

Engineering Problem Solving With C++

Chapter 1 An Introduction to Engineering Problem Solving

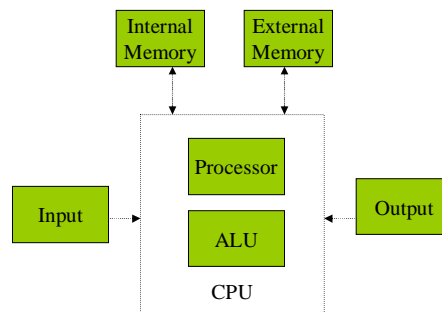
Objectives

- § Understanding of basic terminology for computers.
- § Understanding of a problem-solving methodology used when solving engineering problems with a computer

Computing Systems: Hardware and Software

- § A **computer** is a machine designed to perform operations specified with a set of instructions called a **program**.
- § **Hardware** refers to the computer equipment.
 - keyboard, mouse, terminal, hard disk, printer
- § **Software** refers to the programs that describe the steps we want the computer to perform.

Computer Hardware



- § CPU - Central processing unit
- § ALU - Arithmetic and logic unit
- § ROM - Read only memory
- § RAM - Random access memory

Main Memory

§ Main Memory -

01000001
01000000
01010001
01001101

§ Terminology:

- § Main memory is divided into numbered locations called **bytes**.
- § A byte is traditionally a sequence of 8 **bits**.
- § A bit is a **binary digit** (0 or 1).
- § The location number associated with a byte is called the **address**.
- § A group of consecutive bytes is used for storing the binary representation of a data item, such as a number or a character.
- § What value is represented by the 4th byte?

Number Systems

Base 10 number system uses 10 decimal digits (0,1,2,3,4,5,6,7,8,9)
In the number 123_{10} the position of each digit represents a power of 10.

The number can be written as:

$$\begin{aligned} &3 \times 10^0 + 2 \times 10^1 + 1 \times 10^2 \\ &3 \times 1 + 2 \times 10 + 1 \times 100 \\ &3 + 20 + 100 = 123 \end{aligned}$$

Base 2 number system uses 2 binary digits (0,1)

In the number 01000001_2 the position of each digit represents a power of 2.

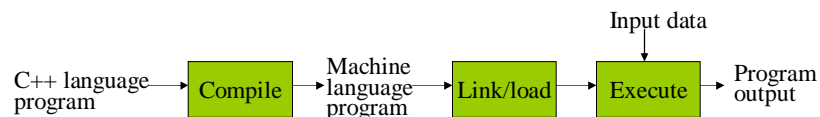
The number can be written as:

$$\begin{aligned} &1 \times 2^0 + 0 \times 2^1 + 0 \times 2^2 + 0 \times 2^3 + 0 \times 2^4 + 0 \times 2^5 + 1 \times 2^6 + 0 \times 2^7 \\ &1 + 0 + 0 + 0 + 0 + 0 + 64 + 0 = 65 \end{aligned}$$

Computer Software

- § Operating System - Provides an interface with the user
 - unix, windows, linux, ...
- § Software Tools
 - word processors (MicrosoftWord, WordPerfect, ...)
 - spreadsheet programs (Excel, Lotus1-2-3, ...)
 - mathematical computation tools (MATLAB, Mathematica, ...)
- § Computer Languages
 - machine language
 - assembly language
 - high level languages (C, C++, Ada, Fortran, Basic, Java)

Executing a Computer Program



- § Compiler
 - Converts **source** program to **object** program
- § Linker
 - Converts **object** program to **executable** program

Key Terms

- § Source Program
 - printable/Readable Program file
- § Object Program
 - nonprintable machine readable file
- § Executable Program
 - nonprintable executable code
- § Syntax errors
 - reported by the compiler
- § Linker errors
 - reported by the linker
- § Execution/Run-time errors
 - reported by the operating system
- § Logic errors
 - not reported

An Engineering Problem-Solving Methodology

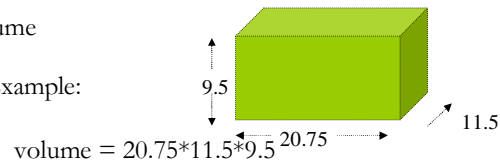
1. PROBLEM STATEMENT
2. INPUT/OUTPUT DESCRIPTION
3. HAND EXAMPLE
4. ALGORITHM DEVELOPMENT
5. TESTING

Example

1. Write a program to compute the volume of cube.
2. Input: length, width, height

Output: volume

3. Hand Example:



4. Algorithm: input length, width and height
compute volume
output volume
5. Implement algorithm in C++ and test.

Basic C++ Program Structure

```
/* *****  
 * Header Comments  
 * ***** */  
  
include files  
global declarations  
  
int main()  
{  
    declarations and executable statements  
    return 0;  
} //end block of main
```

First Program – Volume of a cube

```
/* **** */
/* Program Number One */
/* This program computes the volume of a cube */
/* **** */
#include <iostream>
using namespace std;

int main()
{
    // Declare and initialize objects
    double length( 20.75), width(11.5), height(9.5), volume;
    // Calculate volume
    volume = length * width * height;
    // Print the volume
    cout << "The volume is " << volume << endl;
    // Exit program.
    return 0;
}
/* **** */
```

The C++ Programming Language

- § A superset of C
 - C++ compilers can be used to compile C programs
- § Supports
 - Object Oriented Programming (OOP)
 - Templates
 - Overloading of functions and operators
- § Best to think of C++ as its own language