Classes and Objects in Java

Constructors, Overloading, Static Members

Refer to the Earlier Circle Program

```
// Circle.java:  Contains both Circle class and its user class
//Add Circle class code here
class MyMain
{
	public static void main(String args[])
	{
		Circle aCircle;  // creating reference
		aCircle = new Circle(); // creating object
		aCircle.x = 10;  // assigning value to data field
		aCircle.y = 20;
		aCircle.r = 5;
		double area = aCircle.area(); // invoking method
		double circumf = aCircle.circumference();
		System.out.println("Radius="+aCircle.r+" Area="+area);
		System.out.println("Radius="+aCircle.r+" Circumference ="+circumf);
	}
}
```

```
[raj@mundroo]%: java MyMain
Radius=5.0 Area=78.5
Radius=5.0 Circumference =31.400000000000002
```

Better way of Initialising or Access Data Members x, y, r

- When there too many items to update/access and also to develop a readable code, generally it is done by defining specific method for each purpose.
- To initialise/Update a value:
  - aCircle.setX(10)
- To access a value:
  - aCircle.getX()
- These methods are informally called as Accessors or Setters/Getters Methods.

Accessors – "Getters/Setters"

```
public class Circle {
    public double x,y,r;

    //Methods to return circumference and area
    public double getX() { return x;}
    public double getY() { return y;}
    public double getR() { return r;}
    public double setX(double x_in) { x = x_in;}
    public double serY(double y_in) { y = y_in;}
    public double setR(double r_in) { r = r_in;}

}
```

How does this code looks ? More readable ?

```
// Circle.java:  Contains both Circle class and its user class
//Add Circle class code here
class MyMain
{
        public static void main(String args[])
        {
                Circle aCircle;  // creating reference
                aCircle = new Circle(); // creating object
                aCircle.setX(10);
                aCircle.setY(20);
                aCircle.setR(5);
                double area = aCircle.area(); // invoking method
                double circumf = aCircle.circumference();
                System.out.println("Radius="+aCircle.getR()+" Area="+area);
                System.out.println("Radius="+aCircle.getR()+" Circumference ="+circumf);
        }
}
```

```
[raj@mundroo]%: java MyMain
Radius=5.0 Area=78.5
Radius=5.0 Circumference =31.400000000000002
```

Object Initialisation

- When objects are created, the initial value of data fields is unknown unless its users explicitly do so. For example,
  - ObjectName.DataField1 = 0; // OR
  - ObjectName.SetDataField1(0);
- In many cases, it makes sense if this initialisation can be carried out by default without the users explicitly initialising them.
  - For example, if you create an object of the class called "Counter", it is natural to assume that the counter record-keeping field is initialised to zero unless otherwise specified differently.

```
class Counter
{
        int CounterIndex;
        …
}
Counter counter1 = new Counter();
```

  - What is the value of "counter1.CounterIndex" ?
- In Java, this can be achieved though a mechanism called constructors.

What is a Constructor?

- Constructor is a special method that gets invoked "automatically" at the time of object creation.
- Constructor is normally used for initializing objects with default values unless different values are supplied.
- Constructor has the same name as the class name.
- Constructor cannot return values.
- A class can have more than one constructor as long as they have different signature (i.e., different input arguments syntax).

Defining a Constructor

- Like any other method

```
public class ClassName {

    // Data Fields…

    // Constructor
    public ClassName()
    {
        // Method Body Statements initialising Data Fields
    }

    //Methods to manipulate data fields
}
```

- Invoking:
  - There is NO explicit invocation statement needed: When the object creation statement is executed, the constructor method will be executed automatically.

Defining a Constructor: Example

```
public class Counter {
    int CounterIndex;

    // Constructor
    public Counter()
    {
        CounterIndex = 0;
    }
    //Methods to update or access counter
    public void increase()
    {
        CounterIndex = CounterIndex + 1;
    }
    public void decrease()
    {
        CounterIndex = CounterIndex - 1;
    }
    int getCounterIndex()
    {
      return CounterIndex;
    }
}
```

Trace counter value at each statement and What is the output ?

```
class MyClass {
  public static void main(String args[])
  {
        Counter counter1 = new Counter();
        counter1.increase();
        int a = counter1.getCounterIndex();
        counter1.increase();
        int b = counter1.getCounterIndex();
        if ( a > b )
              counter1.increase();
        else
              counter1.decrease();

        System.out.println(counter1.getCounterIndex());
  }
}
```

A Counter with User Supplied Initial Value ?

