Our First Program

```java
// comments about the class
public class MyProgram {
    // comments about the method
    public static void main (String[] args) {
        System.out.println("Hello World");
    }
}
```

Java Program Structure

```java
// comments about the class
public class MyProgram {
    // comments about the method
    public static void main (String[] args) {
    }
}
```

Comments

- Comments in a program are called **inline documentation**
- They should be included to explain the purpose of the program and describe processing steps
- They do not affect how a program works
- Java comments can take three forms:
  - // this comment runs to the end of the line
  - /* this comment runs to the terminating symbol, even across line breaks */
  - /** this is a javadoc comment */
Our First Program

```java
// comments about the class
public class MyProgram {
    // comments about the method
    public static void main(String[] args) {
        System.out.println("Hello World");
    }
}
```

Identifiers

- Identifiers are the words a programmer uses in a program
- An identifier can be made up of letters, digits, the underscore character ( _ ), and the dollar sign
- Identifiers cannot begin with a digit
- Java is case sensitive - Total, total, and TOTAL are different identifiers
- By convention, programmers use different case styles for different types of identifiers, such as
  - title case for class names - Lincoln
  - upper case for constants - MAXIMUM

Identifiers

- Sometimes we choose identifiers ourselves when writing a program (such as Lincoln)
- Sometimes we are using another programmer’s code, so we use the identifiers that he or she chose (such as println)
- Often we use special identifiers called reserved words that already have a predefined meaning in the language
- A reserved word cannot be used in any other way

Reserved Words

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

White Space

- Spaces, blank lines, and tabs are called white space
- White space is used to separate words and symbols in a program
- Extra white space is ignored
- A valid Java program can be formatted many ways
- Programs should be formatted to enhance readability, using consistent indentation
- See Lincoln2.java (page 34)
- See Lincoln3.java (page 35)

This code is still valid, but hard to read

```java
// comments about the class
public class MyProgram {
    // comments about the method
    public static void main(String[] args) {
        System.out.println("Hello World");
    }
}
```
Run examples from the book

Hardware and Software
- Hardware
  - the physical, tangible parts of a computer
  - keyboard, monitor, disks, wires, chips, etc.
- Software
  - programs and data
  - a program is a series of instructions
- A computer requires both hardware and software
- Each is essentially useless without the other

A Computer Specification
- Consider the following specification for a personal computer:
  - 2.8 GHz Pentium 4 Processor
  - 512 MB RAM
  - 80 GB Hard Disk
  - 48x CD-RW / DVD-ROM Combo Drive
  - 17" Video Display with 1280 x 1024 resolution
  - 56 Kb/s Modem
- What does it all mean?

CPU and Main Memory
- Chip that executes program commands
- Intel Pentium 4
- Sun ultraSPARC III

Secondary Memory Devices
- Information is moved between main memory and secondary memory as needed
- Hard disks
- Floppy disks
- ZIP disks
- Writable CDs
- Writable DVDs
- Tapes

The Central Processing Unit
- A CPU is on a chip called a microprocessor
- It continuously follows the fetch-decode-execute cycle:
  - Retrieve an instruction from main memory
  - Carry out the instruction
  - Determine what the instruction is
  - Execute
  - Decode

A Computer Specification
- Consider the following specification for a personal computer:
  - 2.8 GHz Pentium 4 Processor
  - 512 MB RAM
  - 80 GB Hard Disk
  - 48x CD-RW / DVD-ROM Combo Drive
  - 17" Video Display with 1280 x 1024 resolution
  - 56 Kb/s Modem
- What does it all mean?
Input / Output Devices

- Monitor
- Keyboard
- Central Processing Unit
- Main Memory
- Floppy Disk
- Hard Disk
- Monitor screen
- Keyboard
- Mouse
- Joystick
- Bar code scanner
- Touch screen

I/O devices facilitate user interaction

Software Categories

- Operating System
  - controls all machine activities
  - provides the user interface to the computer
  - manages resources such as the CPU and memory
  - Windows XP, Unix, Linux, Mac OS

- Application program
  - generic term for any other kind of software
  - word processors, missile control systems, games

- Most operating systems and application programs have a graphical user interface (GUI)

Analog vs. Digital

- There are two basic ways to store and manage data:
  - Analog
    - continuous, in direct proportion to the data represented
    - music on a record album - a needle rides on ridges in the grooves that are directly proportional to the voltages sent to the speaker
  - Digital
    - the information is broken down into pieces, and each piece is represented separately
    - music on a compact disc - the disc stores numbers representing specific voltage levels sampled at specific times

