MARKET BASKET INSIGHTS

Problem Statement:

The problem is to analyze customer purchase data to discover associations bet ween products, understand buying patterns, and extract insights to improve ma rketing and sales strategies.

Design Thinking Process:

Empathize: Understand the business and customer needs, gather data on sales a nd customer transactions.

Define: Define the problem and objectives, such as increasing cross-selling, optimizing product placement, or improving inventory management.

Ideate: Generate ideas on what kind of associations might exist and how they can be used to achieve the objectives.

Prototype: Prepare the dataset and choose appropriate tools and algorithm for analysis.

Test: Apply association analysis techniques and evaluate their effectiveness.

Implement: Translate insights into actionable strategies and monitor their im pact on sales and customer behavior.

Phases of Development:

Data Collection: Gather transaction data, including information on products, customers, and purchase history.

Data Preprocessing:

- Handle missing data, outliers, and duplicates.
- Convert data into a suitable format for association analysis.
- Encode categorical variables.
- Remove irrelevant or infrequent items to reduce noise.

Association Analysis Techniques:

- Use algorithms like Apriori or FP-growth to discover frequent itemsets and association rules.

- Set appropriate support and confidence thresholds to filter out relevant rules.
- Generate association rules that reveal item co-occurrence patterns.

Interpretation:

- Examine the discovered association rules, which may include items that tend to be bought together.
- Identify strong and actionable rules based on high confidence and lift values

Business Implications:

- Implement strategies like bundling products frequently bought together.
- Optimize store layouts based on product associations.
- Create targeted marketing campaigns.
- Enhance inventory management to ensure product availability for frequently associated items.
- Monitor changes in customer behavior and adapt strategies accordingly.

Documentation:

- Maintain clear documentation of the entire process, including data sources, preprocessing steps, analysis results, and business actions taken.

Dataset

File name: Assignment-1_Data

List name: retaildata

File format: . xlsx

Number of Row: 522065

Number of Attributes: 7

BillNo: 6-digit number assigned to each transaction. Nominal.

Itemname: Product name. Nominal.

Quantity: The quantities of each product per transaction. Numeric.

Date: The day and time when each transaction was generated. Numeric.

Price: Product price. Numeric.

CustomerID: 5-digit number assigned to each customer. Nominal.

Country: Name of the country where each customer resides. Nominal

Data Preprocessing:

- **Data Collection:** Gather transaction data, typically in the form of a dataset with rows representing transactions and columns representing it ems
- **Data Cleaning**: Remove duplicates, missing values, and irrelevant information. Ensure consistent formatting and encoding of items.
- **Data Transformation**: Convert data into a suitable format, like a binary matrix where rows are transactions, and columns are items with 1s and 0 s representing presence or absence.
- **Support Threshold:** Set a minimum support threshold, which determines how frequent an itemset must be to be considered in the analysis. This helps in reducing the size of the itemset space.

Association Analysis Techniques:

This is a classic algorithm for finding frequent itemsets. It uses a level-wise approach to iteratively discover itemsets with higher support.

- **FP-Growth Algorithm**: This is another frequent itemset mining algorithm that uses a tree structure to efficiently discover frequent itemsets without the need for multiple database scans.
- **Association Rule Generation**: After identifying frequent itemsets, association rules are generated. These rules consist of an antecedent (if) and a consequent (then) part. For example, "If a customer buys item A, then they are likely to buy item B."
- **Confidence and Lift**: These metrics help assess the strength of association rules. Confidence measures how often the rule is correct, while lift measures the significance of the rule's performance compared to random chance.
- **Pruning and Post-Processing**: Remove redundant or less interesting rules to keep the analysis focused on valuable insights.
- **Visualization**: Use data visualization techniques like heatmaps, scatter plots, or network graphs to represent associations and make them more i nterpretable.

Discovered association rules and their business implications:

Discovering association rules from market basket data like this can help businesses understand relationships between products in customer transactions. Association rules typically have the format "If {antecedent}, then {consequent}" and are based on the support,. confidence, and lift metrics. Here's how you might interpret the discovered association rules and their implications:

- **High Support Rules**: Rules with high support indicate that the combinati on of items in the antecedent and consequent frequently occurs together This implies a strong association between these items.

- **High Confidence Rules**: High confidence indicates that when the antecedent items are in the basket, there's a high likelihood of the consequent items also being in the basket.

- **High Lift Rules:** Lift measures how much more likely it is for the consequent to be bought when the antecedent is purchased, compared to when it's bought without the antecedent.A lift greater than 1 suggests a positive association.

Business implications:

- **Product Placement:** Retailers can use these rules to optimize the placement of products in the store. If products frequently bought together are placed close to each other, it can increase sales.

- **Pricing Strategies:** Knowing which products are commonly purchased together can inform pricing strategies. For example, bundling two associated products might attract more sales.

- **Customer Segmentation**: Understanding the association rules can help in customer segmentation. Retailers can target specific customer groups with tailored promotions based on their common purchase patterns.

- **Cross-selling and Upselling**: By identifying associations, businesses can effectively cross-sell and upsell products. For instance, if a customer adds a. laptop to their cart, a suggestion for a laptop bag or accessories can be made.

- **Market Expansion**: If an association rule suggests that a certain combination of products is popular in one country but not in another, it can inform market expansion strategies.

