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**IBM NaanMudhalvan - Artificial Intelligence Group 1**

**Market Basket Insights**

**Phase-3 Submission Document**

**Introduction:**

A potent data mining method called market basket analysis (MBA) is frequently applied in retail and other industries to find hidden patterns and connections in transactional data. By finding connections between products or items that customers regularly buy together, it hehniques, and ultimately increase profitability by using this understanding of buying patterns to guide their decision-making.

The Apriori algorithm is one of the moslps organizations to obtain insightful information about customer behavior. Businesses can increase sales, optimize inventory, improve marketing tect widely used and efficient methods for carrying out Market Basket Analysis. Apriori is a vital tool for retailers and enterprises looking to find valuable associations in their transactional data because of its ability to extract frequent itemsets from enormous datasets in an effective manner.

This guide will examine the main procedures

**Program:**

*# This Python 3 environment comes with many helpful analytics libraries installed*

*# It is defined by the kaggle/python Docker image: https://github.com/kaggle/docker-python*

*# For example, here's several helpful packages to load*

import numpy as np *# linear algebra*

import pandas as pd *# data processing, CSV file I/O (e.g. pd.read\_csv)*

*# Input data files are available in the read-only "../input/" directory*

*# For example, running this (by clicking run or pressing Shift+Enter) will list all files under the input directory*

import os

for dirname, \_, filenames **in** os.walk('/kaggle/input'):

for filename **in** filenames:

print(os.path.join(dirname, filename))

*# You can write up to 20GB to the current directory (/kaggle/working/) that gets preserved as output when you create a version using "Save & Run All"*

*# You can also write temporary files to /kaggle/temp/, but they won't be saved outside of the current session*

/kaggle/input/market-basket-analysis/Assignment-1\_Data.xlsx

/kaggle/input/market-basket-analysis/Assignment-1\_Data.csv

In [2]: from matplotlib import pyplot as plt

df=pd.read\_excel("/kaggle/input/market-basket-analysis/Assignment-1\_Data.xlsx")

In [3]: df.info()

<class 'pandas.core.frame.DataFrame'>

RangeIndex: 522064 entries, 0 to 522063

Data columns (total 7 columns):

# Column Non-Null Count Dtype

--- ------ -------------- -----

0 BillNo 522064 non-null object

1 Itemname 520609 non-null object

2 Quantity 522064 non-null int64

3 Date 522064 non-null datetime64[ns]

4 Price 522064 non-null float64

5 CustomerID 388023 non-null float64

6 Country 522064 non-null object

dtypes: datetime64[ns](1), float64(2), int64(1), object(3)

memory usage: 27.9+ MB

**Step 1: Data Hygiene** We're going to do the following steps:

1. Drop any rows where item name column is null.
2. Drop any rows where item quantity sold is 0 or less.
3. Fill missing customer IDs with a placeholder ID (99999)
4. Create a new column, Sumprice, that tells us total sales revenue (Quantity \* Price) of the item

In [4]: df.isnull().sum()

Out[4]:

BillNo 0

Itemname 1455

Quantity 0

Date 0

Price 0

CustomerID 134041

Country 0

dtype: int64

In [5]:

*#Dropping rows where ItemName isn't available*

df.dropna(subset=["Itemname"],inplace=True)

*#Dropping rows where Quantity <=0*

df = df[df["Quantity"]>0]

df.isnull().sum()

Out[5]:

BillNo 0

Itemname 0

Quantity 0

Date 0

Price 0

CustomerID 132113

Country 0

dtype: int64

In [6]:

*Fill missing customer IDs*

df['CustomerID'].fillna(99999, inplace=True)

*#Create SumPrice column*

df["SumPrice"]=df["Quantity"]\*df["Price"]

**Step 2: EDA** Let's explore the data for any insights. Let's find which countries sell the most items, and what items are the most popular in each country.

In [7]:

*#Find the best selling items in each country*

best\_selling\_items = df.groupby(['Country', 'Itemname']).agg({'Quantity': 'sum'}).reset\_index()

best\_selling\_items = best\_selling\_items.groupby('Country').apply(lambda x: x[x['Quantity'] == x['Quantity'].max()]).reset\_index(drop=True)

best\_selling\_items.sort\_values("Quantity",ascending=False)

