CMPE 102
Programming Logic and Design

Module 1
Introduction to Computers and Programming

1-1

Introduction

- People use computers at…

  - School for writing papers, research, email, online classes, etc.

  - Work for analyzing data, make presentations, business transactions, communicating, control machines, etc.

  - Home for paying bills, shopping online, communicating, playing computer games, etc.

What are some of the ways you use computers?

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Introduction

- Devices that are computers…

  - Smart Phones
  - iPods and tablets
  - Blackberries
  - Car navigation system (GPS)

Can you think of some other devices that are computers?

Introduction

- Computers are designed to do any job that their programs tell them to do.

- A *__program__* is a set of instructions that a computer follows to perform a task.

  For example: Microsoft Word and Adobe Photoshop

- Programs are commonly referred to as *__software__*.

  What software have you used?

Introduction

- ***Programmers*** or ***Software Developers*** are the individuals that create computer software.
- They have the training and skill to design, create, and test computer programs.

What are some of the fields in which computer programs are used?

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Hardware and Software

Concept:

The physical devices that a computer is made of are referred to as the computer's hardware. The programs that run on a computer are referred to as software.

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Hardware and Software

Hardware

- The physical devices that a computer is made of are referred to as the computer's *hardware.*

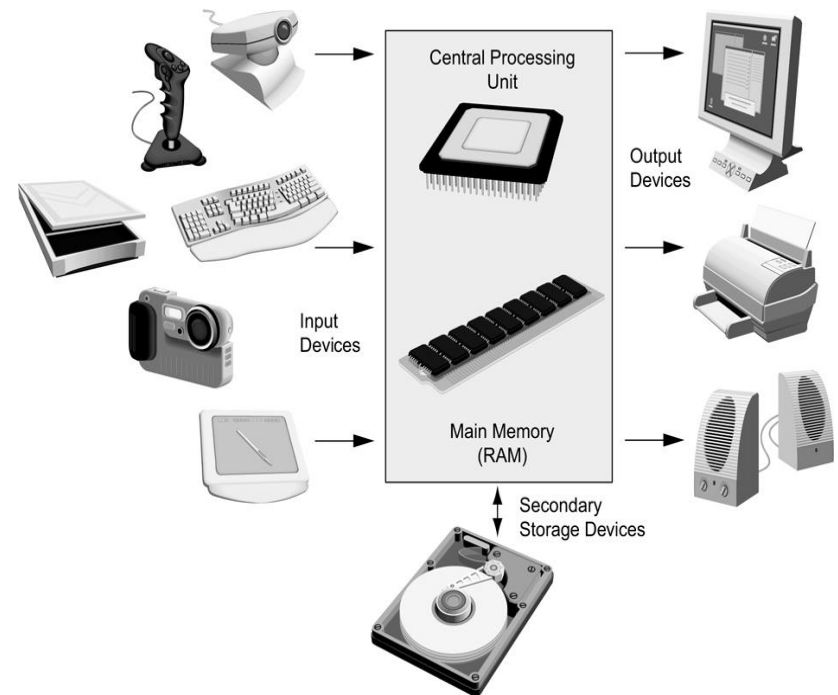- A computer is a system of devices that work together.

Hardware and Software

Hardware

A Computer System consists of:

– Central Processing Unit (CPU)

– Main memory

– Secondary storage

– Input devices

– Output devices

Figure 1-2 Typical components of a computer system

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Hardware and Software

Hardware

Central Processing Unit (CPU)

The CPU is the part of a computer that runs the programs.

Without a CPU a computer cannot run software.