- This can be done by adding another constructor method to the class.

```
public class Counter {
     int CounterIndex;

     // Constructor 1
     public Counter()
     {
          CounterIndex = 0;
     }
     public Counter(int InitValue )
      {
           CounterIndex = InitValue;
      }
}

// A New User Class: Utilising both constructors
     Counter counter1 = new Counter();
     Counter counter2 = new Counter (10);
```

Adding a Multiple-Parameters Constructor to our Circle Class

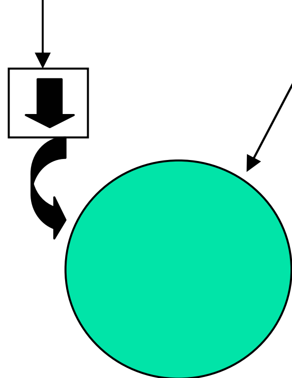
```
public class Circle {
     public double x,y,r;
    // Constructor
    public Circle(double centreX, double centreY,
                                                   double radius)
    {
        x = centreX;
        y = centreY;
        r = radius;
     }
    //Methods to return circumference and area
     public double circumference() { return 2*3.14*r; }
     public double area() { return 3.14 * r * r; }
}
```

Constructors initialise Objects

- Recall the following OLD Code Segment:

```
Circle aCircle = new Circle();
aCircle.x = 10.0; // initialize center and radius
aCircle.y = 20.0
aCircle.r = 5.0;
```

aCircle = new Circle() ;



At creation time the center and radius are not defined.

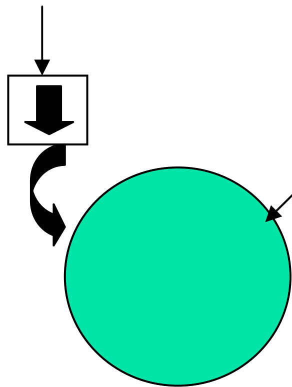
These values are explicitly set later.

Constructors initialise Objects

- With defined constructor

```
Circle aCircle = new Circle(10.0, 20.0, 5.0);
```

aCircle = new Circle(10.0, 20.0, 5.0) ;



aCircle is created with center (10, 20) and radius 5

Multiple Constructors

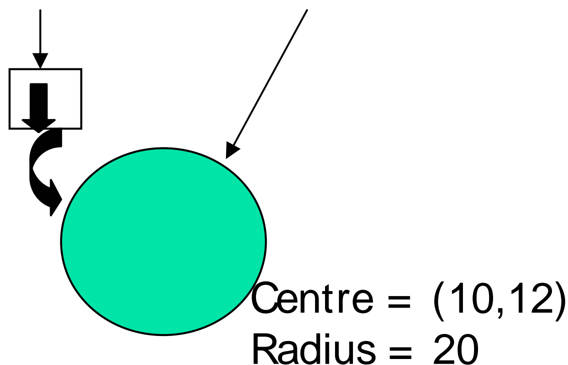
- Sometimes want to initialize in a number of different ways, depending on circumstance.
- This can be supported by having multiple constructors having different input arguments.

