**JAVA**

What is JAVA?

* Originally for intelligent consumer-electronic devices (TV sets, headset…)
* Then used for creating Web pages with dynamic content
* Now also used to:
  + Develop large-scale enterprise applications
  + Enhance WWW server functionality
  + Provide applications for consumer devices (cell phones, etc.)
* Being OOP more important than being efficient for JAVA

**Typical JAVA Development Environment**

Java programs normally undergo five phases

* Edit
  + Programmer writes program (and stores program on disk)
* Compile
  + Compiler creates bytecodes from program
* Load
  + Class loader stores bytecodes in memory
* Verify
  + Bytecode Verifier confirms bytecodes do not violate security restrictions
* Execute
  + JVM translates bytecodes into machine language

file.c

C / C++

a.out works on top of the OS, OS works on top of the hardware.

So a.out directly communicates with the OS.

Your code has to be compiled for different environments all the time.

file.o

|  |
| --- |
| a.out |
| OS |
| CPU / HARDWARE |

file.java

JAVA

you compile file.java through a JAVA compiler. It produces file.class which is byte code not assembly code.

Loader loads file.class on top of JVM.

JVM is a software (interpreter). It is used for running JAVA programs.

You compile all code into a bytecode. Then bytecode is run by JVM which reads bytes line by line and executes them. So JAVA is inbetween (compiler and interpreter).

With this way, doesn’t matter if you have different CPU or OS, as long as you have my JVM, my compiled code will work everywhere (like refrigerator, microwave, TV set, computer…). So you compile once.

JVM and file.class are both softwares. They are using same CPU. This makes your code a bit slower than C code.

file.class

|  |
| --- |
| file.class |
| JAVA VIRTUAL MACHINE (JVM) |
| OS |
| CPU / HARDWARE |

For developers:

* If you install Java Development Environment 🡪 you receive javac and java.

For non-developers:

* If you install Java Runtime Environment (JRE) 🡪 you receive only java.

// Fig. 2.1: Welcome1.java  
// Text-printing program.  
  
public class Welcome1  
{  
 // main method begins execution of Java application  
 public static void main( String args[] )  
 {  
 System.out.println( "Welcome to Java Programming!" );  
 } // end method main

} // end class Welcome1

System is a class.

out is const object defined in System class like cout.

println is the method that takes string or any object then prints on the screen.

public class welcome{

public static void main(String [] args)

{

System.out.printf(“Welcome to Java %s \n”, “Student”);

}

}

How you compile this?

Name of the java compiler is “javac”. You compile the code as this:

javac welcome.java

Now you have (little sized) welcome.class which is bytecode that only JVM can understand. This doesn’t depend on any CPU or OS. Now you have to run your code with “java” which is JVM.

java welcome

If you define “int a=1;” above printf and printf(“Welcome to Java %s \n”,a);, this can still work. In JAVA all the objects can be converted to string. Your DayOfYear object can also be converted to string even if you don’t override it but it would be meaningless (memory address of that object in JVM - Name and hashCode). There is a way to convert int to string.

But if you send string while printf waits for float (%f), then you will get runtime error. C would print some garbage.

![Diagram

Description automatically generated](data:image/jpeg;base64,/9j/4AAQSkZJRgABAQEAYABgAAD/4RDaRXhpZgAATU0AKgAAAAgABAE7AAIAAAAFAAAISodpAAQAAAABAAAIUJydAAEAAAAKAAAQyOocAAcAAAgMAAAAPgAAAAAc6gAAAAgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAE1lcnQAAAAFkAMAAgAAABQAABCekAQAAgAAABQAABCykpEAAgAAAAMwNgAAkpIAAgAAAAMwNgAA6hwABwAACAwAAAiSAAAAABzqAAAACAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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* *YOU CANNOT DECLARE GLOBAL FUNCTIONS OR GLOBAL VARIABLES IN JAVA.*
  + So I make functions part of the class 🡪 method.

Class name must be same with file name.

