**Java**

***Introduction***

History of Java

* Java was originally developed by Sun Microsystems starting in 1991

– James Gosling

– Patrick Naughton

– Chris Warth

– Ed Frank

– Mike Sheridan

* This language was initially called ***Oak***
* Renamed ***Java*** in 1995

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What is Java

* A simple, object‐oriented, distributed, interpreted, robust, secure, architecture neutral, portable, high‐performance, multithreaded, and dynamic language ‐‐ **Sun Microsystems**
* **Object‐Oriented**

– No free functions

– All code belong to some class

– Classes are in turn arranged in a hierarchy or package structure

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What is Java

* **Distributed**

– Fully supports IPv4, with structures to support IPv6

– Includes support for Applets: small programs embedded in HTML documents

* **Interpreted**

– The program are compiled into Java Virtual Machine (JVM) code called bytecode

– Each bytecode instruction is translated into machine code at the time of execution

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What is Java

* **Robust**

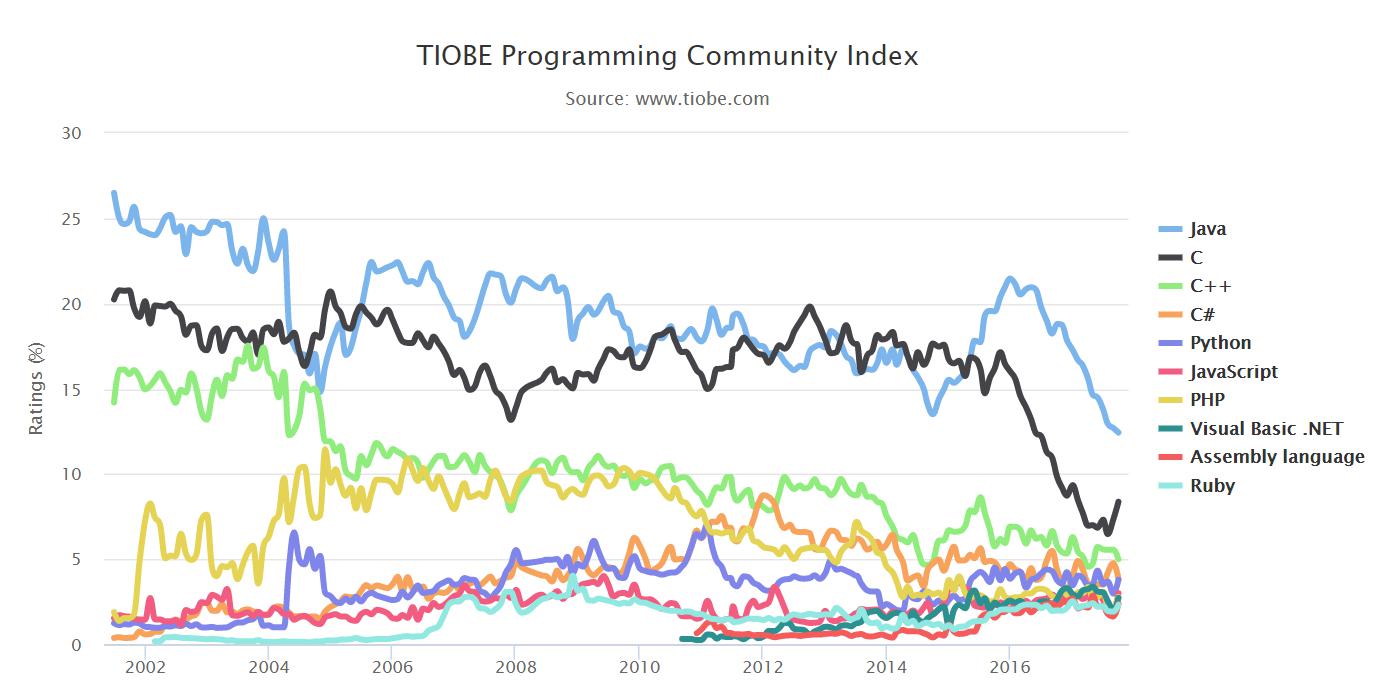
– Java is simple – no pointers/stack concerns

– Exception handling – try/catch/finally series allows for simplified error recovery

– Strongly typed language – many errors caught during compilation

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Java – The Most Popular



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Java Editions

* Java 2 Platform, Standard Edition (J2SE)

