CSI1102
Introduction to Software Design

Chapter 1:
Introduction

Learning objectives

- Understand what problem solving entails
- Understand why problem solving skills are so important
- Describe the various levels of programming languages
- Understand a first Java program and its basic structure

Source: **Sections 1.3-1.5**, Chapter 1 (L&L)

A reminder:
Assumed background knowledge

Basic computer processing concepts

- Computer hardware components
  - CPU, I/O, main memory, secondary memory
- Digital computers and binary numbers
- Networks
  - Network connections
  - LAN and WAN
  - The Internet
  - The WWW

Read through Sections 1.0-1.2 to ensure you are "up to date"

So what is Problem Solving?

- The purpose of writing a program is **to solve a problem**
- The general steps in problem solving are:
  - Understand the problem
  - Dissect the problem into manageable pieces
  - Design a solution
  - Consider alternatives to the solution and refine it
  - Implement the solution
  - Test the solution and fix any problems that exist

Problem Solving:
"Divide and Conquer"

- Many software projects fail because the developer didn't really understand the problem to be solved
- We must **avoid assumptions** and **clarify ambiguities**
- As problems and their solutions become larger, we must organize our development into manageable pieces: **"Divide and Conquer"**

  → This technique is fundamental to software development

Object-oriented approach to Problem Solving

- We will **dissect our solutions into pieces** called **classes** and **objects**, taking an *object-oriented approach*
- *"If you want to eat an elephant, take one bite at a time".*

Problem solving through a programming language

- So suppose we have a problem to be solved
- We choose to design and implement a computer program to solve the problem
- → We use a programming language to encode the solution

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Problem solving through a programming language

- 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***
- Examples of programming languages:
  - Fortran, Cobol, C++, C, Delphi, Pascal, Smalltalk and **JAVA**

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Different Programming 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

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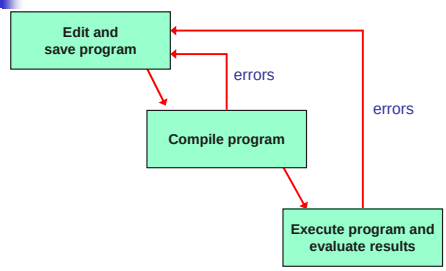
Basic Program Development



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Problem solving using JAVA

- The Java programming language was created by Sun Microsystems, Inc.
- It was introduced in 1995 and it's popularity has grown quickly since
- It is an **object-oriented language**

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Java Program Structure

- 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, **starting from next week**
- A Java application **always** contains a method called `main`
- See `Lincoln.java` (page 30)

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The Java Program Structure

```
//  comments about the class
public class MyProgram
{

}
```

class header

class body

Comments can be placed almost anywhere

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The Java Program Structure (cont)

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

   }
}
```

method header

method body

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A simple Java example

```
//*************************
// An example Java program
//
public class Hello
{
  //---------------------------------------
  // Task: Print the line "Hello World"
  //

  public static void main (String[ ] args)
  {
    System.out.println ("Hello World");
  }

}
```

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About programming language: They all have the following in common

- Basic Components
  - Comments
  - Identifiers
  - (Reserved Words)
  - Symbols (e.g. <, >, =, ...)
  - White Spaces
- Syntax and Semantics
- Translation
- Errors

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What are 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   */
```

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The Importance of Comments

- Describe WHAT, WHY, HOW and by WHOM
- Very important for further use
  - To understand one year from now
  - To be able to develop and extend your program
- Do not add them at the end!!!!

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What are Identifiers?

- *Identifiers* are the **words** a programmer uses in a program
- 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 they chose (such as `println`)

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Identifiers in Java

- 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, Java programmers use different case styles for different types of identifiers, such as
  - *title case* for class names - `Lincoln`
  - *upper case* for constants - `MAXIMUM`

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What are Reserved Words?

- 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

E.g. **IF** (temp < 30) **THEN**

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The Java Reserved Words

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

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About 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

E.g. if (height > tallest)
{
tallest = height;
}

- The *semantics* of a program statement define what that statement **means** (its purpose or role in a program)

E.g. We want to determine the tallest person.

