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

Chapter 2

LEARNING OBJECTIVES

LO1 Make a frequency table for a set of data.
LO2 Organize data into a bar chart.
LO3 Present a set of data in a pie chart.
LO4 Create a frequency distribution for a data set.
LO5 Understand a relative frequency distribution.
LO6 Present data from a frequency distribution in a histogram or frequency polygon.

Describing Data with Charts, Tables and Graphs - Example

LO1 Make a frequency table for a set of data

The Applewood Auto Group (AAG)sells a wide range of vehicles through its **four dealerships.** Ms. Kathryn Ball, a member of the senior management team at AAG, is responsible for tracking and analyzing vehicle sales and the profitability of those vehicles. Kathryn 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**. She is also interested **in describing the demographics of the buyers. What are their ages? How many vehicles have they previously purchased from one of the Applewood dealerships? What type of vehicle did they purchase?** 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

LO2

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

LO2 Organize data into a bar chart

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.

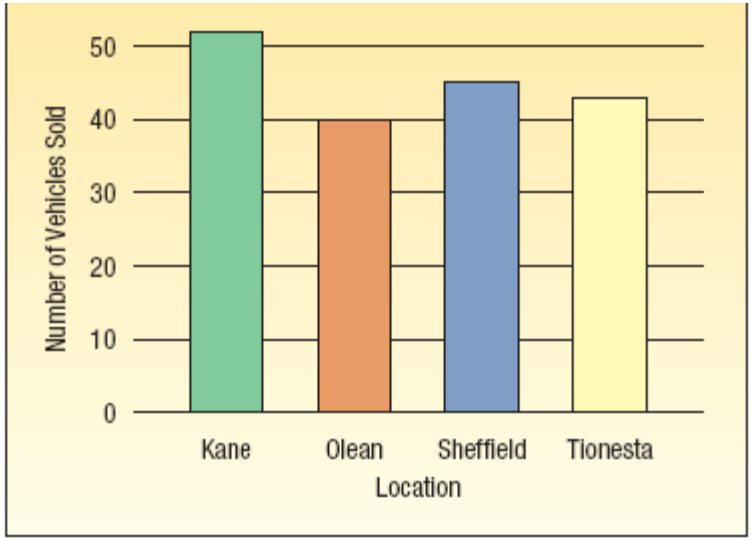


CHART 2–1 Number of Vehicles Sold by Location

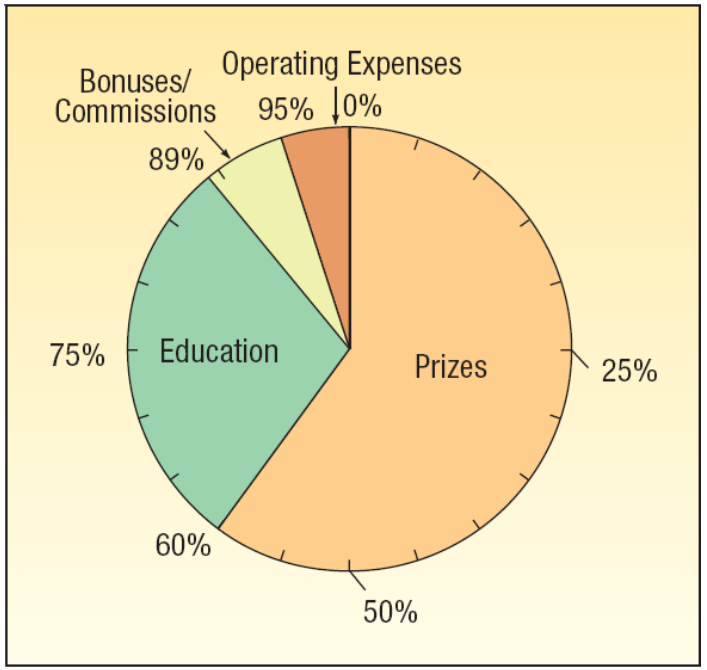
Pie Charts

LO3 Present a set of data in a pie chart.