Jupyter Notebook:

```
import pandas as pd
import numpy as np

#for viz
import matplotlib.pyplot as plt
import seaborn as sns

%matplotlib inline

#to avoid warning
import warnings
warnings.filterwarnings('ignore')

#to display all feature if the number increase
pd.set_option('display.max_columns', None)
```

```
data=pd.read_excel('C:\\Users\\ELCOT\\Downloads\\archive11\\Assignment-1_Data
.xlsx')
```

```
import os
```

```
os.getcwd()
```

```
'C:\\Users\\ELCOT'
```

```
data
```

```
        BillNo                             Itemname  Quantity  \
0       536365   WHITE HANGING HEART T-LIGHT HOLDER         6
1       536365                  WHITE METAL LANTERN         6
2       536365       CREAM CUPID HEARTS COAT HANGER         8
3       536365  KNITTED UNION FLAG HOT WATER BOTTLE         6
4       536365       RED WOOLLY HOTTIE WHITE HEART.         6
...        ...                                  ...       ...
522059  581587          PACK OF 20 SPACEBOY NAPKINS        12
522060  581587          CHILDREN'S APRON DOLLY GIRL         6
522061  581587         CHILDRENS CUTLERY DOLLY GIRL         4
522062  581587      CHILDRENS CUTLERY CIRCUS PARADE         4
522063  581587         BAKING SET 9 PIECE RETROSPOT         3

                     Date  Price  CustomerID         Country
0      2010-12-01 08:26:00   2.55     17850.0  United Kingdom
1      2010-12-01 08:26:00   3.39     17850.0  United Kingdom
2      2010-12-01 08:26:00   2.75     17850.0  United Kingdom
3      2010-12-01 08:26:00   3.39     17850.0  United Kingdom
4      2010-12-01 08:26:00   3.39     17850.0  United Kingdom
...                    ...    ...         ...             ...
```

```
522059 2011-12-09 12:50:00   0.85     12680.0          France
522060 2011-12-09 12:50:00   2.10     12680.0          France
522061 2011-12-09 12:50:00   4.15     12680.0          France
522062 2011-12-09 12:50:00   4.15     12680.0          France
522063 2011-12-09 12:50:00   4.95     12680.0          France

[522064 rows x 7 columns]
```

Apriori Algorithm:

```
# Display basic information about the dataset
print("Number of rows and columns:", data.shape)
print("\nData Types and Missing Values:")
print(data.info())
print("\nFirst few rows of the dataset:")
print(data.head())
```

```
Number of rows and columns: (522064, 7)

Data Types and Missing Values:
<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
None

First few rows of the dataset:
   BillNo                             Itemname  Quantity                 Date
\
0  536365   WHITE HANGING HEART T-LIGHT HOLDER         6 2010-12-01 08:26:00
1  536365                  WHITE METAL LANTERN         6 2010-12-01 08:26:00
2  536365       CREAM CUPID HEARTS COAT HANGER         8 2010-12-01 08:26:00
3  536365  KNITTED UNION FLAG HOT WATER BOTTLE         6 2010-12-01 08:26:00
4  536365       RED WOOLLY HOTTIE WHITE HEART.         6 2010-12-01 08:26:00

   Price  CustomerID         Country
0   2.55     17850.0  United Kingdom
1   3.39     17850.0  United Kingdom
2   2.75     17850.0  United Kingdom
3   3.39     17850.0  United Kingdom
4   3.39     17850.0  United Kingdom
```

```python
#Check Missing Values
print("Missing Values:")
print(data.isnull().sum())

#Drop Rows with Missing Values
data.dropna(inplace=True)
```

```
Missing Values:
BillNo             0
Itemname        1455
Quantity           0
Date               0
Price              0
CustomerID    134041
Country            0
dtype: int64
```

```python
# Convert dataframe into transaction data
transaction_data = data.groupby(['BillNo', 'Date'])['Itemname'].apply(lambda
x: ', '.join(x)).reset_index()

#Drop Unnecessary Columns
columns_to_drop = ['BillNo', 'Date']
transaction_data.drop(columns=columns_to_drop, inplace=True)

# Save the transaction data to a CSV file
transaction_data_path = 'C:\\Users\\ELCOT\\Downloads\\archive11\\transaction_
data.csv'
transaction_data.to_csv(transaction_data_path, index=False)

# Display the first few rows of the transaction data
print("\nTransaction Data for Association Rule Mining:")
print(transaction_data.head())
transaction_data.shape
```

```
Transaction Data for Association Rule Mining:
                                    0                               1  \
0  WHITE HANGING HEART T-LIGHT HOLDER          WHITE METAL LANTERN
1              HAND WARMER UNION JACK    HAND WARMER RED POLKA DOT
2       ASSORTED COLOUR BIRD ORNAMENT    POPPY'S PLAYHOUSE BEDROOM
3            JAM MAKING SET WITH JARS  RED COAT RACK PARIS FASHION
4            BATH BUILDING BLOCK WORD                          None

                               2                                   3  \
0  CREAM CUPID HEARTS COAT HANGER  KNITTED UNION FLAG HOT WATER BOTTLE
1                            None                                None
2       POPPY'S PLAYHOUSE KITCHEN    FELTCRAFT PRINCESS CHARLOTTE DOLL
3  YELLOW COAT RACK PARIS FASHION         BLUE COAT RACK PARIS FASHION
4                            None                                None
```

