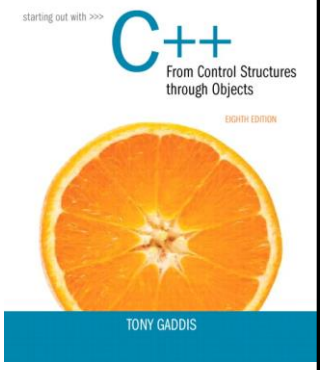
Chapter 1:

Introduction to Computers and Programming



1.1

Why Program?

Why Program?

Computer – programmable machine designed to follow instructions

Program – instructions in computer memory to make it do something

Programmer – person who writes instructions (programs) to make computer perform a task

SO, without programmers, no programs; without programs, a computer cannot do anything

1.2

Computer Systems: Hardware and Software

Main Hardware Component Categories:

1. Central Processing Unit (CPU)
2. Main Memory
3. Secondary Memory / Storage
4. Input Devices
5. Output Devices

Main Hardware Component Categories

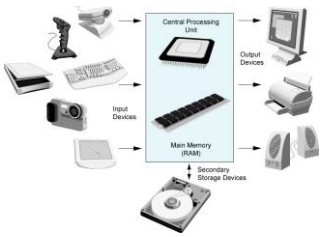


Figure 1-2

Central Processing Unit (CPU)

Comprised of:

- Control Unit
  - Retrieves and decodes program instructions
  - Coordinates activities of all other parts of computer
- Arithmetic & Logic Unit
  - Hardware optimized for high-speed numeric calculation
  - Hardware designed for true/false, yes/no decisions

CPU Organization

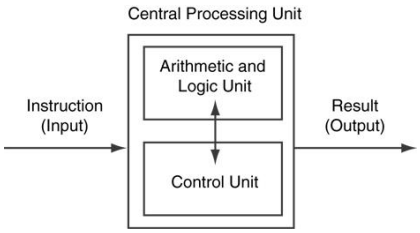


Figure 1-3

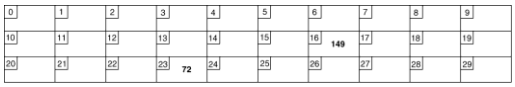
Main Memory

- It is volatile. Main memory is erased when program terminates or computer is turned off
- Also called Random Access Memory (RAM)
- Organized as follows:
  - bit: smallest piece of memory. Has values 0 (off, false) or 1 (on, true)
  - byte: 8 consecutive bits. Bytes have addresses.

Main Memory

- Addresses – Each byte in memory is identified by a unique number known as an *address*.

Main Memory



- In Figure 1-4, the number 149 is stored in the byte with the address 16, and the number 72 is stored at address 23.

Secondary Storage

- Non-volatile: data retained when program is not running or computer is turned off
- Comes in a variety of media:
  - magnetic: floppy disk, hard drive
  - optical: CD-ROM, DVD
  - Flash drives, connected to the USB port

Input Devices

- Devices that send information to the computer from outside
- Many devices can provide input:
  - Keyboard, mouse, scanner, digital camera, microphone
  - Disk drives, CD drives, and DVD drives

Software-Programs That Run on a Computer

- Categories of software:
  - System software: programs that manage the computer hardware and the programs that run on them. *Examples*: operating systems, utility programs, software development tools
  - Application software: programs that provide services to the user. *Examples* : word processing, games, programs to solve specific problems

1.3

Programs and Programming Languages

Programs and Programming Languages

- A program is a set of instructions that the computer follows to perform a task
- We start with an *algorithm*, which is a set of well-defined steps.

Example Algorithm for Calculating Gross Pay

1. Display a message on the screen asking "How many hours did you work?"
2. Wait for the user to enter the number of hours worked. Once the user enters a number, store it in memory.
3. Display a message on the screen asking "How much do you get paid per hour?"
4. Wait for the user to enter an hourly pay rate. Once the user enters a number, store it in memory.
5. Multiply the number of hours by the amount paid per hour, and store the result in memory.
6. Display a message on the screen that tells the amount of money earned. The message must include the result of the calculation performed in Step 5.

Machine Language

- Although the previous algorithm defines the steps for calculating the gross pay, it is not ready to be executed on the computer.
- The computer only executes *machine language* instructions

Machine Language

- Machine language instructions are binary numbers, such as

  1011010000000101

- Rather than writing programs in machine language, programmers use *programming languages*.

Programs and Programming Languages

- Types of languages:
  - Low-level: used for communication with computer hardware directly. Often written in binary machine code (0's/1's) directly.
  - High-level: closer to human language

Some Well-Known Programming Languages (Table 1-1 on Page 10)

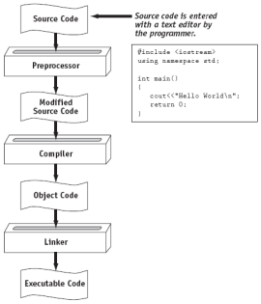
C++
BASIC
Ruby
Java
FORTRAN
Visual Basic
COBOL
C#
JavaScript
C
Python

From a High-Level Program to an Executable File

a) Create file containing the program with a text editor.
b) Run preprocessor to convert source file directives to source code program statements.
c) Run compiler to convert source program into machine instructions.
d) Run linker to connect hardware-specific code to machine instructions, producing an executable file.

