Exercises

1.45 Raising teachers' pay, I A school system employs teachers at salaries between $30,000 and $60,000. The teachers' union and the school board are negotiating the form of next year's increase in the salary schedule. Suppose that every teacher is given a flat $1000 raise.

(a) How much will the mean salary increase? The median salary?

(b) Will a flat $1000 raise increase the spread as measured by the distance between the quartiles?

(c) Will a flat $1000 raise increase the spread as measured by the standard deviation of the salaries?

1.46 Raising teachers' pay, II Suppose that the teachers in the previous exercise each receive a 5% raise. The amount of the raise will vary from $1500 to $3000, depending on present salary. Will a 5% across-the-board raise increase the spread of the distribution as measured by the distance between the quartiles? Do you think it will increase the standard deviation?

1.47 Which AP exam is easier: Calculus AB or Statistics? The table below gives the distribution of grades earned by students taking the AP Calculus AB and AP Statistics exams in 2005:

	5	4	3	2	1
Calculus AB	20.7%	19.5%	17.7%	16.7%	25.2%
Statistics	12.6%	22.8%	25.3%	19.2%	20.1%

(a) Make a graphical display to compare the exam grades for Calculus AB and Statistics.

(b) Write a few sentences comparing the two distributions of exam grades. Do you now know which exam is easier? Why or why not?

1.48 Get your hot dogs here! Face it. "A hot dog isn't a carrot stick." So said *Consumer Reports*, commenting on the low nutritional quality of the all-American frank. Table 1.9 on the next page shows the magazine's laboratory test results for calories and milligrams of sodium (mostly due to salt) in a number of major brands of hot dogs. There are three types: beef, "meat" (mainly pork and beef, but government regulations allow up to 15% poultry meat), and poultry. Because people concerned about their health may prefer low-calorie, low-sodium hot dogs, we ask: "Are there any systematic differences among the three types of hot dogs in these two variables?" Use side-by-side boxplots and numerical summaries to help you answer this question. Write a paragraph explaining your findings. Use the Data Analysis Toolbox (page 93) as a guide.

1.49 Who makes more? A manufacturing company is reviewing the salaries of its full-time employees below the executive level at a large plant. The clerical staff is almost entirely female, while a majority of the production workers and technical staff are male. As a result, the distributions of salaries for male and female employees may be quite different. Table 1.10 on the next page gives the frequencies and relative frequencies for women and men.

(a) Make histograms for these data, choosing a vertical scale that is most appropriate for comparing the two distributions.

CHAPTER 1

Answers to Exercises 1.45–1.50

1.45 (a) The mean and the median will both increase by $1000.
(b) No. The difference $Q_3 - Q_1$ will remain the same.
(c) No. The standard deviation remains unchanged.

1.46 A 5% across-the-board raise will increase both *IQR* and *s*.

1.47 (a) See the *Teacher's Solutions Manual* for graph.
(b) The distribution of scores on the statistics exam is roughly symmetric with a peak at 3. The distribution of scores on the AP calculus exam has a peak at 1 and another slightly lower peak at 5. It is impossible to tell which exam is "easier."

1.48 Answer *Who, What, Why, When, Where, How,* and *by Whom.* There are systematic differences among the three types of hot dogs. See the *Teacher's Solutions Manual* for a complete response.

1.49 (a) See the *Teacher's Solutions Manual* for graph.

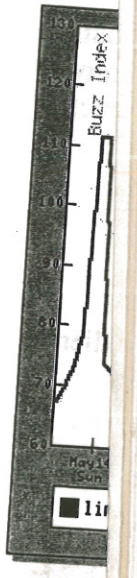
CHAPTER 1

Qui

1. H
cl

W

2. Her
"pe



(a) W

Table 1.9 Calories and sodium (milligrams) in th

Beef Hot Dogs		Meat Hot Dogs	
Calories	Sodium	Calories	Sodium
186	495	173	458
181	477	191	506
176	425	182	473
149	322	190	545
184	482	172	496
190	587	147	360
158	370	146	387
139	322	139	386
175	479	175	507
148	375	136	393
152	330	179	405
111	300	153	372
141	386	107	144
153	401	195	511
190	645	135	405
157	440	140	428
131	317	138	339
149	319		
135	298		
132	253		

Source: *Consumer Reports*, June 1986, pp. 366–367.

