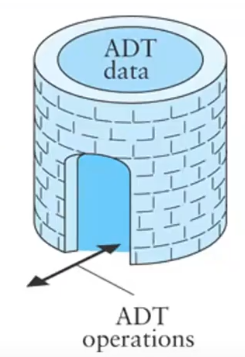
**OBJECT-ORIENTED PROGRAMMING AND CLASS HIERARCHIES**

***ADTs, Interfaces, and the Java API***

ADTs:

* Encapsulation of data and methods.
* Allows for reusable code
* The user need not know about the implementation of the ADT
* ADTs facilitate storage, organization, and processing of information
* Such ADTs often are called data structures
* The Java Collections Framework (part of the Java API) provides implementations of common data structures.
* Interface is good fit for ADT bc we only need methods.

Interfaces:

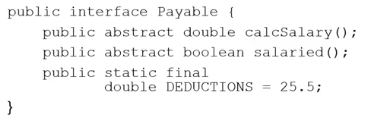
* Fields 🡪 public , static , final (constant)
* Methods 🡪 public abstract

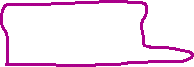
boolean verifyPIN(String pin);

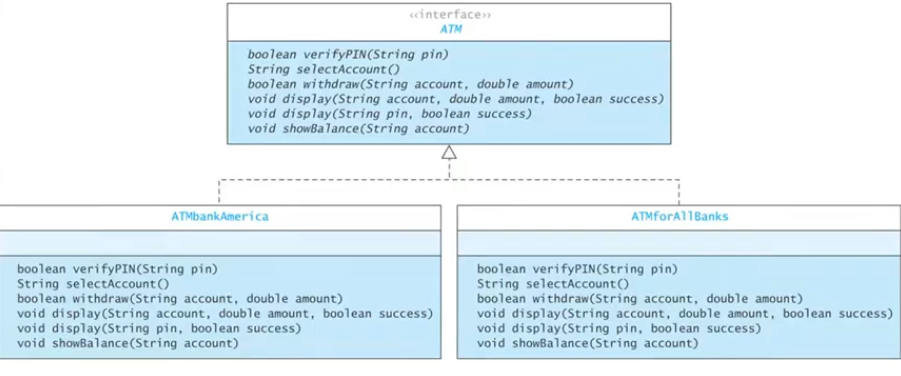
* An interface specifies or describes an ADT to the applications programmer:
  + the methods and the actions that they must perform
  + what arguments, if any, must be passed to each method
  + what result the method will return
* The interface can be viewed as a contract which guarantees how the ADT will function
* A class that implements the interface provides code for the ADT
* As long as the implementation satisfies the ADT contract, the programmer may implement it as he or she chooses
* In addition to implementing all data fields and methods in the interface, the programmer may add:
  + data fields not in the implementation
  + methods not in the implementation

optional

* + constructors (an interface can’t contain constructors because it cannot be instantiated and fields are constant)

DEDUCTIONS are accessible in classes that implement the interface





*If you don’t implement methods in ATMbankAmerica or ATMforAllBanks, then you should define them as abstract classes. Otherwise you get an error.*

You can do 🡪 ATM anATM;

You can do 🡪 ATM anATM = new ATMbankAmerica();

You can’t do 🡪 ATM anATM = new ATM();

Object-Oriented Programming:

* enables reusability
* codes can be extended
* inheritance 🡪 superclass - subclass in JAVA
* subclass may define other variables and methods that are not contained in superclass
* subclass constructor must begin with:

super(. . .);

* + If you don’t call super class’s constructor, than “super();” (no parameter constructor of superclass) will be called automatically
  + If there is no no parameter constructor for superclass, then you get compiler error
* If no constructors are defined for a class, no param constructor is provided by default
* You can access super class’s methods by “super.methodName();”

