Inheritance, overloading and overriding

- Recall
  - with inheritance the behavior and data associated with the child classes are always an extension of the behavior and data associated with the parent class
- In a child class you can
  - redefine a method's implementation (override)
    - a method that is inherited by the parent, and the child class wants to change its behavior
  - define new methods with the same method *name* but different arguments (overload)
    - different tasks are performed by each method but they share the same method name

The Bank Account example

- Accounts must have
  - current balance
  - name of account holder
  - a withdraw method
  - a deposit method
- Current accounts
  - have a maximum withdraw amount
    - you cannot withdraw more than $200 in one transaction
- Savings accounts
  - have a minimum balance that they need to maintain at all times.

The Bank Account example

- Shared behavior and data between Savings and Checking
  - Data
    - current balance
    - name of account holder
  - Behavior (method names **and** implementation)
    - accessors for common data
    - deposit
  - Behavior (method names **without** behavior)
    - withdraw
    - display

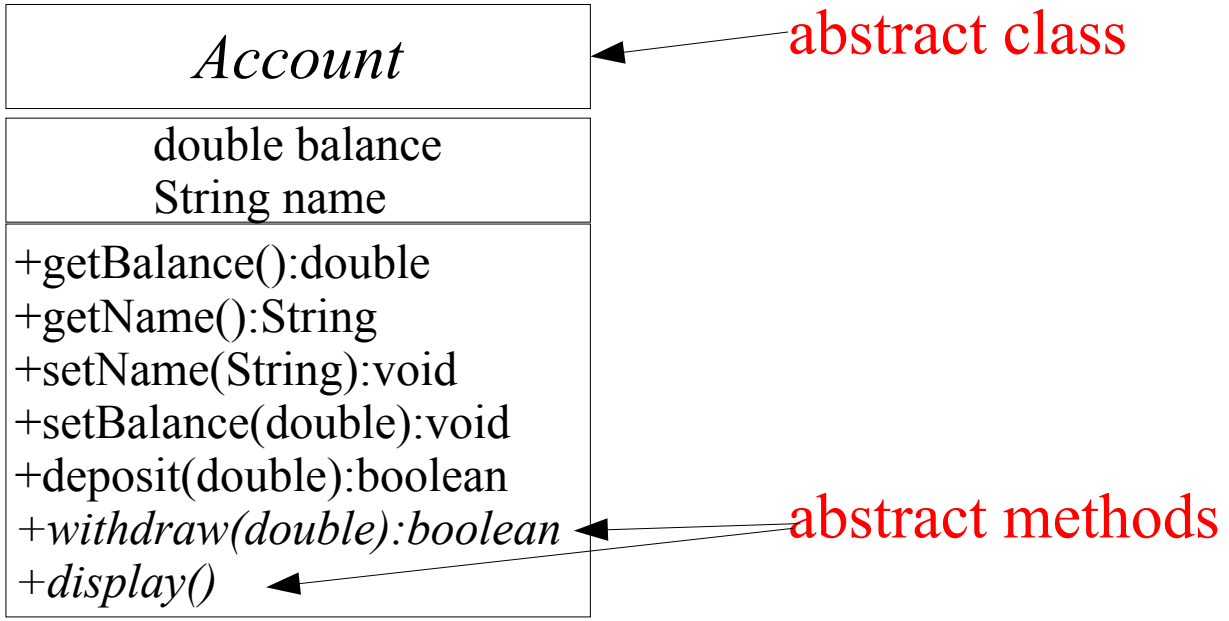
Both types of accounts have these methods and they *behave the same*

Both types of accounts have these methods *but each method behaves differently in each account type*

