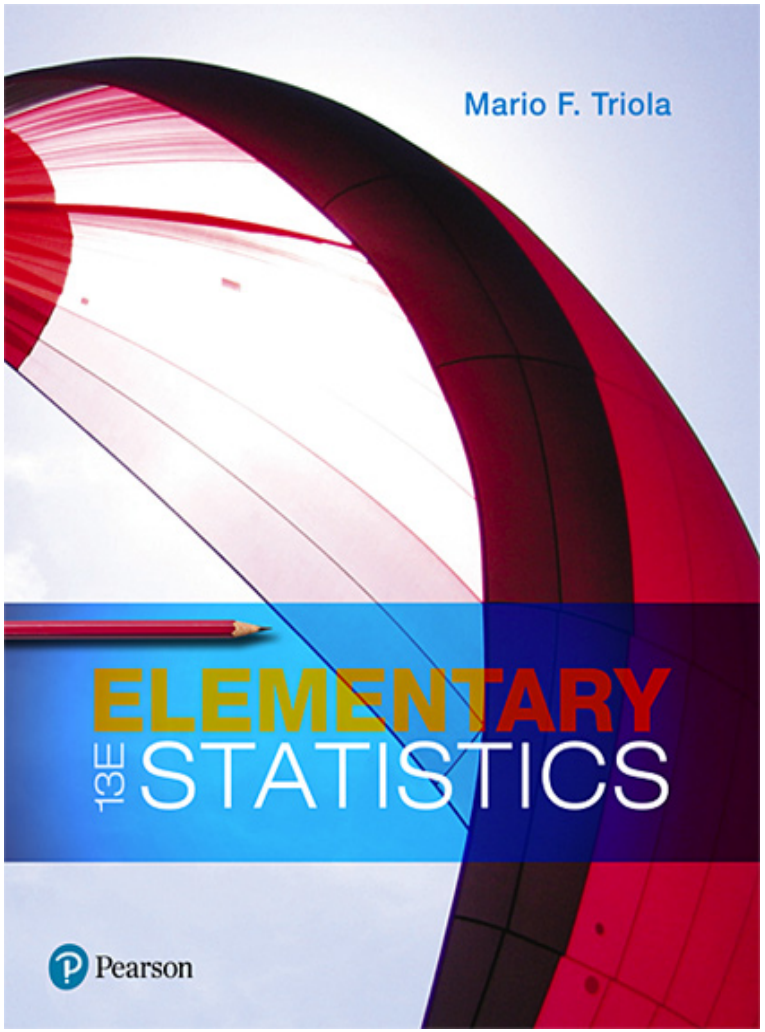
Elementary Statistics

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

When working with large data sets, a **frequency distribution** (or **frequency table**) is often helpful in organizing and summarizing data. A frequency distribution helps us to understand the nature of the **distribution** of a data set.

Frequency Distribution

- Frequency Distribution (or Frequency Table)
  - Shows how data are partitioned among several categories (or **classes**) by listing the categories along with the number (frequency) of data values in each of them.

Definitions (1 of 2)

- Lower class limits
  - The smallest numbers that can belong to each of the different classes
- Upper class limits
  - The largest numbers that can belong to each of the different classes
- Class boundaries
  - The numbers used to separate the classes, but without the gaps created by class limits

Definitions (2 of 2)

- Class midpoints
  - The values in the middle of the classes Each class midpoint can be found by adding the lower class limit to the upper class limit and dividing the sum by 2.
- Class width
  - The difference between two consecutive lower class limits in a frequency distribution

Procedure for Constructing a Frequency Distribution (1 of 2)

1. Select the number of classes, usually between 5 and 20.
2. Calculate the class width.

$$\text{Class width} \approx \frac{(\text{maximum data value}) - (\text{minimum data value})}{\text{number of classes}}$$

Round this result to get a convenient number. (It's usually best to round **up**.)

Procedure for Constructing a Frequency Distribution (2 of 2)

3. Choose the value for the first lower class limit by using either the minimum value or a convenient value below the minimum.

4. Using the first lower class limit and class width, list the other lower class limits.

5. List the lower class limits in a vertical column and then determine and enter the upper class limits.

6. Take each individual data value and put a tally mark in the appropriate class. Add the tally marks to get the frequency.

Example: McDonald's Lunch Service Times (1 of 5)

Using the McDonald's lunch service times in the first table, follow the procedure shown on the next slide to construct the frequency distribution shown in the second table. Use five classes.

Drive-through Service Times (seconds) for McDonald's Lunches

107	139	197	209	281	254	163	150	127	308	206	187	169	83	127	133	140
143	130	144	91	113	153	255	252	200	117	167	148	184	123	153	155	154
100	117	101	138	186	196	146	90	144	119	135	151	197	171	190	169	

McDonald's Lunch Drive-Through Service Times

Time (Seconds)	Frequency
75-124	11
125-174	24
175-224	10
225-274	3
275-324	2

Example: McDonald's Lunch Service Times (2 of 5)

Step 1: Select 5 as the number of desired classes.

