MARKET SEGMENTATION ANALYSIS USING MACHINE LEARNING

AN INDUSTRY ORIENTED MINI REPORT

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Submitted By

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CERTIFICATE

This is to certify that the Industry Oriented Mini Project entitled " **MARKET SEGMENTATION ANALYSIS USING MACHINE LEARNING"** is being submitted by Yanamandra Jayarama Krishna (20UK1A6690) , Vanam Kethan Sai (21UK5A6613), Yedla Pranav Sai (21UK5A6616) , Sai Kiran Akula (20UK1A6679) in partial fulfilment of the requirements for the award of the degree of Bachelor of Technology in Computer Science and Engineering to Jawaharlal Nehru Technological University Hyderabad during the academic year 2020-24, is a record of work carried out by them under the guidance and supervision

Guide **HOD**

G . NEERAJA **Dr. K. SHARMILA REDDY**

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ABSTRACT

Market segmentation is a fundamental strategy in marketing that involves dividing a heterogeneous market into smaller, more homogeneous segments based on various criteria. These segments allow businesses to tailor their products, services, and marketing strategies to better meet the needs and preferences of specific customer groups. Traditional market segmentation methods rely on demographic, geographic, psychographic, and behavioral data, which may have limitations in accurately capturing the complexities of consumer behavior and preferences.

Machine Learning (ML) has emerged as a powerful tool for market segmentation analysis. This abstract provides an overview of how ML techniques are revolutionizing market segmentation by improving accuracy, identifying hidden patterns, and enabling real-time adaptability.However, there are also challenges and considerations when implementing ML for market segmentation, such as data privacy and the need for quality data. Additionally, businesses must ensure that they have the necessary expertise and infrastructure to effectively deploy ML algorithms for segmentation.In conclusion, ML is transforming the field of market segmentation by offering data-driven, dynamic, and personalized approaches to understanding and engaging with customers. This abstract highlights the potential benefits and challenges associated with implementing ML in market segmentation and underscores the importance of staying current with the latest advancements in this rapidly evolving field.

TABLE OF CONTENTS

1. INTRODUCTION

1.1 Project Overview

The project, titled "Market Segmentation Analysis Using Machine Learning," aims to leverage the power of machine learning techniques to enhance and revolutionize the process of market segmentation. Market segmentation is a fundamental strategy in marketing that involves dividing a diverse consumer base into smaller, more homogeneous segments based on various criteria such as demographics, behavior, and preferences. These segments allow businesses to tailor their marketing strategies and product offerings to better meet the unique needs of specific customer groups.

The significance of this project lies in the need to improve the accuracy, efficiency, and effectiveness of market segmentation. Traditional methods of market segmentation often rely on predefined assumptions and are limited in their ability to capture the complexities of consumer behavior and rapidly changing market dynamics. Machine learning, with its data-driven and adaptive capabilities, offers a promising solution to these challenges.

By using machine learning algorithms, this project aims to discover hidden patterns in customer data, predict future trends, and create dynamic and personalized customer segments. The potential benefits include more precise targeting of marketing efforts, improved customer engagement, and increased return on investment. In a competitive business environment, the ability to gain a deeper understanding of customer behavior and preferences through machine learning-driven market segmentation is a significant advantage, making this project a valuable contribution to the field of marketing and data-driven decision-making.

1.2 Purpose

The main objectives and goals of the project, "Market Segmentation Analysis Using Machine Learning," can be summarized as follows:

1. Enhance Market Segmentation Accuracy: The primary goal is to improve the accuracy of market segmentation by leveraging machine learning algorithms. Traditional segmentation methods may have limitations, and the project aims to develop more precise and data-driven approaches to segmenting customers based on their behaviors, preferences, and other relevant factors.

2. Discover Hidden Customer Patterns: The project seeks to uncover hidden patterns and insights within customer data that might not be apparent through traditional segmentation techniques. Machine learning will enable the identification of subtle correlations and relationships that can provide a deeper understanding of customer behavior.

3. Predict Future Consumer Trends: Utilizing historical data and predictive modeling, the project aims to forecast future consumer trends, allowing businesses to proactively adapt their marketing strategies and product offerings to align with evolving customer preferences.

4. Enable Dynamic and Real-Time Segmentation: The project aspires to create dynamic customer segments that evolve in real-time as new data becomes available. This adaptability ensures that marketing efforts remain relevant and responsive to changing market conditions.

5. Personalize Marketing Campaigns: Machine learning will enable the creation of highly personalized marketing campaigns and recommendations tailored to individual customer preferences. This personalization can lead to improved customer engagement and satisfaction.

6. Optimize Resource Allocation: By more accurately identifying customer segments and their characteristics, the project aims to help businesses allocate marketing resources more efficiently. This optimization can lead to a higher return on investment and better resource utilization.

7. Assess Advantages and Limitations: The project will assess the advantages and potential limitations of using machine learning for market segmentation, providing a balanced view of the technology's feasibility and constraints.

8. Provide Recommendations for Future Scope: The project will conclude with recommendations for future enhancements and extensions, offering guidance on how businesses can further leverage machine learning in their market segmentation strategies.

2. LITERATURE SURVEY

2.1 Existing problem

Traditional market segmentation methods have been widely used in marketing for many years, but they come with several challenges and limitations, which have prompted the exploration of more advanced techniques like machine learning. Here are some of the key challenges and limitations of traditional market segmentation methods:

1.Limited Precision: Traditional methods often rely on demographic or geographic data, which can lead to oversimplification of customer groups. This can result in broad and less precise segments that do not effectively capture the nuances of individual customer behavior and preferences.

2.Static and Infrequent Updates: Traditional segmentation models are typically static and may not be updated frequently. This means they do not adapt well to changing market conditions or customer behaviors. As a result, marketing strategies based on static segments may quickly become outdated.