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

TABLE 2–3 Ohio State Lottery Expenses in 2009

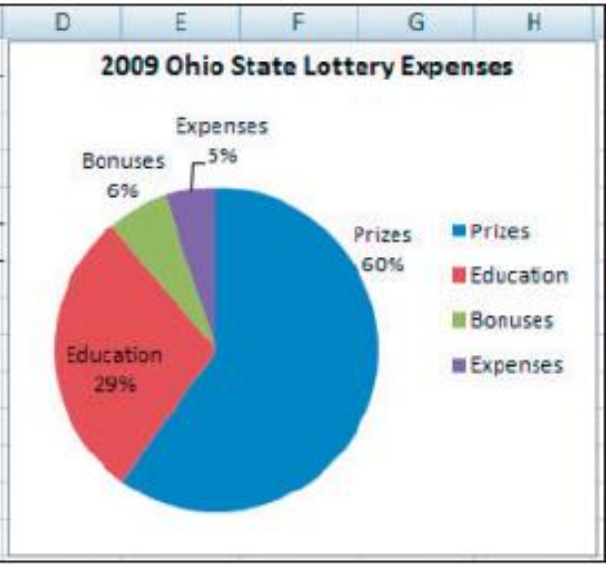
Use of Sales	Amount ($ million)	Percentage of Sales
Prizes	1,460.0	60
Education	702.3	29
Bonuses	150.0	6
Expenses	124.3	5
Total	2,436.6	100

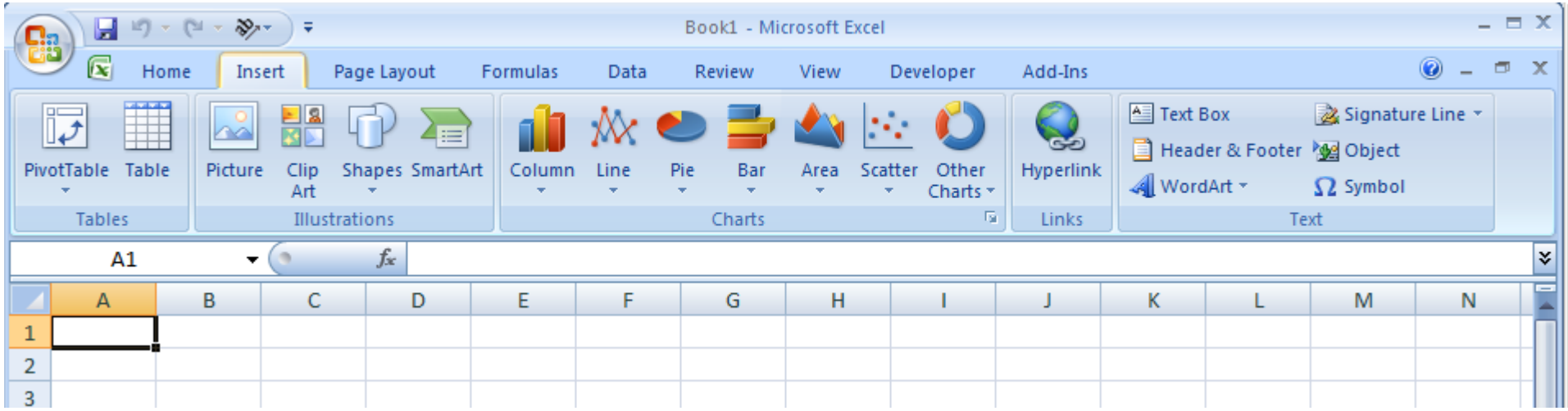


LO3

Pie Chart Using Excel

	A	B	C
1	Use of Sales	Amount ($ Millions)	Percent
2	Prizes	1460.0	60%
3	Education	702.3	29%
4	Bonuses	150.0	6%
5	Expenses	124.3	5%
6	Total	2436.6	100%
7			
8			
9			
10			
11			
12			
13			
14			





Bar Chart and Pie Chart Example

SkiLodges.com is test marketing its new website and is interested in how easy its Web page design is to navigate. It randomly selected 200 regular Internet users and asked them to perform a search task on the Web page. Each person was asked to rate the relative ease of navigation as poor, good, excellent, or awesome. The results are shown in the table on the right.

