9.2 Lines of Fit

Essential Question How can you use data to predict an event?

1 ACTIVITY: Representing Data by a Linear Equation

Work with a partner. You have been working on a science project for 8 months. Each month, you measured the length of a baby alligator.

The table shows your measurements.

	September							April
Month, x	0	1	2	3	4	5	6	7
Length (in.), y	22.0	22.5	23.5	25.0	26.0	27.5	28.5	29.5

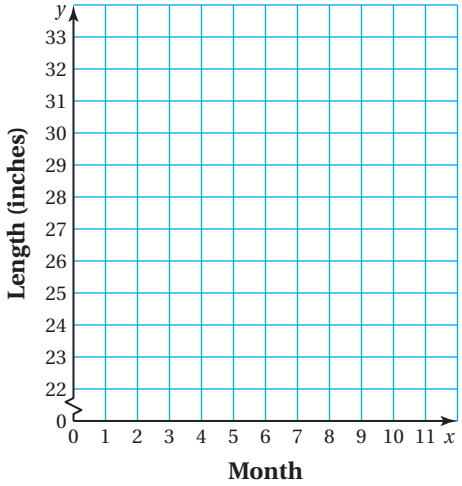
Use the following steps to predict the baby alligator's length next September.

a. Graph the data in the table.

b. Draw a line that you think best approximates the points.

c. Write an equation for your line.

d. **MODELING** Use the equation to predict the baby alligator's length next September.



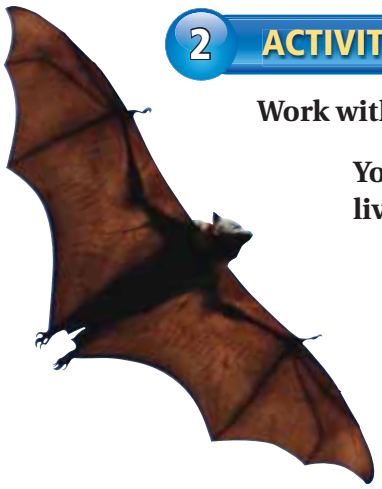
Common Core

Data Analysis

In this lesson, you will

- find lines of fit.
- use lines of fit to solve problems.

Learning Standards
8.SP.1
8.SP.2
8.SP.3



2 ACTIVITY: Representing Data by a Linear Equation

Work with a partner. You are a biologist and study bat populations.

You are asked to predict the number of bats that will be living in an abandoned mine after 3 years.

To start, you find the number of bats that have been living in the mine during the past 8 years.

The table shows the results of your research.

Math Practice 4

Use a Graph

How can you draw a line that "fits" the collection of points? How should the points be positioned around the line?

7 years ago → this year

Year, x	0	1	2	3	4	5	6	7
Bats (thousands), y	327	306	299	270	254	232	215	197

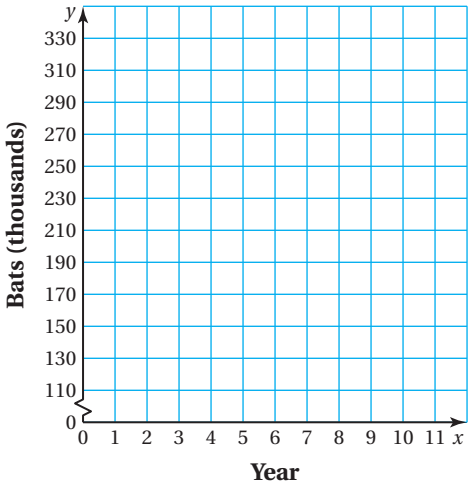
Use the following steps to predict the number of bats that will be living in the mine after 3 years.

a. Graph the data in the table.

b. Draw a line that you think best approximates the points.

c. Write an equation for your line.

d. **MODELING** Use the equation to predict the number of bats in 3 years.



What Is Your Answer?

3. **IN YOUR OWN WORDS** How can you use data to predict an event?

4. **MODELING** Use the Internet or some other reference to find data that appear to have a linear pattern. List the data in a table, and then graph the data. Use an equation that is based on the data to predict a future event.

Practice Use what you learned about lines of fit to complete Exercise 4 on page 382.

9.2 Lesson

Check It Out
Lesson Tutorials
BigIdeasMath.com

Key Vocabulary
line of fit, *p. 380*
line of best fit, *p. 381*

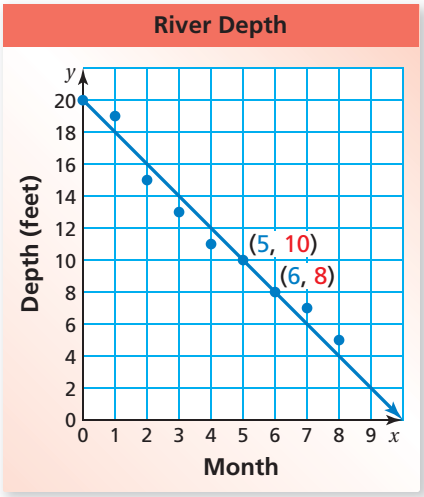
A **line of fit** is a line drawn on a scatter plot close to most of the data points. It can be used to estimate data on a graph.

