

# Capstone\_Presentation

Product Rating Predictor for Fashion Products

Enhancing Customer Experience with Machine Learning

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# Context

## Digitalization of Fashion Retail:

- Online stores and e-commerce platforms, major channels for discovering and purchasing fashion products.

## Challenge of Overwhelming Product Choices:

- The vast number of available products can overwhelm customers.
- Leads to decision fatigue and abandoned shopping carts.

## Limitations of Traditional Browsing Methods:

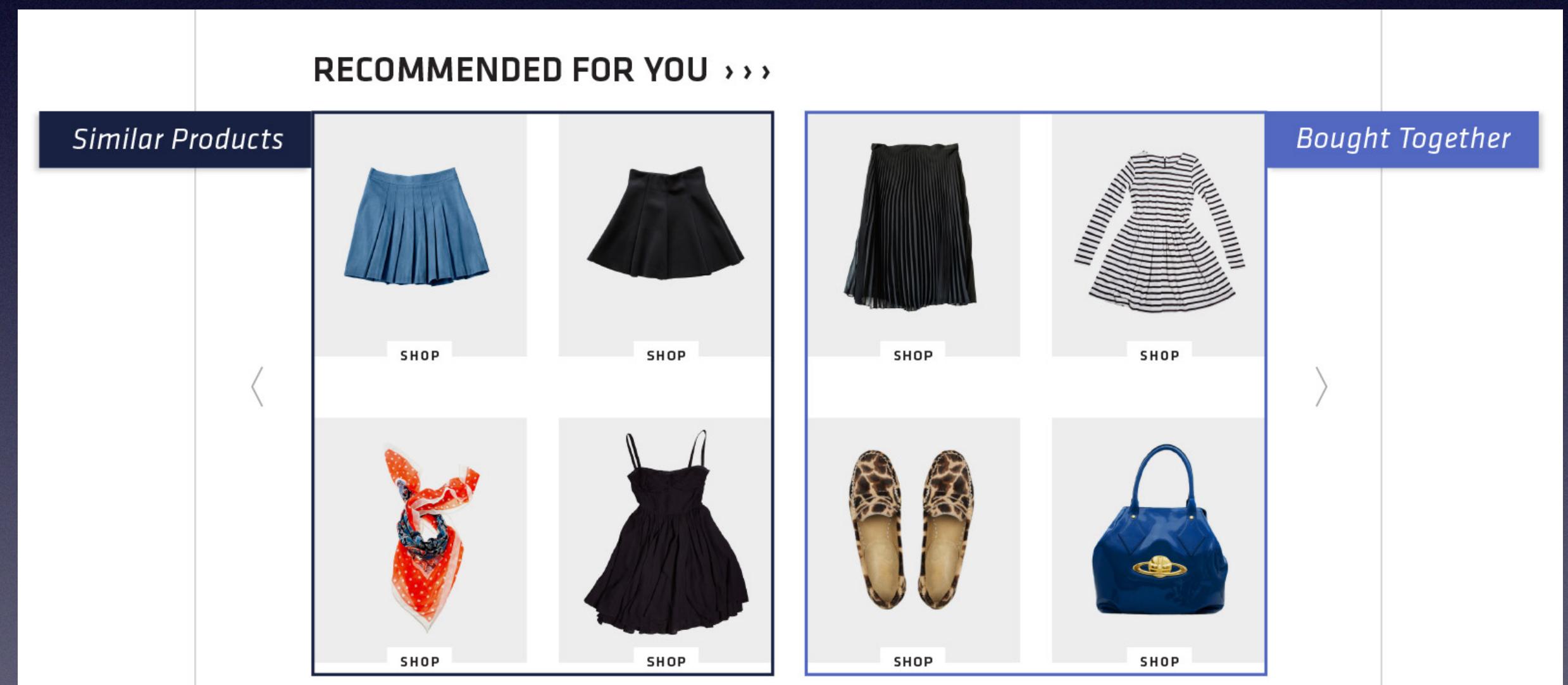
- Sorting by categories or popularity does not fully address individual consumer preferences.
- Results in reduced customer satisfaction and engagement.



# What is the Problem?

What opportunities exist to develop a personalized recommendation system that not only provide more accurate, diverse and personalized recommendations to users but also provide customer insights to the business.

- Results in enhancing the shopping experience, reduce user churn, and increase sales on fashion e-commerce platforms.
- Solve the problem of decision fatigue and improve the overall shopping experience.



# Data Collection

**Gather historical data:** Collected raw data as a csv file with columns such as User ID, Product ID, Product name, Brand, Category, Price, Rating, Color, Size.

**Data sources:** Kaggle, an external data source.

	User ID	Product ID	Product Name	Brand	Category	Price	Rating	Color	Size
0	19	1	Dress	Adidas	Men's Fashion	40	1.043159	Black	XL
1	97	2	Shoes	H&M	Women's Fashion	82	4.026416	Black	L
2	25	3	Dress	Adidas	Women's Fashion	44	3.337938	Yellow	XL
3	57	4	Shoes	Zara	Men's Fashion	23	1.049523	White	S
4	79	5	T-shirt	Adidas	Men's Fashion	79	4.302773	Black	M
5	98	6	Dress	Adidas	Men's Fashion	47	1.379566	Yellow	L
6	16	7	Jeans	Gucci	Men's Fashion	37	1.356750	White	XL
7	63	8	Sweater	Zara	Kids' Fashion	64	4.360303	Blue	XL
8	96	9	Sweater	H&M	Men's Fashion	53	4.466182	Green	XL
9	36	10	T-shirt	Zara	Kids' Fashion	55	4.093234	White	XL

Goal: Create valuable insights that drive sales, engagement, and satisfaction  
Structured data that include user behaviors, product attributes, and transaction details.

# Independent vs Dependent Variables

User ID	Product ID	Product Name	Brand	Category	Price	Color	Size	Rating
19	1	Dress	Adidas	Men's Fashion	40	Black	XL	1.043159
97	2	Shoes	H&M	Women's Fashion	82	Black	L	4.026416
25	3	Dress	Adidas	Women's Fashion	44	Yellow	XL	3.337938
57	4	Shoes	Zara	Men's Fashion	23	White	S	1.049523
79	5	T-shirt	Adidas	Men's Fashion	79	Black	M	4.302773

Identifier

Independent  
Variables

Dependent  
Variable

Features/  
Independent  
Variables

Variables that  
is changed

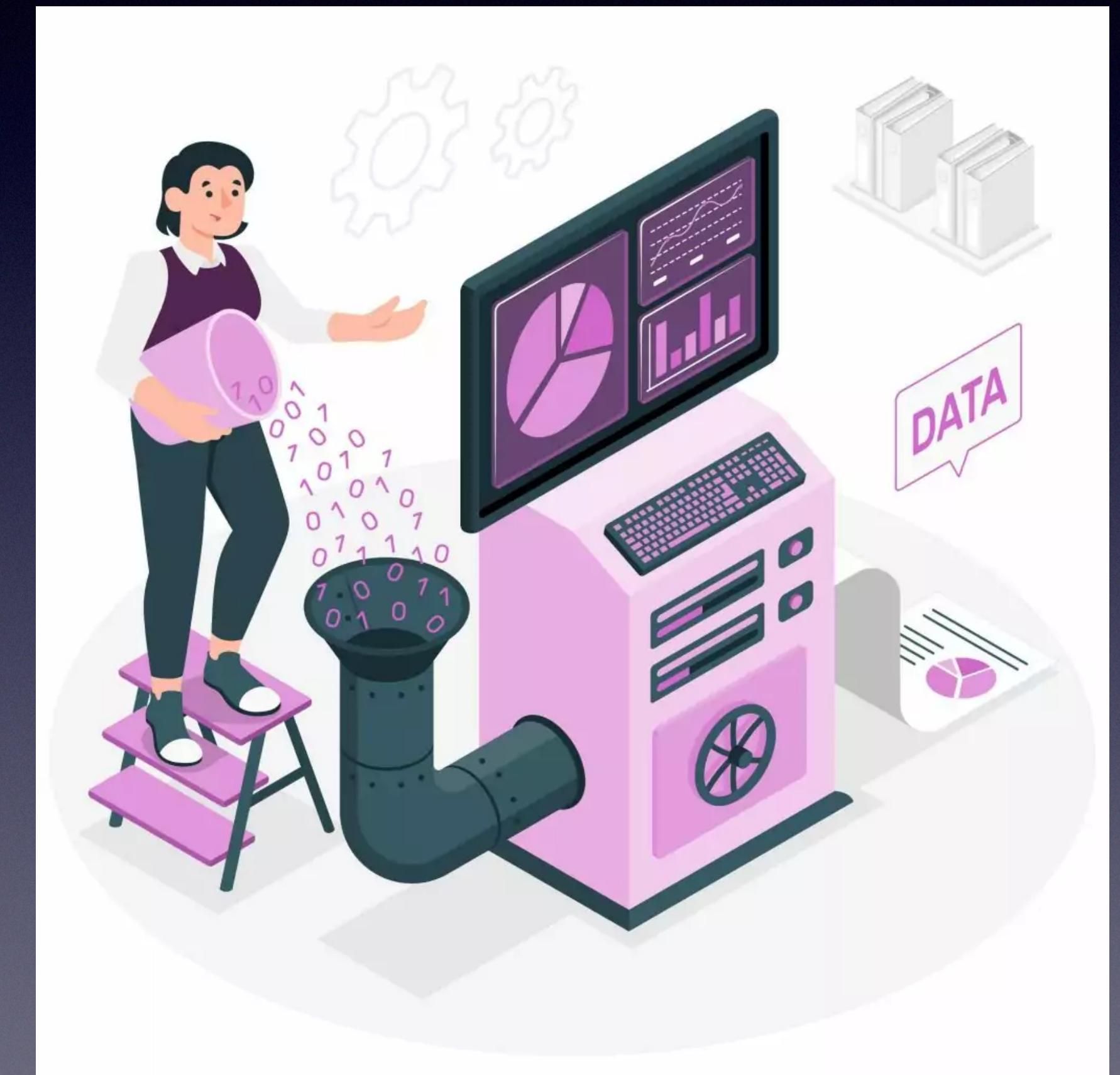
Target Variables/  
Label/ Dependent  
Variables