	4	5
0	RED WOOLLY HOTTIE WHITE HEART.	SET 7 BABUSHKA NESTING BOXES
1	None	None
2	IVORY KNITTED MUG COSY	BOX OF 6 ASSORTED COLOUR TEASPOONS
3	None	None
4	None	None

	6	7
0	GLASS STAR FROSTED T-LIGHT HOLDER	None
1	None	None
2	BOX OF VINTAGE JIGSAW BLOCKS	BOX OF VINTAGE ALPHABET BLOCKS
3	None	None
4	None	None

	8	9
0	None	None
1	None	None
2	HOME BUILDING BLOCK WORD	LOVE BUILDING BLOCK WORD
3	None	None
4	None	None

	10	11	12	13	14	15
0	None	None	None	None	None	None
1	None	None	None	None	None	None
2	RECIPE BOX WITH METAL HEART	DOORMAT NEW ENGLAND	None	None	None	None
3	None	None	None	None	None	None
4	None	None	None	None	None	None

	16	17	18	19	20	21	22	23	24	25	26	27
0	None	None	None	None	None	None	None	None	None	None	None	None
1	None	None	None	None	None	None	None	None	None	None	None	None
2	None	None	None	None	None	None	None	None	None	None	None	None
3	None	None	None	None	None	None	None	None	None	None	None	None
4	None	None	None	None	None	None	None	None	None	None	None	None

	28	29	30	31	32	33	34	35	36	37	38	39
0	None	None	None	None	None	None	None	None	None	None	None	None
1	None	None	None	None	None	None	None	None	None	None	None	None
2	None	None	None	None	None	None	None	None	None	None	None	None
3	None	None	None	None	None	None	None	None	None	None	None	None
4	None	None	None	None	None	None	None	None	None	None	None	None

	40	41	42	43	44	45	46	47	48	49	50	51
0	None	None	None	None	None	None	None	None	None	None	None	None
1	None	None	None	None	None	None	None	None	None	None	None	None
2	None	None	None	None	None	None	None	None	None	None	None	None
3	None	None	None	None	None	None	None	None	None	None	None	None

4	None	None	None	None	None	None	None	None	None	None	None	None

	52	53	54	55	56	57	58	59	60	61	62	63	\
0	None	None	None	None	None	None	None	None	None	None	None	None	
1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	64	65	66	67	68	69	70	71	72	73	74	75	\
0	None	None	None	None	None	None	None	None	None	None	None	None	
1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	76	77	78	79	80	81	82	83	84	85	86	87	\
0	None	None	None	None	None	None	None	None	None	None	None	None	
1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	88	89	90	91	92	93	94	95	96	97	98	99	\
0	None	None	None	None	None	None	None	None	None	None	None	None	
1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	100	101	102	103	104	105	106	107	108	109	110	111	\
0	None	None	None	None	None	None	None	None	None	None	None	None	
1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	112	113	114	115	116	117	118	119	120	121	122	123	\
0	None	None	None	None	None	None	None	None	None	None	None	None	
1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	124	125	126	127	128	129	130	131	132	133	134	135	\
0	None	None	None	None	None	None	None	None	None	None	None	None	
1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	

4	None	None	None	None	None	None	None	None	None	None	None	None

	136	137	138	139	140	141	142	143	144	145	146	147	\
0	None	None	None	None	None	None	None	None	None	None	None	None	
1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	148	149	150	151	152	153	154	155	156	157	158	159	\
0	None	None	None	None	None	None	None	None	None	None	None	None	
1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	160	161	162	163	164	165	166	167	168	169	170	171	\
0	None	None	None	None	None	None	None	None	None	None	None	None	
1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	172	173	174	175	176	177	178	179	180	181	182	183	\
0	None	None	None	None	None	None	None	None	None	None	None	None	
1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	184	185	186	187	188	189	190	191	192	193	194	195	\
0	None	None	None	None	None	None	None	None	None	None	None	None	
1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	196	197	198	199	200	201	202	203	204	205	206	207	\
0	None	None	None	None	None	None	None	None	None	None	None	None	
1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	208	209	210	211	212	213	214	215	216	217	218	219	\
0	None	None	None	None	None	None	None	None	None	None	None	None	
1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	

4	None	None	None	None	None	None	None	None	None	None	None	None

	220	221	222	223	224	225	226	227	228	229	230	231	\
0	None	None	None	None	None	None	None	None	None	None	None	None	
1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	232	233	234	235	236	237	238	239	240	241	242	243	\
0	None	None	None	None	None	None	None	None	None	None	None	None	
1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	244	245	246	247	248	249	250	251	252	253	254	255	\
0	None	None	None	None	None	None	None	None	None	None	None	None	
1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	256	257	258	259	260	261	262	263	264	265	266	267	\
0	None	None	None	None	None	None	None	None	None	None	None	None	
1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	268	269	270	271	272	273	274	275	276	277	278	279	\
0	None	None	None	None	None	None	None	None	None	None	None	None	
1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	280	281	282	283	284	285	286	287	288	289	290	291	\
0	None	None	None	None	None	None	None	None	None	None	None	None	
1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	292	293	294	295	296	297	298	299	300	301	302	303	\
0	None	None	None	None	None	None	None	None	None	None	None	None	
1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	

