



Understanding and Summarizing Data – Descriptive Statistics



Pre-requisites

Hope you have gone through the self-learning content for this session on the PRISM portal.

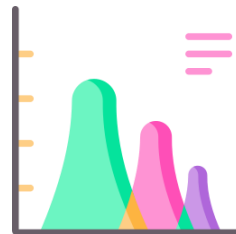
Recap

- **Functions:** Reviewed syntax, arguments, and return values for reusable code blocks.
- **Modules:** Explored code organization and the usage of 'import' for external modules.
- **Files:** Discussed file handling using open(), close(), read(), and write() functions.
- **Lambda Functions:** Introduced single-use, anonymous functions and their uses with map(), filter(), reduce().
- **Errors:** Covered various error types and handling methods, including custom exceptions.
- **OOP:** Recapped classes, objects, inheritance, and encapsulation for complex data structures.

Takeaway from This Session



Statistics: Essential for collecting, analyzing, interpreting, and organizing data. Enables us to find patterns, trends, and make data-driven predictions.



Probability: Crucial for understanding the likelihood of outcomes and the uncertainty in predictions. Helps quantify risk and make informed decisions.

Key Takeaway: A thorough understanding of Statistics and Probability is fundamental to effective Data Science. They transform raw data into actionable insights and guide informed decision-making.

Poll Time

Q: Which of the following statements best describes the importance of statistics and probability for data scientists?

- A. Statistics helps data scientists design user interfaces for data visualization
- B. Probability allows data scientists to predict future events with 100% accuracy
- C. Statistics enables data scientists to explore, analyze, and draw meaningful insights from complex datasets
- D. Probability and statistics are only relevant in the field of finance and economics



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- C. Statistics enables data scientists to explore, analyze, and draw meaningful insights from complex datasets**
- D. Probability and statistics are only relevant in the field of finance and economics





By the End of this Session, you will:

- Comprehend the concepts of mean, median, and mode, and their roles in summarizing data.
- Apply the formulas and methods to calculate mean, median, and mode in given data sets.
- Analyze the implications of the calculated mean, median, and mode in understanding data.
- Utilize measures of central tendency to solve real-world problems and make data-driven decisions in the field of data science.



