COMP3021 Java Programming

Topic 1: Introduction to Java Programming

Dr. Desmond Tsoi

Department of Computer Science & Engineering
The Hong Kong University of Science and Technology
Hong Kong SAR, China

Ref.: Russel C. Bjork, A Comparison of the Syntax and Semnatics of C++ and Java

A Brief History of Java

- Java
  - It is a name of an island of Indonesia
  - It is also an informal name of a type of brewed coffee :P
- History:
  - It is invented by a group people working in Sun Microsystems in 1991
  - One of the major contributor is James Gosling
  - Initially the language is named Oak. Then it is changed to Java after visiting a local coffee shop
  - Now, it is one of the most important general purpose OOP language

James Gosling

Java 2 Platform

Different Java editions for different purposes

- Java 2 Platform, Standard Edition (J2SE)
  - Used for developing client side standalone applications or applets
- Java 2 Platform, Enterprise Edition (J2EE)
  - Used for developing client side applications or programs involving servers
- Java 2 Platform, Micro Edition (J2ME)
  - Used for developing applications for mobile devices
  - Not popular now

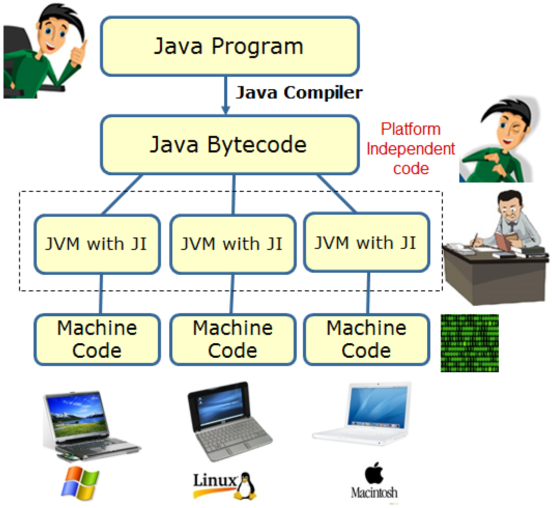
We use Java 2 Standard Edition Version 8.0 (or J2SE 1.8).
A Java Development Kit 8.0 (also known as JDK 1.8) will be used.

Platform Independence

- C++ programs are typically compiled into machine code, which cannot be run on different platforms
    - Since different computers may use different machine languages. So an executable that runs on one machine will not run on another machine that uses a different machine language
- Unlike C++ programs, Java programs are not compiled down to a platform-specific machine language. Instead, they are compiled to a platform-independent language called bytecode
    - Bytecode is designed to be run by a program, called a Java Virtual Machine (JVM), which simulates a real machine

Scott Stricker, Java programming for C/C++ developers, distributed in cis1xx. Available from: https://www.seas.upenn.edu/~cis1xx/resources/JavaForCppProgrammers/j-javac-cpp-ltr.pdf

Platform Independence



- Java compiler converts Java program into bytecode which is platform independent
- Java bytecode is then interpreted and translated by JI (Java Interpreter) to hardware-specific machine code
- JVM or VM = Java Virtual Machine (It is actually a program)

Java Program Development Tools

What do you need in order to write Java programs?

Two components.

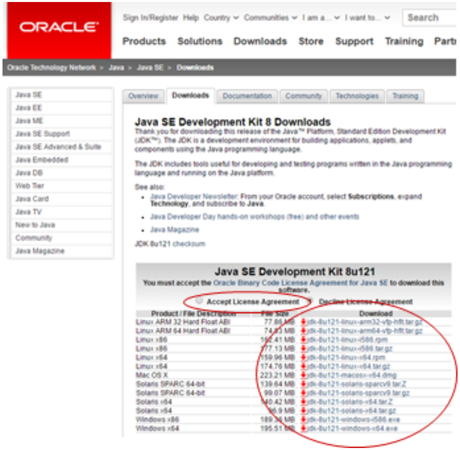
1. Machine with Java Development Kit (JDK) installed

   (We use the JDK version 1.8 for this course)

   `http://www.oracle.com/technetwork/java/javase/downloads/jdk8-downloads-2133151.html`

   Bundled with

   - javac (Java compiler)
   - java (Java runtime)
   - javadoc (Java documentation)


ORACLE
Sign In/Register Help Country Communities I am a... I want to... Search
Products Solutions Downloads Store Support Training Partı
Oracle Technology Network > Java > Java SE > Downloads
Java SE
Java EE
Java ME
Java SE Support
Java SE Advanced & Suite
Java Embedded
Java DB
Web Tier
Java Card
Java TV
New to Java
Community
Java Magazine
Overview Downloads Documentation Community Technologies Training

Java SE Development Kit 8 Downloads

Thank you for downloading this release of the Java™ Platform, Standard Edition Development Kit (JDK™). The JDK is a development environment for building applications, applets, and components using the Java programming language.

The JDK includes tools useful for developing and testing programs written in the Java programming language and running on the Java platform.

See also:

- Java Developer Newsletter: From your Oracle account, select **Subscriptions**, expand **Technology**, and subscribe to **Java**.
- Java Developer Day hands-on workshops (free) and other events
- Java Magazine

JDK 8u121 checksum

Java SE Development Kit 8u121

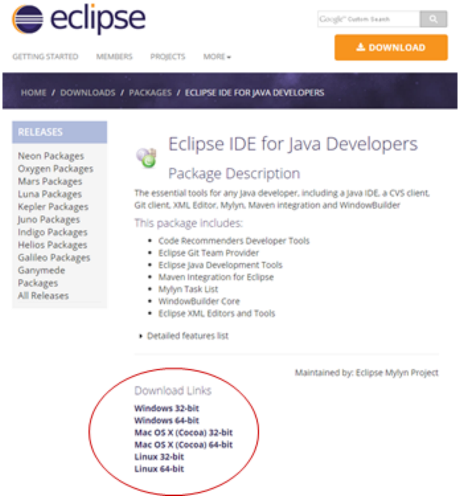
You must accept the Oracle Binary Code License Agreement for Java SE to download this software.