The Bank Account example

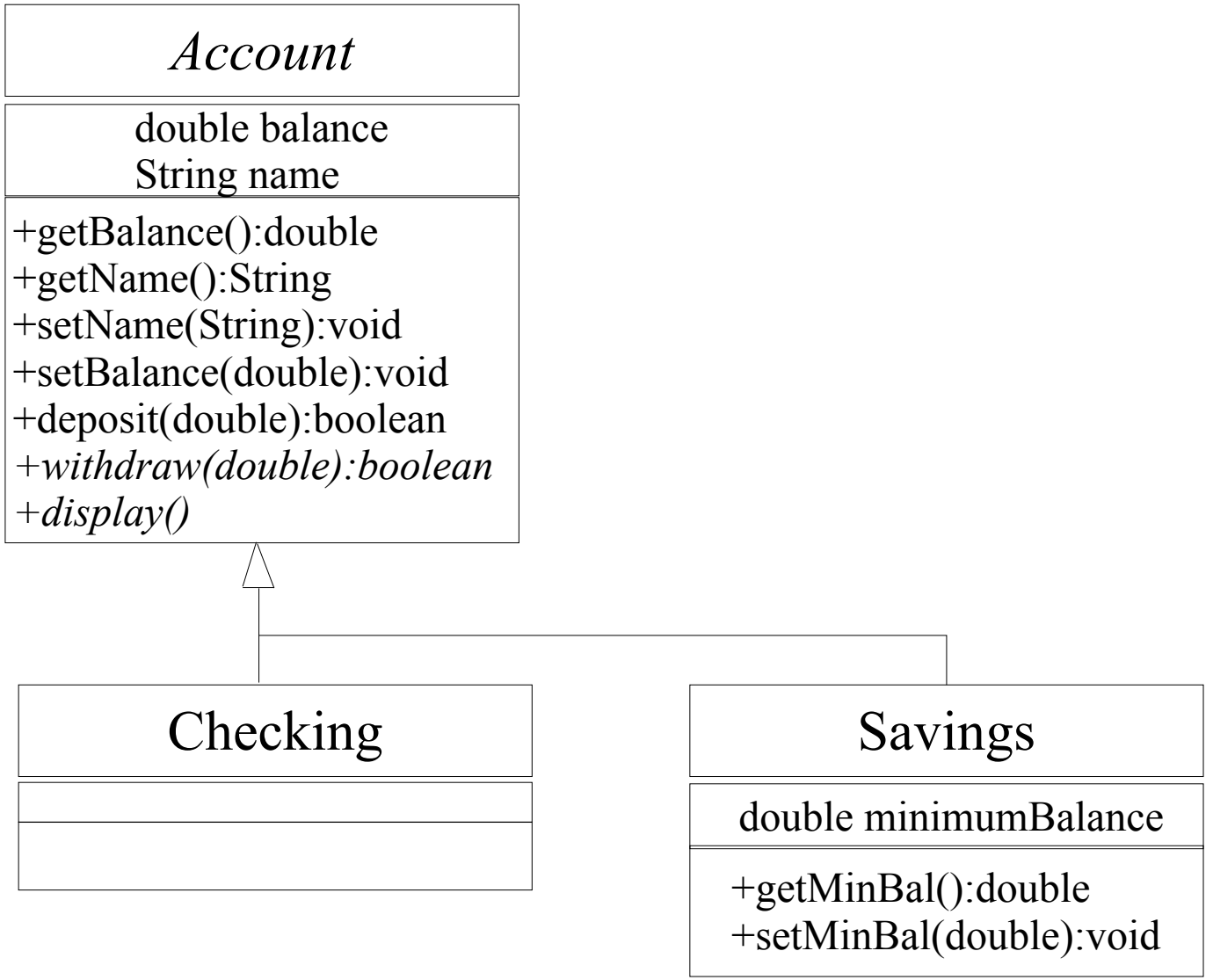
- Account is a generalized idea
- What actually exists in the banking model are savings and checking accounts.
  - both are accounts with specialized operations on them. you can refer to them as accounts but you are using them according what a savings and/or a checking account can do.
- Generalized ideas (i.e. Account) can be directly mapped in java as
  - abstract classes
  - interfaces.

