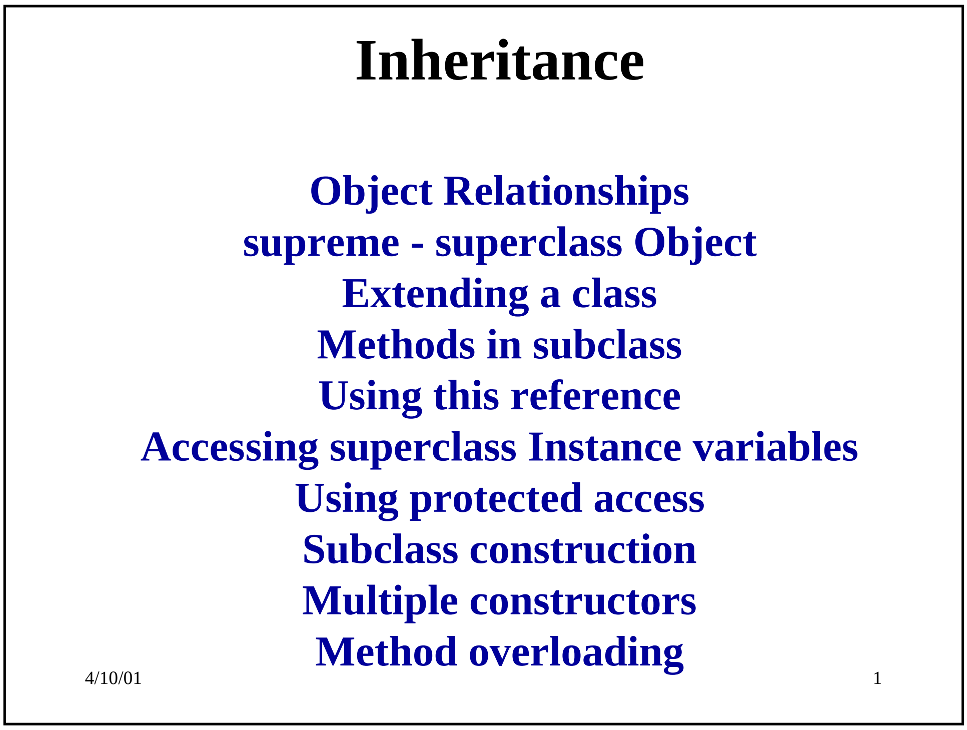
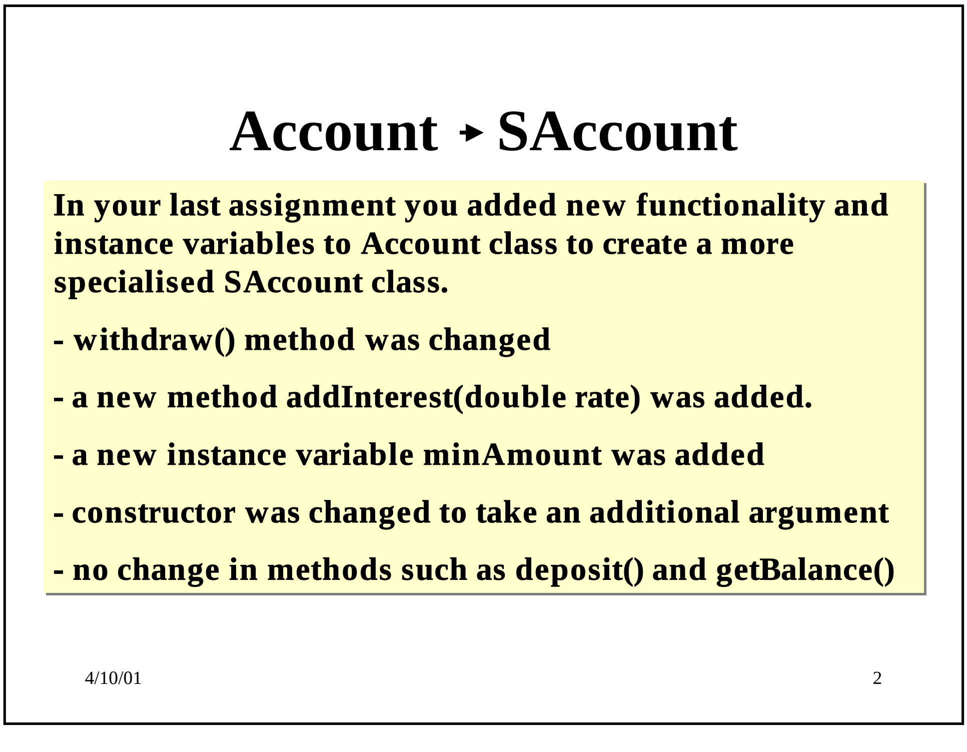


Inheritance

Object Relationships
supreme - superclass Object
Extending a class
Methods in subclass
Using this reference
Accessing superclass Instance variables
Using protected access
Subclass construction
Multiple constructors
Method overloading



Account ‣ SAccount

In your last assignment you added new functionality and instance variables to Account class to create a more specialised SAccount class.

- withdraw() method was changed

- a new method addInterest(double rate) was added.

- a new instance variable minAmount was added

- constructor was changed to take an additional argument

- no change in methods such as deposit() and getBalance()

Could have used inheritance!

Subclass (specialised) superclass

```
class SAccount extends Account
{
     new and redefined methods
     new instance variables;
}
```

- Add a new method addInterest(double rate)
- Redefine withdraw()
- add Instance variable minAmount
- write the constructor

Whenever I change superclass implementation it will be reflected in the subclasses. No worries !!!