Introduction to Statistics

Introduction to Statistics



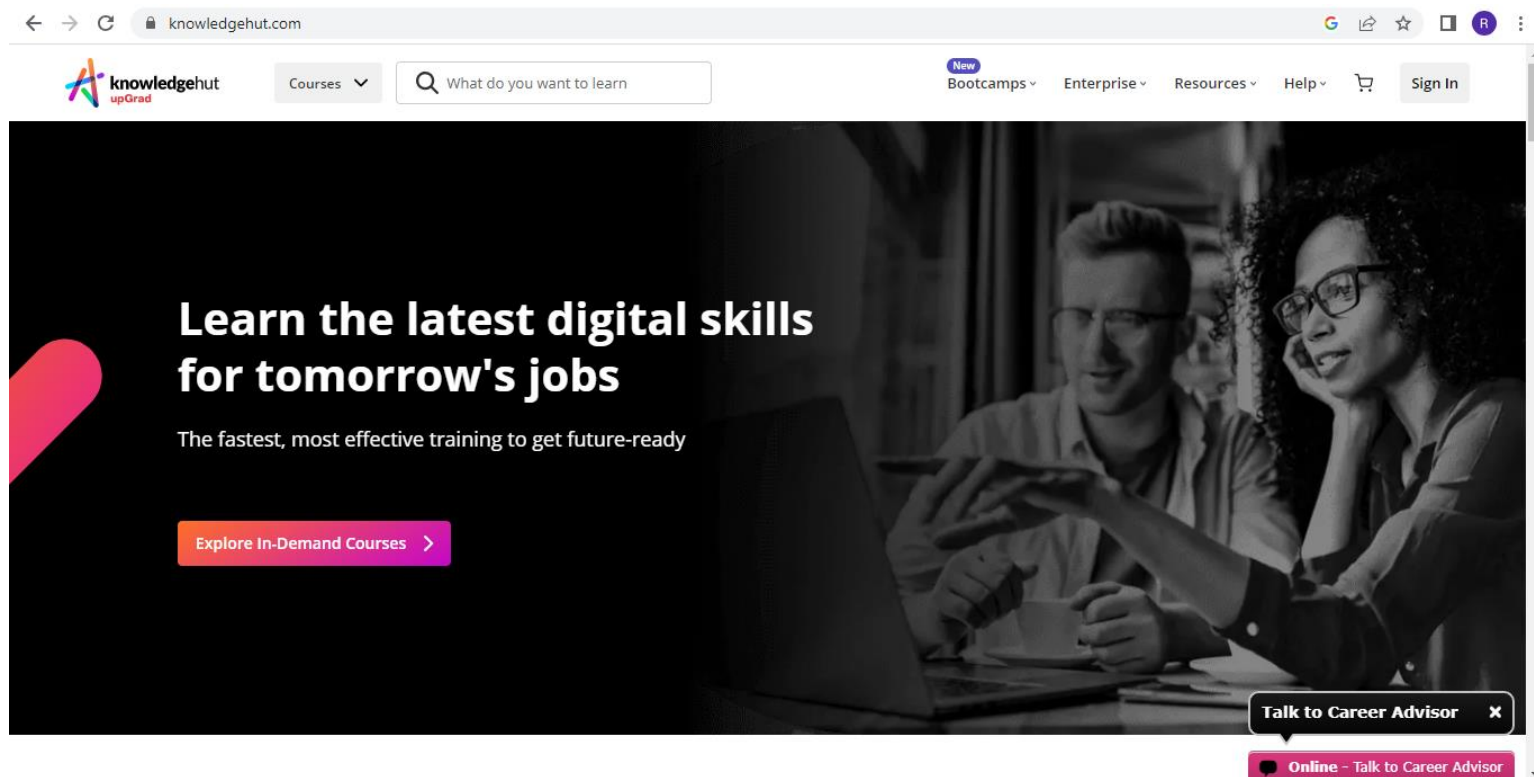
The science of collecting, organizing, presenting, analyzing, and interpreting data to assist in making more effective decisions.



Statistical analysis – used to manipulate, summarize, and investigate data, so that useful decision-making information results.



The Role of Statistics in Data Science



The screenshot shows the homepage of the knowledgehut upGrad website. The browser address bar displays "knowledgehut.com". The navigation bar includes the logo, a "Courses" dropdown, a search bar with the placeholder "What do you want to learn", and links for "New Bootcamps", "Enterprise", "Resources", "Help", and "Sign In". The main banner features a dark background with a photo of two people working on a laptop. The text on the banner reads: "Learn the latest digital skills for tomorrow's jobs" and "The fastest, most effective training to get future-ready". A pink button labeled "Explore In-Demand Courses" is positioned below the text. In the bottom right corner, there is a "Talk to Career Advisor" button and a chat widget indicating "Online - Talk to Career Advisor".

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Courses ▾

What do you want to learn

New
Bootcamps ▾ Enterprise ▾ Resources ▾ Help ▾ Sign In

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Real-world Application of Statistics



Medical Research



Market Research



Risk Assessment and
Insurance



Finance and
Investment



Environmental
Studies



Sports Analytics

Types of Statistics – Descriptive and Inferential

Descriptive Statistics:

- Summarizes and describes the main features of a dataset.
- Focuses on organizing, presenting, and summarizing data.
- Includes measures of central tendency (mean, median, mode), measures of dispersion (range, variance, standard deviation), and measures of shape (skewness, kurtosis).
- Helps in understanding characteristics, patterns, and relationships within a dataset.

