1. Payroll. Here are the summary statistics for the weekly payroll of a small company: lowest salary = $300, mean salary = $700, median = $500, range = $1200, IQR = $600, first quartile = $350, standard deviation = $400.
   a) Do you think the distribution of salaries is symmetric, skewed to the left, or skewed to the right? Explain why.
   b) Between what two values are the middle 50% of the salaries found?
   c) Suppose business has been good and the company gives every employee a $50 raise. Tell the new value of each of the summary statistics.
   d) Instead, suppose the company gives each employee a 10% raise. Tell the new value of each of the summary statistics.

2. Hams. A specialty foods company sells "gourmet hams" by mail order. The hams vary in size from 4.15 to 7.45 pounds, with a mean weight of 6 pounds and standard deviation of 0.65 pounds. The quartiles and median weights are 5.6, 6.2, and 6.55 pounds.
   a) Find the range and the IQR of the weights.
   b) Do you think the distribution of the weights is symmetric or skewed? If skewed, which way? Why?
   c) If these weights were expressed in ounces (1 pound = 16 ounces) what would the mean, standard deviation, quartiles, median, IQR, and range be?
   d) When the company ships these hams, the box and packing materials add 30 ounces. What are the mean, standard deviation, quartiles, median, IQR, and range of weights of boxes shipped (in ounces)?
   e) One customer made a special order of a 10-pound ham. Which of the summary statistics of part d might not change if that data value were added to the distribution?

3. SAT or ACT? Each year thousands of high school students take either the SAT or the ACT, standardized tests used in the college admissions process. Combined SAT scores can go as high as 1600, while the maximum ACT composite score is 36. Since the two exams use very different scales, comparisons of performance are difficult. A convenient rule of thumb is \( SAT = 40 \times ACT + 150 \); that is, multiply an ACT score by 40 and add 150 points to estimate the equivalent SAT score.
   An admissions officer reports the following statistics about the ACT scores of 2355 students who applied to her college. Find the summaries of equivalent SAT scores.
   - Lowest score = 19
   - Standard deviation = 3
   - Median = 28
   - Mean = 27
   - Q3 = 30
   - IQR = 6

4. Cold U? A high school senior uses the Internet to get information on February temperatures in the town where he'll be going to college. He finds a Web site with some statistics, but they are given in degrees Celsius. The conversion formula is \( F = \frac{9}{5}C + 32 \). Determine the Fahrenheit equivalents for the summary information below.
   - Maximum temperature = 11°C
   - Range = 33°C
   - Mean = 1°C
   - Standard deviation = 7°C
   - Median = 2°C
   - IQR = 16°C

5. Temperatures. A town's January high temperatures average 36°F with a standard deviation of 10°, while in July the mean high temperature is 74° and the standard deviation is 8°. In which month is it more unusual to have a day with a high temperature of 55°? Explain.

6. Placement exams. An incoming freshman took her college's placement exams in French and mathematics. In French, she scored 82 and in math, 86. The overall results on the French exam had a mean of 72 and a standard deviation of 8, while the mean math score was 68 with a standard deviation of 12. On which exam did she do better compared with the other freshmen?

7. Final exams. Anna, a language major, took final exams in both French and Spanish and scored 83 on both. Her roommate Megan, also taking both courses, scored 77 on the French exam and 95 on the Spanish exam. Overall, student scores on the French exam had a mean of 81 and a standard deviation of 5, and the Spanish scores had a mean of 74 and a standard deviation of 15.
   a) To qualify for language honors, a major must maintain at least an 85 average for all language courses taken. So far, which student qualifies?
   b) Which student's overall performance was better?

8. MP3s. Two companies market new batteries targeted at owners of personal music players. DuraTunes claims a mean battery life of 11 hours, while RockReady advertises 12 hours.
   a) Explain why you would also like to know the standard deviations of the battery lifespans before deciding which brand to buy.
   b) Suppose those standard deviations are 2 hours for DuraTunes and 1.5 hours for RockReady. You are headed for 8 hours at the beach. Which battery is most likely to last all day? Explain.
   c) If your beach trip is all weekend, and you probably will have the music on for 16 hours, which battery is most likely to last? Explain.

