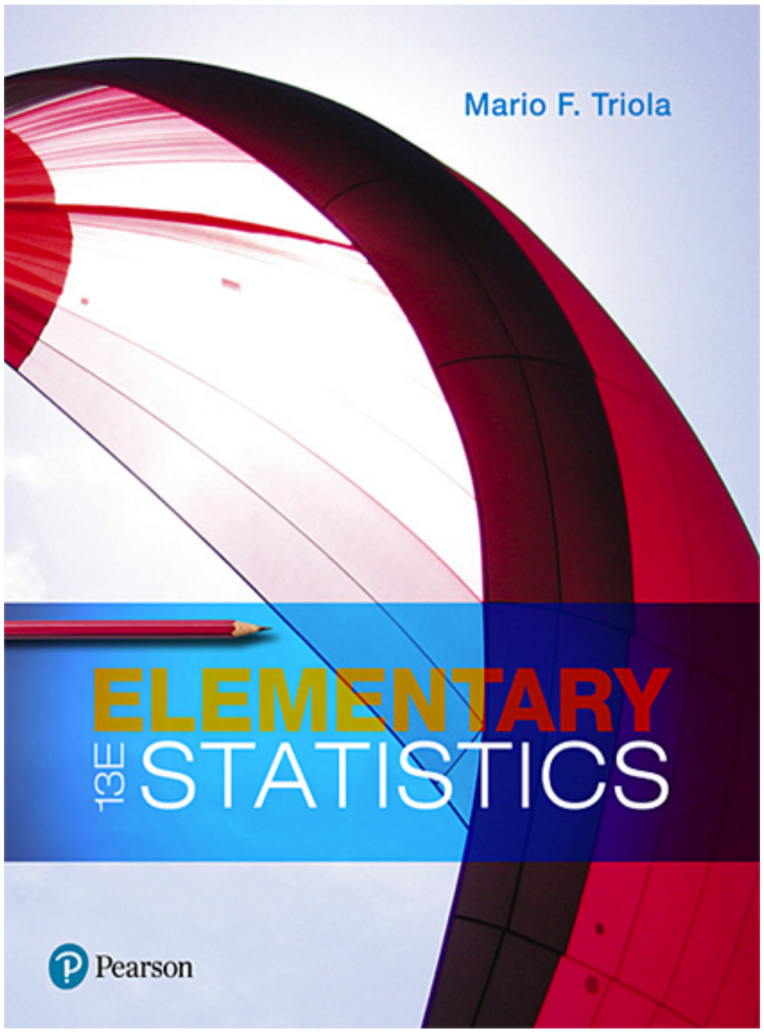
Elementary Statistics

Thirteenth Edition



Chapter 2

Exploring Data with Tables and Graphs

Exploring Data with Tables and Graphs

2-1 Frequency Distributions for Organizing and Summarizing Data

2-2 Histograms

2-3 Graphs that Enlighten and Graphs that Deceive

2-4 Scatterplots, Correlation, and Regression

Key Concept

Introduce the analysis of **paired** sample data.

Discuss **correlation** and the role of a graph called a **scatterplot,** and provide an introduction to the use of the **linear correlation coefficient.**

Provide a very brief discussion of **linear regression,** which involves the equation and graph of the straight line that best fits the sample paired data.

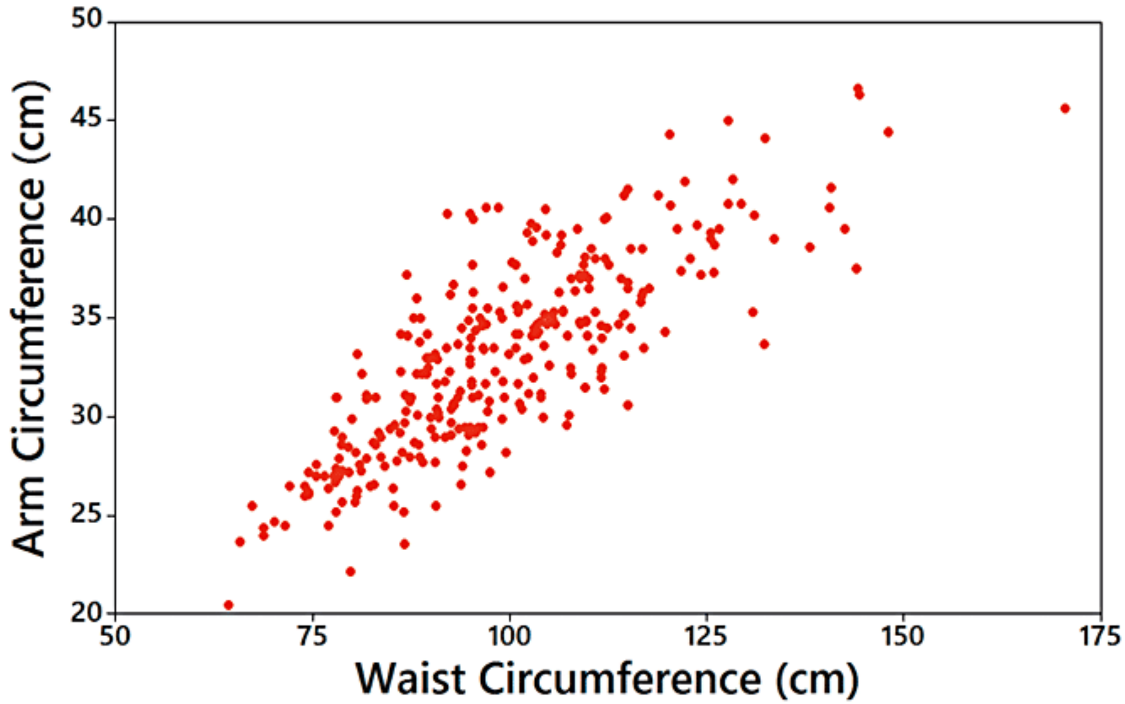
Scatterplot and Correlation (1 of 2)

- **Correlation**
  - A **correlation** exists between two variables when the values of one variable are somehow associated with the values of the other variable.
- **Linear Correlation**
  - A **linear correlation** exists between two variables when there is a correlation and the plotted points of paired data result in a pattern that can be approximated by a straight line.

Scatterplot and Correlation (2 of 2)

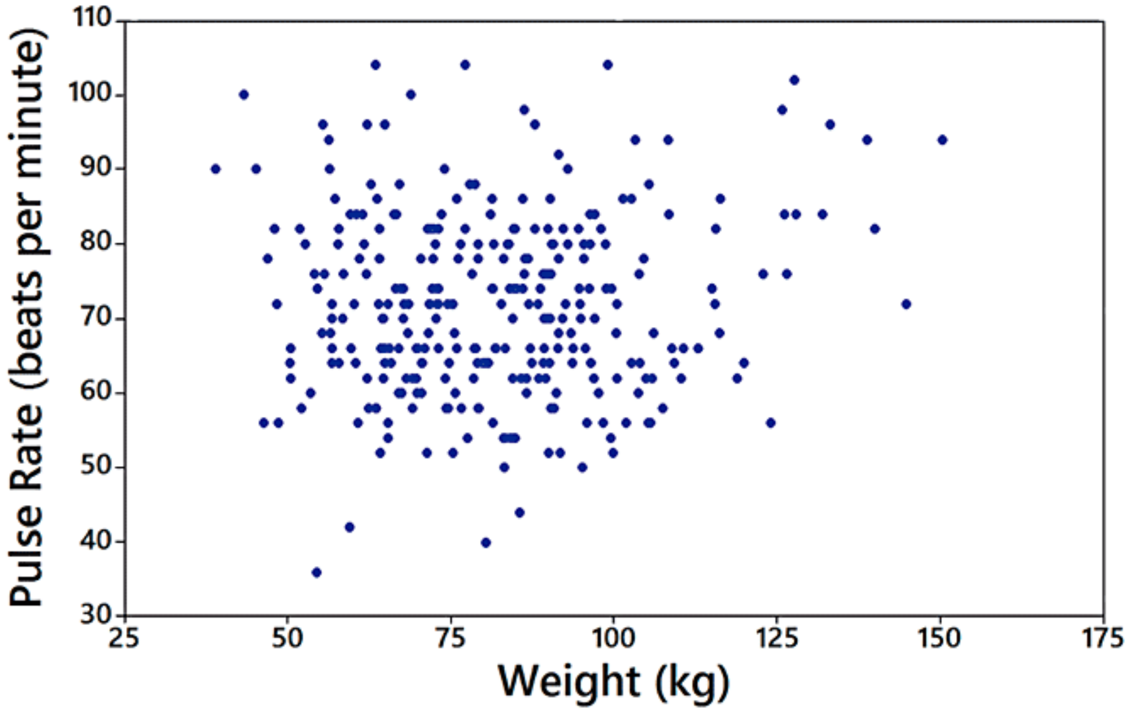
- **Scatterplot** (or **Scatter Diagram**)
  - A **scatterplot** (or **scatter diagram**) is a plot of paired (x, y) quantitative data with a horizontal x-axis and a vertical y-axis. The horizontal axis is used for the first variable (x), and the vertical axis is used for the second variable (y).

Example: Waist and Arm Correlation (1 of 2)



- **Correlation:** The distinct pattern of the plotted points suggests that there is a correlation between waist circumferences and arm circumferences.

Example: Waist and Arm Correlation (2 of 2)



- **No Correlation:** The plotted points do not show a distinct pattern, so it appears that there is no correlation between weights and pulse rates.

Linear Correlation Coefficient *r*

- **Linear Correlation Coefficient *r***
  - The **linear correlation coefficient** is denoted by r, and it measures the strength of the linear association between two variables.

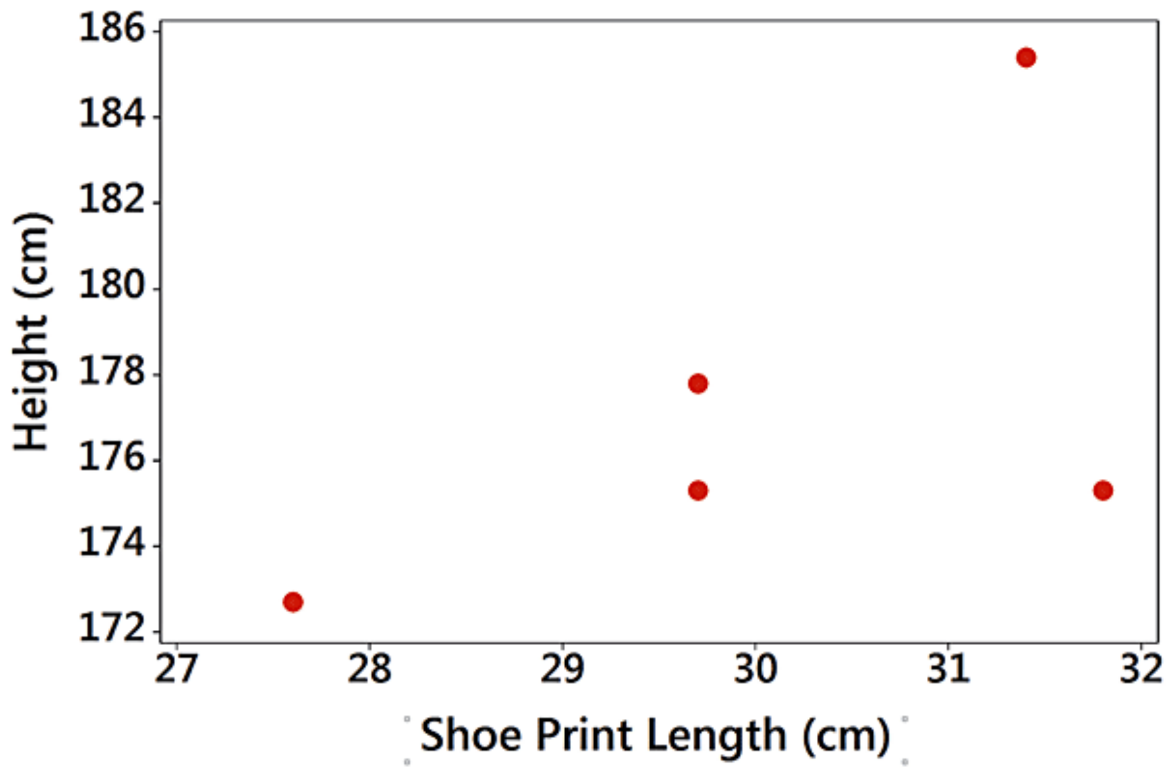
Using *r* for Determining Correlation

The computed value of the linear correlation coefficient, *r*, is always between −1 and 1.

- If *r* is close to −1 or close to 1, there appears to be a correlation.
- If *r* is close to 0, there does not appear to be a linear correlation.

Example: Correlation between Shoe Print Lengths and Heights? (1 of 2)

Shoe Print Length (cm)	29.7	29.7	31.4	31.8	27.6
Height (cm)	175.3	177.8	185.4	175.3	172.7



Example: Correlation between Shoe Print Lengths and Heights? (2 of 2)

It isn't very clear whether there is a linear correlation.

Statdisk

Sample size, n: 5
Degrees of freedom: 3

Correlation Results:
Correlation coeff, r: 0.5912691
Critical r: ±0.8783393
P-value (two-tailed): 0.29369

Regression Results:
Y= b0 + b1x:
Y Intercept, b0: 125.4073
Slope, b1: 1.727452

Total Variation: 95.02
Explained Variation: 33.21891
Unexplained Variation: 61.80109
Standard Error: 4.538762
Coeff of Det, R^2: 0.3495991

P-Value

- ***P*-Value**
  - If there really is no linear correlation between two variables, the ***P*-value** is the probability of getting paired sample data with a linear correlation coefficient r that is at least as extreme as the one obtained from the paired sample data.

Interpreting a *P*-Value from the Previous Example

The *P*-value of 0.294 is high. It shows there is a high chance of getting a linear correlation coefficient of $r = 0.591$ (or more extreme) by chance when there is no linear correlation between the two variables.

Statdisk

```
Sample size, n:  5
Degrees of freedom:  3

Correlation Results:
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Critical r:  ±0.8783393
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```

Interpreting a *P*-Value from the Example Where $n = 5$

Because the likelihood of getting $r = 0.591$ or a more extreme value is so high (29.4% chance), we conclude there is not sufficient evidence to conclude there is a linear correlation between shoe print lengths and heights.

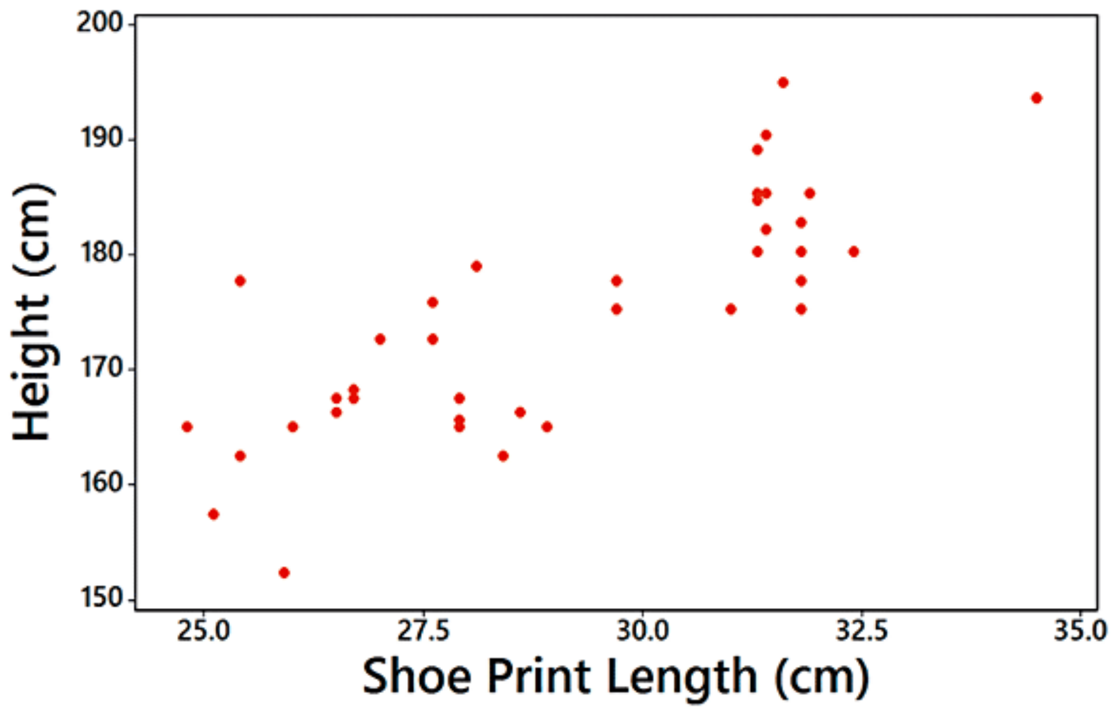
Interpreting a *P*-Value

Only a **small** *P*-value, such as 0.05 or less (or a 5% chance or less), suggests that the sample results are **not** likely to occur by chance when there is no linear correlation, so a small *P*-value supports a conclusion that there is a linear correlation between the two variables.

Example: Correlation between Shoe Print Lengths and Heights (n = 40)

Minitab

```
Pearson correlation of Shoe Print Length and Height = 0.813
P-Value = 0.000
```



Example: Correlation between Shoe Print Lengths and Heights

Minitab

```
Pearson correlation of Shoe Print Length and Height = 0.813
P-Value = 0.000
```

The scatterplot shows a distinct pattern. The value of the linear correlation coefficient is $r = 0.813$, and the P-value is 0.000. Because the P-value of 0.000 is **small**, we have sufficient evidence to conclude there is a linear correlation between shoe print lengths and heights.

Regression

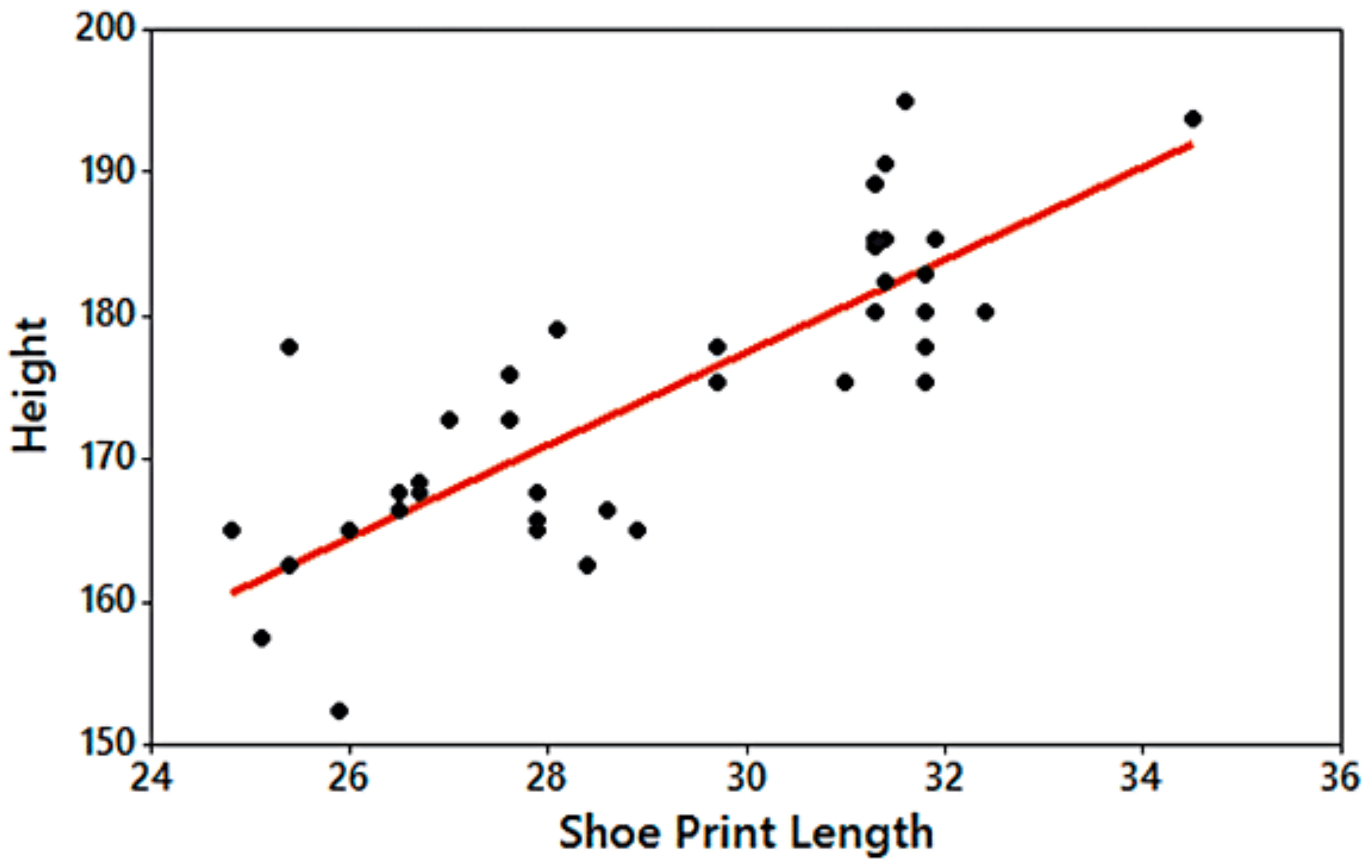
- **Regression**
  - Given a collection of paired sample data, the **regression line** (or **line of best fit,** or **least-squares line**) is the straight line that "best" fits the scatterplot of the data.

The **regression equation**

$$\hat{y} = b_0 + b_1 x$$

algebraically describes the regression line.

Example: Regression Line (1 of 2)



Pearson

Example: Regression Line (2 of 2)

Statdisk

Correlation Results:
Correlation coeff, r: 0.812948
Critical r: ±0.3120061
P-value (two-tailed): 0.000

Regression Results:
Y= b0 + b1x:
Y Intercept, b0: 80.93041
Slope, b1: 3.218561

The general form of the regression equation has a y-intercept of $b_0 = 80.9$ and slope $b_1 = 3.22$.

The equation of the regression line is $\hat{y} = 80.9 + 3.22x$.

Using variable names, the equation is:

Height = 80.9 + 3.22 (Shoe Print Length)