# Exploratory Data Analysis

# Agenda

- Exploratory Data Analysis Quiz
- Univariate Analysis
- Bivariate / Multivariate Analysis
- Missing Value Treatment
- Outlier Detection and Treatment

# Let’s begin the discussion by answering a few questions on Exploratory Data Analysis

# EDA Quiz

What is the primary purpose of conducting a data overview?

A To validate statistical hypotheses

B To create machine learning models

C To understand the high-level structure and patterns of the data

D To make predictions without understanding the data

# EDA Quiz

What is the primary purpose of conducting a data overview?

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C [✓ To understand the high-level structure and patterns of the data]

D To make predictions without understanding the data

# Data Overview

Critical for gaining an early understanding of the data and directing subsequent steps in the analytical process

| Method | Syntax | Description |
|---|---|---|
| Shape of Dataset | `df.shape` | It provides dimensions of the dataset (no. of rows and columns) |
| Information of the dataset | `df.info()` | It provides essential details such as the total number of non-null values, data types of each column, etc. |
| Statistical summary of the dataset | `df.describe()` | It returns a statistical summary of the attributes in the data |

# EDA Quiz

Which statistical measure provides information about the spread or variability of a dataset?

A Mean

B Median

C Mode

D Standard Deviation

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B Median

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D [✓ Standard Deviation]

# Summary Statistics

| Summary Statistic | Description |
|---|---|
| Mean | The average of all values in a numerical attribute |
| Median | The middle value of a numerical attribute when arranged in ascending / descending order. |
| Mode | The most frequently occuring value(s) in an attribute (numerical / categorical) |
| Standard Deviation | The average distance between the mean value and all the values of a numerical attribute |

Spread measures the distance between data points in a dataset, while variability measures the degree of diversity or differences within the dataset.

# EDA Quiz

What is the primary objective of Univariate Analysis?

A Analyze how various variables relate to one another

B Spot patterns and structures in individual variables

C Make confident predictions about future trends

D Identify the independent variables that affect a model’s prediction

# EDA Quiz

**What is the primary objective of Univariate Analysis?**

A. Analyze how various variables relate to one another

B. Spot patterns and structures in individual variables 🟩

C. Make confident predictions about future trends

D. Identify the independent variables that affect a model’s prediction

# Univariate Analysis

The distribution, spread, and central tendency of a single variable in a dataset are examined without taking into account the relationships with other variables

| Plot | Type of variable | Python Function |
|---|---|---|
| Histogram | Numerical | `plt.hist()` or `sns.histplot()` |
| Boxplot | Numerical | `sns.boxplot()` |
| KDE plot | Numerical | `sns.displot()` |
| Bar graph | Categorical | `plt.bar()` or `sns.countplot()` |

# EDA Quiz

When the mean is greater than the median, the distribution becomes:

A Positively skewed

B Negatively skewed

C Symmetric

D Uniform

# EDA Quiz

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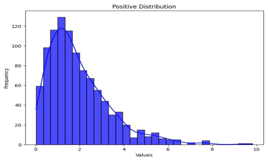
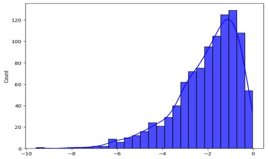
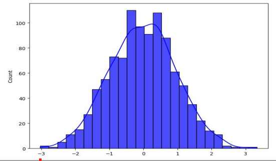
# Skewness

A measure of the deviation of the probability distribution of a variable from its mean.

| Type | Description | Sample Graph |
|---|---|---|
| Positive Skewness (Right Skewed) | ● Majority of the data points are concentrated on the left side.<br>● Mean > Median |  |
| Negative Skewness (Left Skewed) | ● Majority of the data points are concentrated on the right side.<br>● Mean < Median |  |
| Symmetric Distribution | ● Data is evenly distributed on both sides of the mean.<br>● Mean = Median = Mode |  |

# EDA Quiz

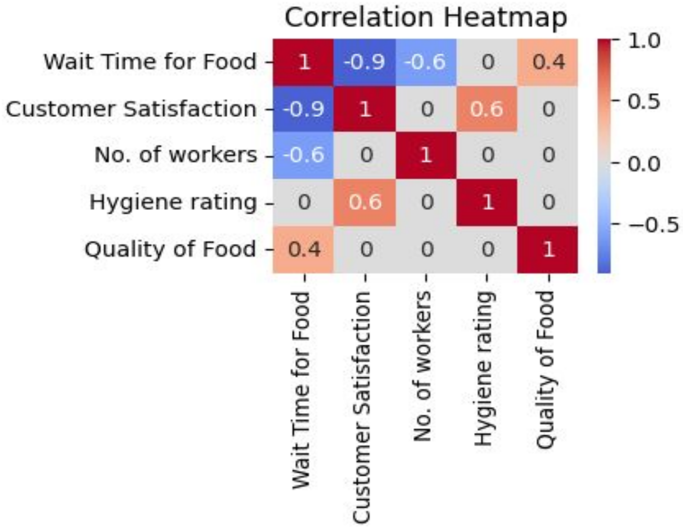
According to the heatmap below, which pair of variables is most correlated with each other?

