Chapter 1 Introduction to Computers and Programs

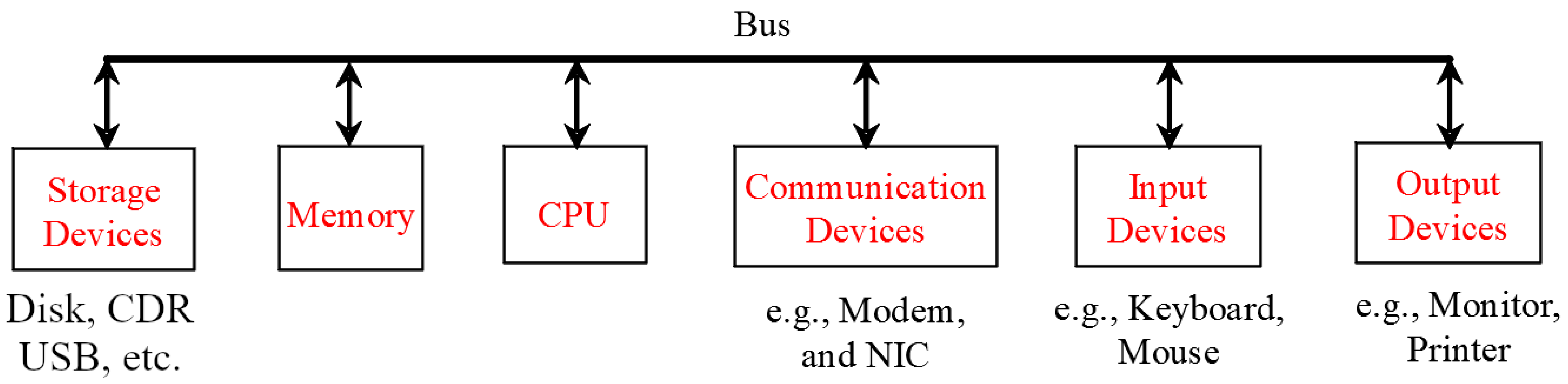
Topics Covered

- Computer Components
  - CPU
  - Memory
  - Storage Devices
  - Output Devices
  - Communication Devices
- Computer Programs

- Computer Languages
  - Machine Language
  - Assembly Language
  - High-level Languages
  - Communication Devices
  - Compilers and Interpreters
- Operating Systems

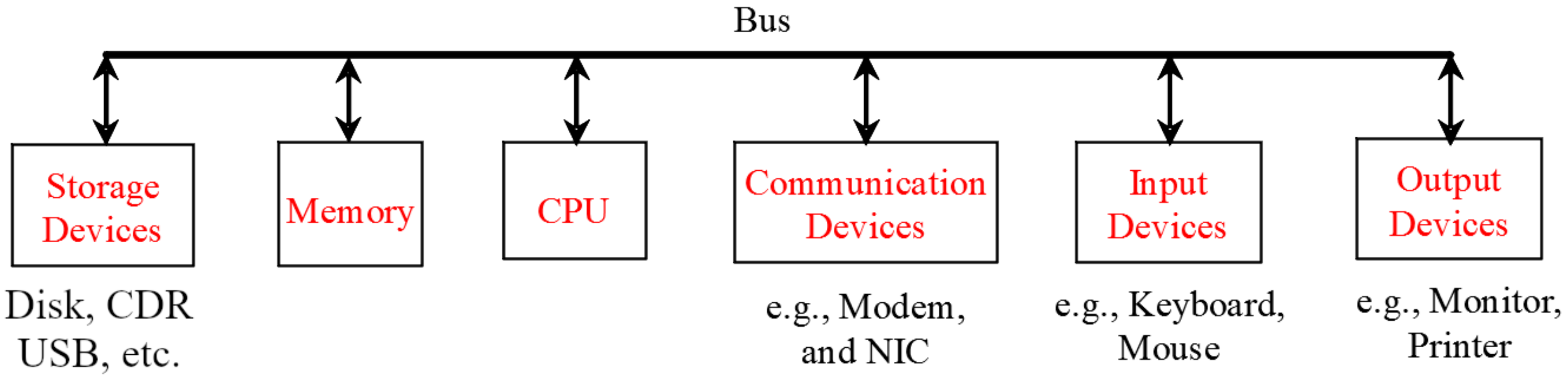
What is a Computer?

