MAJOR PROJECT

July 27, 2024

0.0.1 ONLINE RETAIL RECOMMENDATION SYSTEM

0.0.2 Done by KEERTHANA GOPAL

0.1 Environment Setup

[2]:
```
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import numpy as np
from scipy.sparse.linalg import svds
```

0.2 Data Preparation

[4]:
```
data = pd.read_csv('OnlineRetail.csv')
```

0.3 Data Overview and Exploration

[6]:
```
data.shape
```

[6]:
```
(541909, 8)
```

[8]:
```
data.head()
```

[8]:
```
  InvoiceNo StockCode                          Description  Quantity  \
0    536365    85123A   WHITE HANGING HEART T-LIGHT HOLDER         6
1    536365     71053                  WHITE METAL LANTERN         6
2    536365    84406B       CREAM CUPID HEARTS COAT HANGER         8
3    536365    84029G  KNITTED UNION FLAG HOT WATER BOTTLE         6
4    536365    84029E       RED WOOLLY HOTTIE WHITE HEART.         6

      InvoiceDate  UnitPrice  CustomerID         Country
0  12/1/2010 8:26       2.55     17850.0  United Kingdom
1  12/1/2010 8:26       3.39     17850.0  United Kingdom
2  12/1/2010 8:26       2.75     17850.0  United Kingdom
3  12/1/2010 8:26       3.39     17850.0  United Kingdom
4  12/1/2010 8:26       3.39     17850.0  United Kingdom
```

[10]:
```
data.tail()
```

[10]:
```
       InvoiceNo StockCode                      Description  Quantity  \
541904    581587     22613      PACK OF 20 SPACEBOY NAPKINS        12
541905    581587     22899     CHILDREN'S APRON DOLLY GIRL          6
541906    581587     23254    CHILDRENS CUTLERY DOLLY GIRL          4
541907    581587     23255  CHILDRENS CUTLERY CIRCUS PARADE         4
541908    581587     22138    BAKING SET 9 PIECE RETROSPOT          3

            InvoiceDate  UnitPrice  CustomerID Country
541904  12/9/2011 12:50       0.85     12680.0  France
541905  12/9/2011 12:50       2.10     12680.0  France
541906  12/9/2011 12:50       4.15     12680.0  France
541907  12/9/2011 12:50       4.15     12680.0  France
541908  12/9/2011 12:50       4.95     12680.0  France
```

[12]:
```python
data.columns
```

[12]:
```
Index(['InvoiceNo', 'StockCode', 'Description', 'Quantity', 'InvoiceDate',
       'UnitPrice', 'CustomerID', 'Country'],
      dtype='object')
```

0.4 Viewing DataFrame Information

[14]:
```python
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 541909 entries, 0 to 541908
Data columns (total 8 columns):
 #   Column       Non-Null Count   Dtype
---  ------       --------------   -----
 0   InvoiceNo    541909 non-null  object
 1   StockCode    541909 non-null  object
 2   Description  540455 non-null  object
 3   Quantity     541909 non-null  int64
 4   InvoiceDate  541909 non-null  object
 5   UnitPrice    541909 non-null  float64
 6   CustomerID   406829 non-null  float64
 7   Country      541909 non-null  object
dtypes: float64(2), int64(1), object(5)
memory usage: 33.1+ MB
```

0.5 Identifying Missing Values

[16]:
```python
data.isnull().sum()
```

[16]:
```
InvoiceNo          0
StockCode          0
Description     1454
Quantity           0
```

```
InvoiceDate         0
UnitPrice           0
CustomerID     135080
Country             0
dtype: int64
```

0.6 Data Cleaning

[18]:
```
data.dropna(inplace=True)
```

[20]:
```
data.isnull().sum()
```

[20]:
```
InvoiceNo      0
StockCode      0
Description    0
Quantity       0
InvoiceDate    0
UnitPrice      0
CustomerID     0
Country        0
dtype: int64
```

