

4. In Data Analysis, select Histogram and click the [OK] button.
5. In the Histogram dialog box, type **A1:A50** as the Input Range.
6. Select New Worksheet Ply, and check the Cumulative Percentage option. Click [OK].

By leaving the Chart output unchecked, the new worksheet will display the table only. It decides “bins” for the histogram itself (here it picked a bin size of 7 units), but you can also define your own bin range on the data worksheet.

## 2–3

### Objective 2

Represent data in frequency distributions graphically using histograms, frequency polygons, and ogives.

## Histograms, Frequency Polygons, and Ogives

After the data have been organized into a frequency distribution, they can be presented in graphical form. The purpose of graphs in statistics is to convey the data to the viewers in pictorial form. It is easier for most people to comprehend the meaning of data presented graphically than data presented numerically in tables or frequency distributions. This is especially true if the users have little or no statistical knowledge.

Statistical graphs can be used to describe the data set or to analyze it. Graphs are also useful in getting the audience’s attention in a publication or a speaking presentation. They can be used to discuss an issue, reinforce a critical point, or summarize a data set. They can also be used to discover a trend or pattern in a situation over a period of time.

The three most commonly used graphs in research are as follows:

1. The histogram.
2. The frequency polygon.
3. The cumulative frequency graph, or ogive (pronounced o-jive).

An example of each type of graph is shown in Figure 2–1. The data for each graph are the distribution of the miles that 20 randomly selected runners ran during a given week.

### The Histogram

The **histogram** is a graph that displays the data by using contiguous vertical bars (unless the frequency of a class is 0) of various heights to represent the frequencies of the classes.

### Example 2–4

Construct a histogram to represent the data shown for the record high temperatures for each of the 50 states (see Example 2–2).

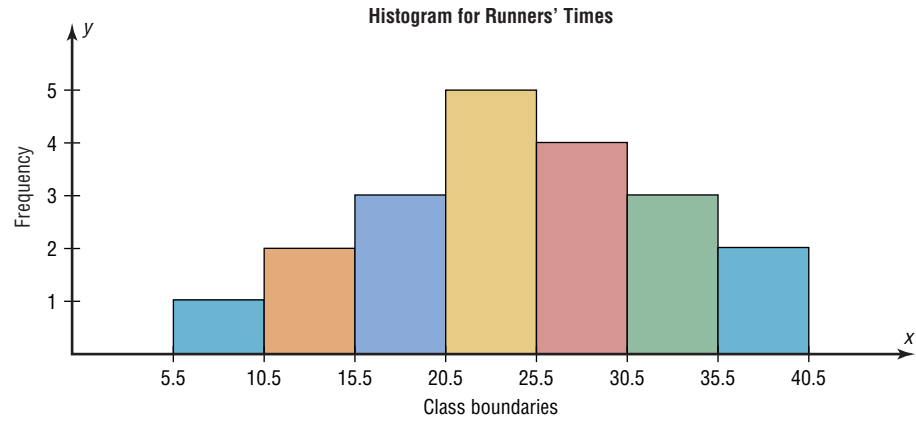
Class boundaries	Frequency
99.5–104.5	2
104.5–109.5	8
109.5–114.5	18
114.5–119.5	13
119.5–124.5	7
124.5–129.5	1
129.5–134.5	1

### Solution

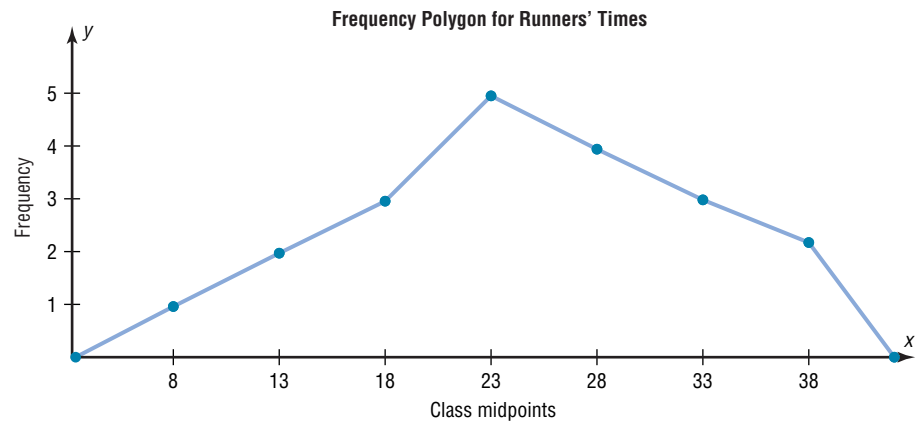
**Step 1** Draw and label the  $x$  and  $y$  axes. The  $x$  axis is always the horizontal axis, and the  $y$  axis is always the vertical axis.