The Bank Account with abstract classes

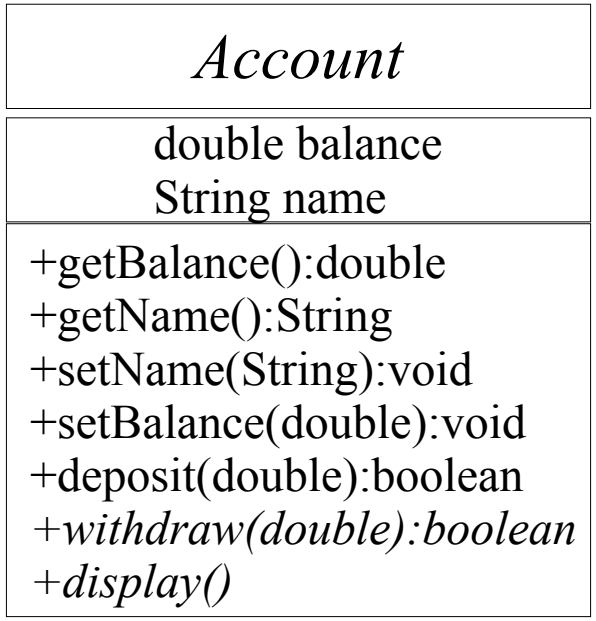


- Abstract classes *cannot* be instantiated
  - there is no constructor !
- Abstract methods *must* be implemented by subclasses of Account
  - there is no body for *withdraw* and *display* inside Account