4	None	None	None	None	None	None	None	None	None	None	None	None

	304	305	306	307	308	309	310	311	312	313	314	315	\
0	None	None	None	None	None	None	None	None	None	None	None	None	
1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	316	317	318	319	320	321	322	323	324	325	326	327	\
0	None	None	None	None	None	None	None	None	None	None	None	None	
1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	328	329	330	331	332	333	334	335	336	337	338	339	\
0	None	None	None	None	None	None	None	None	None	None	None	None	
1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	340	341	342	343	344	345	346	347	348	349	350	351	\
0	None	None	None	None	None	None	None	None	None	None	None	None	
1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	352	353	354	355	356	357	358	359	360	361	362	363	\
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1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	364	365	366	367	368	369	370	371	372	373	374	375	\
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1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	376	377	378	379	380	381	382	383	384	385	386	387	\
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1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	

4	None	None	None	None	None	None	None	None	None	None	None	None

	388	389	390	391	392	393	394	395	396	397	398	399	\
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1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	400	401	402	403	404	405	406	407	408	409	410	411	\
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1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	412	413	414	415	416	417	418	419	420	421	422	423	\
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1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	424	425	426	427	428	429	430	431	432	433	434	435	\
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1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	436	437	438	439	440	441	442	443	444	445	446	447	\
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2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	448	449	450	451	452	453	454	455	456	457	458	459	\
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2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	460	461	462	463	464	465	466	467	468	469	470	471	\
0	None	None	None	None	None	None	None	None	None	None	None	None	
1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	

```
4  None  None  None  None  None  None  None  None  None  None  None  None

    472   473   474   475   476   477   478   479   480   481   482   483  \
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2  None  None  None  None  None  None  None  None  None  None  None  None
3  None  None  None  None  None  None  None  None  None  None  None  None
4  None  None  None  None  None  None  None  None  None  None  None  None

    484   485   486   487   488   489   490   491   492   493   494   495  \
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2  None  None  None  None  None  None  None  None  None  None  None  None
3  None  None  None  None  None  None  None  None  None  None  None  None
4  None  None  None  None  None  None  None  None  None  None  None  None

    496   497   498   499   500   501   502   503   504   505   506   507  \
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2  None  None  None  None  None  None  None  None  None  None  None  None
3  None  None  None  None  None  None  None  None  None  None  None  None
4  None  None  None  None  None  None  None  None  None  None  None  None

    508   509   510   511   512   513   514   515   516   517   518   519  \
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2  None  None  None  None  None  None  None  None  None  None  None  None
3  None  None  None  None  None  None  None  None  None  None  None  None
4  None  None  None  None  None  None  None  None  None  None  None  None

    520   521   522   523   524   525   526   527   528   529   530   531  \
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2  None  None  None  None  None  None  None  None  None  None  None  None
3  None  None  None  None  None  None  None  None  None  None  None  None
4  None  None  None  None  None  None  None  None  None  None  None  None

    532   533   534   535   536   537   538   539   540   541   542   543
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2  None  None  None  None  None  None  None  None  None  None  None  None
3  None  None  None  None  None  None  None  None  None  None  None  None
4  None  None  None  None  None  None  None  None  None  None  None  None

(18192, 544)
```

```python
# Split the 'Itemname' column into individual items
items_df = transaction_data['Itemname'].str.split(', ', expand=True)

# Concatenate the original DataFrame with the new items DataFrame
```

```
transaction_data = pd.concat([transaction_data, items_df], axis=1)

# Drop the original 'Itemname' column
transaction_data = transaction_data.drop('Itemname', axis=1)

# Display the resulting DataFrame
print(transaction_data.head())
```

```
                                   0                              1  \
0  WHITE HANGING HEART T-LIGHT HOLDER          WHITE METAL LANTERN
1              HAND WARMER UNION JACK    HAND WARMER RED POLKA DOT
2       ASSORTED COLOUR BIRD ORNAMENT    POPPY'S PLAYHOUSE BEDROOM
3            JAM MAKING SET WITH JARS  RED COAT RACK PARIS FASHION
4            BATH BUILDING BLOCK WORD                          None

                               2                                     3  \
0  CREAM CUPID HEARTS COAT HANGER  KNITTED UNION FLAG HOT WATER BOTTLE
1                            None                                  None
2      POPPY'S PLAYHOUSE KITCHEN    FELTCRAFT PRINCESS CHARLOTTE DOLL
3  YELLOW COAT RACK PARIS FASHION         BLUE COAT RACK PARIS FASHION
4                            None                                  None

                               4                                     5  \
0  RED WOOLLY HOTTIE WHITE HEART.        SET 7 BABUSHKA NESTING BOXES
1                            None                                  None
2         IVORY KNITTED MUG COSY  BOX OF 6 ASSORTED COLOUR TEASPOONS
3                            None                                  None
4                            None                                  None

                                  6                                7  \
0  GLASS STAR FROSTED T-LIGHT HOLDER                             None
1                               None                             None
2      BOX OF VINTAGE JIGSAW BLOCKS  BOX OF VINTAGE ALPHABET BLOCKS
