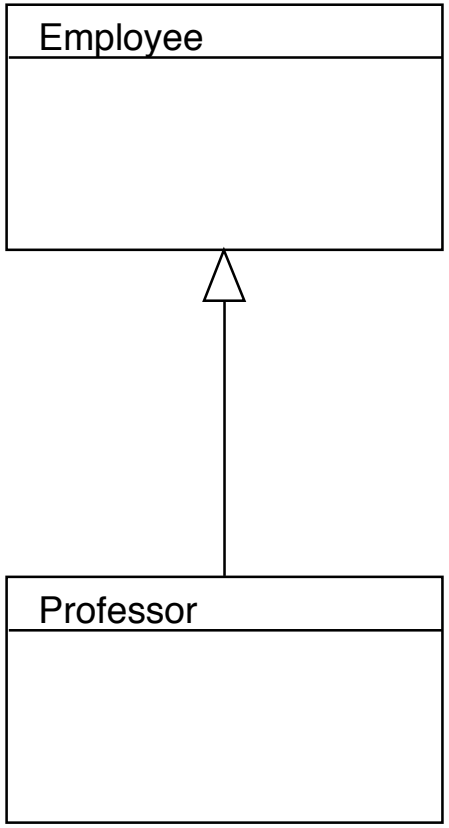
Inheritance

Inheritance

- "Inheritance" is a way of **extending** or building one class on top of another
  - The original class is called the **base class**, or **parent class**.
  - The new class is called the **derived class**, or **child class**.

Diagrammatic Notation (UML)



class Professor
extends
class Employee

UML = Unified Modeling Language

Inherited Capabilities

- **Extension**:
  The derived class can potentially use all data components and methods from the base class, and add more of its own.

- **Over-Riding**:
  It can also selectively re-define or "over-ride" methods of the same name. (It is a good idea to keep the same intuitive meaning of a method.)

Purposes of Inheritence

- **Reusing**: Use the *same* concepts and code for *many* classes (base-class concepts and code shared by derived classes):
  - Work economy: less stuff to implement
  - Intellectual economy : less stuff to understand
- **Generalizing**: Tie together similar classes:
  - Increases the utility of methods that **use** such classes.

Extension = Java Inheritance

- In Java, the keyword for "inherits from" is

  extends

- The derived class *extends* the base class.

- Extension allows over-riding as well; there is no separate keyword for over-riding.

Extension Example

- class **`Account`** defines a basic bank account
- class **`CheckingAccount`** defines a special account for check-writing

```
class Account
{
Money balance;

Account(Money initialBalance)
   {
   balance = initialBalance;
   }

void deposit(Money amount)
   {
   balance = balance.add(amount);
   }

boolean withdraw(Money amount)
   {
   if( balance.lessThan(amount) )
     return false;
   balance = balance.subtract(amount);
   return true;
   }

void showBalance(PrintStream out)
   {
   out.println("Balance: " + balance);
   }
```

