

SmartCart: E-Commerce Purchase Prediction

Author: Venu Prakash

Abstract

This extended report documents the full pipeline, from EDA through deployment, and includes rich explanations, definitions, analogies, and visuals to support teaching and evaluation.

Introduction & Motivation

Introduction and motivation: This section discusses Introduction and motivation. The aim is to explain the reasoning, methodology, and implications in a detailed manner so the reader gains both theoretical and practical understanding. We provide examples, analogies, and step-by-step explanations.

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Dataset Description

The dataset provides session-level customer interactions used to infer purchase behavior. Below is a data dictionary and sample values.

user_id	Type: int64. Example: 1
session_id	Type: int64. Example: 4174
date	Type: datetime64[ns]. Example: 2023-01-01 00:00:00
gender	Type: object. Example: Female
age	Type: int64. Example: 45

location	Type: object. Example: Australia
membership_status	Type: object. Example: Registered
returning_customer	Type: int64. Example: 0
device_type	Type: object. Example: Mobile
browser	Type: object. Example: Edge
time_of_day	Type: object. Example: Morning
time_spent_minutes	Type: int64. Example: 59
pages_viewed	Type: int64. Example: 14
scroll_depth	Type: int64. Example: 17
clicks	Type: int64. Example: 35
traffic_source	Type: object. Example: Referral
ad_campaign	Type: object. Example: Campaign_B
coupon_used	Type: int64. Example: 0
discount_applied	Type: int64. Example: 0
product_category	Type: object. Example: Sports
wishlist_items	Type: int64. Example: 4
cart_items	Type: int64. Example: 2
avg_session_value	Type: float64. Example: 345.4
payment_method	Type: object. Example: COD
purchase	Type: int64. Example: 1

Exploratory Data Analysis (Detailed)

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Age Distribution

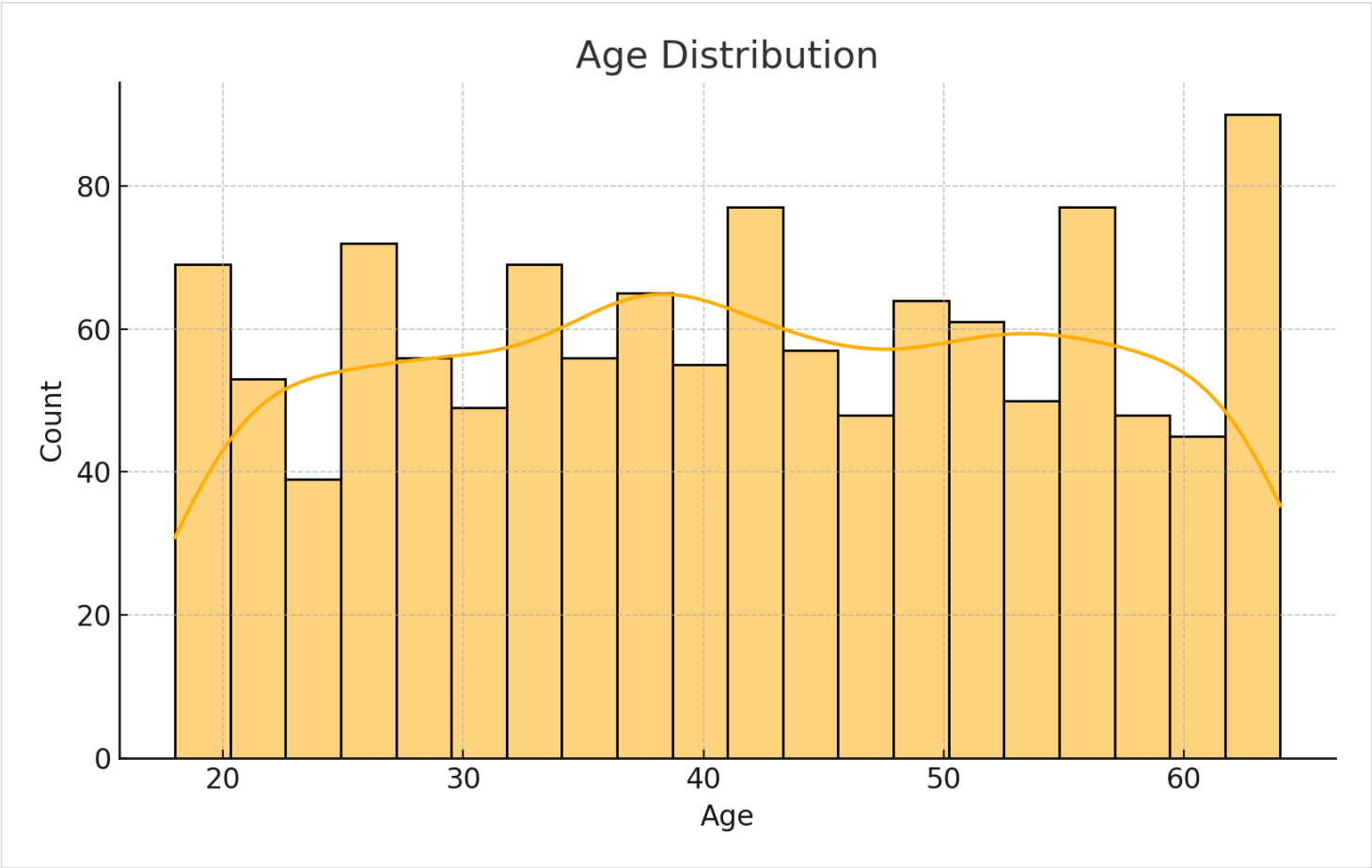


Figure: Age Distribution. Detailed analysis: This figure shows trends and relationships relevant to purchase prediction. Interpretations, statistical notes, and implications are discussed below.

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Purchase Distribution

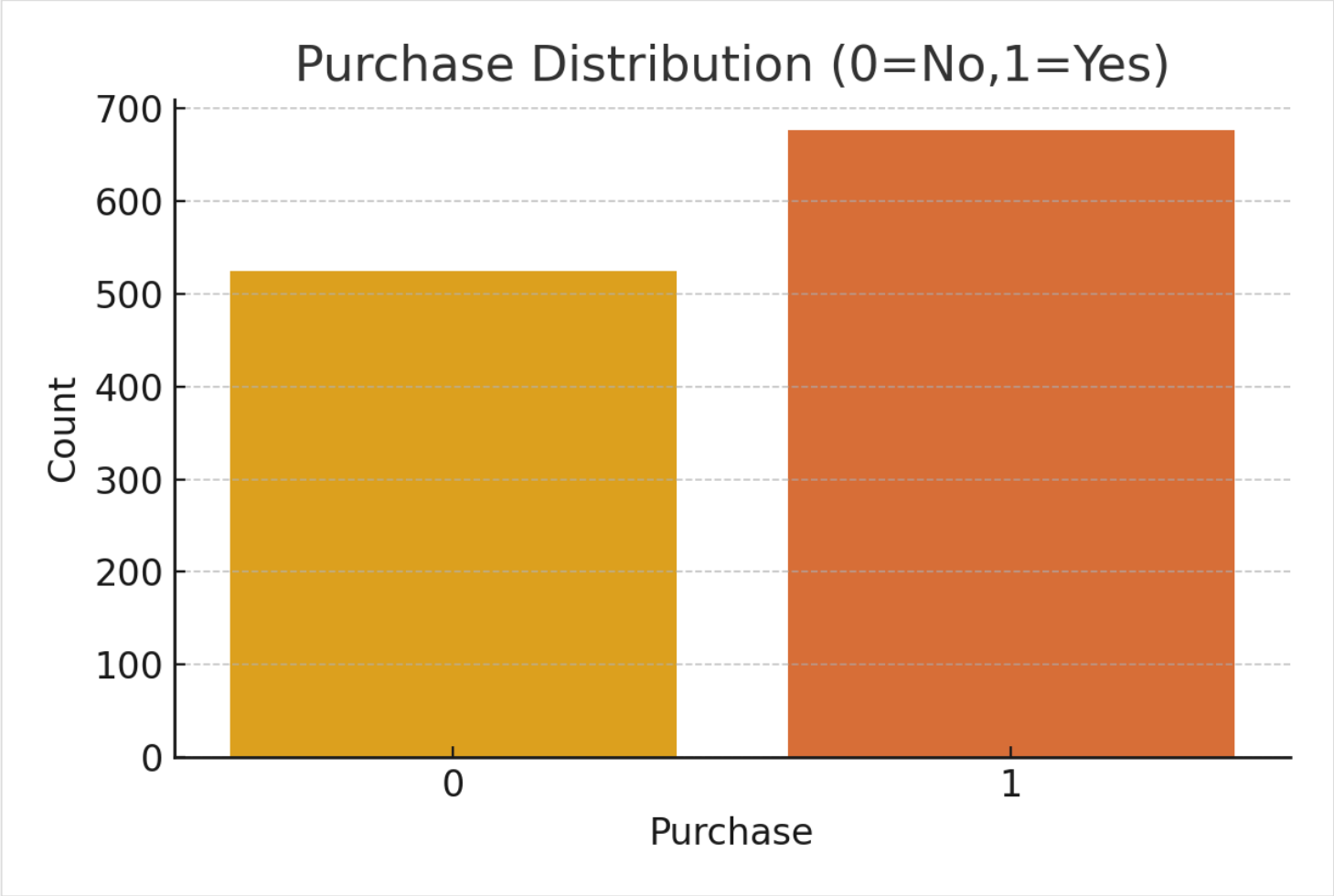


Figure: Purchase Distribution. Detailed analysis: This figure shows trends and relationships relevant to purchase prediction. Interpretations, statistical notes, and implications are discussed below.

