

Business Statistics:  
A Decision-Making Approach  
6<sup>th</sup> Edition

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**Chapter 2**  
Graphs, Charts, and Tables –  
Describing Your Data

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Chapter Goals

**After completing this chapter, you should be able to:**

- Construct a frequency distribution both manually and with a computer
- Construct and interpret a histogram
- Create and interpret bar charts, pie charts, and stem-and-leaf diagrams
- Present and interpret data in line charts and scatter diagrams

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Frequency Distributions

What is a Frequency Distribution?

- A frequency distribution is a list or a table ...
- containing the values of a variable (or a set of ranges within which the data falls) ...
- and the corresponding frequencies with which each value occurs (or frequencies with which data falls within each range)

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### Why Use Frequency Distributions?

- A frequency distribution is a way to summarize data
- The distribution condenses the raw data into a more useful form...
- and allows for a quick visual interpretation of the data

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### Frequency Distribution: Discrete Data

- Discrete data: possible values are countable

Example: An advertiser asks 200 customers how many days per week they read the daily newspaper.

| Number of days read | Frequency  |
|---------------------|------------|
| 0                   | 44         |
| 1                   | 24         |
| 2                   | 18         |
| 3                   | 16         |
| 4                   | 20         |
| 5                   | 22         |
| 6                   | 26         |
| 7                   | 30         |
| <b>Total</b>        | <b>200</b> |



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### Relative Frequency

Relative Frequency: What proportion is in each category?

| Number of days read | Frequency  | Relative Frequency |
|---------------------|------------|--------------------|
| 0                   | 44         | .22                |
| 1                   | 24         | .12                |
| 2                   | 18         | .09                |
| 3                   | 16         | .08                |
| 4                   | 20         | .10                |
| 5                   | 22         | .11                |
| 6                   | 26         | .13                |
| 7                   | 30         | .15                |
| <b>Total</b>        | <b>200</b> | <b>1.00</b>        |

$\frac{44}{200} = .22$

22% of the people in the sample report that they read the newspaper 0 days per week



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### Frequency Distribution: Continuous Data

- Continuous Data: may take on any value in some interval

Example: A manufacturer of insulation randomly selects 20 winter days and records the daily high temperature

**24, 35, 17, 21, 24, 37, 26, 46, 58, 30, 32, 13, 12, 38, 41, 43, 44, 27, 53, 27**

(Temperature is a continuous variable because it could be measured to any degree of precision desired)

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### Grouping Data by Classes

Sort raw data in ascending order:

**12, 13, 17, 21, 24, 24, 26, 27, 27, 30, 32, 35, 37, 38, 41, 43, 44, 46, 53, 58**

- Find range:  $58 - 12 = 46$
- Select number of classes: 5 (usually between 5 and 20)
- Compute class width: 10 (46/5 then round off)
- Determine class boundaries: 10, 20, 30, 40, 50
- Compute class midpoints: 15, 25, 35, 45, 55
- Count observations & assign to classes

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### Frequency Distribution Example

Data in ordered array:

12, 13, 17, 21, 24, 24, 26, 27, 27, 30, 32, 35, 37, 38, 41, 43, 44, 46, 53, 58

| Frequency Distribution |           |                    |
|------------------------|-----------|--------------------|
| Class                  | Frequency | Relative Frequency |
| 10 but under 20        | 3         | .15                |
| 20 but under 30        | 6         | .30                |
| 30 but under 40        | 5         | .25                |
| 40 but under 50        | 4         | .20                |
| 50 but under 60        | 2         | .10                |
| <b>Total</b>           | <b>20</b> | <b>1.00</b>        |

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## Histograms

- The **classes** or **intervals** are shown on the horizontal axis
- **frequency** is measured on the vertical axis
- Bars of the appropriate heights can be used to represent the number of observations within each class
- Such a graph is called a **histogram**

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## Histogram Example

**Data in ordered array:**

12, 13, 17, 21, 24, 24, 26, 27, 27, 30, 32, 35, 37, 38, 41, 43, 44, 46, 53, 58

| Class Midpoint | Frequency |
|----------------|-----------|
| 5              | 0         |
| 15             | 3         |
| 25             | 6         |
| 36             | 5         |
| 45             | 4         |
| 55             | 2         |
| More           | 0         |

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## Questions for Grouping Data into Classes

1. How wide should each interval be?  
(How many classes should be used?)
2. How should the endpoints of the intervals be determined?
  - Often answered by trial and error, subject to user judgment
  - The goal is to create a distribution that is neither too **"jagged"** nor too **"blocky"**
  - Goal is to appropriately show the pattern of variation in the data

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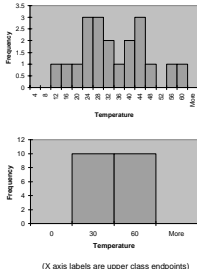
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### How Many Class Intervals?