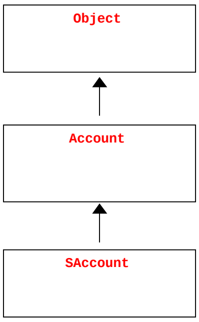
The supreme superclass Object

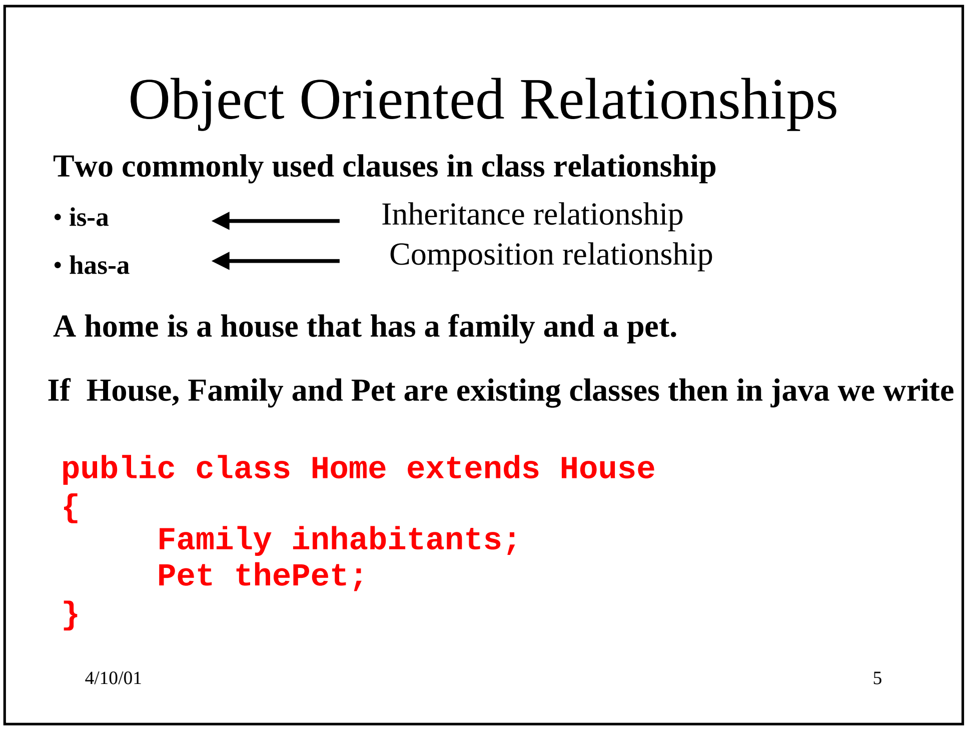
Every class (even one that does not use extends) is a subclass of Object.

Why ?

Object class has a small number of methods that are useful for all classes.

- **equals()**
- **toString()**
- **clone()**





Object Oriented Relationships

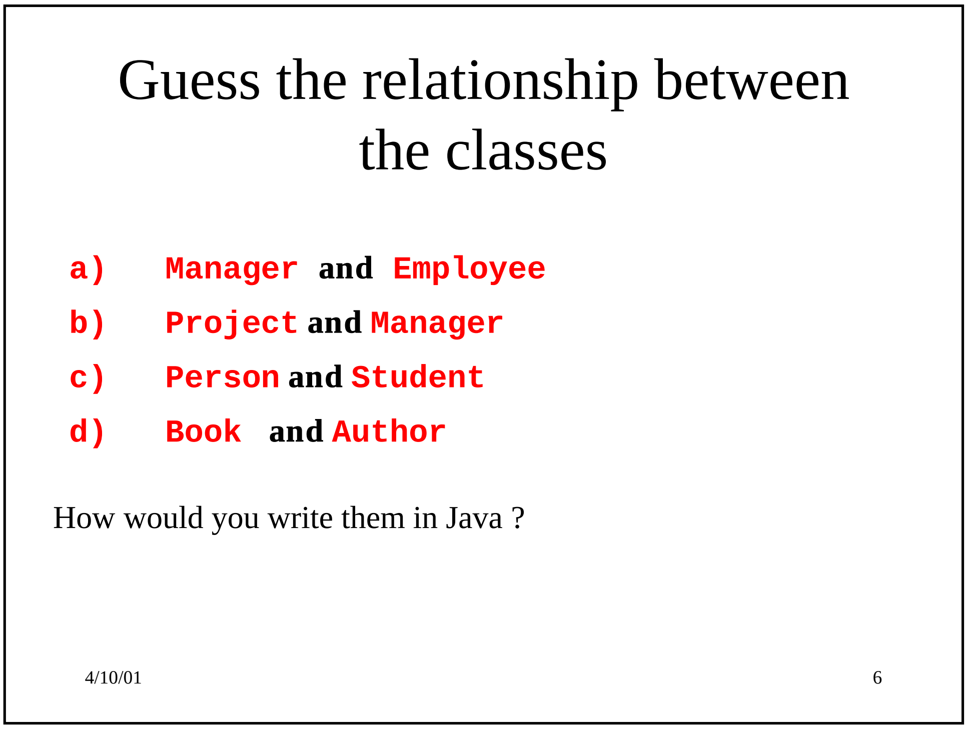
Two commonly used clauses in class relationship

- **is-a** ⟵ Inheritance relationship
- **has-a** ⟵ Composition relationship

A home is a house that has a family and a pet.

If House, Family and Pet are existing classes then in java we write

```
public class Home extends House
{
     Family inhabitants;
     Pet thePet;
}
```