An executable JAVA program should contain a main method. You have to have 1 main method.

main has to be static because JVM will call the main without making any object of the class. It just directly calls Welcome1.main. How it knows what to call 🡪 bc name of the file and name of the class have to be the same. When I say “java Welcome1”, JVM calls Welcome1.main.

Why do we declare our class public?

Because I can have more than 1 class inside same java file. Only one of them has to be public. Whatever is public, it has to have same name as the file name.

Usually we write 1 class for each file.

public class Welcome1  
{  
 public static void main( String args[] )  
 {  
 System.out.println( "Welcome to Java Programming!" );  
 }   
}

🡪 println puts \n at the end automatically, print doesn’t.

**CHECK Addition.java**

We don’t separate header and implementation so what about documentation?

In C++, we give header files along with the compiled code.

In JAVA, there is something called “javadoc”. It scans your class and produce a nice pdf or html file.

**CHECK AddNum.java**

At line 38, why don’t you do 🡪 “int sum = addnum(10, 20);” bc main is part of the same class?

Because main is static and you cannot call non-static methods in static methods bc non-static methods need an object.

javac AddNum.java

compile and run

java AddNum

javadoc AddNum.java produces lots of files

One of the produced files is index.html. This is automatically produced out of my code.

/\*\* 🡪 /\*\* means that this comment is important.

…

\*/

In JAVA, you write your access modifiers at the beginning of each member.

public int addNum(int numA, int numB){

return numA + numB;

}

int sum = 30;

System.out.println(“Sum of 10 and 20 is :” + sum);

//This is string concatenation, sum can be converted into string as we mentioned

|  |  |
| --- | --- |
| C++ | JAVA |
| {  Money m1, m2(10,20);  Money \*mp = new Money(10, 5);  }  After end of block:  //m1 and m2 will be destroyed.  //mp will be destroyed but Money created on heap will stay so we have to delete it. | {  Money m1 = new Money(10, 20);  }  After end of block:  //m1 is Money reference (smart pointer)  //m1 will be destroyed and when it dies, nobody points to object and object will die too. |
| class A{  . . .  }objA;  //I created objA of type classA. | class B{  . . .  }  //You cannot create objB of type classB bc objects cannot have names. So you don’t put “;” at the end of class. |

There is no object creation on the stack in JAVA. You cannot give names to the objects, you give names to pointers.

To delete an object in JAVA, the reference count has to drop to 0.

It is very difficult to have pointer related error (memory leak, dangling reference) in JAVA. They don’t let you touch the objects. All the objects have to be in heap. They are automatically deleted. There is no destructor in JAVA.

JAVA doesn’t let you have an unitialized primitive types.

When you say “Money m;” in JAVA, m’s default value is null. So you can’t call “m.getDollars()”.

In JVM, there is a piece of software called **garbage collector**. It runs time to time and deletes all the objects that are not used anymore. You don’t know when it runs.

Usually garbage collector doesn’t run when you don’t need memory (when you have enough memory).

You can force garbage collector to run but it is not your job.

You don’t think too deep in JAVA.

**Arithmetic Operations**

Operators precedence and arithmetic operations are almost the same as C/C++

“if” statements and conditions are exactly the same.

**Classes**

Class definitions are very similar to C++

Access modifiers (public, private, protected) are the same but you have to put them at the beginning of each field and methods.

Java class functions are called methods

Java class data members are called fields or instance variables.

No global functions or variables in Java. Everything is objects.

Static methods are the same as static member functions.

Static fields are the same as static data members.

Static members are declared like in C++.

Java uses static methods of Math class like global functions in C++ (Math.sin(10)).

For constants, Java uses keyword final.

Method main in an application class is static.

Convention is first letter of class name is capital.

If there is no constructor, everything will be initialized to their default values (0 for fundamental types, false for boolean, null for reference types).

**Primitive Types vs. Reference Types**

Types in Java

* Primitive (their sizes are not machine dependent)
  + boolean, byte, char, short, int, long, float, double
* Reference (sometimes called nonprimitive types (such as strings) ) / smart\_ptr for C++
  + Objects
  + Default value of null
  + Used to invoke an object’s methods

Since you cannot delete an object yourself, you cannot keep a reference in an invalid state.

