Describing Data:
Frequency Tables, Frequency Distributions, and Graphic Presentation

Chapter 02

LEARNING OBJECTIVES

LO 2-1 Make a frequency table for a set of data.

LO 2-2 Organize data into a bar chart.

LO 2-3 Present a set of data using a pie chart.

LO 2-4 Create a frequency distribution for a data set.

LO 2-5 Understand a relative frequency distribution.

LO 2-6 Present data from a frequency distribution in a histogram or frequency polygon.

LO 2-7 Construct and interpret a cumulative frequency distribution.

Describing Data with Charts, Tables and Graphs - Example

The Applewood Auto Group (AAG) sells a wide range of vehicles through its four dealerships. Ms. Kathryn Ball, is responsible for tracking and analyzing vehicle sales and the profitability of those vehicles. She would like to summarize the profit earned on the vehicles sold with tables, charts, and graphs that she would review monthly. She wants to know the profit per vehicle sold, as well as the lowest and highest amount of profit. Partial data for 180 customers are shown on the table on the right.

	A	B	C	D	E
1	Age	Profit	Location	Vehicle-Type	Previous
2	21	$1,387	Tionesta	Sedan	0
3	23	$1,754	Sheffield	SUV	1
4	24	$1,817	Sheffield	Hybrid	1
5	25	$1,040	Sheffield	Compact	0
6	26	$1,273	Kane	Sedan	1
7	27	$1,529	Sheffield	Sedan	1
8	27	$3,082	Kane	Truck	0
9	28	$1,951	Kane	SUV	1
10	28	$2,692	Tionesta	Compact	0
11	29	$1,206	Sheffield	Sedan	0
12	29	$1,342	Kane	Sedan	2
13	30	$443	Kane	Sedan	3
14	30	$754	Olean	Sedan	2

Frequency Table

FREQUENCY TABLE A grouping of qualitative data into mutually exclusive classes showing the number of observations in each class.

TABLE 2–1 Frequency Table for Vehicles Sold Last Month at Applewood Auto Group by Location

Location	Number of Cars
Kane	52
Olean	40
Sheffield	45
Tionesta	43
Total	180

Bar Charts

BAR CHART A graph in which the classes are reported on the horizontal axis and the class frequencies on the vertical axis. The class frequencies are proportional to the heights of the bars.
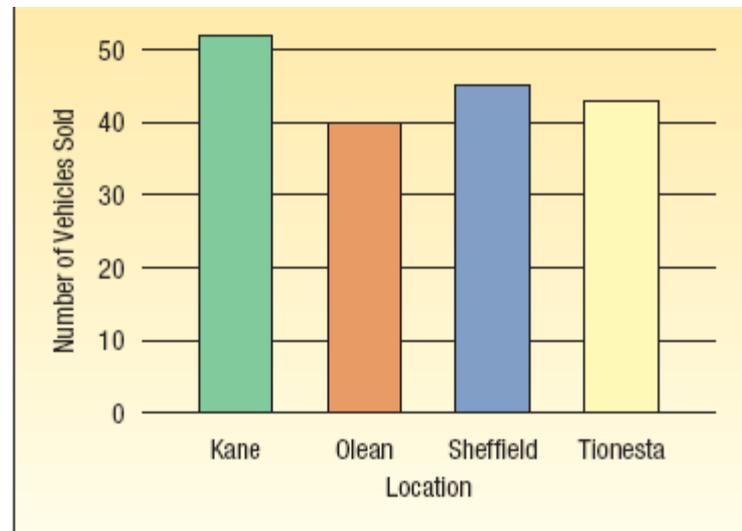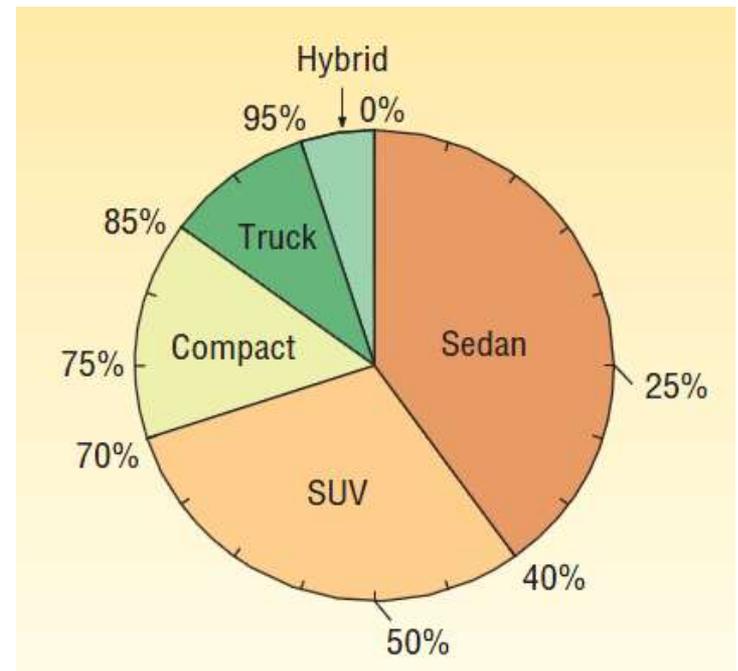

