

10.4 Box-and-Whisker Plots

Essential Question How can you use quartiles to represent data graphically?

1 ACTIVITY: Drawing a Box-and-Whisker Plot

Work with a partner.

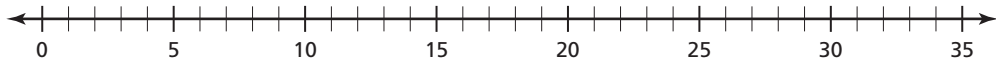
The numbers of pairs of footwear owned by each student in a sixth grade class are shown.

| Numbers of Pairs of Footwear | | | |
|------------------------------|----|----|----|
| 2 | 5 | 12 | 3 |
| 7 | 2 | 4 | 6 |
| 14 | 10 | 6 | 28 |
| 5 | 3 | 2 | 4 |
| 9 | 25 | 4 | 10 |
| 8 | 15 | 5 | 8 |

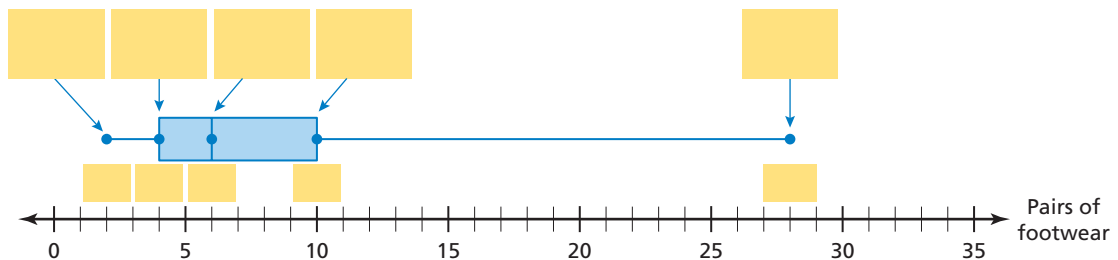
- a. Order the data set from least to greatest. Then write the data on a strip of grid paper with 24 boxes.



- b. Use the strip of grid paper to find the median, the first quartile, and the third quartile. Identify the least value and the greatest value in the data set.
 c. Graph the five numbers that you found in part (b) on the number line below.



- d. The data display shown below is called a *box-and-whisker plot*. Fill in the missing labels and numbers. Explain how a box-and-whisker plot uses quartiles to represent the data.



Data Displays

In this lesson, you will

- make and interpret box-and-whisker plots.
- compare box-and-whisker plots.

Learning Standards

- 6.SP.2
- 6.SP.4
- 6.SP.5c

- e. Using only the box-and-whisker plot, which measure(s) of center can you find for the data set? Which measure(s) of variation can you find for the data set? Explain your reasoning.
 f. Why do you think this type of data display is called a box-and-whisker plot? Explain.

2 ACTIVITY: Conducting a Survey

Have your class conduct a survey. Each student will write on the chalkboard the number of pairs of footwear that he or she owns.

Now, work with a partner to draw a box-and-whisker plot of the data.



3 ACTIVITY: Reading a Box-and-Whisker Plot

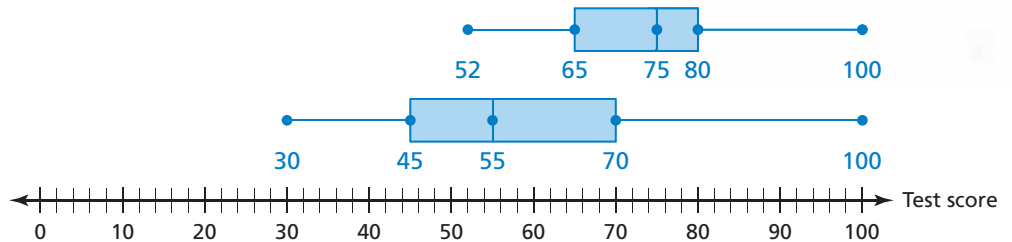
Math Practice 7

View as Components

What do the different components of a box-and-whisker plot represent?