- Many (Narrow class intervals)**
  - may yield a very jagged distribution with gaps from empty classes
  - Can give a poor indication of how frequency varies across classes
- Few (Wide class intervals)**
  - may compress variation too much and yield a blocky distribution
  - can obscure important patterns of variation.



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### General Guidelines

| Number of Data Points | Number of Classes |
|-----------------------|-------------------|
| under 50              | 5 - 7             |
| 50 – 100              | 6 - 10            |
| 100 – 250             | 7 - 12            |
| over 250              | 10 - 20           |

- Class widths can typically be reduced as the number of observations increases
- Distributions with numerous observations are more likely to be smooth and have gaps filled since data are plentiful

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### Class Width

- The class width is the distance between the lowest possible value and the highest possible value for a frequency class
- The minimum class width is

$$W = \frac{\text{Largest Value} - \text{Smallest Value}}{\text{Number of Classes}}$$

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### Histograms in Excel

1  
Select  
Tools/Data Analysis

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### Histograms in Excel

(continued)

2  
Choose Histogram

3  
Input data and bin ranges

Select Chart Output

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### Stem and Leaf Diagram

- A simple way to see distribution details in a data set

METHOD: Separate the sorted data series into leading digits (the **stem**) and the trailing digits (the **leaves**)

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**Example:**

**Data in ordered array:**  
 12, 13, 17, 21, 24, 24, 26, 27, 27, 30, 32, 35, 37, 38, 41, 43, 44, 46, 53, 58

- Here, use the 10's digit for the stem unit:

- 12 is shown as →
- 35 is shown as →

| Stem | Leaf |
|------|------|
| 1    | 2    |
| 3    | 5    |

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**Example:**

**Data in ordered array:**  
 12, 13, 17, 21, 24, 24, 26, 27, 27, 30, 32, 35, 37, 38, 41, 43, 44, 46, 53, 58

- Completed Stem-and-leaf diagram:

| Stem | Leaves      |
|------|-------------|
| 1    | 2 3 7       |
| 2    | 1 4 4 6 7 8 |
| 3    | 0 2 5 7 8   |
| 4    | 1 3 4 6     |
| 5    | 3 8         |

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**Using other stem units**

- Using the 100's digit as the stem:
  - Round off the 10's digit to form the leaves

- 613 would become →
- 776 would become →
- ...
- 1224 becomes →

| Stem | Leaf |
|------|------|
| 6    | 1    |
| 7    | 8    |
| 12   | 2    |

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### Graphing Categorical Data

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graph TD
    A[Categorical Data] --> B[Pie Charts]
    A --> C[Bar Charts]
    A --> D[Pareto Diagram]
    