EXAMPLE 1 Finding a Line of Fit

Month, x	Depth (feet), y
0	20
1	19
2	15
3	13
4	11
5	10
6	8
7	7
8	5

The table shows the depth of a river x months after a monsoon season ends. (a) Make a scatter plot of the data and draw a line of fit. (b) Write an equation of the line of fit. (c) Interpret the slope and the y-intercept of the line of fit. (d) Predict the depth in month 9.

a. Plot the points in a coordinate plane. The scatter plot shows a negative linear relationship. Draw a line that is close to the data points. Try to have as many points above the line as below it.



b. The line passes through (5, 10) and (6, 8).

$$\text{slope} = \frac{\text{rise}}{\text{run}} = \frac{-2}{1} = -2$$

Because the line crosses the y-axis at (0, 20), the y-intercept is 20.

∴ So, an equation of the line of fit is $y = -2x + 20$.

c. The slope is -2, and the y-intercept is 20. So, the depth of the river is 20 feet at the end of the monsoon season and decreases by about 2 feet per month.

Study Tip
A line of fit does not need to pass through any of the data points.

d. To predict the depth in month 9, substitute 9 for x in the equation of the line of fit.

$$y = -2x + 20 = -2(9) + 20 = 2$$

∴ The depth in month 9 should be about 2 feet.

On Your Own

Now You're Ready
Exercises 5 and 6

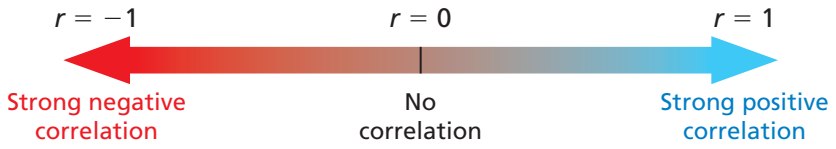
1. The table shows the numbers of people who have attended a festival over an 8-year period. (a) Make a scatter plot of the data and draw a line of fit. (b) Write an equation of the line of fit. (c) Interpret the slope and the y-intercept of the line of fit. (d) Predict the number of people who will attend the festival in year 10.

Year, x	1	2	3	4	5	6	7	8
Attendance, y	420	500	650	900	1100	1500	1750	2400

Study Tip

You know how to use two points to find an equation of a line of fit. When finding an equation of the line of best fit, every point in the data set is used.

Graphing calculators use a method called *linear regression* to find a precise line of fit called a **line of best fit**. This line best models a set of data. A calculator often gives a value r called the *correlation coefficient*. This value tells whether the correlation is positive or negative, and how closely the equation models the data. Values of r range from -1 to 1. When r is close to 1 or -1, there is a strong correlation between the variables. As r gets closer to 0, the correlation becomes weaker.

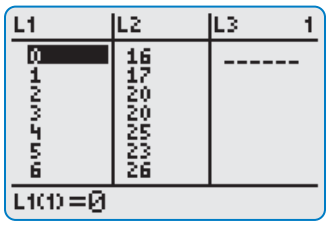


EXAMPLE 2 Finding a Line of Best Fit Using Technology

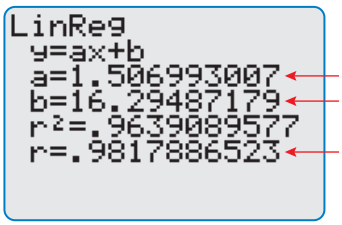
The table shows the worldwide movie ticket sales y (in billions of dollars) from 2000 to 2011, where $x = 0$ represents the year 2000. Use a graphing calculator to find an equation of the line of best fit. Identify and interpret the correlation coefficient.

Year, x	0	1	2	3	4	5	6	7	8	9	10	11
Ticket Sales, y	16	17	20	20	25	23	26	26	28	29	32	33

Step 1: Enter the data from the table into your calculator.



Step 2: Use the *linear regression* feature.

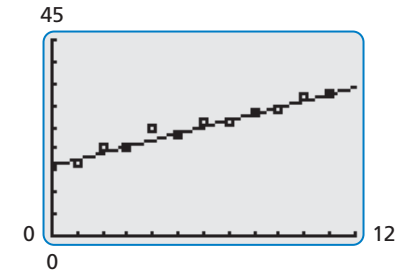


Study Tip

The slope of 1.5 indicates that sales are increasing by about \$1.5 billion each year. The y-intercept of 16 represents the ticket sales of \$16 billion for 2000.

∴ An equation of the line of best fit is $y = 1.5x + 16$. The correlation coefficient is about 0.982. This means that the relationship between years and ticket sales is a strong positive correlation and that the equation closely models the data.