3                               None                             None
4                               None                             None

                         8                        9  \
0                     None                     None
1                     None                     None
2  HOME BUILDING BLOCK WORD  LOVE BUILDING BLOCK WORD
3                     None                     None
4                     None                     None

                           10                   11    12    13    14    15
\
0                       None                 None  None  None  None  None
1                       None                 None  None  None  None  None
2  RECIPE BOX WITH METAL HEART  DOORMAT NEW ENGLAND  None  None  None  None
3                       None                 None  None  None  None  None
```

```
4                                  None                                  None  None  None  None  None

     16    17    18    19    20    21    22    23    24    25    26    27  \
0  None  None  None  None  None  None  None  None  None  None  None  None
1  None  None  None  None  None  None  None  None  None  None  None  None
2  None  None  None  None  None  None  None  None  None  None  None  None
3  None  None  None  None  None  None  None  None  None  None  None  None
4  None  None  None  None  None  None  None  None  None  None  None  None

     28    29    30    31    32    33    34    35    36    37    38    39  \
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1  None  None  None  None  None  None  None  None  None  None  None  None
2  None  None  None  None  None  None  None  None  None  None  None  None
3  None  None  None  None  None  None  None  None  None  None  None  None
4  None  None  None  None  None  None  None  None  None  None  None  None

     40    41    42    43    44    45    46    47    48    49    50    51  \
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1  None  None  None  None  None  None  None  None  None  None  None  None
2  None  None  None  None  None  None  None  None  None  None  None  None
3  None  None  None  None  None  None  None  None  None  None  None  None
4  None  None  None  None  None  None  None  None  None  None  None  None

     52    53    54    55    56    57    58    59    60    61    62    63  \
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1  None  None  None  None  None  None  None  None  None  None  None  None
2  None  None  None  None  None  None  None  None  None  None  None  None
3  None  None  None  None  None  None  None  None  None  None  None  None
4  None  None  None  None  None  None  None  None  None  None  None  None

     64    65    66    67    68    69    70    71    72    73    74    75  \
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1  None  None  None  None  None  None  None  None  None  None  None  None
2  None  None  None  None  None  None  None  None  None  None  None  None
3  None  None  None  None  None  None  None  None  None  None  None  None
4  None  None  None  None  None  None  None  None  None  None  None  None

     76    77    78    79    80    81    82    83    84    85    86    87  \
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1  None  None  None  None  None  None  None  None  None  None  None  None
2  None  None  None  None  None  None  None  None  None  None  None  None
3  None  None  None  None  None  None  None  None  None  None  None  None
4  None  None  None  None  None  None  None  None  None  None  None  None

     88    89    90    91    92    93    94    95    96    97    98    99  \
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1  None  None  None  None  None  None  None  None  None  None  None  None
2  None  None  None  None  None  None  None  None  None  None  None  None
3  None  None  None  None  None  None  None  None  None  None  None  None
```

```
4  None  None  None  None  None  None  None  None  None  None  None  None

    100   101   102   103   104   105   106   107   108   109   110   111  \
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1  None  None  None  None  None  None  None  None  None  None  None  None
2  None  None  None  None  None  None  None  None  None  None  None  None
3  None  None  None  None  None  None  None  None  None  None  None  None
4  None  None  None  None  None  None  None  None  None  None  None  None

    112   113   114   115   116   117   118   119   120   121   122   123  \
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2  None  None  None  None  None  None  None  None  None  None  None  None
3  None  None  None  None  None  None  None  None  None  None  None  None
4  None  None  None  None  None  None  None  None  None  None  None  None

    124   125   126   127   128   129   130   131   132   133   134   135  \
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2  None  None  None  None  None  None  None  None  None  None  None  None
3  None  None  None  None  None  None  None  None  None  None  None  None
4  None  None  None  None  None  None  None  None  None  None  None  None

    136   137   138   139   140   141   142   143   144   145   146   147  \
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2  None  None  None  None  None  None  None  None  None  None  None  None
3  None  None  None  None  None  None  None  None  None  None  None  None
4  None  None  None  None  None  None  None  None  None  None  None  None

    148   149   150   151   152   153   154   155   156   157   158   159  \
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1  None  None  None  None  None  None  None  None  None  None  None  None
2  None  None  None  None  None  None  None  None  None  None  None  None
3  None  None  None  None  None  None  None  None  None  None  None  None
4  None  None  None  None  None  None  None  None  None  None  None  None

    160   161   162   163   164   165   166   167   168   169   170   171  \
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1  None  None  None  None  None  None  None  None  None  None  None  None
2  None  None  None  None  None  None  None  None  None  None  None  None
3  None  None  None  None  None  None  None  None  None  None  None  None
4  None  None  None  None  None  None  None  None  None  None  None  None

    172   173   174   175   176   177   178   179   180   181   182   183  \
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2  None  None  None  None  None  None  None  None  None  None  None  None
3  None  None  None  None  None  None  None  None  None  None  None  None
```