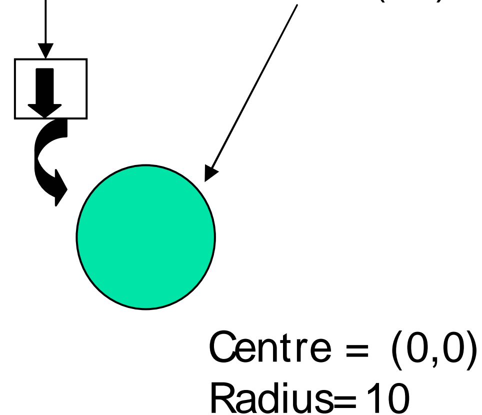
Multiple Constructors

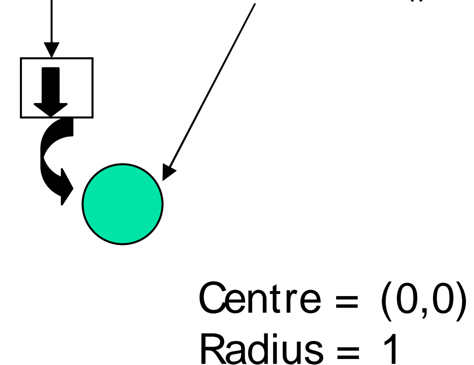
```
public class Circle {
    public double x,y,r; //instance variables
    // Constructors
    public Circle(double centreX, double cenreY, double radius) {
        x = centreX;  y = centreY; r = radius;
    }
    public Circle(double radius) { x=0; y=0; r = radius; }
    public Circle() { x=0; y=0; r=1.0; }

    //Methods to return circumference and area
    public double circumference() { return 2*3.14*r; }
    public double area() { return 3.14 * r * r; }
}
```

Initializing with constructors

```
public class TestCircles {

        public static void main(String args[]){
            Circle circleA = new Circle( 10.0, 12.0, 20.0);
            Circle circleB = new Circle(10.0);
            Circle circleC = new Circle();
        }
}
```







Method Overloading

- Constructors all have the same name.
- Methods are distinguished by their signature:
  - name
  - number of arguments
  - type of arguments
  - position of arguments
- That means, a class can also have multiple usual methods with the same name.

- Not to confuse with *method overriding* (coming up), *method overloading:*

Polymorphism

- Allows a single *method or operator* associated with different meaning depending on the type of data passed to it. It can be realised through:
  - Method Overloading
  - Operator Overloading (Supported in C++, but not in Java)
- Defining the same *method* with different argument types (method overloading) - polymorphism.
- The method body can have different logic depending on the date type of arguments.

Scenario

- A Program needs to find a maximum of two numbers or Strings. Write a separate function for each operation.
  - In C:
    - int max_int(int a, int b)
    - int max_string(char *s1, char *s2)
    - max_int (10, 5) or max_string (“melbourne”, “sydney”)
  - In Java:
    - int max(int a, int b)
    - int max(String s1, String s2)
    - max(10, 5) or max(“melbourne”, “sydney”)
  - Which is better ? Readability and intuitive wise ?

A Program with Method Overloading

```
// Compare.java: a class comparing different items
class Compare {
   static int max(int a, int b)
   {
        if( a > b)
                return a;
        else
        return b;
   }
   static String max(String a, String b)
   {
        if( a.compareTo (b) > 0)
                return a;
        else
                return b;
   }

  public static void main(String args[])
  {
        String s1 = "Melbourne";
        String s2 = "Sydney";
        String s3  = "Adelaide";

        int a = 10;
        int b = 20;

        System.out.println(max(a, b)); // which number is big
        System.out.println(max(s1, s2)); // which city is big
        System.out.println(max(s1, s3)); // which city is big
  }
}
```

The New *this* keyword

- *this* keyword can be used to refer to the object itself. It is generally used for accessing class members (from its own methods) when they have the same name as those passed as arguments.

```
public class Circle {
    public double x,y,r;
     // Constructor
    public Circle (double x, double y, double r) {
        this.x = x;
        this.y = y;
        this.r = r;
    }
  //Methods to return circumference and area
}
```

Static Members

- Java supports definition of global methods and variables that can be accessed without creating objects of a class. Such members are called Static members.
- Define a variable by marking with the static methods.
- This feature is useful when we want to create a variable common to all instances of a class.
- One of the most common example is to have a variable that could keep a count of how many objects of a class have been created.
- Note: Java creates only one copy for a static variable which can be used even if the class is never instantiated.

