2. Airport Parking The number of short-term parking spaces at 15 airports is shown. Find the mean, median, mode, and midrange for the data.

750	3400	1962	700	203
900	8662	260	1479	5905
9239	690	9822	1131	2516

Source: *USA Today*.

3. Natural Gas Drilling Sites The number of natural gas drilling sites in Pennsylvania counties with drilling operations is listed below. Find the mean, median, mode and midrange for the data and discuss the differences in these measures of central tendency. Which best describes the center of the data?

9	112	1	1	6	1008	109	6	14	58
20	136	85	3	58	185	6	415	2	43
26	2	2	2	473	53	76	19	41	462
693	1	2	560	4	191	98			

Source: *Pennsylvania Dept. of Environmental Protection.*

4. Observers in the Frogwatch Program The number of observers in the Frogwatch USA program (a wildlife conservation program dedicated to helping conserve frogs and toads) for the top 10 states with the most observers is 484, 483, 422, 396, 378, 352, 338, 331, 318, and 302. The top 10 states with the most active watchers list these numbers of visits: 634, 464, 406, 267, 219, 194, 191, 150, 130, and 114. Find the mean, median, mode, and midrange for the data. Compare the measures of central tendency for these two groups of data.

Source: www.nwf.org/frogwatch

5. Violent Crimes Shown are the ten U.S. cities (with population over 100,000) with the fewest number of violent crimes reported in 2010. Find the mean, median, mode, and midrange of the data.

Temecula, CA	74	Irvine, CA	120
Murriefa, CA	99	Cary, NC	120
Surprise, AZ	106	Amherst, NY	121
Round Rock, TX	116	Simi Valley, CA	129
Frisco, TX	119	Norman, OK	132

Source: *Time Almanac 2012.*

6. Earnings of Nonliving Celebrities *Forbes* magazine prints an annual Top-Earning Nonliving Celebrities list (based on royalties and estate earnings). Find the mean, median, mode, and midrange for the data. Comment on the skewness. Figures represent millions of dollars.

Kurt Cobain	50	Ray Charles	10
Elvis Presley	42	Marilyn Monroe	8
Charles M. Schulz	35	Johnny Cash	8
John Lennon	24	J.R.R. Tolkien	7
Albert Einstein	20	George Harrison	7
Andy Warhol	19	Bob Marley	7
Theodore Geisel (Dr. Seuss)	10		

Source: articles.moneycentral.msn.com

7. Moons of Jupiter The planet Jupiter has at least 62 moons. In 1610 Galileo first observed the four brightest moons with a telescope. They are listed below with their diameters. Find the mean, median, mode, and midrange, and discuss which of these measures have any meaningful application with respect to these data. (Just for reference, the diameter of Earth is 3959 miles.)

Io	3643 km	2264 miles
Europa	3122	1940
Ganymede	5262	3270
Callisto	4821	2996

Source: *Time Almanac 2012.*

8. Top-Paid CEOs The data shown are the total compensation (in millions of dollars) for the 50 top-paid CEOs for a recent year. Compare the averages, and state which one you think is the best measure.

17.5	18.0	36.8	31.7	31.7
17.3	24.3	47.7	38.5	17.0
23.7	16.5	25.1	17.4	18.0
37.6	19.7	21.4	28.6	21.6
19.3	20.0	16.9	25.2	19.8
25.0	17.2	20.4	20.1	29.1
19.1	25.2	23.2	25.9	24.0
41.7	24.0	16.8	26.8	31.4
16.9	17.2	24.1	35.2	19.1
22.9	18.2	25.4	35.4	25.5

Source: *USA TODAY.*

9. College Enrollments The enrollments at a random selection of independent religiously controlled undergraduate schools are indicated below. Find the mean, median, mode, and midrange. Compare the mean and median and what that says about the data.

1469	1860	1422	1023	2532	1409	1648
1080	2082	1371	1197	1484	1106	1241

Source: *World Almanac 2012.*

10. Foreign Workers The number of foreign workers' certificates for the New England states and the northwestern states is shown. Find the mean, median, and mode for both areas and compare the results.

New England states	Northwest states
6768	1870
3196	622
1112	620
819	23
1019	172
1795	112

Source: Department of Labor.

11. Distances of Stars Of the 25 brightest stars, the distances from earth (in light-years) for those with distances less than 100 light-years are found below. Find the mean, median, mode, and midrange for the data.

