Computer Programming
Java Overview Revisited

14th Week Lecture

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Outline

- Questionnaire Results
- Java Overview
- Java Examples
- C++ vs java
- Q&A

Java Overview

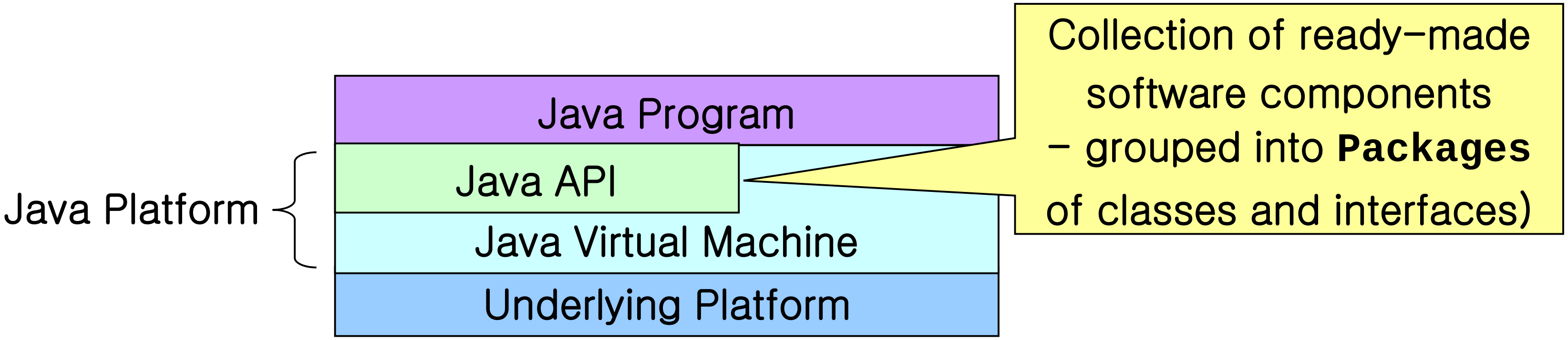
- Object-Oriented Programming Language (OOPL) by Sun in 1991
  - Programming with One or More Classes
  - Simple Structure
    - w/o header files, preprocessor, struct, operator overloading, multiple Inheritance, pointers, etc.
  - Garbage Collection
    - No need to delete or return any storage
  - Dynamic Loading
    - Classes being loaded as needed
  - Platform Independence
    - Java Virtual Machine (JVM)
  - Multithreading
    - Support for multiple threads of execution

Some Differences with C/C++

- Automatic Memory Management
  - Garbage Collector
  - No Dangling Pointers or Memory Leaks
- No Pointer Handling
  - No Explicit Reference/Dereference Operations
- No Makefiles
- No Header Files
  - cf, imported Packages
- No Function Declaration (Similar to C)
- No Default Function Argument

Java Platform

- S/W Platform for Running Java
  - on Top of any Platforms
  - Java Virtual Machine (JVM)
  - Java Application Programming Interface (Java API)



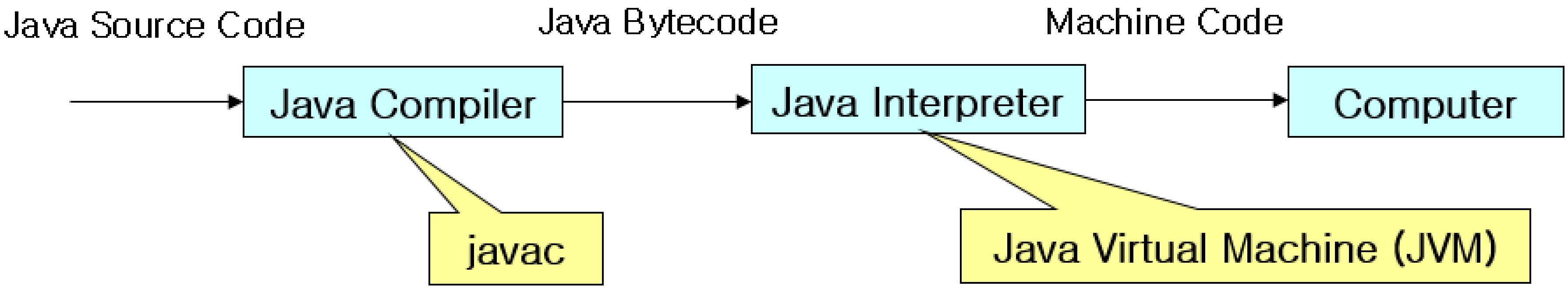
Collection of ready-made software components – grouped into **Packages** of classes and interfaces)