9. Professors. A friend tells you about a recent study dealing with the number of years of teaching experience among current college professors. He remembers the mean but can't recall whether the standard deviation was 6 months, 6 years, or 16 years. Tell him which one it must have been, and why.
10. Rock concerts. A popular band on tour played a series of concerts in large venues. They always drew a large crowd, averaging 21,359 fans. While the band did not announce (and probably never calculated) the standard deviation, which of these values do you think is most likely to be correct; 20, 200, 2000, or 20,000 fans? Explain your choice.

11. Guzzlers? Environmental Protection Agency (EPA) fuel economy estimates for automobile models tested recently predicted a mean of 24.8 mpg and a standard deviation of 6.2 mpg for highway driving. Assume that a Normal model can be applied.
   a) Draw the model for auto fuel economy. Clearly label it, showing what the 68-95-99.7 Rule predicts about miles per gallon.
   b) In what interval would you expect the central 68% of autos to be found?
   c) About what percent of autos should get more than 31 mpg?
   d) About what percent of cars should get between 31 and 37 mpg?
   e) Describe the gas mileage of the worst 2.5% of all cars.

12. IQ. Some IQ tests are standardized to a Normal model with a mean of 100 and a standard deviation of 16.
   a) Draw the model for these IQ scores. Clearly label it, showing what the 68-95-99.7 Rule predicts about the scores.
   b) In what interval would you expect the central 95% of IQ scores to be found?
   c) About what percent of people should have IQ scores above 116?
   d) About what percent of people should have IQ scores between 68 and 84?
   e) About what percent of people should have IQ scores above 132?

13. Winter Olympics 2002 downhill. Fifty-three men qualified for the men's alpine downhill race in Salt Lake City. The gold medal winner finished in 1 minute 39.13 seconds. All competitors' times (in seconds) are found in the following table:
   
<table>
<thead>
<tr>
<th>Time (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>99.1</td>
</tr>
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<tr>
<td>99.41</td>
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<tr>
<td>99.78</td>
</tr>
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<td>99.96</td>
</tr>
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</tr>
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<td>100.30</td>
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<td>100.31</td>
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<td>108.37</td>
</tr>
<tr>
<td>108.84</td>
</tr>
<tr>
<td>109.75</td>
</tr>
<tr>
<td>114.42</td>
</tr>
</tbody>
</table>

   a) The mean time was 102.71 seconds, with a standard deviation of 3.01 seconds. If the normal model is appropriate, what percent of times will be less than 99.7 seconds?
   b) What is the actual percent of times less than 99.7 seconds?

14. Rivets. A company that manufactures rivets believes the shear strength (in pounds) is modeled by W(800, 50).
   a) Draw and label the Normal model.
   b) Would it be safe to use these rivets in a situation requiring a shear strength of 750 pounds? Explain.
   c) About what percent of these rivets would you expect to fail below 900 pounds?
   d) Rivets are used in a variety of applications with varying shear strength requirements. What is the maximum shear strength for which you would feel comfortable approving this company's rivets? Explain your reasoning.

15. Trees. A forester measured 27 of the trees in a large woods that is up for sale. He found a mean diameter of 10.4 inches and a standard deviation of 4.7 inches. Suppose that these trees provide an accurate description of the whole forest and that a Normal model applies.
   a) Draw the Normal model for tree diameters.
   b) What size would you expect the central 95% of all trees to be?
   c) About what percent of the trees should be less than an inch in diameter?
   d) About what percent of the trees should be between 5.7 and 10.4 inches in diameter?
   e) About what percent of the trees should be over 15 inches in diameter?

16. Trees, part 2. Later on the forester shows you a histogram of the tree diameters he used in analyzing the woods that was for sale. Do you think he was justified in using a Normal model? Explain, citing some specific concerns.

