Advanced Programming

Object Oriented Programming in Java -- II

Computer Science

Object Oriented Key Principles

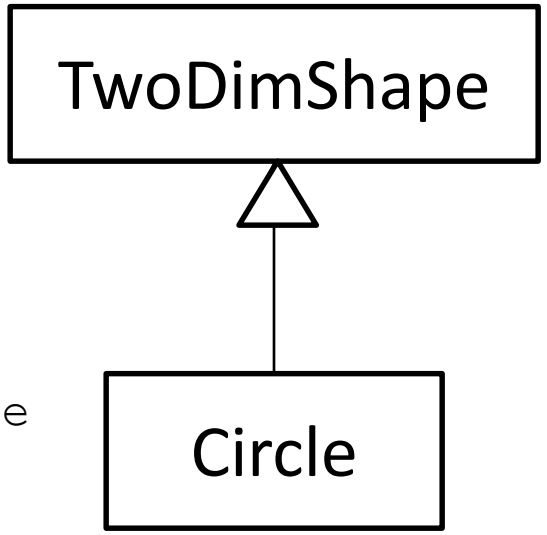
1. Data Abstraction and Encapsulation
2. Inheritance
3. Polymorphism

Inheritance

- A class can extend another class, inheriting all its data members and methods while redefining some of them and/or adding its own.
- Inheritance represents the *is a* relationship between data types. For example: a `Circle` *is a* `Shape`.

Inheritance in Java:

subclass **extends** superclass




```
public class Circle extends TwoDimShape
{
   ...
}
```

Inheritance in Java

- Java supports inheritance
  - A “subclass” inherits from a “superclass”
- In the sub class:
  - In class header use the `extends` keyword to specify the superclass
  - Only declare the additional fields and methods
  - In subclass constructor call the superclass constructor via `super` keyword
  - (optionally) override superclass methods

Inheritance Example

```
public class Square {
   protected int length;
   public Square(int len){length = len;}
   public int perimeter(){return 4 * length;}
   public int area(){return length * length;}
}

public class Rectangle extends Square{
   private int width;
   public Rectangle(int len, int wid){
       super(len);
       width = wid;
   }
   public int perimeter()
       {return 2 * (length + width);}
   public int area(){return length * width;}
}
```

