Essentials of Statistics for Business and Economics 8th edition Anderson Solutions Manual

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Chapter 2
Descriptive Statistics: Tabular and Graphical Displays

Learning Objectives

1. Learn how to construct and interpret summarization procedures for qualitative data such as: frequency and relative frequency distributions, bar graphs and pie charts.

2. Learn how to construct and interpret tabular summarization procedures for quantitative data such as: frequency and relative frequency distributions, cumulative frequency and cumulative relative frequency distributions.

3. Learn how to construct a dot plot and a histogram as graphical summaries of quantitative data.

4. Learn how the shape of a data distribution is revealed by a histogram. Learn how to recognize when a data distribution is negatively skewed, symmetric, and positively skewed.

5. Be able to use and interpret the exploratory data analysis technique of a stem-and-leaf display.

6. Learn how to construct and interpret cross tabulations, scatter diagrams, side-by-side and stacked bar charts.

7. Learn best practices for creating effective graphical displays and for choosing the appropriate type of display.

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Solutions:

1.

Class	Frequency	Relative Frequency
A	60	60/120 = 0.50
B	24	24/120 = 0.20
C	36	36/120 = 0.30
	120	1.00

2. a. 1 – (.22 + .18 + .40) = .20

   b. .20(200) = 40

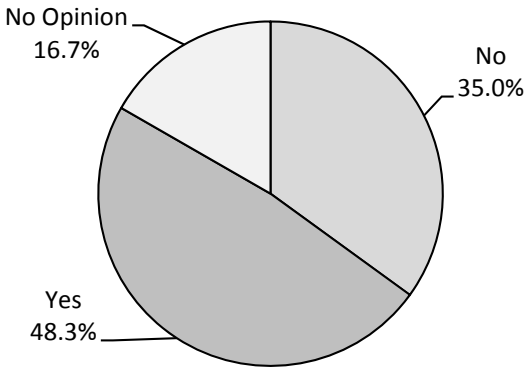
   c/d.

Class	Frequency	Percent Frequency
A	.22(200) = 44	22
B	.18(200) = 36	18
C	.40(200) = 80	40
D	.20(200) = 40	20
Total	200	100

3. a. 360° x 58/120 = 174°

   b. 360° x 42/120 = 126°

   c.



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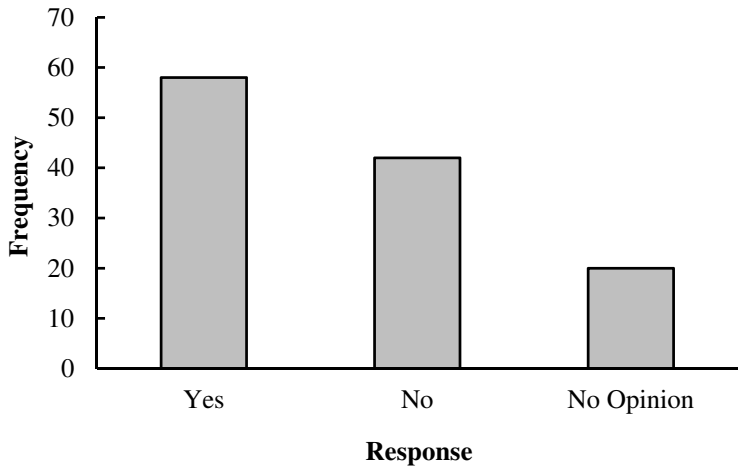
d.

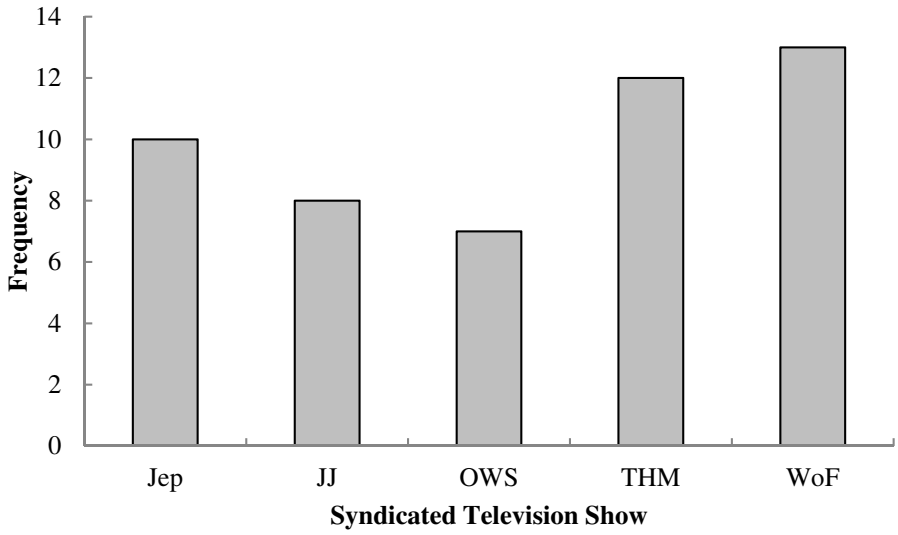


4. a. These data are categorical.

b.

Show	Relative Frequency	% Frequency
Jep	10	20
JJ	8	16
OWS	7	14
THM	12	24
WoF	13	26
Total	50	100

c.



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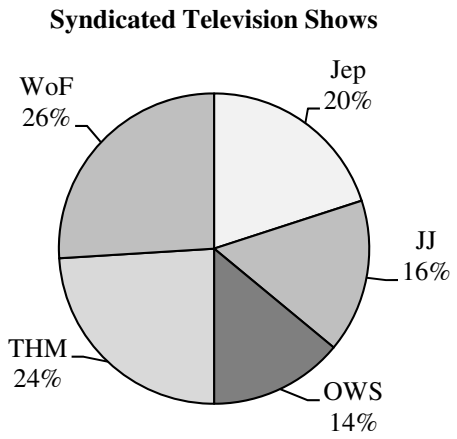
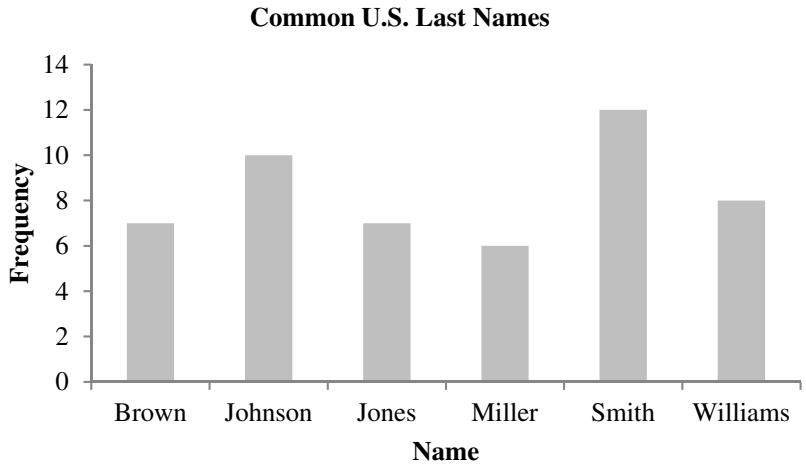


d. The largest viewing audience is for *Wheel of Fortune* and the second largest is for *Two and a Half Men*.

5. a.

Name	Frequency	Relative Frequency	Percent Frequency
Brown	7	0.14	14%
Johnson	10	0.20	20%
Jones	7	0.14	14%
Miller	6	0.12	12%
Smith	12	0.24	24%
Williams	8	0.16	16%
Total:	50	1	100%

b.



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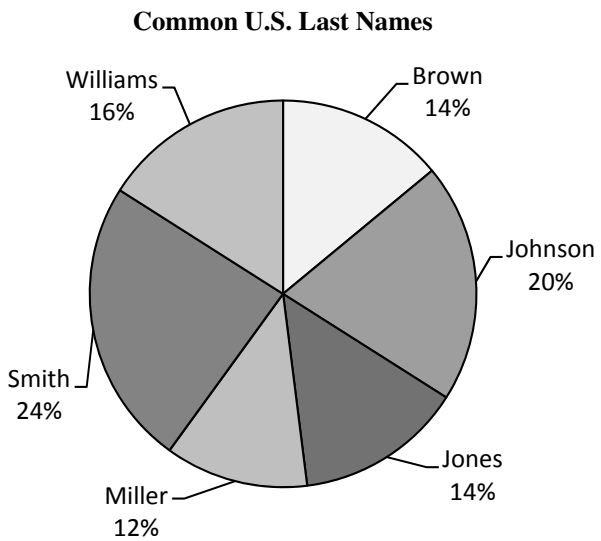
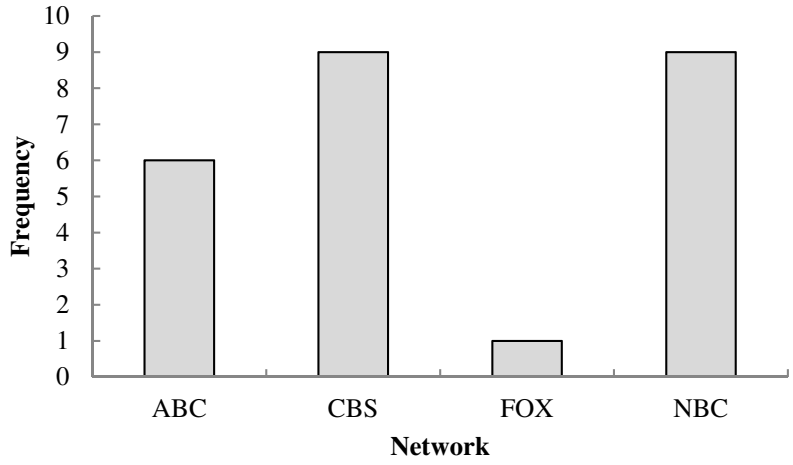
c.



d. The three most common last names are Smith (24%), Johnson (20%), Williams (16%)

6. a.

Network	Relative Frequency	% Frequency
ABC	6	24
CBS	9	36
FOX	1	4
NBC	9	36
Total:	25	100



b. For these data, NBC and CBS tie for the number of top-rated shows. Each has 9 (36%) of the top 25. ABC is third with 6 (24%) and the much younger FOX network has 1(4%).

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7. a.

Rating	Frequency	Percent Frequency
Excellent	20	40
Very Good	23	46
Good	4	8
Fair	1	2
Poor	2	4
	50	100

Management should be very pleased with the survey results. 40% + 46% = 86% of the ratings are very good to excellent. 94% of the ratings are good or better. This does not look to be a Delta flight where significant changes are needed to improve the overall customer satisfaction ratings.

b. While the overall ratings look fine, note that one customer (2%) rated the overall experience with the flight as Fair and two customers (4%) rated the overall experience with the flight as Poor. It might be insightful for the manager to review explanations from these customers as to how the flight failed to meet expectations. Perhaps, it was an experience with other passengers that Delta could do little to correct or perhaps it was an isolated incident that Delta could take steps to correct in the future.

8. a.

Position	Frequency	Relative Frequency
Pitcher	17	0.309
Catcher	4	0.073
1st Base	5	0.091
2nd Base	4	0.073
3rd Base	2	0.036
Shortstop	5	0.091
Left Field	6	0.109
Center Field	5	0.091
Right Field	7	0.127
	55	1.000

b. Pitchers (Almost 31%)

c. 3rd Base (3 – 4%)

d. Right Field (Almost 13%)

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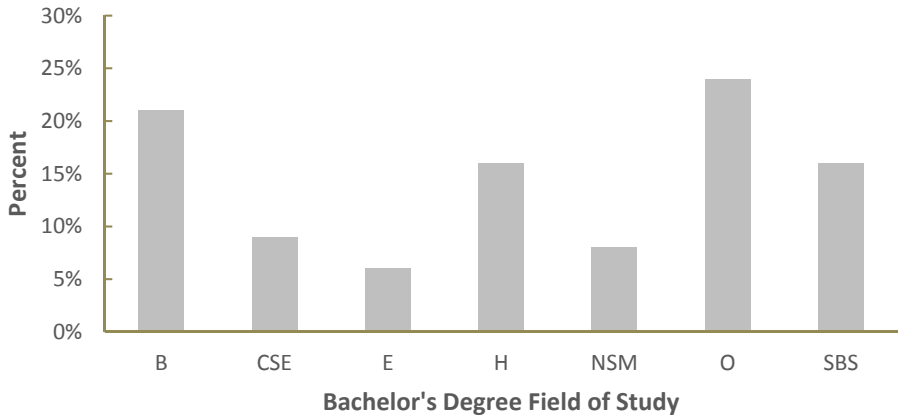
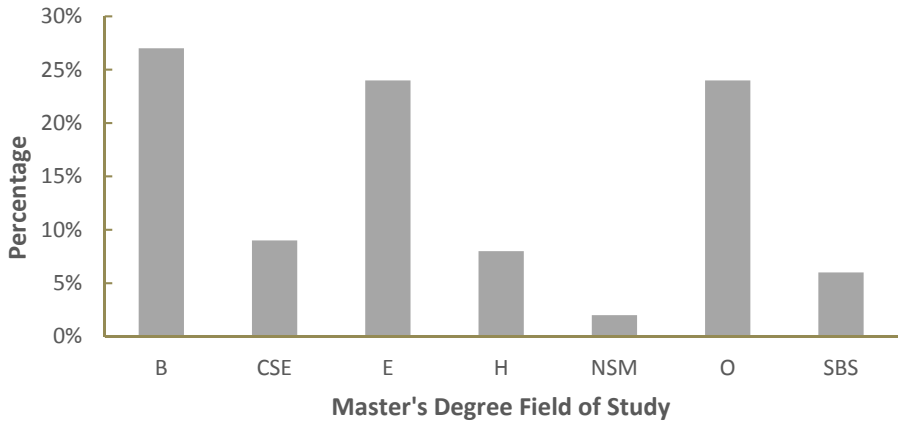
e. Infielders (16 or 29.1%) to Outfielders (18 or 32.7%)

9. a.

	Bachelor's	Master's
B	21%	27%
CSE	9%	9%
E	6%	24%
H	16%	8%
NSM	8%	2%
SBS	16%	6%
O	24%	24%
Total	100%	100%

b.





c. The lowest percentage for a Bachelor's is Education (6%) and for Master's Natural Sciences and Mathematics (2%).

d. The highest percentage for a Bachelor's is Other (24%) and for a Master's is Business (27%).

e.

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	Bachelor's	Master's	Difference
B	21%	27%	6%
CSE	9%	9%	0%
E	6%	24%	18%
H	16%	8%	-8%
NSM	8%	2%	-6%
SBS	16%	6%	-10%
O	24%	24%	- 0%

Education has the largest increase in percent: 18%

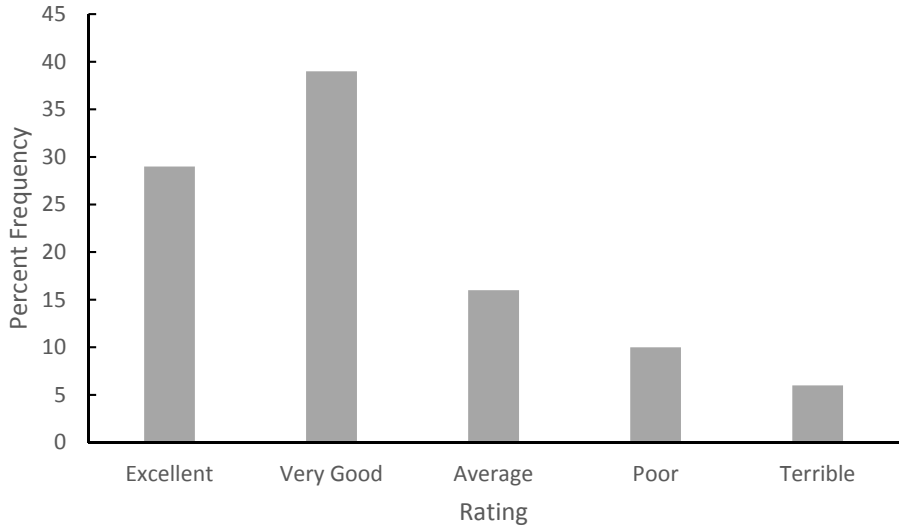
10. a.

Rating	Frequency
Excellent	187
Very Good	252
Average	107
Poor	62
Terrible	41
Total	649

b.

Rating	Percent Frequency
Excellent	29
Very Good	39
Average	16
Poor	10
Terrible	6
Total	100

c.



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d. 29% + 39% = 68% of the guests at the Sheraton Anaheim Hotel rated the hotel as Excellent or Very Good. But, 10% + 6% = 16% of the guests rated the hotel as poor or terrible.

e. The percent frequency distribution for Disney's Grand Californian follows:

Rating	Percent Frequency
Excellent	48
Very Good	31
Average	12
Poor	6
Terrible	3
Total	100

48% + 31% = 79% of the guests at the Sheraton Anaheim Hotel rated the hotel as Excellent or Very Good. And, 6% + 3% = 9% of the guests rated the hotel as poor or terrible.

Compared to ratings of other hotels in the same region, both of these hotels received very favorable ratings. But, in comparing the two hotels, guests at Disney's Grand Californian provided somewhat better ratings than guests at the Sheraton Anaheim Hotel.

11.

Class	Frequency	Relative Frequency	Percent Frequency
12–14	2	0.050	5.0
15–17	8	0.200	20.0
18–20	11	0.275	27.5
21–23	10	0.250	25.0
24–26	9	0.225	22.5
Total	40	1.000	100.0

12.

Class	Cumulative Frequency	Cumulative Relative Frequency
less than or equal to 19	10	.20
less than or equal to 29	24	.48
less than or equal to 39	41	.82
less than or equal to 49	48	.96
less than or equal to 59	50	1.00

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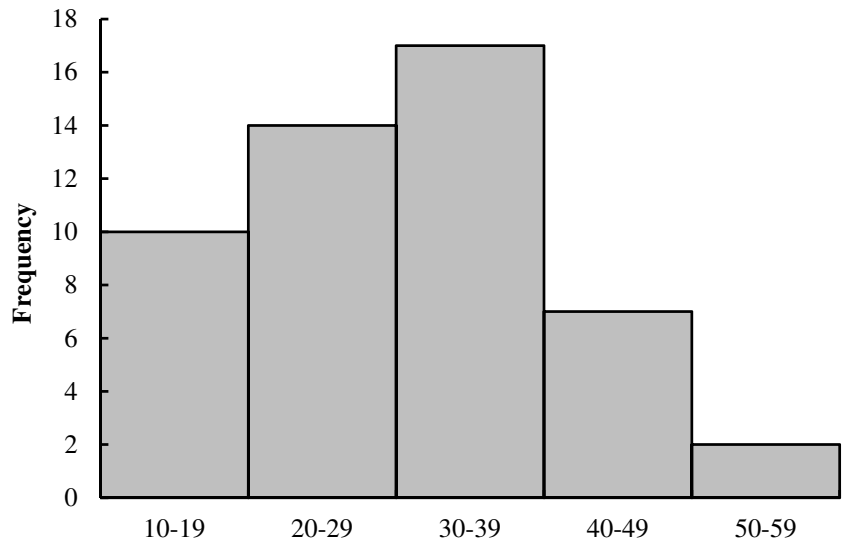
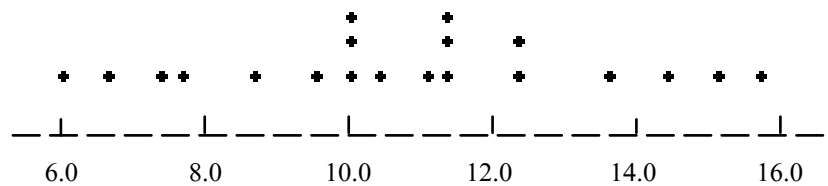
13.



14. a.



b/c.

Class	Frequency	Percent Frequency
6.0 – 7.9	4	20
8.0 – 9.9	2	10
10.0 – 11.9	8	40
12.0 – 13.9	3	15
14.0 – 15.9	3	15
	20	100

15. Leaf Unit = .1

6	3
7	5 5 7
8	1 3 4 8
9	3 6
10	0 4 5
11	3

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16. Leaf Unit = 10

11	6
12	0 2
13	0 6 7
14	2 2 7
15	5
16	0 2 8
17	0 2 3

17. a/b.

Waiting Time	Frequency	Relative Frequency
0 – 4	4	0.20
5 – 9	8	0.40
10 – 14	5	0.25
15 – 19	2	0.10
20 – 24	1	0.05
Totals	20	1.00

c/d.

Waiting Time	Cumulative Frequency	Cumulative Relative Frequency
Less than or equal to 4	4	0.20
Less than or equal to 9	12	0.60
Less than or equal to 14	17	0.85
Less than or equal to 19	19	0.95
Less than or equal to 24	20	1.00

e. 12/20 = 0.60

18. a.

PPG	**Frequency**
10-12	1
12-14	3
14-16	7
16-18	19
18-20	9
20-22	4
22-24	2
24-26	0
26-28	3
28-30	2
Total	50

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b.

PPG	Relative Frequency
10-12	0.02
12-14	0.06
14-16	0.14
16-18	0.38
18-20	0.18
20-22	0.08
22-24	0.04
24-26	0.00
26-28	0.06
28-30	0.04
Total	1.00

c.

PPG	Cumulative Percent Frequency
less than 12	2
less than 14	8
less than 16	22
less than 18	60
less than 20	78
less than 22	86
less than 24	90
less than 26	90
less than 28	96
less than 30	100

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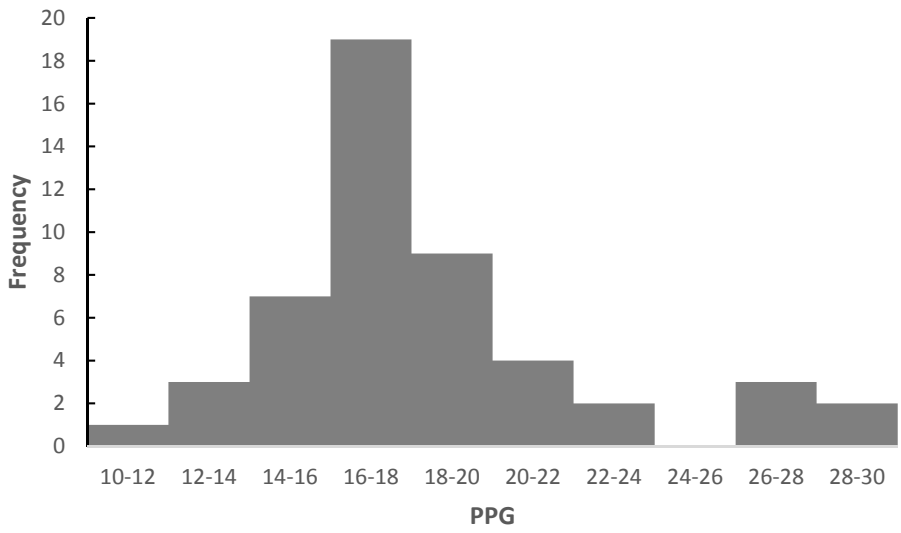
d.



e. There is skewness to the right.

f. (11/50)(100) = 22%

19. a. The largest number of tons is 236.3 million (South Louisiana). The smallest number of tons is 30.2 million (Port Arthur).

b.

Millions Of Tons	Frequency
25-50	11
50-75	9
75-100	2
100-125	0
125-150	1
150-175	0
175-200	0
200-225	0
225-250	2

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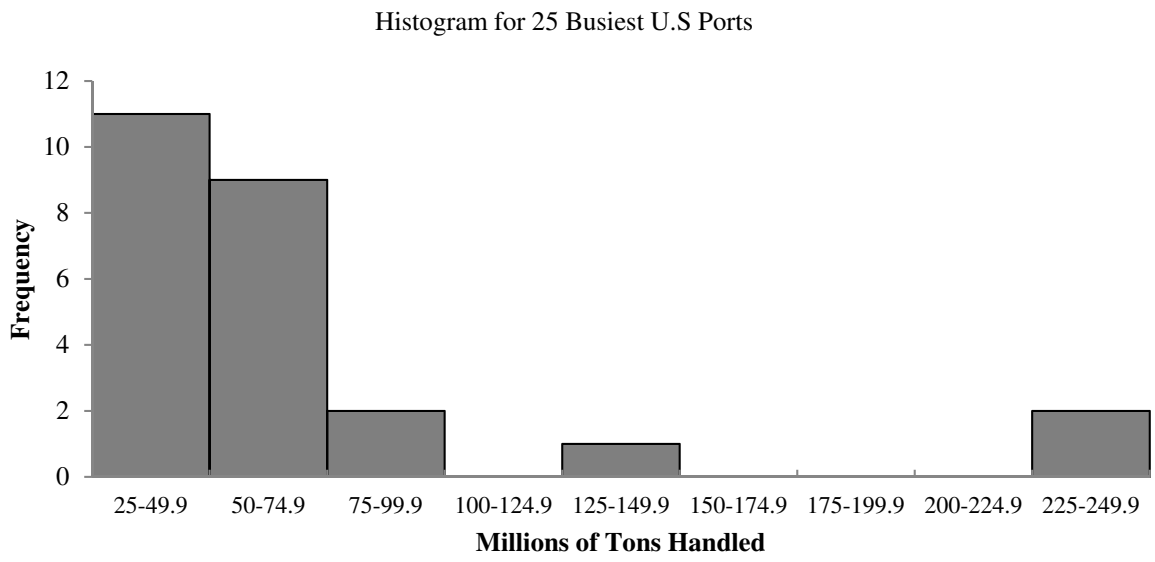
c.



Most of the top 25 ports handle less than 75 million tons. Only five of the 25 ports handle above 75 million tons.

20. a. Lowest = 12, Highest = 23

b.

Hours in Meetings per Week	Frequency	Percent Frequency
11-12	1	4%
13-14	2	8%
15-16	6	24%
17-18	3	12%
19-20	5	20%
21-22	4	16%
23-24	4	16%
	25	100%

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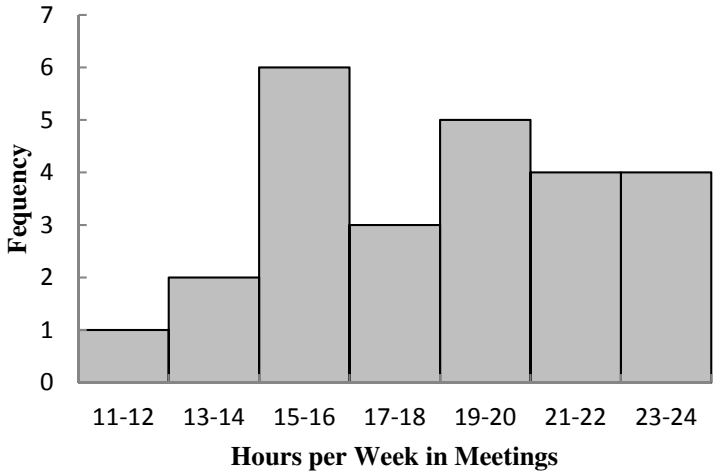

The distribution is slightly skewed to the left.

21. a/b/c/d.

Revenue	Frequency	Relative Frequency	Cumulative Frequency	Cumulative Relative Frequency
0-49	6	.12	6	.12
50-99	29	.58	35	.70
100-149	11	.22	46	.92
150-199	0	.00	46	.92
200-249	1	.02	47	.94
250-299	1	.02	48	.96
300-349	0	.00	48	.96
350-399	0	.00	48	.96
400-449	2	.04	50	1.00
Total	50	1.00		

e. The majority of the large corporations (40) have revenues in the $50 billion to $149 billion range. Only 4 corporations have revenues of over $200 billion and only 2 corporations have revenues over $400 billion. .70, or 70%, of the corporations have revenues under $100 billion. .30, or 30%, of the corporations have revenues of $100 billion or more.

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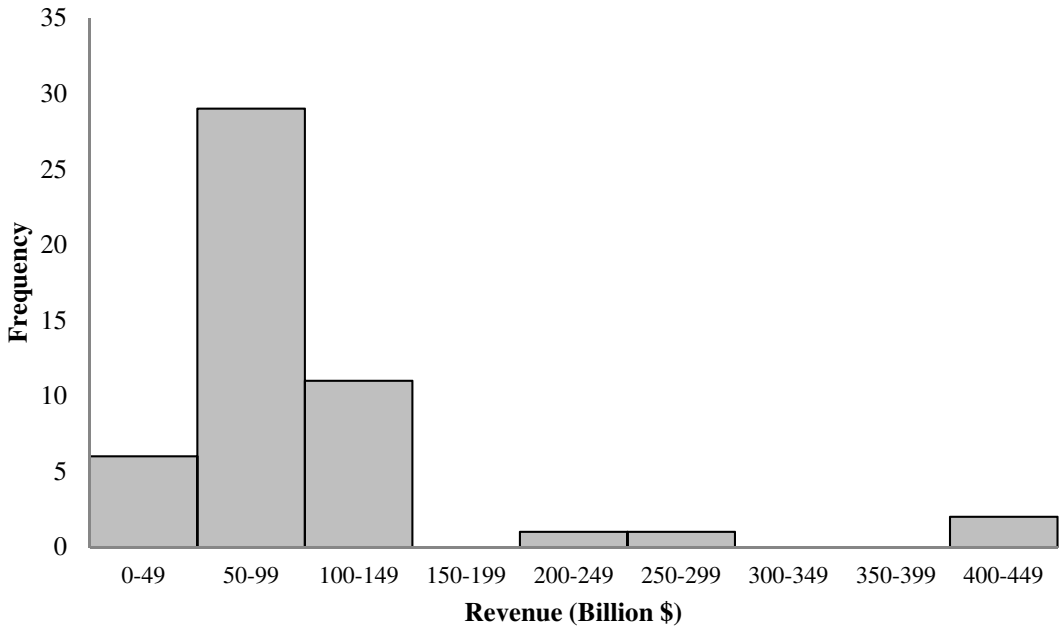
f.



The histogram shows the distribution is skewed to the right with four corporations in the $200 to $449 billion range.

g. Exxon-Mobil is America's largest corporation with an annual revenue of $443 billion. Walmart is the second largest corporation with an annual revenue of $406 billion. All other corporations have annual revenues less than $300 billion. Most (92%) have annual revenues less than $150 billion.

22. a.

# U.S. Locations	Frequency	Percent Frequency
0-4999	10	50
5000-9999	3	15
10000-14999	2	10
15000-19999	1	5
20000-24999	0	0
25000-29999	1	5
30000-34999	2	10
35000-39999	1	5
Total:	20	100

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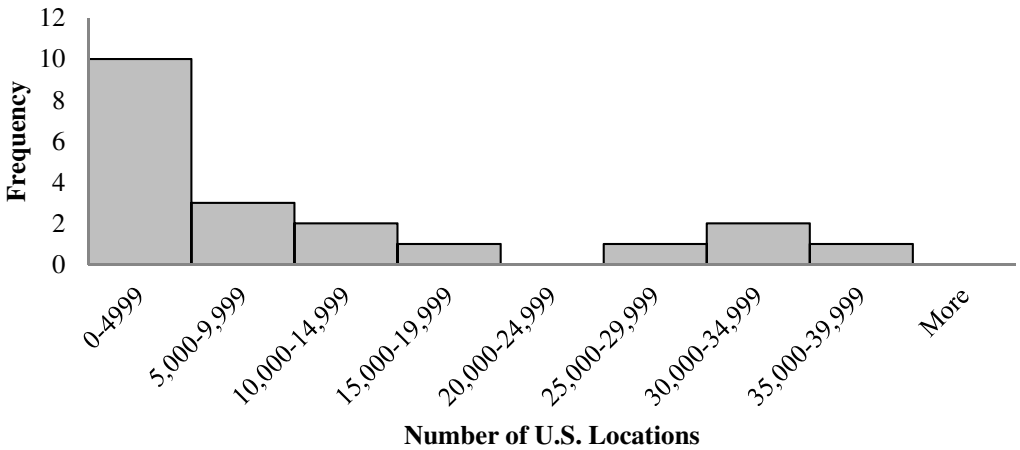
b.



c. The distribution is skewed to the right. The majority of the franchises in this list have fewer than 20,000 locations (50% + 15% + 15% = 80%). McDonald's, Subway and 7-Eleven have the highest number of locations.

23. a. The highest positive YTD % Change for Japan's Nikkei index with a YTD % Change of 31.4%.

b. A class size of 10 results in 10 classes.

YTD % Change	Frequency
-20--15	1
-15--10	1
-10--5	3
-5-0	3
0-5	4
5-10	5
10-15	8
15-20	3
20-25	1
30-35	1

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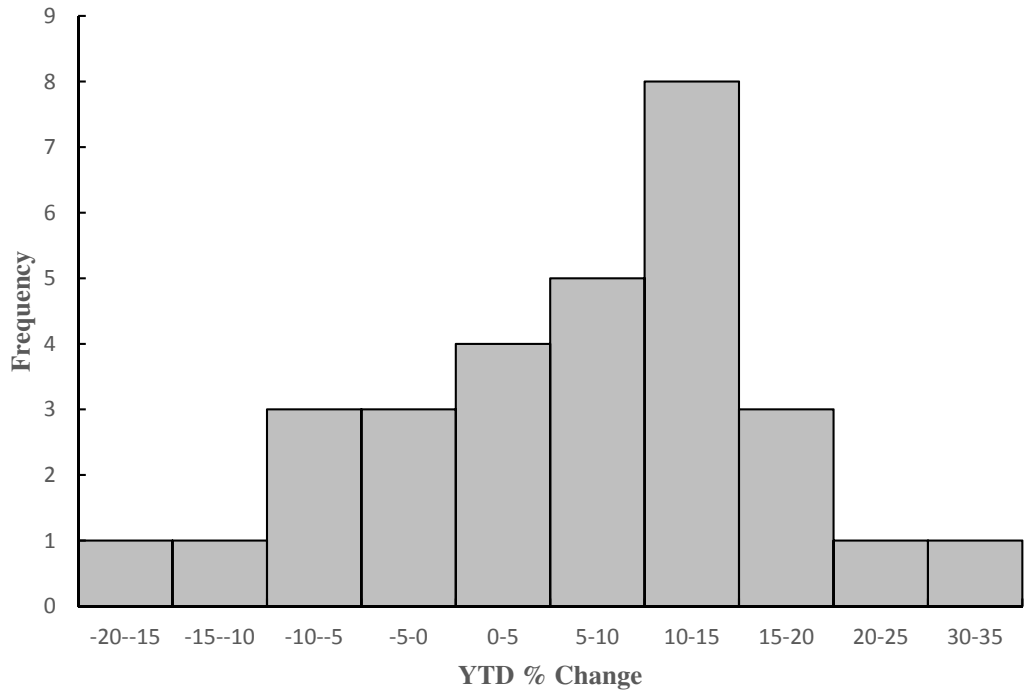

The general shape of the distribution is skewed to the left. Twenty two of the 30 indexes have a positive YTD % Change and 13 have a YTD % Change of 10% or more. Eight of the indexes had a negative YTD % Change.

d. A variety of comparisons are possible depending upon when the study is done.

24.

Starting Median Salary

4	6	8						
5	1	2	3	3	5	6	8	8
6	0	1	1	1	2	2		
7	1	2	5					

Mid-Career Median Salary

8	0	0	4		
9	3	3	5	6	7
10	5	6	6		
11	0	1	4	4	4
12	2	3	6		

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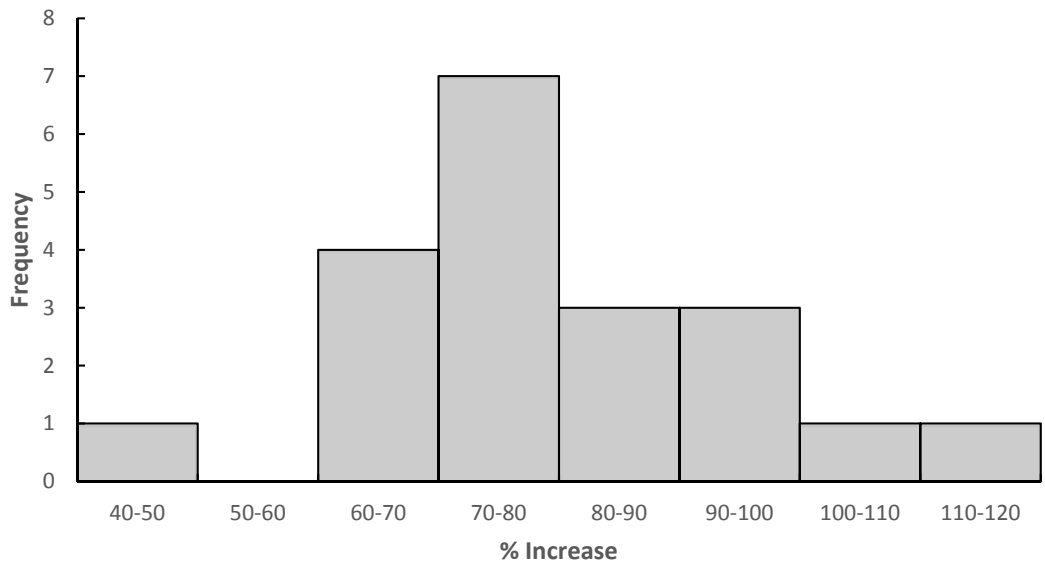
There is a wider spread in the mid-career median salaries than in the starting median salaries. Also, as expected, the mid-career median salaries are higher that the starting median salaries. The mid-career median salaries were mostly in the $93,000 to $114,000 range while the starting median salaries were mostly in the $51,000 to $62,000 range.

25. a.



b. The histogram is skewed to the right.

c.

4	3						
5							
6	1	3	7	9			
7	1	3	4	5	7	7	9
8	2	4	7				
9	0	3	6				
10	0						
11	3						

d. Rotating the stem-and-leaf display counterclockwise onto its side provides a picture of the data that is similar to the histogram as shown in part (a). Although the stem-and-leaf display may appear to offer the same information as a histogram, it has two primary advantages: the stem-and-leaf display is easier to construct by hand; and the stem-and-leaf display provides more information than the histogram because the stem-and-leaf shows the actual data.

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26. a.

2	1 4
2	6 7
3	0 1 1 1 2 3
3	5 6 7 7
4	0 0 3 3 3 3 3 4 4
4	6 6 7 9
5	0 0 0 2 2
5	5 6 7 9
6	1 4
6	6
7	2

b. Most frequent age group: 40-44 with 9 runners

c. 43 was the most frequent age with 5 runners

27. a.

		y		
		1	2	Total
	A	5	0	5
x	B	11	2	13
	C	2	10	12
	Total	18	12	30

b.

		y		
		1	2	Total
	A	100.0	0.0	100.0
x	B	84.6	15.4	100.0
	C	16.7	83.3	100.0

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c.

		y	
		1	2
	A	27.8	0.0
x	B	61.1	16.7
	C	11.1	83.3
	Total	100.0	100.0

d. Category A values for *x* are always associated with category 1 values for *y*. Category B values for *x* are usually associated with category 1 values for y. Category C values for *x* are usually associated with category 2 values for *y*.

28. a.

		y				
		20-39	40-59	60-79	80-100	Grand Total
	10-29			1	4	5
x	30-49	2		4		6
	50-69	1	3	1		5
	70-90	4				4
	Grand Total	7	3	6	4	20

b.

		y				
		20-39	40-59	60-79	80-100	Grand Total
	10-29			20.0	80.0	100
x	30-49	33.3		66.7		100
	50-69	20.0	60.0	20.0		100
	70-90	100.0				100

c.

		y			
		20-39	40-59	60-79	80-100
	10-29	0.0	0.0	16.7	100.0
x	30-49	28.6	0.0	66.7	0.0
	50-69	14.3	100.0	16.7	0.0
	70-90	57.1	0.0	0.0	0.0
	Grand Total	100	100	100	100

d. Higher values of x are associated with lower values of y and vice versa

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29. a.

	Average Miles per Hour					
Make	130-139.9	140-149.9	150-159.9	160-169.9	170-179.9	Total
Buick	100.00	0.00	0.00	0.00	0.00	100.00
Chevrolet	18.75	31.25	25.00	18.75	6.25	100.00
Dodge	0.00	100.00	0.00	0.00	0.00	100.00
Ford	33.33	16.67	33.33	16.67	0.00	100.00

b. 25.00 + 18.75 + 6.25 = 50 percent

c.

	Average Miles per Hour				
Make	130-139.9	140-149.9	150-159.9	160-169.9	170-179.9
Buick	16.67	0.00	0.00	0.00	0.00
Chevrolet	50.00	62.50	66.67	75.00	100.00
Dodge	0.00	25.00	0.00	0.00	0.00
Ford	33.33	12.50	33.33	25.00	0.00
Total	100.00	100.00	100.00	100.00	100.00

d. 75%

30. a.

	Year					
Average Speed	1988-1992	1993-1997	1998-2002	2003-2007	2008-2012	Total
130-139.9	16.7	0.0	0.0	33.3	50.0	100
140-149.9	25.0	25.0	12.5	25.0	12.5	100
150-159.9	0.0	50.0	16.7	16.7	16.7	100
160-169.9	50.0	0.0	50.0	0.0	0.0	100
170-179.9	0.0	0.0	100.0	0.0	0.0	100

b. It appears that most of the faster average winning times occur before 2003. This could be due to new regulations that take into account driver safety, fan safety, the environmental impact, and fuel consumption during races.

31. a. The crosstabulation of condition of the greens by gender is below.

	Green Condition		
Gender	Too Fast	Fine	Total
Male	35	65	100
Female	40	60	100
Total	75	125	200

The female golfers have the highest percentage saying the greens are too fast: 40/100 = 40%. Male golfers have 35/100 = 35% saying the greens are too fast.

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b. Among low handicap golfers, 1/10 = 10% of the women think the greens are too fast and 10/50 = 20% of the men think the greens are too fast. So, for the low handicappers, the men show a higher percentage who think the greens are too fast.

c. Among the higher handicap golfers, 39/51 = 43% of the woman think the greens are too fast and 25/50 = 50% of the men think the greens are too fast. So, for the higher handicap golfers, the men show a higher percentage who think the greens are too fast.

d. This is an example of Simpson's Paradox. At each handicap level a smaller percentage of the women think the greens are too fast. But, when the crosstabulations are aggregated, the result is reversed and we find a higher percentage of women who think the greens are too fast.