- Steps b–d are often performed by a single command or button click.
- Errors detected at any step will prevent execution of following steps.

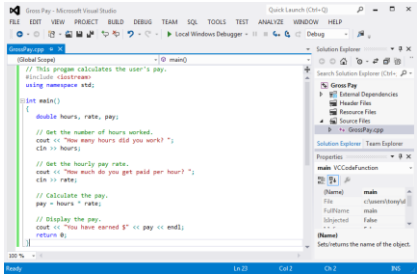
From a High-Level Program to an Executable File



Integrated Development Environments (IDEs)

- An integrated development environment, or IDE, combine all the tools needed to write, compile, and debug a program into a single software application.
- Examples are Microsoft Visual C++, Turbo C++ Explorer, CodeWarrior, etc.

Integrated Development Environments (IDEs)



1.4

What is a Program Made of?

What is a Program Made of?

- Common elements in programming languages:
  - Key Words
  - Programmer-Defined Identifiers
  - Operators
  - Punctuation
  - Syntax

Program 1-1

```
// This program calculates the user's pay.
#include <iostream>
using namespace std;

int main()
{
   double hours, rate, pay;

   // Get the number of hours worked.
   cout << "How many hours did you work? ";
   cin >> hours;

   // Get the hourly pay rate.
   cout << "How much do you get paid per hour? ";
   cin >> rate;

   // Calculate the pay.
   pay = hours * rate;

   // Display the pay.
   cout << "You have earned $" << pay << endl;
   return 0;
}
```


Key Words

- Also known as <u>reserved words</u>
- Have a special meaning in C++
- Can not be used for any other purpose
- Key words in the Program 1-1: `using`, `namespace`, `int`, `double`, and `return`

Key Words

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   double hours, rate, pay;

   // Get the number of hours worked.
   cout << "How many hours did you work? ";
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}
```

Programmer-Defined Identifiers

- Names made up by the programmer
- Not part of the C++ language
- Used to represent various things: variables (memory locations), functions, etc.
- In Program 1-1: `hours`, `rate`, and `pay`.

Operators

- Used to perform operations on data
- Many types of operators:
  - Arithmetic - ex: `+, -, *, /`
  - Assignment – ex: `=`
- Some operators in Program1-1:
  `<<  >>  =  *`

Operators

```
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}
```


Punctuation

- Characters that mark the end of a statement, or that separate items in a list
- In Program 1-1: `,` and `;`

Punctuation

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}
```


Syntax

- The rules of grammar that must be followed when writing a program
- Controls the use of key words, operators, programmer-defined symbols, and punctuation

Variables

- A variable is a named storage location in the computer's memory for holding a piece of data.
- In Program 1-1 we used three variables:
  - The `hours` variable was used to hold the hours worked
  - The `rate` variable was used to hold the pay rate
  - The `pay` variable was used to hold the gross pay

Variable Definitions

- To create a variable in a program you must write a variable definition (also called a variable declaration)
- Here is the statement from Program 1-1 that defines the variables:

```
double hours, rate, pay;
```


Variable Definitions

- There are many different types of data, which you will learn about in this course.
- A variable holds a specific type of data.
- The variable definition specifies the type of data a variable can hold, and the variable name.

Variable Definitions

- Once again, line 7 from Program 1-1:

```
double hours, rate, pay;
```

- The word **`double`** specifies that the variables can hold double-precision floating point numbers. (You will learn more about that in Chapter 2)

1.5

Input, Processing, and Output

Input, Processing, and Output

Three steps that a program typically performs:

1) **Gather input data:**
   - from keyboard
   - from files on disk drives
2) **Process the input data**
3) **Display the results as output:**
   - send it to the screen
   - write to a file

1.6

The Programming Process

The Programming Process

1. Clearly define what the program is to do.
2. Visualize the program running on the computer.
3. Use design tools such as a hierarchy chart, flowcharts, or pseudocode to create a model of the program.
4. Check the model for logical errors.
5. Type the code, save it, and compile it.
6. Correct any errors found during compilation. Repeat Steps 5 and 6 as many times as necessary.
7. Run the program with test data for input.
8. Correct any errors found while running the program. Repeat Steps 5 through 8 as many times as necessary.
9. Validate the results of the program.

1.7

Procedural and Object-Oriented Programming

Procedural and Object-Oriented Programming

- Procedural programming: focus is on the process. Procedures/functions are written to process data.
- Object-Oriented programming: focus is on objects, which contain data and the means to manipulate the data. Messages sent to objects to perform operations.