Accept License Agreement Decline License Agreement

Product / File Description	File Size	Download
Linux ARM 32 Hard Float ABI	77.86 MB	jdk-8u121-linux-arm32-vfp-hflt.tar.gz
Linux ARM 64 Hard Float ABI	74.83 MB	jdk-8u121-linux-arm64-vfp-hflt.tar.gz
Linux x86	162.41 MB	jdk-8u121-linux-i586.rpm
Linux x86	177.13 MB	jdk-8u121-linux-i586.tar.gz
Linux x64	159.96 MB	jdk-8u121-linux-x64.rpm
Linux x64	174.76 MB	jdk-8u121-linux-x64.tar.gz
Mac OS X	223.21 MB	jdk-8u121-macosx-x64.dmg
Solaris SPARC 64-bit	139.64 MB	jdk-8u121-solaris-sparcv9.tar.Z
Solaris SPARC 64-bit	99.07 MB	jdk-8u121-solaris-sparcv9.tar.gz
Solaris x64	140.42 MB	jdk-8u121-solaris-x64.tar.Z
Solaris x64	96.9 MB	jdk-8u121-solaris-x64.tar.gz
Windows x86	189.36 MB	jdk-8u121-windows-i586.exe
Windows x64	195.51 MB	jdk-8u121-windows-x64.exe

Java Program Development Tools

2. Java Integrated Development Environment (JIDE) (i.e. a software with editor, Java compiler & Java execution program)
   - Eclipse (We use Eclipse IDE for Java Developers) `https://eclipse.org/downloads/packages/eclipse-ide-java-developers/lunasr2`
   - BlueJ
   - jGRASP
   - NetBeans
   - JBuilder



Eclipse IDE for Java Developers

Package Description

The essential tools for any Java developer, including a Java IDE, a CVS client, Git client, XML Editor, Mylyn, Maven integration and WindowBuilder

This package includes:

- Code Recommenders Developer Tools
- Eclipse Git Team Provider
- Eclipse Java Development Tools
- Maven Integration for Eclipse
- Mylyn Task List
- WindowBuilder Core
- Eclipse XML Editors and Tools

- Detailed features list

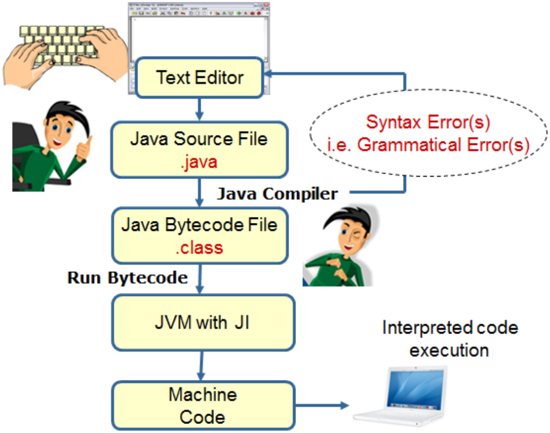
Maintained by: Eclipse Mylyn Project

Download Links

Windows 32-bit
Windows 64-bit
Mac OS X (Cocoa) 32-bit
Mac OS X (Cocoa) 64-bit
Linux 32-bit
Linux 64-bit

All these software are available at the download section of our course website.

Development Cycle of a Java Program



3 Steps

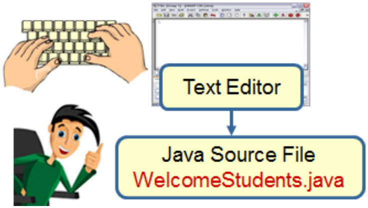
1. Write Java source code using an editor / JIDE and save the code to a file with extension .java
2. Compile source file (.java) into bytecode file (.class) [If any syntax error, go back to step 1!]
3. Run the bytecode file (i.e .class)

My First Java Program

Step 1: Write Java source code using an editor / JIDE and save the code to a file with extension .java

```
/* First Java Application Program to print a text
   "Welcome to COMP3021!" on the screen */
// Filename: WelcomeStudents.java

public class WelcomeStudents {
  public static void main(String[] args) {
    System.out.println("Welcome to COMP3021");
  }
}
```

- Observation: The filename must be the same as the class name!
- Attention: Java is a case-sensitive language, i.e. it treats lower-case and upper-case differently!

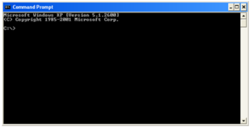


My First Java Program (Cont'd)

Step 2: Compile your program "WelcomeStudents.java" (Windows command prompt, i.e. "cmd", is used here)

- First, open up a command prompt

  Click start → Run... and type "cmd" in the textbox



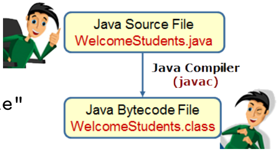
```
Microsoft Windows XP [Version 5.1.2600]
(C) Copyright 1985-2001 Microsoft Corp.

C:\>
```

- Second, go to the directory where your source file is located. Assume your file location is:

  C:\Documents and Settings\Desmond\Desktop\sample

  To change directory, type:

  ```
  "cd C:\Documents and Settings\Desmond\Desktop\sample"
  ```



- Then type:

  ```
  javac WelcomeStudents.java
  ```

  in the command prompt (where javac is Java compiler)

The compiler translates the Java source file "WelcomeStudents.java" into bytecode and saves it to the file "WelcomeStudents.class"

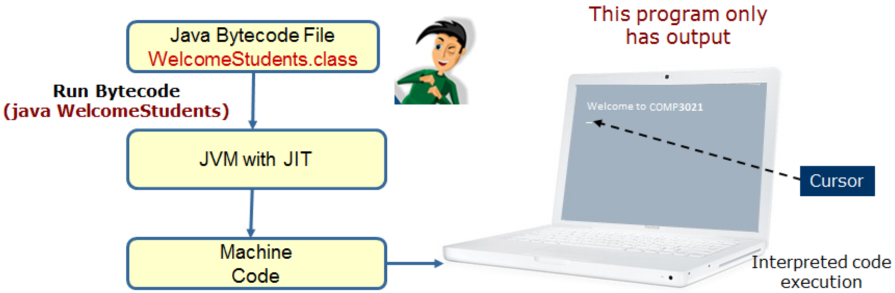
My First Java Program (Cont'd)

Step 3: Run the byte code with the Java interpreter

- Type:

  ```
  java WelcomeStudents
  ```

  where `java` is Java interpreter
  (Remember, no need to put .class after the filename)



The cursor is moved to the beginning of the next line, since println is used.