8.6	36.7	42.2	16.8	33.7	77.5	87.9
4.4	25.3	11.4	65.1	25.1	51.5	

Source: *New York Times Almanac 2010.*

Section 3.2

of data is more variable? (The U.S. average starting salary at this time was $29,641.)

Europe		Asia	
Sweden	$48,704	Korea	$26,852
Germany	41,441	Japan	23,493
Spain	32,679	India	18,247
Finland	32,136	Malaysia	13,647
Denmark	30,384	Philippines	9,857
Netherlands	29,326	Thailand	5,862
Scotland	27,789		

Source: World Almanac.

13. Ages of U.S. Astronaut Candidates The average age of U.S. astronaut candidates in the past has been 34, but candidates have ranged in age from 26 to 46. Use the range rule of thumb to estimate the standard deviation of the applicants' ages.

Source: www.nasa.gov

14. Times Spent in Rush-Hour Traffic A sample of 12 drivers shows the time that they spent (in minutes) stopped in rush-hour traffic on a specific snowy day last winter. Find the range, variance, and standard deviation for the data.

52	56	53
61	49	51
53	58	53
60	71	58

15. Prison Executions The numbers of prisoners executed by the state since 1977 for the top 12 states are listed below. Find the range, variance, and standard deviation of the data.

TX	355	LA	27	AR	27
VA	94	MO	66	AZ	22
AL	34	NC	39	FL	60
OK	79	GA	39	SC	35

Source: New York Times Almanac 2010.

16. Passenger Vehicle Deaths The number of people killed in each state from passenger vehicle crashes for a specific year is shown. Find the range, variance, and standard deviation for the data.

778	309	1110	324	705
1067	826	76	205	152
218	492	65	186	712
193	262	452	875	82
730	1185	2707	1279	390
305	123	948	343	602
69	451	951	104	985
155	450	2080	565	875
414	981	2786	82	793
214	130	396	620	797

Source: National Highway Traffic Safety Administration.

17. Annual Precipitation Days The number of annual precipitation days for one-half of the 50 largest U.S. cities is listed below. Find the range, variance, and standard deviation of the data.

135	128	136	78	116	77	111	79	44	97
116	123	88	102	26	82	156	133	107	35
112	98	45	122	125					

18. Use the data from Exercises 7, 15, and 17 (unemployment, prisoners, precipitation days) and compare the standard deviation with that obtained by the range rule of thumb (R/4.) Comment on the results.

19. Cost per Load of Laundry Detergents The costs per load (in cents) of 35 laundry detergents tested by a consumer organization are shown here. Find the variance and standard deviation for the data.

Class limits	Frequency
13–19	2
20–26	7
27–33	12
34–40	5
41–47	6
48–54	1
55–61	0
62–68	2

20. Automotive Fuel Efficiency Thirty automobiles were tested for fuel efficiency (in miles per gallon). This frequency distribution was obtained. Find the variance and standard deviation for the data.

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

21. Murders in Cities The data show the number of murders in 25 selected cities. Find the variance and standard deviation for the data.

Class limits	Frequency
34–96	13
97–159	2
160–222	0
223–285	5
286–348	1
349–411	1
412–474	0
475–537	1
538–600	2

22. Reaction Times In a study of reaction times to a specific stimulus, a psychologist recorded these data (in seconds). Find the variance and standard deviation for the data.

Class limits	Frequency
2.1–2.7	12
2.8–3.4	13
3.5–4.1	7
4.2–4.8	5
4.9–5.5	2
5.6–6.2	1

36. Solid Waste Production The average college student produces 640 pounds of solid waste each year. If the standard deviation is approximately 85 pounds, within what weight limits will at least 88.89% of all students' garbage lie?

Source: Environmental Sustainability Committee. www.esc.mtu.edu

37. Sale Price of Homes The average sale price of new one-family houses in the United States for 2003 was $246,300. Find the range of values in which at least 75% of the sale prices will lie if the standard deviation is $48,500.

Source: *New York Times Almanac.*

38. Trials to Learn a Maze The average of the number of trials it took a sample of mice to learn to traverse a maze was 12. The standard deviation was 3. Using Chebyshev's theorem, find the minimum percentage of data values that will fall in the range of 4–20 trials.

39. Farm Sizes The average farm in the United States in 2004 contained 443 acres. The standard deviation is 42 acres. Use Chebyshev's theorem to find the minimum percentage of data values that will fall in the range of 338–548 acres.