Out[7]:

|  | Country | Itemname | Quantity |
| --- | --- | --- | --- |
| 47 | United Kingdom | PAPER CRAFT , LITTLE BIRDIE | 80995 |
| 25 | Netherlands | RABBIT NIGHT LIGHT | 4801 |
| 12 | France | RABBIT NIGHT LIGHT | 4024 |
| 20 | Japan | RABBIT NIGHT LIGHT | 3408 |
| 0 | Australia | MINI PAINT SET VINTAGE | 2952 |
| 42 | Sweden | MINI PAINT SET VINTAGE | 2916 |
| 13 | Germany | ROUND SNACK BOXES SET OF4 WOODLAND | 1233 |
| 41 | Spain | CHILDRENS CUTLERY POLKADOT PINK | 729 |
| 43 | Switzerland | PLASTERS IN TIN WOODLAND ANIMALS | 639 |
| 26 | Norway | SMALL FOLDING SCISSOR(POINTED EDGE) | 576 |
| 3 | Belgium | PACK OF 72 RETROSPOT CAKE CASES | 480 |
| 40 | Singapore | CHRISTMAS TREE PAINTED ZINC | 384 |
| 1 | Austria | SET 12 KIDS COLOUR CHALK STICKS | 288 |
| 17 | Iceland | ICE CREAM SUNDAE LIP GLOSS | 240 |
| 19 | Italy | FEATHER PEN,HOT PINK | 240 |
| 29 | Portugal | POLKADOT PEN | 240 |
| 16 | Hong Kong | ROUND SNACK BOXES SET OF4 WOODLAND | 150 |
| 28 | Poland | STRAWBERRY CERAMIC TRINKET BOX | 144 |
| 27 | Poland | CERAMIC CAKE DESIGN SPOTTED MUG | 144 |
| 18 | Israel | WOODLAND CHARLOTTE BAG | 130 |
| 48 | Unspecified | WORLD WAR 2 GLIDERS ASSTD DESIGNS | 96 |
| 2 | Bahrain | ICE CREAM SUNDAE LIP GLOSS | 96 |
| 44 | USA | SET 12 COLOURING PENCILS DOILY | 88 |
| 24 | Malta | GRAND CHOCOLATECANDLE | 81 |
| 46 | United Arab Emirates | BIG DOUGHNUT FRIDGE MAGNETS | 72 |
| 45 | United Arab Emirates | ASSORTED CHEESE FRIDGE MAGNETS | 72 |
| 22 | Lithuania | FELTCRAFT DOLL ROSIE | 48 |
| 23 | Lithuania | RED HARMONICA IN BOX | 48 |
| 15 | Greece | 4 PEAR BOTANICAL DINNER CANDLES | 48 |
| 14 | Greece | 4 LAVENDER BOTANICAL DINNER CANDLES | 48 |
| 4 | Brazil | DOLLY GIRL LUNCH BOX | 24 |
| 5 | Brazil | GREEN REGENCY TEACUP AND SAUCER | 24 |
| 6 | Brazil | PINK REGENCY TEACUP AND SAUCER | 24 |
| 7 | Brazil | ROSES REGENCY TEACUP AND SAUCER | 24 |
| 21 | Lebanon | ASSTD FRUIT+FLOWERS FRIDGE MAGNETS | 24 |
| 8 | Brazil | SET OF 4 PANTRY JELLY MOULDS | 24 |
| 9 | Brazil | SET OF 6 SPICE TINS PANTRY DESIGN | 24 |
| 10 | Brazil | SET/3 RED GINGHAM ROSE STORAGE BOX | 24 |
| 11 | Brazil | SMALL HEART FLOWERS HOOK | 24 |
| 34 | RSA | WOODEN BOX OF DOMINOES | 12 |
| 36 | Saudi Arabia | HOMEMADE JAM SCENTED CANDLES | 12 |
| 37 | Saudi Arabia | PLASTERS IN TIN CIRCUS PARADE | 12 |
| 38 | Saudi Arabia | PLASTERS IN TIN SKULLS | 12 |
| 39 | Saudi Arabia | PLASTERS IN TIN STRONGMAN | 12 |
| 33 | RSA | SET OF 20 KIDS COOKIE CUTTERS | 12 |
| 32 | RSA | PACK OF 6 BIRDY GIFT TAGS | 12 |
| 31 | RSA | ASSORTED BOTTLE TOP MAGNETS | 12 |
| 30 | RSA | 4 TRADITIONAL SPINNING TOPS | 12 |
| 35 | Saudi Arabia | ASSORTED BOTTLE TOP MAGNETS | 12 |

In [8]:

*#Find the total sales by country.*

total\_sales\_country = df.groupby(['Country']).agg({'SumPrice': 'sum'}).reset\_index()

total\_sales\_country = total\_sales\_country.sort\_values('SumPrice', ascending=False).reset\_index(drop=True)

total\_sales\_country

Out[8]:

|  | Country | SumPrice |
| --- | --- | --- |
| 0 | United Kingdom | 9003097.964 |
| 1 | Netherlands | 285446.340 |
| 2 | Germany | 228867.140 |
| 3 | France | 209715.110 |
| 4 | Australia | 138521.310 |
| 5 | Spain | 61577.110 |
| 6 | Switzerland | 57089.900 |
| 7 | Belgium | 41196.340 |
| 8 | Sweden | 38378.330 |
| 9 | Japan | 37416.370 |
| 10 | Norway | 36165.440 |
| 11 | Portugal | 33747.100 |
| 12 | Singapore | 21279.290 |
| 13 | Italy | 17483.240 |
| 14 | Hong Kong | 15691.800 |
| 15 | Austria | 10198.680 |
| 16 | Israel | 8135.260 |
| 17 | Poland | 7334.650 |
| 18 | Greece | 4760.520 |
| 19 | Unspecified | 4749.790 |
| 20 | Iceland | 4310.000 |
| 21 | USA | 3580.390 |
| 22 | Malta | 2725.590 |
| 23 | United Arab Emirates | 1902.280 |
| 24 | Lebanon | 1693.880 |
| 25 | Lithuania | 1661.060 |
| 26 | Brazil | 1143.600 |
| 27 | RSA | 1002.310 |
| 28 | Bahrain | 754.140 |
| 29 | Saudi Arabia | 145.920 |

In [9]:

*#Visualizing Total sales by country.*

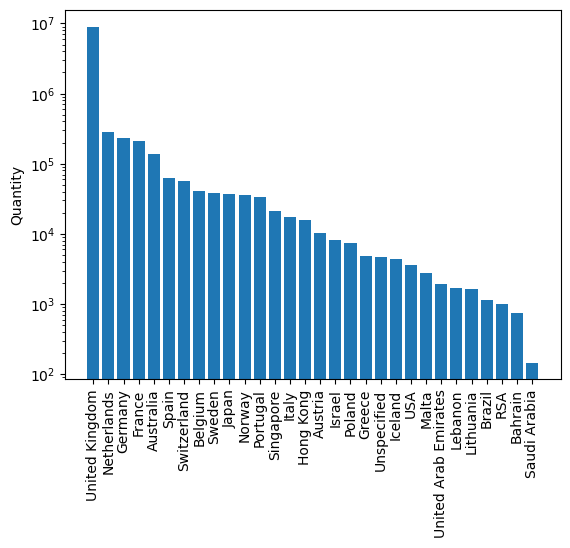
plt.bar(total\_sales\_country["Country"],total\_sales\_country["SumPrice"])

plt.yscale('log')

plt.ylabel('Quantity')

plt.xticks(rotation=90)

plt.show()



So far we've noticed that the UK has the most amount of sales and the most popular item sold in UK is 'PAPER CRAFT, LITTLE BIRDIE'. However, this outsells the most popular items in other countries by a large magnitude. Let's dig in by only looking at UK's grocery store data.

In [10]:

*#Isolate the UK data and let's sort the most popular items in UK by quantity sold.*

only\_uk = df[df["Country"]=="United Kingdom"]

only\_uk.groupby("Itemname")["Quantity"].sum().sort\_values(ascending=False)

Out[10]:

Itemname

PAPER CRAFT , LITTLE BIRDIE 80995

MEDIUM CERAMIC TOP STORAGE JAR 77036

WORLD WAR 2 GLIDERS ASSTD DESIGNS 49526

JUMBO BAG RED RETROSPOT 44268

WHITE HANGING HEART T-LIGHT HOLDER 35744

...

HEN HOUSE W CHICK IN NEST 1

BLACKCHRISTMAS TREE 30CM 1

GOLD COSMETICS BAG WITH BUTTERFLY 1

WATERING CAN SINGLE HOOK PISTACHIO 1

\*Boombox Ipod Classic 1

Name: Quantity, Length: 4046, dtype: int64

In[11]

total\_sales\_item = df.groupby(['Itemname']).agg({'Price': 'mean', 'Quantity': 'sum', 'SumPrice': 'sum'}).reset\_index()

*# Create a new column with the count of rows for each group*

total\_sales\_item['Count'] = df.groupby(['Itemname']).size().values

*# Sort the dataframe by 'SumPrice' column in descending order*

total\_sales\_item = total\_sales\_item.sort\_values("SumPrice", ascending=False)

total\_sales\_item

Out[11]:

|  | Itemname | Price | Quantity | SumPrice | Count |
| --- | --- | --- | --- | --- | --- |
| 1060 | DOTCOM POSTAGE | 291.311822 | 708 | 206248.77 | 708 |
| 2386 | PAPER CRAFT , LITTLE BIRDIE | 2.080000 | 80995 | 168469.60 | 1 |
| 2848 | REGENCY CAKESTAND 3 TIER | 14.043347 | 13119 | 165689.19 | 1930 |
| 3840 | WHITE HANGING HEART T-LIGHT HOLDER | 3.220569 | 36527 | 102588.37 | 2269 |
| 2411 | PARTY BUNTING | 5.808664 | 17812 | 97367.48 | 1677 |
| ... | ... | ... | ... | ... | ... |
| 4025 | allocate stock for dotcom orders ta | 0.000000 | 4 | 0.00 | 1 |
| 4026 | amazon | 0.000000 | 161 | 0.00 | 8 |
| 4027 | amazon adjust | 0.000000 | 10 | 0.00 | 1 |
| 4028 | amazon sales | 0.000000 | 20 | 0.00 | 1 |
| 255 | Adjust bad debt | -3687.353333 | 3 | -11062.06 | 3 |

Interesting. We find out that the most sold item globally, 'PAPER CRAFT, LITTLE BIRDIE' was sold in just one transaction. Perhaps this was a large corporate order. If we were to ever do a marketing or promotional push in the future, that required us to analyse our most popular products, this would be an anomaly that we would need to adjust for.