The hidden variable explaining the reversal is handicap level. Fewer people with low handicaps think the greens are too fast, and there are more men with low handicaps than women.

32. a. Row percentages are shown below.

Region	Under $15,000	$15,000 to $24,999	$25,000 to $34,999	$35,000 to $49,999	$50,000 to $74,999	$75,000 to $99,999	$100,000 and over	Total
Northeast	12.72	10.45	10.54	13.07	17.22	11.57	24.42	100.00
Midwest	12.40	12.60	11.58	14.27	19.11	12.06	17.97	100.00
South	14.30	12.97	11.55	14.85	17.73	11.04	17.57	100.00
West	11.84	10.73	10.15	13.65	18.44	11.77	23.43	100.00

The percent frequency distributions for each region now appear in each row of the table. For example, the percent frequency distribution of the West region is as follows:

Income Level	Percent Frequency
Under $15,000	11.84
$15,000 to $24,999	10.73
$25,000 to $34,999	10.15
$35,000 to $49,999	13.65
$50,000 to $74,999	18.44
$75,000 to $99,999	11.77
$100,000 and over	23.43
Total	100.00

b. West: 18.44 + 11.77 + 23.43 = 53.64%

South: 17.73 + 11.04 + 17.57 = 46.34%

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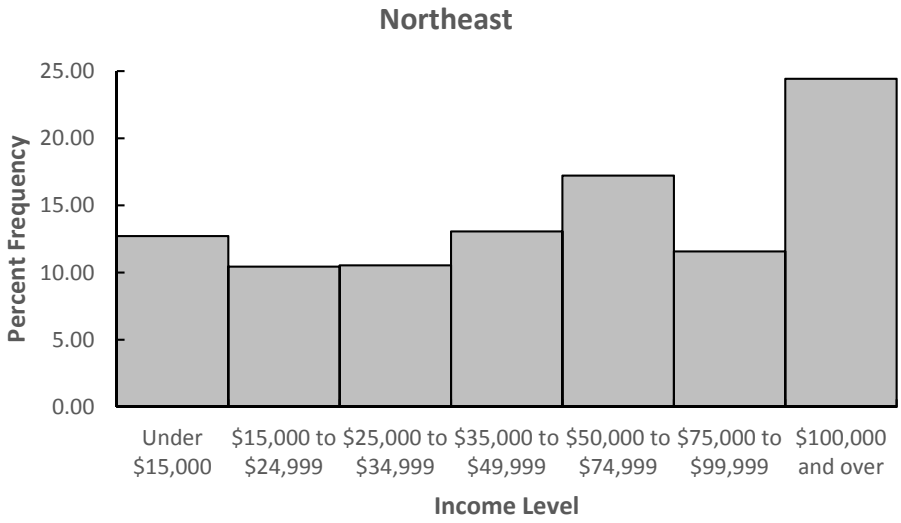
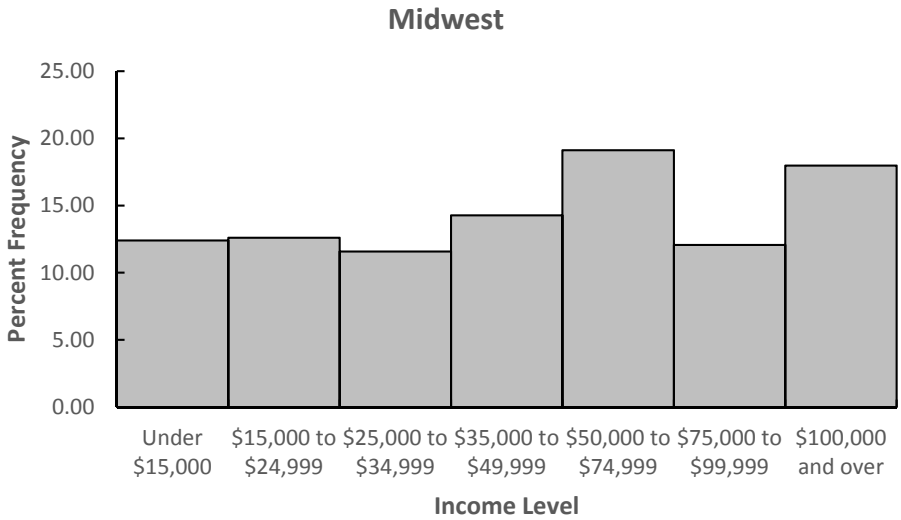
c.





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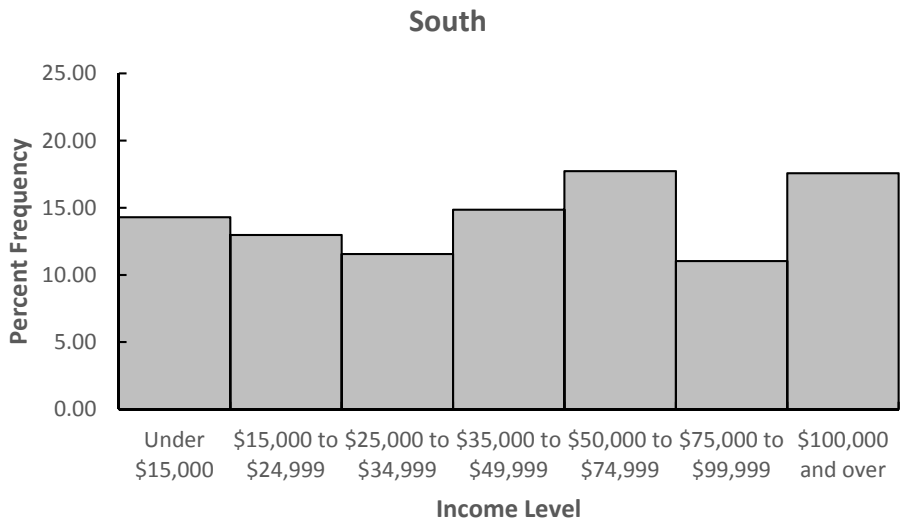

The largest difference appears to be a higher percentage of household incomes of $100,000 and over for the Northeast and West regions.

d. Column percentages are shown below.

Region	Under $15,000	$15,000 to $24,999	$25,000 to $34,999	$35,000 to $49,999	$50,000 to $74,999	$75,000 to $99,999	$100,000 and over
Northeast	17.83	16.00	17.41	16.90	17.38	18.35	22.09
Midwest	21.35	23.72	23.50	22.68	23.71	23.49	19.96
South	40.68	40.34	38.75	39.00	36.33	35.53	32.25
West	20.13	19.94	20.34	21.42	22.58	22.63	25.70
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00

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Each column is a percent frequency distribution of the region variable for one of the household income categories. For example, for an income level of $35,000 to $49,999 the percent frequency distribution for the region variable is as follows:

Region	Percent Frequency
Northeast	16.90
Midwest	22.68
South	39.00
West	21.42
Total	100.00

e. 32.25% of the households with a household income of $100,000 and over are from the South region. To determine the percentage of households from the South region that have a household income of $100,000 and over we need to look at the crosstabulation of row percentages.

Region	Under $15,000	$15,000 to $24,999	$25,000 to $34,999	$35,000 to $49,999	$50,000 to $74,999	$75,000 to $99,999	$100,000 and over	Total
Northeast	12.72	10.45	10.54	13.07	17.22	11.57	24.42	100.00
Midwest	12.40	12.60	11.58	14.27	19.11	12.06	17.97	100.00
South	14.30	12.97	11.55	14.85	17.73	11.04	17.57	100.00
West	11.84	10.73	10.15	13.65	18.44	11.77	23.43	100.00

The crosstabulation of row percentage shows that 17.57 of the households in the South region had a household income of $100,000 and over.

33. a.

	Brand Value ($ billions)						
Industry	0-10	10-20	20-30	30-40	40-50	50-60	Total
Automotive & Luxury	10	4	1				15
Consumer Packaged Goods	7	5					12
Financial Services	11	3					14
Other	14	10		2			26
Technology	7	4		1	1	2	15
Total	49	26	1	3	1	2	82

b.

Industry	Total
Automotive & Luxury	15
Consumer Packaged Goods	12
Financial Services	14
Other	26
Technology	15
Total	82

c.

Brand Value ($ billions)	Frequency
0-10	49

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10-20	26
20-30	1
30-40	3
40-50	1
50-60	2
Total	82

d. The right margin shows the frequency distribution for the fund type variable and the bottom margin shows the frequency distribution for the brand value.

e. Higher brand values are associated with the technology brands. For instance, the crosstabulation shows that 4 of the 15 technology brands (approximately 27%) had a brand value of $30 billion or higher.

34. a.

	Brand Revenue ($ billions)						
Industry	0-25	25-50	50-75	75-100	100-125	125-150	Total
Automotive & Luxury	10	1	1		1	2	15
Consumer Packaged Goods	12						12
Financial Services	2	4	2	2	2	2	14
Other	13	5	3	2	2	1	26
Technology	4	4	4	1	2		15
Total	41	14	10	5	7	5	82

b.

Brand Revenue ($ billions)	**Frequency**
0-25	41
25-50	14
50-75	10
75-100	5
100-125	7
125-150	5
Total	82

c. Consumer packaged goods have the lowest brand revenues; each of the 12 consumer packaged goods brands in the sample data had a brand revenue of less than $25 billion. Approximately 57% of the financial services brands (8 out of 14) had a brand revenue of $50 billion or greater, and 47% of the technology brands (7 out of 15) had a brand revenue of at least $50 billion.

d.

	1-Yr Value Change (%)						
Industry	-60--41	-40--21	-20--1	0-19	20-39	40-60	Total
Automotive & Luxury				11	4		15
Consumer Packaged Goods			2	10			12

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Financial Services		1	6	7			14
Other			2	20	4		26
Technology	1	3	4	4	2	1	15
Total	1	4	14	52	10	1	82

e.

1-Yr Value Change (%)	**Frequency**
-60--41	1
-40--21	4
-20--1	14
0-19	52
20-39	10
40-60	1
Total	82

f. The automotive & luxury brands all had a positive 1-year value change (%). The technology brands had the greatest variability.

35. a.

	Hwy MPG						
Size	15-19	20-24	25-29	30-34	35-39	40-44	Total
Compact	3	4	17	22	5	5	56
Large	2	10	7	3	2		24
Midsize	3	4	30	20	9	3	69
Total	8	18	54	45	16	8	149

b. Midsize and Compact seem to be more fuel efficient than Large.

c.

	City MPG						
Drive	10-14	15-19	20-24	25-29	30-34	40-44	Total
A	7	18	3				28
F		17	49	19	2	3	90
R	10	20		1			31
Total	17	55	52	20	2	3	149

d. Higher fuel efficiencies are associated with front wheel drive cars.

e.

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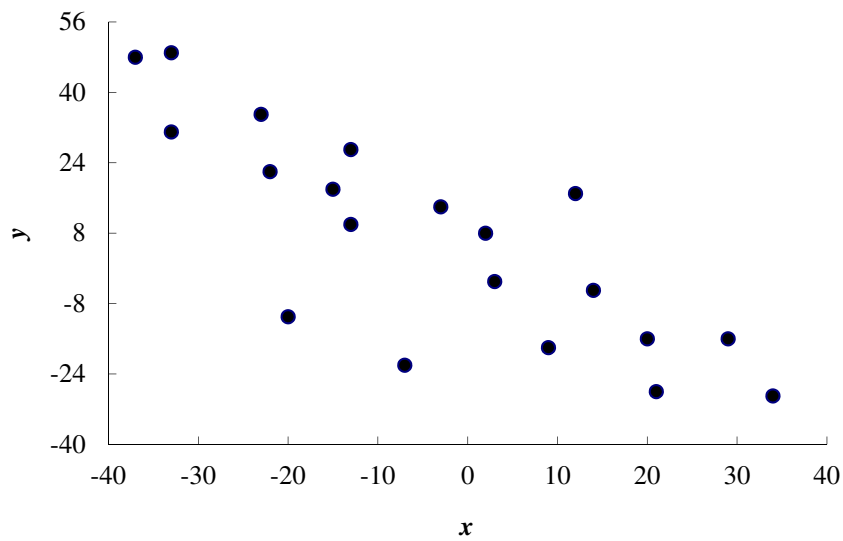
	City MPG						
Fuel Type	10-14	15-19	20-24	25-29	30-34	40-44	Total
P	17	24	12	3			56
R		31	40	17	2	3	93
Total	17	55	52	20	2	3	149

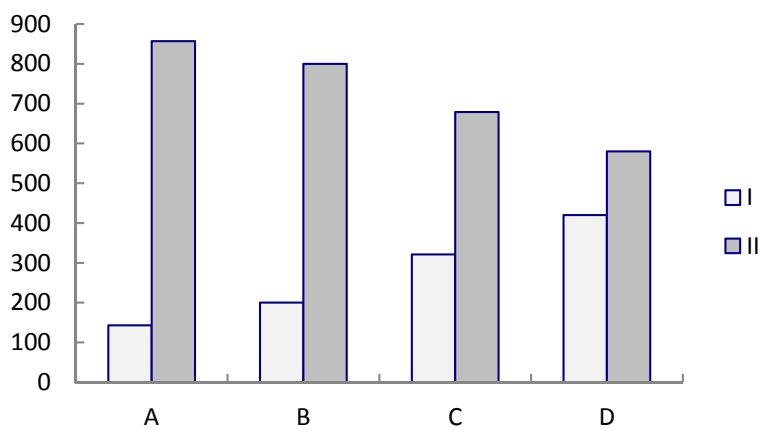
f. Higher fuel efficiencies are associated with cars that use regular gas.

36. a.



b. There is a negative relationship between *x* and *y; y* decreases as *x* increases.

37. a.



b. As X goes from A to D the frequency for I increases and the frequency of II decreases.

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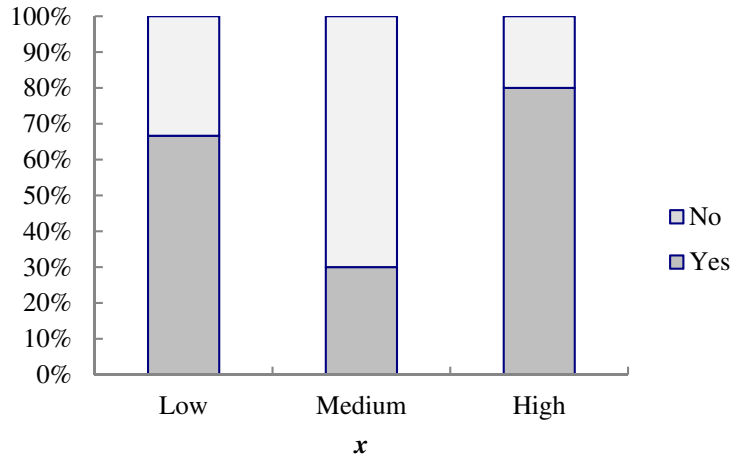
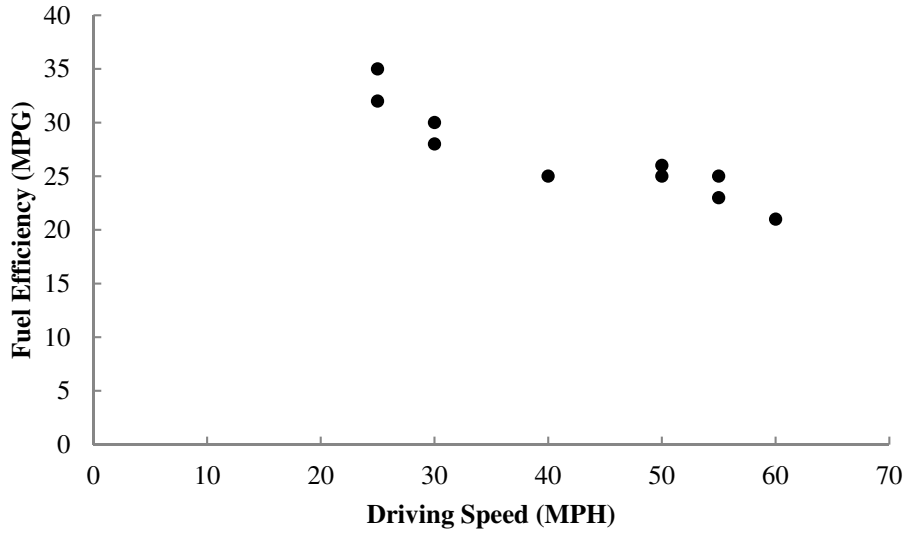
38. a.

		y		
		Yes	No	
x	Low	66.667	33.333	100
	Medium	30.000	70.000	100
	High	80.000	20.000	100

b.



39. a.



b. For midsized cars, lower driving speeds seem to yield higher miles per gallon.

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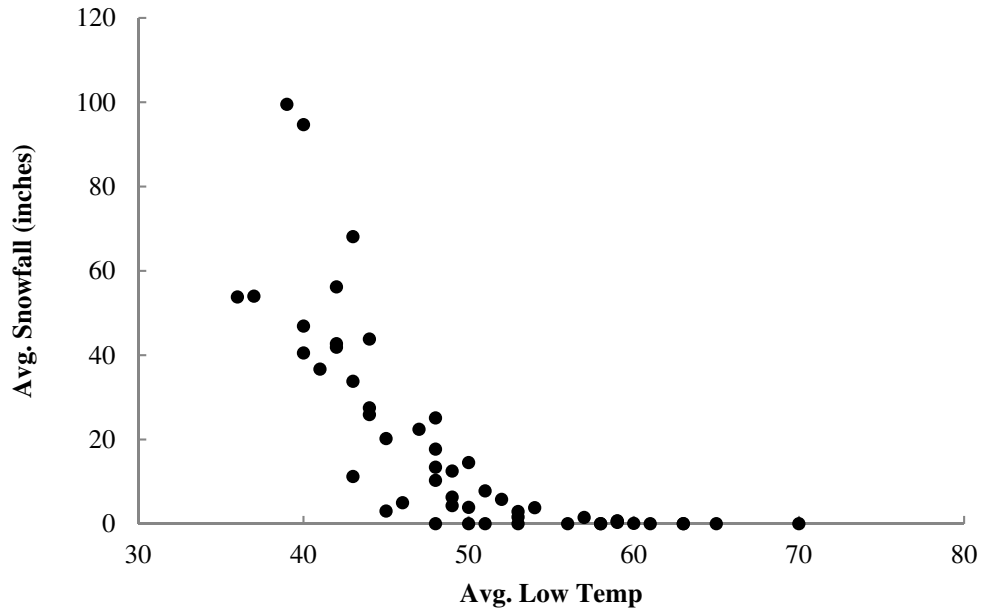
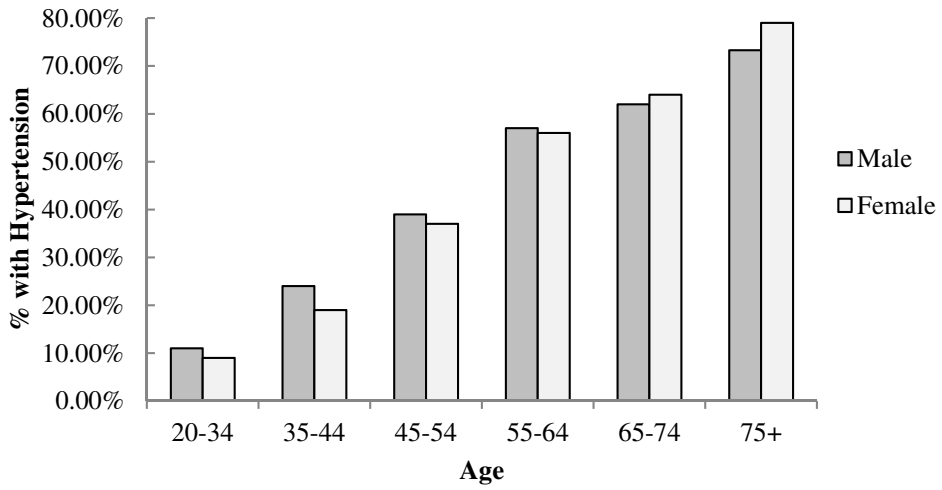
40. a.



b. Colder average low temperature seems to lead to higher amounts of snowfall.

c. Two cities have an average snowfall of nearly 100 inches of snowfall: Buffalo, N.Y and Rochester, NY. Both are located near large lakes in New York.

41. a.



b. The percentage of people with hypertension increases with age.

c. For ages earlier than 65, the percentage of males with hypertension is higher than that for females. After age 65, the percentage of females with hypertension is higher than that for males.

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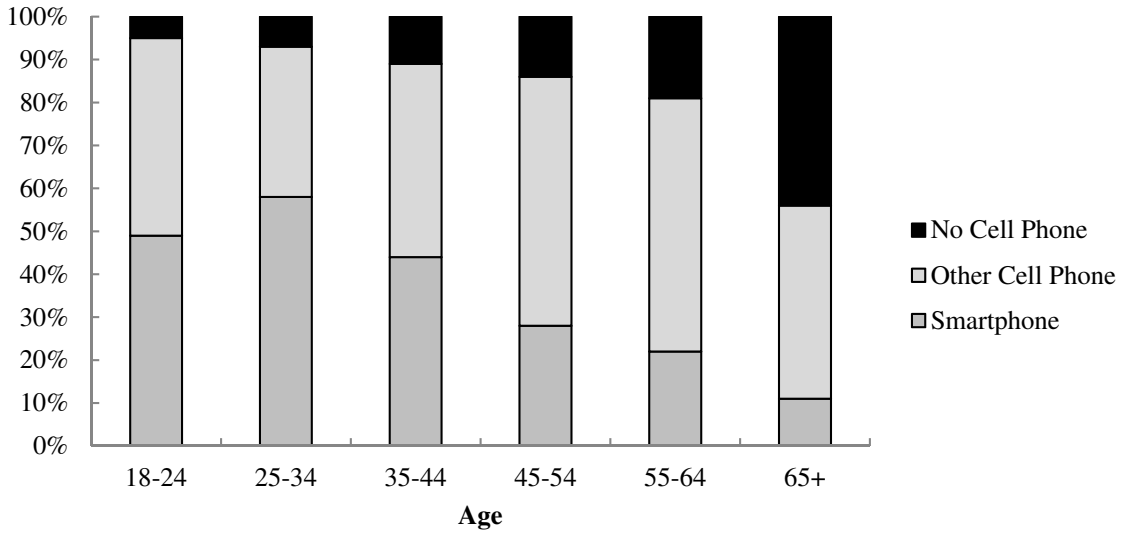
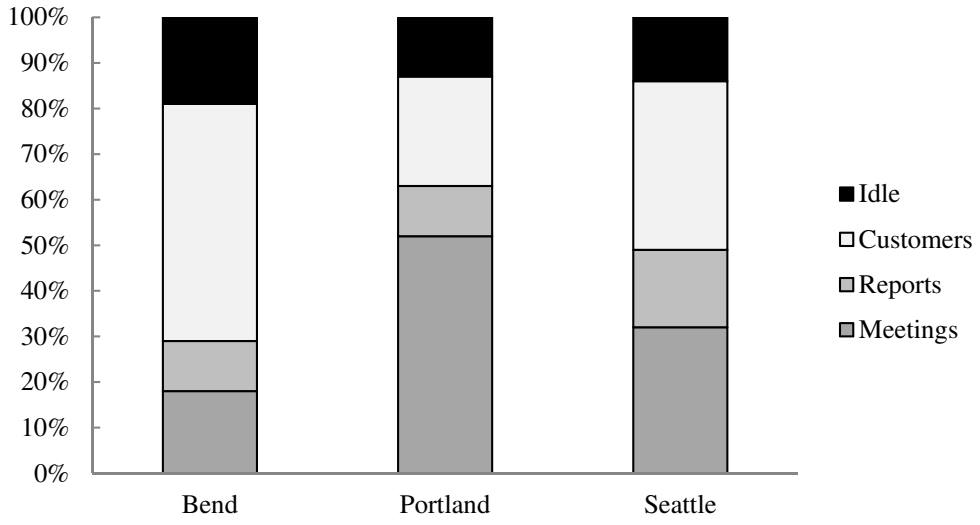
42. a.



b. After an increase in age 25-34, smartphone ownership decreases as age increases. The percentage of people with no cell phone increases with age. There is less variation across age groups in the percentage who own other cell phones.

c. Unless a newer device replaces the smartphone, we would expect smartphone ownership would become less sensitive to age. This would be true because current users will become older and because the device will become to be seen more as a necessity than a luxury.

43. a.



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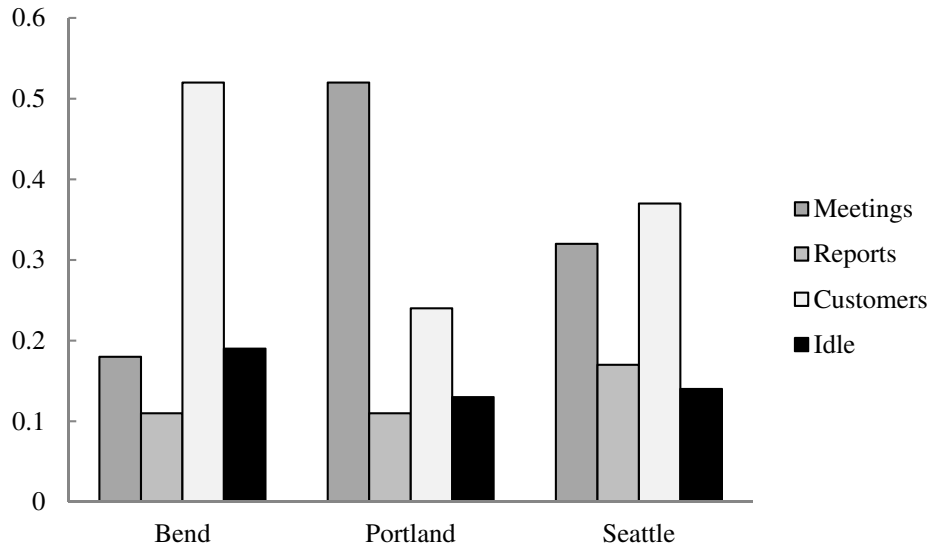
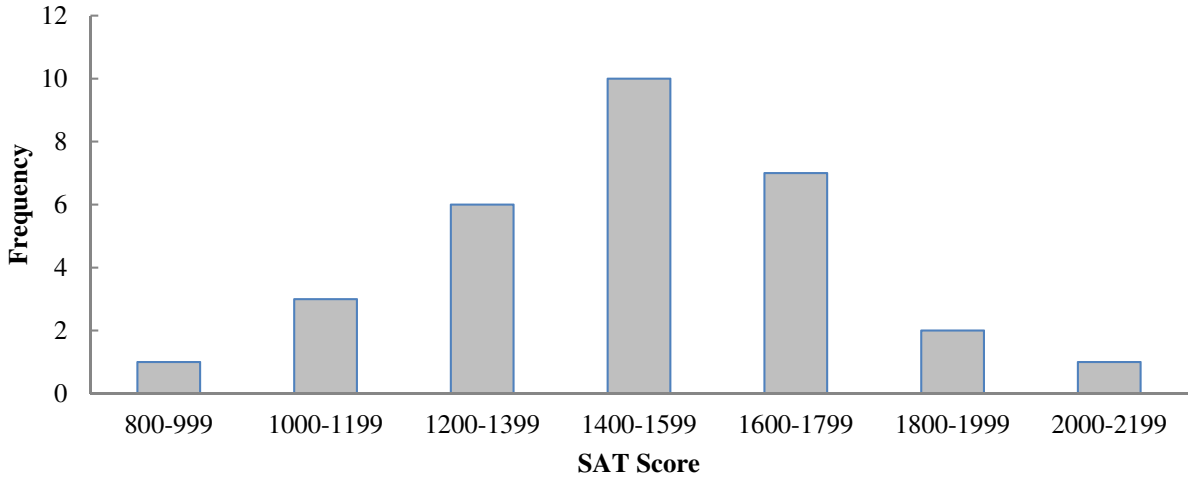
b.



c. The stacked bar chart seems simpler than the side-by-side bar chart and more easily conveys the differences in store managers' use of time.

44. a.

Class	Frequency
800-999	1
1000-1199	3
1200-1399	6
1400-1599	10
1600-1799	7
1800-1999	2
2000-2199	1
Total	30



b. The distribution if nearly symmetrical. It could be approximated by a bell-shaped curve.

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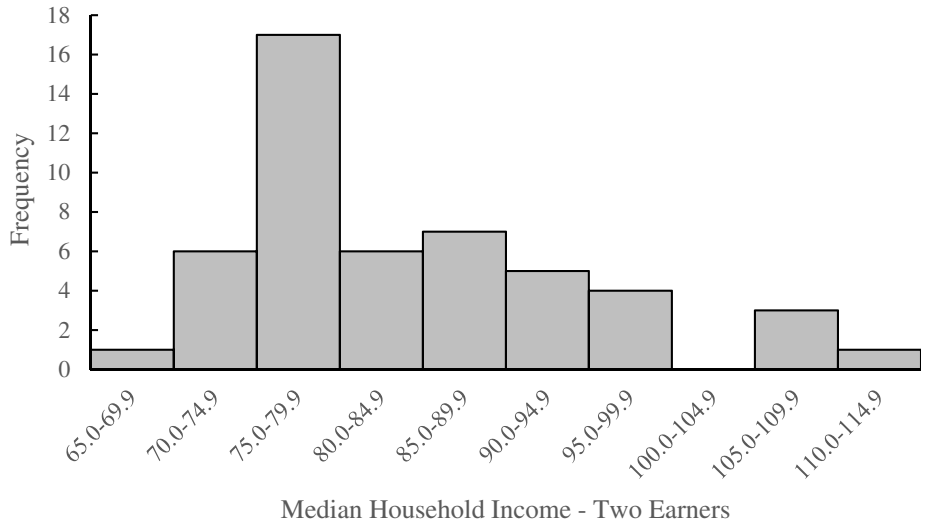
c. 10 of 30 or 33% of the scores are between 1400 and 1599. The average SAT score looks to be a little over 1500. Scores below 800 or above 2200 are unusual.

45. a.

Median Household Income	Frequency	Percent Frequency
65.0-69.9	1	2%
70.0-74.9	6	12%
75.0-79.9	17	34%
80.0-84.9	6	12%
85.0-89.9	7	14%
90.0-94.9	5	10%
95.0-99.9	4	8%
100.0-104.9	0	0%
105.0-109.9	3	6%
110.0-114.9	1	2%
	50	100%

b.



c. The distribution is skewed to the right. There is a gap in the $100.0-$104.9 range. The most frequent range for the median household income is $75.0-$79.9 thousand.

d. New Jersey $110.7 thousand

e. Idaho $67.1 thousand

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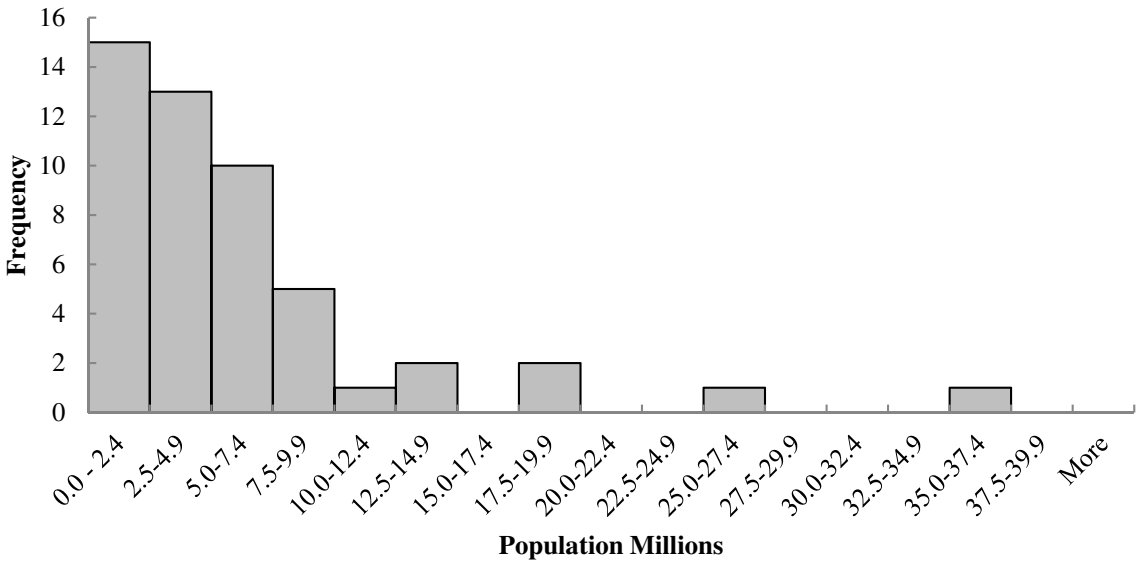
46. a.

Population in Millions	Frequency	% Frequency
0.0 - 2.4	15	30.0%
2.5-4.9	13	26.0%
5.0-7.4	10	20.0%
7.5-9.9	5	10.0%
10.0-12.4	1	2.0%
12.5-14.9	2	4.0%
15.0-17.4	0	0.0%
17.5-19.9	2	4.0%
20.0-22.4	0	0.0%
22.5-24.9	0	0.0%
25.0-27.4	1	2.0%
27.5-29.9	0	0.0%
30.0-32.4	0	0.0%
32.5-34.9	0	0.0%
35.0-37.4	1	2.0%
37.5-39.9	0	0.0%
More	0	0.0%



b. The distribution is skewed to the right.

c. 15 states (30%) have a population less than 2.5 million. Over half of the states have population less than 5 million (28 states – 56%). Only seven states have a population greater than 10 million (California, Florida, Illinois, New York, Ohio, Pennsylvania and Texas). The largest state is California (37.3 million) and the smallest states are Vermont and Wyoming (600 thousand).

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47. a.

```
 1   8
 2   014
 3   18
 4   007899
 5   012444578
 6   00139
 7   237888
 8   011
 9   1
10   3
11   0289
12   9
13   01
14
15   46
16   68
17
18
19   2
20
21
22
23
24
25
26
27   2
```

b. The majority of the start-up companies in this set have less than $90 million in venture capital. Only 6 of the 50 (12%) have more than $150 million.

48. a.

Industry	**Frequency**	**% Frequency**
Bank	26	13%
Cable	44	22%
Car	42	21%
Cell	60	30%
Collection	28	14%
Total	200	100%

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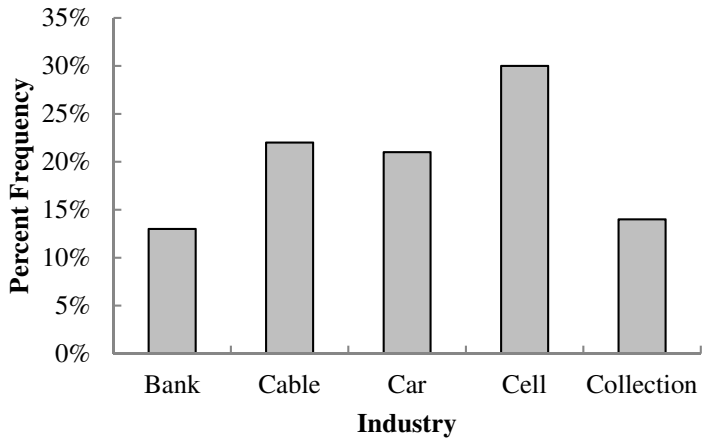
b.



c. The cellular phone providers had the highest number of complaints.

d. The percentage frequency distribution shows that the two financial industries (banks and collection agencies) had about the same number of complaints. Also, new car dealers and cable and satellite television companies also had about the same number of complaints.

49. a.

Beta	Frequency	Percent Frequency
0.00-0.09	1	3.3%
0.10-0.19	1	3.3%
0.20-0.29	1	3.3%
0.30-0.39	0	0.0%
0.40-0.49	1	3.3%
0.50-0.59	1	3.3%
0.60-0.69	3	10.0%
0.70-0.79	2	6.7%
0.80-0.89	4	13.3%
0.90-.99	4	13.3%
1.00-1.09	0	0.0%
1.10-1.19	3	10.0%
1.20-1.29	5	16.7%
1.30-1.39	2	6.7%
1.40-1.49	0	0.0%
1.50-1.59	0	0.0%
1.60-1.69	0	0.0%
1.70-1.80	1	3.3%
1.80-1.90	1	3.3%
Total	30	100.0%

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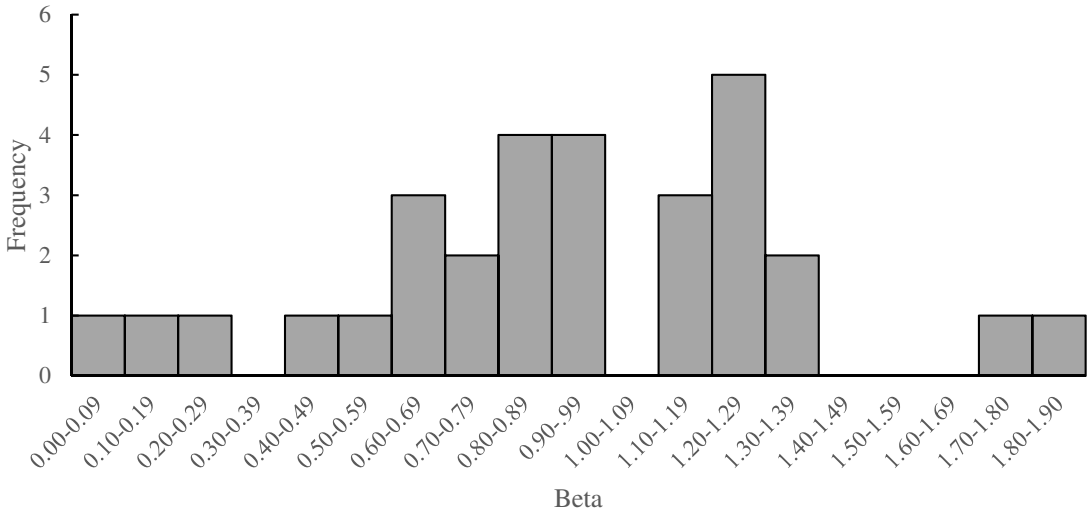
b.



c. The distribution is somewhat skewed to the left.

d. The stock with the highest beta is JP Morgan Chase & Company with a beta of 1.84. The stock with the lowest beta is Verizon Communications Inc. with a beta of .04.

50. a.

Level of Education	**Percent Frequency**
High School graduate	32,773/65,644(100) = 49.93
Bachelor's degree	22,131/65,644(100) = 33.71
Master's degree	9003/65,644(100) = 13.71
Doctoral degree	1737/65,644(100) = 2.65
Total	100.00

13.71 + 2.65 = 16.36% of heads of households have a master's or doctoral degree.

b.

Household Income	**Percent Frequency**
Under $25,000	13,128/65,644(100) = 20.00
$25,000 to $49,999	15,499/65,644(100) = 23.61
$50,000 to $99,999	20,548/65,644(100) = 31.30
$100,000 and over	16,469/65,644(100) = 25.09
Total	100.00

31.30 + 25.09 = 56.39% of households have an income of $50,000 or more.

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c.

	Household Income			
Level of Education	Under $25,000	$25,000 to $49,999	$50,000 to $99,999	$100,000 and over
High School graduate	75.26	64.33	45.95	21.14
Bachelor's degree	18.92	26.87	37.31	47.46
Master's degree	5.22	7.77	14.69	24.86
Doctoral degree	0.60	1.03	2.05	6.53
Total	100.00	100.00	100.00	100.00

There is a large difference between the level of education for households with an income of under $25,000 and households with an income of $100,000 or more. For instance, 75.26% of households with an income of under $25,000 are households in which the head of the household is a high school graduate. But, only 21.14% of households with an income level of $100,000 or more are households in which the head of the household is a high school graduate. It is interesting to note, however, that 45.95% of households with an income of $50,000 to $99,999 are households in which the head of the household his a high school graduate.

51. a. The batting averages for the junior and senior years for each player are as follows:

Junior year:

Allison Fealey	15/40 = .375
Emily Janson	70/200 = .350

Senior year:

Allison Fealey	75/250 = .300
Emily Janson	35/120 = .292

Because Allison Fealey had the higher batting average in both her junior year and senior year, Allison Fealey should receive the scholarship offer.

b. The combined or aggregated two-year crosstabulation is as follows:

	Combined 2-Year Batting	
Outcome	**A. Fealey**	**E. Jansen**
Hit	90	105
No Hit	200	215
Total At Bats	290	320

Based on this crosstabulation, the batting average for each player is as follows:

Combined Junior/Senior Years

Allison Fealey	90/290 = .310
Emily Janson	105/320 = .328

Because Emily Janson has the higher batting average over the combined junior and senior years, Emily Janson should receive the scholarship offer.

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c. The recommendations in parts (a) and (b) are not consistent. This is an example of Simpson's Paradox. It shows that in interpreting the results based upon separate or un-aggregated crosstabulations, the conclusion can be reversed when the crosstabulations are grouped or aggregated. When Simpson's Paradox is present, the decision maker will have to decide whether the un-aggregated or the aggregated form of the crosstabulation is more helpful in identifying the desired conclusion. Note: The authors prefer the recommendation to offer the scholarship to Emily Janson because it is based upon the aggregated performance for both players over a larger number of at-bats. But this is a judgment or personal preference decision. Others may prefer the conclusion based on using the un-aggregated approach in part (a).

52 a.

	Size of Company			
Job Growth (%)	**Small**	**Midsized**	**Large**	**Total**
-10-0	4	6	2	12
0-10	18	13	29	60
10-20	7	2	4	13
20-30	3	3	2	8
30-40	0	3	1	4
60-70	0	1	0	1
Total	32	28	38	98

b. Frequency distribution for growth rate.

Job Growth (%)	**Total**
-10-0	12
0-10	60
10-20	13
20-30	8
30-40	4
60-70	1
Total	98

Frequency distribution for size of company.

Size	**Total**
Small	32
Medium	28
Large	38
Total	98

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c. Crosstabulation showing column percentages.

	Size of Company		
Job Growth (%)	**Small**	**Midsized**	**Large**
-10-0	13	21	5
0-10	56	46	76
10-20	22	7	11
20-30	9	11	5
30-40	0	11	3
60-70	0	4	0
Total	100	100	100

d. Crosstabulation showing row percentages.