Source: *World Almanac.*

40. Citrus Fruit Consumption The average U.S. yearly per capita consumption of citrus fruit is 26.8 pounds. Suppose that the distribution of fruit amounts consumed is bell-shaped with a standard deviation equal to 4.2 pounds. What percentage of Americans would you expect to consume more than 31 pounds of citrus fruit per year?

Source: USDA/Economic Research Service.

41. SAT Scores The national average for mathematics SATs in 2011 was 514. Suppose that the distribution of scores was approximately bell-shaped and that the standard deviation was approximately 40. Within what boundaries would you expect 68% of the scores to fall? What percentage of scores would be above 594?

42. Work Hours for College Faculty The average full-time faculty member in a postsecondary degree-granting institution works an average of 53 hours per week.

   a. If we assume the standard deviation is 2.8 hours, what percentage of faculty members work more than 58.6 hours a week?

   b. If we assume a bell-shaped distribution, what percentage of faculty members work more than 58.6 hours a week?

Source: National Center for Education Statistics.

≛ Extending the Concepts

43. Serum Cholesterol Levels For this data set, find the mean and standard deviation of the variable. The data represent the serum cholesterol levels of 30 individuals. Count the number of data values that fall within 2 standard deviations of the mean. Compare this with the number obtained from Chebyshev's theorem. Comment on the answer.

211	240	255	219	204
200	212	193	187	205
256	203	210	221	249
231	212	236	204	187
201	247	206	187	200
237	227	221	192	196

44. Ages of Consumers For this data set, find the mean and standard deviation of the variable. The data represent the ages of 30 customers who ordered a product advertised on television. Count the number of data values that fall within 2 standard deviations of the mean. Compare this with the number obtained from Chebyshev's theorem. Comment on the answer.

42	44	62	35	20
30	56	20	23	41
55	22	31	27	66
21	18	24	42	25
32	50	31	26	36
39	40	18	36	22

45. Using Chebyshev's theorem, complete the table to find the minimum percentage of data values that fall within k standard deviations of the mean.

k	1.5	2	2.5	3	3.5
Percent					

46. Use this data set: 10, 20, 30, 40, 50

   a. Find the standard deviation.

   b. Add 5 to each value, and then find the standard deviation.

   c. Subtract 5 from each value and find the standard deviation.

   d. Multiply each value by 5 and find the standard deviation.

   e. Divide each value by 5 and find the standard deviation.

   f. Generalize the results of parts *b* through *e*.

   g. Compare these results with those in Exercise 35 of Exercises 3–1.

47. Mean Deviation The mean deviation is found by using this formula:

$$\text{Mean deviation} = \frac{\Sigma |X - \bar{X}|}{n}$$

$\int e c \int i o w$ 3.3

15. Annual Miles Driven The average miles driven annually per licensed driver in the United States is approximately 14,090 miles. If we assume a fairly mound-shaped distribution with a standard deviation of approximately 3500 miles, find the following:

a. z score for 16,000 miles

b. z score for 10,000 miles

c. Number of miles corresponding to z scores of 1.6, -0.5, and 0.

Source: *World Almanac 2012.*

16. Which score indicates the highest relative position?

a. A score of 3.2 on a test with $\overline{X} = 4.6$ and $s = 1.5$

b. A score of 630 on a test with $\overline{X} = 800$ and $s = 200$

c. A score of 43 on a test with $\overline{X} = 50$ and $s = 5$

17. Basketball Scores

a. Shown are all the scores from the second round of the NCAA Men's Basketball Championships 2012. Rank all of the individual scores, and use this set of data to find the percentile corresponding to each of the following scores: 78, 66, and 59.

72–65	70–64	77–54	78–59	73–49	79–70
65–59	66–63	81–66	77–64	68–60	68–64
62–59	79–66	75–70	67–63	58–57	77–58
79–65	74–59	65–60	58–44	72–69	65–50
58–41	88–68	69–62	75–68	61–54	89–67
71–45	86–84				

Using the same set of data, find the score corresponding to each percentile value.

b. 90th percentile

c. 80th percentile

d. 65th percentile

18. College Room and Board Costs Room and board costs for selected schools are summarized in this distribution. Find the approximate cost of room and board corresponding to each of the following percentiles.