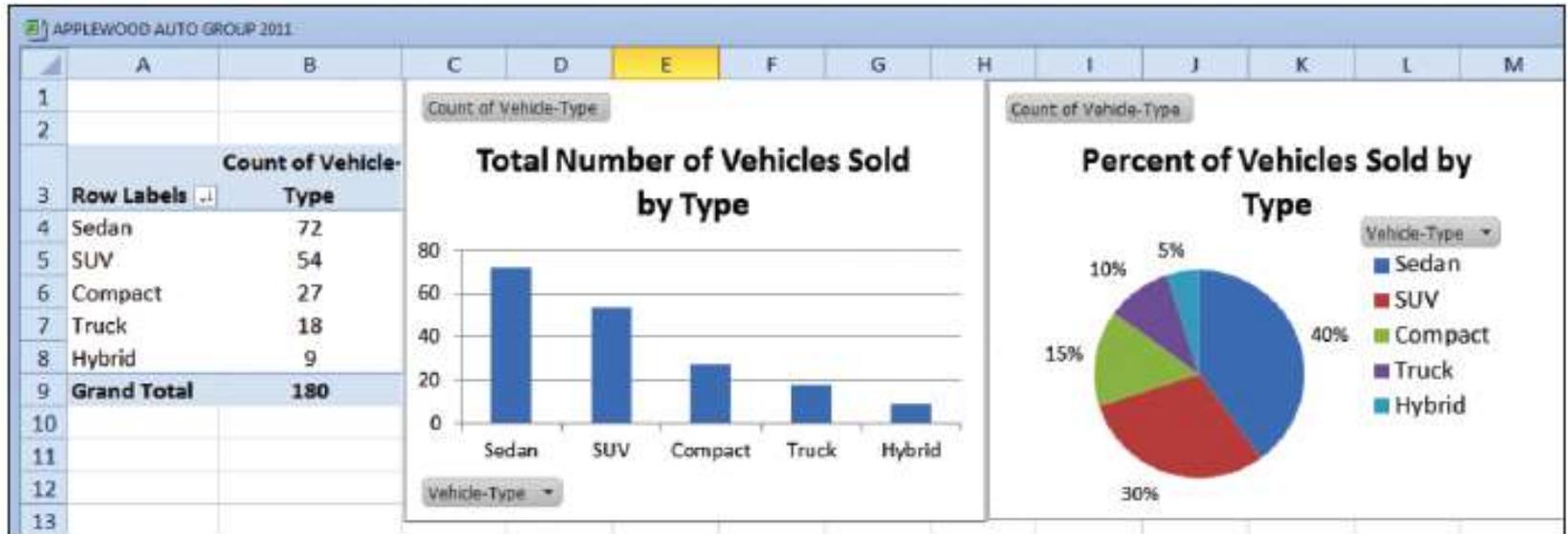**CHART 2–1** Number of Vehicles Sold by Location

Pie Charts

PIE CHART A chart that shows the proportion or percent that each class represents of the total number of frequencies.

Vehicle Sales by Type at Applewood Auto Group

Vehicle Type	Number Sold	Percent Sold
Sedan	72	40
SUV	54	30
Compact	27	15
Truck	18	10
Hybrid	9	5
Total	180	100

Pie Chart Using Excel

Frequency Distribution

FREQUENCY DISTRIBUTION A grouping of data into mutually exclusive classes showing the number of observations in each class.

