OBJECT-ORIENTED PROGRAMMING PRINCIPLES

2ND WEEK LECTURE

엄현상(Eom, Hyeonsang)
School of Computer Science and Engineering
Seoul National University

Outline

- Java Overview
- Java Examples
- C++ vs Java
- Q&A

Java Overview

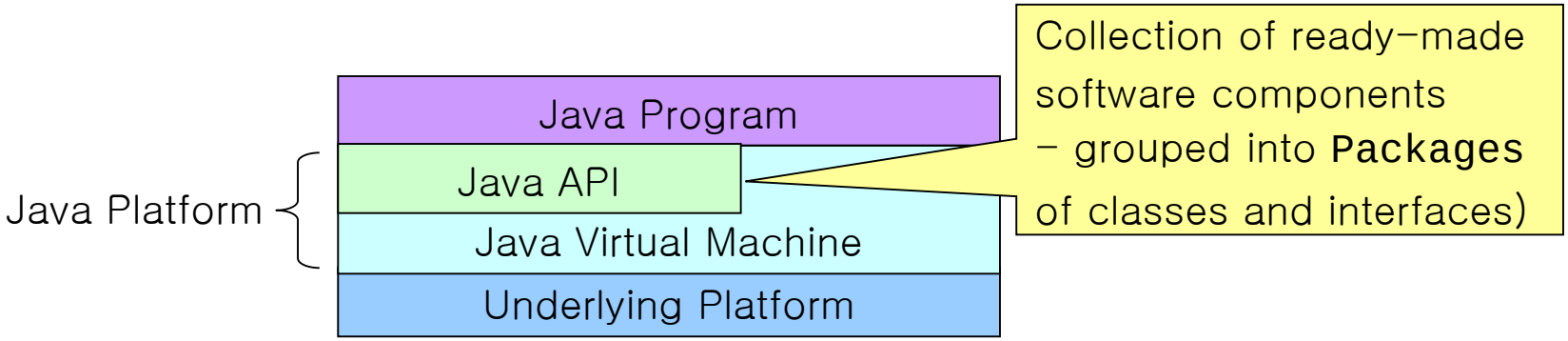
- Object-Oriented Programming Language (OOPL) by Sun in 1991
  - Programming with One or More Classes
  - Simple Structure
    - w/o header files, preprocessor, struct, operator overloading, multiple Inheritance, pointers, etc.
  - Garbage Collection
    - No need to delete or return any storage
  - 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)

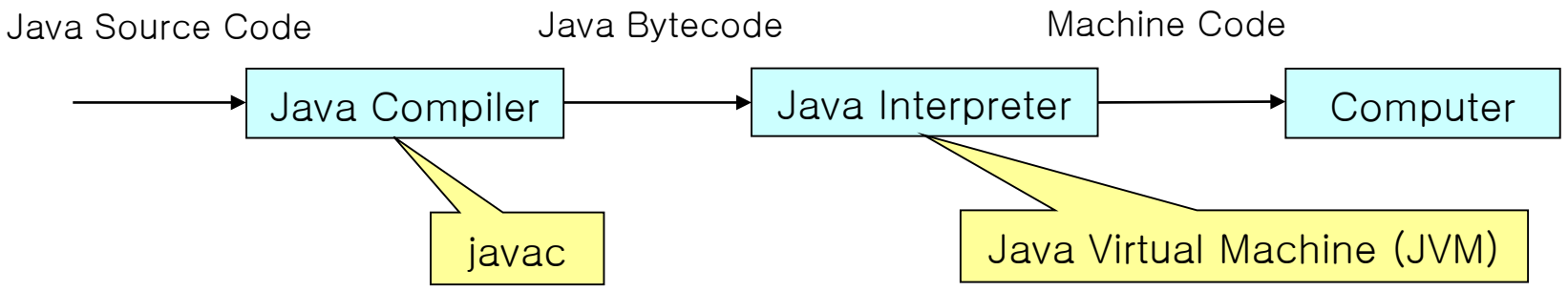


Java Interpreter

- 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");
  }
}
```

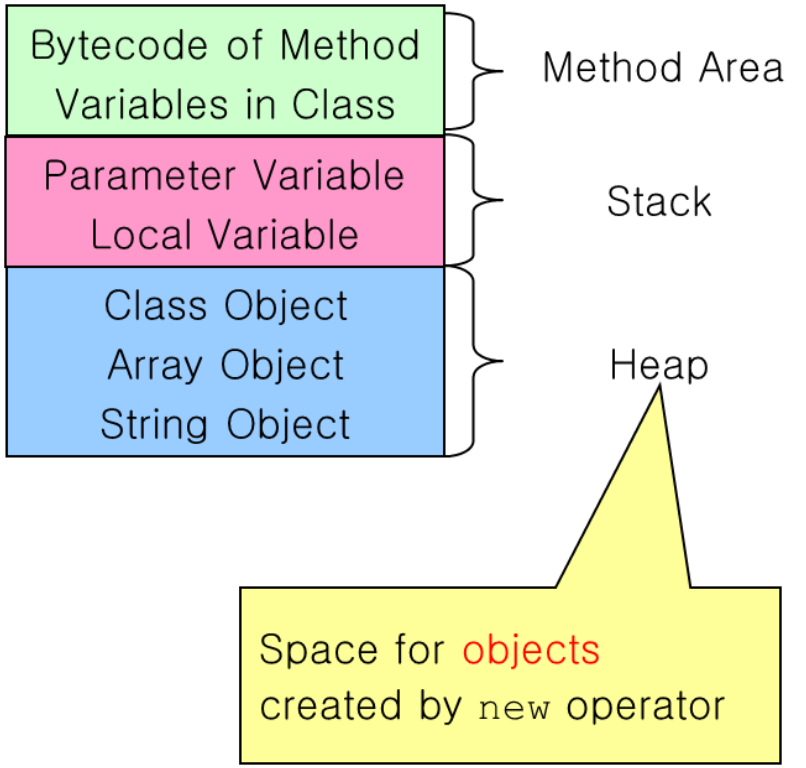
This code must be saved in HelloWorld.java

```
$ 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




```
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

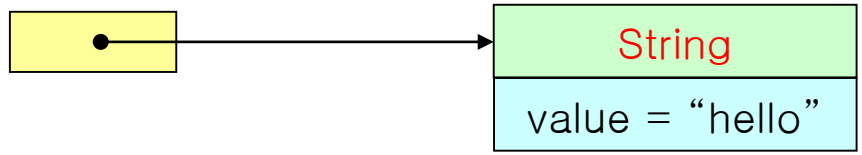
Object

- 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 predefined class
        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
// OKAY : A.title, A.price, and A.SalePrice()
```

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

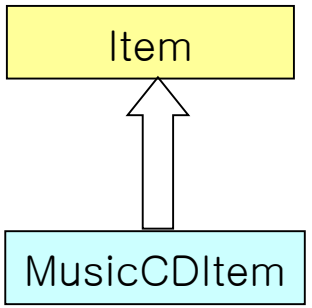
Java Example: Inheritance

- 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
```



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

- Online Retailer Example 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;
        …
}
```