

CHAPTER 6: EXPLORING DATA RELATIONSHIPS

How should we look for relationships in our data? How much can we trust the relationships that we find?

Does the grade on Exam 1 predict the grade on Exam 2 in a math class?

Does the temperature influence the rate at which crickets chirp?

Does the weight on a spring change the amount the spring stretches?

A *response variable* measures an outcome or result of a study.

An *explanatory variable* is a variable that we think explains or causes changes in the response variable.

6.1 Displaying Relationships: Scatterplots

EXAMPLE

The data below is the average monthly temperature ($^{\circ}\text{F}$) and the average daily kWh of electricity used at a particular home each month.

Temp ($^{\circ}\text{F}$)	86	85	83	77	69	62	55	51	52	61	71	80
Electricity (kWh)	76	70	66	38	26	22	25	33	30	26	38	60

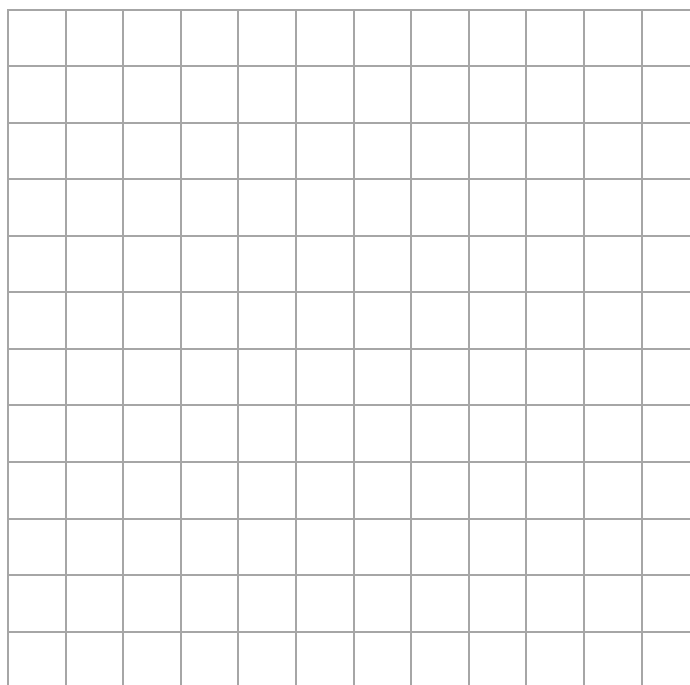
Which is the explanatory variable and which is the response variable?

A **scatterplot** is a graph of two values with explanatory variable on the horizontal axis and the response variable on the vertical axis.

EXAMPLE

The data below is the average monthly temperature ($^{\circ}\text{F}$) and the average daily kWh of electricity used at a particular home each month. Display this information in a scatterplot.

Temp ($^{\circ}\text{F}$)	86	85	83	77	69	62	55	51	52	61	71	80
Electricity (kWh)	76	70	66	38	26	22	25	33	30	26	38	60



Examining a Scatterplot

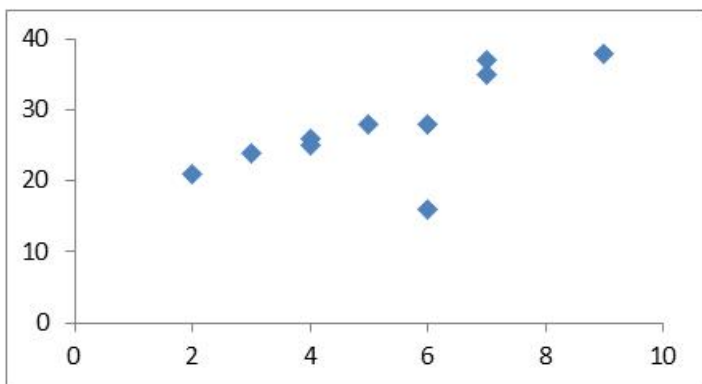
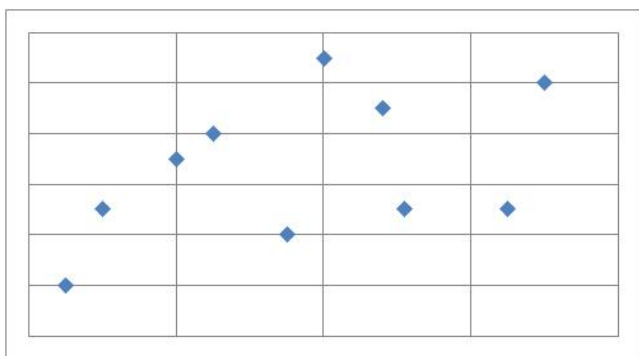
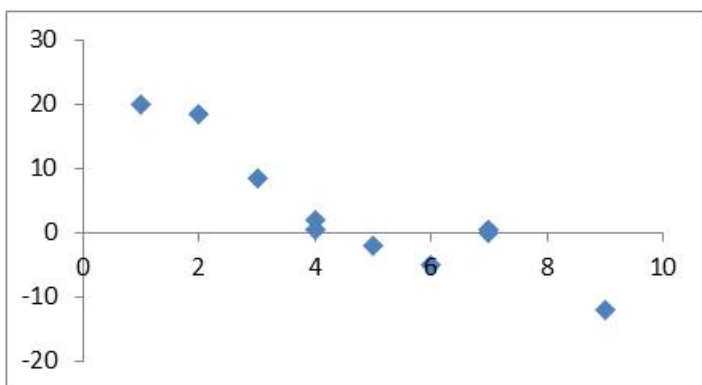
- Look at the overall pattern:
 - Is the form linear or not?
 - What is the general direction?
 - How strong is the relationship
- Look for outliers – do any data points fall outside of the general pattern?