TABLE 2–1 Frequency Table for Vehicles Sold Last Month at Applewood Auto Group by Location

Location	Number of Cars
Kane	52
Olean	40
Sheffield	45
Tionesta	43
Total	180

Relative Class Frequencies

☐ Class frequencies can be converted to **relative class frequencies** to show the fraction of the total number of observations in each class.

☐ A relative frequency captures the relationship between a class total and the total number of observations.

TABLE 2–2 Relative Frequency Table of Vehicles Sold by Type Last Month at Applewood Auto Group

Location	Number of Cars	Relative Frequency
Kane	52	.289
Olean	40	.222
Sheffield	45	.250
Tionesta	43	.239
Total	180	1.000

Frequency Distribution

Class interval: The class interval is obtained by subtracting the lower limit of a class from the lower limit of the next class.

Class frequency: The number of observations in each class.

Class midpoint: A point that divides a class into two equal parts. This is the average of the upper and lower class limits.

Profit	Midpoint	Frequency
$ 200 up to $ 600	$ 400	8
600 up to 1,000	800	11
1,000 up to 1,400	1,200	23
1,400 up to 1,800	1,600	38
1,800 up to 2,200	2,000	45
2,200 up to 2,600	2,400	32
2,600 up to 3,000	2,800	19
3,000 up to 3,400	3,200	4
Total		180

EXAMPLE – Creating a Frequency Distribution Table

Kathryn Ball of the Applewood Auto Group wants to develop tables, charts, and graphs to show the typical profit for each sale. Table 2–4 reports the profit on each of the 180 vehicles sold last month at the four Applewood locations.

▪What is the typical profit on each sale?
▪What is the largest profit on any sale?
▪What is the lowest profit on any sale?
▪Around what value did the profits tend to cluster?

TABLE 2–4 Profit on Vehicles Sold Last Month by the Applewood Auto Group — Highest

$1,387	$2,148	$2,201	$ 963	$ 820	$2,230	$3,043	$2,584	$2,370
1,754	2,207	996	1,298	1,266	2,341	1,059	2,666	2,637
1,817	2,252	2,813	1,410	1,741	3,292	1,674	2,991	1,426
1,040	1,428	323	1,553	1,772	1,108	1,807	934	2,944
1,273	1,889	352	1,648	1,932	1,295	2,056	2,063	2,147
1,529	1,166	482	2,071	2,350	1,344	2,236	2,083	1,973
3,082	1,320	1,144	2,116	2,422	1,906	2,928	2,856	2,502
1,951	2,265	1,485	1,500	2,446	1,952	1,269	2,989	783
2,692	1,323	1,509	1,549	369	2,070	1,717	910	1,538
1,206	1,761	1,638	2,348	978	2,454	1,797	1,536	2,339
1,342	1,919	1,961	2,498	1,238	1,606	1,955	1,957	2,700
443	2,357	2,127	294	1,818	1,680	2,199	2,240	2,222
754	2,866	2,430	1,115	1,824	1,827	2,482	2,695	2,597
1,621	732	1,704	1,124	1,907	1,915	2,701	1,325	2,742
870	1,464	1,876	1,532	1,938	2,084	3,210	2,250	1,837
1,174	1,626	2,010	1,688	1,940	2,639	377	2,279	2,842
1,412	1,761	2,165	1,822	2,197	842	1,220	2,626	2,434
1,809	1,915	2,231	1,897	2,646	1,963	1,401	1,501	1,640
2,415	2,119	2,389	2,445	1,461	2,059	2,175	1,752	1,821
1,546	1,766	335	2,886	1,731	2,338	1,118	2,058	2,487

— Lowest

Constructing a Frequency Table – Example

Step 1: Decide on the number of classes (k).

A useful recipe to determine the number of classes (k) is the "2 to the k rule" such that $2^k > n$

- There were 180 vehicles sold, so $n = 180$.
- We try $k = 7$, then $2^7 = 128$, somewhat less than 180. Hence, 7 is not enough classes.
- We try $k = 8$, then $2^8 = 256$, which is greater than 180.
- The recommended number of classes is 8.

Constructing a Frequency Table – Example

Step 2: Determine the class interval or width.