Running or *executing* a program is the term used when the computer performs the tasks that the program tells it to do.
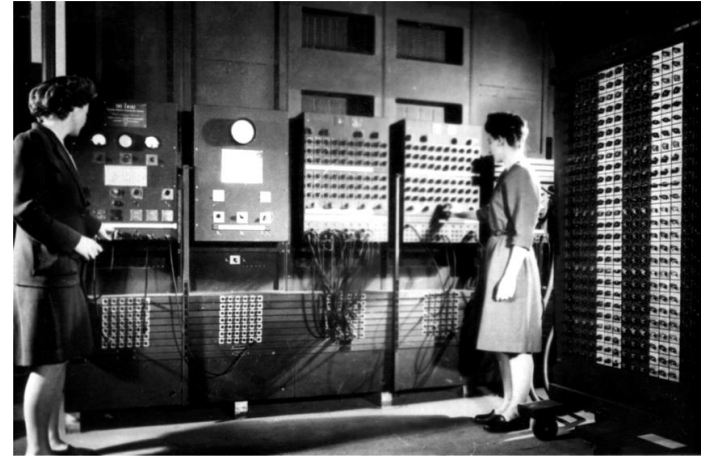
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Hardware and Software

Hardware

ENIAC

- World's first programmable computer
- Built in 1945
- Designed to calculate artillery ballistic tables for the U.S. Army
- CPU was 8 feet tall, 100 feet long, and weighed 30 tons

Microprocessor

- Much smaller
- Much more powerful

Figure 1-3 The ENIAC computer
(courtesy of U.S. Army Historic Computer Images)

Figure 1-4
A lab technician holds a modern microprocessor
(photo courtesy of Intel Corporation)

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Hardware and Software

Hardware

Main Memory

- Considered the computer's work area
- Computer stores the program that is running as well as the data
- Commonly known as the ***random-access memory (RAM)***
- Data is quickly accessed
- RAM is a volatile type of memory
- Used for temporary storage
- RAM is erased when computer is turned off

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Hardware and Software

Hardware

Secondary Storage Devices

- Type of memory that can hold data for long periods of time.
- Programs and important data are stored in secondary storage
- *Disk drive* is a common type of secondary storage
  - **Data is stored by magnetically encoding it onto a circular disk**
  - Most computers have an internal disk drive
  - Some have external disk drives; they are used to create backup copies
- *Floppy drives* record data onto a small floppy disk
  - Holds only a small amount of data
  - Slow to access data
  - Can be unreliable

Hardware and Software

Hardware

Secondary Storage Devices

- **_USB drives_** are small devices that plug into the computer's universal serial bus (USB) port
  - It does not contain a disk
  - The data is stored on flash memory
  - Also known as memory sticks and flash drives
  - Inexpensive, reliable, and small
- **_Optical devices (CD or DVD)_**
  - Data is encoded as a series of pits on the disc's surface
  - Uses laser to encode the data
  - Holds large amounts of data
  - Good medium for creating backups

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Hardware and Software

Hardware

Input Devices

- Any data the computer collects from people and from other devices is called ***input.***

- The hardware component that collects the data is called an ***input device***.

- Common input devices are:
  - Keyboard
  - Mouse
  - Scanner
  - Microphone
  - Digital camera

Can you think of any other input devices?

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Hardware and Software

Hardware

Output Devices

- Any data the computer produces for people or for other devices is called ***output.***

- The hardware component that formats and presents the data is called an ***output device***.

- Common output devices are:
  - monitor
  - Printer

Can you think of any other output devices?

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Hardware and Software

Software

- Everything a computer does is controlled by software.

- Two categories of software:

  - System software

  - Application software

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Hardware and Software

Software

System Software

- Programs that control and manage the basic operations of a computer are referred to as *system software*.

- Includes the following types:

  - *Operating System* controls the internal operations of the computer's hardware and manages all of the devices connected to the computer.

  - *Utility Programs* perform a specialized task that enhances the computer's operation or safeguards data.

  - *Software Developments Tools* are programs that are used to create, modify, and test software.

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Hardware and Software

Software

Application Software

- Programs that people normally spend most of their time running on their computers performing everyday tasks are referred to as *application software*.