Strings became part of the language itself. It is possible to create objects of string without using the new keyword. You can do:

String s = “ABCD”;

This is only one of the exceptional ways of creating an object without new operator (Also there is array).

Money m1 = new Money(10, 20);

both m1 and m2 are pointing to the same place at the heap

Money m2 = m1;

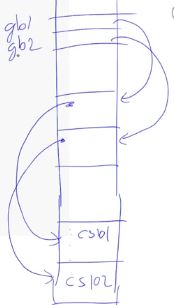
m1.setDollars(15);

If you do “m2 = m1 = null;” instead of “m1.setDollars(15);”, object is killed by garbage collector and you don’t know when it is killed.

Now both m1 and m2 are pointing to an object that has a dollar part of 15.

You should do: “Money m2 = m1.clone();“

Clone is not available by default unlike copy constructor. Clone is protected, you cannot use directly. You have to override it in a proper way, we will see.

**CHECK GradeBook.java, GradeBookTest.java in order**

String s3 = new String(“ABC”);

GradeBook gb3(s3);

gb3 copies the reference of s3 into GradeBook’s string. What happens if I later change s3? gb3 will affected too. So maybe we should have done deep copy in constructor.

But no, we don’t have to. String is kinda special class in JAVA bc String class is inmutable class. It doesn’t have any functions to change String data members. You cannot change it. You cannot add more characters or modify one of the characters. It is constant.

What happens if you need to change the string? Make new one.

But you have to be careful for other classes. You may need to call clone.

For strings, you don’t have += operator. Actually you have but it makes a new string.

There is no const keyword in JAVA. So you don’t have const for getter. JAVA methods don’t make guarantee about I am gonna change this object or not.

**Control Statements**

All control statements (if, if-else, ?:, switch) are all the same.

The repetition statements (while, for, do-while) are all the same.

Compound assignments (+=, \*=, etc.) and post-pre increment decrement (--, ++) exist in Java

break and continue have the same effect.

**Logical Operators**

Logical && and || have the same effect including short circuit evaluation.

Boolean Logical AND (&) Operator

* Works identically to &&
* Except & always evaluate both operands

Boolean Logical OR (|) Operator

* Works identically to ||
* Except | always evaluate both operands

There are no bitwise operators in JAVA.

Promotions allowed for primitive types:

![Graphical user interface, text

Description automatically generated](data:image/jpeg;base64,/9j/4AAQSkZJRgABAQEAYABgAAD/4RDaRXhpZgAATU0AKgAAAAgABAE7AAIAAAAFAAAISodpAAQAAAABAAAIUJydAAEAAAAKAAAQyOocAAcAAAgMAAAAPgAAAAAc6gAAAAgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAE1lcnQAAAAFkAMAAgAAABQAABCekAQAAgAAABQAABCykpEAAgAAAAM2NgAAkpIAAgAAAAM2NgAA6hwABwAACAwAAAiSAAAAABzqAAAACAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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2+1.5 🡪 I can promote 2 (int) to a float so I can make float addition.

**Java API Packages**

No include statements in JAVA.

Including the declaration “import java.util.Scanner;” allows the programmer to use “Scanner” instead of “java.util.Scanner”

“java.lang” package is automatically imported. Object and String is defined inside java.lang.

String doesn’t have any methods that change string itself.

In Java, there is no operator overloading. That’s why you cannot access to members of string using the index operator. Instead they have “charAt(int index)”.

“concat(String str)” makes new string and returns it. Doesn’t add end of the current string.