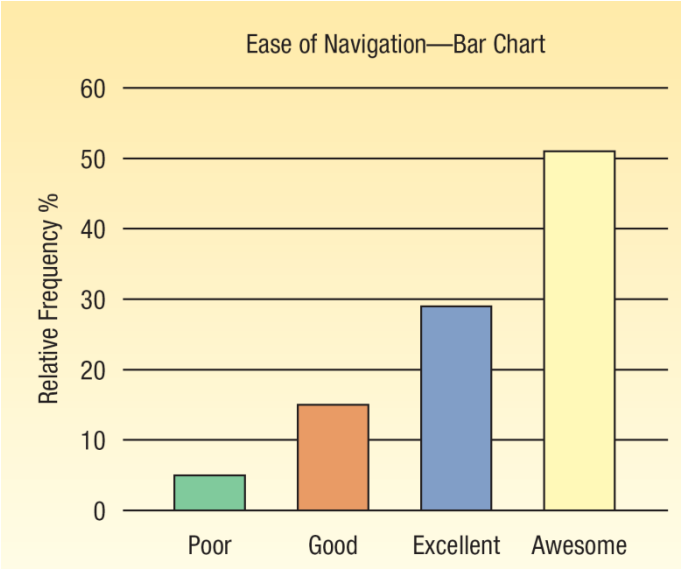
Awesome	102
Excellent	58
Good	30
Poor	10

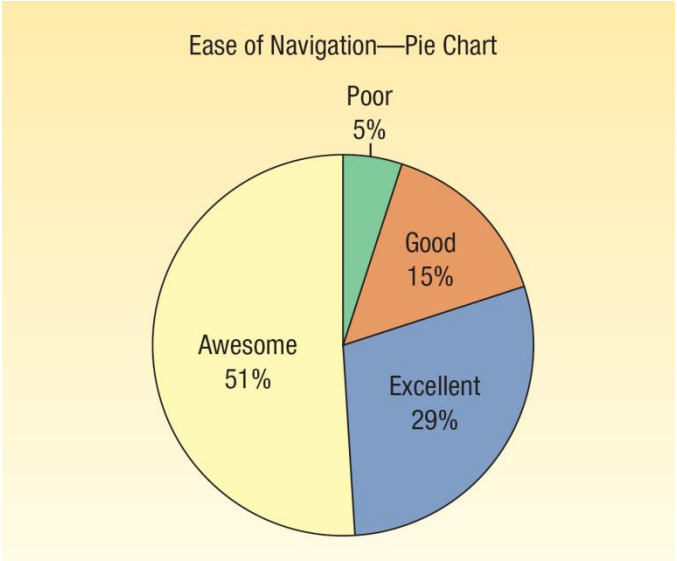
1. What type of measurement scale is used for ease of navigation?
2. Draw a bar chart for the survey results.
3. Draw a pie chart for the survey results.

Bar Chart and Pie Chart Example – Ski Lodges.Com

LO2 and LO3

Awesome	102
Excellent	58
Good	30
Poor	10





1. What type of measurement scale is used for ease of navigation?
2. Draw a bar chart for the survey results.
3. Draw a pie chart for the survey results.

LO5 Understand a relative frequency distribution.

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

LO5

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

LO6 Present data from a frequency distribution in a histogram or frequency polygon.

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					

LO6

Constructing a Frequency Table - Example

- **Step 1: Decide on the number of classes.**

  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 $n = 180$. If we try $k = 7$, then $2^7 = 128$, somewhat less than 180. Hence, 7 is not enough classes. If we let $k = 8$, then $2^8 = 256$, which is greater than 180. So the recommended number of classes is 8.