Variables  
affected  
by the change

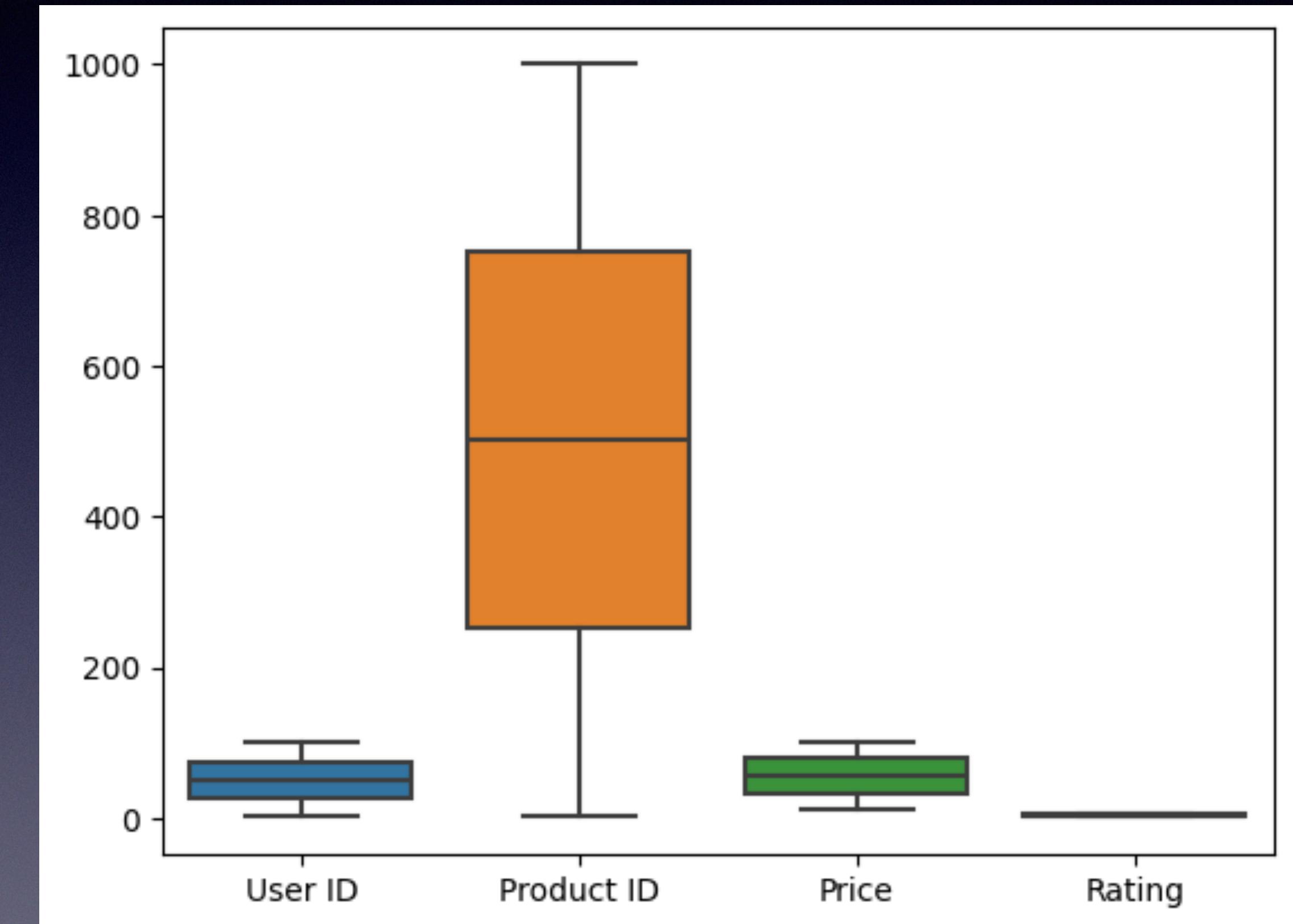
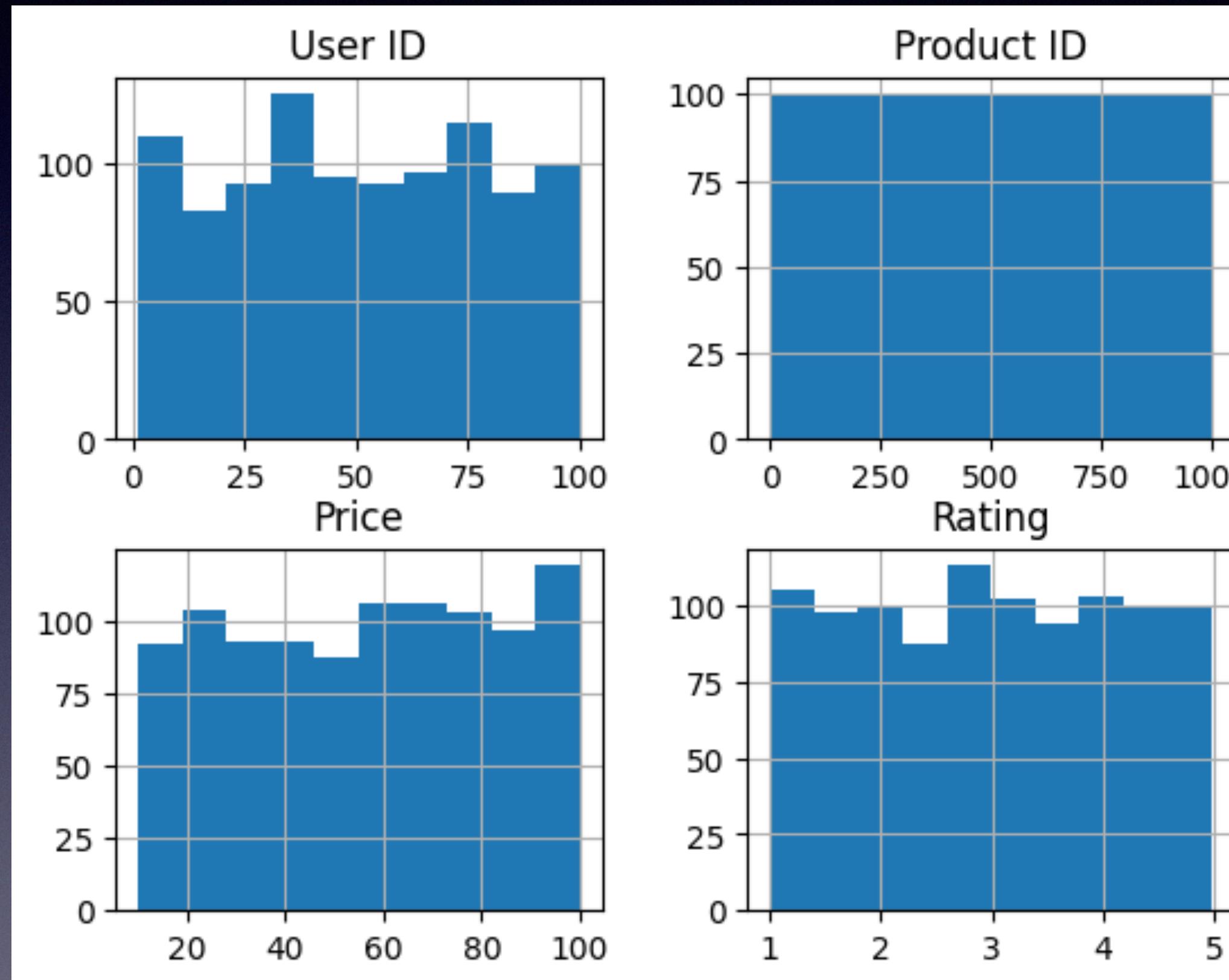
# Data Wrangling / Data Cleaning

