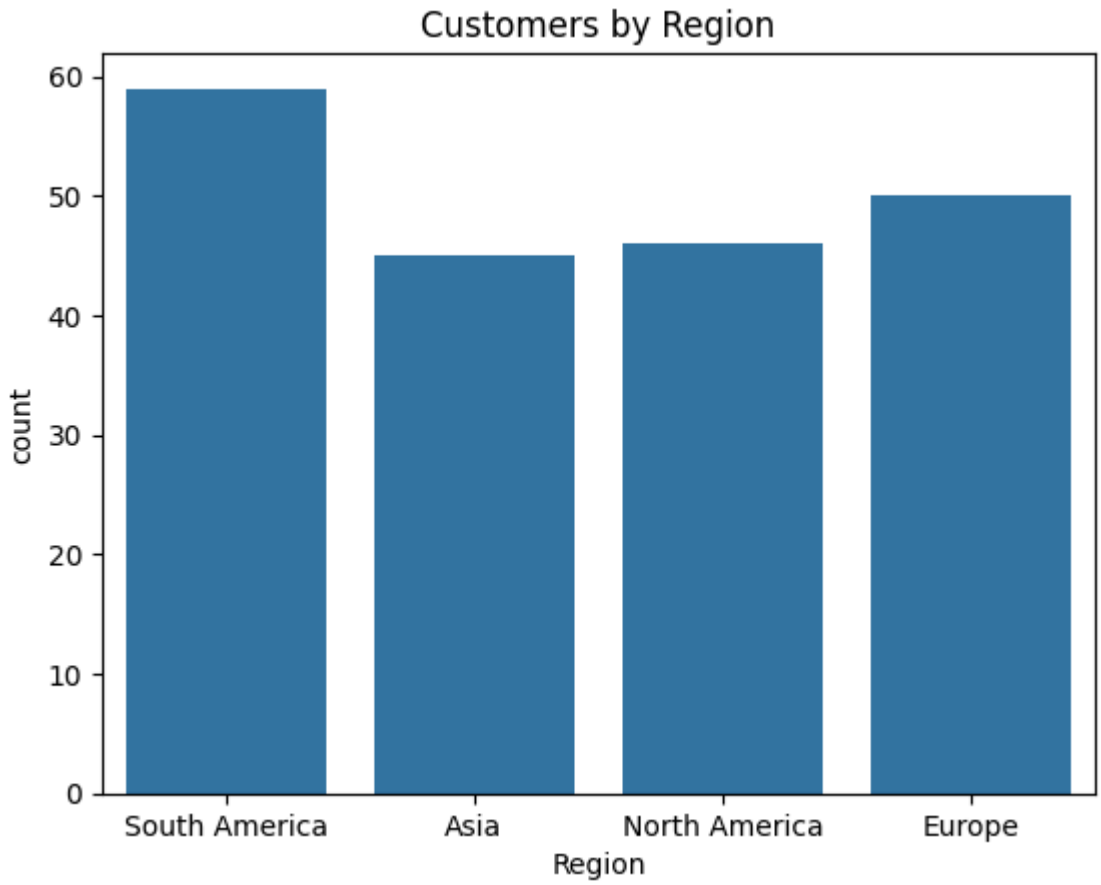
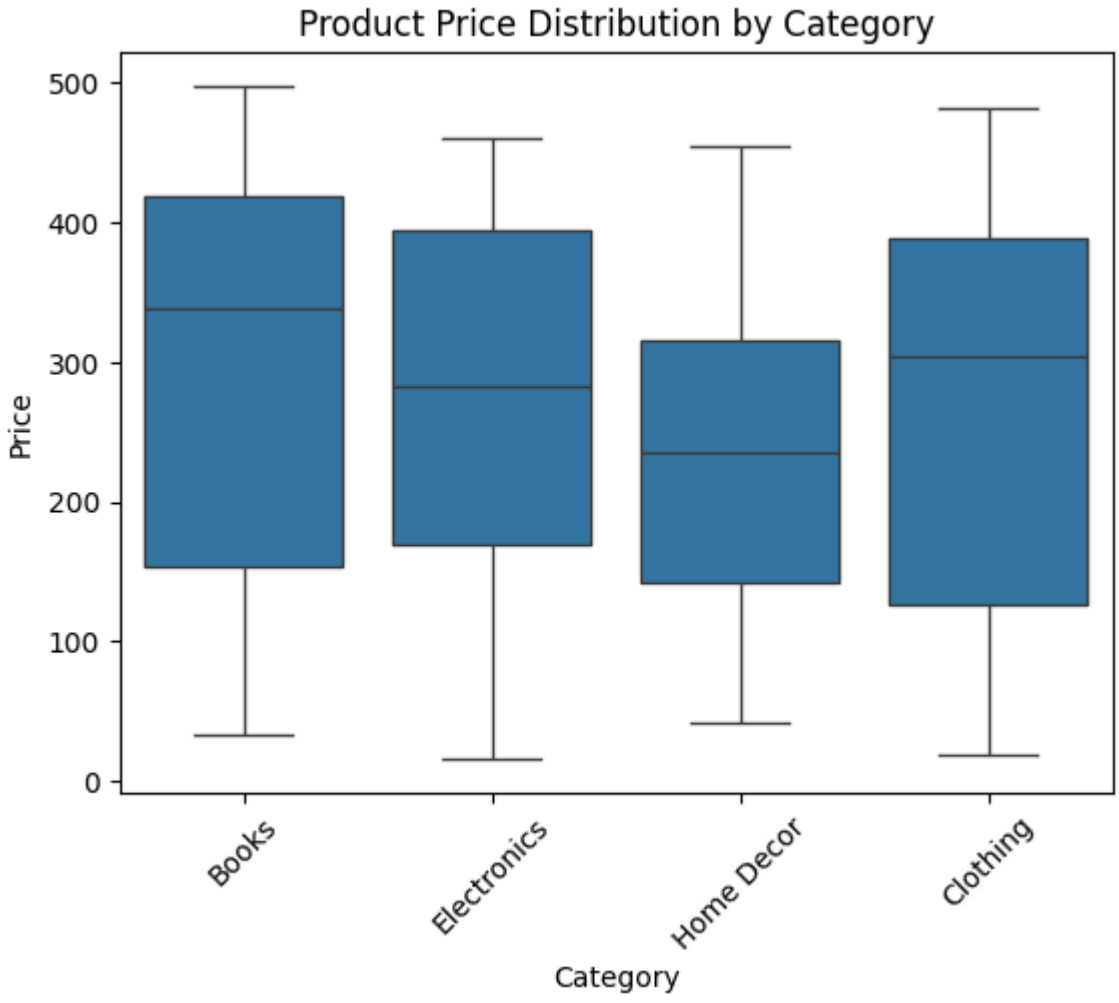
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.metrics.pairwise import cosine_similarity
from sklearn.preprocessing import StandardScaler, LabelEncoder
from sklearn.cluster import KMeans
from sklearn.metrics import davies_bouldin_score
import json