Digital Information

- Computers store all information digitally:
  - numbers
  - text
  - graphics and images
  - video
  - audio
  - program instructions

- In some way, all information is digitized - broken down into pieces and represented as numbers

Representing Text Digitally

- For example, every character is stored as a number, including spaces, digits, and punctuation
- Corresponding upper and lower case letters are separate characters

```
Hi, Heather.
72 105 44 32 72 101 97 116 104 101 114 46
```

Binary Numbers

- Once information is digitized, it is represented and stored in memory using the binary number system
- A single binary digit (0 or 1) is called a bit
- Devices that store and move information are cheaper and more reliable if they have to represent only two states
- A single bit can represent two possible states, like a light bulb that is either on (1) or off (0)
- Permutations of bits are used to store values
### Bit Permutations

<table>
<thead>
<tr>
<th>1 bit</th>
<th>2 bits</th>
<th>3 bits</th>
<th>4 bits</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>00</td>
<td>000</td>
<td>0000</td>
</tr>
<tr>
<td>1</td>
<td>01</td>
<td>001</td>
<td>0001</td>
</tr>
<tr>
<td>10</td>
<td>010</td>
<td>011</td>
<td>0111</td>
</tr>
<tr>
<td>11</td>
<td>100</td>
<td>0101</td>
<td>1100</td>
</tr>
<tr>
<td></td>
<td>101</td>
<td>0110</td>
<td>1110</td>
</tr>
<tr>
<td></td>
<td>110</td>
<td>0111</td>
<td>1111</td>
</tr>
</tbody>
</table>

Each additional bit doubles the number of possible permutations.

### Bit Permutations

- Each permutation can represent a particular item
- There are $2^n$ permutations of $n$ bits
- Therefore, $n$ bits are needed to represent $2^n$ unique items

<table>
<thead>
<tr>
<th>$n$</th>
<th>Permutations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2 items</td>
</tr>
<tr>
<td>2</td>
<td>4 items</td>
</tr>
<tr>
<td>3</td>
<td>8 items</td>
</tr>
<tr>
<td>4</td>
<td>16 items</td>
</tr>
<tr>
<td>5</td>
<td>32 items</td>
</tr>
</tbody>
</table>

### Program Development

- The mechanics of developing a program include several activities
  - writing the program in a specific programming language (such as Java)
  - translating the program into a form that the computer can execute
  - investigating and fixing various types of errors that can occur
- Software tools can be used to help with all parts of this process

### More about binary numbers later...

### Programming Languages

- Each type of CPU executes only a particular machine language
- A program must be translated into machine language before it can be executed
- A compiler is a software tool which translates source code into a specific target language
- Often, that target language is the machine language for a particular CPU type
- The Java approach is somewhat different

### Java Translation

- The Java compiler translates Java source code into a special representation called bytecode
- Java bytecode is not the machine language for any traditional CPU
- Another software tool, called an interpreter, translates bytecode into machine language and executes it
- Therefore the Java compiler is not tied to any particular machine
- Java is considered to be architecture-neutral
Java Translation

Java source code → Java bytecode → Bytecode compiler → Machine code

Syntax and Semantics

- The syntax rules of a language define how we can put together symbols, reserved words, and identifiers to make a valid program.
- The semantics of a program statement define what that statement means (its purpose or role in a program).
- A program that is syntactically correct is not necessarily logically (semantically) correct.
- A program will always do what we tell it to do, not what we meant to tell it to do.

Basic Program Development

Edit and save program → Compile program → Execute program and evaluate results

Errors

- A program can have three types of errors:
  - The compiler will find syntax errors and other basic problems (compile-time errors).
  - If compile-time errors exist, an executable version of the program is not created.
  - A problem can occur during program execution, such as trying to divide by zero, which causes a program to terminate abnormally (run-time errors).
  - A program may run, but produce incorrect results, perhaps using an incorrect formula (logical errors).

Development Environments

- There are many programs that support the development of Java software, including:
  - Sun Java Development Kit (JDK)
  - Sun NetBeans
  - IBM Eclipse
  - Borland JBuilder
  - MetroWerks CodeWarrior
  - BlueJ
  - jGRASP
- Though the details of these environments differ, the basic compilation and execution process is essentially the same.

HW 1 is out

- Posted on the class web page
THE END