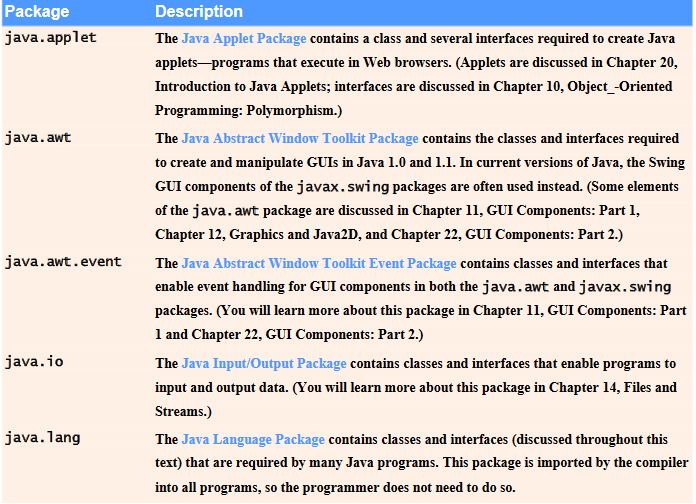
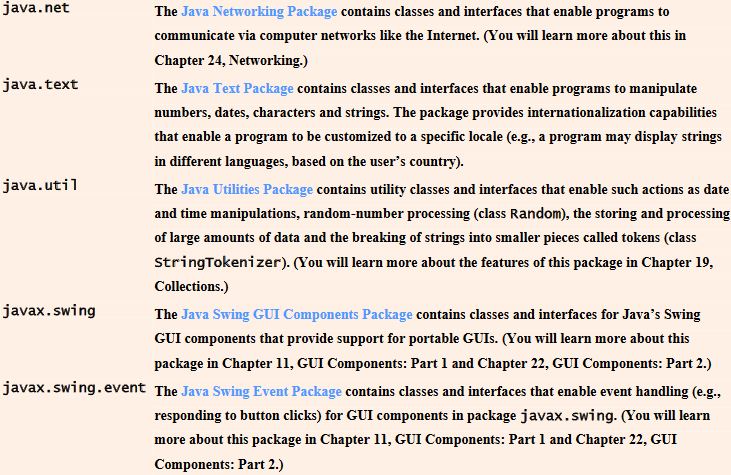
People usually use JAVA bc of the extensive library is available.

Applets are your small applications that work on the browser windows. Remember java bytecode can work on any virtual machine. So if I found java bytecode anywhere, I can make it work on my browser window. All the browsers support JVM. Those applications would be specialized applications and we call them applets. If you are writing an application for browser window, you use the “java.applet”. You extend your class from java.applet and it becomes an application that is runnable through a browser window. Nowadays people don’t like this because this is big security risk. So you should not run JVM on your browser, it is disabled by default. You have to do lots of reconfiguration to enable it.

“java.awt” and subpackage of it “java.awt.event”, “javax.swing” and subpackage of it “javax.swing.event” are for GUI.

BASE CLASS: Superclass for java

DERIVED CLASS: Extended Class for java

****

**Scoping, Shadowing, Overloading**

They work the same way as in C++

Methods can be overloaded.

You may use the same method name for different methods as long as their signatures are different. Definition of signature is same as C++.

**CHECK Scope.java and ScopeTest.java in order**

**Arrays**

Arrays have similarities and differences from C++.

Arrays are reference types, not fundamental types.

Created dynamically with keyword new

int[] c = new int[ 12 ];

* Equivalent to

int[] c; // declare array variable, value of c is null

c = new int[ 12 ]; // create array

* Equivalent to

int c[]; // “int[] c” is better (type variableName;)

* c is a reference, not pointer.
  + You cannot increment c, etc.
* c.length is the length of the array. It is field not method. So you don’t have to send the length of an array when you send this to a method.
* As an exception to other stuff array initializer can be used.

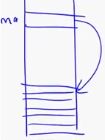
They are not pointers. They are reference types.

Array initializers can be used.

Multiple dimensional arrays are possible (int[][] c;).

Remember pointers in C++, shared\_ptr in JAVA.

**CHECK InitArray.java**

Money[] ma = new Money[10];

* Makes an array of Money references.
* “ma[0].getDollars()” will give you runtime error. Elements are null.

for(int i=0; ma.length; ++i) ma[i] = new Money(10, i);

* Now elements are not null.

You cannot have array of objects in JAVA. All you can get is array of object references or fundamental types.