- For example:
  - Word processing
  - Spreadsheet
  - Database
  - Presentation

Can you think of any other application software?

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How Computers store data

Concept:

All data that is stored in a computer is converted to sequences of 0s and 1s.

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How Computers store Data

- A computer's memory is divided into tiny storage locations known as *bytes*

- One byte represents one number

- A byte is divided into eight smaller storage locations known as *bits (binary digits)*

- Bits are tiny electrical components that can hold either a positive or a negative charge.

- A positive charge is similar to a switch in the *on* position

- A negative charge is similar to a switch in the *off* position

**Figure 1-7** Think of a byte as eight switches

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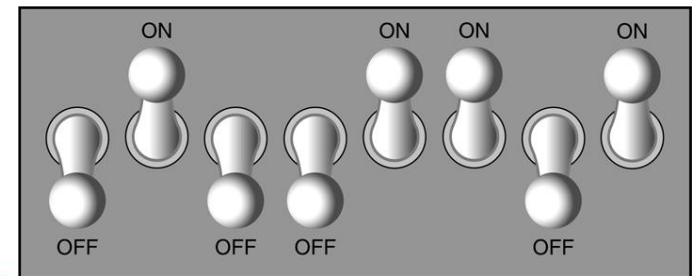
How Computers store Data

Storing Numbers

- The positive charge or the *on* position is represented by the digit 1

- The negative charge or the *off* position is represented by the digit 0

- This corresponds to the binary numbering system where all numeric values are written as a sequence of 0s and 1s

- Each digit in a binary number has a value assigned to it

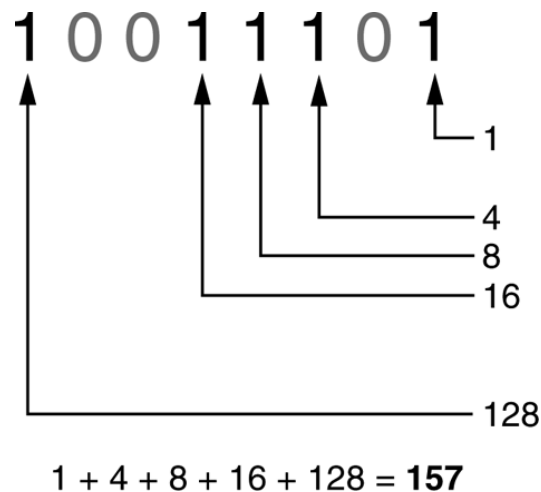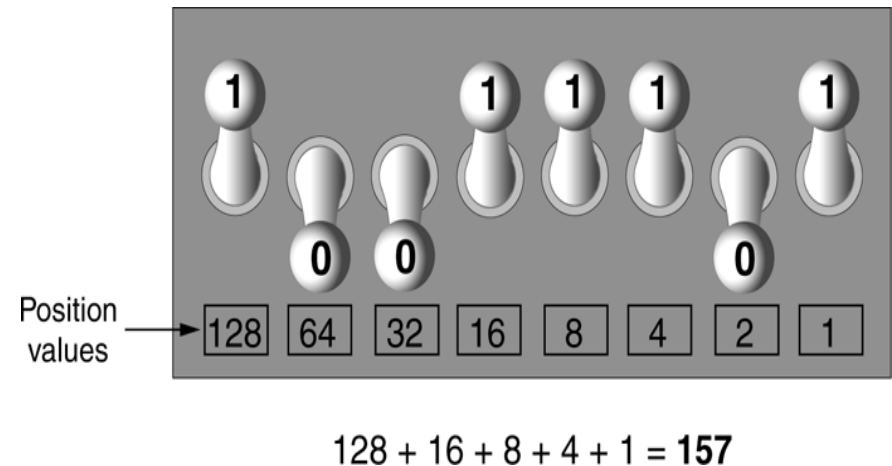**Figure 1-9** The values of binary digits as powers of 2

