CSE 101 - COMPUTER PROGRAMMING I INTRODUCTION

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WHAT IS ENGINEERING?

- Engineering is…
- Analyzing problems
- Solving problems
- Using tools to create solutions
- If a tool does not exist, an engineer may need to create the tool

- Engineering is not…
- Memorizing
- Answering questions
- Finding the one right answer
- An Engineer does not claim someone else's solution as their own

ALGORITHM

- What is an algorithm?
- Components of an algorithm
- How to express algorithms

SOLVING PROBLEMS

- How to solve a problem:
  - Brute Force
  - Lucky Guess
  - Trial-and-Error
  - Experience (your own or someone else's)
  - Scientifically/Algorithmically

ALGORITHM

- Sequence of instructions describing how to accomplish a task
  - Note: Not actually performing the instructions
- Examples
  - Cooking recipe
  - Assembly instructions
  - Directions for driving from Antalya to Ankara
  - Instructions for installing software (such as Java)

INSTALL SOFTWARE ALGORITHM

- Open web browser
- Go to
  - https://www.oracle.com/java/technologies/javase-jdk15-downloads.html
- Click "jdk-15_windows-x64_bin.exe"
- Follow instructions

EXAMPLE – MAKING AYRAN

- Put 500 grams of yogurt into a mixer
- Add ½ liter water
- Add some salt
- Turn on mixer until contents are smooth
- Enjoy!

COMPONENTS OF AN ALGORITHM

- Values and variables (500 grams of yogurt)
- Instructions (Add ½ liter water)
- Sequences (Step 1 then 2)
- Procedures (Turn on mixer)
- Selections (if some condition is true, do something)
- Repetitions (… until smooth)
- Documentation

VALUES AND VARIABLES

- Values
  - Represent quantities, amounts, or measurements
  - May be one of many different types (number, text, other)
- Variables
  - Containers for values
  - Example
    - This jar (Variable) can contain 10 cookies (Value)

INSTRUCTIONS AND SEQUENCE

- Instructions
  - Directions to perform an action on values and variables
  - Examples
    - Put (instruction) 500 grams of yogurt into the mixer
    - Add (instruction) ½ liter of water
- Sequence
  - The order of a program is important
  - What if we performed the corrected ayran recipe in reverse order?

PROCEDURE

- A defined and named sequence of instructions
- Can refer to it by name rather than repeating the same instructions many times
- Examples
  - Mix – can include instructions to close the lid, make sure it is plugged in, press the button, etc.
  - Walk

SELECTION

- Instruction to decide which of two possible sequences is performed
- Based on a true/false condition
- Example
  - If I like ayran (condition), then drink (one sequence), otherwise, say "No thank you" (other sequence)
  - If class is over, then leave the meeting and enjoy the weekend, otherwise, remain online
- Can have multiple conditions
  - If class is over AND I don't have questions…

REPETITION

- Similar to selection but as long as condition is true, repeat sequence
- Test the condition, if true perform instructions, repeat…
- Also known as iteration or loop
- Example
  - Mix (instruction) until (repetition keyword) smooth (condition)
  - While (repetition keyword) teacher is speaking (condition) pay attention and take notes (instruction)