**Figure 2-1**

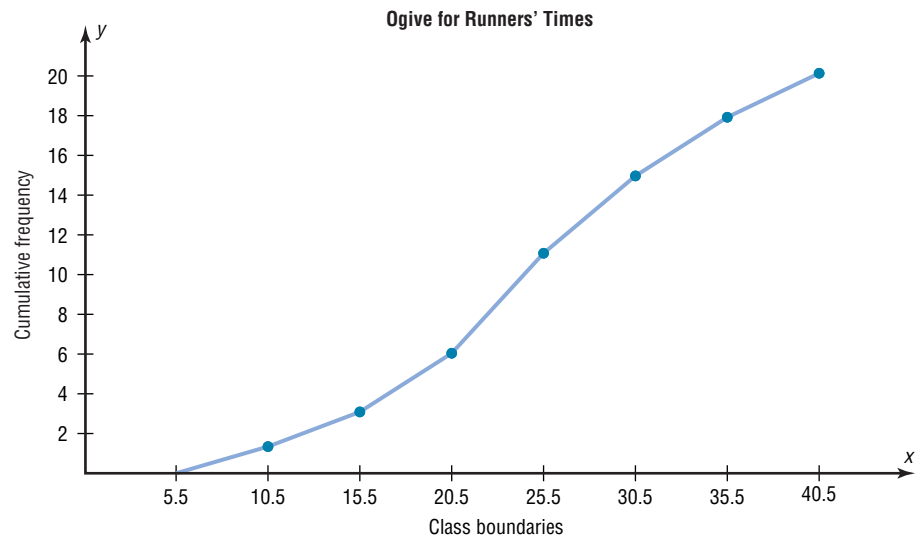
Examples of  
Commonly Used  
Graphs



(a) Histogram



(b) Frequency polygon



(c) Cumulative frequency graph

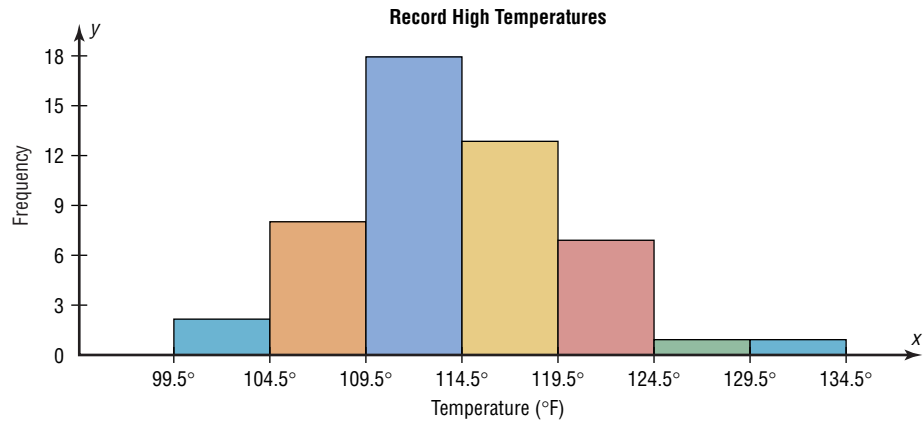
**Figure 2-2**

Histogram for Example 2-4

*Historical Note*

Graphs originated when ancient astronomers drew the position of the stars in the heavens. Roman surveyors also used coordinates to locate landmarks on their maps.

The development of statistical graphs can be traced to William Playfair (1748–1819), an engineer and drafter who used graphs to present economic data pictorially.



**Step 2** Represent the frequency on the y axis and the class boundaries on the x axis.

**Step 3** Using the frequencies as the heights, draw vertical bars for each class. See Figure 2-2.

As the histogram shows, the class with the greatest number of data values (18) is 109.5–114.5, followed by 13 for 114.5–119.5. The graph also has one peak with the data clustering around it.

**The Frequency Polygon**

Another way to represent the same data set is by using a frequency polygon.

The **frequency polygon** is a graph that displays the data by using lines that connect points plotted for the frequencies at the midpoints of the classes. The frequencies are represented by the heights of the points.

Example 2-5 shows the procedure for constructing a frequency polygon.

**Example 2-5**

Using the frequency distribution given in Example 2-4, construct a frequency polygon.

**Solution**

**Step 1** Find the midpoints of each class. Recall that midpoints are found by adding the upper and lower boundaries and dividing by 2:

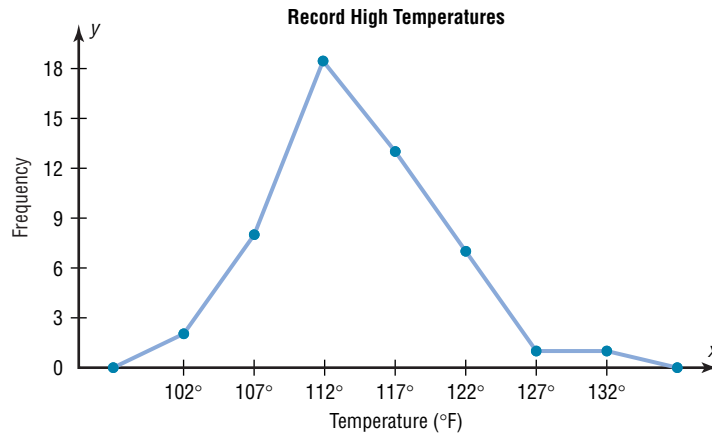
$$\frac{99.5 + 104.5}{2} = 102 \quad \frac{104.5 + 109.5}{2} = 107$$

and so on. The midpoints are

Class boundaries	Midpoints	Frequency
99.5–104.5	102	2
104.5–109.5	107	8
109.5–114.5	112	18
114.5–119.5	117	13
119.5–124.5	122	7
124.5–129.5	127	1
129.5–134.5	132	1

**Figure 2-3**

Frequency Polygon for Example 2-5



- Step 2** Draw the  $x$  and  $y$  axes. Label the  $x$  axis with the midpoint of each class, and then use a suitable scale on the  $y$  axis for the frequencies.
- Step 3** Using the midpoints for the  $x$  values and the frequencies as the  $y$  values, plot the points.
- Step 4** Connect adjacent points with line segments. Draw a line back to the  $x$  axis at the beginning and end of the graph, at the same distance that the previous and next midpoints would be located, as shown in Figure 2-3.

The frequency polygon and the histogram are two different ways to represent the same data set. The choice of which one to use is left to the discretion of the researcher.

### The Ogive

The third type of graph that can be used represents the cumulative frequencies for the classes. This type of graph is called the *cumulative frequency graph* or *ogive*. The **cumulative frequency** is the sum of the frequencies accumulated up to the upper boundary of a class in the distribution.

The **ogive** is a graph that represents the cumulative frequencies for the classes in a frequency distribution.

Example 2-6 shows the procedure for constructing an ogive.

### Example 2-6

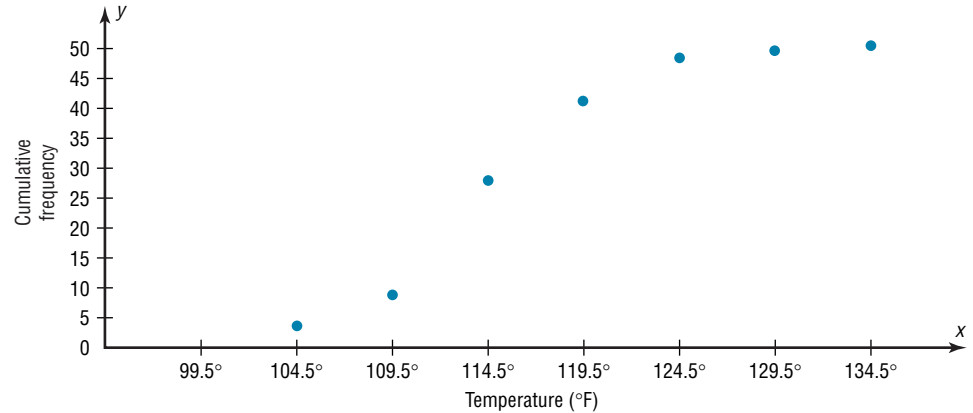
Construct an ogive for the frequency distribution described in Example 2-4.