The formula is: $i \geq (H - L)/k$, where i is the class interval, H is the highest observed value, L is the lowest observed value, and k is the number of classes.

$$i \geq \frac{H - L}{k} = \frac{\$3{,}292 - \$294}{8} = \$374.75$$

Round up to some convenient number, such as a multiple of 10 or 100. Use a class width of $400.

Constructing a Frequency Table – Example

Step 3: Set the individual class limits.

Classes
$ 200 up to $ 600
600 up to 1,000
1,000 up to 1,400
1,400 up to 1,800
1,800 up to 2,200
2,200 up to 2,600
2,600 up to 3,000
3,000 up to 3,400

Constructing a Frequency Table – Example

Step 4: Tally the vehicle profits into the classes.

TABLE 2–7 Frequency Distribution of Profit for Vehicles Sold Last Month at Applewood Auto Group

Profit	Frequency
$ 200 up to $ 600	ЖҤ |||
600 up to 1,000	ЖҤ ЖҤ	
1,000 up to 1,400	ЖҤ ЖҤ ЖҤ ЖҤ |||
1,400 up to 1,800	ЖҤ ЖҤ ЖҤ ЖҤ ЖҤ ЖҤ ЖҤ |||
1,800 up to 2,200	ЖҤ ЖҤ ЖҤ ЖҤ ЖҤ ЖҤ ЖҤ ЖҤ ЖҤ
2,200 up to 2,600	ЖҤ ЖҤ ЖҤ ЖҤ ЖҤ ЖҤ ||
2,600 up to 3,000	ЖҤ ЖҤ ЖҤ ||||
3,000 up to 3,400	||||
Total	

Constructing a Frequency Table – Example

Step 5: Count the number of items in each class.

Profit			Frequency
$ 200 up to $ 600			8
600 up to	1,000		11
1,000 up to	1,400		23
1,400 up to	1,800		38
1,800 up to	2,200		45
2,200 up to	2,600		32
2,600 up to	3,000		19
3,000 up to	3,400		4
Total			180

Relative Frequency Distribution

To convert a frequency distribution to a *relative* frequency distribution, each of the class frequencies is divided by the total number of observations.

TABLE 2–8 Relative Frequency Distribution of Profit for Vehicles Sold Last Month at Applewood Auto Group

Profit	Frequency	Relative Frequency	Found by
$ 200 up to $ 600	8	.044	8/180
600 up to 1,000	11	.061	11/180
1,000 up to 1,400	23	.128	23/180
1,400 up to 1,800	38	.211	38/180
1,800 up to 2,200	45	.250	45/180
2,200 up to 2,600	32	.178	32/180
2,600 up to 3,000	19	.106	19/180
3,000 up to 3,400	4	.022	4/180
Total	180	1.000	

Graphic Presentation of a Frequency Distribution

The three commonly used graphic forms are:

- **Histograms**
- **Frequency polygons**
- **Cumulative frequency distributions**
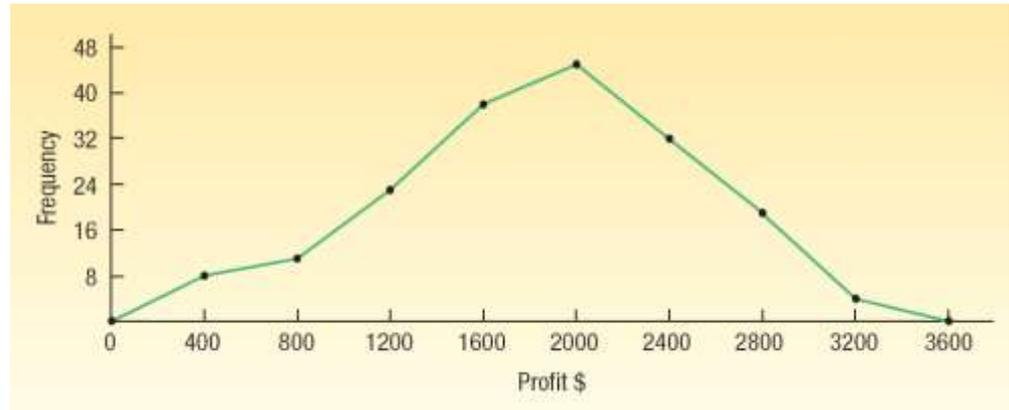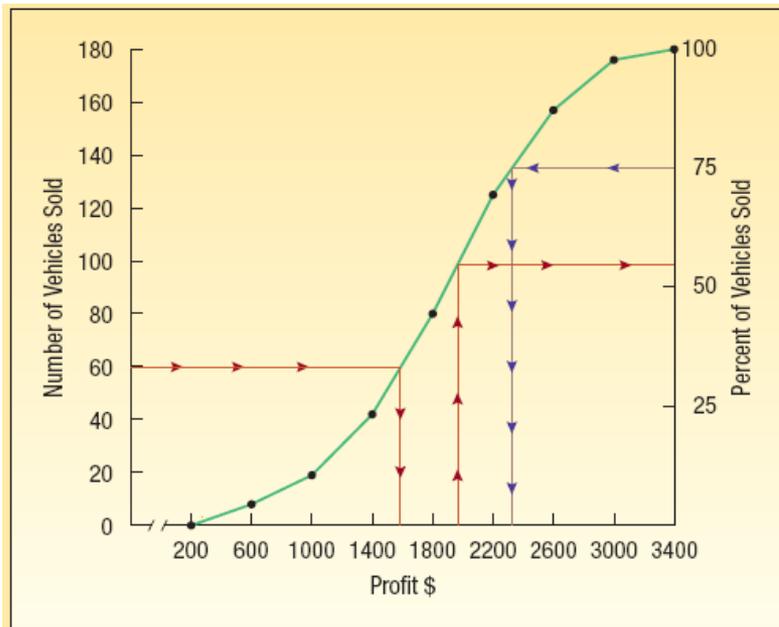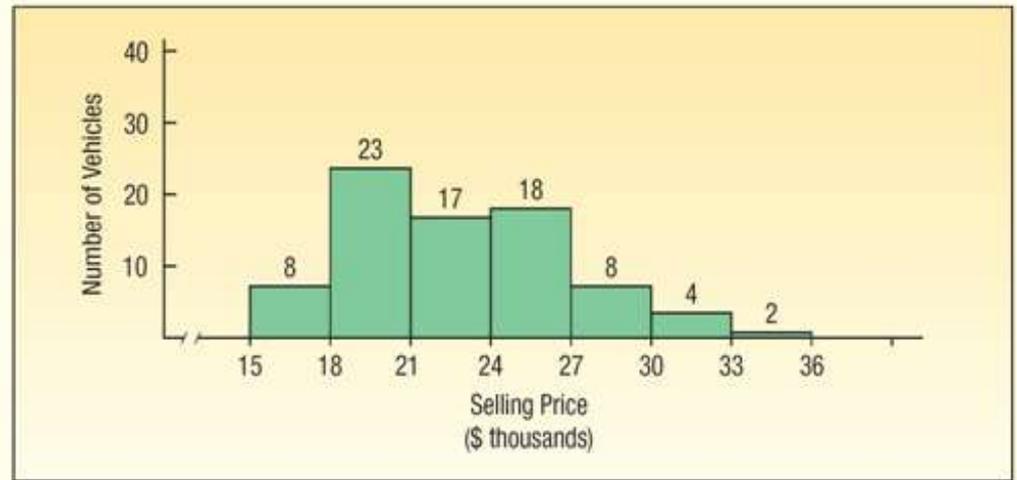
Histogram