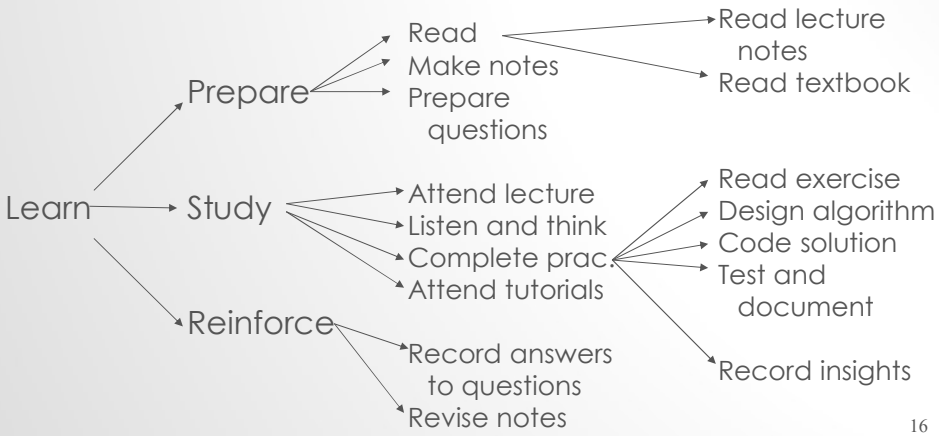
DOCUMENTATION

- Records what the algorithm does
- Describes how it is accomplished
- Explains the purpose of components
- Notes restrictions or expectations
- Example
  - "A recipe for making authentic, tasty ayran"
  - "Taking notes is a terrific way to learn the information presented"

ALGORITHM DESIGN

- Start with the desired goal of the algorithm
- Divide into smaller activities
- Divide these into even smaller activities until each resulting activity is easily performed (possibly in a single instruction)
- Example
  - Learning

LEARNING



EXPRESSING ALGORITHMS

- Natural Language
- Pseudocode
- Flowcharts
- Programming Languages

PSEUDOCODE

- If student's grade is greater than or equal to 90
  - Print "A"
- Else If student's grade is greater than or equal to 80
  - Print "B"
- Else If student's grade is greater than or equal to 70
  - Print "C"
- Else If student's grade is greater than or equal to 60
  - Print "D"
- Else
  - Print "F"

PSEUDOCODE

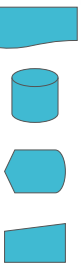
- Set total to 0
- Set classCount to 0
- While more grades exist to input
  - Input the next grade
  - Add grade to total (total = total + grade)
  - Increment classCount (classCount = classCount + 1)
- Set classAverage to total divided by classCount
  - (classAverage = total / classCount)

FLOWCHARTS

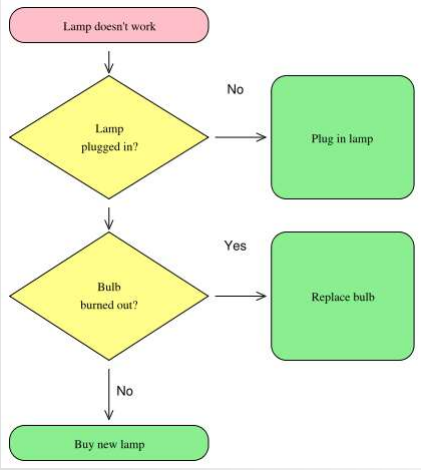
- Visual representation of an algorithm
- Symbols mostly used
  - Start/End
  - Arrows
  - Instructions
  - Input/Output
  - Conditional (Decision)