Performed a series of processes to explore, transform, and validate raw dataset retrieved into a high-quality and reliable data for analysis. This step include checking out following items:

- **Missing values** - No missing value has been detected
- **Outliers** = No outliers detected in all numeric columns including User ID, Product ID, Price, Rating



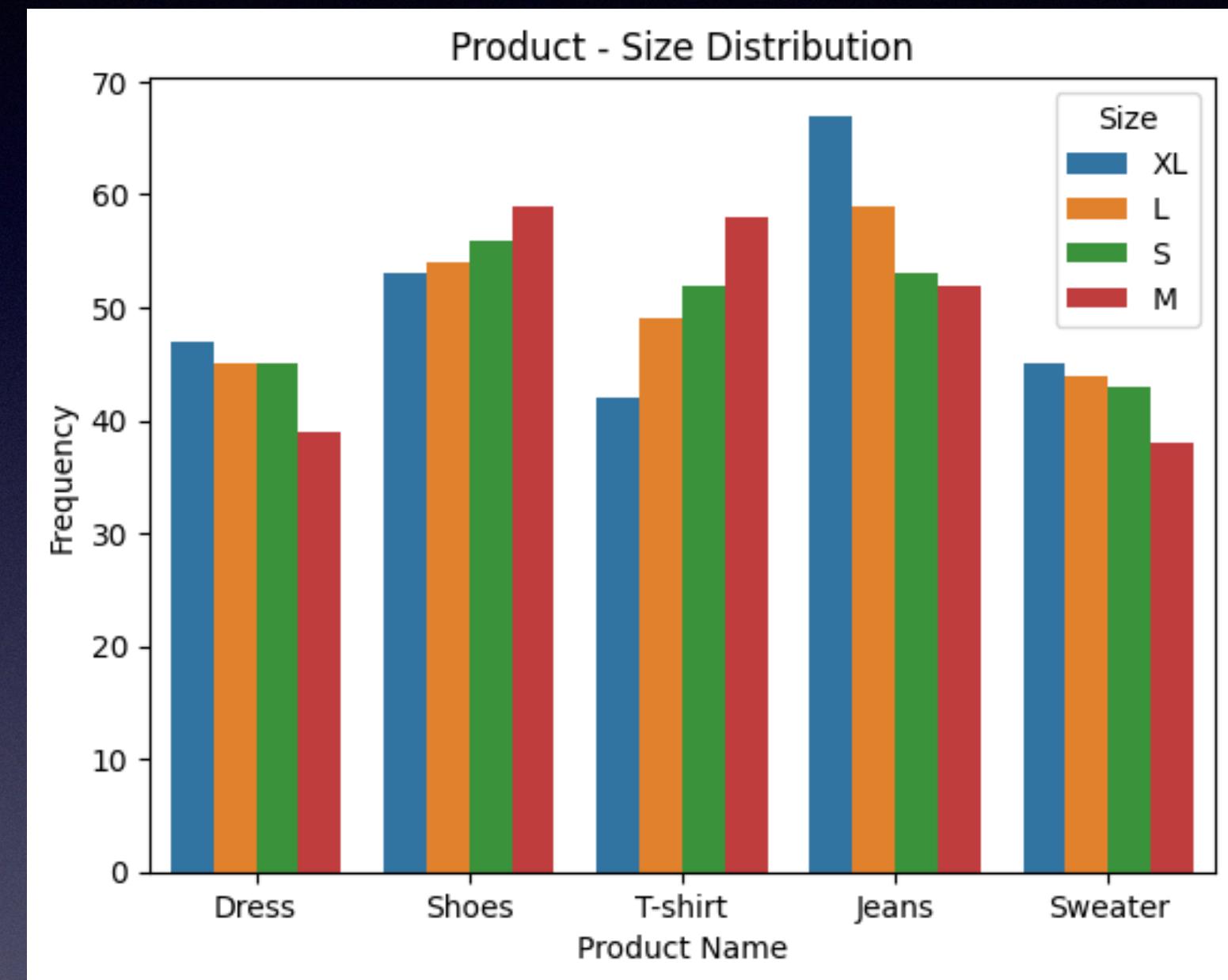
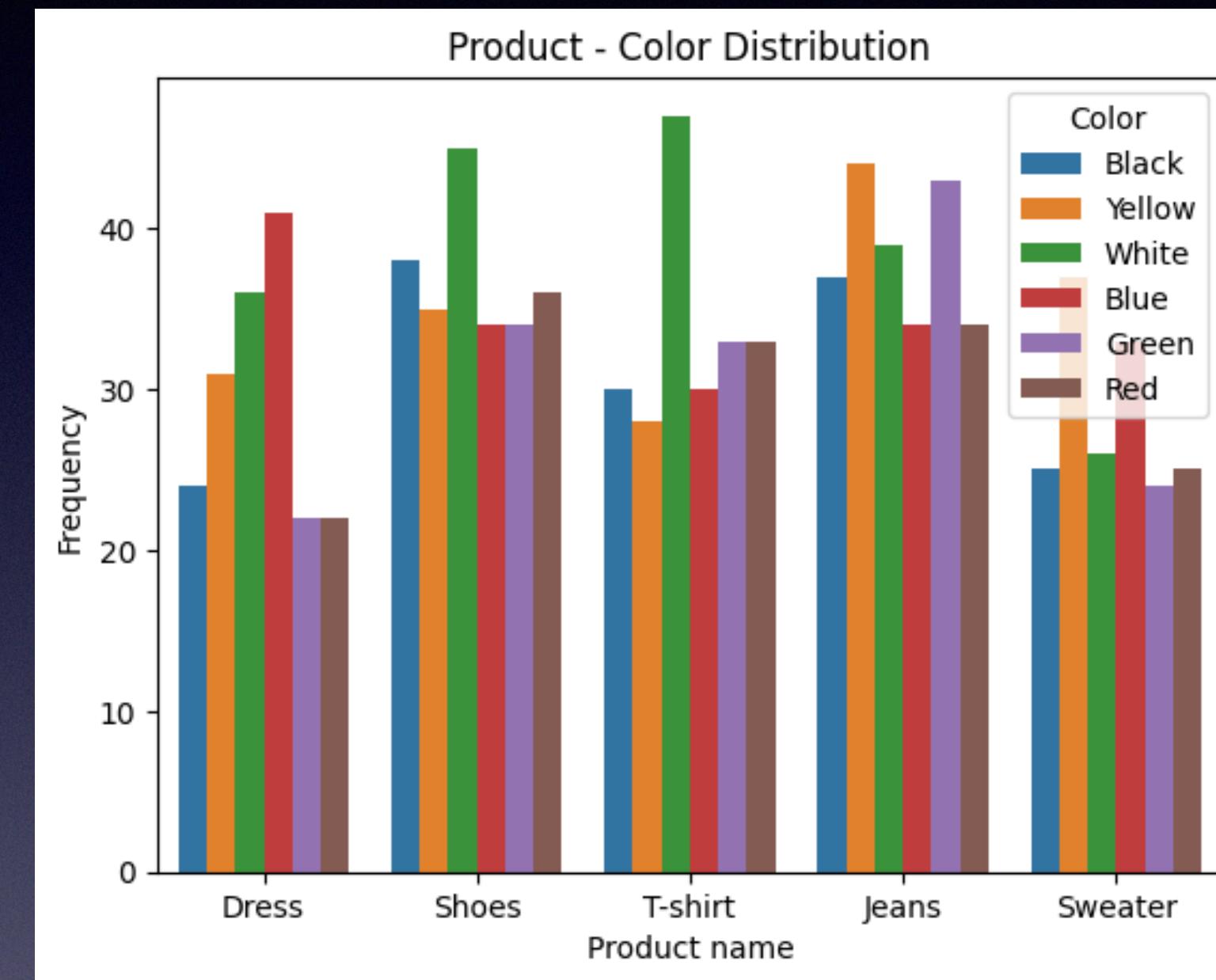
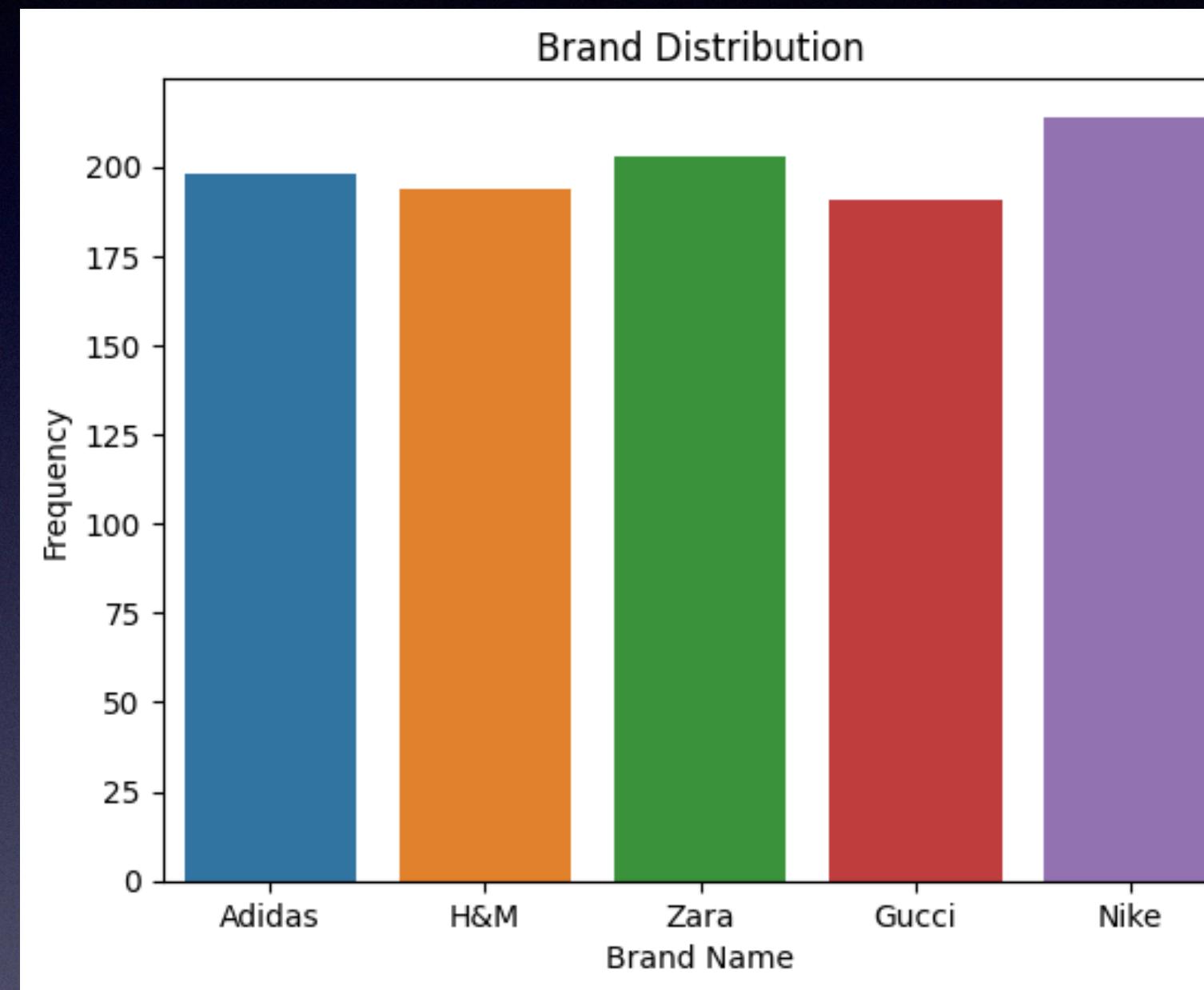
# Visualize Numerical Data Distribution