#### Solution

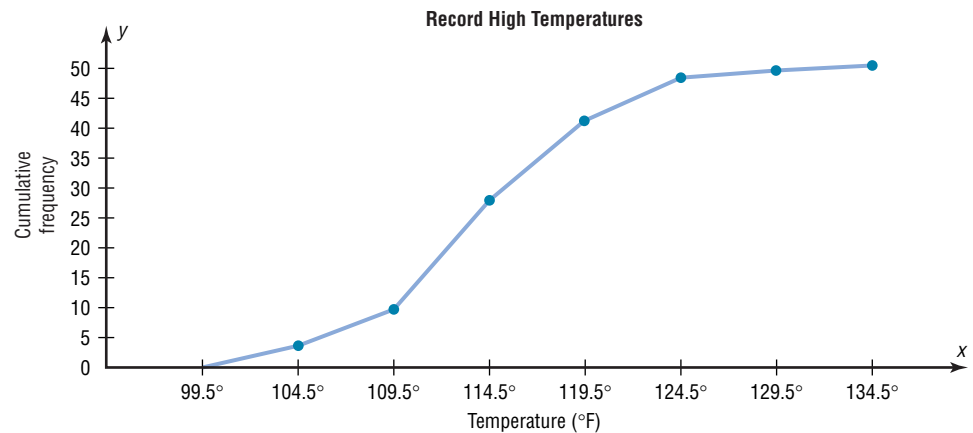
**Step 1** Find the cumulative frequency for each class.

Class boundaries	Cumulative frequency
99.5–104.5	2
104.5–109.5	10
109.5–114.5	28
114.5–119.5	41
119.5–124.5	48
124.5–129.5	49
129.5–134.5	50

**Figure 2-4**  
Plotting the Cumulative  
Frequency for  
Example 2-6



**Figure 2-5**  
Ogive for Example 2-6

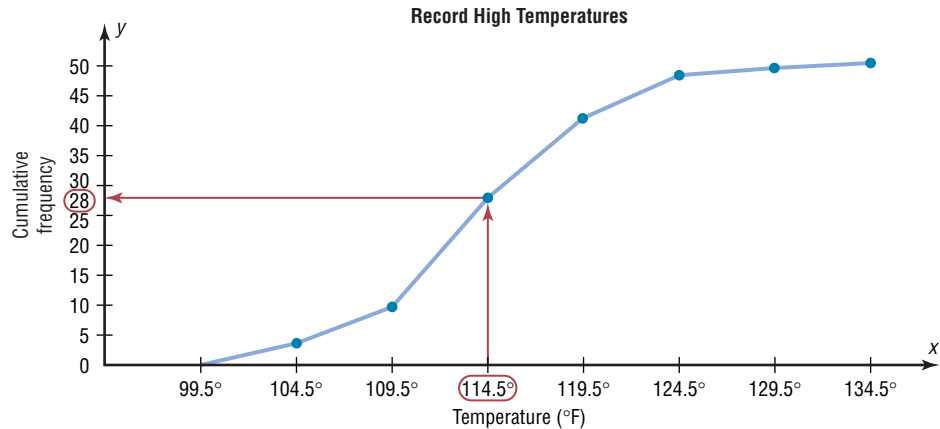


- Step 2** Draw the  $x$  and  $y$  axes. Label the  $x$  axis with the class boundaries. Use an appropriate scale for the  $y$  axis to represent the cumulative frequencies. (Depending on the numbers in the cumulative frequency columns, scales such as 0, 1, 2, 3, . . . , or 5, 10, 15, 20, . . . , or 1000, 2000, 3000, . . . can be used. Do *not* label the  $y$  axis with the numbers in the cumulative frequency column.) In this example, a scale of 0, 5, 10, 15, . . . will be used.
- Step 3** Plot the cumulative frequency at each upper class boundary, as shown in Figure 2-4. Upper boundaries are used since the cumulative frequencies represent the number of data values accumulated up to the upper boundary of each class.
- Step 4** Starting with the first upper class boundary, 104.5, connect adjacent points with line segments, as shown in Figure 2-5. Then extend the graph to the first lower class boundary, 99.5, on the  $x$  axis.

Cumulative frequency graphs are used to visually represent how many values are below a certain upper class boundary. For example, to find out how many record high temperatures are less than 114.5°F, locate 114.5°F on the  $x$  axis, draw a vertical line up until it intersects the graph, and then draw a horizontal line at that point to the  $y$  axis. The  $y$  axis value is 28, as shown in Figure 2-6.

**Figure 2-6**

Finding a Specific  
Cumulative Frequency



The steps for drawing these three types of graphs are shown in the following Procedure Table.

### *Unusual Stat*

Twenty-two percent of Americans sleep 6 hours a day or fewer.

## Procedure Table

### Constructing Statistical Graphs

- Step 1** Draw and label the  $x$  and  $y$  axes.
- Step 2** Choose a suitable scale for the frequencies or cumulative frequencies, and label it on the  $y$  axis.
- Step 3** Represent the class boundaries for the histogram or ogive, or the midpoint for the frequency polygon, on the  $x$  axis.
- Step 4** Plot the points and then draw the bars or lines.

## Relative Frequency Graphs

The histogram, the frequency polygon, and the ogive shown previously were constructed by using frequencies in terms of the raw data. These distributions can be converted to distributions using *proportions* instead of raw data as frequencies. These types of graphs are called **relative frequency graphs**.

Graphs of relative frequencies instead of frequencies are used when the proportion of data values that fall into a given class is more important than the actual number of data values that fall into that class. For example, if one wanted to compare the age distribution of adults in Philadelphia, Pennsylvania, with the age distribution of adults of Erie, Pennsylvania, one would use relative frequency distributions. The reason is that since the population of Philadelphia is 1,478,002 and the population of Erie is 105,270, the bars using the actual data values for Philadelphia would be much taller than those for the same classes for Erie.

To convert a frequency into a proportion or relative frequency, divide the frequency for each class by the total of the frequencies. The sum of the relative frequencies will always be 1. These graphs are similar to the ones that use raw data as frequencies, but the values on the  $y$  axis are in terms of proportions. Example 2-7 shows the three types of relative frequency graphs.