- **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

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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

- **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	𝍸 III
600 up to 1,000	𝍸 𝍸 I
1,000 up to 1,400	𝍸 𝍸 𝍸 𝍸 III
1,400 up to 1,800	𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 III
1,800 up to 2,200	𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸
2,200 up to 2,600	𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 II
2,600 up to 3,000	𝍸 𝍸 𝍸 IIII
3,000 up to 3,400	IIII
Total	

- **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

LO6

Constructing a Frequency Table

- **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	𝍸 III
600 up to 1,000	𝍸 𝍸 I
1,000 up to 1,400	𝍸 𝍸 𝍸 𝍸 III
1,400 up to 1,800	𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 III
1,800 up to 2,200	𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸
2,200 up to 2,600	𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 II
2,600 up to 3,000	𝍸 𝍸 𝍸 IIII
3,000 up to 3,400	IIII
Total	

- **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

- Between $1000 and $3000 the profit on 157 vehicles (87%) was within this range
- The largest concentration was between 1800 and 2200. There is 45 observations, Typical profit is $2000

LO6

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

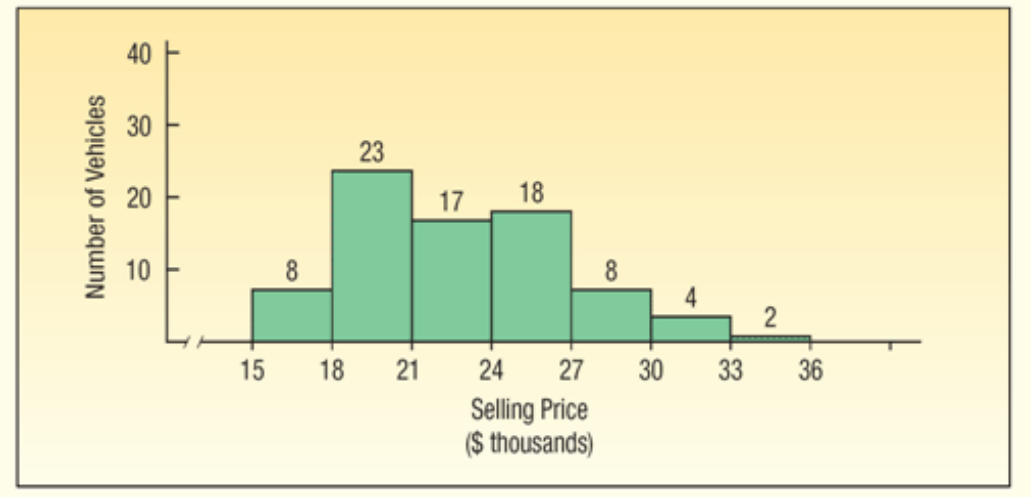
Profit	Frequency	Relative Frequency	Found by
$ 200 up to $ 600	8	.044	8/180
600 up to 1,000	11	.061	11/180
1,000 up to 1,400	23	.128	23/180
1,400 up to 1,800	38	.211	38/180
1,800 up to 2,200	45	.250	45/180
2,200 up to 2,600	32	.178	32/180
2,600 up to 3,000	19	.106	19/180
3,000 up to 3,400	4	.022	4/180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

