Lesson 3.4    Box-and-Whisker Plots

Roller Coasters  The heights, in feet, of suspended roller coasters in the United States are given below. How can the data be displayed so that it is divided into quarters?

35  42  42.5  60  60  70  76  78  81  100

A box-and-whisker plot is a data display that divides data values into four parts. Ordered data are divided into a lower and an upper half by the median. The median of the lower half is the lower quartile. The median of the upper half is the upper quartile. The lower extreme is the least data value. The upper extreme is the greatest data value.

EXAMPLE 1 Making a Box-and-Whisker Plot

To make a box-and-whisker plot of the roller coaster heights given above, first find the median. Then find the lower and upper quartiles.

\[
\text{Median} = \frac{60 + 70}{2} = 65
\]

Lower half

\[
\begin{align*}
35 & \quad 42 & \quad 42.5 & \quad 60 & \quad 60 \\
\end{align*}
\]

Upper half

\[
\begin{align*}
70 & \quad 76 & \quad 78 & \quad 81 & \quad 100 \\
\end{align*}
\]

Lower quartile = 42.5

Upper quartile = 78

Plot the lower extreme, lower quartile, median, upper quartile, and upper extreme using a number line.

Draw a box from the lower quartile to the upper quartile. Then draw a vertical line through the median.

Draw a horizontal line from the box to each of the extremes.

In the Real World

BEFORE

You displayed data using bar graphs and line graphs.

Now

You'll display data using box-and-whisker plots.

WHY?

So you can compare heights of redwood trees, as in Exs. 14–15.

Word Watch

box-and-whisker plot, p. 123
lower quartile, p. 123
upper quartile, p. 123
lower extreme, p. 123
upper extreme, p. 123
Chapter 3  Data and Statistics

Interpreting a Box-and-Whisker Plot

A box-and-whisker plot helps to show how varied, or spread out, the data are.

**EXAMPLE 2** Interpreting a Box-and-Whisker Plot

**Watches** The prices of the watches at a store are displayed in the box-and-whisker plot below.

![Box-and-Whisker Plot](Image)

a. If all of the watches under $31 are on clearance, then about what fraction of the watches are on clearance?

b. If all of the watches from $31 to $71 are on sale, then about what fraction of the watches are on sale?

**Solution**

a. The watches less than $31 are about the same as the number in one of the whiskers, which represents about one quarter of the watches.

b. The watches between $31 and $71 are about the same as the number in the large box of the plot, which represents about half of the watches.

**Your turn now** Complete the following exercises.

1. A movie theater recorded the number of tickets sold for each showing of a movie during its opening weekend. Make a box-and-whisker plot of the ticket data listed below:
   
   497 429 746 469 504 464 326 302 509 467 401 499

2. Use the box-and-whisker plot from Exercise 1 to make a conclusion about the data.

3. In Example 2, is the number of watches between $71 and $120 greater than the number of watches between $16 and $31?
Comparing Box-and-Whisker Plots

Football

The box-and-whisker plots below represent the number of points scored in each game of the 2001–2002 season for the New England Patriots and the St. Louis Rams. What conclusions can you make about the data?

Solution

In general, the Rams scored more points per game than the Patriots. There is more variability in the points scored by the Patriots than by the Rams, with the range for the Patriots being $44 - 3 = 41$ and the range for the Rams being $48 - 15 = 33$.

Exercises

3.4

Vocabulary

In Exercises 1–4, tell whether the statement about the box-and-whisker plot is true or false.

1. The upper extreme is 93.
2. The median is 82.
3. The lower quartile is 58.
4. The upper quartile is 117.

5. DVD Rentals

The number of DVDs rented each day over two weeks at a video rental store are given. Make a box-and-whisker plot of the data.

38, 42, 50, 65, 82, 91, 88, 40, 34, 41, 71, 93, 87, 94

6. Writing

Use the box-and-whisker plot from Exercise 5 to make a conclusion about the data.
Practice and Problem Solving

7. Choose the set of data that is displayed in the box-and-whisker plot.

A. 1, 30, 39, 12, 13, 20, 11, 22, 29
B. 12, 28, 13, 10, 1, 39, 30, 20, 22

Make a box-and-whisker plot of the data.

8. Hourly rates of pay: 8.75, 7.50, 9, 8, 6.50, 8, 6.50, 7, 6, 7, 6.25
9. Pages per chapter in a book: 21, 25, 20, 14, 15, 19, 14, 14, 10, 25
10. Ages of roller rink employees: 24, 22, 30, 18, 29, 38, 33, 17, 22, 25, 16, 41

Fuel Economy The box-and-whisker plots show the average miles per gallon of gasoline used in city driving for 2002 models of small cars and sport utility vehicles.

11. Compare the number of small cars that get less than 25 miles per gallon with those that get more than 25 miles per gallon.
12. About what fraction of the sport utility vehicles get less than 14 miles per gallon?
13. Writing Make a conclusion comparing the two groups of vehicles.

Trees In Exercises 14 and 15, use the heights, to the nearest foot, of coastal redwood trees known to be over 340 feet tall listed below.


14. Make a box-and-whisker plot of the data.
15. Suppose the tallest tree is struck by lightning and its height is reduced to 352 feet. Make a box-and-whisker plot for the new data. How does this plot differ from the one that you made in Exercise 14?
16. Critical Thinking Suppose you have to make a box-and-whisker plot for an unordered data set with 50 values. Explain how a stem-and-leaf plot of the data can help you make the box-and-whisker plot.

Redwood Trees

Suppose the arch in a redwood tree is 2.1 meters high. Can a truck that is 260 centimeters tall pass through the arch?
**Golf** The distances, in yards, that Julia and Ty hit 14 golf balls at a driving range are listed below.

Julia: 116, 147, 167, 157, 88, 130, 155, 118, 144, 220, 213, 222, 52  
Ty: 62, 129, 103, 217, 230, 160, 151, 63, 133, 203, 159, 142, 185, 201

17. Using the same number line, make a box-and-whisker plot for each person.

18. **Interpret** Make a conclusion about the data.

**Challenge** Tell whether the statement is always, sometimes, or never true.

19. When a data set has 13 items, the lower quartile is one of the items.

20. Exactly half of the items in a data set are greater than the median.

21. The upper extreme and the upper quartile are not the same number.

**Mixed Review**

Write the number in scientific notation. *(Lesson 2.5)*

22. 25,500,000  
23. 700,000,000  
24. 9999  
25. 326,700

26. Make a stem-and-leaf plot of the data listed below. *(Lesson 3.3)*

6.6, 6.4, 4.1, 5.5, 5, 4.2, 8.1, 6.8, 8.5, 4.2, 9.5, 8.7, 5.3, 4.2

**Basic Skills** Use a number line to order the numbers from least to greatest.

27. 14, 9, 10, 1, 7, 13, 3

28. 27, 32, 22, 25, 36, 29, 39

**Test-Taking Practice**

29. **Multiple Choice** The box-and-whisker plot shows the heights, in feet, of waves at a beach during one day. What is the lower quartile?

A. 5  
B. 7  
C. 9.5  
D. 11

30. **Multiple Choice** Which statement about the plot above is not true?

F. The smallest wave measured was 5 feet high.

G. About one quarter of the data lie between 9.5 feet and 11 feet.

H. About half of the data lie between 7 feet and 11 feet.

I. The range in heights is 4 feet.