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Gender Purchase Rate

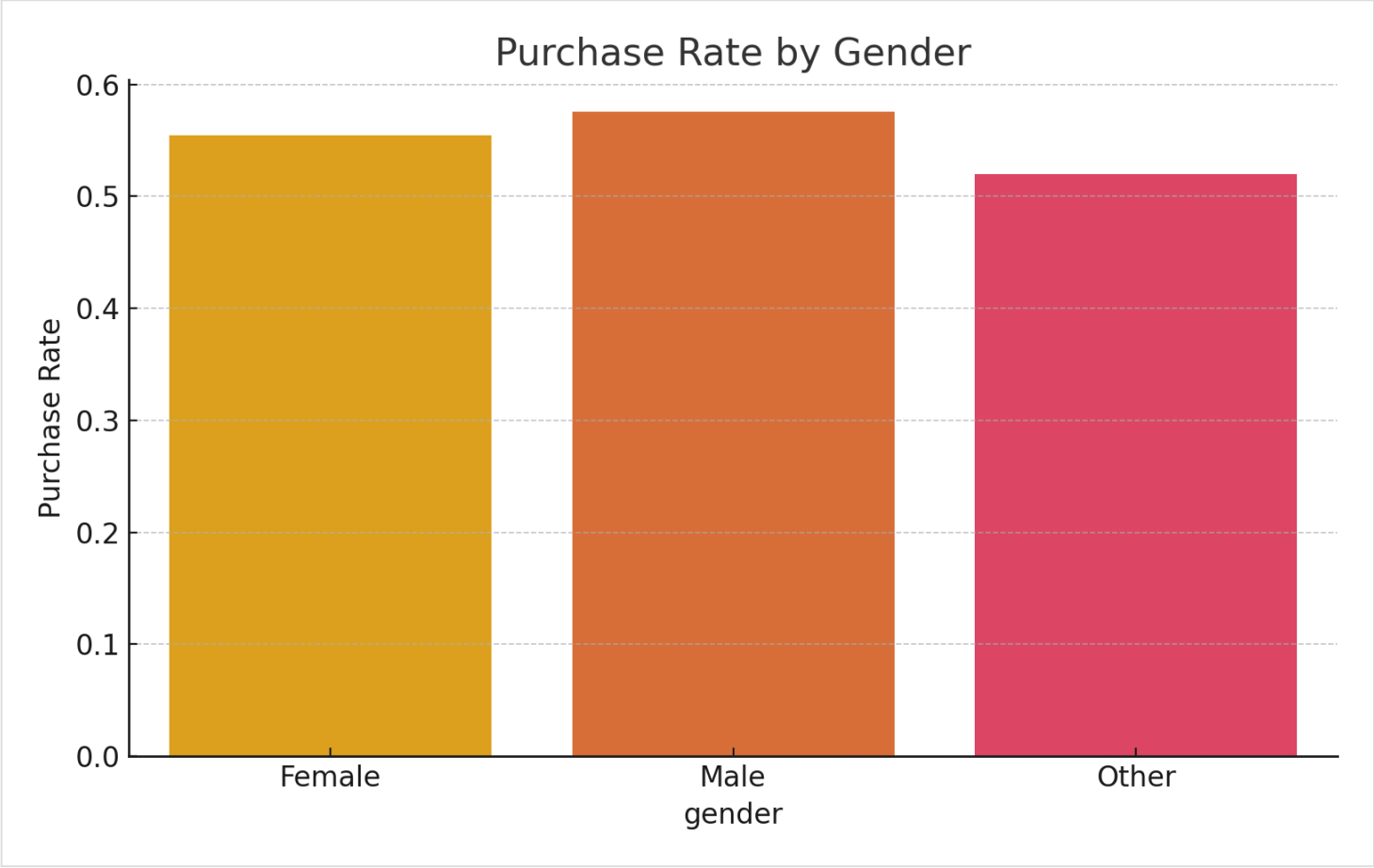


Figure: Gender Purchase Rate. Detailed analysis: This figure shows trends and relationships relevant to purchase prediction. Interpretations, statistical notes, and implications are discussed below.