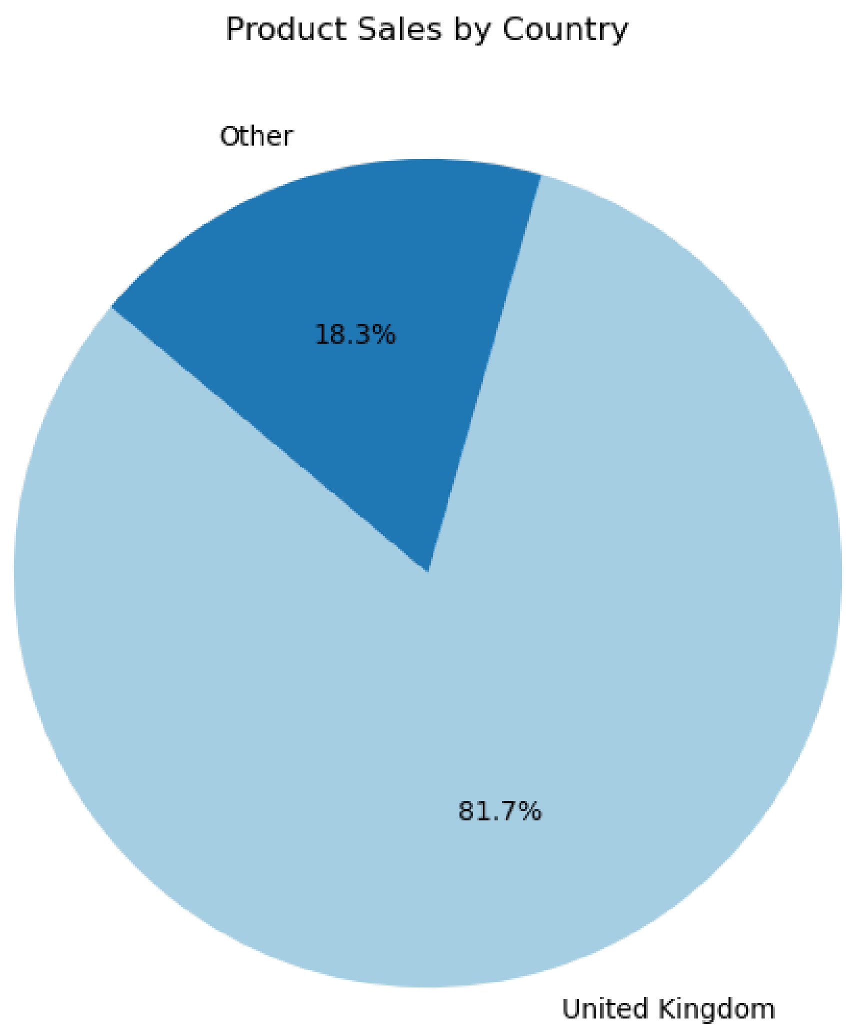
0.7 Exploratory Data Analysis (EDA)

[22]:
```
data.dropna(subset=['CustomerID'], inplace=True)
```

[24]:
```
data['CustomerID'] = data['CustomerID'].astype(int)
```

[26]:
```
sales_by_country = data.groupby('Country')['Quantity'].sum().reset_index()
sales_by_country = sales_by_country.sort_values(by='Quantity', ascending=False).
  ↪reset_index(drop=True)
top_country = sales_by_country.iloc[0]
other_sales = sales_by_country.iloc[1:].sum(numeric_only=True)
other_sales['Country'] = 'Other'
combined_sales = pd.DataFrame([top_country, other_sales])
```

[28]:
```
plt.figure(figsize=(10, 7))
plt.pie(combined_sales['Quantity'], labels=combined_sales['Country'],␣
  ↪autopct='%1.1f%%', startangle=140, colors=plt.cm.Paired.colors)
plt.title('Product Sales by Country')
plt.show()
```