	Size of Company			
Job Growth (%)	**Small**	**Midsized**	**Large**	**Total**
-10-0	33	50	17	100
0-10	30	22	48	100
10-20	54	15	31	100
20-30	38	38	25	100
30-40	0	75	25	100
60-70	0	4	0	100

e. 12 companies had a negative job growth: 13% were small companies; 21% were midsized companies; and 5% were large companies. So, in terms of avoiding negative job growth, large companies were better off than small and midsized companies. But, although 95% of the large companies had a positive job growth, the growth rate was below 10% for 76% of these companies. In terms of better job growth rates, midsized companies performed better than either small or large companies. For instance, 26% of the midsized companies had a job growth of at least 20% as compared to 9% for small companies and 8% for large companies.

53. a.

	Tution & Fees ($)								
Year Founded	1-5000	10001-15000	15001-20000	20001-25000	25001-30000	30001-35000	35001-40000	40001-45000	Total
1600-1649							1		1
1700-1749							2	1	3
1750-1799								4	4
1800-1849				1	3	3	6	8	21
1850-1899	1		2	2	13	14	13	4	49
1900-1949		1		2	3	4	8		18
1950-2000			2	4		1			7
Total	1	1	4	9	19	22	30	17	103

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b.

	Tuition & Fees ($)								
Year Founded	1-5000	10001-15000	15001-20000	20001-25000	25001-30000	30001-35000	35001-40000	40001-45000	Grand Total
1600-1649							100.00		100
1700-1749							66.67	33.33	100
1750-1799								100.00	100
1800-1849				4.76	14.29	14.29	28.57	38.10	100
1850-1899	2.04		4.08	4.08	26.53	28.57	26.53	8.16	100
1900-1949		5.56		11.11	16.67	22.22	44.44		100
1950-2000			28.57	57.14		14.29			100

c. Colleges in this sample founded before 1800 tend to be expensive in terms of tuition.

54. a.

	% Graduate													
Year Founded	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80	80-85	85-90	90-95	95-100	Grand Total
1600-1649													1	1
1700-1749													3	3
1750-1799												1	3	4
1800-1849						1	2	4	2	3	4	3	2	21
1850-1899			1	2	4	3	11	5	9	6	3	4	1	49
1900-1949	1	1	1		1	3		3	2	4	1	1		18
1950-2000	1		1	3			2							7
Grand Total	2	1	3	5	5	7	15	12	13	13	8	9	10	103

b.

	% Graduate													
Year Founded	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80	80-85	85-90	90-95	95-100	Grand Total
1600-1649													100.00	100
1700-1749													100.00	100
1750-1799												25.00	75.00	100
1800-1849						4.76	9.52	19.05	9.52	14.29	19.05	14.29	9.52	100
1850-1899			2.04	4.08	8.16	6.12	22.45	10.20	18.37	12.24	6.12	8.16	2.04	100
1900-1949	5.56	5.56	5.56		5.56	16.67		16.67	11.11	22.22	5.56	5.56		100
1950-2000	14.29		14.29	42.86			28.57							100

c. Older colleges and universities tend to have higher graduation rates.

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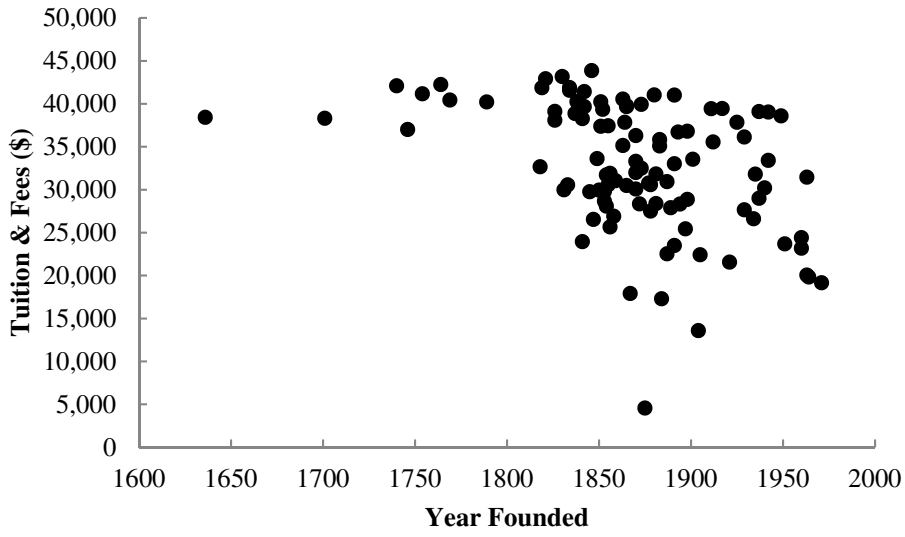
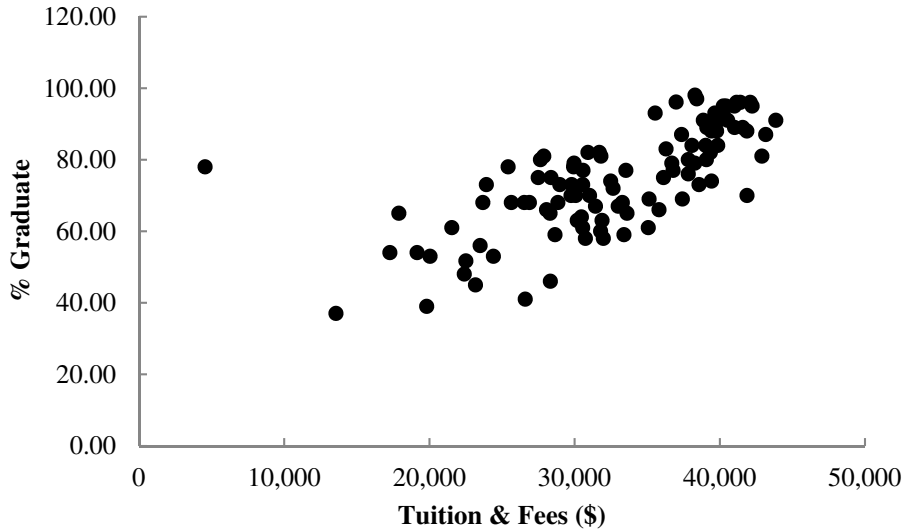
55. a.



b. Older colleges and universities tend to be more expensive.

56. a.



b. There appears to be a strong positive relationship between Tuition & Fees and % Graduation.

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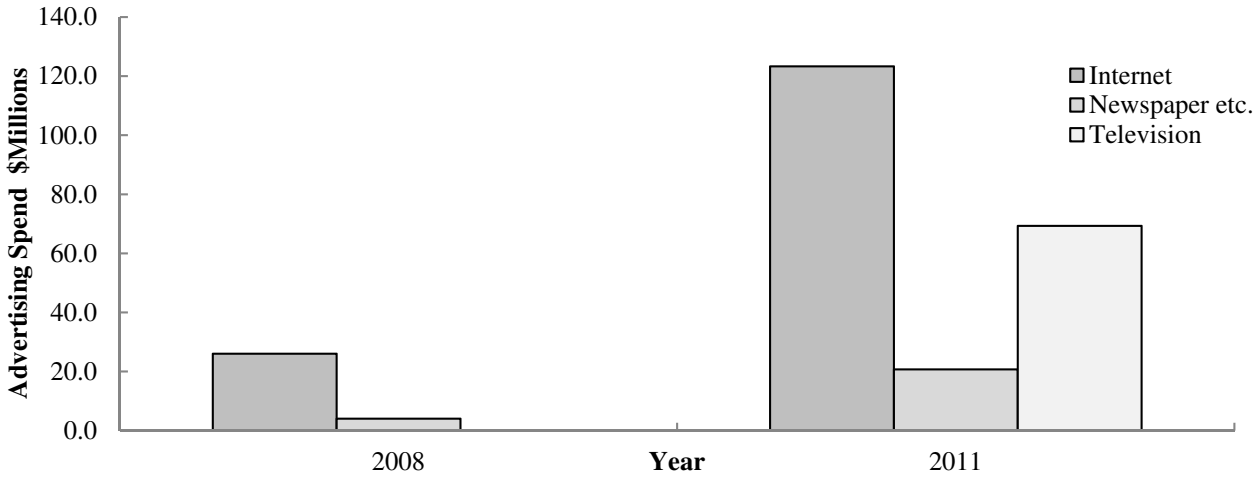
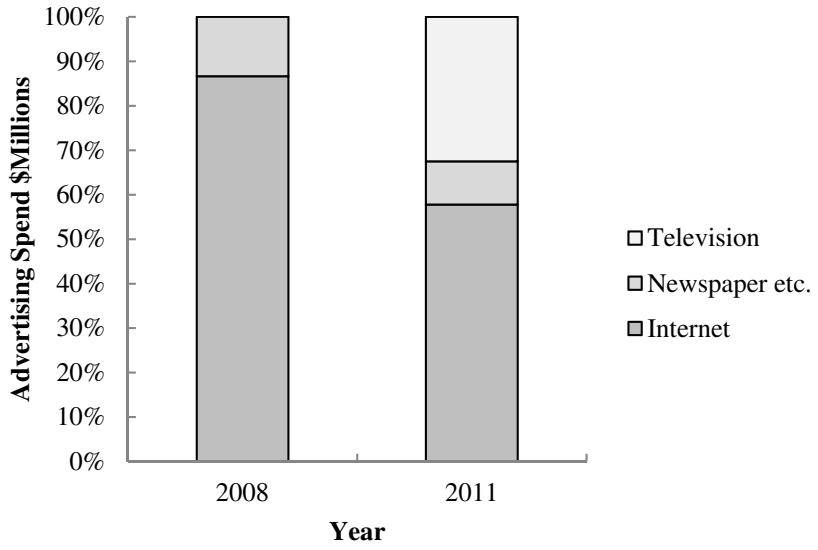
57. a.



b.

	2008	2011
Internet	86.7%	57.8%
Newspaper etc.	13.3%	9.7%
Television	0.0%	32.5%
Total	100.0%	100.0%



c. The graph is part a is more insightful because is shows the allocation of the budget across media, but also dramatic increase in the size of the budget.

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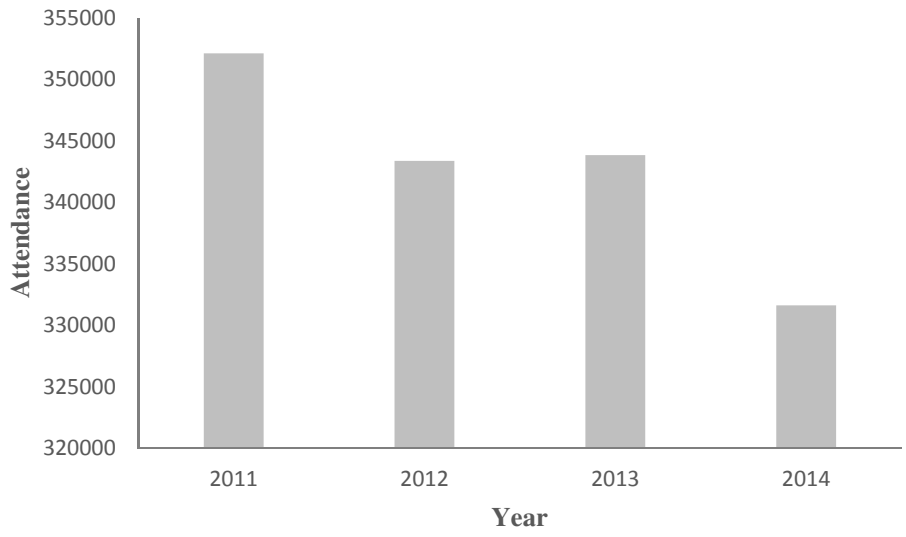
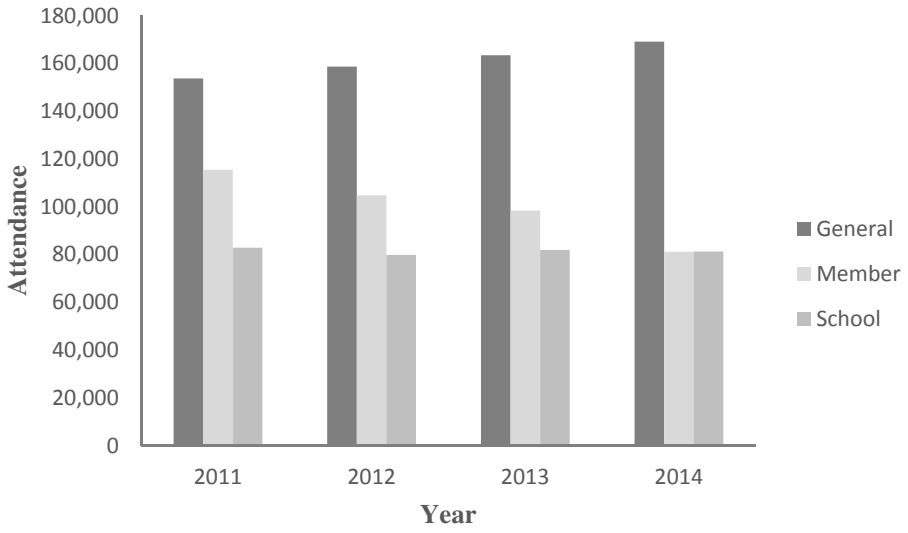
58. a.



Zoo attendance appears to be dropping over time.

b.



c. General attendance is increasing, but not enough to offset the decrease in member attendance. School membership appears fairly stable.

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Solutions to
Case Problems

Chapter 2
Descriptive Statistics: Tabular and Graphical Presentations

Case Problem 1: Pelican Stores

1. There were 70 Promotional customers and 30 Regular customers. Because there are 100 observations in the sample, the frequency and percent frequency distribution are the same. Percent frequency distributions for many of the variables are given.

No. of Items	Percent Frequency
1	29
2	27
3	10
4	10
5	9
6	7
7 or more	8
Total:	100

Net Sales	Percent Frequency
0.00 - 24.99	9
25.00 - 49.99	30
50.00 - 74.99	25
75.00 - 99.99	10
100.00 - 124.99	12
125.00 - 149.99	4
150.00 - 174.99	3
175.00 - 199.99	3
200 or more	4
Total:	100

Method of Payment	Percent Frequency
American Express	2
Discover	4
MasterCard	14
Proprietary Card	70
Visa	10
Total:	100

Gender	Percent Frequency
Female	93
Male	7
Total:	100

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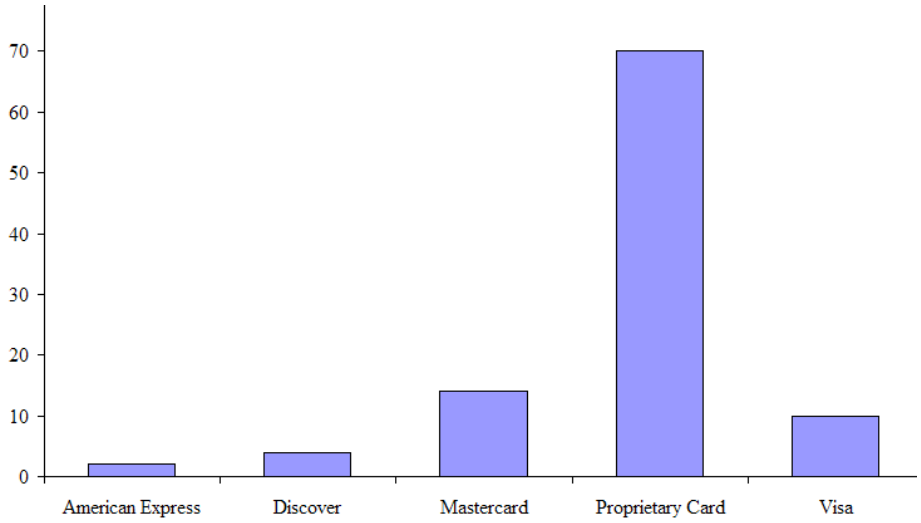
Martial Status	Percent Frequency
Married	84
Single	16
Total:	100

Age	Percent Frequency
20 - 29	10
30 - 39	30
40 - 49	33
50 - 59	16
60 - 69	7
70 - 79	4
Total:	100

These percent frequency distributions provide a profile of Pelican's customers. Many observations are possible, including:

- A large majority of the customers use National Clothing's proprietary credit card.
- Over half of the customers purchase 1 or 2 items, but a few make numerous purchases.
- The percent frequency distribution of net sales shows that 61% of the customers spent $50 or more.
- Customers are distributed across all adult age groups.
- The overwhelming majority of customers are female.
- Most of the customers are married.

2.



3. A crosstabulation of type of customer versus net sales is shown.

	Net Sales											
Customer	0-25	25-50	50-75	75-100	100-125	125-175	175-200	200-225	225-250	250-275	275-300	Total
Promotional	7	17	17	8	9	3	2	3	1	2	1	70
Regular	2	13	8	2	3	1	1					30
Total	9	30	25	10	12	4	3	3	1	2	1	100

From the crosstabulation it appears that net sales are larger for promotional customers.

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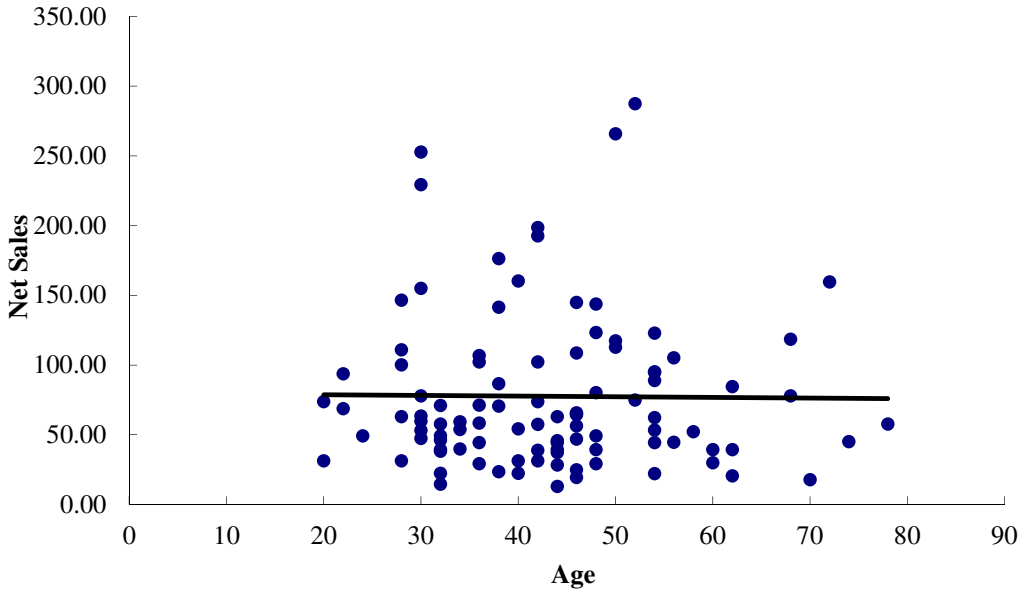
4. A scatter diagram of net Sales vs. age is shown below. A trendline has been fitted to the data. From this, it appears that there is no relationship between net sales and age.



Age is not a factor in determining net sales.

Case Problem 2: The Motion Picture Industry

This case provides the student with the opportunity to use tabular and graphical presentations to analyze data from the motion picture industry. Developing and interpreting frequency distributions, percent frequency distributions and scatter diagrams are emphasized. The interpretations and insights can be quite varied. We illustrate some below.

Frequency Distribution and Percent Frequency Distribution

The choice of the classes for frequency distributions or percent frequency distributions can be expected to vary. The frequency distributions we developed are as follows:

Opening Gross Sales (Millions)			Frequency (or Percentage)
$0	–	9.99	70
10	–	19.99	15
20	–	29.99	8
30	–	39.99	2
40	–	49.99	1
50	–	59.99	1
60	–	69.99	0
70	–	79.99	1
80	–	89.99	0
90	–	99.99	0
100	–	109.99	2
		Total	100

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Total Gross Sales (Millions)	Frequency (or Percentage)
$0 – 49.99	77
50 – 99.99	16
100 – 149.99	1
150 – 199.99	1
200 – 249.99	3
250 – 299.99	1
300 – 349.99	0
350 – 399.99	1
Total	100

Number of Theaters	Frequency (or Percentage)
0 – 499	51
500 – 999	3
1000 – 1499	6
1500 – 1999	7
2000 – 2499	5
2500 – 2999	6
3000 – 3499	17
3500 – 3999	5
Total	100

Number of Weeks in Top 60	Frequency (or Percentage)
0 – 4	33
5 – 9	28
10 – 14	18
15 – 19	15
20 – 24	5
25 – 29	1
Total	100

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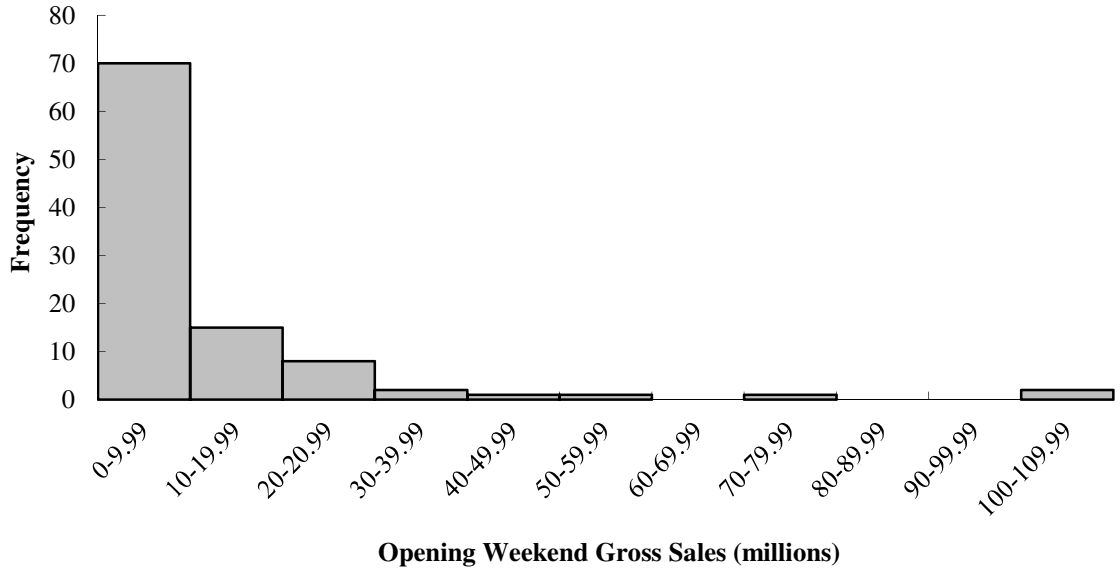
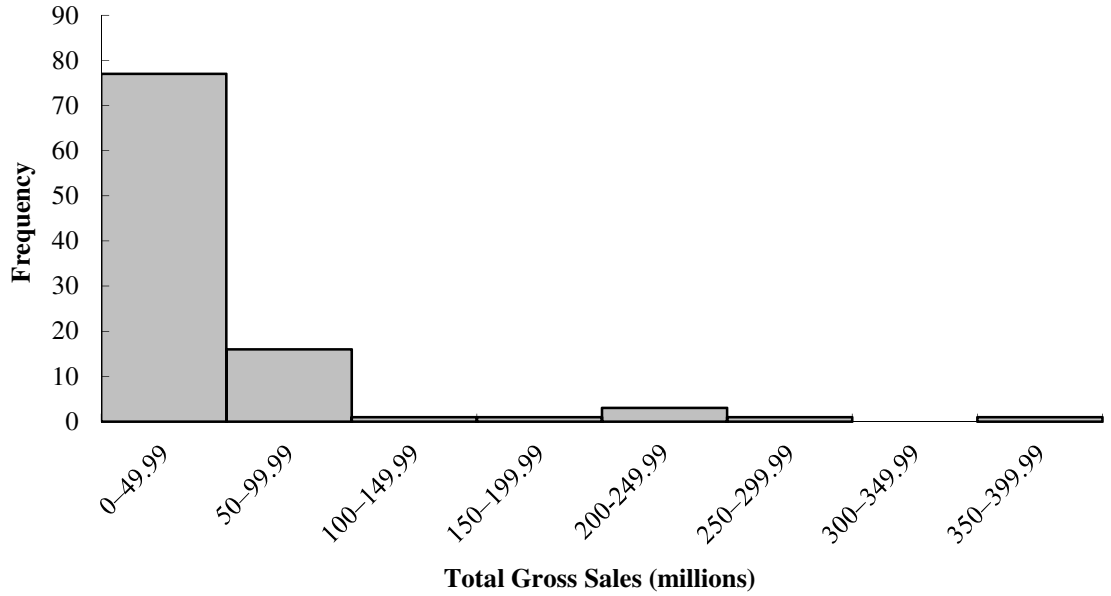
Histograms

The following histograms are based on the frequency distributions shown above.





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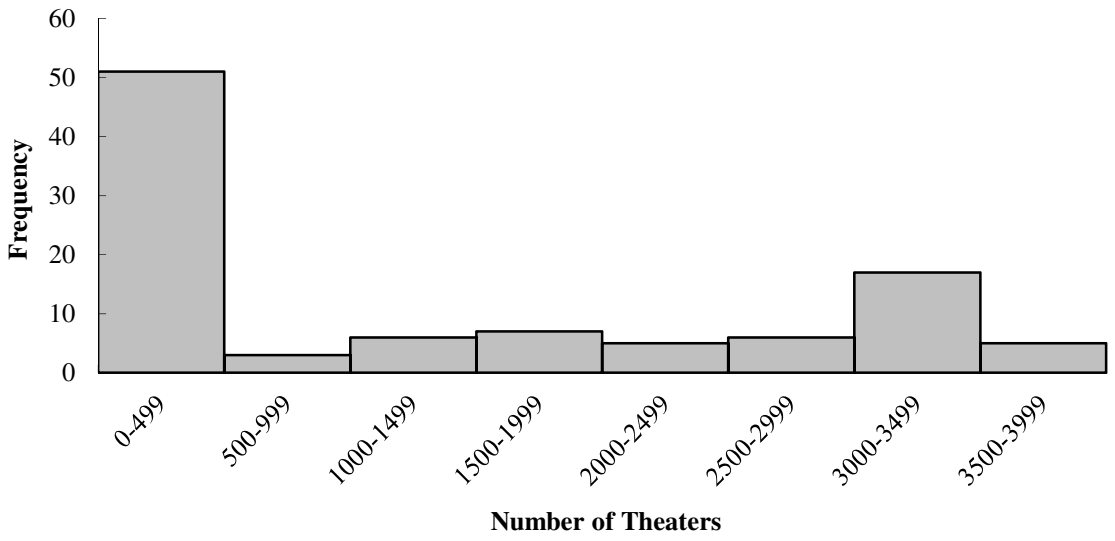

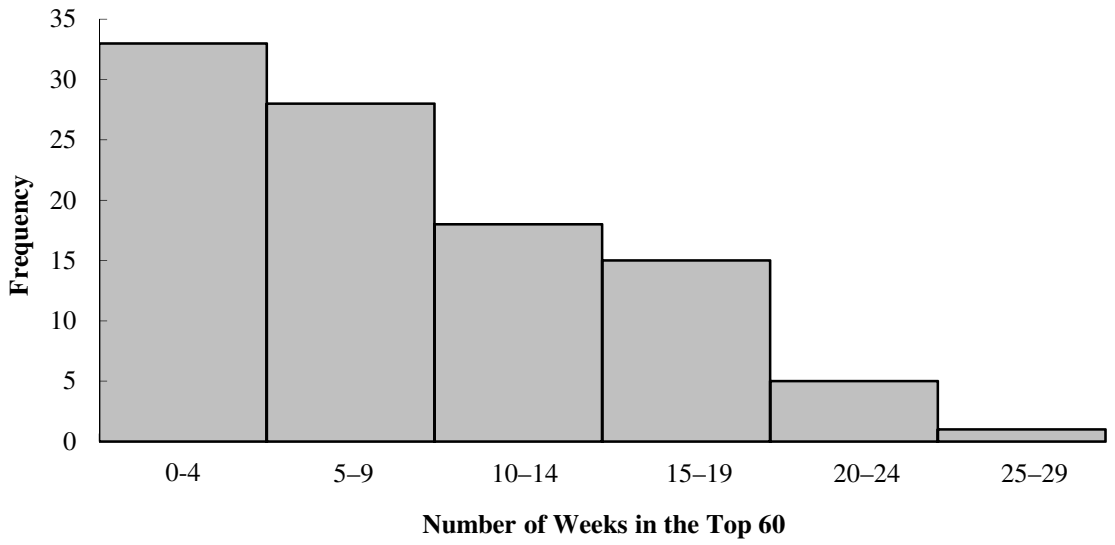

Interpretation

Opening Weekend Gross Sales. The distribution is skewed to the right. Numerous motion pictures have somewhat low opening weekend gross sales, while a relatively few (7%) have an opening weekend gross sales of $30 million or more. Only 2% had opening weekend gross sales of $100 million or more. 70% of the motion pictures had opening weekend gross sales less than $10 million and 85% of the motion pictures had opening weekend gross sales less than $20 million. Unless there is something unusually attractive about the motion picture, an opening weekend gross sales less than $10 million appears typical.

Total Gross Sales. This distribution is also skewed to the right. Again, the majority of the motion pictures have relatively low total gross sales with 77% less than $50 million and 93% less than $100 million. Highly successful blockbuster motion pictures are rare. Total gross sales over $200 million occurred only 5% of the time and over $300 million occurred only 1% of the time. No motion picture reported $400 million in total gross sales. Unless there is something unusually attractive about the motion picture, a total gross sales less than $50 million appears typical.

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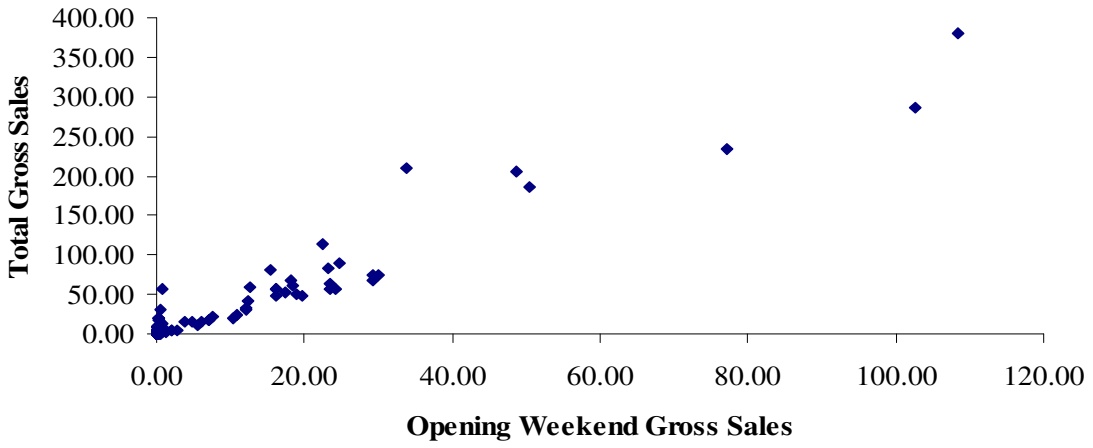
Number of Theaters. This distribution is skewed to the right, but not so much as sales data distributions. The number of theaters range from less than 500 to almost 4000. 51% of the motion pictures had the smaller market exposure with the number of theaters less than 500. Interestingly enough, 22% of the motion pictures had the widest market exposure, appearing in over 3000 theaters. 3000 to 4000 theaters is typical for a highly promoted motion picture.

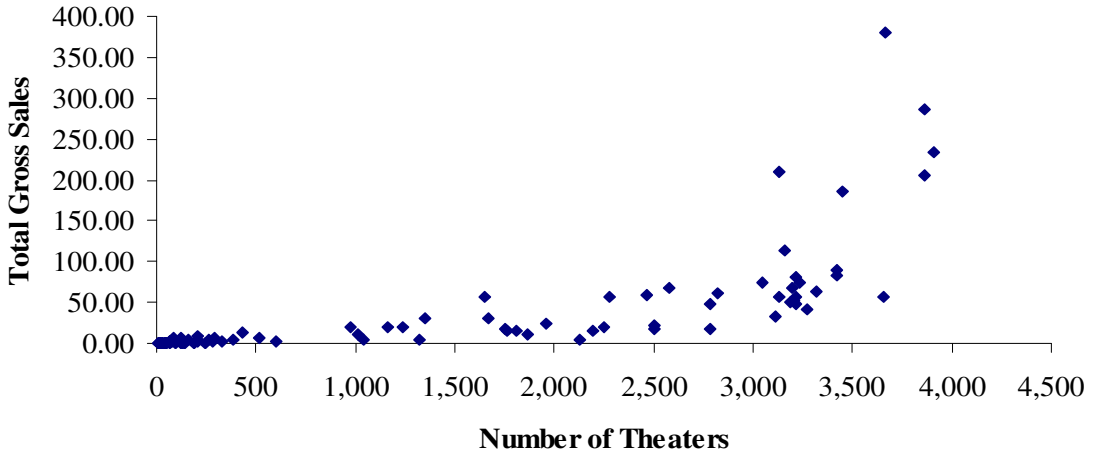
Number of Weeks in Top 60. This distribution is skewed to the right, but not as much as the other distributions. In appears that almost all newly released movies initially make it into the top 60, with 67% staying in the top 60 for 5 or more weeks. Even motion pictures with relative low gross sales can appear in the top 60 motion pictures for a month or more. Almost 40% of the motion pictures are in the top 60 for 10 or more weeks, with 6% of the motion pictures in the top 60 for 20 or more weeks.

General Observations. The data show that there are relative few high-end, highly successful motion pictures. The financial rewards are there for the pictures that make the blockbuster level. But the majority of motion pictures will have low opening weekend gross sales and low total gross sales. Motion pictures being shown in less than 1500 theaters and motion pictures less than 10 weeks in the top 60 are common.

Scatter Diagrams

Three scatter diagrams are suggested to show how Total Gross Sales is related to each of the other three variables.





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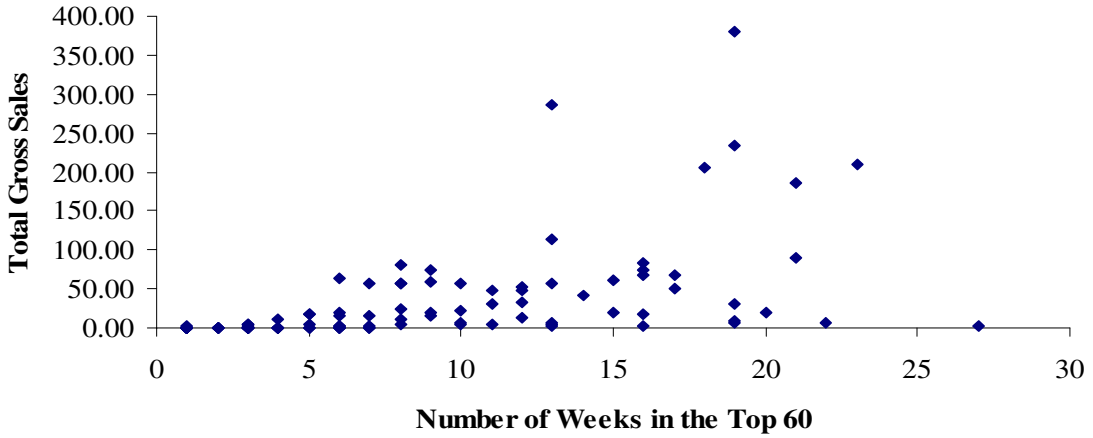

Interpretation

Opening Weekend Gross Sales. The scatter plot of total gross sales and opening weekend gross sales shows a strong positive relationship. Motion pictures with the highest total gross sales were the motion pictures with the highest opening weekend gross sales. How the motion picture does during its opening weekend should be a very good predictor of how the motion picture will do in terms of total gross sales. Note in the scatter diagram that the majority of the motion pictures show a low opening weekend gross sales and a low total gross sales.

Number of Theaters. The scatter plot of the total gross sales and number of theaters also shows a positive relationship. For motion pictures playing in less than 3000 theaters, the total gross sales has a positive relationship with the number of theaters. If the motion picture is shown in more theaters, higher total gross sales are anticipated. For motion pictures playing in more than 3000 theaters, the relationship is not as strong. 3000 to 4000 represents the maximum number of theaters possible. If a motion picture is shown in this many theaters, 15 motion pictures did slightly better in terms of total gross sales. However, the blockbuster motion pictures in this category showed extremely high total gross sales for the number of theaters where the motion picture was shown.

Number of Weeks in Top 60. The scatter plot of the total gross sales and number of weeks in the top 60 shows a positive relationship, but this relationship appears to be the weakest of the three relationships studied. Generally, the more successful, higher gross sales motion pictures are in the top 60 for more weeks. However, this is not always the case. Four of the six motion pictures with the highest total gross sales appeared in the top 60 less than 20 weeks. At the same time, four motion pictures with 20 or more weeks in the top 60 did not have unusually high total gross sales. This suggests that in some cases blockbuster movies with high gross sales may run their course quickly and not have an excessively long run on the top 60 motion picture list. At the same time, perhaps quality motion pictures with a limited audience may not generate the high total gross sales but may still show a run of 20 or more weeks on the top 60 motion picture list. The number of weeks in the top 60 does not appear to the best predictor of total gross sales.

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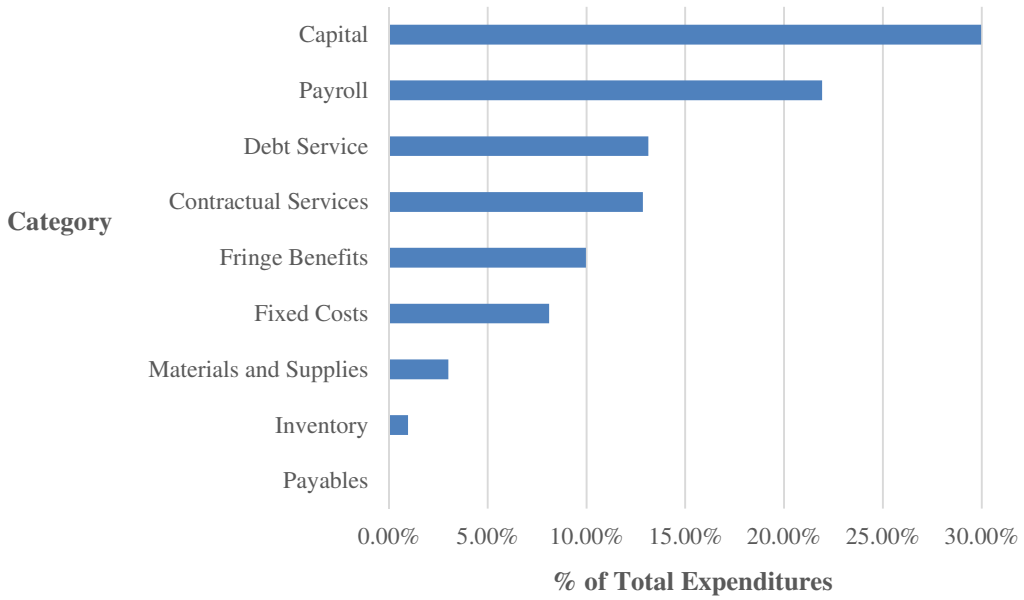
Case Problem 3: Queen City

This case provides the student with the opportunity to use basic tabular and graphical presentations to describe data from the annual expenditures for the city of Cincinnati, Ohio. The data set is large relative to others in the text. It contains 5,427 records of expenditures. As such, one point of this case is to expose students to a larger data set and help them understand that the pivot tables and charts can be used on a larger data set. In some cases, the student will have to copy, paste, and aggregate data to create the desired tables and charts. Style of presentation may vary by student (for example, vertical versus horizontal bar charts may be used). We illustrate with results and comments below.

Expenditures by Category

The pivot table shows expenditures and percentage of total expenditures by category. The bar chart shows percentage of total expenditures by category (both the table and the bar chart are sorted in descending order). Capital expenditures and payroll account for over 50% of all expenditures. Total expenditures are over $660 million. Debt Service seems somewhat high, as it is over 10% of total expenditures.

Category	Total Expenditures	% of Total Expenditures
Capital	$198,365,854	29.98%
Payroll	$145,017,555	21.92%
Debt Service	$86,913,978	13.14%
Contractual Services	$85,043,249	12.85%
Fringe Benefits	$66,053,340	9.98%
Fixed Costs	$53,732,177	8.12%
Materials and Supplies	$19,934,710	3.01%
Inventory	$6,393,394	0.97%
Payables	$180,435	0.03%
Grand Total	$661,634,693	100.0%



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Expenditures by Department

The following table and bar chart show the percentages of total expenditures incurred by department. Note that we have combined all departments that individually incurred less than 1% of the total expenditures. There are 119 departments, and 96 each account for less than 1% of the total expenditures. As shown below, only six individual departments incur 5% or more of the total expenditures. These include, Police, Sewers, Transportation Engineering (Engineering). Fire, Sewer Debt Service and Finance/Risk Management. Debt service on sewers as a percentage of total expenditures appears to be very high.