Work with a partner. The box-and-whisker plots show the test score distributions of two sixth grade achievement tests. The same group of students took both tests. The students took one test in the fall and the other in the spring.

- Compare and contrast the test results.
- Decide which box-and-whisker plot represents the results of which test. How did you make your decision?



What Is Your Answer?

- IN YOUR OWN WORDS** How can you use quartiles to represent data graphically?
- Describe who might be interested in test score distributions like those shown in Activity 3. Explain why it is important for such people to know test score distributions.

Practice

Use what you learned about box-and-whisker plots to complete Exercise 4 on page 463.

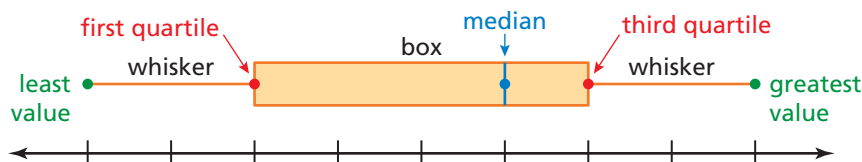
Key Vocabulary

box-and-whisker plot,
p. 460
five-number
summary, p. 460

Key Idea

Box-and-Whisker Plot

A **box-and-whisker plot** represents a data set along a number line by using the least value, the greatest value, and the quartiles of the data. A box-and-whisker plot shows the *variability* of a data set.



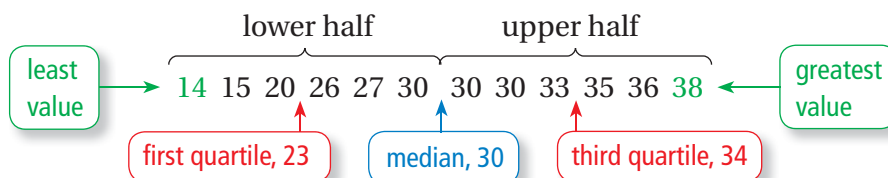
The five numbers that make up the box-and-whisker plot are called the **five-number summary** of the data set.

EXAMPLE 1 Making a Box-and-Whisker Plot

Make a box-and-whisker plot for the ages (in years) of the spider monkeys at a zoo:

15, 20, 14, 38, 30, 36, 30, 30, 27, 26, 33, 35

Step 1: Order the data. Find the median and the quartiles.



Step 2: Draw a number line that includes the least and greatest values. Graph points above the number line that represent the five-number summary.

Step 3: Draw a box using the quartiles. Draw a line through the median. Draw whiskers from the box to the least and the greatest values.



On Your Own

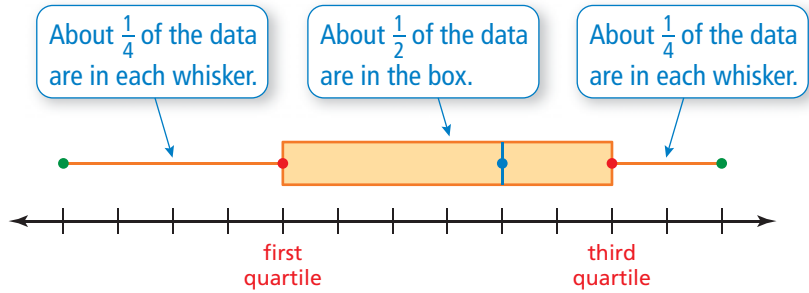
- A group of friends spent 1, 0, 2, 3, 4, 3, 6, 1, 0, 1, 2, and 2 hours online last night. Make a box-and-whisker plot for the data.

Now You're Ready
Exercises 5–8

The figure shows how data are distributed in a box-and-whisker plot.