- ❑A computer consists of a CPU, memory, hard disk, monitor, communication devices, and optionally printers and/or external storage devices.



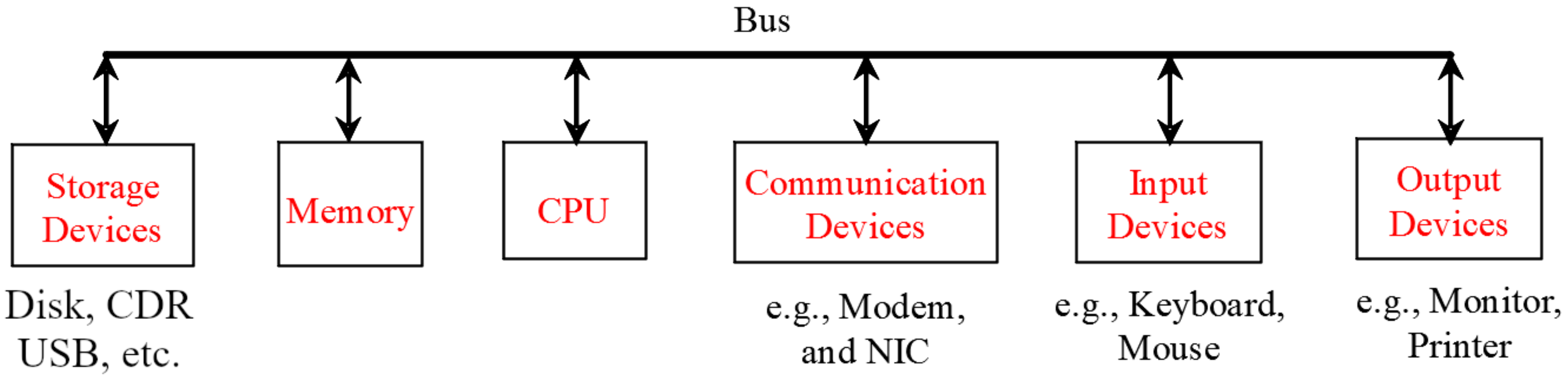
CPU

- The central processing unit (CPU) is the brain of a computer. It retrieves instructions from memory and executes them. The CPU speed is measured in megahertz (MHz), with 1 megahertz equaling 1 million pulses per second. The speed of the CPU has been improved continuously. PCs circa 2018 use an Intel i7 Processor running at ~3 GHz (1 gigahertz is 1000 MHz) and using up to 8 cores.