The Bank Account with abstract classes

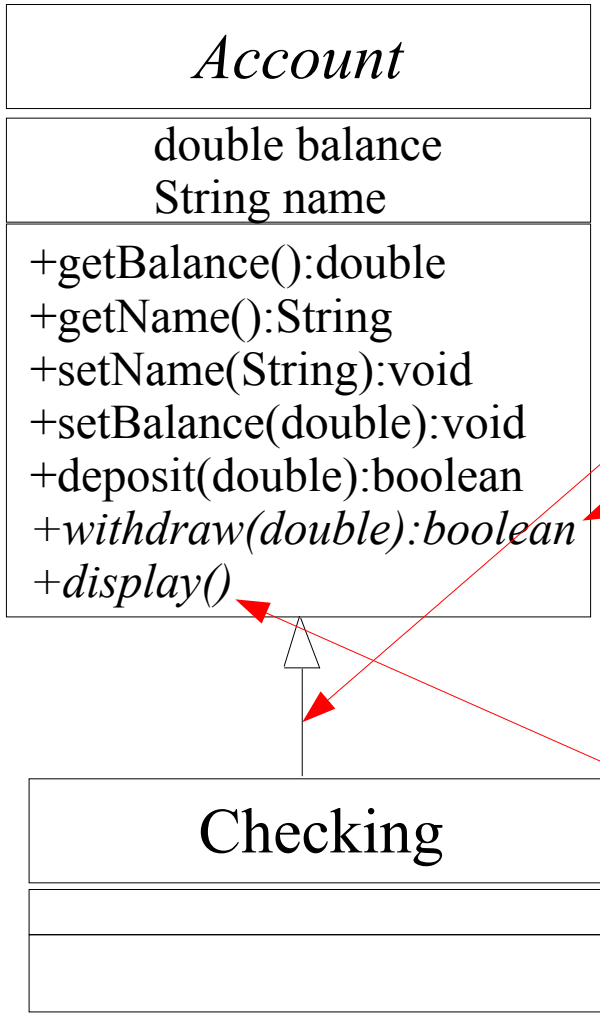


The Bank Account with abstract classes



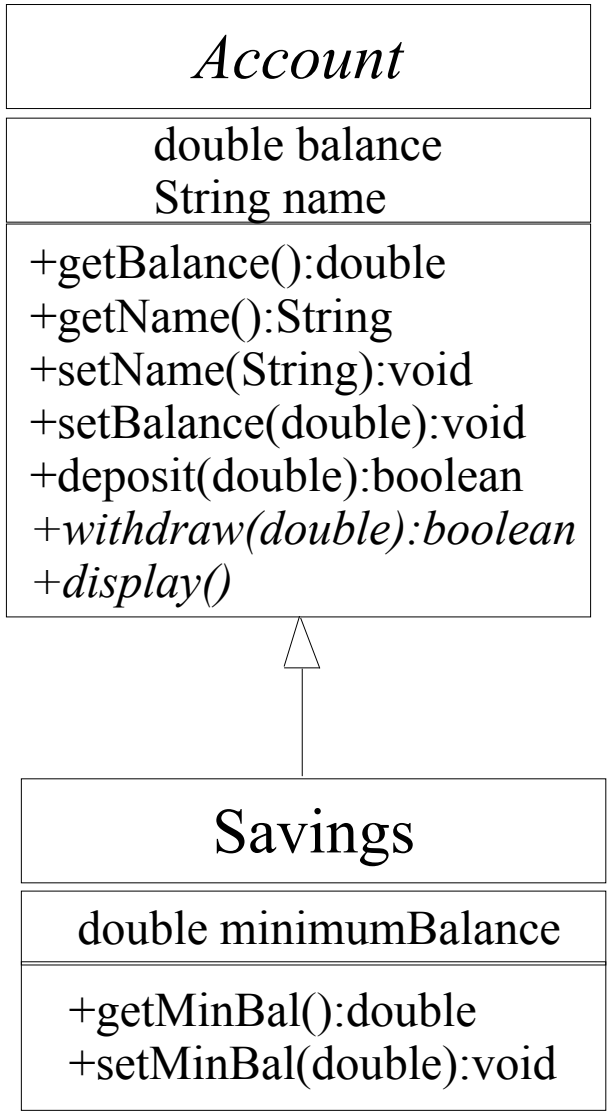

```
abstract public class Account {
  double balance;
   String name;

   public double getBalance(){
     return balance;
   }

   public void setBalance(double val){
     balance = val;
   }

   public String getName(){
     return name;
   }

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

   public boolean deposit(double amount){
     balance = balance + amount;
     return true;
   }

   abstract public boolean withdraw(double amount);
   abstract public void display();
}
```

The Bank Account with abstract classes




```
public class Checking extends Account{
  Checking(String name, double amount){
    this.name = name;
    if (amount > 0){
      this.balance = amount;
    } else {
      // error reporting code omitted
      this.balance = 0;
    }
  }
  public boolean withdraw(double amount){
    if (amount > 0 && amount <= balance) {
      balance = balance - amount;
      return true;
    } else if ( amount > balance){
      // error reporting code omitted
      return false;
    } else {
      // error reporting code omitted
      return false;
    }
  }
  public void display(){
    System.out.println(" ****** Current Account Details
                          ****** ");
    System.out.println(" Name: "+ this.getName());
    System.out.println(" Current Balance: "+
                        this.getBalance());
    System.out.println("\t\t\t\t ****** Current Account
                                  Details ****** ");
  }
}
```

The Bank Account with abstract classes




```
public class Savings extends Account{
  double minimumBalance;
  Savings(String name, double amount, double minBalance){
    this.name = name;
    if (amount > 0){
      this.balance = amount;
    } else {
      // error reporting code omitted
      this.balance = 0;
    }
    if (minBalance > 0){
      this.minimumBalance = minBalance;
    } else {
      // error reporting code omitted
      this.minimumBalance = 0;
    }
  }
  public void setMinBal(double newBal){
    minimumBalance = newBal;
  }

  public double getMinBal(){
    return minimumBalance;
  }

  public boolean withdraw(double amount){
   //code omitted
  }
  public void display(){
    //code omitted
  }
}
```

