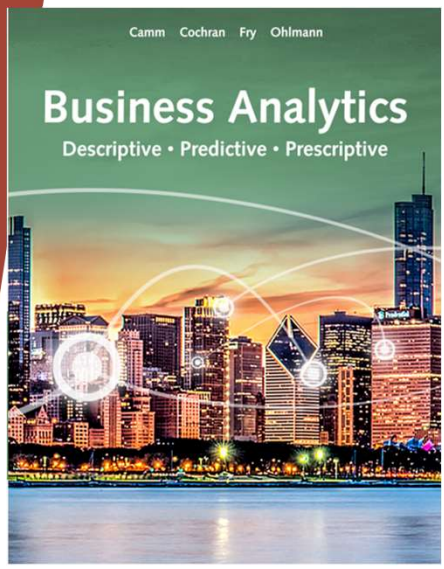

Business Analytics

Chapter 2 – Descriptive Statistics

HAMLINE UNIVERSITY
SCHOOL OF BUSINESS

Overview of Using Data: Definitions and Goals

- **Data:**

  The facts and figures collected, analyzed, and summarized for presentation and interpretation.

Company	Symbol	Industry	Share Price ($)	Volume
Apple	AAPL	Technology	195.57	21,060,685
American Express	AXP	Financial	123.16	2,387,770
Boeing	BA	Manufacturing	369.32	3,002,708
Caterpillar	CAT	Manufacturing	133.71	3,747,782
Cisco Systems	CSCO	Technology	56.08	25,533,426
Chevron Corporation	CVX	Chemical, Oil, and Gas	123.64	4,705,879
Disney	DIS	Entertainment	139.94	14,670,995
Dow, Inc.	DOW	Chemical, Oil, and Gas	49.69	4,002,257
Goldman Sachs	GS	Financial	196.06	1,828,219
The Home Depot	HD	Retail	204.74	3,583,573
IBM	IBM	Technology	138.36	2,797,803
Intel	INTC	Technology	46.85	16,658,127
Johnson & Johnson	JNJ	Pharmaceuticals	144.24	7,516,973

Overview of Using Data: Definitions and Goals

- **Variable:**

A characteristic or a quantity of interest that can take on different values.

- **Observation:**

A set of values corresponding to a set of variables.

Company	Symbol	Industry	Share Price ($)	Volume
Apple	AAPL	Technology	195.57	21,060,685
American Express	AXP	Financial	123.16	2,387,770
Boeing	BA	Manufacturing	369.32	3,002,708
Caterpillar	CAT	Manufacturing	133.71	3,747,782
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IBM	IBM	Technology	138.36	2,797,803
Intel	INTC	Technology	46.85	16,658,127
Johnson & Johnson	JNJ	Pharmaceuticals	144.24	7,516,973

Overview of Using Data: Definitions and Goals

- **Variation:**

The difference in a variable measured over observations.

- **Random variable/uncertain variable:**

A quantity whose values are not known with certainty.

Company	Symbol	Industry	Share Price ($)
Apple	AAPL	Technology	195.57
American Express	AXP	Financial	123.16
Boeing	BA	Manufacturing	369.32
Caterpillar	CAT	Manufacturing	133.71
Cisco Systems	CSCO	Technology	56.08
Chevron Corporation	CVX	Chemical, Oil, and Gas	123.64
Disney	DIS	Entertainment	139.94
Dow, Inc.	DOW	Chemical, Oil, and Gas	49.69
Goldman Sachs	GS	Financial	196.06
The Home Depot	HD	Retail	204.74
IBM	IBM	Technology	138.36
Intel	INTC	Technology	46.85
Johnson & Johnson	JNJ	Pharmaceuticals	144.24

72.41
-246.16
235.61

Types of Data – Population and Sample Data

- **Population:**

  All elements of interest.

- **Sample:**

  Subset of the population.

Are students in a classroom a population or sample?

Types of Data

- **Random sampling:**

  A sampling method to gather a representative sample of the population data.

- Is it truly a random sample?
- Does it really represent the population?
  - Where is your data coming from?
  - Who was polled?
  - How many people were polled?

Types of Data (Slide 1 of 5)

- **Quantitative data:**

  Data on which numeric and arithmetic operations, such as addition, subtraction, multiplication, and division, can be performed.

- **Categorical data:**

  Data on which arithmetic operations cannot be performed.