Static Variables

- Define using *static:*

```
public class Circle {
     // class variable, one for the Circle class, how many circles
    public static int numCircles;

     //instance variables,one for each instance of a Circle
    public double x,y,r;
    // Constructors...
}
```

- Access with the class name (ClassName.StatVarName):

```
nCircles = Circle.numCircles;
```

Static Variables - Example

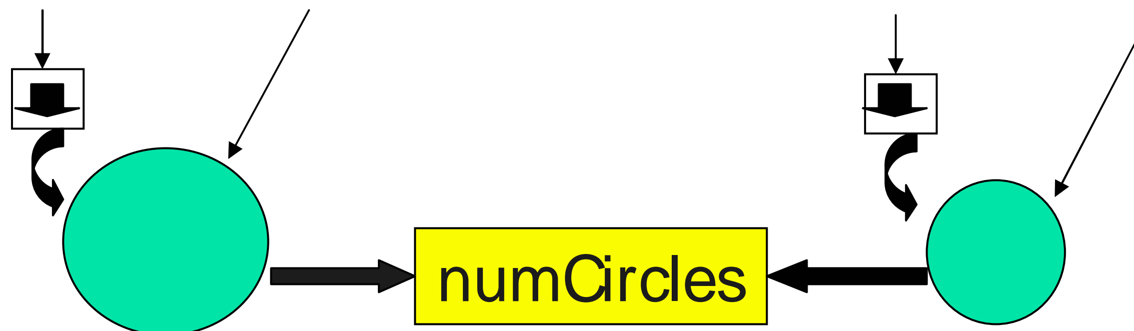
- Using *static variables:*

```
public class Circle {
     // class variable, one for the Circle class, how many circles
    private static int numCircles = 0;
    private double x,y,r;

    // Constructors...
    Circle (double x, double y, double r){
        this.x = x;
        this.y = y;
        this.r = r;
        numCircles++;
    }
}
```

Class Variables - Example

- Using *static variables:*

```
public class CountCircles {

        public static void main(String args[]){
            Circle circleA = new Circle( 10, 12, 20);    // numCircles = 1
            Circle circleB = new Circle( 5, 3, 10);      // numCircles = 2
    }
}
```



Instance Vs Static Variables

- Instance variables : One copy per object. Every object has its own instance variable.
  - E.g. x, y, r (centre and radius in the circle)

- Static variables : One copy per class.
  - E.g. numCircles (total number of circle objects created)

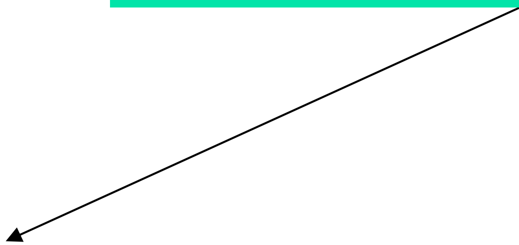
Static Methods

- A class can have methods that are defined as static (e.g., main method).
- Static methods can be accessed without using objects. Also, there is NO need to create objects.
- They are prefixed with keyword "static"
- Static methods are generally used to group related library functions that don't depend on data members of its class. For example, Math library functions.

Comparator class with Static methods

```
// Comparator.java: A class with static data items comparision methods
class Comparator {
	public static int max(int a, int b)
	{
		if( a > b)
			return a;
		else
			return b;
	}

	public static String max(String a, String b)
	{
		if( a.compareTo (b) > 0)
			return a;
		else
			return b;
	}
}

class MyClass {
  public static void main(String args[])
  {
	String s1 = "Melbourne";
	String s2 = "Sydney";
	String s3  = "Adelaide";

	int a = 10;
	int b = 20;

	System.out.println(Comparator.max(a, b)); // which number is big
	System.out.println(Comparator.max(s1, s2)); // which city is big
	System.out.println(Comparator.max(s1, s3)); // which city is big
  }
}
```

Directly accessed using ClassName (NO Objects)



Static methods restrictions

- They can only call other static methods.
- They can only access static data.
- They cannot refer to "this" or "super" (more later) in anyway.

Summary

- Constructors allow seamless initialization of objects.
- Classes can have multiple methods with the same name [Overloading]
- Classes can have static members, which serve as global members of all objects of a class.
- **Keywords:** constructors, polymorphism, method overloading, this, static variables, static methods.