customers = pd.read_csv("Customers.csv")
products = pd.read_csv("Products.csv")
transactions = pd.read_csv("/content/Transactions - Transactions.csv")


customers['SignupDate'] = pd.to_datetime(customers['SignupDate'])
transactions['TransactionDate'] = pd.to_datetime(transactions['TransactionDate'])

# EDA: Summary Statistics
print("Customers Summary:\n", customers.describe(include='all'))
print("Products Summary:\n", products.describe(include='all'))
print("Transactions Summary:\n", transactions.describe(include='all'))
```

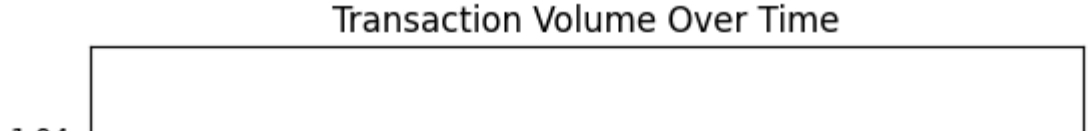
```
Customers Summary:
        CustomerID      CustomerName         Region           SignupDate
count         200               200            200                  200
unique        200               200              4                  NaN
top         C0001  Lawrence Carroll  South America                  NaN
freq            1                 1             59                  NaN
mean          NaN               NaN            NaN  2023-07-19 08:31:12
min           NaN               NaN            NaN  2022-01-22 00:00:00
25%           NaN               NaN            NaN  2022-09-26 12:00:00
50%           NaN               NaN            NaN  2023-08-31 12:00:00
75%           NaN               NaN            NaN  2024-04-12 12:00:00
max           NaN               NaN            NaN  2024-12-28 00:00:00
Products Summary:
        ProductID            ProductName Category       Price
count         100                    100      100  100.000000
unique        100                     66        4         NaN
top          P001  ActiveWear Smartwatch    Books         NaN
freq            1                      4       26         NaN
mean          NaN                    NaN      NaN  267.551700
std           NaN                    NaN      NaN  143.219383
min           NaN                    NaN      NaN   16.080000
25%           NaN                    NaN      NaN  147.767500
50%           NaN                    NaN      NaN  292.875000
75%           NaN                    NaN      NaN  397.090000
max           NaN                    NaN      NaN  497.760000
Transactions Summary:
        TransactionID CustomerID ProductID               TransactionDate  \
count            1000       1000      1000                          1000
unique           1000        199       100                           NaN
top            T00001      C0109      P059                           NaN
freq                1         11        19                           NaN
mean              NaN        NaN       NaN  2024-06-23 15:33:02.768999936
min               NaN        NaN       NaN            2023-12-30 15:29:12
```

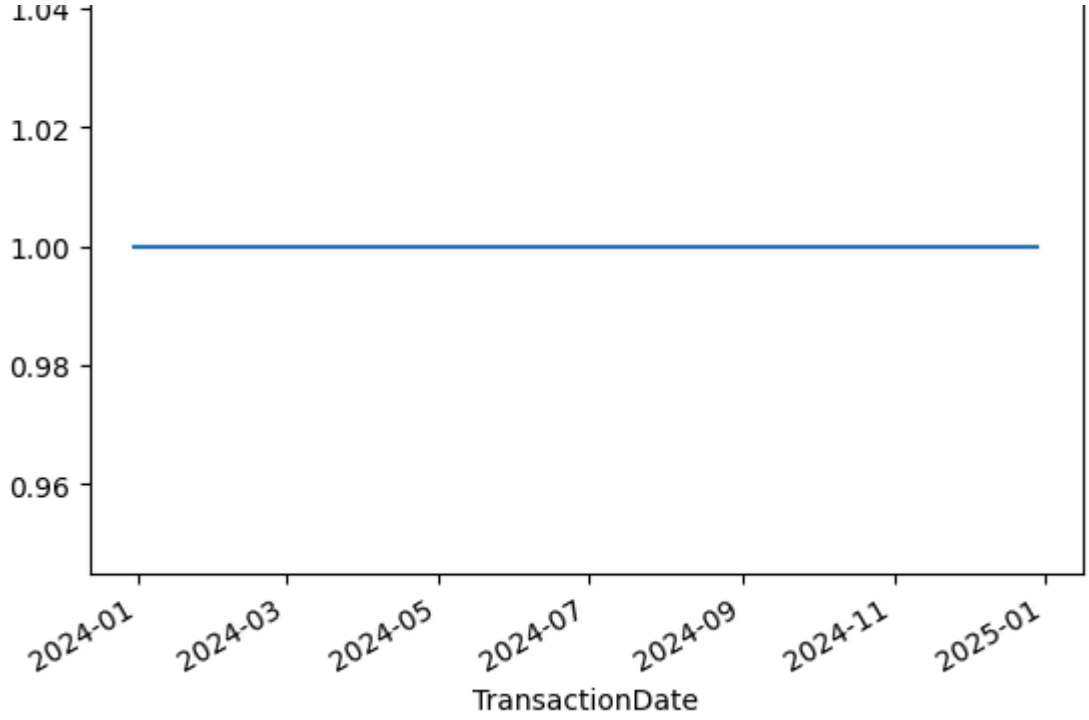
```
25%              NaN        NaN       NaN     2024-03-25 22:05:34.500000
50%              NaN        NaN       NaN     2024-06-26 17:21:52.500000
75%              NaN        NaN       NaN            2024-09-19 14:19:57
max              NaN        NaN       NaN            2024-12-28 11:00:00
std              NaN        NaN       NaN                            NaN

