Mall Customer Segmentation Using K-Means and PCA

Introduction

Customer segmentation helps businesses understand different types of customers based on their behavior and financial characteristics. In this project, unsupervised learning techniques were applied to the Mall Customer dataset to identify meaningful customer groups.

Methodology

The dataset includes customer attributes such as Age, Annual Income (k$), and Spending Score (1–100). Since the data has no predefined labels, K-Means clustering was used to group customers based on similarity.

The Elbow Method was applied to determine the optimal number of clusters, and K=5 was selected. Before clustering, the data was standardized to ensure fair distance calculations.

K-Means minimizes within-cluster variance:

WCSS=∑i=1k∑x∈Ci∥x−μi∥2WCSS = \sum_{i=1}^{k} \sum_{x \in C_i} ||x - \mu_i||^2WCSS=i=1∑kx∈Ci∑∥x−μi∥2

Where:

- CiC_iCi = cluster
- μi\mu_iμi = centroid

Principal Component Analysis (PCA) was applied to reduce dimensionality and visualize clusters in 2D space.

Results

Five distinct customer segments were identified:

1. High Income – High Spending (Premium Customers)
2. High Income – Low Spending (Careful Wealthy Customers)
3. Low Income – High Spending (Impulsive Buyers)
4. Low Income – Low Spending (Budget Customers)
5. Moderate Income – Moderate Spending (Average Customers)

The clusters were clearly separable in both income-spending space and PCA projection.

Business Insights

- Premium customers should be targeted with loyalty programs and luxury promotions.
- Careful wealthy customers can be influenced through personalized marketing and exclusive offers.
- Impulsive buyers respond well to promotional campaigns.
- Budget customers may require discounts and affordable product options.

This segmentation enables data-driven marketing strategies and improves customer targeting efficiency.

Conclusion

Using K-Means clustering and PCA, meaningful customer groups were identified without labeled data. The segmentation provides actionable insights that can help businesses optimize marketing strategies and increase profitability.