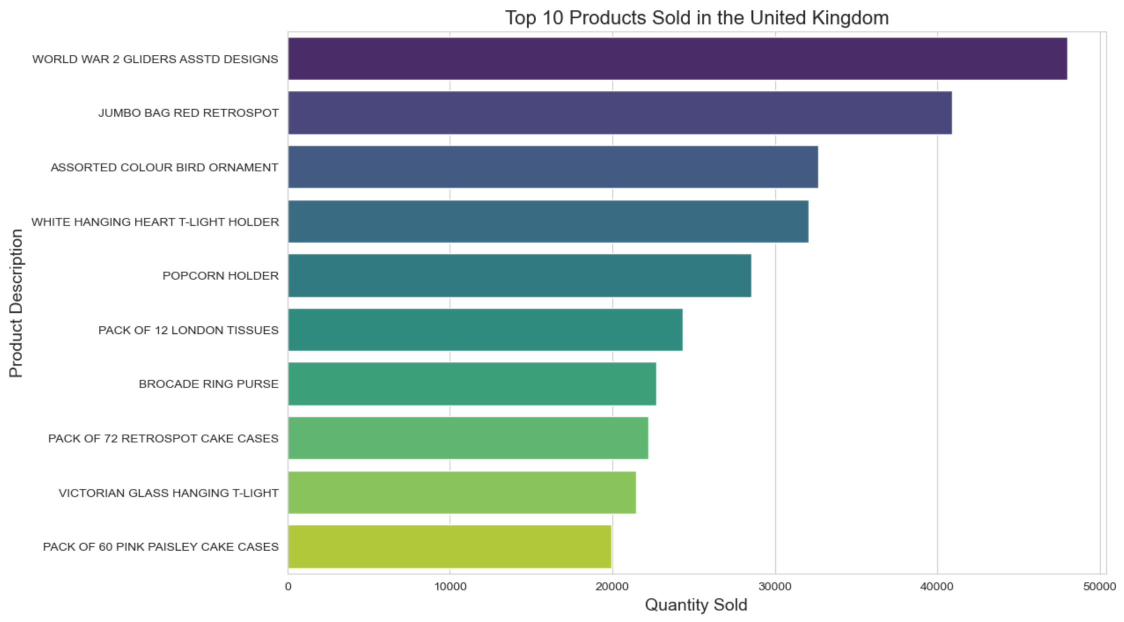
```
[30]: uk_data = data[data['Country'] == 'United Kingdom']
```

```
[32]: product_sales = uk_data.groupby('Description')['Quantity'].sum().reset_index()
      product_sales = product_sales.sort_values(by='Quantity', ascending=False).
       ↪reset_index(drop=True)
      top_products = product_sales.head(10)
      print(top_products)
```