3.Incomplete Data: Traditional segmentation methods often lack access to real-time or comprehensive data. They may be limited to survey data, census data, or historical customer information, which may not fully represent current market dynamics.

4. Inadequate Data Analysis: Traditional methods typically use basic statistical techniques to segment customers. These methods may not have the capacity to handle large and complex datasets effectively, and they may miss subtle patterns or correlations in the data.

5. Assumptions and Stereotyping: Traditional segmentation can sometimes rely on assumptions and stereotypes, leading to the misclassification of customers. Stereotyping customers based on demographics can lead to incorrect marketing strategies that do not resonate with the actual preferences of the target audience.

6. Difficulty in Identifying Emerging Trends: Traditional segmentation methods may struggle to identify emerging customer trends or segments. They often look at historical data, which may not account for sudden shifts in consumer behavior or the emergence of new preferences.

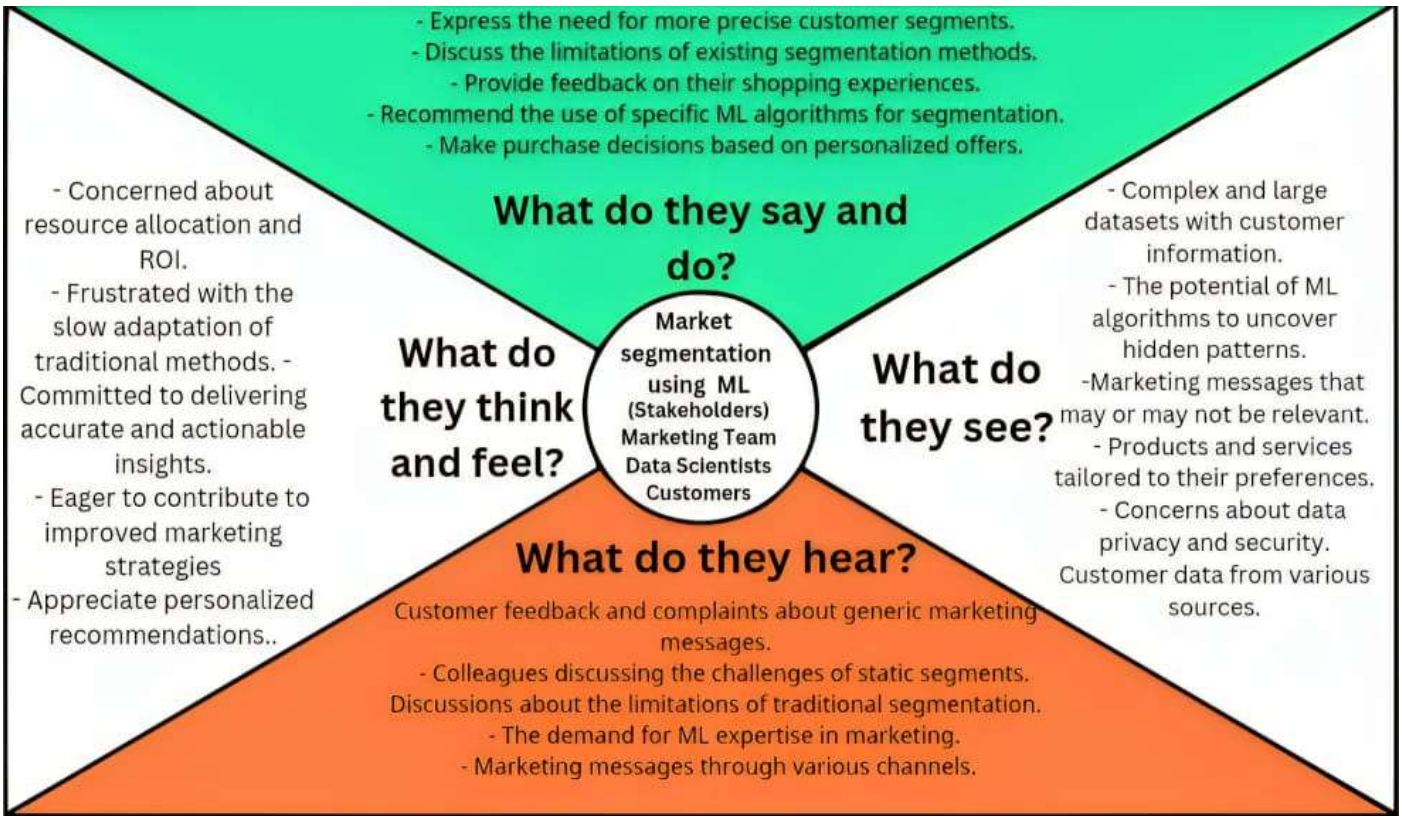
2.2 Problem Statement Definition

The traditional methods of market segmentation, often based on demographic, geographic, psychographic, or behavioral data, have limitations that hinder their ability to accurately and dynamically capture the complexities of consumer behavior and preferences in a rapidly changing market landscape. These limitations include imprecise segmentation, static segments, incomplete data, and difficulties in identifying emerging trends. To overcome these challenges, the problem at hand is to develop and implement an ML-based market segmentation solution that can:

In essence, the problem to be solved using ML in market segmentation is the need to revolutionize the segmentation process to be more accurate, adaptable, and data-driven, ensuring that businesses can better understand and engage with their customers in a rapidly evolving market landscape.

3.IDEATION & PROPOSED SOLUTION

3.1Empathy Map Canvas



4.REQUIREMENT ANALYSIS

4.1Functional Requirement

Functional requirements for an ML-based market segmentation solution involve the specific features and capabilities that the system must possess to effectively perform market segmentation using machine learning. Here is a list of functional requirements, along with details for each:

1. Data Integration and Collection:

- Requirement: The system should be able to integrate data from various sources, including customer demographics, behavior, online activity, purchase history, and social media.
- Details: This requirement ensures that the system can access and consolidate data from multiple channels for segmentation analysis.