Data Distribution is **multi-modal** with multiple peaks.

**Seaborn BoxPlot Result:** No outliers detected in any of the numeric columns including User ID, Product ID, Price, Rating.

# Visualize Categorical Data Distribution



## Summary:

Frequency of Kid's fashion is slightly higher than the men's and women's fashion.

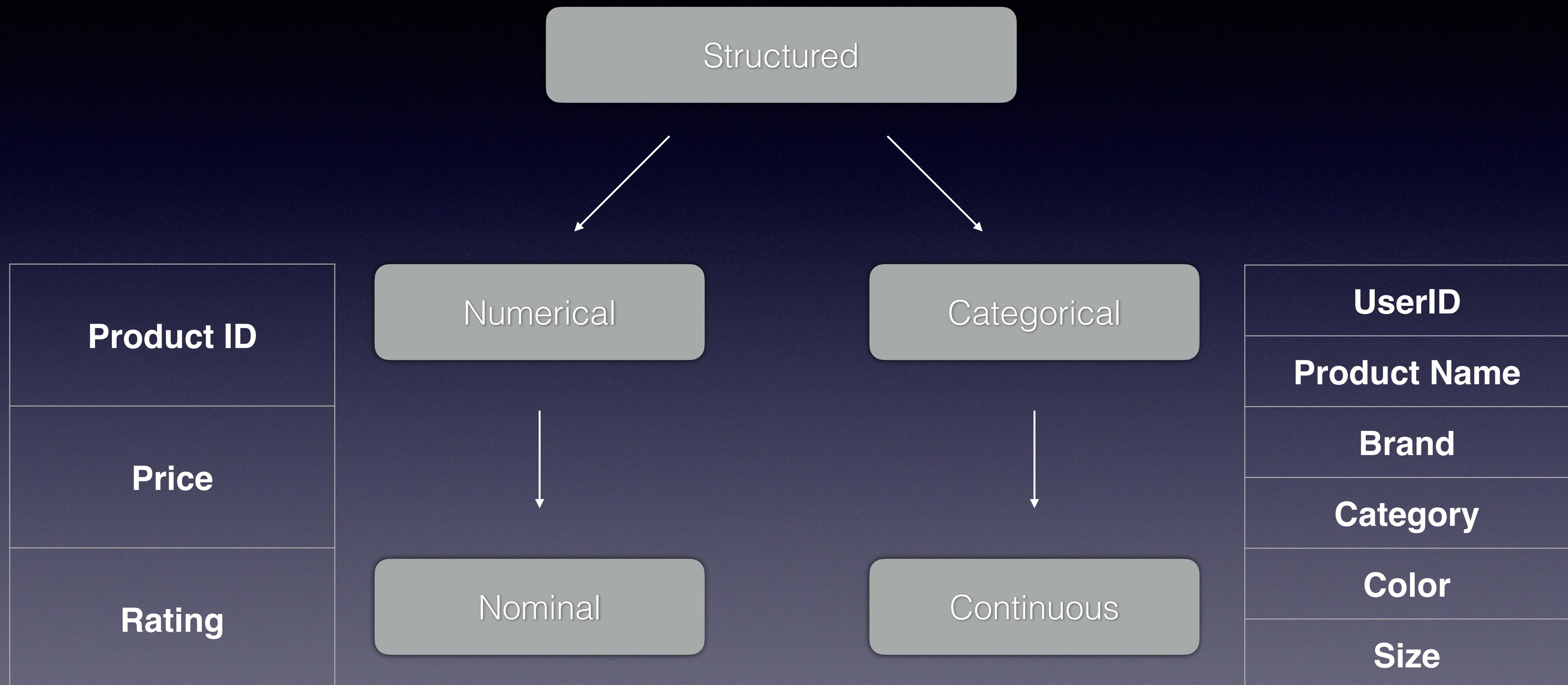
Count of Nike products are slightly higher than any other brands.

Products such as Jeans, shoes and t-shirts are more popular in this dataset.

In product type jeans, XL seems most popular. M size tops the list in two product categories, shoes and t-shirts.

Color White seems extremely popular in shoes and t-shirt categories.