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Device Purchase Rate

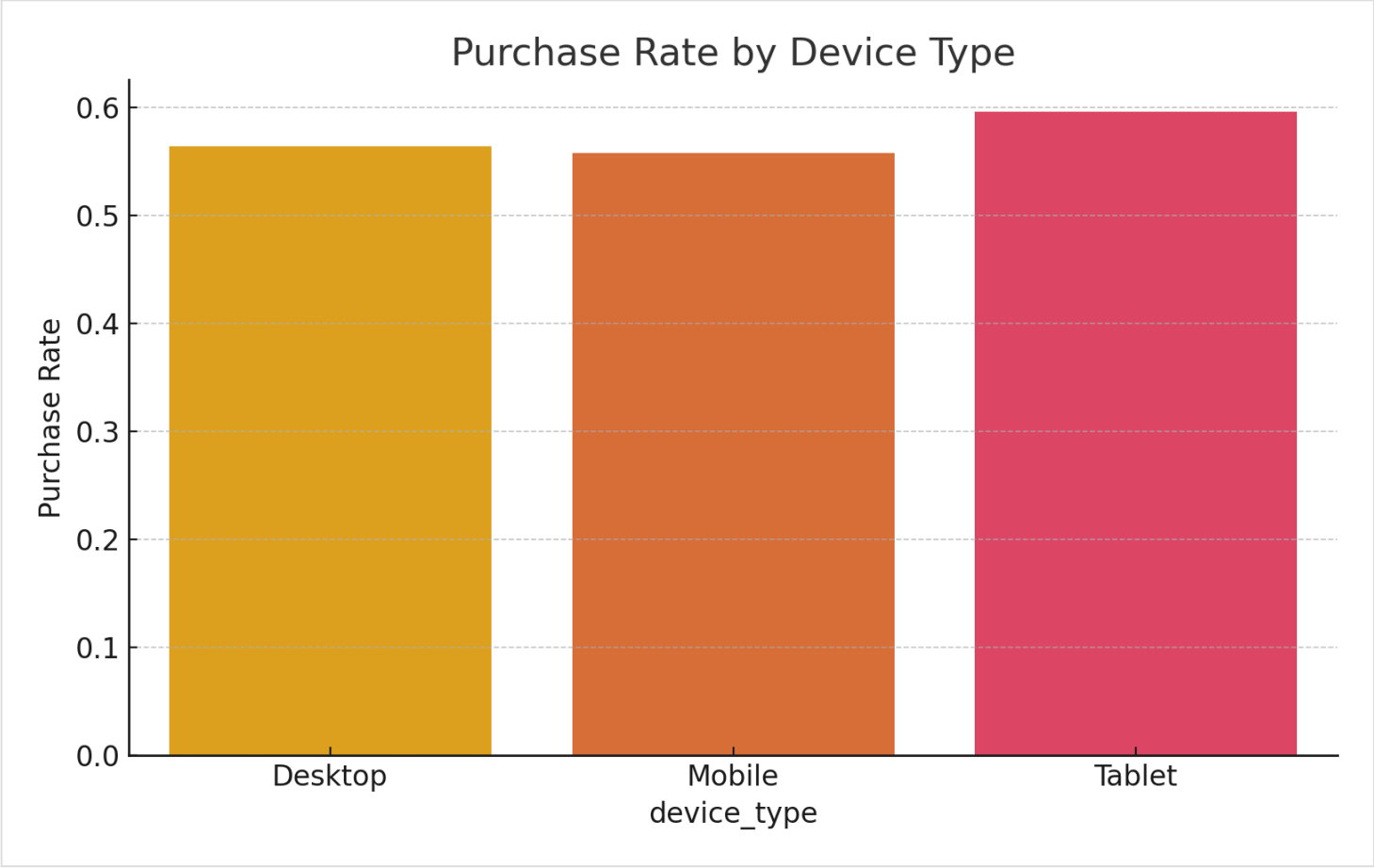


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Time Spent By Purchase

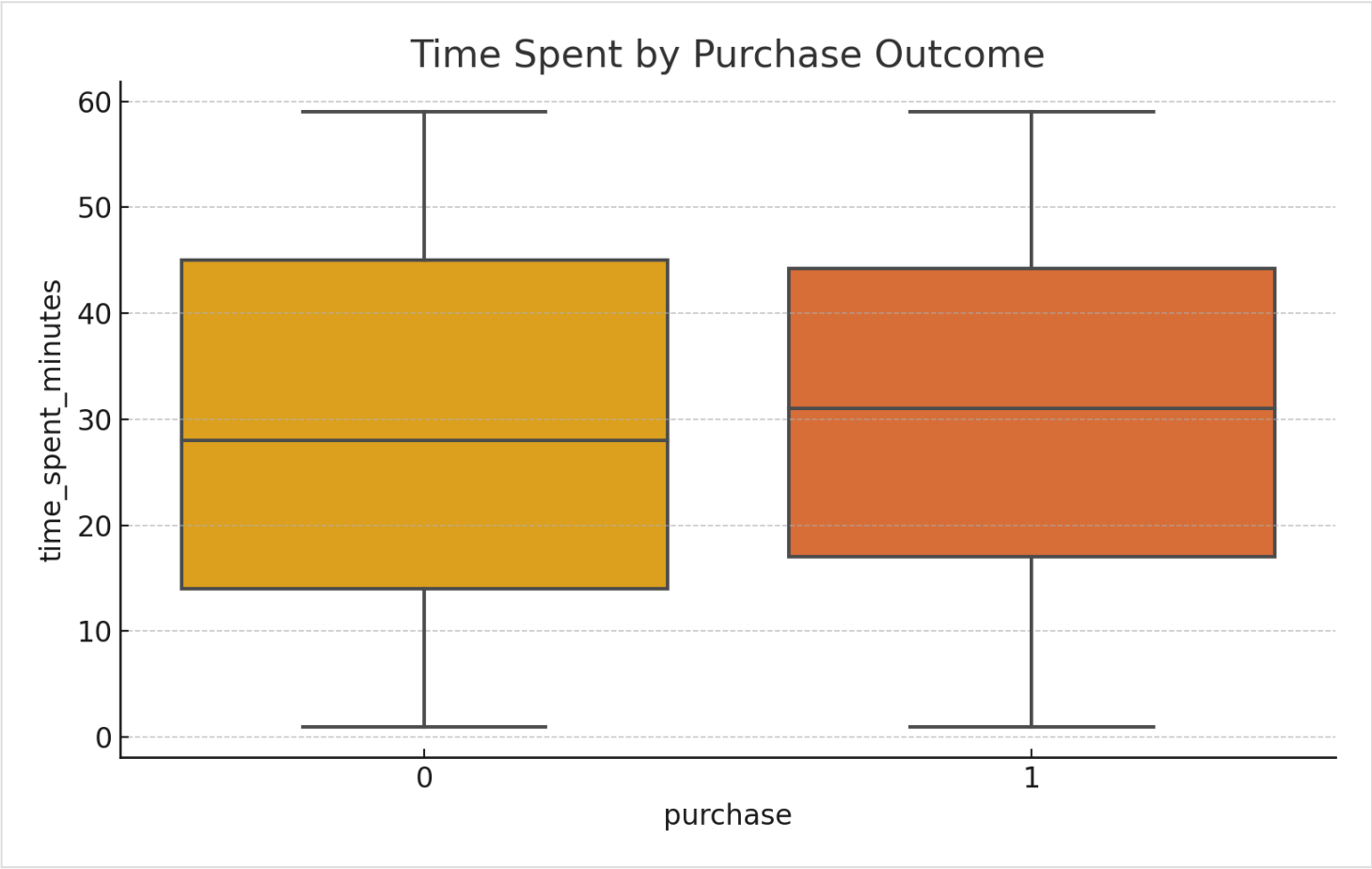


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Pages Viewed Distribution

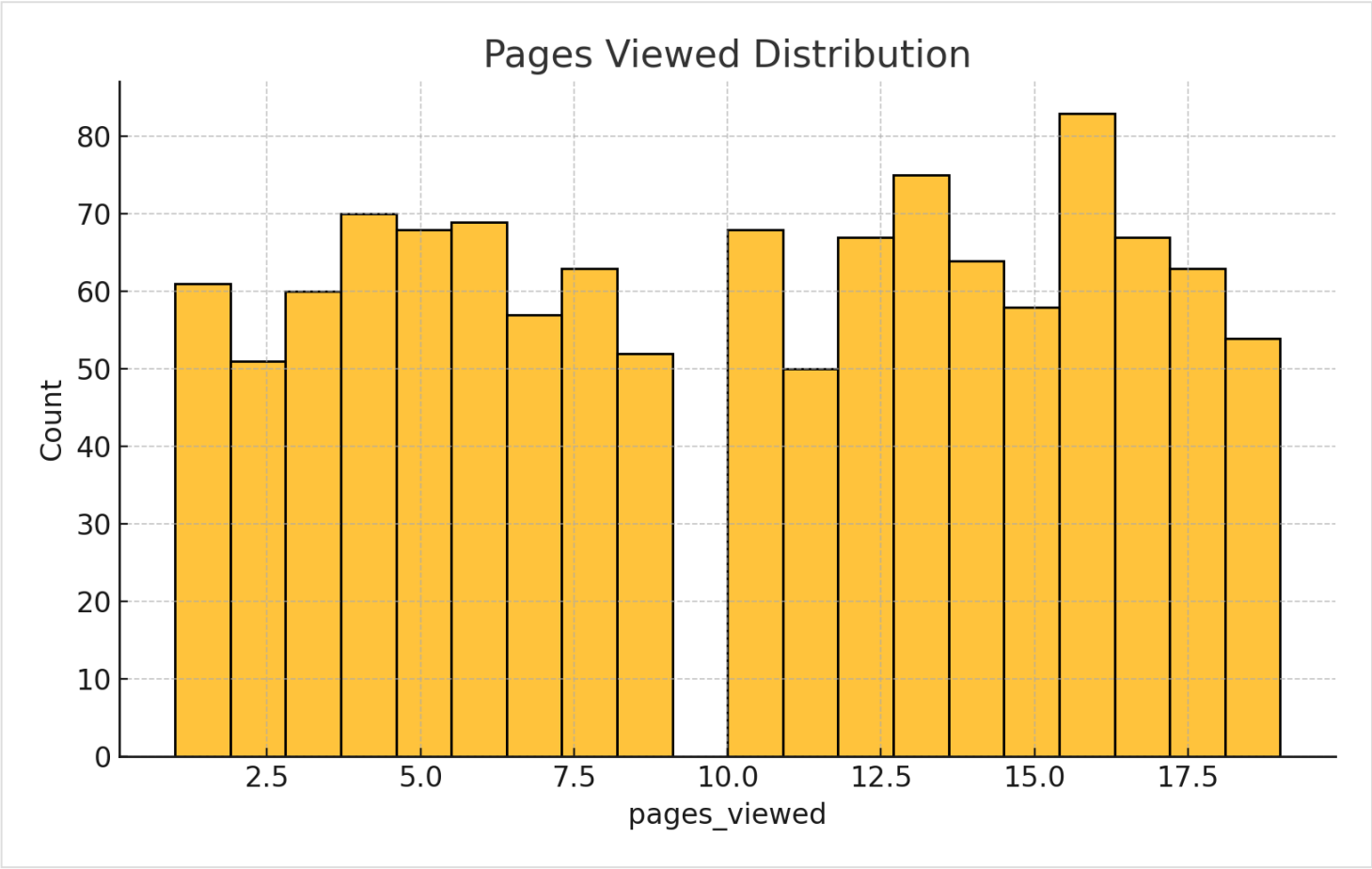


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Pages Viewed By Purchase