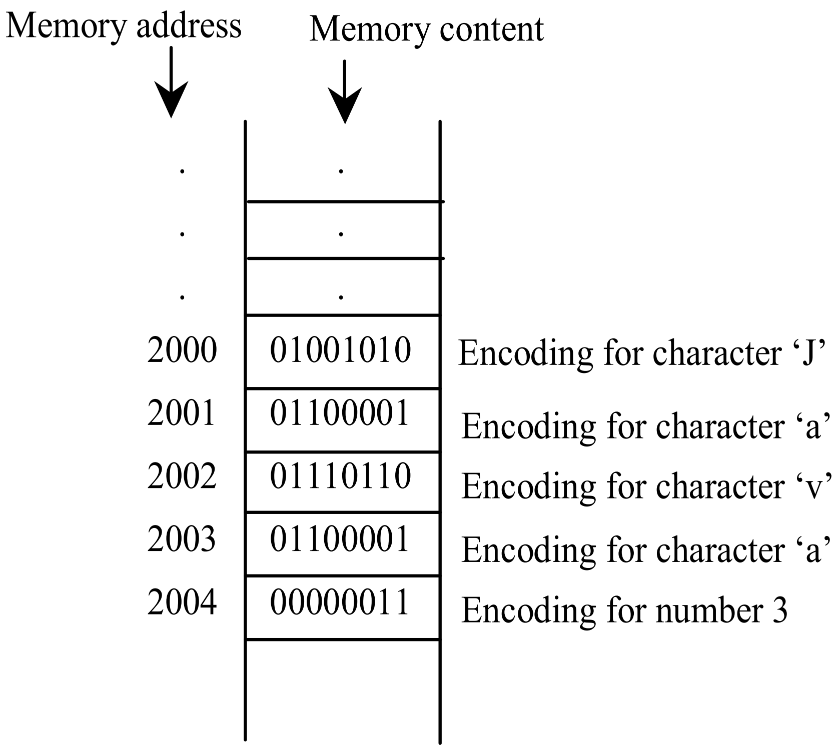
Memory

- *Memory* is used to store data and program instructions for a CPU to execute. A memory unit is an ordered sequence of bytes, each holds eight bits. A program and its data must be brought into memory before it can be executed. A memory byte is never empty, but its initial content may be meaningless to your program. The current content of a memory byte is lost whenever new information is placed in it.



How Data is stored?

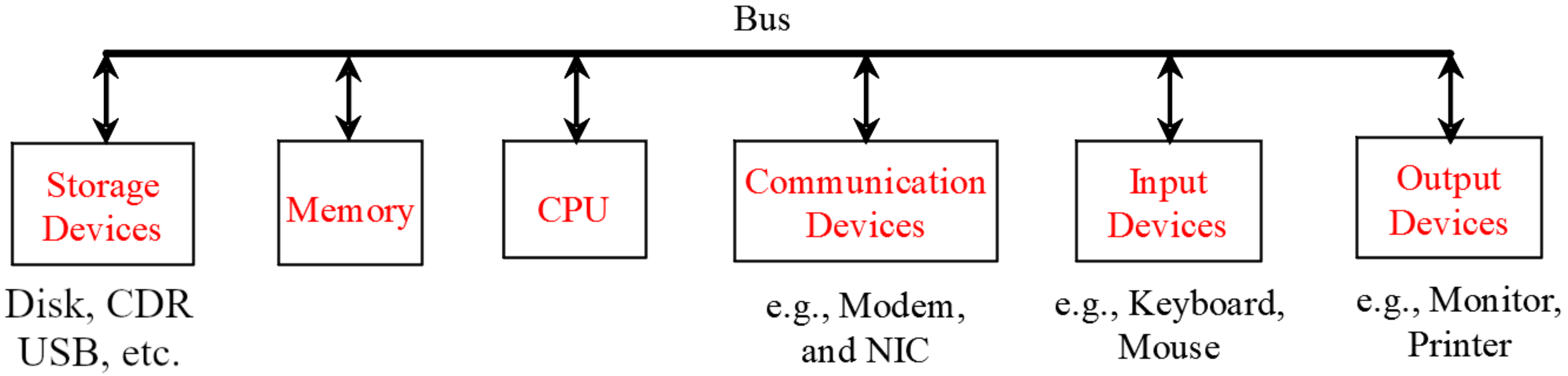
Data of various kinds, such as numbers, characters, and strings, are encoded as a series of bits (zeros and ones). Computers use zeros and ones because digital devices have two stable states, which are referred to as *zero* and *one* by convention. The programmers need not to be concerned about the encoding and decoding of data, which is performed automatically by the system based on the encoding scheme. The encoding scheme varies. For example, character ‘J’ is represented by 01001010 in one byte. A small number such as three can be stored in a single byte. If computer needs to store a large number that cannot fit into a single byte, it uses a number of adjacent bytes. No two data can share or split a same byte. A byte is the minimum storage unit.



