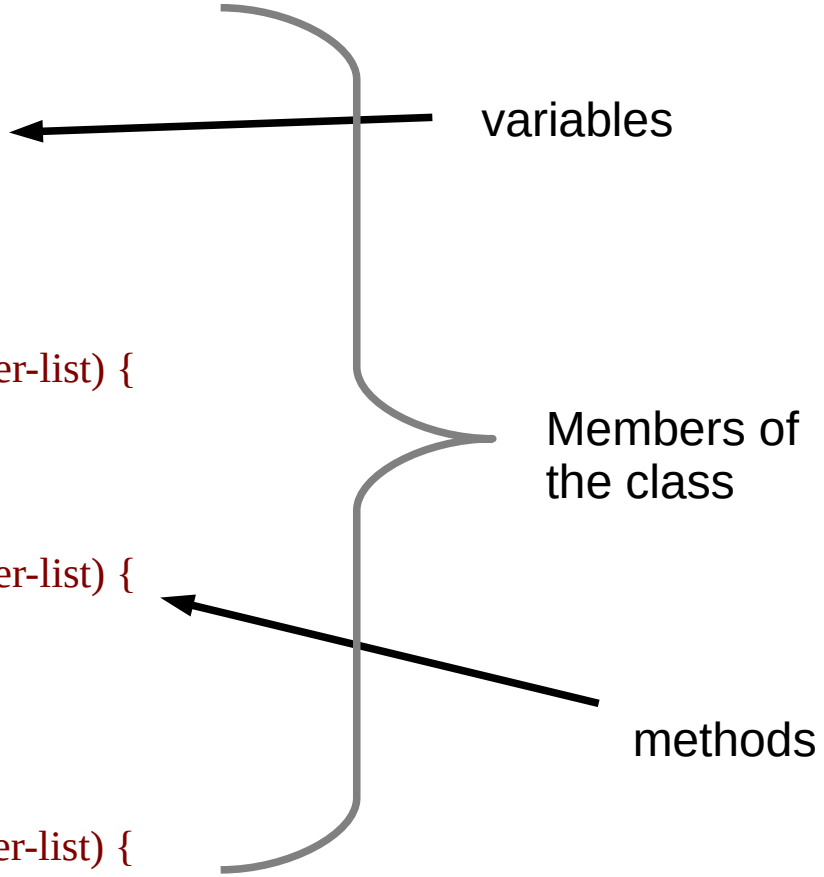
Java classes

Class and Object

- A class provides **template** for an object
- An object is an **instance** of a class.
- In run-time, a number of instances of class is created
- The state of an object represented by data fields (properties or attributes) with their current values
- The behavior of an object (its actions) is defined by methods

A simple form of class

```
class classname {
     type instance-variable1;
     type instance-variable2;
     // ...
     type instance-variableN;

    type methodname1(parameter-list) {
        // body of method
    }
    type methodname2(parameter-list) {
       // body of method
    }
    // ...
    type methodnameN(parameter-list) {
       // body of method
    }
}
```