Less used

- Document
- Magnetic Tape
- Display
- Manual Input

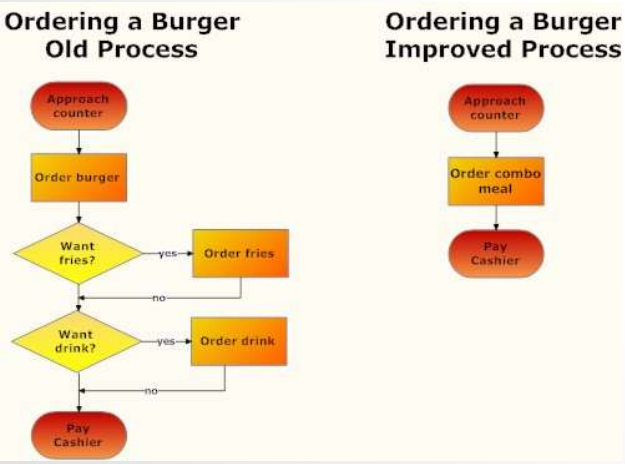


FLOWCHART EXAMPLE



From https://en.wikipedia.org/wiki/Flowchart

FLOWCHART EXAMPLE



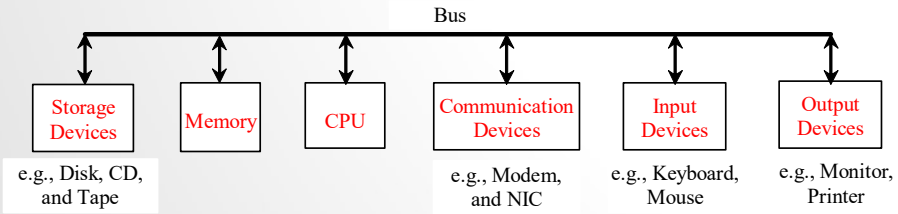
From http://www.smartdraw.com/

Objectives

- To understand computer basics, programs, and operating systems (§§1.2–1.4).
- To describe the relationship between Java and the World Wide Web (§1.5).
- To understand the meaning of Java language specification, API, JDK, and IDE (§1.6).
- To write a simple Java program (§1.7).
- To display output on the console (§1.7).
- To explain the basic syntax of a Java program (§1.7).
- To create, compile, and run Java programs (§1.8).
- To use sound Java programming style and document programs properly (§1.9).
- To explain the differences between syntax errors, runtime errors, and logic errors (§1.10).
- To develop Java programs using NetBeans (§1.11).
- To develop Java programs using Eclipse (§1.12).

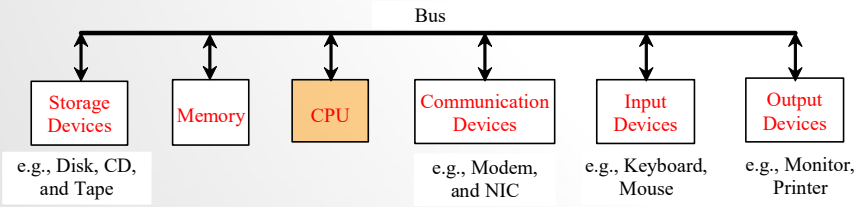
What is a Computer?

A computer consists of a CPU, memory, hard disk, floppy disk, monitor, printer, and communication devices.



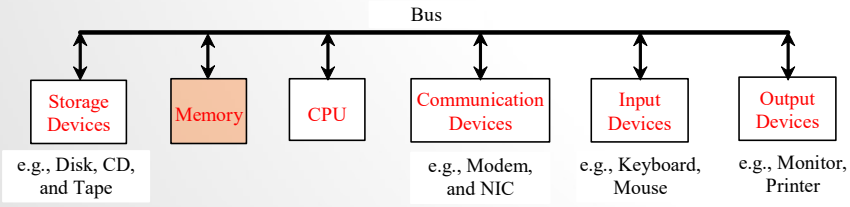
CPU

The central processing unit (CPU) is the brain of a computer. It retrieves instructions from memory and executes them. The CPU speed is measured in megahertz (MHz), with 1 megahertz equaling 1 million pulses per second. The speed of the CPU has been improved continuously. If you buy a PC now, you can get an Intel Pentium 4 Processor at 3 gigahertz (1 gigahertz is 1000 megahertz).



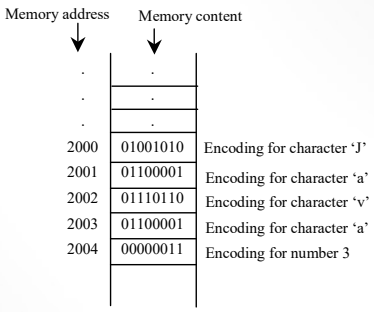
Memory

Memory is to store data and program instructions for CPU to execute. A memory unit is an ordered sequence of bytes, each holds eight bits. A program and its data must be brought to memory before they can be executed. A memory byte is never empty, but its initial content may be meaningless to your program. The current content of a memory byte is lost whenever new information is placed in it.



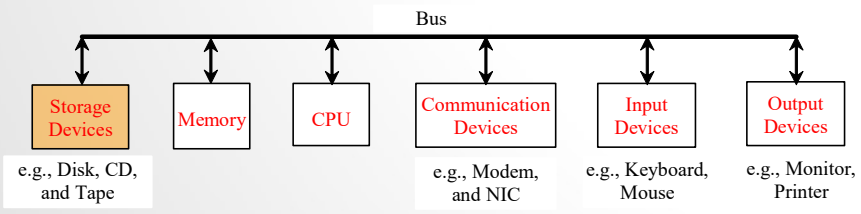
How Data is Stored?