Inferential Statistics:

- Makes inferences or generalizations about a population based on a sample.
- Analyzes sample data to draw conclusions or make predictions about a larger population.
- Relies on probability theory and hypothesis testing.
- Helps in understanding cause-and-effect relationships, making predictions, and testing hypotheses.

Pop Quiz

Q. Which of the following options correctly describes the differences between descriptive statistics and inferential statistics?

- A. Descriptive statistics deals with analyzing sample data, while inferential statistics deals with analyzing population data
- B. Descriptive statistics involves making inferences about a population, while inferential statistics involves summarizing sample data
- C. Descriptive statistics involves hypothesis testing, while inferential statistics involves data visualization techniques
- D. Descriptive statistics are used for qualitative data analysis, while inferential statistics are used for quantitative data analysis



Pop Quiz

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- A. Descriptive statistics deals with analyzing sample data, while inferential statistics deals with analyzing population data**
- B. Descriptive statistics involves making inferences about a population, while inferential statistics involves summarizing sample data
- C. Descriptive statistics involves hypothesis testing, while inferential statistics involves data visualization techniques
- D. Descriptive statistics are used for qualitative data analysis, while inferential statistics are used for quantitative data analysis



Introduction to Descriptive Statistics



Marbles



Descriptive statistics can be used to

- Count the marble
- Sort the marbles by color
- Identify the most common color
- Find the middle marble
- Calculate the average color
- Analyze the color range

Introduction to Inferential Statistics



A sample of the population can be used to identify the suspect.

Inferential statistics is the branch of statistics that involves drawing conclusions, making predictions, and generalizing findings from a sample to a larger population.

Introduction to Inferential Statistics

- **Use Case:** A Marketing Campaign Evaluation
- Suppose a company wants to evaluate the effectiveness of a marketing campaign aimed at increasing customer engagement.
- **TASK:** Let's do some research on how inferential statistics can help us in this.



Pop Quiz

Q. In sports analytics, inferential statistics are commonly used for which of the following?

- A. Comparing player performance in a single game
- B. Analyzing individual player statistics in isolation
- C. Assessing team performance based on historical data
- D. Making predictions about future game outcomes and player performance



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Understanding the Concept of Data

What is Data?

- In the context of computing, data refers to distinct pieces of digital information.
- Data is usually formatted in a specific way and can exist in a variety of forms, such as numbers, text, etc.



What is Statistical Data?

- The collection of data relevant to the problem being studied is commonly the most difficult, expensive, and time-consuming part of the entire research project.
- Statistical data are usually obtained by counting or measuring items.
 - **Primary data** are collected specifically for the analysis desired.
 - **Secondary data** have already been compiled and are available for statistical analysis.

Qualitative and Quantitative Data

Statistical data are usually obtained by counting or measuring items. Most data can be put into the following categories:

Qualitative Data



Information about qualities that can't be measured on the number scale.

Quantitative Data



Observations that are measured on a numerical scale.



Pop Quiz

Q. Is salary data considered quantitative or qualitative?

- A. Quantitative
- B. Qualitative



Pop Quiz

Q. Is salary data considered quantitative or qualitative?

A. Quantitative

B. Qualitative





Computing Mean, Median, and Mode

Importance of Descriptive Statistics

Descriptive statistics are vital in data analysis as they summarize and describe data in a meaningful way.

They provide concise summaries, such as:

- Measures of central tendency
- Variability
- Enabling us to understand patterns, trends, and relationships within the data
- Descriptive statistics simplify complex data, aid in decision making
- Identify outliers and facilitate data comparison

They serve as a foundation for advanced analysis techniques and help us make sense of data by providing valuable insights

Measures of Central Tendencies

Measures of central tendency provide valuable insights into data.

- **Mean** - It represents the average value.
- **Median** - It indicates the middle value.
- **Mode** - It represents the most frequent value.

Measures of central tendency serve as essential tools in data analysis, unlocking key insights and facilitating informed decision-making.

Introduction to Mean

Mean: Summing up all the observations and dividing by the number of observations. Mean of 20, 30, 40 is $(20+30+40)/3 = 30$.

