Unit 3: Class Creation
Writing Methods

Adapted from:

1) Building Java Programs: A Back to Basics Approach
by Stuart Reges and Marty Stepp

2) Runestone CSAwesome Curriculum

https://longbaonguyen.github.io

Modularity

modularity: Writing code in smaller, more manageable components or modules. Then combining the modules into a cohesive system.

- Modularity with methods. Break complex code into smaller tasks and organize it using **methods**.

Methods define the behaviors or functions for objects.

An object's behavior refers to what the object can do (or what can be done to it). **A method is simply a named group of statements.**

static vs non-static

Variables and methods can be classified as **static** or **nonstatic(instance)**.

Non-static or instance: Part of an object, rather than shared by the class. Non-static methods are called using the dot operator along with the object variable name.

static: Part of a class, rather than part of an object. Not copied into each object; shared by all objects of that class. Static methods are called using the dot operator along with the class name unless they are defined in the enclosing class.

Static methods

static method: Stored in a class, not in an object. Shared by all objects of the class, not replicated.

```
public static type name(parameters) {
    statements;


}
```

Methods

Non-static or instance methods belong to individual objects. They are usually implemented inside of an object class rather than the driver class.

Methods in an object class are non-static by default unless explicitly labeled "static".

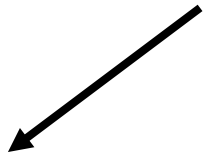
Non-static methods are called through objects of the class.

Nonstatic vs Static

Let's see an example of an object class to understand when to make a method static vs. non-static.

```
class Student{
      String name;
      int id;
      public Student(int new_id, String n){
      id = new_id;
      name = n;
      }
      public void printMyID(){
      System.out.println("My ID is " + id);
      }
      public static void printWelcomeMessage(){
      System.out.println("Welcome all students!");
      }
}


}
```



printMyID is a non-static method and belong to individual student objects. E.g. if there are 5 student objects, there are 5 different copies of printMyID, one for each student.

Nonstatic vs Static

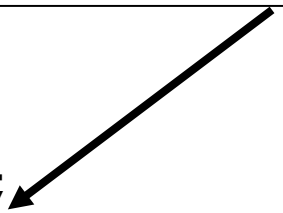
Let's see an example of an object class to understand when to make a method static vs. non-static.

```
class Student{
	int id;
	public Student(int new_id){
		id = new_id;
	}
	public void printMyID(){
		System.out.println("My ID is " + id);
	}
	public static void printWelcomeMessage(){
		System.out.println("Welcome all students!");
	}
}



}
```

printWelcomeMessage is a static(class) method. It belongs to the class rather than individual objects. If there are 5 student objects, there is only ONE shared printWelcomeMessage.



Nonstatic vs Static

Here's how we can use the Student class.

```
class DriverClass{
	public static void main(String[] args){
	// create some Student objects
	Student s1 = new Student(12343);
	Student s2 = new Student(04304);
	// call instance or non-static printMyID()
	s1.printMyID(); // My ID is 12343
	s2.printMyID(); // My ID is 04304
	// call static printWelcomeMessage()
	Student.printWelcomeMessage(); //Welcome all students!
	// this also works but not considered
	// "best practice"
	s1.printWelcomeMessage(); //Welcome all students!
	Student.printMyID();// error!
	}
}
```

Non-static Method Call

MyProgram.java

A program's run begins and ends at the main method.

```
public class MyProgram{
  public static void main(String[] args){
    System.out.println("Begins here.");
    MyClass c = new MyClass();
    c.method1();
    c.method2();
    System.out.println("Ends here.");
  }
}
```

MyClass.java

non-static(instance) methods

```
public class MyClass{
  // constructors not shown
  public void method1(){
    System.out.println("method1");
  }
  public void method2(){
    System.out.println("method2");
  }
}
```

Output:
Begins here.
method1
method2
Ends here.

non-static method is called through the name of an object using the dot notation

Methods with Parameters

When calling a method with parameters, values provided in the parameter list need to correspond to the order and type in the method signature.

MyProgram.java

```
public class MyProgram{
  public static void main(String[] args){
    MyClass c = new MyClass();
    c.method1(); // correct!
    c.method2(); // error! Missing actual parameters
    c.method2(3.5, 4.1); // error! Wrong types
    c.method2(2, 3.1); // correct!
    c.method2(3, 4); // correct, 4 is casted to a double 4.0
  }
}
```

MyClass.java

```
public class MyClass{
  …
  public void method1(){
   …
  }
  public void method2(int x, double y){
   …
  }
}
```

Static Vs Non-static Method Calling

MyClass.java

```
public class MyClass{
        public static void main(String[] args){
            System.out.println(SomeClass.method1());
            SomeClass a = new SomeClass();
            System.out.println(a.method2());
            System.out.println(a.method1());
            System.out.println(SomeClass.method2());

        }
}
```

call static method through name of class

call non-static method through name of an object

This works also but not considered "best practice"

This is an error!