Data of various kinds, such as numbers, characters, and strings, are encoded as a series of bits (zeros and ones). Computers use zeros and ones because digital devices have two stable states, which are referred to as *zero* and *one* by convention. The programmers need not to be concerned about the encoding and decoding of data, which is performed automatically by the system based on the encoding scheme. The encoding scheme varies. For example, character 'J' is represented by 01001010 in one byte. A small number such as three can be stored in a single byte. If computer needs to store a large number that cannot fit into a single byte, it uses a number of adjacent bytes. No two data can share or split a same byte. A byte is the minimum storage unit.



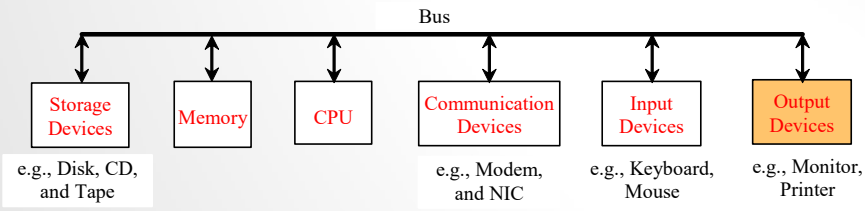
Storage Devices

Memory is volatile, because information is lost when the power is off. Programs and data are permanently stored on storage devices and are moved to memory when the computer actually uses them. There are three main types of storage devices:Disk drives (hard disks and floppy disks), CD drives (CD-R and CD-RW), and Tape drives.



Output Devices: Monitor

The monitor displays information (text and graphics). The resolution and dot pitch determine the quality of the display.



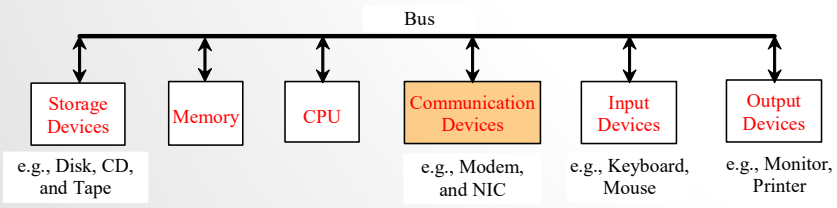
Monitor Resolution and Dot Pitch

resolution The *screen resolution* specifies the number of pixels in horizontal and vertical dimensions of the display device. *Pixels* (short for "picture elements") are tiny dots that form an image on the screen. A common resolution for a 17-inch screen, for example, is 1,024 pixels wide and 768 pixels high. The resolution can be set manually. The higher the resolution, the sharper and clearer the image is.

dot pitch The *dot pitch* is the amount of space between pixels, measured in millimeters. The smaller the dot pitch, the sharper the display.

Communication Devices

A *regular modem* uses a phone line and can transfer data in a speed up to 56,000 bps (bits per second). A *DSL* (digital subscriber line) also uses a phone line and can transfer data in a speed 20 times faster than a regular modem. A *cable modem* uses the TV cable line maintained by the cable company. A cable modem is as fast as a DSL. Network interface card (*NIC*) is a device to connect a computer to a local area network (LAN). The LAN is commonly used in business, universities, and government organizations. A typical type of NIC, called *10BaseT*, can transfer data at 10 mbps (million bits per second).



Programs

Computer *programs*, known as *software*, are instructions to the computer.

You tell a computer what to do through programs. Without programs, a computer is an empty machine. 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

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

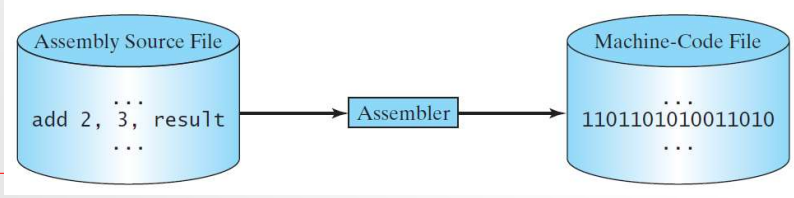
```
1101101010011010
```


Programming Languages

Machine Language Assembly Language High-Level Language

Assembly languages were developed to make programming easy. Since the computer cannot understand assembly language, however, 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

