice Hall, 2012
- http://www.javatpoint.com/difference-between-abstract-class-and-interface