Java Interpreter

- Implementation of the JVM
  - Executing Java Bytecodes
    - Java bytecodes can be considered as intermediate code instructions for the JVM
    - Java programs, once compiled into bytecodes, can be run on any JVM

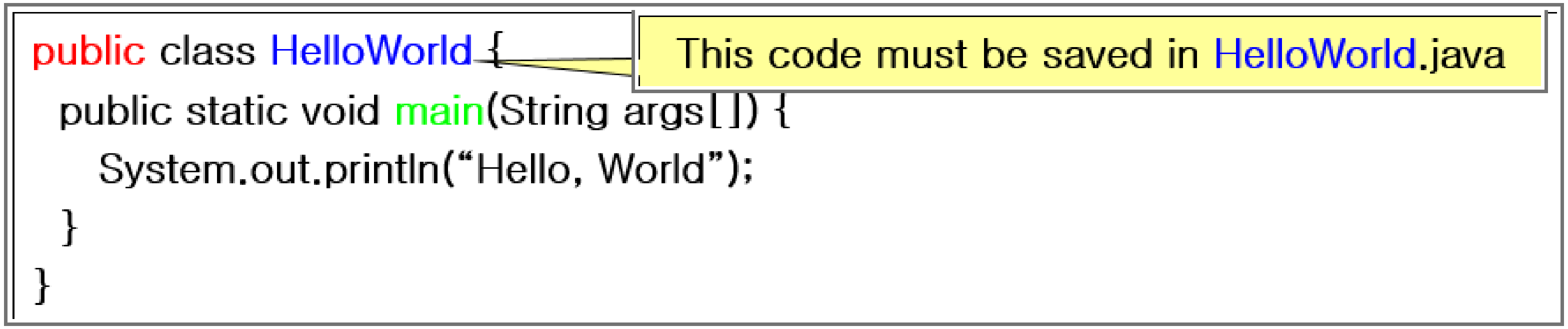
How a Java Program Runs

- Compilation and Interpretation
  - – Compiler First Translates a Java Program into Java Bytecodes
    - Once
  - – Interpreter Parses and Runs Each Java Bytecode Instruction
    - Multiple times on different platforms



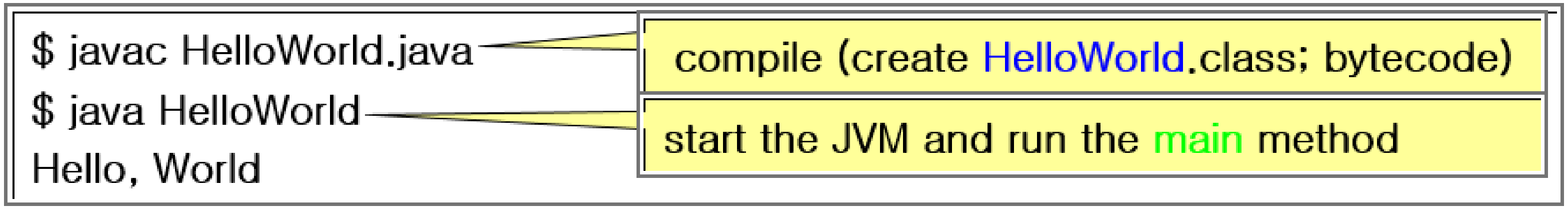
Java Program

- Saved in Files, Each of Which Has the Same Name as the public Class
  - Containing Only One public Class
  - Containing Other Non-public Classes



```
public class HelloWorld {
  public static void main(String args[]) {
    System.out.println(“Hello, World”);
  }
}
```

