Introduction to Statistics

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1 Introduction to Statistics

Statistics is the science of collecting, analyzing, interpreting, presenting, and organizing data.

- **Descriptive Statistics**: Summarize and interpret data to provide meaningful insights.
- **Inferential Statistics**: Make predictions about a population based on sample data.

2 Why Do We Need Statistics?

- **Data-Driven Decision Making**: Provides a basis for informed decisions.
- **Understanding Trends**: Helps identify patterns and trends.
- **Predict Future Events**: Allows for forecasting.
- **Scientific Research**: Essential in hypothesis testing and experimentation.

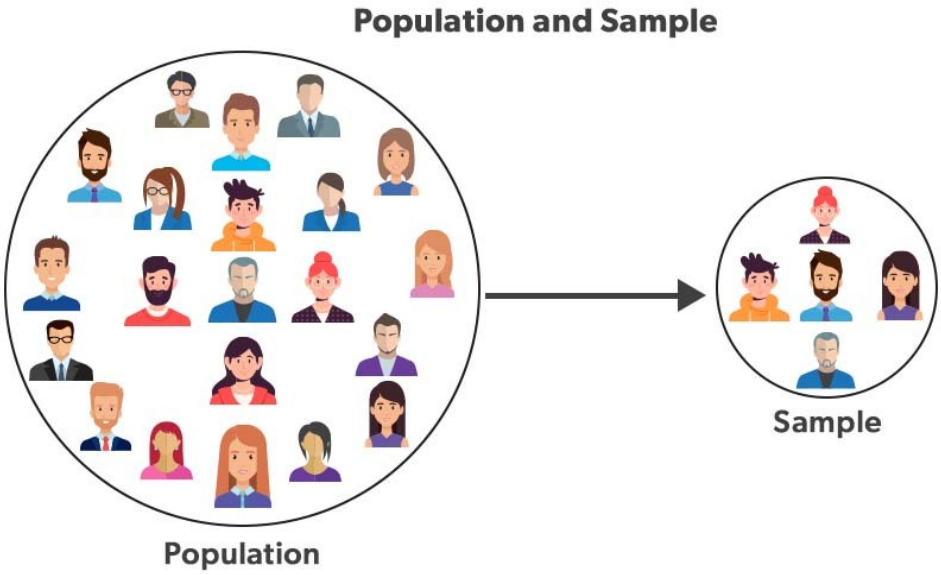
3 Importance of Sampling

- **Efficiency**: It's often impractical to collect data from an entire population.
  - **Example**: Surveying all 7,000 AUC students vs. a sample of 100 students.
- **Cost-Effectiveness**: Sampling can be less expensive.
  - **Example**: Reduced cost in time and resources for surveying a smaller sample.
- **Accuracy**: Proper sampling techniques can yield highly accurate estimates.

- **Example**: A well-designed survey of 100 students can accurately reflect the opinions of all 7,000 students.

4 Population vs. Sample

- **Population**: The entire group that is the subject of the study.
  - **Example**: All 7,000 students at AUC
  - **Notation**: N for size, μ for mean, σ for standard deviation
- **Sample**: A subset of the population used for making inferences about the population.
  - **Example**: A survey of 100 AUC students
  - **Notation**: n for size, $\bar{x}$ for mean, s for standard deviation



5 Methods of Collecting Data

- **Surveys**: Questionnaires or interviews.
- **Observations**: Systematic observation and recording.
- **Experiments**: Controlled settings to observe effects.
- **Archival Data**: Existing records and databases.

6 Types of Variables

- **Quantitative Variables**: Numeric data that can be measured.
  - **Continuous**: Can take any value within a range (e.g., GPA).
  - **Discrete**: Specific, countable values (e.g., Number of Courses).
- **Qualitative Variables**: Descriptive, non-numeric data.
- **Nominal**: Categories without order (e.g., Majors).
- **Ordinal**: Categories with order but not equally spaced (e.g., Class Standing: Freshman, Sophomore, etc.).

7 Measures of Central Tendency 1/3

- **Mean**: The average of all data points.
  - **Population Mean**: $\mu = \frac{\sum_{i=1}^{N} x_i}{N}$
    - **Example**: Average GPA of all 7,000 AUC students is $\mu = 3.5$
  - **Sample Mean**: $\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n}$
    - **Example**: Average GPA of a sampled 100 AUC students is $\bar{x} = 3.48$

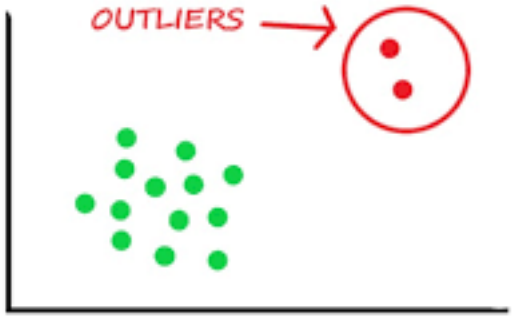
8 Measures of Central Tendency 2/3

- **Median**: Middle value when data is sorted
  - Steps to find Median:
    - Sort the data in ascending order
      - If n is odd, the median is the value at $\frac{n+1}{2}$th position
      - If n is even, the median is the average of values at $\frac{n}{2}$ and $\frac{n}{2} + 1$ positions
- **Mode**: The most frequently occurring value.

9 Measures of Central Tendency 3/3

9.1 When to use each measure

- Use the mean for normally distributed data
- Use the median when the data is skewed or has outliers
- Use the mode when dealing with categorical data



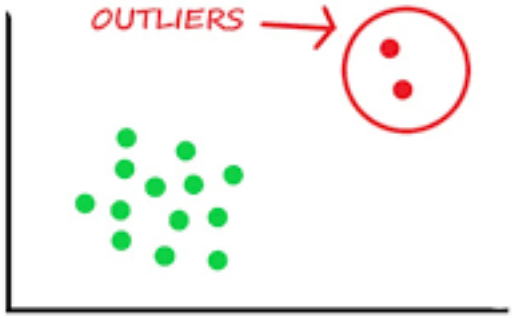
10 Measures of Dispersion 1/2

- **Range**: Difference between the **highest** and **lowest** values.
  - **Example**: highest GPA: 4.0, lowest GPA: 2.9
    - Range: $4.0 - 2.9 = 1.1$
- **Variance**: Average of the squared differences from the Mean.
  - **Population Variance**: $\sigma^2 = \frac{\sum_{i=1}^{N}(x_i - \mu)^2}{N}$
  - **Sample Variance**: $s^2 = \frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}$
- **Standard Deviation**: Square root of the variance.
  - **Population Standard Deviation**: $\sigma = \sqrt{\sigma^2}$
  - **Sample Standard Deviation**: $s = \sqrt{s^2}$

11 Measures of Dispersion 2/2

11.1 When to use each measure

- The range is great for a quick overview, but it is sensitive to outliers.
- Variance and standard deviation are more robust and provide a clearer picture of the spread in your data.



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