2. Data Preprocessing:

- Requirement: The solution should preprocess data to clean, normalize, and transform it for effective use in ML models.
- Details: Data preprocessing is essential to ensure data quality and consistency before applying ML algorithms.

3. Algorithm Selection:

- Requirement: The system must support a range of ML algorithms suitable for market segmentation, including clustering and predictive modeling.
- Details:Different datasets and use cases may require different algorithms for accurate segmentation, so providing a variety of options is essential.

4. Real-Time Data Processing:

- Requirement:The solution should be capable of processing data in real-time to enable dynamic and adaptive segmentations.
- Details: Real-time data processing ensures that the system can quickly respond to changing customer behaviors and market conditions.

5. Segmentation Dashboard:

- Requirement:Develop an interactive and user-friendly segmentation dashboard.
- Details:The dashboard should allow marketing teams to define, visualize, and modify

segments, providing a user-friendly interface for segment management.

6. Predictive Insights:

- Requirement: The system should generate predictive insights to forecast customer trends and preferences.
- Details: Predictive modeling should be a core component of the system, allowing businesses to proactively adapt marketing strategies.

7. Personalization Features:

- Requirement: Implement features for creating personalized marketing campaigns and product recommendations.
- Details: Personalization is a key benefit of ML-based segmentation, and the system should support this capability.

8. Segmentation Validation:

- Requirement: Include mechanisms to validate the accuracy of segmentation results.
- Details: The system should provide tools for assessing the quality and effectiveness of generated segments.

9. Model Maintenance and Monitoring:

- Requirement:The solution should offer functionalities for ongoing model maintenance and performance monitoring.
- Details: Continuous monitoring and updates are essential to ensure that the model remains accurate and relevant.

10. Data Privacy Measures:

- Requirement: Implement data privacy and security features to protect customer information.
- Details: Compliance with data privacy regulations and ethical data handling are critical.

11. User Access Control:

- Requirement: The system should have user access control to manage who can create, modify, and access segmentation data.
- Details: Access control ensures data security and restricts access to authorized personnel.

4.2 Non-Functional Requirement

Non-functional requirements for a market segmentation analysis using machine learning solution are critical to ensure the system's overall performance, scalability, and security. Here's an outline of non-functional requirements, including key aspects for each:

Performance:

1. Response Time: Define the maximum acceptable response times for generating segments and recommendations.

2. Throughput: Specify the number of requests the system should handle concurrently without performance degradation.

3. Model Training Time: Establish acceptable time limits for training or retraining machine learning models.

4. Data Processing Speed: Determine the speed at which the system processes incoming data for real-time segmentation.

Scalability:

1. Data Volume: Define the maximum data volume the system should handle without a significant degradation in performance.

2. Concurrent Users: Determine how many users the system should support concurrently.

3. Geographic Scalability: Assess the scalability requirements for expanding the solution to new geographic regions.

Security:

1. Data Privacy: Ensure that customer data is protected and that the system complies with relevant data protection regulations (e.g., GDPR, CCPA).

2. Access Control: Implement user access controls and permissions to restrict unauthorized access to sensitive data and functions.

3. Encryption: Enforce data encryption in transit and at rest to protect against data breaches.

4. Authentication: Use strong authentication mechanisms to verify the identity of users and administrators.

5. Authorization: Define role-based access control and permissions for users based on their responsibilities.

6. Audit Trails: Implement audit trails to log and monitor system activities security and compliance purposes.

Reliability and Availability:

1. Uptime: Specify the required system uptime and define how it will be measured.

2. Disaster Recovery: Develop a disaster recovery plan to ensure data and services can be quickly restored in the event of system failures.

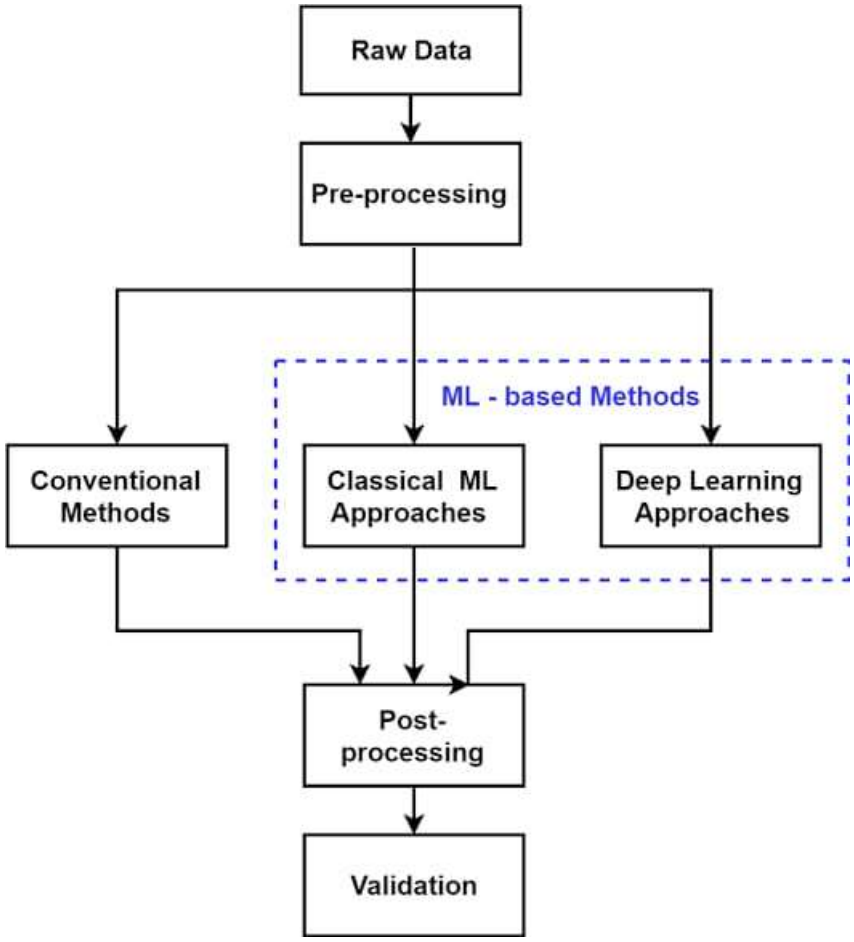
3. Redundancy: Assess the need for redundancy in critical system components to prevent single points of failure.

