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Spring 2020

Chapter 1:

Introduction to Computers and Programming

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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

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1.2

Computer Systems: Hardware and Software

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Main Hardware Component Categories:

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

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Main Hardware Component Categories

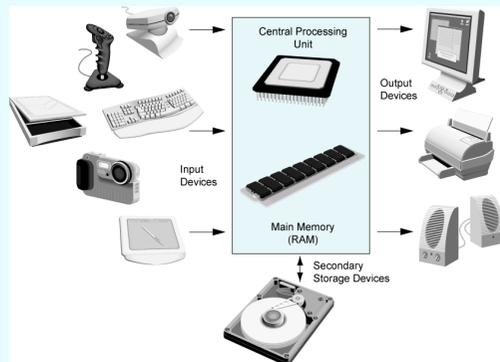


Figure 1-2

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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

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CPU Organization

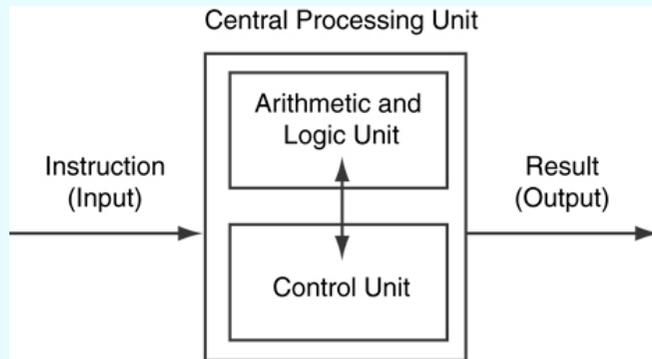


Figure 1-3

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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.

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Main Memory

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

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Main Memory

0	1	2	3	4	5	6	7	8	9	
10	11	12	13	14	15	16	149	17	18	19
20	21	22	23	72	24	25	26	27	28	29

- 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.

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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

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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

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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

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1.3

Programs and Programming Languages

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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.

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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.

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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

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Machine Language

- Machine language instructions are binary numbers, such as

1011010000000101

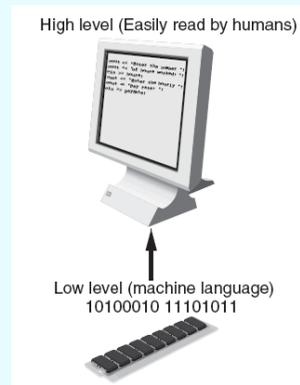
- Rather than writing programs in machine language, programmers use *programming languages*.

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Programs and Programming Languages

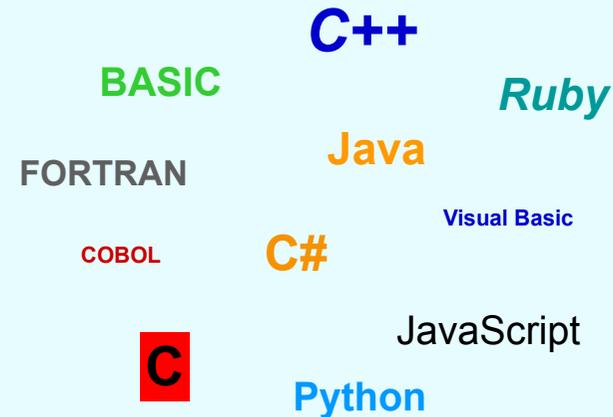
- Types of languages:

- 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



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



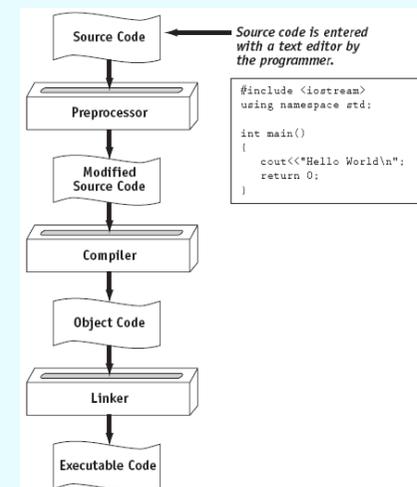
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From a High-Level Program to an Executable File

- Create file containing the program with a text editor.
 - Run preprocessor to convert source file directives to source code program statements.
 - Run compiler to convert source program into machine instructions.
 - 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.

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From a High-Level Program to an Executable File



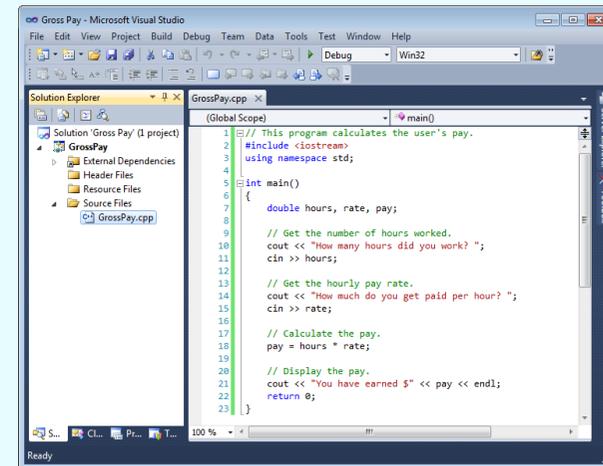
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Integrated Development Environments (IDEs)

- 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.

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Integrated Development Environments (IDEs)



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1.4

What is a Program Made of?

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What is a Program Made of?

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

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Program 1-1

```
1 // This program calculates the user's pay.
2 #include <iostream>
3 using namespace std;
4
5 int main()
6 {
7     double hours, rate, pay;
8
9     // Get the number of hours worked.
10    cout << "How many hours did you work? ";
11    cin >> hours;
12
13    // Get the hourly pay rate.
14    cout << "How much do you get paid per hour? ";
15    cin >> rate;
16
17    // Calculate the pay.
18    pay = hours * rate;
19
20    // Display the pay.
21    cout << "You have earned $" << pay << endl;
22    return 0;
23 }
```

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Key Words

- Also known as reserved words
- 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

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Key Words

```
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23 }
```

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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.

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Operators

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

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Operators

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23 }
```

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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 ;

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Punctuation

```
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```

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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

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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

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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;
```

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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.

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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)

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1.5

Input, Processing, and Output

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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

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1.6

The Programming Process

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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.

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1.7

Procedural and Object-Oriented Programming

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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.

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