Study Tip

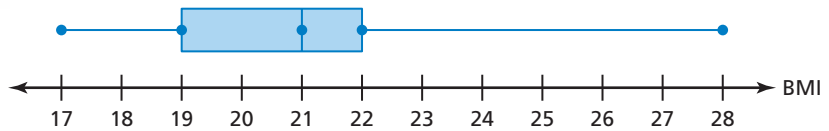
A long whisker or box indicates that the data are more spread out.



EXAMPLE 2 Analyzing a Box-and-Whisker Plot



The box-and-whisker plot shows the body mass index (BMI) of a sixth grade class.



- a. What fraction of the students have a BMI of at least 22?

The right whisker represents students who have a BMI of at least 22.

∴ So, about $\frac{1}{4}$ of the students have a BMI of at least 22.

- b. Are the data more spread out below the first quartile or above the third quartile? Explain.

The right whisker is longer than the left whisker.

∴ So, the data are more spread out above the third quartile than below the first quartile.

- c. Find and interpret the interquartile range of the data.

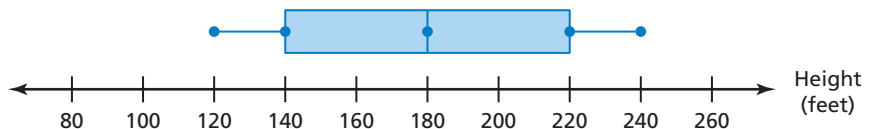
$$\begin{aligned} \text{interquartile range} &= \text{third quartile} - \text{first quartile} \\ &= 22 - 19 = 3 \end{aligned}$$

∴ So, the middle half of the students' BMIs varies by no more than 3.

On Your Own

Now You're Ready
Exercises 11
and 12

2. The box-and whisker plot shows the heights of the roller coasters at an amusement park. (a) What fraction of the roller coasters are between 120 feet tall and 220 feet tall? (b) Are the data more spread out below or above the median? Explain. (c) Find and interpret the interquartile range of the data.



A box-and-whisker plot also shows the shape of a distribution.

Key Ideas

Study Tip

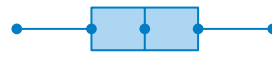
If you can draw a line through the median of a box-and-whisker plot, and each side is a mirror image of the other, then the distribution is symmetric.

Shapes of Box-and-Whisker Plots



Skewed left

- Left whisker longer than right whisker
- Most data on the right



Symmetric

- Whiskers about same length
- Median in the middle of the box



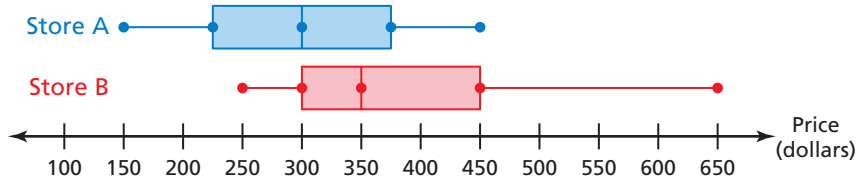
Skewed right

- Right whisker longer than left whisker
- Most data on the left

EXAMPLE 3 Comparing Box-and-Whisker Plots



The double box-and-whisker plot represents the prices of snowboards at two stores.



a. Identify the shape of each distribution.

For Store A, the whisker lengths are equal. The median is in the middle of the box. The data on the left are the mirror image of the data on the right. So, the distribution is symmetric.

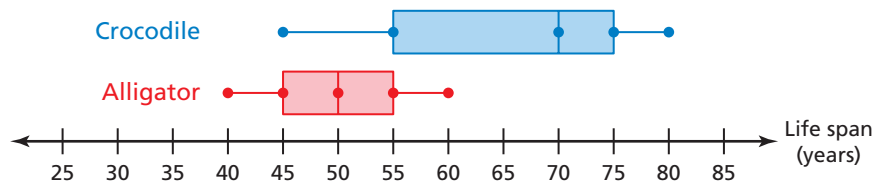
For Store B, the right whisker is longer than the left whisker, and most of the data are on the left side of the display. So, the distribution is skewed right.

b. Which store's prices are more spread out? Explain.