$$1 \quad 0 \quad 0 \quad 1 \quad 1 \quad 1 \quad 0 \quad 1$$

2^0
2^1
2^2
2^3
2^4
2^5
2^6
2^7
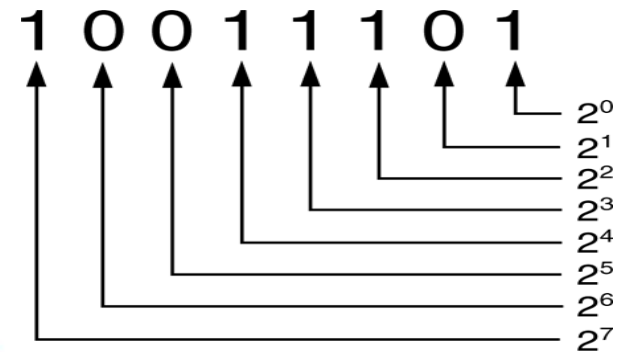
How Computers Store Data

Storing Numbers

For example:

Figure 1-11 Determining the value of 10011101

$$1 + 4 + 8 + 16 + 128 = \mathbf{157}$$

Figure 1-12 The bit pattern for 157

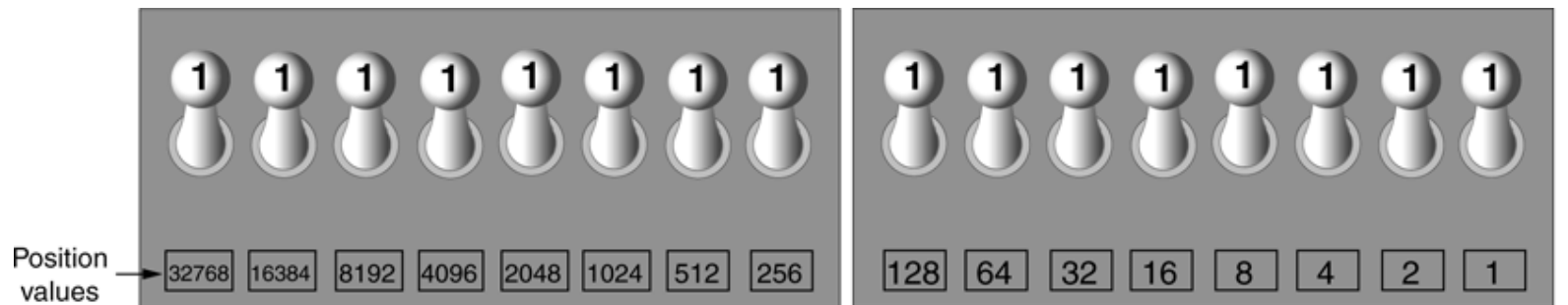$$128 + 16 + 8 + 4 + 1 = \mathbf{157}$$

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How Computers Store Data

Storing Numbers

- The largest value that can be stored in a byte with eight bits is **255**

- Two bytes are used for larger numbers; maximum value is **65535**

Figure 1-13 Two bytes used for a large number

Position values → 32768 16384 8192 4096 2048 1024 512 256 | 128 64 32 16 8 4 2 1

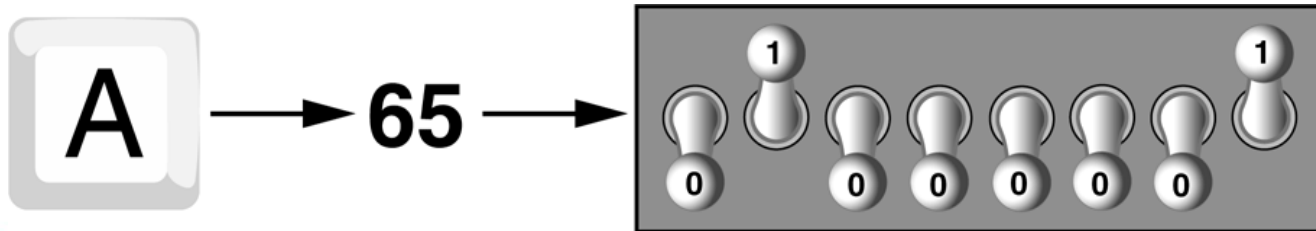32768 + 16384 + 8192 + 4096 + 2048 + 1024 + 512 + 256 + 128 + 64 + 32 + 16 + 8 + 4 + 2 + 1 = **65535**

