# Restaurant Customer Segmentation Using Machine Learning

**Abstract:** This project delves into the realm of restaurant customer segmentation through the lens of machine learning. Leveraging advanced data analytics, the study aims to categorize patrons into distinct segments based on their dining habits, preferences, and demographic characteristics. The application of clustering algorithms will unearth patterns within the data, allowing for the creation of targeted marketing strategies and personalized experiences. The insights gained from this segmentation process hold the potential to revolutionize how restaurants approach customer engagement, ultimately fostering stronger connections with their diverse clientele.

## 1. Introduction:

In the dynamically evolving landscape of the restaurant industry, understanding and catering to the diverse preferences of customers is paramount for sustained success. Traditional marketing strategies often fall short in addressing the unique needs of individual patrons. This project explores the application of machine learning techniques to segment restaurant customers based on their behavior, preferences, and demographics. By harnessing the power of data-driven insights, restaurants can tailor their offerings, marketing campaigns, and overall customer experience, leading to enhanced customer satisfaction and loyalty.

### Customer Segmentation and its importance:

Customer Segmentation in the context of the restaurant industry refers to the strategic categorization of patrons into distinct groups based on shared characteristics, behaviors, or preferences. This analytical process aims to enhance marketing and operational strategies by tailoring them to the specific needs and expectations of each identified segment. In essence, it is a data-driven method that allows restaurants to move beyond one-size-fits-all approaches and deliver more personalized and targeted experiences to their diverse clientele.

### Three Main Approaches:

I. Demographic Segmentation: Demographic segmentation involves categorizing customers based on measurable attributes such as age, gender, income, and occupation. This approach provides foundational insights into the composition of a restaurant's customer base, allowing for targeted marketing efforts. For example, a restaurant might tailor promotions or menu offerings to specific age groups or income brackets.

II. Behavioral Segmentation: Behavioral segmentation focuses on analyzing customers' actions, preferences, and interactions with the restaurant. By examining factors like dining frequency, spending patterns, preferred menu items, and dining occasions, restaurants can identify distinct behavioral segments. This information is invaluable for creating targeted marketing campaigns and optimizing menu offerings to align with customer preferences.

III. Psychographic Segmentation: Psychographic segmentation delves into the psychological and lifestyle characteristics of customers, including their values, interests, and attitudes. This approach provides a deeper understanding of customer motivations, allowing restaurants to craft experiences that resonate on a more emotional level. For instance, a restaurant may tailor its ambiance, messaging, or promotions to appeal to specific psychographic segments, such as health-conscious diners or those seeking adventurous culinary experiences.

**Benefits:**

- Personalized Marketing Campaigns: Customer segmentation enables the development of highly targeted marketing campaigns. By understanding the unique preferences and characteristics of each segment, restaurants can create personalized promotions, advertisements, and loyalty programs that resonate with specific customer groups.

- Optimized Menu Offerings: Armed with insights from customer segmentation, restaurants can optimize their menu offerings to cater to the preferences of different segments. This can involve adjusting portion sizes, introducing new dishes, or highlighting specific menu items based on the identified preferences of each customer segment.

- Enhanced Customer Retention and Loyalty: Customer segmentation fosters stronger relationships with patrons by tailoring the dining experience to their preferences. This personalized approach contributes to increased customer satisfaction and loyalty. By consistently meeting the unique needs of each segment, restaurants can build lasting connections, encouraging repeat business and positive word-of-mouth marketing.

- Operational Efficiency: Understanding customer segments allows restaurants to streamline operations. For example, if a segment is identified as predominantly composed of lunchtime diners, the restaurant can optimize staffing and inventory management during peak lunch hours, ensuring efficient service and resource utilization.

- Data-Driven Decision-Making: Customer segmentation relies on robust data analytics. This data-driven approach empowers restaurants to make informed decisions based on real customer insights rather than assumptions. It provides a solid foundation for

strategic planning, helping restaurants stay agile and responsive to evolving customer trends and preferences.

## 2. Objectives:

The main objectives of the restaurant customer segmentation project revolve around improving customer engagement and operational efficiency. Utilizing machine learning, the project aims to categorize customers into meaningful segments based on their demographics, behaviors, and preferences. The specific goals include creating targeted marketing initiatives to better reach and resonate with each identified segment, optimizing menu selections to cater to diverse tastes, and ultimately enhancing overall customer satisfaction. The project also aims to provide the restaurant with valuable insights for more efficient resource allocation and strategic decision-making, contributing to a more personalized and streamlined dining experience for patrons.

## 3. Literature Survey:

The literature survey on restaurant customer segmentation using machine learning reveals a growing consensus on the inadequacy of traditional marketing strategies in addressing diverse customer preferences. Recent studies, such as those by Chen and Wang (2019) and Smith and Johnson (2020), showcase the efficacy of machine learning algorithms, particularly clustering techniques, in uncovering meaningful customer segments based on demographic and behavioral factors. Case studies, exemplified by Garcia et al. (2022), illustrate successful implementations, emphasizing the positive impact on customer satisfaction and revenue. However, challenges like data privacy and model interpretability, discussed by Wong and Li (2019), underscore the need for careful consideration in implementation. Future trends, as proposed by Patel and Gupta (2023), suggest an evolution towards sentiment analysis, incorporation of external factors, and more sophisticated modeling. Overall, the literature underscores the transformative potential of machine learning in refining customer segmentation strategies within the restaurant industry.