Department	% of Total Expenditures
Department of Police	9.7%
Department of Sewers	8.8%
Transportation and Engineering, (Engineering)	8.7%
Department of Fire	7.2%
Sewers, Debt Service	6.6%
Finance, Risk Management	5.4%
SORTA Operations	3.6%
Water Works, Debt Service	3.2%
Department of water Works	3.1%
Finance, Treasury	2.8%
Economic Development	2.1%
Division of Parking Services	1.9%
Community Development, Housing	1.7%
Enterprise Technology Solutions	1.7%
Public Services, Fleet Services	1.7%
Finance, Accounts & Audits	1.7%
Transportation and Engineering, Planning	1.6%
Public Services, Neighborhood Operations	1.4%
Sewers, Millcreek	1.3%
Health, Primary Health Care Centers	1.2%
Water Works, Water Supply	1.2%
Public Services, Facilities Management	1.1%
Sewers, Wastewater Administration	1.0%
Other Depts. (< 1% each)	21.2%
Total	100.0%

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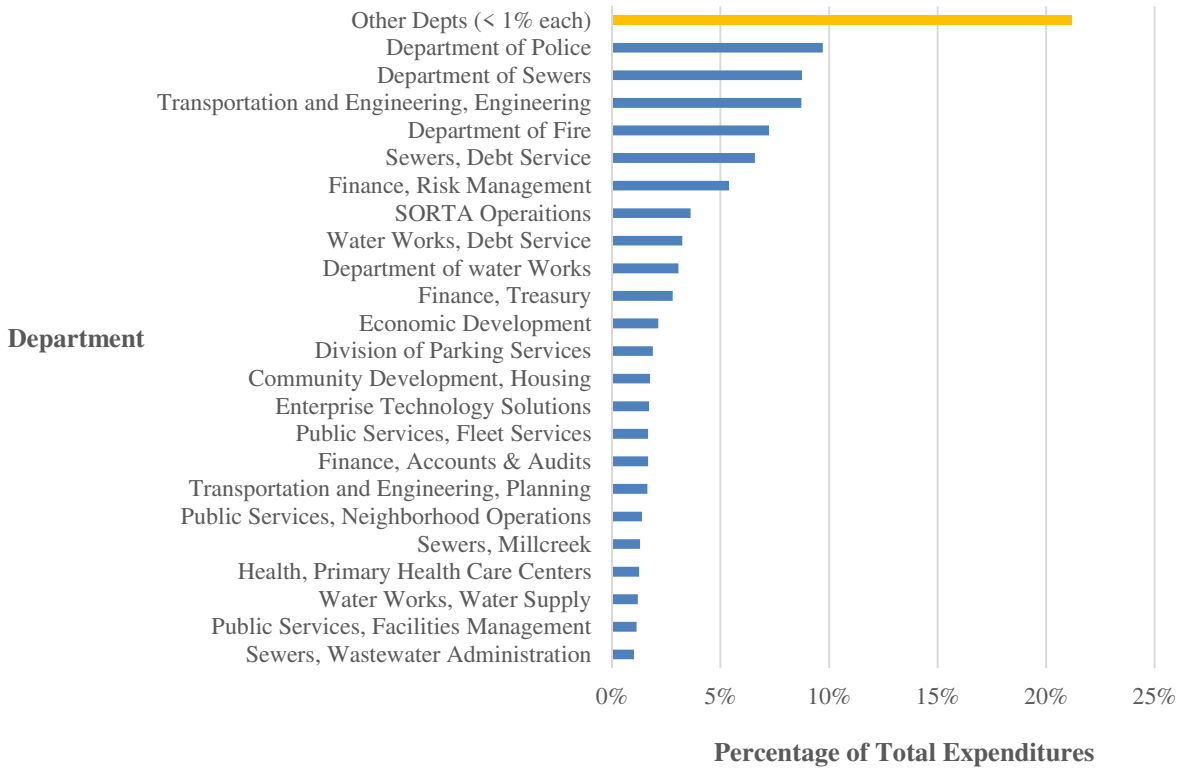

Expenditures by Fund

The following bar table and bar chart show the percentages of total expenditures charged by fund used to pay. Note that we have combined those funds that each cover less than 1% of the total expenditures. There are 129 funds in the data base, and 117 of these funds each account for less than 1% of total expenditures.

Fund	% of Total Expenditures Covered
050 - GENERAL FUND	25.5%
980 - CAPITAL PROJECTS	16.0%
701 - METROPOLITAN SEWER DISTRICT OF GREATER CINCINNATI	12.7%
704 - METROPOLITAN SEWER DISTRICT CAPITAL IMPROVEMENTS	8.8%
101 - WATER WORKS	7.9%
711 - RISK MANAGEMENT	4.9%
759 - INCOME TAX – TRANSIT	3.7%
151 - BOND RETIREMENT – CITY	2.4%
202 - FLEET SERVICES	1.7%
898 - WATER WORKS IMPROVEMENT 12	1.3%
897 - WATER WORKS IMPROVEMENT 11	1.3%
302 - INCOME TAX – INFRASTRUCTURE	1.1%
Other (< 1 % each).	12.9%
Total	100.0%

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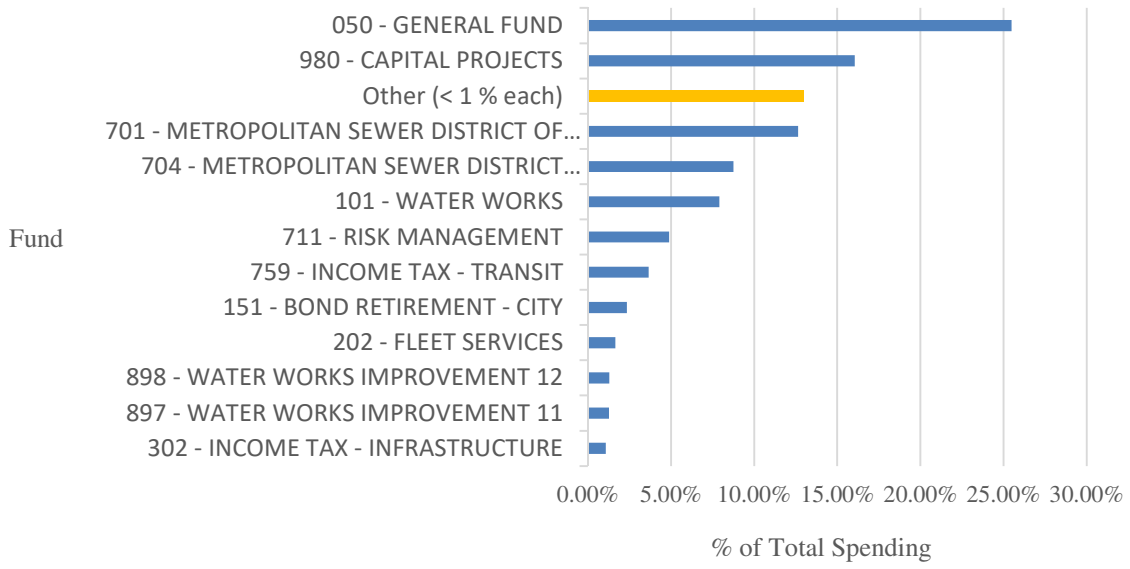

Other Points: There are 5,427 records of expenditures in the data base, of which 235 (4.3%) are negative.

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Essentials of Statistics for Business and Economics (8e)

Anderson, Sweeney, Williams, Camm, Cochran

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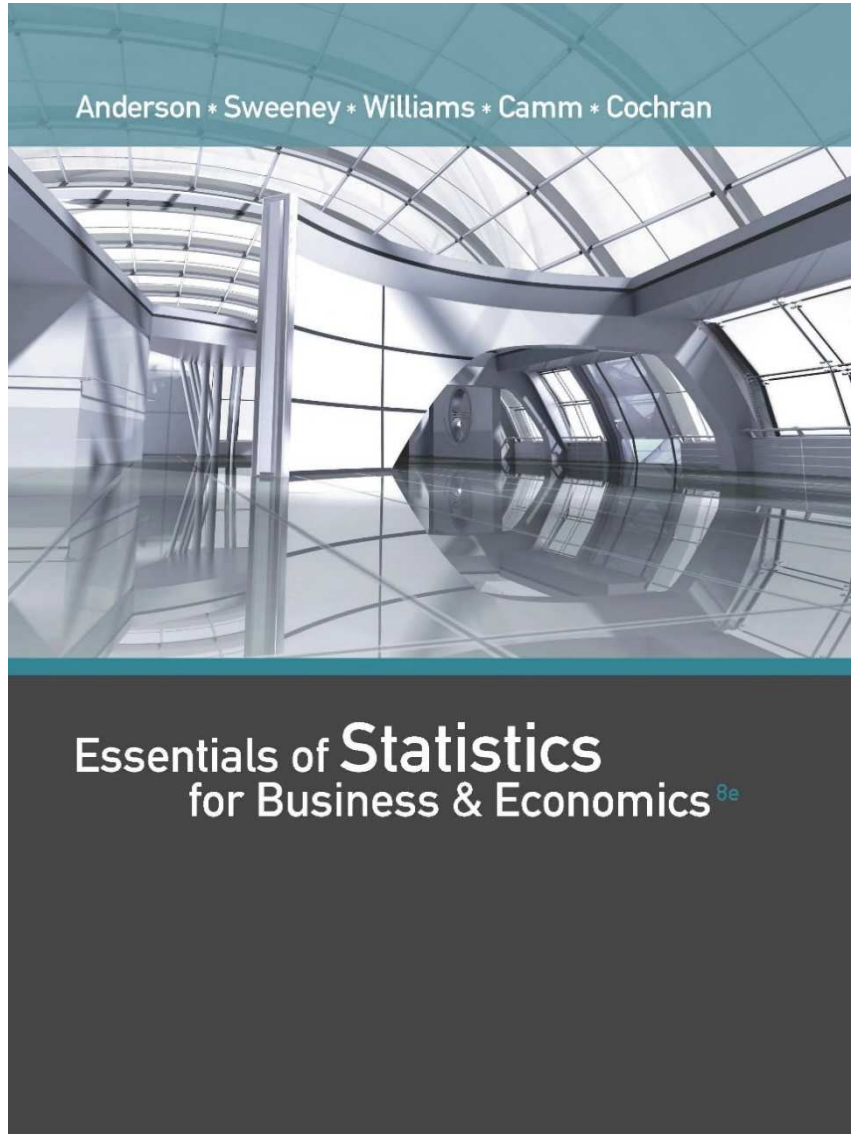

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Chapter 2
Part A - Descriptive Statistics: Tabular and Graphical Displays

- Summarizing Data for a Categorical Variable
  - Categorical data use labels or names to identify categories of like items.
- Summarizing Data for a Quantitative Variable
  - Quantitative data are numerical values that indicate how much or how many.

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Summarizing Categorical Data

- Frequency Distribution
- Relative Frequency Distribution
- Percent Frequency Distribution
- Bar Chart
- Pie Chart

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Frequency Distribution

- A frequency distribution is a tabular summary of data showing the number (frequency) of observations in each of several non-overlapping categories or classes.
- The objective is to provide insights about the data that cannot be quickly obtained by looking only at the original data.

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Frequency Distribution

Example: Marada Inn

- Guests staying at Marada Inn were asked to rate the quality of their accommodations as being *excellent*, *above average*, *average*, *below average*, or *poor*.
- The ratings provided by a sample of 20 guests are:

Below Average	Average	Above Average
Above Average	Above Average	Above Average
Above Average	Below Average	Below Average
Average	Poor	Poor
Above Average	Excellent	Above Average
Average	Above Average	Average
Above Average	Average	

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Frequency Distribution

- Example: Marada Inn

Rating	Frequency
Poor	2
Below Average	3
Average	5
Above Average	9
Excellent	1
Total	20

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Relative Frequency Distribution

- The relative frequency of a class is the fraction or proportion of the total number of data items belonging to the class.

$$\text{Relative frequency of a class} = \frac{\text{Frequency of the class}}{n}$$

- A relative frequency distribution is a tabular summary of data showing the relative frequency for each class.

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Percent Frequency Distribution

- The percent frequency of a class is the relative frequency multiplied by 100.
- A percent frequency distribution is a tabular summary of a set of data showing the percent frequency for each class.

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Relative Frequency and Percent Frequency Distributions

- Example: Marada Inn

Rating	Relative Frequency	Percent Frequency
Poor	.10	10
Below Average	.15	15
Average	.25	25
Above Average	.45	45
Excellent	.05	5
Total	1.00	100

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Bar Chart

- A bar chart is a graphical display for depicting qualitative data.
- On one axis (usually the horizontal axis), we specify the labels that are used for each of the classes.
- A frequency, relative frequency, or percent frequency scale can be used for the other axis (usually the vertical axis).
- Using a bar of fixed width drawn above each class label, we extend the height appropriately.
- The bars are separated to emphasize the fact that each class is a separate category.

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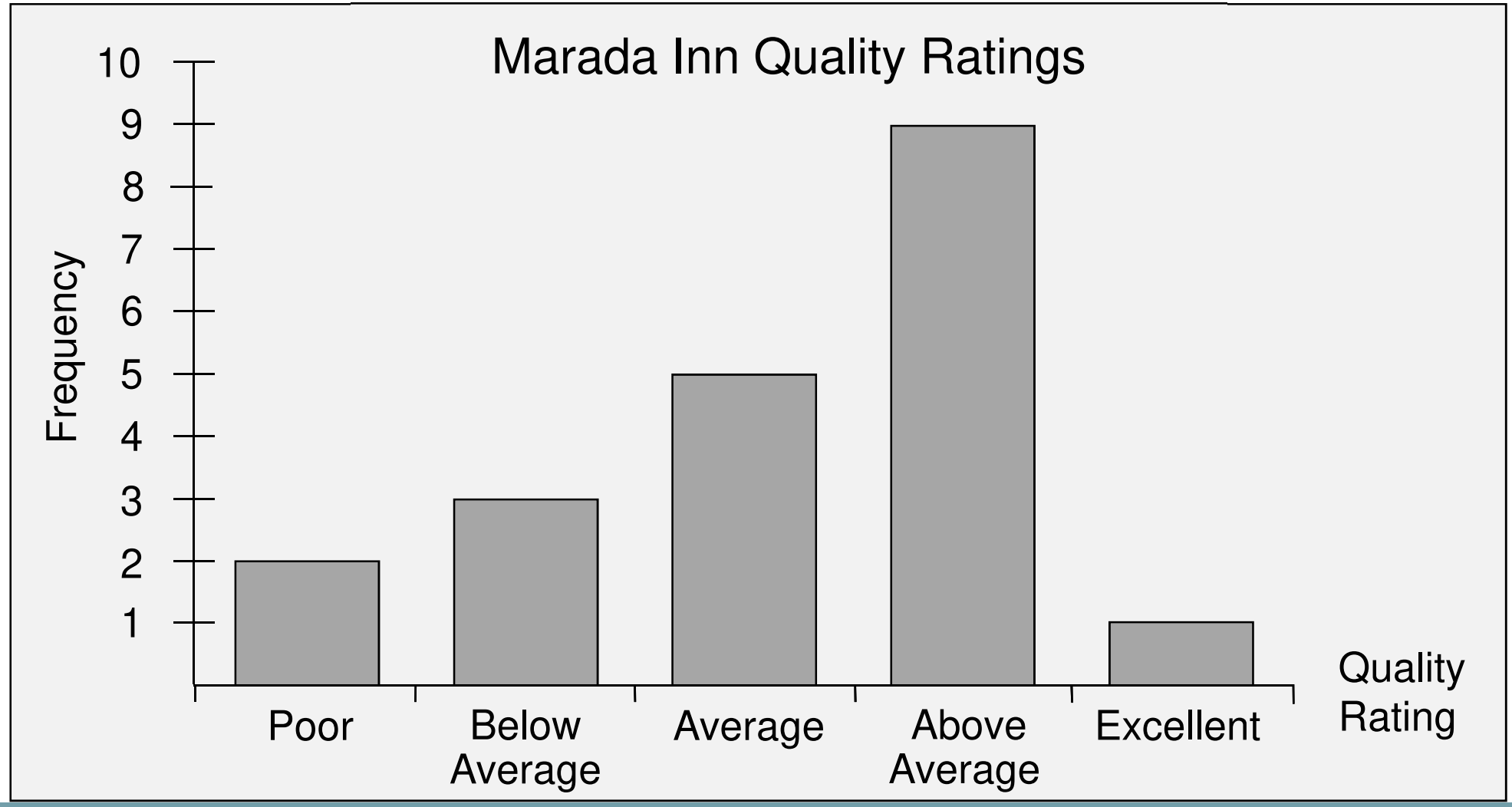
Bar Chart



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Pareto Diagram

- In quality control, bar charts are used to identify the most important causes of problems.
- When the bars are arranged in descending order of height from left to right (with the most frequently occurring cause appearing first) the bar chart is called a Pareto diagram.
- This diagram is named for its founder, Vilfredo Pareto, an Italian economist.

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Pie Chart

- The pie chart is a commonly used graphical display for presenting relative frequency and percent frequency distributions for categorical data.
- First draw a circle; then use the relative frequencies to subdivide the circle into sectors that correspond to the relative frequency for each class.
- Since there are 360 degrees in a circle, a class with a relative frequency of .25 would consume .25(360) = 90 degrees of the circle.

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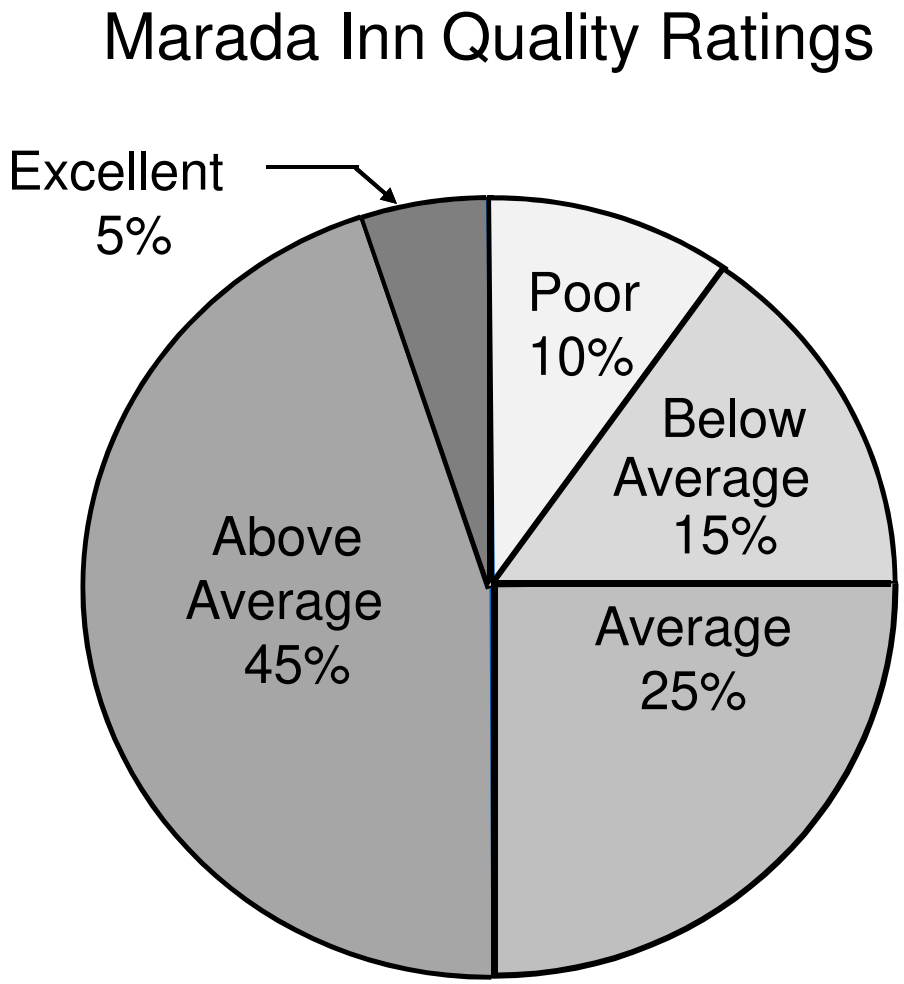
Pie Chart



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Example: Marada Inn

- One-half of the customers surveyed gave Marada a quality rating of "above average" or "excellent" (looking at the left side of the pie). This might please the manager.
- For each customer who gave an "excellent" rating, there were two customers who gave a "poor" rating (looking at the top of the pie). This should displease the manager.

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Summarizing Quantitative Data

- Frequency Distribution
- Relative Frequency and Percent Frequency Distributions
- Dot Plot
- Histogram
- Cumulative Distributions
- Stem-and-Leaf Display

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Frequency Distribution

- Example: Hudson Auto Repair

  The manager of Hudson Auto would like to gain a better understanding of the cost of parts used in the engine tune-ups performed in the shop. She examines 50 customer invoices for tune-ups. The costs of parts, rounded to the nearest dollar, are listed on the next slide.

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Frequency Distribution

- Example: Hudson Auto Repair

Sample of Parts Cost($) for 50 Tune-ups

91	78	93	57	75	52	99	80	97	62
71	69	72	89	66	75	79	75	72	76
104	74	62	68	97	105	77	65	80	109
85	97	88	68	83	68	71	69	67	74
62	82	98	101	79	105	79	69	62	73

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Frequency Distribution

The three steps necessary to define the classes for a frequency distribution with quantitative data are:

1. Determine the number of non-overlapping classes.
2. Determine the width of each class.
3. Determine the class limits.

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Frequency Distribution

- Guidelines for Determining the Number of Classes
  - Use between 5 and 20 classes.
  - Data sets with a larger number of elements usually require a larger number of classes.
  - Smaller data sets usually require fewer classes.
  - The goal is to use enough classes to show the variation in the data, but not so many classes that some contain only a few data items.

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Frequency Distribution

- Guidelines for Determining the Width of Each Class
  - Use classes of equal width.
  - Approximate Class Width =

$$\frac{\text{Largest data value} - \text{Smallest data value}}{\text{Number of classes}}$$

  - Making the classes the same width reduces the chance of inappropriate interpretations.

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Frequency Distribution

- Note on Number of Classes and Class Width
  - In practice, the number of classes and the appropriate class width are determined by trial and error.
  - Once a possible number of classes is chosen, the appropriate class width is found.
  - The process can be repeated for a different number of classes.
  - Ultimately, the analyst uses judgment to determine the combination of the number of classes and class width that provides the best frequency distribution for summarizing the data.

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Frequency Distribution

- Guidelines for Determining the Class Limits
  - Class limits must be chosen so that each data item belongs to one and only one class.
  - The lower class limit identifies the smallest possible data value assigned to the class.
  - The upper class limit identifies the largest possible data value assigned to the class.
  - The appropriate values for the class limits depend on the level of accuracy of the data.
  - An open-end class requires only a lower class limit or an upper class limit.

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Frequency Distribution

- Class Midpoint
  - In some cases, we want to know the midpoints of the classes in a frequency distribution for quantitative data.
  - The <u>class midpoint</u> is the value halfway between the lower and upper class limits.

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Frequency Distribution

- Example: Hudson Auto Repair

  If we choose six classes:

  Approximate Class Width = (109 - 50)/6 = 9.83≅ 10

Parts Cost ($)	Frequency
50-59	2
60-69	13
70-79	16
80-89	7
90-99	7
100-109	5
Total	50

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Relative Frequency and Percent Frequency Distributions

- Example: Hudson Auto Repair

Parts Cost ($)	Relative Frequency	Percent Frequency
50-59	.04 = 2/50	4 = .04(100)
60-69	.26	26
70-79	.32	32
80-89	.14	14
90-99	.14	14
100-109	.10	10
Total	1.00	100

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Relative Frequency and Percent Frequency Distributions

- Example: Hudson Auto Repair

Insights Gained from the Percent Frequency Distribution:

- Only 4% of the parts costs are in the $50-59 class.
- 30% of the parts costs are under $70.
- The greatest percentage (32% or almost one-third) of the parts costs are in the $70-79 class.
- 10% of the parts costs are $100 or more.

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Dot Plot

- One of the simplest graphical summaries of data is a dot plot.
- A horizontal axis shows the range of data values.
- Then each data value is represented by a dot placed above the axis.

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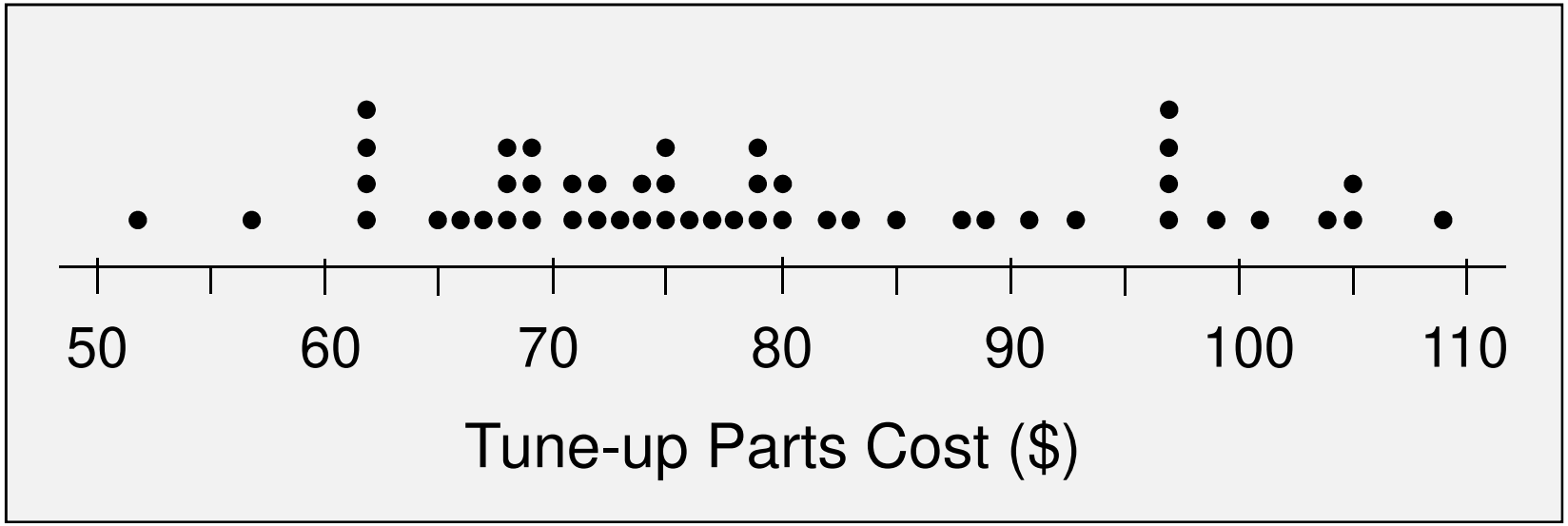
Dot Plot

- Example: Hudson Auto Repair



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Histogram

- Another common graphical display of quantitative data is a histogram.
- The variable of interest is placed on the horizontal axis.
- A rectangle is drawn above each class interval with its height corresponding to the interval's frequency, relative frequency, or percent frequency.
- Unlike a bar graph, a histogram has no natural separation between rectangles of adjacent classes.

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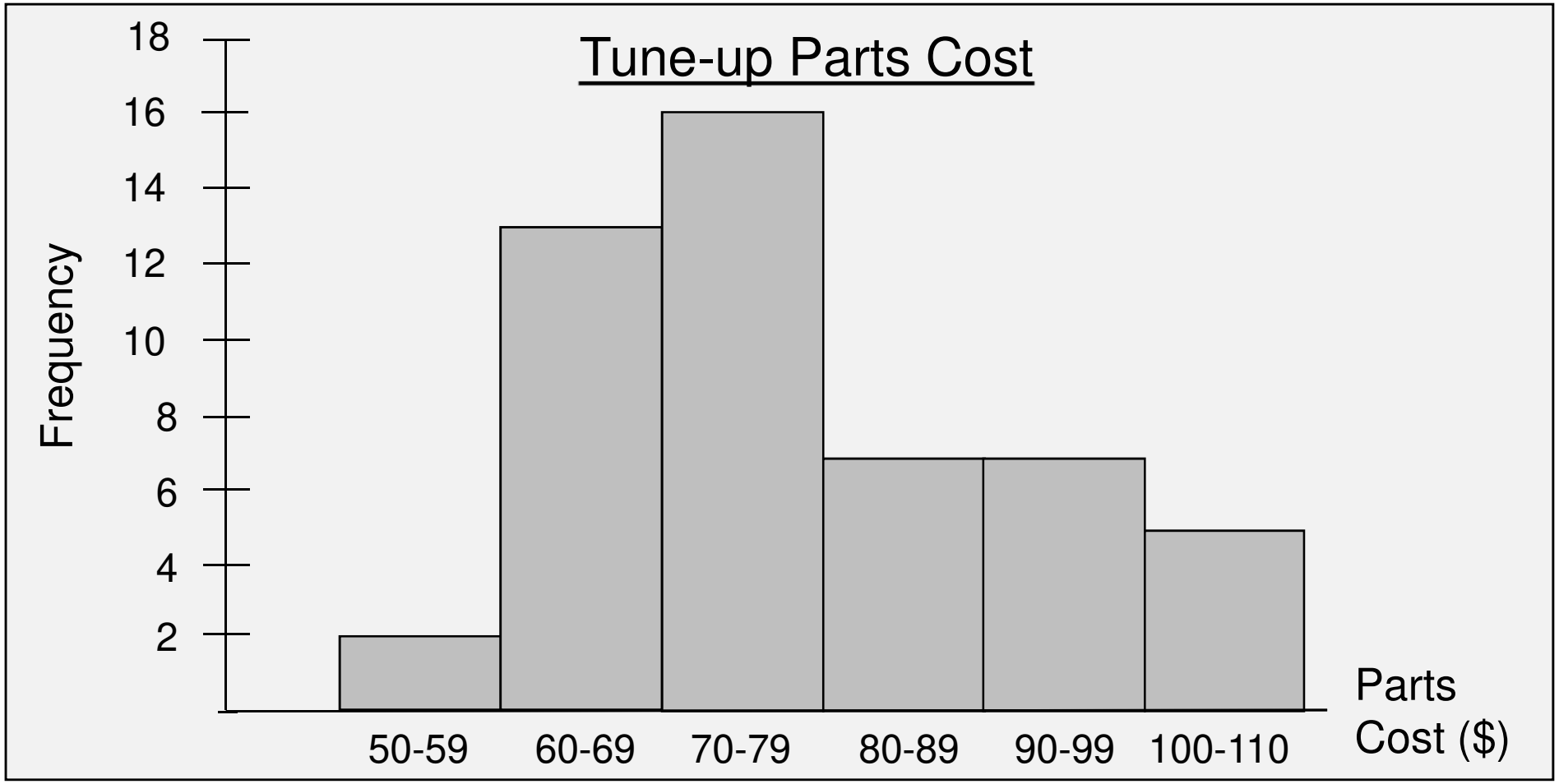
Histogram

- Example: Hudson Auto Repair



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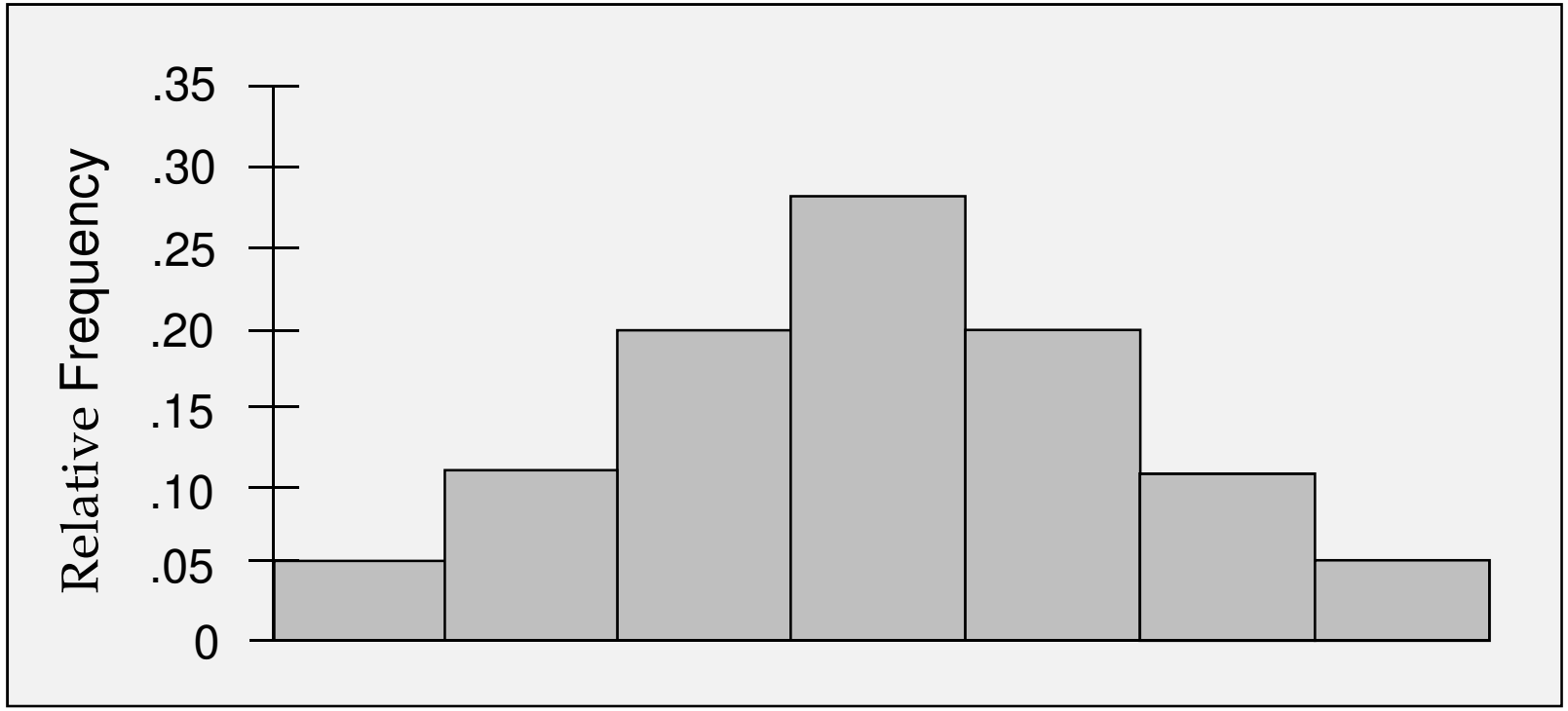
Histograms Showing Skewness

- Symmetric
  - Left tail is the mirror image of the right tail
  - Example: Heights of People



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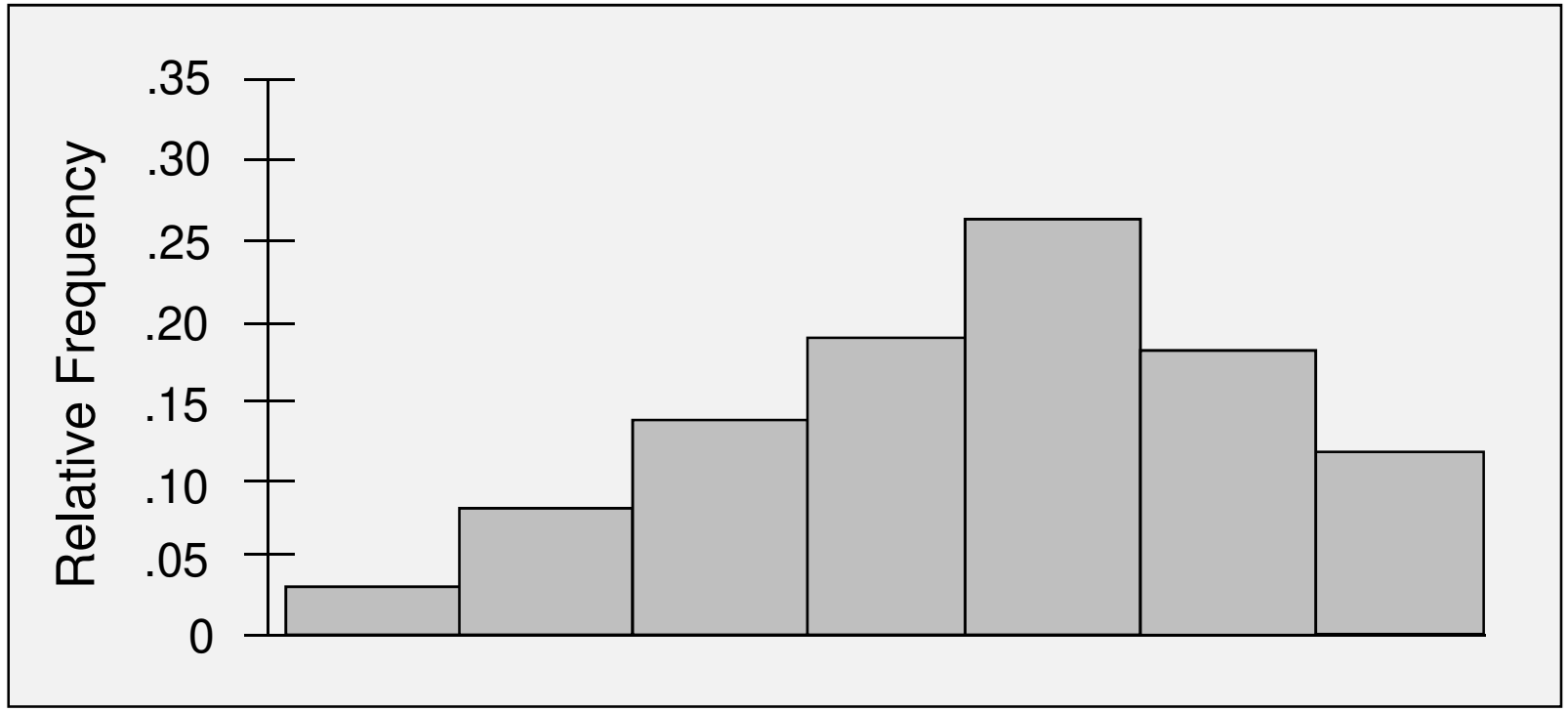
Histograms Showing Skewness

- Moderately Skewed Left
  - A longer tail to the left
  - Example: Exam Scores



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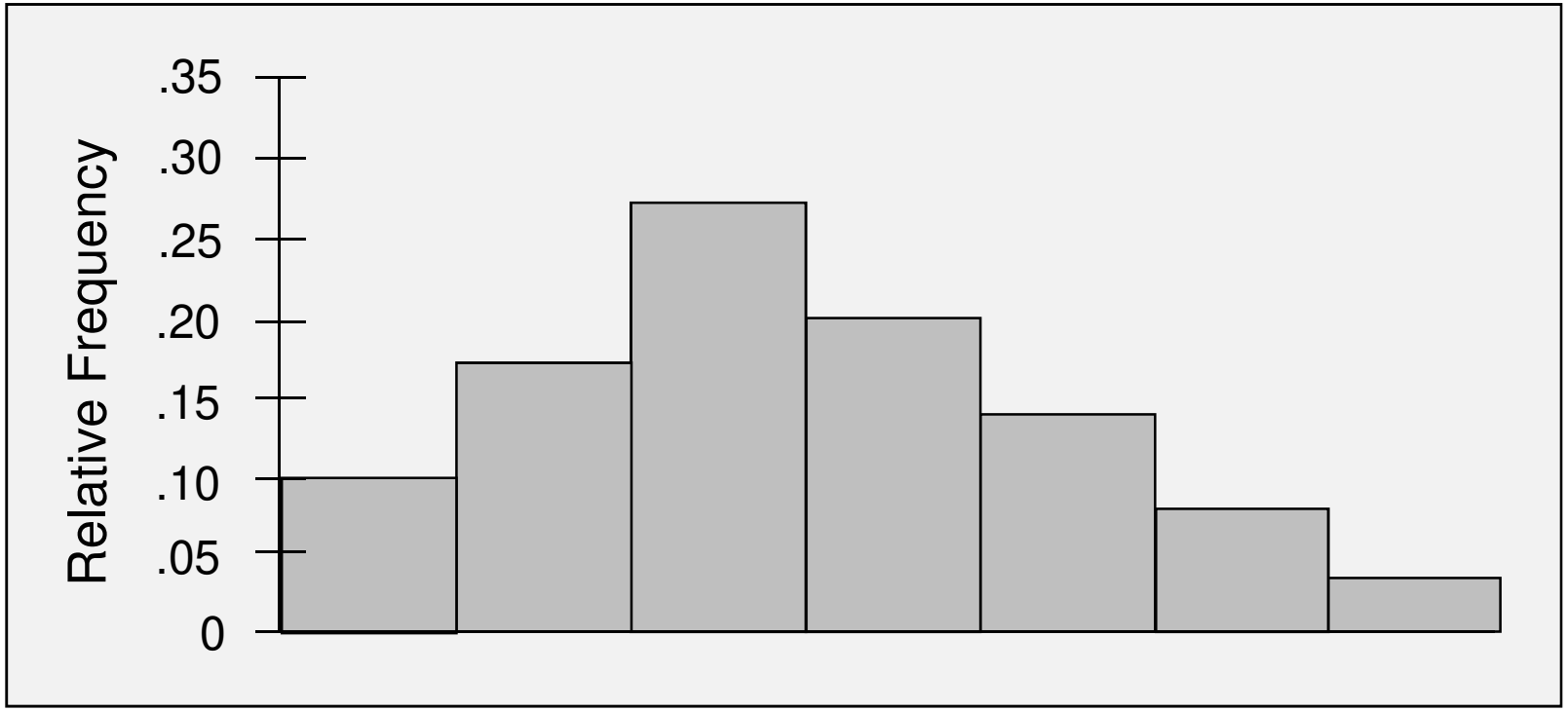
Histograms Showing Skewness

- Moderately Right Skewed
  - A Longer tail to the right
  - Example: <u>Housing Values</u>



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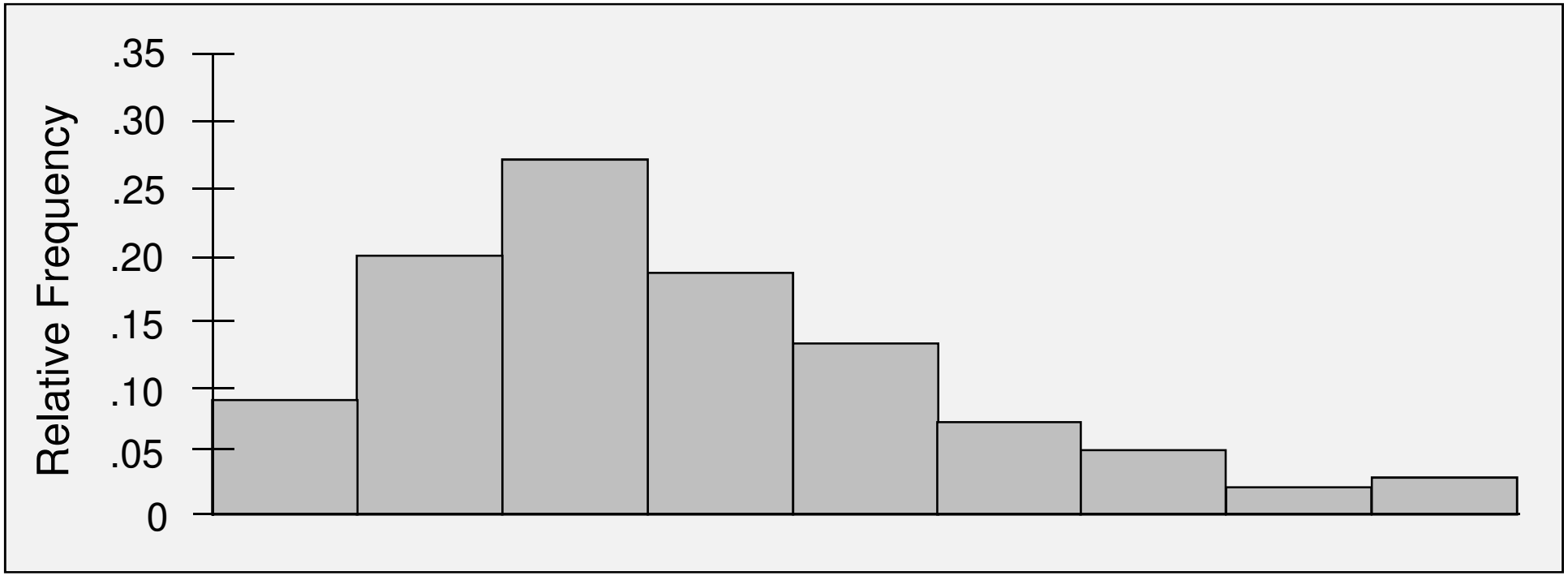
Histograms Showing Skewness

- Highly Skewed Right
  - A very long tail to the right
  - Example: Executive Salaries



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Cumulative Distributions

- Cumulative frequency distribution - shows the *number* of items with values less than or equal to the upper limit of each class.
- Cumulative relative frequency distribution – shows the *proportion* of items with values less than or equal to the upper limit of each class.
- Cumulative percent frequency distribution – shows the *percentage* of items with values less than or equal to the upper limit of each class.