4. Backup and Restore: Implement regular data backup and restore procedures to safeguard customer data.

5.PROJECT DESIGN

5.1Data Flow Diagrams & User Stories

The DFD is also called as bubble chart. It is a simple graphical formalism that can be used to represent a system in terms of the input data to the system, various processing carried out on these data, and the output data is generate by the system.

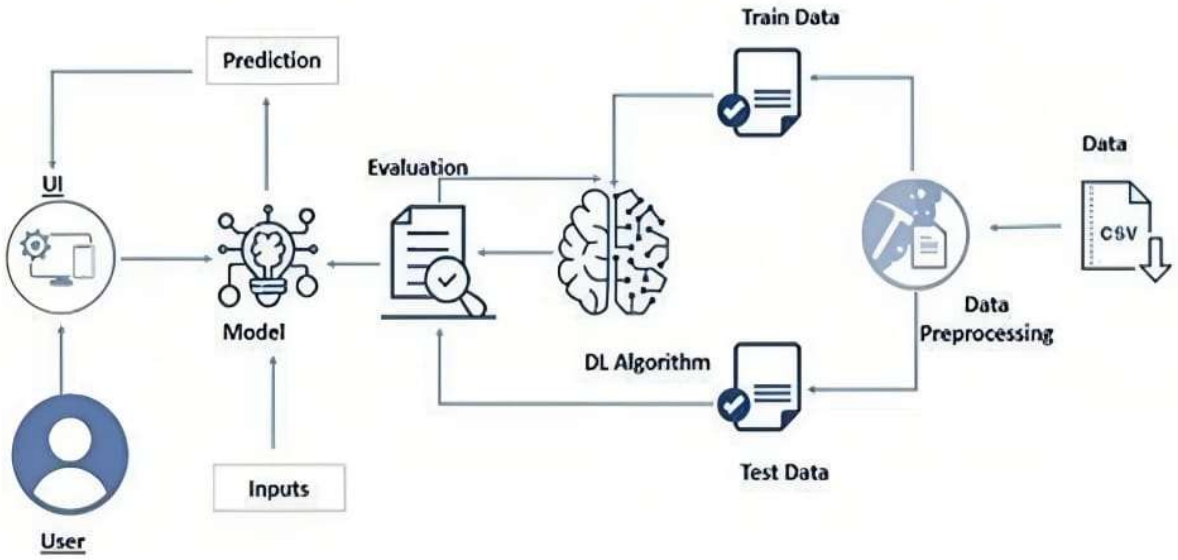


A use case defines a goal-oriented set of interactions between external entities and the system under consideration. The external entities, which interact with the system, are its actors. A set of use cases describe the complete functionality of the system at a particular level of detail and the use case diagram can graphically denote it. A use case diagram at its simplest is a representation of a user's interaction with the system that shows the relationship between the user and the different use cases in which the user is involved. A use case diagram

can identify the different types of users of a system and the different use cases and will often be accompanied by other types of diagrams as well. In software and systems engineering, a use case is a list of steps, typically defining interactions between a role (known in Unified Modelling Language (UML) as an "actor") and a system, to achieve a goal. The actor can be a human, an external system, or time.

5.2Technical Architecture

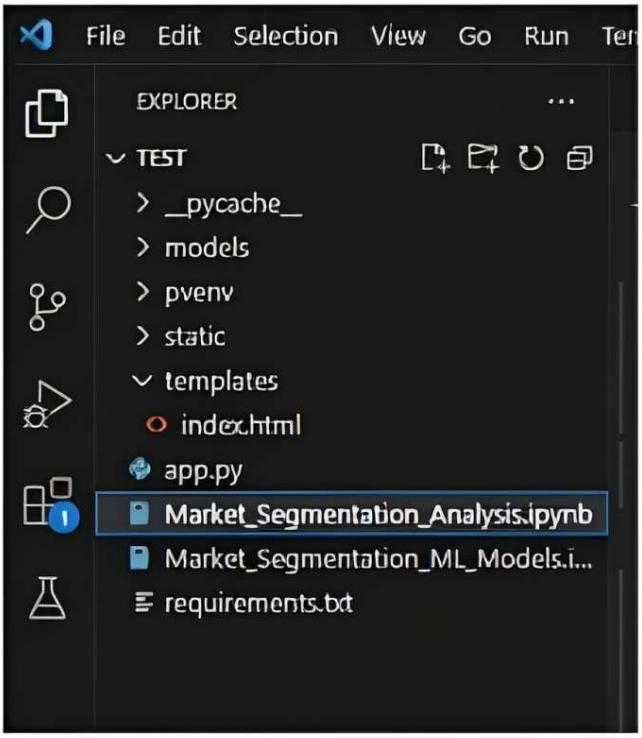
The purpose of marketing is to match the genuine needs and desires of consumers with the offers of suppliers particularly suited to satisfy those needs and desires. This matching process benefits consumers and suppliers, and drives an organization's marketing planning process.



