Market Basket Insights

# TEAM MEMBER

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PHASE 1

PROBLEM DEFINITION AND DESIGN THINKING

TITLE:Market Basket Insights

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Abstract:

Market Basket Insights play a pivotal role in understanding customer behavior and optimizing business strategies. This abstract outlines a comprehensive approach to extracting valuable insights from market basket data, encompassing data source selection, data preparation, association analysis, insight generation, visualization, and business recommendations modules.



**Problem Definition:** The problem is to perform market basket analysis on a provided dataset to unveil hidden patterns and associations between products. The goal is to understand customer purchasing behavior and identify potential cross-selling opportunities for a retail business. This project involves using association analysis techniques, such as Apriori algorithm, to find frequently co-occurring products and generate insights for business optimization

**Design Thinking:**

Data Source:

Choosing the right data source is crucial for market basket analysis. In this study, we leverage transactional data sourced from point-of-sale systems and online sales platforms. The dataset contains information on customer purchases, including product IDs, timestamps, and customer demographics. This rich dataset serves as the foundation for our analysis.

Data Preparation:

Data preparation is an essential step in ensuring the quality and consistency of the dataset. We perform data cleaning, handling missing values, and transforming the data into a suitable format for analysis. Additionally, we preprocess the data to generate transaction-item matrices, which serve as the input for association analysis.

Association Analysis:

Association analysis, specifically Apriori or FP-growth algorithms, is employed to uncover patterns and associations within customer transactions. By identifying frequently co-occurring items in baskets, we determine product affinities and customer preferences. This module extracts association rules, including support, confidence, and lift, which quantify the strength and relevance of discovered patterns.

Insight Generation:

The insights generated from association analysis shed light on customer purchasing behaviors and product relationships. We identify cross-selling opportunities, uncover hidden product connections, and gain a deeper understanding of customer preferences. This module also enables us to segment customers based on their purchasing patterns, creating valuable customer profiles.

Visualization:

To facilitate a clear understanding of the results, we employ data visualization techniques. Heatmaps, network graphs, and scatter plots are used to represent association rules and customer segments. These visualizations aid in conveying complex patterns and insights to stakeholders in an intuitive manner.

Business Recommendations:

The final module involves deriving actionable recommendations based on the insights gained. We propose strategies for optimizing product placement, bundling, and promotions. These recommendations are tailored to enhance sales, customer satisfaction, and overall business performance.

In conclusion, this holistic approach to Market Basket Insights, comprising data source selection, data preparation, association analysis, insight generation, visualization, and business recommendations, equips businesses with valuable knowledge to make informed decisions and drive growth. By harnessing the power of market basket data, organizations can enhance their marketing strategies and customer experiences while maximizing profitability.

**DATASET:**

**Dataset Link:**[**https://www.kaggle.com/datasets/aslanahmedov/market-basket-analysis**](https://www.kaggle.com/datasets/aslanahmedov/market-basket-analysis)

**Sample Code:**

*# 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

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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]:

linkcode

*#Visualizing Total sales by country.*

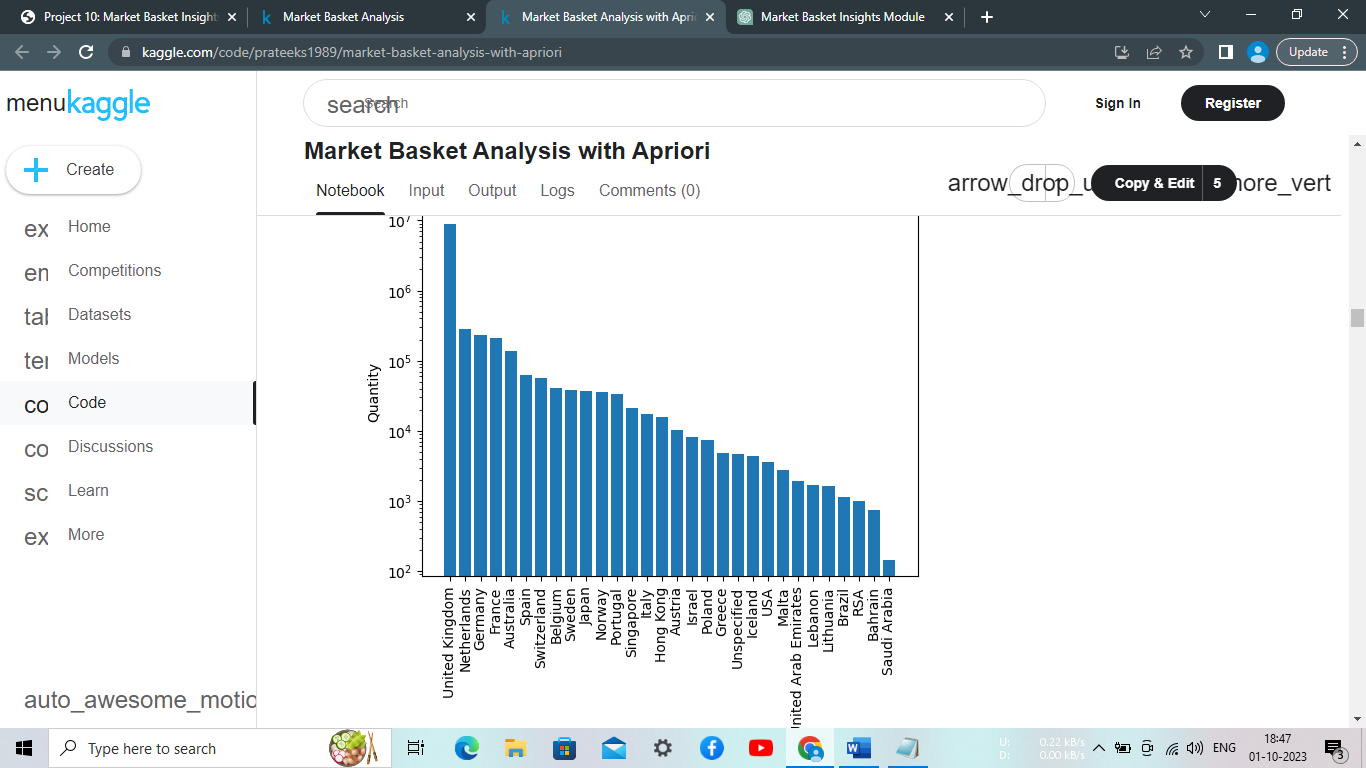
plt.bar(total\_sales\_country["Country"],total\_sales\_country["SumPrice"])

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]:

*#Let's find out what items, across the globe, bring in the most revenue.*

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 |

4056 rows × 5 columns

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 | ... | 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 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 522059 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 522060 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 522061 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 522062 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 522063 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

520136 rows × 4056 columns

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 | ... | 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 | BillNo |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 536365 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 536365 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 536365 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 536365 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 536365 |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 522059 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 581587 |
| 522060 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 581587 |
| 522061 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 581587 |
| 522062 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 581587 |
| 522063 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 581587 |

520136 rows × 4057 columns

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 | ... | 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 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| BillNo |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 536365 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 536366 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 536367 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 536368 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 536369 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 581586 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 581587 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| A563185 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| A563186 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| A563187 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

19735 rows × 4056 columns

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

Out[16]:

|  | 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 | ... | 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 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| BillNo |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 536365 | [WHITE HANGING HEART T-LIGHT HOLDER, WHITE MET... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | 0 | 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 | ... | 0 | 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 | ... | 0 | 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 | ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 536369 | [BATH BUILDING BLOCK WORD] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 581586 | [LARGE CAKE STAND HANGING STRAWBERY, SET OF 3... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 581587 | [CIRCUS PARADE LUNCH BOX, PLASTERS IN TIN CIRC... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| A563185 | [Adjust bad debt] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| A563186 | [Adjust bad debt] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| A563187 | [Adjust bad debt] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

19735 rows × 4057 columns

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]:

|  | 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 | ... | 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 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| BillNo |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 536365 | [WHITE HANGING HEART T-LIGHT HOLDER, WHITE MET... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | 0 | 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 | ... | 0 | 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 | ... | 0 | 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 | ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 536369 | [BATH BUILDING BLOCK WORD] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 581586 | [LARGE CAKE STAND HANGING STRAWBERY, SET OF 3... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 581587 | [CIRCUS PARADE LUNCH BOX, PLASTERS IN TIN CIRC... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| A563185 | [Adjust bad debt] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| A563186 | [Adjust bad debt] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| A563187 | [Adjust bad debt] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

19735 rows × 4057 columns

In [18]:

from mlxtend.frequent\_patterns import apriori

from mlxtend.frequent\_patterns import association\_rules

print(transaction\_matrix.dtypes)

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... |

1896 rows × 2 columns

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 |

3342 rows × 10 columns

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 |
| 533 | (HERB MARKER THYME) | (HERB MARKER PARSLEY) | 0.011806 | 0.011756 | 0.010641 | 0.901288 | 76.667715 | 0.010502 | 10.011344 | 0.998748 |
| 532 | (HERB MARKER PARSLEY) | (HERB MARKER THYME) | 0.011756 | 0.011806 | 0.010641 | 0.905172 | 76.667715 | 0.010502 | 10.420950 | 0.998697 |