Two variables are ***positively associated*** if an *increase* in one variable tends to accompany an *increase* in the other variable.

Two variables are ***negatively associated*** if an *increase* in one variable tends to accompany a *decrease* in the other variable.

EXAMPLE

Examine the scatterplots below and determine if there is a positive or negative association between the explanatory and response variables. Is it a linear relationship? Is it a strong relationship? Are there outliers?



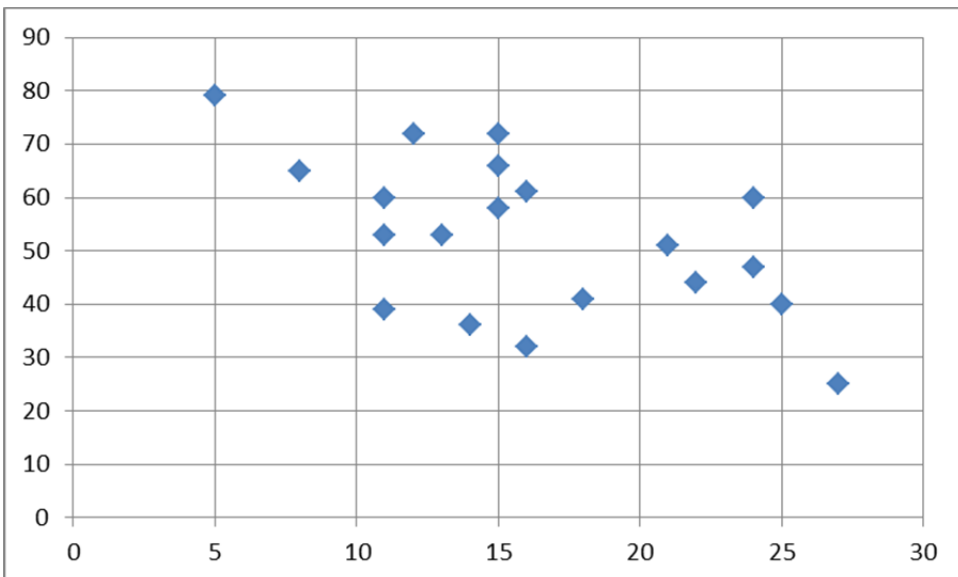
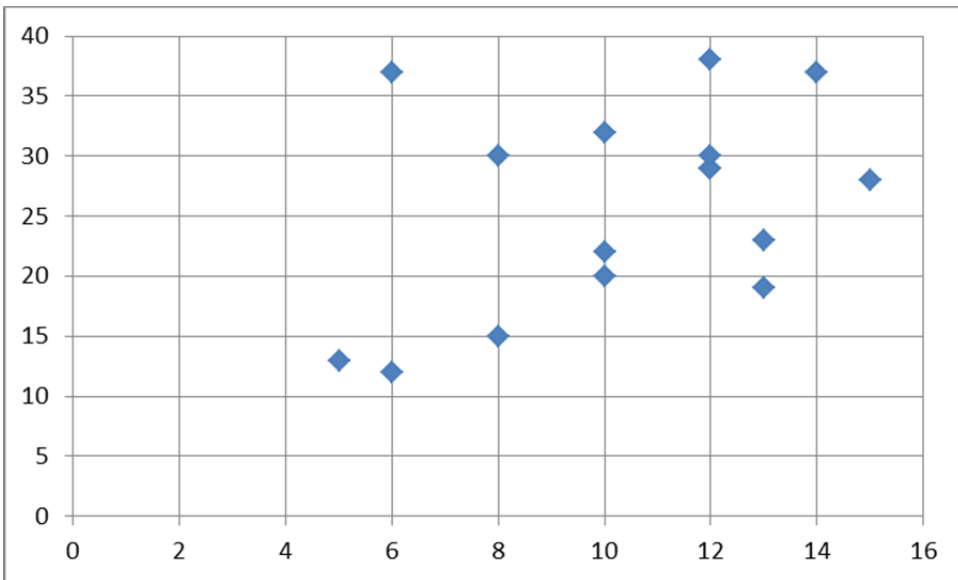
6.2 Making Predictions: Regression Lines

A *regression line* is a straight line that describes how the response variable changes as the explanatory variable changes.