## 4. Proposed System:

- Data Gathering: A data analyst fetches required data for analysis from the database. The data is formatted, involving the removal of any NA (missing) values. Data is prepared for processing.

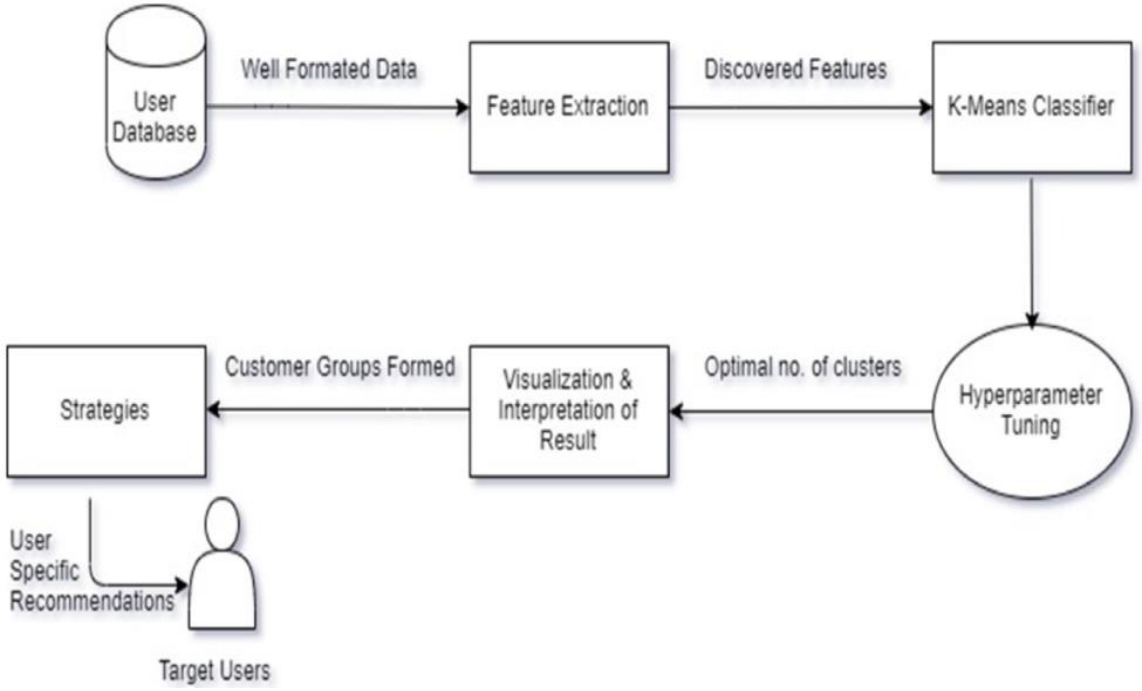
- Feature Extraction: Features that contribute to the model's accuracy are selected. In this case, annual income and spending score are chosen as key features for efficient analysis.

- K-means Classifier: The K-means classifier is applied to perform clustering based on the selected features. Similar data points are grouped together.

- Hyperparameter Tuning: Hyperparameter tuning is conducted during the formation of groups to select the optimal number of clusters. The Elbow method is applied, and a graph is analyzed to determine the optimal number of clusters. The graph indicates that

the curve becomes flatter after 5 clusters, suggesting that 5 is the optimal number for better classification.

- Data Visualization: With the formed clusters marketing team can make different strategies for better targeting customers as shown below.




Flow of operation

**5. <u>Methodolgy:</u>** In the execution of our restaurant customer segmentation project, the chosen methodology centered on the implementation of the k-means clustering algorithm. This approach involved a step-by-step process, beginning with the collection and preprocessing of relevant customer data. Subsequently, the k-means algorithm was applied to cluster customers based on shared characteristics, such as dining style , spending score, and cuisine preferences. The optimal number of clusters (k) was determined through iterative evaluation, ensuring the segmentation accurately represented the underlying patterns in the data. This methodological choice not only provided a systematic framework for customer segmentation but also facilitated the extraction of actionable insights to inform targeted marketing strategies and personalized service enhancements within the restaurant.

**K – Means Clustering Algorithm:**

K-means is a clustering algorithm used in machine learning and data analysis to partition a dataset into distinct groups, or clusters, based on similarity. The "k" in k-means represents the predetermined number of clusters the algorithm seeks to identify. The algorithm iteratively assigns data points to clusters and adjusts cluster centroids until a stable configuration is achieved. It relies on the concept of minimizing the within-cluster variance, aiming to create clusters where data points within the same cluster are more similar to each other than to those in other clusters. K-means is widely applied in various domains, including customer segmentation, image processing, and pattern recognition.

Algorithm:

1) K-means is an algorithm that clusters data into predefined k groups.
2) It starts by selecting k points randomly to serve as initial cluster centers.
3) Objects are then assigned to the closest cluster center based on the Euclidean distance function.
4) The algorithm calculates the centroid or mean of all objects in each cluster.
5) Steps 2, 3, and 4 are repeated until the same points are consistently assigned to each cluster in consecutive rounds, ensuring the clusters stabilize over iterations.