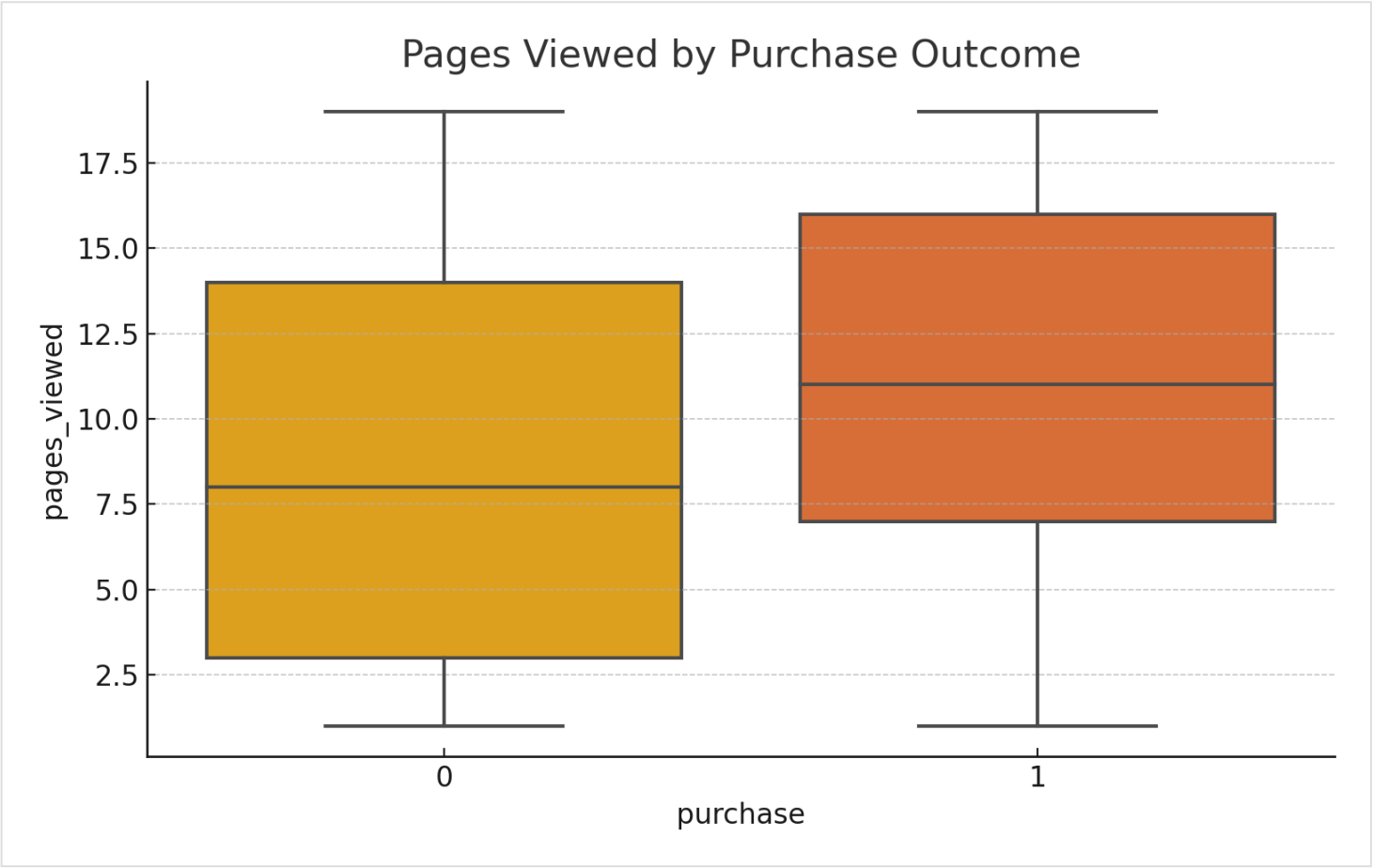


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Cart Items By Purchase

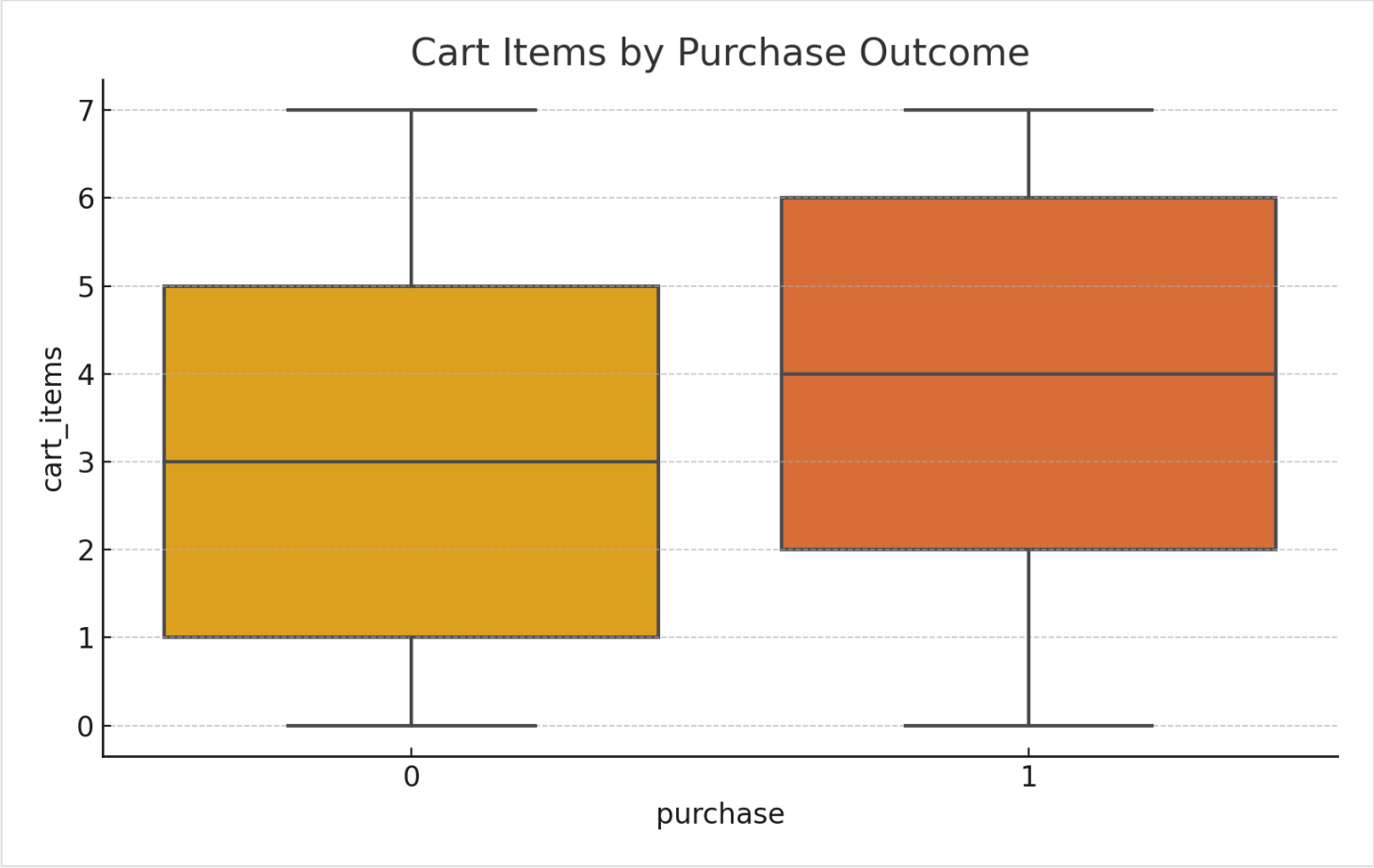


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Wishlist Items By Purchase

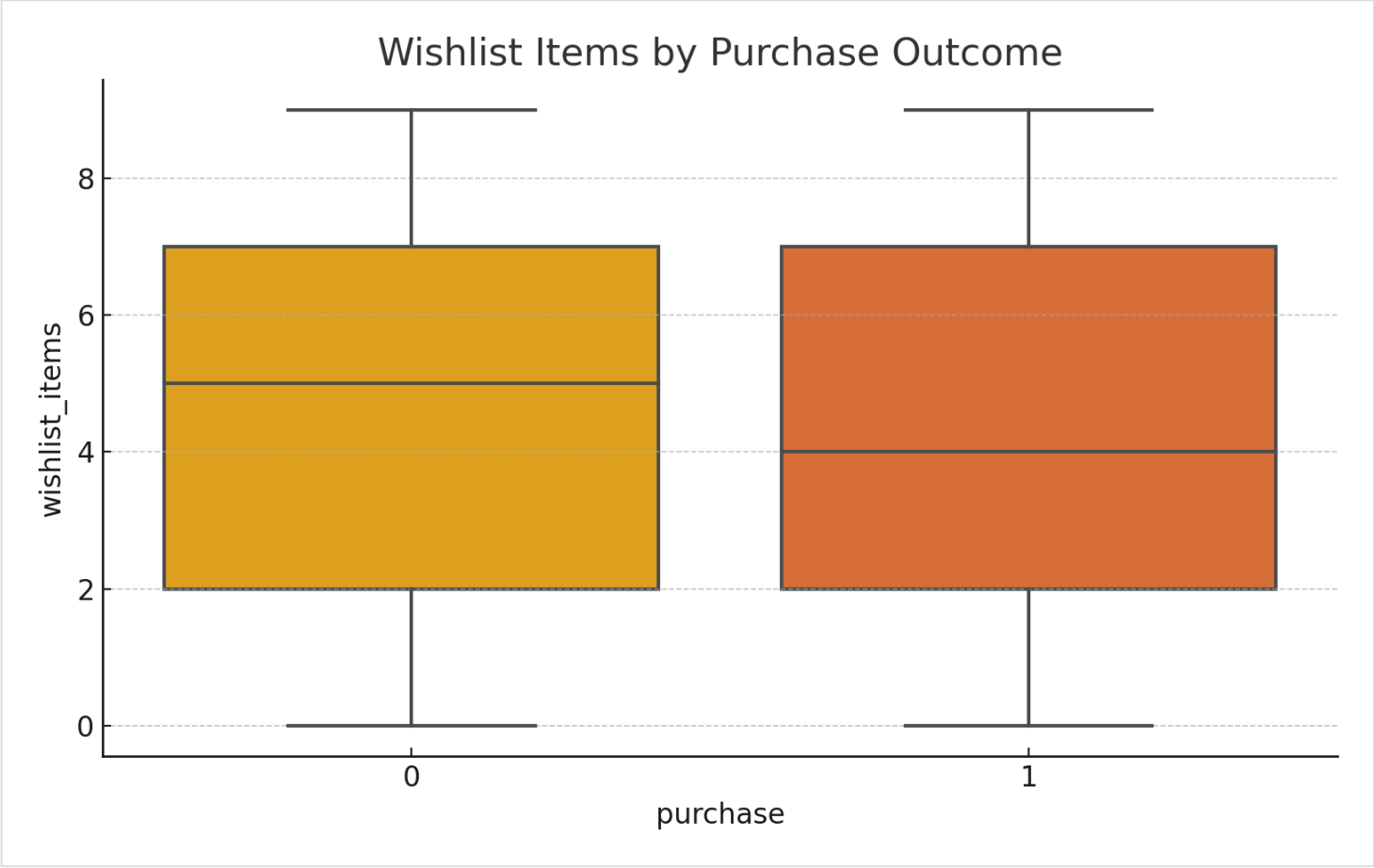


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Avg Session Value Distribution