– Used for developing Desktop based application and networking applications

* Java 2 Platform, Enterprise Edition (J2EE)

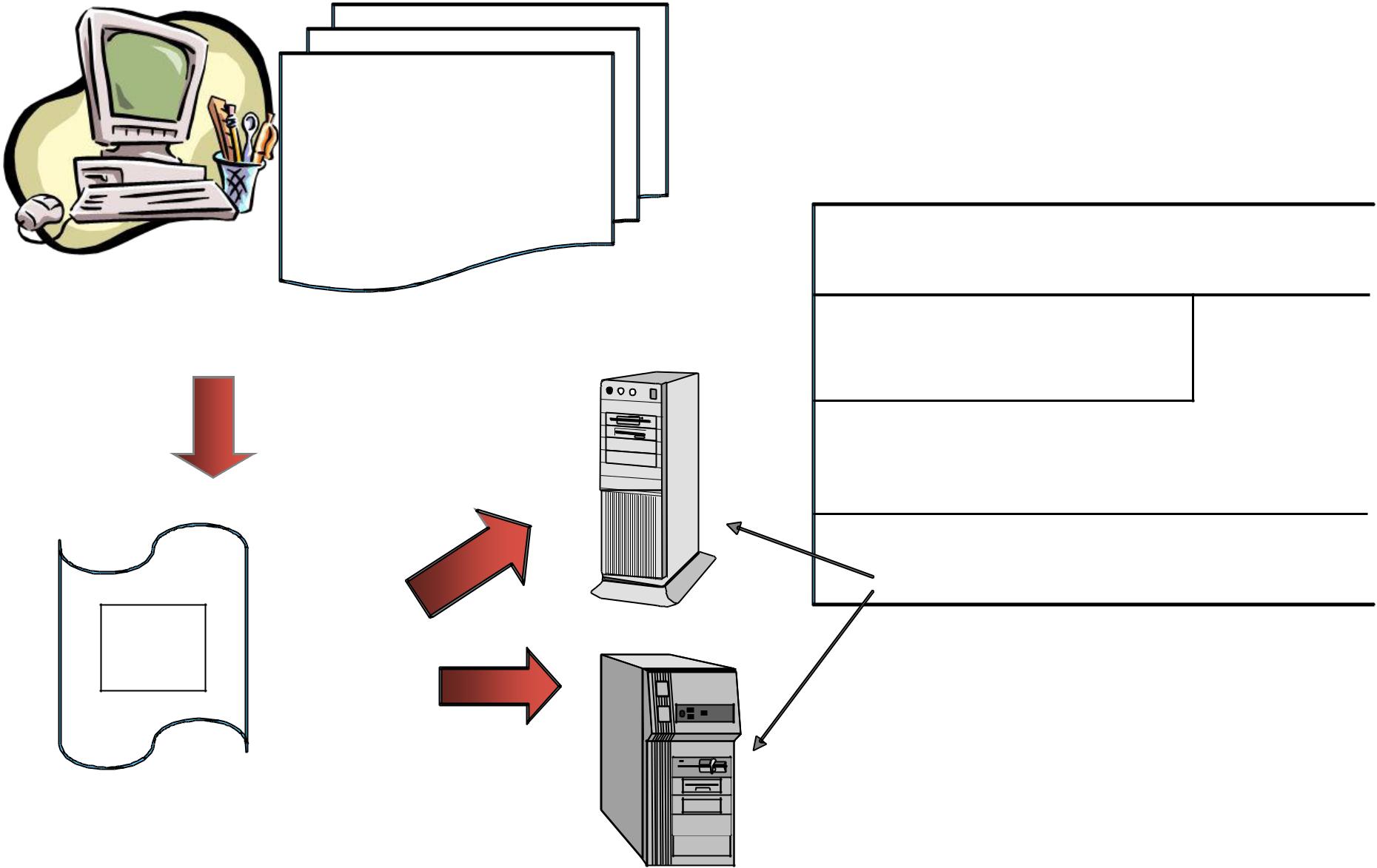
– Used for developing large‐scale, distributed networking applications and Web‐based applications

* Java 2 Platform, Micro Edition (J2ME)

– Used for developing applications for small memory‐constrained devices, such as cell phones, pagers and PDAs

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Java platform



public class HelloWorld

{

public static void main( String [] args )