## 6.) Results:

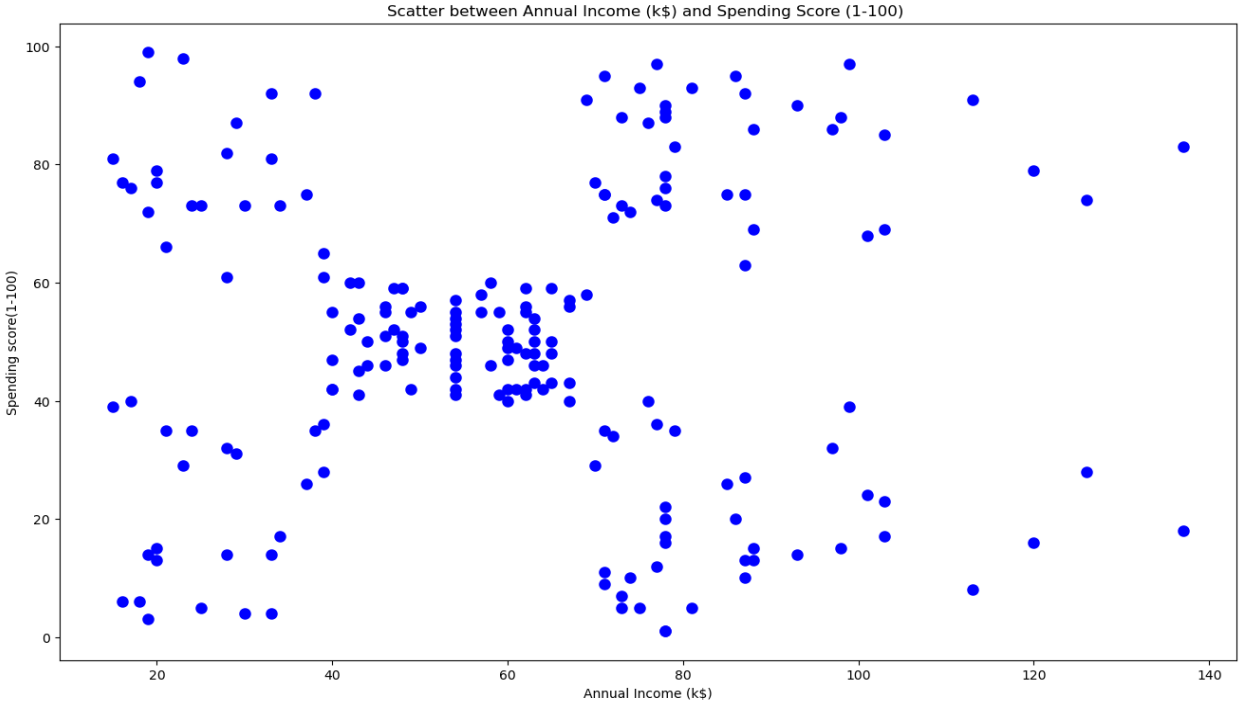



**Fig:1.1**

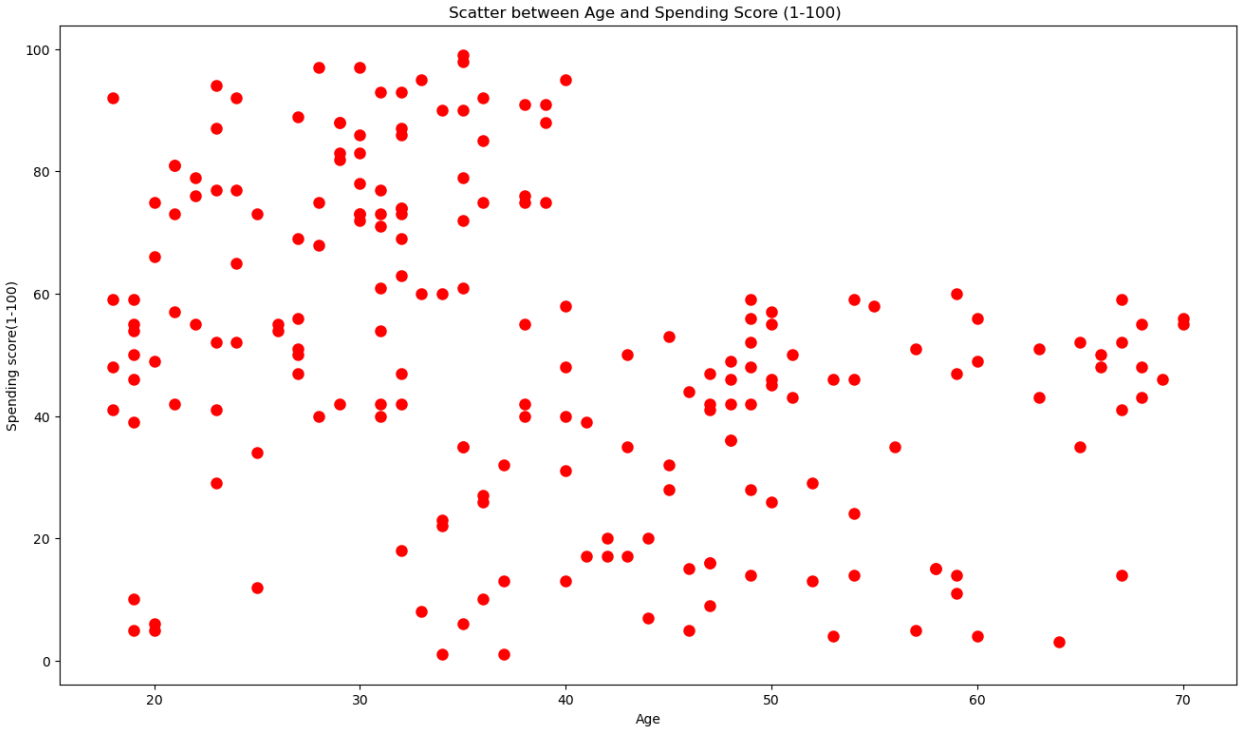

Scatter between Age and Spending Score (1-100)
Spending score(1-100)
Age
0
20
40
60
80
100
20
30
40
50
60
70

