Introduction to Java

Introduction to Programming and Computational Problem Solving - 2
CSE 8B
Lecture 2
Announcements

• Assignment 1 will be released today
  – Due Apr 12, 11:59 PM

• Educational research study (extra credit)
  – Apr 7, weekly survey (if study starts this week)
Programs

• Computer programs (i.e., software) are instructions to the computer
• You tell a computer what to do through programs
• Computers do not understand human languages, so you need to use computer languages to communicate with them
• Programs are written using programming languages
Programming languages

- Machine language
- Assembly language
- High-level language
Programming languages

• Machine language
  – Machine language is a set of primitive instructions built into every computer
  – The instructions are in the form of binary code, so you must enter binary codes for various instructions
  – Programming with native machine language is a tedious process, and the programs are highly difficult to read and modify
  – For example, to add two numbers, you might write an instruction in binary like this:
    1101101010011010
Programming languages

• Assembly language
  – Assembly languages were developed to make programming easier than machine languages
  – Since the computer cannot understand assembly language, a program called assembler is used to convert assembly language programs into machine code
  – For example, to add two numbers, you might write an instruction in assembly code like this:
    ADDF3 R1, R2, R3
Programming languages

• High-level language
  – High-level languages are English-like and easier to learn and program than assembly languages
  • For example, the following is a high-level language statement that computes the area of a circle with radius 5:
    
    \[
    \text{area} = 5 \times 5 \times 3.1415;
    \]
Interpreting/Compiling source code

• A program written in a high-level language is called a source program or source code
• Because a computer cannot understand a source program, a source program must be translated into machine code for execution
• The translation can be done using another programming tool called an interpreter or a compiler
Interpreting source code

• An interpreter reads one statement from the source code, translates it to the machine code or virtual machine code, and then executes it right away

• A statement from the source code may be translated into several machine instructions
Compiling source code

• A compiler translates the entire source code into a machine-code file, and the machine-code file is then executed.
Java

• The **compiler** of Java is called *javac*
  – Java source code is compiled into the Java Virtual Machine (JVM) code called bytecode

• The **interpreter** of Java is called *java*
  – The bytecode is machine-independent and can run on any machine that has a Java interpreter, which is part of the JVM (write once, run anywhere)
Introduction to Java

• Java is:
  – a high-level programming language
    • Computer-specific details are abstracted
  – an object-oriented programming language
    • Based on classes
  – a strongly typed language
    • Programmers must explicitly identify the type of every variable, method, and object
  – a general-purpose programming language
    • Not specialized to a particular application domain
  – platform independent
    • Write a program once and run it on any computer
Anatomy of a Java program

- Class name
- Main method
- Statements
- Statement terminator
- Reserved words
- Comments
- Blocks
Class name

• Every Java program must have at least one class
• Each class has a name corresponding to filename
• Naming convention: capitalize the first letter of each word in the name class (e.g., ComputeArea)
• This class name is Welcome (stored in Welcome.java)

```java
// This program prints Welcome to Java!
public class Welcome {
    public static void main(String[] args) {
        System.out.println("Welcome to Java!");
    }
}
```
main method

• In order to run a class, the class must contain a method named main
• The program is executed from the main method
• This line defines the main method

```java
// This program prints Welcome to Java!
public class Welcome {
    public static void main(String[] args) {
        System.out.println("Welcome to Java!");
    }
}
```
Statement

• A statement represents an action or a sequence of actions
• This is a statement to display the greeting “Welcome to Java!”

// This program prints Welcome to Java!
public class Welcome {
    public static void main(String[] args) {
        System.out.println("Welcome to Java!");
    }
}

CSE 8B, Spring 2023
Java application programming interface (API) documentation

• Documentation for all Java built-in classes and methods

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

• Java 11 API Documentation
  https://docs.oracle.com/en/java/javase/11/docs/api/

• Use the documentation!
println and print

println

public void println(String x)

Prints a String and then terminate the line. This method behaves as though it invokes print(String) and then println().

Parameters:
x - The String to be printed.

print

public void print(String s)

Prints a string. If the argument is null then the string "null" is printed. Otherwise, the string's characters are converted into bytes according to the platform's default character encoding, and these bytes are written in exactly the manner of the write(int) method.

Parameters:
s - The String to be printed

println

public void println()

Terminates the current line by writing the line separator string. The line separator string is defined by the system property line.separator, and is not necessarily a single newline character ('\n').
Statement terminator

• Every statement in Java ends with a semicolon

```java
// This program prints Welcome to Java!
public class Welcome {
    public static void main(String[] args) {
        System.out.println("Welcome to Java!");
    }
}
```
Reserved words

• Reserved words or keywords are words that have a specific meaning to the compiler and **cannot be used for other purposes in the program**
• For example, when the compiler sees the word `class`, it understands that the word after `class` is the name for the class

```java
// This program prints Welcome to Java!
public class Welcome {
    public static void main(String[] args) {
        System.out.println("Welcome to Java!");
    }
}
```
Comments