**Example 2-7**

Construct a histogram, frequency polygon, and ogive using relative frequencies for the distribution (shown here) of the miles that 20 randomly selected runners ran during a given week.

Class boundaries	Frequency	Cumulative frequency
5.5–10.5	1	1
10.5–15.5	2	3
15.5–20.5	3	6
20.5–25.5	5	11
25.5–30.5	4	15
30.5–35.5	3	18
35.5–40.5	2	20
	20	

**Solution**

**Step 1** Convert each frequency to a proportion or relative frequency by dividing the frequency for each class by the total number of observations.

For class 5.5–10.5, the relative frequency is  $\frac{1}{20} = 0.05$ ; for class 10.5–15.5, the relative frequency is  $\frac{2}{20} = 0.10$ ; for class 15.5–20.5, the relative frequency is  $\frac{3}{20} = 0.15$ ; and so on.

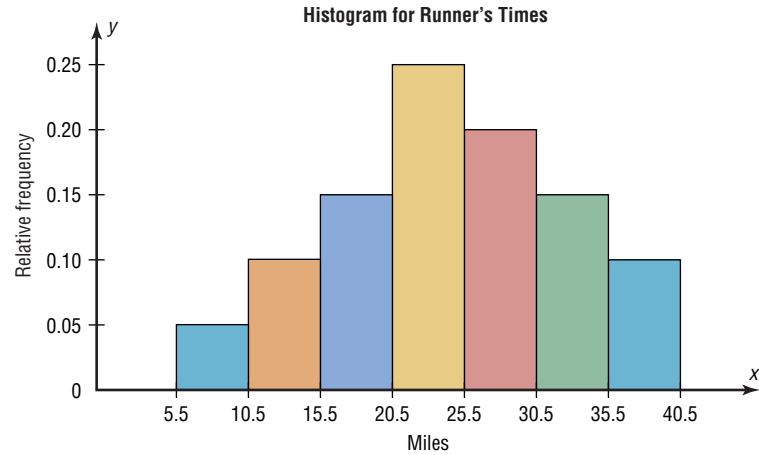
Place these values in the column labeled Relative frequency.

**Step 2** Find the cumulative relative frequencies. To do this, add the frequency in each class to the total frequency of the preceding class. In this case,  $0 + 0.05 = 0.05$ ,  $0.05 + 0.10 = 0.15$ ,  $0.15 + 0.15 = 0.30$ ,  $0.30 + 0.25 = 0.55$ , etc. Place these values in the column labeled Cumulative relative frequency.

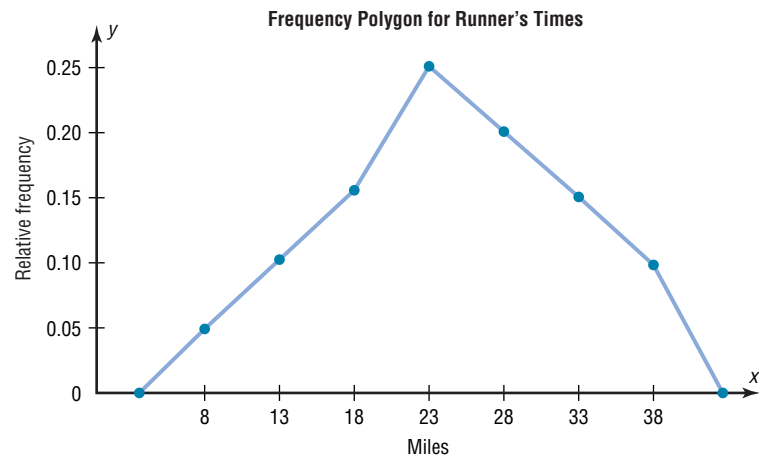
Using the same procedure, find the relative frequencies for the Cumulative frequency column. The relative frequencies are shown here.

Class boundaries	Midpoints	Relative frequency	Cumulative relative frequency
5.5–10.5	8	0.05	0.05
10.5–15.5	13	0.10	0.15
15.5–20.5	18	0.15	0.30
20.5–25.5	23	0.25	0.55
25.5–30.5	28	0.20	0.75
30.5–35.5	33	0.15	0.90
35.5–40.5	38	0.10	1.00
		1.00	

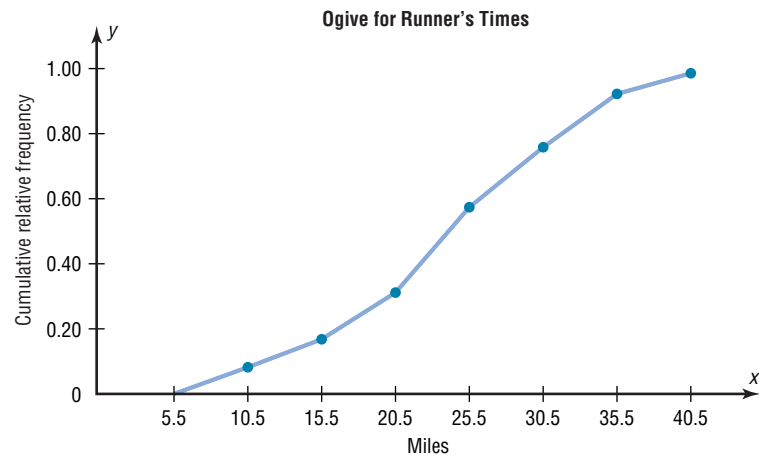
**Step 3** Draw each graph as shown in Figure 2-7. For the histogram and ogive, use the class boundaries along the  $x$  axis. For the frequency polygon, use the midpoints on the  $x$  axis. The scale on the  $y$  axis uses proportions.