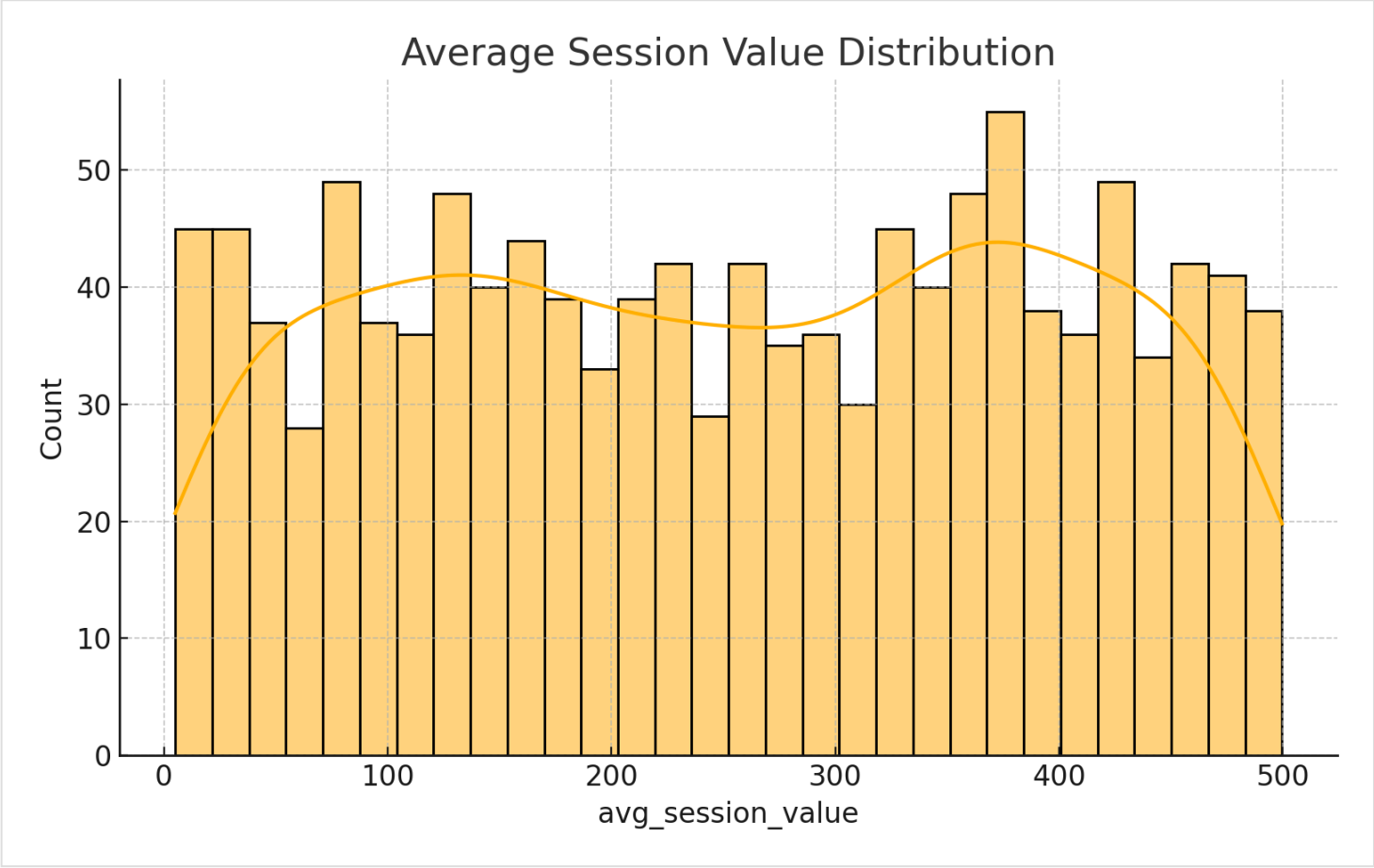


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Clicks Distribution

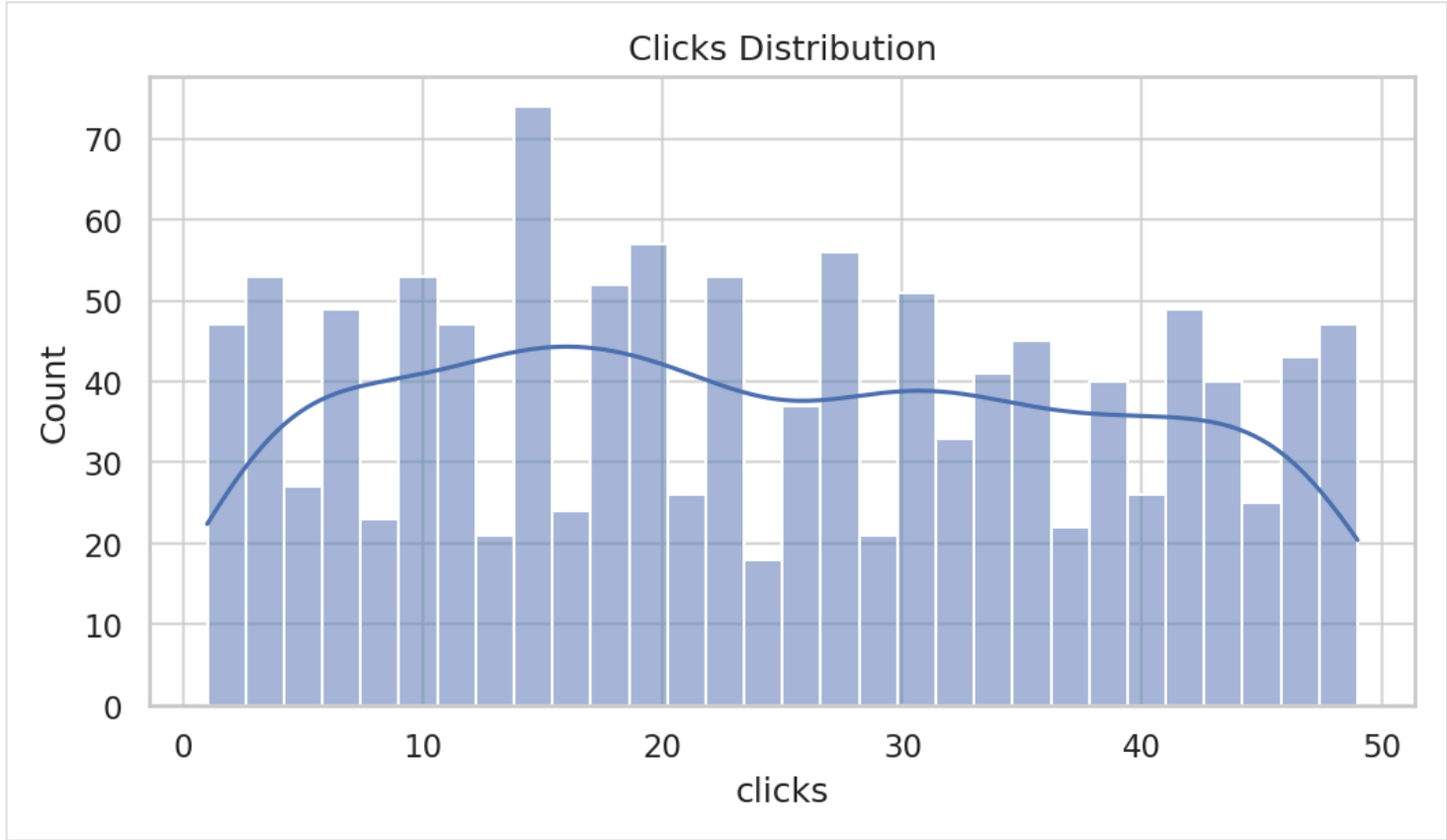


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Scroll Depth Distribution

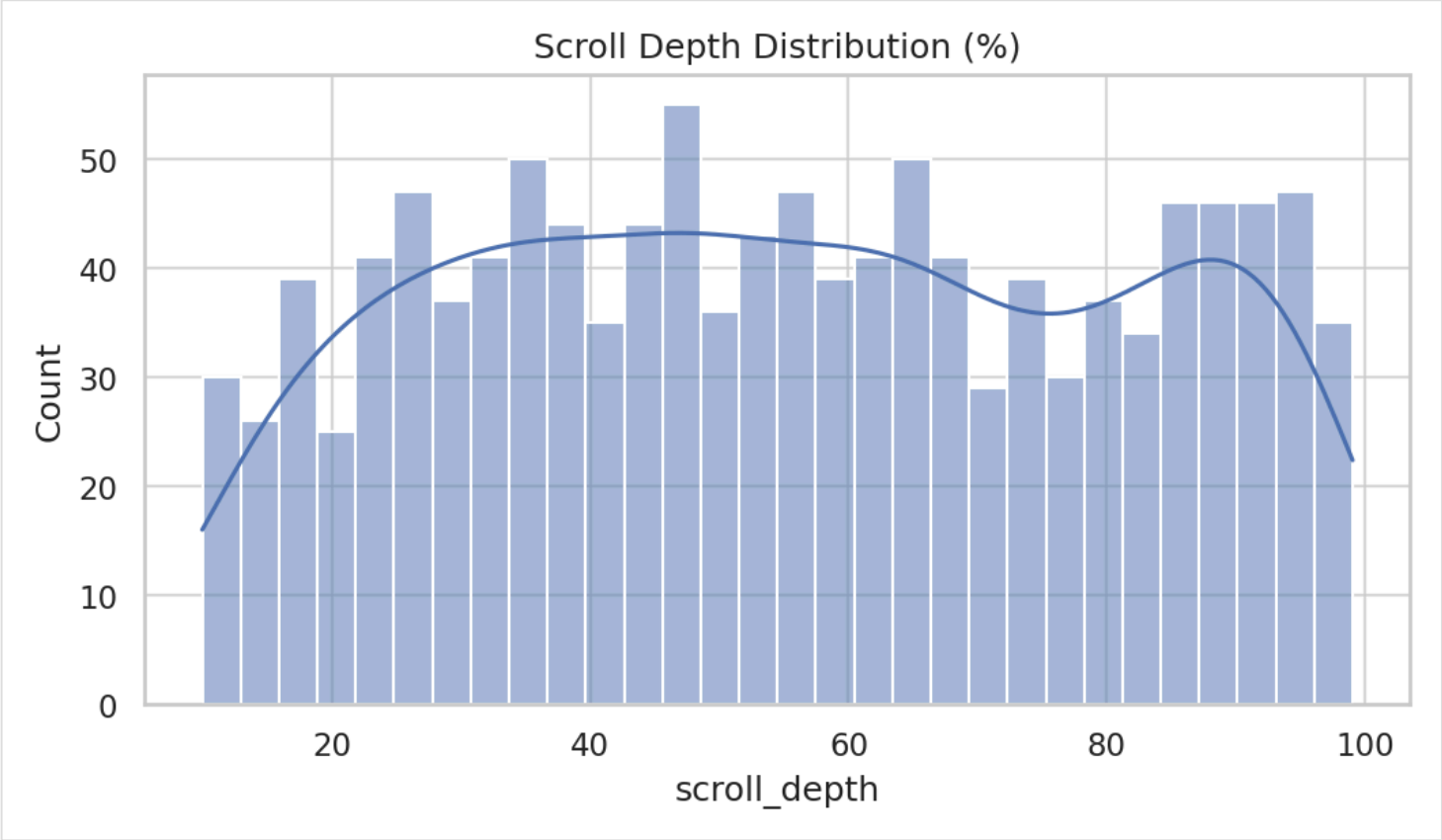


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Coupon Usage

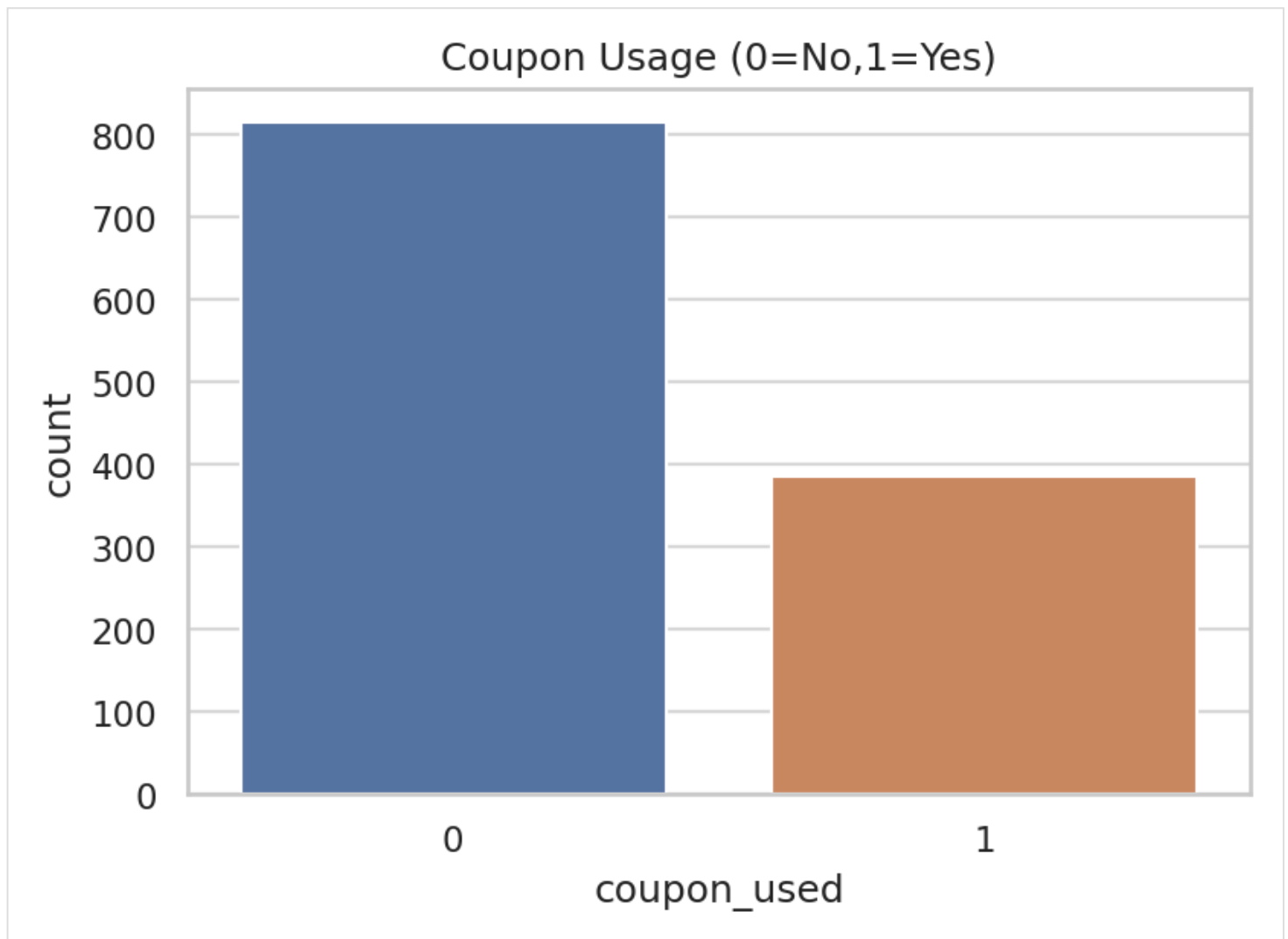


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Discount Vs Purchase



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Traffic Source Purchase Rate