C Q Q

Company	Symbol	Industry	Share Price ($)	Volume
Apple	AAPL	Technology	195.57	21,060,685
American Express	AXP	Financial	123.16	2,387,770
Boeing	BA	Manufacturing	369.32	3,002,708
Caterpillar	CAT	Manufacturing	133.71	3,747,782
Cisco Systems	CSCO	Technology	56.08	25,533,426
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IBM	IBM	Technology	138.36	2,797,803
Intel	INTC	Technology	46.85	16,658,127
Johnson & Johnson	JNJ	Pharmaceuticals	144.24	7,516,973

Types of Data

- **Cross-sectional data:**

  Data collected from several entities at the same, or approximately the same point in time.

- **Time series data:**

  Data collected over several time periods.

Company	Symbol	Industry	Share Price ($)	Volume
Apple	AAPL	Technology	195.57	21,060,685
American Express	AXP	Financial	123.16	2,387,770
Boeing	BA	Manufacturing	369.32	3,002,708
Caterpillar	CAT	Manufacturing	133.71	3,747,782
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Goldman Sachs	GS	Financial	196.06	1,828,219
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IBM	IBM	Technology	138.36	2,797,803
Intel	INTC	Technology	46.85	16,658,127
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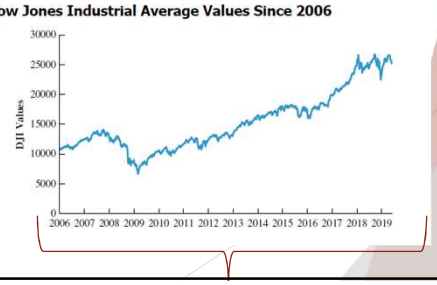


Other Examples

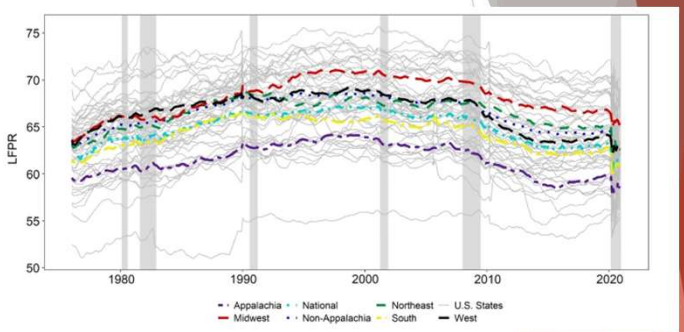
C.S.

NYC Population by Borough

Borough	2010
Bronx	1,388,314
Brooklyn	2,510,073
Manhattan	1,588,494
Queens	2,235,370
Staten Island	469,602
Total	8,191,853

Source: U.S. Census Bureau
Table 1: Cross Sectional Data

T.S.



C.S. + T.S.

New York City Population by Borough

Borough	2010	2011	2012	2013	2014
Bronx	1,388,314	1,399,815	1,414,225	1,427,317	1,438,159
Brooklyn	2,510,073	2,544,903	2574864	2,602,373	2,621,793
Manhattan	1,588,494	1,610,027	1,625,198	1,632,005	1,636,268
Queens	2,235,370	2,261,430	2,280,639	2,303,993	2,321,580
Staten Island	469,602	471,063	470,977	472,691	473,279
Total	8,191,853	8,287,238	8,365,903	8,438,379	8,491,079

Source: U.S. Census Bureau
Table 3: Cross Sectional and Longitudinal Data

T.S.

Types of Data – Data Sources

- Experimental study:
  - A variable of interest is first identified.
  - Then one or more other variables are identified and controlled or manipulated
  - so that data can be obtained about how they influence the variable of interest.

- Example: Drug Study
  - Variables: Blood Pressure, Dosage
  - Random Sample
  - Controls: Placebo, dosage
  - Data collected before and after
  - Statistical Analysis

Types of Data – Data Sources

- Nonexperimental study or observational study:
  - Makes no attempt to control the variables of interest.
  - A survey is perhaps the most common type of observational study.

Customer Opinion Questionnaire Used by Chops City Grill Restaurant

Chop's
CITY GRILL

Date: _____ Server Name: _____

Our customers are our top priority. Please take a moment to fill out our survey card, so we can better serve your needs. You may return this card to the front desk or return by mail. Thank you!