4	None	None	None	None	None	None	None	None	None	None	None	None

	184	185	186	187	188	189	190	191	192	193	194	195	\
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2	None	None	None	None	None	None	None	None	None	None	None	None	
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4	None	None	None	None	None	None	None	None	None	None	None	None	

	196	197	198	199	200	201	202	203	204	205	206	207	\
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4	None	None	None	None	None	None	None	None	None	None	None	None	

	208	209	210	211	212	213	214	215	216	217	218	219	\
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1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	220	221	222	223	224	225	226	227	228	229	230	231	\
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2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	232	233	234	235	236	237	238	239	240	241	242	243	\
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2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	244	245	246	247	248	249	250	251	252	253	254	255	\
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2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	256	257	258	259	260	261	262	263	264	265	266	267	\
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2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	

4	None	None	None	None	None	None	None	None	None	None	None	None

	268	269	270	271	272	273	274	275	276	277	278	279	\
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4	None	None	None	None	None	None	None	None	None	None	None	None	

	280	281	282	283	284	285	286	287	288	289	290	291	\
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3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	292	293	294	295	296	297	298	299	300	301	302	303	\
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3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	304	305	306	307	308	309	310	311	312	313	314	315	\
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1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	316	317	318	319	320	321	322	323	324	325	326	327	\
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2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	328	329	330	331	332	333	334	335	336	337	338	339	\
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2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	340	341	342	343	344	345	346	347	348	349	350	351	\
0	None	None	None	None	None	None	None	None	None	None	None	None	
1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	

4	None	None	None	None	None	None	None	None	None	None	None	None

	352	353	354	355	356	357	358	359	360	361	362	363	\
0	None	None	None	None	None	None	None	None	None	None	None	None	
1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	364	365	366	367	368	369	370	371	372	373	374	375	\
0	None	None	None	None	None	None	None	None	None	None	None	None	
1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	376	377	378	379	380	381	382	383	384	385	386	387	\
0	None	None	None	None	None	None	None	None	None	None	None	None	
1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	388	389	390	391	392	393	394	395	396	397	398	399	\
0	None	None	None	None	None	None	None	None	None	None	None	None	
1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	400	401	402	403	404	405	406	407	408	409	410	411	\
0	None	None	None	None	None	None	None	None	None	None	None	None	
1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	412	413	414	415	416	417	418	419	420	421	422	423	\
0	None	None	None	None	None	None	None	None	None	None	None	None	
1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	424	425	426	427	428	429	430	431	432	433	434	435	\
0	None	None	None	None	None	None	None	None	None	None	None	None	
1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	

4	None	None	None	None	None	None	None	None	None	None	None	None

	436	437	438	439	440	441	442	443	444	445	446	447	\
0	None	None	None	None	None	None	None	None	None	None	None	None	
1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	448	449	450	451	452	453	454	455	456	457	458	459	\
0	None	None	None	None	None	None	None	None	None	None	None	None	
1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	460	461	462	463	464	465	466	467	468	469	470	471	\
0	None	None	None	None	None	None	None	None	None	None	None	None	
1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	472	473	474	475	476	477	478	479	480	481	482	483	\
0	None	None	None	None	None	None	None	None	None	None	None	None	
1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	484	485	486	487	488	489	490	491	492	493	494	495	\
0	None	None	None	None	None	None	None	None	None	None	None	None	
1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	496	497	498	499	500	501	502	503	504	505	506	507	\
0	None	None	None	None	None	None	None	None	None	None	None	None	
1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	
4	None	None	None	None	None	None	None	None	None	None	None	None	

	508	509	510	511	512	513	514	515	516	517	518	519	\
0	None	None	None	None	None	None	None	None	None	None	None	None	
1	None	None	None	None	None	None	None	None	None	None	None	None	
2	None	None	None	None	None	None	None	None	None	None	None	None	
3	None	None	None	None	None	None	None	None	None	None	None	None	

```
4  None  None  None  None  None  None  None  None  None  None  None  None

    520   521   522   523   524   525   526   527   528   529   530   531  \
0  None  None  None  None  None  None  None  None  None  None  None  None
1  None  None  None  None  None  None  None  None  None  None  None  None
2  None  None  None  None  None  None  None  None  None  None  None  None
3  None  None  None  None  None  None  None  None  None  None  None  None
4  None  None  None  None  None  None  None  None  None  None  None  None

    532   533   534   535   536   537   538   539   540   541   542   543
0  None  None  None  None  None  None  None  None  None  None  None  None
1  None  None  None  None  None  None  None  None  None  None  None  None
2  None  None  None  None  None  None  None  None  None  None  None  None
3  None  None  None  None  None  None  None  None  None  None  None  None
4  None  None  None  None  None  None  None  None  None  None  None  None
```

```python
# Convert items to boolean columns
df_encoded = pd.get_dummies(transaction_data, prefix='', prefix_sep='').group
by(level=0, axis=1).max()

# Save the transaction data to a CSV file
df_encoded.to_csv('transaction_data_encoded.csv', index=False)

# Load transaction data into a DataFrame
df_encoded = pd.read_csv('transaction_data_encoded.csv')

from mlxtend.frequent_patterns import apriori, association_rules

# Association Rule Mining
frequent_itemsets = apriori(df_encoded, min_support=0.007, use_colnames=True)
rules = association_rules(frequent_itemsets, metric="confidence", min_thresho
ld=0.5)

# Display information of the rules
print("Association Rules:")
print(rules.head())
```

```
Association Rules:

                Antecedents                consequents  \

0        (CHOCOLATE BOX RIBBONS)        (6 RIBBONS RUSTIC CHARM)

    1  (60 CAKE CASES DOLLY GIRL DESIGN)  (PACK OF 72 RETROSPOT CAKE CASES)

    2  2     (60 TEATIME FAIRY CAKE CASES)  (PACK OF 72 RETROSPOT CAKE CASES)

3  (ALARM CLOCK BAKELIKE CHOCOLATE)      (ALARM CLOCK BAKELIKE GREEN)
```

4 (ALARM CLOCK BAKELIKE CHOCOLATE) (ALARM CLOCK BAKELIKE PINK)