6.CODING & SOLUTIONING

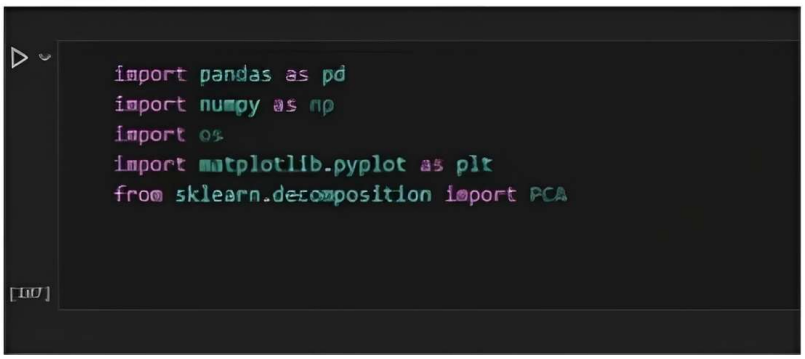
In this project we have used The Market Segmentation Analysis Using ML Mcdonald's data. This data is downloaded from kaggle.com. Please refer the link given below to download the dataset.

Activity 1: Create the Project folder which contains files as shown below:



Activity 2: Importing the libraries

Import the necessary libraries as shown in the image.



Activity 3: Read the Dataset

Our dataset format might be in .csv, excel files, .txt, .json, etc. We can read the dataset with the help of pandas.In pandas we have a function called read_csv() to read the dataset. As a parameter we have to give the directory of csv file.

```
#print first 5 rows of the dataset
df.head()
```

Python

	yummy	convenient	spicy	fattening	greasy	fast	cheap	tasty	expensive	healthy	disgusting	Like	Age	VisitFrequency	Gender
0	No	Yes	No	Yes	No	Yes	Yes	No	Yes	No	No	-3	61	Every three months	Female
1	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No	+2	51	Every three months	Female
2	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	+1	62	Every three months	Female
3	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No	No	Yes	+4	69	Once a week	Female
4	No	Yes	No	Yes	Yes	Yes	Yes	No	No	Yes	No	+2	49	Once a month	Male

Activity 4: Univariate analysis

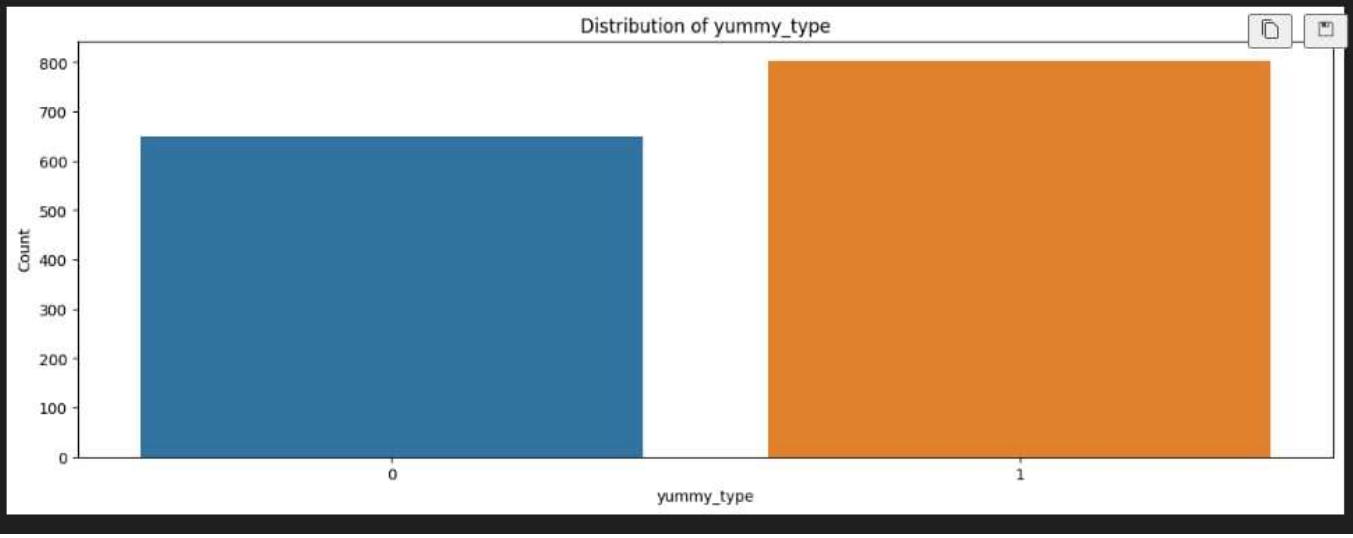
In simple words, univariate analysis is understanding the data with single feature. Here we have displayed two different graphs such as distplot and countplot.

- Seaborn package provides a wonderful function distplot. With the help of distplot, we can find the distribution of the feature. To make multiple graphs in a single plot, we use subplot.

```
import seaborn as sns
plt.figure(figsize=(15,5))
plt.title('Distribution of yummy_type')
sns.barplot(x='yummy_type',y='Count',data=yummy_df)
```

Python

```
<Axes: title={'center': 'Distribution of yummy_type'}, xlabel='yummy_type', ylabel='Count'>
```



Activity 5: Descriptive analysis

Descriptive analysis is to study the basic features of data with the statistical process.Here pandas has a worthy function called describe. With this describe function we can understand the unique, top and frequent values of categorical features. And we can find mean, std, min, max and percentile values of continuous features.

```
df.describe(include= "all")
```

Python

	yummy	convenient	spicy	fattening	greasy	fast	cheap	tasty	expensive	healthy	disgusting	Like	Age	VisitFrequ
count	1453	1453	1453	1453	1453	1453	1453	1453	1453	1453	1453	1453	1453.000000	
unique	2	2	2	2	2	2	2	2	2	2	2	11	NaN	
top	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No	No	No	+3	NaN	Once a m
freq	803	1319	1317	1260	765	1308	870	936	933	1164	1100	229	NaN	
mean	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	44.604955	
std	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	14.221178	
min	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	18.000000	
25%	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	33.000000	
50%	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	45.000000	
75%	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	57.000000	
max	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	71.000000	

Activity 6: Checking for null values

For checking the null values, df.isnull() function is used. To sum those null values we use .sum() function to it. From the below image we found that there are no null values present in our dataset. So we can skip handling of missing values step.