SERVICE SURVEY	Excellent	Good	Average	Fair	Poor
Overall Experience	❑	❑	❑	❑	❑
Greeting by Hostess	❑	❑	❑	❑	❑
Manager (Table Visit)	❑	❑	❑	❑	❑
Overall Service	❑	❑	❑	❑	❑
Professionalism	❑	❑	❑	❑	❑
Menu Knowledge	❑	❑	❑	❑	❑
Friendliness	❑	❑	❑	❑	❑
Wine Selection	❑	❑	❑	❑	❑
Menu Selection	❑	❑	❑	❑	❑
Food Quality	❑	❑	❑	❑	❑
Food Presentation	❑	❑	❑	❑	❑
Value for $ Spent	❑	❑	❑	❑	❑

What comments could you give us to improve our restaurant?

Thank you, we appreciate your comments. —The staff of Chops City Grill.

Modifying Data in Excel

Sorting and Filtering Data in Excel

Conditional Formatting of Data in Excel

Modifying Data in Excel

Table 2.2: 20 Top-Selling Automobiles in United States in February 2019

Rank (by February 2019 Sales)	Manufacturer	Model	Sales (February 2019)	Sales (February 2018)
1	Toyota	Corolla	29,016	25,021
2	Toyota	Camry	24,267	30,865
3	Honda	Civic	22,979	25,816
4	Honda	Accord	20,254	19,753
5	Nissan	Sentra	17,072	17,148
6	Nissan	Altima	16,216	19,703
7	Ford	Fusion	13,163	16,721
8	Chevrolet	Malibu	10,799	11,890

Modifying Data in Excel

Table 2.2: 20 Top-Selling Automobiles in United States in February 2019 (cont.)

Rank (by February 2019 Sales)	Manufacturer	Model	Sales (February 2019)	Sales (February 2018)
9	Hyundai	Elantra	10,304	15,724
10	Kia	Soul	8,592	6,631
11	Chevrolet	Cruze	7,361	12,875
12	Nissan	Versa	7,410	7,196
13	Volkswagen	Jetta	7,109	4,592
14	Kia	Optima	7,212	6,402
15	Kia	Forte	6,953	7,662
16	Hyundai	Sonata	6,481	6,700

Modifying Data in Excel

Table 2.2: 20 Top-Selling Automobiles in United States in February 2019 (cont.)

Rank (by February 2019 Sales)	Manufacturer	Model	Sales (February 2019)	Sales (February 2018)
17	Tesla	Model 3	5,750	2,485
18	Dodge	Charger	6,547	7,568
19	Ford	Mustang	5,342	5,800
20	Ford	Fiesta	5,035	3,559

Modifying Data in Excel

Figure 2.3: Data for 20 Top-Selling Automobiles Entered into Excel with Percent Change in Sales from 2018

	A	B	C	D	E	F
1	Rank (by February 2019 Sales)	Manufacturer	Model	Sales (February 2019)	Sales (February 2018)	Percent Change in Sales from 2018
2	1	Toyota	Corolla	29016	25021	16.0%
3	2	Toyota	Camry	24267	30865	-21.4%
4	3	Honda	Civic	22979	25816	-11.0%
5	4	Honda	Accord	20254	19753	2.5%
6	5	Nissan	Sentra	17072	17148	-0.4%
7	6	Nissan	Altima	16216	19703	-17.7%
8	7	Ford	Fusion	13163	16721	-21.3%
9	8	Chevrolet Cruze	Malibu	10799	11890	-9.2%
10	9	Hyundai	Elantra	10304	15724	-34.5%
11	10	Kia	Soul	8592	6631	29.6%
12	11	Chevrolet	Cruze	7361	12875	-42.8%
13	12	Nissan	Versa	7410	7196	3.0%
14	13	Volkswagen	Jetta	7109	4592	54.8%
15	14	Kia	Optima	7212	6402	12.7%
16	15	Kia	Forte	6953	7662	-9.3%
17	16	Hyundai	Sonata	6481	6700	-3.3%
18	17	Tesla	Model 3	5750	2485	131.4%
19	18	Dodge	Charger	6547	7568	-13.5%
20	19	Ford	Mustang	5342	5800	-7.9%
21	20	Ford	Fiesta	5035	3559	41.5%