Notation: Let x_1, x_2, \dots, x_n are n observations of a variable x .

Then the mean of this variable,

$$\bar{x} = \frac{x_1 + x_2 + \dots + x_n}{n} = \frac{\sum_{i=1}^n x_i}{n}$$

Introduction to Median

Median: It is the middle value in an ordered sequence of observations. That is, to find the median, one needs to order the data set and then find the middle value.

- In the case of an even number of observations, the average of the two middlemost values is the median.
- **Example:** To find the median of {9, 3, 6, 7, 5}, first sort the data giving {3, 5, 6, 7, 9}, then choose the middle value 6.
- If the number of observations is even, e.g., {9, 3, 6, 7, 5, 2}, then the median is the average of the two middle values from the sorted sequence, in this case, $(5 + 6) / 2 = 5.5$.

Introduction to Mode

Mode: The value that is observed most frequently. The mode is undefined for sequences in which no observation is repeated.

Example:

- Dataset representing the number of goals scored by a soccer team in their last ten matches: **2, 1, 3, 2, 4, 2, 1, 1, 3, 2**.
- Identify the value(s) that occur most frequently in the dataset. In this case, the number **2** appears three times, while all other numbers occur less frequently.
- Therefore, the mode of this dataset is **2**.

Introduction to Mode

Example:

- Dataset representing the favorite colors of a group of people:
Red, Blue, Green, Blue, Red, Yellow, Blue, and Red.
- To find the mode in this case, identify the category that appears most frequently.
- In this dataset, the color **Red** appears three times, while the other colors occur less frequently.
- Therefore, the mode of this dataset is **Red**.

Pop Quiz

Q. Consider a dataset with the following values: 10, 15, 20, 25, 30.
Which of the following statements is true?

- A. The mean is equal to the median
- B. The mean is greater than the median
- C. The median is greater than the mean
- D. The mean and median cannot be determined without additional information



Pop Quiz

Q. Consider a dataset with the following values: 10, 15, 20, 25, 30.
Which of the following statements is true?

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Application of Central Tendencies



Finance



Education



Healthcare



Market Research



Sports Analytics



Demographics



Quality
Control



Social
Sciences



Economics



Data
Analysis

Limitations of Measures of Central Tendencies

- **Skewed Data:** Measures of central tendencies may not accurately represent the data if it is skewed or heavily influenced by outliers.
- **Non-representative Samples:** Central tendencies can be misleading if the sample is not representative of the entire population.
- **Categorical Data:** Measures like the mean may not be applicable to categorical data, as it lacks a numerical scale.

Limitations of Measures of Central Tendencies

- **Equal Weighting:** Measures of central tendencies assume equal weighting for all data points, which may not reflect the true importance or significance of each observation.
- **Lack of Context:** Central tendencies provide a summary but may not capture the complete context or nuances of the data.
- **Lack of Variability Information:** Measures of central tendencies do not convey information about the spread or variability of the data.
- **Sensitivity to Extreme Values:** The mean can be highly influenced by extreme values, impacting its representativeness.

Activity

Measures of Central Tendency

Consider the following dataset representing the ages of a group of people: 25, 32, 28, 40, 22, 35, 30.

- a) Calculate the mean age of the group
- b) Determine the median age
- c) Identify the mode, if any

Summary

- ✓ Gained a comprehensive understanding of mean, median, and mode, and their significance in summarizing data.
- ✓ Applied formulas and methods to calculate mean, median, and mode in various data sets.
- ✓ Analyzed the implications of the calculated mean, median, and mode in understanding the central point of our data.
- ✓ Utilized measures of central tendency to solve real-world problems, demonstrating their importance in making data-driven decisions in data science.



Next Session:

Continuous Probability Distribution and
Probability Theory

THANK YOU!

Please complete your assessments and review the self-learning content
for this session on the **PRISM** portal.