• Comments make the code more readable by adding details
• Implementation comments are meant for commenting out code or for comments about the particular implementation
• // comments out everything after it on the line
• The comment delimiters /*...*/ comments out everything between /* and */

```java
// This program prints Welcome to Java!
public class Welcome {
    public static void main(String[] args) {
        System.out.println("Welcome to Java!");
    }
}
```
Blocks

- A pair of braces in a program forms a block that groups components of a program.
Blocks

• Two different block styles

public class Test {
    public static void main(String[] args) {
        System.out.println("Block Styles");
    }
}

End-of-line style

public class Test {
    public static void main(String[] args) {
        System.out.println("Block Styles");
    }
}

Next-line style

Corresponding braces are column-aligned

First and last lines of block are column-align
# Special symbols

<table>
<thead>
<tr>
<th>Character</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>{}</td>
<td>Opening and closing braces</td>
<td>Denotes a block to enclose statements.</td>
</tr>
<tr>
<td>()</td>
<td>Opening and closing parentheses</td>
<td>Used with methods.</td>
</tr>
<tr>
<td>[]</td>
<td>Opening and closing brackets</td>
<td>Denotes an array.</td>
</tr>
<tr>
<td>//</td>
<td>Double slashes</td>
<td>Precedes a comment line.</td>
</tr>
<tr>
<td>&quot; &quot;</td>
<td>Opening and closing quotation marks</td>
<td>Enclosing a string (i.e., sequence of characters).</td>
</tr>
<tr>
<td>;</td>
<td>Semicolon</td>
<td>Marks the end of a statement.</td>
</tr>
</tbody>
</table>
Identifiers

- Identifiers are the **names** that identify the elements such as **classes, methods, and variables** in a program.
- An identifier is a sequence of characters that consist of letters, digits, underscores (\_), and dollar signs ($).
- An identifier must start with a letter, an underscore (\_), or a dollar sign ($).
- An identifier cannot start with a digit.
- An identifier cannot be a reserved word.
  - List of reserved words
    - [https://docs.oracle.com/javase/tutorial/java/nutsandbolts/_keywords.html](https://docs.oracle.com/javase/tutorial/java/nutsandbolts/_keywords.html)
- An identifier cannot be `true`, `false`, or `null`.
- An identifier can be of any length.
Variable and method names

• Naming convention: Use lowercase. If the name consists of several words, concatenate all in one, use lowercase for the first word, and capitalize the first letter of each subsequent word in the name
  – For example, the variables \(\text{radius}\) and \(\text{area}\), and the method \(\text{computeArea}\).
Variables

- Variables are used to represent values that may be changed in the program

```java
// Compute the first area
radius = 1.0;
area = radius * radius * 3.14159;
System.out.println("The area is " + area + " for radius " + radius);

// Compute the second area
radius = 2.0;
area = radius * radius * 3.14159;
System.out.println("The area is " + area + " for radius " + radius);
```
Declaring variables

```c
int x; // Declare x to be an integer variable
double radius; // Declare radius to be a double variable
char a; // Declare a to be a character variable
```
Assignment statements

x = 1;          // Assign 1 to x
radius = 1.0;   // Assign 1.0 to radius
a = 'A';        // Assign 'A' to a
Declaring and initializing in one step

```java
int x = 1;
double radius = 1.0;
char a = 'A';
```
Named constants

• Naming convention: capitalize all letters in constants, and use underscores to connect words

```java
final datatype CONSTANTNAME = VALUE;

final double PI = 3.14159;
final int MAX_VALUE = 3;
final char FIRST_UPPER_CASE = 'A';
```
public class ComputeArea {
    /** Main method */
    public static void main(String[] args) {
        double radius;
        double area;

        // Assign a radius
        radius = 20;

        // Compute area
        area = radius * radius * 3.14159;

        // Display results
        System.out.println("The area for the circle of radius " +
                          radius + " is " + area);
    }
}

Documentation (or doc or Javadoc) comments
- The comment delimiters /*...*/ comments out everything between /* and */, including the * following the begin delimiter */
- /** indicates this is beginning of a doc comment
public class ComputeArea {
    /** Main method */
    public static void main(String[] args) {
        double radius;
        double area;

        // Assign a radius
        radius = 20;

        // Compute area
        area = radius * radius * 3.14159;

        // Display results
        System.out.println("The area for the circle of radius "+radius +" is "+area);
    }
}
Trace a program execution

```java
public class ComputeArea {
    /** Main method */
    public static void main(String[] args) {
        double radius;
        double area;

        // Assign a radius
        radius = 20;

        // Compute area
        area = radius * radius * 3.14159;

        // Display results
        System.out.println("The area for the circle of radius " +
                           radius + " is " + area);
    }
}
```
public class ComputeArea {
    /** Main method */
    public static void main(String[] args) {
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        double area;

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        System.out.println("The area for the circle of radius " +
                          radius + " is " + area);
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    public static void main(String[] args) {
        double radius;
        double area;

        // Assign a radius
        radius = 20;

        // Compute area
        area = radius * radius * 3.14159;

        // Display results
        System.out.println("The area for the circle of radius "+
                radius + " is "+ area);
    }
}
Developing, compiling, and running Java programs

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

Welcome.class
Bytecode (generated by the compiler for JVM to read and interpret)
... Method Welcome()
  0 aload_0 ...