Machine Language Assembly Language High-Level Language

The high-level languages are English-like and easy to learn and program. For example, the following is a high-level language statement that computes the area of a circle with radius 5:

```
area = 5 * 5 * 3.1415;
```


Popular High-Level Languages

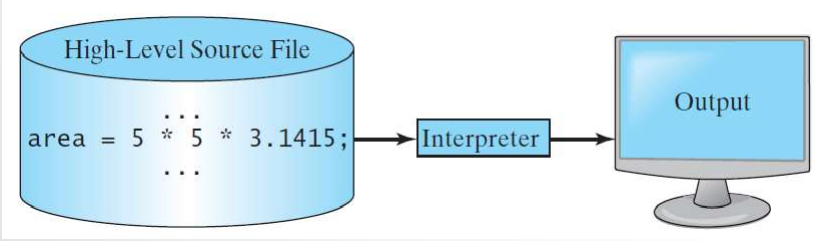
Language	Description
Ada	Named for Ada Lovelace, who worked on mechanical general-purpose computers. The Ada language was developed for the Department of Defense and is used mainly in defense projects.
BASIC	Beginner's All-purpose Symbolic Instruction Code. It was designed to be learned and used easily by beginners.
C	Developed at Bell Laboratories. C combines the power of an assembly language with the ease of use and portability of a high-level language.
C++	C++ is an object-oriented language, based on C.
C#	Pronounced "C Sharp." It is a hybrid of Java and C++ and was developed by Microsoft.
COBOL	COmmon Business Oriented Language. Used for business applications.
FORTRAN	FORmula TRANslation. Popular for scientific and mathematical applications.
Java	Developed by Sun Microsystems, now part of Oracle. It is widely used for developing platform-independent Internet applications.
Pascal	Named for Blaise Pascal, who pioneered calculating machines in the seventeenth century. It is a simple, structured, general-purpose language primarily for teaching programming.
Python	A simple general-purpose scripting language good for writing short programs.
Visual Basic	Visual Basic was developed by Microsoft and it enables the programmers to rapidly develop graphical user interfaces.

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*.

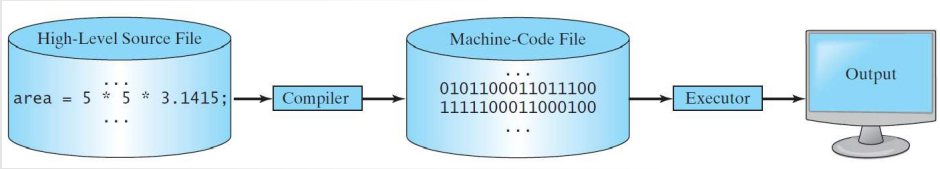
Interpreting Source Code

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, as shown in the following figure. Note that a statement from the source code may be translated into several machine instructions.



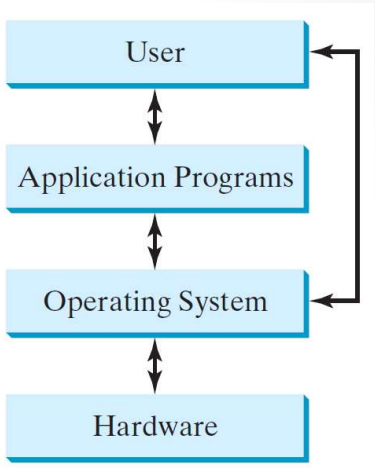
Compiling Source Code

A compiler translates the entire source code into a machine-code file, and the machine-code file is then executed, as shown in the following figure.



Operating Systems

The *operating system* (OS) is a program that manages and controls a computer's activities. The popular operating systems for general-purpose computers are Microsoft Windows, Mac OS, and Linux. Application programs, such as a Web browser or a word processor, cannot run unless an operating system is installed and running on the computer.



Why Java?

The answer is that Java enables users to develop and deploy applications on the Internet for servers, desktop computers, and small hand-held devices. The future of computing is being profoundly influenced by the Internet, and Java promises to remain a big part of that future. Java is the Internet programming language.

- Java is a general purpose programming language.
- Java is the Internet programming language.

Java, Web, and Beyond

- Java can be used to develop standalone applications.
- Java can be used to develop applications running from a browser.
- Java can also be used to develop applications for hand-held devices.
- Java can be used to develop applications for Web servers.