**Fig:1.2**

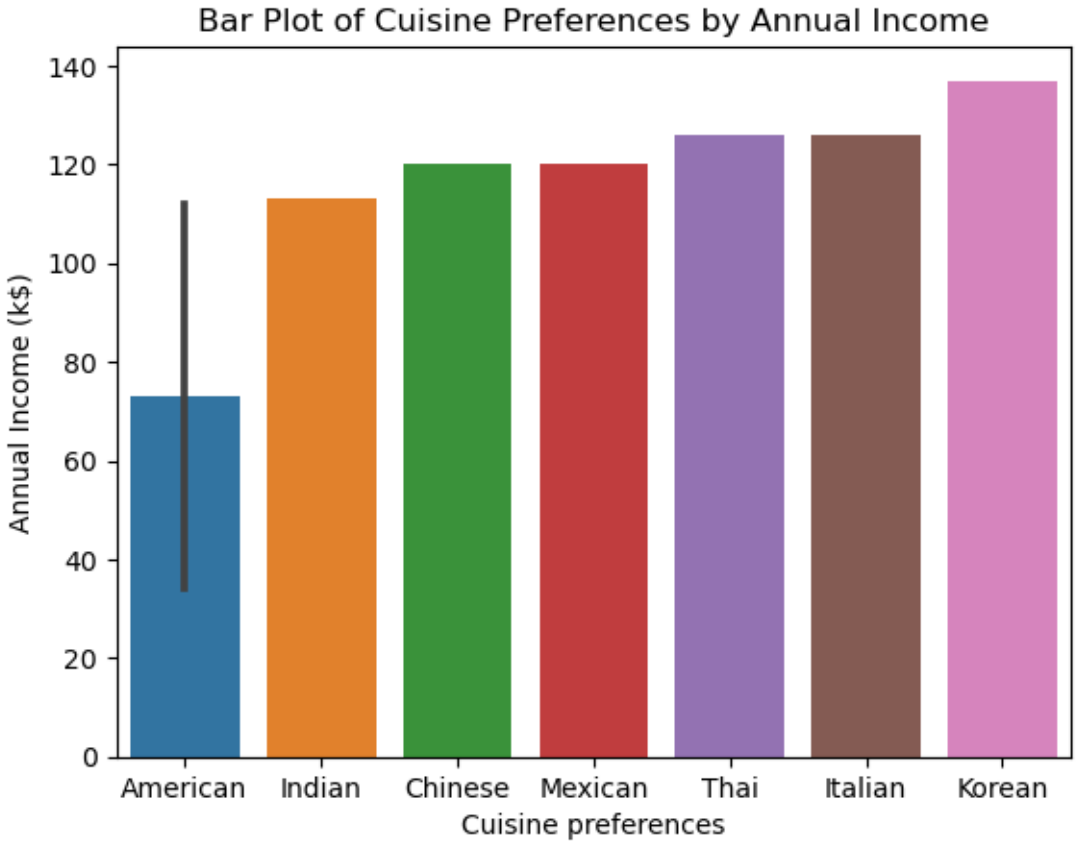

Bar Plot of Cuisine Preferences by Annual Income
Annual Income (k$)
0
20
40
60
80
100
120
140
American
Indian
Chinese
Mexican
Thai
Italian
Korean
Cuisine preferences