How Computers Store Data

Storing Characters

- Characters are stored in the computer's memory as binary number

- *ASCII (American Standard Code for Information Interchange)* is a coding scheme

Figure 1-14 The letter A is stored in memory as the number 65

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How Computers store Data

Storing Characters

- ASCII is a set of 128 numeric codes

- ASCII is limited

- ***Unicode*** is an extensive encoding scheme

  - It is compatible with ASCII

  - It represents characters for many languages in the world

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How Computers Store Data

Advanced Number Storage

- Binary numbering system can be used to represent only integer numbers

- Negative numbers are encoded using ***two's complement***

- Real numbers are encoded using ***floating-point notation***

How Computers Store Data

Other Types of Data

- ***Digital data*** is data that is stored in binary

- A ***digital device*** is any device that works with binary data

- Digital images are composed of tiny dots of color known as ***pixels (picture elements)***

- Digital sound is broken into small pieces known as ***samples***

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How Program Works

Concept:

A computer's CPU can only understand instructions that are written in machine language. Because people find it very difficult to write entire programs in machine language, other programming languages have been invented.

How Program Works

- CPU is the most important component in a computer
- CPU is not a brain
- CPU is not smart
- CPU is an electronic device that is designed to do specific things.

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How Program Works

CPU is designed to perform the following operations:

- Read a piece of data from main memory

- Adding two numbers

- Subtracting one number from another number

- Multiplying two numbers

- Dividing one number by another number

- Moving a piece of data from one memory location to another

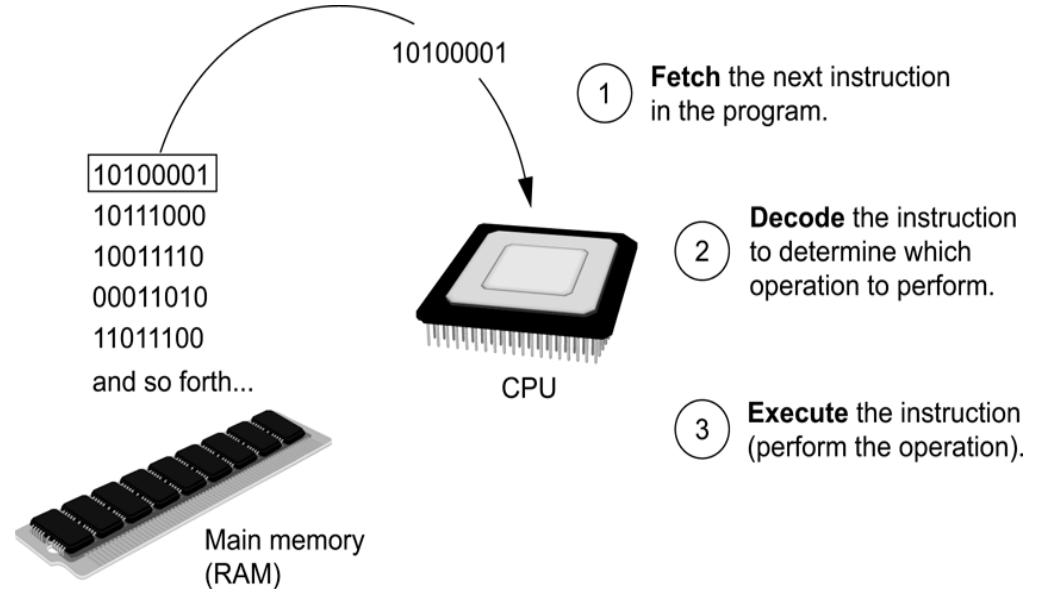- Determining whether one value is equal to another value