Only allow withdrawal if sufficient funds; return boolean to indicate success or failure.

```
class CheckingAccount extends Account
{
Money serviceCharge;

CheckingAccount(Money initialBalance, Money serviceCharge)
   {
   super(initialBalance);
   this.serviceCharge = serviceCharge;
   }

boolean cashCheck(Money amount)
   {
   return withdraw(amount.add(serviceCharge));
   }

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```

Additional variable for the derived class.

"super" means "the constructor of the base class".

Added service charge

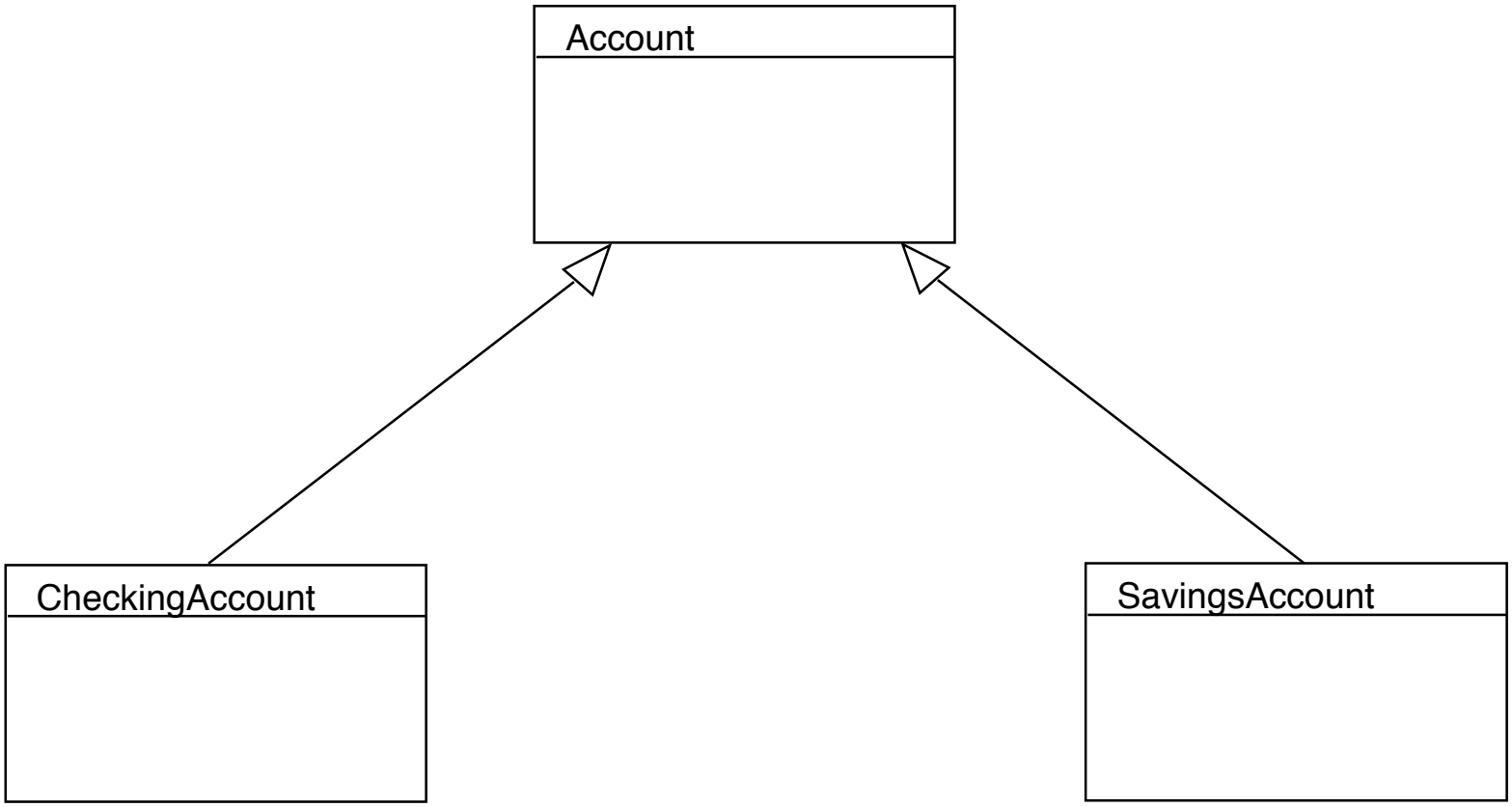
```
(program continued)

  public static void main(String arg[])
  {
  CheckingAccount myCheckingAccount =
    new CheckingAccount(new Money(10000),
                        new Money(100));

  myCheckingAccount.showBalance(System.out);

  myCheckingAccount.deposit(new Money(5000));
  myCheckingAccount.showBalance(System.out);

  myCheckingAccount.cashCheck(new Money(2000));
  myCheckingAccount.showBalance(System.out);

  myCheckingAccount.cashCheck(new Money(1000));
  myCheckingAccount.showBalance(System.out);

  myCheckingAccount.withdraw(new Money(1000));
  myCheckingAccount.showBalance(System.out);
  }
}
```

Program Output