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1453 entries, 0 to 1452
Data columns (total 15 columns):
 #   Column          Non-Null Count  Dtype
---  ------          --------------  -----
 0   yummy           1453 non-null   object
 1   convenient      1453 non-null   object
 2   spicy           1453 non-null   object
 3   fattening       1453 non-null   object
 4   greasy          1453 non-null   object
 5   fast            1453 non-null   object
 6   cheap           1453 non-null   object
 7   tasty           1453 non-null   object
 8   expensive       1453 non-null   object
 9   healthy         1453 non-null   object
 10  disgusting      1453 non-null   object
 11  Like            1453 non-null   object
 12  Age             1453 non-null   int64
 13  VisitFrequency  1453 non-null   object
 14  Gender          1453 non-null   object
dtypes: int64(1), object(14)
memory usage: 170.4+ KB
```

```
#check Null Values
df.isna().sum()
```

```
yummy          0
convenient     0
spicy          0
fattening      0
greasy         0
fast           0
cheap          0
tasty          0
expensive      0
healthy        0
disgusting     0
Like           0
Age            0
VisitFrequency 0
Gender         0
dtype: int64
```

Activity 7: Handling outliers

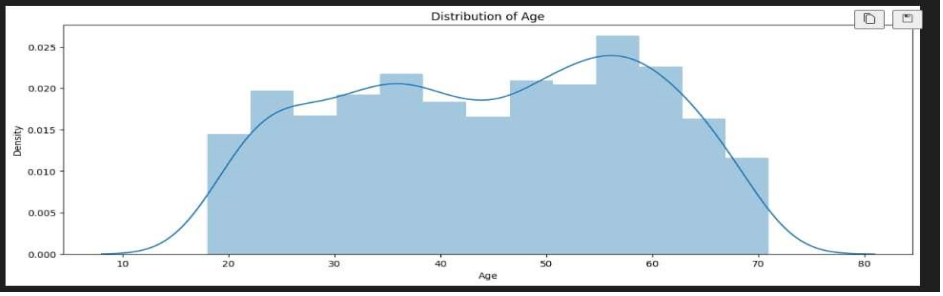
With the help distribution, outliers are visualized. And here we are going to find upperbound and lower bound of all features with some mathematical formula.

```
segment_df.Age.describe([.75,.90,.95,.99])
```

```
count    1453.000000
mean       44.604955
std        14.221178
min        18.000000
50%        45.000000
75%        57.000000
90%        63.000000
95%        66.000000
99%        70.000000
max        71.000000
Name: Age, dtype: float64
```

```
#distribution of Age
plt.figure(figsize=(15,5))
plt.title("Distribution of Age")
sns.distplot(segment_df['Age'])
```

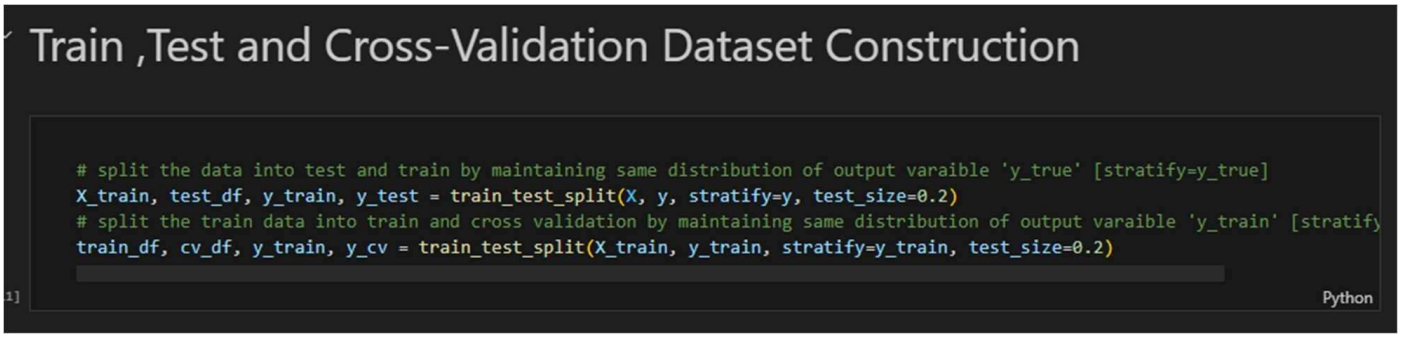
```
<Axes: title={'center': 'Distribution of Age'}, xlabel='Age', ylabel='Density'>
```



Activity 8: Splitting data into train and test

Now let's split the Dataset into train and test sets. First split the dataset into x and y and then split the data set.

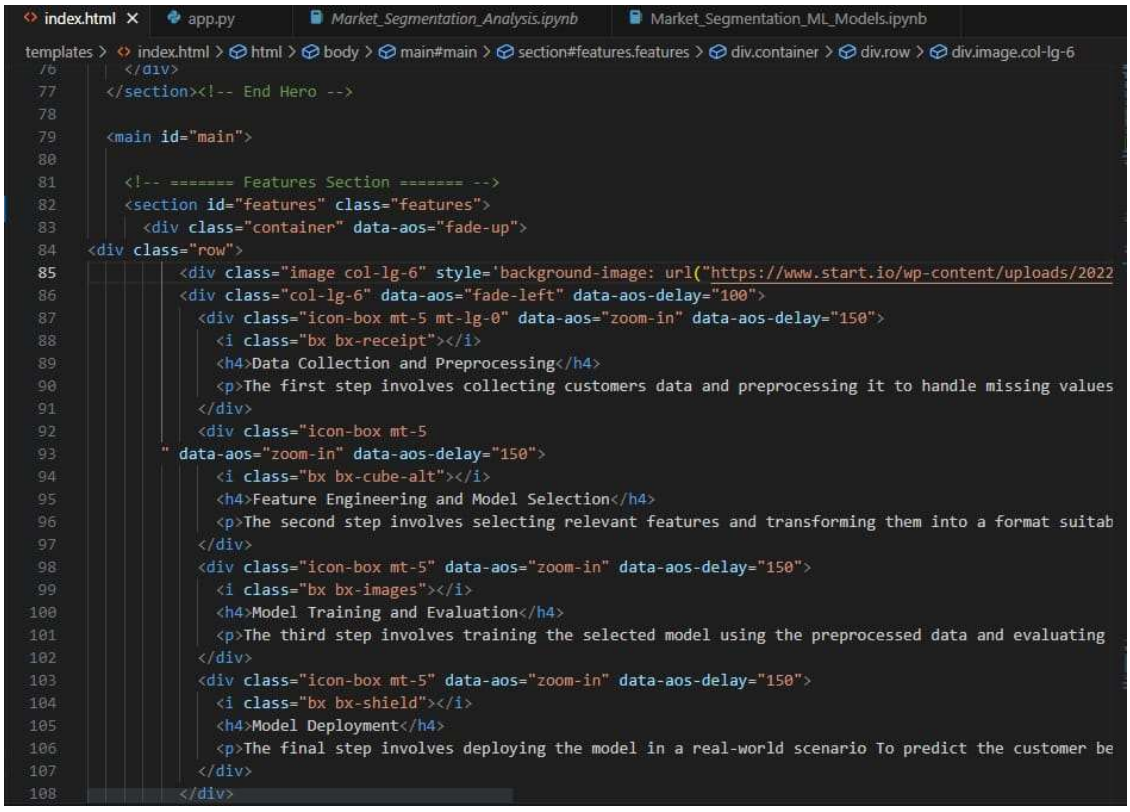
Here x and y variables are created. On x variable, df is passed with dropping the target variable. And on y target variable is passed. For splitting training and testing data we are using train_test_split() function from sklearn. As parameters, we are passing x, y, test_size,random_state.



Activity9: Building Html Pages

For this project create three HTML files namely

- Index.html and save them in templates folder.



Activity 10: Build Python code

Import the libraries