Costs (in dollars)	Frequency
3000.5–4000.5	5
4000.5–5000.5	6
5000.5–6000.5	18
6000.5–7000.5	24
7000.5–8000.5	19
8000.5–9000.5	8
9000.5–10,000.5	5

a. 30th percentile

b. 50th percentile

c. 75th percentile

d. 90th percentile

Source: *World Almanac.*

Using the same data, find the approximate percentile rank of each of the following costs.

e. 5500   g. 6500

f. 7200   h. 8300

19. Achievement Test Scores The data shown represent the scores on a national achievement test for a group of 10th-grade students. Find the approximate percentile ranks of these scores by constructing a percentile graph.

a. 220   d. 280

b. 245   e. 300

c. 276

Score	Frequency
196.5–217.5	5
217.5–238.5	17
238.5–259.5	22
259.5–280.5	48
280.5–301.5	22
301.5–322.5	6

For the same data, find the approximate scores that correspond to these percentiles.

f. 15th   i. 65th

g. 29th   j. 80th

h. 43rd

20. Airplane Speeds The airborne speeds in miles per hour of 21 planes are shown. Find the approximate values that correspond to the given percentiles by constructing a percentile graph.

Class	Frequency
366–386	4
387–407	2
408–428	3
429–449	2
450–470	1
471–491	2
492–512	3
513–533	4
	21

Source: *The World Almanac and Book of Facts.*

a. 9th   d. 60th

b. 20th   e. 75th

c. 45th

Using the same data, find the approximate percentile ranks of the following speeds in miles per hour (mph).

f. 380 mph   i. 505 mph

g. 425 mph   j. 525 mph

h. 455 mph

21. Average Weekly Earnings The average weekly earnings in dollars for various industries are listed below. Find the percentile rank of each value.

804   736   659   489   777   623   597   524   228

For the same data, what value corresponds to the 40th percentile?

Source: *New York Times Almanac.*

22. **Test Scores** Find the percentile rank for each test score in the data set.

    12, 28, 35, 42, 47, 49, 50

    What value corresponds to the 60th percentile?

23. **Hurricane Damage** Find the percentile rank for each value in the data set. The data represent the values in billions of dollars of the damage of 10 hurricanes.

    1.1, 1.7, 1.9, 2.1, 2.2, 2.5, 3.3, 6.2, 6.8, 20.3

    What value corresponds to the 40th percentile?

    Source: Insurance Services Office.

24. **Test Scores** Find the percentile rank for each test score in the data set.

    5, 12, 15, 16, 20, 21

    What test score corresponds to the 33rd percentile?

25. **Gasoline Taxes** A random selection of state gasoline taxes per gallon is given below. Find the first and third quartile values for the data.

    | 16 | 18 | 35.3 | 25 | 23.5 | 27.1 | 32.5 | 16 | 22 |
    | 17.5 | 19 | 29.5 | 7.5 | 12 | | | | |

    Source: World Almanac 2012.

26. **Sheep Population** The data show the number of sheep in the top 12 major sheep-producing states. Find the first and third quartiles for the data.

Arizona	160,000	New Mexico	120,000
California	610,000	Oregon	225,000
Colorado	375,000	Texas	830,000
Idaho	220,000	Utah	290,000
Montana	255,000	Washington	60,000
Nevada	75,000	Wyoming	375,000

Source: U.S. Department of Agriculture.

27. **Earthquakes** Eleven major earthquakes had Richter magnitudes as shown. Find the first and third quartiles for the data.

    7.0, 6.2, 7.7, 8.0, 6.4, 6.2, 7.2, 5.4, 6.4, 6.5, 7.2

28. **Police Calls in Schools** The number of incidents in which police were needed for a sample of 9 schools in Allegheny County is 7, 37, 3, 8, 48, 11, 6, 0, 10. Find the first and third quartiles for the data.

29. Check each data set for outliers.

    a. 16, 18, 22, 19, 3, 21, 17, 20
    b. 24, 32, 54, 31, 16, 18, 19, 14, 17, 20
    c. 321, 343, 350, 327, 200

30. Check each data set for outliers.

    a. 88, 72, 97, 84, 86, 85, 100
    b. 145, 119, 122, 118, 125, 116
    c. 14, 16, 27, 18, 13, 19, 36, 15, 20

Extending the Concepts

31. Another measure of the average is called the *midquartile;* it is the numerical value halfway between Q_1 and Q_3, and the formula is

    $$\text{Midquartile} = \frac{Q_1 + Q_3}{2}$$

    Using this formula and other formulas, find Q_1, Q_2, Q_3, the midquartile, and the interquartile range for each data set.

    a. 5, 12, 16, 25, 32, 38
    b. 53, 62, 78, 94, 96, 99, 103

32. An employment evaluation exam has a variance of 250. Two particular exams with raw scores of 142 and 165 have z scores of -0.5 and 0.955, respectively. Find the mean of the distribution.