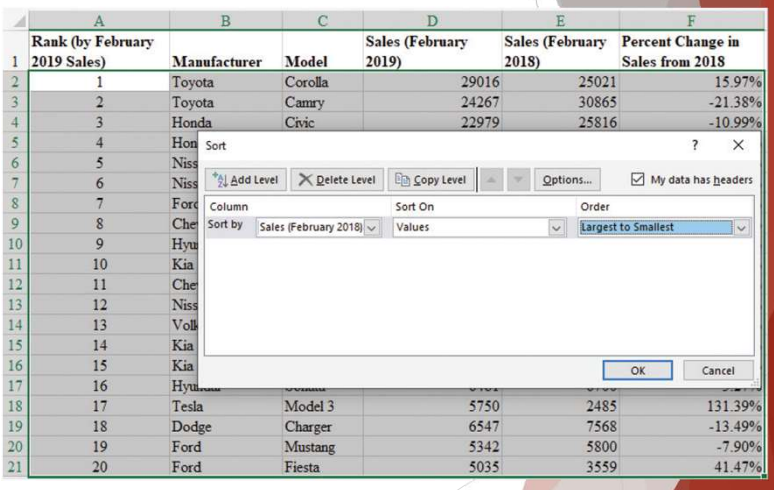
Modifying Data in Excel (Slide 5 of 14)

Sorting and Filtering Data in Excel:

- To sort the automobiles by February 2018 sales:
  - Step 1: Select cells A1:F21.
  - Step 2: Click the **Data** tab in the Ribbon.
  - Step 3: Click **Sort** in the **Sort & Filter** group.
  - Step 4: Select the check box for **My data has headers.**
  - Step 5: In the first **Sort by** dropdown menu, select **Sales (February 2018).**
  - Step 6: In the **Order** dropdown menu, select **Largest to Smallest.**
  - Step 7: Click **OK.**

Modifying Data in Excel

Figure 2.4: Using Excel's Sort Function to Sort the Top-Selling Automobiles Data



	A	B	C	D	E	F
1	Rank (by February 2019 Sales)	Manufacturer	Model	Sales (February 2019)	Sales (February 2018)	Percent Change in Sales from 2018
2	1	Toyota	Corolla	29016	25021	15.97%
3	2	Toyota	Camry	24267	30865	-21.38%
4	3	Honda	Civic	22979	25816	-10.99%
5	4	Hon				
6	5	Niss				
7	6	Niss				
8	7	Ford				
9	8	Che				
10	9	Hyu				
11	10	Kia				
12	11	Che				
13	12	Niss				
14	13	Volk				
15	14	Kia				
16	15	Kia				
17	16	Hyu				
18	17	Tesla	Model 3	5750	2485	131.39%
19	18	Dodge	Charger	6547	7568	-13.49%
20	19	Ford	Mustang	5342	5800	-7.90%
21	20	Ford	Fiesta	5035	3559	41.47%

Modifying Data in Excel

Figure 2.5: Top-Selling Automobiles Data Sorted by Sales in February 2018 Sales

	A	B	C	D	E	F
1	**Rank (by February 2019 Sales)**	**Manufacturer**	**Model**	**Sales (February 2019)**	**Sales (February 2018)**	**Percent Change in Sales from 2018**
2	2	Toyota	Camry	24267	30865	-21.38%
3	3	Honda	Civic	22979	25816	-10.99%
4	1	Toyota	Corolla	29016	25021	15.97%
5	4	Honda	Accord	20254	19753	2.54%
6	6	Nissan	Altima	16216	19703	-17.70%
7	5	Nissan	Sentra	17072	17148	-0.44%
8	7	Ford	Fusion	13163	16721	-21.28%
9	9	Hyundai	Elantra	10304	15724	-34.47%
10	11	Chevrolet	Cruze	7361	12875	-42.83%
11	8	Chevrolet Cruze	Malibu	10799	11890	-9.18%
12	15	Kia	Forte	6953	7662	-9.25%
13	18	Dodge	Charger	6547	7568	-13.49%
14	12	Nissan	Versa	7410	7196	2.97%
15	16	Hyundai	Sonata	6481	6700	-3.27%
16	10	Kia	Soul	8592	6631	29.57%
17	14	Kia	Optima	7212	6402	12.65%
18	19	Ford	Mustang	5342	5800	-7.90%
19	13	Volkswagen	Jetta	7109	4592	54.81%
20	20	Ford	Fiesta	5035	3559	41.47%
21	17	Tesla	Model 3	5750	2485	131.39%