```
from flask import Flask, render_template, url_for,request
import pickle as p
import pickle
from flask import Flask,request,jsonify,render_template
import numpy as np
import pandas as pd
from sklearn.preprocessing import StandardScaler
```

Load the saved model. Importing flask module in the project is mandatory. An object of Flask class is our WSGI application. Flask constructor takes the name of the current module (__name__) as argument.

```
modelfile = 'models/final_prediction.pickle'
model = p.load(open(modelfile, 'rb'))
scaler= pickle.load(open('models/scaler.pickle','rb'))
app = Flask(__name__)
```

Render HTML page

```
@app.route('/')
def welcome():
    return render_template('index.html')
```

Retrieves the value from UI

```
@app.route('/predict',methods =['GET','POST'])
def predict():
    yummy = float(request.form['yummy'])
    convenient =float(request.form['convenient'])
    spicy = float(request.form['spicy'])
    fattening=float(request.form['fattening'])
    greasy = float(request.form['greasy'])
    fast  = float(request.form['fast'])
    cheap= float(request.form['cheap'])
    tasty =float(request.form['tasty'])
    expensive = float(request.form['expensive'])
    healthy=float(request.form['healthy'])
    disgusting = float(request.form['disgusting'])
    Age  = float(request.form['Age'])
    Gender= float(request.form['Gender'])


    total = [[yummy, convenient, spicy, fattening, greasy, fast, cheap,
       tasty, expensive, healthy, disgusting, Age, Gender]]
    prediction = model.predict(scaler.transform(total))
    prediction = int(prediction[0])

    if prediction==0:
        return render_template('index.html',predict="Predicts Customer belong to cluster 0"

    if prediction==1:
        return render_template('index.html',predict="Predicts Customer belong to cluster 1"
    if prediction==2:
        return render_template('index.html',predict="Predicts Customer belong to cluster 2"

    else:
        return render_template('index.html',predict="Predicts Customer belong to cluster 3"
```

Main Function