Continuous Probability Distribution and Probability Theory



Pre-requisites

Hope you have gone through the self-learning content for this session on the PRISM portal.



By the end
of this
session,
you will:

- Identify and justify the use of measures such as range, variance, standard deviation, and interquartile range.
- Evaluate data sets for skewness and kurtosis to understand the distribution.
- Grasp the concepts of normal distribution, standard normal distribution, and z-scores.
- Utilize simple probability and Bayes' theorem to solve real-world problems.
- Combine the understanding of dispersion, distribution shape, probability distributions, and probability theory to analyze and interpret complex data sets.

Recap

In our last session, we delved into the following key topics:

- **Measures of Central Tendencies:** We explored the concepts of mean, median, and mode, understanding their crucial role in summarizing data.
- **Calculations:** We applied formulas and methods to calculate the mean, median, and mode in various data sets, honing our practical skills.
- **Interpretation of Central Tendencies:** We analyzed the implications of the calculated mean, median, and mode, enhancing our understanding of the data.
- **Application in Data Science:** We saw how measures of central tendency can be applied to solve real-world problems, underlining their significance in making data-driven decisions in the field of data science.

Takeaway from This Session

Dispersion Measures: Understanding range, variance, standard deviation, and interquartile range aids in assessing data variability.

Skewness & Kurtosis: Evaluating these helps understand data distribution shape, crucial for accurate predictions.

Probability Distributions: Grasping normal distribution, standard normal distribution, and z-scores is key for statistical tests and models.

Probability Theory: Applying simple probability and Bayes' theorem forms the basis of many machine learning algorithms.

Integration: Combining these concepts enables comprehensive analysis and interpretation of complex data sets, driving insightful decision-making.

Poll Time

Q. Which of the following is NOT a measure of central tendency?

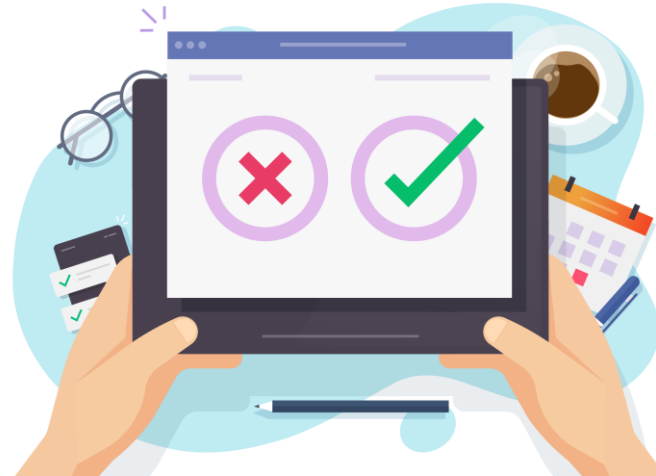
- a. Mean
- b. Median
- c. Mode
- d. Range



Poll Time

Q. Which of the following is NOT a measure of central tendency?

- a. Mean
- b. Median
- c. Mode
- d. Range**





Introduction to Measuring Variability

Measures of Dispersion

- Variability in data refers to the extent to which the data points deviate from each other, or from a measure of central tendency, such as the mean or the median.
- Variability is an important aspect of data analysis and is often measured using various statistics, such as range, variance, and standard deviation.

Measures of Dispersion

- These measures provide insights into how spread out or dispersed the data is, indicating the variability or spread of values within the dataset.
- By calculating and analyzing measures of dispersion, such as range, variance, or standard deviation, one can understand the extent to which data points deviate from the central value.
- Thus, the term "measures of dispersion" highlights their purpose in assessing the spread or dispersion of data points in relation to the central tendency.

Aspects of Measures of Dispersion

Introduction to Range

- Range in the variability of the data refers to the difference between the largest and smallest values in a dataset. It is a simple measure of variability that gives an idea of how spread out the data is.
- To calculate the range, subtract the smallest value from the largest value in the dataset.