```
Balance: $100.0

Balance: $150.0

Balance: $129.0

Balance: $118.0

Balance: $108.0
```

(Link to the complete program: **Bank**)

Multiple derived classes



Service charge added

No service charge

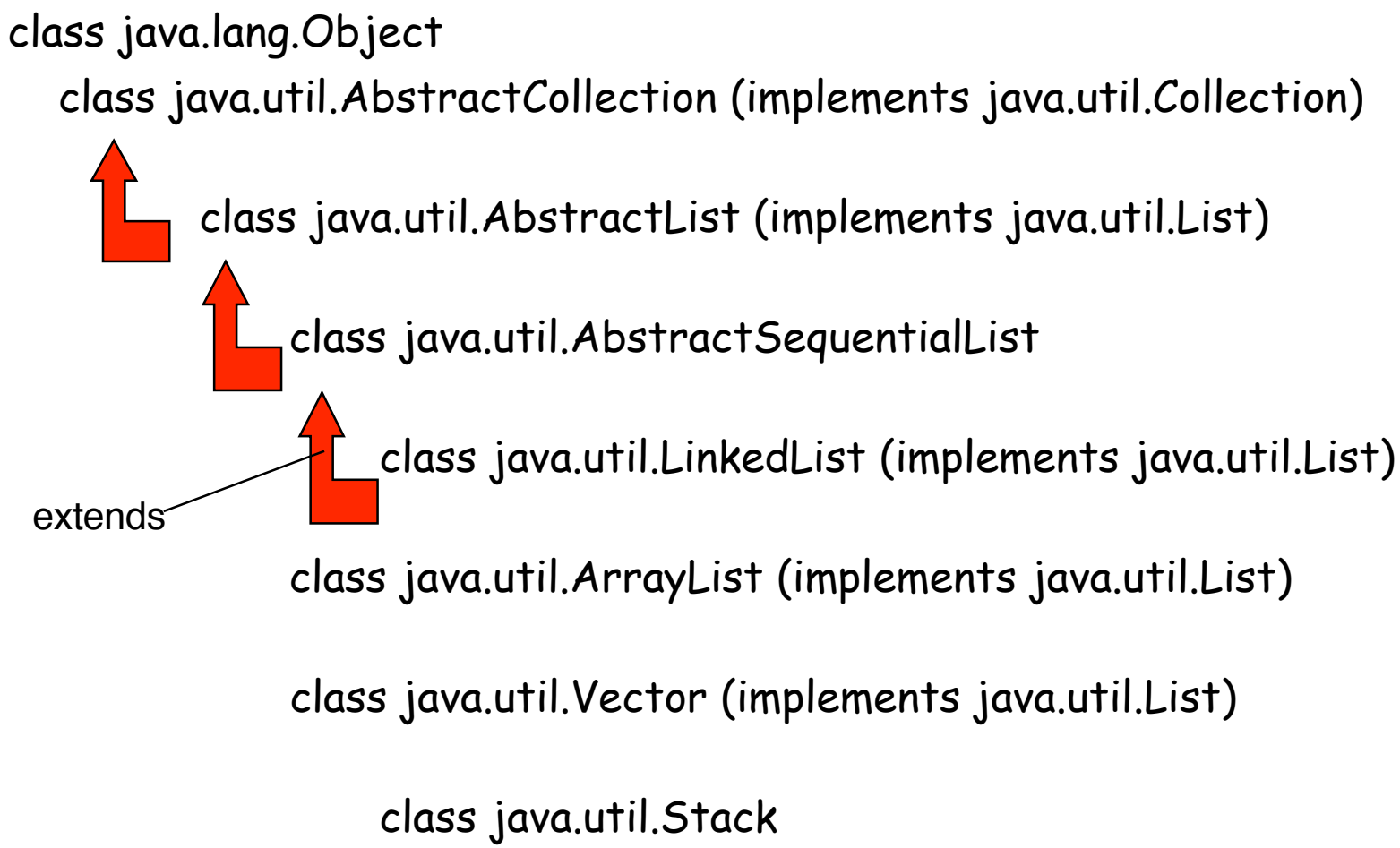
Interest accruing

Which methods can be over-ridden?

- In order to be over-ridden, a method must be declared either:
  - `public`
  - `protected`

in the base class.

Inheritance Examples abound in Java Libraries



Implications of Inheritance

- The preceding diagram means, for example, that to find all methods for class java.util.Stack, you may wish to look at method descriptions in:
  - java.util.Vector
  - java.util.AbstractList
  - java.util.AbstractCollection
  - java.lang.Object

Methods of java.util.Stack

- Methods of Stack proper:
  - Object push(Object item)
  - Object pop()
  - boolean empty()
  - Object peek()
  - int search(Object o)
- Methods of Vector:
  - add, add, addAll, addAll, addElement, capacity, clear, clone, contains, containsAll, copyInto, elementAt, elements, ensureCapacity, equals, firstElement, get, hashCode, indexOf, insertElementAt, isEmpty, lastElement, lastIndexOf, remove, removeAll, removeAllElements, removeElement, removeElementAt, removeRange, retainAll, set, setElementAt, setSize, size, subList, toArray, toString, trimToSize
- Methods of AbstractList:
  - iterator, listIterator
- Methods of Object (not otherwise over-ridden)
  - finalize, getClass, notify, notifyAll, wait

Testing where Object is in Hierarchy