Remember, in C++, if you don’t have no parameter constructor or default constructor, you cannot make arrays of those kind of classes. In JAVA this is possible because array’s elements are not objects, they are references. To make Money objects, you need to use new operator one by one and you get to choose your constructor.

**Enhanced for Statement**

Enhanced for statement (Starting from “Java SE 5”, SE: standard edition)

* Allows iterates through elements of an array or a collection without using a counter
* Syntax

for ( parameter : arrayName )

statement

**CHECK EnhancedForTest.java**

JAVA INITIALIZES ALL THE FIELDS TO THEIR DEFAULT VALUES WHICH IS 0 FOR FUNDAMENTAL TYPES, NULL FOR REFERENCE TYPE. BUT IF IT IS A LOCAL VARIABLE (“int total;”) IT DOESN’T GET INITIALIZED. YOU ARE GONNA GET AN UNITIALIZED DATA OR STH LIKE THAT.

Local variable declarations with initializers:

(Starting from “Java SE 10”)

var list = new ArrayList<String>(); // infers ArrayList<String>

var stream = list.stream(); // infers Stream<String>

var path = Paths.get(fileName); // infers Path

var bytes = Files.readAllBytes(path); // infers bytes[]

ArrayList<String> 🡪 We call this generic instead of template in JAVA.

**Passing Data to Methods**

Notes on passing arguments to methods

* Two ways to pass arguments to methods
  + Pass-by-value
    - Copy of argument’s value is passed to called method
    - In Java, every primitive is pass-by-value
  + Pass-by-reference
    - Caller gives called method direct access to caller’s data
    - Called method can manipulate this data
    - Improved performance over pass-by-value
    - In Java, every object is pass-by-reference
      * In Java, arrays are objects
      * Therefore, arrays are passed to methods by reference (copy)

In C, we don’t have call-by-reference, we have simulated call-by-reference.

In C++, we have both call-by-value and call-by-reference.

In JAVA, we have call-by-value only.

If you are passing an int to a method, that int has to be copied.

If you are passing a reference to a method, that reference has to be copied. Copying the reference doesn’t mean that you are copying the object. If you copy the reference and modify your object through that reference, you end up modifying your object (as like in C - simulated call-by-reference). It looks like a simulated call-by-reference.

Since arrays are referenced objects, their references are pass-by-value. Since they are pass-by-value, I get the reference itself, I can modify the array itself using that reference.

REMEMBER, YOU CANNOT TOUCH AN OBJECT IN JAVA, THEY DON’T EVEN HAVE NAMES. REFERENCES HAVE NAMES. SO YOU CANNOT SEND OBJECT ITSELF TO A METHOD, ONLY REFERENCES CAN BE SENT TO A METHOD.

We don’t have default arguments in JAVA.

There is no -> operator in JAVA. Everything is “.” operator bc everything in JAVA is through references (smart pointers).

Money f(){

return new Money(10, 20);

}

This is safe. If somebody gets the reference to returned Money, they can keep using it. If nobody gets it, it will be deleted automatically.

You might say that I am going to return a reference to a local object. But there are no local objects in JAVA. Everything has to be created on the heap.

Money g(){

Money m;

return m;

}

This is returning a reference, not object. Since I didn’t assign anything to m, it just returns a null reference.

If you return a reference to a private object, other people can modify it and that’s what I don’t like. If you return a string, that’s okay bc string is not mutable. BUT if you have a Money object as a private field in your class, and if you return it, they can change your Money object. There is no const keyword so there is no guarantee that nobody is gonna change it. There are some ways and we are gonna see them.





If I have a Money object in my class, I don’t return a Money reference but I return a InmutableMoney reference. There is “isA” relationship between them, every Money object can behave like InmutableMoney object.

So users cannot modify their values bc there is no set element int InmutableMoney.

What happens if customers do downcasting?

So they are shooting themselves from the foot. That is their problem.

There is no move semantic in JAVA. It doesn’t make sense because I am not assigning an object to another object.

Point of move semantic was “If I am doing the assignment, instead of copying the content of the other object, I was stealing it. Then we left it to be killed.”. In JAVA I don’t have any object assignments. Maybe I can do the cloning or copy constructor stuff but it is not needed. Even if it is needed, JAVA is okay with efficiency loss.