33. A particular standardized test has scores that have a mound-shaped distribution with mean equal to 125 and standard deviation equal to 18. Tom had a raw score of 158, Dick scored at the 98th percentile, and Harry had a z score of 2.00. Arrange these three students in order of their scores from lowest to highest. Explain your reasoning.

Technology   Step by Step

TI-84 Plus
Step by Step

Calculating Descriptive Statistics

To calculate various descriptive statistics:

1. Enter data into L1.
2. Press **STAT** to get the menu.
3. Press → to move cursor to CALC; then press 1 for 1-Var Stats.
4. Press **2nd [L1]**, then **ENTER**.

The calculator will display

$\bar{x}$	sample mean
$\sum x$	sum of the data values
$\sum x^2$	sum of the squares of the data values

12. **Innings Pitched** Construct a boxplot for the following data which represent the number of innings pitched by the ERA leaders for the past few years. Comment on the shape of the distribution.

192 228 186 199 238 217 213 234 264 187
214 115 238 246

Source: *World Almanac.*

13. **Teacher Strikes** The number of teacher strikes over a 13-year period in Pennsylvania is shown. Construct a boxplot for the data. Is the distribution symmetric?

20	18	7	13
7	14	5	9
9	9	10	17
15			

Source: Pennsylvania School Boards Association.

14. **Visitors Who Travel to Foreign Countries** Construct a boxplot for the number (in millions) of visitors who traveled to a foreign country each year for a random selection of years. Comment on the skewness of the distribution.

4.3	0.5	0.6	0.8	0.5
0.4	3.8	1.3	0.4	0.3

15. **Protein Contest of Energy Bars** The numbers of grams of protein in a random selection of granola and protein bars are listed below. Construct a boxplot for the data.

14	15	11	4	26	10	24
15	12	15	27	8	10	10

Compare your results to a boxplot for the amount of protein found in single servings of various high-protein drinks, as shown below.

18	42	40	40	15	10	15
15	20	21	42	20	34	

16. **Size of Dams** These data represent the volumes in cubic yards of the largest dams in the United States and in South America. Construct a boxplot of the data for each region and compare the distributions.

United States	South America
125,628	311,539
92,000	274,026
78,008	105,944
77,700	102,014
66,500	56,242
62,850	46,563
52,435	
50,000	

Source: *New York Times Almanac.*

17. **Graduation Rates** The graduation rates of several large state schools are shown below. Identify the five-number summary and the interquartile range, and draw a boxplot.

59.0 64.0 48.0 40.4 69.0 40.0 70.0 60.0
77.0 60.0 77.0 78.0 59.0 85.0

18. **Number of Tornadoes** A four-month record for the number of tornadoes in 2003–2005 is given here.
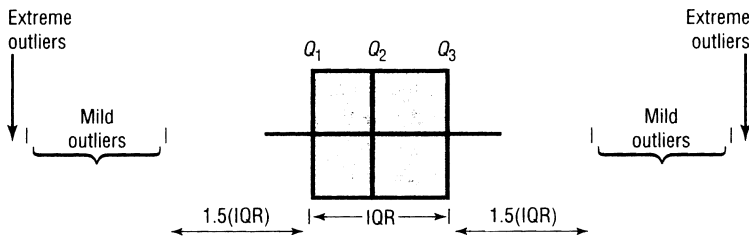
	2005	2004	2003
April	132	125	157
May	123	509	543
June	316	268	292
July	138	124	167

a. Which month had the highest mean number of tornadoes for this 3-year period?

b. Which year has the highest mean number of tornadoes for this 4-month period?

c. Construct three boxplots and compare the distributions.

Source: NWS. Storm Prediction Center.

Extending the Concepts

19. **Unhealthy Smog Days** A *modified boxplot* can be drawn by placing a box around Q_1 and Q_3 and then extending the whiskers to the highest and/or lowest values within 1.5 times the interquartile range (that is, $Q_3 - Q_1$). *Mild outliers* are values greater than $Q_3 + 1.5(IQR)$ or less than $Q_1 - 1.5(IQR)$. Extreme outliers are values greater than $Q_3 + 3(IQR)$ or less than $Q_1 - 3(IQR)$.

For the data shown here, draw a modified boxplot and identify any mild or extreme outliers. The data represent the number of unhealthy smog days for a specific year for the highest 10 locations.

97	39	43	66	91
43	54	42	53	39

Source: U.S. Public Interest Research Group and Clean Air Network.