{

System.out.println(“hello”);

}

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | } |  | Java Program ( Class File ) |  |
|  |  |  |  |
| HelloWorld.java | | Windows NT | Java API |  |
| Compile | **Java** |  | Java Virtual Machine |  |
| **javac** |  |  |
| Interpreter | |  |  |
|  |  |  |
|  |  |  | Hardware-Based Platform |  |
| 2387D47803 | Java |  |  |  |
| A96C16A484 |  |  |  |
| 54B646F541 | Bytecode |  |  |  |
| 06515EE464 |  |  |  |

**Java**

Interpreter

HelloWorld.class

Power Macintosh

|  |
| --- |
| Java Platform |

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Java Development Environment

* Edit

– Create/edit the source code

* Compile

– Compile the source code

* Load

– Load the compiled code

* Verify

– Check against security restrictions

* Execute

– Execute the compiled

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Phase 1: Creating a Program

* Any text editor or Java IDE (Integrated Development Environment) can be used to develop Java programs
* Java source‐code file names must end with the ***.java*** extension
* Some popular Java IDEs are

– NetBeans

– Eclipse

– JCreator

– **IntelliJ**

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Phase 2: Compiling a Java Program

* ***javac Welcome.java***

– Searches the file in the current directory

– Compiles the source file

– Transforms the Java source code into bytecodes

– Places the bytecodes in a file named **Welcome.class**

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Bytecodes

* They are not machine language binary code
* They are independent of any particular microprocessor or hardware platform
* They are platform‐independent instructions
* Another entity (interpreter) is required to convert the bytecodes into machine codes that the underlying microprocessor understands
* This is the job of the **JVM** (Java Virtual Machine)

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JVM (Java Virtual Machine)

* It is a part of the JDK and the foundation of the Java platform
* It can be installed separately or with JDK
* A virtual machine (VM) is a software application that simulates a computer, but hides the underlying operating system and hardware from the programs that interact with the VM
* It is the JVM that makes Java a portable language

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JVM (Java Virtual Machine)

* The same bytecodes can be executed on any platform containing a compatible JVM
* The JVM is invoked by the java command

– ***java Welcome***

* It searches the class Welcome in the current directory and executes the main method of class Welcome
* It issues an error if it cannot find the class Welcome or if class Welcome does not contain a method called main with proper signature

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Phase 3: Loading a Program

* One of the components of the JVM is the class loader
* The class loader takes the .class files containing the programs bytecodes and transfers them to RAM
* The class loader also loads any of the .class files provided by Java that our program uses

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Phase 4: Bytecode Verification

* Another component of the JVM is the bytecode verifier
* Its job is to ensure that bytecodes are valid and do not violate Java’s security restrictions
* This feature helps to prevent Java programs arriving over the network from damaging our system

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Phase 5: Execution

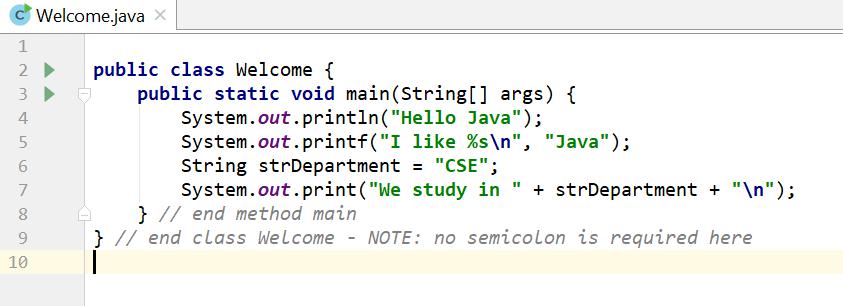
* Now the actual execution of the program begins
* Bytecodes are converted to machine language suitable for the underlying OS and hardware
* Java programs actually go through two compilation phases

– Source code ‐> Bytecodes

– Bytecodes ‐> Machine language

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Editing a Java Program



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Examining Welcome.java

* A Java source file can contain multiple classes, but only one class can be a public class
* Typically Java classes are grouped into packages (similar to namespaces in C++)
* A public class is accessible across packages
* The source file name must match the name of the public class defined in the file with the .java extension