Example:

The dataset of test scores ranges from 60 to 95, the range is calculated as **$95 - 60 = 35$** . This means that the data spans a range of 35 points.

Introduction to Variance

- In statistics, variance is a measure of the spread or variability of a set of data points around their mean or expected value.
- It is calculated by taking the average of the squared differences between each data point and the mean.

Mathematically, the variance is defined as:

$$\sigma^2 = \frac{\sum (\chi - \mu)^2}{N}$$

Where χ is a data point, the mean is the mean or expected value of the data, n is the number of data points, and the sum is taken over all the data points.

Introduction to Standard Deviation

- Standard deviation is a commonly used measure of variability in statistics.
- It is the square root of the variance, which measures the spread or dispersion of a set of data points around their mean or expected value.

The standard deviation is calculated as the square root of the variance, as follows:

$$\sigma = \sqrt{\frac{\sum (x_i - \mu)^2}{N}}$$

Where variance is the average of the squared differences between each data point and the mean.

Pop Quiz

Q. Calculate the standard deviation for the given dataset: 10, 15, 20, 25, 30.

- A. 5
- B. 7.07
- C. 8.66
- D. 10



Pop Quiz

Q. Calculate the standard deviation for the given dataset: 10, 15, 20, 25, 30.

A. 5

B. 7.07

C. 8.66

D. 10



Introduction to Inter Quartile Range

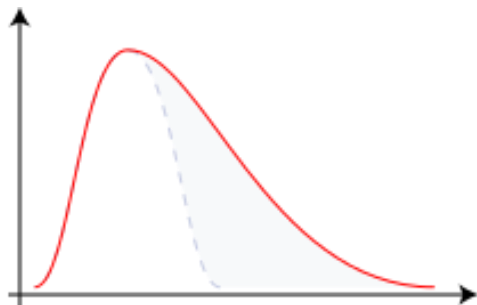
- The simplest definition of the Interquartile Range (IQR) is that it is the range between the first quartile (Q1) and the third quartile (Q3) in a dataset.
- It represents the spread or variability of the middle 50% of the data.
- To calculate the IQR, arrange the data in ascending order, find the value of Q1 (the median of the lower half of the data) and Q3 (the median of the upper half of the data), then subtract Q1 from Q3.
- The resulting value represents the interquartile range, providing insights into the central spread of the dataset.

Introduction to Skewness

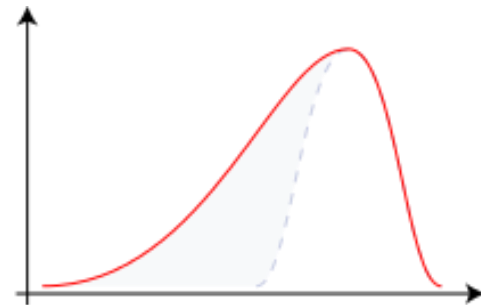
- Skewness in data refers to the measure of the asymmetry or lack of symmetry in its distribution.
- It provides insights into the shape of the distribution and the direction and degree of deviation from a perfectly symmetrical distribution.
- A distribution can be classified as positively skewed, negatively skewed, or symmetrical (no skewness).

Introduction to Skewness

- **Positively skewed data** has a long tail on the right side, with the majority of the values concentrated on the left side.
- **Negatively skewed data** has a long tail on the left side, with the majority of the values concentrated on the right side.
- **Symmetrical data** has an equal balance of values on both sides of the central tendency.



Positive or right skewed: Longer right tail



Negative or left skewed: Longer left tail

Introduction to Kurtosis

- Kurtosis is a statistical measure that quantifies the shape and peakedness (or flatness) of a probability distribution.
- Positive kurtosis indicates a distribution with heavier or fatter tails and a higher peak, suggesting a greater probability of extreme values. Negative kurtosis indicates a distribution with lighter or thinner tails and a lower peak, suggesting fewer extreme values.
- Kurtosis helps in understanding the characteristics of a distribution and is useful in fields such as finance, risk management, and data analysis.