![Table

Description automatically generated](data:image/jpeg;base64,/9j/4AAQSkZJRgABAQEAYABgAAD/4RDaRXhpZgAATU0AKgAAAAgABAE7AAIAAAAFAAAISodpAAQAAAABAAAIUJydAAEAAAAKAAAQyOocAAcAAAgMAAAAPgAAAAAc6gAAAAgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAE1lcnQAAAAFkAMAAgAAABQAABCekAQAAgAAABQAABCykpEAAgAAAAMyMgAAkpIAAgAAAAMyMgAA6hwABwAACAwAAAiSAAAAABzqAAAACAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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4rvb+vLXciLbgn3Vz6DopFbcobpkZ5pagrcKKKKACiiigAooooAKKKKACkYkKSgBbHAJxk0tFAHLeCfHNv4xTUoWs5dN1LSrpra9sJ3DPER0bI6qcHB9jSy+NoW+I0XhDTrKS8uEtvtN9cK4Edmh+6G45Zuw9wa4v4qC4+HmvwfE3QoVk+QWOr2e7aLpG4if8A3lbaM9cY966z4ceEpvDWhy3eryLca9q8v2zU7kc7pG6ID/dQHAH19aI6q/bf1/rX8Alo7d9vT+tPxOwooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigDh/E/xT0rwl8QNH8MavBJGNVjDJe7x5cRLFVDD3Ixntmtzxn4ni8G+D7/X57Z7qOyRWaFGClssF6n615t498NWHi/47Weh6qm63u/DM67gOY283KuvuDgj6Vh694mv5vgd4u8H+KX/AOKi8PxRwysx/wCPuDzU8uceuRjPvjPWpT9zz1+67X4f1sWkvaJdNF96T/G/9XPfbeXz7aKYDAkQNj0yM1JVbTv+QXa/9cU/9BFWa0krSaMoNuKbCiiipKCiiigAooooAKKKKACiiigAooooAKKKKACiiigDmPiF42g+H3hGXXrqzkvI45UjMUbhSdxxnJrW0DXbHxNoFnrGkyia0vIhJG3cZ6g+hByCPUVwXx/APwvwRkHUrT/0aKp6OT8Kfia2gS/J4V8TTNNpjn7lndn70PsrdR+A9TRDW6fey+5O3zv+nUJabdtfvf5W/qx3Xg3xZF4x0i5v4LV7VYL2a0KO4YkxttLcetdBXnHwQ/5EzU/+w7ff+ja9HoXwp+S/IOr9X+YUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFAEdxMLe1lmI3CNC+PXAzXH/DT4m6V8TNGnvNOie0uLWTZPaSuGZAfutkdQeefUGur1L/AJBV3/1wf/0E185eDrC68H/DXwp8S9BhaT7LFJb67axjm5tDM/z47snXPpjsKI2u77afK9/8v1CV7K2+v4WPdoPFkU3xEuvCYtXEtvpyX5uN42sGfZtx68ZzXQV5foF/a6r+0Le3+nzLPa3Pha3lilQ5DqZiQa9Qp2fKr+f5tCveTt5fkmFFFFIYUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFcj8Vv+SR+KP+wZN/6Aa66qWs6Raa9ol5pOpIz2l5C0MyqxUlWGCMjpUzTlFpFQdpJs8q07Q/iH4i+F+m+GJpdHh0y8sYY5dXWWQzm1ZB8ghK48zb8pO7H411Nt4JuNP+KOk6tYLEmj6doB0xFL/OGDgrxjptHWuysLKHTdOtrG1BWC2iWGME5IVQAOfoKnrWTTm5L+tGv1M4pqKi/62f6HH2vhnUIvjLfeJ38r+z59Gjskw/z+YspY8Y6YPWsC2+GV/D8aX19poT4dWV9Sitt3zC+eNY2YrjGMAtn1Nen0VC0t5X/F3/Mp638/8rfkec6p4W8T6T8VLvxf4ZttM1WPULKO1mtr+4aCS3KdDG4RvlPcY60zwz4M8U23xI1nxD4nubCdNY0xbdhZ7gts6tgRqG5ZdvO44JJPAr0milZWt6/je/5ju739Pwt/keR6Z8MtfufhSvgrWns7GfSZUm0nVLSZpd0iyM6syFRtxkDqep9K2ZLT4n659gsNQl0fQoIZke+1DTbmSWW4VeSsSMgCBu+4nr+B9Doqru936/PuTZWsv6QUUUUhhRRRQAUUUUAFFFFABRRRQAUUUUAcT8XPCmo+NfhzeaJovk/a5pYXXzn2rhZAx5wewrtIlKRIp6hQDTqKForfP+vuB6tPsFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAcXeeFdRn+NOneKE8n+zrbSJLN8v8/mM+4YGOmO+a5/40fCm78eWUF/4bmitdahX7PIZHKLc25OSjEA9CAR+PtXqlFK2iXb/ADv+o7tNv+v60IbSJobGCJ8bkjVTj1AxU1FFU3d3JSsrBRRRSGFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFAHGfFXwrqPjHwUNL0fyftH2yCb98+1dqOGPODzitPxx4Rs/G/hO70a9PltIN9vOv3oJl5Rx7g/mMjvXQUUraW+f5f5DTs7/wBdf8zhvhD4T1jwZ4GOmeI5IZb9ryaeSSGQuH3nOckDk813NFFU3clKwUUUUhhRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQBDeRNPYzxJjdJGyrn1IxXKfDPwpdeGPhfpvhzXkglnhjljnRDvjYM7HHI5GGrsaKO/n/wf8w7eR5R8OfhXqPgT4l6zfrcpPoMtp9n05WlLSQqZBJ5ZBHABLYOefxr1eiijol2Dq33CiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigD//2Q==)

Diagram

Description automatically generated

A screenshot of a computer

Description automatically generated with medium confidence

When overriding a method, the method must have same name, same number and types of parameters in the same order.

If not, method will overload.

The annotation @Override preceding an overridden method will signal the compiler to issue an error if it does not find a corresponding method to override:

@Override

public String toString() { … }

USE THE @Override ANNOTATION IN YOUR CODE.