Antecedent support consequent support support confidence lift \

0 0.012368 0.039193 0.007036 0.568889 14.515044

1 0.018525 0.054529 0.010059 0.543027 9.958409

2 0.034631 0.054529 0.017315 0.500000 9.169355

3 0.017150 0.042931 0.011379 0.663462 15.454151

4 0.017150 0.032652 0.009125 0.532051 16.294742

Leverage conviction zhangs_metric

0 0.006551 2.228676 0.942766

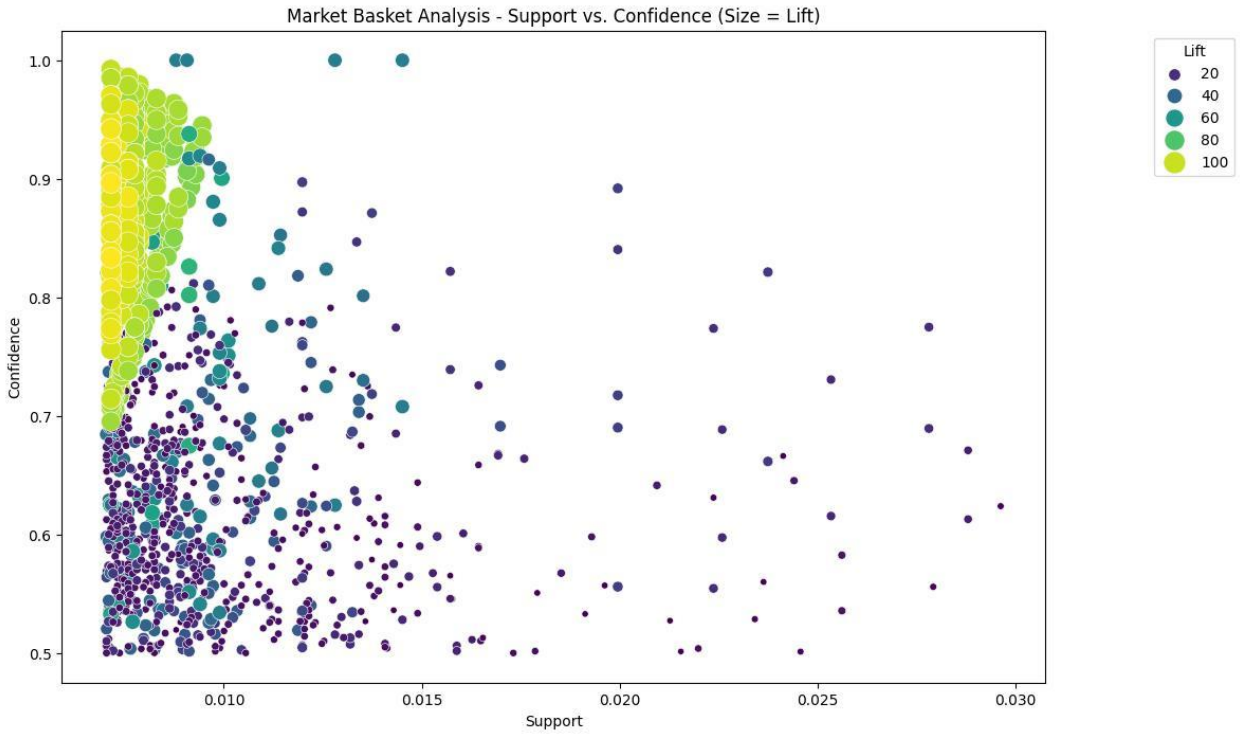
1 0.009049 2.068984 0.916561

2 0.015427 1.890941 0.922902

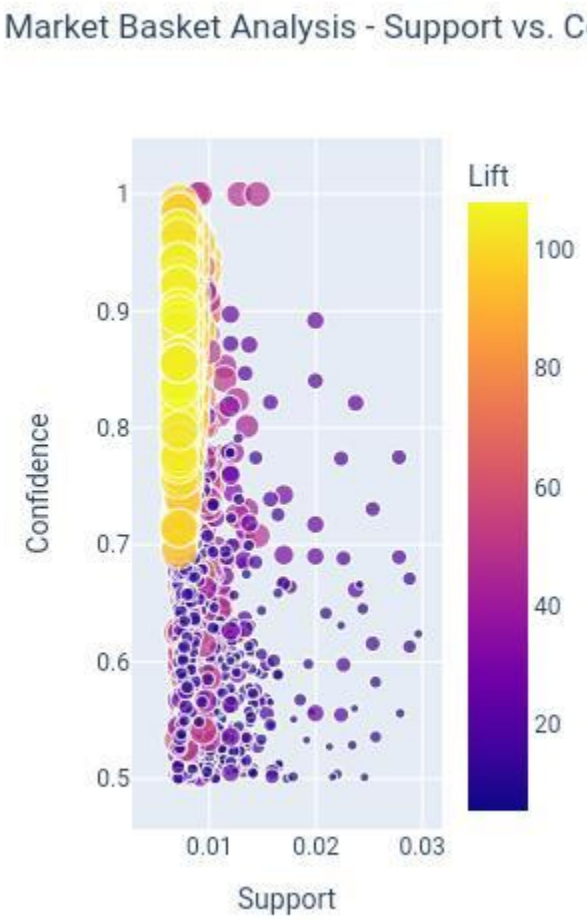
3 0.010642 2.843862 0.951613

4 0.008565 2.067210 0.955009

```
 import matplotlib.pyplot as plt
import seaborn as sns

# Plot scatterplot for Support vs. Confidence

plt.figure(figsize=(12, 8))

sns.scatterplot(x="support", y="confidence", size="lift", data=rules, hue=
"lift", palette="viridis", sizes=(20, 200))

plt.title('Market Basket Analysis - Support vs. Confidence (Size = Lift)'

plt.xlabel('Support')

plt.ylabel('Confidence')

plt.legend(title='Lift', loc='upper right', bbox_to_anchor=(1.2, 1))

plt.show()
```