Modifying Data in Excel

Sorting and Filtering Data in Excel (cont.):

- Using Excel's Filter function to see the sales of models made by Nissan:
  - Step 1: Select cells A1:F21.
  - Step 2: Click the **Data** tab in the Ribbon.
  - Step 3: Click **Filter** in the **Sort & Filter** group.
  - Step 4: Click on the **Filter Arrow** in column B, next to **Manufacturer.**
  - Step 5: If all choices are checked, you can easily deselect all choices by unchecking (**Select All**). Then select only the check box for **Nissan**.
  - Step 6. Click **OK.**

Modifying Data in Excel (Slide 9 of 14)

Figure 2.6: Top-Selling Automobiles Data Filtered to Show Only Automobiles Manufactured by Nissan

	A	B	C	D	E	F
1	Rank (by February 2019 Sales)	Manufacturer	Model	Sales (February 2019)	Sales (February 2018)	Percent Change in Sales from 2018
6	5	Nissan	Sentra	17072	17148	-0.44%
7	6	Nissan	Altima	16216	19703	-17.70%
12	12	Nissan	Versa	7410	7196	2.97%

Modifying Data in Excel (Slide 10 of 14)

Conditional Formatting of Data in Excel:

- Makes it easy to identify data that satisfy certain conditions in a data set.
- To identify the automobile models in Table 2.2 for which sales had decreased from February 2018 to February 2019:
  - Step 1: Starting with the original data shown in Figure 2.3, select cells F1:F21.
  - Step 2: Click on the **Home** tab in the Ribbon.
  - Step 3: Click **Conditional Formatting** in the **Styles** group.
  - Step 4: Select **Highlight Cells Rules**, and click **Less Than…** from the dropdown menu.
  - Step 5: Enter *0%* in the **Format cells that are LESS THAN**: box.
  - Step 6: Click **OK.**

Modifying Data in Excel (Slide 11 of 14)

Figure 2.7: Using Conditional Formatting in Excel to Highlight Automobiles with Declining Sales from February 2018

	A	B	C	D	E	F
1	Rank (by February 2019 Sales)	Manufacturer	Model	Sales (February 2019)	Sales (February 2018)	Percent Change in Sales from 2018
2	1	Toyota	Corolla	29016	25021	15.97%
3	2	Toyota	Camry	24267	30865	-21.38%
4	3	Honda	Civic	22979	25816	-10.99%
5	4	Honda	Accord	20254	19753	2.54%
6	5	Nissan	Sentra	17072	17148	-0.44%
7	6	Nissan	Altima	16216	19703	-17.70%
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9	8	Chevrolet Cruze	Malibu	10799	11890	-9.18%
10	9	Hyundai	Elantra	10304	15724	-34.47%
11	10	Kia	Soul	8592	6631	29.57%
12	12	Nissan	Versa	7410	7196	2.97%
13	11	Chevrolet	Cruze	7361	12875	-42.83%
14	14	Kia	Optima	7212	6402	12.65%
15	13	Volkswagen	Jetta	7109	4592	54.81%
16	15	Kia	Forte	6953	7662	-9.25%
17	18	Dodge	Charger	6547	7568	-13.49%
18	16	Hyundai	Sonata	6481	6700	-3.27%
19	17	Tesla	Model 3	5750	2485	131.39%
20	19	Ford	Mustang	5342	5800	-7.90%
21	20	Ford	Fiesta	5035	3559	41.47%

Modifying Data in Excel (Slide 12 of 14)

Figure 2.8: Using Conditional Formatting in Excel to Generate Data Bars for the Top-Selling Automobiles Data

	A	B	C	D	E	F
1	Rank (by February 2019 Sales)	Manufacturer	Model	Sales (February 2019)	Sales (February 2018)	Percent Change in Sales from 2018
2	1	Toyota	Corolla	29016	25021	15.97%
3	2	Toyota	Camry	24267	30865	-21.38%
4	3	Honda	Civic	22979	25816	-10.99%
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13	11	Chevrolet	Cruze	7361	12875	-42.83%
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15	13	Volkswagen	Jetta	7109	4592	54.81%
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17	18	Dodge	Charger	6547	7568	-13.49%
18	16	Hyundai	Sonata	6481	6700	-3.27%
19	17	Tesla	Model 3	5750	2485	131.39%
20	19	Ford	Mustang	5342	5800	-7.90%
21	20	Ford	Fiesta	5035	3559	41.47%