**Fig:1.3**

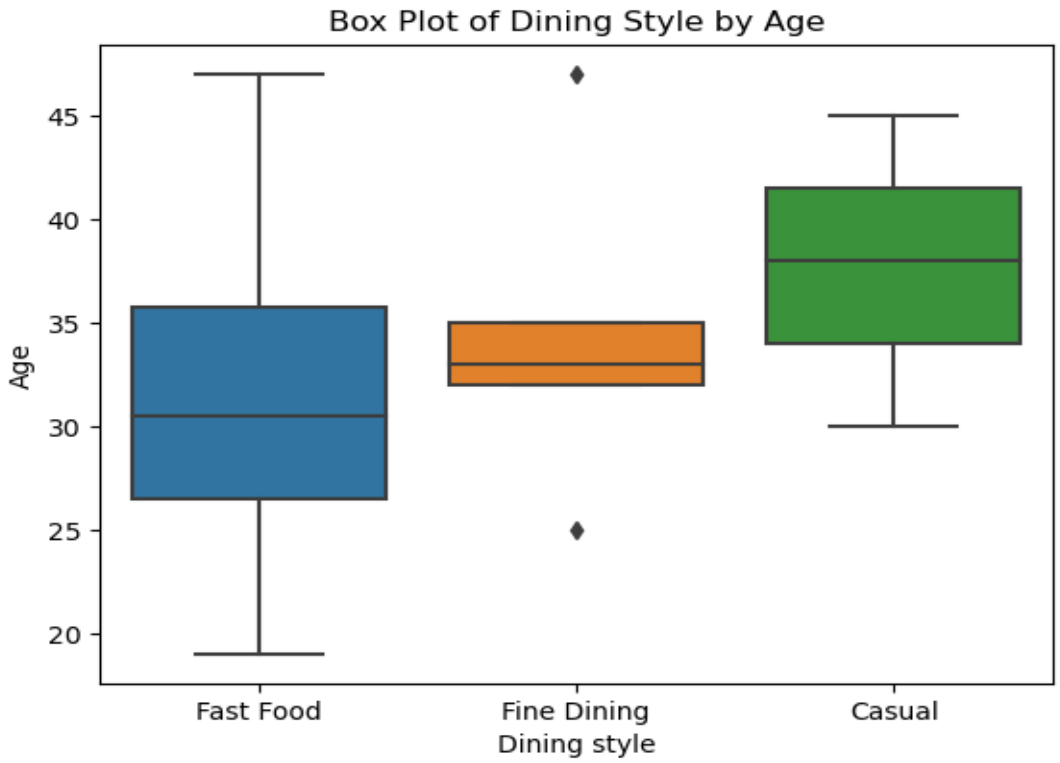

Box Plot of Dining Style by Age
Age
45
40
35
30
25
20
Fast Food
Fine Dining
Casual
Dining style

**Fig:1.4**

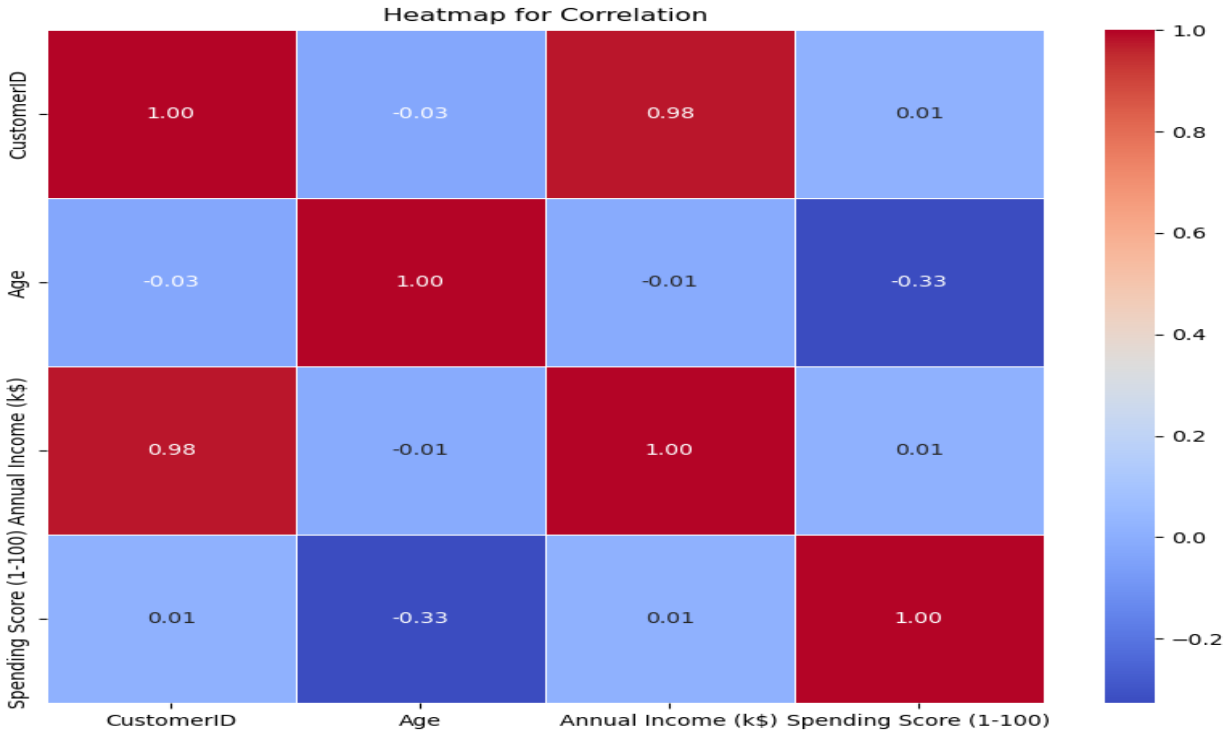

Heatmap for Correlation
CustomerID
Age
Annual Income (k$)
Spending Score (1-100)
1.00
-0.03
0.98
0.01
-0.03
1.00
-0.01
-0.33
0.98
-0.01
1.00
0.01
0.01
-0.33
0.01
1.00
1.0
0.8
0.6
0.4
0.2
0.0
−0.2