Memory address	Memory content	
.	.	
.	.	
.	.	
2000	01001010	Encoding for character ‘J’
2001	01100001	Encoding for character ‘a’
2002	01110110	Encoding for character ‘v’
2003	01100001	Encoding for character ‘a’
2004	00000011	Encoding for number 3

Storage Devices

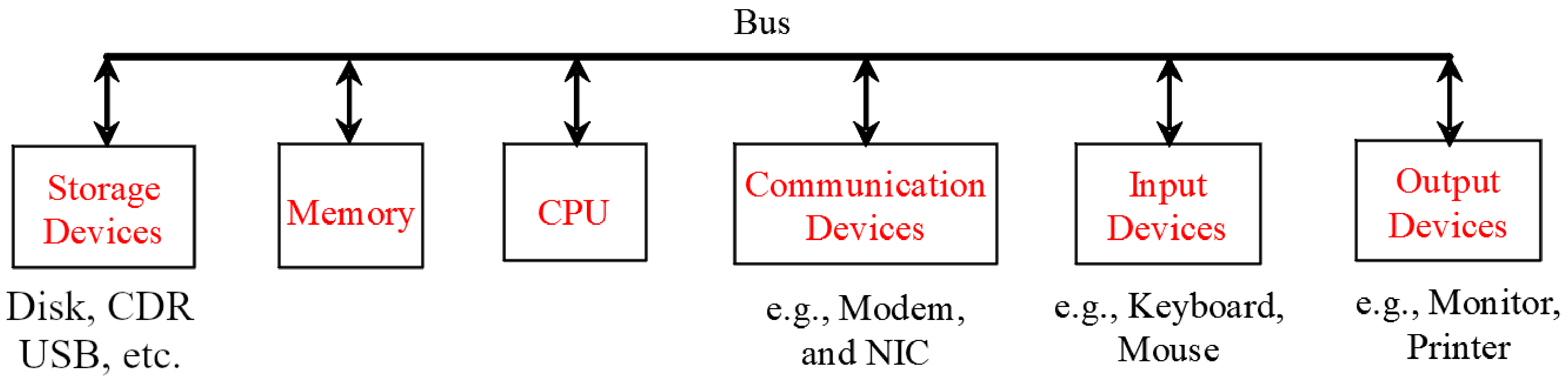
Memory is volatile, and information in memory is lost when the power is off. Programs and data are permanently stored on storage devices and are moved to memory when the computer actually uses them. There are three main types of storage devices:Disk drives (hard disks and floppy disks), CD drives (CD-R and CD-RW), and Tape drives.



platform By Per Scholas

Output Devices: Monitor

The monitor displays information (text and graphics). The resolution and dot pitch determine the quality of the display. Many modern monitors are touch screens and thus also serve as input devices.



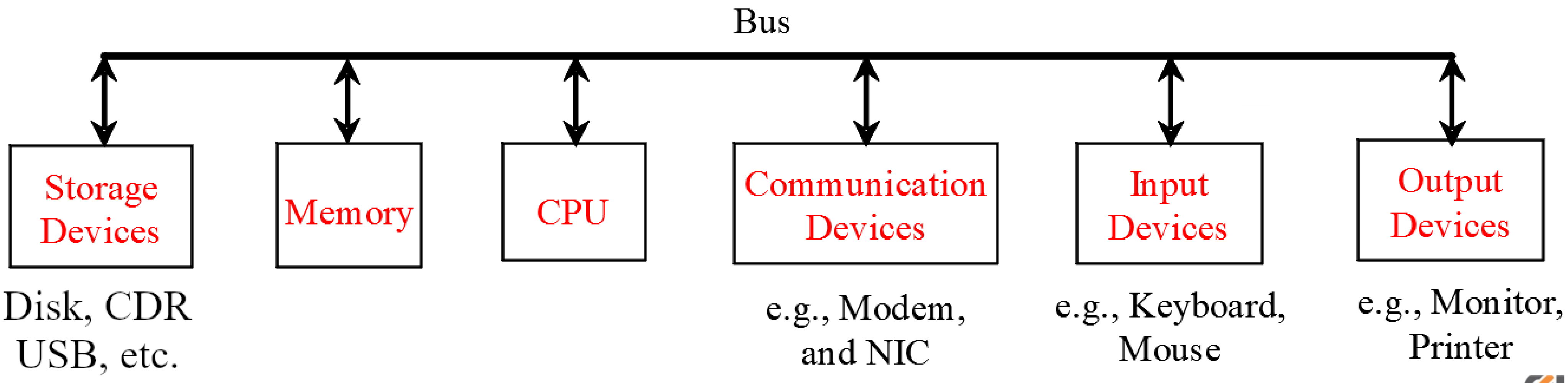
Monitor Resolution and Dot Pitch

- Resolution
  - The *screen resolution* specifies the number of pixels in horizontal and vertical dimensions of the display device. *Pixels* (short for “picture elements”) are tiny dots that form an image on the screen. A common resolution for a 17-inch screen, for example, is 1280 pixels wide and 1024 pixels high. The resolution can be set manually. The higher the resolution, the sharper and clearer the image is.