**Step 3: EDA** Market Basket Analysis using Apriori Algorithm and Association Rule Mining

1. Convert the Dataset into transactional format (Each row is one bill number with every item sold in that bill in a list)
2. Create a one-hot matrix of the products (Product sold = 1, Not sold = 0)
3. Merge the transactional matrix and the one hot matrix
4. Import the mlxtend library and perform association mining and generate association rules

In [12]:

*#Convert the dataset into transactional format*

transactions = df.groupby(['BillNo'])['Itemname'].apply(list)

transactions

Out[12]:

BillNo

536365 [WHITE HANGING HEART T-LIGHT HOLDER, WHITE MET...

536366 [HAND WARMER UNION JACK, HAND WARMER RED POLKA...

536367 [ASSORTED COLOUR BIRD ORNAMENT, POPPY'S PLAYHO...

536368 [JAM MAKING SET WITH JARS, RED COAT RACK PARIS...

536369 [BATH BUILDING BLOCK WORD]

...

581586 [LARGE CAKE STAND HANGING STRAWBERY, SET OF 3...

581587 [CIRCUS PARADE LUNCH BOX, PLASTERS IN TIN CIRC...

A563185 [Adjust bad debt]

A563186 [Adjust bad debt]

A563187 [Adjust bad debt]

Name: Itemname, Length: 19735, dtype: object

In [13]

*#Create a one-hot matrix of the products*

one\_hot = pd.get\_dummies(df['Itemname'])

one\_hot

Out [13]

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **\*Boombox Ipod Classic** | **\*USB Office Mirror Ball** | **10 COLOUR SPACEBOY PEN** | **12 COLOURED PARTY BALLOONS** | **12 DAISY PEGS IN WOOD BOX** | **12 EGG HOUSE PAINTED WOOD** | **12 HANGING EGGS HAND PAINTED** | **12 IVORY ROSE PEG PLACE SETTINGS** | **12 MESSAGE CARDS WITH ENVELOPES** | **12 PENCIL SMALL TUBE WOODLAND** | **...** |
| **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| **1** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| **2** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| **3** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| **4** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| **...** | **...** | **...** | **...** | **...** | **...** | **...** | **...** | **...** | **...** | **...** |
| **522059** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| **522060** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| **522061** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| **522062** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| **522063** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |

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| **...** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **536365** |
| **...** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **536365** |
| **...** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **536365** |
| **...** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **536365** |
| **...** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **536365** |
| **...** | **...** | **...** | **...** | **...** | **...** | **...** | **...** | **...** | **...** | **...** |
| **...** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **581587** |
| **...** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **581587** |
| **...** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **581587** |
| **...** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **581587** |
| **...** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **581587** |

In [14]

*#Add the BillNo column back to the one-hot encoded matrix*

one\_hot['BillNo']=df['BillNo']

one\_hot

Out [14]

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **\*Boombox Ipod Classic** | **\*USB Office Mirror Ball** | **10 COLOUR SPACEBOY PEN** | **12 COLOURED PARTY BALLOONS** | **12 DAISY PEGS IN WOOD BOX** | **12 EGG HOUSE PAINTED WOOD** | **12 HANGING EGGS HAND PAINTED** | **12 IVORY ROSE PEG PLACE SETTINGS** | **12 MESSAGE CARDS WITH ENVELOPES** | **12 PENCIL SMALL TUBE WOODLAND** | **...** |
| **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| **1** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| **2** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| **3** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| **4** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| **...** | **...** | **...** | **...** | **...** | **...** | **...** | **...** | **...** | **...** | **...** |
| **522059** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| **522060** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| **522061** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| **522062** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| **522063** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **taig adjust** | **taig adjust** | **taig adjust** | **taig adjust** | **taig adjust** | **taig adjust** | **taig adjust** | **taig adjust** | **taig adjust** | **taig adjust** | **taig adjust** |
| **...** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **536365** |
| **...** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **536365** |
| **...** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **536365** |
| **...** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **536365** |
| **...** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **536365** |
| **...** | **...** | **...** | **...** | **...** | **...** | **...** | **...** | **...** | **...** | **...** |
| **...** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **581587** |
| **...** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **581587** |
| **...** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **581587** |
| **...** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **581587** |
| **...** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **581587** |