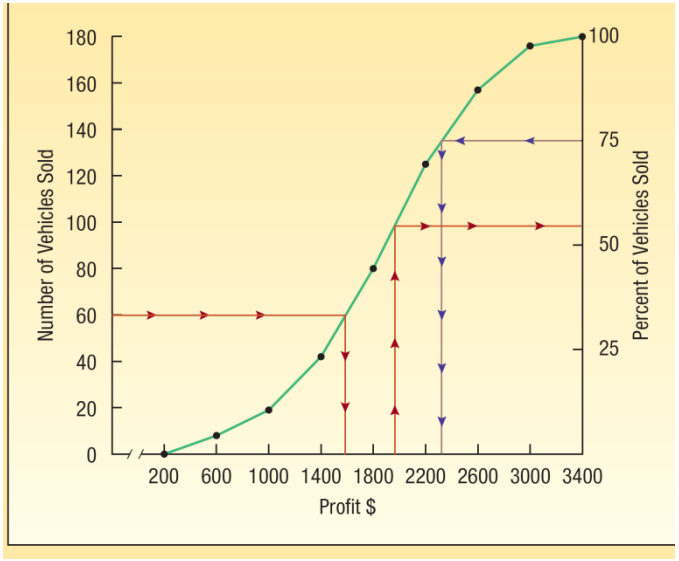
LO6

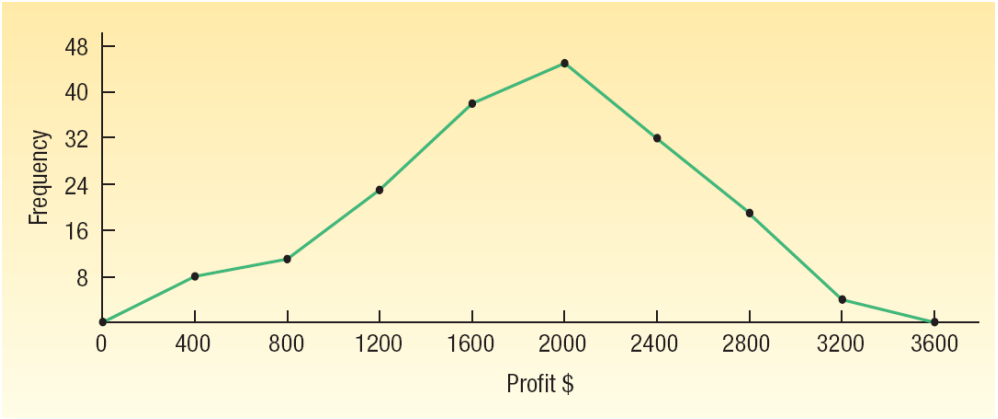
Graphic Presentation of a Frequency Distribution

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.