Overloading the constructor

Distinguish the constructor by number of arguments and types for each argument.

```
public class Savings extends Account{
  double minimumBalance;

  Savings(String name, double amount, double minBalance){
    this.name = name;
    if (amount > 0){
      this.balance = amount;
    } else {
      // error reporting code omitted
      this.balance = 0;
    }
    if (minBalance > 0){
      this.minimumBalance = minBalance;
    } else {
      // error reporting code omitted
      this.minimumBalance = 0;
    }
  }

  Savings(String name, double amount){
    this.name = name;
    if (amount > 0){
      this.balance = amount;
    } else {
      this.balance = 0;
    }
    this.minimumBalance = 0;
  }

}
```

Overloading the constructor

```
public class Main{

  public static void main(String[] args){
   Savings mySavings =
            new Savings(“John”,100.00,50.00);
   Savings anotherSavings =
            new Savings(“Mary”,200.00);
  }
}
```

```
public class Savings extends Account{
  double minimumBalance;

  Savings(String name, double amount,
                       double minBalance){
    this.name = name;
    if (amount > 0){
      this.balance = amount;
    } else {
      // error reporting code omitted
      this.balance = 0;
    }
    if (minBalance > 0){
      this.minimumBalance = minBalance;
    } else {
      // error reporting code omitted
      this.minimumBalance = 0;
    }
  }

  Savings(String name, double amount){
    this.name = name;
    if (amount > 0){
      this.balance = amount;
    } else {
      this.balance = 0;
    }
    this.minimumBalance = 0;
  }

}
```

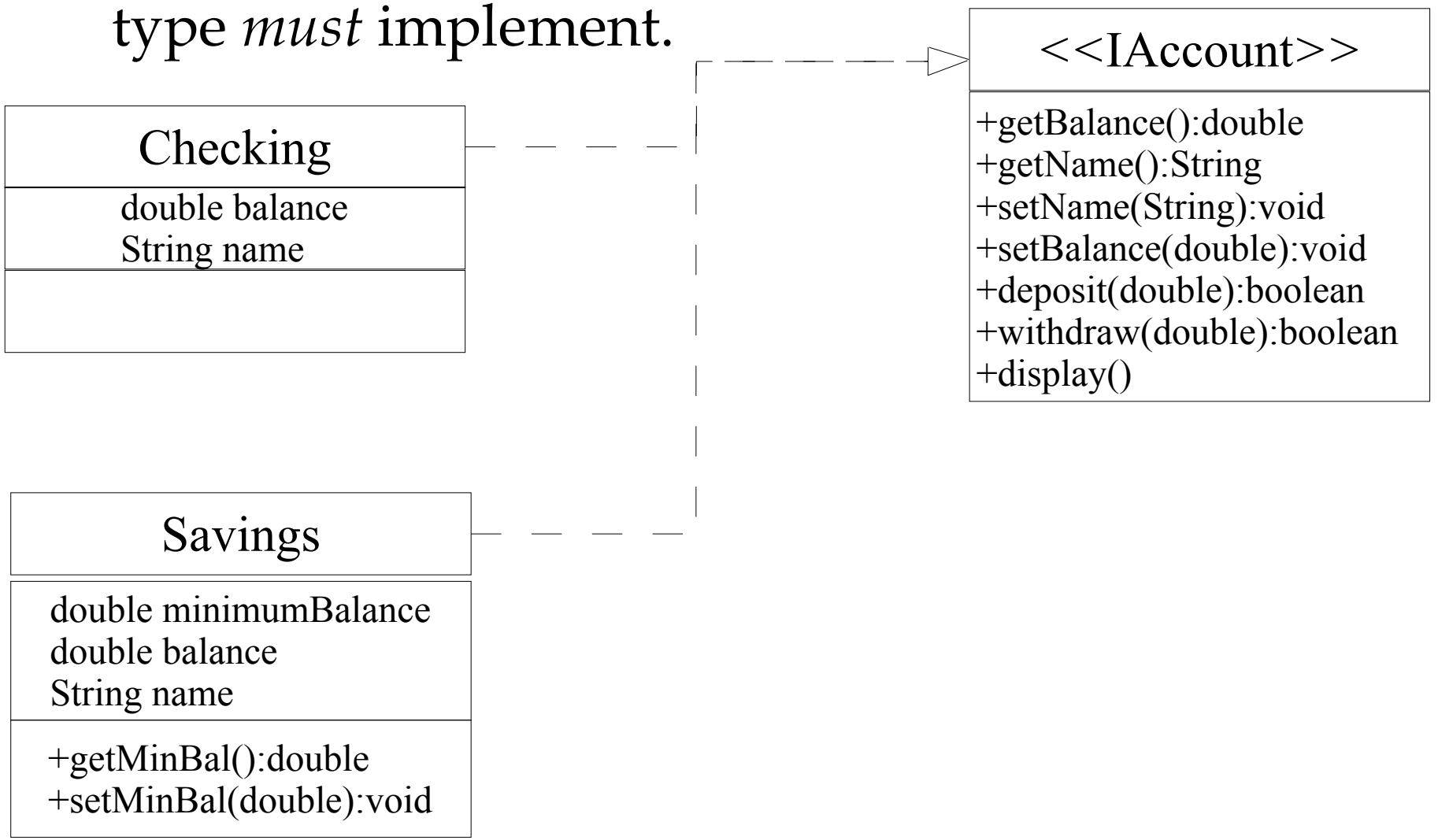
Overloading a method

```
public class Main{

  public static void main(String[] args){
   Savings mySavings =
             new Savings(“John”,100.00,50.00);
   Savings anotherSavings =
             new Savings(“Mary”,200.00);

   mySavings.display();
   mySavings.display(“Today”);
  }
}
```