In[15]

*#Now, we group the One-Hot Matrix by BillNo and sum the values*

one\_hot = one\_hot.groupby('BillNo').sum()

one\_hot

Out[15]

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| \*Boombox Ipod Classic | \*USB Office Mirror Ball | 10 COLOUR SPACEBOY PEN | 12 COLOURED PARTY BALLOONS | 12 DAISY PEGS IN WOOD BOX | 12 EGG HOUSE PAINTED WOOD | 12 HANGING EGGS HAND PAINTED | 12 IVORY ROSE PEG PLACE SETTINGS | 12 MESSAGE CARDS WITH ENVELOPES | 12 PENCIL SMALL TUBE WOODLAND | ... |
| BillNo |  |  |  |  |  |  |  |  |  |  |
| 536365 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 536366 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 536367 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 536368 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 536369 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 581586 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 581587 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| A563185 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| A563186 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| A563187 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| returned | taig adjust | test | to push order througha s stock was | website fixed | wrongly coded 20713 | wrongly coded 23343 | wrongly marked | wrongly marked 23343 | wrongly sold (22719) barcode |  |
|  |  |  |  |  |  |  |  |  |  |  |
| ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

In[16]

*#Now, we merge the one-hot encoded matrix, with the transactional data*

transaction\_matrix = pd.merge(transactions, one\_hot, on='BillNo')

transaction\_matrix

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Itemname | \*Boombox Ipod Classic | \*USB Office Mirror Ball | 10 COLOUR SPACEBOY PEN | 12 COLOURED PARTY BALLOONS | 12 DAISY PEGS IN WOOD BOX | 12 EGG HOUSE PAINTED WOOD | 12 HANGING EGGS HAND PAINTED | 12 IVORY ROSE PEG PLACE SETTINGS | 12 MESSAGE CARDS WITH ENVELOPES | ... |
| BillNo |  |  |  |  |  |  |  |  |  |  |
| 536365 | [WHITE HANGING HEART T-LIGHT HOLDER, WHITE MET... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 536366 | [HAND WARMER UNION JACK, HAND WARMER RED POLKA... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 536367 | [ASSORTED COLOUR BIRD ORNAMENT, POPPY'S PLAYHO... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 536368 | [JAM MAKING SET WITH JARS, RED COAT RACK PARIS... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 536369 | [BATH BUILDING BLOCK WORD] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

In [17]:

*#Now we have to convert the product columns to 0s and 1s. We are converting sum values to binary as number doesn't matter*

transaction\_matrix[one\_hot.columns[:-1]] = (transaction\_matrix[one\_hot.columns[:-1]] >= 1).astype(int)

transaction\_matrix

Out [17]

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| emname | \*Boombox Ipod Classic | \*USB Office Mirror Ball | 10 COLOUR SPACEBOY PEN | 12 COLOURED PARTY BALLOONS | 12 DAISY PEGS IN WOOD BOX | 12 EGG HOUSE PAINTED WOOD | 12 HANGING EGGS HAND PAINTED | 12 IVORY ROSE PEG PLACE SETTINGS | 12 MESSAGE CARDS WITH ENVELOPES | ... |
| BillNo |  |  |  |  |  |  |  |  |  |  |
| 536365 | [WHITE HANGING HEART T-LIGHT HOLDER, WHITE MET... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 536366 | [HAND WARMER UNION JACK, HAND WARMER RED POLKA... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 536367 | [ASSORTED COLOUR BIRD ORNAMENT, POPPY'S PLAYHO... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 536368 | [JAM MAKING SET WITH JARS, RED COAT RACK PARIS... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

In [18]

from mlxtend.frequent\_patterns import apriori

from mlxtend.frequent\_patterns import association\_rules

print(transaction\_matrix.dtypes)

Out [18]

Itemname object

\*Boombox Ipod Classic int64

\*USB Office Mirror Ball int64

10 COLOUR SPACEBOY PEN int64

12 COLOURED PARTY BALLOONS int64

...

wrongly coded 20713 int64

wrongly coded 23343 int64

wrongly marked int64

wrongly marked 23343 int64

wrongly sold (22719) barcode uint8

Length: 4057, dtype: object

In [19]

transaction\_matrix.iloc[:, 1:] = transaction\_matrix.iloc[:, 1:].astype(bool)