A Wait Time for Food and Customer Satisfaction

B No. of workers and Wait Time for Food

C Hygiene rating and Customer satisfaction

D Wait time for Food and Quality of Food



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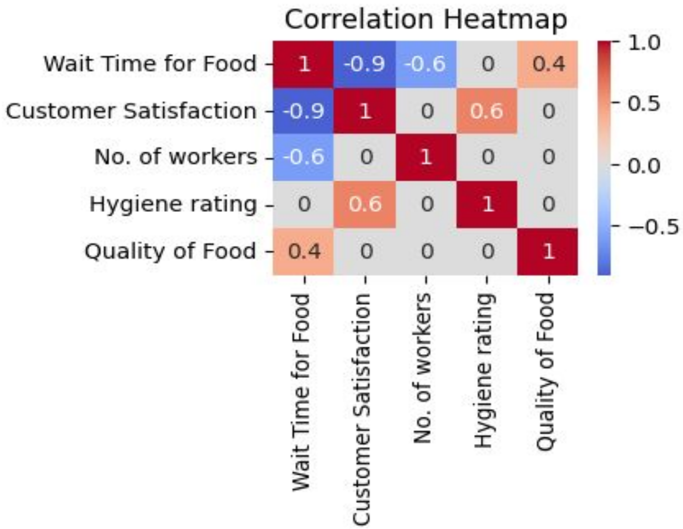


# Correlation

A statistical measure of the **association between two variables**

**Measures both strength and direction** of the relationship between pairs of variables

A **correlation heatmap** displays the correlation coefficients between pairs of variables, using **color intensity to represent the strength and direction of correlations**.

The **strength of the correlation is independent of the direction** - one can have strong positive and negative correlations - **-0.9 correlation is stronger than +0.6**

**Same magnitude but different directions of correlation  imply variables with opposite relationship** - inverse association for -ve correlation and direct association for +ve correlation

# EDA Quiz

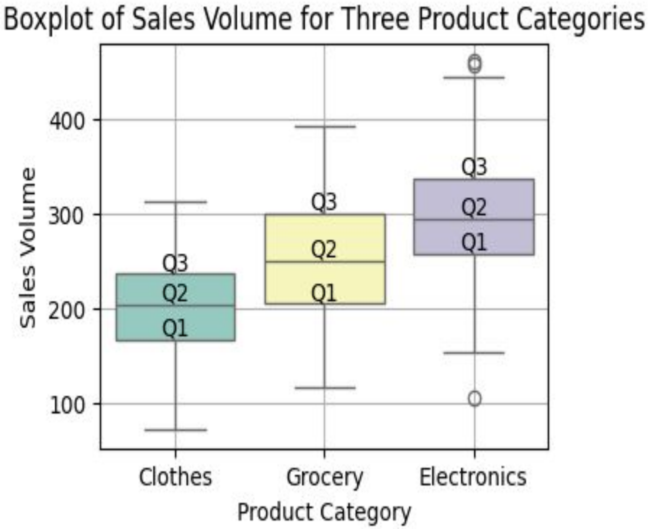
According to the given boxplot, x% of Electronics category has higher Sales volume than y% of Clothes category. What are the values of x and y?

A 25, 100

B 50, 75

C 10, 100

D 50, 100


Boxplot of Sales Volume for Three Product Categories

# EDA Quiz

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C 10, 100

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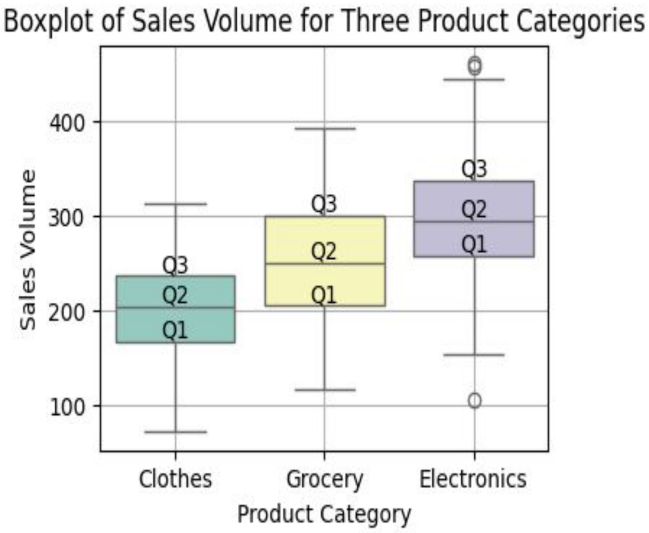
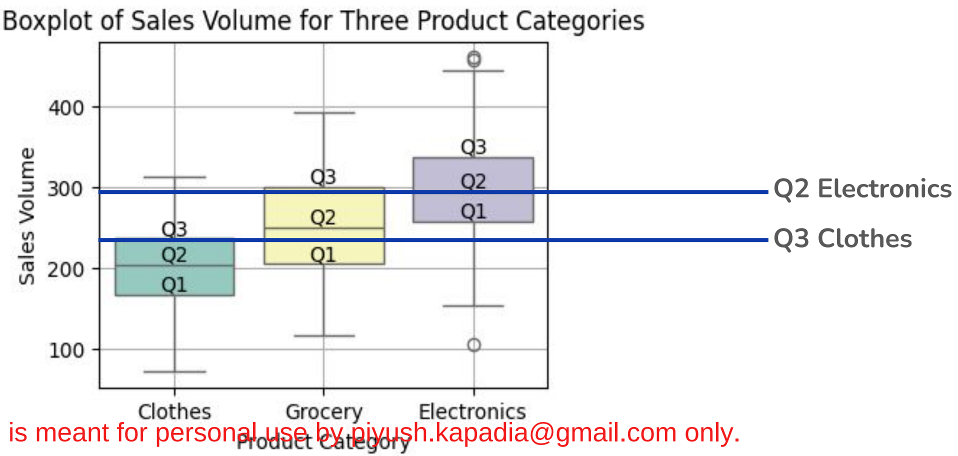