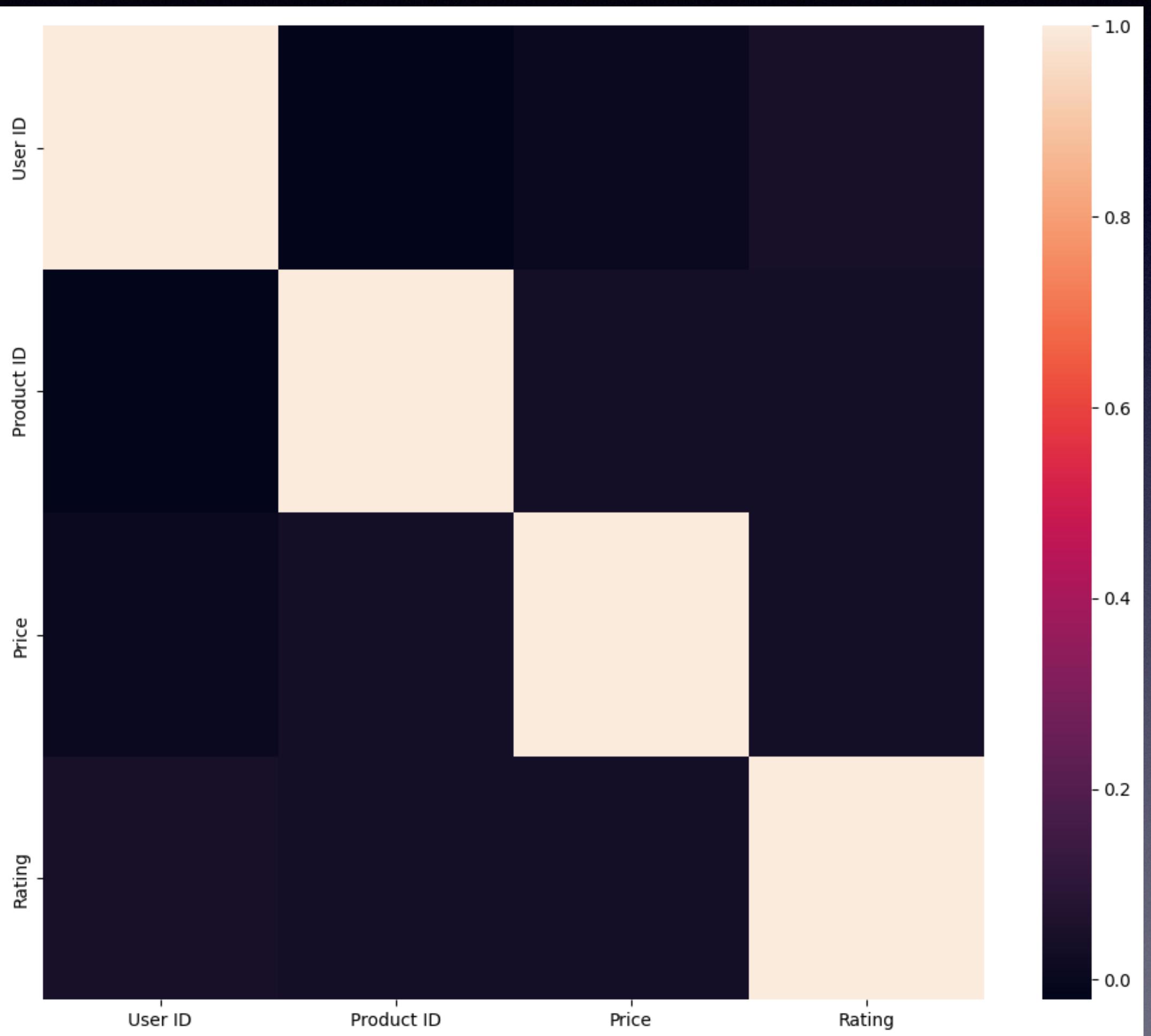
# Type of Dataset



# Exploratory Data Analysis

**Feature correlation heatmap** - Gain a high level view of relationships amongst the features

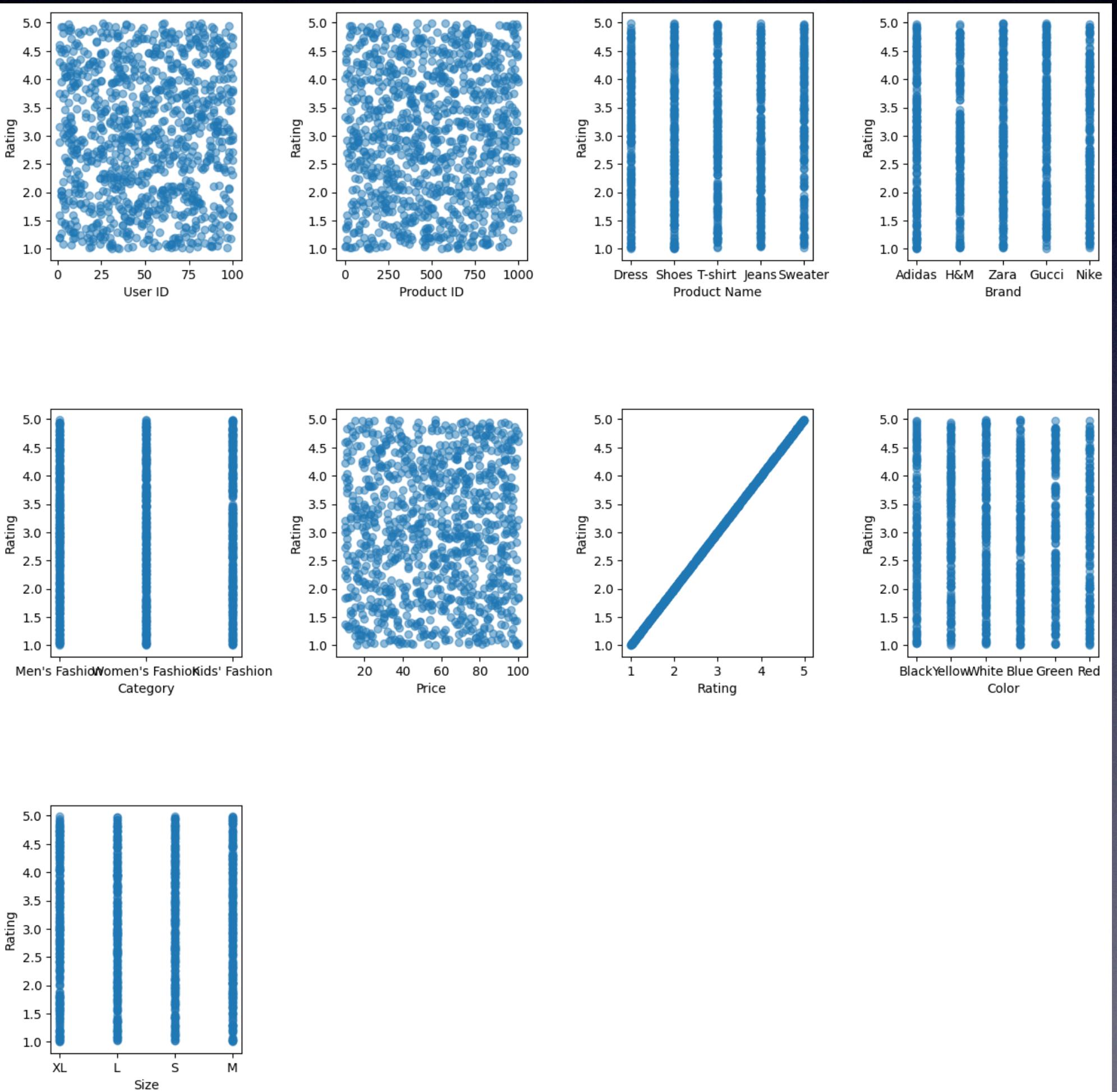
- There is no correlation between any of the features including the target variable “Rating”.
- Suggests non-linear relationships between the features.



# Exploratory Data Analysis - Continue

Created a Scatter plots for visualizing the relationship between a numeric feature against target variable, Rating.

- Further confirms no clear relationship between various features.
- User ID, Product ID and Price seems too concentrated and no meaningful insight can be extracted.
- 



# Statistical Analysis Summary

Tested multiple product attributes to see if they significantly affect **product ratings** using hypothesis testing and ANOVA.

Factor Compared	Test Type	p-value	Significant ?	Conclusion
Men's vs Women's Fashion	t-test	0.520	✗ No	No significant difference in average ratings between categories
Price vs Rating	Pearson Correlation	0.284	✗ No	No significant correlation between price and rating
Brand vs Rating	ANOVA	0.156	✗ No	No brand stands out with significantly higher or lower ratings
Color vs Rating	ANOVA	0.727	✗ No	Color does not influence product rating
Size vs Rating	ANOVA	0.896	✗ No	No rating differences among product sizes

**Insight:** User ratings are consistent across product features. There is no statistical evidence that brand, price, size, color, or category significantly influence how users rate products in this dataset.

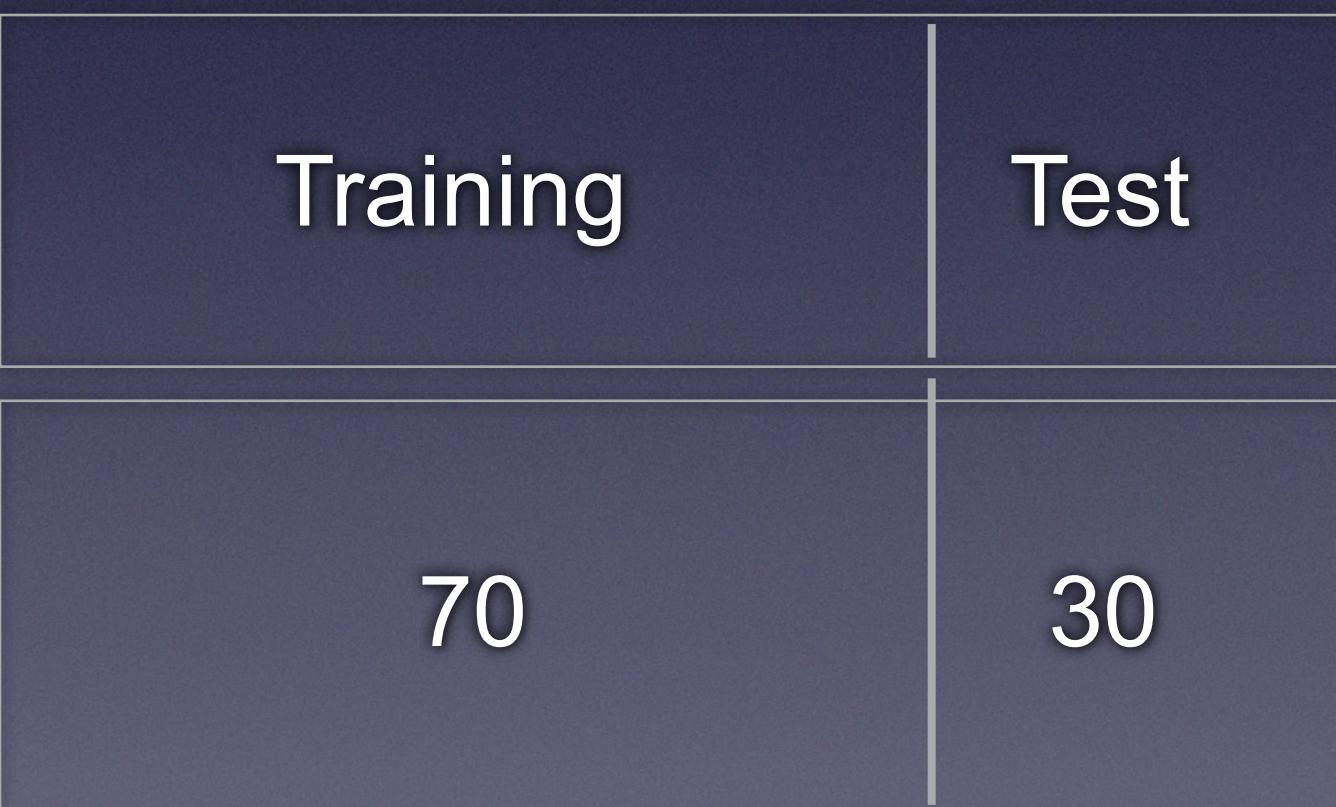
# Pre-processing and Training data

Help us learn the relationship between the input features and the target variable (Rating).