Guess the relationship between the classes

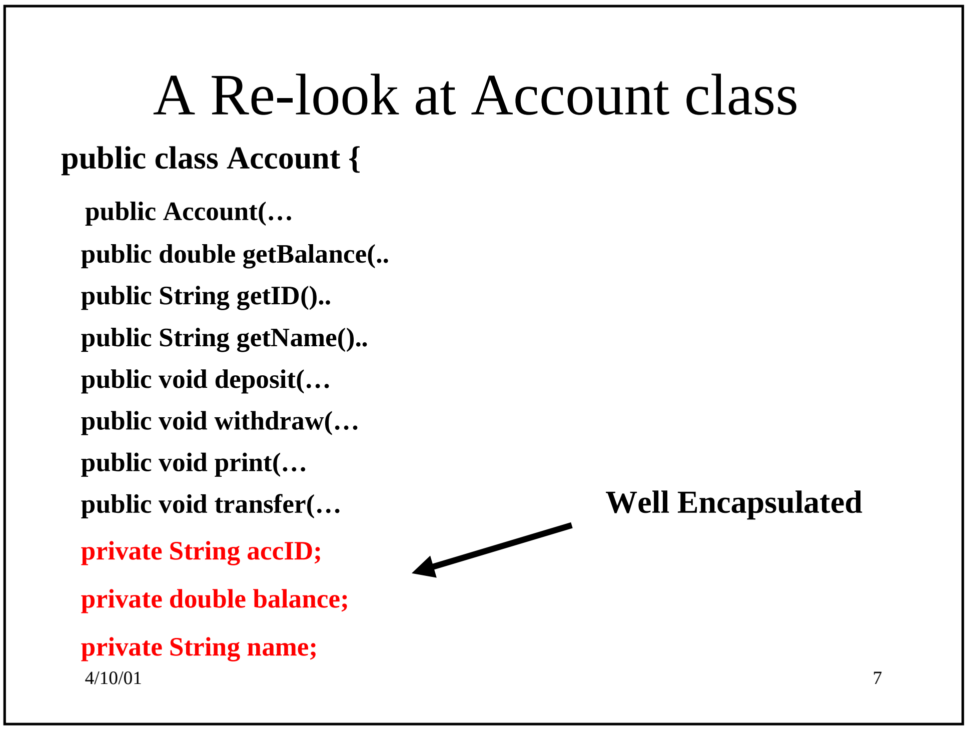
a) `Manager` **and** `Employee`

b) `Project` **and** `Manager`

c) `Person` **and** `Student`

d) `Book` **and** `Author`

How would you write them in Java ?



A Re-look at Account class

public class Account {

public Account(…

public double getBalance(..

public String getID()..

public String getName()..

public void deposit(…

public void withdraw(…

public void print(…

public void transfer(…

private String accID;

private double balance;

private String name;

Well Encapsulated

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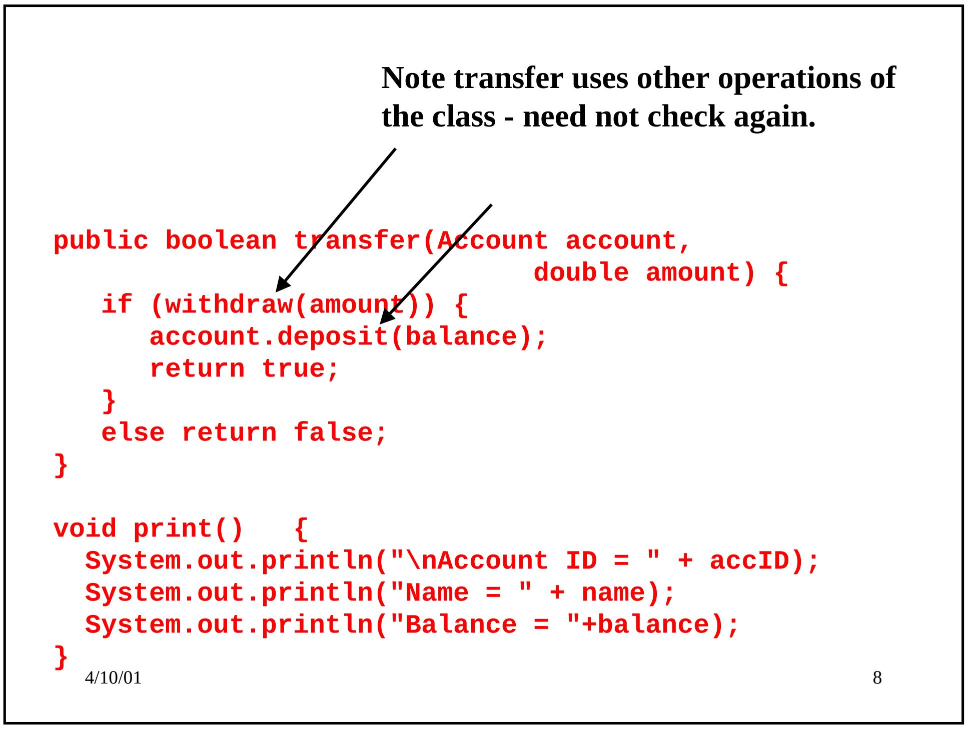

Note transfer uses other operations of the class - need not check again.

```
public boolean transfer(Account account,
                              double amount) {
   if (withdraw(amount)) {
      account.deposit(balance);
      return true;
   }
   else return false;
}

void print()   {
  System.out.println("\nAccount ID = " + accID);
  System.out.println("Name = " + name);
  System.out.println("Balance = "+balance);
}
```