In [22]:

linkcode

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*

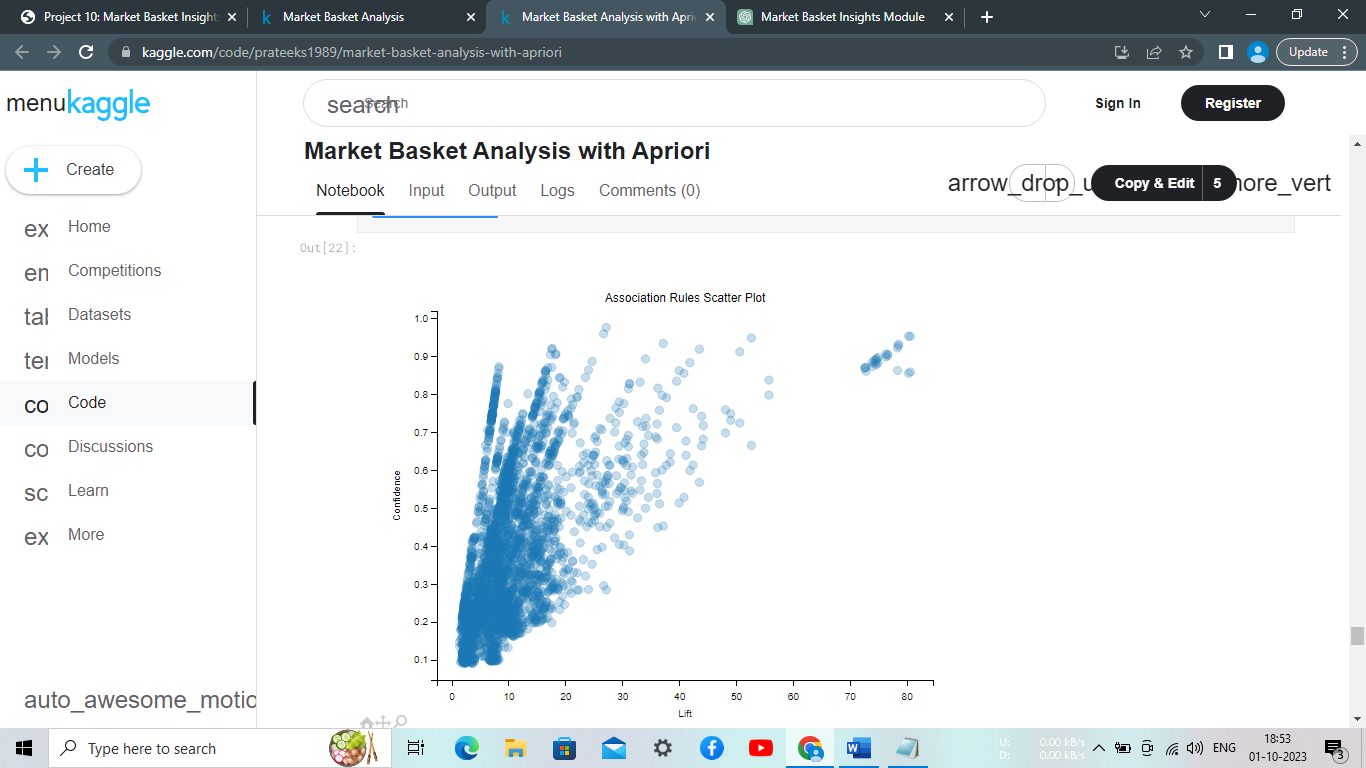
ax.set\_xlabel("Lift")

ax.set\_ylabel("Confidence")

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

*# Show the plot*

mpld3.display()



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 |
| 3028 | (POPPY'S PLAYHOUSE KITCHEN) | (POPPY'S PLAYHOUSE LIVINGROOM, POPPY'S PLAYHOU... | 0.021535 | 0.012820 | 0.011046 | 0.512941 | 40.011439 | 0.010770 | 2.026819 | 0.996466 |
| 3029 | (POPPY'S PLAYHOUSE BEDROOM) | (POPPY'S PLAYHOUSE LIVINGROOM, POPPY'S PLAYHOU... | 0.020927 | 0.012921 | 0.011046 | 0.527845 | 40.851066 | 0.010776 | 2.090582 | 0.996372 |
| 3038 | (REGENCY TEA PLATE GREEN, REGENCY TEA PLATE PINK) | (REGENCY TEA PLATE ROSES) | 0.013023 | 0.021079 | 0.011958 | 0.918288 | 43.563491 | 0.011684 | 11.980125 | 0.989936 |
| 3039 | (REGENCY TEA PLATE ROSES) | (REGENCY TEA PLATE GREEN, REGENCY TEA PLATE PINK) | 0.021079 | 0.013023 | 0.011958 | 0.567308 | 43.563491 | 0.011684 | 2.281015 | 0.998084 |