HISTOGRAM A graph in which the classes are marked on the horizontal axis and the class frequencies on the vertical axis. The class frequencies are represented by the heights of the bars and the bars are drawn adjacent to each other.
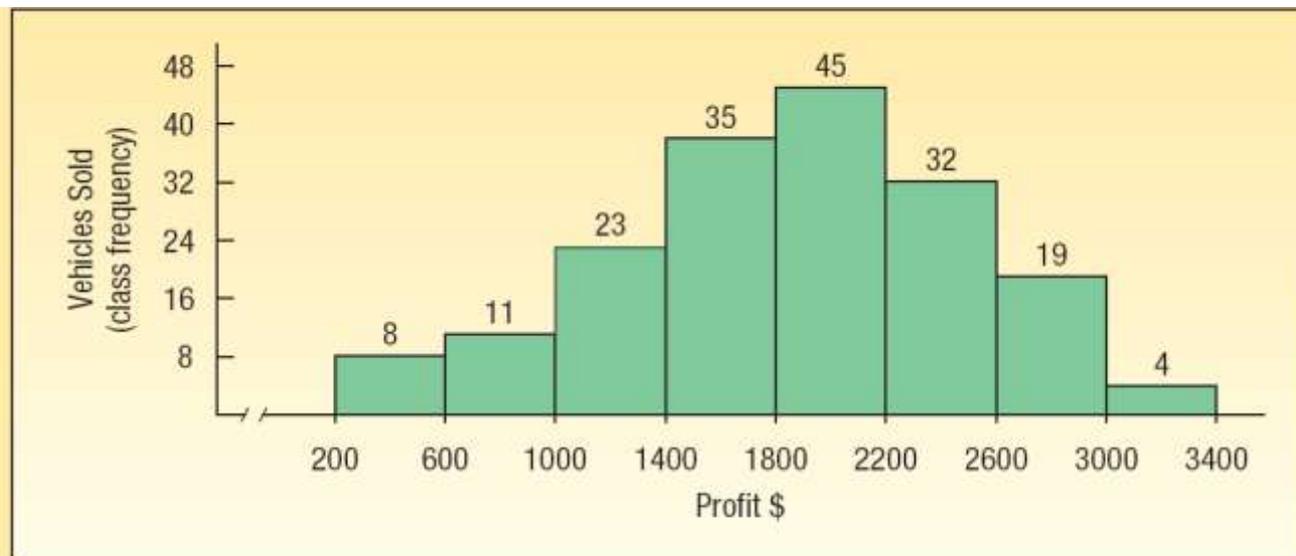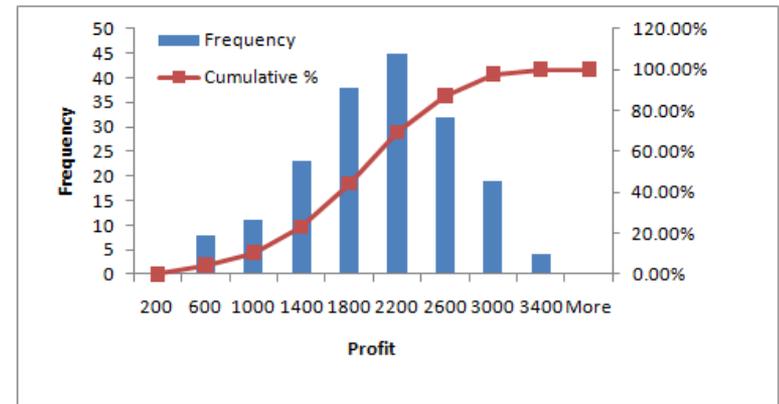

CHART 2–4 Histogram of the Profit on 180 Vehicles Sold at the Applewood Auto Group

Histogram Using Excel

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
3																
4	$1,387	$2,148	$2,201	963	820	$2,230	$3,043	$2,584	$2,370		*Profit*	*Frequency*	*Cumulative %*			
5	1,754	2,207	996	1,298	1,266	2,341	1,059	2,666	2,637		200	0	0.00%			
6	1,817	2,252	2,813	1,410	1,741	3,292	1,674	2,991	1,426		600	8	4.44%			
7	1,040	1,428	323	1,553	1,772	1,108	1,807	934	2,944		1000	11	10.56%			
8	1,273	1,889	352	1,648	1,932	1,295	2,056	2,063	2,147		1400	23	23.33%			
9	1,529	1,166	482	2,071	2,350	1,344	2,236	2,083	1,973		1800	38	44.44%			
10	3,082	1,320	1,144	2,116	2,422	1,906	2,928	2,856	2,502		2200	45	69.44%			
11	1,951	2,265	1,485	1,500	2,446	1,952	1,269	2,989	783		2600	32	87.22%			
12	2,692	1,323	1,509	1,549	369	2,070	1,717	910	1,538		3000	19	97.78%			
13	1,206	1,761	1,638	2,348	978	2,454	1,797	1,536	2,339		3400	4	100.00%			
14	1,342	1,919	1,961	2,498	1,238	1,606	1,955	1,957	2,700		More	0	100.00%			
15	443	2,357	2,127	294	1,818	1,680	2,199	2,240	2,222							
16	754	2,866	2,430	1,115	1,824	1,827	2,482	2,695	2,597							
17	1,621	732	1,704	1,124	1,907	1,915	2,701	1,325	2,742							
18	870	1,464	1,876	1,532	1,938	2,084	3,210	2,250	1,837							
19	1,174	1,626	2,010	1,688	1,940	2,639	377	2,279	2,842							
20	1,412	1,761	2,165	1,822	2,197	842	1,220	2,626	2,434							
21	1,809	1,915	2,231	1,897	2,646	1,963	1,401	1,501	1,640							
22	2,415	2,119	2,389	2,445	1,461	2,059	2,175	1,752	1,821							
23	1,546	1,766	335	2,886	1,731	2,338	1,118	2,058	2,487							
24																
25																
26																
27																
28																