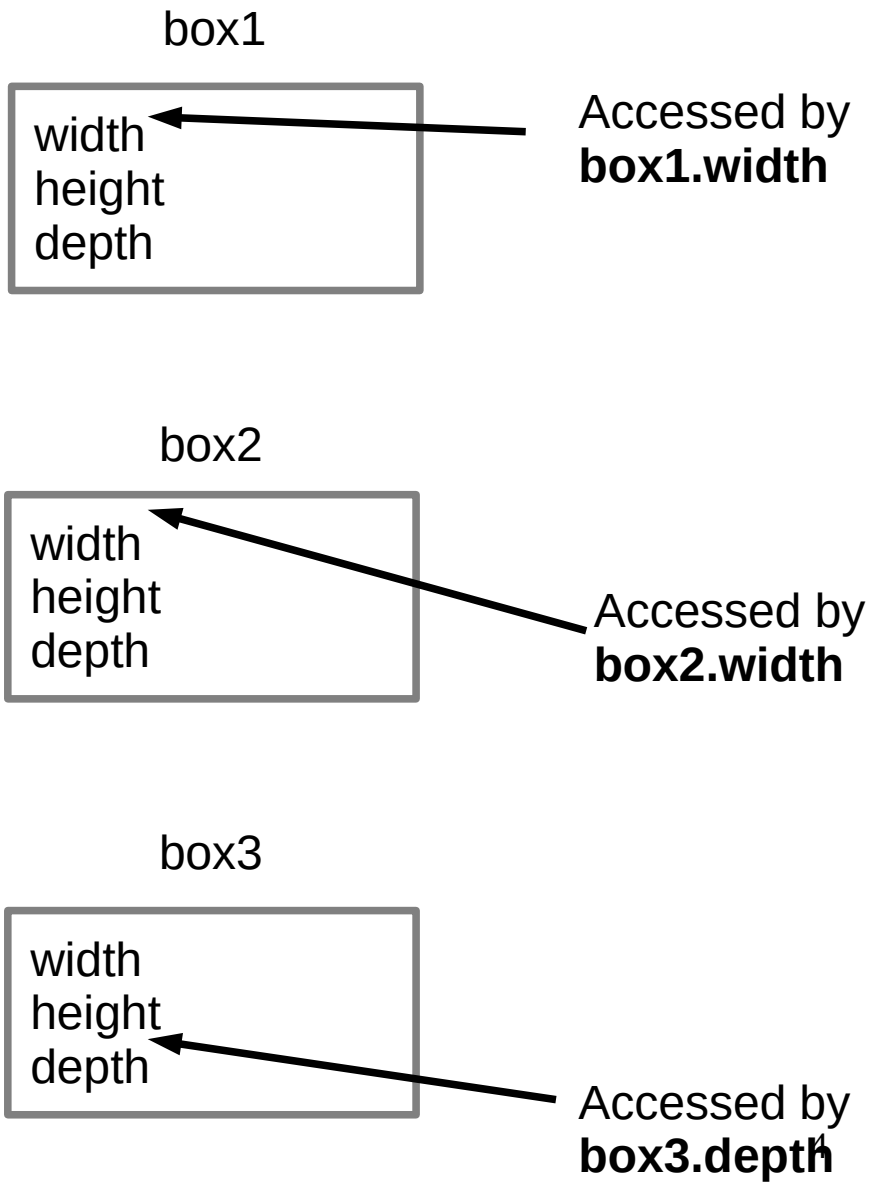


Example

```
class Box {
        double width;
        double height;
        double depth;
}
```

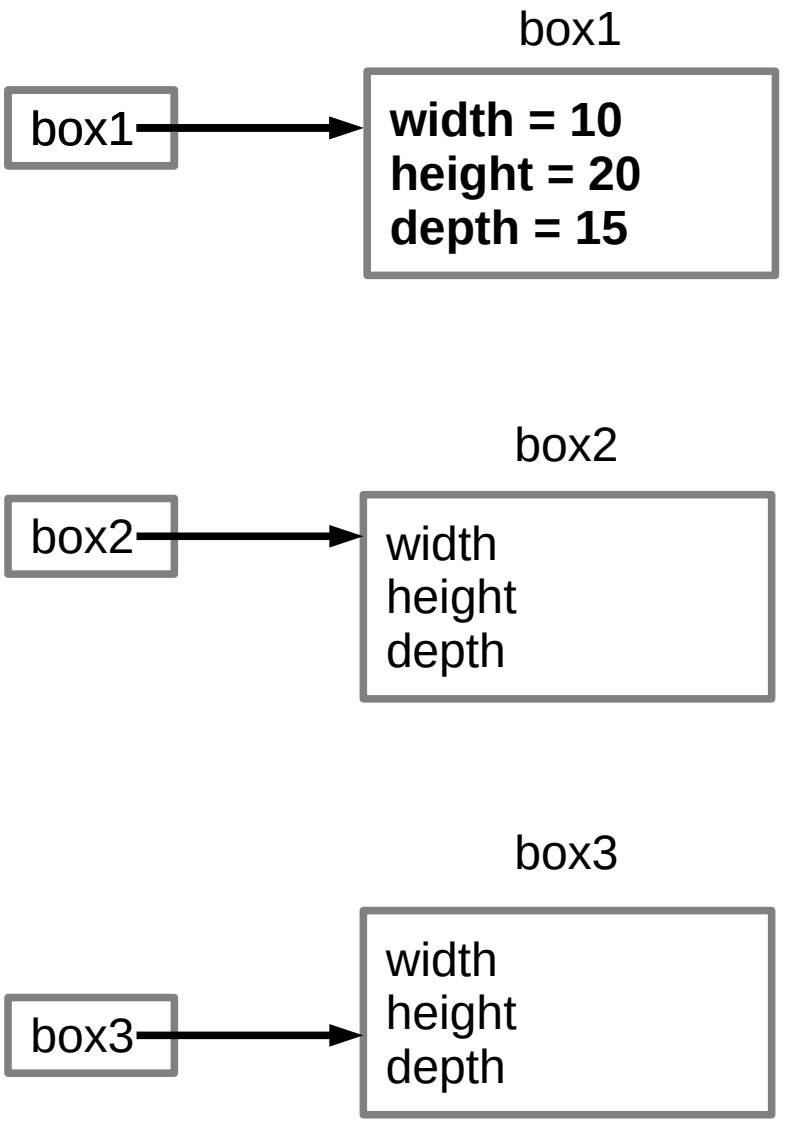
Creating objects of Box class

```
Box box1 = new Box();
Box box2 = new Box();
Box box3 = new Box();
```



