market basket analysis

In [1]:
```
##import packages for data visualization and do #apriori algorithm
```

In [35]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from mlxtend.frequent_patterns import apriori
from mlxtend.frequent_patterns import association_rules
import warnings
warnings.filterwarnings("ignore", message="Specific warning message you want to ignore")


import seaborn as sns
```

In [3]:
```
##loading the dataset
```

In [4]:
```
data=pd.read_excel("Assignment-1_Data.xlsx")
data
```

Out[4]:

	BillNo	Itemname	Quantity	Date	Price	CustomerID	Country
0	536365	WHITE HANGING HEART T-LIGHT HOLDER	6	2010-12-01 08:26:00	2.55	17850.0	United Kingdom
1	536365	WHITE METAL LANTERN	6	2010-12-01 08:26:00	3.39	17850.0	United Kingdom
2	536365	CREAM CUPID HEARTS COAT HANGER	8	2010-12-01 08:26:00	2.75	17850.0	United Kingdom
3	536365	KNITTED UNION FLAG HOT WATER BOTTLE	6	2010-12-01 08:26:00	3.39	17850.0	United Kingdom
4	536365	RED WOOLLY HOTTIE WHITE HEART.	6	2010-12-01 08:26:00	3.39	17850.0	United Kingdom
...	...	...	...	...	...	...	...
522059	581587	PACK OF 20 SPACEBOY NAPKINS	12	2011-12-09 12:50:00	0.85	12680.0	France
522060	581587	CHILDREN'S APRON DOLLY GIRL	6	2011-12-09 12:50:00	2.10	12680.0	France
522061	581587	CHILDRENS CUTLERY DOLLY GIRL	4	2011-12-09 12:50:00	4.15	12680.0	France
522062	581587	CHILDRENS CUTLERY CIRCUS PARADE	4	2011-12-09 12:50:00	4.15	12680.0	France
522063	581587	BAKING SET 9 PIECE RETROSPOT	3	2011-12-09 12:50:00	4.95	12680.0	France

522064 rows × 7 columns

In [5]:
```
data['BillNo'] =  data['BillNo'].astype('str')
data= data[~data['BillNo'].str.contains('C')]
```

In [6]:
```
##data preprocessing
```

In [7]:
```
###identifying any duplicates entry in the dataset
```

In [8]:
```
df = pd.DataFrame(data)
df= df.drop_duplicates()
```

In [9]:
```
df
```

Out[9]:

	BillNo	Itemname	Quantity	Date	Price	CustomerID	Country
0	536365	WHITE HANGING HEART T-LIGHT HOLDER	6	2010-12-01 08:26:00	2.55	17850.0	United Kingdom
1	536365	WHITE METAL LANTERN	6	2010-12-01 08:26:00	3.39	17850.0	United Kingdom
2	536365	CREAM CUPID HEARTS COAT HANGER	8	2010-12-01 08:26:00	2.75	17850.0	United Kingdom
3	536365	KNITTED UNION FLAG HOT WATER BOTTLE	6	2010-12-01 08:26:00	3.39	17850.0	United Kingdom
4	536365	RED WOOLLY HOTTIE WHITE HEART.	6	2010-12-01 08:26:00	3.39	17850.0	United Kingdom
...	...	...	...	...	...	...	...
522059	581587	PACK OF 20 SPACEBOY NAPKINS	12	2011-12-09 12:50:00	0.85	12680.0	France
522060	581587	CHILDREN'S APRON DOLLY GIRL	6	2011-12-09 12:50:00	2.10	12680.0	France
522061	581587	CHILDRENS CUTLERY DOLLY GIRL	4	2011-12-09 12:50:00	4.15	12680.0	France
522062	581587	CHILDRENS CUTLERY CIRCUS PARADE	4	2011-12-09 12:50:00	4.15	12680.0	France
522063	581587	BAKING SET 9 PIECE RETROSPOT	3	2011-12-09 12:50:00	4.95	12680.0	France

516778 rows × 7 columns

In [10]:
```
if df.duplicated().any().any():
    print("Duplicates found in the dataset")
else:
```