Frequency Polygon

Profit	Midpoint	Frequency
$ 200 up to $ 600	$ 400	8
600 up to 1,000	800	11
1,000 up to 1,400	1,200	23
1,400 up to 1,800	1,600	38
1,800 up to 2,200	2,000	45
2,200 up to 2,600	2,400	32
2,600 up to 3,000	2,800	19
3,000 up to 3,400	3,200	4
Total		180

- ☐ A **frequency polygon,** similar to a histogram, also shows the shape of a distribution.

- ☐ It consists of line segments connecting the class midpoints of the class frequencies.
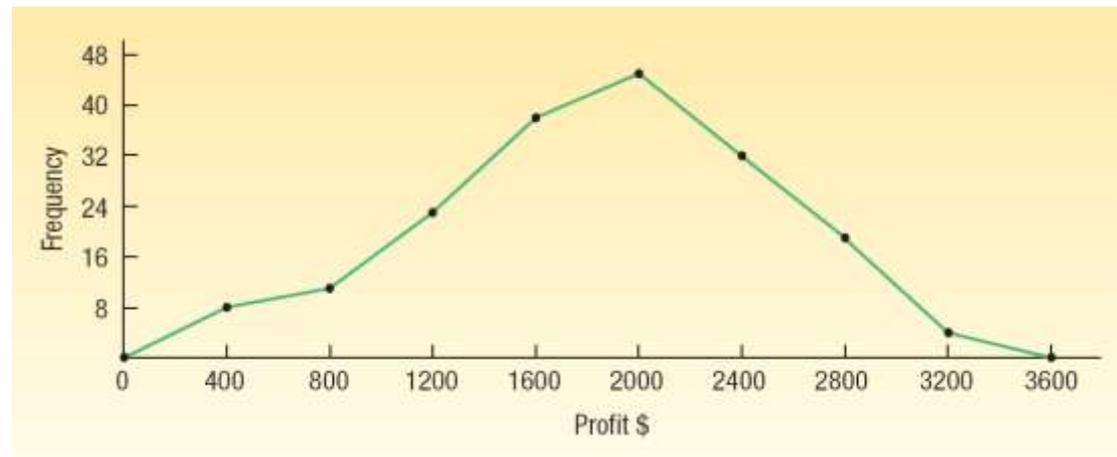
Histogram vs. Frequency Polygon

□ Both provide a quick picture of the main characteristics of the data (highs, lows, points of concentration, etc.).

□ Advantage of the histogram – it depicts each class as a rectangle, with the height of the rectangular bar representing the number in each class.

□ Advantage of the frequency polygon: It allows us to compare directly two or more frequency distributions.

CHART 2–4 Histogram of the Selling Prices of 80 Vehicles at Whitner Autoplex
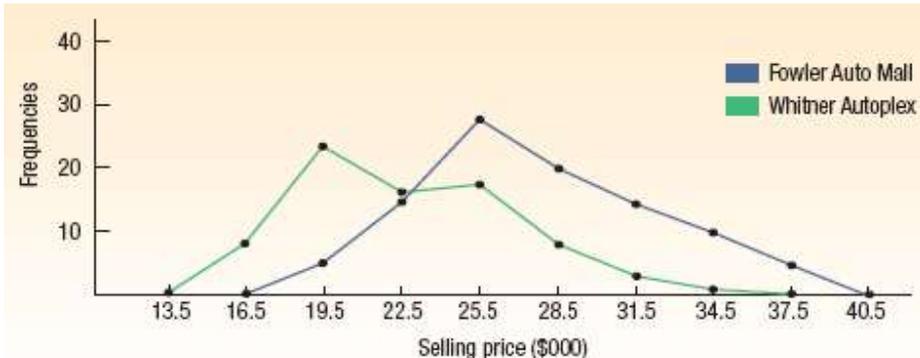
Cumulative Frequency Distribution