The regression line is a line that is as close as possible to all the points.

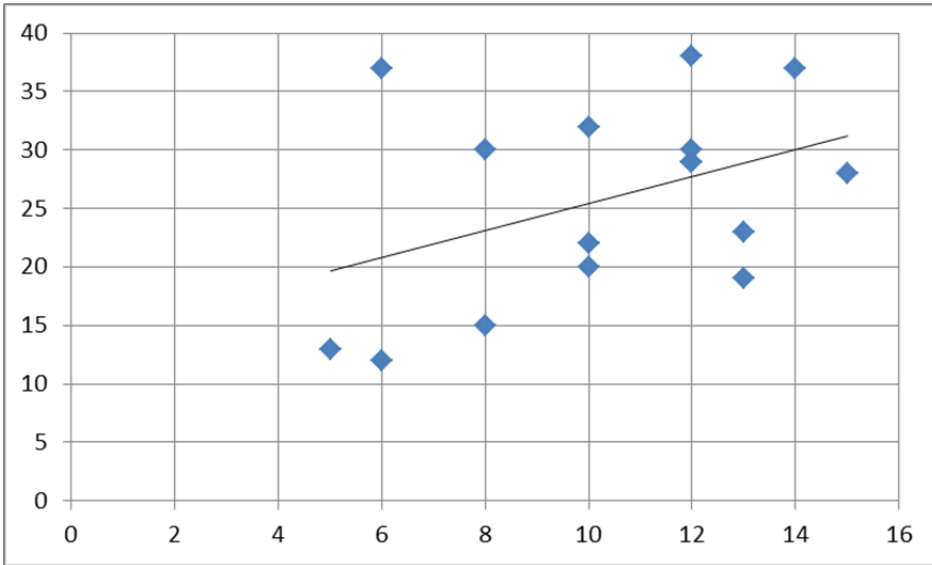
EXAMPLE

Draw the estimated regression line for the scatterplots in the previous example and the scatterplots below.

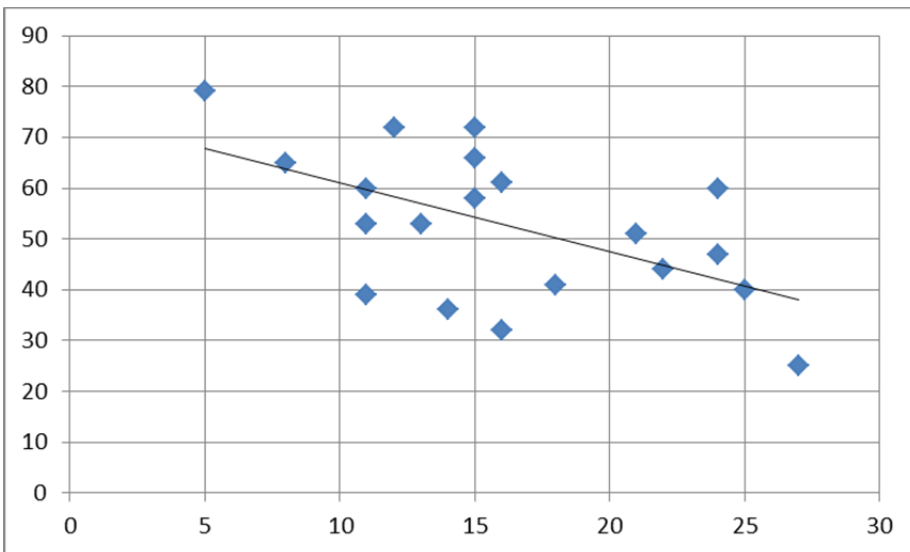


EXAMPLE

Use the given regression line to make predictions about the variables below.



- (a) If $x = 8$, what is y ?
- (b) If $y = 30$, what is x ?
- (c) If $x=2$, what is y ?



- (a) If $x = 15$, what is y ?
- (b) If $y = 50$, what is x ?
- (c) If $x = 30$, what is y ?

Interpolation is using the regression line to find values *between* the minimum and maximum data values.

Extrapolation is using the regression line to find values that are *outside* the minimum and maximum values.

6.3 Correlation

The *correlation* measures the direction and strength of the straight line relationship between two numerical variables.