17. TV watching. A survey of 200 college students conducted during the week of March 15, 1999, showed the following distribution of the number of hours of TV watched per week:

   a) According to the Normal model, what percent of students will watch fewer than one standard deviation below the mean number of hours?
   b) For these data, what does that mean? Explain.
   c) Explain the problem in using the Normal model for these data.
18. Customer Database. A large philanthropic organization keeps records on the people who have contributed to their cause. In addition to keeping records of past giving, the organization buys demographic data on neighborhoods from the U.S. Census Bureau. Eighteen of these variables concern the ethnicity of the neighborhood of the donor. Here is a histogram and summary statistics for the percentage of whites in the neighborhoods of 500 donors:

<table>
<thead>
<tr>
<th>Count</th>
<th>500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>83.59</td>
</tr>
<tr>
<td>Median</td>
<td>93</td>
</tr>
<tr>
<td>StdDev</td>
<td>22.26</td>
</tr>
<tr>
<td>IQR</td>
<td>17</td>
</tr>
<tr>
<td>Q1</td>
<td>80</td>
</tr>
<tr>
<td>Q3</td>
<td>97</td>
</tr>
</tbody>
</table>

a) Which is a better summary of the percentage of white residents in the neighborhoods, the mean or the median? Explain.
b) Which is a better summary of the spread, the IQR or the standard deviation? Explain.
c) From a Normal model, about what percentage of neighborhoods should have a percent white within one standard deviation of the mean?
d) What percentage of neighborhoods actually have a percent white within one standard deviation of the mean?
e) Explain the discrepancy between parts c and d.

19. Normal models. What percent of a standard Normal model is found in each region? Be sure to draw a picture first.
   a) $z > 1.5$
   b) $z < 2.25$
   c) $-1 < z < 1.15$
   d) $|z| > 0.5$

20. Normal models, again. What percent of a standard Normal model is found in each region? Draw a picture first.
   a) $z > -2.05$
   b) $z < -0.33$
   c) $1.2 < z < 1.8$
   d) $|z| < 1.28$

21. More Normal models. In a standard Normal model, what value(s) of z cut(s) off the region described? Don't forget to draw a picture.
   a) the highest 20%
   b) the highest 75%
   c) the lowest 3%
   d) the middle 90%

22. Yet another Normal model. In a standard Normal model, what value(s) of z cut(s) off the region described? Remember to draw a picture first.
   a) the lowest 12%
   b) the highest 30%
   c) the highest 7%
   d) the middle 50%

23. Parameters. Every Normal model is defined by its parameters, the mean and the standard deviation. For each model described below, find the missing parameter. As always, start by drawing a picture.
   a) $\mu = 20$, 45% above 30; $\sigma =$ ?
   b) $\mu = 88$, 2% below 50; $\sigma =$ ?
   c) $\sigma = 5$, 80% below 100; $\mu =$ ?
   d) $\sigma = 15.6$, 10% above 17.2; $\mu =$ ?

24. Parameters II. Every Normal model is defined by its parameters, the mean and the standard deviation. For each model described below, find the missing parameter. Don't forget to draw a picture.
   a) $\mu = 1250$, 35% below 1200; $\sigma =$ ?
   b) $\mu = 0.64$, 12% above 0.70; $\sigma =$ ?
   c) $\sigma = 0.5$, 90% above 10.0; $\mu =$ ?
   d) $\sigma = 220$, 3% below 202; $\mu =$ ?

25. Cholesterol. Assume the cholesterol levels of adult American women can be described by a Normal model with a mean of 188 mg/dL and a standard deviation of 24.
   a) Draw and label the Normal model.
   b) What percent of adult women do you expect to have cholesterol levels over 200 mg/dL?
   c) What percent of adult women do you expect to have cholesterol levels between 150 and 170 mg/dL?
   d) Estimate the interquartile range of the cholesterol levels.
   e) Above what value are the highest 15% of women's cholesterol levels?