Poll Time

Q. Calculate the Interquartile Range (IQR) for the given dataset: 15, 20, 25, 30, 35, 40, 45, 50.

- A. 20
- B. 25
- C. 30
- D. 35



Poll Time

Q. Calculate the Interquartile Range (IQR) for the given dataset: 15, 20, 25, 30, 35, 40, 45, 50.

- A. 20
- B. 25
- C. 30**
- D. 35





Continuous Probability Distributions

Introduction to Continuous Probability Distribution

Definition: A Continuous Probability Distribution represents the probabilities of all possible outcomes of a continuous random variable. Unlike discrete random variables, which have countable outcomes, continuous random variables can take on an infinite number of outcomes.

Examples: Height, weight, time, and temperature are examples of continuous variables as they can take on any value within a certain range.

Introduction to Normal Distribution

Definition

The Normal Distribution, also known as the Gaussian distribution, is a type of continuous probability distribution for a real-valued random variable. It is characterized by its bell-shaped and symmetrical curve, where the mean, median, and mode are all equal and located at the center of the distribution.

Examples

- *Heights of people*: The heights of a large group of individuals follow a normal distribution, with most people being of average height and fewer people being very short or very tall.
- *Measurement errors*: Errors in measurements are often normally distributed, with most errors being small and few errors being large.

Pop Quiz

Q. Which of the following is not a characteristic of a continuous probability distribution?

- A. The probability of a single, specific outcome is zero.
- B. Probabilities are measured over intervals of outcomes, not individual outcomes.
- C. The total probability of all outcomes is equal to 1.
- D. It can only take on a countable number of outcomes.



Pop Quiz

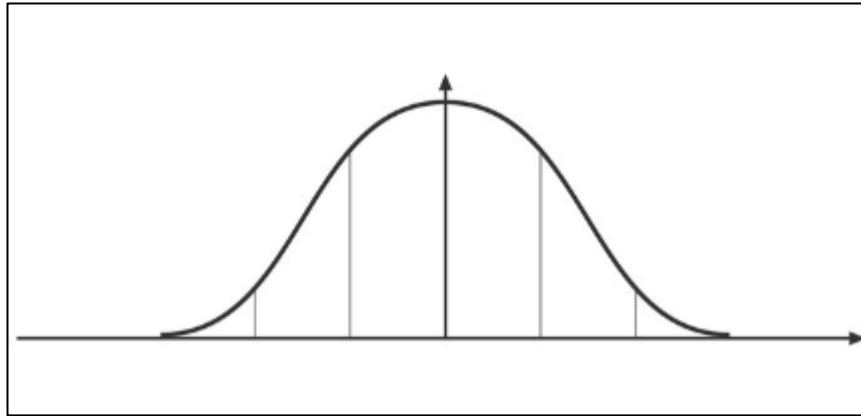
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- C. The total probability of all outcomes is equal to 1.
- D. It can only take on a countable number of outcomes.**



Introduction to Bell-shaped Curve

Definition: The Bell-Shaped Curve, also known as the Gaussian or Normal Distribution, is a type of continuous probability distribution that has a symmetrical, bell-shaped curve.



Introduction to Standard Normal Distribution

Definition: The Standard Normal Distribution is a special case of the Normal Distribution. It is a continuous probability distribution with a mean of 0 and a standard deviation of 1.

