Programming with Java for Beginners

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Class, Exceptions, Scope

Class and Object Series

Assumptions & Expectations

Class and Object Series

- **Assumptions**
  - Method and Class series
- **Expectations**
  - Understand classes

Objectives

Class and Object Series

- **Class**
- **Error handling**
- **Scope and life time of variables**

Class and Objects:

Class and Object Series I

Java is an object oriented programming language
Essential to learn about objects

Real-world objects: computer, desk, dog, car

All real-world objects have ***state*** and ***behavior***

A dog's states are his/her color, breed, name
A dog's behaviors are barking, fetching, wagging

Identifying state and behavior of real-world objects
leads to thinking in OO programming

Class and Objects:

Class and Object Series I

Software objects consist of ***state*** and ***behavior***

int myAge = 12; Literally myAge is an object whose state is value 12. The behavior of myAge is: it can be added, subtracted, compared etc.

Concept of objects are applied to new type of objects created by programmers where built in objects (data types) are not sufficient to solve the need.

For example: String object (character arrays are not sufficient to provide the functionality)

Defining Classes:

Class and Object Series I

- User stories (requirement gathering)
- Identify nouns to make up your class
- Organize classes to solve user stories
- Restrict access to data within class
- Use visibility modifiers in methods for accessibility to clients (of class)
- Pass data to/from methods as parameters
- Create instance variables for class, built in types and use locally or pass as parameters
- Create helper methods as utility

Defining Classes:
Class and Object Series I

- User stories (requirement gathering)
- Identify **nouns** to make up your class
  - Verb/Adj make up *behavior* and *state*
- Organize classes to solve user stories

John loves *drawing* **boxes**. **He** wants to *draw* boxes of different *shape*, *size* and *colors*. **He** does not know what *size*, *shape* or *color* of **box** **he** wants to *draw* beforehand but **he** would know once **he** *starts drawing*.

Defining Classes:
Class and Object Series I

- Identify nouns, verbs and adjectives

Nouns: John (client), He, Box

Verb: Draw, drawing

Adjective: Shape, size, color

Defining Class:

Class and Object Series I

Class: A blue print to create an individual object.
It describes the characteristics of similar objects.
Small box or big box: both of them are a Box

```
public class Box {
   int width = 20;
   int height = 10;

   void changeHeight() {40};
   void changeWidth() {20};

   void Draw();
```

Class and Objects:

Class and Object Series I

Object's state is stored in ***fields*** (variables)
it could be primitive data type or another object

```
public class Box {
   int width = 20;
   int height = 10;
   String hLineSymbol = "-";
   String vLineSymbol = "|";
…
}
```

Class and Objects:

Class and Object Series I

Object's behavior is defined by ***methods*** (functions) it operates on internal state. Hides details. Providing OOP Encapsulation.

```
void changeHLSymbol(String hLine)
{
      hLineSymbol = hLine;
}
void changeVLSymbol(String vLine)
{
      vLineSymbol = vLine;
}
```

Class and Objects:

Class and Object Series I

- **Demo**

Class and Objects:

Defining Class:

Class and Object Series II

- Restrict access to data within class
- Use visibility modifiers in methods for accessibility to clients (of class)
- Create helper methods as utility

```
public class Box {
   private int width = 20;
   private int height = 10;

   private void trimHeight() {};

   public void changeHeight() {40};
   public void Draw();
```

Using Class:

Class and Object Series II

Object: A BIG BOX or a small box is an instance (object) of a Box blue print (class)
Object is run time entity consisting of data (state) and responds to messages (behavior)

```
import MyUtility.*;
public class FirstJavaHello {
     public static void main(..){
        Box bigBox = new Box();
        bigBox.drawBox();
     }
}
```

Using Class :

Class and Object Series II

An object is an instance of its class (blue print), and the process of creating a new object is called ***instantiation.***

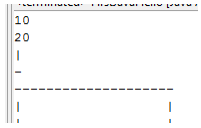
bigBox is **instantiated** from Box class

new operator is used to instantiate a new object

```
import MyUtility.*;
public class FirstJavaHello {
     public static void main(..){
        Box bBox, sBox;    //declr varble
        bBox = new Box(); //instantiate
        bBox.drawBox();    //use
     }
}
```

Using Class :

Class and Object Series II



bBox is a reference to an box object (bBox is an interface not real object --which is in memory).

A box object keeps track of height and width

What is the value of height and width of new object?

Use **accessor** methods

```
Box bBox, sBox;    //declr varble
bBox = new Box(); //instantiate

System.out.println(bBox.findHeight());
System.out.println(bBox.findWidth());
System.out.println(bBox.findVLSymbol());
System.out.println(bBox.findHLSymbol());
```

Using Class :
Class and Object Series II

bBox is a reference to an box object
A box object keeps track of height and width
How do you change these values?
Use **mutator** methods:

```
Box bBox, sBox;    //declr varble
bBox = new Box(); //instantiate

bBox.changeHeight(8);
bBox.changeWidth(8);
bBox.changeHLineSymbol("*");
bBox.changeVLineSymbol("*");
```

Using Class :
Class and Object Series II

Always write a special method called: toString as well

```
public String toString()
{
return "\nName: " + boxName +
       "\nHeight: " + height +
       "\nWeidth: " + width +
       "\nH Line Sysmbol: " +hLineSymbol +
       "\nV Line Symbol: " + vLineSymbol +
       "\n\n";
}
```

Using Class :

Class and Object Series II

You can directly call the **toString** method for that object.