**Figure 2-7**Graphs for  
Example 2-7

(a) Histogram



(b) Frequency polygon



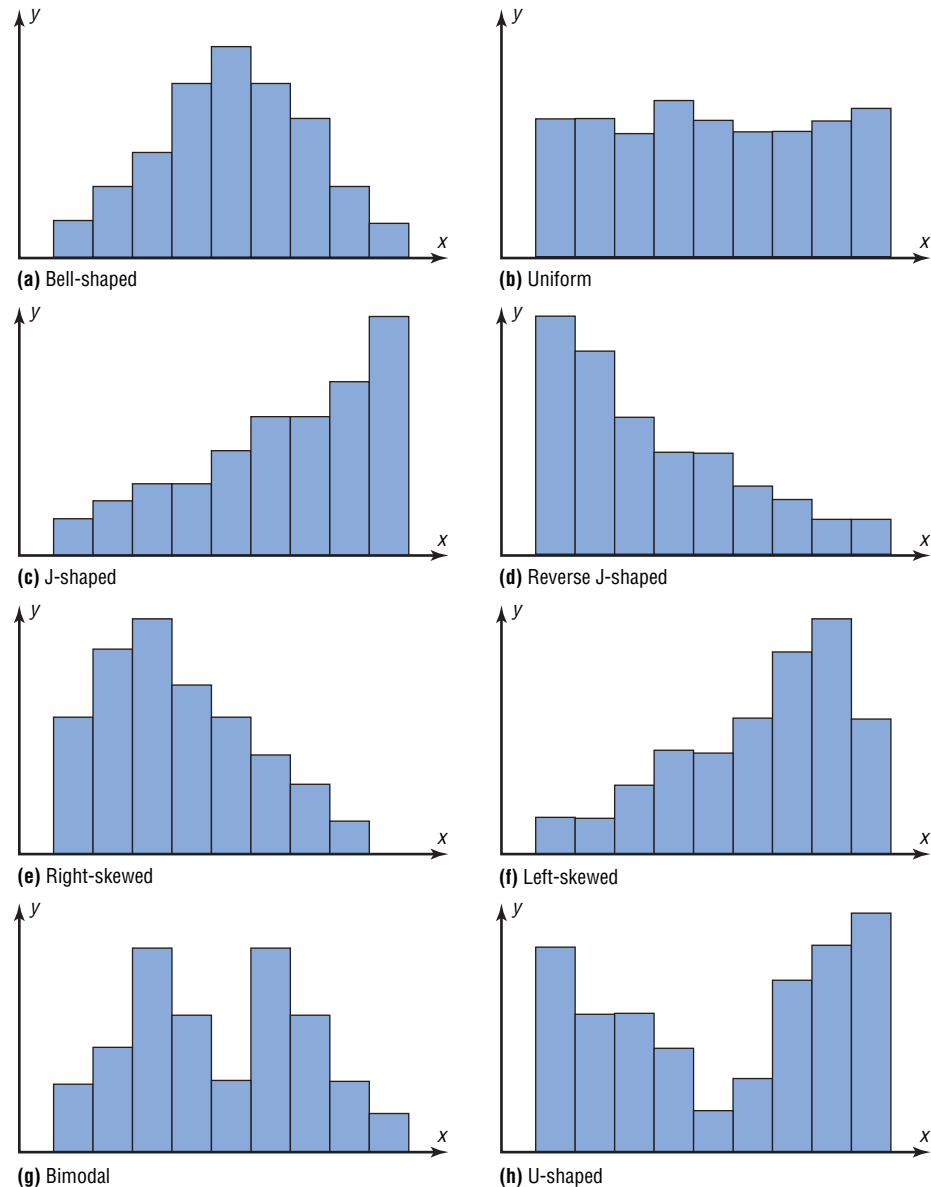
(c) Ogive

### Distribution Shapes

When one is describing data, it is important to be able to recognize the shapes of the distribution values. In later chapters you will see that the shape of a distribution also determines the appropriate statistical methods used to analyze the data.



**Figure 2–8**  
Distribution Shapes



A distribution can have many shapes, and one method of analyzing a distribution is to draw a histogram or frequency polygon for the distribution. Several of the most common shapes are shown in Figure 2–8: *the bell-shaped or mound-shaped, the uniform-shaped, the J-shaped, the reverse J-shaped, the positively or right-skewed shaped, the negatively or left-skewed shaped, the bimodal-shaped, and the U-shaped.*

Distributions are most often not perfectly shaped, so it is not necessary to have an exact shape but rather to identify an overall pattern.

A *bell-shaped distribution* shown in Figure 2–8(a) has a single peak and tapers off at either end. It is approximately symmetric; i.e., it is roughly the same on both sides of a line running through the center.

A *uniform distribution* is basically flat or rectangular. See Figure 2–8(b).

A *J-shaped distribution* is shown in Figure 2–8(c), and it has a few data values on the left side and increases as one moves to the right. A *reverse J-shaped distribution* is the opposite of the J-shaped distribution. See Figure 2–8(d).

When the peak of a distribution is to the left and the data values taper off to the right, a distribution is said to be *positively or right-skewed*. See Figure 2-8(e). When the data values are clustered to the right and taper off to the left, a distribution is said to be *negatively or left-skewed*. See Figure 2-8(f). Skewness will be explained in detail in Chapter 3, pages 108–109. Distributions with one peak, such as those shown in Figure 2-8(a), (e), and (f), are said to be *unimodal*. (The highest peak of a distribution indicates where the mode of the data values is. The mode is the data value that occurs more often than any other data value. Modes are explained in Chapter 3.) When a distribution has two peaks of the same height, it is said to be *bimodal*. See Figure 2-8(g). Finally, the graph shown in Figure 2-8(h) is a *U-shaped* distribution.

Distributions can have other shapes in addition to the ones shown here; however, these are some of the more common ones that you will encounter in analyzing data.

When you are analyzing histograms and frequency polygons, look at the shape of the curve. For example, does it have one peak or two peaks? Is it relatively flat, or is it U-shaped? Are the data values spread out on the graph, or are they clustered around the center? Are there data values in the extreme ends? These may be *outliers*. (See Section 3-4 for an explanation of outliers.) Are there any gaps in the histogram, or does the frequency polygon touch the  $x$  axis somewhere other than the ends? Finally, are the data clustered at one end or the other, indicating a *skewed distribution*?

For example, the histogram for the record high temperatures shown in Figure 2-2 shows a single peaked distribution, with the class 109.5–114.5 containing the largest number of temperatures. The distribution has no gaps, and there are fewer temperatures in the highest class than in the lowest class.

## Applying the Concepts 2-3

### Selling Real Estate

Assume you are a realtor in Bradenton, Florida. You have recently obtained a listing of the selling prices of the homes that have sold in that area in the last 6 months. You wish to organize that data so you will be able to provide potential buyers with useful information. Use the following data to create a histogram, frequency polygon, and cumulative frequency polygon.