**Fig:1.5**

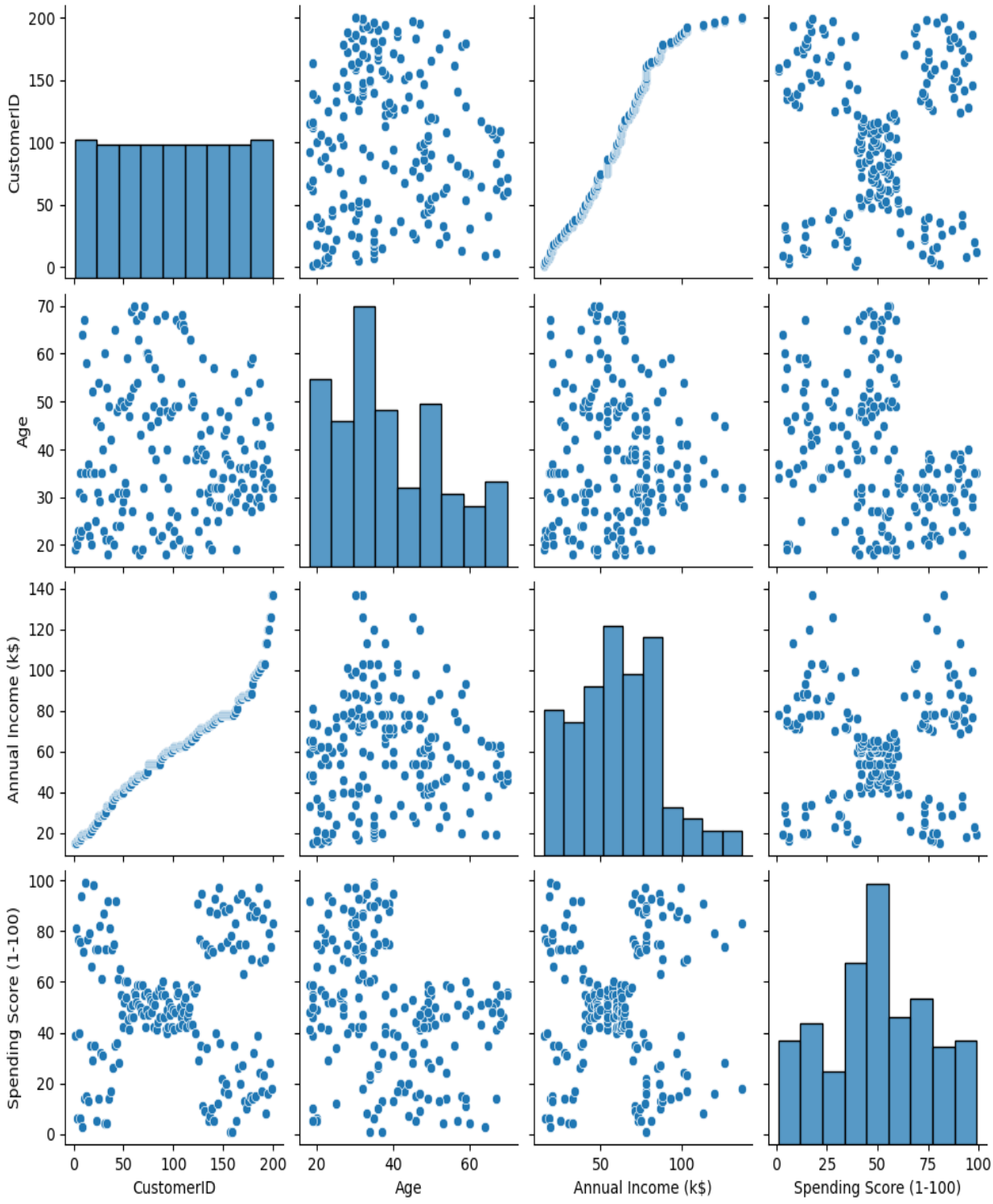

CustomerID
Age
Annual Income (k$)
Spending Score (1-100)
CustomerID
Age
Annual Income (k$)
Spending Score (1-100)