Migration from C++ to Java

- After COMP2012, you have become a competent C++ programmer. Because of that, it's probably best to learn Java by comparing it to C++
- In the following section, we discuss the similarities and differences between the two languages. Before we start, you need to get familiar with the following Java terminologies

C++	Java
Non-static data member	Instance variable
Static data member	Class variable
Non-static member function	Method
Static member function	Class method
Base class	Superclass
Derived class	Subclass
this pointer	this reference
Inherits	Extends
Function overloading	Method overloading
Function overriding	Method overriding

Java Naming Convention

- In addition to the terminologies, it is also important to understand the naming conventions of Java so as to make your programs easy to read

Type	Naming Rules	Examples
Classes	Names should be nouns and the first letter of each word in the class name should be capitalized	Person Circle Rectangle FoodItem
Variables	Lowercase letters should be used for variables with single word. If the name consists of several words, then we use lowercase for the first letter of the first word, and use capital letter for the first letter of the subsequent words. Although "_" and "$" are valid characters to being a variable name, you are not recommend to do so.	firstName lastName radius length width
Constants	Uppercase letters should be used for symbolic constants, and underscores should be used to separate between words	PI MAX_LENGTH

Methods	Names should be verbs and lowercase letters should be used for method names with single word. If the name consists of several words, then we use lowercase for the first letter of the first word, and use capital letter for the first letter of the subsequent words.	getRadius()
		setRadius()
		calculateArea()

(Refer to the Appendix for list of reserved words in Java)

Part I

Similarities between Java and C++

James Gosling

Bjarne Stroustrup

Comments

- Comments are identical in C++ and Java, both have
  - // Single line comment
  - /* Comment in paragraph */

  (Except that Java has /** */ for javadoc)
- javadoc is a documentation generator for generating documentation in HTML format from Java source code
  - The basic structure of writing comments is to embed them inside /** ... */ together with the tags in the following table

Tag	Description	Syntax
@author	Adds the author of a class	@author name-text
@param	Adds a parameter with the specified parameter-name followed by the specified description to the "Parameters" section	@param parameter-name description
@return	Adds a "Returns" section with the description text	@return description
@see	Adds a "See Also" heading with a link or text entry that points to reference	@see reference
@version	Adds a "Version" subheading with the specified version-text to the generated docs when the version option is used	@version version-text

`http://docs.oracle.com/javase/8/docs/technotes/tools/windows/javadoc.html`

Javadoc Documentation

More details about defining Java classes will be given later.

```
/**
* Balloon.java - A simple class for demonstrating the use of javadoc comments.
* @author Desmond Tsoi
* @version 1.0
*/
public class Balloon {
  /**
   * Diameter, x-coordinate and y-coordinate of Balloon
   */
  private int diameter, x, y;
  private String color;

  /**
   * Default constructor for Balloon
   * Set diameter to 5 and coordinates to (0,0)
   */
  public Balloon() {
    diameter = 5; x = 0; y = 0;
  }
  /**
  * Retrieve the value of diameter.
  * @return An int data type
  */
  public int getDiameter() { return diameter; }
```

Javadoc Documentation

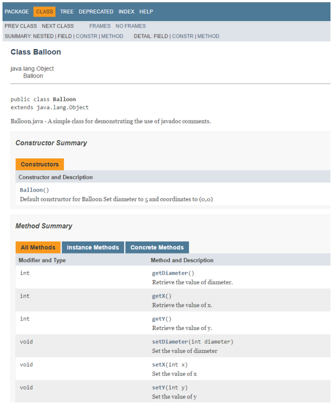
More details about defining Java classes will be given later.

```
  /**
  * Retrieve the value of x.
  * @return An int data type
  */
  public int getX() { return x; }
  /**
  * Retrieve the value of y.
  * @return An int data type
  */
  public int getY() { return y; }
  /**
  * Set the value of diameter
  * @param diameter A variable of type int
  */
  public void setDiameter(int diameter) { this.diameter = diameter; }
  /**
  * Set the value of x
  * @param x A variable of type int
  */
  public void setX(int x) { this.x = x; }
  /**
  * Set the value of y
  * @param y A variable of type int
  */
  public void setY(int y) { this.y = y; }
}
```

Javadoc Documentation

At Windows “cmd”, type:

```
javadoc Balloon.java
```



PACKAGE CLASS TREE DEPRECATED INDEX HELP

PREV CLASS NEXT CLASS FRAMES NO FRAMES

SUMMARY: NESTED | FIELD | CONSTR | METHOD DETAIL: FIELD | CONSTR | METHOD

Class Balloon

java.lang.Object
  Balloon

```
public class Balloon
extends java.lang.Object
```

Balloon.java - A simple class for demonstrating the use of javadoc comments.

Constructor Summary

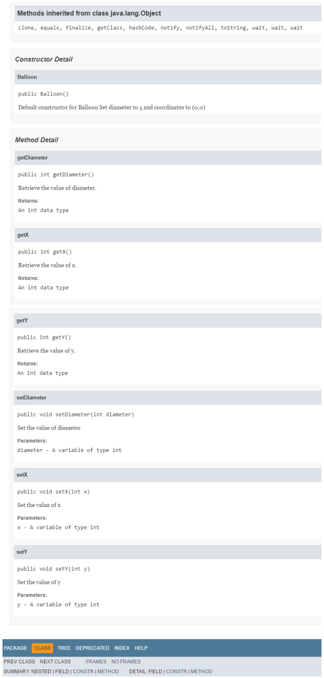
Constructors

Constructor and Description
`Balloon()` Default constructor for Balloon Set diameter to 5 and coordinates to (0,0)

Method Summary

All Methods | Instance Methods | Concrete Methods

Modifier and Type	Method and Description
`int`	`getDiameter()` Retrieve the value of diameter.
`int`	`getX()` Retrieve the value of x.
`int`	`getY()` Retrieve the value of y.
`void`	`setDiameter(int diameter)` Set the value of diameter
`void`	`setX(int x)` Set the value of x
`void`	`setY(int y)` Set the value of y



Methods inherited from class java.lang.Object

`clone, equals, finalize, getClass, hashCode, notify, notifyAll, toString, wait, wait, wait`

Constructor Detail

Balloon

`public Balloon()`

Default constructor for Balloon Set diameter to 5 and coordinates to (0,0)

Method Detail

getDiameter

`public int getDiameter()`

Retrieve the value of diameter.