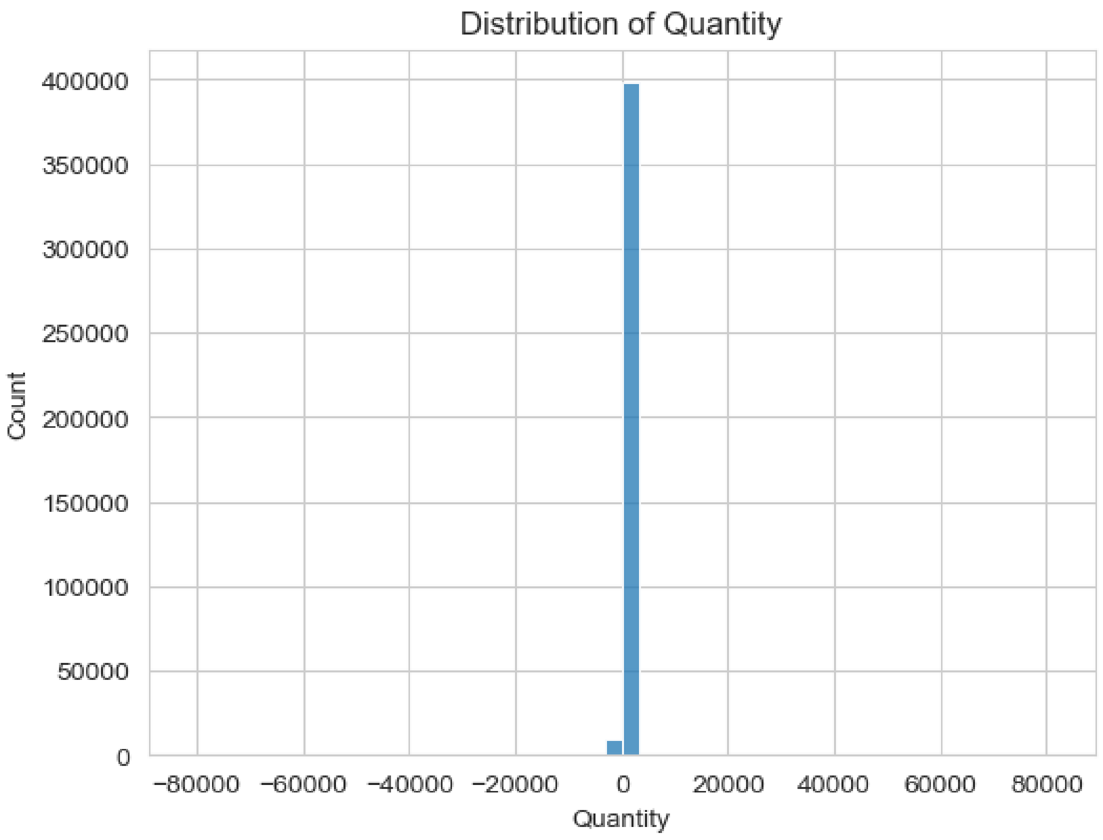
```
                          Description  Quantity
0   WORLD WAR 2 GLIDERS ASSTD DESIGNS     47982
1             JUMBO BAG RED RETROSPOT     40880
2       ASSORTED COLOUR BIRD ORNAMENT     32679
3  WHITE HANGING HEART T-LIGHT HOLDER     32097
4                      POPCORN HOLDER     28562
```

```
5          PACK OF 12 LONDON TISSUES     24313
6                 BROCADE RING PURSE     22708
7      PACK OF 72 RETROSPOT CAKE CASES     22205
8      VICTORIAN GLASS HANGING T-LIGHT     21456
9   PACK OF 60 PINK PAISLEY CAKE CASES     19916
```