How Program Works

- CPU only understands instructions written in *machine language*

- Machine language instructions are written in 1s and 0s

- The entire set of instructions that a CPU can execute is known as the CPU's *instruction set*

- Each brand of microprocessors (Intel, AMD, and Motorola) has a unique instruction set

How Program Works

- ***Fetch-decode-execute cycle*** is the term used when the CPU executes the instructions in a program.

- The cycle consist of three steps:
    - Fetch
    - Decode
    - Execute

Figure 1-17 The fetch-decode-execute cycle

10100001

10100001
10111000
10011110
00011010
11011100
and so forth...

Main memory (RAM)

CPU

(1) **Fetch** the next instruction in the program.

(2) **Decode** the instruction to determine which operation to perform.

(3) **Execute** the instruction (perform the operation).
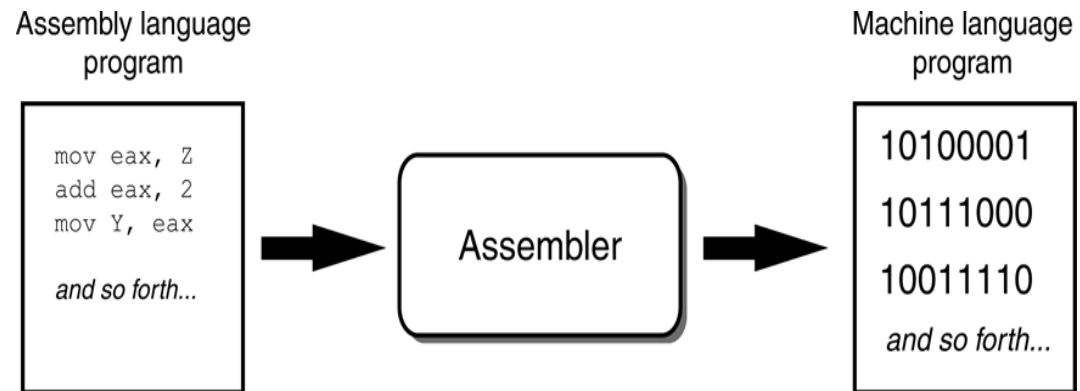
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How Program Works

From Machine Language to Assembly Language

•Computers only understand machine language

•Machine language is difficult to write

•*__Assembly language__* uses short words that are known as mnemonics

•*__Assembler__* is used to translate an assembly language program to machine language

Figure 1-18 An assembler translates an assembly language program to a machine language program

Assembly language program

```
mov eax, Z
add eax, 2
mov Y, eax

and so forth...
```

Assembler

Machine language program

```
10100001
10111000
10011110

and so forth...
```

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How Program Works

High-Level Languages

• Assembly language is referred to as a ***low-level language***

• ***High-level languages*** allow you to create powerful and complex programs without knowing how the CPU works, using words that are easy to understand.

For example:

Ada, BASIC, Python, C++, Ruby, Visual Basic

Do you know of any other high-level computer programming languages?

How Program Works

Key Words, Operators, and Syntax: an Overview

- ***Key words*** or ***reserved words*** have specific meaning and purpose in the programming language

- ***Operators*** perform various operations on data

- ***Syntax*** is a set of rules that must be strictly followed when writing a program

