

# KDD- Experiment 6

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## Dataset used: Market Basket Optimisation

## Libraries used:

Pandas | mlxtend - TransactionEncoder , apriori

## Apriori algorithm using libraries:

```
In [1]: import pandas as pd

# Load the dataset
Market_data = pd.read_csv(r'C:\sia\Market_Basket_Optimisation.csv', header=None)
print("The Dataset is as follows:")
print(Market_data.dropna(), '\n')
```

```
The Dataset is as follows:
   0      1      2      3      4      5  \
0  shrimp almonds avocado vegetables mix green grapes whole weat flour

   6      7      8      9      10  \
0  yams cottage cheese energy drink tomato juice low fat yogurt

   11      12      13      14      15      16  \
0  green tea honey salad mineral water salmon antioxydant juice

   17      18      19
0  frozen smoothie spinach olive oil
```

```
In [2]: Market_data.shape
```

Out[2]: (7501, 20)

```
In [3]: # Convert the dataframe into a List of Lists
transactions = []
for i in range(len(Market_data)):
    transaction = [str(Market_data.values[i,j]) for j in range(len(Market_data.columns))]
    transactions.append(transaction)
```

```
In [4]: from mlxtend.preprocessing import TransactionEncoder

# Convert the List of transactions into a pandas DataFrame with binary values
te = TransactionEncoder()
te_ary = te.fit_transform(transactions)
transactions_df = pd.DataFrame(te_ary, columns=te.columns_)
print(transactions_df)
```

```
   asparagus almonds antioxydant juice asparagus avocado babies food  \
0      False      True           True  False      False      True      False
1      False      False           False  False      False      False      False
2      False      False           False  False      False      False      False
3      False      False           False  False      False      True       False
4      False      False           False  False      False      False      False
...      ...      ...           ...      ...      ...      ...      ...
7496     False      False           False  False      False      False      False
7497     False      False           False  False      False      False      False
7498     False      False           False  False      False      False      False
7499     False      False           False  False      False      False      False
7500     False      False           False  False      False      False      False
```

```
   bacon barbecue sauce black tea blueberries ... turkey  \
0      False           False      False      False ...      False
1      False           False      False      False ...      False
2      False           False      False      False ...      False
3      False           False      False      False ...      True
4      False           False      False      False ...      False
...      ...      ...           ...      ...      ...      ...
7496     False           False      False      False ...      False
7497     False           False      False      False ...      False
7498     False           False      False      False ...      False
7499     False           False      False      False ...      False
7500     False           False      False      False ...      False
```

```
   vegetables mix water spray white wine whole weat flour  \
0              True      False      False      False      True
1              False      False      False      False      False
2              False      False      False      False      False
3              False      False      False      False      False
4              False      False      False      False      False
...      ...      ...           ...      ...      ...
7496              False      False      False      False      False
7497              False      False      False      False      False
7498              False      False      False      False      False
7499              False      False      False      False      False
7500              False      False      False      False      False
```

```
   whole wheat pasta whole wheat rice yams yogurt cake zucchini
0              False      False      True  False  False  False
1              False           False  False  False  False  False
2              False           False  False  False  False  False
3              False           False  False  False  False  False
4              False           True  False  False  False  False
...      ...      ...           ...      ...      ...
7496              False           False  False  False  False  False
7497              False           False  False  False  False  False
7498              False           False  False  False  False  False
7499              False           False  False  False  False  False
7500              False           False  False  True   False  False
```

[7501 rows x 121 columns]

```
In [11]: from mlxtend.frequent_patterns import apriori, association_rules

# Find frequent itemsets
frequent_itemsets = apriori(transactions_df, min_support=0.05, use_colnames=True)
frequent_itemsets
```

Out[11]:

	support	itemsets
0	0.087188	(burgers)
1	0.081056	(cake)
2	0.059992	(chicken)
3	0.163845	(chocolate)
4	0.080389	(cookies)
5	0.051060	(cooking oil)
6	0.179709	(eggs)
7	0.079323	(escalope)
8	0.170911	(french fries)
9	0.063325	(frozen smoothie)
10	0.095321	(frozen vegetables)
11	0.052393	(grated cheese)
12	0.132116	(green tea)
13	0.098254	(ground beef)
14	0.076523	(low fat yogurt)
15	0.129583	(milk)
16	0.238368	(mineral water)
17	0.999867	(nan)
18	0.065858	(olive oil)
19	0.095054	(pancakes)
20	0.071457	(shrimp)
21	0.050527	(soup)
22	0.174110	(spaghetti)
23	0.068391	(tomatoes)
24	0.062525	(turkey)
25	0.058526	(whole wheat rice)
26	0.087188	(burgers, nan)
27	0.081056	(cake, nan)
28	0.059992	(chicken, nan)
29	0.052660	(chocolate, mineral water)
30	0.163845	(chocolate, nan)
31	0.080389	(cookies, nan)
32	0.051060	(nan, cooking oil)
33	0.050927	(mineral water, eggs)
34	0.179709	(nan, eggs)
35	0.079323	(escalope, nan)
36	0.170911	(french fries, nan)
37	0.063192	(frozen smoothie, nan)
38	0.095321	(nan, frozen vegetables)
39	0.052393	(nan, grated cheese)
40	0.131982	(green tea, nan)
41	0.098254	(nan, ground beef)
42	0.076390	(nan, low fat yogurt)
43	0.129583	(milk, nan)
44	0.238235	(mineral water, nan)
45	0.059725	(spaghetti, mineral water)
46	0.065725	(nan, olive oil)
47	0.095054	(pancakes, nan)
48	0.071324	(shrimp, nan)
49	0.050527	(nan, soup)
50	0.174110	(spaghetti, nan)
51	0.068391	(tomatoes, nan)
52	0.062525	(nan, turkey)
53	0.058526	(whole wheat rice, nan)
54	0.052660	(chocolate, mineral water, nan)
55	0.050927	(mineral water, nan, eggs)
56	0.059725	(spaghetti, mineral water, nan)

we set the 'min\_support' parameter to '0.05'. This means that we're only interested in itemsets that appear in at least 5% of the transactions.

In [13]:

```
# Generate association rules
rules = association_rules(frequent_itemsets, metric="lift", min_threshold=1)
rules.head(10)
```

Out[13]:

	antecedents	consequents	antecedent support	consequent support	support	confidence	lift	leverage	conviction
0	(burgers)	(nan)	0.087188	0.999867	0.087188	1.000000	1.000133	0.000012	inf
1	(nan)	(burgers)	0.999867	0.087188	0.087188	0.087200	1.000133	0.000012	1.000013
2	(cake)	(nan)	0.081056	0.999867	0.081056	1.000000	1.000133	0.000011	inf
3	(nan)	(cake)	0.999867	0.081056	0.081056	0.081067	1.000133	0.000011	1.000012
4	(chicken)	(nan)	0.059992	0.999867	0.059992	1.000000	1.000133	0.000008	inf
5	(nan)	(chicken)	0.999867	0.059992	0.059992	0.060000	1.000133	0.000008	1.000009
6	(chocolate)	(mineral water)	0.163845	0.238368	0.052660	0.321400	1.348332	0.013604	1.122357
7	(mineral water)	(chocolate)	0.238368	0.163845	0.052660	0.220917	1.348332	0.013604	1.073256
8	(chocolate)	(nan)	0.163845	0.999867	0.163845	1.000000	1.000133	0.000022	inf
9	(nan)	(chocolate)	0.999867	0.163845	0.163845	0.163867	1.000133	0.000022	1.000026

Here, we set the metric parameter to "lift". This means that we're interested in association rules that have a lift score of at least '1'. The 'min\_threshold' parameter is set to '1', which means that we're only interested in rules with a lift score of at least 1.

## Observations:

1. The most frequent items purchased together are "mineral water" and "eggs". Other popular combinations include "mineral water" and "spaghetti", "chocolate" and "mineral water", "ground beef" and "mineral water", and "milk" and "mineral water".
2. The support values for the frequent itemsets are relatively low, indicating that most items are not frequently purchased together. However, the lift values for the frequent itemsets are high, indicating that there is a strong association between the items in the frequent itemsets.
3. The association rules generated from the frequent itemsets also have high confidence values, indicating that the consequent is likely to be purchased given the antecedent. For example, the rule {mineral water} -> {eggs} has a confidence of 0.23, meaning that when a customer purchases mineral water, there is a 23% chance that they will also purchase eggs.
4. Some items have low support values, which means that they are not frequently purchased. This may be due to various reasons such as the items being seasonal or not being popular among customers.
5. It may be beneficial for the store to group certain items together or offer discounts on items that are frequently purchased together to increase sales and customer satisfaction.

## Apriori algorithm without using libraries:

```
In [7]: import pandas as pd

# Load the market basket optimization dataset:
df = pd.read_csv(r'C:\sia\Market_Basket_Optimisation.csv', header=None)

In [8]: # Define a function to get the support of an itemset
def get_support(itemset, transactions):
    count = 0
    for transaction in transactions:
        if all(item in transaction for item in itemset):
            count += 1
    return count / len(transactions)

# Define a function to generate candidate itemsets of length k+1 from itemsets of length k
def generate_candidates(itemsets):
    candidates = []
    for i in range(len(itemsets)):
        for j in range(i+1, len(itemsets)):
            if itemsets[i][-1] == itemsets[j][-1]:
                candidate = itemsets[i] + (itemsets[j][-1],)
                candidates.append(candidate)
    return candidates

In [9]: # Define the Apriori algorithm
def apriori(transactions, min_support):
    itemsets = []
    for item in set([item for transaction in transactions for item in transaction]):
        itemsets.append((item,))
    frequent_itemsets = []
    k = 1
    while itemsets:
        candidates = generate_candidates(itemsets)
        itemsets = []
        for candidate in candidates:
            support = get_support(candidate, transactions)
            if support >= min_support:
                itemsets.append(candidate)
                frequent_itemsets.append((candidate, support))
        k += 1
    return frequent_itemsets

# Run the Apriori algorithm on the dataset
transactions = []
for i in range(len(df)):
    transactions.append([str(df.values[i,j]) for j in range(len(df.columns))])
frequent_itemsets = apriori(transactions, 0.01)

In [10]: # Print the frequent itemsets and their supports
for itemset, support in frequent_itemsets:
    print(itemset, support)
```

('black tea', 'nan') 0.014264764698040262  
('yams', 'nan') 0.011331822423676844  
('butter', 'nan') 0.030129316091187842  
('ham', 'nan') 0.026529796027196375  
('melons', 'nan') 0.011998400213304892  
('olive oil', 'nan') 0.0657245700573257  
('olive oil', 'mineral water') 0.027596320490601255  
('olive oil', 'milk') 0.017064391414478068  
('olive oil', 'spaghetti') 0.022930275963204905  
('olive oil', 'frozen vegetables') 0.011331822423676844  
('olive oil', 'eggs') 0.011998400213304892  
('olive oil', 'chocolate') 0.01639781362485002  
('olive oil', 'ground beef') 0.014131449140114652  
('olive oil', 'pancakes') 0.010798560191974404  
('nan', 'vegetables mix') 0.025596587121717106  
('nan', 'tomato sauce') 0.014131449140114652  
('nan', 'burgers') 0.0871883748833489  
('nan', 'french wine') 0.022530329289428077  
('nan', 'french fries') 0.1709105452606319  
('nan', 'hot dogs') 0.03239568057592321  
('nan', 'pepper') 0.026529796027196375  
('nan', 'tomatoes') 0.06839088121583789  
('nan', 'frozen smoothie') 0.0631915744567391  
('nan', 'mint') 0.0174643380882549  
('nan', 'green tea') 0.13198240234635383  
('nan', 'cottage cheese') 0.03172910278629516  
('nan', 'body spray') 0.011465137981602452  
('nan', 'eggplant') 0.013198240234635382  
('nan', 'mineral water') 0.23823490201306494  
('nan', 'energy drink') 0.026529796027196375  
('nan', 'milk') 0.12958272230369283  
('nan', 'cooking oil') 0.0510598586855086  
('nan', 'pasta') 0.01573123583522197  
('nan', 'muffins') 0.024130115984535395  
('nan', 'whole wheat pasta') 0.029462738301559793  
('nan', 'champagne') 0.04679376083188908  
('nan', 'spaghetti') 0.17411011865084655  
('nan', 'brownies') 0.03372883615517931  
('nan', 'honey') 0.047327023063591524  
('nan', 'herb & pepper') 0.04946007199040128  
('nan', 'whole wheat rice') 0.058525529929342755  
('nan', 'grated cheese') 0.0523930142647647  
('nan', 'salmon') 0.04239434742034395  
('nan', 'cake') 0.08105585921877083  
('nan', 'nonfat milk') 0.010398613518197574  
('nan', 'frozen vegetables') 0.09532062391681109  
('nan', 'parmesan cheese') 0.01986401813091588  
('nan', 'yogurt cake') 0.027329689374750034  
('nan', 'eggs') 0.17970937208372217  
('nan', 'rice') 0.018797493667511  
('nan', 'magazines') 0.010931875749900012  
('nan', 'low fat yogurt') 0.07638981469137449  
('nan', 'chocolate') 0.1638448206905746  
('nan', 'mushroom cream sauce') 0.019064124783362217  
('nan', 'soup') 0.05052659645380616  
('nan', 'shrimp') 0.0713238234902013  
('nan', 'carrots') 0.01533128916144514  
('nan', 'red wine') 0.028129582722303693  
('nan', 'cookies') 0.08038928142914278  
('nan', 'strawberries') 0.021330489268097587  
('nan', 'protein bar') 0.01853086255165978  
('nan', 'energy bar') 0.027063058258898813  
('nan', 'oil') 0.023063591521130515  
('nan', 'escalope') 0.0793227569657379  
('nan', 'cider') 0.010531929076123183  
('nan', 'avocado') 0.03319557392347687  
('nan', 'fromage blanc') 0.013598186908412212  
('nan', 'ground beef') 0.09825356619117451  
('nan', 'white wine') 0.01653112918277563  
('nan', 'chicken') 0.05999200106652446  
('nan', 'fresh bread') 0.043060925209972005  
('nan', 'gums') 0.013464871350486601  
('nan', 'fresh tuna') 0.022263698173576856  
('nan', 'tomato juice') 0.030262631649113452  
('nan', 'light mayo') 0.027196373816824423  
('nan', 'pancakes') 0.09505399280095987  
('nan', 'cereals') 0.025729902679642713  
('nan', 'turkey') 0.06252499666711105  
('nan', 'meatballs') 0.020930542594320756  
('nan', 'barbecue sauce') 0.010798560191974404  
('nan', 'almonds') 0.020263964804692707  
('nan', 'light cream') 0.01559792027729636  
('nan', 'extra dark chocolate') 0.011998400213304892  
('burgers', 'french fries') 0.021997067057725635  
('burgers', 'green tea') 0.0174643380882549  
('burgers', 'mineral water') 0.024396747100386616  
('burgers', 'milk') 0.01786428476203173  
('burgers', 'spaghetti') 0.021463804826023197  
('burgers', 'cake') 0.011465137981602452  
('burgers', 'frozen vegetables') 0.010531929076123183  
('burgers', 'eggs') 0.02879616051193174  
('burgers', 'chocolate') 0.017064391414478068  
('burgers', 'ground beef') 0.011998400213304892  
('burgers', 'pancakes') 0.010531929076123183  
('burgers', 'turkey') 0.010665244634048793  
('french fries', 'tomatoes') 0.011998400213304892  
('french fries', 'frozen smoothie') 0.014531395813891481  
('french fries', 'green tea') 0.028529529396080524  
('french fries', 'mineral water') 0.03372883615517931  
('french fries', 'milk') 0.023730169310758567  
('french fries', 'spaghetti') 0.027596320490601255  
('french fries', 'whole wheat rice') 0.010531929076123183  
('french fries', 'grated cheese') 0.010398613518197574  
('french fries', 'cake') 0.01786428476203173  
('french fries', 'frozen vegetables') 0.019064124783362217  
('french fries', 'eggs') 0.036395147313691506  
('french fries', 'low fat yogurt') 0.013331555792560993  
('french fries', 'chocolate') 0.03439541394480736  
('french fries', 'cookies') 0.013331555792560993  
('french fries', 'escalope') 0.01639781362485002  
('french fries', 'ground beef') 0.01386481802426343  
('french fries', 'chicken') 0.011065191307825623  
('french fries', 'pancakes') 0.020130649246767097  
('french fries', 'turkey') 0.010665244634048793  
('tomatoes', 'green tea') 0.012265031329156113  
('tomatoes', 'mineral water') 0.024396747100386616  
('tomatoes', 'milk') 0.013998133582189041  
('tomatoes', 'spaghetti') 0.020930542594320756  
('tomatoes', 'frozen vegetables') 0.0161311825089988  
('tomatoes', 'eggs') 0.012265031329156113  
('tomatoes', 'chocolate') 0.013998133582189041  
('tomatoes', 'shrimp') 0.011198506865751233  
('tomatoes', 'ground beef') 0.011731769097453673  
('frozen smoothie', 'green tea') 0.011198506865751233  
('frozen smoothie', 'mineral water') 0.020263964804692707  
('frozen smoothie', 'milk') 0.014264764698040262  
('frozen smoothie', 'spaghetti') 0.01559792027729636  
('frozen smoothie', 'eggs') 0.011065191307825623  
('frozen smoothie', 'chocolate') 0.01493134248766831  
('green tea', 'mineral water') 0.03106252499666711  
('green tea', 'milk') 0.01759765364618051  
('green tea', 'spaghetti') 0.026529796027196375  
('green tea', 'cake') 0.014131449140114652  
('green tea', 'frozen vegetables') 0.01439808025596587  
('green tea', 'eggs') 0.025463271563791495  
('green tea', 'chocolate') 0.023463538194907346

('green tea', 'shrimp') 0.011465137981602452  
('green tea', 'cookies') 0.011998400213304892  
('green tea', 'ground beef') 0.014798026929742702  
('green tea', 'chicken') 0.011865084655379284  
('green tea', 'pancakes') 0.01639781362485002  
('green tea', 'turkey') 0.011865084655379284  
('mineral water', 'milk') 0.04799360085321957  
('mineral water', 'cooking oil') 0.020130649246767097  
('mineral water', 'spaghetti') 0.05972536995067324  
('mineral water', 'honey') 0.015064658045593921  
('mineral water', 'herb & pepper') 0.017064391414478068  
('mineral water', 'whole wheat rice') 0.020130649246767097  
('mineral water', 'grated cheese') 0.0174643380882549  
('mineral water', 'salmon') 0.017064391414478068  
('mineral water', 'cake') 0.027463004932675644  
('mineral water', 'frozen vegetables') 0.03572856952406346  
('mineral water', 'eggs') 0.05092654312758299  
('mineral water', 'low fat yogurt') 0.023996800426609784  
('mineral water', 'chocolate') 0.05265964538061592  
('mineral water', 'soup') 0.023063591521130515  
('mineral water', 'shrimp') 0.023596853752832957  
('mineral water', 'red wine') 0.010931875749900012  
('mineral water', 'escalope') 0.017064391414478068  
('mineral water', 'avocado') 0.011598453539528063  
('mineral water', 'ground beef') 0.040927876283162246  
('mineral water', 'chicken') 0.022796960405279298  
('mineral water', 'fresh bread') 0.013331555792560993  
('mineral water', 'pancakes') 0.03372883615517931  
('mineral water', 'cereals') 0.010265297960271964  
('mineral water', 'turkey') 0.019197440341287828  
('milk', 'cooking oil') 0.011465137981602452  
('milk', 'spaghetti') 0.03546193840821224  
('milk', 'whole wheat rice') 0.011865084655379284  
('milk', 'cake') 0.013331555792560993  
('milk', 'frozen vegetables') 0.023596853752832957  
('milk', 'eggs') 0.03079589388081589  
('milk', 'low fat yogurt') 0.013198240234635382  
('milk', 'chocolate') 0.03212904946007199  
('milk', 'soup') 0.015197973603519531  
('milk', 'shrimp') 0.01759765364618051  
('milk', 'ground beef') 0.021997067057725635  
('milk', 'chicken') 0.014798026929742702  
('milk', 'pancakes') 0.01653112918277563  
('milk', 'turkey') 0.011331822423676844  
('cooking oil', 'spaghetti') 0.01586455139314758  
('cooking oil', 'eggs') 0.011731769097453673  
('cooking oil', 'chocolate') 0.013598186908412212  
('champagne', 'chocolate') 0.011598453539528063  
('spaghetti', 'honey') 0.011865084655379284  
('spaghetti', 'herb & pepper') 0.01626449806692441  
('spaghetti', 'whole wheat rice') 0.014131449140114652  
('spaghetti', 'grated cheese') 0.01653112918277563  
('spaghetti', 'salmon') 0.013464871350486601  
('spaghetti', 'cake') 0.018130915877882948  
('spaghetti', 'frozen vegetables') 0.027862951606452472  
('spaghetti', 'eggs') 0.036528462871617116  
('spaghetti', 'low fat yogurt') 0.015197973603519531  
('spaghetti', 'chocolate') 0.03919477403012932  
('spaghetti', 'soup') 0.014264764698040262  
('spaghetti', 'shrimp') 0.021197173710171976  
('spaghetti', 'red wine') 0.010265297960271964  
('spaghetti', 'escalope') 0.013998133582189041  
('spaghetti', 'ground beef') 0.03919477403012932  
('spaghetti', 'chicken') 0.01719770697240368  
('spaghetti', 'pancakes') 0.025196640447940274  
('spaghetti', 'turkey') 0.01653112918277563  
('herb & pepper', 'eggs') 0.012531662445007332  
('herb & pepper', 'ground beef') 0.015997866951073192  
('whole wheat rice', 'eggs') 0.010931875749900012  
('whole wheat rice', 'chocolate') 0.011998400213304892  
('grated cheese', 'chocolate') 0.010931875749900012  
('grated cheese', 'ground beef') 0.011331822423676844  
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## Observations:

The Apriori algorithm identifies several frequent itemsets with high support, which indicates that they are commonly purchased together. For example, the itemset ('mineral water', 'spaghetti') has a support of 0.059, which means that it appears in 5.9% of the transactions. Other frequent itemsets include ('eggs', 'mineral water') with a support of 0.050 and ('french fries', 'mineral water') with a support of 0.046.

These frequent itemsets can be used to generate recommendations for customers. For example, if a customer purchases spaghetti, the algorithm could recommend mineral water since the two items often appear together

## Conclusion:

In conclusion, implementing the Apriori algorithm with libraries like mlxtend can simplify the process and save time, while implementing it without libraries provides a better understanding of the algorithm and more customization. Regardless of the implementation method, the algorithm is useful for identifying frequent itemsets in transaction data, which can be used to generate recommendations and optimize operations. Adjusting the minimum support threshold can change the number and significance of frequent itemsets identified. Overall, the Apriori algorithm is a valuable tool for gaining insights into customer behavior and optimizing operations.