Chapter 1: Introduction

Outline

Introduction
What Is a Computer?
Computer Hardware
Computer Software
Computer Programming Languages
Machine Code, Assembly Languages and High-Level Languages.
The History of C
Object-Oriented Programming in C++
Compilation-Based Execution of Programs
Executing Programs Using an Interpreter
A C/C++ Interpreter Ch
Introduction

• We will learn the C programming language
  – Learn structured programming and proper programming techniques.
  – Introduction to numerical computing in Ch.

• The prerequisite is trigonometry
  – No prior programming experience is required.
What is a Computer?

• Computer
  – A computer is a machine that manipulates data based on a list of instructions called program.
  – A computer consists of hardware and software.

• Computer Hardware
  – Computer hardware is the physical part of a computer.
  – A typical computer consists of central processing unit (CPU), main memory and external memory, and input and output devices.
  – A CPU consists of control unit (CU), arithmetic and logic unit (ALU), and registers.
Samples of Computer Hardware

A single board computer and a tiny computer.
The von Newmann Computer Architecture

Both programs and data are stored in the same memory
Major Components of a Computer

1. Input devices
   • Obtains information from input devices (keyboard, mouse)
2. Output devices
   • Outputs information (to screen, printer, control other devices)
3. Main memory
   • Installs programs and data for rapid access
4. CPU:
   4.1 Arithmetic and logic unit (ALU)
      • Performs arithmetic calculations and logic decisions
   4.2 Control unit (CU)
      • Supervises and coordinates activities of the computer
   4.3 Registers
      Fast memory
5. External memory
   • Store programs and data permanently (hard disks, CDs, USB)
Hardware Trends

Moore’s Law (1965):

The number of transistors that can be inexpensively placed on an integrated circuit increases exponentially, doubling approximately every two years.

Based on Moore’s law, every two years, the following approximately double:

– CPU speed at which computers execute their programs.
– The amount of main memory.
– The amount of secondary memory.
Computer Software

*Computer software* refers to a collection of computer programs that can be loaded into main memory and executed in the CPU of a computer.

Computer software can be classified as operating system and application software.

*An operating system* is a software program for management and coordination of activities and sharing the resources of a computer.

*Application software* refers to programs developed to assist users in completing specific tasks.

*A process*: a running program.

*Software is harder than hardware...* (Cyrus Comment: Sometimes! 😊)
Interaction of Users and Computer Hardware through Software

Two interface methods:
(1) Command shell
(2) Graphical user interface (GUI)
Graphical User Interface
Command Shells and Their Inventors

- Bourne shell (sh)  Stephen Bourne
- C shell (ch)  Bill Joys
- Korn shell (ksh)  David Korn
- BASH shell (sh, bash)  Brian J. Fox
- Ch (C/C++) shell (ch)  Harry H. Cheng
- MS-DOS shell (cmd, command)  Tim Paterson
Ch Command Shell

Using commands `pwd`, `cd`, and `ls` to print the working directory, change directory, and list files in the Ch home directory.

C:/Ch> pwd
C:/Ch
C:/Ch> ls
bin/ demos/ docs/ include/ license/ README.TXT sbin/
config/ dl/ extern/ lib/ package/ release/ toolkit/
C:/Ch> cd docs
C:/Ch/docs>
C:/Ch/docs> ls
README.TXT chguide.pdf chinstall.pdf chref.pdf man/
Computer Programming Languages

Three types of programming languages

1. Machine code or machine languages
   A sequence of 0’s and 1’s giving machine specific instructions
   Example: 00011001

2. Assembly language
   Using meaningful symbols to represent machine code.
   Example: add hl,de

Assembler: Assembly code $\rightarrow$ machine code
Disassembler: machine code $\rightarrow$ assembly code
Computer Programming Languages

3. High-level languages
Similar to everyday English and use mathematical notations (processed by compilers or interpreters)
Example of a C statement:

\[ a = a + 8; \]
Computer Programming Languages

3. High-level languages
Similar to everyday English and use mathematical notations
(processed by compilers or interpreters)
Example of a C statement:
\[ a = a + 8; \]
## Comparison of High-Level Language with Machine Code and Assembly Code

The memory addresses, machine code, and assembly code corresponding to a C statement `a = a + 8` for the Rabbit 3000 8-bit microprocessor.