Method void main(java.lang.String[])
  0 getstatic #2 ...
  3 ldc #3 <String "Welcome to Java!">
  5 invokevirtual #4 ...
  8 return

"Welcome to Java" is displayed on the console
Welcome to Java!

Create/Modify Source Code
Source Code
Saved on the disk
Compile Source Code
e.g., javac Welcome.java
If compile errors occur
Stored on the disk
Bytecode
Run Bytecode
e.g., java Welcome
Not java Welcome.class
Result
If runtime errors or incorrect result
Programming errors

• Syntax errors
  – Detected by the compiler
    • The \textit{compiler} of Java is called \texttt{javac}

• Runtime errors
  – Causes the program to abort
    • The \textit{interpreter} of Java is called \texttt{java}

• Logic errors
  – Produces incorrect result
Syntax errors

- If you mistype part of a program, the compiler may issue a syntax error. The message usually displays the type of the error, the line number where the error was detected, the code on that line, and the position of the error within the code.

- For example, following is an error caused by omitting a semicolon at the end of a statement

  Testing.java:8: error: ';' expected
  count++  ^
  count++

  1 error

- If you see any compiler errors, then your program did not successfully compile, and the compiler did not create a .class file. Carefully verify the program, fix any errors that you detect, and try again.
Syntax errors

- Semantic Errors: In addition to verifying that your program is syntactically correct, the compiler checks for other basic correctness. For example, the compiler warns you each time you use a variable that has not been initialized.

```java
Testing.java:8: error: variable count might not have been initialized
    count++;
    ^
Position of the error within the code

Testing.java:9: error: variable count might not have been initialized
    System.out.println("Input has " + count + " chars.");
    ^
Position of the error within the code

2 errors
```

- Again, your program did not successfully compile, and the compiler did not create a .class file. Fix the error and try again.
Runtime errors

Exception in thread "main"

• If you encounter this, see https://docs.oracle.com/javase/tutorial/getStarted/problems/index.html#interpreter
Java Software Development
Java versions

- The Java roadmap includes long-term support (LTS) versions, with non-LTS versions along the way.
- Non-LTS versions are unsupported feature releases, allowing developers to explore features that may be in the next LTS version.
- Best practice is to only use LTS versions.
- Current LTS versions:
  - Java 8 (released Mar 2014, supported until Dec 2030)
  - Java 11 (released Sep 2018, supported until Sep 2026)
  - Java 17 (released Sep 2021, supported until Sep 2029)

Not a typo
Java Development Kit (JDK)

1. Develop on UCSD Linux Cloud
   – https://linuxcloud.ucsd.edu
   – Java 11 is already installed and configured on your UCSD Linux Cloud account

2. Develop on your personal computer
   – Download, install, and configure Java SE Development Kit 11, which is the same version installed and configured on your UCSD Linux Cloud account
   – Important: issues with your personal computer will not excuse late assignment submissions (or missed prelecture quizzes, etc.)
     • Best practice is to save your source code to your UCSD Google Drive, so you can finish on UCSD Linux Cloud and/or a UCSD computer

• Your source code must compile and run from the command-line on your UCSD Linux Cloud class account
Text editor

• Use whatever text editor you want
  – Visual Studio Code (highly recommended and used in CSE 8B), Notepad, Notepad++, vi (or Vim), Emacs, etc.
  – Important note: Visual Studio Code will offer to install extensions, enabling it to be an integrated development environment (IDE)
    • Should you choose to do this, the instructional team will not assist you in configuring it
    • On UCSD Linux Cloud, do not install Visual Studio Code Extensions! Linux Cloud will go down.

• Compile and run from the command line
• Beware of integrated development environments (IDEs) that generate source code!
  – Your source code must compile and run from the command-line on your UCSD Linux Cloud class account
  – Typing all code yourself will best prepare you for the exams
Welcome to UCSD Linux Cloud

Please login with the account you intend to use on the ETS Linux systems. Accounts without access will be denied. You may need to use a course specific account instead of your personal account. Unsure of which account to use? Please use the Account Lookup Tool.
All accounts must be registered in Duo. If you receive a “This account is not enrolled” error after login, please enroll your account in Duo here.
This service is based on Apache Guacamole. You can find a basic user guide here.
UCSD Linux Cloud

• Use your CSE 8B course account, not your personal account
  – Use the Account Lookup Tool
    • Also used to find the lab door codes
• Register your CSE 8B course account in Duo
• Do not forget to logout before closing browser tab/window! Linux Cloud will go down.

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All accounts must be registered in Duo. If you receive a “This account is not enrolled” error after login, please enroll your account in Duo here.
This service is based off Apache Guacamole. You can find a basic user guide here.
Next lecture

• Numbers and mathematics