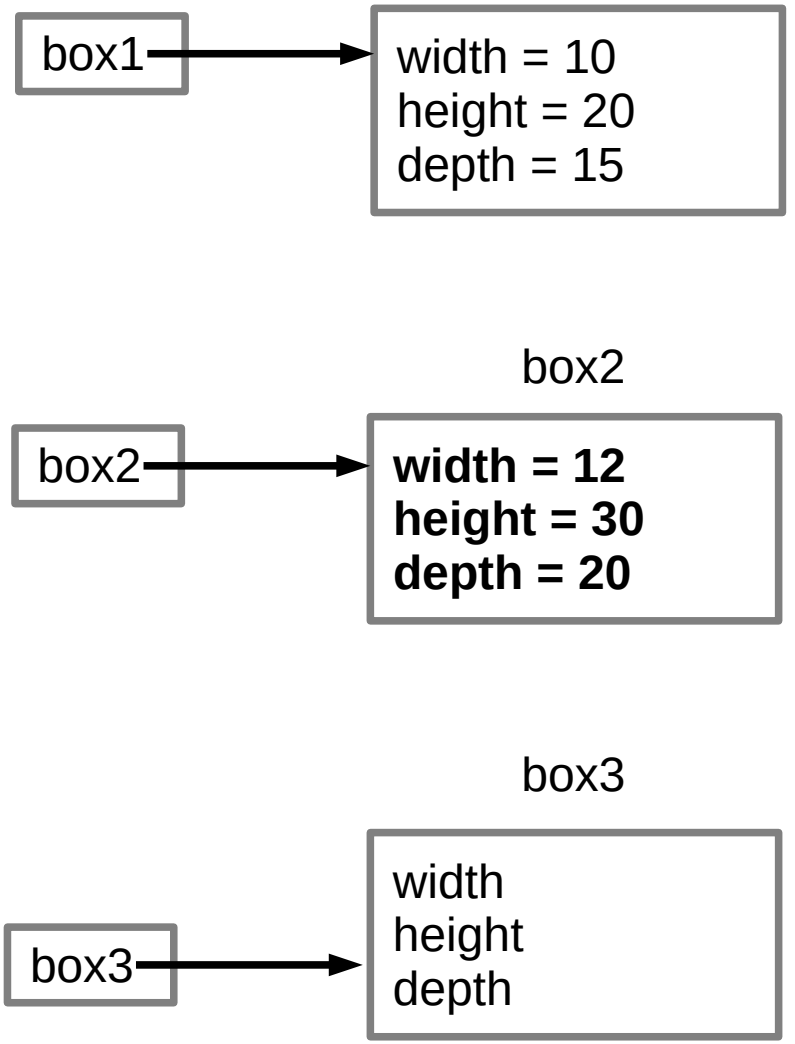
Example

```
class Box {
  double width;
  double height;
  double depth;
}

class BoxDemo {
  public static void main(String args[]) {
    Box box1 = new Box();
    Box box2 = new Box();
    Box box3 = new Box();

    box1.width = 10;
    box1.height = 20;
    box1.depth = 15;

    box2.width = 12;
    box2.height = 30;
    box2.depth = 20;

    double vol;
    vol = box1.width * box1.height * box1.depth;
    System.out.println("Volume of box1 is " + vol);

    vol = box2.width * box2.height * box2.depth;
    System.out.println("Volume of box2 is " + vol);

  }
}
```



Example(2)

```
class Box {
  double width;
  double height;
  double depth;
}

class BoxDemo {
  public static void main(String args[]) {
    Box box1 = new Box();
    Box box2 = new Box();
    Box box3 = new Box();

    box1.width = 10;
    box1.height = 20;
    box1.depth = 15;

    box2.width = 12;
    box2.height = 30;
    box2.depth = 20;

    double vol;
    vol = box1.width * box1.height * box1.depth;
    System.out.println("Volume of box1 is " + vol);

    vol = box2.width * box2.height * box2.depth;
    System.out.println("Volume of box2 is " + vol);

  }
}
```