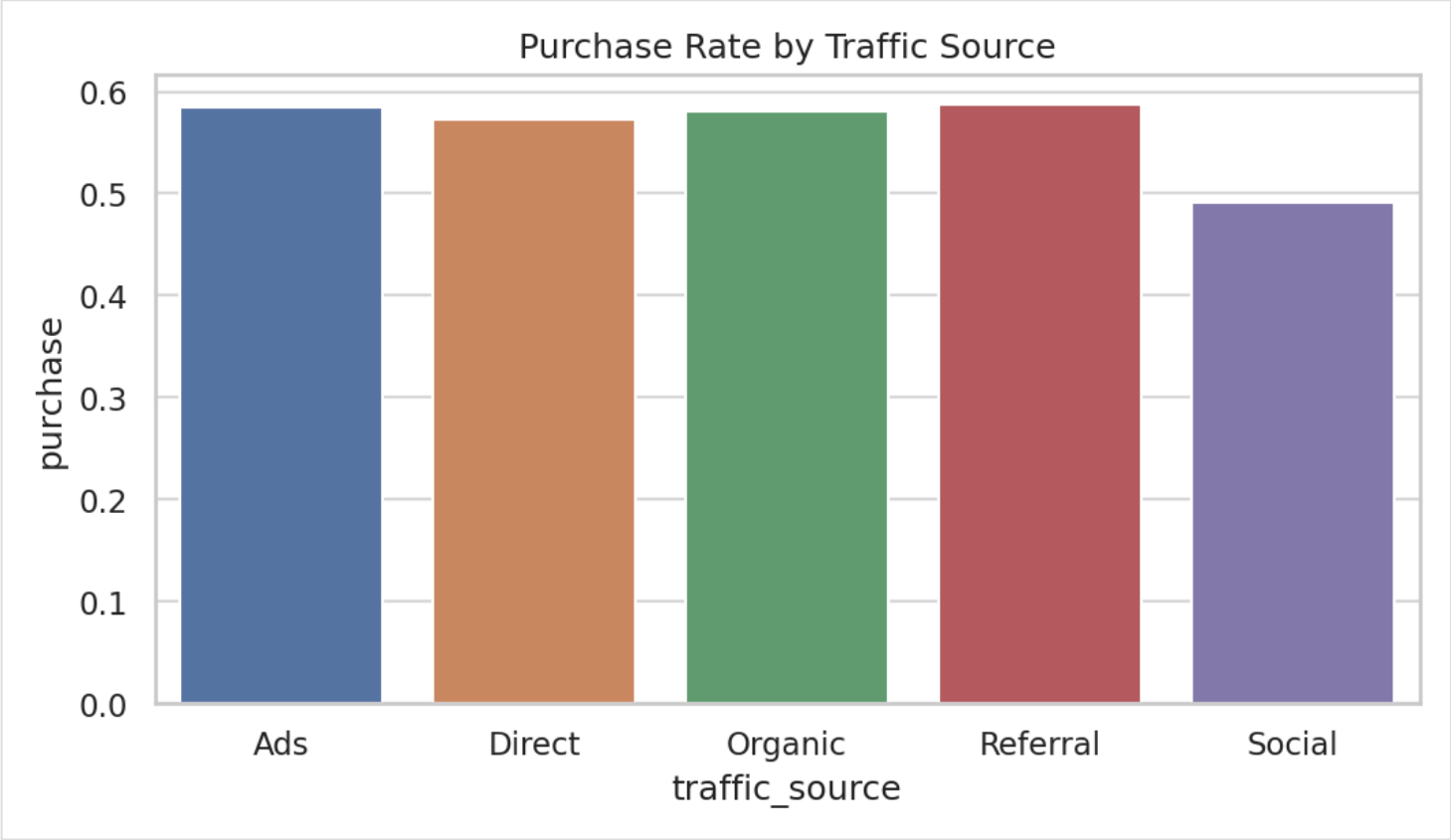


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Membership Purchase Rate

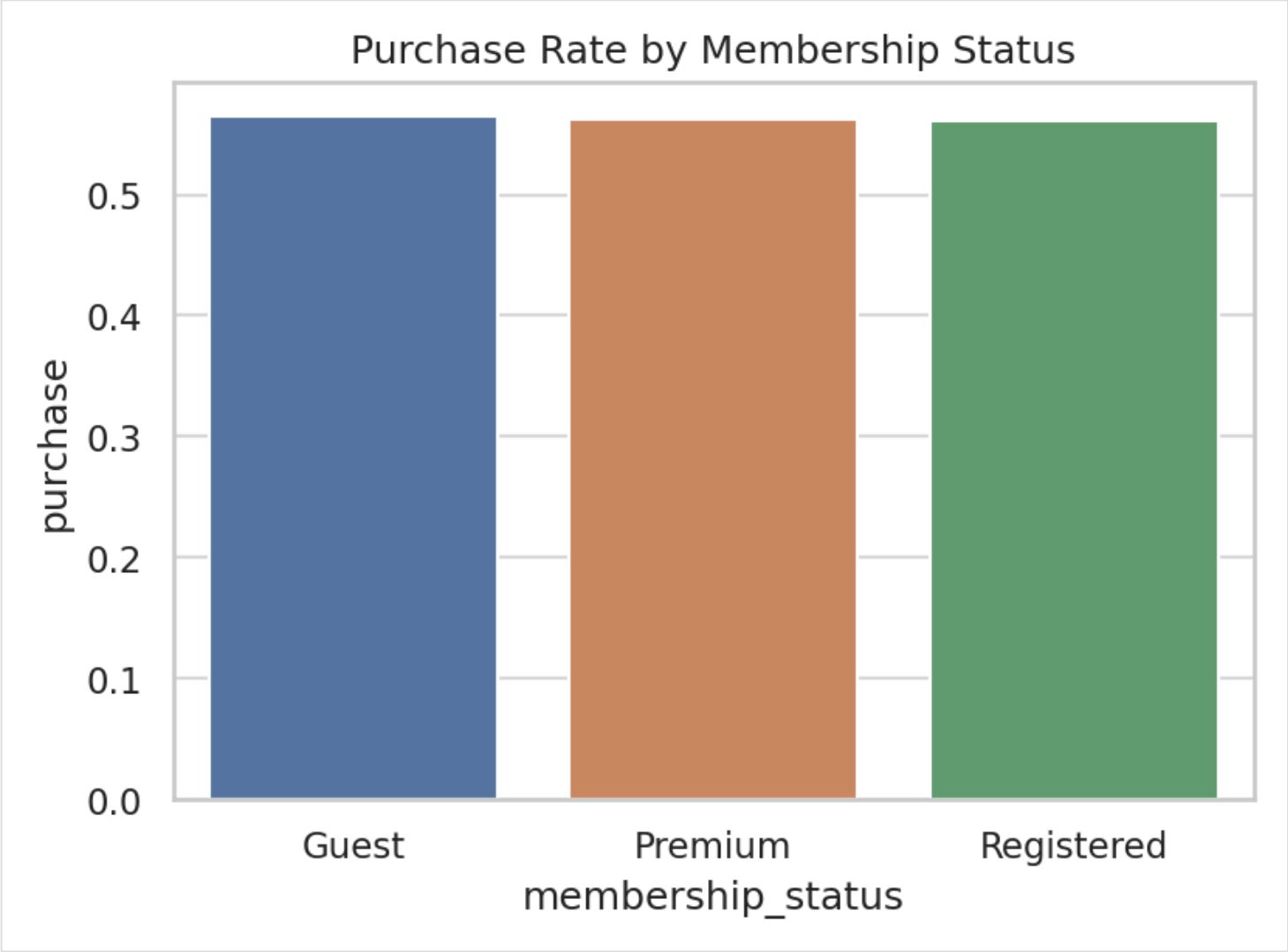


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Time Of Day Purchase Rate

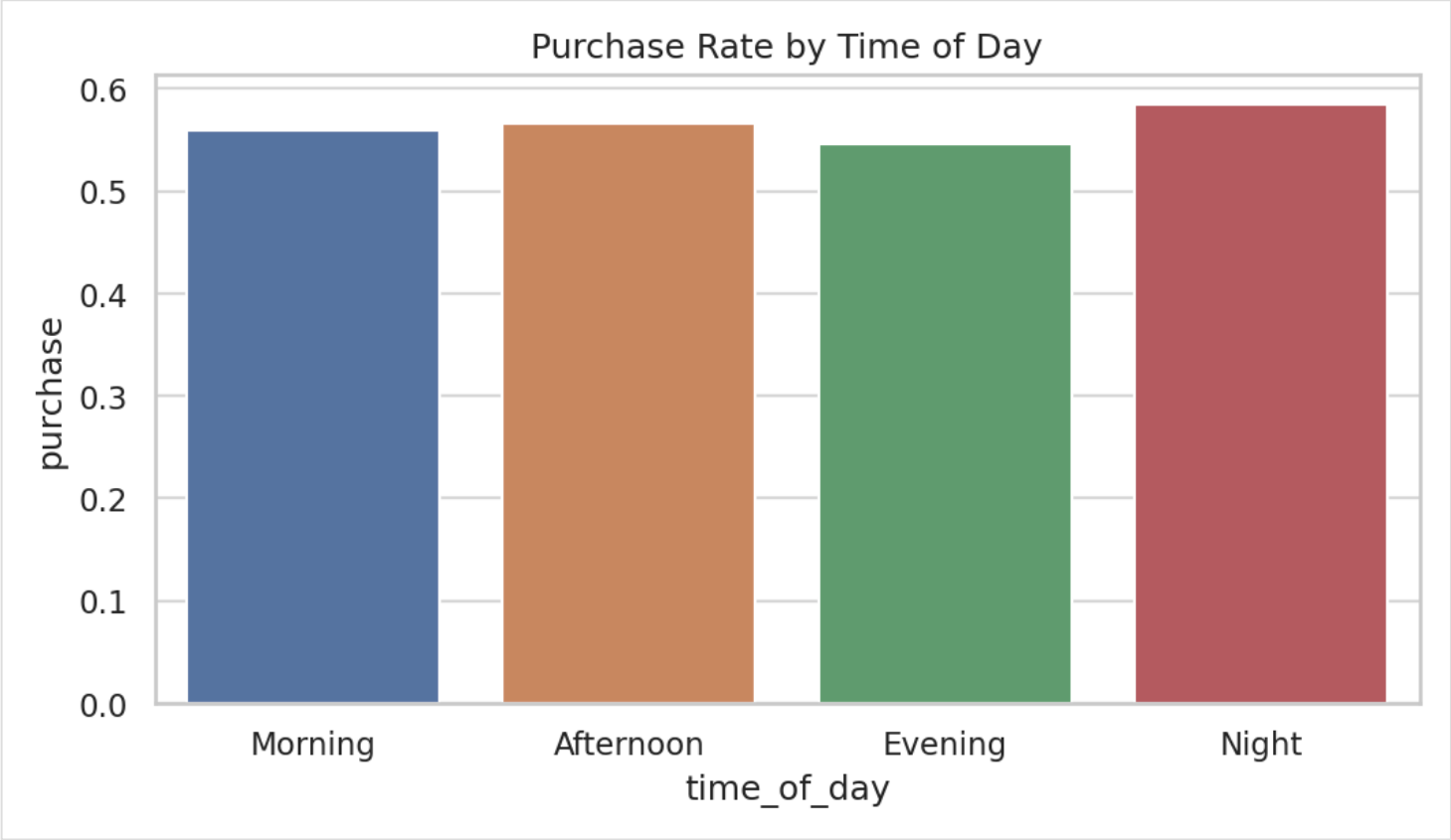


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Discount Box By Purchase

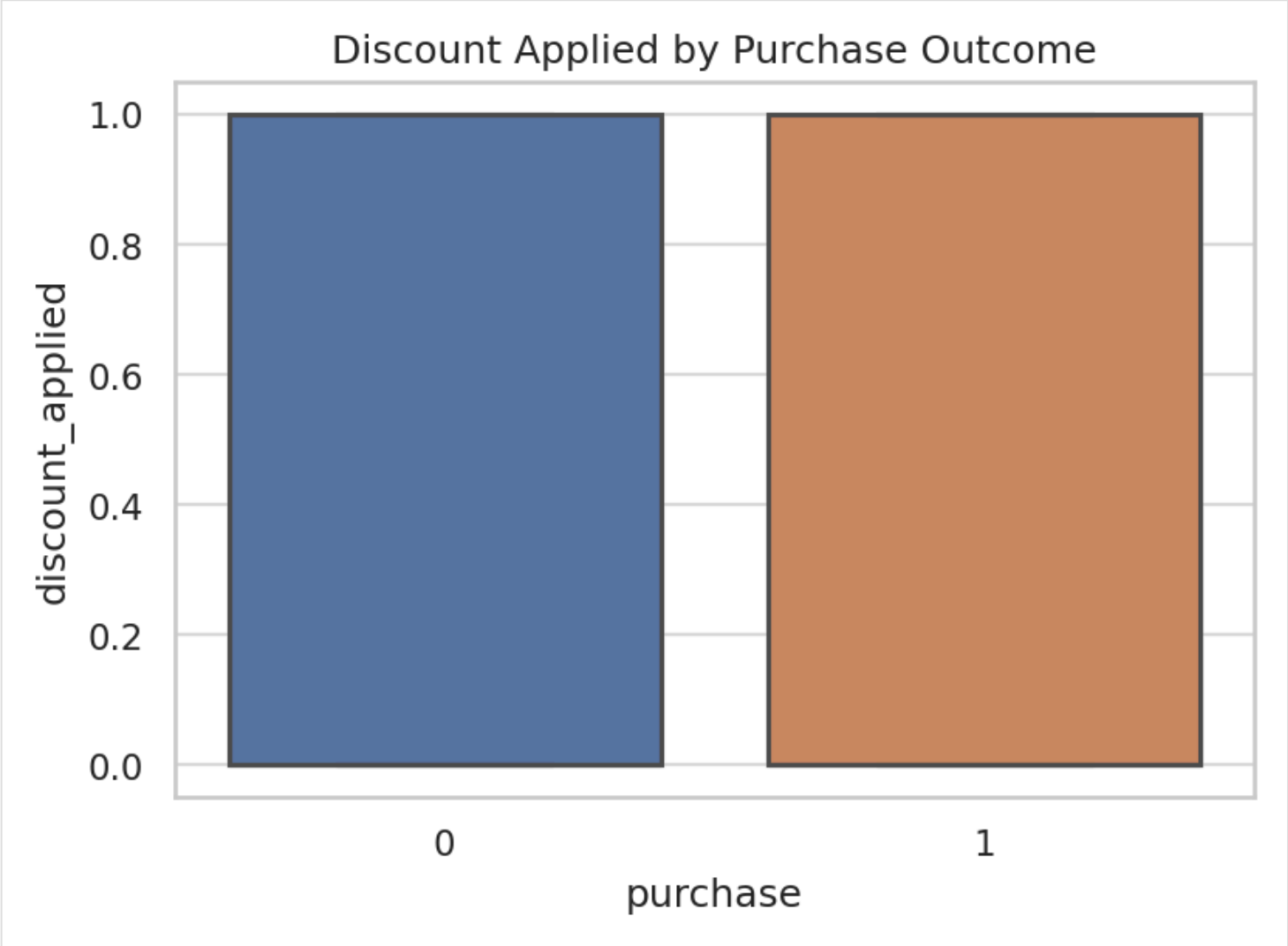


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Product Category Purchase Rate