142,000	127,000	99,600	162,000	89,000	93,000	99,500
73,800	135,000	119,500	67,900	156,300	104,500	108,650
123,000	91,000	205,000	110,000	156,300	104,000	133,900
179,000	112,000	147,000	321,550	87,900	88,400	180,000
159,400	205,300	144,400	163,000	96,000	81,000	131,000
114,000	119,600	93,000	123,000	187,000	96,000	80,000
231,000	189,500	177,600	83,400	77,000	132,300	166,000

1. What questions could be answered more easily by looking at the histogram rather than the listing of home prices?
2. What different questions could be answered more easily by looking at the frequency polygon rather than the listing of home prices?
3. What different questions could be answered more easily by looking at the cumulative frequency polygon rather than the listing of home prices?
4. Are there any extremely large or extremely small data values compared to the other data values?
5. Which graph displays these extremes the best?
6. Is the distribution skewed?

See page 93 for the answers.

## Exercises 2–3

1. For 108 randomly selected college applicants, the following frequency distribution for entrance exam scores was obtained. Construct a histogram, frequency polygon, and ogive for the data. (The data for this exercise will be used for Exercise 13 in this section.)

Class limits	Frequency
90–98	6
99–107	22
108–116	43
117–125	28
126–134	9

Applicants who score above 107 need not enroll in a summer developmental program. In this group, how many students do not have to enroll in the developmental program?

2. For 75 employees of a large department store, the following distribution for years of service was obtained. Construct a histogram, frequency polygon, and ogive for the data. (The data for this exercise will be used for Exercise 14 in this section.)

Class limits	Frequency
1–5	21
6–10	25
11–15	15
16–20	0
21–25	8
26–30	6

A majority of the employees have worked for how many years or less?

3. The scores for the 2002 LPGA—Giant Eagle are shown.

Score	Frequency
202–204	2
205–207	7
208–210	16
211–213	26
214–216	18
217–219	4

Source: LPGA.com.

Construct a histogram, frequency polygon, and ogive for the distribution. Comment on the skewness of the distribution.

4. The salaries (in millions of dollars) for 31 NFL teams for a specific season are given in this frequency distribution.

Class limits	Frequency
39.9–42.8	2
42.9–45.8	2
45.9–48.8	5
48.9–51.8	5
51.9–54.8	12
54.9–57.8	5

Source: NFL.com.

Construct a histogram, frequency polygon, and ogive for the data; and comment on the shape of the distribution.

5. Thirty automobiles were tested for fuel efficiency, in miles per gallon (mpg). The following frequency distribution was obtained. Construct a histogram, frequency polygon, and ogive for the data.

Class boundaries	Frequency
7.5–12.5	3
12.5–17.5	5
17.5–22.5	15
22.5–27.5	5
27.5–32.5	2

6. Construct a histogram, frequency polygon, and ogive for the data in Exercise 14 in Section 2–2, and analyze the results.
7. The air quality measured for selected cities in the United States for 1993 and 2002 is shown. The data are the number of days per year that the cities failed to meet acceptable standards. Construct a histogram for both years and see if there are any notable changes. If so, explain. (The data in this exercise will be used for Exercise 17 in this section.)

1993		2002	
Class	Frequency	Class	Frequency
0–27	20	0–27	19
28–55	4	28–55	6
56–83	3	56–83	2
84–111	1	84–111	0
112–139	1	112–139	0
140–167	0	140–167	3
168–195	1	168–195	0

Source: World Almanac and Book of Facts.

8. In a study of reaction times of dogs to a specific stimulus, an animal trainer obtained the following data, given in seconds. Construct a histogram, frequency polygon, and ogive for the data, and analyze the results.

(The histogram in this exercise will be used for Exercise 18 in this section, Exercise 16 in Section 3-2, and Exercise 26 in Section 3-3.)

Class limits	Frequency
2.3–2.9	10
3.0–3.6	12
3.7–4.3	6
4.4–5.0	8
5.1–5.7	4
5.8–6.4	2


9. Construct a histogram, frequency polygon, and ogive for the data in Exercise 15 of Section 2-2, and analyze the results.
10. The frequency distributions shown indicate the percentages of public school students in fourth-grade reading and mathematics who performed at or above the required proficiency levels for the 50 states in the United States. Draw histograms for each and decide if there is any difference in the performance of the students in the subjects.

Class	Reading Frequency	Math Frequency
17.5–22.5	7	5
22.5–27.5	6	9
27.5–32.5	14	11
32.5–37.5	19	16
37.5–42.5	3	8
42.5–47.5	1	1

Source: National Center for Educational Statistics.


11. Construct a histogram, frequency polygon, and ogive for the data in Exercise 16 in Section 2-2, and analyze the results.
12. For the data in Exercise 18 in Section 2-2, construct a histogram for the home run distances for each player and compare them. Are they basically the same, or are there any noticeable differences? Explain your answer.
13. For the data in Exercise 1 in this section, construct a histogram, frequency polygon, and ogive, using relative frequencies. What proportion of the applicants need to enroll in the summer developmental program?
14. For the data in Exercise 2 in this section, construct a histogram, frequency polygon, and ogive, using relative

frequencies. What proportion of the employees have been with the store for more than 20 years?

-  15. The number of calories per serving for selected ready-to-eat cereals is listed here. Construct a frequency distribution using 7 classes. Draw a histogram, frequency polygon, and ogive for the data, using relative frequencies. Describe the shape of the histogram.

130 190 140 80 100 120 220 220 110 100  
 210 130 100 90 210 120 200 120 180 120  
 190 210 120 200 130 180 260 270 100 160  
 190 240 80 120 90 190 200 210 190 180  
 115 210 110 225 190 130

Source: *The Doctor's Pocket Calorie, Fat, and Carbohydrate Counter.*

-  16. The amount of protein (in grams) for a variety of fast-food sandwiches is reported here. Construct a frequency distribution using 6 classes. Draw a histogram, frequency polygon, and ogive for the data, using relative frequencies. Describe the shape of the histogram.