- Dot pitch
  - The *dot pitch* is the amount of space between pixels, measured in millimeters. The smaller the dot pitch, the sharper the display.

Communication Devices

- A *regular modem* uses a phone line and can transfer data in a speed up to 56,000 bps (bits per second). A *DSL* (digital subscriber line) also uses a phone line and can transfer data in a speed 20 times faster than a regular modem. A *cable modem* uses the TV cable line maintained by the cable company. A cable modem is as fast as a DSL. Network interface card (*NIC*) is a device to connect a computer to a local area network (LAN). The LAN is commonly used in business, universities, and government organizations. A typical type of NIC, called *10BaseT*, can transfer data at 10 mbps (million bits per second).



Programs

- Computer *programs*, known as *software*, are instructions to the computer.

- You tell a computer what to do through programs. Without programs, a computer is an empty machine. Computers do not understand human languages, so you need to use computer languages to communicate with them.

- Programs are written using programming languages.

Programming Languages

Machine Language   Assembly Language   High-Level Language

- Machine language is a set of primitive instructions built into every computer. The instructions are in the form of binary code, so you have to enter binary codes for various instructions. Program with native machine language is a tedious process. Moreover the programs are highly difficult to read and modify. For example, to add two numbers, you might write an instruction in binary like this:

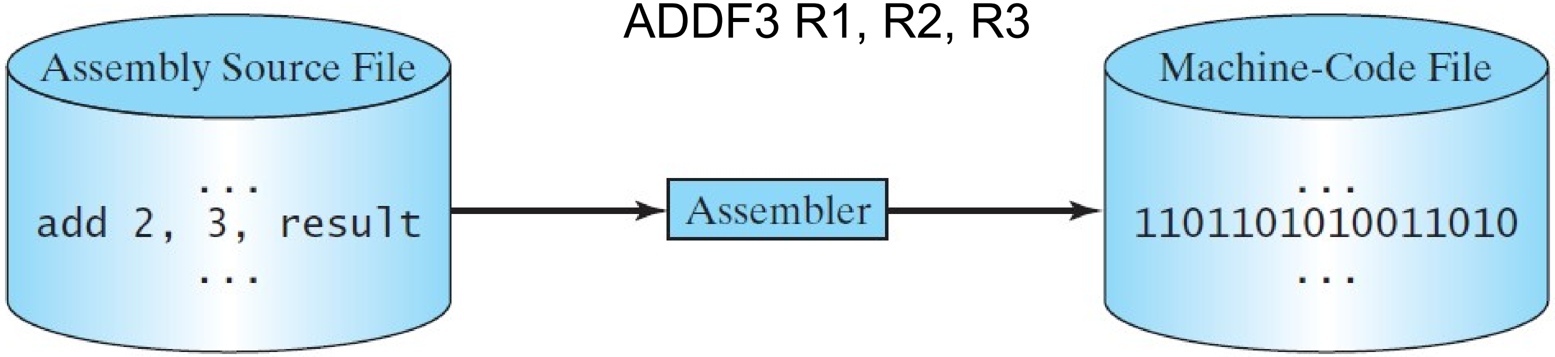
  - 1101101010011010

Programming Languages

Machine Language Assembly Language High-Level Language

- Assembly languages were developed to make programming easy. Since the computer cannot understand assembly language, however, a program called an *assembler* is used to convert assembly language programs into machine code. For example, to add two numbers, you might write an instruction in assembly code like this:

ADDF3 R1, R2, R3



Programming Languages

Machine Language Assembly Language High-Level Language

- The high-level languages are English-like and easy to learn and program. For example, the following is a high-level language statement that computes the area of a circle with radius 5:

```
area = 5 * 5 * 3.1415;
```

Popular High-Level Languages

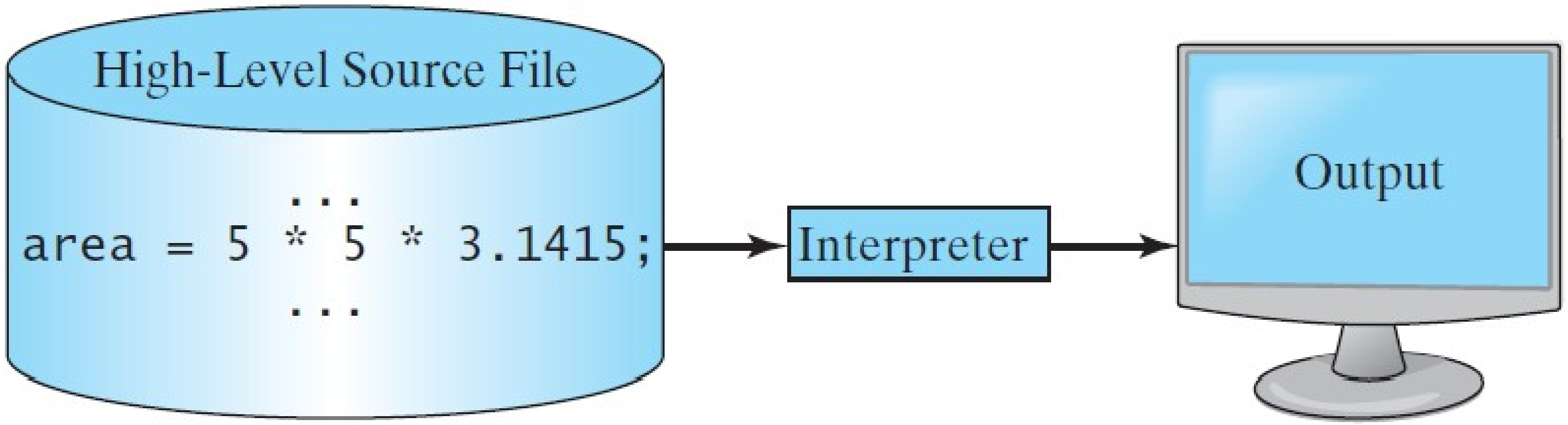
Language	Description
Ada	Named for Ada Lovelace, who worked on mechanical general-purpose computers. The Ada language was developed for the Department of Defense and is used mainly in defense projects.
BASIC	Beginner's All-purpose Symbolic Instruction Code. It was designed to be learned and used easily by beginners.
C	Developed at Bell Laboratories. C combines the power of an assembly language with the ease of use and portability of a high-level language.
C++	C++ is an object-oriented language, based on C.
C#	Pronounced "C Sharp." It is a hybrid of Java and C++ and was developed by Microsoft.
COBOL	COmmon Business Oriented Language. Used for business applications.
FORTRAN	FORmula TRANslation. Popular for scientific and mathematical applications.
Java	Developed by Sun Microsystems, now part of Oracle. It is widely used for developing platform-independent Internet applications.
Pascal	Named for Blaise Pascal, who pioneered calculating machines in the seventeenth century. It is a simple, structured, general-purpose language primarily for teaching programming.
Python	A simple general-purpose scripting language good for writing short programs.
Visual Basic	Visual Basic was developed by Microsoft and it enables the programmers to rapidly develop graphical user interfaces.

Interpreting/Compiling Source Code

❑A program written in a high-level language is called a *source program* or *source code*. Because a computer cannot understand a source program, a source program must be translated into machine code for execution. The translation can be done using another programming tool called either an *interpreter* or a *compiler*.