# Quartiles and Boxplot

Q1 is the value below which 25% of the data falls, i.e, 25% of data values <= Q1

Q2 (median) is the value below which 50% of the data falls, i.e., it splits the dataset into two equal halves

Q3 is the value below which 75% of the data falls, i.e, 75% of data values <= Q3



# EDA Quiz

Consider a dataset containing the columns Work experience (in years) and salary ($), Which of the following methods are generally used to deal with missing values in the salary column?

A Imputation by Mean

B Imputation by Median

C Imputation by Mode

D Dropping the missing values

# EDA Quiz

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# Missing Values in Data

Missing values indicate that there is no data for a given variable or observation, and are generally represented as `None` or `NaN` (Not a Number).

The **selection of a treatment technique is influenced by various factors**, including the nature and amount of missing data, the type of analysis, and the study's specific objectives.

# Missing Value Treatment

| Method | Working |
|---|---|
| Imputation by Mean | Replaces missing values with the mean of non-missing values in the column |
| Imputation by Median | Replaces missing values with the median of non-missing values in the column - more suitable when the data is skewed |
| Imputation by Mode | Replaces missing values with the most frequently occurring value in the column - primarily used for categorical variables |
| Dropping rows with missing values | Removes rows with missing values from the dataset - appropriate when the missing values are few and dropping them doesn't impact the analysis |
| Dropping attributes with missing values | Removes attributes with missing values from the dataset - appropriate when the proportion of missing values in the attribute is high and imputation might impact the data distribution |

# EDA Quiz

In general, data points which are less than Q1 - x * Interquartile Range (IQR) or greater than Q3 + x * IQR are considered to be outliers.
What is the value of x?

A 1

B 3

C 1.5

D 2

# EDA Quiz

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What is the value of x?

A 1

B 3

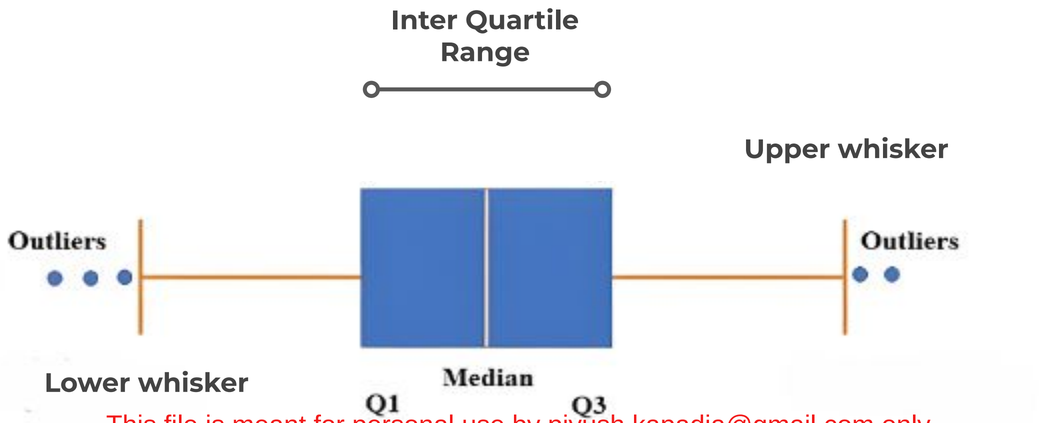
C [✓ 1.5]

D 2

# Outlier Detection

Data points that **deviate significantly from the majority of the observations** in a dataset, potentially impacting analysis and modeling

Values less than Q1 - 1.5 * IQR (lower whisker) or greater than Q3 + 1.5 * IQR (upper whisker) are considered as outliers.



# Happy Learning !