Java's History

- James Gosling and Sun Microsystems
- Oak
- Java, May 20, 1995, Sun World
- HotJava
  - The first Java-enabled Web browser
- Early History Website:

http://www.java.com/en/javahistory/index.jsp

Companion Website

Characteristics of Java

- Java Is Simple
- Java Is Object-Oriented
- Java Is Distributed
- Java Is Interpreted
- Java Is Robust
- Java Is Secure
- Java Is Architecture-Neutral
- Java Is Portable
- Java's Performance
- Java Is Multithreaded
- Java Is Dynamic

www.cs.armstrong.edu/liang/JavaCharacteristics.pdf

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Java is partially modeled on C++, but greatly simplified and improved. Some people refer to Java as "C++--" because it is like C++ but with more functionality and fewer negative aspects.

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Java is inherently object-oriented. Although many object-oriented languages began strictly as procedural languages, Java was designed from the start to be object-oriented. Object-oriented programming (OOP) is a popular programming approach that is replacing traditional procedural programming techniques.

One of the central issues in software development is how to reuse code. Object-oriented programming provides great flexibility, modularity, clarity, and reusability through encapsulation, inheritance, and polymorphism.

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Distributed computing involves several computers working together on a network. Java is designed to make distributed computing easy. Since networking capability is inherently integrated into Java, writing network programs is like sending and receiving data to and from a file.

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You need an interpreter to run Java programs. The programs are compiled into the Java Virtual Machine code called bytecode. The bytecode is machine-independent and can run on any machine that has a Java interpreter, which is part of the Java Virtual Machine (JVM).

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Companion Website

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Java compilers can detect many problems that would first show up at execution time in other languages.

Java has eliminated certain types of error-prone programming constructs found in other languages.

Java has a runtime exception-handling feature to provide programming support for robustness.

Companion Website

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Java implements several security mechanisms to protect your system against harm caused by stray programs.

Companion Website

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Write once, run anywhere

With a Java Virtual Machine (JVM), you can write one program that will run on any platform.

Companion Website

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Because Java is architecture neutral, Java programs are portable. They can be run on any platform without being recompiled.

Companion Website

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Multithread programming is smoothly integrated in Java, whereas in other languages you have to call procedures specific to the operating system to enable multithreading.

Companion Website

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Java was designed to adapt to an evolving environment. New code can be loaded on the fly without recompilation. There is no need for developers to create, and for users to install, major new software versions. New features can be incorporated transparently as needed.

JDK Editions

- Java Standard Edition (J2SE)
  - J2SE can be used to develop client-side standalone applications or applets.
- Java Enterprise Edition (J2EE)
  - J2EE can be used to develop server-side applications such as Java servlets, Java ServerPages, and Java ServerFaces.
- Java Micro Edition (J2ME).
  - J2ME can be used to develop applications for mobile devices such as cell phones.

This book uses J2SE to introduce Java programming.

Popular Java IDEs

- NetBeans
- Eclipse
- IntelliJ
- jGrasp

A Simple Java Program

Listing 1.1

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

Animation

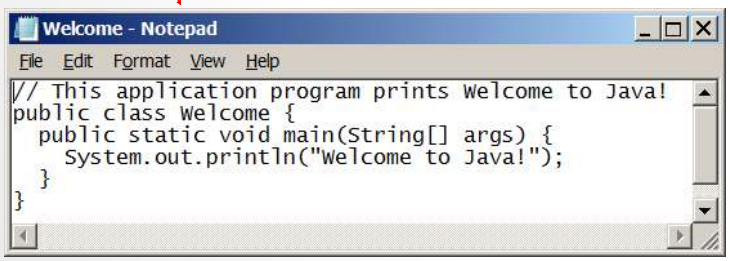
Welcome

Run

IMPORTANT NOTE: If you cannot run the buttons, see www.cs.armstrong.edu/liang/javaslidenote.doc.