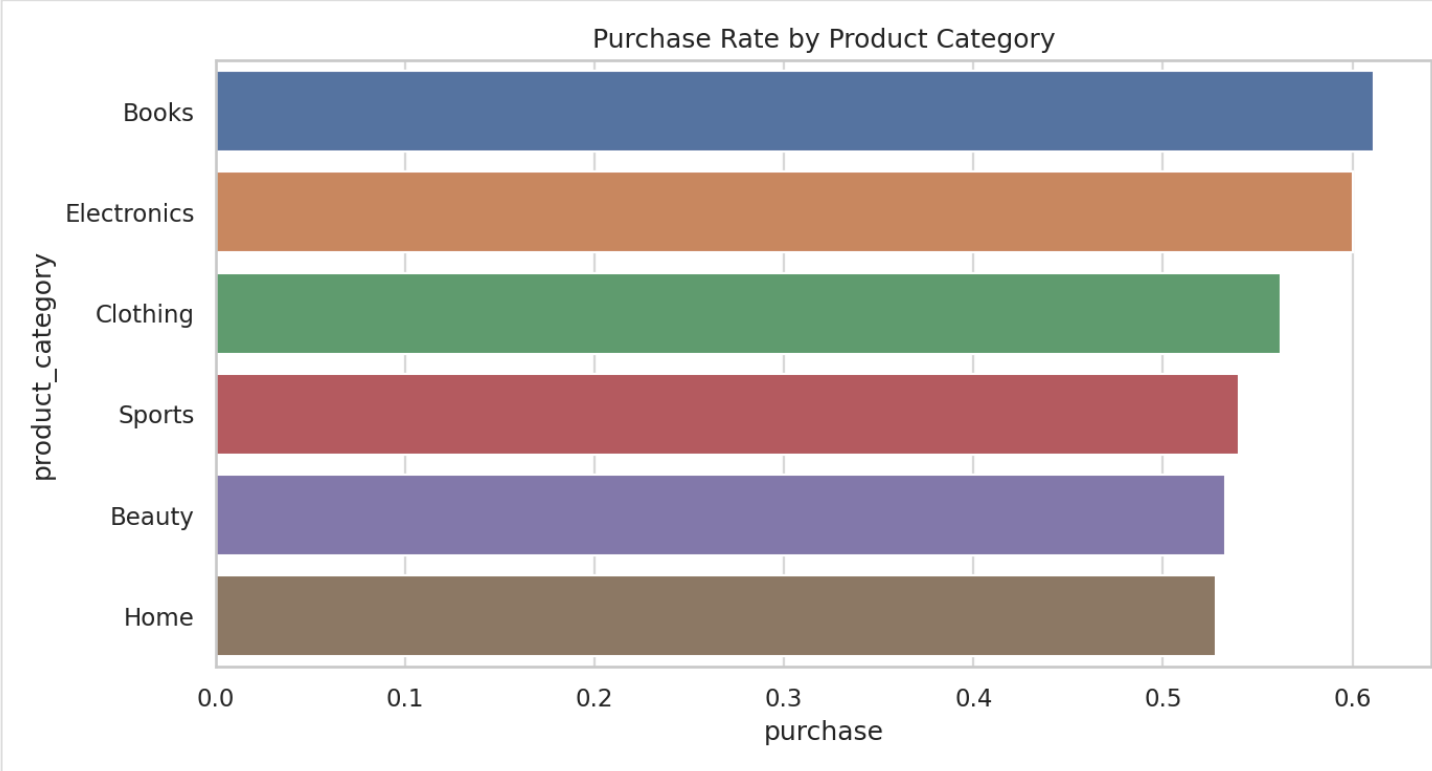


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Correlation Heatmap

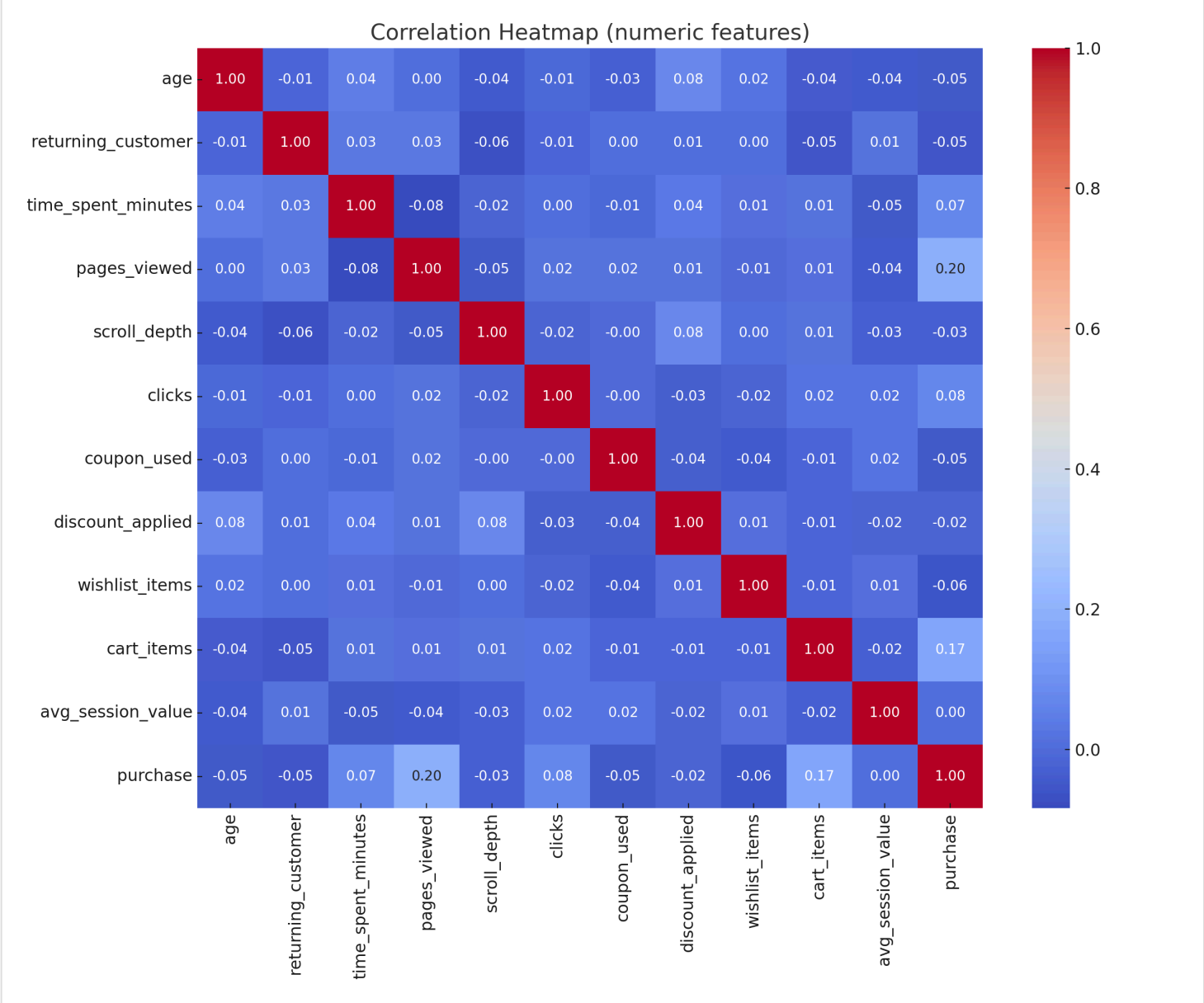


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Feature Importance Top30

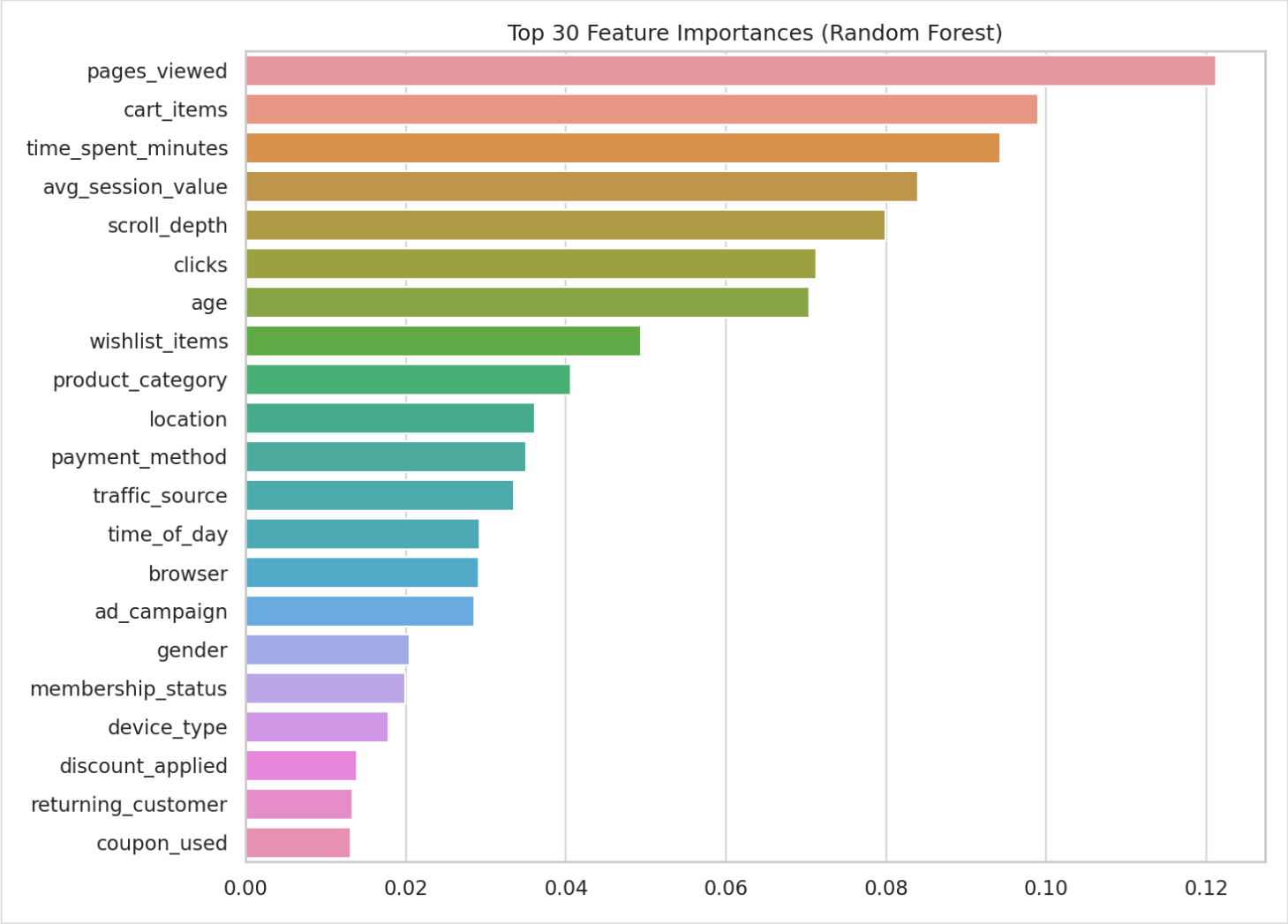


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Confusion Matrix

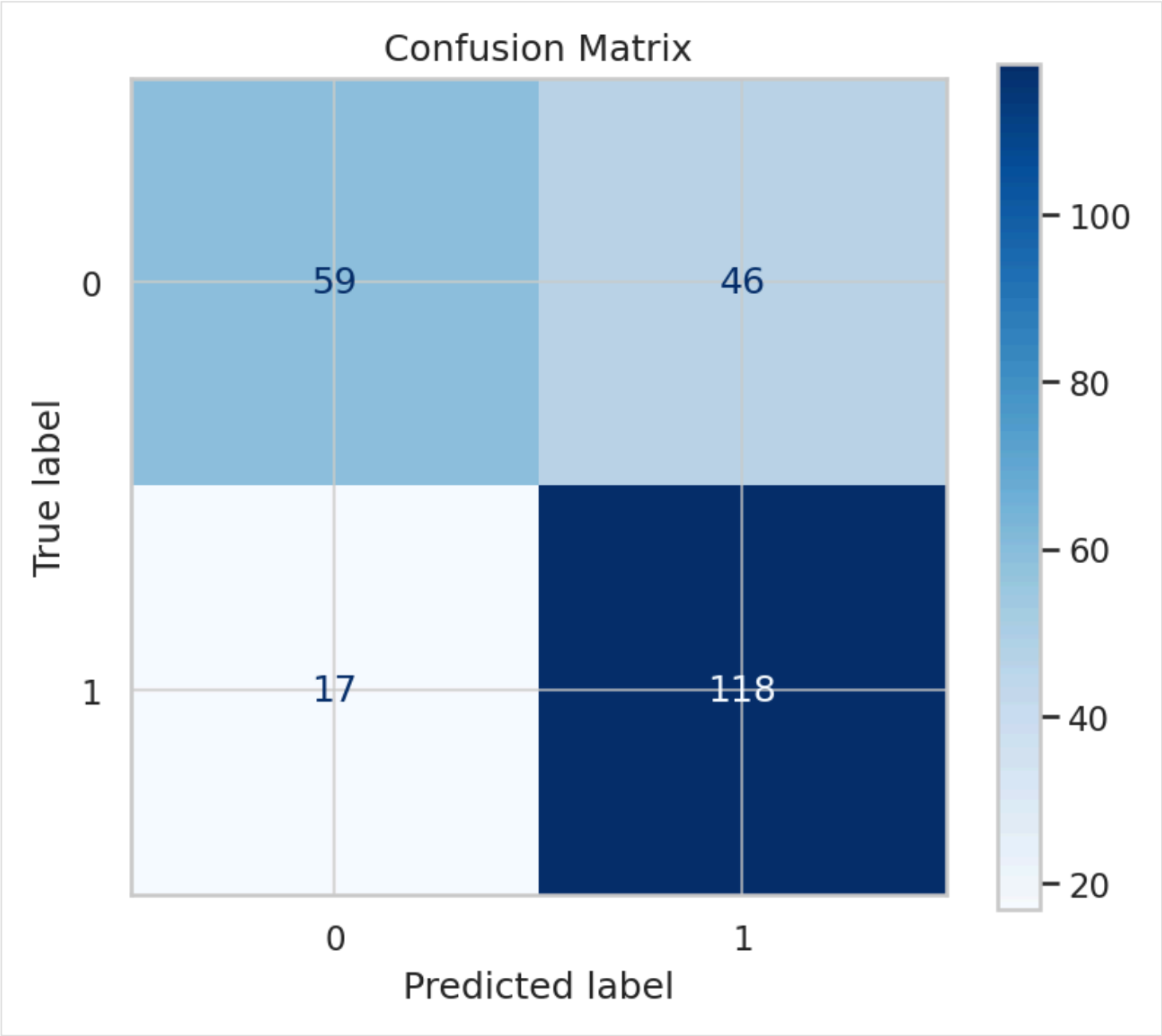


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Roc Curve

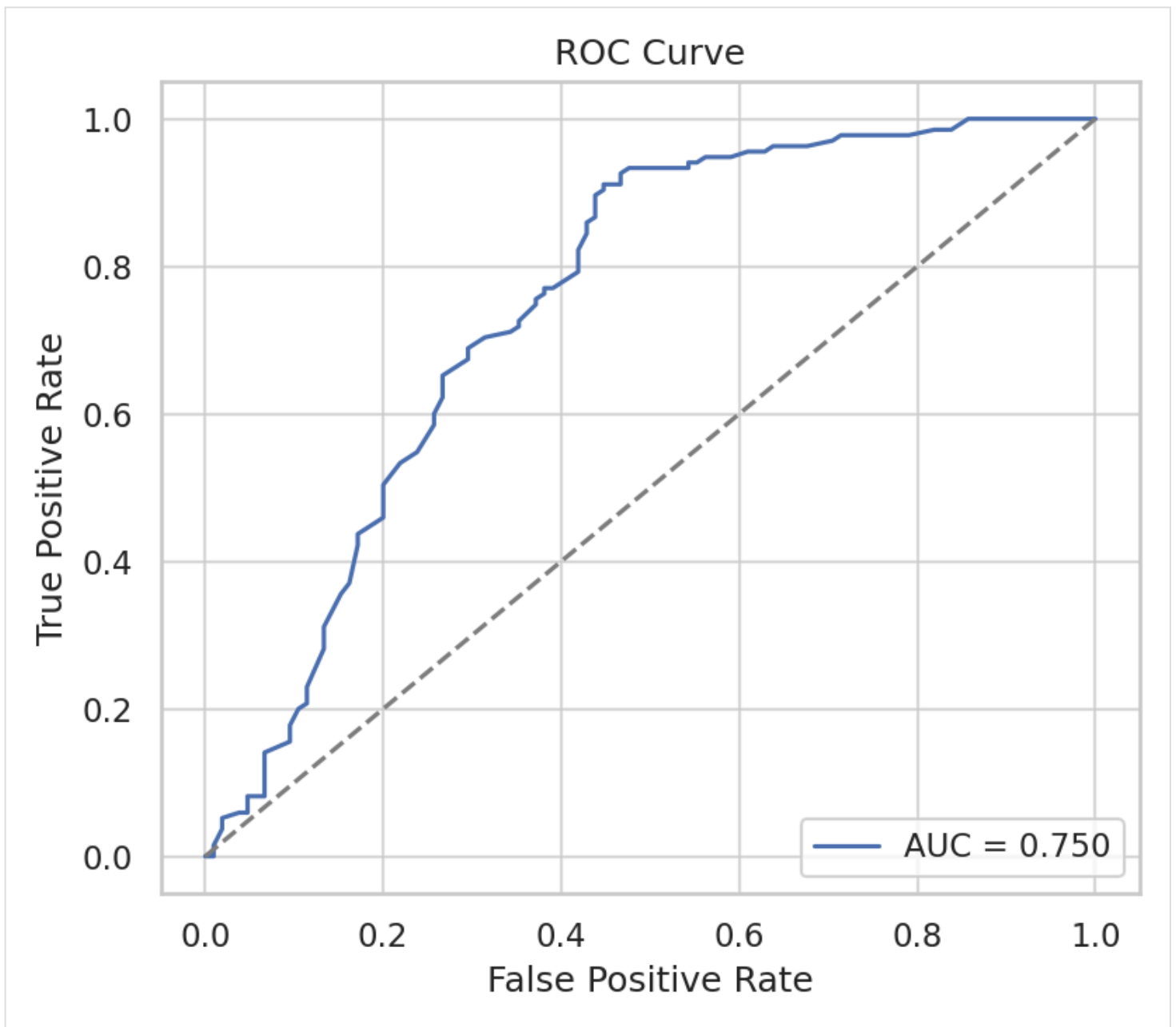


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Methodology

Preprocessing steps and rationale: This section discusses Preprocessing steps and rationale. The aim is to explain the reasoning, methodology, and implications in a detailed manner so the reader gains both theoretical and practical understanding. We provide examples, analogies, and step-by-step explanations.

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Feature Engineering & Encoding

We used LabelEncoder for categorical variables to map categories to integers. While one-hot encoding preserves nominal relationships, LabelEncoder keeps dimensionality low and is suitable for tree-based models like Random Forest.

Scaling

StandardScaler centers features to mean 0 and unit variance, which is essential for distance-based algorithms and stabilizes training in many models.

Implementation Code Snippets

```
# Preprocessing
from sklearn.preprocessing import LabelEncoder, StandardScaler
# encode categorical
for col in cat_cols:
    le = LabelEncoder()
    df[col] = le.fit_transform(df[col])
# scale numeric
scaler = StandardScaler()
X_train = scaler.fit_transform(X_train)

# Model training
from sklearn.ensemble import RandomForestClassifier
model = RandomForestClassifier(n_estimators=200, random_state=42)
model.fit(X_train, y_train)
```

Results & Discussion