Note that method1 and method2 both belong to a different class than the driver class where they are being called.

SomeClass.java

```
public class SomeClass{
        public SomeClass(){…}. // constructor
        public static int method1() // static method
        {…}
        public int method2() // non-static or instance method
        { }}
```

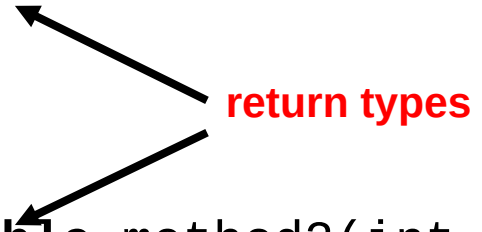
Method Returns

Methods in Java can have **return types**. Such **non-void** methods return values back that can be used by the program. A method can use the keyword "**return**" to return a value.

```
public type methodName(type var1,…, type var2){
…
}
```

Examples:

```
public int method1(){
…
}
```

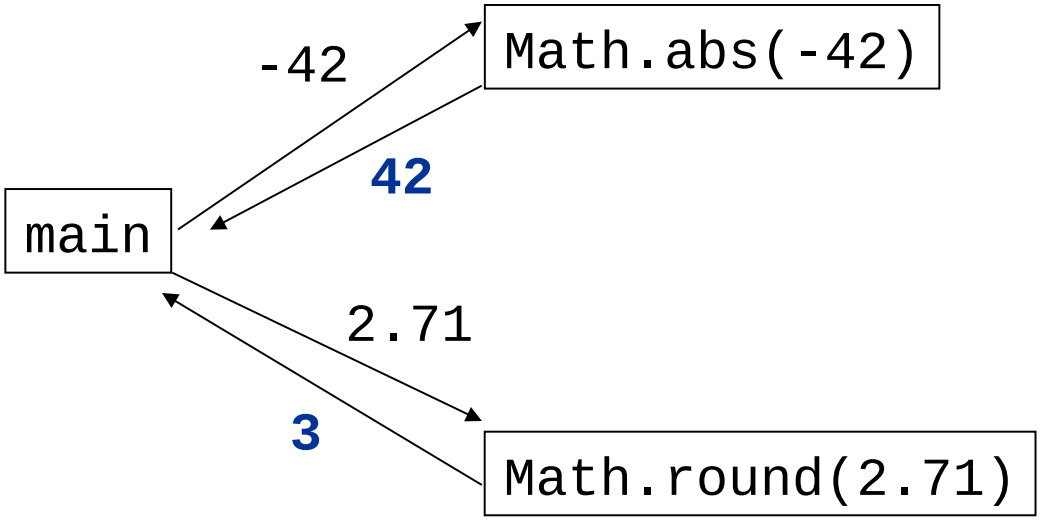



```
public double method2(int x){
…
}
```

Note: Method parameters are its inputs and method returns are its outputs.

Return

- **return**: To send out a value as the result of a method.
  - The opposite of a parameter:
    - Parameters send information *in* from the caller to the method.
    - Return values send information *out* from a method to its caller.
      - A call to the method can be used as part of an expression.



Calling Non-void Methods

A non-void method does return a value and should be stored or printed. Otherwise, that value will be lost.

```
public class MyClass{
        public static void main(String[] args){
        int a = 3 + printX(5); //error! Does not return!
        int b = twiceX(3); // correct, b = 6
        twiceX(10); // value is lost, this does nothing.
        }
        public static void printX(int x){
        System.out.println(“The input x is” + x);
        }
        public static int twiceX(int x){
        return 2 * x;
        }
}
```

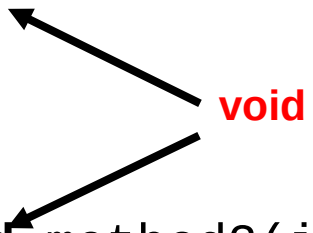
Void Methods

Void methods do not have return values. Once the execution of the method completes, the flow of control returns to the point immediately following where the method was called.

```
public void methodName(type var1,…, type var2){
…
}
```

Examples:

```
public void method1(){
…
}
```




```
public void method2(int x){
…
}
```

Calling Void Methods

Code from a method can directly call another method in the same enclosing class without using the dot notation.