Returns:
`An int data type`

getX

`public int getX()`

Retrieve the value of x.

Returns:
`An int data type`

getY

`public int getY()`

Retrieve the value of y.

Returns:
`An int data type`

setDiameter

`public void setDiameter(int diameter)`

Set the value of diameter

Parameters:
`diameter - A variable of type int`

setX

`public void setX(int x)`

Set the value of x

Parameters:
`x - A variable of type int`

setY

`public void setY(int y)`

Set the value of y

Parameters:
`y - A variable of type int`

PACKAGE CLASS TREE DEPRECATED INDEX HELP

PREV CLASS NEXT CLASS FRAMES NO FRAMES

SUMMARY: NESTED | FIELD | CONSTR | METHOD DETAIL: FIELD | CONSTR | METHOD

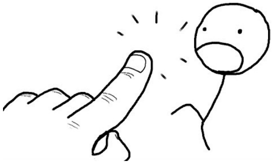
`http://course.cse.ust.hk/comp3021/examples/Balloon/`

Arithmetic, Relational, Logical Operators & Control Constructs

- The following operators are common between C++ and Java
  - Arithmetic operators: +, −, *, /, %, ++, −−, +=, -=, *=, /=, %=
  - Relational operators: >, >=, <, <=, ==, !=
  - Logical operators: &&, ||, !

  (Refer to the Appendix for precedence of operators)
- C++ and Java also have the same set of control constructs
  - if-else
  - switch
  - for
  - while
  - do-while
  - conditional operators (i.e. ? :)

  (Except that Java also has "for-each" loop)



for-each Loop

Concepts of collection will be covered later.

- for-each construct is applicable to arrays / collections, where it provides an easy way to access each element without having to specify the index

Syntax

```
for(<data type> <variable> : <array> | <collection>) {
  ...
}
```

where <data type> is the type of data in the array or collection, <variable> is a variable in <data type> to store element of array, <array> and <collection> are the names of array and collection respectively

for-each Loop

```java
// Define a array of strings
String[] fruits = { "Apple", "Banana", "Orange" };
// Print all the strings on screen using for-each loop
for(String fruit : fruits)
  System.out.println(fruit);

// Equivalent statement using for loop
for(int i = 0; i < fruits.length; i++) {
  String fruit = fruits[i];
  System.out.println(fruit);
}
```

Part II

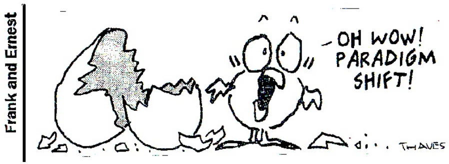
Differences between Java and C++

James Gosling

Bjarne Stroustrup

Programming Paradigms

- C++ was developed as an extension of C and it is a hybrid of two distinct programming paradigms: procedural and object-oriented paradigms
    - In C++, it is possible to have variables and functions, which are declared outside of any class
- Different from C++, Java was designed from ground up as an object-oriented language, not a hybrid
    - In Java, everything in a program is part of some class. Because of this, Java has neither global data (i.e. variables and objects) nor global functions



Programming Paradigms - C++

```cpp
// Filename: Fib.cpp
#include <iostream>
using namespace std;

int fibCallsCounter; // Global variable

int fib(int n) {     // Global function
  fibCallsCounter++;
  return (n <= 2) ? 1 : fib(n-1) + fib(n-2);
}

int main(int argc, char* argv[]) {
  while(true) {
    int n;
    fibCallsCounter = 0; // Refer to global variable
    cout << "Desired value of n (0 to quite): ";
    cin >> n;
    if(n == 0)
      break;
    // fib(n) refers to a global function call
    cout << "The " << n << "th fibonacci number is " << fib(n) << endl;
    cout << "Function was called " << fibCallsCounter << " times" << endl;
  }
}
```

Programming Paradigms - Java

```java
// Filename: Fib.java
import java.util.Scanner;

public class Fib {
  private static int fibCallsCounter;
  private static int fib(int n) {
    fibCallsCounter++;
    return (n <= 2) ? 1 : fib(n-1) + fib(n-2);
  }
  public static void main(String[] args) throws IOException {
    Scanner sc = new Scanner(System.in);
    while(true) {
      int n;
      fibCallsCounter = 0;
      System.out.print("Desired value of n (0 to quite): ");
       n = sc.nextInt();
      if(n == 0)
        break;
      System.out.println("The " + n + "th fibonacci number is " + fib(n));
      System.out.println("Function was called " + fibCallsCounter + " times");
    }
    sc.close();
  }
}
```

Primitive Data Types

- C++ and Java provide similar data types but they do not use exactly the same type names.
- The table below shows all the primitive data types supported by Java

Type	Size	Range
byte	1 byte	-128 to 127
short	2 bytes	$-32{,}768$ to $32{,}767$
int	4 bytes	$-2{,}147{,}483{,}648$ to $2{,}147{,}483{,}647$
long	8 bytes	$-9{,}223{,}372{,}036{,}854{,}775{,}808$ to $9{,}223{,}372{,}036{,}854{,}775{,}807$
float	4 bytes	$-$ve range: $-3.4028235 \times 10^{38}$ to -1.4×10^{-45} $+$ve range: 1.4×10^{-45} to 3.4028235×10^{38}
double	8 bytes	$-$ve range: $-1.7976931348623157 \times 10^{308}$ to -4.9×10^{-324} $+$ve range: 4.9×10^{-324} to $1.7976931348623157 \times 10^{308}$
char	2 bytes	0 to 65,535 (unsigned)
boolean	not precisely defined	true or false

Types other than the 8 primitive data types are non-primitive

Primitive Data Types

More details about Java console I/O will be given soon.