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Cumulative Distributions

- The last entry in a cumulative frequency distribution always equals the total number of observations.
- The last entry in a cumulative relative frequency distribution always equals 1.00.
- The last entry in a cumulative percent frequency distribution always equals 100.

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Cumulative Distributions

- Hudson Auto Repair

Cost ($)	Cumulative Frequency	Cumulative Relative Frequency	Cumulative Percent Frequency
≤ 59	2	.04	4
≤ 69	15 = 2+13	.30 = 15/50	30 = .30(100)
≤ 79	31	.62	62
≤ 89	38	.76	76
≤ 99	45	.90	90
≤ 109	50	1.00	100

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Stem-and-Leaf Display

- A stem-and-leaf display shows both the rank order and shape of a distribution of data.
- It is similar to a histogram on its side, but it has the advantage of showing the actual data values.
- The leading digits of each data item are arranged to the left of a vertical line.
- To the right of the vertical line we record the last digit for each item in rank order.
- Each line (row) in the display is referred to as a stem.
- Each digit on a stem is a leaf.

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Example: Hudson Auto Repair

The manager of Hudson Auto would like to gain a better understanding of the cost of parts used in the engine tune-ups performed in the shop. She examines 50 customer invoices for tune-ups. The costs of parts, rounded to the nearest dollar, are listed on the next slide.

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Stem-and-Leaf Display

- Example: Hudson Auto Repair

Sample of Parts Cost ($) for 50 Tune-ups

91	78	93	57	75	52	99	80	97	62
71	69	72	89	66	75	79	75	72	76
104	74	62	68	97	105	77	65	80	109
85	97	88	68	83	68	71	69	67	74
62	82	98	101	79	105	79	69	62	73

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Stem-and-Leaf Display

- Example: Hudson Auto Repair

5	2 7
6	2 2 2 2 5 6 7 8 8 8 9 9 9
7	1 1 2 2 3 4 4 5 5 5 6 7 8 9 9 9
8	0 0 2 3 5 8 9
9	1 3 7 7 7 8 9
10	1 4 5 5 9

Stems Leaves

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Stretched Stem-and-Leaf Display

- If we believe the original stem-and-leaf display has condensed the data too much, we can stretch the display vertically by using two stems for each leading digit(s).
- Whenever a stem value is stated twice, the first value corresponds to leaf values of 0 - 4, and the second value corresponds to leaf values of 5 - 9.

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Stretched Stem-and-Leaf Display

- Example: Hudson Auto Repair

5	2
5	7
6	2 2 2 2
6	5 6 7 8 8 8 9 9 9
7	1 1 2 2 3 4 4
7	5 5 5 6 7 8 9 9 9
8	0 0 2 3
8	5 8 9
9	1 3
9	7 7 7 8 9
10	1 4
10	5 5 9

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Stem-and-Leaf Display

- Leaf Units
  - A single digit is used to define each leaf.
  - In the preceding example, the leaf unit was 1.
  - Leaf units may be 100, 10, 1, 0.1, and so on.
  - Where the leaf unit is not shown, it is assumed to equal 1.
  - The leaf unit indicates how to multiply the stem-and-leaf numbers in order to approximate the original data.

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Stem-and-Leaf Display

- Example: Leaf Unit = 0.1

If we have data with values such as

8.6 11.7 9.4 9.1 10.2 11.0 8.8

Leaf Unit = 0.1

8	6 8
9	1 4
10	2
11	0 7

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Stem-and-Leaf Display

- Example: Leaf Unit = 10

If we have data with values such as

1806 1717 1974 1791 1682 1910 1838

Leaf Unit = 10

16	8
17	1 9
18	0 3
19	1 7

The 82 in 1682 is rounded down to 80 and is represented as an 8.

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End of Chapter 2, Part A

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Anderson, Sweeney, Williams, Camm, Cochran

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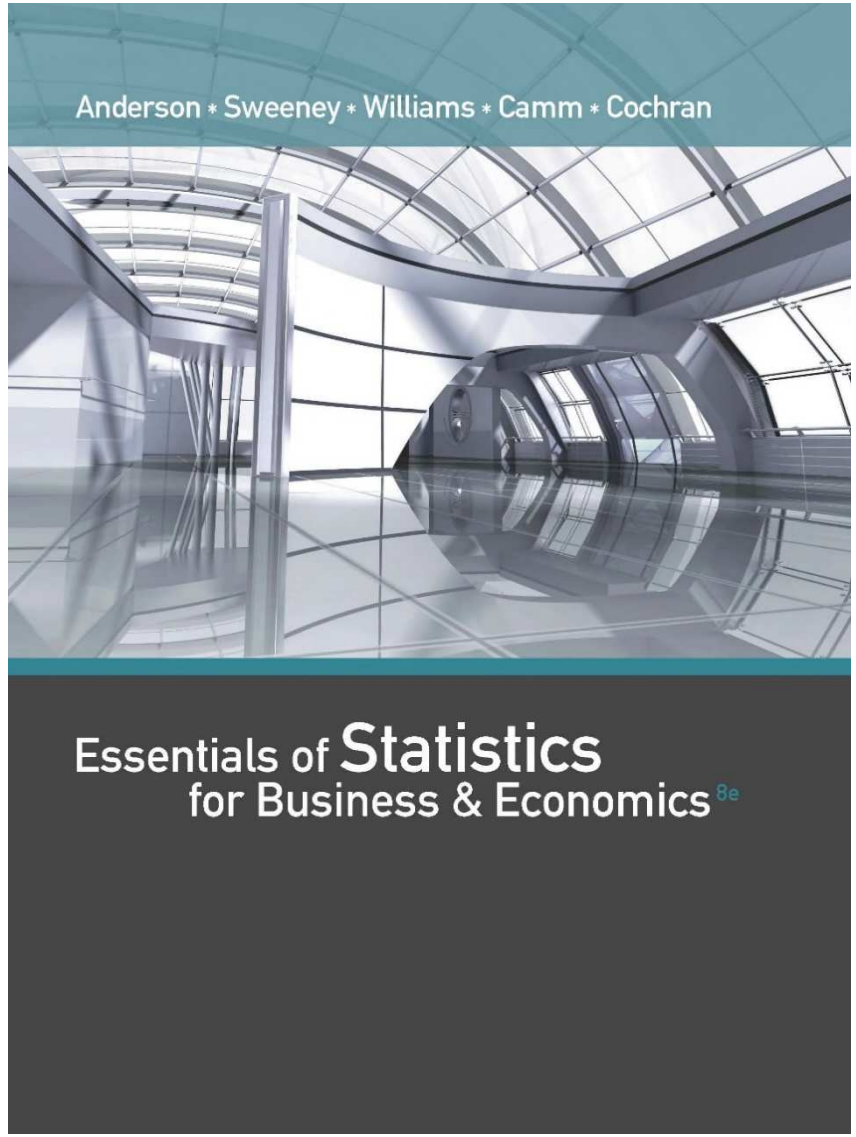

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Chapter 2, Part B
Descriptive Statistics: Tabular and Graphical Displays

- Summarizing Data for Two Variables Using Tables
- Summarizing Data for Two Variables Using Graphical Displays
- Data Visualization: Best Practices in Creating Effective Graphical Displays

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Summarizing Data for Two Variables sing Tables

- Thus far we have focused on methods that are used to summarize the data for one variable at a time.
- Often a manager is interested in tabular and graphical methods that will help understand the relationship between two variables.
- Crosstabulation is a method for summarizing the data for two variables.

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Crosstabulation

- A crosstabulation is a tabular summary of data for two variables.
- Crosstabulation can be used when:
  - one variable is categorical and the other is quantitative,
  - both variables are categorical, or
  - both variables are quantitative.
- The left and top margin labels define the classes for the two variables.

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Crosstabulation

- Example: Finger Lakes Homes

  The number of Finger Lakes homes sold for each style and price for the past two years is shown below.

Price Range	Home Style: Colonial	Log	Split	A-Frame	Total
< $250,000	18	6	19	12	55
≥ $250,000	12	14	16	3	45
Total	30	20	35	15	100

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Crosstabulation

- Example: Finger Lakes Homes

  Insights Gained from Preceding Crosstabulation

  - The greatest number of homes (19) in the sample are a split-level style and priced at less than $250,000.
  - Only three homes in the sample are an A-Frame style and priced at $250,000 or more.

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Crosstabulation: Row or Column Percentages

- Converting the entries in the table into row percentages or column percentages can provide additional insight about the relationship between the two variables.

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Crosstabulation: Row Percentages

- Example: Finger Lakes Homes

Price Range	Home Style: Colonial	Log	Split	A-Frame	Total
< $250,000	32.73	10.91	34.55	21.82	100
≥ $250,000	26.67	31.11	35.56	6.67	100

Note: row totals are actually 100.01 due to rounding.

(Colonial and ≥ $250K)/(All ≥ $250K) x 100 = (12/45) x 100

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Crosstabulation: Column Percentages

- Example: Finger Lakes Homes

Price Range	Home Style			
	Colonial	Log	Split	A-Frame
< $250,000	60.00	30.00	54.29	80.00
≥ $250,000	40.00	70.00	45.71	20.00
Total	100	100	100	100

(Colonial and ≥ $250K)/(All Colonial) x 100 = (12/30) x 100

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Crosstabulation: Simpson's Paradox

- Data in two or more crosstabulations are often aggregated to produce a summary crosstabulation.
- We must be careful in drawing conclusions about the relationship between the two variables in the aggregated crosstabulation.
- In some cases the conclusions based upon an aggregated crosstabulation can be completely reversed if we look at the unaggregated data. The reversal of conclusions based on aggregate and unaggregated data is called Simpson's paradox.

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Summarizing Data for Two Variables Using Graphical Displays

- In most cases, a graphical display is more useful than a table for recognizing patterns and trends.
- Displaying data in creative ways can lead to powerful insights.
- Scatter diagrams and trendlines are useful in exploring the relationship between two variables.

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Scatter Diagram and Trendline

- A scatter diagram is a graphical presentation of the relationship between two quantitative variables.
- One variable is shown on the horizontal axis and the other variable is shown on the vertical axis.
- The general pattern of the plotted points suggests the overall relationship between the variables.
- A trendline provides an approximation of the relationship.

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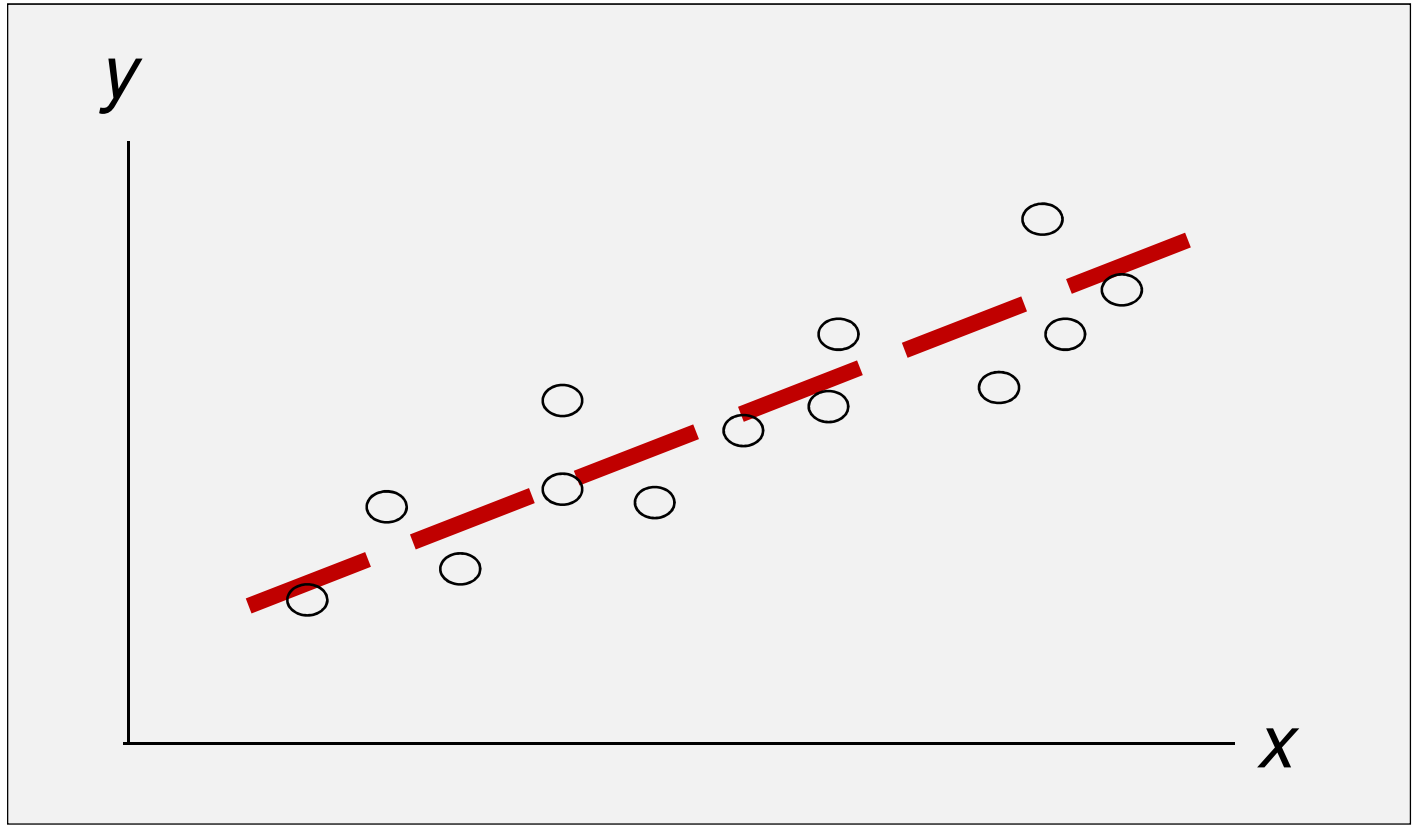
Scatter Diagram

- A Positive Relationship



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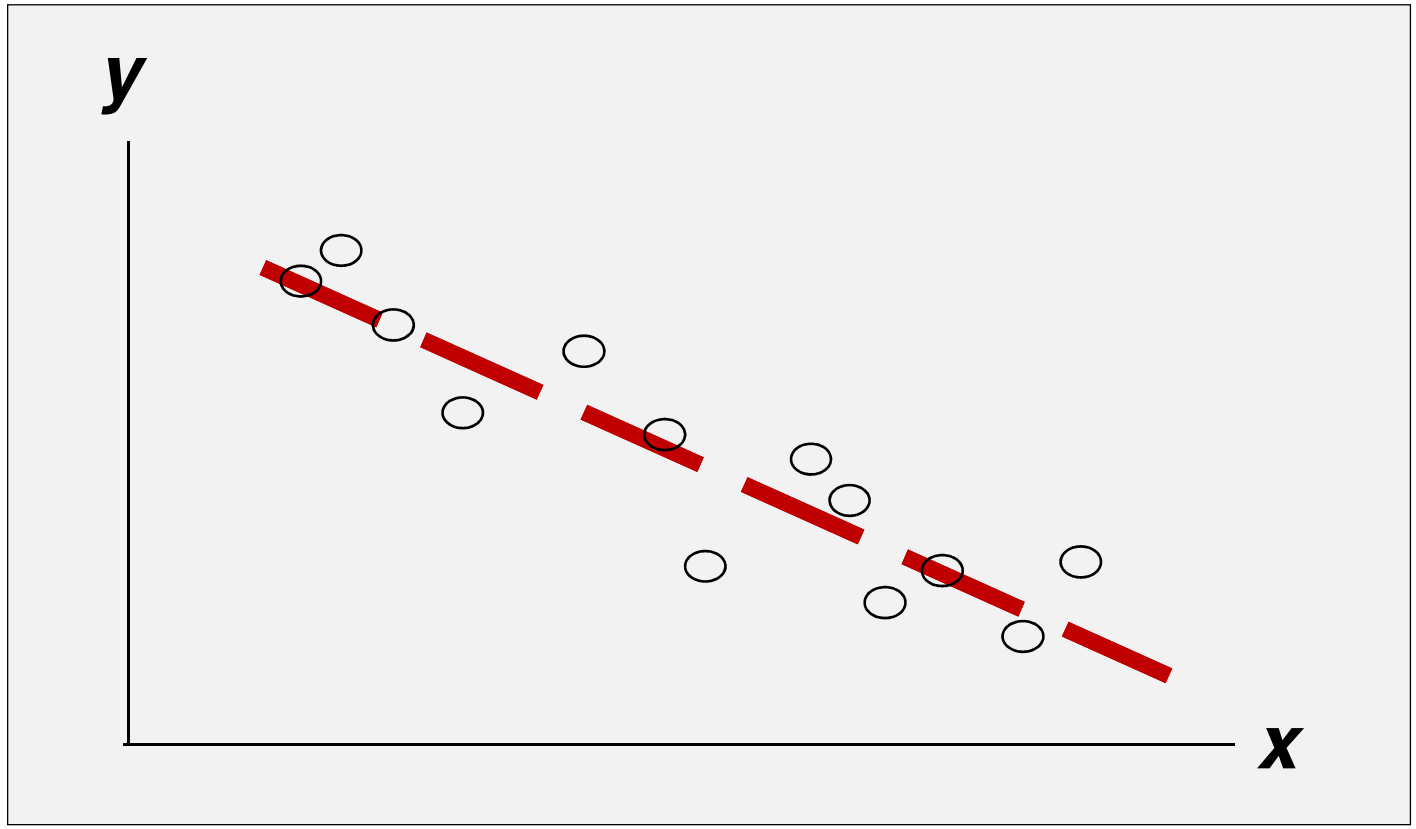
Scatter Diagram

- A Negative Relationship



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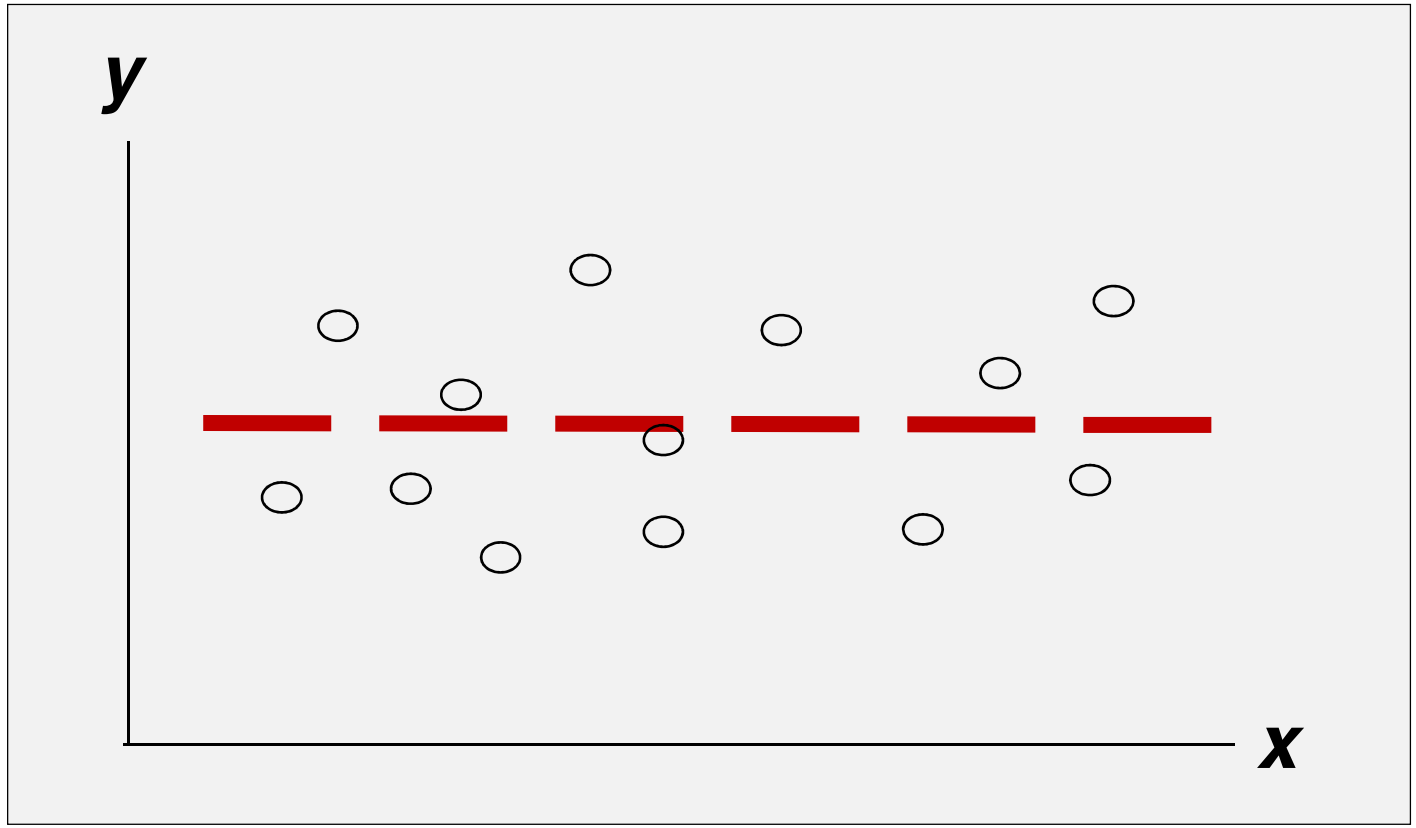
Scatter Diagram

- No Apparent Relationship



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Scatter Diagram

- Example: Panthers Football Team

The Panthers football team is interested in investigating the relationship, if any, between interceptions made and points scored.

x = Number of Interceptions	y = Number of Points Scored
1	14
3	24
2	18
1	17
3	30

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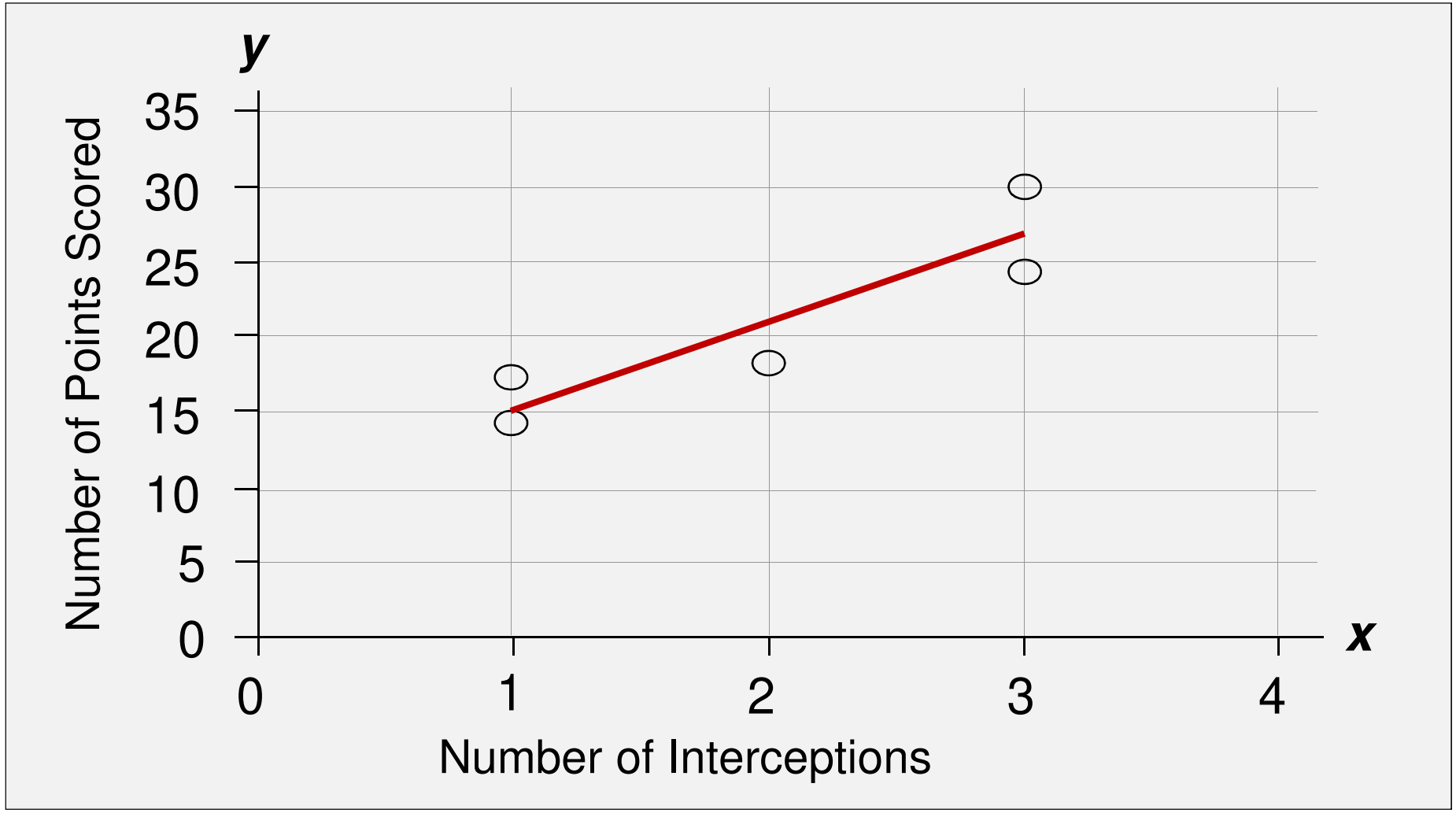
Scatter Diagram and Trendline



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Example: Panthers Football Team

- Insights Gained from the preceding Scatter Diagram
  - The scatter diagram indicates a positive relationship between the number of interceptions and the number of points scored.
  - Higher points scored are associated with a higher number of interceptions.
  - The relationship is not perfect; all plotted points in the scatter diagram are not on a straight line.

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Side-by-Side Bar Chart

- A side-by-side bar chart is a graphical display for depicting multiple bar charts on the same display.
- Each cluster of bars represents one value of the first variable.
- Each bar within a cluster represents one value of the second variable.

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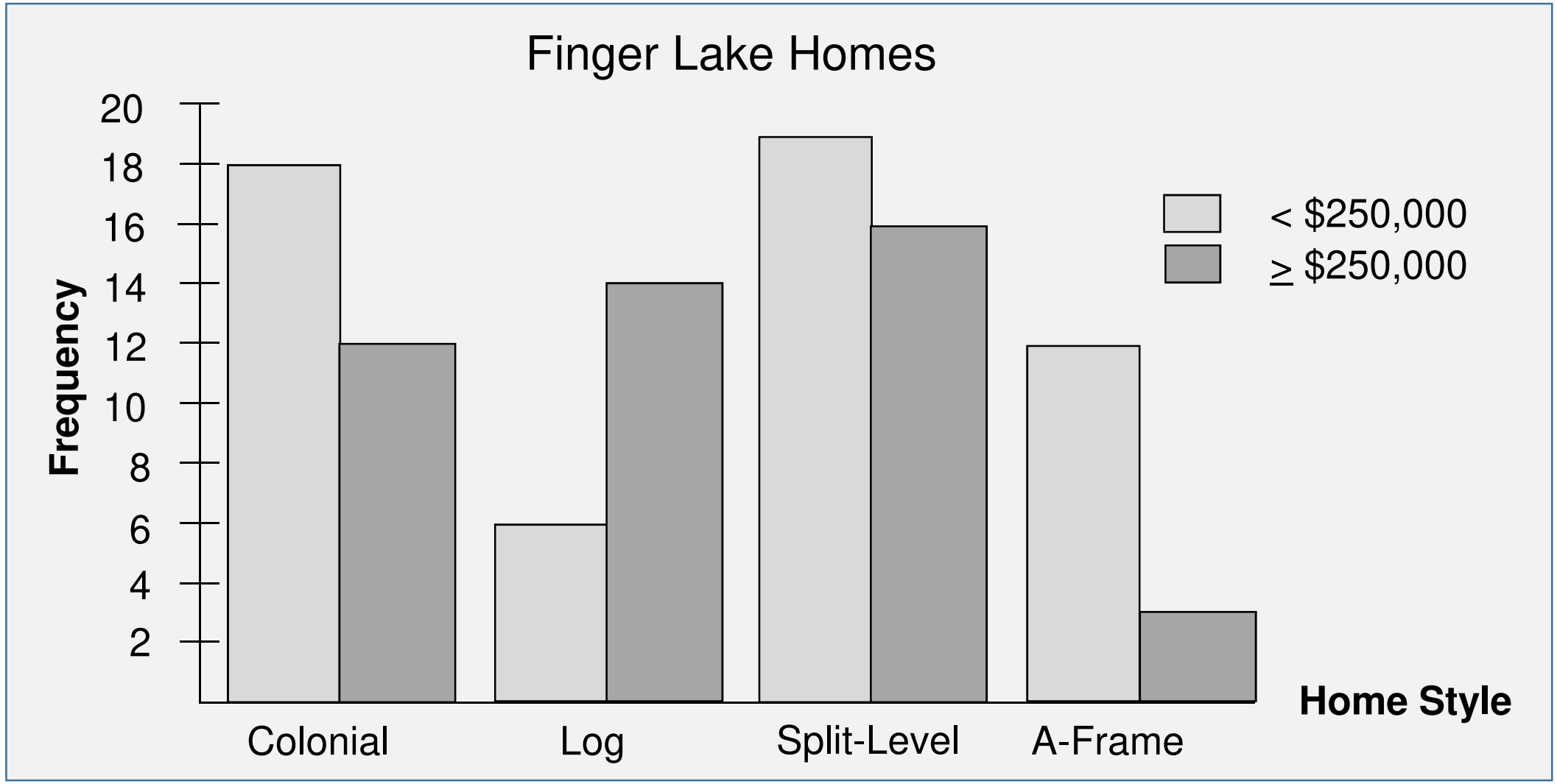
Side-by-Side Bar Chart



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Stacked Bar Chart

- A stacked bar chart is another way to display and compare two variables on the same display.
- It is a bar chart in which each bar is broken into rectangular segments of a different color.
- If percentage frequencies are displayed, all bars will be of the same height (or length), extending to the 100% mark.

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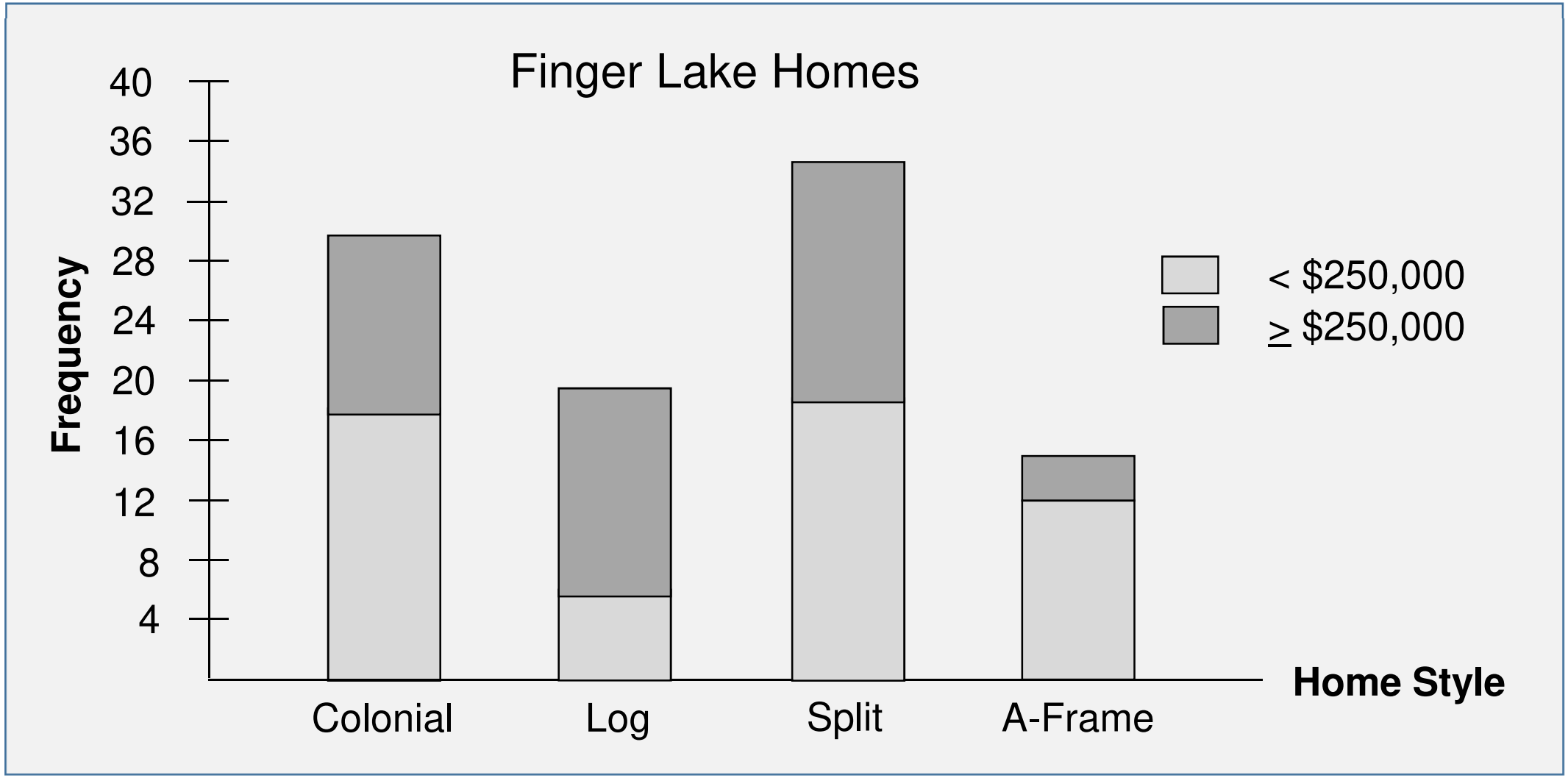
Stacked Bar Chart



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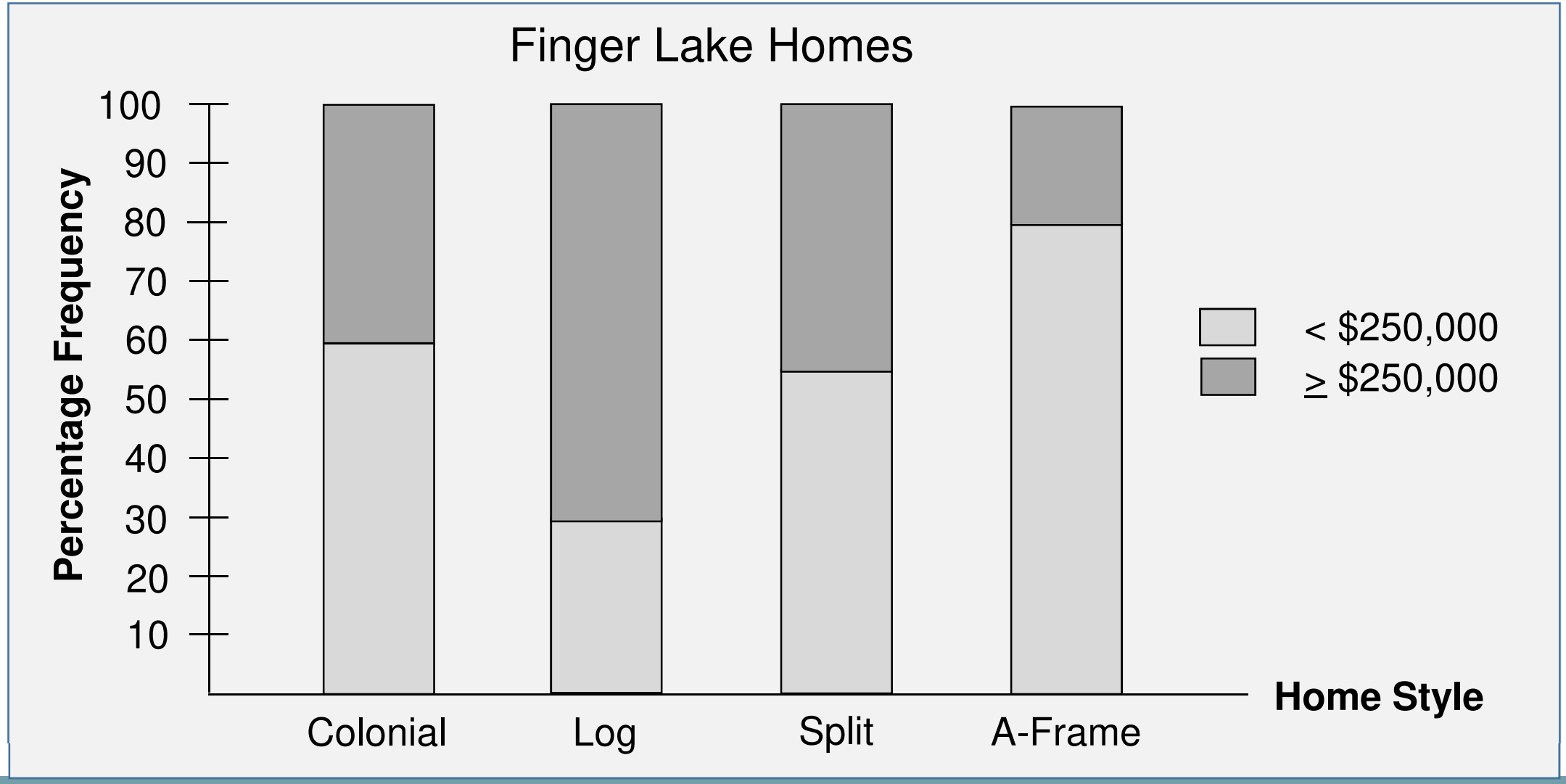
Stacked Bar Chart



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Data Visualization: Best Practices in Creating Effective Graphical Displays

- Data visualization is the use of graphical displays to summarize and present information about a data set.
- The goal is to communicate as effectively and clearly as possible, the key information about the data.

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Creating Effective Graphical Displays

- Creating effective graphical displays is as much art as it is science.
- Here are some guidelines . . .
  - Give the display a clear and concise title.
  - Keep the display simple.
  - Clearly label each axis and provide the units of measure.
  - If colors are used, make sure they are distinct.
  - If multiple colors or line types are used, provide a legend.

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Choosing the Type of Graphical Display

- Displays used to <u>show the distribution of data</u>:

  <u>Bar Chart</u> to show the frequency distribution and relative frequency distribution for categorical data

  <u>Pie Chart</u> to show the relative frequency and percent frequency for categorical data

  <u>Dot Plot</u> to show the distribution for quantitative data over the entire range of the data

  <u>Histogram</u> to show the frequency distribution for quantitative data over a set of class intervals

  <u>Stem-and-Leaf Display</u> to show both the rank order and shape of the distribution for quantitative data

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Choosing the Type of Graphical Display

- Displays used to make comparisons:

  Side-by-Side Bar Chart to compare two variables

  Stacked Bar Chart to compare the relative frequency or percent frequency of two categorical variables

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Choosing the Type of Graphical Display

- Displays used to <u>show relationships</u>:

  <u>Scatter Diagram</u> to show the relationship between two quantitative variables

  <u>Trendline</u> to approximate the relationship of data in a scatter diagram

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Data Dashboards

- A data dashboard is a widely used data visualization tool.
- It organizes and presents key performance indicators (KPIs) used to monitor an organization or process.
- It provides timely summary information that is easy to read, understand, and interpret.
- Some additional guidelines include . . .
  - Minimize the need for screen scrolling.
  - Avoid unnecessary use of color or 3D displays.
  - Use borders between charts to improve readability.