23 30 20 27 44 26 35 20 29 29  
 25 15 18 27 19 22 12 26 34 15  
 27 35 26 43 35 14 24 12 23 31  
 40 35 38 57 22 42 24 21 27 33

Source: *The Doctor's Pocket Calorie, Fat, and Carbohydrate Counter.*

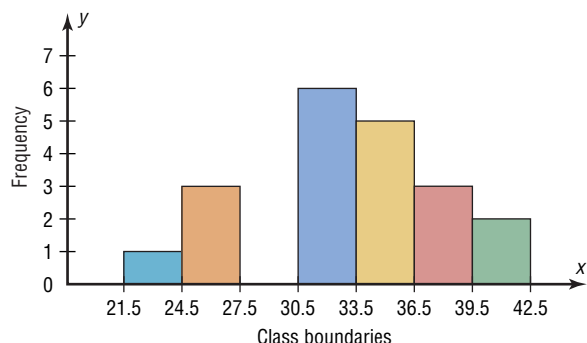
17. For the data for year 2002 in Exercise 7 in this section, construct a histogram, frequency polygon, and ogive, using relative frequencies.
18. The animal trainer in Exercise 8 in this section selected another group of dogs who were much older than the first group and measured their reaction times to the same stimulus. Construct a histogram, frequency polygon, and ogive for the data.

Class limits	Frequency
2.3–2.9	1
3.0–3.6	3
3.7–4.3	4
4.4–5.0	16
5.1–5.7	14
5.8–6.4	4

Analyze the results and compare the histogram for this group with the one obtained in Exercise 8 in this section. Are there any differences in the histograms? (The data in this exercise will be used for Exercise 16 in Section 3-2 and Exercise 26 in Section 3-3.)

## Extending the Concepts

19. Using the histogram shown here, do the following.



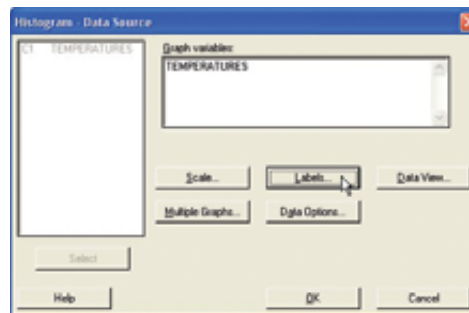
- Construct a frequency distribution; include class limits, class frequencies, midpoints, and cumulative frequencies.
  - Construct a frequency polygon.
  - Construct an ogive.
20. Using the results from Exercise 19, answer these questions.
- How many values are in the class 27.5–30.5?
  - How many values fall between 24.5 and 36.5?
  - How many values are below 33.5?
  - How many values are above 30.5?

## Technology Step by Step

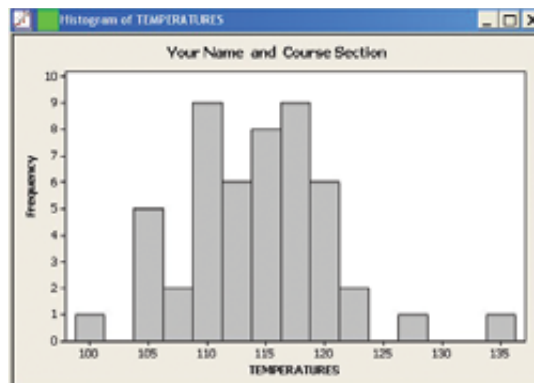
### MINITAB Step by Step

#### Construct a Histogram

- Enter the data from Example 2–2, the high temperatures for the 50 states.
- Select **Graph>Histogram**.
- Select [Simple], then click [OK].
- Click C1 TEMPERATURES in the Graph variables dialog box.
- Click [Labels]. There are two tabs, Title/Footnote and Data Labels.
  - Click in the box for Title, and type in Your Name and Course Section.
  - Click [OK]. The Histogram dialog box is still open.
- Click [OK]. A new graph window containing the histogram will open.



- Click the **File** menu to print or save the graph.



## TI-83 Plus or TI-84 Plus Step by Step

Input

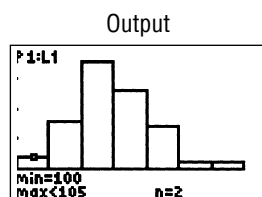
```

WINDOW
Xmin=100
Xmax=135
Xscl=5
Ymin=-5
Ymax=20
Yscl=5
Xres=1
  
```

Input

```

2nd Plot2 Plot3
Off Off
Type: L1 L2 L3 L4 L5 L6 L7 L8 L9 L0
Xlist:L1
Freq:1
  
```



8. Click **File>Exit**.
9. Save the project as **Ch2-3.mpj**.

### Constructing a Histogram

To display the graphs on the screen, enter the appropriate values in the calculator, using the **WINDOW** menu. The default values are  $X_{\min} = -10$ ,  $X_{\max} = +10$ ,  $Y_{\min} = -10$ , and  $Y_{\max} = +10$ .

The  $X_{\text{scl}}$  changes the distance between the tick marks on the  $x$  axis and can be used to change the class width for the histogram.

To change the values in the **WINDOW**:

1. Press **WINDOW**.
2. Move the cursor to the value that needs to be changed. Then type in the desired value and press **ENTER**.
3. Continue until all values are appropriate.
4. Press **[2nd] [QUIT]** to leave the **WINDOW** menu.

To plot the histogram from raw data:

1. Enter the data in  $L_1$ .
2. Make sure **WINDOW** values are appropriate for the histogram.
3. Press **[2nd] [STAT PLOT] ENTER**.
4. Press **ENTER** to turn the plot on, if necessary.
5. Move cursor to the Histogram symbol and press **ENTER**, if necessary.
6. Make sure **Xlist** is  $L_1$ .
7. Make sure **Freq** is 1.
8. Press **GRAPH** to display the histogram.
9. To obtain the number of data values in each class, press the **TRACE** key, followed by **◀** or **▶** keys.

### Example TI2-1

Plot a histogram for the following data from Examples 2-2 and 2-4.

112	100	127	120	134	118	105	110	109	112
110	118	117	116	118	122	114	114	105	109
107	112	114	115	118	117	118	122	106	110
116	108	110	121	113	120	119	111	104	111
120	113	120	117	105	110	118	112	114	114

Press **TRACE** and use the arrow keys to determine the number of values in each group.

