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DEMOGRAPHY

Master1: in Applied Statistics / Planning and Monitoring Evaluation

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Compendium of statistics and definition in statistics

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Plan

INTRODUCTION

I-MEANING OF STATISTICS

II- Fundamental Concepts and Definition

II-1- Population and Sample

II-2- Parameters and Statistics

II-3- Descriptive and Inferential Statistics

CONCLUSION

Introduction

Statistics is a fundamental discipline that serves as the backbone for decision-making, scientific research, and data-driven insights in various fields. It provides tools and methodologies for collecting, organizing, analyzing, and interpreting data to uncover patterns, relationships, and trends. Understanding statistical concepts is essential not only for researchers and professionals but also for anyone seeking to make informed decisions in an increasingly data-centric world. This compendium aims to offer clear and concise definitions of key statistical concepts, ranging from foundational terms such as mean, median, and variance to more advanced topics like hypothesis testing, regression analysis, and machine learning. By organizing these concepts systematically, this resource serves as a practical guide for students, educators, and practitioners who wish to deepen their understanding or refresh their knowledge of statistics.

I- MEANING OF STATISTICS

The word « statistics » is derived from the Latin word « status » and it means « political state » or « government ». Centuries ago, the word statistics was used to refer to kings needing information about land, agriculture, population and their military. But nowadays, Statistics is the science of gaining information from numerical and categorical data. Statistics is a branch of mathematics that deals with collecting, analyzing, interpreting, presenting, and organizing data. It enables us to summarize complex data sets, draw conclusions, and make decisions based on data. Statistics can involve descriptive measures (such as averages and percentages) and inferential techniques, which help predict or infer population characteristics based on sample data.

II- Fundamental Concepts and Definition

II-1- Population and Sample

❖ Population

Population is the collection of all individuals or items under consideration in a statistical study. (Weiss, 1999). The entire group of individuals or items that you are interested in studying.

In statistics, a population refers to the entire set of individuals, items, or observations that share a common characteristic and are of interest in a particular statistical study. The population encompasses all subjects that fit a defined criteria or parameters, such as:

People: For example, all voters in a country, students in a school, or patients with a specific disease.

Objects: Such as all manufactured products from a factory, all books in a library, or all cars produced by a certain company.

Events: Like all outcomes from an experiment or all recorded temperatures over a month.

❖ Sample

Sample is that part of the population from which information is collected. (Weiss, 1999). A subset of the population selected for observation and analysis. Use in Statistical Analysis:

Samples are used to estimate population parameters (e.g., mean, variance) and to conduct hypothesis testing. A sample is a subset of individuals or observations taken from a larger population. The purpose of using a sample is to estimate characteristics (parameters) of the whole population without needing to collect data from every single member.

Types of Samples

- **Random Sample:** Each member of the population has an equal chance of being selected, reducing selection bias.
- **Stratified Sample:** The population is divided into subgroups (or strata) based on specific characteristics, and samples are drawn from each stratum.
- **Systematic Sample:** A sample is selected using a fixed interval method (e.g. every 10th individual).
- **Convenience Sample:** Samples are taken from a group that is easily accessible, which may lead to bias.

II-2- Parameters and Statistic

❖ Parameter

A numerical characteristic of a population, such as a mean or standard deviation. Parameters are numerical values that summarize characteristics of a population. They are often unknown and are estimated by using statistics calculated from a sample.

Common Parameters:

- **Mean (μ):** The average of a population.
- **Standard deviation (σ):** A measure of the dispersion or variability in a set of values.
- **Proportion (p):** The fraction of the population that has a certain characteristic.

❖ Statistic(singular)

A numerical measure that describes a characteristic of a sample. Example : The percentage in a sample of registered voters who intend to vote in the next election

II-3- Descriptive and Inferential Statistics

❖ Descriptive Statistics

- Methods for summarizing and describing the features of a dataset, including measures such as mean, median, mode, range, and standard deviation. Descriptive statistics summarize and organize data in a meaningful way. They provide a quick overview of the basic features of a dataset. Common methods and measures include:

Measures of Central Tendency

- **Mean:** The average of a set of values.
- **Median:** The middle value when the data is arranged in order.
- **Mode:** The most frequently occurring value in the dataset.

Measures of Dispersion:

- **Range:** The difference between the highest and lowest values.
- **Variance:** Measures how far a set of numbers are spread out from their average value.
- **Standard Deviation:** The square root of the variance, providing a measure of the spread of values. Graphs and Charts: Such as histograms, bar graphs, and pie charts to visually represent data distribution.

❖ Inferential Statistics

- Techniques that allow you to infer or generalize characteristics of a population based on a sample.

Inferential statistics allow us to make predictions or inferences about a population based on a sample of data. It uses probability theory to derive conclusions that are generalizable to a larger group. Key concepts include: Hypothesis Testing: The process of making decisions about population parameters based on sample statistics. Includes:

- **Null Hypothesis (H₀)** : No effect or no difference.
- **Alternative Hypothesis (H₁)** : Indicates the presence of an effect or difference.
- **Confidence Intervals:** A range of values derived from sample data that is likely to contain the value of an unknown population parameter.

- **Regression Analysis:** Used to understand relationships between variables and to predict future outcomes.
- **ANOVA (Analysis of Variance):** A statistical method used to compare the means of three or more samples.

❖ **Bias**

Systematic error introduced into sampling or testing that skews results in a particular direction. This compendium covers fundamental concepts essential for understanding and conducting statistical analyses. For deeper exploration, further study into each concept and practice with real data may be beneficial.

Conclusion

Statistics plays a pivotal role in making sense of the complexities of the world by providing a structured approach to analyzing and interpreting data. Mastery of statistical concepts empowers individuals to draw meaningful conclusions, make informed decisions, and contribute to advancements in various fields of study. This compendium has provided a concise overview of essential statistical definitions and ideas, offering a foundation for further exploration and application. As the field of statistics continues to evolve alongside advancements in technology and data science, a strong grasp of its core principles will remain indispensable for navigating an increasingly data-driven future.