Polymorphism:

* enables JVM to determine at run time which of the classes in a hierarchy is referenced by a superclass variable or parameter

Computer theComputer = new Notebook(“Bravo”, “Intel”, 4, 240, 2/4, 15);

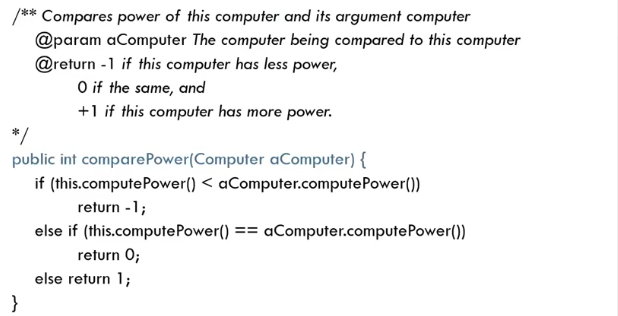
System.out.println(theComputer.toString());

Which toString method will be called (Computer is super, Notebook is sub)?

Notebook’s toString method will be called.

JVM identifies theComputer as Notebook and calls the toString() method associated with Notebook.

Type cannot be determined at compile time, but it can be determined at run time.



You can compare computer with a notebook bc notebook IS A computer.

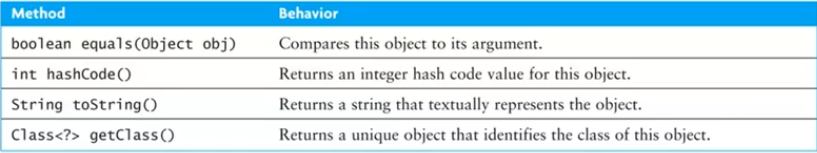
Abstract Classes:

* {*visibility*} abstract class {*className*}
* cannot be instantiated
* may declare abstract methods
  + {*visibility*} abstract {*returnType*} {*methodName*} (*parameters*);
* concrete class that is a subclass of an abstract class must provide an implementation for abstract methods
* USE AN ABSTRACT CLASS IN A CLASS HIERARCHY WHEN YOU NEED A BASE CLASS FOR 2 OR MORE SUBCLASSES THAT SHARE SOME ATTRIBUTES
* Table

  Description automatically generatedInterfaces cannot have constructors but abstract classes can.

Class Object:

* Object is the root of the class hierarchy
* Every class has Object as a superclass



*(equals’ı override ettiysen hashCode’u da override etmelisin)*

If you don’t override toString you get: “ArrayBasedPD@ef08879” (name of the class, @, instance’s hash code).

You can do 🡪 Object athing = new Integer(25);

This is legal 🡪 athing.toString();

This is not legal 🡪 athing.intValue();

Object has a toString() method, but it does not have an intValue() method. Even though Integer does, the reference is considered of type Object.

You can do 🡪 athing.equals(new Integer(“25”)); 🡪 equals method of Integer class will be called if it is overridden in Integer (yes it is). If not, JVM will go up to the Object class’s equals method and it will be called.

You can’t do 🡪 Integer aNum = aThing;

You can do this 🡪 Integer aNum = (Integer) aThing;

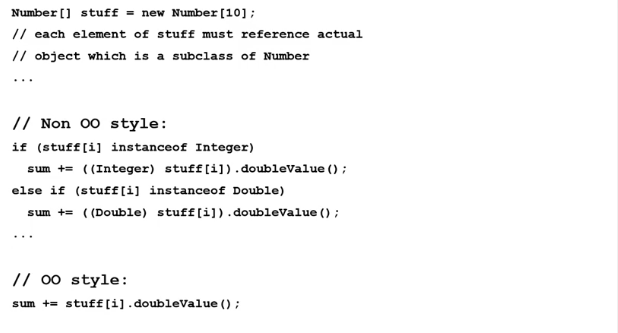
* Casting does not change the object. It creates an anonymous reference to the object.



Downcast:

* Cast superclass type to subclass type
* Java checks at run time to make sure it’s legal
* If it’s not legal, it throws ClassCastException

You can check with “instanceof”. 🡪 if (obj instanceof Integer) { … }

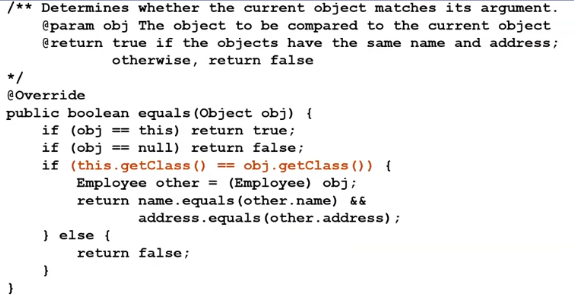


Leave JVM to resolve the thing and checks whether the stuff[i] is of type Integer or Double.

So try to avoid using instanceof operator as much as possible.

Object.equals method has a parameter of type Object so you can’t change it! If you change parameter type then it is not overriding but overloading.

public boolean equals (Object other) { … }



Class **Class**:

* Every class has a Class object that is created automatically when the class is loaded into an app
* When you define a class, Java compiler provides an object of type class for you.
* Each Class object is unique for the class
* Method getClass() is a member of Object that returns a reference to this unique object
* If “this.getClass() == obj.getClass” is true in the previous example, then we know that obj and this are both of class Employee