This code must be saved in HelloWorld.java

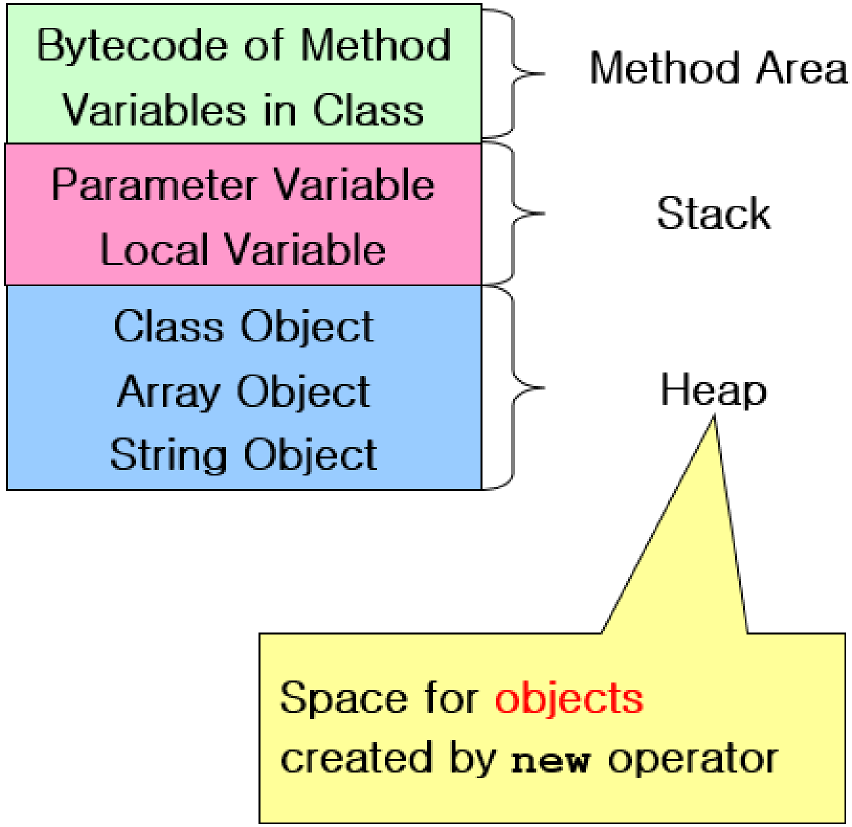


```
$ javac HelloWorld.java
$ java HelloWorld
Hello, World
```

compile (create HelloWorld.class; bytecode)

start the JVM and run the main method

Memory Layout of a Java Program



Space for objects created by **`new`** operator

```
public class MemoryModelTest {
      static int x=0;
      public static void main(String args[]) {
         int a=10, b=20, c;
         c = add(a, b);
      }
      static int add(int a, int b) {
         return(a + b);
      }
   }
```

Sample Program:
MemoryModelTest.java

Class

- Unit of Programming
  - Java Program: a Collection of Classes
    - Source code in .java files
- Description (Blueprint) of Objects (Instances)
  - Common Characteristics
- Instances Have These Characteristics
  - Attributes (Data Fields) for Each Object
  - Methods (Operations) That Work on the Objects

Member Access Control

- Way to Control Access to a Class’ Members from Other Classes
  - **private**
    - Accessible only in the class itself
  - Default (package or friendly)
    - Accessible in the same-package subclasses of the class or in the classes of the same package
  - **protected**
    - Accessible in the subclasses of the class or in the classes of the same package
  - **public**
    - Accessible everywhere

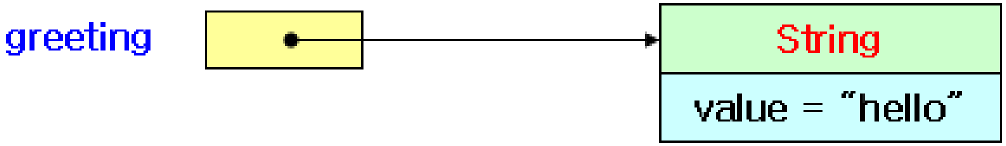
Object

- Instance of a Class
- Uniquely Identifiable Entity
  - w/ Its State, Behavior, and Interface
  - Maintaining Data Values in Its Attributes
  - Referenced by a Reference Variable (of Reference Type)
    - Inheriting from the Class Object
      - w/ a number of methods
      - toString(), equals(), … &, clone()

Managing Objects

- Referencing Objects of Specified Types
  - Objects Created by the new Operator
- Creating Objects by Executing the Constructors
  - Constructor (Function) Overloading

```
String greeting = new String("hello");
```



- Deleting Objects via Garbage Collection
  - Reference Count for Each Object

Cleanup occurs at the convenience of the Java runtime environment

Java Example: Abstraction

- Online Retailer Such as Amazon.Com
  - Item: Type, Title, Maker, Price, Availability,   etc.

```
class Item { // Class definition
        public String title; // String is a
        public double price;            // double is a primitive data type
        public double SalePrice(){ return (price * 0.9);}
}

Item A = new Item();    // Class object definition and creation

// OKA                                        ice()
```

Attribute of the class

Method of the class

Variable of reference type

Java Example: Encapsulation

- Online Retailer Example Cont’d

```
class Item {
    public String title;
    public double price;
    private int inStockQuantity;
    public double SalePrice(){ return (price * 0.9);}
    public boolean isAvailable(){
            if(inStockQuantity > 0) return true;
            else return false;
    }
}

Item A = new Item(); // Class object definition and creation

// NOT OKAY: A.inStockQuantity
// OKAY: A.isAvailable()
```

inStockQuantity attribute is not accessible outside of the Item class

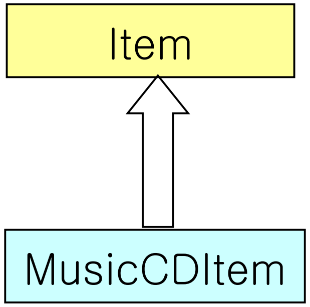
Java Example: Inheritance

- Online Retailer Example Cont’d

```
class MusicCDItem extends Item {
        public String singer_name;
}

// Class object definition and creation
MusicCDItem B = new MusicCDItem;

// OKAY: B.singer_name, B.title, B.price, B.SalePrice(),
// and B.isAvailable()
// NOT OKAY: B.inStockQuantity
```