<table>
<thead>
<tr>
<th>Memory address</th>
<th>Machine code</th>
<th>Assembly code</th>
</tr>
</thead>
<tbody>
<tr>
<td>0X1EA1</td>
<td>000100010000100000000000000000</td>
<td>ld de,0x0008</td>
</tr>
<tr>
<td>0X1EA4</td>
<td>110001000000000000000000000000</td>
<td>ld hl,(sp+0)</td>
</tr>
<tr>
<td>0X1EA6</td>
<td>00011001</td>
<td>add hl,de</td>
</tr>
<tr>
<td>0X1EA7</td>
<td>110101000000000000000000000000</td>
<td>ld (sp+0),hl</td>
</tr>
</tbody>
</table>
High-level Computer Languages and Their Inventors

- FORTRAN  John W. Backus, 1954
- BASIC       George Kemeny and Tom Kurtz, 1964
- Pascal      Nicolas Wirth
- C           Dennis M. Ritchie
- C++         Bjarne Stroustrup
- Java        James Gosling
- C#          Anders Hejlsberg
C/C++ Are Dominant Languages in Industry and University

- Most large-scale projects are written in C/C++
- Most off-the-shelf software packages are written in C/C++
- The language of choice for real-time and embedded computing
TIOBE Programming Community Index for June 2009

http://www.tiobe.com/index.php/content/paperinfo/tpci/index.html

1   Java                20.147%
2   C                    16.779%
3   C++                 10.594%
20 MATLAB       0.527%
26 Fortran     0.374%

C/C++ combined together is 27.373%
Programming Language Popularity

http://langpop.com/
History of C

• C
  – Invented by Ritchie based on B, a simplified version of BCPL.
  – Used to develop Unix operating system and Unix commands
  – Most system software such as OS are written in C or C++
  – Replacement for assembly language for hardware interface.
  – By late 1970's C had evolved to “K & R C“

• C Standards
    It is called C89. Some call it C90.
  – 2nd C standard was ratified in 1999, called C99.
    Numerical extensions such as complex numbers, variable length arrays, and IEEE floating-point arithmetic are major enhancement in C99. C99 will be pointed out whenever features in C99 only are presented.
C++ Language

- "C with classes" invented by Bjarne Stroustrup at Bell Labs in 1980s.
- Powerful object-oriented capabilities
  - polymorphism
  - inheritance
  - information hiding
- C++ is very powerful, but too complicated. Without a solid foundation in C, it is impossible to master object-oriented features of C++.
- C++ is a superset of C89
- C++ is no longer a superset of C99
Phases of Compilation-Based Execution of a Program

1. Edit
2. Compile
3. Link
4. Execute
Compilation-Based Execution of a C Program

Creating an executable program from a C program using compiler and linker in Windows.

Executing the created executable program.
Scripting Languages and Their Inventors

- Tcl/Tk       John Ousterhout
- Python      Guido van Rossum
- Perl        Larry Walls
- PHP         Rasmus Lerdorf
- Ruby        Yukihiro Matsumoto
- Ch (C/C++)  Harry Cheng
Ch versus Other Languages

Ch is a C/C++ interpreter. It is especially suitable for learning computer programming in C and C++.
Phases of Interpreter-Based Execution of a Program

1. Edit

2. Execute
Interpretive Execution of a C Program

Executing a C program using an interpreter.
Array-Based Mathematical Software and Their Inventors

- MATLAB  Cleve Moler and others
- Mathematica  Stephen Wolfram and others
- Ch (C/C++)  Harry H. Cheng
Computing Paradigm

• 1970’s --- Mainframe

• 1980’s --- Client/Server

• 1990’s --- Network Computing

• 2000's --- Ubiquitous Computing