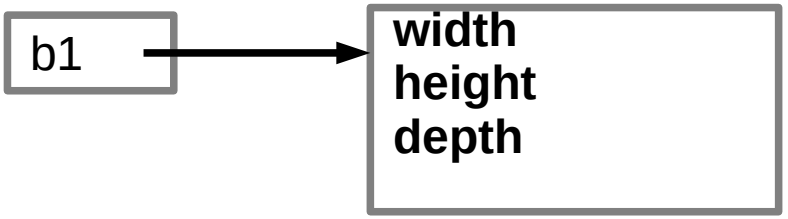
Two steps involved in object declaration

- Box box1;
  - Declare a reference to object
  - Its simply a variable that can refer to an object
- box1 = new Box();
  - new operator dynamically allocates memory for object of type Box and returns a reference to it.
  - Box() specifies the constructor for the class Box.
  - A constructor defines what occurs when an object of a class is created.

What will be result of the following statement?

Box b1 = new Box();

Box b2 = b1;

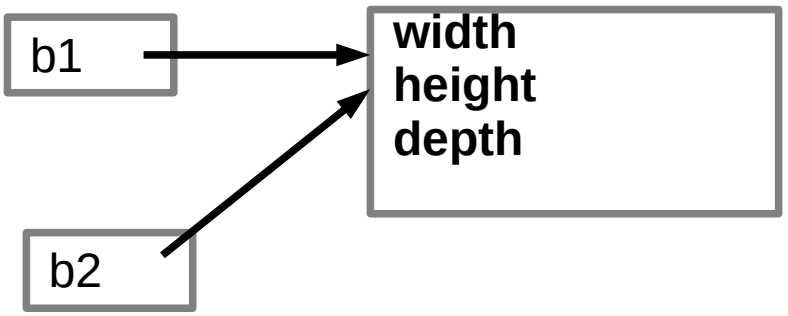


???

Assignment of object reference variable

Box b1 = new Box();

Box b2 = b1;



- The assignment of b1 to b2 did not allocate any memory or copy any part of the original object.
- It simply makes b2 refer to the same object as does b1.
- Any changes made to the object through b2 will affect the object to which b1 is referring

Method example

```
class Box {
        double width;
        double height;
        double depth;

        void volume() {
           System.out.print("Volume is ");
           System.out.println(width * height * depth);
        }
}

class BoxDemo3 {
        public static void main(String args[]) {
                Box mybox1 = new Box();
                Box mybox2 = new Box();

                mybox1.width = 10;
                mybox1.height = 20;
                mybox1.depth = 15;

                mybox2.width = 3;
                mybox2.height = 6;
                mybox2.depth = 9;

                // display volume of first box
                mybox1.volume();
                // display volume of second box
                mybox2.volume();
        }
}
```

Method with parameters

```
class Box {
  double width;
  double height;
  double depth;

  // compute and return volume
  double volume() {
    return width * height * depth;
  }

  // sets dimensions of box
  void setDim(double w, double h, double d)
{
    width = w;
    height = h;
    depth = d;
  }
}
```

```
class BoxDemo5 {
  public static void main(String args[]) {
    Box mybox1 = new Box();
    Box mybox2 = new Box();
    double vol;

    // initialize each box
    mybox1.setDim(10, 20, 15);
    mybox2.setDim(3, 6, 9);

    // get volume of first box
    vol = mybox1.volume();
    System.out.println("Volume is " + vol);

    // get volume of second box
    vol = mybox2.volume();
    System.out.println("Volume is " + vol);
  }
}
```

Another example

```
public class TV {
        int channel = 1; // Default channel is 1
        int volumeLevel = 1; // Default volume level is 1
        boolean on = false;

        public void turnOn() {
                on = true;
        }
        public void turnOff() {
                on = false;
        }
        public void setChannel(int newChannel) {
                if (on && newChannel >= 1
                                && newChannel <= 120)
                        channel = newChannel;
        }
        public void setVolume(int newVolumeLevel) {
                if (on && newVolumeLevel >= 1
                                && newVolumeLevel <= 7)
                        volumeLevel = newVolumeLevel;
        }
```

```
public void channelUp() {
                if (on && channel < 120)
                        channel++;
        }
        public void channelDown() {
        if (on && channel > 1)
                channel--;
        }
        public void volumeUp() {
                if (on && volumeLevel < 7)
                        volumeLevel++;
        }
        public void volumeDown() {
                if (on && volumeLevel > 1)
                        volumeLevel--;
        }
}
```

Constructor

- Java allows objects to initialize themselves when they are created using a constructor.
- Constructors have the same name as the class in which it resides and is syntactically similar to a method.
- Once defined, the constructor is automatically called immediately when the object is created, before the new operator completes.
- Constructors have no return type because, the implicit return type of a class constructor is the class type itself.