The value of the correlation is a number r that is between -1 and 1, inclusive. That is $-1 \leq r \leq 1$.

For positive association, $r > 0$. For negative association, $r < 0$. For no association, $r = 0$.

The closer $|r|$ is to 1, the stronger the association.

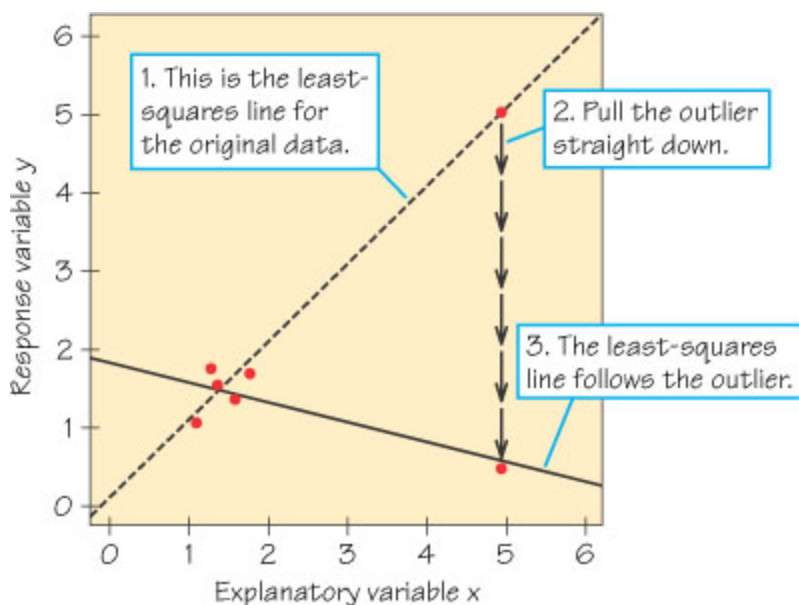
The r value for the Prius mileage is -0.989 and the r value for the spring distance is 0.998.

6.4 Least Squares Regression

Skip this section.

6.5 Interpreting Correlation and Regression

Outliers will have a very strong effect on both the regression line and the correlation!



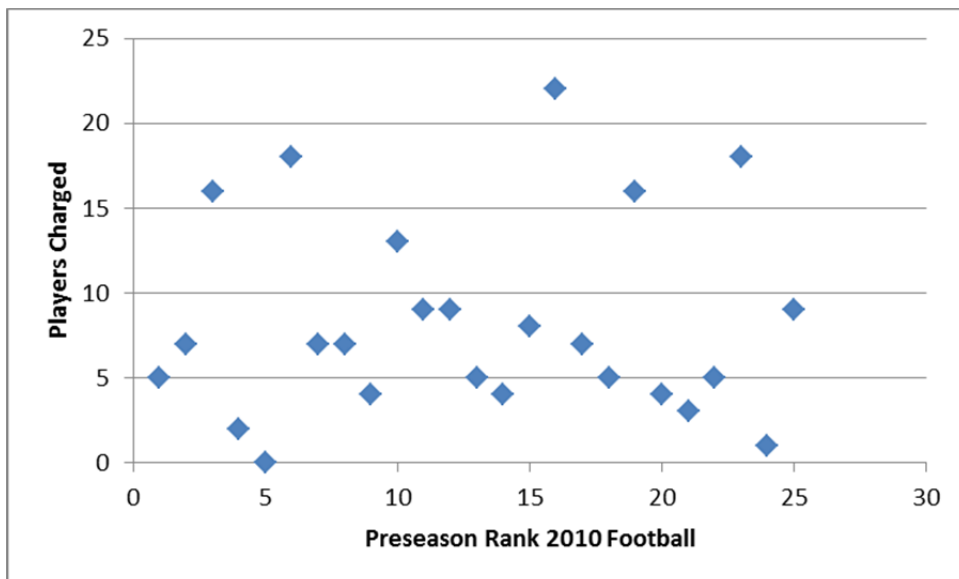
CORRELATION DOES NOT MEAN CAUSATION!

EXAMPLE

Before the introduction of the polio vaccine, investigators noticed a strong positive correlation between the amount of soda drinks and ice cream sold in a week and the incidence of polio. Does that mean that polio is caused by soda and ice cream?

EXAMPLE

http://sportsillustrated.cnn.com/2011/writers/the_bonus/02/27/cfb.crime



EXAMPLE

Eating breakfast helps students be successful.

http://amcbt.indstate.edu/volume_30/v30-4p15-19.pdf

EXAMPLE

Coffee is bad for you.

<http://www.mayoclinic.com/health/blood-pressure/AN00792>

Coffee is good for you

<http://www.webmd.com/food-recipes/features/coffee-new-health-food>