*#Perform frequent itemset mining*

frequent\_itemsets = apriori(transaction\_matrix.iloc[:, 1:], min\_support=0.01, use\_colnames=True)

frequent\_itemsets

Out [19]

| support | itemsets |
| --- | --- |
| 0 | 0.015809 | (10 COLOUR SPACEBOY PEN) |
| 1 | 0.012567 | (12 MESSAGE CARDS WITH ENVELOPES) |
| 2 | 0.017887 | (12 PENCIL SMALL TUBE WOODLAND) |
| 3 | 0.018242 | (12 PENCILS SMALL TUBE RED RETROSPOT) |
| 4 | 0.017887 | (12 PENCILS SMALL TUBE SKULL) |
| ... | ... | ... |
| 1891 | 0.011249 | (JUMBO BAG RED RETROSPOT, JUMBO SHOPPER VINTAG... |
| 1892 | 0.011249 | (LUNCH BAG CARS BLUE, LUNCH BAG BLACK SKULL.,... |
| 1893 | 0.010388 | (LUNCH BAG CARS BLUE, LUNCH BAG BLACK SKULL.,... |
| 1894 | 0.010286 | (LUNCH BAG SUKI DESIGN, LUNCH BAG BLACK SKULL... |
| 1895 | 0.010286 | (CHARLOTTE BAG PINK POLKADOT, CHARLOTTE BAG SU.. |

In [20]

*# generate association rules*

rules = association\_rules(frequent\_itemsets, metric="lift", min\_threshold=1)

rules

Out [20]

| antecedents | consequents | antecedent support | consequent support | support | confidence | lift | leverage | conviction | zhangs\_metric |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | (DOTCOM POSTAGE) | (6 RIBBONS RUSTIC CHARM) | 0.035875 | 0.047732 | 0.010236 | 0.285311 | 5.977290 | 0.008523 | 1.332422 | 0.863685 |
| 1 | (6 RIBBONS RUSTIC CHARM) | (DOTCOM POSTAGE) | 0.047732 | 0.035875 | 0.010236 | 0.214437 | 5.977290 | 0.008523 | 1.227305 | 0.874439 |
| 2 | (JAM MAKING SET PRINTED) | (6 RIBBONS RUSTIC CHARM) | 0.056549 | 0.047732 | 0.011806 | 0.208781 | 4.373992 | 0.009107 | 1.203545 | 0.817611 |
| 3 | (6 RIBBONS RUSTIC CHARM) | (JAM MAKING SET PRINTED) | 0.047732 | 0.056549 | 0.011806 | 0.247346 | 4.373992 | 0.009107 | 1.253499 | 0.810041 |
| 4 | (6 RIBBONS RUSTIC CHARM) | (JAM MAKING SET WITH JARS) | 0.047732 | 0.055181 | 0.010337 | 0.216561 | 3.924538 | 0.007703 | 1.205988 | 0.782546 |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 3337 | (CHARLOTTE BAG PINK POLKADOT) | (RED RETROSPOT CHARLOTTE BAG, STRAWBERRY CHARL... | 0.037395 | 0.013073 | 0.010286 | 0.275068 | 21.040551 | 0.009797 | 1.361406 | 0.989475 |
| 3338 | (CHARLOTTE BAG SUKI DESIGN) | (STRAWBERRY CHARLOTTE BAG, CHARLOTTE BAG PINK ... | 0.044337 | 0.012212 | 0.010286 | 0.232000 | 18.998008 | 0.009745 | 1.286183 | 0.991315 |
| 3339 | (STRAWBERRY CHARLOTTE BAG) | (RED RETROSPOT CHARLOTTE BAG, CHARLOTTE BAG PI... | 0.036281 | 0.012668 | 0.010286 | 0.283520 | 22.381034 | 0.009827 | 1.378031 | 0.991284 |
| 3340 | (WOODLAND CHARLOTTE BAG) | (STRAWBERRY CHARLOTTE BAG, CHARLOTTE BAG PINK ... | 0.041905 | 0.012364 | 0.010286 | 0.245466 | 19.853534 | 0.009768 | 1.308934 | 0.991166 |
| 3341 | (RED RETROSPOT CHARLOTTE BAG) | (STRAWBERRY CHARLOTTE BAG, CHARLOTTE BAG PINK ... | 0.052090 | 0.011198 | 0.010286 | 0.197471 | 17.633876 | 0.009703 | 1.232107 | 0.995127 |

In [21]

*#Let's see the top 10 rules by lift*

rules.sort\_values('lift', ascending=False).head(10)

Out [21]