**Fig:1.6**

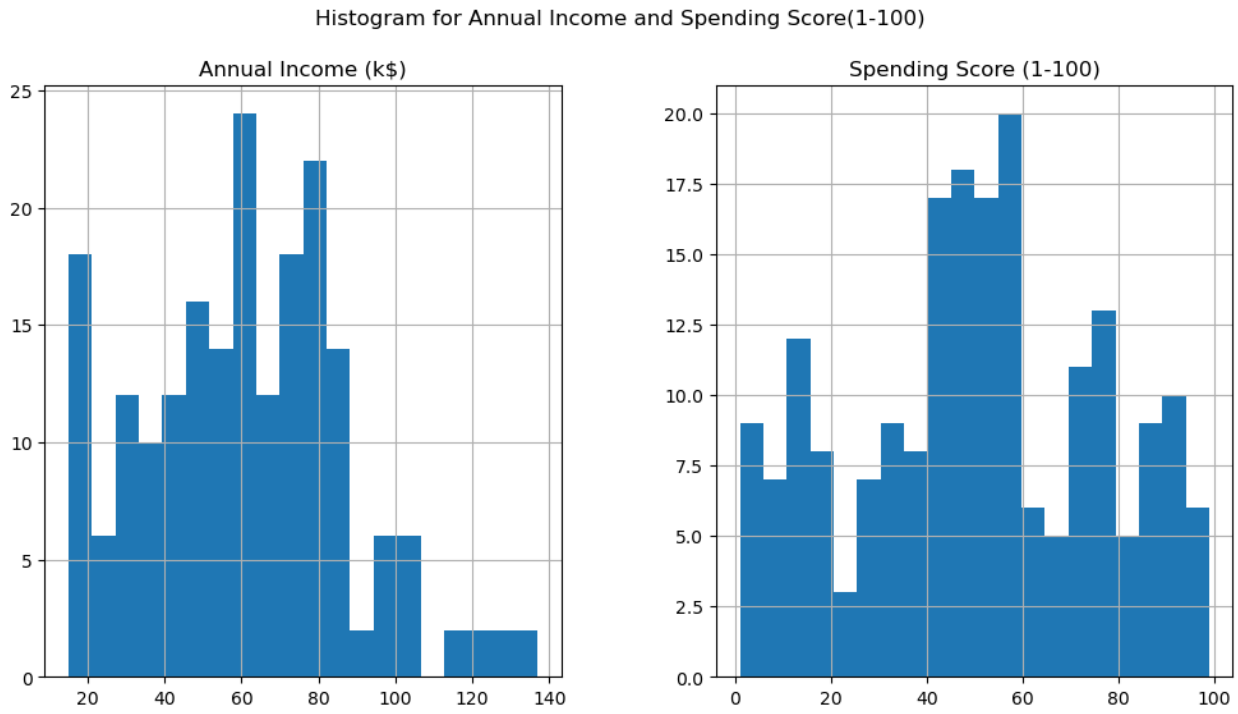

Histogram for Annual Income and Spending Score(1-100)
Annual Income (k$)
Spending Score (1-100)

**Fig:1.7**

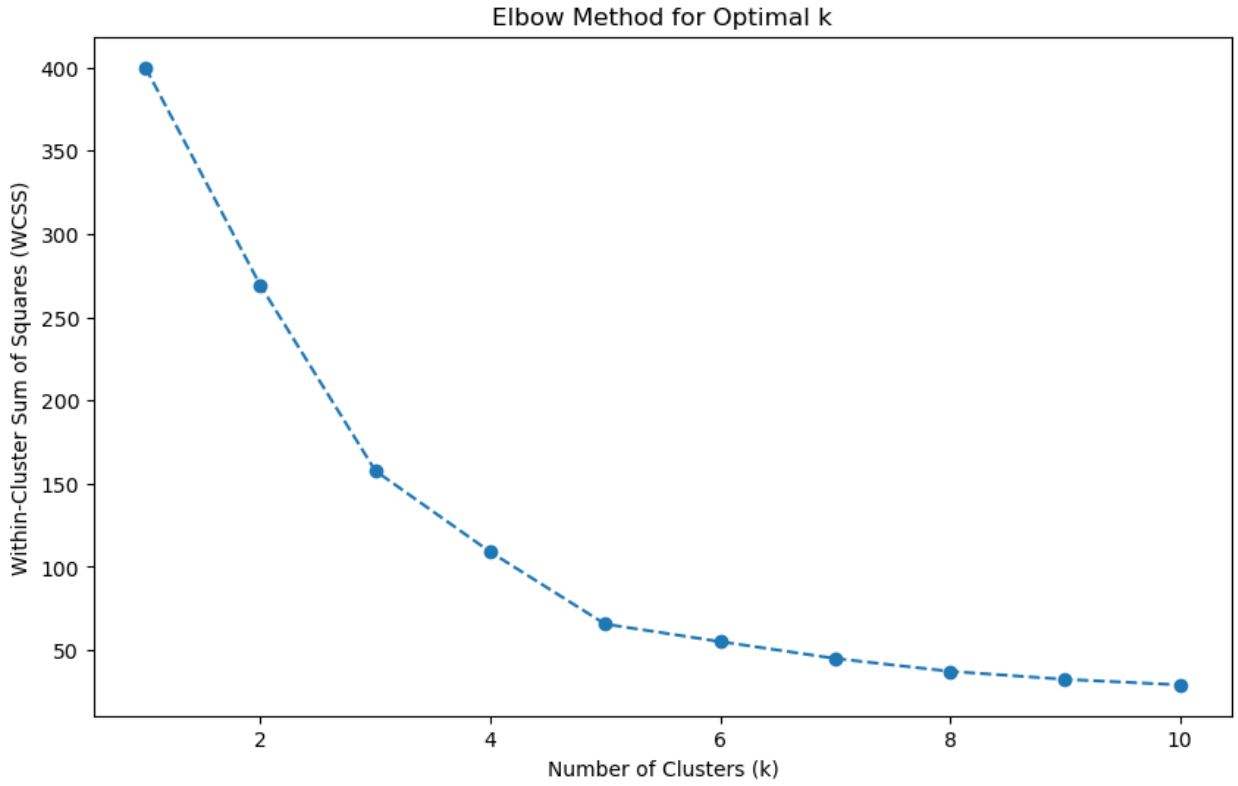

Elbow Method for Optimal k
Within-Cluster Sum of Squares (WCSS)
Number of Clusters (k)

**Fig:1.8**


Clustered Data
Spending Score (1-100)
Annual Income (k$)
cluster
100
80
60
40
20
0
20
40
60
80
100
120
140
4
3.5
3
2.5
2
1.5
1
0.5
0