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2}$$

x = value of the variable or data being examined
 $f(x)$ = the probability density function
 μ = the mean
 σ = the standard deviation

Working with Z-Score

Definition: A Z-Score is a statistical measurement that describes a value's relationship to the mean of a group of values. It is measured in terms of standard deviations from the mean.

$$z = \frac{x - \mu}{\sigma}$$

x = test value
μ = the mean
σ = the standard deviation

Pop Quiz

Q. What is the mean and standard deviation of a standard normal distribution?

- A. Mean = 0, Standard Deviation = 0
- B. Mean = 1, Standard Deviation = 1
- C. Mean = 0, Standard Deviation = 1
- D. Mean = 1, Standard Deviation = 0



Pop Quiz

Q. What is the mean and standard deviation of a standard normal distribution?

A. Mean = 0, Standard Deviation = 0

B. Mean = 1, Standard Deviation = 1

C. Mean = 0, Standard Deviation = 1

D. Mean = 1, Standard Deviation = 0







Introduction to Probability Theory

Introduction to Probability Theory

Definition: Probability Theory is a branch of mathematics concerned with the analysis of random phenomena. It provides a mathematical framework for quantifying uncertainty and making informed predictions.

Types of Probability:

Simple Probability: The probability of a single event occurring.

Joint Probability: The probability of two events occurring together.

Conditional Probability: The probability of an event given that another event has occurred.



Demo – Calculating Simple Probability

Pop Quiz

Q. When a coin is flipped. What is the probability of getting heads?

- A. 0
- B. 0.25
- C. 0.5
- D. 1



Pop Quiz

Q. When a coin is flipped. What is the probability of getting heads?

A. 0

B. 0.25

☒ C. **0.5**

D. 1



Demo – Calculation of Probabilities

Poll Time

Q. In probability theory, the rule of multiplication applies to which of the following?

- A. Mutually exclusive events
- B. Dependent events
- C. Independent events
- D. Both B and C



Poll Time

Q. In probability theory, the rule of multiplication applies to which of the following?

- A. Mutually exclusive events
- B. Dependent events
- C. Independent events
- D. **Both B and C**



Introduction to Bayes' Theorem

Introduction to Bayes' Theorem

Definition: Bayes' Theorem is a fundamental concept in probability theory and statistics that describes how to update the probabilities of hypotheses when given evidence. It's used to revise existing predictions or theories (posterior probabilities) given new or additional evidence.

$$P(A|B) = \frac{P(B|A)P(A)}{P(B)}$$

$P(A|B)$ is the posterior probability of hypothesis A given the evidence B.
 $P(B|A)$ is the likelihood of evidence B given that hypothesis A is true.
 $P(A)$ and $P(B)$ are the probabilities of hypothesis A and evidence B independent of each other.

Pop Quiz

Q. What is Bayes' Theorem used for?

- A. Calculate the probability of an event based on prior knowledge of conditions that might be related to the event
- B. Determine the mean of a dataset
- C. Calculate the standard deviation of a dataset
- D. Determine the mode of a dataset



Pop Quiz

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Case Study on Descriptive Statistics

Activity 1

Scenario:

Let's use the same Case Study: Abhilash and his friends wish to perform a descriptive statistical analysis on the dataset to make decisions about the food they consume on a daily basis. The goal of this analysis is to maintain good nutrition for a healthier diet.

Perform the following analysis on the given dataset:

- Find the variance for total_fat to get how total_fat is varying among different food items.
- How to get a number of records, mean, standard deviation, min value, max values, and quartiles with 1 line of code?

Activity 1

Perform the following analysis on the given dataset:

- Find the correlation between different features available in the dataset.
- Find the distribution of columns, sugars, total_fat, water, and protein by plotting the histogram.
- Find the skewness and kurtosis for all the numeric features available in the dataset.
- Plot the scatter plot for features of water vs. sugars to get a visual representation of the relationship between them.

Summary



Explored range, variance, standard deviation, and interquartile range.



Assessed skewness and kurtosis for understanding data shape.



Mastered normal distribution, standard normal distribution, and z-scores.



Applied simple probability and Bayes' theorem in real-world scenarios.



Combined various statistical concepts for comprehensive data analysis.



Session Feedback



Next Session:

Deep Dive into Bayes, Central Limit Theorem, and
Discrete Probability Distributions

THANK YOU

Please complete your assessments and review the self-learning content
for this session on the **PRISM** portal.



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