26. Tires. A tire manufacturer believes that the treadlife of its snow tires can be described by a Normal model with a mean of 32,000 miles and standard deviation of 2500 miles.
   a) If you buy a set of these tires, would it be reasonable for you hope they'll last 40,000 miles? Explain.
   b) Approximately what fraction of these tires can be expected to last less than 30,000 miles?
   c) Approximately what fraction of these tires can be expected to last between 30,000 and 35,000 miles?
   d) Estimate the IQR of the treadlifes.
   e) In planning a marketing strategy, a local tire dealer wants to offer a refund to any customer whose tires fail to last a certain number of miles. However, the dealer does not want to take too big a risk. If the dealer is willing to give refunds to no more than 1 of every 25 customers, for what mileage can he guarantee these tires to last?
27. Kindergarten. Companies who design furniture for elementary school classrooms produce a variety of sizes for kids of different ages. Suppose the heights of kindergarten children can be described by a Normal model with a mean of 38.2 inches and standard deviation of 1.8 inches.
   a) What fraction of kindergarten kids should the company expect to be less than 3 feet tall?
   b) In what height interval should the company expect to find the middle 80% of kindergarteners?
   c) At least how tall are the biggest 10% of kindergarteners?

28. Body temperatures. Most people think that the "normal" adult body temperature is 98.6°F. That figure, based on a 19th century study, has recently been challenged. In a 1992 article in the Journal of the American Medical Association, researchers reported that a more accurate figure may be 98.2°F. Furthermore, the standard deviation appeared to be around 0.7°F. Assume that a Normal model is appropriate.
   a) In what interval would you expect most people's body temperatures to be? Explain.
   b) What fraction of people would be expected to have body temperatures above 98.6°F?
   c) Below what body temperature are the coolest 20% of all people?

29. First steps. While only 5% of babies have learned to walk by the age of 10 months, 75% are walking by 13 months of age. If the age at which babies develop the ability to walk can be described by a Normal model, find the parameters (mean and standard deviation).

30. Trout. Wildlife biologists believe that the weights of adult trout can be described by a Normal model. They collect data from fishermen, finding that 22% of the trout caught were thrown back because they were below the 2-pound minimum, and only 6% weighed over 5 pounds. What mean and standard deviation should define the model?

31. Eggs. Hens usually begin laying eggs when they are about 6 months old. Young hens tend to lay smaller eggs, often weighing less than the desired minimum weight of 54 grams.
   a) The average weight of the eggs produced by the young hens is 50.9 grams, and only 28% of their eggs exceed the desired minimum weight. If a Normal model is appropriate, what would the standard deviation of the egg weights be?
   b) By the time these hens have reached the age of 1 year, the eggs they produce average 67.1 grams, and 98% of them are above the minimum weight. What is the standard deviation for the appropriate Normal model for these older hens?
   c) Are egg sizes more consistent for the younger hens or the older ones? Explain.
   d) A certain poultry farmer finds that 8% of his eggs are underweight and that 12% weigh over 70 grams. Estimate the mean and standard deviation of his eggs.