However, there are other situations where the method **toString** is implicitly called.

For instance:

- **toString** is called implicitly when a Box object is concatenated with a string.
- **toString is called when** Box object is in an argument to the method **println**

Using Class :

Class and Object Series II

Example of implicit use of **toString** method

```
String str;
str = "This is Johns Big Box: \n" +
                        bigBox.toString();
//this is equivalent
str = "This is Johns Big Box: \n"+bigBox;

System.out.println(smallBox.toString());
//this is equivalent
System.out.println(bigBox);
```

Using Class :

Class and Object Series II

```
public class FirstJavaHello {
    public static void main(String[] args){
        Box bBox = new Box();
        System.out.println(bBox.findHeight());
        System.out.println(bBox.findWidth());
        System.out.println(bBox.findVLSymbol());
        System.out.println(bBox.findHLSymbol());
        bBox.drawBox();

        bBox.changeHeight(8);
        bBox.changeWidth(8);
        bBox.changeHLineSymbol("*");
        bBox.changeVLineSymbol("*");
        System.out.println(bBox.findHeight());
        System.out.println(bBox.findWidth());
        System.out.println(bBox.findVLSymbol());
        System.out.println(bBox.findHLSymbol());
        bBox.drawBox();

    }
}
```

```
10
20
|
-
----------
|        |
|        |
|        |
|        |
|        |
|        |
|        |
|        |
----------
8
8
*
*
********
*      *
*      *
*      *
*      *
*      *
*      *
*      *
********
```

Using Class :

Class and Object Series II

Object state and behavior:

Combining state and behavior in a single software entity is called **Encapsulation**

Objects have **behavior** defined by methods

Objects have **state** because at any moment instance variable has values in them

Each object has unique ID handled internally

Using Class :

Class and Object Series II

Object state and behavior:

Combining state and behavior in a single software entity is called **Encapsulation**

```
public class Box {
   private int width = 20;
   …
   private String vLineSymbol = "|";
…
void changeHLSymbol(String hLine) {};
…
}
```

Using Class :

Class and Object Series II

JVM, Computer Memory and Your Program:

```
Memory holds:
  compiled class templates(always)
  variables that refer objects and
  object themselves (come and go)
       -  in first instantiation,
          disappears when not needed
JVM keep track of object references
Unreferenced objects are deleted via
  garbage collection
```

Using Class :
Class and Object Series II

Primitive Types, Reference Types, and the null Value:

In Java there are two fundamental types, for example:

Primitive types: byte, char, int, double, boolean etc, (box that contains a value of that primitive type)

Reference types: all classes, for instance, String, Student, … ((a box that contains a pointer to an object)

Reference variables can be assigned the value null which will eventually be garbage collected

Two or more variables can refer to the same object

Using Class :
Class and Object Series II

Primitive Types, Reference Types, and the null Value:

```
Box bigBox, smallBox;
bigBox = new Box();

smallBox = bigBox;
System.out.println(bigBox);
System.out.println(smallBox);
```

```
Name: Default Box
Height: 10
Weidth: 20
H Line Sysmbol: -
V Line Symbol: |
```

```
Name: Default Box
Height: 10
Weidth: 20
H Line Sysmbol: -
V Line Symbol: |
```

Using Class :

Class and Object Series II

Primitive Types, Reference Types, and the null Value:

```
smallBox = bigBox;

//you can break the connection by
assigning null to it
smallBox = null;
//you can only assign null to objects not
//primitive variables
//int i;
//i = null; //cant be done
```

Class and Objects:

Class and Object Series II

- **Demo**

Class and Objects:

Errors in Java Program :

Class and Object Series III

- Syntax errors: compiler will report this error
- Semantic error: logical error – compiler has no clue
- Runtime errors: logical error which crashes your prog
  1. Divide by zero
  2. Subscript out of range for arrays
  3. Stuffing wrong data type
  4. Calling a function on null object
- How to tackle them?

```
Exception in thread "main" java.lang.NullPointerException
        at FirstJavaHello.main(FirstJavaHello.java:508)
```

Errors in Java Program :

Class and Object Series III

•How to tackle them?