Both boxes appear to be the same length. So, the interquartile range of each data set is equal. However, the range of the prices in Store B is greater than the range of the prices in Store A. So, the prices in Store B are more spread out.

On Your Own

3. The double box-and-whisker plot represents the life spans of crocodiles and alligators at a zoo. Identify the shape of each distribution. Which reptile's life spans are more spread out? Explain.



Now You're Ready
Exercises 13–17

Vocabulary and Concept Check

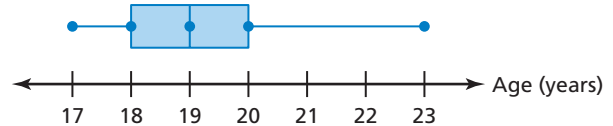
- VOCABULARY** Explain how to find the five-number summary of a data set.
- NUMBER SENSE** In a box-and-whisker plot, what fraction of the data is greater than the first quartile?
- DIFFERENT WORDS, SAME QUESTION** Which is different? Find “both” answers.

Is the distribution skewed right?

Is the left whisker longer than the right whisker?

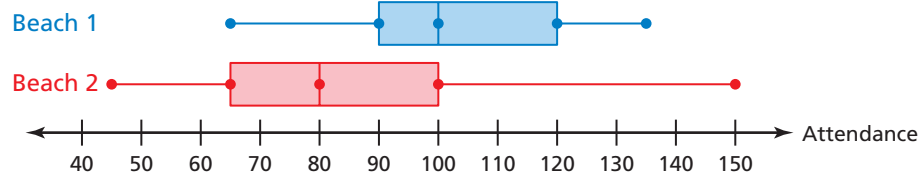
Are the data more spread out below the first quartile than above the third quartile?

Does the lower fourth of the data vary more than the upper fourth of the data?



Practice and Problem Solving

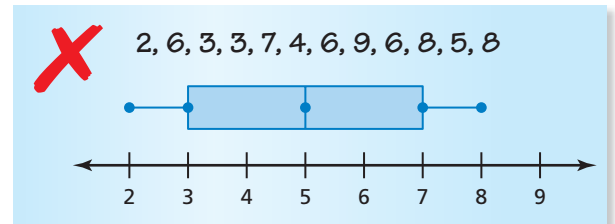
- The box-and-whisker plots represent the daily attendance at two beaches during July. Compare and contrast the attendances for the two beaches.



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

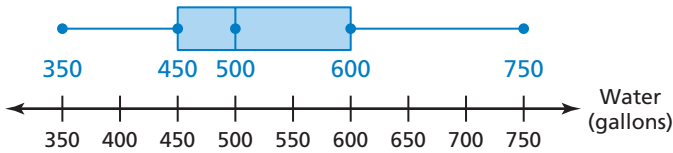
- Ages of teachers (in years): 30, 62, 26, 35, 45, 22, 49, 32, 28, 50, 42, 35
- Quiz scores: 8, 12, 9, 10, 12, 8, 5, 9, 7, 10, 8, 9, 11
- Donations (in dollars): 10, 30, 5, 15, 50, 25, 5, 20, 15, 35, 10, 30, 20
- Ski lengths (in centimeters): 180, 175, 205, 160, 210, 175, 190, 205, 190, 160, 165, 195

- ERROR ANALYSIS** Describe and correct the error in making a box-and-whisker plot for the data.

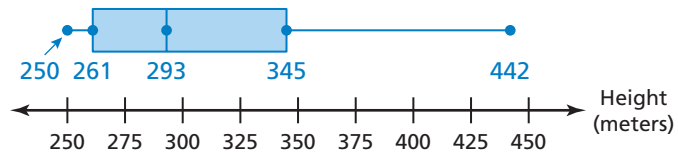


- CAMPING** The numbers of days 12 friends went camping during the summer are 6, 2, 0, 10, 3, 6, 6, 4, 12, 0, 6, and 2. Make a box-and-whisker plot for the data. What is the range of the data?