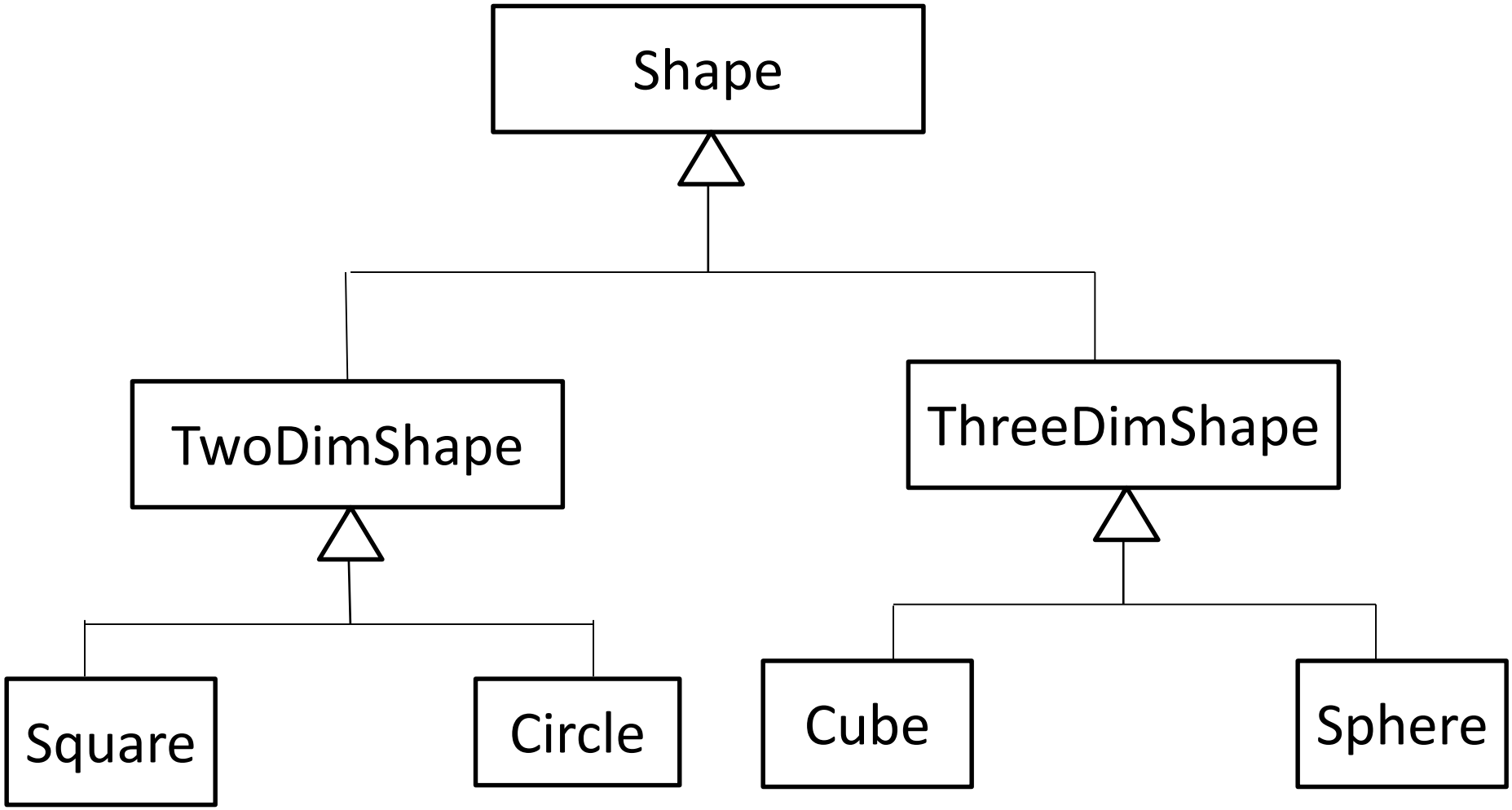
Visibility

- `public`
  - Any field or method specified as `public` can be used by any external class
  - Class constructors, accessor methods should be specified as `public`
- `private`
  - Any field or method specified as `private` can be used by code inside the class
  - Fields and internal helper methods should be `private`
- `protected`
  - Any field or method specified as `protected` can be used by code inside the class and in subclasses
    - i.e. classes which inherit from the original class

Multiple Inheritance

- Multiple inheritance allows a class to be derived from two or more classes, inheriting the members of all parents
  - Collisions, such as the same variable name in two parents, have to be resolved
- Java supports single inheritance, meaning that a derived class can have only one parent class
- Java does not support multiple inheritance via two or more classes

