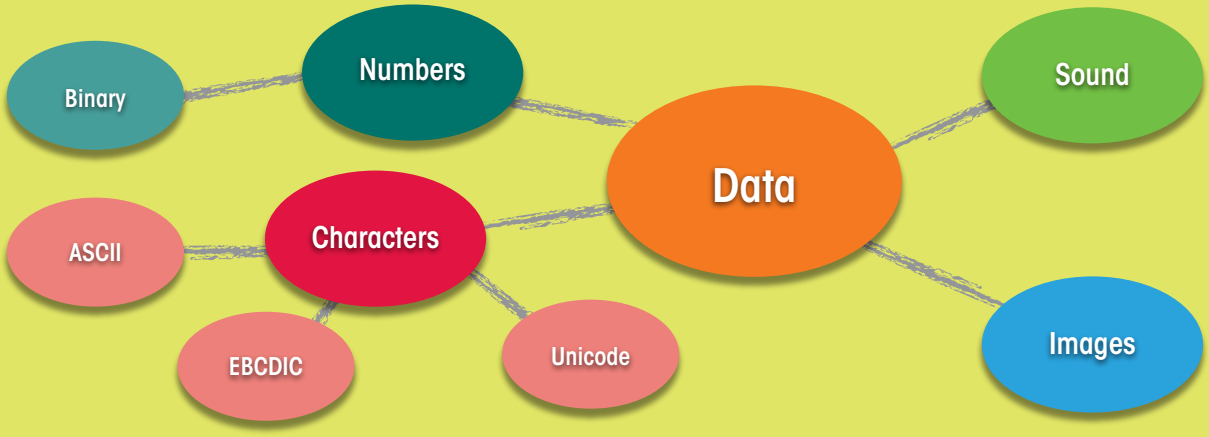

Digital Data Representation

SECTION C

COMPUTERS AND OTHER DIGITAL DEVICES work with all sorts of "stuff," including text, numbers, music, images, speech, and video. The amazing aspect of digital technology is that it distills all these different elements down to simple pulses of electricity and stores them as 0s and 1s. Understanding the data representation concepts presented in Section C will help you grasp the essence of the digital world and get a handle on all the jargon pertaining to bits, bytes, megahertz, and gigabytes.

DATA REPRESENTATION BASICS

What is data? As you learned earlier in the chapter, *data* refers to the symbols that represent people, events, things, and ideas. Data can be a name, a number, the colors in a photograph, or the notes in a musical composition.

Is there a difference between data and information? In everyday conversation, people use the terms *data* and *information* interchangeably. Nevertheless, some technology professionals make a distinction between the two terms. They define data as the symbols that represent people, events, things, and ideas. Data becomes information when it is presented in a format that people can understand and use. As a general rule, remember that (technically speaking) data is used by machines, such as computers; information is used by humans.

What is data representation? **Data representation** refers to the form in which data is stored, processed, and transmitted. For example, devices such as smartphones, iPods, and computers store numbers, text, music, photos, and videos in formats that can be handled by electronic circuitry. Those formats are data representations. Data can be represented using digital or analog methods.

What's the difference between analog and digital? For a simple illustration of the difference between analog and digital, consider the way you can control the lights in a room using a traditional light switch or a dimmer switch (Figure 1-24).

A traditional light switch has two discrete states: on and off. There are no in-between states, so this type of light switch is digital. A dimmer switch, on the other hand, has a rotating dial that controls a continuous range of brightness. It is, therefore, analog.

Digital data is text, numbers, graphics, sound, and video that have been converted into discrete digits such as 0s and 1s. In contrast, **analog data** is represented using an infinite scale of values.

TERMINOLOGY NOTE

The word *data* can be correctly treated either as a plural noun or as an abstract mass noun, so phrases such as "The data are being processed" and "The data is being processed" are both correct usage. In this textbook, the word *data* is paired with singular verbs and modifiers.

FIGURE 1-24

A computer is a digital device, more like a standard light switch than a dimmer switch.

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How does digital data work? Imagine that you want to send a message by flashing a light. Your light switch offers two states: on and off. You can use sequences of ons and offs to represent various letters of the alphabet. To write down the representation for each letter, you can use 0s and 1s. The 0s represent the off state of your light switch; the 1s indicate the on state. For example, the sequence *on on off off* would be written as 1100, and you might decide that sequence represents the letter *A*.

Digital devices are electronic and so you can envision data flowing within these devices as pulses of light. In reality, digital signals are represented by two different voltages, such as +5 volts and +.2 volts. They can also be represented by two different tones as they flow over a phone line. Digital data can also take the form of light and dark spots etched onto the surface of a CD or the positive and negative orientation of magnetic particles on the surface of a hard disk.

The 0s and 1s used to represent digital data are referred to as binary digits. It is from this term that we get the word *bit*—*bi*nary digi*t*. A **bit** is a 0 or 1 used in the digital representation of data.

REPRESENTING NUMBERS, TEXT, IMAGES, AND SOUND

How do digital devices represent numbers? **Numeric data** consists of numbers that can be used in arithmetic operations. For example, your annual income is numeric data, as is your age. Digital devices represent numeric data using the binary number system, also called base 2.

The **binary number system** has only two digits: 0 and 1. No numeral like 2 exists in this system, so the number two is represented in binary as 10 (pronounced "one zero"). You'll understand why if you think about what happens when you're counting from 1 to 10 in the familiar decimal system. After you reach 9, you run out of digits. For ten, you have to use the digits 10—zero is a placeholder and the 1 indicates one group of tens.

In binary, you just run out of digits sooner—right after you count to 1. To get to the next number, you have to use the 0 as a placeholder and the 1 indicates one group of twos. In binary, then, you count 0 (zero), 1 (one), 10 (one zero), instead of counting 0, 1, 2 in decimal. If you need to brush up on binary numbers, refer to Figure 1-25 and to the lab at the end of the chapter.

Decimal (Base 10)	Binary (Base 2)
0	0
1	1
2	10
3	11
4	100
5	101
6	110
7	111
8	1000
9	1001
10	1010
11	1011
1000	1111101000

FIGURE 1-25

The decimal system uses ten symbols to represent numbers: 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9. The binary number system uses only two symbols: 0 and 1.

TRY IT!

The table shows the binary equivalent of numbers 1 through 11. What is the binary for the number 12?

- ❍ 10111
- ❍ 1100
- ❍ 10000
- ❍ 1111