Example of constructor

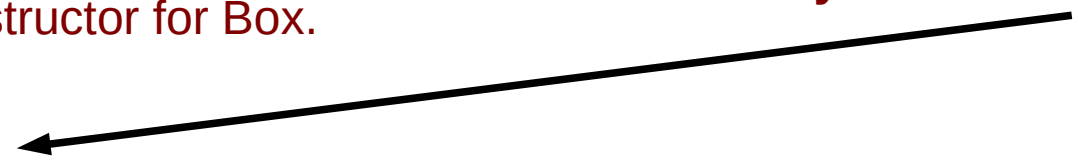
```
class Box {
    double width;
    double height;
    double depth;
    // This is the constructor for Box.
    Box() {
       System.out.println("Constructing Box");
       width = 10;
       height = 10;
       depth = 10;
    }
    double volume() {
       return width * height * depth;
    }
}
```

Box mybox1 = new Box();

Example of parameterized constructor

```
class Box {
    double width;
    double height;
    double depth;
    // This is the constructor for Box.

    Box(double w, double h, double d) {
       System.out.println("Constructing Box");
       width = w;
       height = h;
       depth = d;
    }
    double volume() {
       return width * height * depth;
    }
}
```

Box mybox1 = new Box(10, 20, 15);



The this Keyword

- Sometimes a method will need to refer to the object that invoked it.
- Java defines the **this** keyword can be used inside any method to refer to the current object.
- **this** is always a reference to the object on which the method was invoked.
- Can be used anywhere as reference to an object of the current class' type.

Consider the following

```
class Box {
    double width;
    double height;
    double depth;
    // This is the constructor for Box.

    Box(double width, double height, double depth)
{
        width = 10;  which width ?
        height = 10; which height?
        depth = 10; which depth?
    }
}
```

Use of this to resolve namespace-collision

```
Box(double width, double height, double depth) {
    this.width = width;
    this.height = height;
    this.depth = depth;
}
```

Garbage Collection

- Automatic memory deallocation technique is called **garbage collection**.
- When no references to an object exist, that object is assumed to be no longer needed, and the memory occupied by the object can be reclaimed.
- There is no explicit need to destroy objects as in C++.
- Garbage collection only occurs sporadically (if at all) during the execution of your program.
- Different Java run-time implementations will take varying approaches to garbage collection

The finalize( ) Method

- It is the alternate term for destructors in C++
- It defines an action to be performed when an object is destroyed
- The mechanism is called **finalization**
- Exectuted when an object is just about to be reclaimed by the garbage collector
- to add a finalizer to a class, we define the **finalize**( ) method

```
protected void finalize( )
{
        // finalization code here
}
```

Example

```
class Box {
    double width;
    double height;
    double depth;
    Box(double w, double h, double d) {
        System.out.println("Constructing Box");
        width = 10;
        height = 10;
        depth = 10;
    }
    double volume() {
        return width * height * depth;
    }
    protected void finalize() {
        System.out.println("box object destroyed");
        System.out.println(“Inside finalize of Box”);
    }
}
```