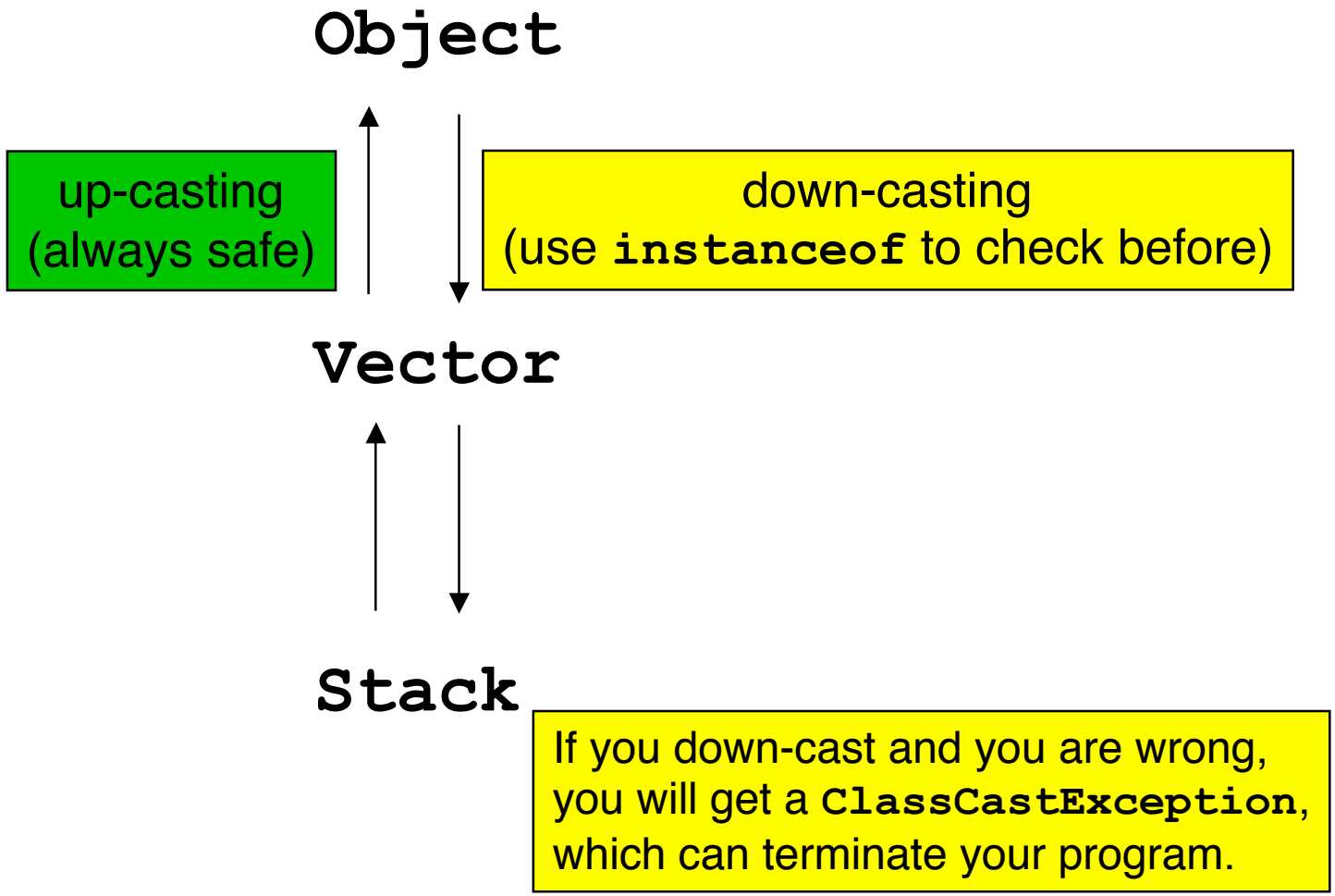
- *instanceof* operator

  Object ob = …;

  if(ob instanceof Vector) …
  if(ob instanceof Stack) …

More than one can be true!

Casting


Object
up-casting
(always safe)
down-casting
(use instanceof to check before)
Vector
Stack
If you down-cast and you are wrong,
you will get a ClassCastException,
which can terminate your program.

class *Object*

- Object is the ancestor of all classes
- Some methods of Object:
  - boolean equals(Object)
  - Class getClass(): returns the "most derived" *Class object*
  - String toString()
- Method of class Class:
  - String getName()
  - So Ob.getClass().getName() will get you the class name of the object.

Implementing an Interface is similar to Inheritance

- Interface ≈ Base Class
- Implementation ≈ Derived Class

- By declaring methods to use the Interface rather than the Implementation class as an argument, more **generality** is afforded to that method.

Example

- `java.util.Iterator` is standard interface
- Make `ClosedList.Iterator` implement `java.util.Iterator`
- Any other code accepting a `java.util.Iterator` can now use our:

  `ClosedList.Iterator`

- We can *still* do everything we did before.

Discussion

- Are there any opportunities for Inheritance in SLQueue vs. DLDeque?

Multiple Inheritance

- Some languages allow one class to derive from **multiple** base classes; Java does not.
- The nearest thing would be a class deriving from a **single** basic class and implementing one or more interface at the same time.