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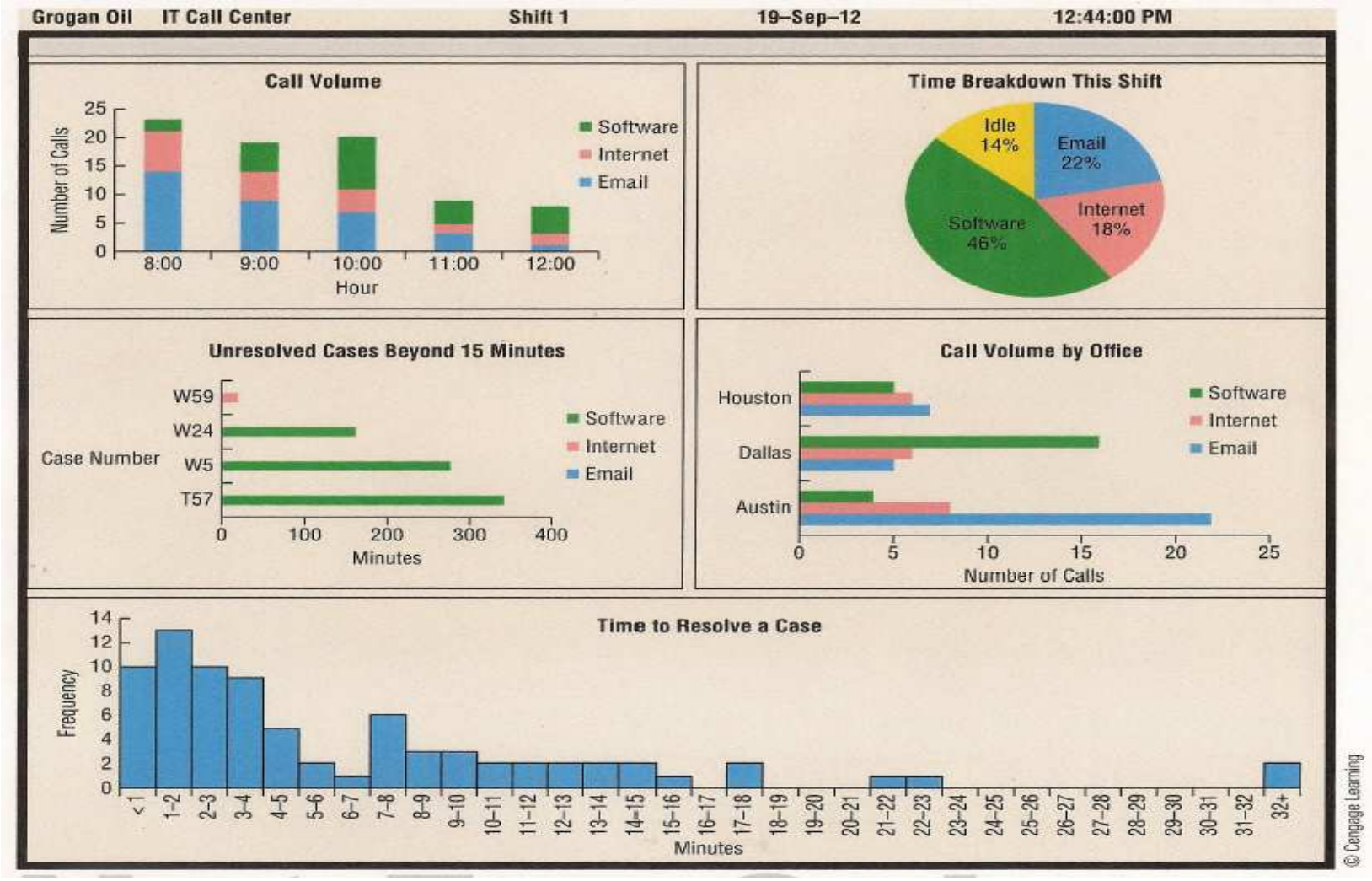
Data Dashboard Example



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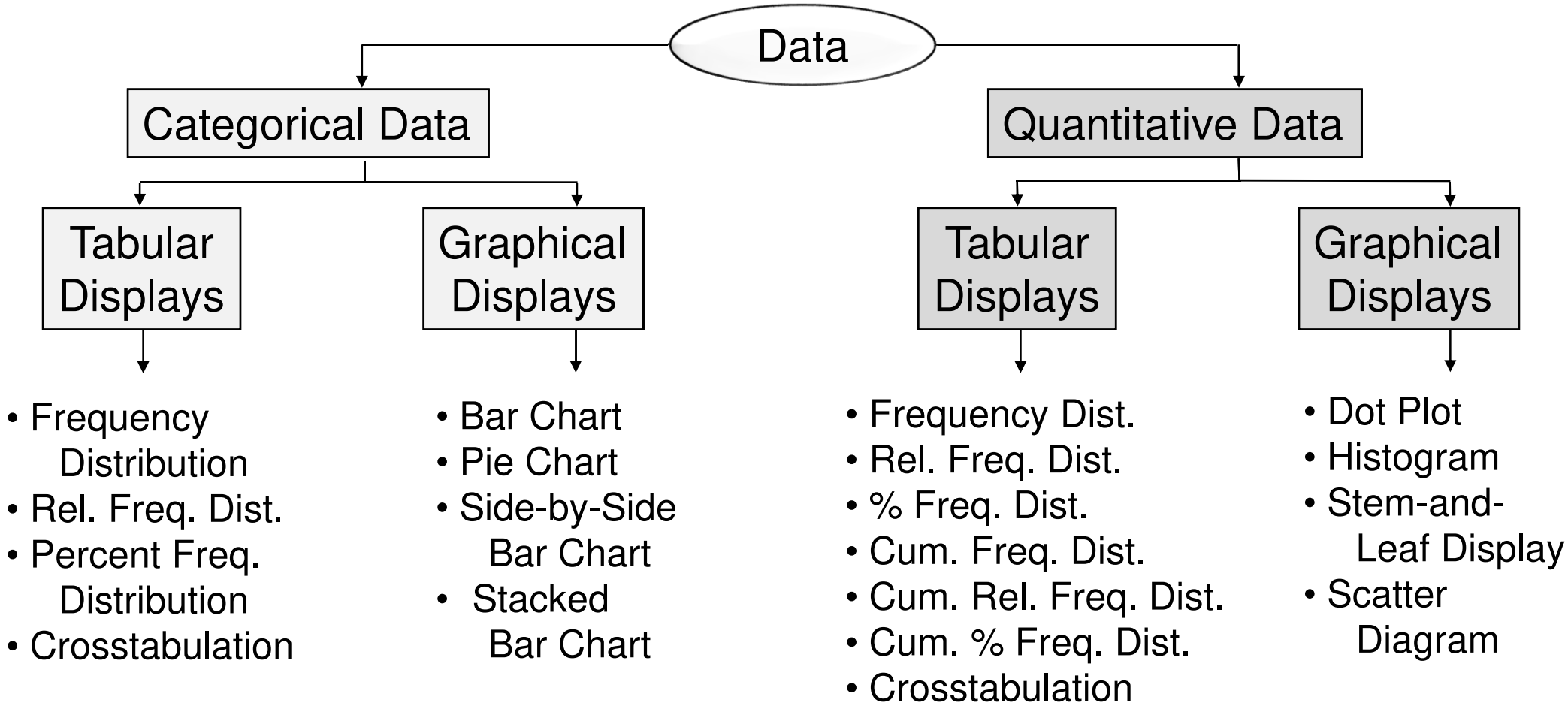
Tabular and Graphical Displays



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End of Chapter 2, Part B

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Solutions to
Case Problems

Chapter 2
Descriptive Statistics: Tabular and Graphical Presentations

Case Problem 1: Pelican Stores

1. There were 70 Promotional customers and 30 Regular customers. Because there are 100 observations in the sample, the frequency and percent frequency distribution are the same. Percent frequency distributions for many of the variables are given.

No. of Items	Percent Frequency
1	29
2	27
3	10
4	10
5	9
6	7
7 or more	8
Total:	100

Net Sales	Percent Frequency
0.00 - 24.99	9
25.00 - 49.99	30
50.00 - 74.99	25
75.00 - 99.99	10
100.00 - 124.99	12
125.00 - 149.99	4
150.00 - 174.99	3
175.00 - 199.99	3
200 or more	4
Total:	100

Method of Payment	Percent Frequency
American Express	2
Discover	4
MasterCard	14
Proprietary Card	70
Visa	10
Total:	100

Gender	Percent Frequency
Female	93
Male	7
Total:	100

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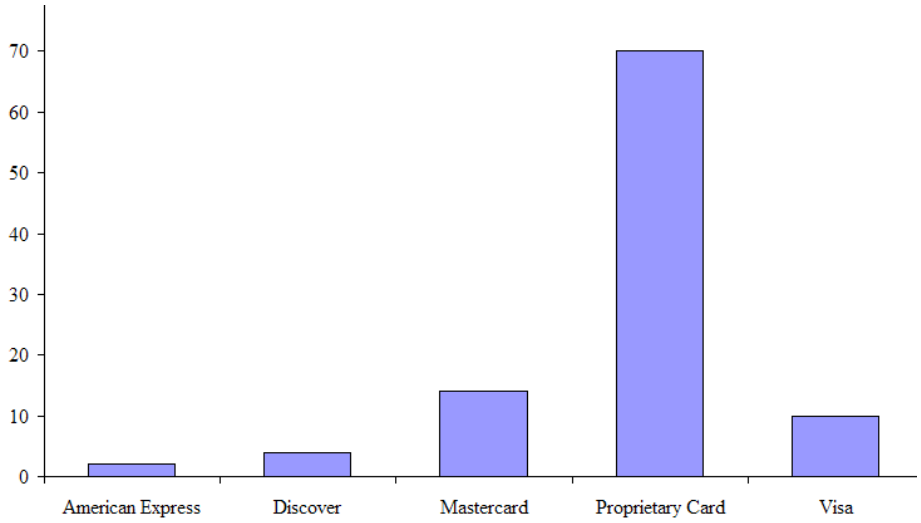
Martial Status	Percent Frequency
Married	84
Single	16
Total:	100

Age	Percent Frequency
20 - 29	10
30 - 39	30
40 - 49	33
50 - 59	16
60 - 69	7
70 - 79	4
Total:	100

These percent frequency distributions provide a profile of Pelican's customers. Many observations are possible, including:

- A large majority of the customers use National Clothing's proprietary credit card.
- Over half of the customers purchase 1 or 2 items, but a few make numerous purchases.
- The percent frequency distribution of net sales shows that 61% of the customers spent $50 or more.
- Customers are distributed across all adult age groups.
- The overwhelming majority of customers are female.
- Most of the customers are married.

2.



3. A crosstabulation of type of customer versus net sales is shown.

	Net Sales											
Customer	0-25	25-50	50-75	75-100	100-125	125-175	175-200	200-225	225-250	250-275	275-300	Total
Promotional	7	17	17	8	9	3	2	3	1	2	1	70
Regular	2	13	8	2	3	1	1					30
Total	9	30	25	10	12	4	3	3	1	2	1	100

From the crosstabulation it appears that net sales are larger for promotional customers.

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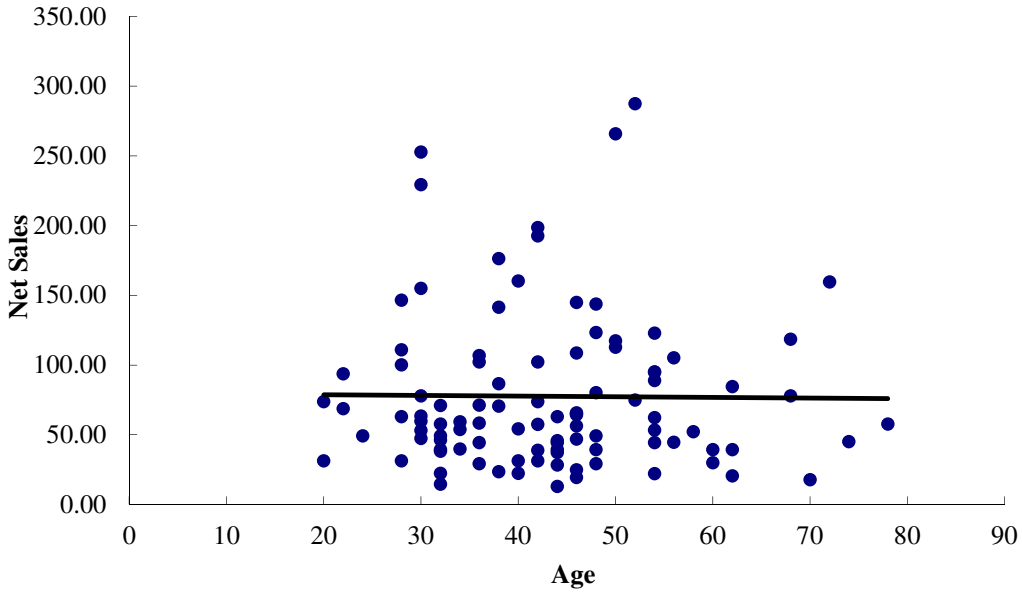
4. A scatter diagram of net Sales vs. age is shown below. A trendline has been fitted to the data. From this, it appears that there is no relationship between net sales and age.



Age is not a factor in determining net sales.

Case Problem 2: The Motion Picture Industry

This case provides the student with the opportunity to use tabular and graphical presentations to analyze data from the motion picture industry. Developing and interpreting frequency distributions, percent frequency distributions and scatter diagrams are emphasized. The interpretations and insights can be quite varied. We illustrate some below.

Frequency Distribution and Percent Frequency Distribution

The choice of the classes for frequency distributions or percent frequency distributions can be expected to vary. The frequency distributions we developed are as follows:

Opening Gross Sales (Millions)			Frequency (or Percentage)
$0	–	9.99	70
10	–	19.99	15
20	–	29.99	8
30	–	39.99	2
40	–	49.99	1
50	–	59.99	1
60	–	69.99	0
70	–	79.99	1
80	–	89.99	0
90	–	99.99	0
100	–	109.99	2
		Total	100

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Total Gross Sales (Millions)	Frequency (or Percentage)
$0 – 49.99	77
50 – 99.99	16
100 – 149.99	1
150 – 199.99	1
200 – 249.99	3
250 – 299.99	1
300 – 349.99	0
350 – 399.99	1
Total	100

Number of Theaters	Frequency (or Percentage)
0 – 499	51
500 – 999	3
1000 – 1499	6
1500 – 1999	7
2000 – 2499	5
2500 – 2999	6
3000 – 3499	17
3500 – 3999	5
Total	100

Number of Weeks in Top 60	Frequency (or Percentage)
0 – 4	33
5 – 9	28
10 – 14	18
15 – 19	15
20 – 24	5
25 – 29	1
Total	100

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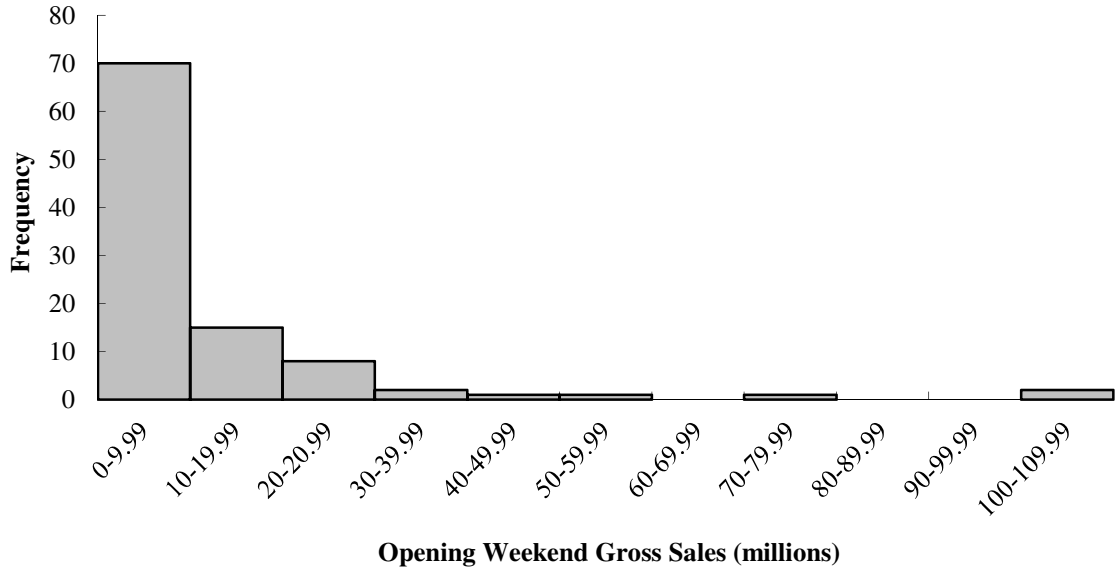
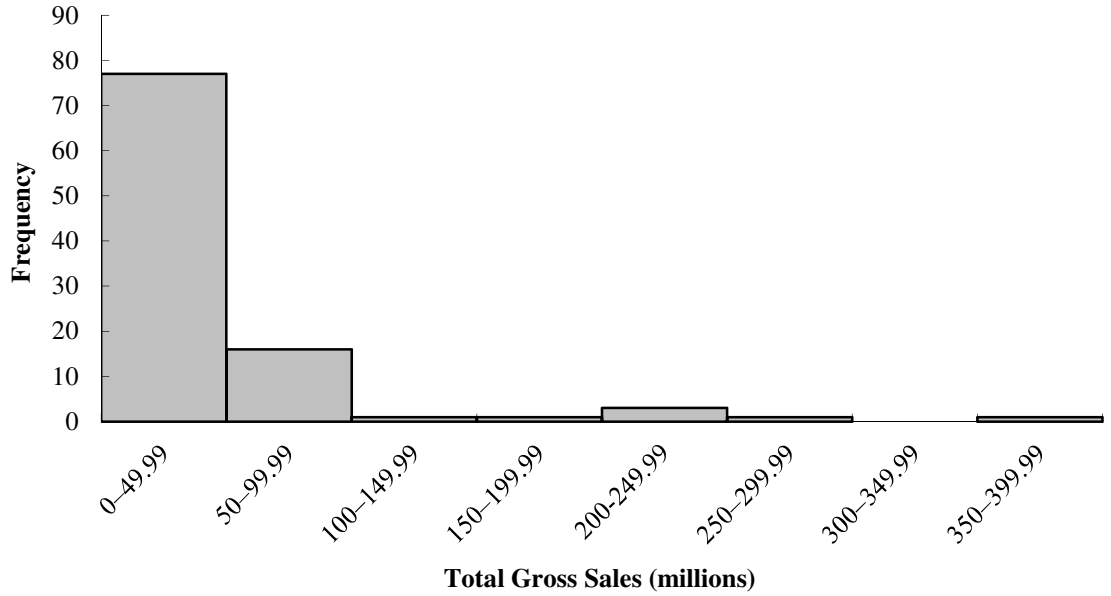
Histograms

The following histograms are based on the frequency distributions shown above.





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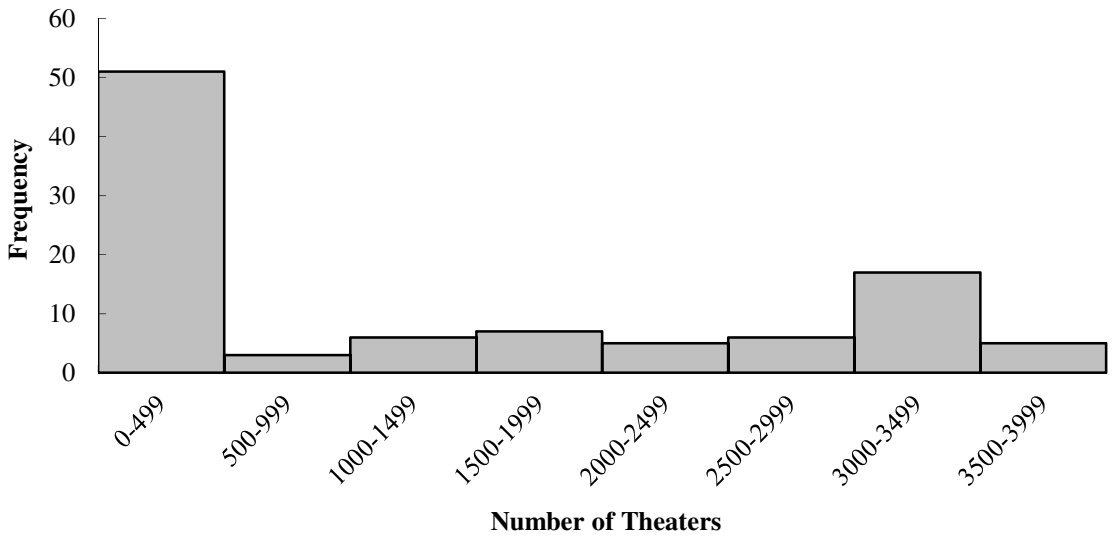

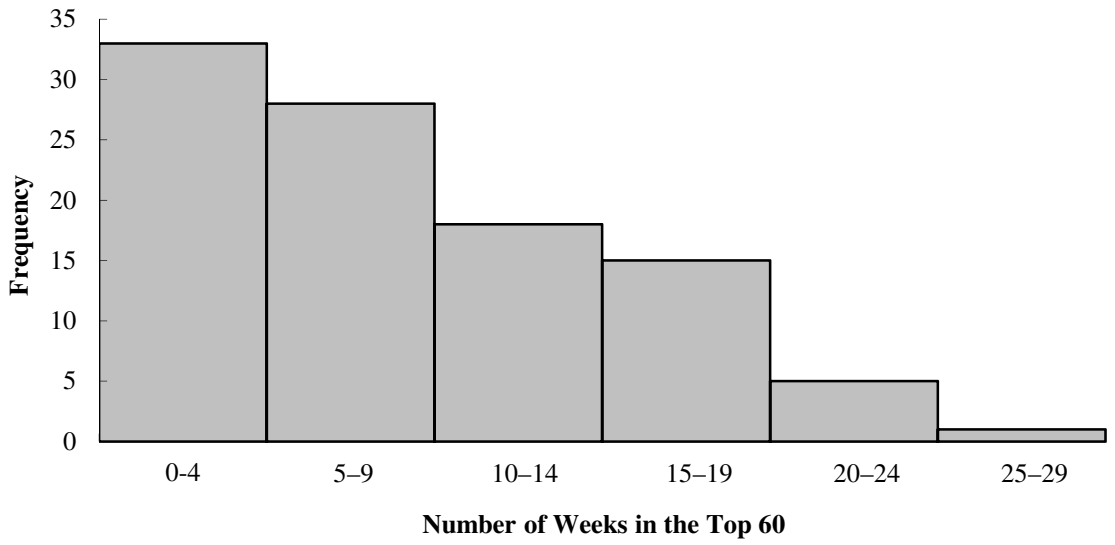

Interpretation

Opening Weekend Gross Sales. The distribution is skewed to the right. Numerous motion pictures have somewhat low opening weekend gross sales, while a relatively few (7%) have an opening weekend gross sales of $30 million or more. Only 2% had opening weekend gross sales of $100 million or more. 70% of the motion pictures had opening weekend gross sales less than $10 million and 85% of the motion pictures had opening weekend gross sales less than $20 million. Unless there is something unusually attractive about the motion picture, an opening weekend gross sales less than $10 million appears typical.

Total Gross Sales. This distribution is also skewed to the right. Again, the majority of the motion pictures have relatively low total gross sales with 77% less than $50 million and 93% less than $100 million. Highly successful blockbuster motion pictures are rare. Total gross sales over $200 million occurred only 5% of the time and over $300 million occurred only 1% of the time. No motion picture reported $400 million in total gross sales. Unless there is something unusually attractive about the motion picture, a total gross sales less than $50 million appears typical.

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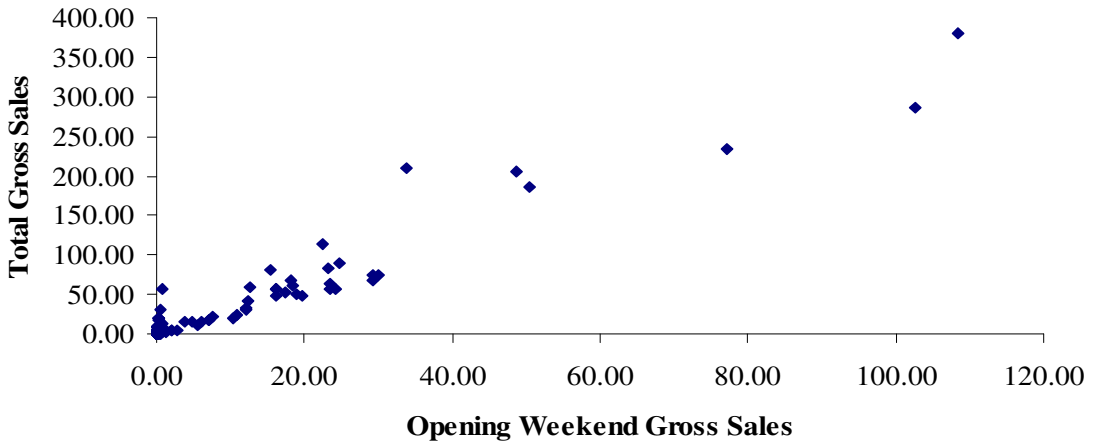
Number of Theaters. This distribution is skewed to the right, but not so much as sales data distributions. The number of theaters range from less than 500 to almost 4000. 51% of the motion pictures had the smaller market exposure with the number of theaters less than 500. Interestingly enough, 22% of the motion pictures had the widest market exposure, appearing in over 3000 theaters. 3000 to 4000 theaters is typical for a highly promoted motion picture.

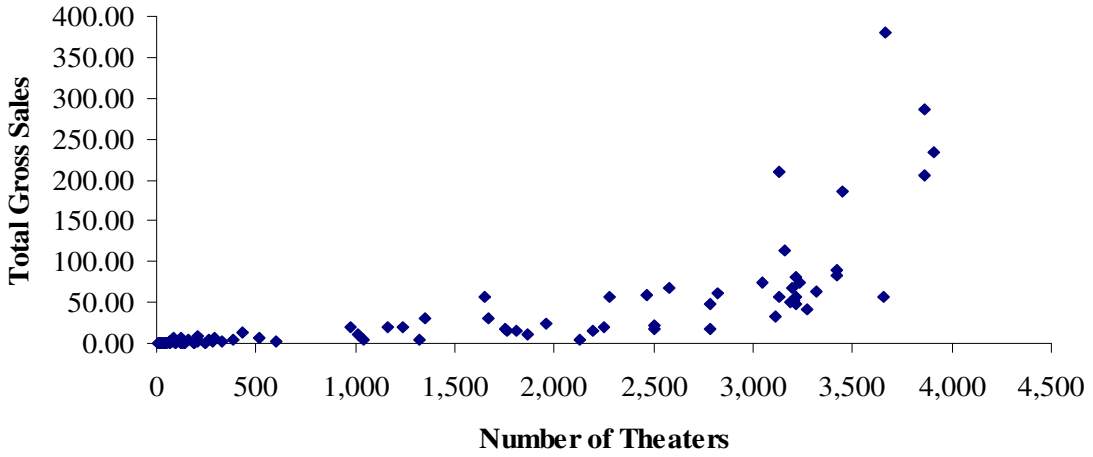
Number of Weeks in Top 60. This distribution is skewed to the right, but not as much as the other distributions. In appears that almost all newly released movies initially make it into the top 60, with 67% staying in the top 60 for 5 or more weeks. Even motion pictures with relative low gross sales can appear in the top 60 motion pictures for a month or more. Almost 40% of the motion pictures are in the top 60 for 10 or more weeks, with 6% of the motion pictures in the top 60 for 20 or more weeks.

General Observations. The data show that there are relative few high-end, highly successful motion pictures. The financial rewards are there for the pictures that make the blockbuster level. But the majority of motion pictures will have low opening weekend gross sales and low total gross sales. Motion pictures being shown in less than 1500 theaters and motion pictures less than 10 weeks in the top 60 are common.

Scatter Diagrams

Three scatter diagrams are suggested to show how Total Gross Sales is related to each of the other three variables.





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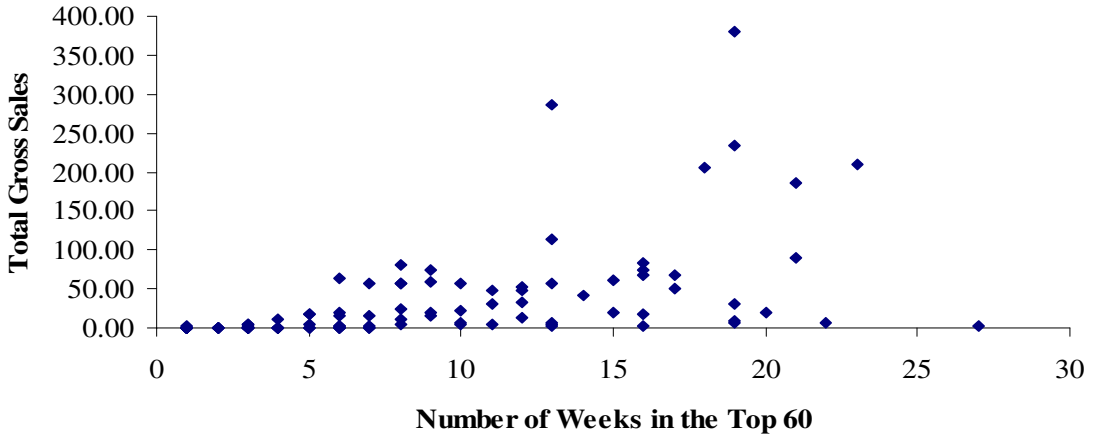

Interpretation

Opening Weekend Gross Sales. The scatter plot of total gross sales and opening weekend gross sales shows a strong positive relationship. Motion pictures with the highest total gross sales were the motion pictures with the highest opening weekend gross sales. How the motion picture does during its opening weekend should be a very good predictor of how the motion picture will do in terms of total gross sales. Note in the scatter diagram that the majority of the motion pictures show a low opening weekend gross sales and a low total gross sales.

Number of Theaters. The scatter plot of the total gross sales and number of theaters also shows a positive relationship. For motion pictures playing in less than 3000 theaters, the total gross sales has a positive relationship with the number of theaters. If the motion picture is shown in more theaters, higher total gross sales are anticipated. For motion pictures playing in more than 3000 theaters, the relationship is not as strong. 3000 to 4000 represents the maximum number of theaters possible. If a motion picture is shown in this many theaters, 15 motion pictures did slightly better in terms of total gross sales. However, the blockbuster motion pictures in this category showed extremely high total gross sales for the number of theaters where the motion picture was shown.

Number of Weeks in Top 60. The scatter plot of the total gross sales and number of weeks in the top 60 shows a positive relationship, but this relationship appears to be the weakest of the three relationships studied. Generally, the more successful, higher gross sales motion pictures are in the top 60 for more weeks. However, this is not always the case. Four of the six motion pictures with the highest total gross sales appeared in the top 60 less than 20 weeks. At the same time, four motion pictures with 20 or more weeks in the top 60 did not have unusually high total gross sales. This suggests that in some cases blockbuster movies with high gross sales may run their course quickly and not have an excessively long run on the top 60 motion picture list. At the same time, perhaps quality motion pictures with a limited audience may not generate the high total gross sales but may still show a run of 20 or more weeks on the top 60 motion picture list. The number of weeks in the top 60 does not appear to the best predictor of total gross sales.

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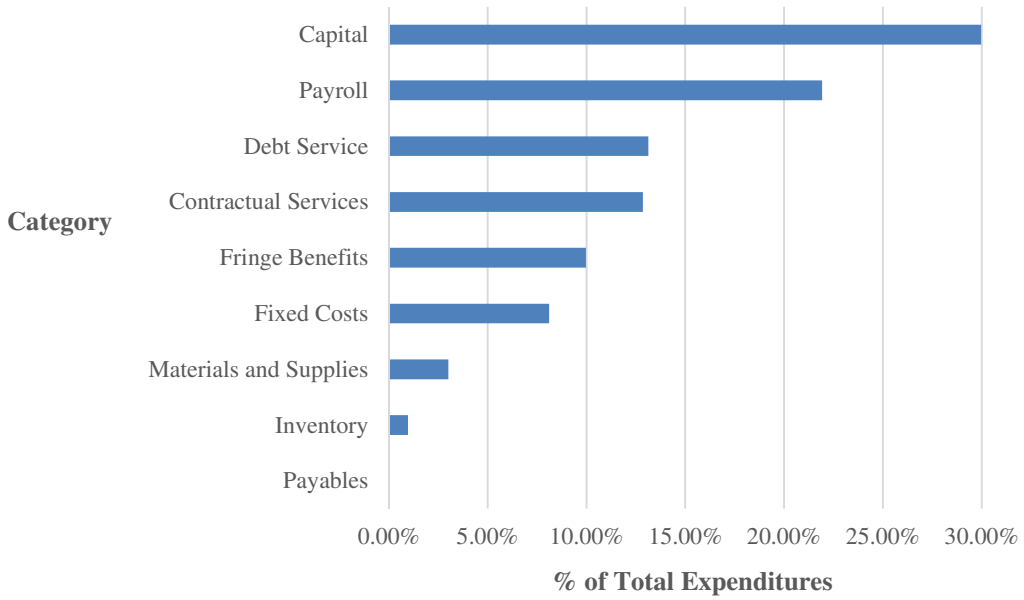
Case Problem 3: Queen City

This case provides the student with the opportunity to use basic tabular and graphical presentations to describe data from the annual expenditures for the city of Cincinnati, Ohio. The data set is large relative to others in the text. It contains 5,427 records of expenditures. As such, one point of this case is to expose students to a larger data set and help them understand that the pivot tables and charts can be used on a larger data set. In some cases, the student will have to copy, paste, and aggregate data to create the desired tables and charts. Style of presentation may vary by student (for example, vertical versus horizontal bar charts may be used). We illustrate with results and comments below.

Expenditures by Category

The pivot table shows expenditures and percentage of total expenditures by category. The bar chart shows percentage of total expenditures by category (both the table and the bar chart are sorted in descending order). Capital expenditures and payroll account for over 50% of all expenditures. Total expenditures are over $660 million. Debt Service seems somewhat high, as it is over 10% of total expenditures.

Category	Total Expenditures	% of Total Expenditures
Capital	$198,365,854	29.98%
Payroll	$145,017,555	21.92%
Debt Service	$86,913,978	13.14%
Contractual Services	$85,043,249	12.85%
Fringe Benefits	$66,053,340	9.98%
Fixed Costs	$53,732,177	8.12%
Materials and Supplies	$19,934,710	3.01%
Inventory	$6,393,394	0.97%
Payables	$180,435	0.03%
Grand Total	$661,634,693	100.0%



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Expenditures by Department

The following table and bar chart show the percentages of total expenditures incurred by department. Note that we have combined all departments that individually incurred less than 1% of the total expenditures. There are 119 departments, and 96 each account for less than 1% of the total expenditures. As shown below, only six individual departments incur 5% or more of the total expenditures. These include, Police, Sewers, Transportation Engineering (Engineering). Fire, Sewer Debt Service and Finance/Risk Management. Debt service on sewers as a percentage of total expenditures appears to be very high.

Department	% of Total Expenditures
Department of Police	9.7%
Department of Sewers	8.8%
Transportation and Engineering, (Engineering)	8.7%
Department of Fire	7.2%
Sewers, Debt Service	6.6%
Finance, Risk Management	5.4%
SORTA Operations	3.6%
Water Works, Debt Service	3.2%
Department of water Works	3.1%
Finance, Treasury	2.8%
Economic Development	2.1%
Division of Parking Services	1.9%
Community Development, Housing	1.7%
Enterprise Technology Solutions	1.7%
Public Services, Fleet Services	1.7%
Finance, Accounts & Audits	1.7%
Transportation and Engineering, Planning	1.6%
Public Services, Neighborhood Operations	1.4%
Sewers, Millcreek	1.3%
Health, Primary Health Care Centers	1.2%
Water Works, Water Supply	1.2%
Public Services, Facilities Management	1.1%
Sewers, Wastewater Administration	1.0%
Other Depts. (< 1% each)	21.2%
Total	100.0%

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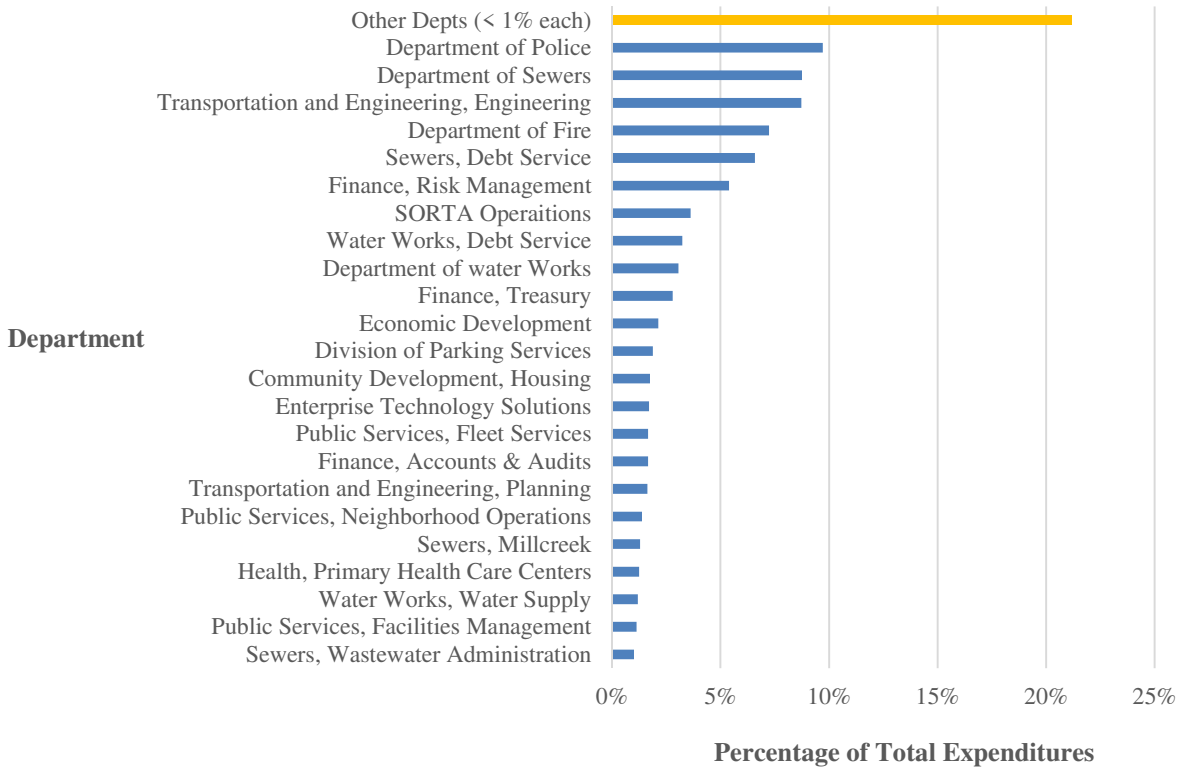

Expenditures by Fund

The following bar table and bar chart show the percentages of total expenditures charged by fund used to pay. Note that we have combined those funds that each cover less than 1% of the total expenditures. There are 129 funds in the data base, and 117 of these funds each account for less than 1% of total expenditures.

Fund	% of Total Expenditures Covered
050 - GENERAL FUND	25.5%
980 - CAPITAL PROJECTS	16.0%
701 - METROPOLITAN SEWER DISTRICT OF GREATER CINCINNATI	12.7%
704 - METROPOLITAN SEWER DISTRICT CAPITAL IMPROVEMENTS	8.8%
101 - WATER WORKS	7.9%
711 - RISK MANAGEMENT	4.9%
759 - INCOME TAX – TRANSIT	3.7%
151 - BOND RETIREMENT – CITY	2.4%
202 - FLEET SERVICES	1.7%
898 - WATER WORKS IMPROVEMENT 12	1.3%
897 - WATER WORKS IMPROVEMENT 11	1.3%
302 - INCOME TAX – INFRASTRUCTURE	1.1%
Other (< 1 % each).	12.9%
Total	100.0%

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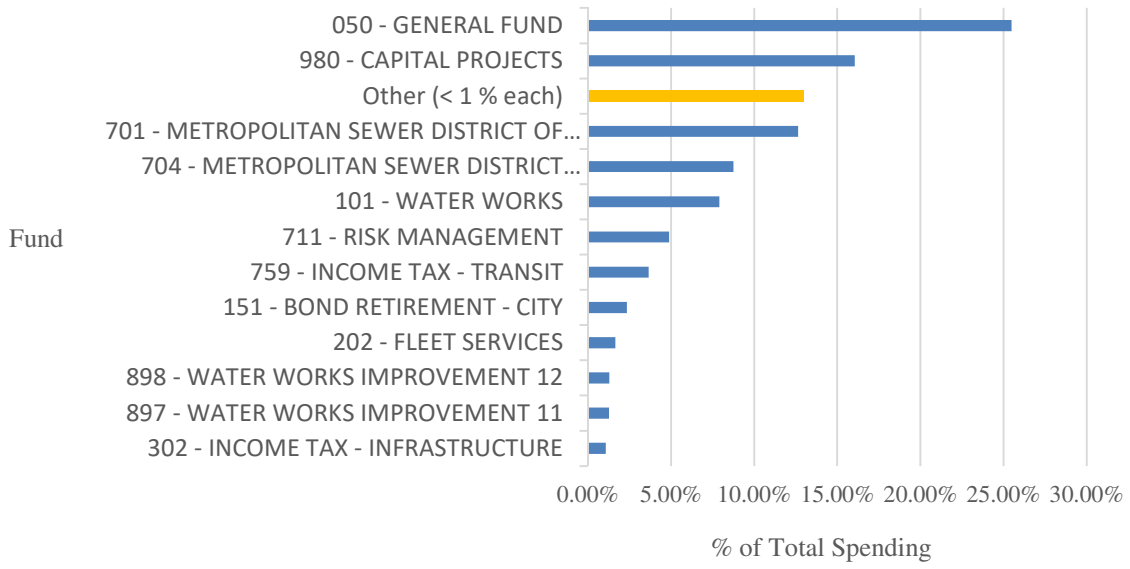

Other Points: There are 5,427 records of expenditures in the data base, of which 235 (4.3%) are negative.