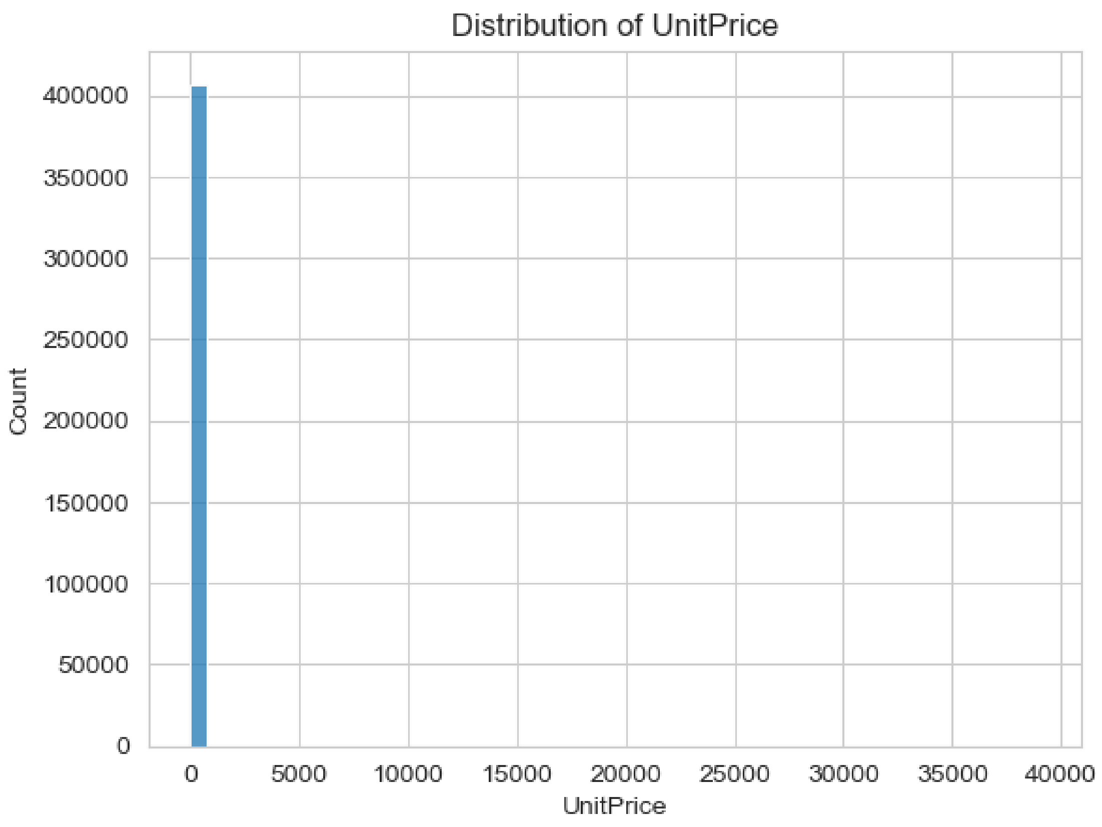
[34]:
```
sns.set_style("whitegrid")
plt.figure(figsize=(12, 8))
sns.barplot(x='Quantity', y='Description', data=top_products,␣
 ↪hue='Description', dodge=False, palette='viridis', legend=False)
plt.title('Top 10 Products Sold in the United Kingdom', fontsize=16)
plt.xlabel('Quantity Sold', fontsize=14)
plt.ylabel('Product Description', fontsize=14)
plt.show()
```



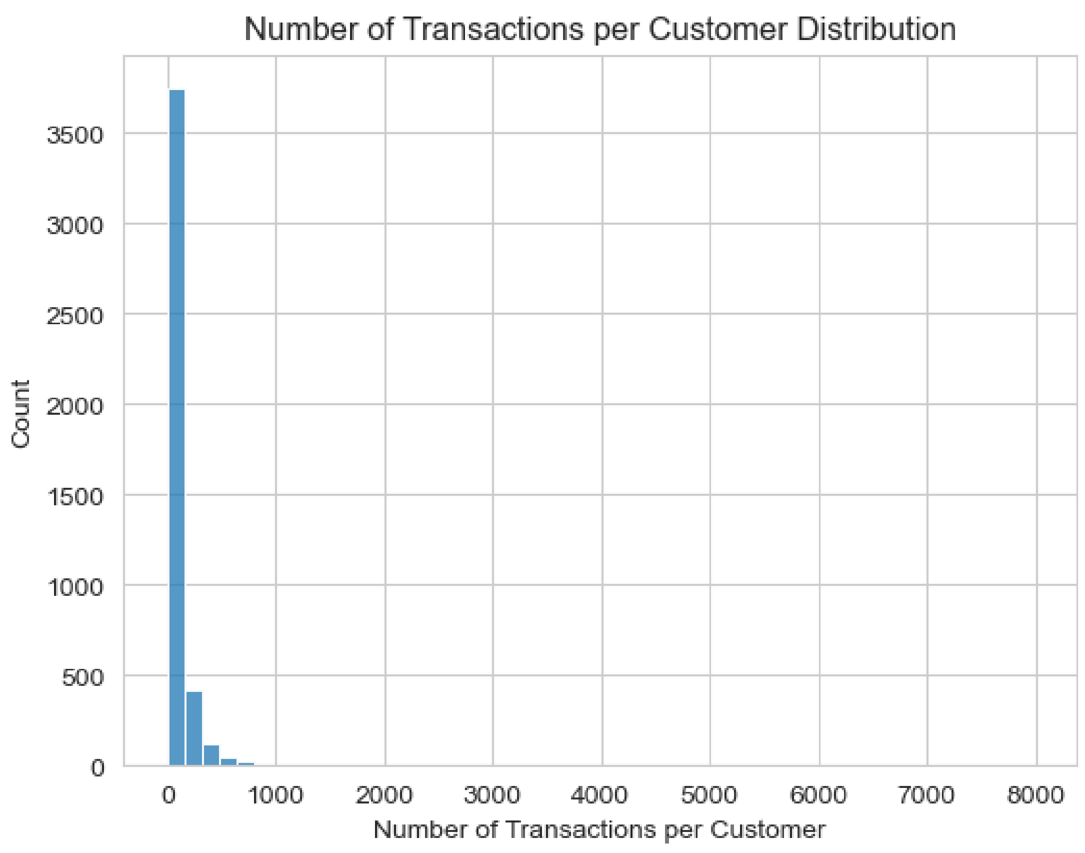
[36]:
```
sns.histplot(data['Quantity'], bins=50, kde=False)
plt.xlabel('Quantity')
plt.ylabel('Count')
plt.title('Distribution of Quantity')
plt.show()
```