32. Tomatoes. Agricultural scientists are working on developing an improved variety of Roma tomatoes. Marketing research indicates that customers are likely to bypass Romas that weigh less than 70 grams. The current variety of Roma plants produces fruit that average 74 grams, but 11% of the tomatoes are too small. It is reasonable to assume that a Normal model applies.
   a) What is the standard deviation of the weights of Romas now being grown?
   b) Scientists hope to reduce the frequency of undersized tomatoes to no more than 4%. One way to accomplish this is to raise the average size of the fruit. If the standard deviation remains the same, what target mean should they have as a goal?
   c) The researchers produce a new variety with a mean weight of 75 grams, which meets the 4% goal. What is the standard deviation of the weights of these new Romas?
   d) Based on their standard deviations, compare the tomatoes produced by the two varieties.
1. a) Skewed to the right; mean is higher than median.
   b) $350 and $950.
2. a) Range 3.30 pounds. IQR 0.95 pounds.
   b) Slightly skewed to the left because the mean is lower than the median and the first quartile is farther from the median than the third quartile.
   c) Mean 96 oz. SD 10.4 oz. Q1 89.6 oz. Q3 104.8 oz. Median 99.2 oz. IQR 15.2 oz. Range 52.8 oz.
   d) Mean 126 oz. SD 10.4 oz. Q1 119.6 oz. Q3 134.8 oz. Median 129.2 oz. IQR 15.2 oz. Range 52.8 oz.
   e) Median, IQR.
3. Lowest score = 910 Mean = 1230 Standard deviation = 120 Top 25% above 1350 Median = 1270 IQR = 240
4. Maximum temperature = 51.8°F Range = 59.4°F Mean = 33.8°F
   Standard deviation = 12.6°F Median = 35.6°F IQR = 28.8°F
5. In January, a high of 55 is not quite 2 standard deviations above the mean, whereas in July a high of 55 is more than 2 standard deviations lower than the mean. So it's less likely to happen in July.
6. In French she scored 1.25 standard deviations higher than the mean. On the math exam she scored 1.50 standard deviations higher than the mean, so she did "better" on the math exam.
7. a) Megan
   b) Anna
8. a) To know something about their consistency and the chances they will last a certain amount of time,
   b) RockReady. Mean is larger and SD smaller.
   c) 16 hours is 2.5 SD higher than DuraTunes's mean, and 2.67 SD higher than RockReady's mean. So, although neither battery has much chance of lasting 16 hours, DuraTunes's chance is greater.
9. College professors can have between 0 and maybe 40 (or possibly 50) years experience. A standard deviation of 1/2 year is impossible, because many professors would be 10 or 20 SDs away from the mean, whatever it is. An SD of 16 years would mean that 2 SDs on either side of the mean is plus or minus 32, for a range of 64 years. That's too high. So, the SD must be 6 years.
10. Probably 2000, but it could be 20000 if they played to a few really large audiences (like sold-out stadiums).
11. a) 
   b) 18.6 to 31.0 mpg
   c) 16%
   d) 13.5%
   e) less than 12.4 mpg
12. a) 
   b) 68 to 132IQ points
   c) 16%
   d) 13.5%
   e) 2.5%
13. a) 16%
   b) 5.7%
   c) Because the Normal model doesn't fit well.
   d) Distribution is skewed to the right with an outlier on the high side.
14. a) 

b) Chances are 84% that the strength is at least 750 pounds. That means 16% of the time it will be below. Seems like much too high a percentage.

c) 97.5%

d) In the extreme case, I would want a very small probability of failure, maybe less than 1 out of a million. For this I'd need to be sure that 800 was 6 SDs higher than my limit. So I might not use the rivets if I needed them to have shear strength more than 500 pounds.

15. a) 

b) Between 1.0 and 19.8 inches

c) 2.5%

d) 34%

e) 16%

16. Since the histogram is not unimodal and symmetric, it is not wise to have faith in numbers from the Normal model.

17. a) 16%
b) 16% of the students should be watching less than -1.27 hours a week, but no one can watch less than 0 hours, so the model doesn't fit well.

c) Data are strongly skewed to the right, not symmetric.

18. a) Median because the distribution is so skewed to the left.
b) IQR. Distribution is skewed.
c) 68%
d) More than 75%
e) Normal model is not appropriate. Data are strongly skewed.

19. a) 6.68% b) 98.78% c) 71.63% d) 61.71%

20. a) 97.98% b) 37.07% c) 7.91% d) 79.95%

21. a) -1.175 b) 0.524 c) 1.476 d) -0.675 to 0.675

22. a) -1.175 b) 0.524 c) 1.476 d) -0.675 to 0.675

23. a) 79.55 b) 18.50 c) 95.79 d) -2.77

24. a) 129.77 b) 0.05 c) 10.64 d) 615.77

25. a) 0.842 b) -0.675 c) -1.881 d) -1.645 to 1.645

26. a) No, that's more than 3 SDs above the mean,
b) 21.2%
c) 67.3%
d) Quartiles at 30,314 and 33,686 miles, so 3,372 miles
e) 27,623 miles

27. a) 11.1%
b) (35.9, 40.5) inches
c) 40.5 inches

28. a) Based on the Normal model, we expect 95% to be between 96.8 and 99.6 degrees,
b) 28.4%
c) 97.6 degrees

29. Mean 12.1 months, SD 1.3 months

30. Mean 3 lb, SD 1.3 lb

31. a) 5.3 grams

b) 6.4 grams
c) Younger because SD is smaller.
d) Mean 62.7 grams, SD 6.2 grams

32. a) 3.26 grams

b) 75.71 grams
c) 2.86 grams
d) The new tomatoes are more consistent in their weights.