| antecedents | consequents | antecedent support | consequent support | support | confidence | lift | leverage | conviction | zhangs\_metric |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 2080 | (HERB MARKER THYME) | (HERB MARKER PARSLEY, HERB MARKER ROSEMARY) | 0.011806 | 0.010641 | 0.010134 | 0.858369 | 80.666258 | 0.010009 | 6.985474 | 0.999403 |
| 2077 | (HERB MARKER PARSLEY, HERB MARKER ROSEMARY) | (HERB MARKER THYME) | 0.010641 | 0.011806 | 0.010134 | 0.952381 | 80.666258 | 0.010009 | 20.752065 | 0.998225 |
| 2081 | (HERB MARKER ROSEMARY) | (HERB MARKER PARSLEY, HERB MARKER THYME) | 0.011857 | 0.010641 | 0.010134 | 0.854701 | 80.321530 | 0.010008 | 6.809118 | 0.999400 |
| 2076 | (HERB MARKER PARSLEY, HERB MARKER THYME) | (HERB MARKER ROSEMARY) | 0.010641 | 0.011857 | 0.010134 | 0.952381 | 80.321530 | 0.010008 | 20.751001 | 0.998172 |
| 534 | (HERB MARKER THYME) | (HERB MARKER ROSEMARY) | 0.011806 | 0.011857 | 0.010996 | 0.931330 | 78.546183 | 0.010856 | 14.389831 | 0.999064 |
| 535 | (HERB MARKER ROSEMARY) | (HERB MARKER THYME) | 0.011857 | 0.011806 | 0.010996 | 0.927350 | 78.546183 | 0.010856 | 13.602194 | 0.999115 |
| 2079 | (HERB MARKER PARSLEY) | (HERB MARKER THYME, HERB MARKER ROSEMARY) | 0.011756 | 0.010996 | 0.010134 | 0.862069 | 78.400604 | 0.010005 | 7.170281 | 0.998989 |
| 2078 | (HERB MARKER THYME, HERB MARKER ROSEMARY) | (HERB MARKER PARSLEY) | 0.010996 | 0.011756 | 0.010134 | 0.921659 | 78.400604 | 0.010005 | 12.614647 | 0.998221 |

In [22]

import mpld3

*# create scatter plot with x and y as lift and confidence values*

fig, ax = plt.subplots()

scatter = ax.scatter(rules['lift'], rules['confidence'], alpha=0.5)

*# Define tooltips*

tooltips = []

for i **in** range(len(rules)):

rule = rules.iloc[i]

tooltip = f"Rule: **{**rule['antecedents']**}** -> **{**rule['consequents']**}\n**Support: **{**rule['support']**:**.3f**}\n**Confidence: **{**rule['confidence']**:**.3f**}\n**Lift: **{**rule['lift']**:**.3f**}**"

tooltips.append(tooltip)

*# Add tooltips to scatter plot using mpld3*

mpld3.plugins.connect(fig, mpld3.plugins.PointHTMLTooltip(scatter, tooltips))

*# Set axis labels and title*

ax.set\_xlabel("Lift")

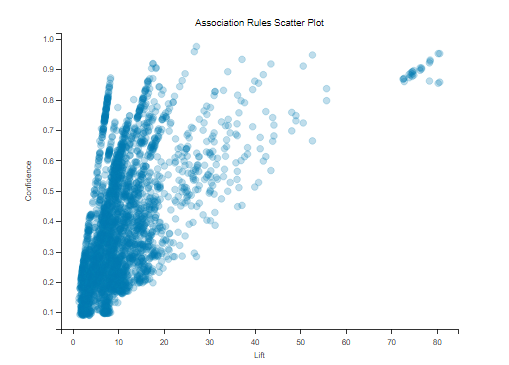
ax.set\_ylabel("Confidence")

ax.set\_title("Association Rules Scatter Plot")

*# Show the plot*

mpld3.display()

Out [22]



In [23]

rules[(rules['lift'] > 40) & (rules['lift'] < 50)]

Out [23]