Interpreting Source Code

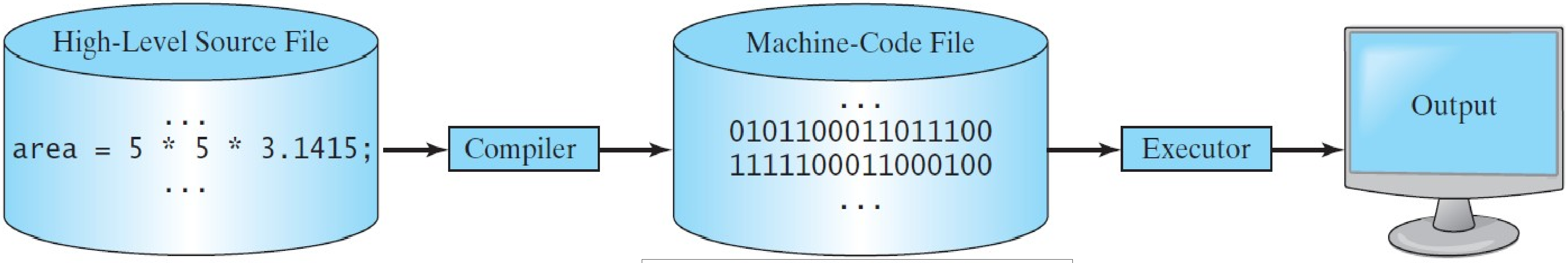
- An *interpreter* reads one statement from the source code, translates it to the machine code or virtual machine code, and then executes it right away, as shown in the following figure. Note that a statement from the source code may be translated into several machine instructions.



```
...
area = 5 * 5 * 3.1415;
...
```

Compiling Source Code

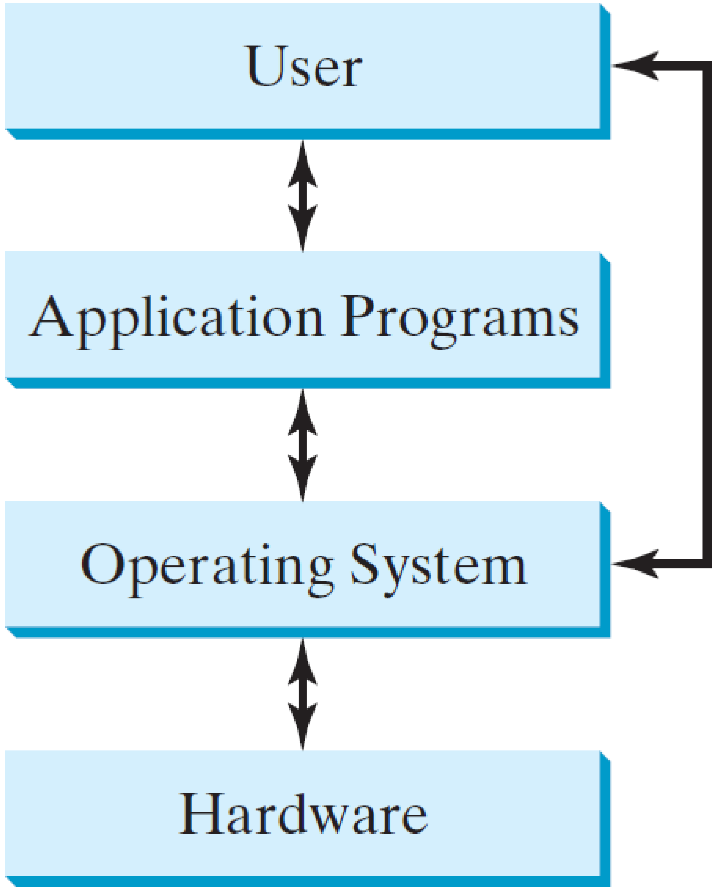
- A *compiler* translates the entire source code into a machine-code file, and the machine-code file is then executed, as shown in the following figure.



Stored on disk as an executable (.exe) file.

Operating Systems

- The *operating system* (OS) is a program that manages and controls a computer’s activities. The popular operating systems for general-purpose computers are Microsoft Windows, Mac OS, and Linux. Application programs, such as a Web browser or a word processor, cannot run unless an operating system is installed and running on the computer.



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Questions?