- ***Statements*** are individual instructions written in a programming language

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How Program Works

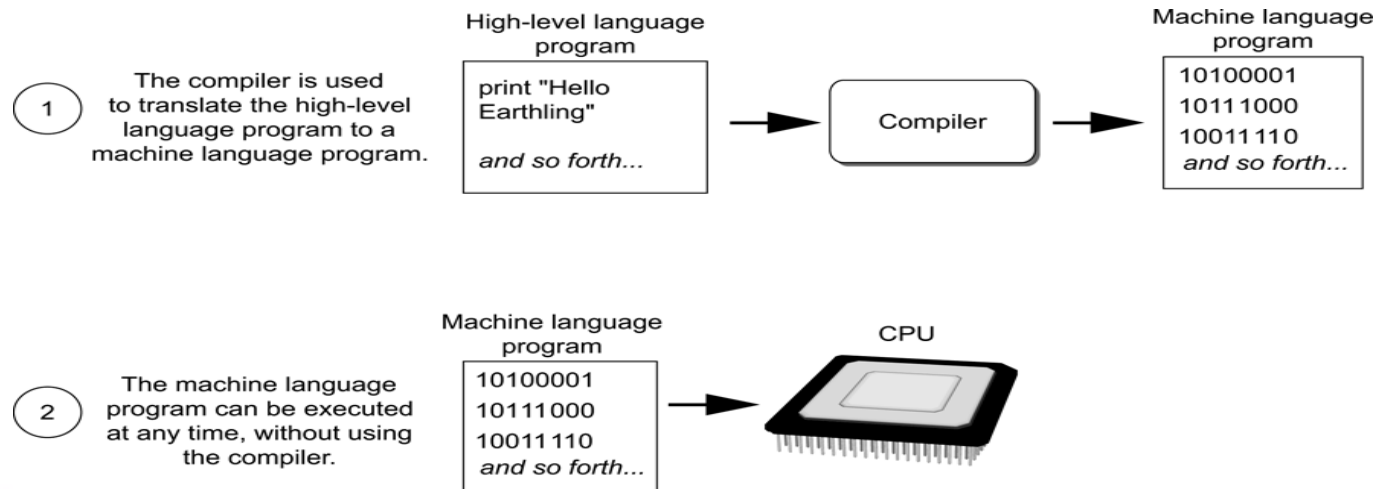## Compilers and Interpreters

• The statements written in a high-level language are called ***source code*** or simply ***code***

• Source code is translated to machine language using a compiler or an interpreter

• ***Syntax error*** is a mistake such as a:

  • Misspelled word

  • Missing punctuation character

  • Incorrect use of an operator

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How Program Works

Compilers and Interpreters

- *Compiler* is a program that translates a high-level language program into a separate machine language program

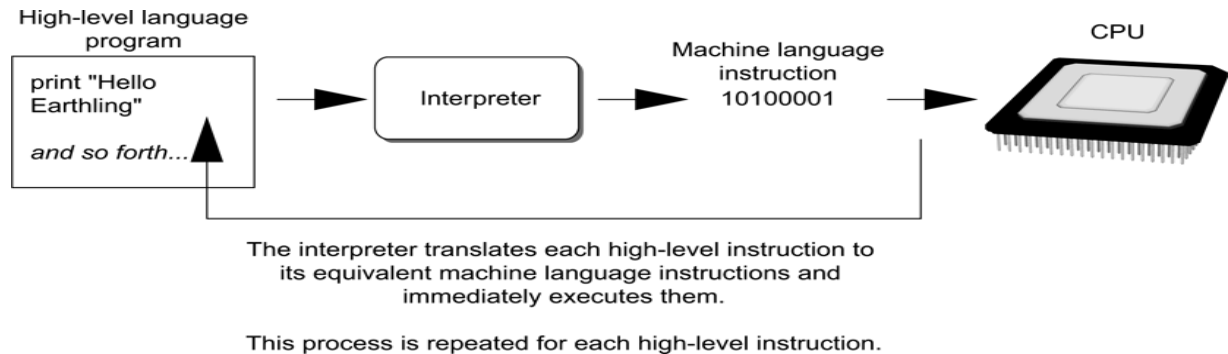**Figure 1-19** Compiling a high-level program and executing it

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How Program Works

Compilers and Interpreters

- An ***interpreter*** is a program that both translates and executes the instructions in a high-level language program

Figure 1-20 Executing a high-level program with an interpreter

- Python language uses an interpreter

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Using Python

Concept:

The Python interpreter can run Python programs that are saved in files, or can interactively execute Python statements that are typed at the keyboard. Python comes with a program named IDLE that simplifies the process of writing, executing, and testing programs.