Item

MusicCDItem

Java Example: Polymorphism

- Online Retailer Example Cont’d

```
class Item {
    public String title;
    public double price;
    private int inStockQuantity;
    public double SalePrice(){ return (price * 0.9);}
    public boolean isAvailable(){
        if(inStockQuantity > 0) return true;
        else return false;
    }
    public void specificInfo()     {
        System.out.println("no info: a base-class object");
    }
}
```

Java Example: Polymorphism Cont’d

```
class MusicCDItem extends Item {
        public String singer_name;
        public void specificInfo(){
                System.out.println("signer name=" + singer_name +
                                " : a derived-class object");
        }
}
```

```
public class OnlineRetailer {
        static void printSpecificInfo(Item Item){item.specificInfo();}
        public static void main(String args[]){ … }
}
```

```
Item A = new Item();
MusicCDItem B = new MusicCDItem();

printSpecificInfo(A); // Call Item.specificInfo()
printSpecificInfo(B); // Call MusicCDItem.specificInfo()
// - Another derived class (e.g., MovieDVDItem) with specificInfo()
```

Static Modifier

- Use: Static Attributes & Static Methods
- Features
  - All Classes Share Static Members
  - It Is Possible to Invoke Static Methods w/o Instantiation
  - In Static Methods, It Is Allowed to Access Non-Static Data or Non-Static Methods of Classes after the Instantiation of the Objects

```
class A{
        private int i = 5;
        public static printI(){
                System.out.println(i);                  // error!
                System.out.println(new A().i);
        }
}
```

Static Modifier Cont’d

- Differences between C++ and Java
  - Static Method Invocation
    - C++ : Class::method();
    - Java : Class.method();
  - Static Data Member Initialization
    - C++ : No In-Class Initialization (ANSI/ISO)
    - Java : In-Class Initialization

C++

```
class A{
public:
        static int i; // declare
        …
}
int A::i = 0; // define & initialize
```

JAVA

```
class A{
        public static int i = 10;
        …
}
```

Locating Classes

- Filesystem Names Consist of:
  - CLASSPATH
    - Environment Variable Set to a List of Pathnames:
      - Separated by “;” in autoexec.bat on Windows
      - Separated by “:” in a Shell Initialization File on Unix/Linux
        - » Bash: $ export CLASSPATH=/a:/a/Java/:.
  - Package Name
    - Name of a Collection of Individual .class Files in a Directory
  - Class Name

Locating Classes Cont’d

- CLASSPATH Tells the Class Loader Where to Begin Looking for All Possible Starting Places
  - Take the Full Name Including the Package Name, e.g., Java.d1.j11
  - Replace the Dots with “/” or “\” and Suffix with “.class,” e.g., Java/d1/j11.class
  - Concatenate It onto Each Element of the CLASSPATH

```
/a/Java/d1/j11.class
/a/Java/Java/d1/j11.class
./Java/d1/j11.class
```

Locating Classes Cont’d

- Package Statement (at the Top of Each Source File)
  - Which Package the Class Belongs to

package *packagename*;
E.g., package d1; (with /a/Java as an element of CLASSPATH)

- Import Statement
  - Permitting Using a Class Name Directly

import *packagename.classname*;
E.g., import d1.j11; (with /a/Java as an element of CLASSPATH)

Example: Locating Classes

- CLASSPATH=/a:/a/Java:.
- Current Directory: /a/Java/d1
- File j11.java

```
// package d1;
public class j11 {
    protected static int i = 1;
}
```

- File j12.java

```
// package d1;
// import d1.j11;
public class j12 extends j11 {
    public static void main(String args[]) {
        System.out.println("i = " + i);
    }
}
```

```
i = 1
```

Example: Locating Classes Cont’d

- CLASSPATH=/a:/a/Java:.
- /a/Java/d1/j11.java

```
package d1;
public class j11 {
    protected static int i = 1;
}
```

- /a/Java/d2/j15.java

```
package d2;
import d1.j11;
public class j15 extends j11 {
    public static void main(String args[]) {
        System.out.println("i = " + i);
    }
}
```

```
i = 1
```

Error

```
javac –d . j15.java ../d1/j11.java
```