- 2 11. **DUNK TANK** The box-and-whisker plot represents the numbers of gallons of water needed to fill different types of dunk tanks offered by a company.



- What fraction of the dunk tanks require at least 500 gallons of water?
 - Are the data more spread out below the first quartile or above the third quartile? Explain.
 - Find and interpret the interquartile range of the data.
12. **BUILDINGS** The box-and-whisker plot represents the heights (in meters) of the tallest buildings in Chicago.

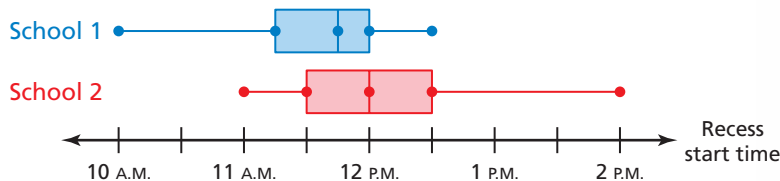


- What percent of the buildings are no taller than 345 meters?
- Is there more variability in the heights above 345 meters or below 261 meters? Explain.
- Find and interpret the interquartile range of the data.

Identify the shape of the distribution. Explain.



17. **RECESS** The double box-and-whisker plot represents the start times of recess for two schools.

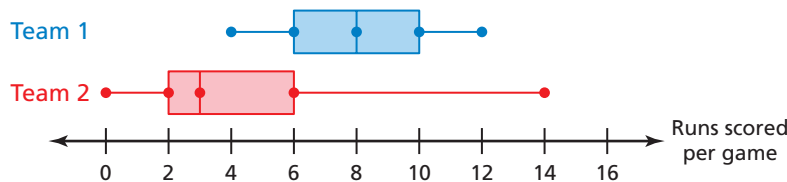


- Identify the shape of each distribution.
- Which school's start times for recess are more spread out? Explain.
- Which school is more likely to have recess before lunch? Explain.



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

18. Temperatures (in °C): 5, 1, 4, 0, 9, 0, -8, 5, 2, 4, -1, 10, 7, -5
19. Checking account balances (in dollars): 30, 0, -10, 50, 20, 90, -15, 40, 100, 45, -20, 70
20. **REASONING** The data set in Exercise 18 has an outlier. Describe how removing the outlier affects the box-and-whisker plot.
21. **CHOOSE TOOLS** What are the most appropriate measures to describe the center and the variation of the distribution in Exercise 12?
22. **OPEN-ENDED** Write a data set with 12 values that has a symmetric box-and-whisker plot.
23. **CRITICAL THINKING** When would a box-and-whisker plot *not* have one or both whiskers?
24. **STRUCTURE** Draw a histogram that could represent the distribution shown in Exercise 15.
25. **REASONING** The double box-and-whisker plot represents the runs scored per game by two softball teams during a 32-game season.



- a. Which team is more consistent at scoring runs? Explain.
 - b. In how many games did Team 2 score 6 runs or less?
 - c. Team 1 played Team 2 once during the season. Which team do you think won? Explain.
 - d. Which team do you think has the greater mean? Explain.
26. **Choose Tools** A market research company wants to summarize the variability of the SAT scores of graduating seniors in the United States. Do you think the company should use a stem-and-leaf plot, a histogram, or a box-and-whisker plot? Explain.



Fair Game Review what you learned in previous grades & lessons

Copy and complete the statement using $<$ or $>$. (Section 6.3)

27. $-\frac{2}{3}$ $-\frac{3}{4}$

28. $-2\frac{1}{5}$ $-2\frac{1}{6}$

29. -5.3 -5.5

30. **MULTIPLE CHOICE** Which of the following items is most likely represented by a rectangular prism with a volume of 1785 cubic inches? (Section 8.4)

- | | |
|--|--|
| <input type="radio"/> (A) closet | <input type="radio"/> (B) computer tower |
| <input type="radio"/> (C) filing cabinet | <input type="radio"/> (D) your math book |