Table 1.10 Salary distributions of female and male in a large factory

	Women	
Salary ($1000)	Number	%
10–15	89	11.8
15–20	192	25.4
20–25	236	31.2
25–30	111	14.7
30–35	86	11.4
35–40	25	3.3
40–45	11	1.5
45–50	3	0.4
50–55	2	0.3
55–60	0	0.0
60–65	0	0.0
65–70	1	0.1
Total	756	100.1

(b) Describe the shapes of the salary distributions and the chief differences between them.

(c) Explain why the total for women is greater than 100%.

1.50 Linear transformations In each of the following settings, give the values of a and b for the linear transformation $x_{new} = a + bx$ that expresses the change in measurement units. Then explain how the transformation will affect the mean, the IQR, the median, and the standard deviation of the original distribution.

(a) You collect data on the power of car engines, measured in horsepower. Your teacher requires you to convert the power to watts. One horsepower is 746 watts.

(b) You measure the temperature (in degrees Fahrenheit) of your school's swimming pool at 20 different locations within the pool. Your swim team coach wants the summary statistics in degrees Celsius ($°F = (9/5)°C + 32$).

(c) Mrs. Swaynos has given a very difficult statistics test and is thinking about "curving" the grades. She decides to add 10 points to each student's score.

Section 1.2 Summary

A numerical summary of a distribution should report its **center** and its **spread,** or **variability**.

The mean $\bar{x}$ and the median M describe the center of a distribution in different ways. The mean is the average of the observations, and the median is the midpoint of the values.

When you use the median to indicate the center of a distribution, describe its spread by giving the **quartiles.** The **first quartile** Q_1 has about one-fourth of the observations below it, and the **third quartile** Q_3 has about three-fourths of the observations below it. An extreme observation is an **outlier** if it is smaller than $Q_1 - (1.5 \times IQR)$ or larger than $Q_3 + (1.5 \times IQR)$.

The **five-number summary** consists of the median, the quartiles, and the high and low extremes and provides a quick overall description of a distribution. The median describes the center, and the quartiles and extremes show the spread.

Boxplots based on the five-number summary are useful for comparing two or more distributions. The box spans the quartiles and shows the spread of the central half of the distribution. The median is marked within the box. Lines extend from the box to the smallest and the largest observations that are not outliers. Outliers are plotted as isolated points.

The **variance** s^2 and especially its square root, the **standard deviation** s, are common measures of spread about the mean as center. The standard deviation s is zero when there is no spread and gets larger as the spread increases.

The median is a **resistant** measure of center because it is relatively unaffected by extreme observations. The mean is nonresistant. Among measures of spread, the quartiles are resistant, but the standard deviation is not.

The mean and standard deviation are strongly influenced by outliers or skewness in a distribution. They are good descriptions for symmetric distributions and are most useful for the Normal distributions, which will be introduced in the next chapter.

CHAPTER 1

1.49 (b) Both histograms are skewed to the right. The range of salaries is the same.
(c) Roundoff error.

1.50 (a) Let $x_{new} = 746x$. The mean, median, IQR, and standard deviation will all be multiplied by 746.
(b) Let $x_{new} = (5/9)(x - 32)$. Multiply the old mean (median) by 5/9 and subtract 160/9. The IQR and standard deviation will be multiplied by 5/9.
(c) Let $x_{new} = x + 10$. The mean and median will increase by 10. The IQR and standard deviation will remain the same.

CHAPTER 1

There are four quizzes in the *Platinum Resource Binder* for Section 1.2.

Answers to Exercises 1.51–1.58

1.51 (a) Most people will "round" their answers when asked to give an estimate like this. 300 and 360 are suspicious.

(b) See the *Teacher's Solutions Manual* for graph. The stemplots suggest that women (claim to) study more than men.

1.52 See the *Teacher's Solutions Manual* for graph. The older adults are more likely to have earned no more than a high school diploma. The younger adults are more likely to have gone to college and to have completed a bachelor's degree.

1.53 (a) *Group 1:* $\bar{x} = 23.75$, $s = 5.07$. *Group 2:* $\bar{x} = 14.08$, $s = 4.98$. *Group 3:* $\bar{x} = 15.78$, $s = 5.76$. See the *Teacher's Solutions Manual* for graphs.

The median and quartiles are not affected by outliers, and and two extremes describe the two sides of a distribution se number summary is the preferred numerical summary for skew

Linear transformations are quite useful for changing unit Linear transformations have the form $x_{new} = a + bx$. When yo to all the values in a data set, the mean and median increase spread do not change. When you multiply all the values in a da b, the mean, median, IQR, and standard deviation are multipl

Back-to-back stemplots and **side-by-side boxplots** are us quantitative distributions.