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About Syntax and Semantics

- 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 !!!
- Typical error → incorrect boundaries

E.g. (height > tallest) instead of (height >= tallest)

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What are White Spaces?

- 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 in many ways
- Programs should be formatted to enhance readability, using consistent indentation
  - See `Lincoln2.java` (page 37)
  - See `Lincoln3.java` (page 38)

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A BADLY structured Java example

```
//*************************
// A poorly formatted, though valid,  Java program
//
public class Hello {  public static void main (String[ ] args)
  { System.out.println ("Hello World"); }}
```

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A nicely formatted example

```
//*****************************
// A nicely formatted Java program

public class Hello
{
   public static void main (String[ ] args)
   {
     System.out.println ("Hello World");
   }
}
```

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Translation of Programming Languages

- A program must be **translated into machine language** before it can be executed on a particular type of CPU
- 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
- An *interpreter* translates and executes one statement at a time
- The Java approach is somewhat different

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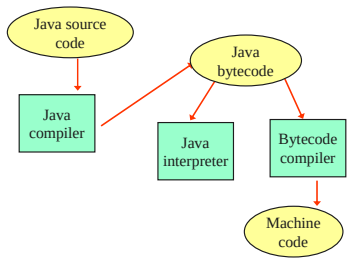
Translation in Java



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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*

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About 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***)

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Creating your program: Java Development Environments

- Sun Java Development Kit (JDK)
- Sun Forte for Java
- Borland JBuilder
- MetroWerks CodeWarrior
- Microsoft Visual J++
- Symantec Café
- Monash BlueJ
- RealJ (www.realj.com) ← Used in Lab B02

- Though the details of these environments differ, the basic compilation and execution process is essentially the same

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A word about Graphics

- Most computer programs have graphical components
- A picture or drawing must be digitized for storage on a computer
- A picture consists of pixels, and each pixel is stored separately
- Each pixel color is represented by a mix of Red, Blue and Green
- More details about graphics follow later in the course

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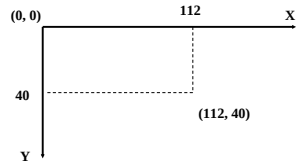
Coordinate Systems

- Each pixel can be identified using a two-dimensional coordinate system
- When referring to a pixel in a Java program, we use a coordinate system with the origin in the top-left corner



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Representing Color

- A black and white picture could be stored using one bit per pixel (0 = white and 1 = black)
- A colored picture requires more information; there are several techniques for representing colors
- For example, every color can be represented as a mixture of the three additive primary colors Red, Green, and Blue
- Each color is represented by three numbers between 0 and 255 that collectively are called an *RGB value*

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The Color Class

- A color in a Java program is represented as an object created from the `Color` class
- The `Color` class also contains several predefined colors, including the following:

Object	RGB Value
`Color.black`	`0, 0, 0`
`Color.blue`	`0, 0, 255`
`Color.cyan`	`0, 255, 255`
`Color.orange`	`255, 200, 0`
`Color.white`	`255, 255, 255`
`Color.yellow`	`255, 255, 0`

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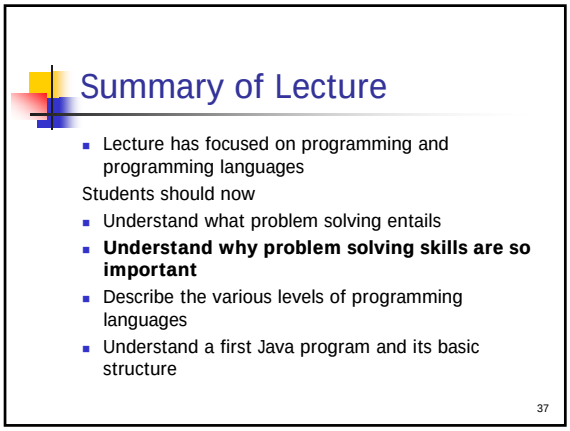
Summary of Lecture
Lecture has focused on programming and programming languages
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Describe the various levels of programming languages
Understand a first Java program and its basic structure
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