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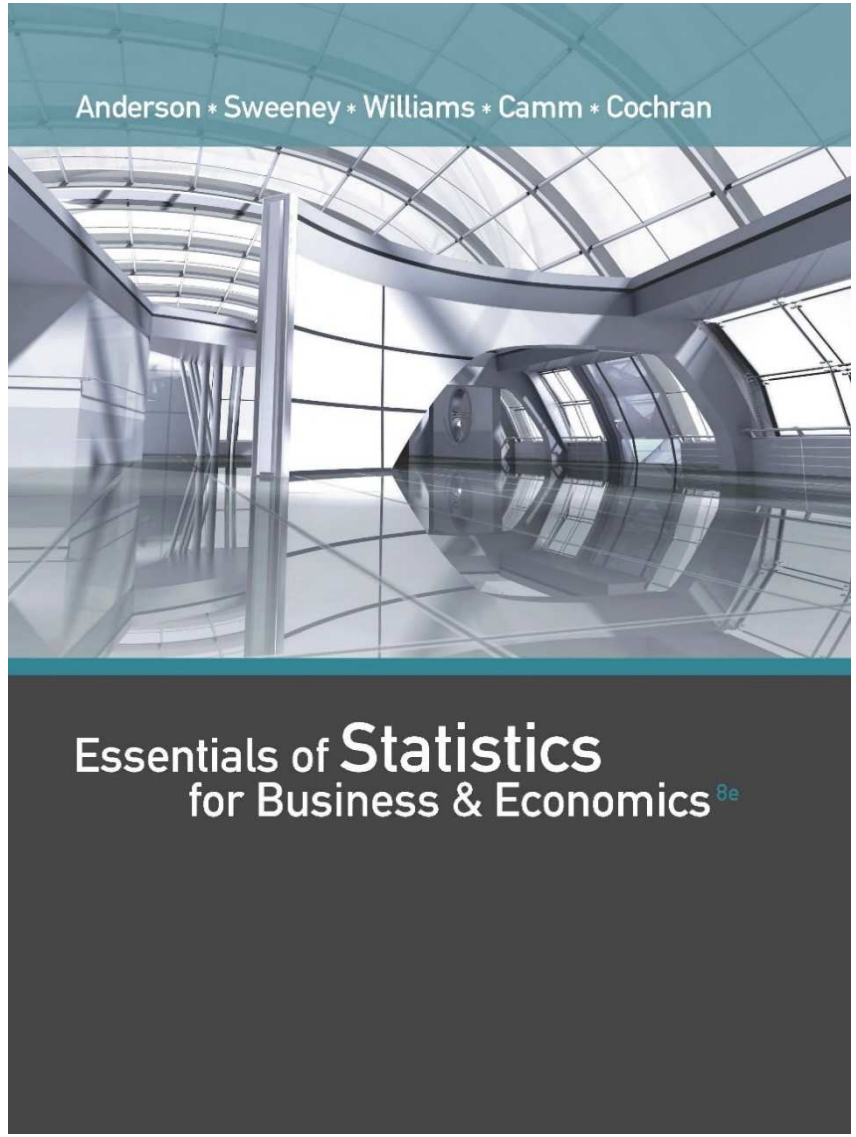

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Chapter 2
Part A - Descriptive Statistics: Tabular and Graphical Displays

- Summarizing Data for a Categorical Variable
  - Categorical data use labels or names to identify categories of like items.
- Summarizing Data for a Quantitative Variable
  - Quantitative data are numerical values that indicate how much or how many.

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Summarizing Categorical Data

- Frequency Distribution
- Relative Frequency Distribution
- Percent Frequency Distribution
- Bar Chart
- Pie Chart

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Frequency Distribution

- A frequency distribution is a tabular summary of data showing the number (frequency) of observations in each of several non-overlapping categories or classes.
- The objective is to provide insights about the data that cannot be quickly obtained by looking only at the original data.

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Frequency Distribution

Example: Marada Inn

- Guests staying at Marada Inn were asked to rate the quality of their accommodations as being *excellent*, *above average*, *average*, *below average*, or *poor*.
- The ratings provided by a sample of 20 guests are:

Below Average	Average	Above Average
Above Average	Above Average	Above Average
Above Average	Below Average	Below Average
Average	Poor	Poor
Above Average	Excellent	Above Average
Average	Above Average	Average
Above Average	Average	

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Frequency Distribution

- Example: Marada Inn

Rating	Frequency
Poor	2
Below Average	3
Average	5
Above Average	9
Excellent	1
Total	20

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Relative Frequency Distribution

- The relative frequency of a class is the fraction or proportion of the total number of data items belonging to the class.

$$\text{Relative frequency of a class} = \frac{\text{Frequency of the class}}{n}$$

- A relative frequency distribution is a tabular summary of data showing the relative frequency for each class.

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Percent Frequency Distribution

- The percent frequency of a class is the relative frequency multiplied by 100.
- A percent frequency distribution is a tabular summary of a set of data showing the percent frequency for each class.

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Relative Frequency and Percent Frequency Distributions

- Example: Marada Inn

Rating	Relative Frequency	Percent Frequency
Poor	.10	10
Below Average	.15	15
Average	.25	25
Above Average	.45	45
Excellent	.05	5
Total	1.00	100

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Bar Chart

- A bar chart is a graphical display for depicting qualitative data.
- On one axis (usually the horizontal axis), we specify the labels that are used for each of the classes.
- A frequency, relative frequency, or percent frequency scale can be used for the other axis (usually the vertical axis).
- Using a bar of fixed width drawn above each class label, we extend the height appropriately.
- The bars are separated to emphasize the fact that each class is a separate category.

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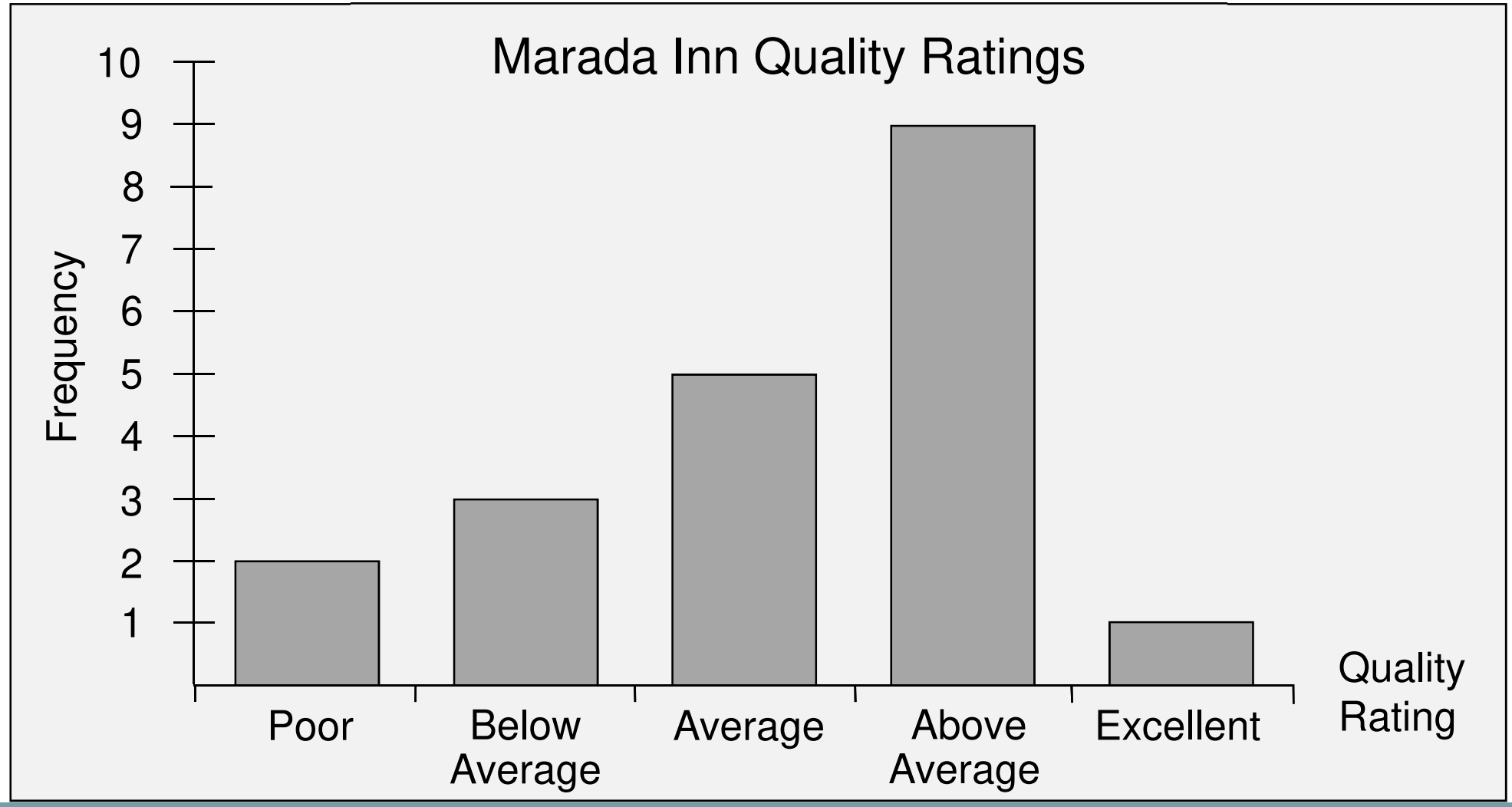
Bar Chart



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Pareto Diagram

- In quality control, bar charts are used to identify the most important causes of problems.
- When the bars are arranged in descending order of height from left to right (with the most frequently occurring cause appearing first) the bar chart is called a Pareto diagram.
- This diagram is named for its founder, Vilfredo Pareto, an Italian economist.

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Pie Chart

- The pie chart is a commonly used graphical display for presenting relative frequency and percent frequency distributions for categorical data.
- First draw a circle; then use the relative frequencies to subdivide the circle into sectors that correspond to the relative frequency for each class.
- Since there are 360 degrees in a circle, a class with a relative frequency of .25 would consume .25(360) = 90 degrees of the circle.

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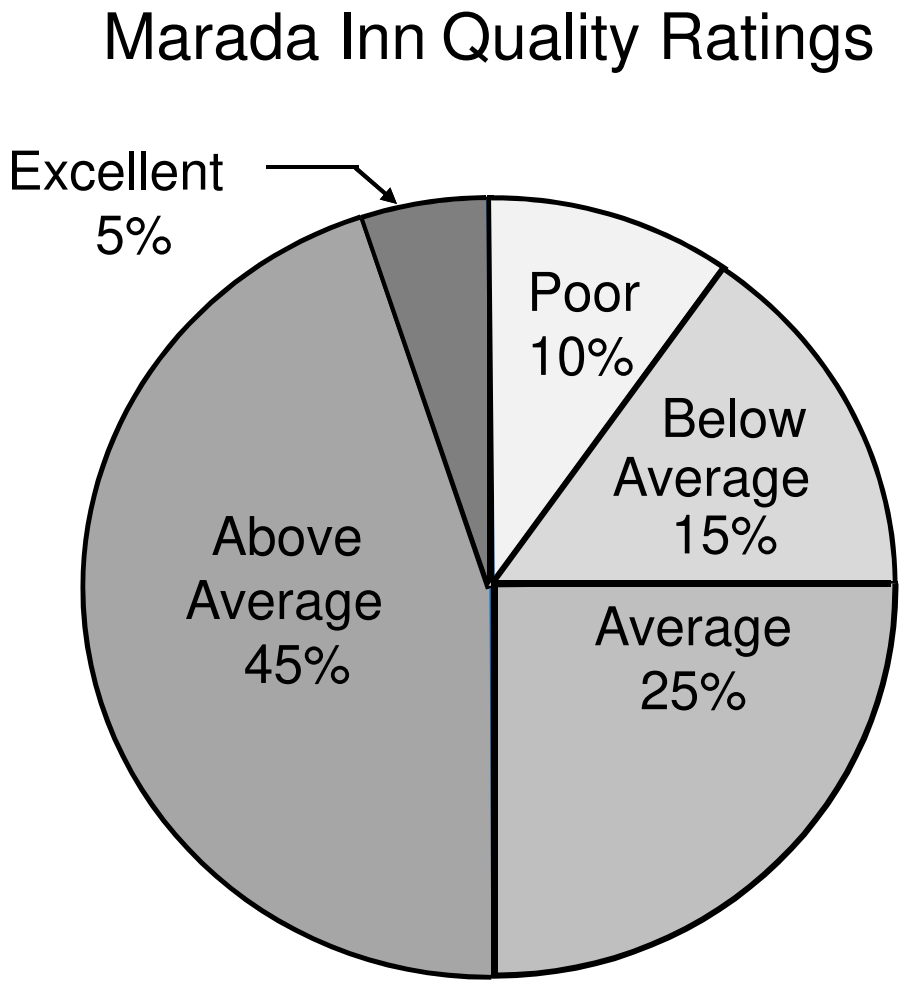
Pie Chart



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Example: Marada Inn

- One-half of the customers surveyed gave Marada a quality rating of "above average" or "excellent" (looking at the left side of the pie). This might please the manager.
- For each customer who gave an "excellent" rating, there were two customers who gave a "poor" rating (looking at the top of the pie). This should displease the manager.

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Summarizing Quantitative Data

- Frequency Distribution
- Relative Frequency and Percent Frequency Distributions
- Dot Plot
- Histogram
- Cumulative Distributions
- Stem-and-Leaf Display

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Frequency Distribution

- Example: Hudson Auto Repair

  The manager of Hudson Auto would like to gain a better understanding of the cost of parts used in the engine tune-ups performed in the shop. She examines 50 customer invoices for tune-ups. The costs of parts, rounded to the nearest dollar, are listed on the next slide.

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Frequency Distribution

- Example: Hudson Auto Repair

Sample of Parts Cost($) for 50 Tune-ups

91	78	93	57	75	52	99	80	97	62
71	69	72	89	66	75	79	75	72	76
104	74	62	68	97	105	77	65	80	109
85	97	88	68	83	68	71	69	67	74
62	82	98	101	79	105	79	69	62	73

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Frequency Distribution

The three steps necessary to define the classes for a frequency distribution with quantitative data are:

1. Determine the number of non-overlapping classes.
2. Determine the width of each class.
3. Determine the class limits.

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Frequency Distribution

- Guidelines for Determining the Number of Classes
  - Use between 5 and 20 classes.
  - Data sets with a larger number of elements usually require a larger number of classes.
  - Smaller data sets usually require fewer classes.
  - The goal is to use enough classes to show the variation in the data, but not so many classes that some contain only a few data items.

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Frequency Distribution

- Guidelines for Determining the Width of Each Class
  - Use classes of equal width.
  - Approximate Class Width =

$$\frac{\text{Largest data value} - \text{Smallest data value}}{\text{Number of classes}}$$

  - Making the classes the same width reduces the chance of inappropriate interpretations.

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Frequency Distribution

- Note on Number of Classes and Class Width
  - In practice, the number of classes and the appropriate class width are determined by trial and error.
  - Once a possible number of classes is chosen, the appropriate class width is found.
  - The process can be repeated for a different number of classes.
  - Ultimately, the analyst uses judgment to determine the combination of the number of classes and class width that provides the best frequency distribution for summarizing the data.

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Frequency Distribution

- Guidelines for Determining the Class Limits
  - Class limits must be chosen so that each data item belongs to one and only one class.
  - The lower class limit identifies the smallest possible data value assigned to the class.
  - The upper class limit identifies the largest possible data value assigned to the class.
  - The appropriate values for the class limits depend on the level of accuracy of the data.
  - An open-end class requires only a lower class limit or an upper class limit.

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Frequency Distribution

- Class Midpoint
  - In some cases, we want to know the midpoints of the classes in a frequency distribution for quantitative data.
  - The <u>class midpoint</u> is the value halfway between the lower and upper class limits.

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Frequency Distribution

- Example: Hudson Auto Repair

  If we choose six classes:

  Approximate Class Width = (109 - 50)/6 = 9.83≅ 10

Parts Cost ($)	Frequency
50-59	2
60-69	13
70-79	16
80-89	7
90-99	7
100-109	5
Total	50

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Relative Frequency and Percent Frequency Distributions

- Example: Hudson Auto Repair

Parts Cost ($)	Relative Frequency	Percent Frequency
50-59	.04 = 2/50	4 = .04(100)
60-69	.26	26
70-79	.32	32
80-89	.14	14
90-99	.14	14
100-109	.10	10
Total	1.00	100

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Relative Frequency and Percent Frequency Distributions

- Example: Hudson Auto Repair

Insights Gained from the Percent Frequency Distribution:

- Only 4% of the parts costs are in the $50-59 class.
- 30% of the parts costs are under $70.
- The greatest percentage (32% or almost one-third) of the parts costs are in the $70-79 class.
- 10% of the parts costs are $100 or more.

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Dot Plot

- One of the simplest graphical summaries of data is a dot plot.
- A horizontal axis shows the range of data values.
- Then each data value is represented by a dot placed above the axis.

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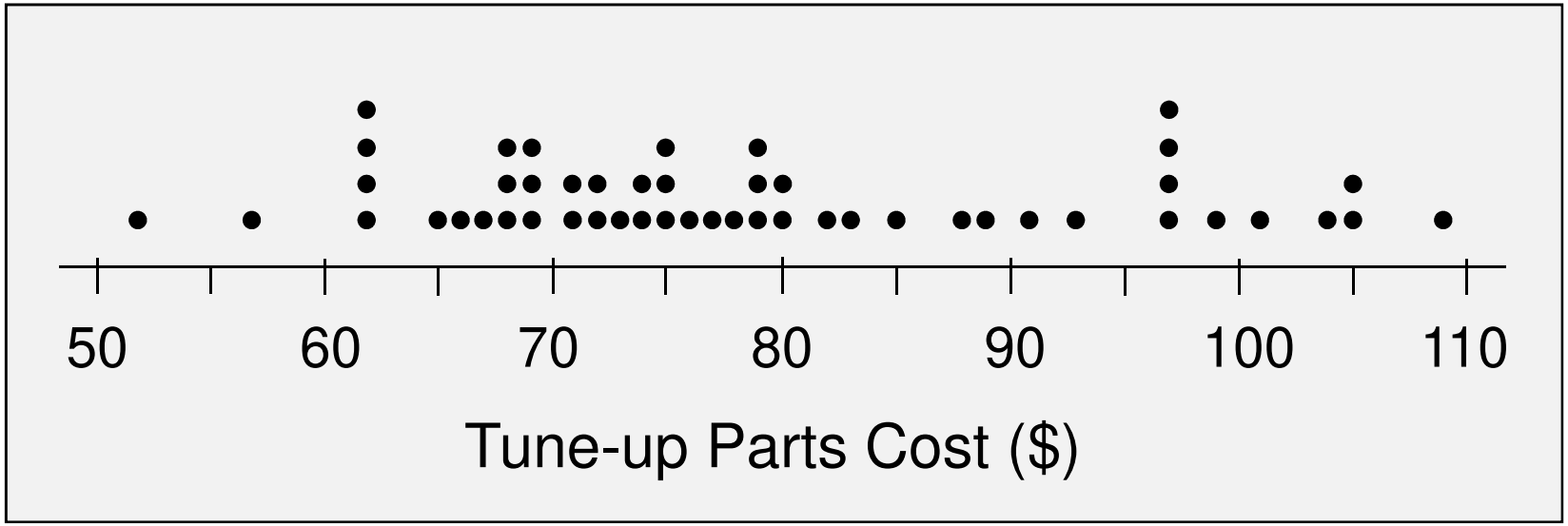
Dot Plot

- Example: Hudson Auto Repair



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Histogram

- Another common graphical display of quantitative data is a histogram.
- The variable of interest is placed on the horizontal axis.
- A rectangle is drawn above each class interval with its height corresponding to the interval's frequency, relative frequency, or percent frequency.
- Unlike a bar graph, a histogram has no natural separation between rectangles of adjacent classes.

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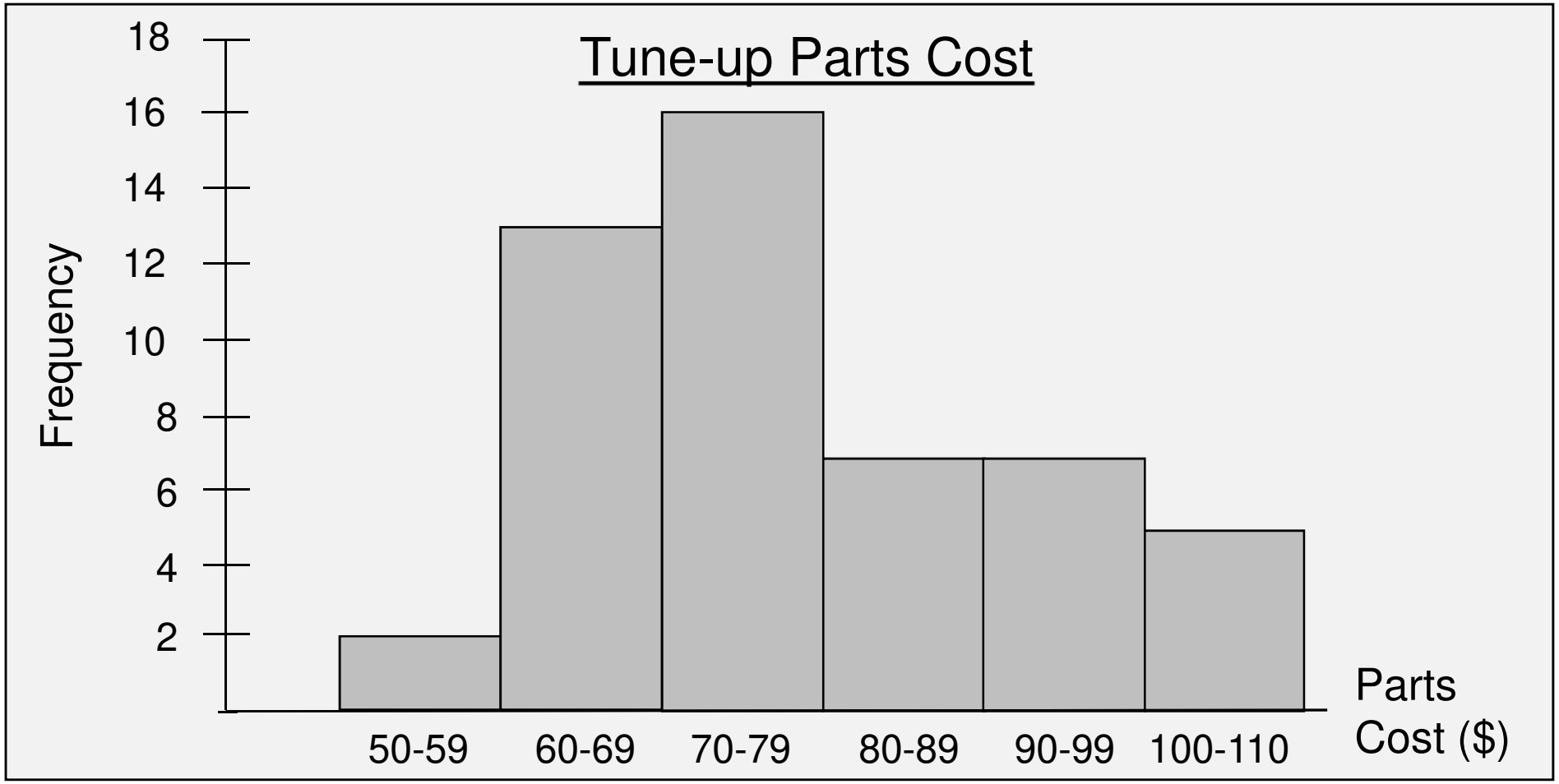
Histogram

- Example: Hudson Auto Repair



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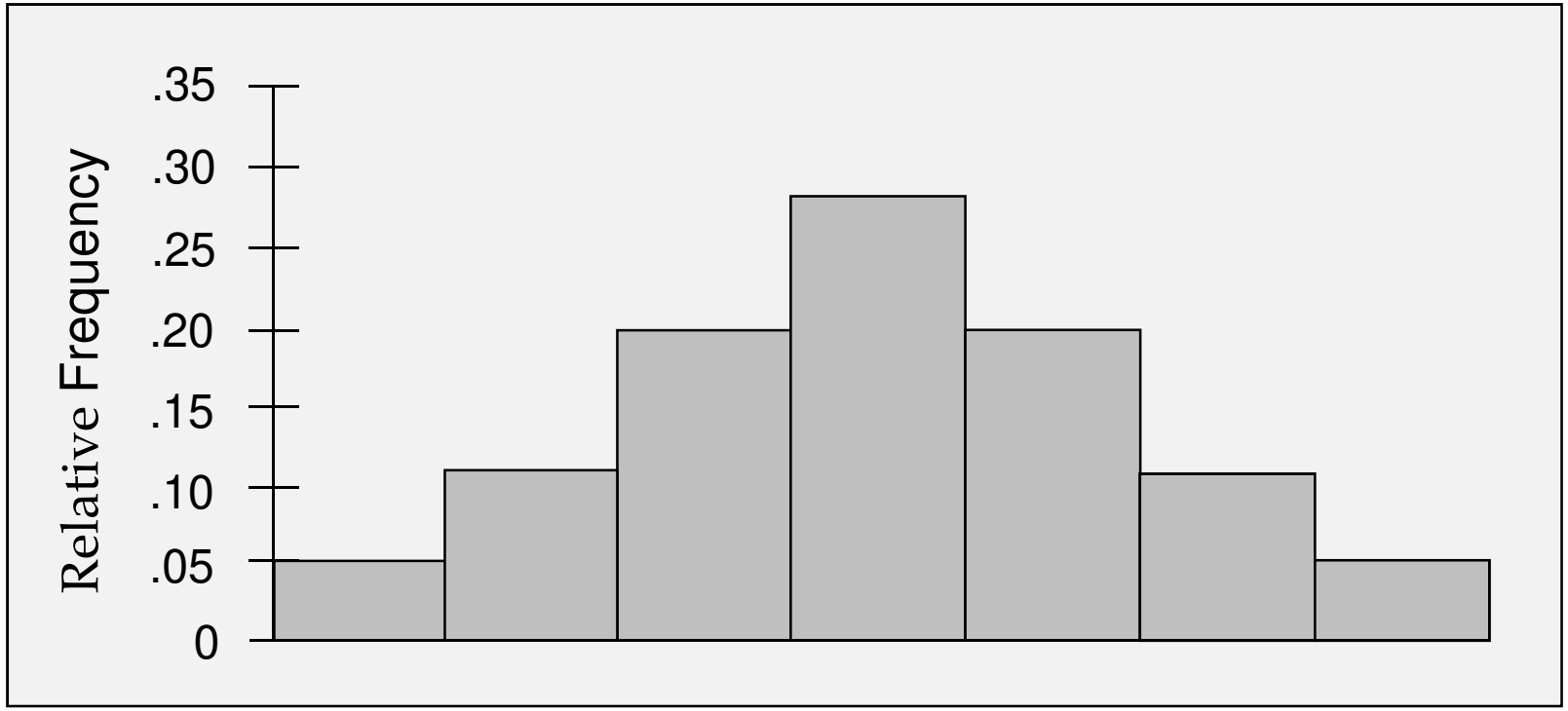
Histograms Showing Skewness

- Symmetric
  - Left tail is the mirror image of the right tail
  - Example: Heights of People



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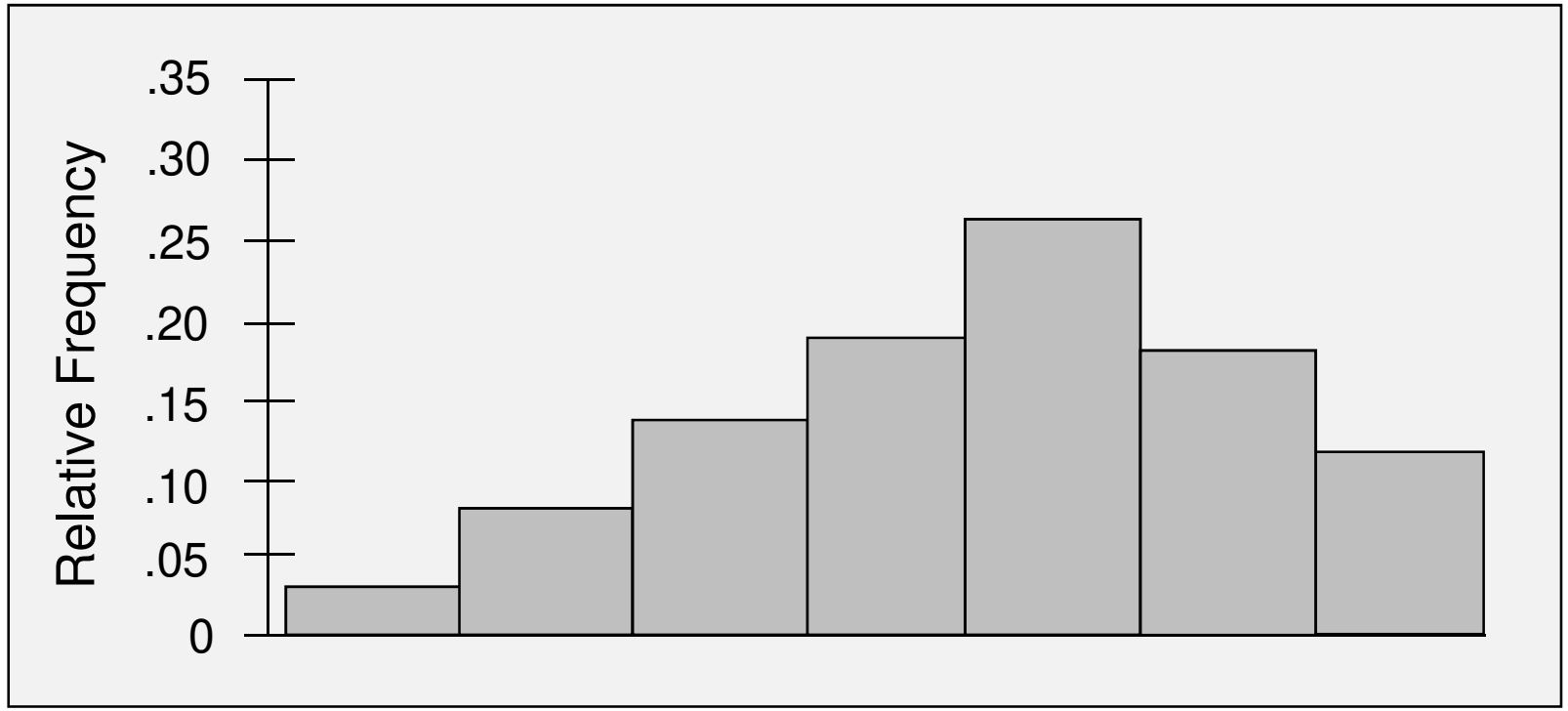
Histograms Showing Skewness

- Moderately Skewed Left
  - A longer tail to the left
  - Example: Exam Scores



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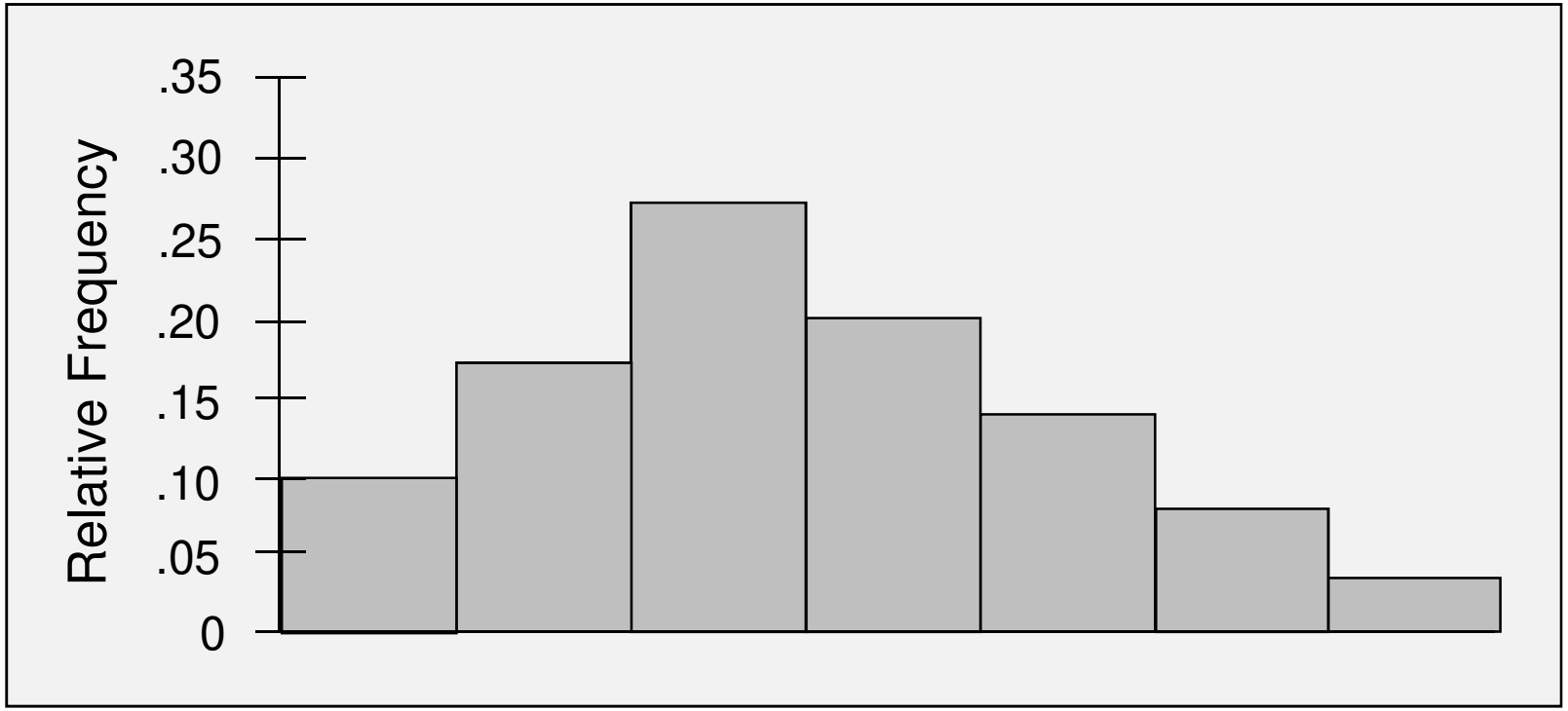
Histograms Showing Skewness

- Moderately Right Skewed
  - A Longer tail to the right
  - Example: <u>Housing Values</u>



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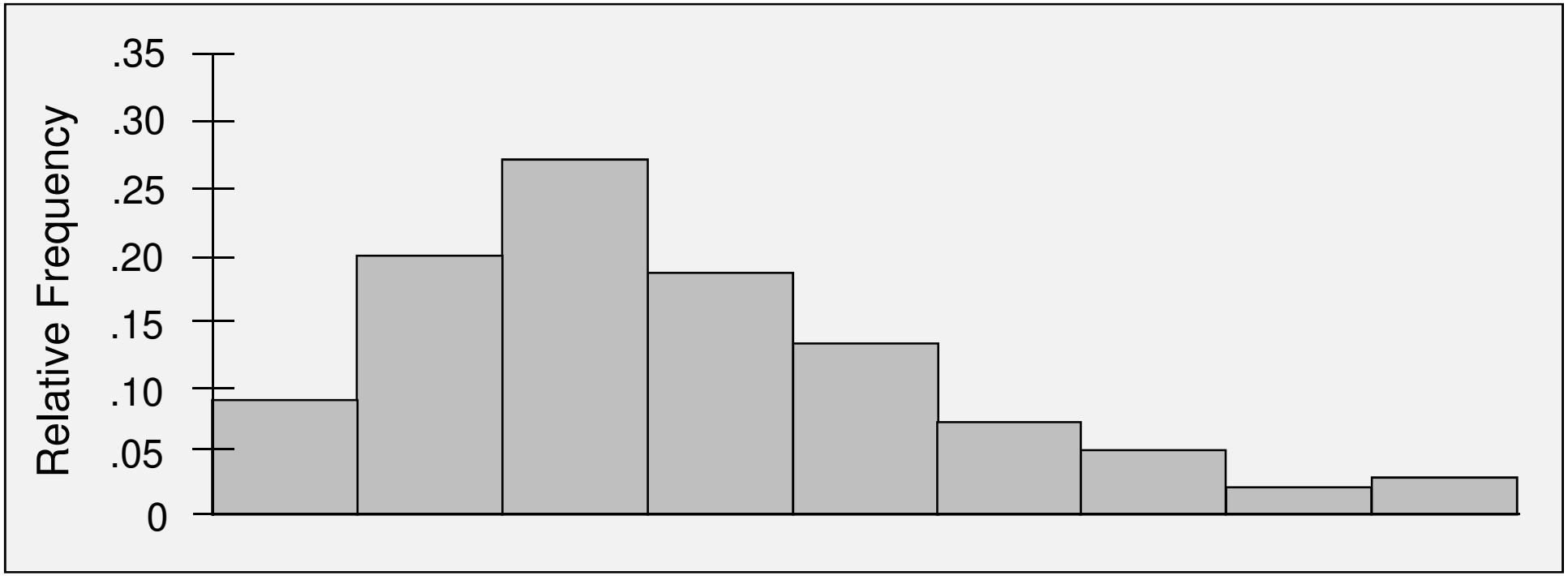
Histograms Showing Skewness

- Highly Skewed Right
  - A very long tail to the right
  - Example: Executive Salaries



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Cumulative Distributions

- Cumulative frequency distribution - shows the *number* of items with values less than or equal to the upper limit of each class.
- Cumulative relative frequency distribution – shows the *proportion* of items with values less than or equal to the upper limit of each class.
- Cumulative percent frequency distribution – shows the *percentage* of items with values less than or equal to the upper limit of each class.

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Cumulative Distributions

- The last entry in a cumulative frequency distribution always equals the total number of observations.
- The last entry in a cumulative relative frequency distribution always equals 1.00.
- The last entry in a cumulative percent frequency distribution always equals 100.

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Cumulative Distributions

- Hudson Auto Repair

Cost ($)	Cumulative Frequency	Cumulative Relative Frequency	Cumulative Percent Frequency
≤ 59	2	.04	4
≤ 69	15 = 2+13	.30 = 15/50	30 = .30(100)
≤ 79	31	.62	62
≤ 89	38	.76	76
≤ 99	45	.90	90
≤ 109	50	1.00	100

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Stem-and-Leaf Display

- A stem-and-leaf display shows both the rank order and shape of a distribution of data.
- It is similar to a histogram on its side, but it has the advantage of showing the actual data values.
- The leading digits of each data item are arranged to the left of a vertical line.
- To the right of the vertical line we record the last digit for each item in rank order.
- Each line (row) in the display is referred to as a stem.
- Each digit on a stem is a leaf.

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Example: Hudson Auto Repair

The manager of Hudson Auto would like to gain a better understanding of the cost of parts used in the engine tune-ups performed in the shop. She examines 50 customer invoices for tune-ups. The costs of parts, rounded to the nearest dollar, are listed on the next slide.

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Stem-and-Leaf Display

- Example: Hudson Auto Repair

Sample of Parts Cost ($) for 50 Tune-ups

91	78	93	57	75	52	99	80	97	62
71	69	72	89	66	75	79	75	72	76
104	74	62	68	97	105	77	65	80	109
85	97	88	68	83	68	71	69	67	74
62	82	98	101	79	105	79	69	62	73

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Stem-and-Leaf Display

- Example: Hudson Auto Repair

5	2 7
6	2 2 2 2 5 6 7 8 8 8 9 9 9
7	1 1 2 2 3 4 4 5 5 5 6 7 8 9 9 9
8	0 0 2 3 5 8 9
9	1 3 7 7 7 8 9
10	1 4 5 5 9

Stems Leaves

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Stretched Stem-and-Leaf Display

- If we believe the original stem-and-leaf display has condensed the data too much, we can stretch the display vertically by using two stems for each leading digit(s).
- Whenever a stem value is stated twice, the first value corresponds to leaf values of 0 - 4, and the second value corresponds to leaf values of 5 - 9.

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Stretched Stem-and-Leaf Display

- Example: Hudson Auto Repair

5	2
5	7
6	2 2 2 2
6	5 6 7 8 8 8 9 9 9
7	1 1 2 2 3 4 4
7	5 5 5 6 7 8 9 9 9
8	0 0 2 3
8	5 8 9
9	1 3
9	7 7 7 8 9
10	1 4
10	5 5 9

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Stem-and-Leaf Display

- Leaf Units
  - A single digit is used to define each leaf.
  - In the preceding example, the leaf unit was 1.
  - Leaf units may be 100, 10, 1, 0.1, and so on.
  - Where the leaf unit is not shown, it is assumed to equal 1.
  - The leaf unit indicates how to multiply the stem-and-leaf numbers in order to approximate the original data.

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Stem-and-Leaf Display

- Example: Leaf Unit = 0.1

If we have data with values such as

8.6 11.7 9.4 9.1 10.2 11.0 8.8

Leaf Unit = 0.1

8	6 8
9	1 4
10	2
11	0 7

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Stem-and-Leaf Display

- Example: Leaf Unit = 10

If we have data with values such as

1806 1717 1974 1791 1682 1910 1838

Leaf Unit = 10

16	8
17	1 9
18	0 3
19	1 7

The 82 in 1682 is rounded down to 80 and is represented as an 8.

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End of Chapter 2, Part A

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Essentials of Statistics for Business and Economics (8e)

Anderson, Sweeney, Williams, Camm, Cochran

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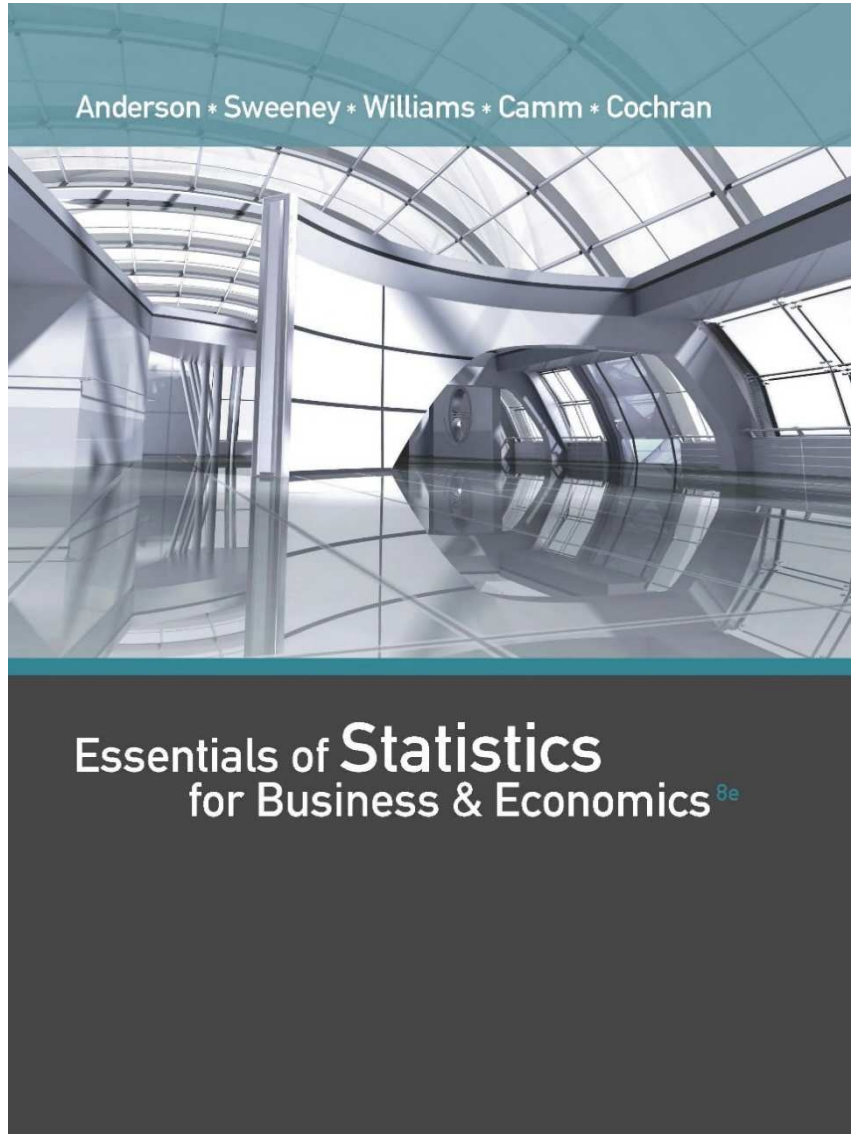

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Chapter 2, Part B
Descriptive Statistics: Tabular and Graphical Displays

- Summarizing Data for Two Variables Using Tables
- Summarizing Data for Two Variables Using Graphical Displays
- Data Visualization: Best Practices in Creating Effective Graphical Displays

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Summarizing Data for Two Variables sing Tables

- Thus far we have focused on methods that are used to summarize the data for one variable at a time.
- Often a manager is interested in tabular and graphical methods that will help understand the relationship between two variables.
- Crosstabulation is a method for summarizing the data for two variables.

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Crosstabulation

- A crosstabulation is a tabular summary of data for two variables.
- Crosstabulation can be used when:
  - one variable is categorical and the other is quantitative,
  - both variables are categorical, or
  - both variables are quantitative.
- The left and top margin labels define the classes for the two variables.

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Crosstabulation

- Example: Finger Lakes Homes

  The number of Finger Lakes homes sold for each style and price for the past two years is shown below.

Price Range	Home Style: Colonial	Log	Split	A-Frame	Total
< $250,000	18	6	19	12	55
≥ $250,000	12	14	16	3	45
Total	30	20	35	15	100

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Crosstabulation

- Example: Finger Lakes Homes

  Insights Gained from Preceding Crosstabulation

  - The greatest number of homes (19) in the sample are a split-level style and priced at less than $250,000.
  - Only three homes in the sample are an A-Frame style and priced at $250,000 or more.

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Crosstabulation: Row or Column Percentages

- Converting the entries in the table into row percentages or column percentages can provide additional insight about the relationship between the two variables.

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Crosstabulation: Row Percentages

- Example: Finger Lakes Homes

Price Range	Home Style: Colonial	Log	Split	A-Frame	Total
< $250,000	32.73	10.91	34.55	21.82	100
≥ $250,000	26.67	31.11	35.56	6.67	100

Note: row totals are actually 100.01 due to rounding.

(Colonial and ≥ $250K)/(All ≥ $250K) x 100 = (12/45) x 100

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Crosstabulation: Column Percentages

- Example: Finger Lakes Homes

Price Range	Home Style			
	Colonial	Log	Split	A-Frame
< $250,000	60.00	30.00	54.29	80.00
≥ $250,000	40.00	70.00	45.71	20.00
Total	100	100	100	100

(Colonial and ≥ $250K)/(All Colonial) x 100 = (12/30) x 100

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Crosstabulation: Simpson's Paradox

- Data in two or more crosstabulations are often aggregated to produce a summary crosstabulation.
- We must be careful in drawing conclusions about the relationship between the two variables in the aggregated crosstabulation.
- In some cases the conclusions based upon an aggregated crosstabulation can be completely reversed if we look at the unaggregated data. The reversal of conclusions based on aggregate and unaggregated data is called Simpson's paradox.

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Summarizing Data for Two Variables Using Graphical Displays

- In most cases, a graphical display is more useful than a table for recognizing patterns and trends.
- Displaying data in creative ways can lead to powerful insights.
- Scatter diagrams and trendlines are useful in exploring the relationship between two variables.

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Scatter Diagram and Trendline

- A scatter diagram is a graphical presentation of the relationship between two quantitative variables.
- One variable is shown on the horizontal axis and the other variable is shown on the vertical axis.
- The general pattern of the plotted points suggests the overall relationship between the variables.
- A trendline provides an approximation of the relationship.

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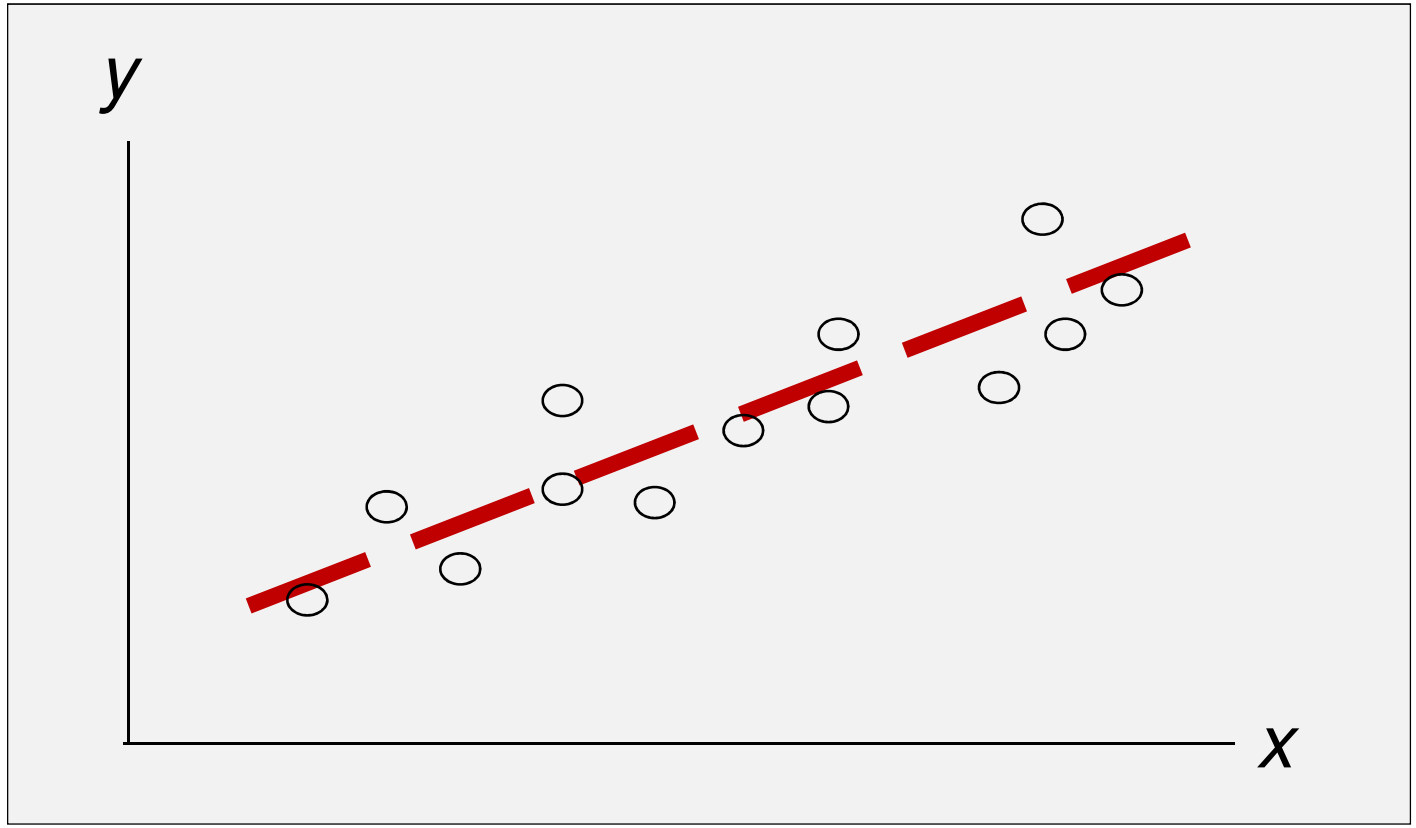
Scatter Diagram

- A Positive Relationship



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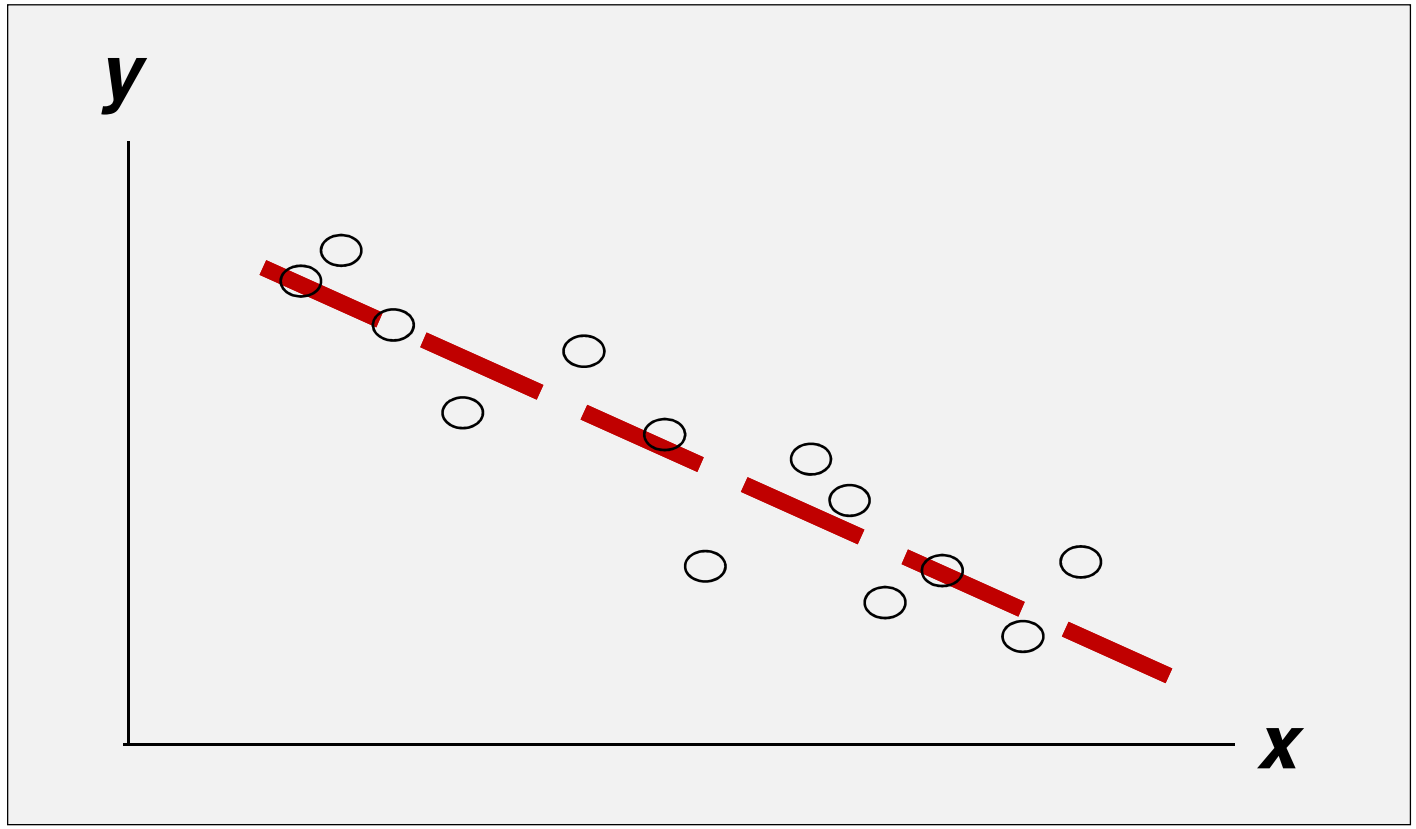
Scatter Diagram

- A Negative Relationship



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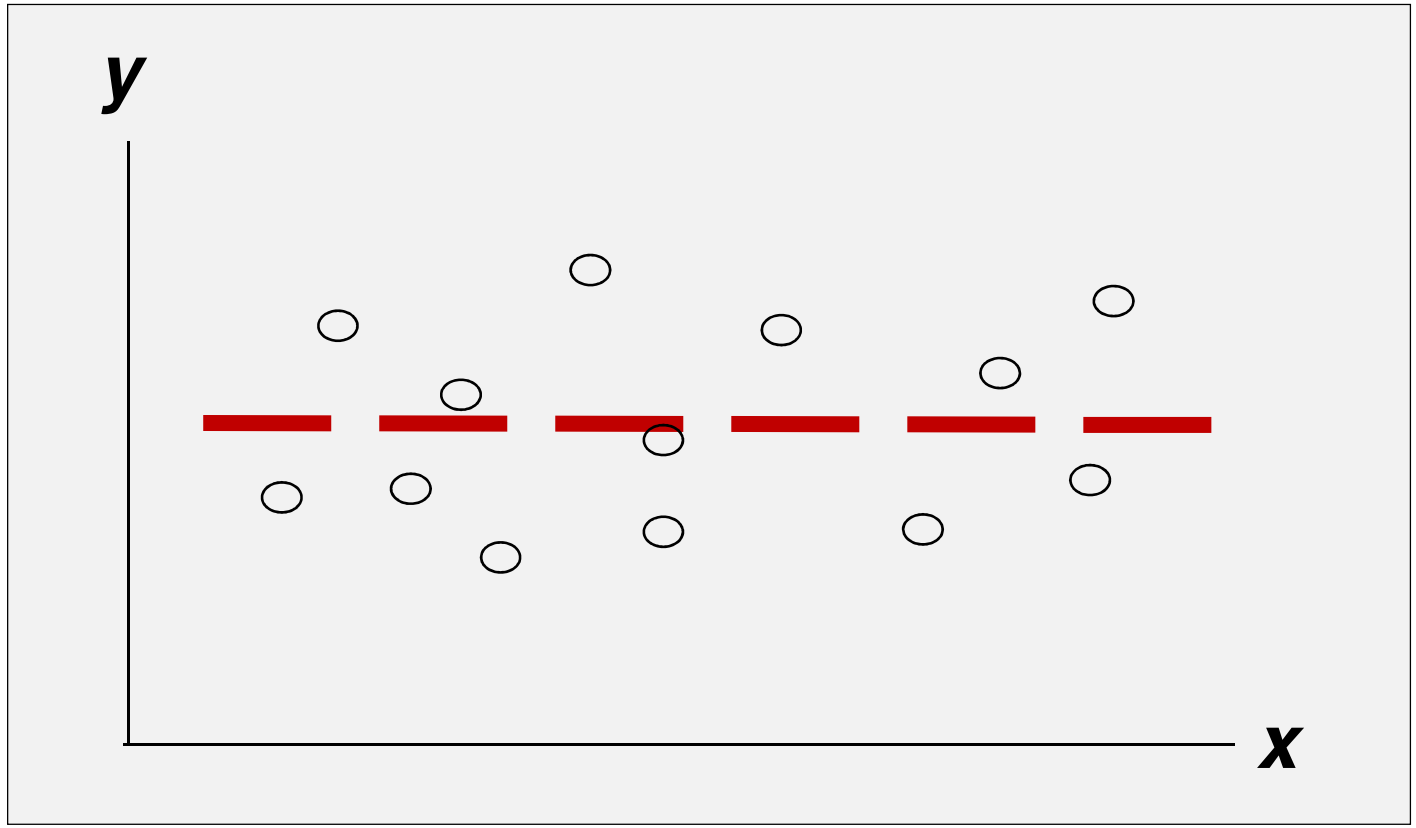
Scatter Diagram

- No Apparent Relationship



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Scatter Diagram

- Example: Panthers Football Team

The Panthers football team is interested in investigating the relationship, if any, between interceptions made and points scored.

x = Number of Interceptions	y = Number of Points Scored
1	14
3	24
2	18
1	17
3	30

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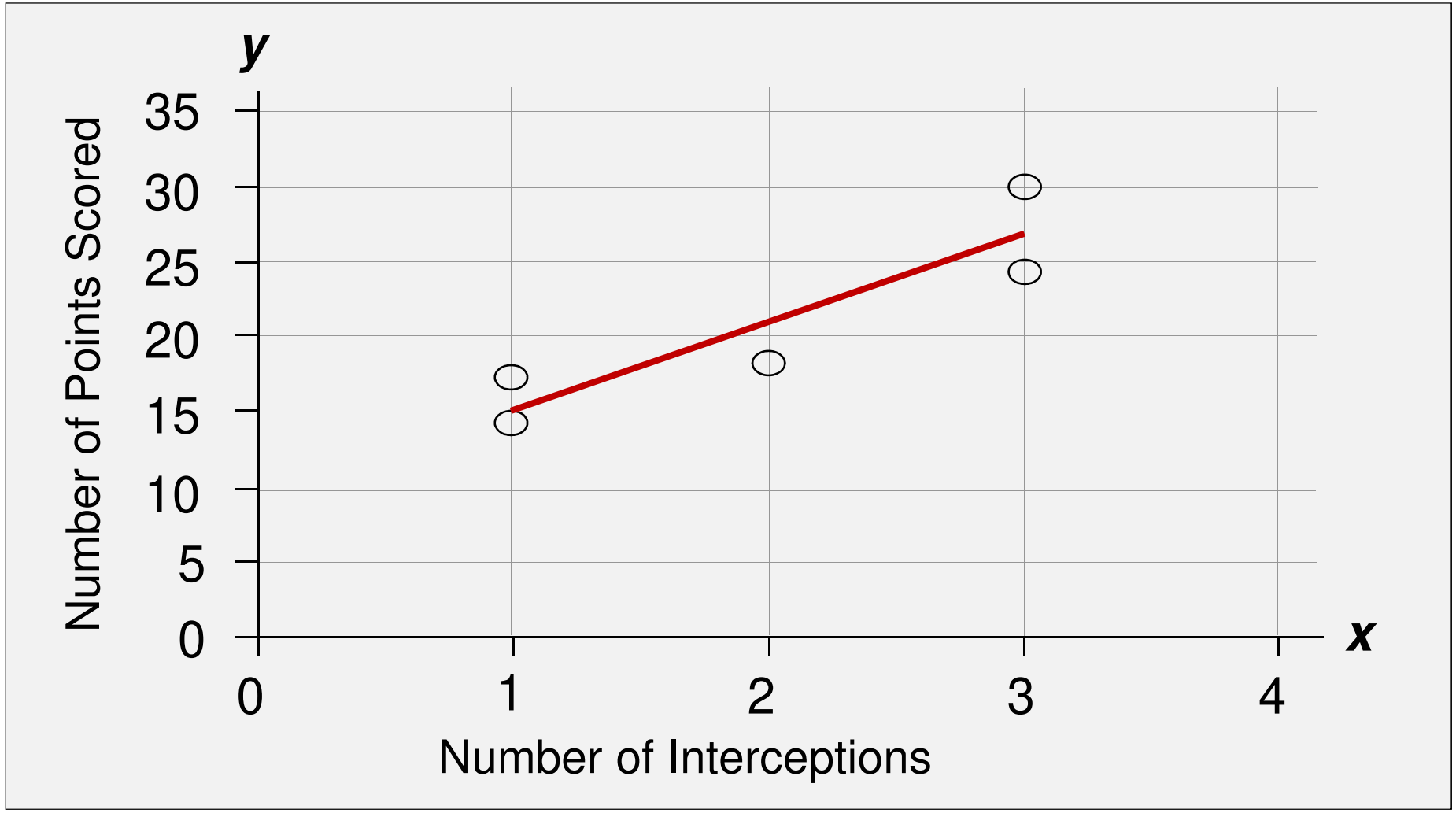
Scatter Diagram and Trendline



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Example: Panthers Football Team

- Insights Gained from the preceding Scatter Diagram
  - The scatter diagram indicates a positive relationship between the number of interceptions and the number of points scored.
  - Higher points scored are associated with a higher number of interceptions.
  - The relationship is not perfect; all plotted points in the scatter diagram are not on a straight line.

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Side-by-Side Bar Chart

- A side-by-side bar chart is a graphical display for depicting multiple bar charts on the same display.
- Each cluster of bars represents one value of the first variable.
- Each bar within a cluster represents one value of the second variable.

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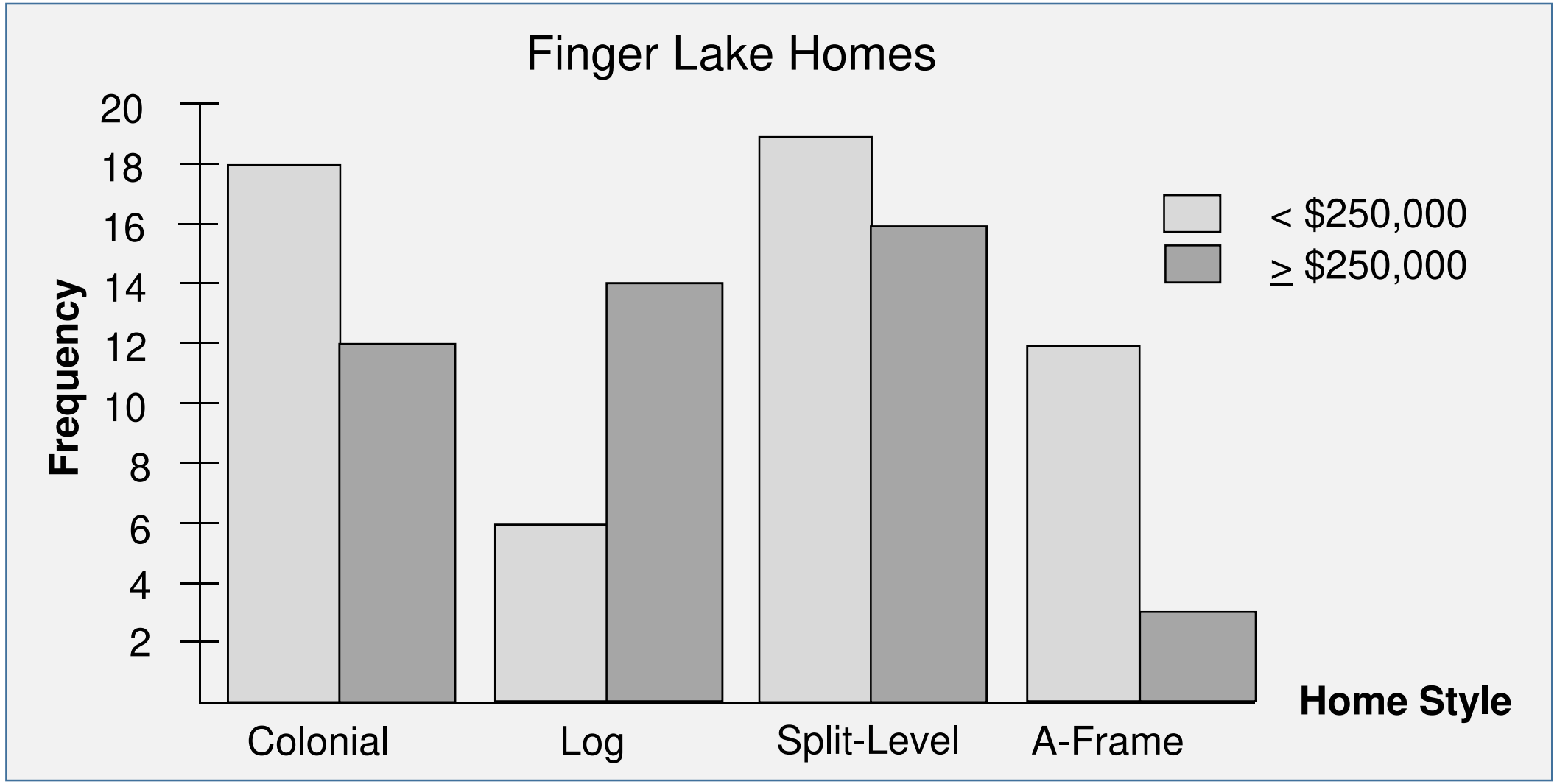
Side-by-Side Bar Chart



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Stacked Bar Chart

- A stacked bar chart is another way to display and compare two variables on the same display.
- It is a bar chart in which each bar is broken into rectangular segments of a different color.
- If percentage frequencies are displayed, all bars will be of the same height (or length), extending to the 100% mark.

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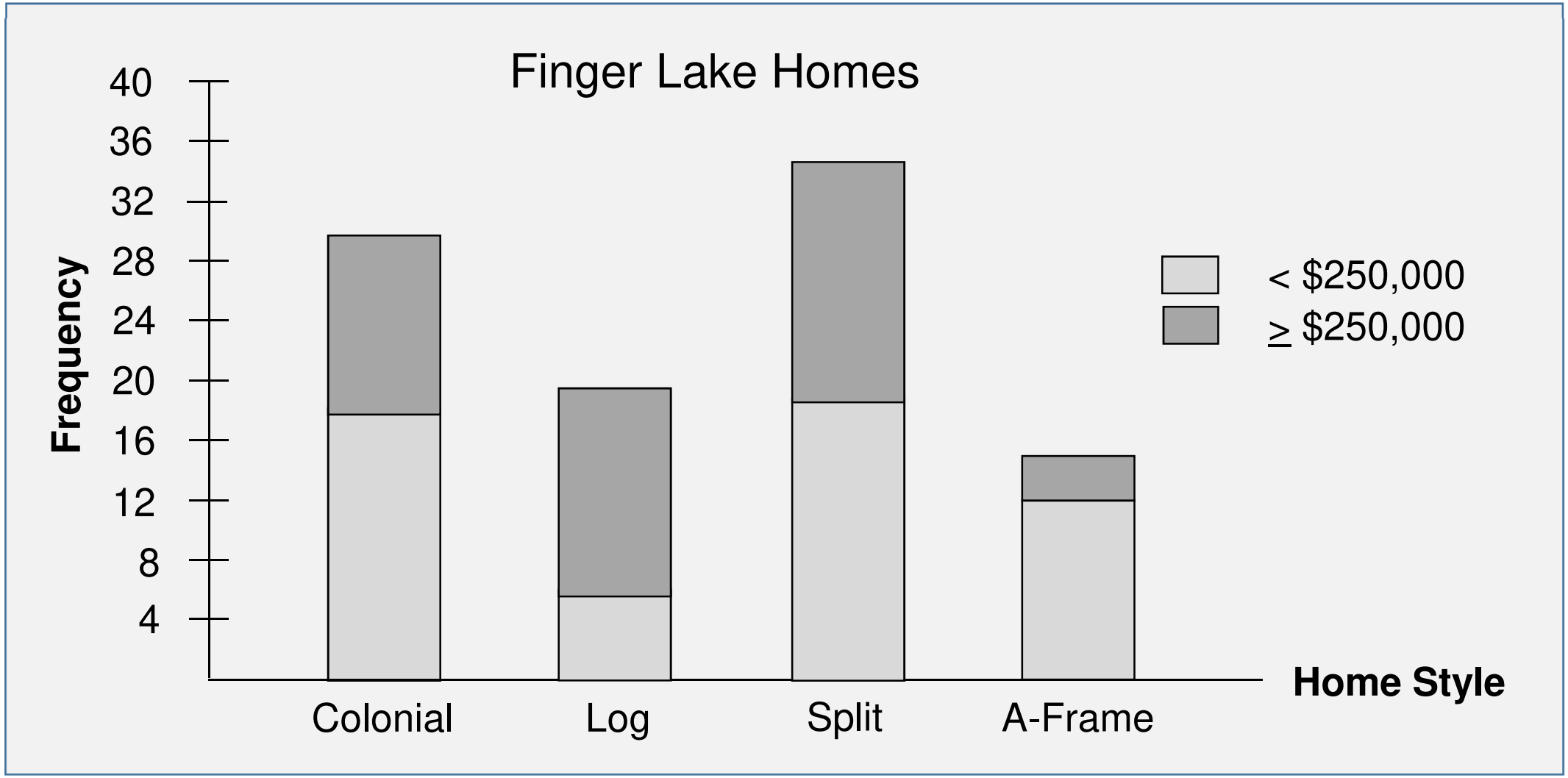
Stacked Bar Chart



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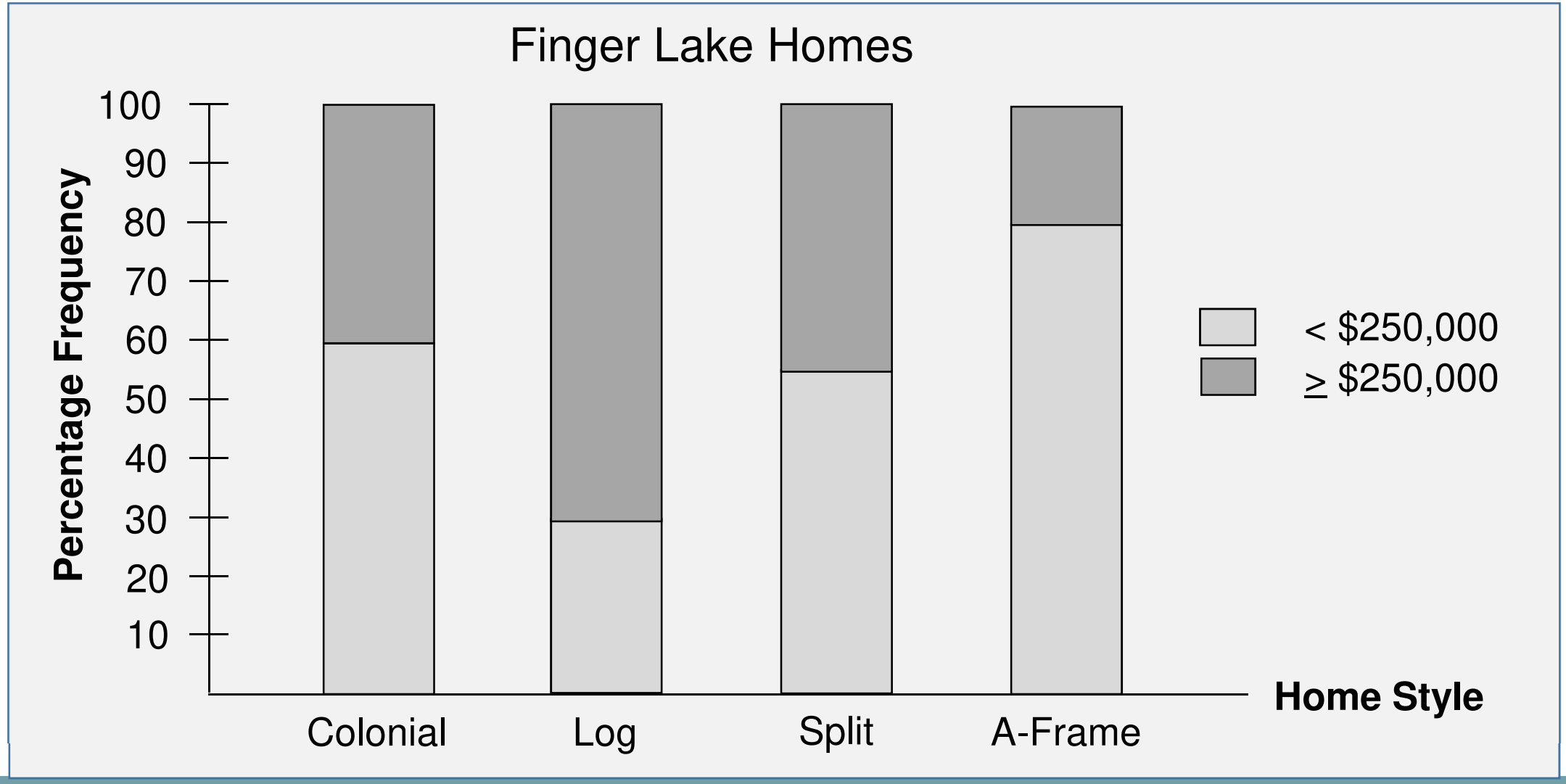
Stacked Bar Chart



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Data Visualization: Best Practices in Creating Effective Graphical Displays

- Data visualization is the use of graphical displays to summarize and present information about a data set.
- The goal is to communicate as effectively and clearly as possible, the key information about the data.

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Creating Effective Graphical Displays

- Creating effective graphical displays is as much art as it is science.
- Here are some guidelines . . .
  - Give the display a clear and concise title.
  - Keep the display simple.
  - Clearly label each axis and provide the units of measure.
  - If colors are used, make sure they are distinct.
  - If multiple colors or line types are used, provide a legend.

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Choosing the Type of Graphical Display

- Displays used to <u>show the distribution of data</u>:

  <u>Bar Chart</u> to show the frequency distribution and relative frequency distribution for categorical data

  <u>Pie Chart</u> to show the relative frequency and percent frequency for categorical data

  <u>Dot Plot</u> to show the distribution for quantitative data over the entire range of the data

  <u>Histogram</u> to show the frequency distribution for quantitative data over a set of class intervals

  <u>Stem-and-Leaf Display</u> to show both the rank order and shape of the distribution for quantitative data

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Choosing the Type of Graphical Display

- Displays used to make comparisons:

  Side-by-Side Bar Chart to compare two variables

  Stacked Bar Chart to compare the relative frequency or percent frequency of two categorical variables

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Choosing the Type of Graphical Display

- Displays used to <u>show relationships</u>:

  <u>Scatter Diagram</u> to show the relationship between two quantitative variables

  <u>Trendline</u> to approximate the relationship of data in a scatter diagram

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Data Dashboards

- A data dashboard is a widely used data visualization tool.
- It organizes and presents key performance indicators (KPIs) used to monitor an organization or process.
- It provides timely summary information that is easy to read, understand, and interpret.
- Some additional guidelines include . . .
  - Minimize the need for screen scrolling.
  - Avoid unnecessary use of color or 3D displays.
  - Use borders between charts to improve readability.

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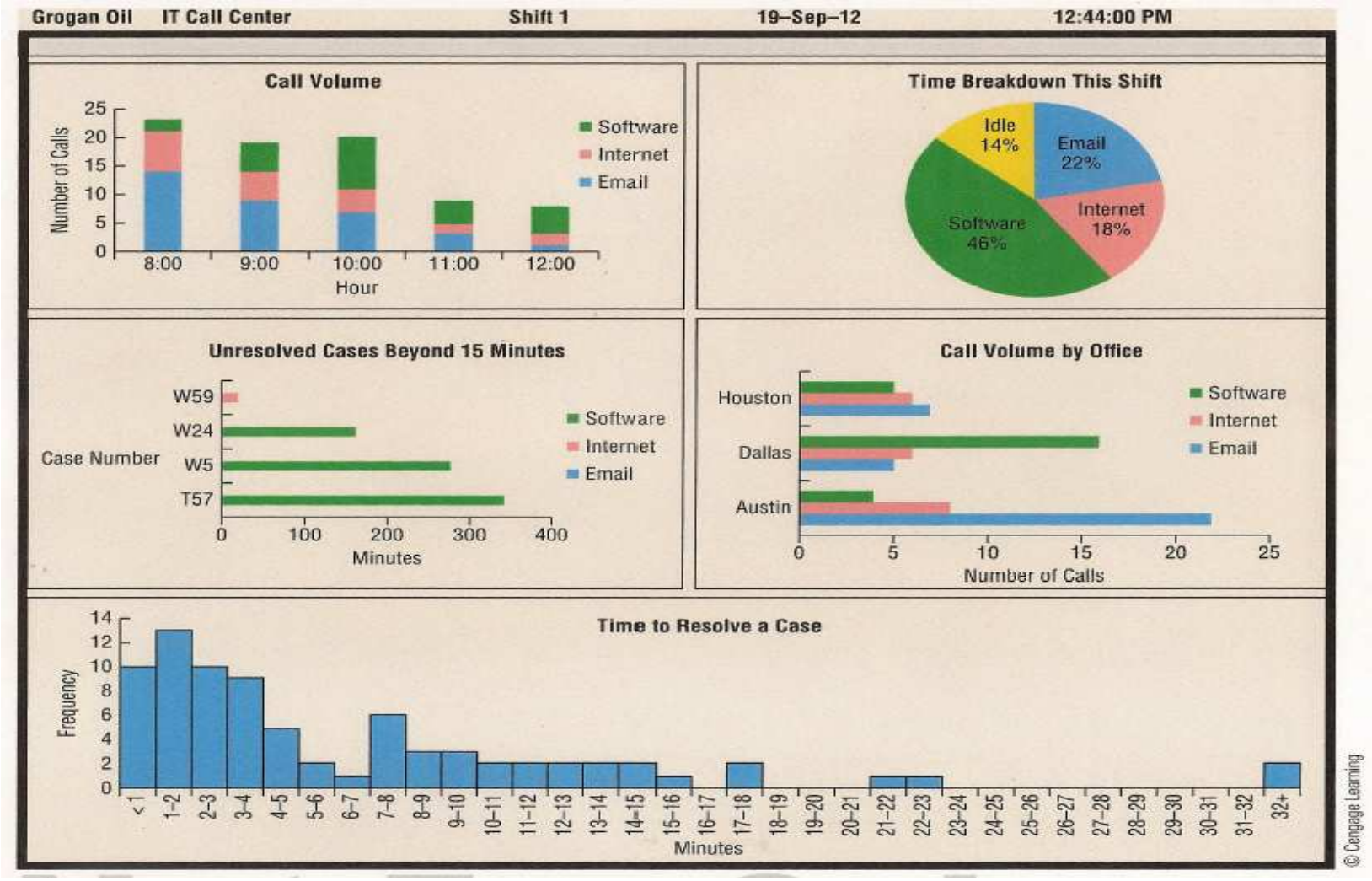
Data Dashboard Example



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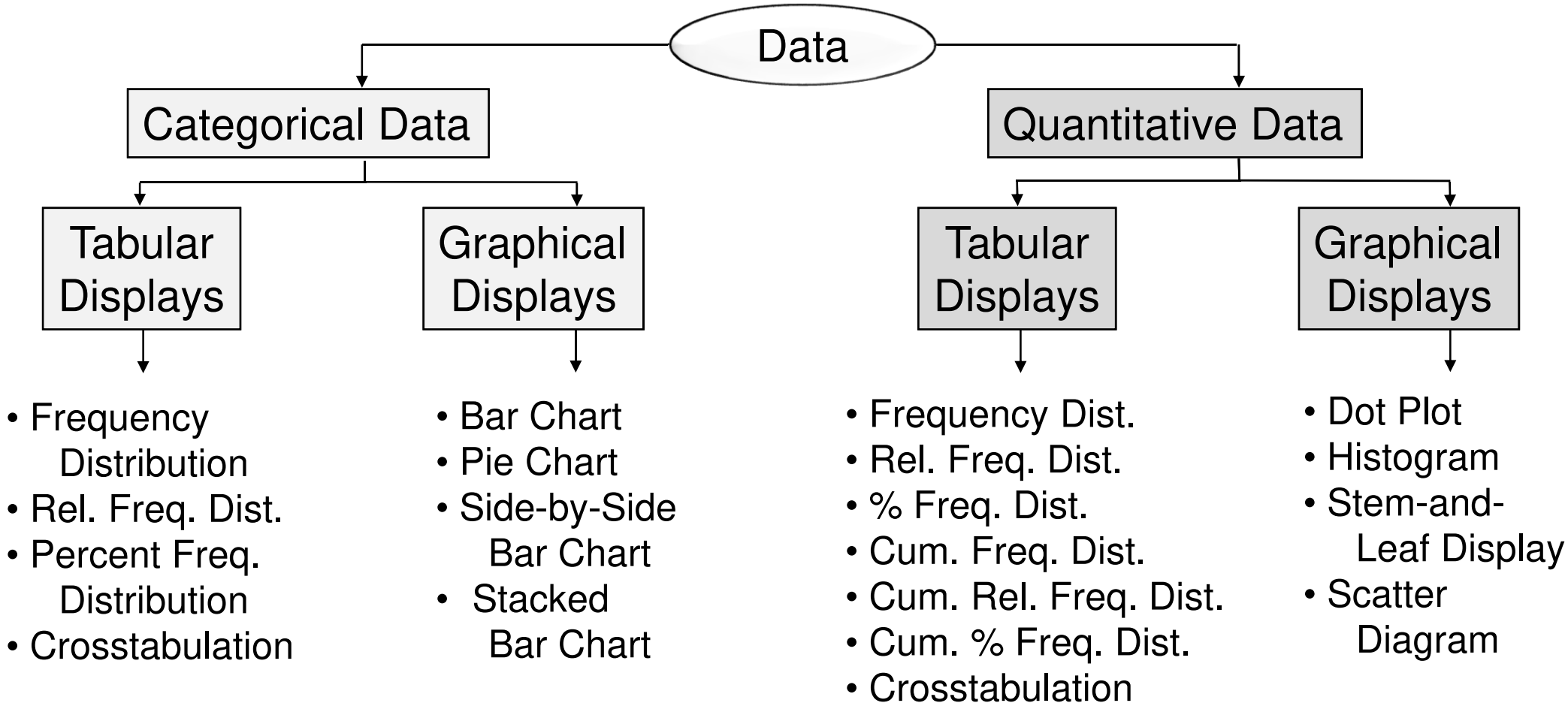
Tabular and Graphical Displays



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End of Chapter 2, Part B

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