- C++ regards the type char as an integer type. Thus char can be used as a one-byte integer in some contexts, which is equivalent to the Java type byte

C++

```cpp
char val = 10;
cout << "val: " << (int)val << endl;
```

Java

```java
byte val = 10;
System.out.println("val: " + val);
```

- Type-checking and type requirements are much tigher in Java. For example:
  - Conditional expressions (e.g. those in if, while and do-while) can be only boolean, not integral

Java - Wrong

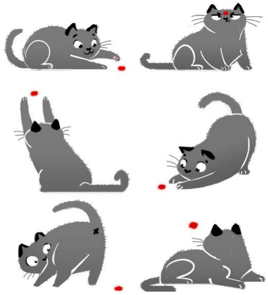
```java
Scanner sc = new Scanner(System.in);
int x = sc.nextInt();
if(x)
  System.out.println("true");
else
  System.out.println("false");
```

Java - Correct

```java
Scanner sc = new Scanner(System.in);
int x = sc.nextInt();
if(x != 0)
  System.out.println("true");
else
  System.out.println("false");
```

Non-Primitive Data Types - Reference Types

- Types other than the 8 primitive data types are non-primitive
- Non-primitive types are called reference types
- Reference types in Java are something similar to C++ pointers, but
  - No asterisk operator is needed when declaring reference
  - No arithmetic can be done with references
  - No dereference can be done with references



Reference Types: Question and Answers

- Is Scanner a primitive type?
  - No. It is a non-primitive type (or reference type)
- How to declare a Scanner reference?

  -
    ```
    Scanner sc; // Remember: No asterisk is needed!
        // Also, no object of Scanner type is instantiated
    ```
- How can it point at a Scanner object?
  - `sc = new Scanner(System.in);`
- Can it point at null?
  - Yes, do the following.

    ```
    sc = null; // Remember: All letters should be in lowercase
    ```
- Can we do this?

  ```
  sc++;
  ```

  - No. Arithmetic cannot be done with references

Note

Java references are not related to C++ references at all

Instantiation of Variables or Objects

- C++ allows instantiation of variables or objects of all types (both primitive and non-primitive) using new keyword or without
- But Java requires all variables of primitive types (i.e. byte, short, int, long, float, double, char, boolean) to be instantiated without using new keyword, and all objects (i.e. non-primitive types) to be instantiated using new

<u>C++</u>

```
int x = 10;
int* y = new int;

Person* p = new Person("Tom", 'M', 18);

Person q; // An object
          // is instantiated
```

<u>Java</u>

```
int x = 10;
// Nothing equivalent

Person p = new Person("Tom", 'M', 18);

Person q; // Correct, but no object
          // is instantiated
```

Array Types

- C++ allows instantiation of arrays using new keyword or without
- Java only allows instantiation of arrays using new keyword

C++

```
int arr[10];
int* p = new int[10];
int* q = new int[20];
int* r; // Only defines a pointer
int* s; // Only defines a pointer
Person pArr[30];
Person* pPtr = new Person[30];
```

Java

```
int arr[10]; // Wrong
int p[] = new int[10];
int[] q = new int[20];
int[] r; // Only defines a reference
int s[]; // Only defines a reference
Person pArr[30]; // Wrong
Person[] pPtr = new Person[30];
```

- Bounds checking is performed in Java, but not in C++. When you try to access an element of an array that is out of legal range, runtime error occurs
- In Java, a length member is available in array to tell how many elements are there

Memory Allocation and De-allocation

- In C++, the programmer is responsible for explicitly freeing storage allocated using new by using the corresponding operator delete
- In Java, the programmer is not necessary to free the storage allocated using new. The storage will be reclaimed by Java when there are no more references to the storage.
  - "Garbage Collection"

C++

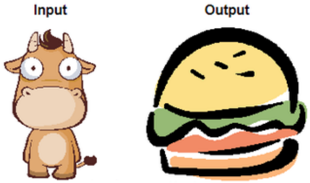
```cpp
void someFunction() {
  SomeClass* p = new SomeClass;

  // ... Code that uses p

  // ... Now suppose the object we
  // ... created is no longer being used

  // Free up the space allocated by new
  delete p;
}
```

Java

```java
void someMethod() {
  SomeClass p = new SomeClass();

  // ... Code that uses p

  // ... Now p is no longer needed

  // No need to worry about freeing
  // up space allocated by new
  // Garbage collector
  // will do it for us
}
```

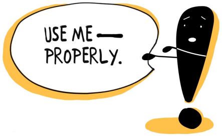
Support for Console and GUI Input / Output

- C++ standard libraries provide strong support for textual input / output to the standard input and standard output (normally the command line), but they provide no support for GUI input / output
  - To write GUI programs, one must use platform-specific GUI libraries, e.g. X-Windows on Unix platforms, which means GUI programs will require extensive rewriting when being ported from one platform to another
- Java defines a platform-independent set of GUI tools through packages
  (More details about packages will be given later in this course)
  - GUI programs written in Java can run without modification on any system supporting Java

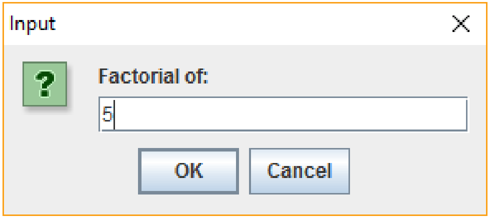


Example of Java GUI Input / Output

```
import javax.swing.JFrame;
import javax.swing.JOptionPane;

public class FactorialCalculator {
  public static void main(String[] args) {
    JFrame frame = new JFrame("Factorial Calculator");
    Object[] options = { "Yes", "No" };
    String n;
    int fact;
    do {
      n = JOptionPane.showInputDialog(frame, "Factorial of:");
      int i = 2;
      fact = 1;
      while(i <= Integer.parseInt(n)) {
        fact *= i;
        ++i;
      }
    }while(JOptionPane.showOptionDialog(frame,
      "The factorial of " + n + " is " + fact,
      "Want to play again?",
      JOptionPane.YES_NO_OPTION,
      JOptionPane.QUESTION_MESSAGE, null,
      options, options[0]) == JOptionPane.YES_OPTION);
  }
}
```

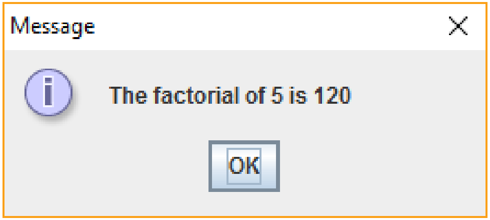


Example of Java GUI Input / Output - Screen Output



Factorial of:

5



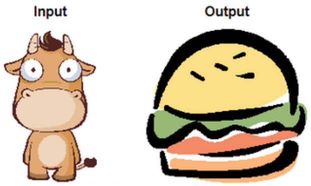
The factorial of 5 is 120

Support for Console and GUI Input / Output

- C++ provides operators (<< and >>) for outputting and inputting data, while Java does not support the use of operators for I/O