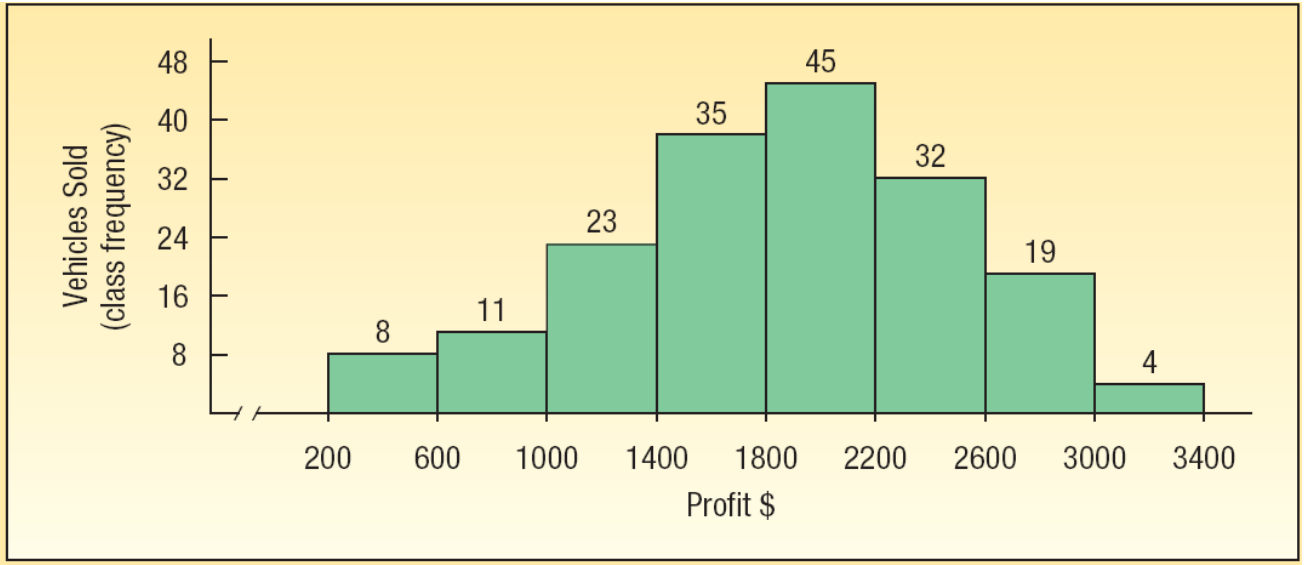


CHART 2–4 Histogram of the Profit on 180 Vehicles Sold at the Applewood Auto Group

LO6

Histogram Using Excel

	A	B	C	D	E	F	G	H	I
3									
4	$1,387	$2,148	$2,201	963	820	$2,230	$3,043	$2,584	$2,370
5	1,754	2,207	996	1,298	1,266	2,341	1,059	2,666	2,637
6	1,817	2,252	2,813	1,410	1,741	3,292	1,674	2,991	1,426
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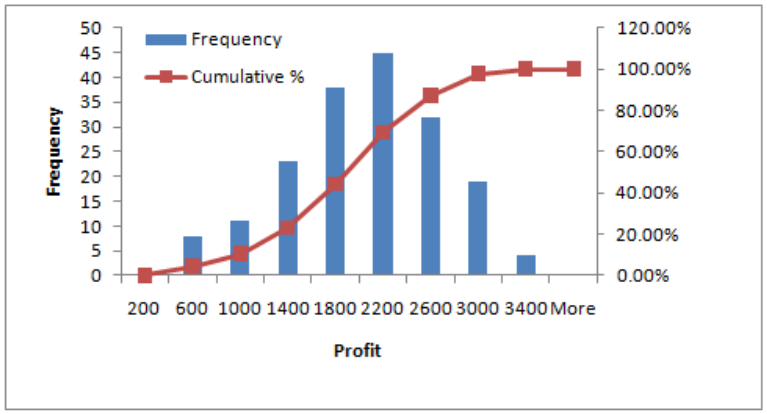
22	2,415	2,119	2,389	2,445	1,461	2,059	2,175	1,752	1,821
23	1,546	1,766	335	2,886	1,731	2,338	1,118	2,058	2,487
24									
25									
26									
27									
28									

Profit	*Frequency*	*Cumulative %*
200	0	0.00%
600	8	4.44%
1000	11	10.56%
1400	23	23.33%
1800	38	44.44%
2200	45	69.44%
2600	32	87.22%
3000	19	97.78%
3400	4	100.00%
More	0	100.00%



LO6

Frequency Polygon

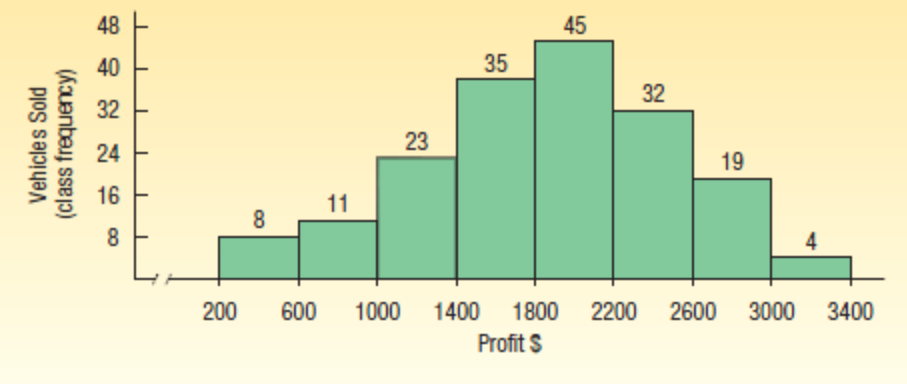
- A **frequency polygon,** similar to a histogram, also shows the shape of a distribution

- It consists of line segments connecting the class midpoints of the class frequencies.