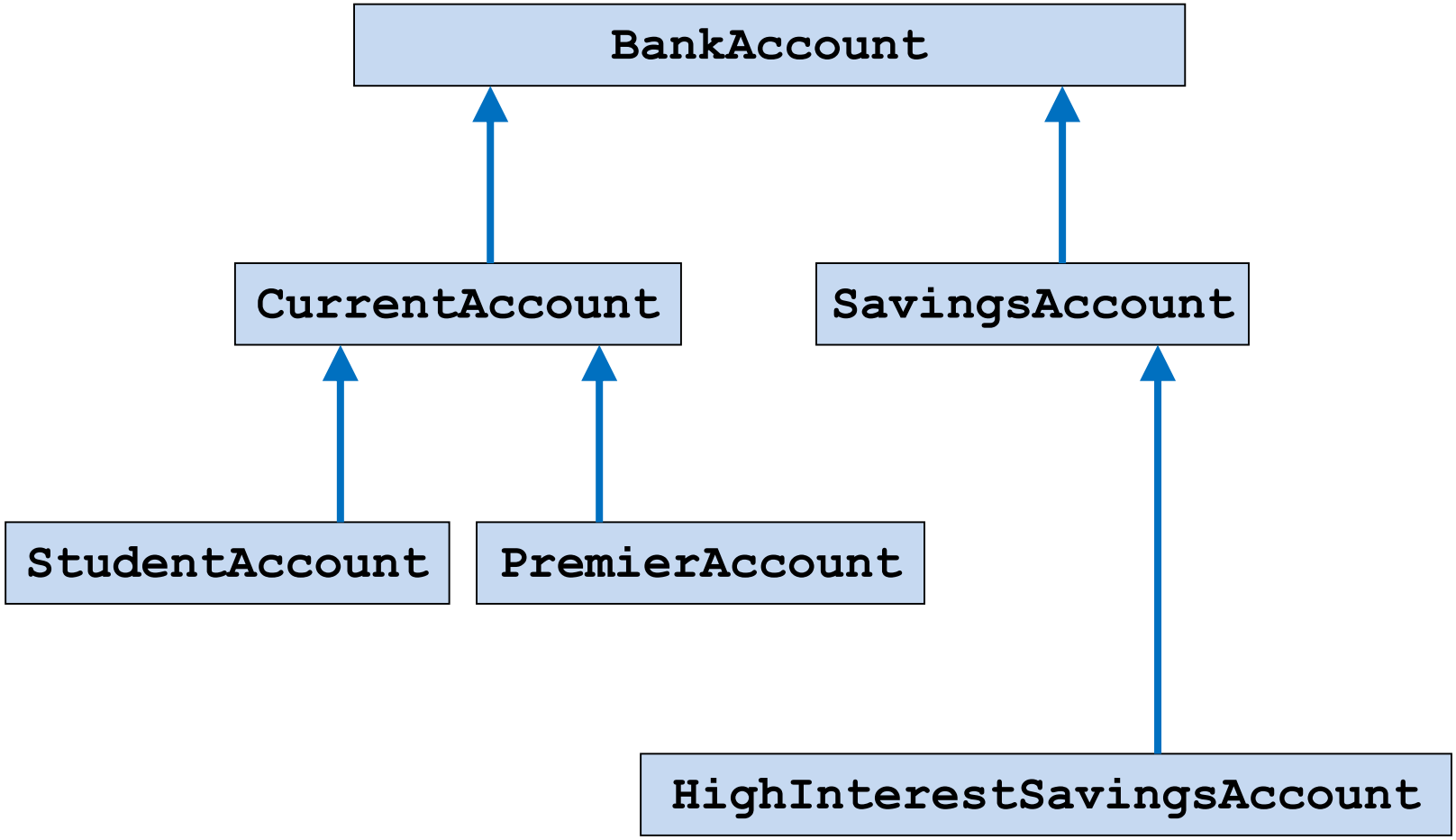
Inheritance Hierarchy Example



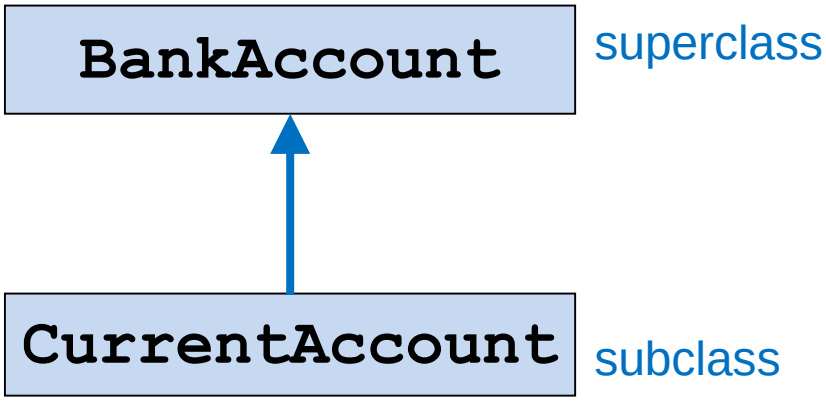
Inheritance Relationships

- Inheritance creates an is-a relationship,
  - I.e. the child is a specialised version of the parent
- A child class of one parent can be the parent of another child, forming a class hierarchy.
- A subclass will inherit all attributes and operations defined in any of its super classes
  - Subclass may be augmented with additional attributes and operations
  - Subclass can override attributes and operations