           Quantity   TotalValue       Price
count   1000.000000  1000.000000  1000.00000
unique          NaN          NaN         NaN
top             NaN          NaN         NaN
freq            NaN          NaN         NaN
mean       2.537000   689.995560   272.55407
min        1.000000    16.080000    16.08000
25%        2.000000   295.295000   147.95000
50%        3.000000   588.880000   299.93000
75%        4.000000  1011.660000   404.40000
max        4.000000  1991.040000   497.76000
std        1.117981   493.144478   140.73639
```

```
# EDA: Visualizations
sns.countplot(data=customers, x='Region')
plt.title('Customers by Region')
plt.show()

sns.boxplot(data=products, x='Category', y='Price')
plt.title('Product Price Distribution by Category')
plt.xticks(rotation=45)
plt.show()

transactions.groupby('TransactionDate').size().plot(title='Transaction Volume Over Time')
plt.show()
```


Customers by Region
count
Region
South America
Asia
North America
Europe
0
10
20
30
40
50
60

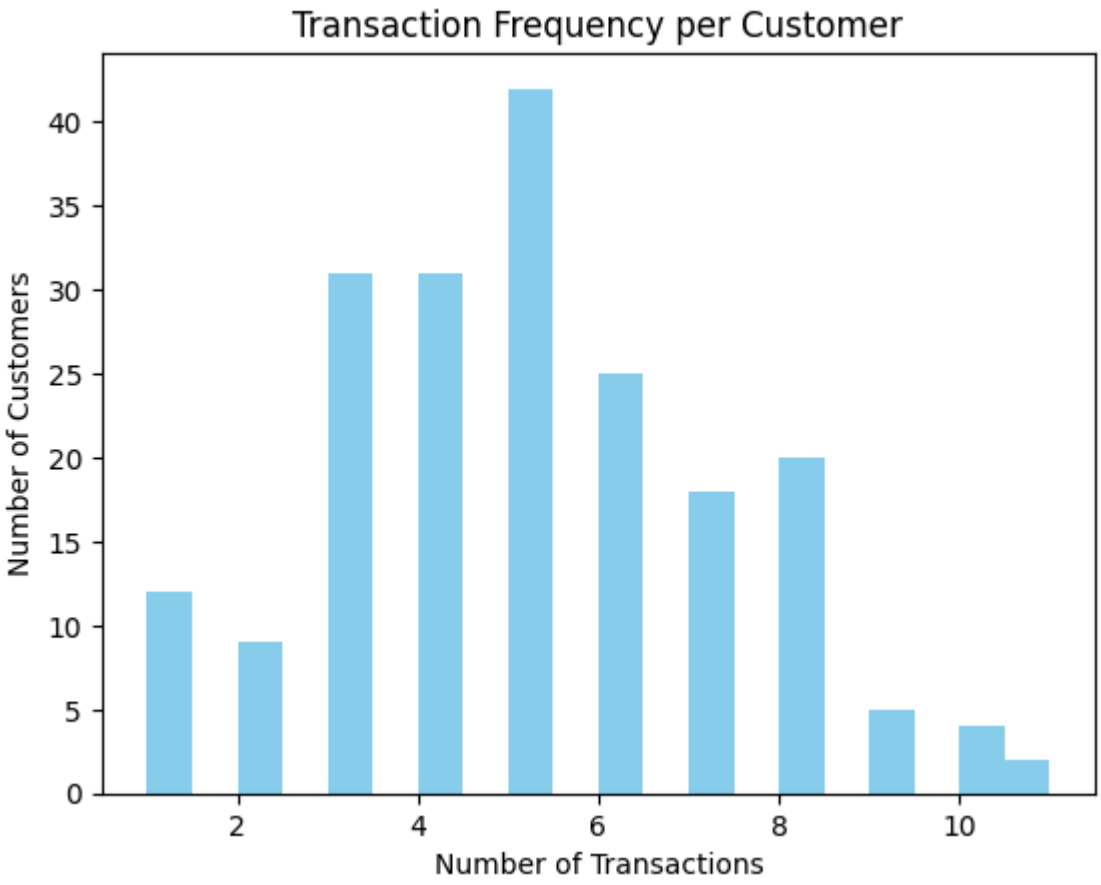

Product Price Distribution by Category
Price
Category
Books
Electronics
Home Decor
Clothing
0
100
200
300
400
500

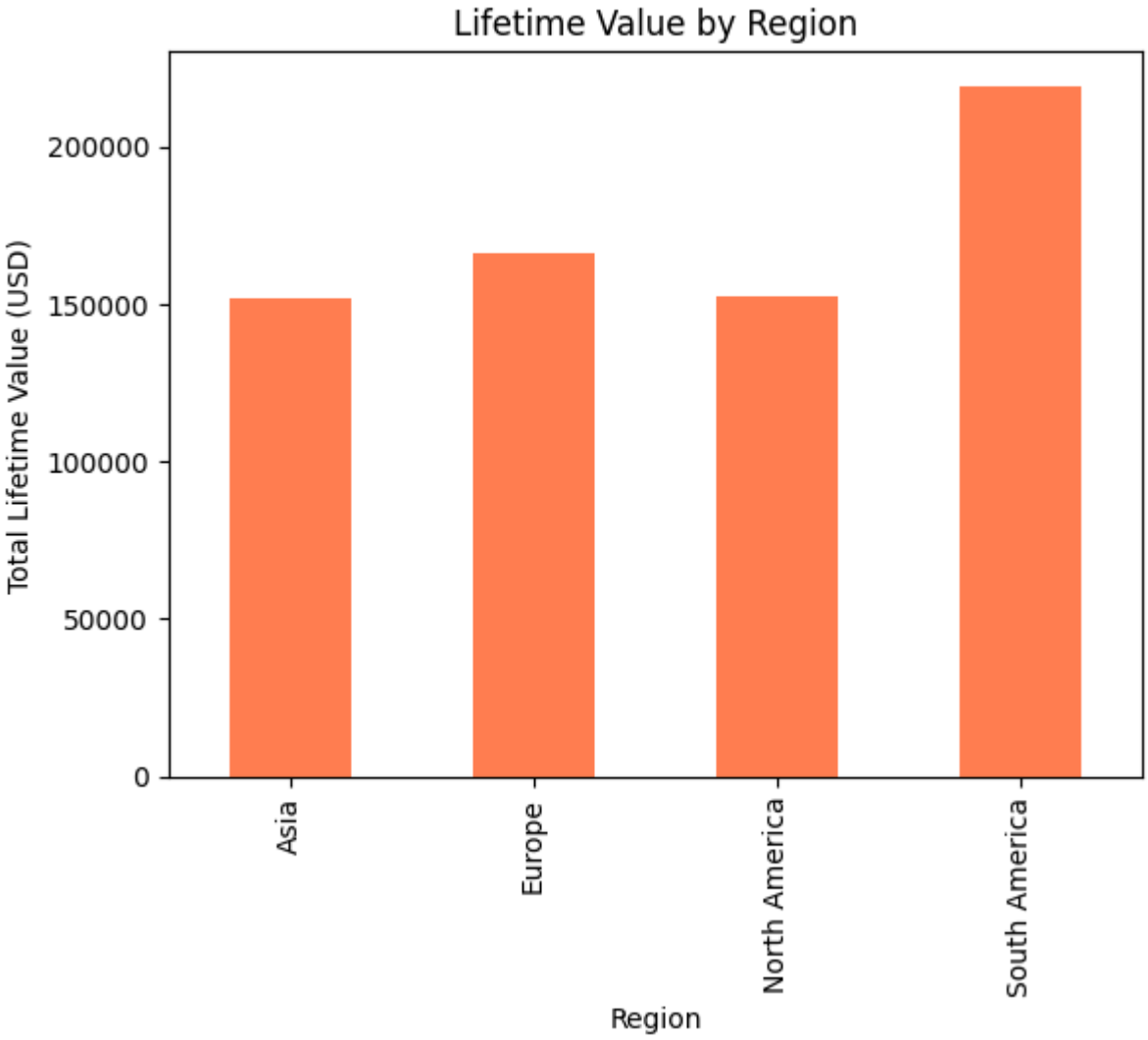

Transaction Volume Over Time