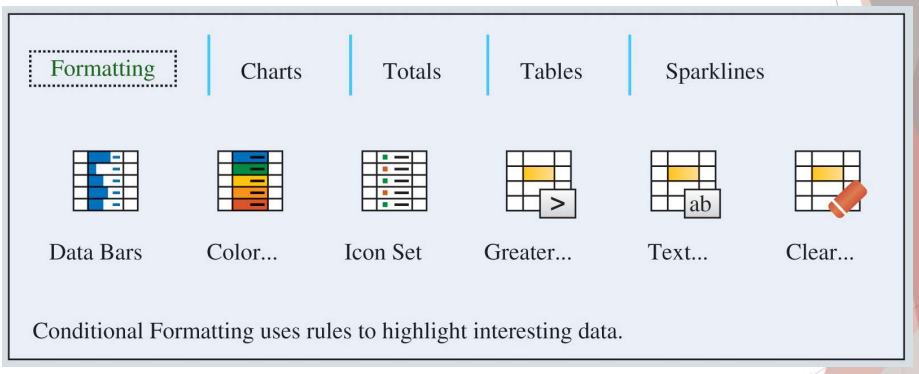
Modifying Data in Excel (Slide 13 of 14)

Conditional Formatting of Data in Excel (cont.):

- **Quick Analysis** button appears just outside the bottom-right corner of a group of selected cells.
- It provides shortcuts for Conditional Formatting, adding Data Bars, and other operations.

Modifying Data in Excel (Slide 14 of 14)

Figure 2.9 Excel Quick Analysis Button Formatting Options



Creating Distributions from Data

Frequency Distributions for Categorical Data

Relative Frequency and Percent Frequency Distributions

Frequency Distributions for Quantitative Data

Histograms

Cumulative Distributions

Creating Distributions from Data

Frequency Distributions for Categorical Data:

- **Frequency distribution**: A summary of data that shows the number (frequency) of observations in each of several nonoverlapping classes, typically referred to as **bins.**

Creating Distributions from Data

Table 2.3: Data from a Sample of 50 Soft Drink Purchases

Coca-Cola	Sprite	Pepsi
Diet Coke	Coca-Cola	Coca-Cola
Pepsi	Diet Coke	Coca-Cola
Diet Coke	Coca-Cola	Coca-Cola
Coca-Cola	Diet Coke	Pepsi
Coca-Cola	Coca-Cola	Dr. Pepper
Dr. Pepper	Sprite	Coca-Cola
Diet Coke	Pepsi	Diet Coke
Pepsi	Coca-Cola	Pepsi
Pepsi	Coca-Cola	Pepsi
Coca-Cola	Coca-Cola	Pepsi
Dr. Pepper	Pepsi	Pepsi
Sprite	Coca-Cola	Coca-Cola
Coca-Cola	Sprite	Dr. Pepper
Diet Coke	Dr. Pepper	Pepsi
Coca-Cola	Pepsi	Sprite
Coca-Cola	Diet Coke	

Creating Distributions from Data

Table 2.4: Frequency Distribution of Soft Drink Purchases

Soft Drink	Frequency
Coca-Cola	19
Diet Coke	8
Dr. Pepper	5
Pepsi	13
Sprite	5
Total	50

- The frequency distribution summarizes information about the popularity of the five soft drinks:
  - Coca-Cola is the leader.
  - Pepsi is second.
  - Diet Coke is third.
  - Sprite and Dr. Pepper are tied for fourth.

Creating Distributions from Data

Figure 2.10: Creating a Frequency Distribution for Soft Drinks Data in Excel

	A	B	C	D	E
1	Sample Data			Bins	
2	Coca-Cola	Coca-Cola		Coca-Cola	19
3	Diet Coke	Sprite		Diet Coke	8
4	Pepsi	Pepsi		Dr. Pepper	5
5	Diet Coke	Coca-Cola		Pepsi	13
6	Coca-Cola	Pepsi		Sprite	5
7	Coca-Cola	Sprite			
8	Dr. Pepper	Dr. Pepper			
9	Diet Coke	Pepsi			
10	Pepsi	Diet Coke			
11	Pepsi	Pepsi			
12	Coca-Cola	Coca-Cola			
13	Dr. Pepper	Coca-Cola			
14	Sprite	Diet Coke			
15	Coca-Cola	Pepsi			
16	Diet Coke	Pepsi			
17	Coca-Cola	Pepsi			
18	Coca-Cola	Coca-Cola			
19	Diet Coke	Dr. Pepper			
20	Coca-Cola	Sprite			
21	Coca-Cola	Coca-Cola			
22	Coca-Cola	Coca-Cola			
23	Sprite	Pepsi			
24	Coca-Cola	Dr. Pepper			
25	Coca-Cola	Pepsi			
26	Diet Coke	Pepsi			