```

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### Bar and Pie Charts

- Bar charts and Pie charts are often used for qualitative (category) data
- Height of bar or size of pie slice shows the frequency or percentage for each category

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### Pie Chart Example

#### Current Investment Portfolio

| Investment Type | Amount<br>(in thousands \$) | Percentage |
|-----------------|-----------------------------|------------|
| Stocks          | 46.5                        | 42.27      |
| Bonds           | 32.0                        | 29.09      |
| CD              | 15.5                        | 14.09      |
| Savings         | 16.0                        | 14.55      |
| <b>Total</b>    | <b>110</b>                  | <b>100</b> |

(Variables are Qualitative)

Percentages are rounded to the nearest percent

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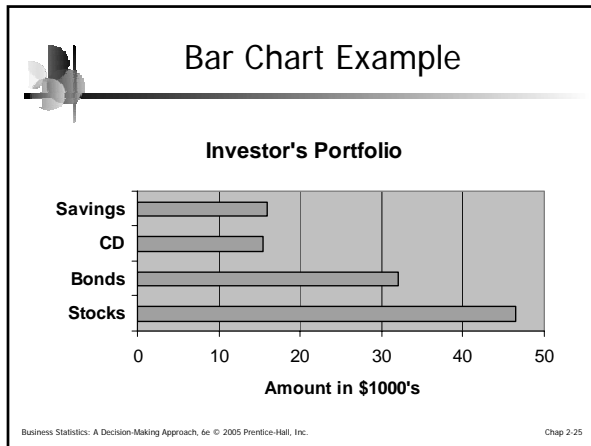
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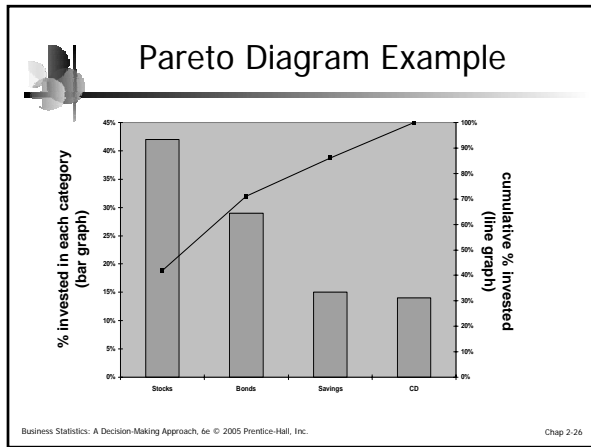
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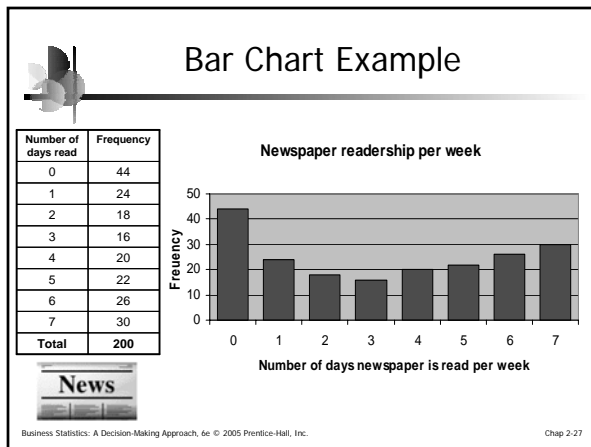
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### Tabulating and Graphing Multivariate Categorical Data

- Investment in thousands of dollars

| Investment Category | Investor A   | Investor B | Investor C  | Total      |
|---------------------|--------------|------------|-------------|------------|
| Stocks              | 46.5         | 55         | 27.5        | <b>129</b> |
| Bonds               | 32.0         | 44         | 19.0        | <b>95</b>  |
| CD                  | 15.5         | 20         | 13.5        | <b>49</b>  |
| Savings             | 16.0         | 28         | 7.0         | <b>51</b>  |
| <b>Total</b>        | <b>110.0</b> | <b>147</b> | <b>67.0</b> | <b>324</b> |

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### Tabulating and Graphing Multivariate Categorical Data (continued)

- Side by side charts

**Comparing Investors**

| Category | Investor A | Investor B | Investor C |
|----------|------------|------------|------------|
| Savings  | 16.0       | 28.0       | 7.0        |
| CD       | 15.5       | 20.0       | 13.5       |
| Bonds    | 32.0       | 44.0       | 19.0       |
| Stocks   | 46.5       | 55.0       | 27.5       |

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### Side-by-Side Chart Example

- Sales by quarter for three sales territories:

|       | 1st Qtr | 2nd Qtr | 3rd Qtr | 4th Qtr |
|-------|---------|---------|---------|---------|
| East  | 20.4    | 27.4    | 59      | 20.4    |
| West  | 30.6    | 38.6    | 34.6    | 31.6    |
| North | 45.9    | 46.9    | 45      | 43.9    |

**Sales by Quarter**

| Quarter | East | West | North |
|---------|------|------|-------|
| 1st Qtr | 20.4 | 30.6 | 45.9  |
| 2nd Qtr | 27.4 | 38.6 | 46.9  |
| 3rd Qtr | 59   | 34.6 | 45    |
| 4th Qtr | 20.4 | 31.6 | 43.9  |

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### Line Charts and Scatter Diagrams

- Line charts show values of one variable vs. time
  - Time is traditionally shown on the horizontal axis
- Scatter Diagrams show points for bivariate data
  - one variable is measured on the vertical axis and the other variable is measured on the horizontal axis

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### Line Chart Example

| Year | Inflation Rate |
|------|----------------|
| 1985 | 3.56           |
| 1986 | 1.86           |
| 1987 | 3.65           |
| 1988 | 4.14           |
| 1989 | 4.82           |
| 1990 | 5.40           |
| 1991 | 4.21           |
| 1992 | 3.01           |
| 1993 | 2.99           |
| 1994 | 2.56           |
| 1995 | 2.83           |
| 1996 | 2.95           |
| 1997 | 2.29           |
| 1998 | 1.56           |
| 1999 | 2.21           |
| 2000 | 3.36           |
| 2001 | 2.85           |
| 2002 | 1.58           |

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### Scatter Diagram Example

| Volume per day | Cost per day |
|----------------|--------------|
| 23             | 125          |
| 26             | 140          |
| 29             | 146          |
| 33             | 160          |
| 38             | 167          |
| 42             | 170          |
| 50             | 188          |
| 55             | 195          |
| 60             | 200          |

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### Types of Relationships

- Linear Relationships

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### Types of Relationships

*(continued)*

- Curvilinear Relationships

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### Types of Relationships

*(continued)*

- No Relationship

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## Chapter Summary

- Data in raw form are usually not easy to use for decision making -- Some type of organization is needed:
  - ◆ Table
  - ◆ Graph
- Techniques reviewed in this chapter:
  - Frequency Distributions and Histograms
  - Bar Charts and Pie Charts
  - Stem and Leaf Diagrams
  - Line Charts and Scatter Diagrams

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