Void methods do not have return values and are therefore not called as part of an expression.

```
public class MyClass{
	public static void main(String[] args){
		printX(5); // Output: The input x is 5
	}
	public static void printX(int x){
		System.out.println(“The input x is” + x);
	}
}
```

Calling Methods with Parameters

When calling a method with parameters, values provided in the parameter list need to correspond to the order and type in the method signature.

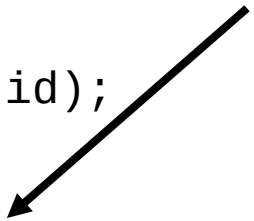
```
public class MyProgram{
  public static void main(String[] args){
        double ave = average(4, 5); // saved return value
        System.out.println(sum(2.4, 5.1)); // print it
        sum(4.0, 3.2);    // returned value is lost
                          // DON"T DO THIS!
  }
  public static double average(int x, int y){
  …
  }
  public static double sum(double x, double y){
  …
  }
}
```

Nonstatic vs Static

```
class Student{
      int id;
      public Student(int new_id){
      id = new_id;
      }
      public void printMyID(){
      System.out.println(“My ID is “ + id);
      printWelcomeMessage();
      }
      public static void printWelcomeMessage(){
      System.out.println(“Welcome all students!”);
      }
}



}
```



Can an instance method in a class call a static method in the same class?

Yes!

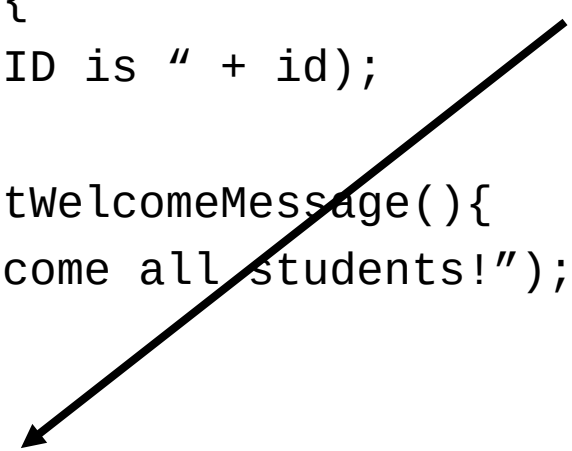
Nonstatic vs Static

```
class Student{
      int id;
      public Student(int new_id){
      id = new_id;
      }
      public void printMyID(){
      System.out.println("My ID is " + id);
      }
      public static void printWelcomeMessage(){
      System.out.println("Welcome all students!");
      printMyID();
      }
}



}
```

Can a static method in a class call an instance method in the same class?



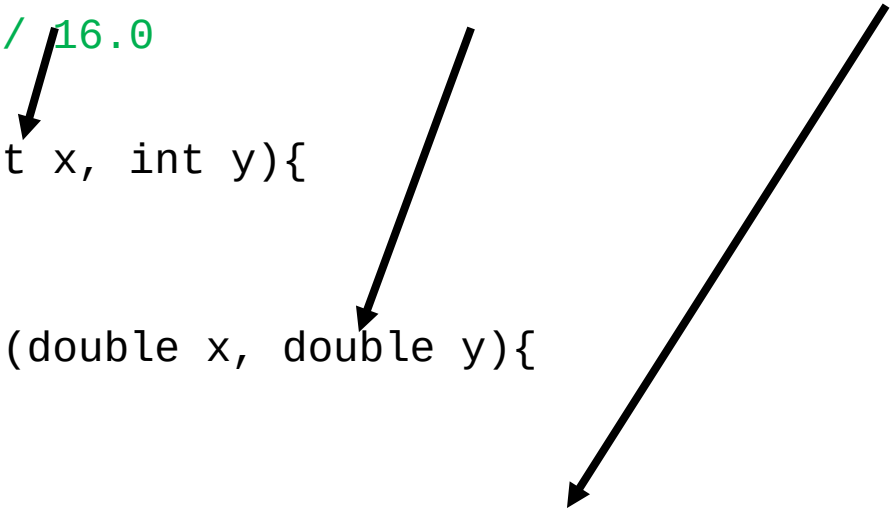
No! Why?

Overloaded Methods

Methods are said to be **overloaded** when there are multiple methods with the same name but a different signature.