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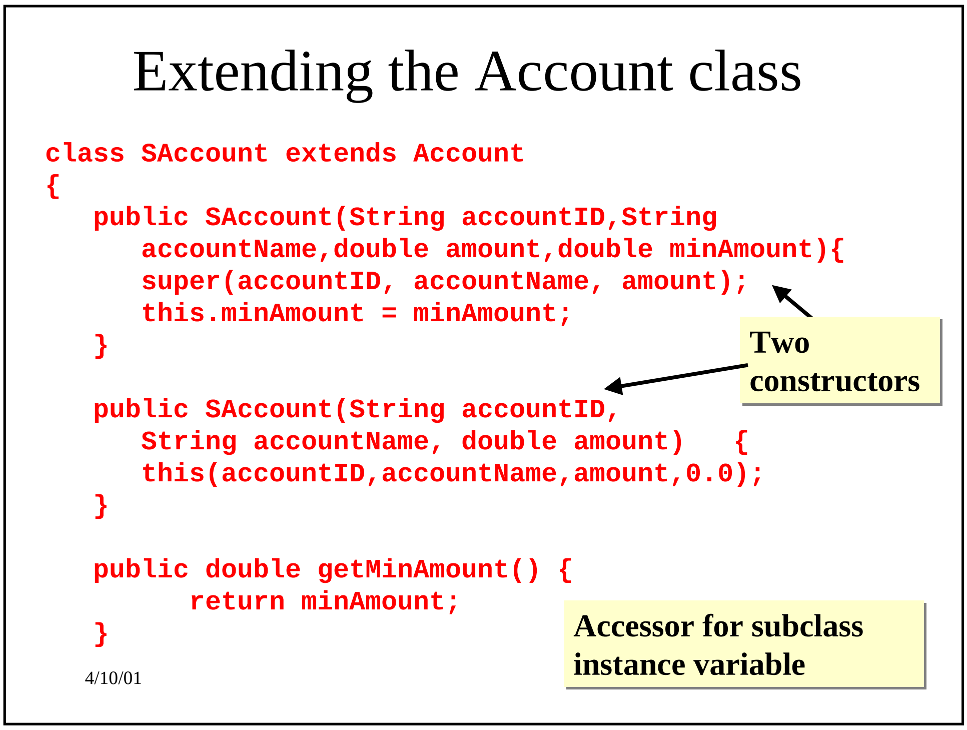


Extending the Account class

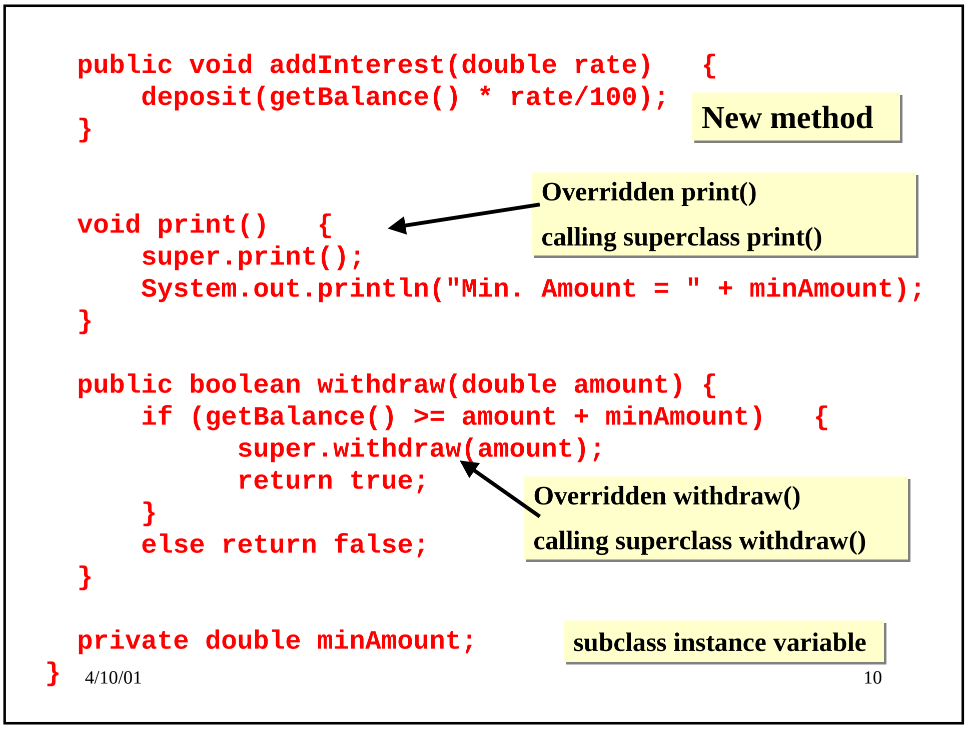
```
class SAccount extends Account
{
   public SAccount(String accountID,String
      accountName,double amount,double minAmount){
      super(accountID, accountName, amount);
      this.minAmount = minAmount;
   }

   public SAccount(String accountID,
      String accountName, double amount)   {
      this(accountID,accountName,amount,0.0);
   }

   public double getMinAmount() {
         return minAmount;
   }
```

Two constructors

Accessor for subclass instance variable



```
  public void addInterest(double rate)   {
      deposit(getBalance() * rate/100);
  }

  void print()   {
      super.print();
      System.out.println("Min. Amount = " + minAmount);
  }

  public boolean withdraw(double amount) {
      if (getBalance() >= amount + minAmount)   {
            super.withdraw(amount);
            return true;
      }
      else return false;
  }

  private double minAmount;
}
```

New method

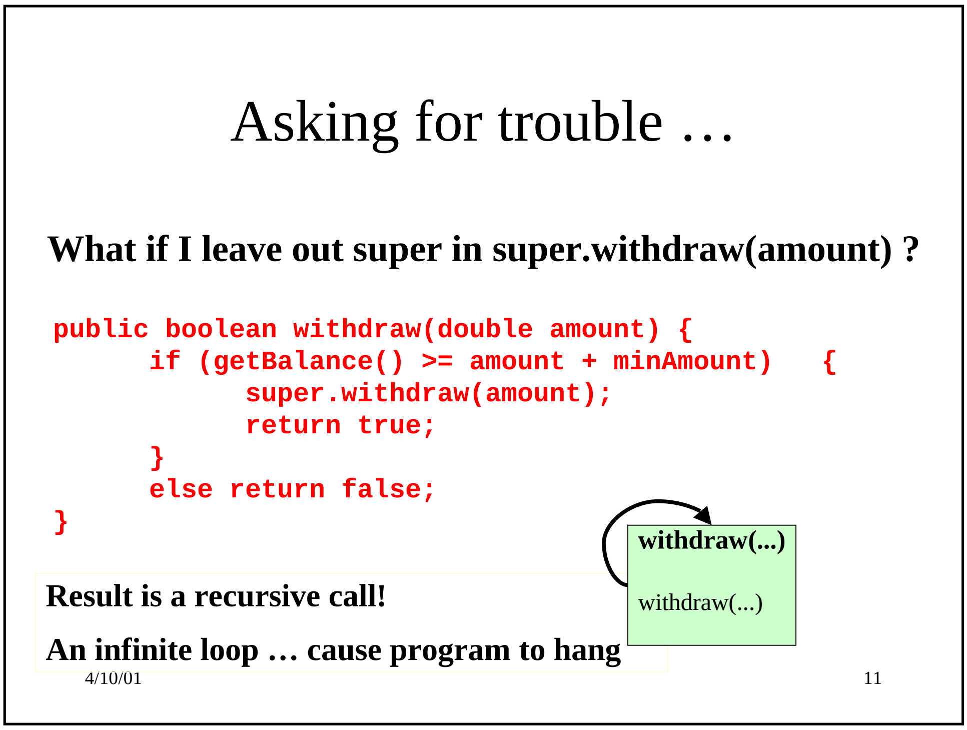
Overridden print()

calling superclass print()