```
// C++
int n;
cout << "Enter n: ";
cin >> n;
cout << "Value of n: " << n << endl;
```

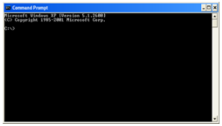
```
// Java
Scanner sc = new Scanner(System.in);
System.out.print("Enter n: ");
int n = sc.nextInt();
System.out.println("Value of n: " + n);
```



Display Data on Monitor's Screen in Java

- Java provides two methods to display data on monitor's screen (specifically is the command window)
  1. System.out.print()
  2. System.out.println()

System.out is a standard output object, i.e., an object with methods that output data to screen



```
Microsoft Windows XP [Version 5.1.2600]
(C) Copyright 1985-2001 Microsoft Corp.

C:\>
```

Syntax

```
System.out.print(<data> [ +<data>]);
System.out.println(<data> [ +<data>]);
System.out.println();
```

where <data> is the type of data that you would like to display, <data> can be in types: byte, short, int, long, float, double, char, boolean, String, etc. [...] may be repeated zero or more times, but must be separated by +

Display Data on Monitor's Screen in Java

```
// Filename: OutputDataDemo1.java
/* An example showing how to output data on screen */
public class OutputDataDemo1 {
  public static void main(String[] args) {
    int val = 9;
    System.out.println(val);
    System.out.print("You should be able to see this text ");
    System.out.println("on screen");
    System.out.print("How about this text?");
    System.out.print("Can you see the effect?");
  }
}
```

Screen output:

```
9
You should be able to see this text on screen
How about this text?Can you see the effect?
```

Display Data on Monitor's Screen in Java

```java
// Filename: OutputDataDemo2.java
/* An example showing how to output different types
   of data on screen */
public class OutputDataDemo2 {
  public static void main(String[] args) {
    String str = "Tom";
    char gender = 'M';
    int age = 18;
    double height = 1.71;
    System.out.println("Hi " + str);
    System.out.println("Your age is " + age);
    System.out.println("Your gender is " + gender);
    System.out.println("Your height is " + height + 'm');
  }
}
```

Screen output:

```
Hi Tom
Your age is 18
Your gender is M
Your height is 1.71m
```

Get User's Input from Keyboard in Java

- Java provides a class named "Scanner" for getting user's input from keyboard
- The Scanner class is a part of the package java.util
  - Package is a collection of classes
- To use the Scanner class, you can follow the syntax shown below

Syntax

```
// Put the following line at the top of the Java source file
import java.util.Scanner;

Scanner <object name>  = new Scanner(System.in);
<variable name> = <object name>.<method name>();
<object name>.close();
```

where <object name> is the name of the newly created Scanner class object, new is the keyword to create an object, <variable name> is the name of the variable to store the data obtained from the keyboard using Scanner method

Scanner Class Methods

Method	Description
boolean nextBoolean()	Returns the next input token as a Boolean value
byte nextByte()	Returns the next input token as a byte value
short nextShort()	Returns the next input token as a short value
int nextInt()	Returns the next input token as an int value
long nextLong()	Returns the next input token as a long value
float nextFloat()	Returns the next input token as a float value
double nextDouble()	Returns the next input token as a double value
String next()	Returns the next input token as a String value
String nextLine()	Returns all input remaining on the current line as a String value

- The details in the method column describe two things: name of the method and type of data returned
- For instance: int nextInt()
  - This means the name of the method for obtaining an int from keyboard is nextInt, and
  - The keyword int means it returns an int, which is the integer it obtains

https://docs.oracle.com/javase/8/docs/api/java/util/Scanner.html

Example: Get User's Input from Keyboard in Java

```java
// Filename: InputDataDemo.java
/* An example showing how to get input
   from keyboard */
import java.util.Scanner;
public class InputDataDemo {
  public static void main(String[] args) {
    Scanner sc = new Scanner(System.in);
    System.out.print("Enter your name: ");
    String name = sc.nextLine();
    System.out.print("Enter your age: ");
    int age = sc.nextInt();
    System.out.print("Enter your gender: ");
    String gender = sc.next();
    System.out.print("Enter your height: ");
    double height = sc.nextDouble();
    sc.close();
    System.out.println();
    System.out.println("Your name is " + name);
    System.out.println("Your age is " + age);
    System.out.println("Your gender is " + gender);
    System.out.println("Your height is " + height);
  }
}
```

Screen output:

```
Enter your name: Tom
Enter your age: 18
Enter your gender: M
Enter your height: 1.72

Your name is Tom
Your age is 18
Your gender is M
Your height is 1.72
```

Class

Concepts of packages will be covered later.

- Both C++ and Java allow class members to have public, protected, or private accessibility
- Java also uses default (package) accessibility when no other accessibility is specified
- The meaning of protected is somewhat different in C++ and Java
  - C++ protected members can only be accessed from derived classes
  - Java protected members can be accessed from derived classes and from other classes in the same package
- C++ breaks the declarations of members up into groups, proceeded by an access specifier followed by a colon, while Java requires each member to have the access specified as part of its declaration
- Initialization of data members in C++ can be done via member initialization list (MIL), but MIL is not available in Java
- Member functions in C++ can be made as constant member functions, but this is not available in Java

Constructors

- Both C++ and Java provide a default constructor if you do not define one
- However, Java has no copy constructors (why? Consider the following!)