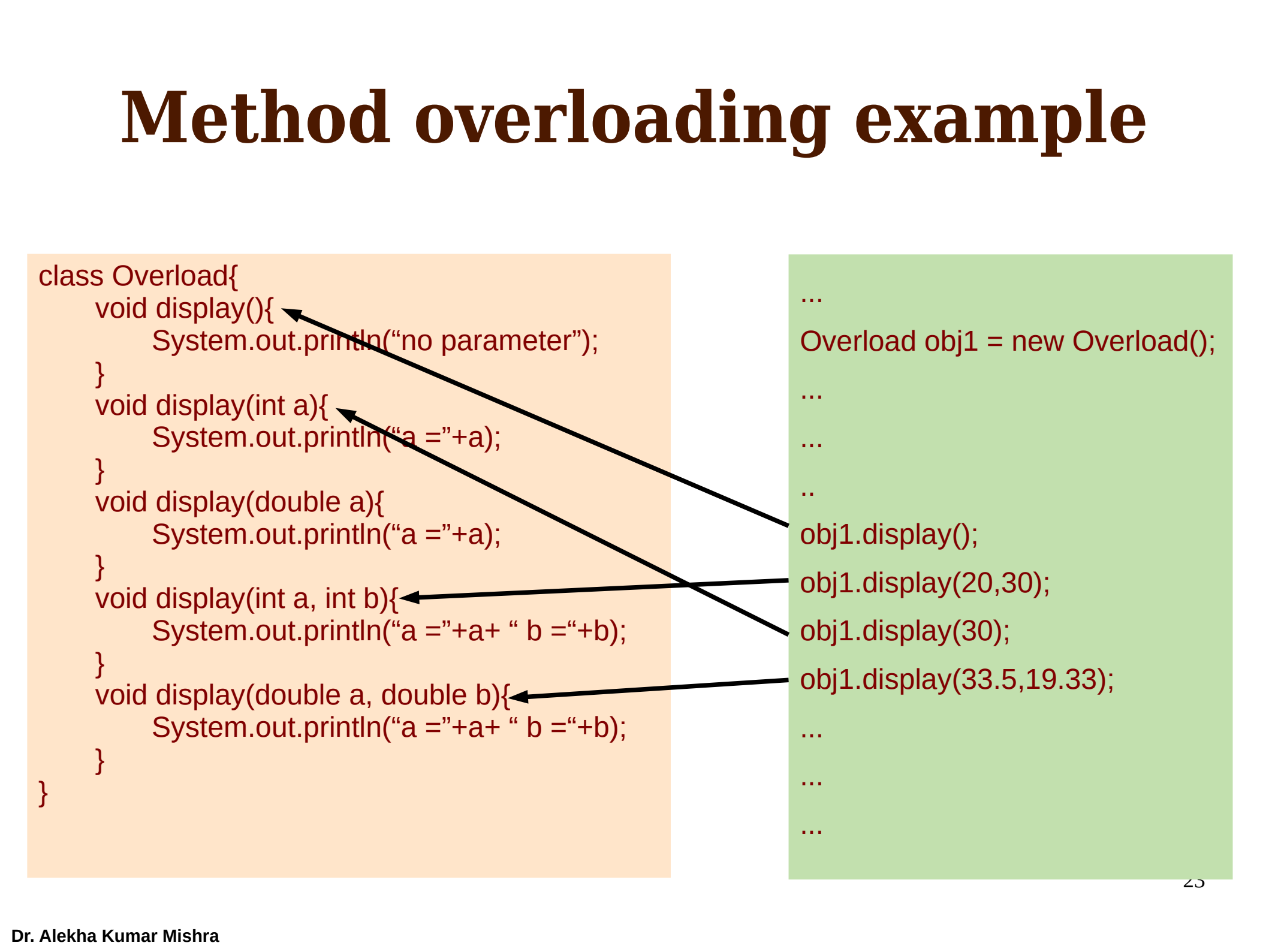
Polymorphism via method overloading

- Two or more methods within the same class that share the same name is referred as the process of method overloading.
- Java's one way to support polymorphism.
- Java uses the type and/or number of arguments as its guide to determine which version of the overloaded method to actually call.
- **NOTE**: Different return types of overloaded method are insufficient to distinguish two versions of a method.
- Java simply executes the version of the method whose parameters match the arguments used in the call.

Method overloading example

```
class Overload{
      void display(){
            System.out.println(“no parameter”);
      }
      void display(int a){
            System.out.println(“a =”+a);
      }
      void display(double a){
            System.out.println(“a =”+a);
      }
      void display(int a, int b){
            System.out.println(“a =”+a+ “ b =“+b);
      }
      void display(double a, double b){
            System.out.println(“a =”+a+ “ b =“+b);
      }
}
```

```
...
Overload obj1 = new Overload();
...
...
..
obj1.display();
obj1.display(20,30);
obj1.display(30);
obj1.display(33.5,19.33);
...
...
...
```



Which method ??

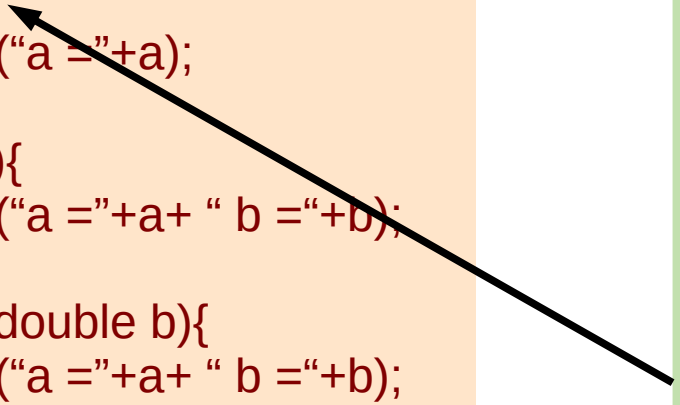
```
class Overload{
        void display(){
                System.out.println(“no parameter”);
        }
        void display(double a){
                System.out.println(“a =”+a);
        }
        void display(int a, int b){
                System.out.println(“a =”+a+ “ b =“+b);
        }
        void display(double a, double b){
                System.out.println(“a =”+a+ “ b =“+b);
        }
}
```

```
...
Overload obj1 = new Overload();
...
...
..
obj1.display();
obj1.display(20,30);
obj1.display(30); ??
obj1.display(33.5);
...
...
...
```