Overridden withdraw()

calling superclass withdraw()

subclass instance variable



Asking for trouble …

What if I leave out super in super.withdraw(amount) ?

```
public boolean withdraw(double amount) {
      if (getBalance() >= amount + minAmount)   {
            super.withdraw(amount);
            return true;
      }
      else return false;
}
```

withdraw(...)

withdraw(...)

Result is a recursive call!

An infinite loop … cause program to hang

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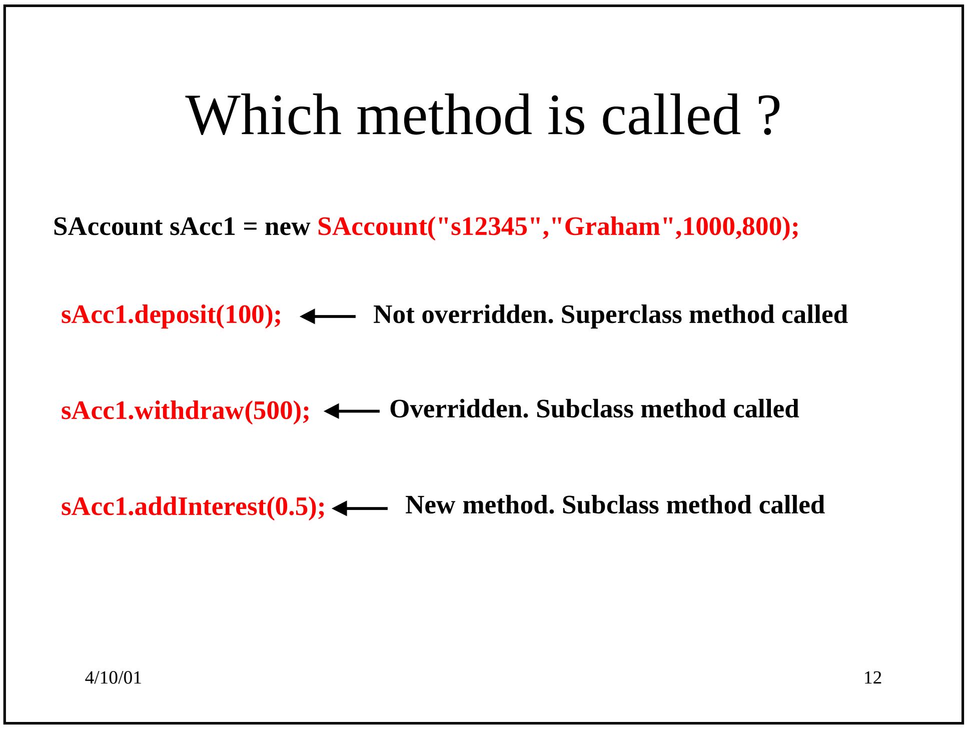

Which method is called ?

SAccount sAcc1 = new SAccount("s12345","Graham",1000,800);

sAcc1.deposit(100); ⟵ **Not overridden. Superclass method called**

sAcc1.withdraw(500); ⟵ **Overridden. Subclass method called**

sAcc1.addInterest(0.5); ⟵ **New method. Subclass method called**

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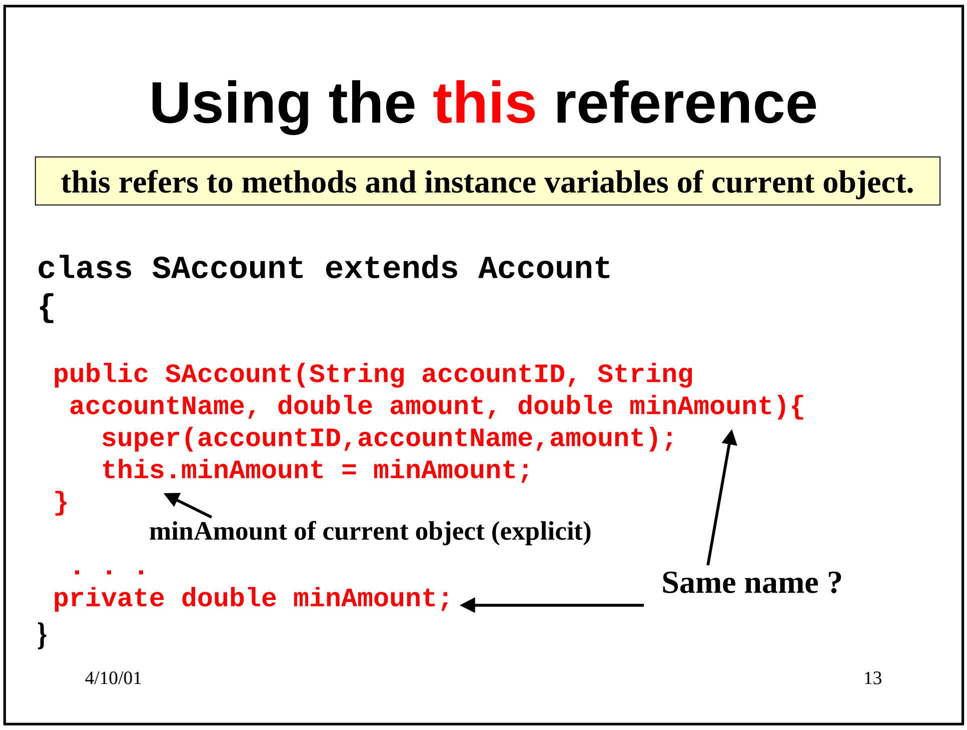

Using the this reference

this refers to methods and instance variables of current object.

```
class SAccount extends Account
{

 public SAccount(String accountID, String
  accountName, double amount, double minAmount){
    super(accountID,accountName,amount);
    this.minAmount = minAmount;
 }
  . . .
 private double minAmount;
}
```

minAmount of current object (explicit)

Same name ?