```
public class Person
{
  private string name = "Tom";
  private char gender = 'M';
  private int age = 18;
  public Person() { }
  // The following shows a similar construct of copy constructor in C++
  public Person(Person p) {
    // ...
  }
}
```

this Keyword

- In C++, "this" variable is a pointer to the object whose member function is being invoked
  - Syntax: (*this). or this$->$ is used to access members in the same class
- In Java, "this" variable is a reference to the object whose method is being invoked
  - Syntax: this. is used to access members in the same class

Class (C++)

```
// Person.h
#ifndef PERSON_H
#define PERSON_H
#include <iostream>
using namespace std;
class Person {
  // C++ breaks the declarations
  // of members up into groups
  private:
    string name;
    char gender;
    int age;
  public:
    Person::Person(string name,
                   char gender,
                   int age)
        // Initialization of
        // data members using MIL
        : name(name),
          gender(gender),
          age(age) {}
```

```
    // Constant member functions exist
    string Person::getName() const
      { return name; }
    char Person::getGender() const
      { return gender; }
    int Person::getAge() const
      { return age; }
    void Person::setName(string name)
      { this->name = name; }  // this pointer
    void Person::setGender(char gender)
      { this->gender = gender; } // this pointer
    void Person::setAge(int age)
      { this->age = age; }    // this pointer
    void Person::print() const {
      cout << "Name: " << name << endl;
      cout << "Gender: " << gender << endl;
      cout << "Age: " << age << endl;
    }
}; // This semicolon is important
#endif
```

Class (Java)

```
// Person.java
public class Person {
  // Initialization can be done on declarations
  private string name = "Tom"
  private char gender = 'M';
  private int age = 18;
  // No member initialization list
  public Person(string name, char gender, int age) {
    this.name = name;      // this reference
    this.gender = gender; // this reference
    this.age = age;        // this reference
  }
  // No constant methods
  public string getName() { return name; }
  public char getGender() { return gender; }
  public int getAge() { return age; }
  public void setName(string n) { name = n; }
  public void setGender(char g) { gender = g; }
  public void setAge(int a) { age = a; }
  public void print() {
    System.out.println("Name: " + name + "\nGender: " + gender + "\nAge: " + age);
  }
} // No semi-colon here
```

Separation of Class Definition and Implementation

- C++ allows the definition of a class to be declared in a separate file from its implementation
    - Class definition in .h file
    - Class implementation in .cpp file
- Java does not support the kind of separation of class definition and implementation

Separation of Class Definition and Implementation (C++)

```
// Person.h
#ifndef PERSON_H
#define PERSON_H
#include <iostream>
using namespace std;
class Person {
  private:
    string name;
    char gender;
    int age;
  public:
    Person(string name,
           char gender,
           int age);
    string getName() const;
    char getGender() const;
    int getAge() const;
    void setName(string name);
    void setGender(char gender);
    void setAge(int age);
    void print() const;
}; // This semicolon is important
#endif
```

```
// Person.cpp
#include "Person.h"
Person::Person(string name,
               char gender,
               int age)
   : name(name), gender(gender), age(age) {}
string Person::getName() const
  { return name; }
char Person::getGender() const
  { return gender; }
int Person::getAge() const
  { return age; }
void Person::setName(string name)
  { this->name = name; }
void Person::setGender(char gender)
  { this->gender = gender; }
void Person::setAge(int age)
  { this->age = age; }
void Person::print() const {
  cout << "Name: " << name << endl;
  cout << "Gender: " << gender << endl;
  cout << "Age: " << age << endl;
}
```

No Separation of Class Definition and Implementation (Java)

```
// Person.java
public class Person {
  private string name;
  private char gender;
  private int age;
  public Person(string name, char gender, int age) {
    this.name = name;
    this.gender = gender;
    this.age = age;
  }
  public string getName() { return name; }
  public char getGender() { return gender; }
  public int getAge() { return age; }
  public void setName(string n) { name = n; }
  public void setGender(char g) { gender = g; }
  public void setAge(int a) { age = a; }
  public void print() {
    System.out.println("Name: " + name + "\nGender: " + gender + "\nAge: " + age);
  }
} // No semi-colon here
```

Inheritance

- C++ allows multiple inheritance, i.e. a class may inherit from any number of base classes
- Different from C++, Java allows a class inherits from exactly one base class
  - If no base class is specified, the base class is the class "Object", which thus serves as a root class for the entire inheritance hierarchy
- In C++, base class is specified using colon (i.e. :), but in Java, "extends" keyword is used
- In C++, initialization of data members inherited from base class is done using member initialization list, but in Java, "super" keyword is used at the start of the constructor body to invoke constructor of the base class
- In C++, three kinds of inheritance are available namely public, protected and private. In Java, only public inheritance is available
  - Note: In Java, if a method is public in the base class and you override it, your overridden method must also be public

Inheritance (C++)

```cpp
// Student.h
#ifndef STUDENT_H
#define STUDENT_H

#include "Person.h"

// : is used for inheritance
// Can specify different type of
// inheritance by modifying the
// accessor modifier after :
// This example uses public
// inheritance
class Student : public Person {
  private:
    string major;
  public:
    Student(string name, char gender,
            int age, string major);
    string getMajor() const;
    void setMajor(string major);
    void print() const;
};
#endif
```

```cpp
// Student.cpp
#include "Student.h"
Student::Student(string name, char gender,
                 int age, string major)
  // Initialization of inherited data
  // members is done via
  // member initialization list
  : Person(name, gender, age), major(major)
{}

string Student::getMajor() const {
  return major;
}

void Student::setMajor(string major) {
  this->major = major;
}

void Student::print() const {
  // Call print() of the base class
  Person::print();
  cout << "Major: " << major << endl;
}
```

Inheritance (Java)

```
// Student.java

// extends is used for inheritance
// No access modifier shoudl be placed after extends
// since only public inheritance is available
public class Student extends Person {
  private String major;

  public Student(String name, char gender, int age, String major) {
    // Initialization of inherited instance variables is done
    // using the keyword super
    super(name, gender, age);
    this.major = major;
  }

  public String getMajor() { returm major; }

  public void setMajor(String major) { this.major = major; }

  public void print() {
    // Call print() of the superclass
    super.print();
    System.out.println("Major: " + major);
  }
}
```

Polymorphism: Static and Dynamic Binding (C++)

```
#include <iostream>
using namespace std;
class A {
  public:
    void funcX() { cout << "funcX in A" << endl; }
    void funcY() { cout << "funcY in A" << endl; }
};

class B : public A {
  public:
    void funcY() { cout << "funcY in B" << endl; }
};
```

- Which version of funcY() will be called by doing the following?