Automatic type conversion

```
class Overload{
      void display(){
            System.out.println("no parameter");
      }
      void display(double a){
            System.out.println("a ="+a);
      }
      void display(int a, int b){
            System.out.println("a ="+a+ " b ="+b);
      }
      void display(double a, double b){
            System.out.println("a ="+a+ " b ="+b);
      }
}
```

```
...
Overload obj1 = new Overload();
...
...
..
obj1.display();
obj1.display(20,30);
obj1.display(30);
obj1.display(33.5);
...
...
...
```



Overloading Constructors

```
// Recall Box class
...
...
  Box(double w, double h, double d) {
    width = w;
    height = h;
    depth = d;
  }

  // constructor used when no dimensions
specified
  Box() {
    width = -1;  // use -1 to indicate
    height = -1; // an uninitialized
    depth = -1;  // box
  }

  // constructor used when cube is created
  Box(double len) {
    width = height = depth = len;
  }

  // compute and return volume
  double volume() {
    return width * height * depth;
  }
}
```

```
class OverloadCons {
  public static void main(String args[]) {
    // create boxes using the various constructors
    Box mybox1 = new Box(10, 20, 15);
    Box mybox2 = new Box();
    Box mycube = new Box(7);

    double vol;

    vol = mybox1.volume();
    System.out.println("Volume of mybox1 is " + vol);

    vol = mybox2.volume();
    System.out.println("Volume of mybox2 is " + vol);

    vol = mycube.volume();
    System.out.println("Volume of mycube is " + vol);
  }
}
```

Using Objects as Parameters

```
class Test {
  int a, b;

  Test(int i, int j) {
    a = i;
    b = j;
  }

  // return true if o is equal to the invoking object
  boolean equals(Test o) {
    if(o.a == a && o.b == b) return true;
    else return false;
  }
}

class PassOb {
  public static void main(String args[]) {
    Test ob1 = new Test(100, 22);
    Test ob2 = new Test(100, 22);
    Test ob3 = new Test(-1, -1);

    System.out.println("ob1 == ob2: " + ob1.equals(ob2));

    System.out.println("ob1 == ob3: " + ob1.equals(ob3));
  }
}
```

Object passing to constructors

```
class Box {
  double width;
  double height;
  double depth;

  // construct clone of an object
  Box(Box ob) { // pass object to constructor
    width = ob.width;
    height = ob.height;
    depth = ob.depth;
  }

  Box(double w, double h, double d) {
    width = w;
    height = h;
    depth = d;
  }
...
...
```

```
...
...
Box mybox1 = new Box(10, 20, 15);

Box myclone = new Box(mybox1);
```

Java way of passing parameter

- When you pass a primitive type to a method, it is passed by value
- When you pass an object to a method
  - Objects are passed effectively by call-by-reference.
  - The parameter that receives a reference to an object will refer to the same object as that referred to by the argument.

Object pass by reference

```
class Test {
  int a, b;

  Test(int i, int j) {
    a = i;
    b = j;
  }

  // pass an object
  void meth(Test o) {
    o.a *=  2;
    o.b /= 2;
  }
}
```

```
class CallByRef {
  public static void main(String args[]) {
    Test ob = new Test(15, 20);

    System.out.println("ob.a and ob.b before
            call: " +ob.a + " " + ob.b);

    ob.meth(ob);

    System.out.println("ob.a and ob.b after call:
            " +ob.a + " " + ob.b);
  }
}
```

Returning Objects

```
class Test {
  int a;

  Test(int i) {
    a = i;
  }

  Test incrByTen() {
    Test temp = new Test(a+10);
    return temp;
  }
}
```

```
class RetOb {
  public static void main(String args[]) {
    Test ob1 = new Test(2);
    Test ob2;

    ob2 = ob1.incrByTen();
    System.out.println("ob1.a: " + ob1.a);
    System.out.println("ob2.a: " + ob2.a);

    ob2 = ob2.incrByTen();
    System.out.println("ob2.a after second
            increase: "+ ob2.a);
  }
}
```