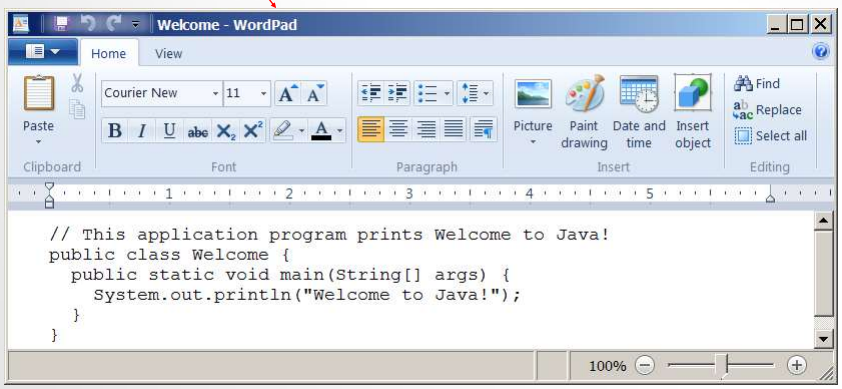
Creating and Editing Using NotePad

To use NotePad, type
notepad Welcome.java
from the DOS prompt.

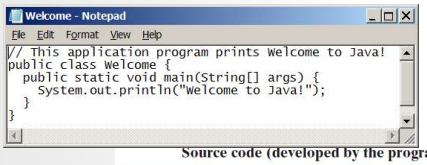


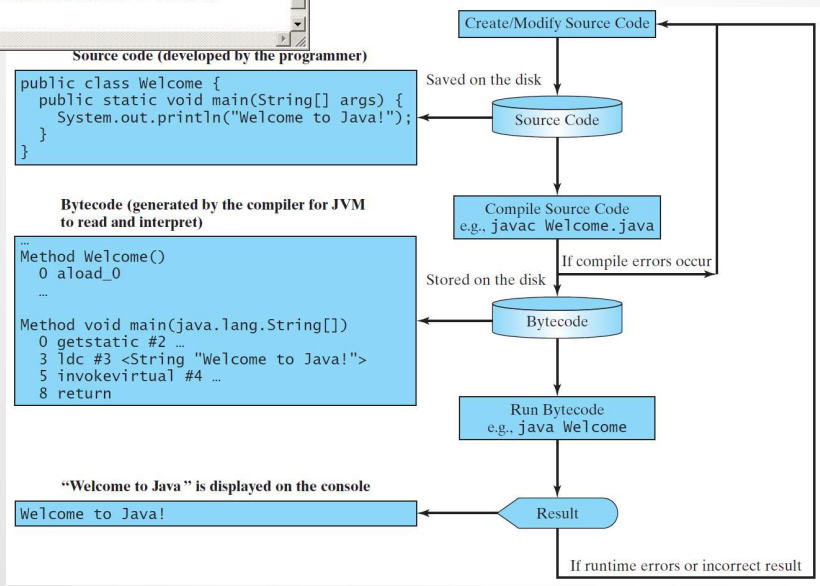
Creating and Editing Using WordPad

To use WordPad, type
write Welcome.java
from the DOS prompt.



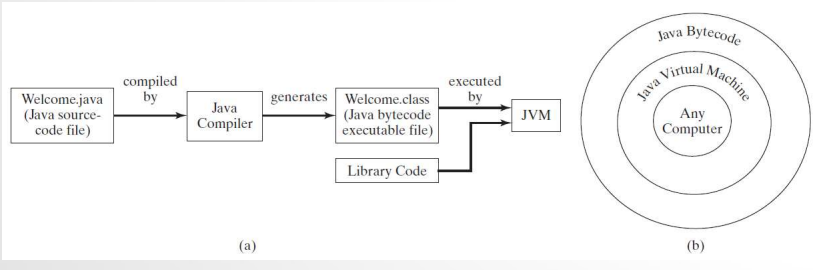
Creating, Compiling, and Running Programs





Compiling Java Source Code

You can port a source program to any machine with appropriate compilers. The source program must be recompiled, however, because the object program can only run on a specific machine. Nowadays computers are networked to work together. Java was designed to run object programs on any platform. With Java, you write the program once, and compile the source program into a special type of object code, known as *bytecode*. The bytecode can then run on any computer with a Java Virtual Machine, as shown below. Java Virtual Machine is a software that interprets Java bytecode.



