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Chapter 1
WHY STATISTICS?

METHODS OF KNOWING: How do we learn the truth?

1 Authority

2 Rationalism

3 Intuition

4 The scientific method
We understand something to be true because of **tradition** or because **someone of authority** says it’s true

- **Example:** We believe that atoms exist because physicists say they exist even though you’ve probably never seen one with your own eyes

- **Example:** Because of tradition, being taught that high doses of vitamin C will lessen the effects of a cold
The rules of logic are used to analyze information and deduce what is true and what is not.

- **Example:** Syllogism
  - All stats instructors are interesting
  - Mr. X is a stats instructor
  - Therefore, Mr. X is interesting

- Can lead to wrong conclusions and inaccurate generalizations
Chapter 1
WHY STATISTICS?

METHODS OF KNOWING: Intuition

1. The **sudden**, often **clarifying idea** that springs into consciousness (not in parts but as a whole)

   - **Example:** While watching a movie, the solution to a problem you were working on earlier suddenly comes to mind as if someone just flipped a switch
By reasoning deductively through existing theory or inductively through existing facts or intuition, the scientist proposes a truth about some feature of reality.

An **objective experiment** is designed to test the truthfulness of the proposal (known as a hypothesis) through the collection of data and analyzing this data using statistical methods.

- **Examples:** Pharmaceutical drugs, Education programs, Auto safety features.
An objective experiment involves:

1. Defining the problem to be studied and the questions to be answered

2. Specifying the null and alternative hypotheses

3. Operationally defining the
   - Independent variable (IV) and its levels
     - The researcher changes the type or amount of this variable from one group to the next
   - Dependent variable (DV)
     - The data collected by the researcher
     - The data represent the amount observed
An objective experiment involves:

1. Trying to determine if changes in the IV are associated with changes in the DV

   • **Example:**
     - One group takes a new sleeping medication while a second group takes no medication.
     - The researcher might compare the average time it takes each group to fall asleep.
     - The IV is the amount of sleep medication each group takes. There are two levels – the group that takes the medication and the group that doesn’t
     - The DV is the average amount of time it takes each group to fall asleep (measured in minutes)
An objective experiment involves:

1. Deciding which statistical method to use to analyze the data collected
   - The type of data collected affects which statistical methods can be used
   - The type of question the researcher is trying to answer can also affect what statistical method to use

2. Understanding who or what the results of the statistical analysis applies to

3. Knowing the difference between statistical significance and practical significance
Enables the researcher to:

• Draw conclusions about a population based on the results from a sample from the population

• **Example:** The news media draw conclusions about which political candidates will win an election from surveys based on only a fraction of the population (usually around 1500 likely voters)
Enables the researcher to:

- Understand the difference between results that reflect chance error from results that indicate a real effect

**Example:** A coin is flipped 10 times. We expect 5 heads and 5 tails but we observe seven heads and three tails. Is this outcome due to chance or due to a biased (unfair) coin?
There are many definitions of the term statistics, but for our purpose we’ll define it as:

• The science of collecting (through observation), analyzing (with statistical methods), and interpreting data

So what is meant by data?
The term Data refers to:

1. What is observed
2. What has been measured
3. The numbers entered into a statistics problem
4. The dependent variable (DV)

**EXAMPLES:** Heart rate (BPM), Average life of a mechanical part (in days), Amount of fruit yielded per acre (in pounds), Number of correct items on a test
Describe a quality or characteristic using non-numeric labels

- **EXAMPLES:**
  - Slow, average, fast
  - Small, medium, large
  - Poor, good, excellent
  - Close, nearby, far away
  - Lazy, acceptable, efficient
  - None, some, many
Describe the amount of a characteristic using numeric values

- EXAMPLES:
  - Speed measured in seconds
  - Size measured in pounds
  - Quality measured on a scale from 1 to 10
  - Distance measured in miles
  - Performance measured by amount of output
  - Quantity measured as number produced
Chapter 1

TYPES OF DATA: DISCRETE VS. CONTINUOUS

Discrete Data:

1. Numeric data that have no intervals between values
   - These are non-decimal or whole values

   - EXAMPLES:
     - Number of unemployment claims
     - Degrees awarded last semester
     - Total number of citations issued last month
     - Gender
     - Number of cars sold last month
     - Total number of homeruns hit last season
Continuous Data:

1. Numeric data with intervals between values
   - These can be decimal or fraction values

   - EXAMPLES:
     - Fever measured in Fahrenheit
     - Price of a gallon of gas
     - Rate of inflation per year
     - Amount of weight lost (in pounds and ounces)
     - Olympic time records (hundredths of a second)
     - Distance traveled (meters, millimeters)
Data can also be categorized into one of four scales:

1. **Nominal** - Less Information
2. **Ordinal**
3. **Interval**

NOIR
Chapter 1

SCALES OF DATA: NOMINAL SCALE

Nominal scale data:

1. Describe which category or group the participant belongs to
2. Provide information as to how many participants are in each group/category

- **EXAMPLE: **Favorite brand of athletic shoes

<table>
<thead>
<tr>
<th></th>
<th>Reebok</th>
<th>Nike</th>
<th>LA Gear</th>
<th>Addidas</th>
<th>Wilson</th>
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<tr>
<td>Frequency</td>
<td>🅱️⓪</td>
<td>🅱️⓪</td>
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<td>🅱️ⅢⅢⅢ</td>
<td>🅱️ⅢⅢ</td>
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- **EXAMPLES: **Gender, Year in school, County of residence, Species of trees observed, political party
Ordinal scale data:

1. Describe which magnitude or rank
2. Provide information as to which scores rank smaller and which rank larger

- **EXAMPLES:**
  - Place finished in a race (i.e., 1\(^{st}\), 2\(^{nd}\), 3\(^{rd}\))
  - A rank order of Macy’s top selling stores across the country
  - Year in school (i.e., freshman, sophomore, etc.)
  - The floors of an apartment building
  - A rank order of the top paying jobs in nursing
Chapter 1

SCALES OF DATA: INTERVAL SCALE

Interval scale data:

1. Describe the **amount** measured
2. Provide information as to **how much** was observed
3. Have equal intervals across the scale, but the meaning or weight of the intervals changes across the scale
   - The meaning or weight of the intervals is non-linear
4. The value of zero on the scale is arbitrary and not absolute
   - **EXAMPLES:**
     - The Fahrenheit and Celsius scales
     - Intelligence tests and psychological inventories
     - Likert-type scales such as instructor evaluations

DISAGREE STRONGLY  1  2  3  4  5  AGREE STRONGLY
Ratio scale data:

1. Describe the **amount** measured
2. Provide information as to **how much** was observed
3. Have equal intervals across the scale and the meaning or weight of the intervals is **linear** across the scale
4. The value of zero on the scale means absolute zero

**EXAMPLES:**
- Blood pressure
- Miles per gallon
- Time measured in seconds
- Weight lost over six months
Descriptive versus Inferential statistics

1. Descriptive statistics refers to:
   - Statistical tools for describing characteristics of the data
     - **EXAMPLES:**
       - Mode, Mean, Median
       - Standard deviation, Five-number summary
       - Pie charts, Histograms, Scatterplots
   - Statistical methods for describing how variables are related to each other
     - **EXAMPLES:**
       - Correlation
       - Regression analysis
Inferential statistics refers to:

- Statistical tools that enable the researcher to draw conclusions about a population from a sub-group or sample of the population

**EXAMPLES:**

- Statistical tests such as the *t*-test and chi-square test
- Confidence intervals
A population refers to:

1. An **entire group of elements** that well-defined by a set of characteristics

- **EXAMPLES:**
  - All students currently enrolled in at UNM-VC
  - All Pinon pine trees in the Cibola National Forrest
  - All commuters on I-25 from 6:00 a.m. to 9:00 a.m., Monday through Friday
A sample refers to:

1. A subset of elements taken from the defined population

   - **EXAMPLES:**
     - One-hundred students randomly selected from the current registration list at UNM-VC
     - One-thousand randomly selected Pinon pine trees in the Cibola National Forrest
     - Five-hundred commuters observed on I-25 at random times from 6:00 a.m. to 9:00 a.m., Monday through Friday
End of Chapter 1