Access Control

- Encapsulation a feature of OOP that provides Access Control
- Access control can prevent misuse of data
- Some aspects of access control are related mostly to inheritance or packages
- Java's access specifiers are **public**, **private**, and **protected**.
- Java also defines a default access level.
- **protected** applies only when inheritance is involved

public and private

- When a member of a class is specified as **public**, then that member can be accessed by any other code
- When a member of a class is specified as **private**, then that member can only be accessed by other members of its class
- When no access specifier is used, then by **default** the member of a class is **public** within its own package, but cannot be accessed outside of its package
- Example :
  - public int i;
  - private double j;
  - private int myfunction(int a, char b) { // ... }

Example

```
class Test {
  int a; // default access
  public int b; // public access
  private int c; // private access

  // methods to access c
  void setc(int i) { // set c's value
    c = i;
  }
  int getc() { // get c's value
    return c;
  }
}
```

```
class AccessTest {
  public static void main(String args[]) {
    Test ob = new Test();

    ob.a = 10;        //ok?
    ob.b = 20;        //ok?
    ob.c = 100;       // ok??

    ob.setc(100);  // OK??

    System.out.println("a, b, and c: " + ob.a + " " +
                       ob.b + " " + ob.getc());
  }
}
```

static

- It is possible to create a member that can be used by itself, without reference to a specific instance.
- Such a member, precedes its declaration with the keyword static.
- A static member can be accessed before any objects of its class are created, and without reference to any object.
- Both methods and variables can be declared to static.
- The most common example of a static member is main( ).
- Instance variables declared as static are essentially, global variables for a class.
- When objects of its class are declared, no copy of a static variable is made. Instead, all instances of the class share the same static variable.

static method

- Methods declared as static have several restrictions:
  - They can only call other static methods.
  - They must only access static data.
  - They cannot refer to **this** or **super** in any way.
  - If you need to do computation in order to initialize your static variables, you can declare a **static block** that gets executed exactly once, when the class is first loaded.

Example of static

```
class UseStatic {
  static int a = 3;
  static int b;

  static void meth(int x) {
    System.out.println("x = " + x);
    System.out.println("a = " + a);
    System.out.println("b = " + b);
  }

  static {
    System.out.println("Static block initialized.");
    b = a * 4;
  }

  public static void main(String args[]) {
    meth(42);
  }
}
```

Accessing static outside its own class

- Outside of the class in which they are defined, static methods and variables can be used by specifying the name of their class followed by the dot operator.
  - classname.method( )
- This is how Java implements a controlled version of global methods and global variables

Example

```
class StaticDemo {
  static int a = 42;
  static int b = 99;
  static void callme() {
    System.out.println("a = " + a);
  }
}

class StaticByName {
  public static void main(String args[]) {
    StaticDemo.callme();
    System.out.println("b = " + StaticDemo.b);
  }
}
```

The ‘final’ keyword

- A variable can be declared as **final** to prevent its content from being modified.
- We must initialize a final variable when it is declared.
- It is a common coding convention to choose all uppercase identifiers for final variables.
- Variables declared as final do not occupy memory on a per-instance basis.
- Thus, a final variable is essentially a constant.
- The keyword final can also be applied to methods, but its meaning is substantially different
- Example
- final int PI = 3.14;
- final int FILE_NEW = 1;

Nested class

- The scope of a nested class is bounded by the scope of its enclosing class.
- Thus, if class B is defined within class A, then B does not exist independently of A.
- A nested class has access to the members, including private members, of the class in which it is nested.
- However, the enclosing class does not have access to the members of the nested class.
- It is also possible to declare a nested class that is local to a block.

Nested class(2)

- There are two types of nested classes:
  - Static
  - Non-static (Inner class)
- A static nested class is one that has the static modifier applied.
- Because it is static, it must access the members of its enclosing class through an object.
- Because of this restriction, static nested classes are seldom used.
- An inner class is a non-static nested class.
- It has access to all of the variables and methods of its outer class and may refer to them directly in the same way that other non-static members of the outer class do.

Example

```
class Outer {
  int outer_x = 100;

  void test() {
    Inner inner = new Inner();
    inner.display();
  }

  // this is an innner class
  class Inner {
    void display() {
      System.out.println("display: outer_x = " + outer_x);
    }
  }
}

class InnerClassDemo {
  public static void main(String args[]) {
    Outer outer = new Outer();
    outer.test();
  }
}
```

Output??

```
class Outer {
  int outer_x = 100;

  void test() {
    Inner inner = new Inner();
    inner.display();
  }

  // this is an innner class
  class Inner {
    int y = 10; // y is local to Inner
    void display() {
      System.out.println("display: outer_x = " +
outer_x);
    }
  }

  void showy() {
    System.out.println(y);
  }
}
```

```
class InnerClassDemo {
  public static void main(String args[])
{
    Outer outer = new Outer();
    outer.test();
  }
}
```