animation

Trace a Program Execution

Enter main method

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

animation

Trace a Program Execution

Execute statement

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

animation

Trace a Program Execution

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

print a message to the console

Two More Simple Examples

Animation

WelcomeWithThreeMessages Run

Animation

ComputeExpression Run

Companion Website

Supplements on the Companion Website

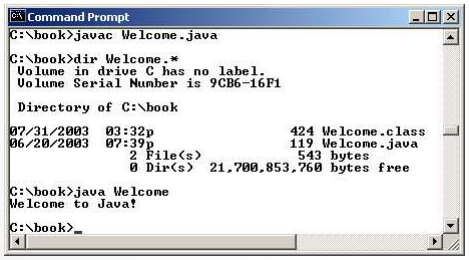
- See Supplement I.B for installing and configuring JDK
- See Supplement I.C for compiling and running Java from the command window for details

www.cs.armstrong.edu/liang/intro10e

Companion Website

Compiling and Running Java from the Command Window

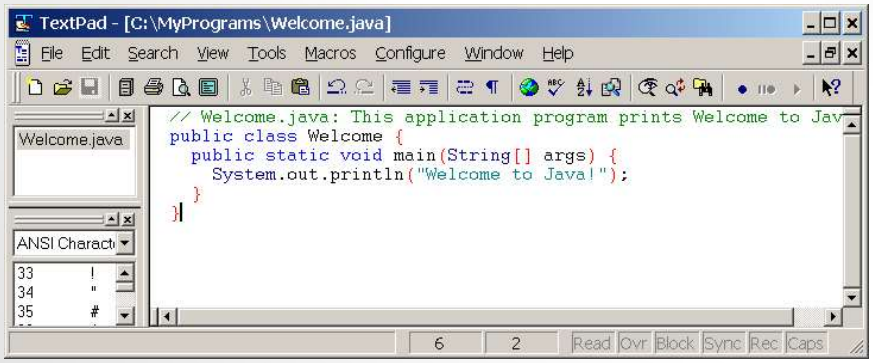
- Set path to JDK bin directory
  - set path=c:\Program Files\java\jdk-15\bin
- Set classpath to include the current directory
  - set classpath=.
- Compile
  - javac Welcome.java
- Run
  - java Welcome



Compiling and Running Java from TextPad

Companion Website

- See Supplement II.A on the Website for details



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. By convention, class names start with an uppercase letter. In this example, the class name is Welcome.

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


Main Method

Line 2 defines the 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 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. The statement System.out.println("Welcome to Java!") in the program in Listing 1.1 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!");
  }
}
```


Statement Terminator

Every statement in Java ends with a semicolon (;).

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

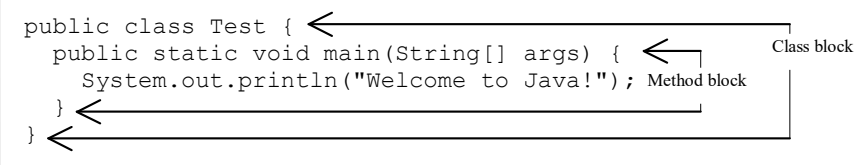

Reserved words

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.

```
// 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.



Special Symbols

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

{ ... }

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

(...)

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


;

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


// ...

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


" ... "

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


Programming Style and Documentation

- Appropriate Comments
- Naming Conventions
- Proper Indentation and Spacing Lines
- Block Styles

Appropriate Comments

Include a summary at the beginning of the program to explain what the program does, its key features, its supporting data structures, and any unique techniques it uses.

Include your name, class section, instructor, date, and a brief description at the beginning of the program.

Naming Conventions

- Choose meaningful and descriptive names.
- Class names:
  - Capitalize the first letter of each word in the name. For example, the class name `ComputeExpression`.

Proper Indentation and Spacing

- Indentation
  - Indent two spaces.
- Spacing
  - Use blank line to separate segments of the code.

Block Styles

Use end-of-line style for braces.

Next-line style

```
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");
  }
}
```


Programming Errors

- Syntax Errors
  - Detected by the compiler
- Runtime Errors
  - Causes the program to abort
- Logic Errors
  - Produces incorrect result