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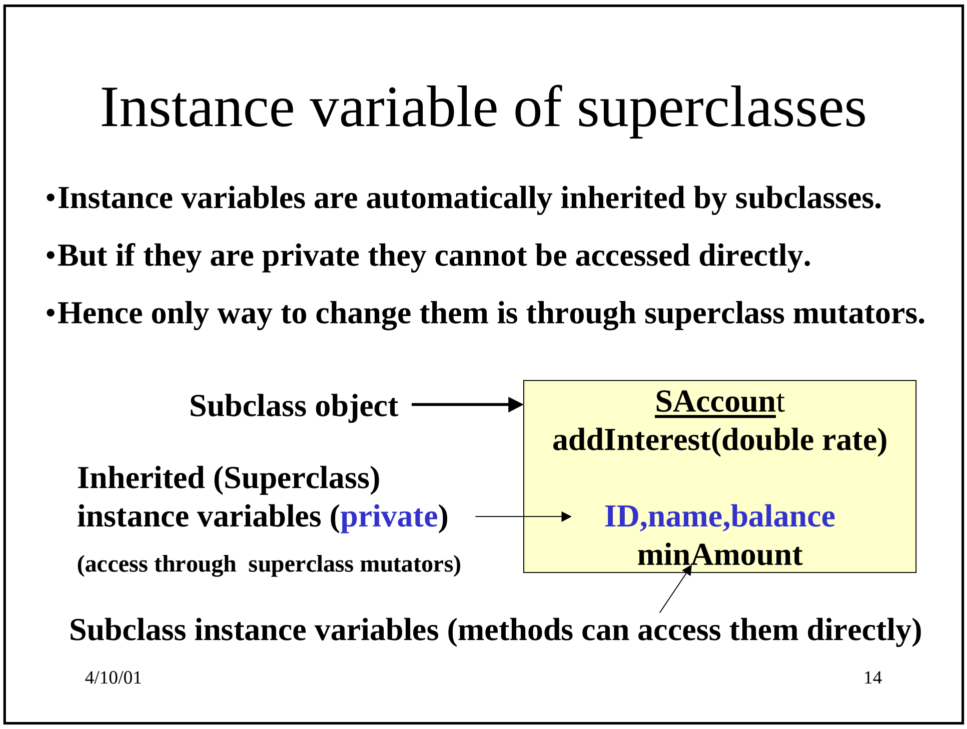

Instance variable of superclasses

- Instance variables are automatically inherited by subclasses.
- But if they are private they cannot be accessed directly.
- Hence only way to change them is through superclass mutators.

Subclass object

Inherited (Superclass) instance variables (private)

(access through superclass mutators)

SAccount

addInterest(double rate)

ID,name,balance

minAmount

Subclass instance variables (methods can access them directly)

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What’s wrong with SAccount withdraw() below ?

```
class SAccount extends Account
{
   public boolean withdraw(double amount) {
      if (balance >= amount + minAmount)
      {
            balance -= amount;
            return true;
      }
      else return false;
  }

  private double minAmount;
}
```

balance is a private instance variable of superclass Account !!!

Protected Access

- **protected alternative to `private` and `public`**
- **If an instance variable is declared protected it can be accessed by methods of that *class*, its *subclasses* and all *other classes* within the same *package* (or *directory*).**
- **However, it cannot be accessed by other class users.**
- **Next Sample code illustrates the difference between the different *access specifiers*.**

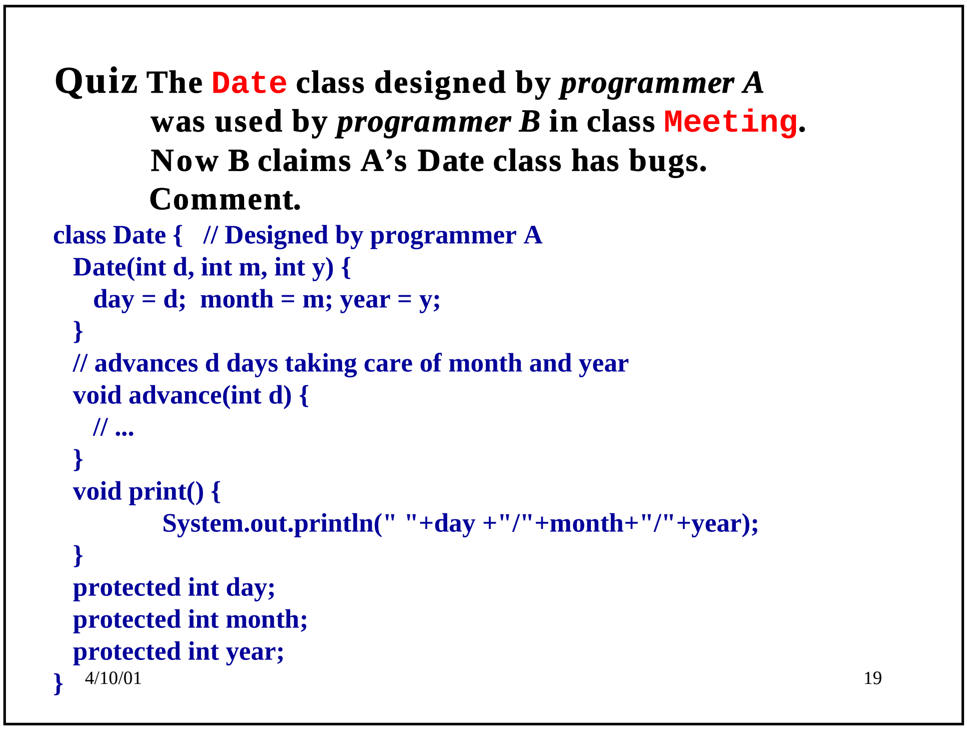
```
class A {
            …
            private int x;
            protected int y;
            public int z;
            void increment1() {
              x++;        // valid
              y++;        // valid
              z++;        // valid
            }
}
class B extends A {
            void increment2() {
                        x++;        // invalid
                        y++;        // valid
                        z++;        // valid
            }
}
class SomeOtherClass {  // not in same package
           void increment3() {
                  …
                  A a = new A(…);
                  a.x++; // invalid
                  a.y++;             // invalid
                  a.z++;             // valid
            }
}
```

