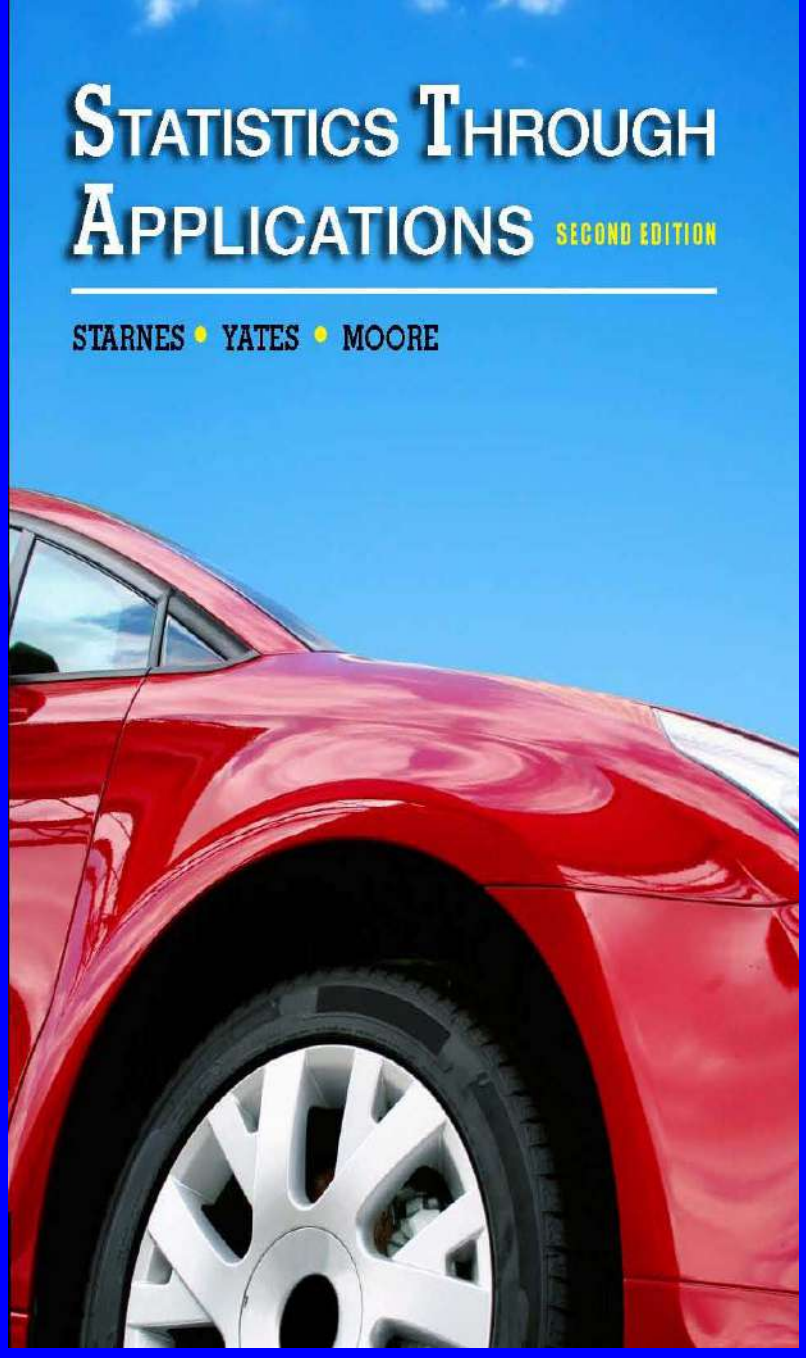


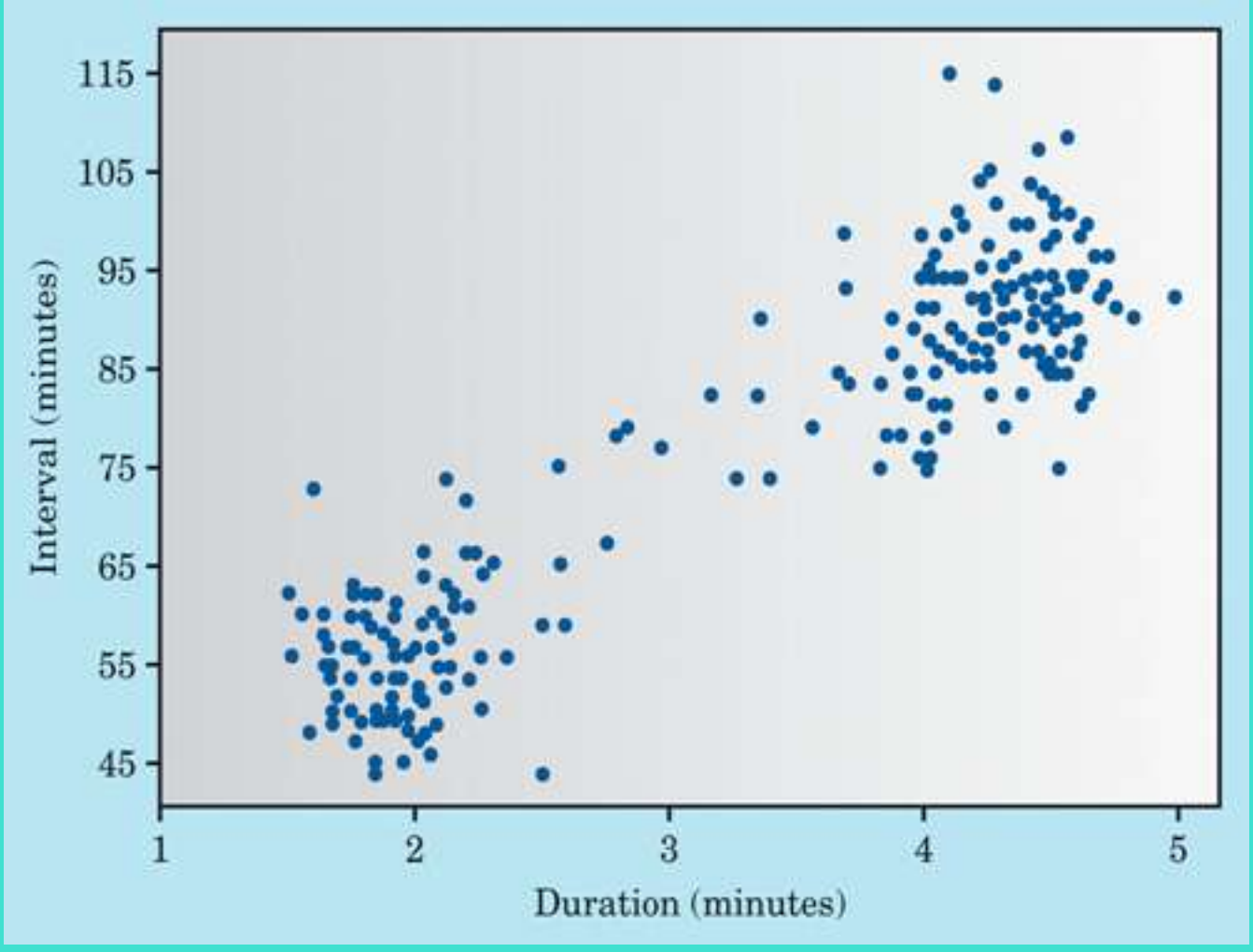
Chapter 4

Describing Relationships

Section 4.1
Scatterplots and Correlation

Scatterplot

Most common way to display relationship between 2 quantitative variables
One variable on the vertical axis
One variable on the horizontal axis
Individual is the point fixed by value of both variables



Shows how the interval between eruptions is related to the duration of the previous eruption.

"Duration" helps to explain "interval"

Figure 4.2

Scatterplot of the interval between eruptions of Old Faithful against the duration of the previous eruption.

Response variable
measures an outcome or result of a study

Explanatory variable
we think it explains or causes changes in the response variable

"Duration" is the explanatory variable
"Interval" is the response variable

The explanatory variable always is plotted on the horizontal axis!

Interpreting scatterplots...

- Look for the overall pattern and deviations
- Describe the overall pattern by the direction, form, and strength of the relationship
- Identify outliers

Direction

Positive association

The two variables increase together or decrease together

"Positive slope"

Negative association

As one variable increases, the other decreases.