Section 1.2 Exercises

1.51 Do girls study more than boys? We asked the students in three how many minutes they studied on a typical weeknight. Here are the samples of 30 girls and 30 boys from the classes:

Girls					Bo		
180	120	180	360	240	90	120	
120	180	120	240	170	90	45	
150	120	180	180	150	150	120	
200	150	180	150	180	240	60	1
120	60	120	180	180	30	230	1
90	240	180	115	120	0	200	1

(a) Examine the data. Why are you not surprised that most response minutes? We eliminated one student who claimed to study 30,000 m there any other responses you consider suspicious?

(b) Make a back-to-back stemplot of these data. Report the approxim groups. Does it appear that girls study more than boys (or at least cla

1.52 Educational attainment Table 1.11 on the next page shows achieved by U.S. adults aged 25 to 34 and by those aged 65 to 74. C tions of educational attainment graphically. Write a few sentences display shows.

1.53 Logging in rain forests "Conservationists have despaired over rainforest by logging, clearing, and burning." These words begin a study of the effects of logging in Borneo. Researchers compared fore been logged (Group 1) with similar plots nearby that had been (Group 2) and 8 years earlier (Group 3). All plots were 0.1 hectare counts of trees for plots in each group:[18]

Group 1:	27	22	29	21	19	33	16	20	24	2
Group 2:	12	12	15	9	20	18	17	14	14	
Group 3:	18	4	22	15	18	19	22	12	12	

(a) Give a complete comparison of the three distributions, using bo ical summaries.

CHAPTER 1

1.57 (a) *Normal:* 272.0, 333.0, 358.0, 401.3, 462.0. *New:* 318.00, 379.25, 406.50, 429.25, 477.00. See the *Teacher's Solutions Manual* for graph. All five statistics in the five-number summary for the normal corn are lower than the corresponding statistics for the chicks fed with new corn.

(b) *Normal:* $\bar{x} = 366.3$, $s = 50$. *New:* $\bar{x} = 402.95$, $s = 42.73$. 36.65 grams higher for chicks fed normal corn.

(c) *Normal:* $\bar{x} = 12.921$ oz, $s = 1.792$ oz. *New:* $\bar{x} = 14.213$ oz, $s = 1.507$ oz.

1.58 (a) Mean.

(b) Median.

Teaching Tip

Be sure to do the Case Closed! This allows the students to fully investigate the Case Study presented at the beginning of the chapter. Which network wins the ratings war?

Answers to Case Closed!

1. See the *Teacher's Solutions Manual* for graph. The centers of the distributions are roughly the same, with the center line being just a little higher for CBS. ABC has the most variability, while NBC has the least variability. The ratings are skewed to the right for ABC, roughly symmetric for CBS, and slightly skewed to the left for NBC.

varieties that have more of these amino acids. To test a new corn as an animal food group of 20 one-day-old male chicks was fed a ration containing the new corn. A contr group of another 20 chicks was fed a ration that was identical except that it contain normal corn. Here are the weight gains (in grams) after 21 days:[20]

Normal corn				New corn			
380	321	366	356	361	447	401	3
283	349	402	462	434	403	393	4
356	410	329	399	406	318	467	4
350	384	316	272	427	420	477	3
345	455	360	431	430	339	410	3

(a) Compute five-number summaries for the weight gains of the two groups of chick Then make boxplots to compare the two distributions. What do the data show about t effect of the new corn?

(b) The researchers actually reported means and standard deviations for the two groups chicks. What are they? How much larger is the mean weight gain of chicks fed the new cor

(c) The weights are given in grams. There are 28.35 grams in an ounce. Use the results part (b) to compute the means and standard deviations of the weight gains measured ounces.

1.58 Mean or median? Which measure of center, the mean or the median, should yo use in each of the following situations?

(a) Middletown is considering imposing an income tax on citizens. The city governme wants to know the average income of citizens so that it can estimate the total tax base.

(b) In a study of the standard of living of typical families in Middletown, a sociologist es mates the average family income in that city.

CASE CLOSED!

Nielsen ratings

Begin by reviewing the ratings data in the Nielsen ratings Case Study (page 37). Then answer each of the following questions in complete sentences. Be sure to communicate clearly enough for any of your classmates to understand what you are saying.

1. Construct by hand an appropriate graphical display for comparing the Nielsen ratings of the three networks. Write a few sentences describing what you see.