**Use CatBoostEncoder, target-based categorical encoder to encode Categorical Features:**

- User ID
- Product Name
- Brand
- Category
- Color
- Size
- 

Split Dataset



# Machine Learning Algorithms

Choosing the right ML algorithm is crucial.

The choice depends on Problem Type:

- **Type of problem: Regression Problem**  
(Target, Rating is continuous)
- **Nature of the data: Supervised learning as Labeled data**
- **Goals of the analysis: Predict a continuous numerical value**
- **Model performance: Mean Squared Error (MSE), R-squared (R<sup>2</sup>) and RMSE**

Target variable  
(continuous)

Regression

Non -Linear  
Relationship

Random Forest  
Regressor

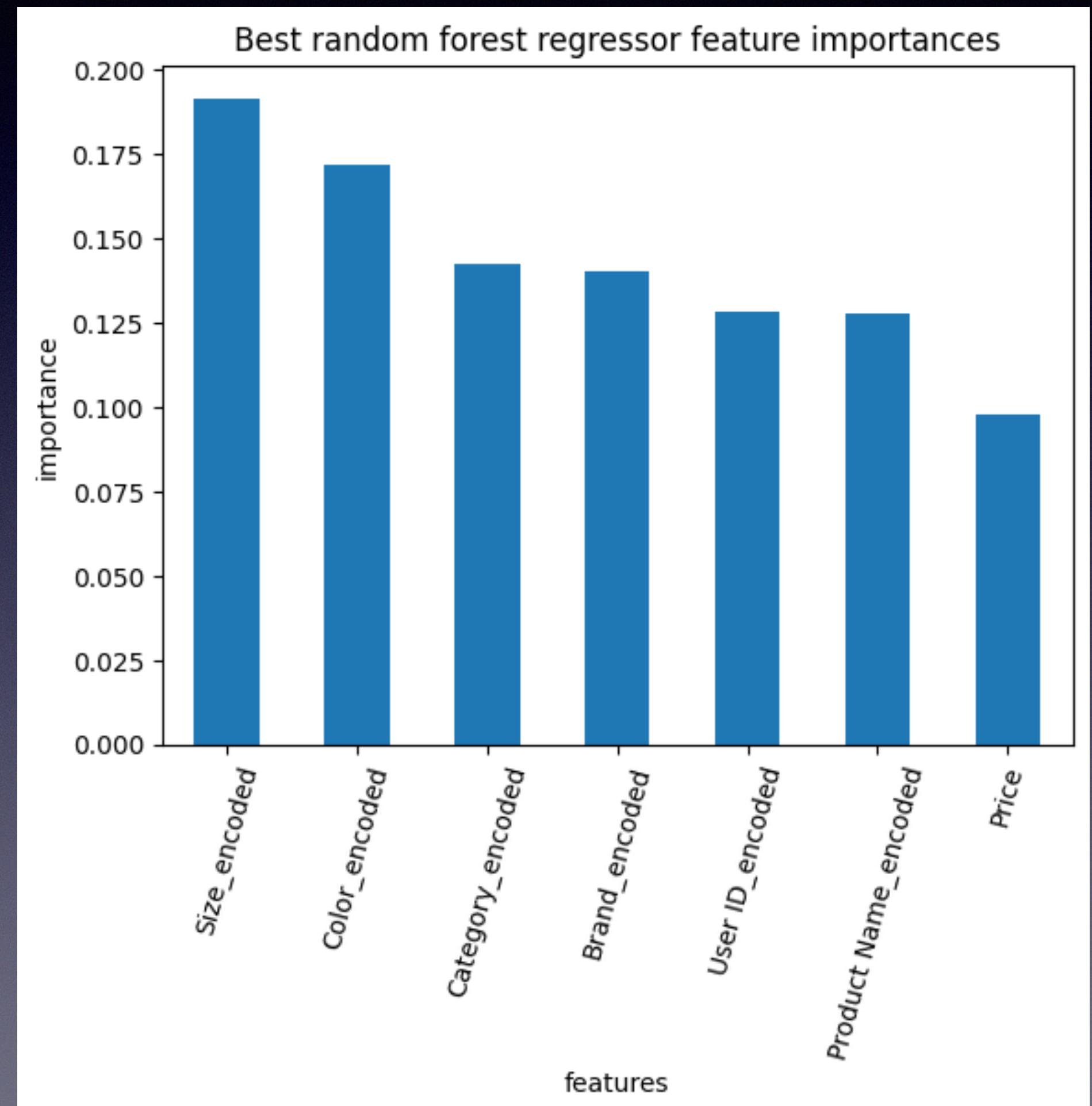
XGBoost

CatBoost

# Random Forest Model

Identify the dominant features based on their importance in a Random Forest model are as follows:

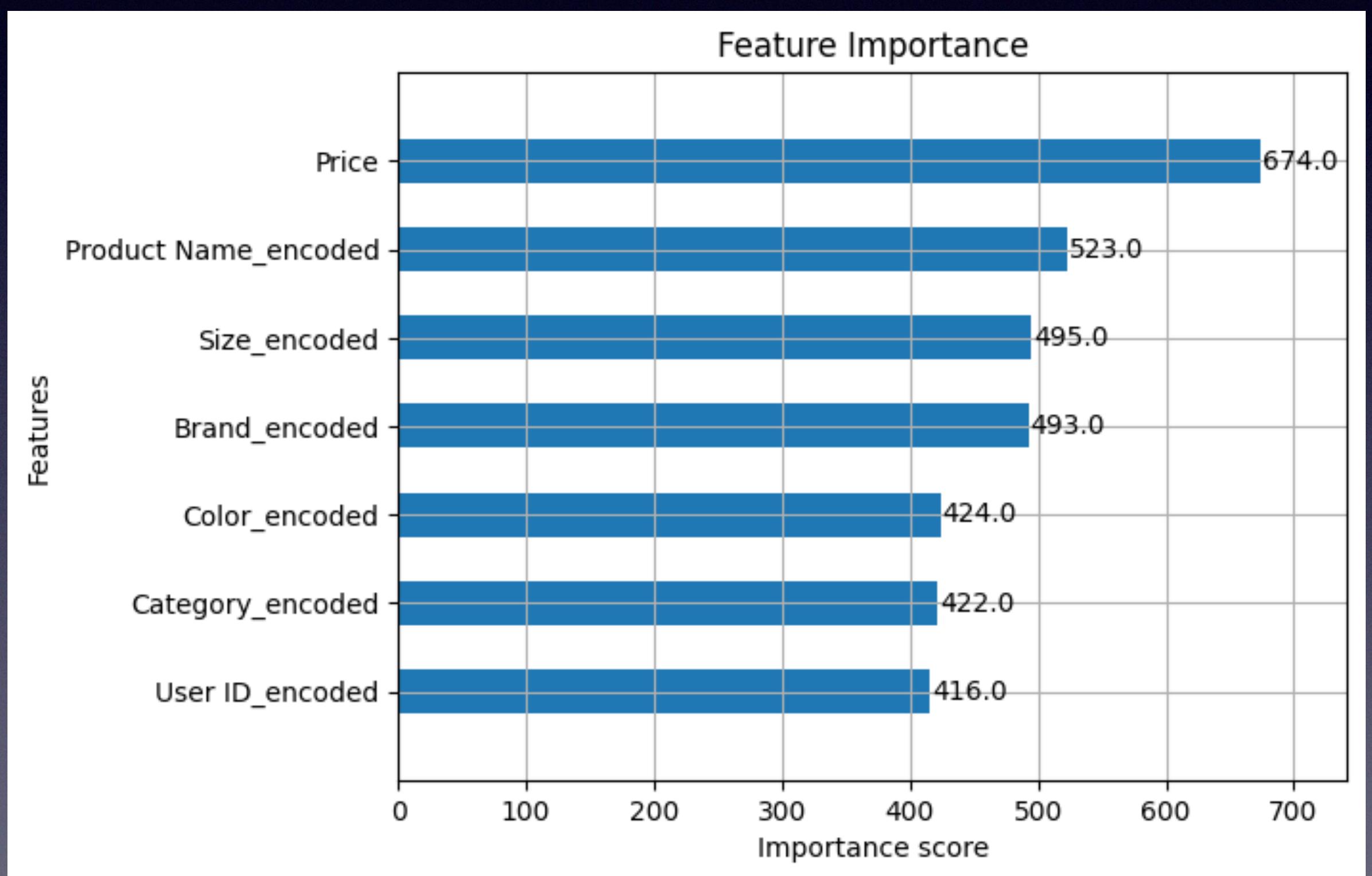
- Size
- Color
- Category
- Brand
- User ID
- Product Name
- Price