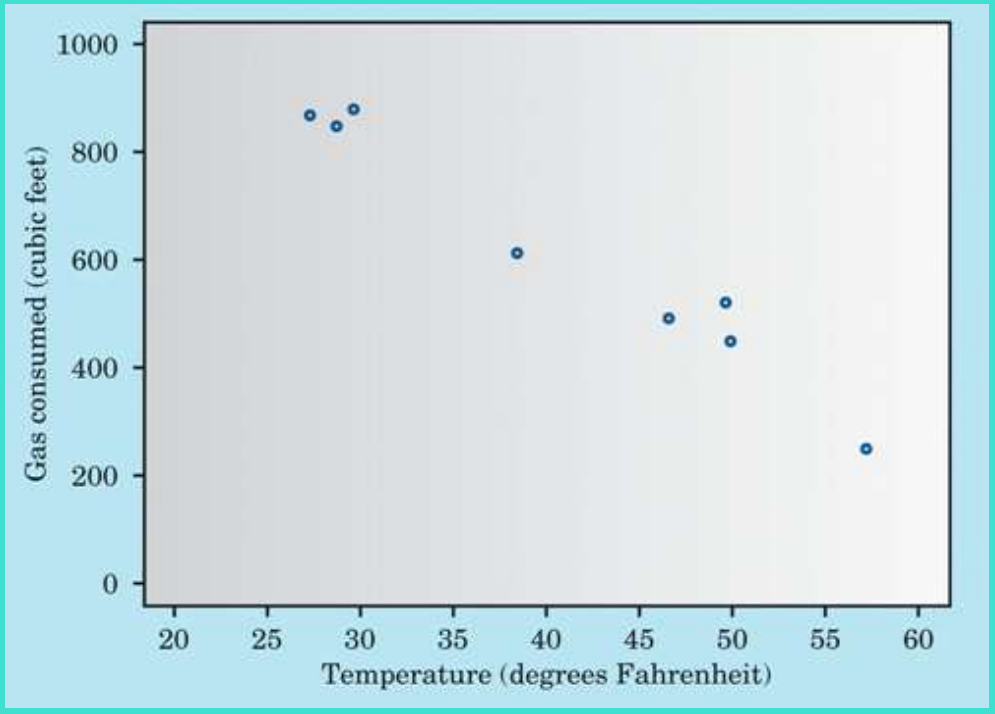
"Negative slope"

Form

Is the data clustered? linear? scattered?

Strength

Determined by how closely the points follow a form



What is the association (+/–) form strength?

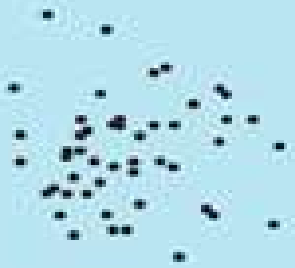
Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Temp (x)	49.4	38.2	27.2	28.6	29.5	46.4	49.7	57.1
Gas consumed (y)	520	610	870	850	880	490	450	250

Correlation

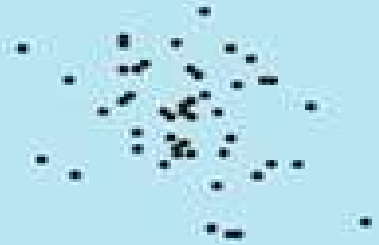
Describes the direction and strength of a straight-line relationship between two quantitative variables.

$$r = \frac{1}{n-1}\sum\left[\left(\frac{x-\bar{x}}{s_x}\right)\left(\frac{y-\bar{y}}{s_y}\right)\right]$$

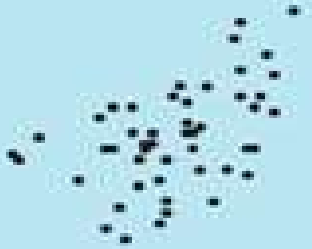
Positive r = positive association
Negative r = negative association
Always between -1 and +1
Correlation of 0 is weak, -1 and +1 is strong



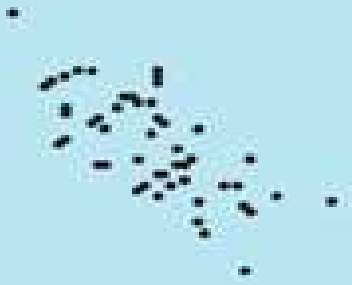
Correlation $r = 0$



Correlation $r = -0.3$



Correlation $r = 0.5$



Correlation $r = -0.7$

Correlation $r = 0.9$

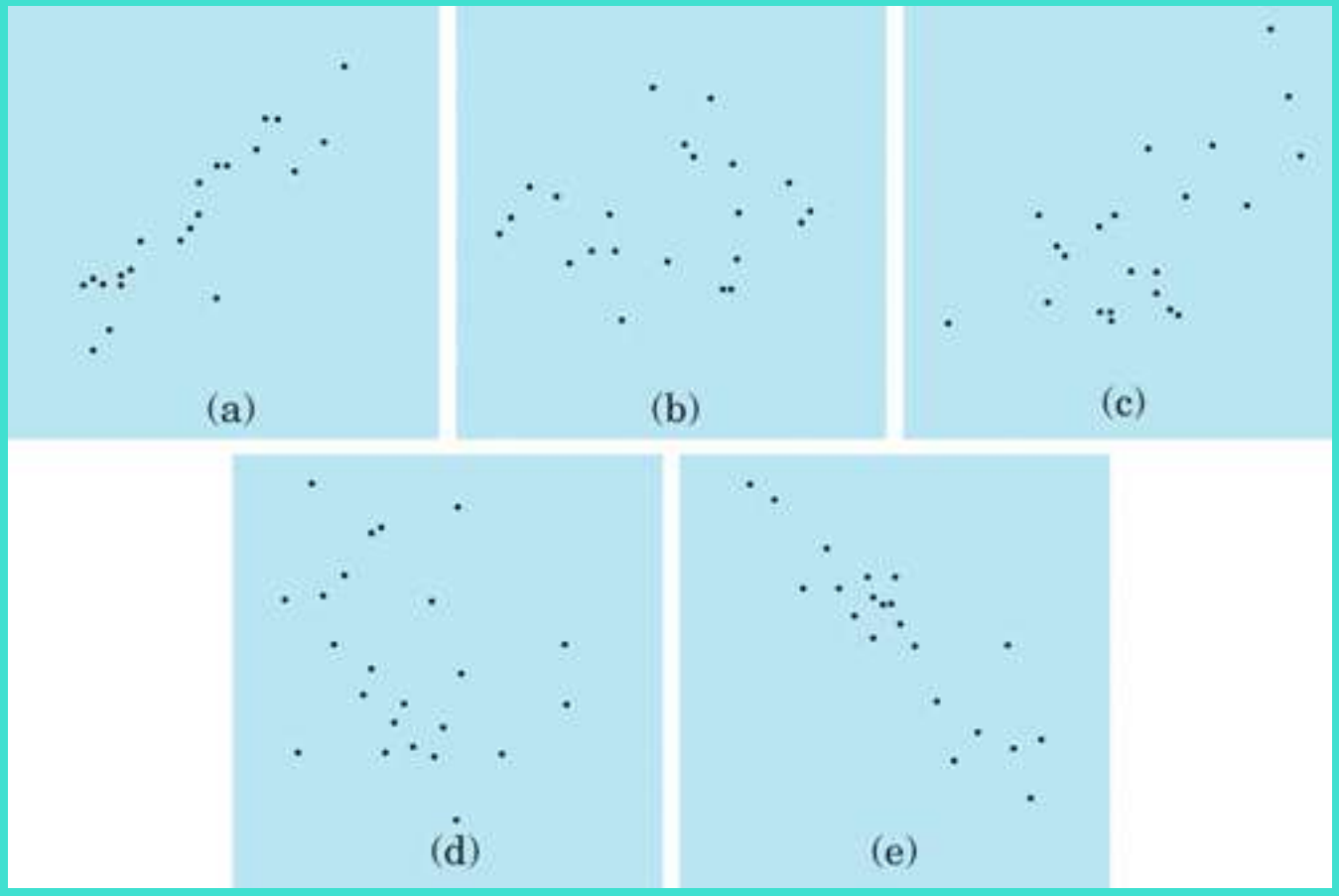
Correlation $r = -0.99$

Correlation

Does not change when units of measurement change
Ignores the distinction between explanatory and response variables (can interchange x and y)
Measures the strength of only straight-line association between 2 variables
Is strongly affected by a few outliers

"He says we've ruined his positive correlation between height and weight."

Match each correlation value with its scatterplot



r=-0.7

r=-0.9

r=-0.3

r= 0

r= 0.7

r= 0.9

Abraham Wald (1902-1950), like many statisticians, worked on war problems during WWII. Wald invented some statistical methods that were military secrets until the war ended. Here is one of his simpler ideas. Asked where extra armor should be added to airplanes, Wald studied the location of enemy bullet holes in planes returning from combat. He plotted the location on an outline of the plan. As data accumulated, most of the outline was filled up. Where should extra armor be placed?

Place the armor in the few spots with no bullet holes, said Wald. That's where bullets hit the planes that didn't make it back!