**Fig:1.9**

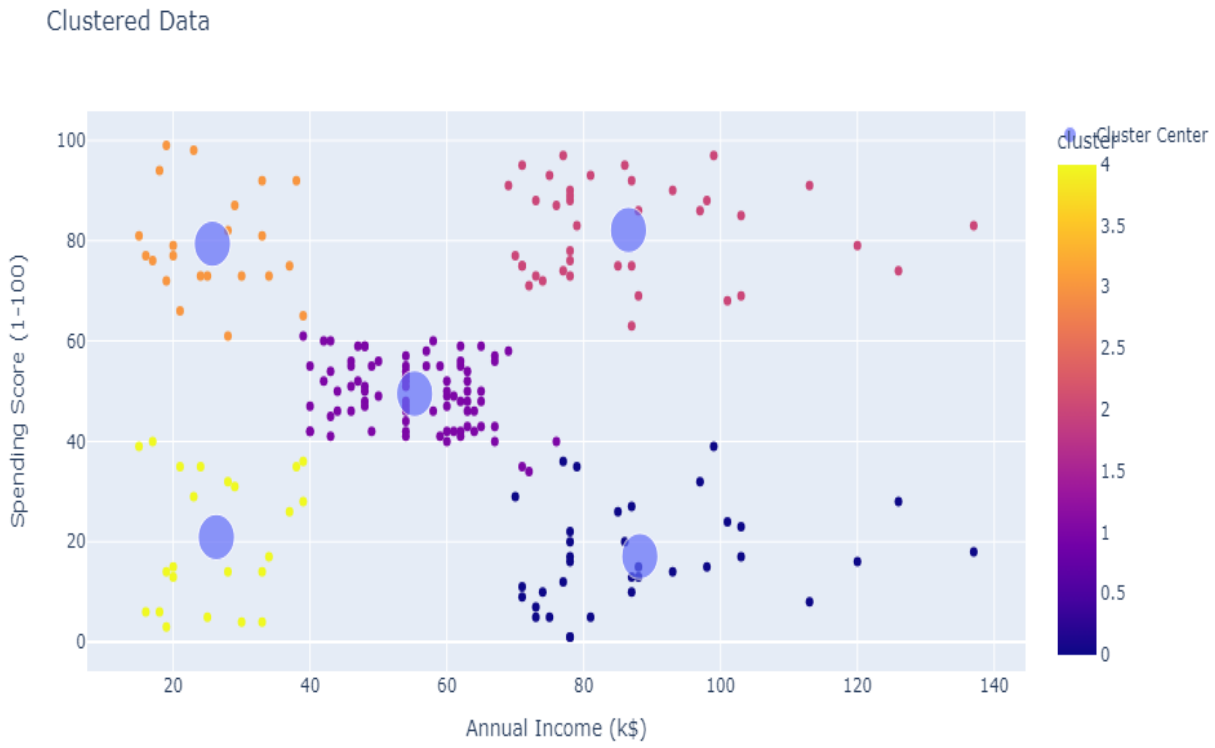

Clustered Data
Spending Score (1-100)
Annual Income (k$)
cluster
Cluster Center
100
80
60
40
20
0
20
40
60
80
100
120
140
4
3.5
3
2.5
2
1.5
1
0.5
0

**Fig:2.0**

## 7. Conclusion:

In conclusion, the implementation of the K-means clustering algorithm for restaurant customer segmentation, utilizing annual income and spending score as key features, has proven to be a valuable approach. The clustering analysis has effectively grouped customers based on their similar characteristics, allowing for targeted marketing strategies and personalized service enhancements. The hyperparameter tuning, particularly through the Elbow method, has contributed to the identification of an optimal number of clusters, ensuring meaningful segmentation. The project demonstrates the practicality and efficacy of leveraging machine learning techniques in the restaurant industry to enhance customer understanding and optimize business strategies.

**Future Scope:** The success of this project opens avenues for further exploration and improvement. Future endeavors could involve:

1. Integration of Additional Features: Including more features, such as customer demographics, preferences, or external factors, could provide a more comprehensive understanding of customer behavior.

2. Dynamic Segmentation: Implementing real-time updates to customer segments based on changing preferences and market dynamics would enhance the system's adaptability.

3. Predictive Analytics: Incorporating predictive modeling to forecast future customer trends and preferences, enabling proactive decision-making and strategic planning.

4. Integration with Customer Feedback: Integrating customer feedback data to refine segmentation and tailor strategies based on direct input from patrons.

5. Mobile Application Integration: Developing a user-friendly mobile application that leverages the segmentation insights to enhance the overall customer experience and loyalty.

## 8. References:


i. TAMA, B. A. (2015). DATA MINING FOR PREDICTING CUSTOMER SATISFACTION IN FAST-FOOD RESTAURANT. Journal of Theoretical and Applied Information Technology, Vol. 75.

ii. Sukru Ozan, "A Case Study on Customer Segmentation by using Machine Learning Methods", IEEE, Year: 2018.

iii. Jayant Tikmani, Sudhanshu Tiwari, Sujata Khedkar “Telecom customer segmentation based on cluster analysis An Approach to Customer Classification using k-means”, IJIRCCE,Year: 2015.

iv. Chinedu Pascal Ezenkwu, Simeon Ozuomba, Constance kalu Electrical/Electronics and Computer Engineering Department, University of Uyo, Akwa Ibom State, Nigeria

"Application of K-Means Algorithm for Efficient Customer Segmentation: A Strategy for Targeted Customer Services", IJARAI,Year: 2015.

v. https://www.kaggle.com/datasets/joebeachcapital/customer-segmentation

vi. https://ijcrt.org/papers/IJCRT_196519.pdf

vii. https://neptune.ai/blog/customer-segmentation-using-machine-learning