```
# EDA: Customer Behavior Analysis
customer_transaction_counts = transactions['CustomerID'].value_counts()
plt.hist(customer_transaction_counts, bins=20, color='skyblue')
plt.title('Transaction Frequency per Customer')
plt.xlabel('Number of Transactions')
plt.ylabel('Number of Customers')
plt.show()

customer_ltv = transactions.groupby('CustomerID')['TotalValue'].sum()
ltv_by_region = customers.merge(customer_ltv, on='CustomerID').groupby('Region')['TotalVa
ltv_by_region.plot(kind='bar', color='coral')
plt.title('Lifetime Value by Region')
plt.ylabel('Total Lifetime Value (USD)')
plt.xlabel('Region')
plt.show()

# EDA: Product Trends
top_products = transactions.groupby('ProductID')['TotalValue'].sum().nlargest(10)
top_products = top_products.reset_index().merge(products, on='ProductID')
plt.barh(top_products['ProductName'], top_products['TotalValue'], color='teal')
plt.title('Top 10 Products by Revenue')
plt.xlabel('Total Revenue (USD)')
plt.ylabel('Product Name')
plt.show()

sns.boxplot(data=products, x='Category', y='Price', palette='pastel')
plt.title('Product Price Distribution by Category')
plt.xticks(rotation=45)
plt.show()

# Pareto Analysis
product_revenue = transactions.groupby('ProductID')['TotalValue'].sum()
cumulative_revenue = product_revenue.sort_values(ascending=False).cumsum()
cumulative_percentage = cumulative_revenue / cumulative_revenue.max() * 100
```

```
plt.plot(cumulative_percentage.values, color='purple')
plt.axhline(80, color='red', linestyle='--')
plt.title('Pareto Analysis: Revenue Contribution')
plt.xlabel('Products (sorted by revenue)')
plt.ylabel('Cumulative Revenue (%)')
plt.show()

# EDA: Transaction Patterns
transactions['Month'] = transactions['TransactionDate'].dt.month
txn_by_month = transactions.groupby('Month')['TotalValue'].sum()
txn_by_month.plot(kind='line', marker='o', color='green')
plt.title('Monthly Transaction Revenue')
plt.xlabel('Month')
plt.ylabel('Total Revenue (USD)')
plt.show()

repeat_purchases = transactions.groupby(['CustomerID', 'ProductID']).size().reset_index(n
repeat_purchases = repeat_purchases[repeat_purchases['PurchaseCount'] > 1]
print("Number of repeat purchases:", repeat_purchases.shape[0])

# EDA: Signup Trends
signup_counts = customers['SignupDate'].dt.year.value_counts().sort_index()
signup_counts.plot(kind='bar', color='orange')
plt.title('Customer Signups by Year')
plt.xlabel('Year')
plt.ylabel('Number of Signups')
plt.show()

# Correcting the merge operation by renaming the Series
txn_counts = transactions.groupby('CustomerID').size().reset_index(name='TransactionCount
signup_vs_txn = customers.merge(txn_counts, on='CustomerID', how='left')

# Plotting
sns.scatterplot(data=signup_vs_txn, x='SignupDate', y='TransactionCount', hue='Region', p
plt.title('Signup Date vs Transaction Activity')
plt.xlabel('Signup Date')
plt.ylabel('Transaction Count')
plt.show()


# EDA: High-value Customers
high_value_customers = customer_ltv.nlargest(int(0.1 * len(customer_ltv)))
print("High-value customers contribute:", high_value_customers.sum() / customer_ltv.sum()
```





Top 10 Products by Revenue