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Using Python

The Python Interpreter

- A program that can read Python programming statements and execute them is the ***Python interpreter***

- Python interpreter has two modes:

  - ***Interactive*** mode waits for a statement from the keyboard and executes it

  - ***Script*** mode reads the contents of a file (***Python program*** or ***Python script***) and interprets each statement in the file

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Using Python

Interpreter Mode

- Invoke Python interpreter through Windows or command line
- **>>>** is the prompt that indicates the interpreter is waiting for a Python statement

```
>>> print 'Python programming is fun!'   [ENTER]
Python programming is fun!

>>>
```

- Statements typed in interactive mode are not saved as a program

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Using Python

Writing Python Programs and Running Them in Script Mode

- Use a text editor to create a file containing the Python statements

- Save the file with a *.py* extension
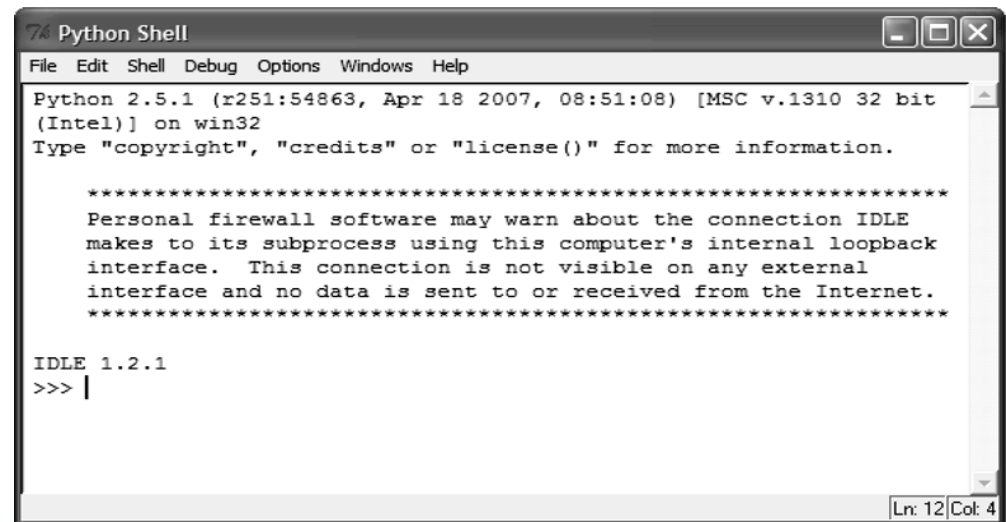
- To run the program:

```
>>> python test.py     [ENTER]
```

Using Python

The IDLE Programming Environment

- Integrated DeveLopment Environment (**IDLE**)
  - Automatically installed when Python language is installed
  - It has a built-in text editor
  - IDLE editor colorizes code

Figure 1-21 IDLE


```
7% Python Shell
File  Edit  Shell  Debug  Options  Windows  Help
Python 2.5.1 (r251:54863, Apr 18 2007, 08:51:08) [MSC v.1310 32 bit
(Intel)] on win32
Type "copyright", "credits" or "license()" for more information.

    ****************************************************************
    Personal firewall software may warn about the connection IDLE
    makes to its subprocess using this computer's internal loopback
    interface.  This connection is not visible on any external
    interface and no data is sent to or received from the Internet.
    ****************************************************************

IDLE 1.2.1
>>> |
                                                              Ln: 12 Col: 4
```

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