Check Use a graphing calculator to make a scatter plot and graph the line of best fit.



On Your Own

Now You're Ready
Exercises 8–10

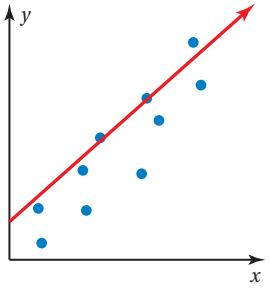
2. Use a graphing calculator to find an equation of the line of best fit for the data in Example 1. Identify and interpret the correlation coefficient.

9.2 Exercises

Check It Out
Help with Homework
BigIdeasMath.com

Vocabulary and Concept Check

1. **WRITING** Explain why a line of fit is helpful when analyzing data.
2. **REASONING** Tell whether the line drawn on the graph is a good fit for the data. Explain your reasoning.
3. **NUMBER SENSE** Which correlation coefficient indicates a stronger relationship: -0.98 or 0.91? Explain.



Practice and Problem Solving

4. **BLUEBERRIES** The table shows the weights y of x pints of blueberries.

Number of Pints, x	0	1	2	3	4	5
Weight (pounds), y	0	0.8	1.50	2.20	3.0	3.75

   a. Graph the data in the table.
   b. Draw a line that you think best approximates the points.
   c. Write an equation for your line.
   d. Use the equation to predict the weight of 10 pints of blueberries.
   e. Blueberries cost \$2.25 per pound. How much do 10 pints of blueberries cost?

1 5. **HOT CHOCOLATE** The table shows the daily high temperature (°F) and the number of hot chocolates sold at a coffee shop for eight randomly selected days.

Temperature (°F), x	30	36	44	51	60	68	75	82
Hot Chocolates, y	45	43	36	35	30	27	23	17

   a. Make a scatter plot of the data and draw a line of fit.
   b. Write an equation of the line of fit.
   c. Interpret the slope and the y-intercept of the line of fit.
   d. Predict the number of hot chocolates sold when the high temperature is 20°F.

6. **VACATION** The table shows the distance you are away from home over a 6-hour period of your vacation.

Hours, x	Distance (miles), y
1	62
2	123
3	188
4	228
5	280
6	344

   a. Make a scatter plot of the data and draw a line of fit.
   b. Write an equation of the line of fit.
   c. About how many miles per hour do you travel?
   d. About how far were you from home when you started?
   e. Predict the distance from home in 7 hours.

7. REASONING A data set has no relationship. Is it possible to find a line of fit for the data? Explain.

8. AMUSEMENT PARK The table shows the attendance y (in thousands) at an amusement park from 2004 to 2013, where $x = 4$ represents the year 2004. Use a graphing calculator to find an equation of the line of best fit. Identify and interpret the correlation coefficient.

Year, x	4	5	6	7	8	9	10	11	12	13
Attendance (thousands), y	850	845	828	798	800	792	785	781	775	760

9. SNOWSTORM The table shows the total snow depth y (in inches) on the ground during a snowstorm x hours after it began. Use a graphing calculator to find an equation of the line of best fit. Identify and interpret the correlation coefficient. Use your equation to estimate how much snow was on the ground before the snowstorm began.

Hours, x	1	2	3	4	5	6	7	8
Snow Depth (inches), y	5	6	6.75	7.75	8.5	9.5	10.5	11.5

10. TEXTING The table shows the numbers y (in billions) of text messages sent from 2006 to 2011, where $x = 6$ represents the year 2006.

Year, x	Text Messages (billions), y
6	113
7	241
8	601
9	1360
10	1806
11	2206

a. Use a graphing calculator to find an equation of the line of best fit. Identify and interpret the correlation coefficient.

b. Interpret the slope of the line of best fit. Does the y-intercept make sense for this problem? Explain.

c. Predict the number of text messages sent in 2015.

11. Modeling The table shows the height y (in feet) of a baseball x seconds after it was hit.

Seconds, x	Height (feet), y
0	3
0.5	39
1	67
1.5	87
2	99

a. Use a graphing calculator to find an equation of the line of best fit. Identify and interpret the correlation coefficient.

b. Predict the height after 5 seconds.

c. The actual height after 5 seconds is about 3 feet. Why do you think this is different from your prediction?

Fair Game Review *What you learned in previous grades & lessons*

Write the decimal as a fraction or a mixed number. *(Section 7.4)*

12. $0.\overline{2}$ **13.** $-2.\overline{7}$ **14.** $-1.4\overline{6}$ **15.** $0.\overline{81}$

16. MULTIPLE CHOICE Which expression represents the volume of a sphere with radius r? *(Section 8.3)*

(A) $\frac{1}{3}\pi r^2 h$ (B) $\pi r^2 h$ (C) $4\pi r^2$ (D) $\frac{4}{3}\pi r^3$