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Examining Welcome.java

* In Java, there is no provision to declare a class, and then define the member functions outside the class
* Body of every member function of a class (called method in Java) must be written when the method is declared
* Java methods can be written in any order in the source file
* A method defined earlier in the source file can call a method defined later

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Examining Welcome.java

* ***public static void main(String[] args)***

– **main** is the starting point of every Java application

– **public** is used to make the method accessible by all

– **static** is used to make main a static method of class Welcome. Static methods can be called without using any object; just using the class name. JVM call main using the **ClassName.methodName** (*Welcome.main*) notation

– **void** means main does not return anything

– **String args[ ]** represents an array of String objects that holds the command line arguments passed to the application. *Where is the length of args array?*

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Examining Welcome.java

* Think of JVM as a outside Java entity who tries to access the main method of class Welcome

– main must be declared as a public member of class Welcome

* JVM wants to access main without creating an object of class Welcome

– main must be declared as static

* JVM wants to pass an array of String objects containing the command line arguments

– main must take an array of String as parameter

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Examining Welcome.java

* ***System.out.println()***

– Used to print a line of text followed by a new line

– **System** is a class inside the Java API

– **out** is a public static member of class System

– **out** is an object of another class of the Java API

– **out** represents the standard output (similar to stdout or cout)

– **println** is a public method of the class of which out is an object

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Examining Welcome.java

* **System.out.print()** is similar to **System.out.println()**,but does not print a new line automatically
* **System.out.printf()** is used to print formatted outputlike printf() in C
* In Java, characters enclosed by double quotes ("") represents a String object, where String is a class of the Java API
* We can use the plus operator (+) to concatenate multiple String objects and create a new String object

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Compiling a Java Program

* Place the .java file in the bin directory of your Java installation

– ***C:\Program Files\Java\jdk1.8.0\_144\bin***

* Open a command prompt window and go to the bin directory
* Execute the following command

– ***javac Welcome.java***

* If the source code is ok, then javac (the Java compiler) will produce a file called Welcome.class in the current directory

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Compiling a Java Program

* If the source file contains multiple classes then javac will produce separate .class files for each class
* Every compiled class in Java will have their own .class file
* .class files contain the bytecodes of each class
* So, a .class file in Java contains the bytecodes of a single class only