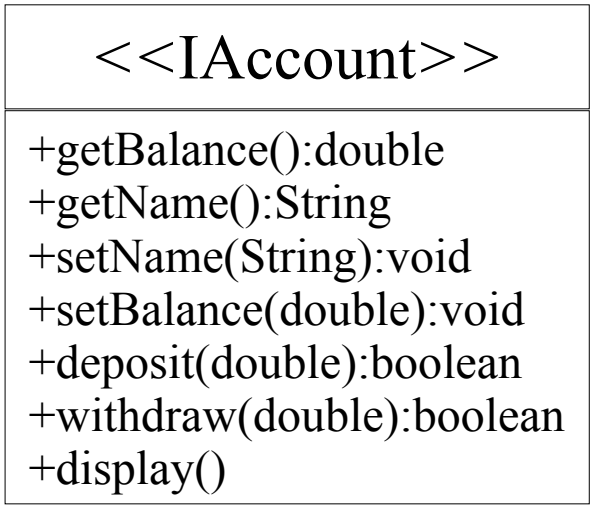
```
public class Savings extends Account{
  double minimumBalance;

  public void display(){
   System.out.println("\n ******
          Savings Account Details ****** ");
   System.out.println(" Name: "+
                this.getName());
   System.out.println(" Current Balance: "+
                this.getBalance());
   System.out.println(" Minimum Balance: "+
                this.getMinBal());
   System.out.println("\t\t\t\t ******
     Savings Account Details ******\n ");
  }

  public void display(String date){
   System.out.println(date+”your balance
              is “+this.getBalance());
  }

}
```

Bank account with interfaces only!

- Interfaces in java define sets of operations that the type *must* implement.



Bank account with interfaces only!




```
interface IAccount {

  public double getBalance();
  public String getName();
  public void setName(String aName);
  public void setBalance(double amount);
  public boolean deposit(double amount);
  public boolean withdraw(double amount);
  public void display();
}
```

- There is no implementation inside interfaces !

Bank account with interfaces only!