Step 2: Calculate the class width as shown below. Note that we round 45 up to 50,which is a more convenient number.

$$\text{Class width} \approx \frac{(\text{maximum data value}) - (\text{minimum data value})}{\text{number of classes}}$$

$$= \frac{308 - 83}{5} = 45 \approx 50 \quad \text{(rounded up to a more convenient number)}$$

Example: McDonald's Lunch Service Times (3 of 5)

Step 3: The minimum data value is 83, which is not a very convenient starting point, so go to a value below 83 and select the more convenient value of 75 as the first lower class limit.

Step 4: Add the class width of 50 to the starting value of 75 to get the second lower class limit of 125. Continue to add the class width of 50 until we have five lower class limits. The lower class limits are therefore 75, 125, 175, 225, and 275.

Example: McDonald's Lunch Service Times (4 of 5)

Step 5: List the lower class limits vertically, as shown below. From this list, we identify the corresponding upper class limits as 124, 174, 224, 274, and 324.

75-
125-
175-
225-
275-

Example: McDonald's Lunch Service Times (5 of 5)

Step 6: Enter a tally mark for each data value in the appropriate class. Then add the tally marks to find the frequencies shown in the table.

Time (Seconds)	Frequency
75-124	11
125-174	24
175-224	10
225-274	3
275-324	2

Relative Frequency Distribution (1 of 2)

- Relative Frequency Distribution or Percentage Frequency Distribution
  - Each class frequency is replaced by a relative frequency (or proportion) or a percentage.

$$\text{Relative frequency for a class} = \frac{\text{frequency for a class}}{\text{sum of all frequencies}}$$

$$\text{Percentage for a class} = \frac{\text{frequency for a class}}{\text{sum of all frequencies}} \times 100\%$$

Relative Frequency Distribution (2 of 2)

- Relative Frequency Distribution or Percentage Frequency Distribution
  - Each class frequency is replaced by a relative frequency (or proportion) or a percentage.

The sum of the percentages in a relative frequency distribution must be very close to 100% (with a little wiggle room for rounding errors).

Cumulative Frequency Distribution

- Cumulative Frequency Distribution
  - The frequency for each class is the sum of the frequencies for that class and all previous classes.

Cumulative Frequency Distribution of McDonald's Lunch Service Times

Time (Seconds)	Cumulative Frequency
Less than 125	11
Less than 175	35
Less than 225	45
Less than 275	48
Less than 325	50

Critical Thinking: Using Frequency Distributions to Understand Data

In statistics we are often interested in determining whether the data have a **normal distribution**.

1. The frequencies start low, then increase to one or two high frequencies, and then decrease to a low frequency.
2. The distribution is approximately symmetric. Frequencies preceding the maximum frequency should be roughly a mirror image of those that follow the maximum frequency.

Gaps

- The presence of gaps can show that the data are from two or more different populations.
- However, the converse is not true, because data from different populations do not necessarily result in gaps.

Example: Exploring Data: What Does a Gap Tell Us? (1 of 2)

The table shown is a frequency distribution of the weights (grams) of randomly selected pennies.

Weight (grams) of Penny	Frequency
2.40-2.49	18
2.50-2.59	19
2.60-2.69	0
2.70-2.79	0
2.80-2.89	0
2.90-2.99	2
3.00-3.09	25
3.10-3.19	8

Example: Exploring Data: What Does a Gap Tell Us? (2 of 2)

- Examination of the frequencies reveals a large **gap** between the lightest pennies and the heaviest pennies.
- This suggests that we have two different populations:
  - Pennies made before 1983 are 95% copper and 5% zinc.
  - Pennies made after 1983 are 2.5% copper and 97.5% zinc.

Comparisons

Combining two or more relative frequency distributions in one table makes comparisons of data much easier.

Example: Comparing McDonald's and Dunkin' Donuts (1 of 2)

The table shows the relative frequency distributions for the drive-through lunch service times (seconds) for McDonald's and Dunkin' Donuts.

Time (seconds)	McDonald's	Dunkin' Donuts
25-74		22%
75-124	22%	44%
125-174	48%	28%
175-224	20%	6%
225-274	6%	
275-324	4%	

Example: Comparing McDonald's and Dunkin' Donuts (2 of 2)

Time (seconds)	McDonald's	Dunkin' Donuts
25-74		22%
75-124	22%	44%
125-174	48%	28%
175-224	20%	6%
225-274	6%	
275-324	4%	

- Because of the dramatic differences in their menus, we might expect the service times to be very different.
- By comparing the relative frequencies, we see that there are major differences. The Dunkin' Donuts service times appear to be lower than those at McDonald's.