| antecedents | consequents | antecedent support | consequent support | support | confidence | lift | leverage | conviction | zhangs\_metric |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 124 | (BLUE POLKADOT CUP) | (PINK POLKADOT CUP) | 0.016418 | 0.015505 | 0.010489 | 0.638889 | 41.204158 | 0.010234 | 2.726293 | 0.992017 |
| 125 | (PINK POLKADOT CUP) | (BLUE POLKADOT CUP) | 0.015505 | 0.016418 | 0.010489 | 0.676471 | 41.204158 | 0.010234 | 3.040164 | 0.991098 |
| 264 | (CHILDRENS CUTLERY SPACEBOY) | (CHILDRENS CUTLERY DOLLY GIRL) | 0.017938 | 0.014441 | 0.010996 | 0.612994 | 42.447170 | 0.010737 | 2.546626 | 0.994276 |
| 265 | (CHILDRENS CUTLERY DOLLY GIRL) | (CHILDRENS CUTLERY SPACEBOY) | 0.014441 | 0.017938 | 0.010996 | 0.761404 | 42.447170 | 0.010737 | 4.115997 | 0.990749 |
| 552 | (JAM JAR WITH PINK LID) | (JAM JAR WITH GREEN LID) | 0.016874 | 0.015100 | 0.011198 | 0.663664 | 43.951015 | 0.010944 | 2.928319 | 0.994020 |
| 553 | (JAM JAR WITH GREEN LID) | (JAM JAR WITH PINK LID) | 0.015100 | 0.016874 | 0.011198 | 0.741611 | 43.951015 | 0.010944 | 3.804827 | 0.992230 |
| 1556 | (REGENCY SUGAR BOWL GREEN) | (REGENCY MILK JUG PINK) | 0.014897 | 0.015252 | 0.011148 | 0.748299 | 49.062083 | 0.010920 | 3.912377 | 0.994432 |
| 1557 | (REGENCY MILK JUG PINK) | (REGENCY SUGAR BOWL GREEN) | 0.015252 | 0.014897 | 0.011148 | 0.730897 | 49.062083 | 0.010920 | 3.660690 | 0.994790 |
| 1568 | (REGENCY TEA PLATE ROSES) | (REGENCY TEA PLATE PINK) | 0.021079 | 0.014289 | 0.012617 | 0.598558 | 41.888426 | 0.012316 | 2.455423 | 0.997146 |
| 1569 | (REGENCY TEA PLATE PINK) | (REGENCY TEA PLATE ROSES) | 0.014289 | 0.021079 | 0.012617 | 0.882979 | 41.888426 | 0.012316 | 8.365322 | 0.990277 |
| 1616 | (SET OF 3 WOODEN TREE DECORATIONS) | (SET OF 3 WOODEN STOCKING DECORATION) | 0.014492 | 0.015759 | 0.010996 | 0.758741 | 48.147134 | 0.010767 | 4.079608 | 0.993630 |
| 1617 | (SET OF 3 WOODEN STOCKING DECORATION) | (SET OF 3 WOODEN TREE DECORATIONS) | 0.015759 | 0.014492 | 0.010996 | 0.697749 | 48.147134 | 0.010767 | 3.260564 | 0.994909 |
| 3024 | (POPPY'S PLAYHOUSE LIVINGROOM, POPPY'S PLAYHOU... | (POPPY'S PLAYHOUSE BEDROOM) | 0.012921 | 0.020927 | 0.011046 | 0.854902 | 40.851066 | 0.010776 | 6.747663 | 0.988291 |
| 3025 | (POPPY'S PLAYHOUSE LIVINGROOM, POPPY'S PLAYHOU... | (POPPY'S PLAYHOUSE KITCHEN) | 0.012820 | 0.021535 | 0.011046 | 0.861660 | 40.011439 | 0.010770 | 7.072902 | 0.987669 |
| 3026 | (POPPY'S PLAYHOUSE KITCHEN, POPPY'S PLAYHOUSE ... | (POPPY'S PLAYHOUSE LIVINGROOM) | 0.015404 | 0.016215 | 0.011046 | 0.717105 | 44.225226 | 0.010797 | 3.477566 | 0.992680 |
| 3027 | (POPPY'S PLAYHOUSE LIVINGROOM) | (POPPY'S PLAYHOUSE KITCHEN, POPPY'S PLAYHOUSE ... | 0.016215 | 0.015404 | 0.011046 | 0.681250 | 44.225226 | 0.010797 | 3.088928 | 0.993498 |

**Conclusion:**

This program outlines the essential steps for conducting Market Basket Analysis (MBA) using the Apriori algorithm. Market Basket Analysis is a valuable data mining technique that helps businesses uncover hidden patterns and relationships within transactional data, enabling them to make data-driven decisions and enhance various aspects of their operations.

Here's a summary of the key steps covered in this program:

1. **Data Hygiene**: The program begins by cleaning and preparing the transactional data. It involves removing rows with missing item names, filtering out rows with zero or negative quantities, filling missing customer IDs with a placeholder, and creating a new column to calculate total sales revenue.
2. **Exploratory Data Analysis (EDA):** The EDA section explores the dataset to gain insights into customer behavior. It identifies the best-selling items in different countries, visualizes total sales by country, and examines the most popular products in the United Kingdom.
3. **Market Basket Analysis:** The main focus of the program is on performing Market Basket Analysis using the Apriori algorithm and association rule mining. The steps include:

* Converting the dataset into a transactional format where each row represents a bill with the items purchased.
* Creating a one-hot matrix of products, indicating whether each item was purchased in a bill.
* Merging the transactional matrix and the one-hot matrix to prepare the data for analysis.
* Applying the Apriori algorithm to find frequent itemsets with a specified minimum support threshold.
* Generating association rules based on these frequent itemsets, considering lift as a metric.

The generated association rules provide insights into item associations and can be used to make strategic decisions in areas such as product placement, marketing campaigns, and customer experience improvement.

In practice, businesses can leverage these insights to optimize their operations, enhance sales strategies, and ultimately provide a better shopping experience for customers. Additionally, the program demonstrates how to use Python and popular libraries like pandas and mlxtend to perform these analyses efficiently.

Market Basket Analysis is a powerful tool for retailers and businesses seeking to unlock the hidden potential within their transactional data, enabling them to make informed decisions and drive profitability.