# XG Boost Model

Identify the dominant features based on their importance in a XG Boost model are as follows:

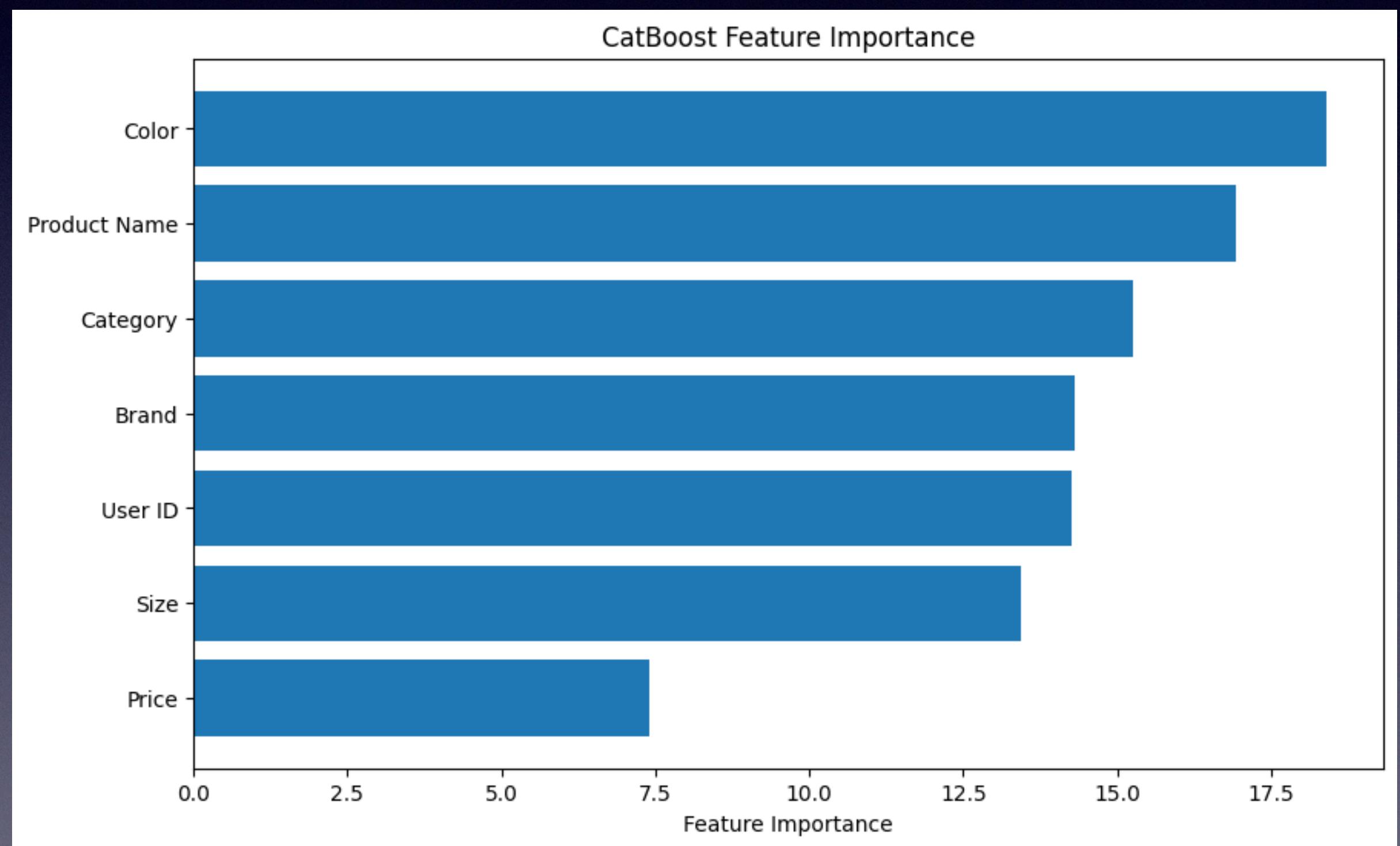
- Price
- Product Name
- Size
- Brand
- Category
- Color
- User ID



# CatBoost Model

Identify the top dominant features based on their importance in a Cat Boost model are as follows:

- Color
- Product Name
- Category
- Brand
- User ID
- Size
- Price



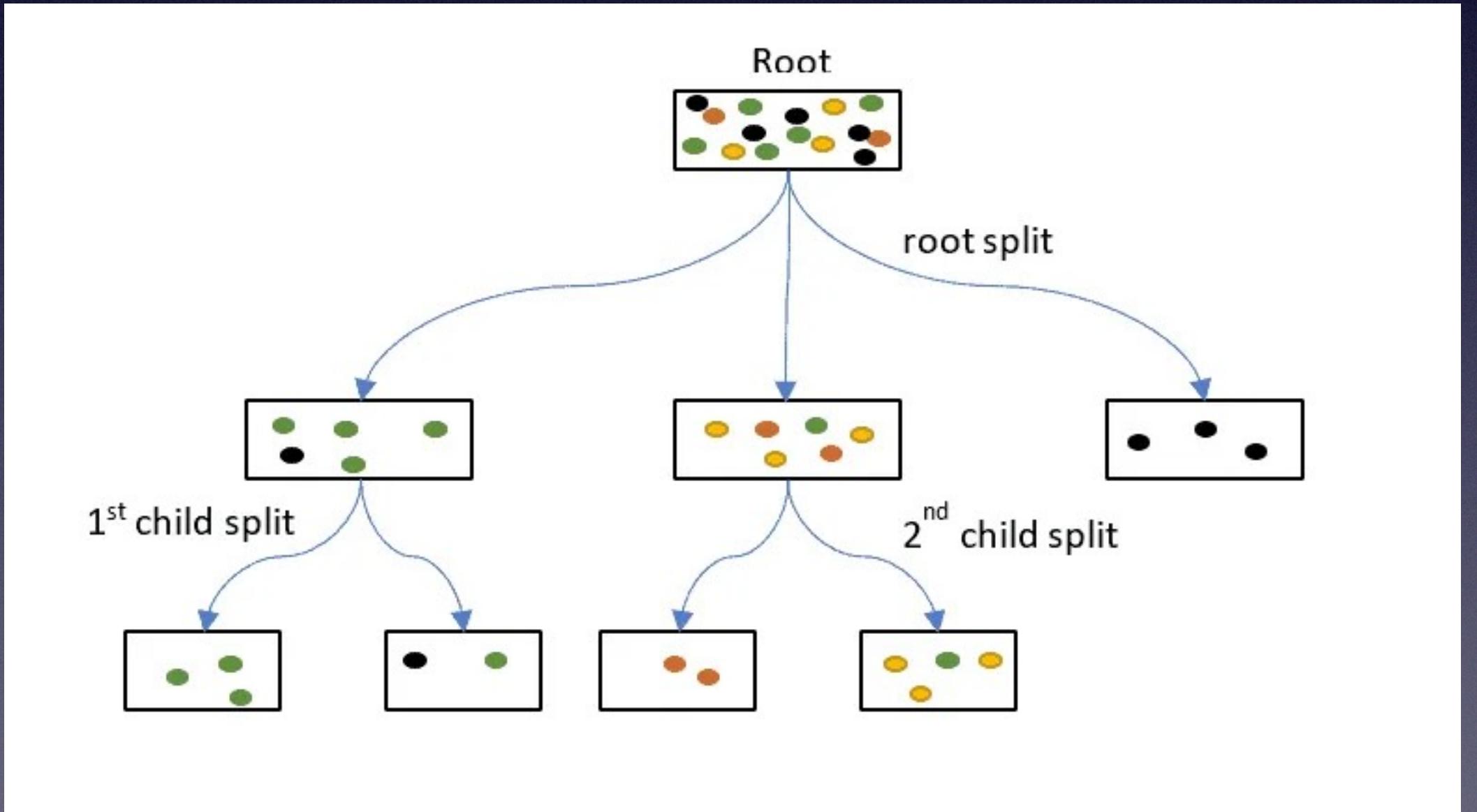
# ML steps

	Random Forest	XGBoost	Cat Boost
Import libraries	scikit-learn	xgboost	scikit-learn
Initialize the model	RandomForestRegressor()	xgb.XGBRegressor()	CatBoostRegressor()
Train the model	model.fit(X_train, y_train)	model.fit(X_train, y_train)	model.fit(X_train, y_train)
Predict on test data	model.predict(X_test)	model.predict(X_test)	model.predict(X_test)
Evaluate the model	Mean Squared error: 1.26 Mean Absolute Error: 0.96 RMSE: 1.12	Mean Squared error: 1.50 RMSE: 1.22	RMSE: 0.02 (Post-Hyperparameter Tuning)
Hyperparameter Tuning	GridSearchCV	GridSearchCV	GridSearchCV

# CatBoost Algorithm Overview

## Key Features:

- An advanced **gradient boosting** algorithm optimized for performance, particularly when handling **categorical data**.
- Dataset include large number of categorical features such as Color, Size, User ID, Category etc.
- Making it an excellent choice for our training dataset
- Its ability to handle categorical variables directly and its **ordered boosting** method provide a significant advantage over other algorithms like **XGBoost** and **Random Forest Model**.