Inheritance Hierarchy Example



Banking Inheritance Example



- Subclass inherits the variables and methods defined by the super class

```
public class CurrentAccount extends BankAccount {
```

- Subclass specializes by adding its own members:
  - fields: `overdraftLimit`
  - methods: `getOverdraftLimit()`, `setOverdraftLimit()`, `debit()` - overridden

Superclass – BankAccount (1)

```
public class BankAccount {

   //fields
   private String number;
   private String name;
   private double balance;

   //default constructor
   public BankAccount(){
        number = "--------";
        name = "--------";
        balance = 0.0;
   }

   //overloaded constructor
   public BankAccount(String accountNo, String accountName){
        number = accountNo;
        name = accountName;
        balance = 0.0;
   }
```

Superclass – BankAccount (2)

```
public String getAccountNo() {return number;}

public String getAccountName() {return name;}

public double getBalance() {return balance;}
public void setAccountName(String accountName)
    {name=accountName;}

public void credit (double amount)
    {balance = balance + amount;}

public void debit (double amount)
    {balance = balance - amount;}

}
```

Adding constructors in a subclass

- Super class constructors are not inherited by the sub class, even though they have public visibility
  - However we need to use the super class constructor in order to set up the *"parent's part"* of the object
- The `super` reference is a reference to the super class of a sub class
  - Whereas `this` is a reference to the class itself
- `Super()` is used to invoke the parent's constructor

```
super(accountNo, accountName);
```

- The sub class constructor specifies parameters to:
  - Initialise fields from its super class
  - And to initialise its own fields

Subclass Constructors

```
//default constructor
public CurrentAccount(String accountNo,
String accountName){
   //invoke the parent's constructor
   super(accountNo, accountName);
   //initialise field
   overdraftLimit = 0.0;
}

//overloaded constructor
public CurrentAccount(String accountNo,
String accountName, double accountLimit){
   super(accountNo, accountName);
   overdraftLimit = accountLimit;
}
```

Overriding methods

- A subclass can override the definition of an inherited method in favour of its own
  - Unless the original method is defined as `final` in the super class
- The new overridden version of the method must have the same signature as the parent's method
  - But can have a different body
- The type of the object executing the method determines which version of the method is invoked

Overloading vs. Overriding

- Overloading
  - Multiple methods with the same name in the same class, but with different signatures (parameters)
  - Allows similar operation to be defined in different ways for different parameters
- Overriding
  - Two methods with same name and the same signature
    - Original version in a parent class
    - Recoded version in a child class
  - Allows a similar operation to be defined in different ways for different sub classes

Inheritance Design Issues (1)

- All derivations should be is a relationships
  - i.e. a sub class is a child of super class
- Override methods as appropriate to tailor or change the functionality of a child
- Add new variables to children, but don't redefine inherited variables
  - Use visibility modifiers carefully to provide needed access without violating encapsulation

Inheritance Design Issues (2)

- Allow each class to manage its own data
  - Use the super reference to invoke the parent's constructor to set up its data
- The `final` modifier
  - If the final modifier is applied to a method, then that method cannot be overridden in any descendant classes
  - If the final modifier is applied to an entire class, then that class cannot be used to derive any children at all

Summary

- A subclass inherits methods and fields from superclass by using the keyword “extends”
- Multiple Inheritance from classes is not supported in Java
- Classes form a hierarchy in any application
- A subclass does not inherit constructors
- A subclass can redefine a method specifically for its own needs