

Chapter 1

Introduction

Chapter Scope

- Introduce the Java programming language
- Program compilation and execution
- Problem solving in general
- The software development process
- Overview of object-oriented principles

Java

- A computer is made up of hardware and software
- *hardware* – the physical, tangible pieces that support the computing effort
- *program* – a series of instructions that the hardware executes one after another
- Programs are sometimes called *applications*
- *software* – consists of programs and the data those programs use

Java

- A *programming language* specifies the words and symbols that we can use to write a program
- A programming language employs a set of rules that dictate how the words and symbols can be put together to form valid *program statements*
- The Java programming language was created by Sun Microsystems, Inc.
- It was introduced in 1995 and its popularity grew quickly

Java

- In the Java programming language
 - a program is made up of one or more *classes*
 - a class contains one or more *methods*
 - a method contains program *statements*
- These terms will be explored in detail throughout the course
- A Java application always contains a method called `main`

```
//*****
//  Lincoln.java          Java Foundations
//
//  Demonstrates the basic structure of a Java application.
//*****

public class Lincoln
{
    //-----
    //  Prints a presidential quote.
    //-----
    public static void main(String[] args)
    {
        System.out.println("A quote by Abraham Lincoln:");

        System.out.println("Whatever you are, be a good one.");
    }
}
```

A Java Program

```
public class MyProgram
```

```
{
```

class header



class body



Comments can be placed almost anywhere

```
}
```

A Java Program

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

method body
method header
```


Comments

- Comments should be included to explain the purpose of the program and describe processing
- 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 */
```

Identifiers

- *Identifiers* are the words a programmer uses in a program
 - can be made up of letters, digits, the underscore character (`_`), and the dollar sign
 - 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

- Java reserved words:

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

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

```
//*****  
//  Lincoln2.java      Java Foundations  
//  
//  Demonstrates a poorly formatted, though valid, program.  
//*****  
  
public class Lincoln2{public static void main(String[]args){  
System.out.println("A quote by Abraham Lincoln:");  
System.out.println("Whatever you are, be a good one.");}}
```

```

//*****
//  Lincoln3.java      Java Foundations
//
//  Demonstrates another valid program that is poorly formatted.
//*****

        public      class
    Lincoln3
    {
        public
    static
        void
    main
        (
String
        []
        args
        )
    {
    System.out.println      (
"A quote by Abraham Lincoln:"
        )
        ;      System.out.println
            (
                "Whatever you are, be a good one."
            )
        ;
    }
    }

```

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

Language Levels

- There are four programming language levels
 - machine language
 - assembly language
 - high-level language
 - fourth-generation language
- Each type of CPU has its own specific *machine language*
- The other levels were created to make it easier for a human being to read and write programs

Language Levels

- A high-level expression and its lower level equivalents:

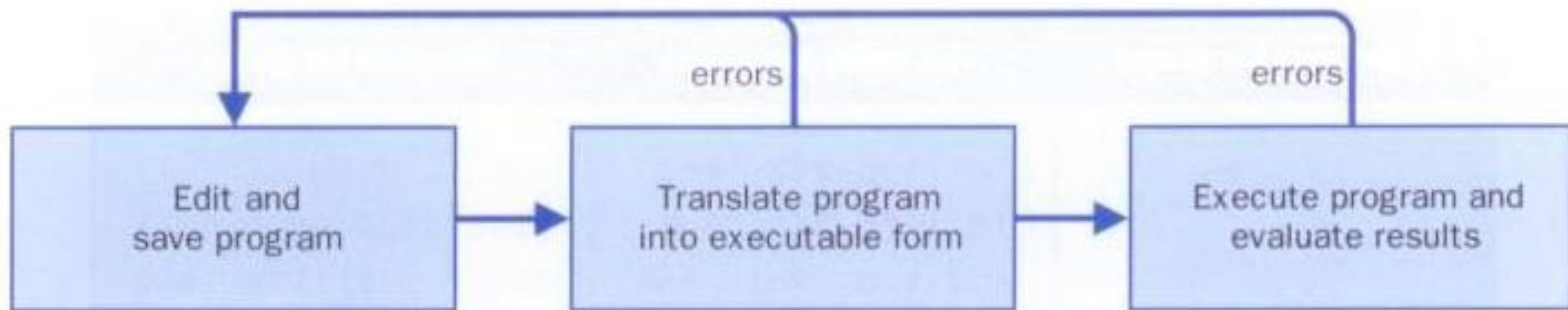
| High-Level Language | Assembly Language | Machine Language |
|----------------------------|--------------------------------|---------------------|
| <code><a + b></code> | <code>ld [%fp-20], %o0</code> | ... |
| | <code>ld [%fp-24], %o1</code> | 1101 0000 0000 0111 |
| | <code>add %o0, %o1, %o0</code> | 1011 1111 1110 1000 |
| | | 1101 0010 0000 0111 |
| | | 1011 1111 1110 1000 |
| | | 1001 0000 0000 0000 |
| | | ... |

Compilation

- 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

Basic Programming Steps

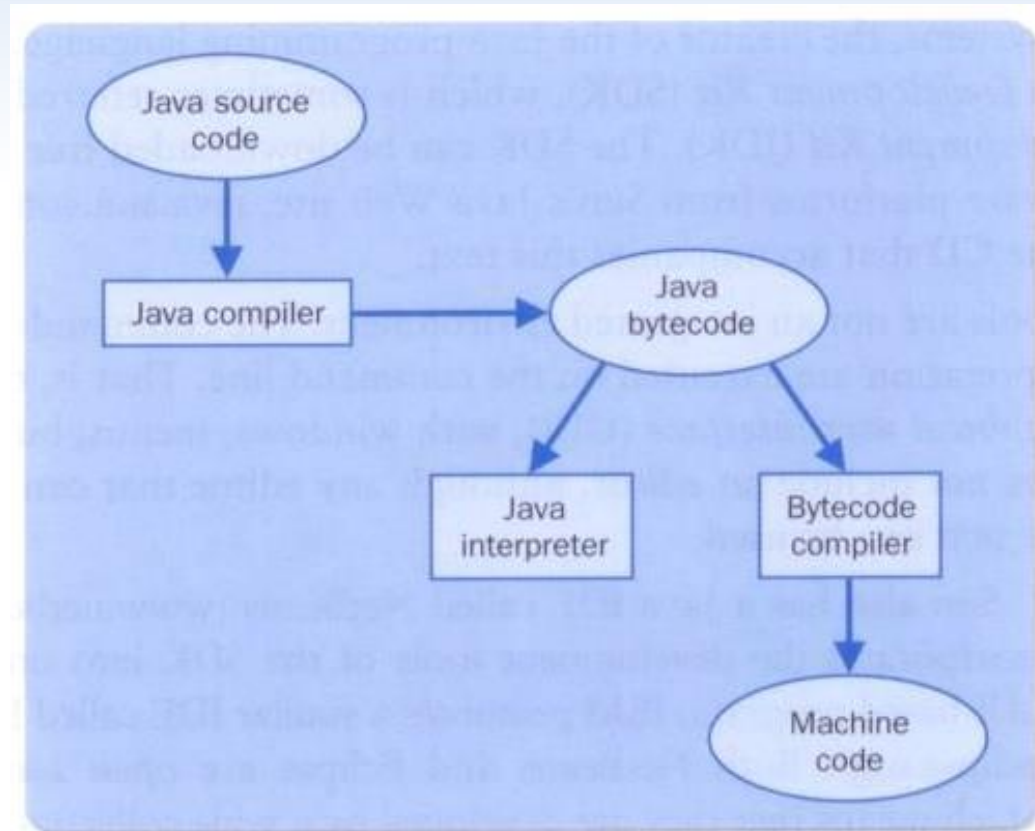
- A program is written in an editor, compiled into an executable form, and then executed
- If errors occur during compilation, an executable version is not created



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



Development Environments

- A *development environment* is the set of tools used to create, test, and modify a program
- An *integrated development environment* (IDE) combine the tools into one software program
- All development environments contain key tools, such as a compiler and interpreter
- Others include additional tools, such as a *debugger*, which helps you find errors

Development Environments

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

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

Errors

- A program can have three types of errors:
 - The compiler will find syntax errors and other basic problems (*compile-time errors*)
 - 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*)

Problem Solving

- The purpose of writing a program is to solve a problem
- Solving a problem consists of multiple activities
 - understand the problem
 - design a solution
 - consider alternatives and refine the solution
 - implement the solution
 - test the solution
- These activities are not purely linear – they overlap and interact

Problem Solving

- The key to designing a solution is breaking it down into manageable pieces
- When writing software, we design separate pieces that are responsible for certain parts of the solution
- *An object-oriented approach* lends itself to this kind of solution decomposition
- We will dissect our solutions into pieces called objects and classes

Development Activities

- Any proper software development effort consists of four basic *development activities*
 - establishing the requirements
 - creating a design
 - implementing the design
 - testing
- These steps also are never purely linear and often overlap and interact

Development Activities

- *Software requirements* specify *what* a program must accomplish
- Requirements are expressed in a document called a *functional specification*
- A *software design* indicates how a program will accomplish its requirements
- *Implementation* is the process of writing the source code that will solve the problem
- *Testing* is the act of ensuring that a program will solve the intended problem given all of the constraints under which it must perform

Object-Oriented Programming

- Java is an *object-oriented* programming language
- As the term implies, an object is a fundamental entity in a Java program
- Objects can be used effectively to represent real-world entities
- For instance, an object might represent a particular employee in a company
- Each employee object handles the processing and data management related to that employee

Objects

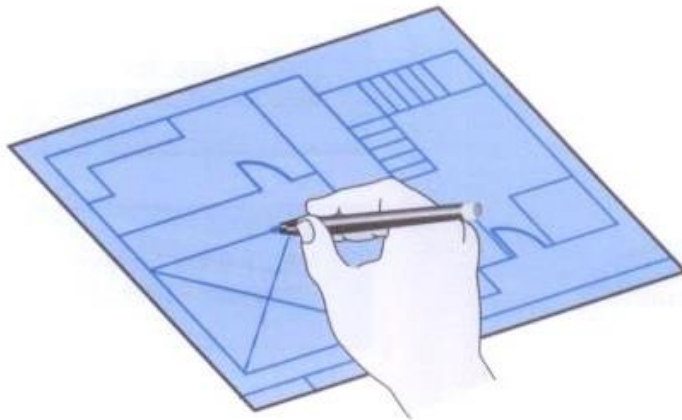
- An object has
 - *state* - descriptive characteristics
 - *behaviors* - what it can do (or what can be done to it)
- The state of a bank account includes its account number and its current balance
- The behaviors associated with a bank account include the ability to make deposits and withdrawals
- Note that the behavior of an object might change its state

Classes

- An object is defined by a *class*
- A class is the blueprint of an object
- The class uses methods to define the behaviors of the object
- The class that contains the main method of a Java program represents the entire program
- A class represents a concept, and an object represents the embodiment of that concept
- Multiple objects can be created from the same class

Classes and Objects

- A class is like a blueprint from which you can create many of the "same" house with different characteristics



Classes and Objects

- An object is *encapsulated*, protecting the data it manages
- One class can be used to derive another via *inheritance*
- Classes can be organized into hierarchies

Classes and Objects