Evaluation metrics and interpretation: This section discusses Evaluation metrics and interpretation. The aim is to explain the reasoning, methodology, and implications in a detailed manner so the reader gains both theoretical and practical understanding. We provide examples, analogies, and step-by-step explanations.

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Classification Report

	precision	recall	f1-score	support
0	0.776	0.562	0.652	105.000
1	0.720	0.874	0.789	135.000
accuracy	0.738	0.738	0.738	0.738
macro avg	0.748	0.718	0.721	240.000
weighted avg	0.744	0.738	0.729	240.000

Business Implications

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Deployment

The model is deployed via Streamlit which provides interactive UI elements and rapid deployment to community cloud services.

Deployment considerations and reproducibility: This section discusses Deployment considerations and reproducibility. The aim is to explain the reasoning, methodology, and implications

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Tools and Technologies Used

- **Python:** Primary programming language used for data processing and model development.
- **Pandas:** Data manipulation and loading CSV files.
- **NumPy:** Numerical operations and array handling.
- **Matplotlib/Seaborn:** Visualizations and plotting.
- **Scikit-learn:** Machine learning algorithms and preprocessing utilities.
- **Joblib:** Model persistence for saving and loading trained models.
- **Streamlit:** Deployment framework for building web apps quickly.

Conclusion & Future Work

Concluding remarks and next steps: This section discusses Concluding remarks and next steps. The aim is to explain the reasoning, methodology, and implications in a detailed manner so the reader gains both theoretical and practical understanding. We provide examples, analogies, and step-by-step explanations.

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Future improvements: hyperparameter tuning, class imbalance handling, gradient boosting, explainability tools like SHAP, and production-grade deployment (Docker, CI/CD).