TABLE 2–9 Cumulative Frequency Distribution for Profit on Vehicles Sold Last Month at Applewood Auto Group

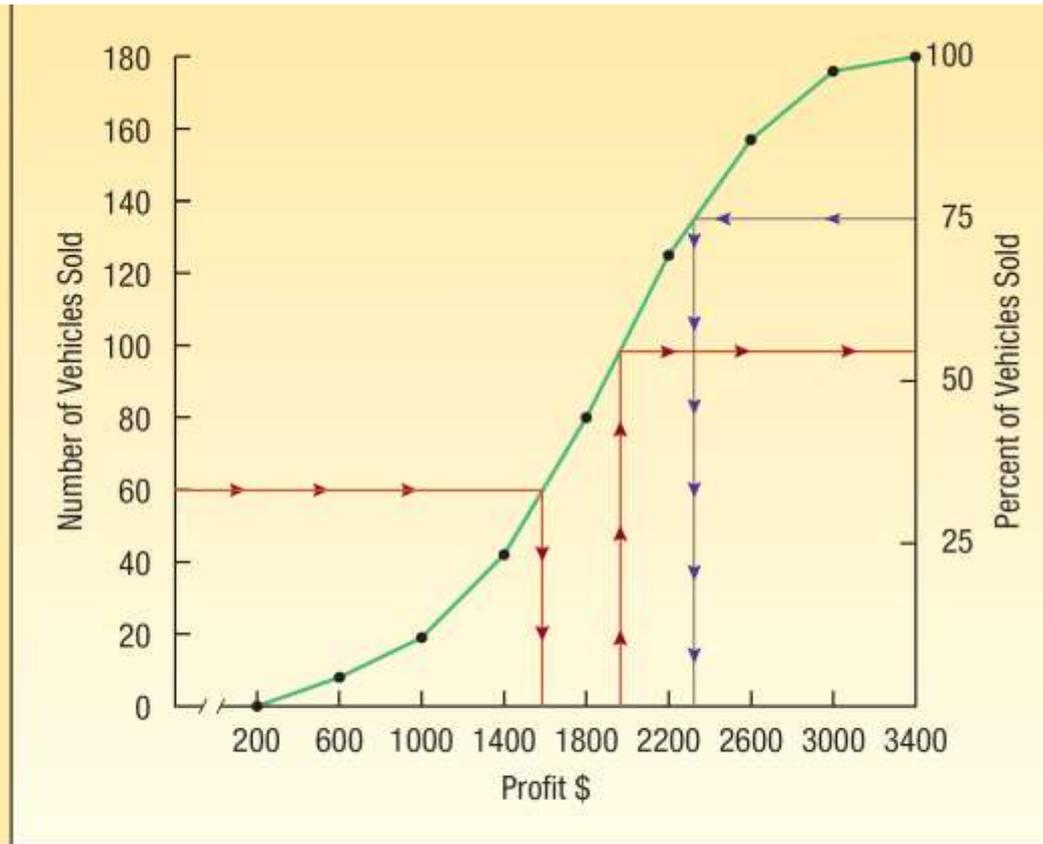| Profit	Frequency	Cumulative Frequency	Found by
$ 200 up to $ 600	8	8	8
600 up to 1,000	11	19	8 + 11
1,000 up to 1,400	23	42	8 + 11 + 23
1,400 up to 1,800	38	80	8 + 11 + 23 + 30
1,800 up to 2,200	45	125	8 + 11 + 23 + 30 + 45
2,200 up to 2,600	32	157	8 + 11 + 23 + 30 + 45 + 32
2,600 up to 3,000	19	176	8 + 11 + 23 + 30 + 45 + 32 + 19
3,000 up to 3,400	4	180	8 + 11 + 23 + 30 + 45 + 32 + 19 + 4
Total	180		

Cumulative Frequency Distribution

CHART 2–7 Cumulative Frequency Distribution for Vehicle Profit