  ```
  A* ptr = new B;
  ptr->funcY();
  ```

  The funcY() in A is called. As funcY() is non-virtual function and so the pointer variable "ptr" is declared to refer to an object of class A, the class A version of funcY() would be used, regardless of the actual type of the object the variable "ptr" currently points to. (Static binding)

Polymorphism: Static and Dynamic Binding (C++)

```
#include <iostream>
using namespace std;
class A {
  public:
    void funcX() { cout << "funcX in A" << endl; }
    virtual void funcY() { cout << "funcY in A" << endl; }
};

class B : public A {
  public:
    virtual void funcY() { cout << "funcY in B" << endl; }
};
```

- Which version of funcY() will be called by doing the following?

  ```
  A* ptr = new B;
  ptr->funcY();
  ```

  The funcY() in B is called. As funcY() is virtual function and so the pointer variable "ptr" is declared to refer to the actual type of the object the variable "ptr" currently points to. (Dynamic binding)

Polymorphism: Static and Dynamic Binding (Java)

- How about Java?

```
public class A {
  public void funcX() { System.out.println("funcX in A"); }
  public void funcY() { System.out.println("funcY in A"); }
}

public class B extends A {
  @Override
  public void funcY() { System.out.println("funcY in B"); }
}
```

  Which version of funcY() will be called by doing the following?

```
A aRef = new B();
aRef.funcY();
```

  The funcY() in B is called as Java does dynamic binding for overriding by default.

How to call funcY in A?

Const-ness

- Both C++ and Java allow a variable declaration to specify that the variable is a constant, i.e. its value cannot be changed after it is declared. C++ uses the keyword "const" for this, while Java uses "final"

C++

```
const double PI = 3.14159;
```

Java

```
final double PI = 3.14159;
```

- There is a major difference between C++ const and Java final when they are applied to functions / methods

C++

```
class A {
  public:
    const Person* func() { ... }
};
```

Java

```
public class A {
  public final Person func()
  { ... }
}
```

  - Left: It means func() returns a pointer to Person, which cannot be used to modify the Person object to which it points
  - Right: It means func() cannot be overridden in any subclass / derived class of the A

C++ Features that are not available in Java

- Preprocessor (e.g. #include, #ifndef, #define, #endif)
- Namespace
- Enumeration types
- Forward declaration
- Named types (i.e. typedef)
- Structure (i.e. struct)
- Scope resolution operator (i.e. ::)
    - Java uses dot operator for everything
- Default arguments
- Implicit type conversion
- Friend functions / classes
- Operator overloading
- Templates (i.e. function templates or class templates)

Features that are available in Java but not in C++

- Interface
- Object class and reflection
- ...

Java Application Programming Interface (API)

- Java Application Programming Interface (API) is a collection of classes with their respective fields, constructors, and respective methods
- The APIs provide information about classes, parameters, and other useful information to programmers

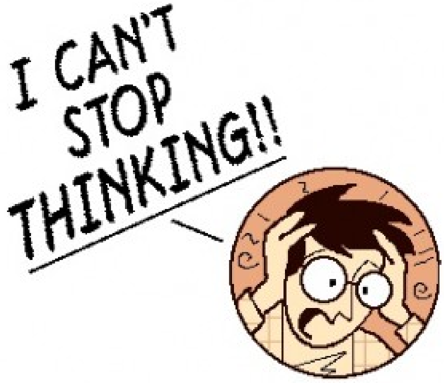
Java 1.8 API Documentation:
`https://docs.oracle.com/javase/8/docs/api/`

Eclipse: Press <F2>

Useful tip: To show the documentations for the selected type / class / method in Eclipse: <SHIFT-F2>

That's all!

Any questions?



Appendix: List of Java Reserved Words

abstract	continue	for	new	switch
assert***	default	goto*	package	synchronized
boolean	do	if	private	this
break	double	implements	protected	throw
byte	else	import	public	throws
case	enum****	instanceof	return	transient
catch	extends	int	short	try
char	final	interface	static	void
class	finally	long	strictfp**	volatile
const*	float	native	super	while

* not used

** added in Java 1.2

*** added in Java 1.4

**** added in Java 1.5

Appendix: Arithmetic, Relational and Logical Operators

Precedence	Operator	Description	Associativity
1 (highest)	()	Parentheses	Left to Right
	[]	Array subscript	
	.	Member selection	
2	++	Unary post-increment	Right to Left
	−−	Unary post-decrement	
3	++	Unary pre-increment	Right to Left
	−−	Unary pre-decrement	
	+	Unary plus	
	−	Unary minus	
	!	Unary logical negation	
	∼	Unary bitwise complement	
	(type)	Unary type cast	
4	*	Multiplication	Left to Right
	/	Division	
	%	Modulus	
5	+	Addition	Left to Right
	−	Subtraction	

Appendix: Arithmetic, Relational and Logical Operators

Precedence	Operator	Description	Associativity
6	<<	Bitwise left shift	Left to Right
	>>	Bitwise right shift with sign extension	
	>>>	Bitwise right shift with zero extension	
7	<	Relational less than	Left to Right
	<=	Relational less than or equal	
	>	Relational greater than	
	>=	Relational greater than or equal	
	instanceof	Type comparison (objects only)	
8	==	Relational is equal to	Left to Right
	!=	Relational is not equal to	
9	&	Bitwise AND	Left to Right
10	^	Bitwise exclusive OR	Left to Right
11	|	Bitwise inclusive OR	Left to Right
12	&&	Logical AND	Left to Right
13	||	Logical OR	Left to Right
14	? :	Ternary conditional	Right to left
15 (lowest)	=	Assignment	Right to left
	+=	Addition assignment	
	-=	Subtraction assignment	
	*=	Multiplication assignment	
	/=	Division assignment	
	%=	Modulus assignment	