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Executing a Java Program

* After successful compilation execute the following command

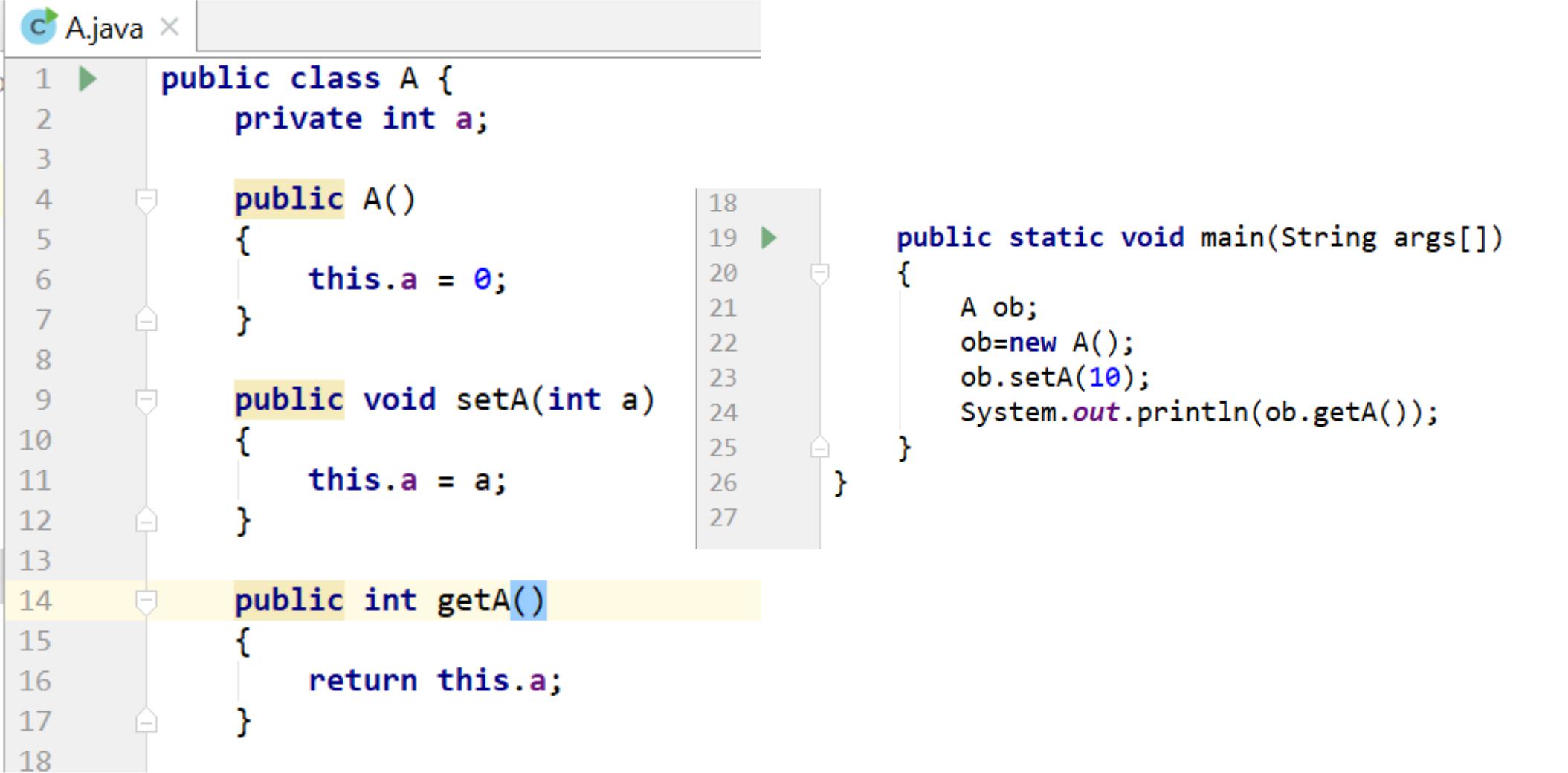
– ***java Welcome***

– *Note that we have omitted the .class extension here*

* The JVM will look for the class file *Welcome.class* and search for a *public static void main(String args[* *])* method inside the class
* If the JVM finds the above two, it will execute the body of the main method, otherwise it will generate an error and will exit immediately

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Another Java Program



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Examining A.java

* The variable of a class type is called a reference

– *ob* is a reference to A object

* Declaring a class reference is not enough, we have to use new to create an object
* Every Java object has to be instantiated using keyword **new**
* We access a public member of a class using the dot operator (.)

– Dot (.) is the only member access operator in Java.

– Java does not have **::, ->, &** and **\***



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Primitive (built‐in) Data types

* Integers

– byte8‐bit integer (new)