To use protected or not ?

Many programmers use the `protected` feature as it strikes a balance between *absolute protection* and *no protection* at all.

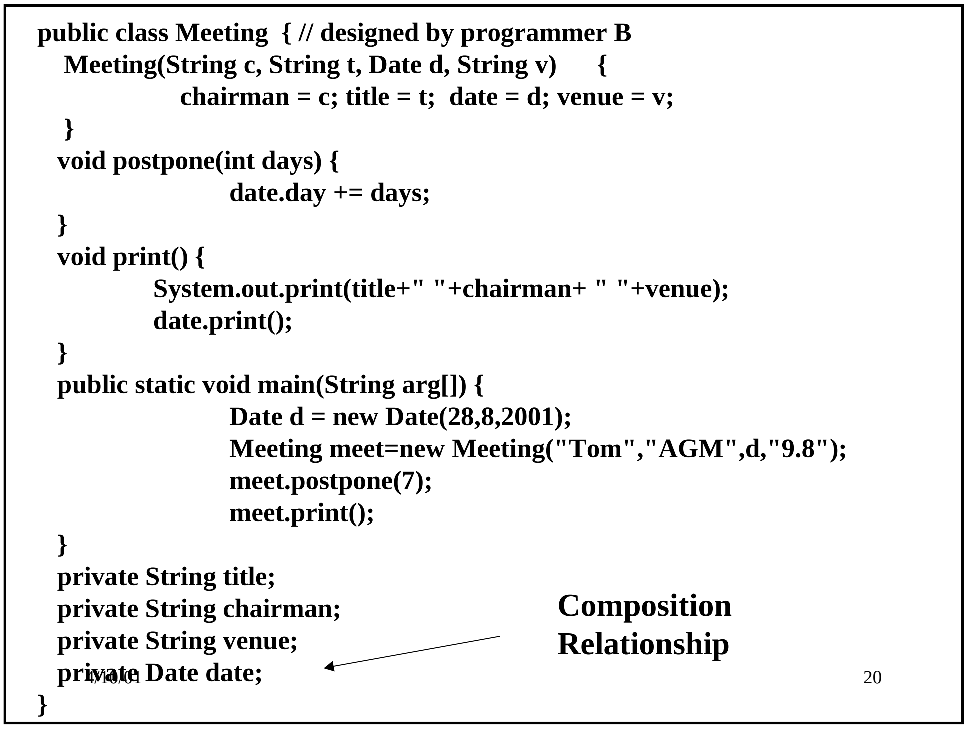
However, they break the *encapsulation rule* as the designer of the *superclass* has no control over the authors of the *subclass*.

Furthermore, classes with protected data are hard to modify as someone may have written a subclass based on it and may have accessed the protected data directly.



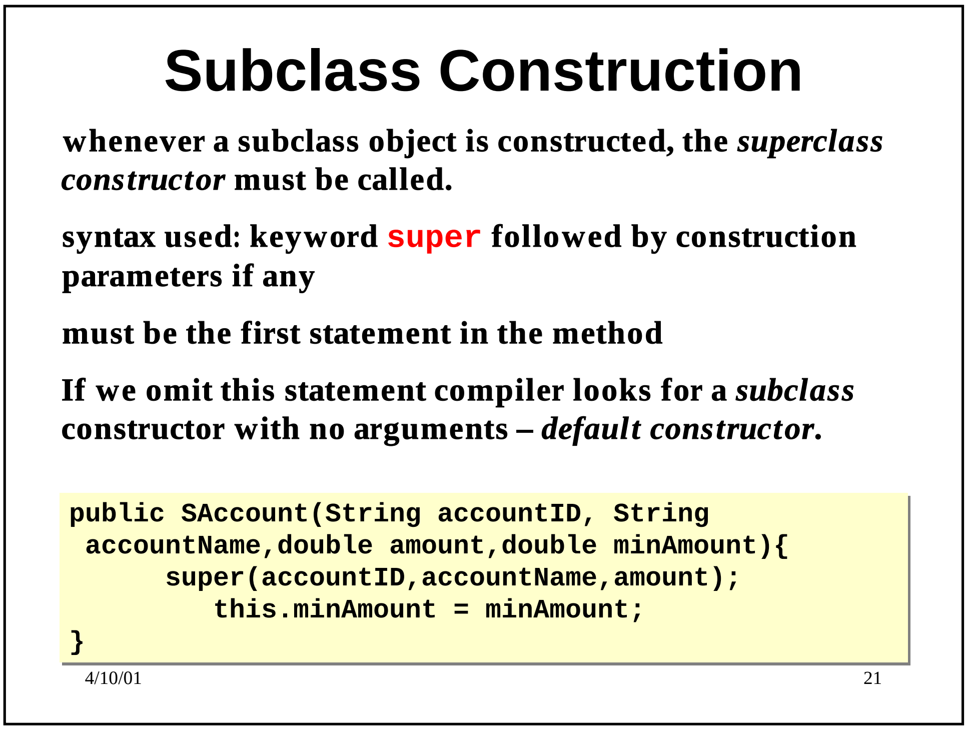
Quiz The `Date` class designed by *programmer A* was used by *programmer B* in class `Meeting`. Now B claims A's Date class has bugs. Comment.

```
class Date {   // Designed by programmer A
   Date(int d, int m, int y) {
      day = d;  month = m; year = y;
   }
   // advances d days taking care of month and year
   void advance(int d) {
      // ...
   }
   void print() {
            System.out.println(" "+day +"/"+month+"/"+year);
   }
   protected int day;
   protected int month;
   protected int year;
}
```



```
public class Meeting  { // designed by programmer B
    Meeting(String c, String t, Date d, String v)      {
                  chairman = c; title = t;  date = d; venue = v;
    }
   void postpone(int days) {
                         date.day += days;
   }
   void print() {
             System.out.print(title+" "+chairman+ " "+venue);
             date.print();
   }
   public static void main(String arg[]) {
                         Date d = new Date(28,8,2001);
                         Meeting meet=new Meeting("Tom","AGM",d,"9.8");
                         meet.postpone(7);
                         meet.print();
   }
   private String title;
   private String chairman;
   private String venue;
   private Date date;
}
```

Composition Relationship



Subclass Construction

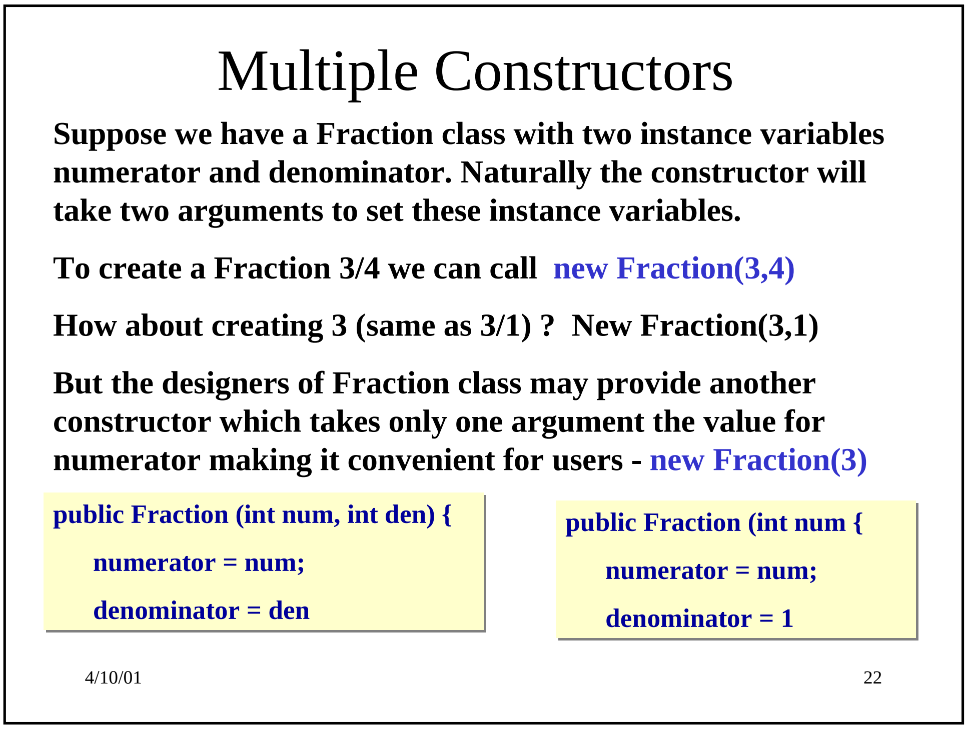
whenever a subclass object is constructed, the *superclass constructor* must be called.

syntax used: keyword `super` followed by construction parameters if any

must be the first statement in the method

If we omit this statement compiler looks for a *subclass* constructor with no arguments – *default constructor*.

```
public SAccount(String accountID, String
 accountName,double amount,double minAmount){
      super(accountID,accountName,amount);
         this.minAmount = minAmount;
}
```



Multiple Constructors

Suppose we have a Fraction class with two instance variables numerator and denominator. Naturally the constructor will take two arguments to set these instance variables.

To create a Fraction 3/4 we can call new Fraction(3,4)

How about creating 3 (same as 3/1) ? New Fraction(3,1)

But the designers of Fraction class may provide another constructor which takes only one argument the value for numerator making it convenient for users - new Fraction(3)

```
public Fraction (int num, int den) {
     numerator = num;
     denominator = den
```

```
public Fraction (int num {
     numerator = num;
     denominator = 1
```

SAccount Multiple Constructors

SAccount = new SAccount(“s1234”,”Sam”, 120, 100);

SAccount = new SAccount(“s1235”,”Tom”, 3500, 0);

SAccount = new SAccount(“s1236”,”Tom”, 4200, 0);

SAccount = new SAccount(“s1237”,”Tom”, 3800, 0);

Most accounts have minimum amount set to 0.

Why not provide a constructor which will set it to 0 if no value is passed for min Amount ?

We can provide an additional constructor that will use the services of the first one with value for minAmount set to 0.

```
// note only 3 arguments are passed
public SAccount(String accountID,
      String accountName, double amount){
   this(accountID,accountName,amount,0.0);
}
```

Calls the existing SAccount constructor with 4 arguments.

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Method Overloading

- **To attract wealthy customers new CEO of Bank XYZ starts giving new saving account holders *stepwise interest rates.***
- **one rate for the first $2,000 and another rate for amounts in excess of $2,000.**
- **This would mean we would need another method that takes the two different rates as arguments.**
- **SAccount oldFellow = new SAccount(……..);**
- **SAccount newFellow = new SAccount(……..);**
- **oldFellow.addInterest(1.1);**
- **newFellow.addInterest(1.1, 1.2);**

void addInterest(double rate) {
…
void addInterest(double r1, double r2) {
…

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