Also killing an object is not determined by me, it is determined by garbage collector.

**Variable-Length Argument Lists**

New feature in J2 SE 5.0

Unspecified number of arguments

Use ellipsis (…) in method’s parameter list

* Can occur only once in parameter list
* Must be placed at the end of parameter list

Array whose elements are all of the same type

**CHECK VarargsTest.java**

**Using Command-Line Arguments**

Command-line arguments

* Pass arguments from the command line
  + String args[]
* Appear after the class name in the java command
  + java MyClass a b
* Number of arguments passed in from command line
  + args.length
* First command-line argument
  + args[ 0 ]

**CHECK InitArray.java**

Integer.parseInt() 🡪 method to convert string into int, it is static (I don’t call it with object)

Integer is class name inside the java.lang package.

parseInt method takes a string and return an integer.

**Overloaded Constructors**

Provide multiple constructor definitions with different signatures

No-argument constructor

* A constructor invoked without arguments

The “*this”* reference can be used to invoke another constructor

* Allowed only as the first statement (first executable line in your constructor) in a constructor’s body
* This is another way of constructor delegation

*this* keyword is same as C++

**CHECK Time2.java**

In JAVA, we don’t have a separate term for copy constructor. There is no copy constructor, it is not distinguished from any other constructor. Standard method for copying stuff is “clone()“ method. You clone the objects.

**Garbage Collection and Method finalize (No pointers in JAVA)**

Garbage collection

* Runs time to time and checks object’s reference counts
* JVM marks an object for garbage collection when there are no more references to that object
* JVM’s garbage collector will retrieve those objects memory (delete it) so it can be used for other objects
* You don’t know when the object is deleted. Even if reference count is 0, garbage collection may not run until your program ends.

finalize method

* All classes in Java have the finalize method
  + Inherited from the Object class
* When object’s reference count is zero, before it is deleted finalize method is called. This is like destructor. But I know when destructor is called but I don’t know when finalize is called.
* finalize is called by the garbage collector when it performs termination housekeeping
* finalize takes no parameters and has return type *void*

**CHECK Employee.java, EmployeeTest.java in order**

{

Employee e1 = new Employee();

e1 = null;

}

//Even I reach to the end of block, I am not sure Employee object is deleted bc reference count reaching 0 doesn’t mean that garbage collector will delete my object.

In JAVA, everything is virtual. If you don’t want them to be virtual, you say final. Then these methods will not be overriddable.

**final Instance Variables**

Principle of least privilege

* Code should have only the privilege ad access it needs to accomplish its task, but no more

final instance variables

* Keyword final
  + Specifies that a variable is not modifiable (is a constant)
* final instance variables can be initialized at their declaration
  + If they are not initialized in their declarations, they must be initialized in all constructors

Recall: There is no const method in JAVA.

void m(final Money mo){

mo.setDollars(10); 🡪 OK

mo = new Money(); 🡪 NOT OK

}

This doesn’t mean that I won’t change the object referenced by mo. It means that I am not going to change mo. That is why setDollars is okay but assign new value to mo is not.

If you say method m is final, then you are not going to override that method.

**CHECK Increment.java, IncrementTest.java in order**

**Creating Packages**

Packages are kind of libraries. In JAVA we like to put our stuffs inside packages. Packages are kind of namespaces. They are in between libraries and namepaces.

To declare a reusable class:

* Declare a public class
* Add a package declaration to the source-code file
  + must be the very first executable statement in the file
  + package name should consist of your Internet domain name in reverse order followed by other names for the package
    - example: com.deitel.jhtp6.ch08
      * I am working at deitel company, under jhtp6 project, under ch08 subproject
    - example: tr.edu.gtu.cse.cse241.project1
    - Using unique package names is important.
    - package name is part of the fully qualified class name
      * Distinguishes between multiple classes with the same name belonging to different packages
      * Prevents name conflict (also called name collision)
    - Class name without package name is the simple name

**CHECK Time1.java**