– short16‐bit integer

– int 32‐bit signed integer

– long64‐bit signed integer

* Real Numbers

– float32‐bit floating‐point number

– double 64‐bit floating‐point number

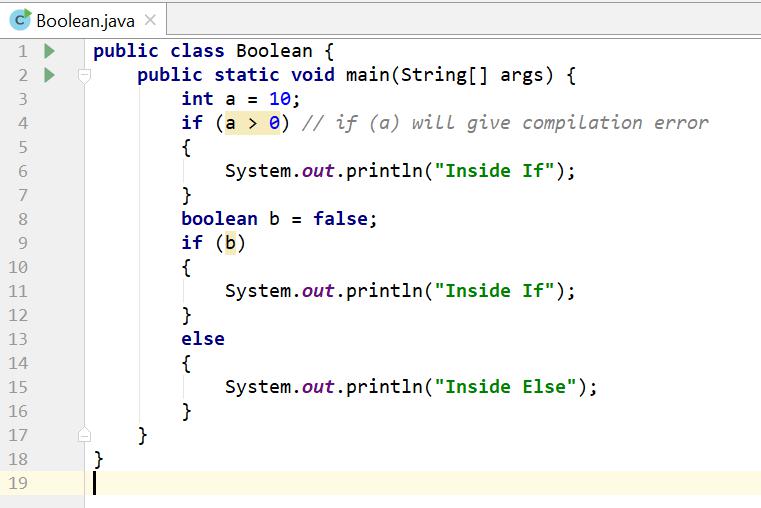
* Other types

– char16‐bit, Unicode 2.1 character

– boolean true or false, *false is not 0 in Java*

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Boolean Type



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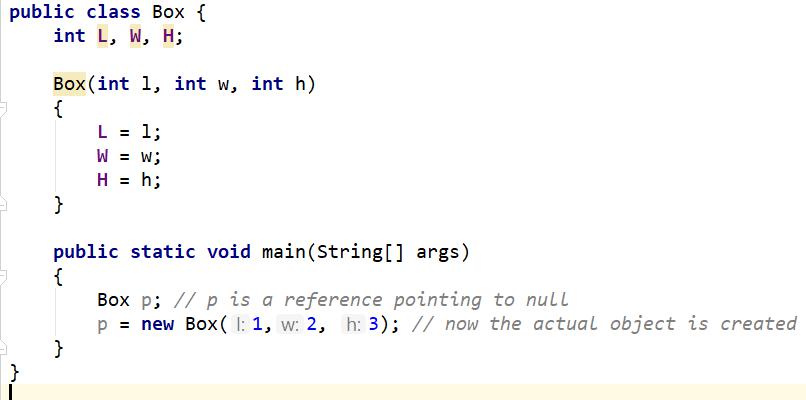
Non‐primitive Data types

* The non‐primitive data types in java are

– Objects

– Array

* Non‐primitive types are also called reference types



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Primitive vs. Non‐primitive type

* Primitive types are handled by value – the actual primitive values are stored in variable and passed to methods

***int x = 10;***

***public MyPrimitive(int x) { }***

* Non‐primitive data types (objects and arrays) are handled by reference – the reference is stored in variable and passed to methods

***Box b = new Box(1,2,3);***

***public MyNonPrimitive(Box x) { }***

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Java References

* Java references are used to point to Java objects created by new
* Java objects are **always** passed **by reference** to other functions, ***never by value***
* Java references act as pointers but does not allow pointer arithmetic
* We cannot read the value of a reference and hence cannot find the address of a Java object
* We cannot take the address of a Java reference

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Java References

* We can make a Java reference point to a new object

– By copying one reference to another

***ClassName ref2 = ref1; // Here ref1 is declared earlier***

– By creating a new object and assign it to the reference

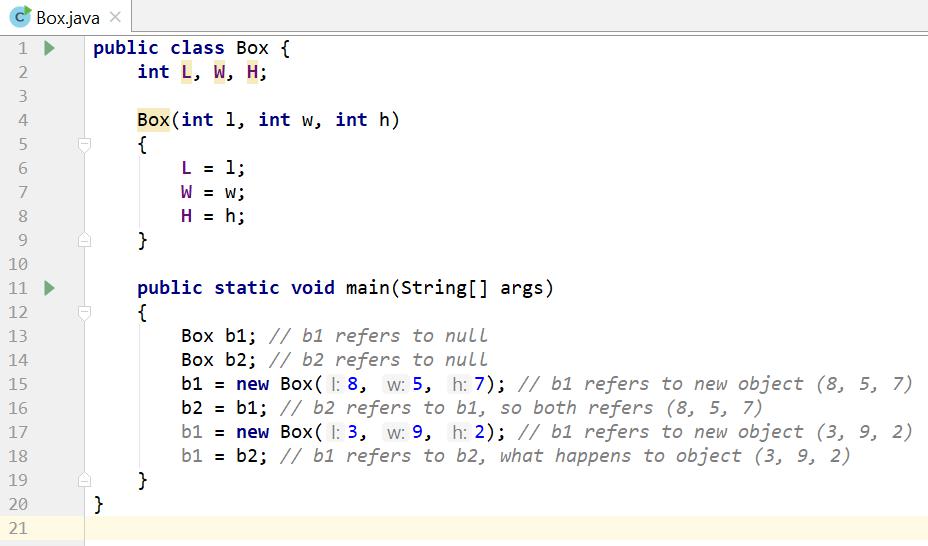
***ClassName ref1 = new ClassName();***

* We cannot place arbitrary values to a reference except the special value **null** which means that the reference is pointing to nothing

***ClassName ref1 = 100; // compiler error ClassName ref2 = null; // no problem***

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Java References



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Textbook

* We will mostly follow Java 8, if time permits will see the new features of Java 9
* Books

– Java: The Complete Reference, 9th Edition by Herbert Schildt

– Effective Java, 2nd edition by Joshua Bloch

* Web

[– http://rifatshahriyar.github.io/CSE107.html](http://rifatshahriyar.github.io/CSE107.html)

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