Three methods named "add".

```
public class MyClass{
        public static void main(String[] args){
        double a = add(1, 2) + add(1.8, 5.2) + add(1, 2, 3);
        System.out.println(a); // 16.0
        }
        public static int add(int x, int y){
        return x + y;
        }
        public static double add(double x, double y){
        return x + y;
        }
        public static int add(int x, int y, int z){
        return x + y + z;
        }
}
```



Point class

```
// A Point object represents an (x, y) location.
public class Point {
    private int x;
    private int y;

    public Point(int initialX, int initialY) {
        x = initialX;
        y = initialY;
    }
    // accessor methods
    public int getX() {
        return x;
    }

    public int getY() {
        return y;
    }

    public void setLocation(int newX, int newY) {
        x = newX;
        y = newY;
    }

    public void translate(int dx, int dy) {
        setLocation(x + dx, y + dy);
    }
}
```

Limitations of variables

- Idea: Make a variable to represent the size.
  - Use the variable's value in the methods.

- Problem: A variable in one method can't be seen in others.

```
public static void main(String[] args) {
    int size = 4;
    topHalf();
    printBottom();
}

public static void topHalf() {
    for (int i = 1; i <= size; i++) {    // ERROR: size not found
        ...
    }
}

public static void bottomHalf() {
    for (int i = size; i >= 1; i--) {    // ERROR: size not found
        ...
    }
}
```

Comments

Adding comments to your code helps to make it more readable and maintainable.

In the commercial world, software development is usually a team effort where many programmers will use your code and maintain it for years.

Commenting is essential in this kind of environment and a good habit to develop. Comments will also help you to remember what you were doing when you look back to your code a month or a year from now.

Comments

There are 3 types of comments in Java:

1) // Single line comment

2) /* Multiline comment */

3) /** Documentation comment */

We have seen the first two types of comments. The third is also a special version of the multi-line comment, /** */, called **the documentation comment.**

Java has a tool called javadoc that comes with the Java JDK that will pull out all of these comments to make documentation of a class as a web page.

Preconditions/Postconditions

A **precondition** is a condition that must be true for your method code to work, for example the assumption that the parameters have values and are not null. There is no expectation that the method will check to ensure preconditions are satisfied.

The methods could check for these preconditions, but they do not have to. The precondition is what the method expects in order to do its job properly.

A **postcondition** is a condition that is true after running the method. It is what the method promises to do. Postconditions describe the outcome of running the method, for example what is being returned or the changes to the instance variables.

Preconditions/Postconditions

```
/**
* Constructor that takes the x and y position of Sprite object
* Preconditions: parameters x and y are coordinates from 0 to
* the width and height of the window
*
* Postconditions: the Sprite object is placed in (x,y) coordinates
* @param x the x position to place the Sprite
* @param y the y position to place the Sprite */

public Sprite(int x, int y) {
        center_x = x;
        center_y = y;
}
```

Lab 1

Write a class called `MyComplex` which models the complex numbers a + bi. It contains:

1) Two private double variables `real` and `img`.
2) A default constructor to create a complex number at 0 + 0i.
3) A constructor which takes two double a and b and initializes this complex number to a + bi.
4) Setters and Getters(accessors and mutators) for private variables real and img.
5) `toString()` that returns “a + bi” form of the complex number. If b is negative, we want the string to be "a - bi".

Lab 1

6) `isReal()` and `isImaginary()` that returns whether this complex number is real(imaginary part is 0) or imaginary(real part is 0), respectively. For example, 4 is real while 5i is imaginary but 4 + 5i is neither and 0 is both.

7) `void add(MyComplex c)`: Add complex number c to this complex number. Hint: (a+bi)+(c+di)=(a+c)+(b+d)i

8) `void multiply(MyComplex c)`: Multiply c to this complex number. Hint: (a+bi)*(c+di)=(ac-bd)+(ad+bc)i

9) `void conjugate()` changes this complex number into its conjugate. Hint: The conjugate of a + bi is a - bi.

Lab 1

10) `double argument()` returns the argument(angle) in radians of this complex number. This angle is the same as theta of polar coordinates. Hint: Use Math.atan2(y,x).

11) `double magnitude()` returns the magnitude or length of this complex number. Hint: The magnitude of a+bi is Math.sqrt(a*a+b*b). For example, the magnitude of 3+4i is 5.

Lab 1

MyComplex should also contains the following **static methods:**

1)`MyComplex addNew(MyComplex a, MyComplex b)` returns a complex number that is the sum of a and b.

2)`MyComplex multiplyNew(MyComplex a, MyComplex b)` returns the complex number that is the product a*b.

References

1) Building Java Programs: A Back to Basics Approach by Stuart Reges and Marty Stepp

2) Runestone CSAwesome Curriculum: https://runestone.academy/runestone/books/published/csawesome/index.html

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