# Top-N recommended products

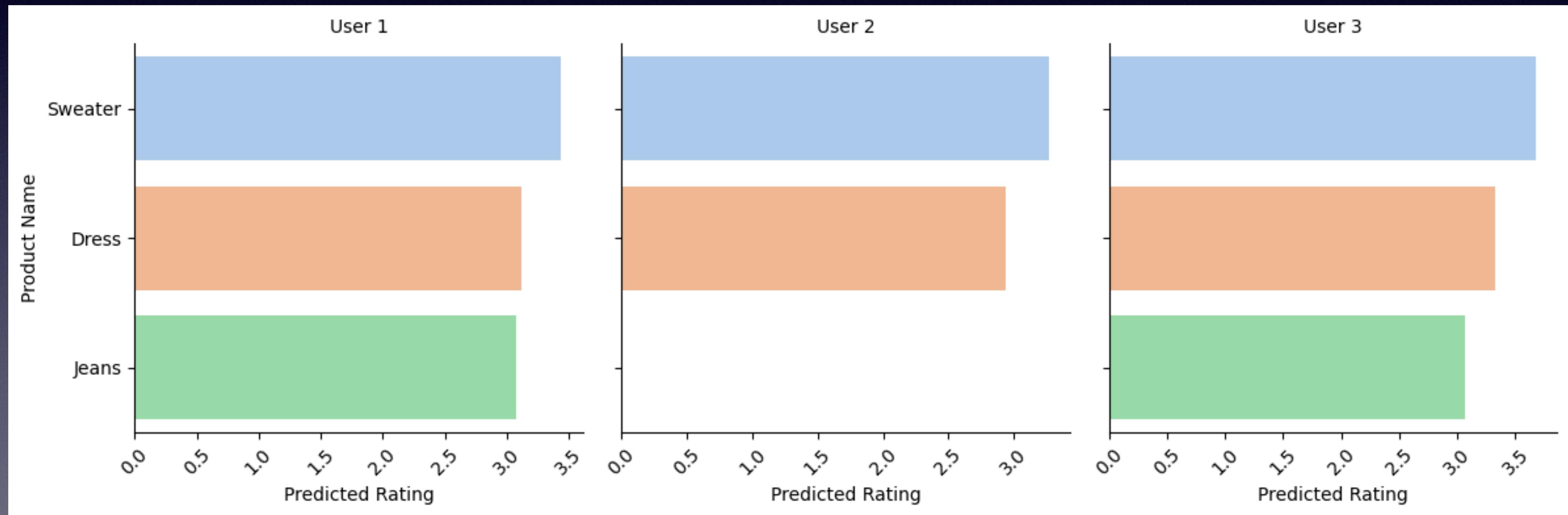
Trained **CatBoost model** to predict personalized product ratings based on user-product feature data.

For each user, the top-N products were selected by sorting predicted ratings in descending order.

The final output is a ranked list of product recommendations tailored to each user's preferences.

User ID	Product Name	Predicted Rating
1	Shoes	3.438652
1	Dress	3.119049
1	T-shirt	3.074043
2	Jeans	3.265303
2	T-shirt	2.937461
3	Sweater	3.672730
3	Dress	3.327020
3	Jeans	3.065744
4	Jeans	3.121159

# Top-N recommended products - continue

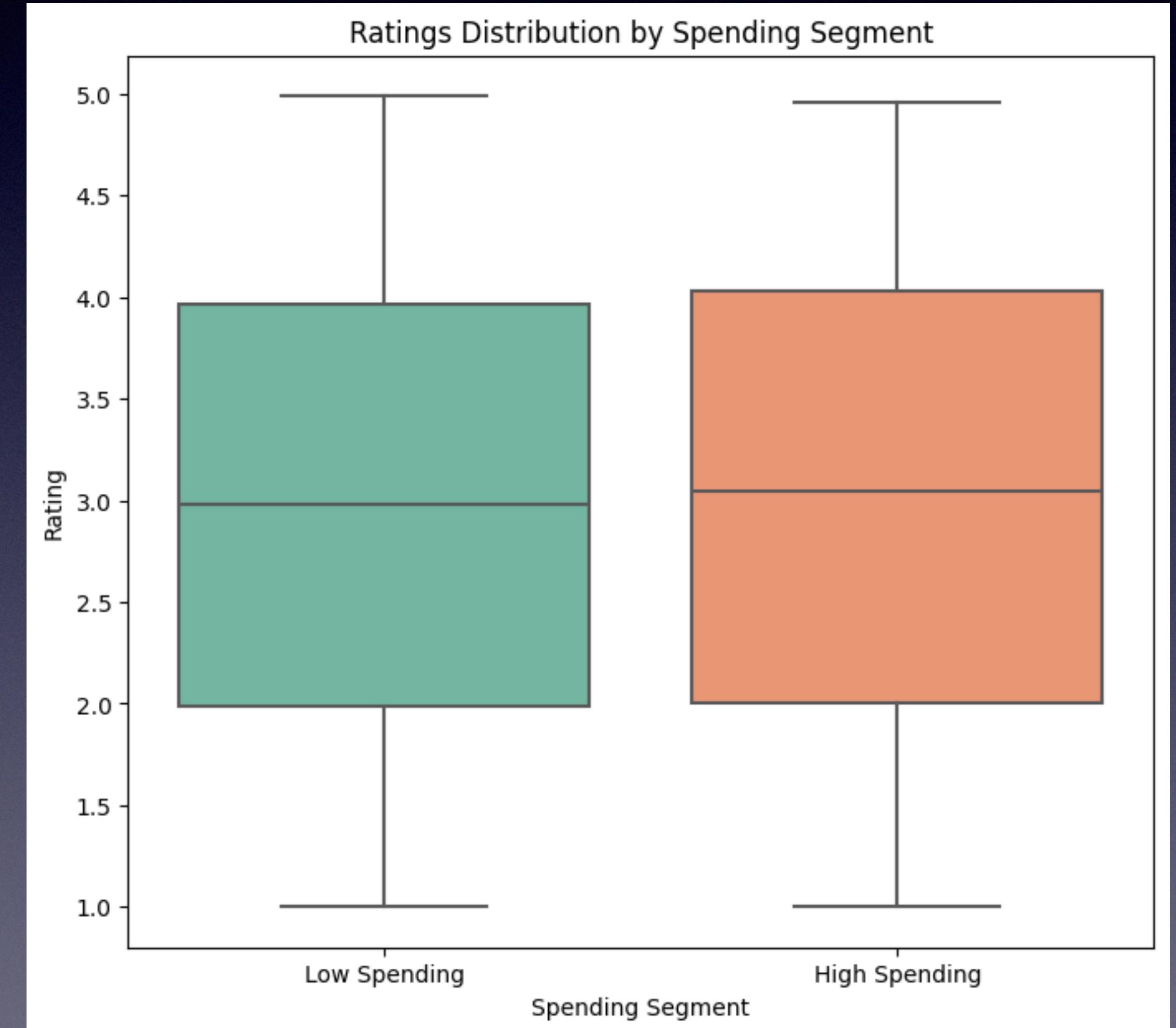


# Distribution of Ratings per Segment

- **High-Spending:** Users whose total spending or average purchase amount is above a threshold, 70.
- **Low-Spending:** Users whose total spending or average purchase amount is below a certain threshold, which is 70.

## Computed Average Rating per Spending Segment

Spending Segment	Rating
High - Spending	3.04
Low - Spending	2.97



Insight: High spenders tends to rate products slightly more positively than low spenders.

# Recommendation and Key Findings

- Tuning the model periodically with fresh data to keep it up to date.
- Add more relevant features that may significantly affect the ratings by the user since no current attributes are affecting rating behavior.
- Can add features affects especially time-based features that track **seasonal preferences** (e.g., winter jackets in cold months).
- Recommend products based on **recent purchases** or **trends**.
- Can include external data sources such as marketing campaigns, competitor actions to stay updated.