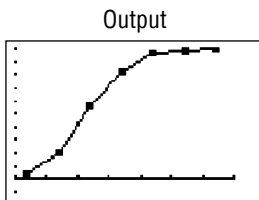
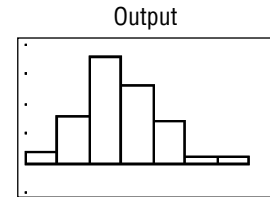
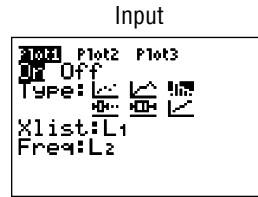
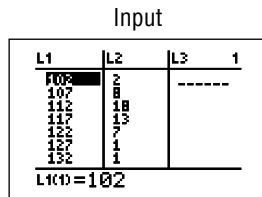
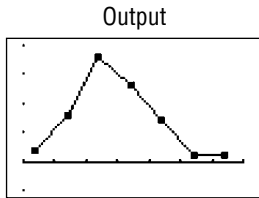
To graph a histogram from grouped data:

1. Enter the midpoints into  $L_1$ .
2. Enter the frequencies into  $L_2$ .
3. Make sure **WINDOW** values are appropriate for the histogram.
4. Press **[2nd] [STAT PLOT] ENTER**.
5. Press **ENTER** to turn the plot on, if necessary.
6. Move cursor to the histogram symbol, and press **ENTER**, if necessary.
7. Make sure **Xlist** is  $L_1$ .
8. Make sure **Freq** is  $L_2$ .
9. Press **GRAPH** to display the histogram.

**Example TI2-2**

Plot a histogram for the data from Examples 2-4 and 2-5.

Class boundaries	Midpoints	Frequency
99.5–104.5	102	2
104.5–109.5	107	8
109.5–114.5	112	18
114.5–119.5	117	13
119.5–124.5	122	7
124.5–129.5	127	1
129.5–134.5	132	1



To graph a frequency polygon from grouped data, follow the same steps as for the histogram except change the graph type from histogram (third graph) to a line graph (second graph).

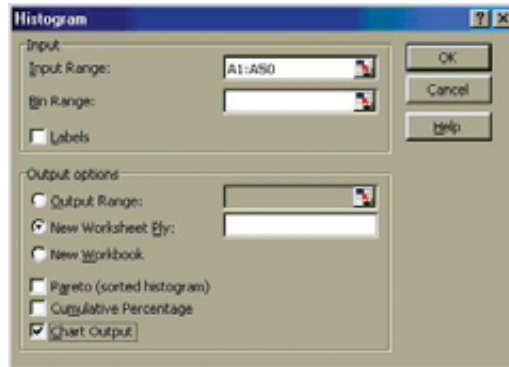
To graph an ogive from grouped data, modify the procedure for the histogram as follows:

1. Enter the upper class boundaries into  $L_1$ .
2. Enter the cumulative frequencies into  $L_2$ .
3. Change the graph type from histogram (third graph) to line (second graph).
4. Change the  $Y_{max}$  from the WINDOW menu to the sample size.

**Excel**  
Step by Step

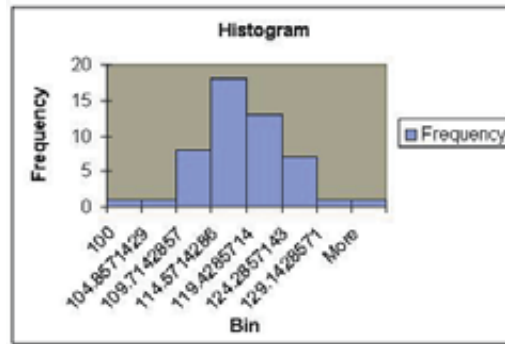
**Constructing a Histogram**

1. Press **[Ctrl]-N** for a new worksheet.
2. Enter the data from Examples 2-2 and 2-4 in column A, one number per cell.
3. Select **Tools>Data Analysis**.
4. In Data Analysis, select Histogram and click the **[OK]** button.
5. In the Histogram dialog box, type **A1:A50** as the Input Range.



6. Select New Worksheet Ply and Chart Output. Click **[OK]**.

Excel presents both a table and a chart on the new worksheet ply. It decides “bins” for the histogram itself (here it picked a bin size of 7 units), but you can also define your own bin range on the data worksheet.



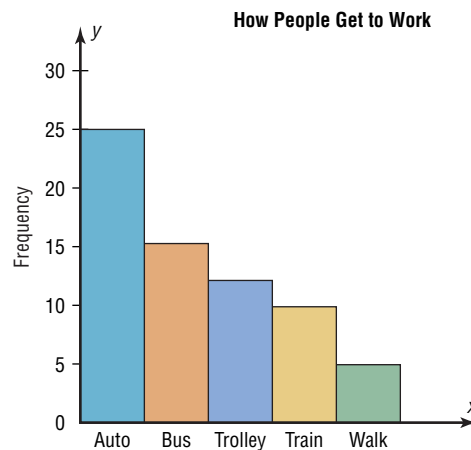
The vertical bars on the histogram can be made contiguous by right-clicking on one of the bars and selecting **Format Data Series**. Select the Options tab, then enter **0** in the Gap Width box.

**2-4**

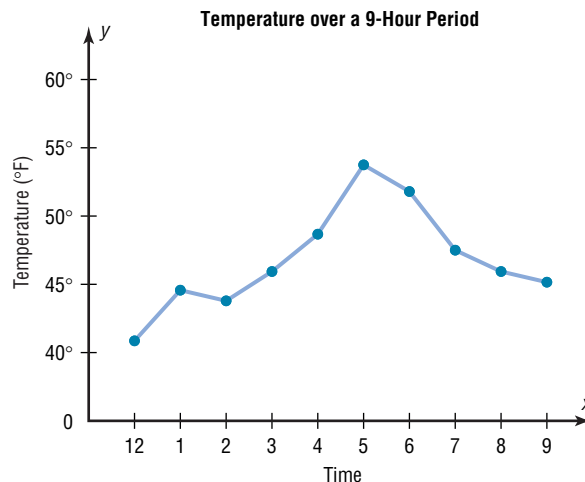
**Other Types of Graphs**

In addition to the histogram, the frequency polygon, and the ogive, several other types of graphs are often used in statistics. They are the Pareto chart, the time series graph, and the pie graph. Figure 2-9 shows an example of each type of graph.

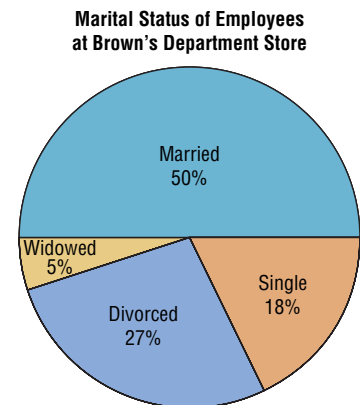
**Figure 2-9**  
Other Types of Graphs  
Used in Statistics



(a) Pareto chart



(b) Time series graph



(c) Pie graph