[38]:
```
sns.histplot(data['UnitPrice'], bins=50, kde=False)
plt.xlabel('UnitPrice')
plt.ylabel('Count')
plt.title('Distribution of UnitPrice')
plt.show()
```



[40]:
```
transactions_per_customer = data.groupby('CustomerID').size()
sns.histplot(transactions_per_customer, bins=50, kde=False)
plt.xlabel('Number of Transactions per Customer')
plt.ylabel('Count')
plt.title('Number of Transactions per Customer Distribution')
plt.show()
```



0.8 Creating User-Item Matrix

[42]:
```
user_item_matrix = data.pivot_table(index='CustomerID', columns='StockCode',␣
↪values='Quantity', aggfunc='sum', fill_value=0)
```

[44]:
```
user_item_matrix.head()
```

[44]:
```
StockCode   10002  10080  10120  10123C  10124A  10124G  10125  10133  10135  \
CustomerID
12346           0      0      0       0       0       0      0      0      0
12347           0      0      0       0       0       0      0      0      0
12348           0      0      0       0       0       0      0      0      0
12349           0      0      0       0       0       0      0      0      0
12350           0      0      0       0       0       0      0      0      0

StockCode   11001  …  90214Y  90214Z  BANK CHARGES  C2  CRUK  D  DOT  M  \
CustomerID        …
12346           0  …       0       0             0   0     0  0    0  0
12347           0  …       0       0             0   0     0  0    0  0
12348           0  …       0       0             0   0     0  0    0  0
```

```
12349            0  …      0      0         0   0     0  0    0  0
12350            0  …      0      0         0   0     0  0    0  0

StockCode   PADS  POST
CustomerID
12346          0     0
12347          0     0
12348          0     9
12349          0     1
12350          0     1

[5 rows x 3684 columns]
```

0.9 Collaborative Filtering Using SVD (Scipy)

[46]:
```
user_item_matrix_filled = user_item_matrix.fillna(0)
user_ratings_mean = np.mean(user_item_matrix_filled, axis=1)
R_demeaned = user_item_matrix_filled.values - user_ratings_mean.values.
  ↪reshape(-1, 1)
```