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

Histogram Versus 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.



LO6

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

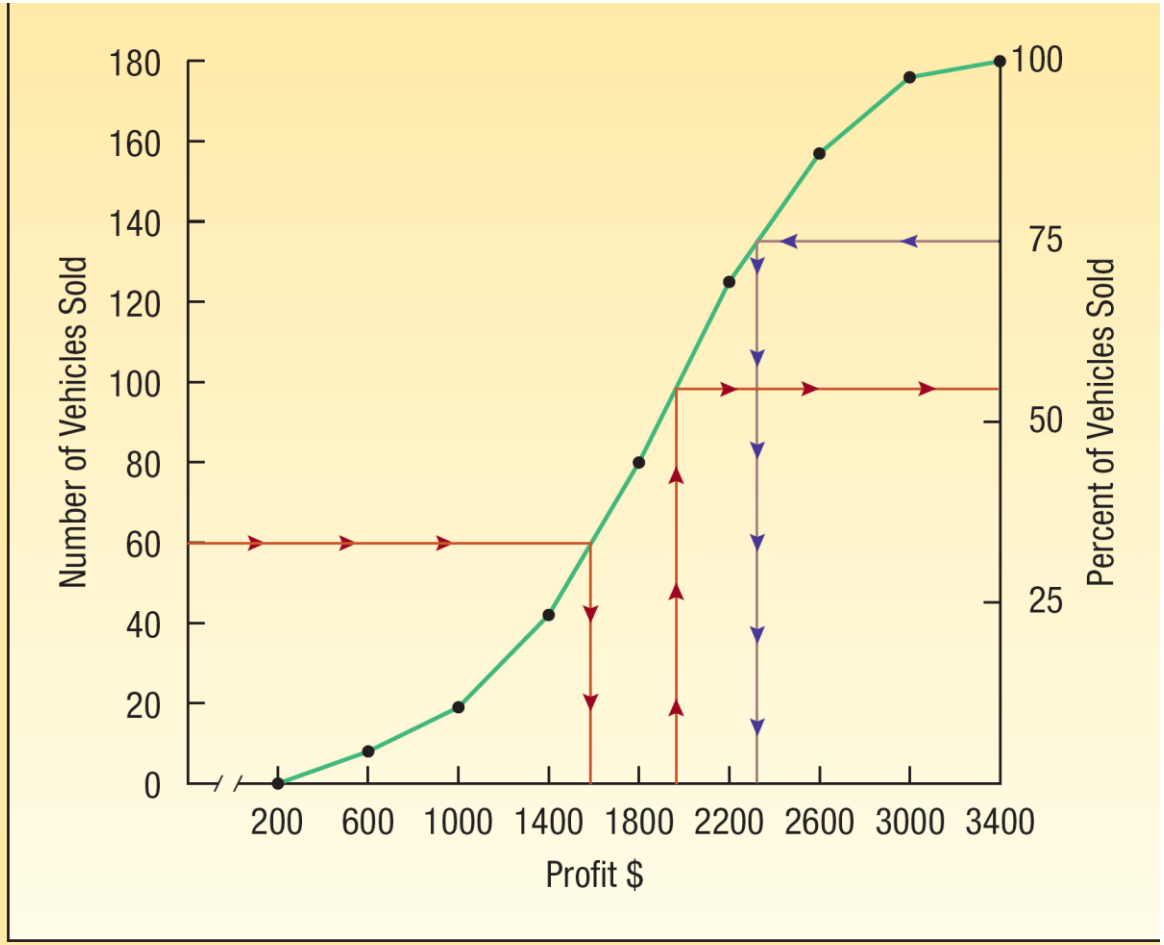


CHART 2–7 Cumulative Frequency Distribution for Vehicle Profit