Savings
double minimumBalance double balance String name
+getMinBal():double +setMinBal(double):void

```
public class Savings implements IAccount{
  double minimumBalance;
  double balance;
  String name;



// Same as Slide 7
  public double getBalance(){ }
  public void setBalance(double val){ }
  public String getName(){  }
  public void setName(String aName){ }
  public boolean deposit(double amount){ }

// Same as Slide 9
  Savings(String name, double amount){  }
  Savings(String name, double amount,
                 double minBalance){  }
  public void setMinBal(double newBal){  }
  public double getMinBal(){  }
  public boolean withdraw(double amount){ }
  public void display(){ }


}
```

Bank account with interfaces only!

Checking
double balance String name

```
public class Checking implements IAccount{
  double minimumBalance;
  double balance;
  String name;



// Same as Slide 7
  public double getBalance(){ }
  public void setBalance(double val){ }
  public String getName(){  }
  public void setName(String aName){ }
  public boolean deposit(double amount){ }

// Same as Slide 8
  public boolean withdraw(double amount){ }
  public void display(){ }


}
```

Interfaces or Abstract classes

- Java allows you to implement as many interfaces as you like
  - you can only extend one abstract class not more !
- Abstract classes can also contain state (instance variables) and implemented methods
  - interfaces cannot have instance variables (they can have static variables) and cannot have implementations for methods

Interfaces or Abstract classes (cont)

- Both define a type
  - with abstract classes you can also share implementation and enforce method signatures to be implemented later
  - with interfaces you can only enforce method signatures that need to be implemented later
  - A class can implement multiple interfaces but extend *only* one class (concrete or abstract)

Types Revisited

- In Java each interface defines a type. Interface extension and implementation as *subtype* relationships
- A subtype relation in Java is:
  - *if class C_1 extends class C_2 then C_1 is a subtype of C_2*
  - *if interface I_1 extends I then I_1 is a subtype of I*
  - *if class C implements interface I then C is a subtype of I*
  - *for every interface I, I is a subtype of Object*
  - *for every type T , T[ ] is a subtype of Object*
  - *if T_1 is a subtype of T_2 then T_1[ ] is a subtype of T_2[ ]*

Upcasting

- Operation that changes the runtime type of an instance to one of its supertypes (i.e. move up the hierarchy)
  - force an instance that is of type Savings Account to be viewed as of type Account.

```
public class Main{

  public static void main(String[] args){
   Savings mySavings = new Savings("John",100.00,50.00);
   Savings anotherSavings = new Savings("Mary",200.00);
   Checking cAccount = new Checking("Michael", 89.00);
   mySavings.display();
   mySavings.display("Today");

   Account oneAC = (Account) mySavings;
   Account secondAC= (Account) cAccount;
   Account[] allAccounts = new Account[10];
   allAccounts[0] = oneAC;
   allAccounts[1] = secondAC;
  }
}
```

Force mySavings to be used as of type Account

Downcasting

- Operation that changes the runtime type of an instance to one of its supertypes (i.e. move down the hierarchy)
  - force an instance that is of type Account to be viewed as of type Savings Account.

```
public class Main{

  public static void main(String[] args){
   Savings mySavings = new Savings("John",100.00,50.00);
   Savings anotherSavings = new Savings("Mary",200.00);
   Checking cAccount = new Checking("Michael", 89.00);
   mySavings.display();
   mySavings.display("Today");

   Account oneAC = (Account) mySavings;
   Account secondAC= (Account) cAccount;
   Account[] allAccounts = new Account[10];
   allAccounts[0] = oneAC;
   allAccounts[1] = secondAC;

   Savings saveAcc = (Savings) allAccounts[0];
   Savings saveAcc2 = (Savings) allAccounts[1];
  }
}
```

Force the first element of the array that is of type Account to be used as of type Savings

The second element in the list is an instance of Checking Account, stored as of type Account. Casting it to Savings is wrong!