1. Syntax errors: With help of compiler and document
2. Logical errors: by debugging and not doing sloppy programming
3. Runtime errors by using exception handling


```
Exception in thread "main" java.lang.NullPointerException
        at FirstJavaHello.main(FirstJavaHello.java:508)
```

Errors in Java Program :

Class and Object Series III

```
public static int getValidInteger() {
          while (num == -9999 && ..) {
            Scanner input = new
                    Scanner(System.in);
            if (numberOfTry == 1)
            ..
            else
            ..
            if (input.hasNextInt())
                num = input.nextInt();
        }
        return num;
    }
```

Errors in Java Program :

Class and Object Series III

Using the function which checks error for us:

How do you improve this to use for all numbers?

```
Box bigBox, smallBox;
bigBox = new Box();

int boxSize = getValidInteger();
bigBox.changeHeight(boxSize);

bigBox.changeWidth(getValidInteger());
```

Exceptions in Java Program :

Class and Object Series III

When your program crashes for some situation which JVM does not know how to handle (divide by zero or subscript out of range or null pointer exception), JVM will create a special object called **exception** and throw.

As a programmer it is up to you to catch that exception object and handle the situation relatively gracefully

```
Exception in thread "main" java.lang.NullPointerException
        at FirstJavaHello.main(FirstJavaHello.java:508)
```

```
Something horrible happen while drwing smallbox: java.lang.NullPointerException
```

Using Class :

Class and Object Series III

Introducing Exception:

```
smallBox = null;
try {  //try block. trying to do
       // something which could go wrong
     smallBox.drawBox();
}
catch (Exception e ) {
// control is transferred here if any
// exception is raised in try block
System.out.println("Something horrible
happen while drwing smallbox: " + e);
} // you can have many cach block
```

Class and Objects:
Class and Object Series III

- **Demo**

Exception Handling:

Class Construct:
Class and Object Series IV

Most classes have similar constructs
- A name with some modifiers
- Some instance variables
- One or more method describing how to initialize the object (**Constructors** – method)
- A constructor is a special method with the same name as the class
- More methods which signifies how your object responds to messages

Class Construct:

Class and Object Series IV

Most classes have similar constructs

```
public class Box {
      private int width = 20;
      …
      public Box() {};
      public Box(int w, int h, String
            hLine, String vLine, String
            boxName) {};
      …
      private void drawHorizontalLine()
      public void drawBox()

}
```

Class Construct:

Class and Object Series IV

Most classes have similar constructs
- Constructor is called when you use **new** operator
- Used for initializing the state of newly instantiated object
- Can have multiple constructors
- **Default Constructor** has empty body
- If you don't provide JVM provides one DC
- If you have multiple constructor can chain them

```
public Box() {}
public Box(int w, int h, String hLine,
String vLine, String boxName) {}
```

Life Time and Scope of Variables:

Class and Object Series IV

Class has two main parts:
Instance variables and Methods

When a new object is created it will have its own new set of instance variables **(Global Variables)** (common pool of data for all methods)
Object: contains data and responds to messages
Class: has template to create object and has code

When a method executes – it does for an object it has complete access of instance variable and **local variable**

Scope of Variables:

Class and Object Series IV

Scope is region of program where the variable is visible

Scope of parameter and local variable is restricted to the methods

Scope of instance variable (global variable) is all methods of the class

Compiler will flag it as error if you go out of scope

Scope of Variables:
Class and Object Series IV

```
public class Box {
     private int width = 20;
     …
     public Box() {};
     public Box(int w, int h, String
          hLine, String vLine, String
          boxName) {};
     …
     private void drawHorizontalLine()
     public void drawBox()
 }
```

Scope of Variables:
Class and Object Series IV

Block scope { }

```
{
     int myInt = 50;
}

{
     int myInt = 70;
}
```

Life Time of Variables:
Class and Object Series IV

The time period during which the variable can be used

Local variables: Single execution of method
Formal parameter: Single execution of method (new value for next call)

Instance (global) **Variable**: Available during life time of object

Recycling (**duplicating**) the variable names: Is allowed because of scope resolution will take care of the issue

Life Time of Variables:
Class and Object Series IV

Good usage of:

- Instance variable
  - Be careful not to use it for other purposes
- Parameter
- Local variable
  - Do not use to remember sate of object

Class Hierarchy in Java:
Class and Object Series IV

Java has hierarchy of classes

Object is the base of this hierarchy

A class immediately after another class is called
subclass (child) of its **superclass (**parent)

All classes in Java has one parent and many children
(except Object class)

Class Hierarchy in Java:
Class and Object Series IV

Java has hierarchy of classes

A new class in the hierarchy will **inherit** commonality
of its parent class (superclass)

You use **extend** keyword to extend the base class

If you omit extend, it automatically inherits from Objects

Class Hierarchy in Java:

Class and Object Series IV

Inheritance:

Different kinds of objects have commonality and differences: Some additional features

Mountain bikes have gears, while mountain bikes also have two wheels like road bike.

Specialized objects *inherit* the commonality from other classes

subclass inherits commonality from *superclasses*
class SolidBox ***extends*** *Box*{ …}

Class and Objects:

Class and Object Series IV

- **Demo**

Write your class:

Summary

Class and Object Series

- Class
- Error handling
- Scope and life time of variables