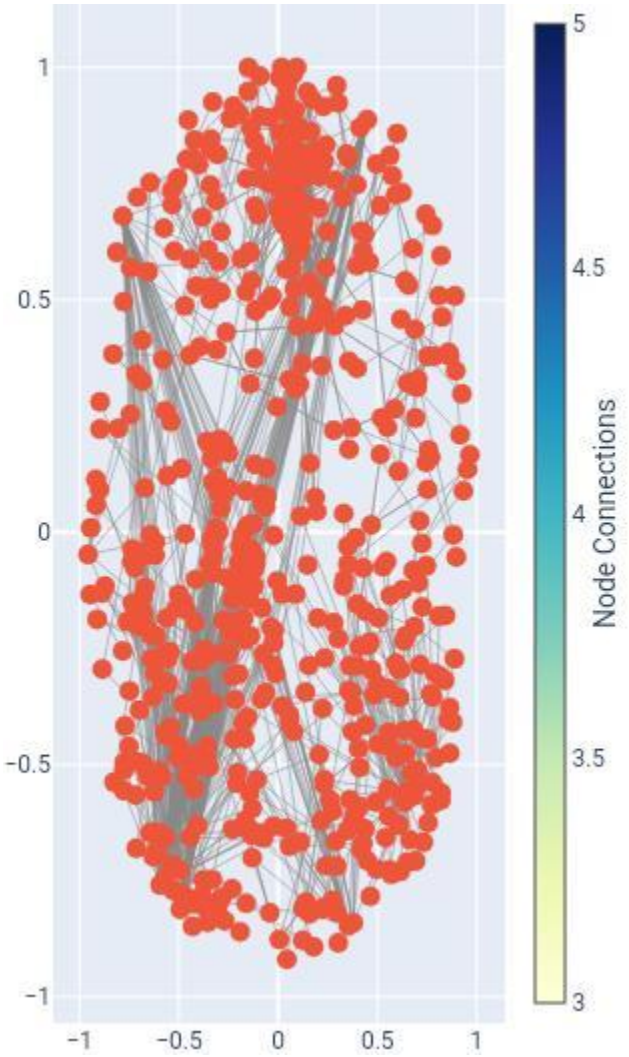

```
import plotly.express as px

# Convert frozensets to lists for serialization

rules['antecedents'] = rules['antecedents'].apply(list)

rules['consequents'] = rules['consequents'].apply(list)

# Create an interactive scatter plot using plotly express

fig = px.scatter(rules, x="support", y="confidence", size="lift",

 color="lift", hover_name="consequents",

 title='Market Basket Analysis - Support vs. Confidence',

labels={'support': 'Support', 'confidence': 'Confidence'})

# Customize the layout

fig.update_layout(xaxis_title='Support',yaxis_title='Confidence', coloraxi
s_colorbar_title='Lift',showlegend=True)

# Show the interactive plot

fig.show()
```




```
import networkx as nx
import matplotlib.pyplot as plt
import plotly.graph_objects as go

# Create a directed graph
G = nx.DiGraph()

# Add nodes and edges from association rules
for idx, row in rules.iterrows():
    G.add_node(tuple(row['antecedents']), color='skyblue')
    G.add_node(tuple(row['consequents']), color='orange')
    G.add_edge(tuple(row['antecedents']), tuple(row['consequents']), weight=r
ow['support'])

# Set node positions using a spring layout
pos = nx.spring_layout(G)
```

```
# Create an interactive plot using plotly
edge_x = []
edge_y = []
for edge in G.edges(data=True):
    x0, y0 = pos[edge[0]]
    x1, y1 = pos[edge[1]]
    edge_x.append(x0)
    edge_x.append(x1)
    edge_x.append(None)
    edge_y.append(y0)
    edge_y.append(y1)
    edge_y.append(None)

edge_trace = go.Scatter(
    x=edge_x, y=edge_y,
    line=dict(width=0.5, color='#888'),
    hoverinfo='none',
    mode='lines')

node_x = []
node_y = []
for node in G.nodes():
    x, y = pos[node]
    node_x.append(x)
    node_y.append(y)

node_trace = go.Scatter(
    x=node_x, y=node_y,
    mode='markers',
    hoverinfo='text',
    marker=dict(
        showscale=True,
        colorscale='YlGnBu',
        size=10,
        colorbar=dict(
            thickness=15,
            title='Node Connections',
            xanchor='left',
            titleside='right'
        )
    )
)

# Customize the layout
layout = go.Layout(
    showlegend=False,
    hovermode='closest',
    margin=dict(b=0, l=0, r=0, t=0),
)
```

```
# Create the figure
fig = go.Figure(data=[edge_trace, node_trace], layout=layout)

# Show the interactive graph
fig.show()
```



Conclusion

Based on the results of these calculations can be used as a recommendation for retail owne rs to arrange the arrangement of product catalogs and take strategic steps to improve prod uct marketing.. By utilizing the association rules which are discovered as a result of the anal yses, the retailer can apply effective marketing and sales promotion strategies, he will be ab le increase customer engagement and improve customer experience and identify customer behavior.