Creating Distributions from Data

Relative Frequency and Percent Frequency Distributions:

- **Relative frequency distribution**: A tabular summary of data showing the relative frequency for each bin.
- **Percent frequency distribution**: Summarizes the percent frequency of the data for each bin.
  - Used to provide estimates of the relative likelihoods of different values of a random variable.

Creating Distributions from Data

Table 2.5: Relative Frequency and Percent Frequency Distributions of Soft Drink Purchases

Soft Drink	Relative Frequency	Percent Frequency (%)
Coca-Cola	0.38	38
Diet Coke	0.16	16
Dr. Pepper	0.10	10
Pepsi	0.26	26
Sprite	0.10	10
Total	1.00	100

Creating Distributions from Data

Frequency Distributions for Quantitative Data:

- Three steps necessary to define the classes for a frequency distribution with quantitative data:
  1. Determine the number of nonoverlapping bins.
  2. Determine the width of each bin.
  3. Determine the bin limits.

APPROXIMATE BIN WIDTH

$$\frac{\text{Largest data value} - \text{smallest data value}}{\text{Number of bins}} \qquad (2.1)$$

Creating Distributions from Data

Table 2.6: Year-End Audit Times (Days)

12	14	19	18
15	15	18	17
20	27	22	23
22	21	33	28
14	18	16	13

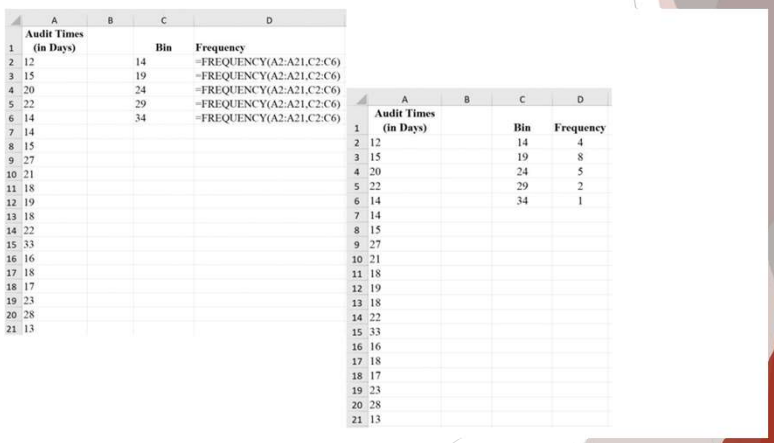
Creating Distributions from Data

Table 2.7: Frequency, Relative Frequency, and Percent Frequency Distributions for the Audit Time Data

Audit Times (days)	Frequency	Relative Frequency	Percent Frequency
10–14	4	0.20	20
15–19	8	0.40	40
20–24	5	0.25	25
25–29	2	0.10	10
30–34	1	0.05	5

Creating Distributions from Data

Figure 2.11: Using Excel to Generate a Frequency Distribution for Audit Times Data



	A	B	C	D
1	Audit Times (in Days)		Bin	Frequency
2	12		14	=FREQUENCY(A2:A21,C2:C6)
3	15		19	=FREQUENCY(A2:A21,C2:C6)
4	20		24	=FREQUENCY(A2:A21,C2:C6)
5	22		29	=FREQUENCY(A2:A21,C2:C6)
6	14		34	=FREQUENCY(A2:A21,C2:C6)
7	14			
8	15			
9	27			
10	21			
11	18			
12	19			
13	18			
14	22			
15	33			
16	16			
17	18			
18	17			
19	23			
20	28			
21	13			

	A	B	C	D
1	Audit Times (in Days)		Bin	Frequency
2	12		14	4
3	15		19	8
4	20		24	5
5	22		29	2
6	14		34	1
7	14			
8	15			
9	27			
10	21			
11	18			
12	19			
13	18			
14	22			
15	33			
16	16			
17	18			
18	17			
19	23			
20	28			
21	13			