```
    print("No duplicates found in the dataset")
```

```
No duplicates found in the dataset
```

In [11]:
```
##identifying any missing data found in the dataset
```

In [12]:
```
missing_values = data.isnull().sum()
```

In [13]:
```
missing_values
```

Out[13]:
```
BillNo             0
Itemname        1455
Quantity           0
Date               0
Price              0
CustomerID    134041
Country            0
dtype: int64
```

In [14]:
```
##filling the missing data using mode function in the respected columns
```

In [15]:
```
data_cleaned = df.dropna(subset=["CustomerID"])
mode_itemname = data_cleaned['Itemname'].mode()[0]
data_cleaned = data_cleaned.copy()
data_cleaned['Itemname'].fillna(mode_itemname, inplace=True)
data_cleaned.head()
```

Out[15]:

	BillNo	Itemname	Quantity	Date	Price	CustomerID	Country
0	536365	WHITE HANGING HEART T-LIGHT HOLDER	6	2010-12-01 08:26:00	2.55	17850.0	United Kingdom
1	536365	WHITE METAL LANTERN	6	2010-12-01 08:26:00	3.39	17850.0	United Kingdom
2	536365	CREAM CUPID HEARTS COAT HANGER	8	2010-12-01 08:26:00	2.75	17850.0	United Kingdom
3	536365	KNITTED UNION FLAG HOT WATER BOTTLE	6	2010-12-01 08:26:00	3.39	17850.0	United Kingdom
4	536365	RED WOOLLY HOTTIE WHITE HEART.	6	2010-12-01 08:26:00	3.39	17850.0	United Kingdom

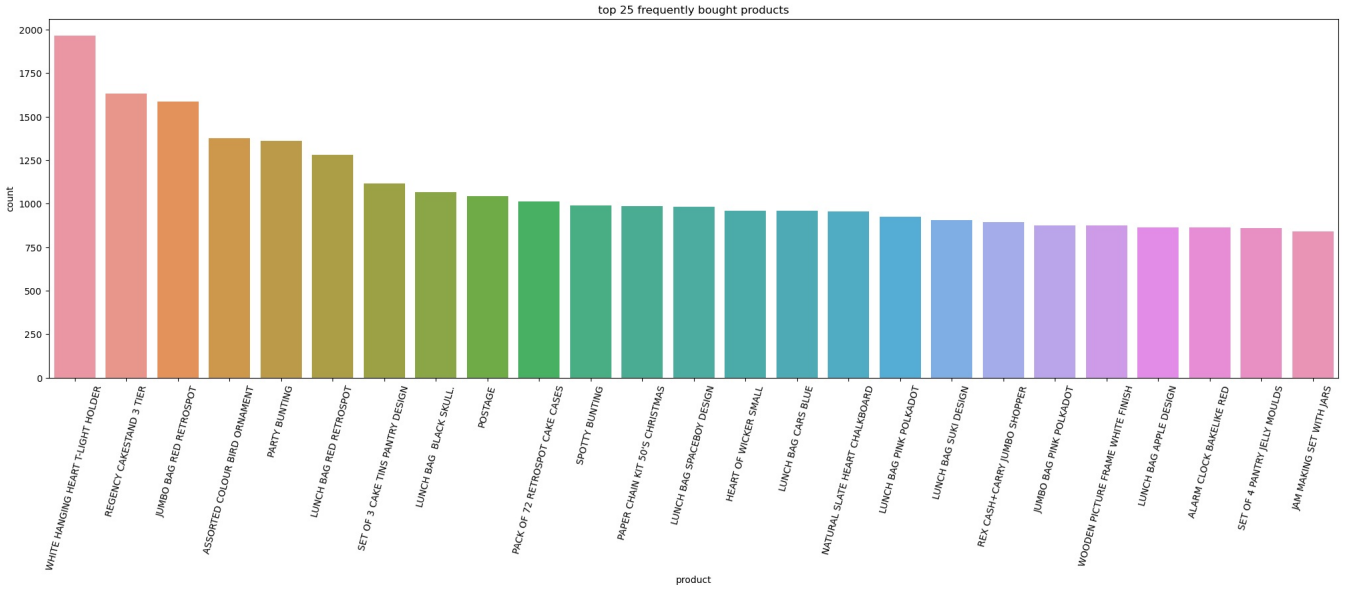
In [16]:
```
data_cleaned.isnull().sum()
```

Out[16]:
```
BillNo        0
Itemname      0
Quantity      0
Date          0
Price         0
CustomerID    0
Country       0
dtype: int64
```

In [17]:
```
df=data_cleaned
```

In [18]:
```
## top 25 frequently bought items by customer
```

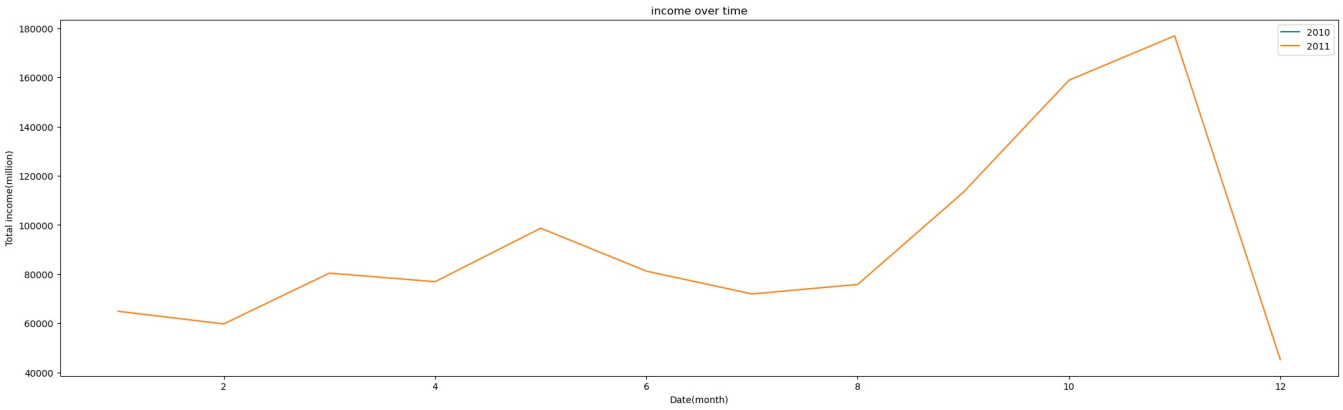
In [19]:
```
plt.rcParams['figure.figsize']=25,7
sns.countplot(data=df,x=df['Itemname'],order=df['Itemname'].value_counts().head(25).index)
plt.xticks(rotation=75)
plt.xlabel('product')
plt.title('top 25 frequently bought products')
plt.show()
```



In [20]:
```
# calculating the sales trend based on the year
```

In [21]:
```
df[df["Date"].dt.year==2010].groupby(df["Date"].dt.month)["Price"].sum().plot()
df[df["Date"].dt.year==2011].groupby(df["Date"].dt.month)["Price"].sum().plot()
plt.legend(['2010','2011'])
plt.title("income over time")
plt.ylabel('Total income(million)')
plt.xlabel("Date(month)")
```

Out[21]:
```
Text(0.5, 0, 'Date(month)')
```



In [22]:
```
##assign the original dataframe to df2
```

In [23]:
```
df2=df
#filter rows based on item occurences
item_counts=df2['Itemname'].value_counts(ascending=False)
filtered_items=item_counts.loc[item_counts >1].reset_index()['index']
df2=df2[df2['Itemname'].isin(filtered_items)]
#filter rows based on bill number occurences

bill_counts=df2['BillNo'].value_counts(ascending=False)
filtered_bills=bill_counts.loc[bill_counts > 1].reset_index()['index']
df2=df2[df2['BillNo'].isin(filtered_bills)]
```

In [24]:
```
df2
```

Out[24]:

	BillNo	Itemname	Quantity	Date	Price	CustomerID	Country
0	536365	WHITE HANGING HEART T-LIGHT HOLDER	6	2010-12-01 08:26:00	2.55	17850.0	United Kingdom
1	536365	WHITE METAL LANTERN	6	2010-12-01 08:26:00	3.39	17850.0	United Kingdom
2	536365	CREAM CUPID HEARTS COAT HANGER	8	2010-12-01 08:26:00	2.75	17850.0	United Kingdom
3	536365	KNITTED UNION FLAG HOT WATER BOTTLE	6	2010-12-01 08:26:00	3.39	17850.0	United Kingdom
4	536365	RED WOOLLY HOTTIE WHITE HEART.	6	2010-12-01 08:26:00	3.39	17850.0	United Kingdom
...	...	...	...	...	...	...	...
522059	581587	PACK OF 20 SPACEBOY NAPKINS	12	2011-12-09 12:50:00	0.85	12680.0	France
522060	581587	CHILDREN'S APRON DOLLY GIRL	6	2011-12-09 12:50:00	2.10	12680.0	France
522061	581587	CHILDRENS CUTLERY DOLLY GIRL	4	2011-12-09 12:50:00	4.15	12680.0	France
522062	581587	CHILDRENS CUTLERY CIRCUS PARADE	4	2011-12-09 12:50:00	4.15	12680.0	France
522063	581587	BAKING SET 9 PIECE RETROSPOT	3	2011-12-09 12:50:00	4.95	12680.0	France

381232 rows × 7 columns

generate association rules

In [25]:
```
basket = (df2[df2['Country'] == 'Germany' ].groupby(['BillNo','Itemname'])['Quantity'].sum().unstack().fillna(0
```

In [26]:
```
basket
```

Out[26]:

Itemname	10 COLOUR SPACEBOY PEN	12 COLOURED PARTY BALLOONS	12 IVORY ROSE PEG PLACE SETTINGS	12 MESSAGE CARDS WITH ENVELOPES	12 PENCIL SMALL TUBE WOODLAND	12 PENCILS SMALL TUBE RED RETROSPOT	12 PENCILS SMALL TUBE SKULL	12 PENCILS TALL TUBE POSY	12 PENCILS TALL TUBE RED RETROSPOT	12 PENCILS TALL TUBE SKULLS	...	YU
BillNo												
536527	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	
536840	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	
536861	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	
536967	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	
536983	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	
...	...	...	...	...	...	...	...	...	...	...	...	
581266	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	
581494	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	
581570	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	
581574	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	
581578	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	

434 rows × 1692 columns

In [27]:
```
df2 = df2[df2['Country'] == 'Germany']
df2
```

Out[27]:

	BillNo	Itemname	Quantity	Date	Price	CustomerID	Country
1099	536527	SET OF 6 T-LIGHTS SANTA	6	2010-12-01 13:04:00	2.95	12662.0	Germany
1100	536527	ROTATING SILVER ANGELS T-LIGHT HLDR	6	2010-12-01 13:04:00	2.55	12662.0	Germany
1101	536527	MULTI COLOUR SILVER T-LIGHT HOLDER	12	2010-12-01 13:04:00	0.85	12662.0	Germany
1102	536527	5 HOOK HANGER MAGIC TOADSTOOL	12	2010-12-01 13:04:00	1.65	12662.0	Germany
1103	536527	3 HOOK HANGER MAGIC GARDEN	12	2010-12-01 13:04:00	1.95	12662.0	Germany
...	...	...	...	...	...	...	...
521956	581578	SET OF 4 PANTRY JELLY MOULDS	12	2011-12-09 12:16:00	1.25	12713.0	Germany
521957	581578	PACK OF 20 NAPKINS PANTRY DESIGN	12	2011-12-09 12:16:00	0.85	12713.0	Germany
521958	581578	PACK OF 20 NAPKINS RED APPLES	12	2011-12-09 12:16:00	0.85	12713.0	Germany
521959	581578	JINGLE BELL HEART ANTIQUE SILVER	12	2011-12-09 12:16:00	2.08	12713.0	Germany
521960	581578	RIBBON REEL MAKING SNOWMEN	10	2011-12-09 12:16:00	1.65	12713.0	Germany

9002 rows × 7 columns

In [28]:
```
# Create a pivot table using the filtered DataFrame
pivot_table = pd.pivot_table(df2[['BillNo','Itemname']], index='BillNo', columns='Itemname', aggfunc=lambda x:
```

In [29]:
```
pivot_table
```

Out[29]:

Itemname	10 COLOUR SPACEBOY PEN	12 COLOURED PARTY BALLOONS	12 IVORY ROSE PEG PLACE SETTINGS	12 MESSAGE CARDS WITH ENVELOPES	12 PENCIL SMALL TUBE WOODLAND	12 PENCILS SMALL TUBE RED RETROSPOT	12 PENCILS SMALL TUBE SKULL	12 PENCILS TALL TUBE POSY	12 PENCILS TALL TUBE RED RETROSPOT	12 PENCILS TALL TUBE SKULLS	...	YU
BillNo												
536527	False	False	False	False	False	False	False	False	False	False	...	
536840	False	False	False	False	False	False	False	False	False	False	...	
536861	False	False	False	False	False	False	False	False	False	False	...	
536967	False	False	False	False	False	False	False	False	False	False	...	
536983	False	False	False	False	False	False	False	False	False	False	...	
...	...	...	...	...	...	...	...	...	...	...	...	
581266	False	False	False	False	False	False	False	False	False	False	...	
581494	False	False	False	False	False	False	False	False	False	False	...	
581570	False	False	False	False	False	False	False	False	False	False	...	
581574	False	False	False	False	False	False	False	False	False	False	...	
581578	False	False	False	False	False	False	False	False	False	False	...	

434 rows × 1692 columns

In [30]:
```
# Generate frequent itemsets with minimum support of 0.1 (10%)
frequent_itemsets = apriori(pivot_table, min_support=0.05,use_colnames=True)

# Generate association rules
rules = association_rules(frequent_itemsets, "confidence", min_threshold = 0.5)

# Print frequent itemsets
print("Frequent Itemsets:")
print(frequent_itemsets)

# Print association rules
print("\nAssociation Rules:")
rules
```

```
Frequent Itemsets:
      support                                            itemsets
0    0.108295                          (6 RIBBONS RUSTIC CHARM)
1    0.073733                       (ALARM CLOCK BAKELIKE PINK)
2    0.050691                           (BLUE HARMONICA IN BOX)
3    0.050691                               (BLUE POLKADOT CUP)
4    0.069124                     (CHARLOTTE BAG APPLES DESIGN)
..        ...                                                ...
113  0.069124  (POSTAGE, PLASTERS IN TIN WOODLAND ANIMALS, RO...
114  0.057604  (RED RETROSPOT CHARLOTTE BAG, WOODLAND CHARLOT...
115  0.131336  (POSTAGE, ROUND SNACK BOXES SET OF 4 FRUITS, R...
116  0.064516  (POSTAGE, SPACEBOY LUNCH BOX, ROUND SNACK BOXE...
117  0.062212  (POSTAGE, WOODLAND CHARLOTTE BAG, ROUND SNACK ...

[118 rows x 2 columns]

Association Rules:
```

Out[30]:

	antecedents	consequents	antecedent support	consequent support	support	confidence	lift	leverage	conviction	zhangs_metric
0	(6 RIBBONS RUSTIC CHARM)	(POSTAGE)	0.108295	0.843318	0.096774	0.893617	1.059644	0.005447	1.472811	0.063123
1	(ALARM CLOCK BAKELIKE PINK)	(POSTAGE)	0.073733	0.843318	0.052995	0.718750	0.852288	-0.009185	0.557092	-0.157617
2	(BLUE HARMONICA IN BOX)	(POSTAGE)	0.050691	0.843318	0.050691	1.000000	1.185792	0.007942	inf	0.165049
3	(CHARLOTTE BAG APPLES DESIGN)	(POSTAGE)	0.069124	0.843318	0.064516	0.933333	1.106740	0.006222	2.350230	0.103607
4	(COFFEE MUG APPLES DESIGN)	(POSTAGE)	0.064516	0.843318	0.057604	0.892857	1.058743	0.003196	1.462366	0.059310
...	...	...	...	...	...	...	...	...	...	...
65	(POSTAGE, SPACEBOY LUNCH BOX)	(ROUND SNACK BOXES SET OF4 WOODLAND)	0.096774	0.258065	0.064516	0.666667	2.583333	0.039542	2.225806	0.678571
66	(SPACEBOY LUNCH BOX, ROUND SNACK BOXES SET OF4...	(POSTAGE)	0.073733	0.843318	0.064516	0.875000	1.037568	0.002336	1.253456	0.039090
67	(SPACEBOY LUNCH BOX)	(POSTAGE, ROUND SNACK BOXES SET OF4 WOODLAND)	0.108295	0.237327	0.064516	0.595745	2.510225	0.038815	1.886612	0.674695
68	(POSTAGE, WOODLAND CHARLOTTE BAG)	(ROUND SNACK BOXES SET OF4 WOODLAND)	0.122120	0.258065	0.062212	0.509434	1.974057	0.030697	1.512407	0.562069
69	(WOODLAND CHARLOTTE BAG, ROUND SNACK BOXES SET...	(POSTAGE)	0.066820	0.843318	0.062212	0.931034	1.104014	0.005861	2.271889	0.100960

70 rows × 10 columns

In [31]:
```
rules = rules.sort_values(['confidence', 'lift'], ascending =[False, False])

rules
```

Out[31]:

	antecedents	consequents	antecedent support	consequent support	support	confidence	lift	leverage	conviction	zhangs_metric
2	(BLUE HARMONICA IN BOX)	(POSTAGE)	0.050691	0.843318	0.050691	1.000000	1.185792	0.007942	inf	0.165049
23	(PLASTERS IN TIN STRONGMAN)	(POSTAGE)	0.073733	0.843318	0.071429	0.968750	1.148736	0.009248	5.013825	0.139785
32	(RETROSPOT TEA SET CERAMIC 11 PC)	(POSTAGE)	0.059908	0.843318	0.057604	0.961538	1.140185	0.007082	4.073733	0.130784
33	(ROUND SNACK BOXES SET OF 4 FRUITS)	(POSTAGE)	0.165899	0.843318	0.158986	0.958333	1.136384	0.019081	3.760369	0.143887
49	(ROUND SNACK BOXES SET OF 4 FRUITS, PLASTERS I...	(POSTAGE)	0.052995	0.843318	0.050691	0.956522	1.134236	0.005999	3.603687	0.124972
...	...	...	...	...	...	...	...	...	...	...
54	(PLASTERS IN TIN SPACEBOY)	(POSTAGE, PLASTERS IN TIN WOODLAND ANIMALS)	0.112903	0.124424	0.057604	0.510204	4.100529	0.043556	1.787634	0.852364
68	(POSTAGE, WOODLAND CHARLOTTE BAG)	(ROUND SNACK BOXES SET OF4 WOODLAND)	0.122120	0.258065	0.062212	0.509434	1.974057	0.030697	1.512407	0.562069
64	(ROUND SNACK BOXES SET OF4 WOODLAND)	(POSTAGE, ROUND SNACK BOXES SET OF 4 FRUITS)	0.258065	0.158986	0.131336	0.508929	3.201087	0.090308	1.712610	0.926773
46	(WOODLAND CHARLOTTE BAG)	(ROUND SNACK BOXES SET OF4 WOODLAND)	0.133641	0.258065	0.066820	0.500000	1.937500	0.032332	1.483871	0.558511
50	(POSTAGE, PLASTERS IN TIN CIRCUS PARADE)	(ROUND SNACK BOXES SET OF4 WOODLAND)	0.105991	0.258065	0.052995	0.500000	1.937500	0.025643	1.483871	0.541237

70 rows × 10 columns

In [32]:
```
rules.sort_values(by='support', ascending=False)
```

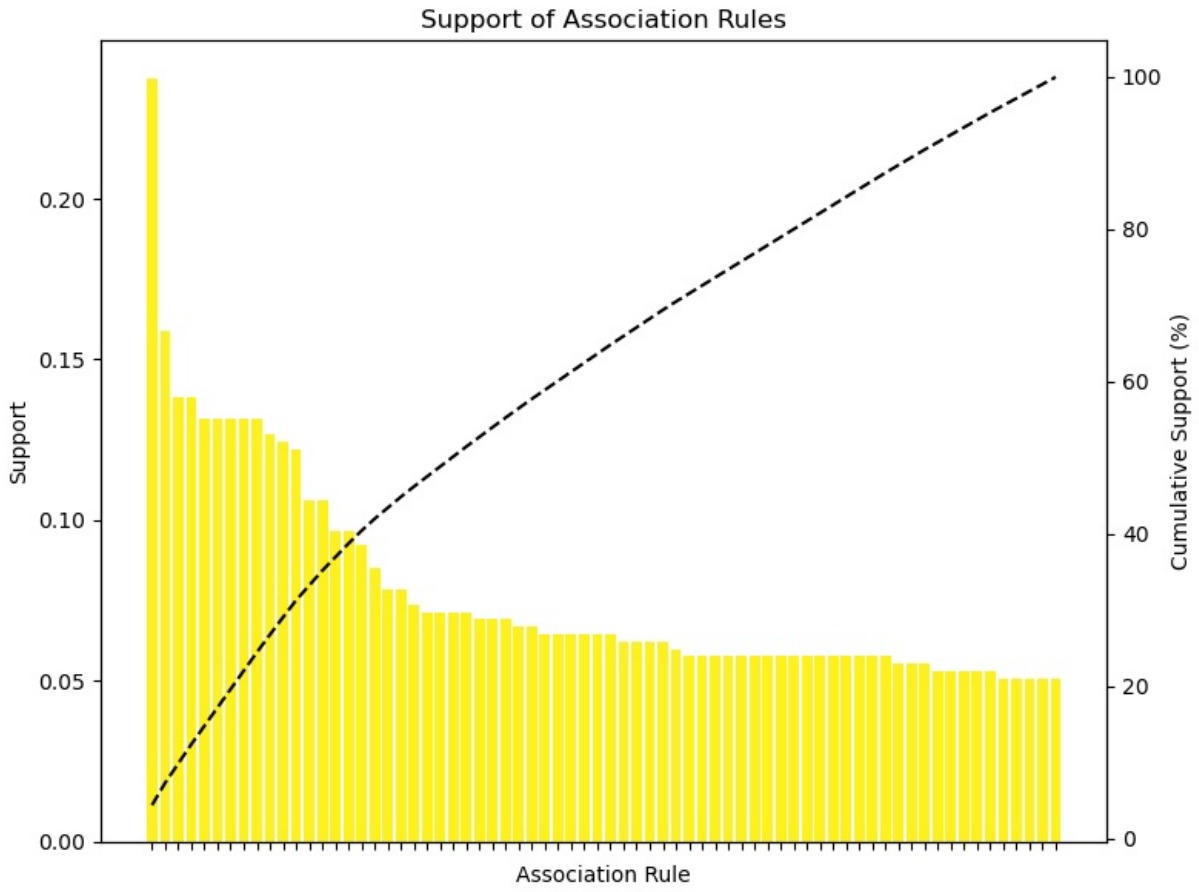
Out[32]:

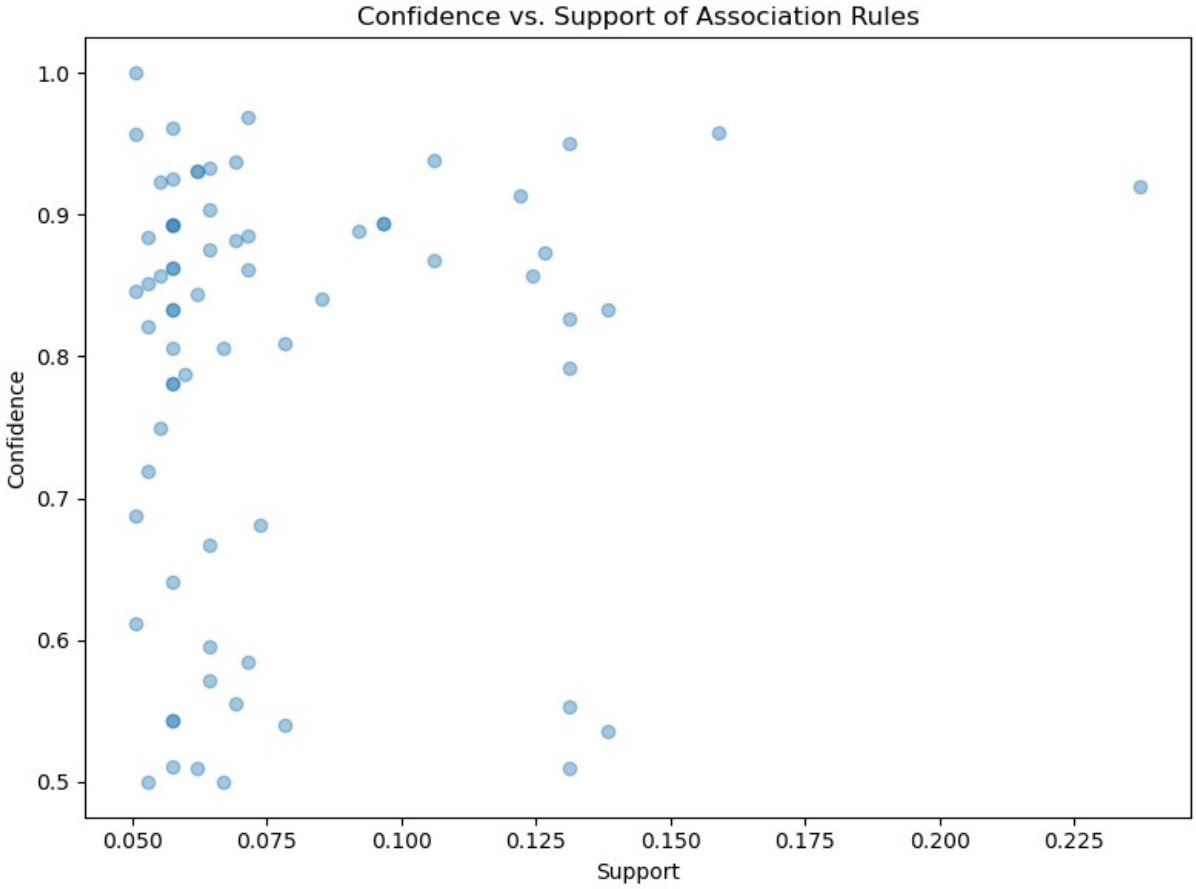
	antecedents	consequents	antecedent support	consequent support	support	confidence	lift	leverage	conviction	zhangs_metric
34	(ROUND SNACK BOXES SET OF4 WOODLAND)	(POSTAGE)	0.258065	0.843318	0.237327	0.919643	1.090505	0.019697	1.949821	0.111862
33	(ROUND SNACK BOXES SET OF 4 FRUITS)	(POSTAGE)	0.165899	0.843318	0.158986	0.958333	1.136384	0.019081	3.760369	0.143887
43	(ROUND SNACK BOXES SET OF 4 FRUITS)	(ROUND SNACK BOXES SET OF4 WOODLAND)	0.165899	0.258065	0.138249	0.833333	3.229167	0.095436	4.451613	0.827624
44	(ROUND SNACK BOXES SET OF4 WOODLAND)	(ROUND SNACK BOXES SET OF 4 FRUITS)	0.258065	0.165899	0.138249	0.535714	3.229167	0.095436	1.796526	0.930435
64	(ROUND SNACK BOXES SET OF4 WOODLAND)	(POSTAGE, ROUND SNACK BOXES SET OF 4 FRUITS)	0.258065	0.158986	0.131336	0.508929	3.201087	0.090308	1.712610	0.926773
...	...	...	...	...	...	...	...	...	...	...
10	(JUMBO BAG RED RETROSPOT)	(JUMBO BAG WOODLAND ANIMALS)	0.082949	0.103687	0.050691	0.611111	5.893827	0.042091	2.304806	0.905436
18	(PLASTERS IN TIN STRONGMAN)	(PLASTERS IN TIN CIRCUS PARADE)	0.073733	0.122120	0.050691	0.687500	5.629717	0.041687	2.809217	0.887834
37	(SKULL LUNCH BOX WITH CUTLERY)	(POSTAGE)	0.059908	0.843318	0.050691	0.846154	1.003363	0.000170	1.018433	0.003565
49	(ROUND SNACK BOXES SET OF 4 FRUITS, PLASTERS I...	(POSTAGE)	0.052995	0.843318	0.050691	0.956522	1.134236	0.005999	3.603687	0.124972
2	(BLUE HARMONICA IN BOX)	(POSTAGE)	0.050691	0.843318	0.050691	1.000000	1.185792	0.007942	inf	0.165049

70 rows × 10 columns

In [43]:
```
# Sort rules by support in descending order
sorted_rules = rules.sort_values(by='support', ascending=False)
```

```
# Calculate cumulative support
cumulative_support = np.cumsum(sorted_rules['support'] / np.sum(sorted_rules['support']) * 100)

# Bar plot for Support
fig, ax1 = plt.subplots(figsize=(8, 6))
ax1.bar(range(len(sorted_rules)), sorted_rules['support'], align='center' ,color='#FFF219')


plt.xticks(range(len(sorted_rules)), ['' for _ in range(len(sorted_rules))])  # Remove x-axis labels
ax1.set_xlabel('Association Rule')
ax1.set_ylabel('Support')
ax1.set_title('Support of Association Rules')

# CDF plot for cumulative support
ax2 = ax1.twinx()
ax2.plot(range(len(sorted_rules)), cumulative_support, color='#000000', linestyle='--')
ax2.set_ylabel('Cumulative Support (%)', c='#000000')

plt.tight_layout()
plt.show()

# Scatter plot for Confidence vs. Support
plt.figure(figsize=(8, 6))
plt.scatter(rules['support'], rules['confidence'], alpha=0.4)
plt.xlabel('Support')
plt.ylabel('Confidence')
plt.title('Confidence vs. Support of Association Rules')
plt.tight_layout()
plt.show()
```





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