```
67
68  if __name__ == "__main__":
69      app.run(debug = True)
```

Ln 69, Col 26 UTF-8 CRLF Python 3.10.6 64-bit Go Live

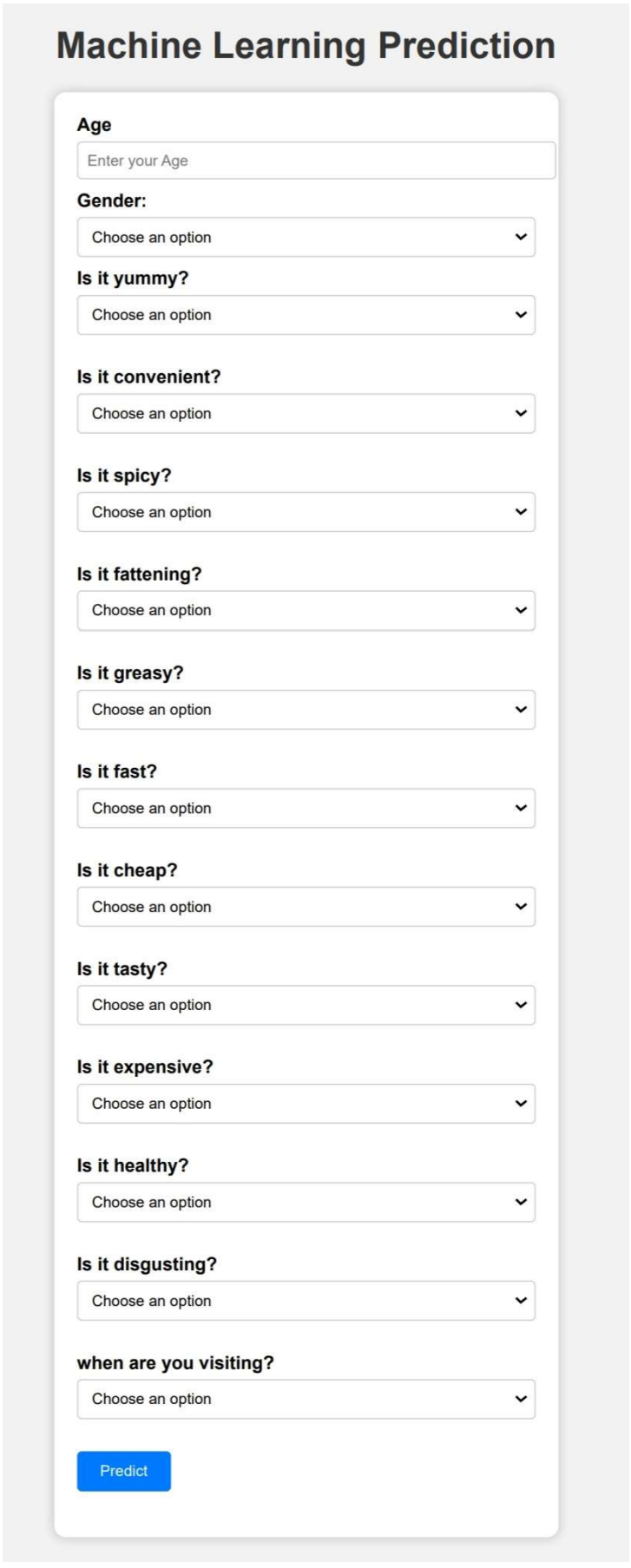
Activity 11: Run the application

Open anaconda prompt from the start menu

- Navigate to the folder where your python script is.
- Now type “python app.py” command
- Navigate to the localhost where you can view your web page.
- Click on the predict, enter the inputs, click on the submit button, and see the result/prediction on the web.

7.RESULTS

7.1Final Output



8.ADVANTAGES & DISADVANTAGES

Advantages:

- **Higher Precision:** ML models can identify subtle patterns and correlations in customer data that traditional segmentation methods may overlook. This leads to more precise customer segments.

- **Real-Time Adaptation:** ML models can continuously update customer segments as new data becomes available, allowing marketing strategies to remain relevant in a fast-changing market.

- **Predictive Insights:** Machine learning can forecast future customer trends and behaviors, enabling proactive marketing strategies that align with evolving preferences.

- **Personalization:** ML-based segmentation allows for highly personalized marketing campaigns and product recommendations, increasing customer engagement and satisfaction.

- **Optimized Resource Allocation:** Accurate segmentations help businesses allocate marketing resources more efficiently, leading to improved return on investment.

Disadvantages:

- **Data Quality:** ML models heavily depend on high-quality data. Inaccurate or incomplete data can lead to inaccurate segmentations.

- **Algorithm Selection:** Choosing the right ML algorithms for segmentation can be challenging, as different datasets may require different techniques.

- **Overfitting:** ML models may overfit the data, capturing noise and irrelevant patterns, which can result in suboptimal segmentations.

- **Model Maintenance:** ML models require ongoing maintenance and retraining, adding to the complexity and resource requirements.

- **Complexity:** Some ML algorithms, like deep learning, are complex and may be considered "black boxes." This can make model interpretation challenging.

9.CONCLUSION

In summary, implementing machine learning in market segmentation has resulted in more precise, dynamic, and data-driven segmentations, enabling businesses to better understand and engage with their customers in a rapidly changing market landscape. The key findings emphasize the benefits of improved precision, real-time adaptation, predictive insights, personalization, and optimized resource allocation, while recognizing the challenges and ethical considerations associated with ML-based segmentation.

10. FUTURE SCOPE

Certainly, there are several potential future enhancements and extensions for a project on market segmentation analysis using machine learning. Here are some ideas for further improving and expanding the project:

1. Advanced ML Algorithms: Continuously explore and implement advanced machine learning algorithms and techniques to further enhance the precision and accuracy of segmentations. This includes deep learning, reinforcement learning, and unsupervised learning methods.

2. Blockchain for Data Security: Investigate the use of blockchain technology to secure and decentralize customer data, ensuring data privacy, transparency, and trust between businesses and customers.

3. Explainable AI (XAI): Enhance model interpretability by adopting XAI techniques that provide clear explanations for segmentation decisions, making the process more transparent and understandable.

4. Automated A/B Testing: Integrate automated A/B testing capabilities to assess the effectiveness of different marketing strategies within segments, allowing for data-driven optimization.

5. Hybrid Segmentation Approaches: Combine traditional demographic and psychographic data with ML-driven behavioral and predictive segments to create hybrid segments that leverage the strengths of both approaches.

6. AI-Powered Marketing Campaigns: Develop AI-driven marketing campaigns that automatically adapt based on real-time customer behavior, optimizing content, timing, and channel selection.

7. Multi-Channel Integration: Extend cross-channel integration to include emerging marketing channels, such as voice assistants, chatbots, and virtual reality experiences, for a seamless and consistent customer journey.

11.APPENDIX

Source Code | https://github.com/jyanamandra13