[48]:
```
U, sigma, Vt = svds(R_demeaned, k=50)
```

[50]:
```
sigma = np.diag(sigma)
```

[52]:
```
predicted_ratings = np.dot(np.dot(U, sigma), Vt) + user_ratings_mean.values.
  ↪reshape(-1, 1)
predicted_ratings_df = pd.DataFrame(predicted_ratings, columns=user_item_matrix.
  ↪columns)
```

0.10 Recommendations for customer with Descriptions

[54]:
```
def get_top_n_recommendations(CustomerID, n=10):
    customer_index = user_item_matrix.index.get_loc(CustomerID)
    customer_predictions = predicted_ratings_df.iloc[customer_index].
  ↪sort_values(ascending=False)
    purchased_products = user_item_matrix.columns[user_item_matrix.
  ↪iloc[customer_index] > 0]
    recommendations = customer_predictions.drop(purchased_products)
    top_n_recommendations = recommendations.head(n).reset_index()
    top_n_recommendations.columns = ['StockCode', 'Predicted Rating']
    product_info = data[['StockCode', 'Description']].drop_duplicates()
    top_n_recommendations = top_n_recommendations.merge(product_info,␣
  ↪on='StockCode', how='left')
    return top_n_recommendations[['StockCode', 'Description', 'Predicted␣
  ↪Rating']]
```

[56]:
```python
CustomerID = 17850
recommendations = get_top_n_recommendations(CustomerID, n=10)
print(f"Top 10 recommendations for customer {CustomerID}:\n{recommendations}")
```

```
Top 10 recommendations for customer 17850:
   StockCode                         Description  Predicted Rating
0      21232        STRAWBERRY CERAMIC TRINKET BOX         41.629816
1      21232        STRAWBERRY CERAMIC TRINKET POT         41.629816
2      84212         ASSORTED FLOWER COLOUR "LEIS"         21.945908
3      84949         SILVER HANGING T-LIGHT HOLDER         19.650624
4      22095                  LADS ONLY TISSUE BOX         18.379924
5      22646    CERAMIC STRAWBERRY CAKE MONEY BANK         18.235100
6     85099B               JUMBO BAG RED RETROSPOT         16.961831
7      71477     COLOUR GLASS. STAR T-LIGHT HOLDER         16.858674
8      71477    COLOURED GLASS STAR T-LIGHT HOLDER         16.858674
9      22041          RECORD FRAME 7" SINGLE SIZE          15.439506
10     21108    FAIRY CAKE FLANNEL ASSORTED COLOUR         14.585567
11     21175           GIN + TONIC DIET METAL SIGN         13.595696
12     21175         GIN AND TONIC DIET METAL SIGN         13.595696
```

[58]:
```python
CustomerID = 13047
recommendations = get_top_n_recommendations(CustomerID, n=10)
print(f"Top 10 recommendations for customer {CustomerID}:\n{recommendations}")
```

```
Top 10 recommendations for customer 13047:
   StockCode                          Description  Predicted Rating
0      84949         SILVER HANGING T-LIGHT HOLDER          10.646674
1      22492                MINI PAINT SET VINTAGE          10.077383
2      21915                  RED  HARMONICA IN BOX          8.244715
3      23230                   WRAP ALPHABET DESIGN          6.377619
4      21914                  BLUE HARMONICA IN BOX          5.947999
5      23209              LUNCH BAG DOILEY PATTERN           5.281656
6      23209               LUNCH BAG VINTAGE DOILY           5.281656
7      23209              LUNCH BAG VINTAGE DOILEY           5.281656
8      23203             JUMBO BAG DOILEY PATTERNS           5.056550
9      23203              JUMBO BAG VINTAGE DOILEY           5.056550
10     23203               JUMBO BAG VINTAGE DOILY           5.056550
11     22865                HAND WARMER OWL DESIGN           5.056101
12     22909   SET OF 20 VINTAGE CHRISTMAS NAPKINS           4.838799
13     22469                  HEART OF WICKER SMALL          4.801508
```

[ ]: