

Problem Statement 6

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Dataset

```
In [1]: import pandas as pd
import time
from itertools import combinations
#Market Data
df=pd.read_csv("Market_Basket_Optimisation.csv",header=None)
df
```

[illegible]

7501 rows × 20 columns

```
In [2]: records = [set([y for y in x if pd.notna(y)]) for x in df.values.tolist()]

#import chess.dat
file=open('chess.dat','r')
lines=file.readlines()
chess=[]
for line in lines:
    chess.append(set(line[:-2].split(' ')))
```

Question 1

Test Drive ACLOSE algorithm to mine closed frequent patterns on a sample dataset of your choice. Test the same on a FIMI benchmark dataset which you have used for Apriori/FP-growth implementations.

```
In [3]: def generate_ci_cfi(k, lfi):
        no_fi = len(lfi)
        cfi = []
        for i in range(no_fi):
            j = i+1
            while( (j<no_fi) and (lfi[i][:k-1] == lfi[j][:k-1]) ):

                ci = [lfi[i][k-1]] + [lfi[j][k-1]] + lfi[i][:k-1]
                ci_present = False
                if k == 1:
                    ci_present = True
                elif ((ci[-2:] in lfi) and (k == 2)):
                    ci_present = True
                elif( all((list(_)+ci[-2:]) in lfi for _ in combinations(ci[:-2], k-2)) ):
                    ci_present = True

                if (ci_present):
                    cfi.append(ci)
                j += 1

        return cfi
```

In [4]:

```
def generate_closure_cfi(transactions, generators):
    generators_trans_indices = [[] for _ in range(len(generators))]
    for trans_index, transaction in enumerate(transactions):
        for generator_is, generator in enumerate(generators):
            if all(_item in transaction for _item in generator):
                generators_trans_indices[generator_is].append(trans_index)

    generator_cs = []
    for generator_tis in (generators_trans_indices):

        if generator_tis:
            closure = transactions[generator_tis[0]].copy()

        else:
            closure = set()

        for trans_index in (generator_tis[1:]):
            closure.intersection_update(transactions[trans_index])
        generator_cs.append(closure)
    return generator_cs
```

In [5]:

```
def print_items_CFI(types,k,item,item_count):
    if(types=='C'):
        print(types+"{}: ".format(k), end='')
        for itemset, support in zip(item, item_count):
            print("{} -> {}".format(itemset, support), end=', ')
    else:
        print("L{}: ".format(k), end='')
        for itemset, support in item_count:
            print("{} -> {}".format(itemset, support), end=', ')
    print("\n")
```

In [6]:

```
def AClose(transactions, min_support):
    items = set()
    for transaction in transactions:
        items.update(transaction)
    items = sorted(list(items))

    generators = []

    k = 1

    ci_count = []
    cil = [[item] for item in items]

    while (cil):
        print("LEVEL {}".format(k))
        cil_count = [0]*len(cil)

        for transaction in (transactions):
            for i, itemset in enumerate(cil):
                if (all(_item in transaction for _item in itemset)):
                    cil_count[i] += 1

        print_items_CFI('C',k,cil,cil_count)

        li_count = [(itemset,support) for itemset, support in zip(cil, cil_count) if support >= min_support]

        print_items_CFI('L',k,li_count)

        print("Itemsets Pruned from L{}: ".format(k), end='')
        for li, li_sup_count in li_count.copy():
            for ci, ci_sup_count in cil_count:
                if (all(_item in li for _item in ci) and ci_sup_count == li_sup_count):
                    print(li, end=', ')
                    li_count.remove((li, li_sup_count))
                    break
        print("\n(After Pruning:)")

        print_items_CFI('L',k,li_count)
        level_frequent_itemsets = [itemset for itemset,support in li_count]
        cil = generate_ci_cfi(k, level_frequent_itemsets)
        generators.extend(level_frequent_itemsets)
```

```

        k += 1

        ci_count = li_count

    generators_closures = generate_closure_cfi(transactions, generators)

    closed_frequent_itemsets = []

    for generator_closure in generators_closures:
        if generator_closure not in closed_frequent_itemsets:
            closed_frequent_itemsets.append(generator_closure)

    closed_frequent_itemsets_cnts = [0]*len(closed_frequent_itemsets)
    for transaction in transactions:
        for i, itemset in enumerate(closed_frequent_itemsets):
            if all(_item in transaction for _item in itemset):
                closed_frequent_itemsets_cnts[i] += 1
    return closed_frequent_itemsets, closed_frequent_itemsets_cnts

```

In [7]: CFI, CFI_count = AClose(records, 352)

LEVEL 1:

C1: [' asparagus'] -> 1, ['almonds'] -> 153, ['antioxydant juice'] -> 67, ['asparagus'] -> 35, ['avocado'] -> 250, ['babies food'] -> 34, ['bacon'] -> 65, ['barbecue sauce'] -> 81, ['black tea'] -> 107, ['blueberries'] -> 69, ['body spray'] -> 86, ['bramble'] -> 14, ['brownies'] -> 253, ['bug spray'] -> 65, ['burger sauce'] -> 44, ['burgers'] -> 654, ['butter'] -> 226, ['cake'] -> 608, ['candy bars'] -> 73, ['carrots'] -> 115, ['cauliflower'] -> 36, ['cereals'] -> 193, ['champagne'] -> 351, ['chicken'] -> 450, ['chili'] -> 46, ['chocolate'] -> 1229, ['chocolate bread'] -> 32, ['chutney'] -> 31, ['cider'] -> 79, ['clothes accessories'] -> 63, ['cookies'] -> 603, ['cooking oil'] -> 383, ['corn'] -> 36, ['cottage cheese'] -> 239, ['cream'] -> 7, ['dessert wine'] -> 33, ['eggplant'] -> 99, ['eggs'] -> 1348, ['energy bar'] -> 203, ['energy drink'] -> 200, ['escalope'] -> 595, ['extra dark chocolate'] -> 90, ['flax seed'] -> 68, ['french fries'] -> 1282, ['french wine'] -> 169, ['fresh bread'] -> 323, ['fresh tuna'] -> 167, ['fromage blanc'] -> 102, ['frozen smoothie'] -> 475, ['frozen vegetables'] -> 715, ['gluten free bar'] -> 52, ['grated cheese'] -> 393, ['green beans'] -> 65, ['green grapes'] -> 68, ['green tea'] -> 991, ['ground beef'] -> 737, ['gums'] -> 101, ['ham'] -> 199, ['hand protein bar'] -> 39, ['herb & pepper'] -> 371, ['honey'] -> 356, ['hot dogs'] -> 243, ['ketchup'] -> 33, ['light cream'] -> 117, ['light mayo'] -> 204, ['low fat yogurt'] -> 574, ['magazines'] -> 82, ['mashed potato'] -> 31, ['mayonnaise'] -> 46, ['meatballs'] -> 157, ['melons'] -> 90, ['milk'] -> 972, ['mineral water'] -> 1788, ['mint'] -> 131, ['mint green tea'] -> 42, ['muffins'] -> 181, ['mushroom cream sauce'] -> 143, ['napkins'] -> 5, ['nonfat milk'] -> 78, ['oatmeal'] -> 33, ['oil'] -> 173, ['olive oil'] -> 494, ['pancakes'] -> 713, ['parmesan cheese'] -> 149, ['pasta'] -> 118, ['pepper'] -> 199, ['pet food'] -> 49, ['pickles'] -> 45, ['protein bar'] -> 139, ['red wine'] -> 211, ['rice'] -> 141, ['salad'] -> 37, ['salmon'] -> 319, ['salt'] -> 69, ['sandwich'] -> 34, ['shallot'] -> 58, ['shampoo'] -> 37, ['shrimp'] -> 536, ['soda'] -> 47, ['soup'] -> 379, ['spaghetti'] -> 1306, ['sparkling water'] -> 47, ['spinach'] -> 53, ['strawberries'] -> 16

0, ['strong cheese'] -> 58, ['tea'] -> 29, ['tomato juice'] -> 228, ['tomato sauce'] -> 106, ['tomatoes'] -> 513, ['toothpaste'] -> 61, ['turkey'] -> 469, ['vegetables mix'] -> 193, ['water spray'] -> 3, ['white wine'] -> 124, ['whole weat flour'] -> 70, ['whole wheat pasta'] -> 221, ['whole wheat rice'] -> 439, ['yams'] -> 86, ['yogurt cake'] -> 205, ['zucchini'] -> 71,

L1: ['burgers'] -> 654, ['cake'] -> 608, ['chicken'] -> 450, ['chocolate'] -> 1229, ['cookies'] -> 603, ['cooking oil'] -> 383, ['eggs'] -> 1348, ['escalope'] -> 595, ['french fries'] -> 1282, ['frozen smoothie'] -> 475, ['frozen vegetables'] -> 715, ['grated cheese'] -> 393, ['green tea'] -> 991, ['ground beef'] -> 737, ['herb & pepper'] -> 371, ['honey'] -> 356, ['low fat yogurt'] -> 574, ['milk'] -> 972, ['mineral water'] -> 1788, ['olive oil'] -> 494, ['pancakes'] -> 713, ['shrimp'] -> 536, ['soup'] -> 379, ['spaghetti'] -> 1306, ['tomatoes'] -> 513, ['turkey'] -> 469, ['whole wheat rice'] -> 439,

Itemsets Pruned from L1:

(After Pruning:)

L1: ['burgers'] -> 654, ['cake'] -> 608, ['chicken'] -> 450, ['chocolate'] -> 1229, ['cookies'] -> 603, ['cooking oil'] -> 383, ['eggs'] -> 1348, ['escalope'] -> 595, ['french fries'] -> 1282, ['frozen smoothie'] -> 475, ['frozen vegetables'] -> 715, ['grated cheese'] -> 393, ['green tea'] -> 991, ['ground beef'] -> 737, ['herb & pepper'] -> 371, ['honey'] -> 356, ['low fat yogurt'] -> 574, ['milk'] -> 972, ['mineral water'] -> 1788, ['olive oil'] -> 494, ['pancakes'] -> 713, ['shrimp'] -> 536, ['soup'] -> 379, ['spaghetti'] -> 1306, ['tomatoes'] -> 513, ['turkey'] -> 469, ['whole wheat rice'] -> 439,

LEVEL 2:

C2: ['burgers', 'cake'] -> 86, ['burgers', 'chicken'] -> 47, ['burgers', 'chocolate'] -> 128, ['burgers', 'cookies'] -> 42, ['burgers', 'cooking oil'] -> 43, ['burgers', 'eggs'] -> 216, ['burgers', 'escalope'] -> 53, ['burgers', 'french fries'] -> 165, ['burgers', 'frozen smoothie'] -> 54, ['burgers', 'frozen vegetables'] -> 79, ['burgers', 'grated cheese'] -> 41, ['burgers', 'green tea'] -> 131, ['burgers', 'ground beef'] -> 90, ['burgers', 'herb & pepper'] -> 31, ['burgers', 'honey'] -> 47, ['burgers', 'low fat yogurt'] -> 50, ['burgers', 'milk'] -> 134, ['burgers', 'mineral water'] -> 183, ['burgers', 'olive oil'] -> 48, ['burgers', 'pancakes'] -> 79, ['burgers', 'shrimp'] -> 66, ['burgers', 'soup'] -> 47, ['burgers', 'spaghetti'] -> 161, ['burgers', 'tomatoes'] -> 62, ['burgers', 'turkey'] -> 80, ['burgers', 'whole wheat rice'] -> 67, ['cake', 'chicken'] -> 49, ['cake', 'chocolate'] -> 102, ['cake', 'cookies'] -> 30, ['cake', 'cooking oil'] -> 37, ['cake', 'eggs'] -> 143, ['cake', 'escalope'] -> 31, ['cake', 'french fries'] -> 134, ['cake', 'frozen smoothie'] -> 48, ['cake', 'frozen vegetables'] -> 77, ['cake', 'grated cheese'] -> 36, ['cake', 'green tea'] -> 106, ['cake', 'ground beef'] -> 61, ['cake', 'herb & pepper'] -> 34, ['cake', 'honey'] -> 33, ['cake', 'low fat yogurt'] -> 52, ['cake', 'milk'] -> 100, ['cake', 'mineral water'] -> 206, ['cake', 'olive oil'] -> 49, ['cake', 'pancakes'] -> 89, ['cake', 'shrimp'] -> 57, ['cake', 'soup'] -> 46, ['cake', 'spaghetti'] -> 136, ['cake', 'tomatoes'] -> 63, ['cake', 'turkey'] -> 52, ['cake', 'whole wheat rice'] -> 58, ['chicken', 'chocolate'] -> 110, ['chicken', 'cookies'] -> 19, ['chicken', 'cooking oil'] -> 51, ['chicken', 'eggs'] -> 108, ['chicken', 'escalope'] -> 27, ['chicken', 'french fries'] -> 83, ['chicken', 'frozen smoothie'] -> 50, ['chicken', 'frozen vegetables'] -> 67, ['chicken', 'grated cheese'] -> 32, ['chicken', 'green tea'] -> 89, ['chicken', 'ground beef'] -> 71, ['chicken', 'herb & pepper'] -> 37, ['chicken', 'honey'] -> 31, ['chicken', 'low fat yogurt'] -> 33, ['chicken', 'milk'] -> 111, ['chicken', 'mineral water'] -> 171, ['chicken', 'olive oil'] -> 54, ['chicken', 'pancakes'] -> 68, ['chicken', 'shrimp'] -> 47, ['chicken', 'soup'] -> 45, ['chicken', 'spaghetti'] -> 129, ['chicken', 'tomatoes'] -> 48, ['chicken', 'turkey'] -> 36, ['chicken', 'whole wheat rice'] -> 41, ['chocolate', 'cookies'] -> 78, ['chocolate', 'cooking oil'] -> 102, ['chocolate', 'eggs'] -> 249, ['choc

olate', 'escalope'] -> 132, ['chocolate', 'french fries'] -> 258, ['chocolate', 'frozen smoothie'] -> 112, ['chocolate', 'frozen vegetables'] -> 172, ['chocolate', 'grated cheese'] -> 82, ['chocolate', 'green tea'] -> 176, ['chocolate', 'ground beef'] -> 173, ['chocolate', 'herb & pepper'] -> 68, ['chocolate', 'honey'] -> 60, ['chocolate', 'low fat yogurt'] -> 111, ['chocolate', 'milk'] -> 241, ['chocolate', 'mineral water'] -> 395, ['chocolate', 'olive oil'] -> 123, ['chocolate', 'pancakes'] -> 149, ['chocolate', 'shrimp'] -> 135, ['chocolate', 'soup'] -> 76, ['chocolate', 'spaghetti'] -> 294, ['chocolate', 'tomatoes'] -> 105, ['chocolate', 'turkey'] -> 85, ['chocolate', 'whole wheat rice'] -> 90, ['cookies', 'cooking oil'] -> 16, ['cookies', 'eggs'] -> 79, ['cookies', 'escalope'] -> 19, ['cookies', 'french fries'] -> 100, ['cookies', 'frozen smoothie'] -> 23, ['cookies', 'frozen vegetables'] -> 19, ['cookies', 'grated cheese'] -> 21, ['cookies', 'green tea'] -> 90, ['cookies', 'ground beef'] -> 33, ['cookies', 'herb & pepper'] -> 18, ['cookies', 'honey'] -> 15, ['cookies', 'low fat yogurt'] -> 40, ['cookies', 'milk'] -> 33, ['cookies', 'mineral water'] -> 56, ['cookies', 'olive oil'] -> 12, ['cookies', 'pancakes'] -> 39, ['cookies', 'shrimp'] -> 31, ['cookies', 'soup'] -> 17, ['cookies', 'spaghetti'] -> 60, ['cookies', 'tomatoes'] -> 22, ['cookies', 'turkey'] -> 20, ['cookies', 'whole wheat rice'] -> 30, ['cooking oil', 'eggs'] -> 88, ['cooking oil', 'escalope'] -> 40, ['cooking oil', 'french fries'] -> 59, ['cooking oil', 'frozen smoothie'] -> 36, ['cooking oil', 'frozen vegetables'] -> 51, ['cooking oil', 'grated cheese'] -> 43, ['cooking oil', 'green tea'] -> 53, ['cooking oil', 'ground beef'] -> 63, ['cooking oil', 'herb & pepper'] -> 40, ['cooking oil', 'honey'] -> 25, ['cooking oil', 'low fat yogurt'] -> 49, ['cooking oil', 'milk'] -> 86, ['cooking oil', 'mineral water'] -> 151, ['cooking oil', 'olive oil'] -> 38, ['cooking oil', 'pancakes'] -> 59, ['cooking oil', 'shrimp'] -> 45, ['cooking oil', 'soup'] -> 40, ['cooking oil', 'spaghetti'] -> 119, ['cooking oil', 'tomatoes'] -> 50, ['cooking oil', 'turkey'] -> 43, ['cooking oil', 'whole wheat rice'] -> 41, ['eggs', 'escalope'] -> 83, ['eggs', 'french fries'] -> 273, ['eggs', 'frozen smoothie'] -> 83, ['eggs', 'frozen vegetables'] -> 163, ['eggs', 'grated cheese'] -> 68, ['eggs', 'green tea'] -> 191, ['eggs', 'ground beef'] -> 150, ['eggs', 'herb & pepper'] -> 94, ['eggs', 'honey'] -> 43, ['eggs', 'low fat yogurt'] -> 126, ['eggs', 'milk'] -> 231, ['eggs', 'mineral water'] -> 382, ['eggs', 'olive oil'] -> 90, ['eggs', 'pancakes'] -> 163, ['eggs', 'shrimp'] -> 106, ['eggs', 'soup'] -> 68, ['eggs', 'spaghetti'] -> 274, ['eggs', 'tomatoes'] -> 92, ['eggs', 'turkey'] -> 146, ['eggs', 'whole wheat rice'] -> 82, ['escalope', 'french fries'] -> 123, ['escalope', 'frozen smoothie'] -> 41, ['escalope', 'frozen vegetables'] -> 57, ['escalope', 'grated cheese'] -> 36, ['escalope', 'green tea'] -> 67, ['escalope', 'ground beef'] -> 62, ['escalope', 'herb & pepper'] -> 27, ['escalope', 'honey'] -> 29, ['escalope', 'low fat yogurt'] -> 35, ['escalope', 'milk'] -> 58, ['escalope', 'mineral water'] -> 128, ['escalope', 'olive oil'] -> 18, ['escalope', 'pancakes'] -> 44, ['escalope', 'shrimp'] -> 32, ['escalope', 'soup'] -> 26, ['escalope', 'spaghetti'] -> 105, ['escalope', 'tomatoes'] -> 41, ['escalope', 'turkey'] -> 32, ['escalope', 'whole wheat rice'] -> 39, ['french fries', 'frozen smoothie'] -> 109, ['french fries', 'frozen vegetables'] -> 143, ['french fries', 'grated cheese'] -> 78, ['french fries', 'green tea'] -> 214, ['french fries', 'ground beef'] -> 104, ['french fries', 'herb & pepper'] -> 52, ['french fries', 'honey'] -> 67, ['french fries', 'low fat yogurt'] -> 100, ['french fries', 'milk'] -> 178, ['french fries', 'mineral water'] -> 253, ['french fries', 'olive oil'] -> 69, ['french fries', 'pancakes'] -> 151, ['french fries', 'shrimp'] -> 75, ['french fries', 'soup'] -> 57, ['french fries', 'spaghetti'] -> 207, ['french fries', 'tomatoes'] -> 90, ['french fries', 'turkey'] -> 80, ['french fries', 'whole wheat rice'] -> 79, ['frozen smoothie', 'frozen vegetables'] -> 75, ['frozen smoothie', 'grated cheese'] -> 24, ['frozen smoothie', 'green tea'] -> 84, ['frozen smoothie', 'ground beef'] -> 57, ['frozen smoothie', 'herb & pepper'] -> 28, ['frozen smoothie', 'honey'] -> 44, ['frozen smoothie', 'low fat yogurt'] -> 55, ['frozen smoothie', 'milk'] -> 107, ['frozen smoothie', 'mineral water'] -> 152, ['frozen smoothie', 'olive oil'] -> 52, ['frozen smoothie', 'pancakes'] -> 68, ['frozen smoothie', 'shrimp'] -> 55, ['frozen smoothie', 'soup'] -> 19, ['frozen smoothie', 'spaghetti'] -> 117, ['frozen smoothie', 'tomatoes'] -> 49, ['frozen smoothie', 'turkey'] -> 31, ['frozen smoothie', 'whole wheat rice'] -> 45, ['frozen v

vegetables', 'grated cheese'] -> 51, ['frozen vegetables', 'green tea'] -> 108, ['frozen vegetables', 'ground beef'] -> 127, ['frozen vegetables', 'herb & pepper'] -> 45, ['frozen vegetables', 'honey'] -> 57, ['frozen vegetables', 'low fat yogurt'] -> 76, ['frozen vegetables', 'milk'] -> 177, ['frozen vegetables', 'mineral water'] -> 268, ['frozen vegetables', 'olive oil'] -> 85, ['frozen vegetables', 'pancakes'] -> 101, ['frozen vegetables', 'shrimp'] -> 125, ['frozen vegetables', 'soup'] -> 60, ['frozen vegetables', 'spaghetti'] -> 209, ['frozen vegetables', 'tomatoes'] -> 121, ['frozen vegetables', 'turkey'] -> 66, ['frozen vegetables', 'whole wheat rice'] -> 68, ['grated cheese', 'green tea'] -> 59, ['grated cheese', 'ground beef'] -> 85, ['grated cheese', 'herb & pepper'] -> 49, ['grated cheese', 'honey'] -> 31, ['grated cheese', 'low fat yogurt'] -> 42, ['grated cheese', 'milk'] -> 59, ['grated cheese', 'mineral water'] -> 131, ['grated cheese', 'olive oil'] -> 47, ['grated cheese', 'pancakes'] -> 52, ['grated cheese', 'shrimp'] -> 33, ['grated cheese', 'soup'] -> 22, ['grated cheese', 'spaghetti'] -> 124, ['grated cheese', 'tomatoes'] -> 33, ['grated cheese', 'turkey'] -> 37, ['grated cheese', 'whole wheat rice'] -> 34, ['green tea', 'ground beef'] -> 111, ['green tea', 'herb & pepper'] -> 48, ['green tea', 'honey'] -> 70, ['green tea', 'low fat yogurt'] -> 57, ['green tea', 'milk'] -> 132, ['green tea', 'mineral water'] -> 233, ['green tea', 'olive oil'] -> 75, ['green tea', 'pancakes'] -> 123, ['green tea', 'shrimp'] -> 86, ['green tea', 'soup'] -> 53, ['green tea', 'spaghetti'] -> 199, ['green tea', 'tomatoes'] -> 92, ['green tea', 'turkey'] -> 89, ['green tea', 'whole wheat rice'] -> 68, ['ground beef', 'herb & pepper'] -> 120, ['ground beef', 'honey'] -> 51, ['ground beef', 'low fat yogurt'] -> 72, ['ground beef', 'milk'] -> 165, ['ground beef', 'mineral water'] -> 307, ['ground beef', 'olive oil'] -> 106, ['ground beef', 'pancakes'] -> 109, ['ground beef', 'shrimp'] -> 86, ['ground beef', 'soup'] -> 73, ['ground beef', 'spaghetti'] -> 294, ['ground beef', 'tomatoes'] -> 88, ['ground beef', 'turkey'] -> 69, ['ground beef', 'whole wheat rice'] -> 61, ['herb & pepper', 'honey'] -> 24, ['herb & pepper', 'low fat yogurt'] -> 44, ['herb & pepper', 'milk'] -> 69, ['herb & pepper', 'mineral water'] -> 128, ['herb & pepper', 'olive oil'] -> 38, ['herb & pepper', 'pancakes'] -> 55, ['herb & pepper', 'shrimp'] -> 53, ['herb & pepper', 'soup'] -> 27, ['herb & pepper', 'spaghetti'] -> 122, ['herb & pepper', 'tomatoes'] -> 33, ['herb & pepper', 'turkey'] -> 36, ['herb & pepper', 'whole wheat rice'] -> 25, ['honey', 'low fat yogurt'] -> 30, ['honey', 'milk'] -> 58, ['honey', 'mineral water'] -> 113, ['honey', 'olive oil'] -> 36, ['honey', 'pancakes'] -> 50, ['honey', 'shrimp'] -> 33, ['honey', 'soup'] -> 24, ['honey', 'spaghetti'] -> 89, ['honey', 'tomatoes'] -> 40, ['honey', 'turkey'] -> 43, ['honey', 'whole wheat rice'] -> 29, ['low fat yogurt', 'milk'] -> 99, ['low fat yogurt', 'mineral water'] -> 180, ['low fat yogurt', 'olive oil'] -> 51, ['low fat yogurt', 'pancakes'] -> 71, ['low fat yogurt', 'shrimp'] -> 47, ['low fat yogurt', 'soup'] -> 43, ['low fat yogurt', 'spaghetti'] -> 114, ['low fat yogurt', 'tomatoes'] -> 45, ['low fat yogurt', 'turkey'] -> 38, ['low fat yogurt', 'whole wheat rice'] -> 49, ['milk', 'mineral water'] -> 360, ['milk', 'olive oil'] -> 128, ['milk', 'pancakes'] -> 124, ['milk', 'shrimp'] -> 132, ['milk', 'soup'] -> 114, ['milk', 'spaghetti'] -> 266, ['milk', 'tomatoes'] -> 105, ['milk', 'turkey'] -> 85, ['milk', 'whole wheat rice'] -> 89, ['mineral water', 'olive oil'] -> 207, ['mineral water', 'pancakes'] -> 253, ['mineral water', 'shrimp'] -> 177, ['mineral water', 'soup'] -> 173, ['mineral water', 'spaghetti'] -> 448, ['mineral water', 'tomatoes'] -> 183, ['mineral water', 'turkey'] -> 144, ['mineral water', 'whole wheat rice'] -> 151, ['olive oil', 'pancakes'] -> 81, ['olive oil', 'shrimp'] -> 61, ['olive oil', 'soup'] -> 67, ['olive oil', 'spaghetti'] -> 172, ['olive oil', 'tomatoes'] -> 54, ['olive oil', 'turkey'] -> 40, ['olive oil', 'whole wheat rice'] -> 26, ['pancakes', 'shrimp'] -> 79, ['pancakes', 'soup'] -> 51, ['pancakes', 'spaghetti'] -> 189, ['pancakes', 'tomatoes'] -> 74, ['pancakes', 'turkey'] -> 72, ['pancakes', 'whole wheat rice'] -> 52, ['shrimp', 'soup'] -> 42, ['shrimp', 'spaghetti'] -> 159, ['shrimp', 'tomatoes'] -> 84, ['shrimp', 'turkey'] -> 48, ['shrimp', 'whole wheat rice'] -> 44, ['soup', 'spaghetti'] -> 107, ['soup', 'tomatoes'] -> 52, ['soup', 'turkey'] -> 37, ['soup', 'whole wheat rice'] -> 27, ['spaghetti', 'tomatoes'] -> 157, ['spaghetti', 'turkey'] -> 124, ['spaghetti', 'whole wheat rice'] -> 106, ['tomatoes', 'turkey'] -> 49, ['tomatoes', 'whole wheat rice'] -> 45, ['turkey', 'whole wheat rice'] -> 53,

L2: ['chocolate', 'mineral water'] -> 395, ['eggs', 'mineral water'] -> 382, ['milk', 'mineral water'] -> 360, ['mineral water', 'spaghetti'] -> 448,

Itemsets Pruned from L2:

(After Pruning:)

L2: ['chocolate', 'mineral water'] -> 395, ['eggs', 'mineral water'] -> 382, ['milk', 'mineral water'] -> 360, ['mineral water', 'spaghetti'] -> 448,

In [8]:

```
print("Closed Frequent Itemsets (CFIs)")
print("-----")
for itemset, cnt in zip(CFI, CFI_count):
    print("Itemset: {} Support count: {}".format(itemset, cnt))
```

Closed Frequent Itemsets (CFIs)

Itemset: {'burgers'} Support count: 654
Itemset: {'cake'} Support count: 608
Itemset: {'chicken'} Support count: 450
Itemset: {'chocolate'} Support count: 1229
Itemset: {'cookies'} Support count: 603
Itemset: {'cooking oil'} Support count: 383
Itemset: {'eggs'} Support count: 1348
Itemset: {'escalope'} Support count: 595
Itemset: {'french fries'} Support count: 1282
Itemset: {'frozen smoothie'} Support count: 475
Itemset: {'frozen vegetables'} Support count: 715
Itemset: {'grated cheese'} Support count: 393
Itemset: {'green tea'} Support count: 991
Itemset: {'ground beef'} Support count: 737
Itemset: {'herb & pepper'} Support count: 371
Itemset: {'honey'} Support count: 356
Itemset: {'low fat yogurt'} Support count: 574
Itemset: {'milk'} Support count: 972
Itemset: {'mineral water'} Support count: 1788
Itemset: {'olive oil'} Support count: 494
Itemset: {'pancakes'} Support count: 713
Itemset: {'shrimp'} Support count: 536
Itemset: {'soup'} Support count: 379
Itemset: {'spaghetti'} Support count: 1306
Itemset: {'tomatoes'} Support count: 513
Itemset: {'turkey'} Support count: 469
Itemset: {'whole wheat rice'} Support count: 439

Itemset: {'chocolate', 'mineral water'} Support count: 395
 Itemset: {'eggs', 'mineral water'} Support count: 382
 Itemset: {'milk', 'mineral water'} Support count: 360
 Itemset: {'chocolate', 'mineral water'} Support count: 340

Test_Drive ACLOSE Algorithm with fimi dataset:

Dataset used: Chess.dat

In [9]: CFI, CFI_count = AClose(chess, 3156)

LEVEL 1:

C1: ['1'] -> 1669, ['10'] -> 322, ['11'] -> 2129, ['12'] -> 1067, ['13'] -> 1722, ['14'] -> 1474, ['15'] -> 2026, ['16'] -> 1170, ['17'] -> 2500, ['18'] -> 696, ['19'] -> 1980, ['2'] -> 1527, ['20'] -> 1216, ['21'] -> 2225, ['22'] -> 971, ['23'] -> 1817, ['24'] -> 1379, ['25'] -> 2860, ['26'] -> 336, ['27'] -> 2205, ['28'] -> 991, ['29'] -> 3181, ['3'] -> 2839, ['30'] -> 15, ['31'] -> 2526, ['32'] -> 446, ['33'] -> 224, ['34'] -> 3040, ['35'] -> 156, ['36'] -> 3099, ['37'] -> 97, ['38'] -> 2196, ['39'] -> 1000, ['4'] -> 357, ['40'] -> 3170, ['41'] -> 26, ['42'] -> 2714, ['43'] -> 482, ['44'] -> 2612, ['45'] -> 584, ['46'] -> 2556, ['47'] -> 640, ['48'] -> 3013, ['49'] -> 183, ['5'] -> 2971, ['50'] -> 1975, ['51'] -> 1221, ['52'] -> 3185, ['53'] -> 11, ['54'] -> 2216, ['55'] -> 980, ['56'] -> 3021, ['57'] -> 175, ['58'] -> 3195, ['59'] -> 1, ['6'] -> 225, ['60'] -> 3149, ['61'] -> 47, ['62'] -> 3060, ['63'] -> 136, ['64'] -> 2631, ['65'] -> 565, ['66'] -> 3021, ['67'] -> 175, ['68'] -> 1984, ['69'] -> 1212, ['7'] -> 3076, ['70'] -> 2007, ['71'] -> 1189, ['72'] -> 2345, ['73'] -> 851, ['74'] -> 2407, ['75'] -> 789, ['8'] -> 120, ['9'] -> 2874,

L1: ['29'] -> 3181, ['40'] -> 3170, ['52'] -> 3185, ['58'] -> 3195,

Itemsets Pruned from L1:

(After Pruning:)

L1: ['29'] -> 3181, ['40'] -> 3170, ['52'] -> 3185, ['58'] -> 3195,

LEVEL 2:

C2: ['29', '40'] -> 3155, ['29', '52'] -> 3170, ['29', '58'] -> 3180, ['40', '52'] -> 3159, ['40', '58'] -> 3169, ['52', '58'] -> 3184,

L2: ['29', '52'] -> 3170, ['29', '58'] -> 3180, ['40', '52'] -> 3159, ['40', '58'] -> 3169, ['52', '58'] -> 3184,

Itemsets Pruned from L2:

(After Pruning:)

L2: ['29', '52'] -> 3170, ['29', '58'] -> 3180, ['40', '52'] -> 3159, ['40', '58'] -> 3169, ['52', '58'] -> 3184,

In [10]:

```
print("Closed Frequent Itemsets (CFIs)")
print("-----")
for itemset, cnt in zip(CFI, CFI_count):
    print("Itemset: {} Support count: {}".format(itemset, cnt))
```

Closed Frequent Itemsets (CFIs)

```
Itemset: {'29'} Support count: 3181
Itemset: {'40'} Support count: 3170
Itemset: {'52'} Support count: 3185
Itemset: {'58'} Support count: 3195
Itemset: {'52', '29'} Support count: 3170
Itemset: {'58', '29'} Support count: 3180
Itemset: {'52', '40'} Support count: 3159
Itemset: {'58', '40'} Support count: 3169
Itemset: {'58', '52'} Support count: 3184
```

Question 2

Test Drive Pincer search to mine maximal frequent patterns on a sample dataset of your choice. Test the same on a FIMI benchmark dataset which you have used for Apriori/FP-growth implementations.

In [11]:

```
def generate_MFCS(MFCS, Si):
    MFCS = MFCS.copy()
    for Si_item in Si:
        for MFCS_item in MFCS.copy():
            if (all(item in MFCS_item for item in Si_item)):
                MFCS.remove(MFCS_item)
            for items in Si_item:
                new_MFCS_itemset = MFCS_item.copy()
                new_MFCS_itemset.remove(items)
                if not any(all(item in _MFCS_itemset for item in new_MFCS_itemset) for _MFCS_itemset in MFCS):
                    MFCS.append(new_MFCS_itemset)
    return MFCS
```

In [12]:

```
def prune_ci(ci, MFS):
    ci = ci.copy()
    for itemset in ci.copy():
        if any(all(item in MFS_item for item in itemset) for MFS_item in MFS):
            ci.remove(itemset)
    return ci

def generate_ci(k, li):
    li_no = len(li)
    ci = []
    for i in range(li_no):
        j = i+1
        while ((j<li_no) and (li[i][:k-1] == li[j][:k-1])):
            ci_item = li[i][:k-1] + [li[i][k-1]] + [li[j][k-1]]
            ci_item_present = False
            if k == 1:
                ci_item_present = True
            elif (k == 2) and (ci_item[-2:] in li):
                ci_item_present = True
            elif all((list(_)+ci_item[-2:]) in li for _ in combinations(ci_item[:-2], k-2)):
                ci_item_present = True
            if ci_item_present:
                ci.append(ci_item)
            j += 1
    return ci

def prune_ci_MFCS(ci, MFCS):
    ci = ci.copy()
    for itemset in ci.copy():
        if not any(all(item in MFCS_item for item in itemset) for MFCS_item in MFCS):
            ci.remove(itemset)
    return ci

def print_items_MFI(item, item_count):
    for itemset, support in zip(item, item_count):
        print("{} -> {}".format(itemset, support), end=', ')
    #print("-----testing stage 3-----")
```

In [13]:

```
def pincerSearch(transactions, min_support):
    items = set()
    for transaction in transactions:
        items.update(transaction)
    items = sorted(list(items))
    k = 1
    li = []
    ci = [[item] for item in items]
    Si = []
    MFCS = [items.copy()]
    MFS = []

    print("MFCS = {}".format(MFCS))
    print("MFS = {}\n".format(MFS))

    while ci:
        print("LEVEL {}: ".format(k))
        print("C{} = {}".format(k, ci))
        ci_count = [0]*len(ci)
        MFCS_count = [0]*len(MFCS)

        for transaction in transactions:

            for i, itemset in enumerate(ci):
                if all(_item in transaction for _item in itemset):
                    ci_count[i] += 1

            for i, itemset in enumerate(MFCS):
                if all(_item in transaction for _item in itemset):
                    MFCS_count[i] += 1

        print("\nCandicate Set along with Count:")
        print_items_MFI(ci, ci_count)

        print("\n\nMFCS Set along with Count:")
        print_items_MFI(MFCS, MFCS_count)

        MFS.extend([itemset for itemset, support in zip(MFCS, MFCS_count) if ((support >= min_support) and (
        print("MFS = {}".format(MFS))

        li = [itemset for itemset, support in zip(ci, ci_count) if support >= min_support]
        Si = [itemset for itemset, support in zip(ci, ci_count) if support < min_support]
```

```

print("L{} = {}".format(k, li))
print("S{} = {}".format(k, Si))

MFCS = generate_MFCS(MFCS, Si)
print("MFCS = {}".format(MFCS))

li = prune_ci(li, MFS)

ci = generate_ci(k, li)

ci = prune_ci_MFCS(ci, MFCS)

k += 1
print("\n")
# print("-----testing end stage-----")

return MFCS, MFS

```

In [14]:

```

min_support_count = 125
MFCS, MFS = pincerSearch(records, min_support_count)
print("MFS = {}".format(MFS))

```

```

MFCS = [[' asparagus', 'almonds', 'antioxydant juice', 'asparagus', 'avocado', 'babies food', 'bacon', 'barbecue sauce', 'black tea', 'blueberries', 'body spray', 'bramble', 'brownies', 'bug spray', 'burger sauce', 'burgers', 'butter', 'cake', 'candy bars', 'carrots', 'cauliflower', 'cereals', 'champagne', 'chicken', 'chili', 'chocolate', 'chocolate bread', 'chutney', 'cider', 'clothes accessories', 'cookies', 'cooking oil', 'corn', 'cottage cheese', 'cream', 'dessert wine', 'eggplant', 'eggs', 'energy bar', 'energy drink', 'escalope', 'extra dark chocolate', 'flax seed', 'french fries', 'french wine', 'fresh bread', 'fresh tuna', 'fromage blanc', 'frozen smoothie', 'frozen vegetables', 'gluten free bar', 'grated cheese', 'green beans', 'green grapes', 'green tea', 'ground beef', 'gums', 'ham', 'hand protein bar', 'herb & pepper', 'honey', 'hot dogs', 'ketchup', 'light cream', 'light mayo', 'low fat yogurt', 'magazines', 'mashed potato', 'mayonnaise', 'meatballs', 'melons', 'milk', 'mineral water', 'mint', 'mint green tea', 'muffins', 'mushroom cream sauce', 'napkins', 'nonfat milk', 'oatmeal', 'oil', 'olive oil', 'pancakes', 'parmesan cheese', 'pasta', 'pepper', 'pet food', 'pickles', 'protein bar', 'red wine', 'rice', 'salad', 'salmon', 'salt', 'sandwich', 'shallot', 'shampoo', 'shrimp', 'soda', 'soup', 'spaghetti', 'sparkling water', 'spinach', 'strawberries', 'strong cheese', 'tea', 'tomato juice', 'tomato sauce', 'tomatoes', 'toothpaste', 'turkey', 'vegetables mix', 'water spray', 'white wine', 'whole weat flour', 'whole wheat pasta', 'whole wheat rice', 'yams', 'yogurt cake', 'zucchini']]

```

MFS = []

LEVEL 1:

C1 = [[' asparagus'], ['almonds'], ['antioxydant juice'], ['asparagus'], ['avocado'], ['babies food'], ['bacon'], ['barbecue sauce'], ['black tea'], ['blueberries'], ['body spray'], ['bramble'], ['brownies'], ['bug spray'], ['burger sauce'], ['burgers'], ['butter'], ['cake'], ['candy bars'], ['carrots'], ['cauliflower'], ['cereals'], ['champagne'], ['chicken'], ['chili'], ['chocolate'], ['chocolate bread'], ['chutney'], ['cider'], ['clothes accessories'], ['cookies'], ['cooking oil'], ['corn'], ['cottage cheese'], ['cream'], ['dessert wine'], ['eggplant'], ['eggs'], ['energy bar'], ['energy drink'], ['escalope'], ['extra dark chocolate'], ['flax seed'], ['french fries'], ['french wine'], ['fresh bread'], ['fresh tuna'], ['fromage blanc'], ['frozen smoothie'], ['frozen vegetables'], ['gluten free bar'], ['grated cheese'], ['green beans'], ['green grapes'], ['green tea'], ['ground beef'], ['gums'], ['ham'], ['hand protein bar'], ['herb & pepper'], ['honey'], ['hot dogs'], ['ketchup'], ['light cream'], ['light mayo'], ['low fat yogurt'], ['magazines'], ['mashed potato'], ['mayonnaise'], ['meatballs'], ['melons'], ['milk'], ['mineral water'], ['mint'], ['mint green tea'], ['muffins'], ['mushroom cream sauce'], ['napkins'], ['nonfat milk'], ['oatmeal'], ['oil'], ['olive oil'], ['pancakes'], ['parmesan cheese'], ['pasta'], ['pepper'], ['pet food'], ['pickles'], ['protein bar'], ['red wine'], ['rice'], ['salad'], ['salmon'], ['salt'], ['sandwich'], ['shallot'], ['shampoo'], ['shrimp'], ['soda'], ['soup'], ['spaghetti'], ['sparkling water'], ['spinach'], ['strawberries'], ['strong cheese'], ['tea'], ['tomato juice'], ['tomato sauce'], ['tomatoes'], ['toothpaste'], ['turkey'], ['vegetables mix'], ['water spray'], ['white wine'], ['whole weat flour'], ['whole wheat pasta'], ['whole wheat rice'], ['yams'], ['yogurt cake'], ['zucchini']]]

on'], ['barbecue sauce'], ['black tea'], ['blueberries'], ['body spray'], ['bramble'], ['brownies'], ['bug spray'], ['burger sauce'], ['burgers'], ['butter'], ['cake'], ['candy bars'], ['carrots'], ['cauliflower'], ['cereals'], ['champagne'], ['chicken'], ['chili'], ['chocolate'], ['chocolate bread'], ['chutney'], ['cider'], ['clothes accessories'], ['cookies'], ['cooking oil'], ['corn'], ['cottage cheese'], ['cream'], ['dessert wine'], ['eggplant'], ['eggs'], ['energy bar'], ['energy drink'], ['escalope'], ['extra dark chocolate'], ['flax seed'], ['french fries'], ['french wine'], ['fresh bread'], ['fresh tuna'], ['fromage blanc'], ['frozen smoothie'], ['frozen vegetables'], ['gluten free bar'], ['grated cheese'], ['green beans'], ['green grapes'], ['green tea'], ['ground beef'], ['gums'], ['ham'], ['hand protein bar'], ['herb & pepper'], ['honey'], ['hot dogs'], ['ketchup'], ['light cream'], ['light mayo'], ['low fat yogurt'], ['magazines'], ['mashed potato'], ['mayonnaise'], ['meatballs'], ['melons'], ['milk'], ['mineral water'], ['mint'], ['mint green tea'], ['muffins'], ['mushroom cream sauce'], ['napkins'], ['nonfat milk'], ['oatmeal'], ['oil'], ['olive oil'], ['pancakes'], ['parmesan cheese'], ['pasta'], ['pepper'], ['pet food'], ['pickles'], ['protein bar'], ['red wine'], ['rice'], ['salad'], ['salmon'], ['salt'], ['sandwich'], ['shallot'], ['shampoo'], ['shrimp'], ['soda'], ['soup'], ['spaghetti'], ['sparkling water'], ['spinach'], ['strawberries'], ['strong cheese'], ['tea'], ['tomato juice'], ['tomato sauce'], ['tomatoes'], ['toothpaste'], ['turkey'], ['vegetables mix'], ['water spray'], ['white wine'], ['whole wheat flour'], ['whole wheat pasta'], ['whole wheat rice'], ['yams'], ['yogurt cake'], ['zucchini']]

Candidate Set along with Count:

['asparagus'] -> 1, ['almonds'] -> 153, ['antioxydant juice'] -> 67, ['asparagus'] -> 35, ['avocado'] -> 250, ['babies food'] -> 34, ['bacon'] -> 65, ['barbecue sauce'] -> 81, ['black tea'] -> 107, ['blueberries'] -> 69, ['body spray'] -> 86, ['bramble'] -> 14, ['brownies'] -> 253, ['bug spray'] -> 65, ['burger sauce'] -> 44, ['burgers'] -> 654, ['butter'] -> 226, ['cake'] -> 608, ['candy bars'] -> 73, ['carrots'] -> 115, ['cauliflower'] -> 36, ['cereals'] -> 193, ['champagne'] -> 351, ['chicken'] -> 450, ['chili'] -> 46, ['chocolate'] -> 1229, ['chocolate bread'] -> 32, ['chutney'] -> 31, ['cider'] -> 79, ['clothes accessories'] -> 63, ['cookies'] -> 603, ['cooking oil'] -> 383, ['corn'] -> 36, ['cottage cheese'] -> 239, ['cream'] -> 7, ['dessert wine'] -> 33, ['eggplant'] -> 99, ['eggs'] -> 1348, ['energy bar'] -> 203, ['energy drink'] -> 200, ['escalope'] -> 595, ['extra dark chocolate'] -> 90, ['flax seed'] -> 68, ['french fries'] -> 1282, ['french wine'] -> 169, ['fresh bread'] -> 323, ['fresh tuna'] -> 167, ['fromage blanc'] -> 102, ['frozen smoothie'] -> 475, ['frozen vegetables'] -> 715, ['gluten free bar'] -> 52, ['grated cheese'] -> 393, ['green beans'] -> 65, ['green grapes'] -> 68, ['green tea'] -> 991, ['ground beef'] -> 737, ['gums'] -> 101, ['ham'] -> 199, ['hand protein bar'] -> 39, ['herb & pepper'] -> 371, ['honey'] -> 356, ['hot dogs'] -> 243, ['ketchup'] -> 33, ['light cream'] -> 117, ['light mayo'] -> 204, ['low fat yogurt'] -> 574, ['magazines'] -> 82, ['mashed potato'] -> 31, ['mayonnaise'] -> 46, ['meatballs'] -> 157, ['melons'] -> 90, ['milk'] -> 972, ['mineral water'] -> 1788, ['mint'] -> 131, ['mint green tea'] -> 42, ['muffins'] -> 181, ['mushroom cream sauce'] -> 143, ['napkins'] -> 5, ['nonfat milk'] -> 78, ['oatmeal'] -> 33, ['oil'] -> 173, ['olive oil'] -> 494, ['pancakes'] -> 713, ['parmesan cheese'] -> 149, ['pasta'] -> 118, ['pepper'] -> 199, ['pet food'] -> 49, ['pickles'] -> 45, ['protein bar'] -> 139, ['red wine'] -> 211, ['rice'] -> 141, ['salad'] -> 37, ['salmon'] -> 319, ['salt'] -> 69, ['sandwich'] -> 34, ['shallot'] -> 58, ['shampoo'] -> 37, ['shrimp'] -> 536, ['soda'] -> 47, ['soup'] -> 379, ['spaghetti'] -> 1306, ['sparkling water'] -> 47, ['spinach'] -> 53, ['strawberries'] -> 160, ['strong cheese'] -> 58, ['tea'] -> 29, ['tomato juice'] -> 228, ['tomato sauce'] -> 106, ['tomatoes'] -> 513, ['toothpaste'] -> 61, ['turkey'] -> 469, ['vegetables mix'] -> 193, ['water spray'] -> 3, ['white wine'] -> 124, ['whole wheat flour'] -> 70, ['whole wheat pasta'] -> 221, ['whole wheat rice'] -> 439, ['yams'] -> 86, ['yogurt cake'] -> 205, ['zucchini'] -> 71,

MFCS Set along with Count:

```
[' asparagus', 'almonds', 'antioxydant juice', 'asparagus', 'avocado', 'babies food', 'bacon', 'barbecue sauce', 'black tea', 'blueberries', 'body spray', 'bramble', 'brownies', 'bug spray', 'burger sauce', 'burgers', 'butter', 'cake', 'candy bars', 'carrots', 'cauliflower', 'cereals', 'champagne', 'chicken', 'chili', 'chocolate', 'chocolate bread', 'chutney', 'cider', 'clothes accessories', 'cookies', 'cooking oil', 'corn', 'cottage cheese', 'cream', 'dessert wine', 'eggplant', 'eggs', 'energy bar', 'energy drink', 'escalope', 'extra dark chocolate', 'flax seed', 'french fries', 'french wine', 'fresh bread', 'fresh tuna', 'fromage blanc', 'frozen smoothie', 'frozen vegetables', 'gluten free bar', 'grated cheese', 'green beans', 'green grapes', 'green tea', 'ground beef', 'gums', 'ham', 'hand protein bar', 'herb & pepper', 'honey', 'hot dogs', 'ketchup', 'light cream', 'light mayo', 'low fat yogurt', 'magazines', 'mashed potato', 'mayonnaise', 'meatballs', 'melons', 'milk', 'mineral water', 'mint', 'mint green tea', 'muffins', 'mushroom cream sauce', 'napkins', 'nonfat milk', 'oatmeal', 'oil', 'olive oil', 'pancakes', 'parmesan cheese', 'pasta', 'pepper', 'pet food', 'pickles', 'protein bar', 'red wine', 'rice', 'salad', 'salmon', 'salt', 'sandwich', 'shallot', 'shampoo', 'shrimp', 'soda', 'soup', 'spaghetti', 'sparkling water', 'spinach', 'strawberries', 'strong cheese', 'tea', 'tomato juice', 'tomato sauce', 'tomatoes', 'toothpaste', 'turkey', 'vegetables mix', 'water spray', 'white wine', 'whole wheat flour', 'whole wheat pasta', 'whole wheat rice', 'yams', 'yogurt cake', 'zucchini'] -> 0, MFCS = []
```

```
L1 = [['almonds'], ['avocado'], ['brownies'], ['burgers'], ['butter'], ['cake'], ['cereals'], ['champagne'], ['chicken'], ['chocolate'], ['cookies'], ['cooking oil'], ['cottage cheese'], ['eggs'], ['energy bar'], ['energy drink'], ['escalope'], ['french fries'], ['french wine'], ['fresh bread'], ['fresh tuna'], ['frozen smoothie'], ['frozen vegetables'], ['grated cheese'], ['green tea'], ['ground beef'], ['ham'], ['herb & pepper'], ['honey'], ['hot dogs'], ['light mayo'], ['low fat yogurt'], ['meatballs'], ['milk'], ['mineral water'], ['mint'], ['muffins'], ['mushroom cream sauce'], ['oil'], ['olive oil'], ['pancakes'], ['parmesan cheese'], ['pepper'], ['protein bar'], ['red wine'], ['rice'], ['salmon'], ['shrimp'], ['soup'], ['spaghetti'], ['strawberries'], ['tomato juice'], ['tomatoes'], ['turkey'], ['vegetables mix'], ['whole wheat pasta'], ['whole wheat rice'], ['yogurt cake']]
```

```
S1 = [[' asparagus'], ['antioxydant juice'], ['asparagus'], ['babies food'], ['bacon'], ['barbecue sauce'], ['black tea'], ['blueberries'], ['body spray'], ['bramble'], ['bug spray'], ['burger sauce'], ['candy bars'], ['carrots'], ['cauliflower'], ['chili'], ['chocolate bread'], ['chutney'], ['cider'], ['clothes accessories'], ['corn'], ['cream'], ['dessert wine'], ['eggplant'], ['extra dark chocolate'], ['flax seed'], ['fromage blanc'], ['gluten free bar'], ['green beans'], ['green grapes'], ['gums'], ['hand protein bar'], ['ketchup'], ['light cream'], ['magazines'], ['mashed potato'], ['mayonnaise'], ['melons'], ['mint green tea'], ['napkins'], ['nonfat milk'], ['oatmeal'], ['pasta'], ['pet food'], ['pickles'], ['salad'], ['salt'], ['sandwich'], ['shallot'], ['shampoo'], ['soda'], ['sparkling water'], ['spinach'], ['strong cheese'], ['tea'], ['tomato sauce'], ['toothpaste'], ['water spray'], ['white wine'], ['whole wheat flour'], ['yams'], ['zucchini']]
```

```
MFCS = [['almonds', 'avocado', 'brownies', 'burgers', 'butter', 'cake', 'cereals', 'champagne', 'chicken', 'chocolate', 'cookies', 'cooking oil', 'cottage cheese', 'eggs', 'energy bar', 'energy drink', 'escalope', 'french fries', 'french wine', 'fresh bread', 'fresh tuna', 'frozen smoothie', 'frozen vegetables', 'grated cheese', 'green tea', 'ground beef', 'ham', 'herb & pepper', 'honey', 'hot dogs', 'light mayo', 'low fat yogurt', 'meatballs', 'milk', 'mineral water', 'mint', 'muffins', 'mushroom cream sauce', 'oil', 'olive oil', 'pancakes', 'parmesan cheese', 'pepper', 'protein bar', 'red wine', 'rice', 'salmon', 'shrimp', 'soup', 'spaghetti', 'strawberries', 'tomato juice', 'tomatoes', 'turkey', 'vegetables mix', 'whole wheat pasta', 'whole wheat rice', 'yogurt cake']]
```


LEVEL 2:

```
C2 = [['almonds', 'avocado'], ['almonds', 'brownies'], ['almonds', 'burgers'], ['almonds', 'butter'], ['almonds', 'cake'], ['almonds', 'cereals'], ['almonds', 'champagne'], ['almonds', 'chicken'], ['almonds', 'chocolate'], ['almonds', 'cookies'], ['almonds', 'cooking oil'], ['almonds', 'cottage cheese'], ['almonds', 'eggs'], ['almonds', 'energy bar'], ['almonds', 'energy drink'], ['almonds', 'escalope'], ['almonds', 'french fries'], ['almonds', 'french wine'], ['almonds', 'fresh bread'], ['almonds', 'fresh tuna'], ['almonds', 'frozen smoothie'], ['almonds', 'frozen vegetables'], ['almonds', 'grated cheese'], ['almonds', 'green tea'], ['almonds', 'ground beef'], ['almonds', 'ham'], ['almonds', 'herb & pepper'], ['almonds', 'honey'], ['almonds', 'hot dogs'], ['almonds', 'light mayo'], ['almonds', 'low fat yogurt'], ['almonds', 'meatballs'], ['almonds', 'milk'], ['almonds', 'mineral water'], ['almonds', 'mint'], ['almonds', 'muffins'], ['almonds', 'mushroom cream sauce'], ['almonds', 'oil'], ['almonds', 'olive oil'], ['almonds', 'pancakes'], ['almonds', 'parmesan cheese'], ['almonds', 'pepper'], ['almonds', 'protein bar'], ['almonds', 'red wine'], ['almonds', 'rice'], ['almonds', 'salmon'], ['almonds', 'shrimp'], ['almonds', 'soup'], ['almonds', 'spaghetti'], ['almonds', 'strawberries'], ['almonds', 'tomato juice'], ['almonds', 'tomatoes'], ['almonds', 'turkey'], ['almonds', 'vegetables mix'], ['almonds', 'whole wheat pasta'], ['almonds', 'whole wheat rice'], ['almonds', 'yogurt cake'], ['avocado', 'brownies'], ['avocado', 'burgers'], ['avocado', 'butter'], ['avocado', 'cake'], ['avocado', 'cereals'], ['avocado', 'champagne'], ['avocado', 'chicken'], ['avocado', 'chocolate'], ['avocado', 'cookies'], ['avocado', 'cooking oil'], ['avocado', 'cottage cheese'], ['avocado', 'eggs'], ['avocado', 'energy bar'], ['avocado', 'energy drink'], ['avocado', 'escalope'], ['avocado', 'french fries'], ['avocado', 'french wine'], ['avocado', 'fresh bread'], ['avocado', 'fresh tuna'], ['avocado', 'frozen smoothie'], ['avocado', 'frozen vegetables'], ['avocado', 'grated cheese'], ['avocado', 'green tea'], ['avocado', 'ground beef'], ['avocado', 'ham'], ['avocado', 'herb & pepper'], ['avocado', 'honey'], ['avocado', 'hot dogs'], ['avocado', 'light mayo'], ['avocado', 'low fat yogurt'], ['avocado', 'meatballs'], ['avocado', 'milk'], ['avocado', 'mineral water'], ['avocado', 'mint'], ['avocado', 'muffins'], ['avocado', 'mushroom cream sauce'], ['avocado', 'oil'], ['avocado', 'olive oil'], ['avocado', 'pancakes'], ['avocado', 'parmesan cheese'], ['avocado', 'pepper'], ['avocado', 'protein bar'], ['avocado', 'red wine'], ['avocado', 'rice'], ['avocado', 'salmon'], ['avocado', 'shrimp'], ['avocado', 'soup'], ['avocado', 'spaghetti'], ['avocado', 'strawberries'], ['avocado', 'tomato juice'], ['avocado', 'tomatoes'], ['avocado', 'turkey'], ['avocado', 'vegetables mix'], ['avocado', 'whole wheat pasta'], ['avocado', 'whole wheat rice'], ['avocado', 'yogurt cake'], ['brownies', 'burgers'], ['brownies', 'butter'], ['brownies', 'cake'], ['brownies', 'cereals'], ['brownies', 'champagne'], ['brownies', 'chicken'], ['brownies', 'chocolate'], ['brownies', 'cookies'], ['brownies', 'cooking oil'], ['brownies', 'cottage cheese'], ['brownies', 'eggs'], ['brownies', 'energy bar'], ['brownies', 'energy drink'], ['brownies', 'escalope'], ['brownies', 'french fries'], ['brownies', 'french wine'], ['brownies', 'fresh bread'], ['brownies', 'fresh tuna'], ['brownies', 'frozen smoothie'], ['brownies', 'frozen vegetables'], ['brownies', 'grated cheese'], ['brownies', 'green tea'], ['brownies', 'ground beef'], ['brownies', 'ham'], ['brownies', 'herb & pepper'], ['brownies', 'honey'], ['brownies', 'hot dogs'], ['brownies', 'light mayo'], ['brownies', 'low fat yogurt'], ['brownies', 'meatballs'], ['brownies', 'milk'], ['brownies', 'mineral water'], ['brownies', 'mint'], ['brownies', 'muffins'], ['brownies', 'mushroom cream sauce'], ['brownies', 'oil'], ['brownies', 'olive oil'], ['brownies', 'pancakes'], ['brownies', 'parmesan cheese'], ['brownies', 'pepper'], ['brownies', 'protein bar'], ['brownies', 'red wine'], ['brownies', 'rice'], ['brownies', 'salmon'], ['brownies', 'shrimp'], ['brownies', 'soup'], ['brownies', 'spaghetti'], ['brownies', 'strawberries'], ['brownies', 'tomato juice'], ['brownies', 'tomatoes'], ['brownies', 'turkey'], ['brownies', 'vegetables mix'], ['brownies', 'whole wheat pasta'], ['brownies', 'whole wheat rice'], ['brownies', 'yogurt cake'], ['burgers', 'butter'], ['burgers', 'cake'], ['burgers', 'cereals'], ['burgers', 'champagne'], ['burgers', 'chicken'], ['burgers', 'chocolate'], ['burgers', 'cookies'], ['burgers', 'cooking oil'], ['burgers', 'cottage cheese'], ['burgers', 'eggs'], ['burger
```

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Candidate Set along with Count:

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MFCS Set along with Count:

['almonds', 'avocado', 'brownies', 'burgers', 'butter', 'cake', 'cereals', 'champagne', 'chicken', 'chocolate', 'cookies', 'cooking oil', 'cottage cheese', 'eggs', 'energy bar', 'energy drink', 'escalope', 'french fries', 'french wine', 'fresh bread', 'fresh tuna', 'frozen smoothie', 'frozen vegetables', 'grated cheese', 'green tea', 'ground beef', 'ham', 'herb & pepper', 'honey', 'hot dogs', 'light mayo', 'low fat yogurt', 'meatballs', 'milk', 'mineral water', 'mint', 'muffins', 'mushroom cream sauce', 'oil', 'olive oil', 'pancakes', 'parmesan cheese', 'pepper', 'protein bar', 'red wine', 'rice', 'salmon', 'shrimp', 'soup', 'spaghetti', 'strawberries', 'tomato juice', 'tomatoes', 'turkey', 'vegetables mix', 'whole wheat pasta', 'whole wheat rice', 'yogurt cake'] -> 0, MFS = []

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'vegetables mix'], ['shrimp', 'whole wheat pasta'], ['shrimp', 'whole wheat rice'], ['shrimp', 'yogurt cake'], ['soup', 'spaghetti'], ['soup', 'strawberries'], ['soup', 'tomato juice'], ['soup', 'tomatoes'], ['soup', 'turkey'], ['soup', 'vegetables mix'], ['soup', 'whole wheat pasta'], ['soup', 'whole wheat rice'], ['soup', 'yogurt cake'], ['spaghetti', 'strawberries'], ['spaghetti', 'tomato juice'], ['spaghetti', 'tomatoes'], ['spaghetti', 'turkey'], ['spaghetti', 'vegetables mix'], ['spaghetti', 'whole wheat pasta'], ['spaghetti', 'whole wheat rice'], ['spaghetti', 'yogurt cake'], ['strawberries', 'tomato juice'], ['strawberries', 'tomatoes'], ['strawberries', 'turkey'], ['strawberries', 'vegetables mix'], ['strawberries', 'whole wheat pasta'], ['strawberries', 'whole wheat rice'], ['strawberries', 'yogurt cake'], ['tomato juice', 'tomatoes'], ['tomato juice', 'turkey'], ['tomato juice', 'vegetables mix'], ['tomato juice', 'whole wheat pasta'], ['tomato juice', 'whole wheat rice'], 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ar', 'yogurt cake'], ['red wine', 'rice'], ['red wine', 'salmon'], ['red wine', 'shrimp'], ['red wine', 'soup'], ['red wine', 'spaghetti'], ['red wine', 'strawberries'], ['red wine', 'tomato juice'], ['red wine', 'tomatoes'], ['red wine', 'turkey'], ['red wine', 'vegetables mix'], ['red wine', 'whole wheat pasta'], ['red wine', 'whole wheat rice'], ['red wine', 'yogurt cake'], ['rice', 'salmon'], ['rice', 'shrimp'], ['rice', 'soup'], ['rice', 'spaghetti'], ['rice', 'strawberries'], ['rice', 'tomato juice'], ['rice', 'tomatoes'], ['rice', 'turkey'], ['rice', 'vegetables mix'], ['rice', 'whole wheat pasta'], ['rice', 'whole wheat rice'], ['rice', 'yogurt cake'], ['salmon', 'shrimp'], ['salmon', 'soup'], ['salmon', 'spaghetti'], ['salmon', 'strawberries'], ['salmon', 'tomato juice'], ['salmon', 'tomatoes'], ['salmon', 'turkey'], ['salmon', 'vegetables mix'], ['salmon', 'whole wheat pasta'], ['salmon', 'whole wheat rice'], ['salmon', 'yogurt cake'], ['shrimp', 'soup'], ['shrimp', 'strawberries'], ['shrimp', 'tomato juice'], ['shrimp', 'tomatoes'], ['shrimp', 'turkey'], ['shrimp', 'vegetables mix'], ['shrimp', 'whole wheat pasta'], ['shrimp', 'whole wheat rice'], ['shrimp', 'yogurt cake'], ['soup', 'spaghetti'], ['soup', 'strawberries'], ['soup', 'tomato juice'], ['soup', 'tomatoes'], ['soup', 'turkey'], ['soup', 'vegetables mix'], ['soup', 'whole wheat pasta'], ['soup', 'whole wheat rice'], ['soup', 'yogurt cake'], ['spaghetti', 'strawberries'], ['spaghetti', 'tomato juice'], ['spaghetti', 'turkey'], ['spaghetti', 'vegetables mix'], ['spaghetti', 'whole wheat pasta'], ['spaghetti', 'whole wheat rice'], ['spaghetti', 'yogurt cake'], ['strawberries', 'tomato juice'], ['strawberries', 'tomatoes'], ['strawberries', 'turkey'], ['strawberries', 'vegetables mix'], ['strawberries', 'whole wheat pasta'], ['strawberries', 'whole wheat rice'], ['strawberries', 'yogurt cake'], ['tomato juice', 'tomatoes'], ['tomato juice', 'turkey'], ['tomato juice', 'vegetables mix'], ['tomato juice', 'whole wheat pasta'], ['tomato juice', 'whole wheat rice'], ['tomato juice', 'yogurt cake'], ['tomatoes', 'turkey'], ['tomatoes', 'vegetables mix'], ['tomatoes', 'whole wheat pasta'], ['tomatoes', 'whole wheat rice'], ['tomatoes', 'yogurt cake'], ['turkey', 'vegetables mix'], ['turkey', 'whole wheat pasta'], ['turkey', 'whole wheat rice'], ['turkey', 'yogurt cake'], ['vegetables mix', 'whole wheat pasta'], ['vegetables mix', 'whole wheat rice'], ['vegetables mix', 'yogurt cake'], ['whole wheat pasta', 'whole wheat rice'], ['whole wheat pasta', 'yogurt cake'], ['whole wheat rice', 'yogurt cake']]

MFCS = [['almonds'], ['avocado'], ['brownies'], ['burgers', 'chocolate', 'eggs', 'french fries', 'green tea', 'milk', 'mineral water', 'spaghetti'], ['butter'], ['cake', 'eggs', 'french fries', 'mineral water', 'spaghetti'], ['cereals'], ['champagne'], ['chicken', 'mineral water', 'spaghetti'], ['cookies'], ['cooking oil', 'mineral water'], ['cottage cheese'], ['energy bar'], ['energy drink'], ['chocolate', 'escalope', 'mineral water'], ['french wine'], ['fresh bread'], ['fresh tuna'], ['frozen smoothie', 'mineral water'], ['chocolate', 'eggs', 'frozen vegetables', 'ground beef', 'milk', 'mineral water', 'spaghetti'], ['chocolate', 'eggs', 'french fries', 'frozen vegetables', 'milk', 'mineral water', 'spaghetti'], ['grated cheese', 'mineral water'], ['chocolate', 'frozen vegetables', 'milk', 'mineral water', 'shrimp', 'spaghetti'], ['ham'], ['herb & pepper', 'mineral water'], ['honey'], ['hot dogs'], ['light mayo'], ['eggs', 'low fat yogurt', 'mineral water'], ['meatballs'], ['chocolate', 'eggs', 'french fries', 'mineral water', 'pancakes', 'spaghetti'], ['mint'], ['muffins'], ['mushroom cream sauce'], ['oil'], ['milk', 'mineral water', 'olive oil', 'spaghetti'], ['parmesan cheese'], ['pepper'], ['protein bar'], ['red wine'], ['rice'], ['mineral water', 'salmon'], ['mineral water', 'soup'], ['eggs', 'mineral water', 'turkey'], ['mineral water', 'spaghetti', 'tomatoes'], ['strawberries'], ['tomato juice'], ['mineral water', 'whole wheat rice'], ['vegetables mix'], ['whole wheat pasta'], ['yogurt cake']]

LEVEL 3:

C3 = [['burgers', 'chocolate', 'eggs'], ['burgers', 'chocolate', 'french fries'], ['burgers', 'chocolate', 'green tea'], ['burgers', 'chocolate', 'milk'], ['burgers', 'chocolate', 'mineral water'], ['burgers', 'choco

late', 'spaghetti'], ['burgers', 'eggs', 'french fries'], ['burgers', 'eggs', 'green tea'], ['burgers', 'eggs', 'milk'], ['burgers', 'eggs', 'mineral water'], ['burgers', 'eggs', 'spaghetti'], ['burgers', 'french fries', 'green tea'], ['burgers', 'french fries', 'milk'], ['burgers', 'french fries', 'mineral water'], ['burgers', 'french fries', 'spaghetti'], ['burgers', 'green tea', 'milk'], ['burgers', 'green tea', 'mineral water'], ['burgers', 'green tea', 'spaghetti'], ['burgers', 'milk', 'mineral water'], ['burgers', 'milk', 'spaghetti'], ['burgers', 'mineral water', 'spaghetti'], ['cake', 'eggs', 'french fries'], ['cake', 'eggs', 'mineral water'], ['cake', 'eggs', 'spaghetti'], ['cake', 'french fries', 'mineral water'], ['cake', 'french fries', 'spaghetti'], ['cake', 'mineral water', 'spaghetti'], ['chicken', 'mineral water', 'spaghetti'], ['chocolate', 'eggs', 'french fries'], ['chocolate', 'eggs', 'frozen vegetables'], ['chocolate', 'eggs', 'green tea'], ['chocolate', 'eggs', 'ground beef'], ['chocolate', 'eggs', 'milk'], ['chocolate', 'eggs', 'mineral water'], ['chocolate', 'eggs', 'pancakes'], ['chocolate', 'eggs', 'spaghetti'], ['chocolate', 'escalope', 'mineral water'], ['chocolate', 'french fries', 'frozen vegetables'], ['chocolate', 'french fries', 'green tea'], ['chocolate', 'french fries', 'milk'], ['chocolate', 'french fries', 'mineral water'], ['chocolate', 'french fries', 'pancakes'], ['chocolate', 'french fries', 'spaghetti'], ['chocolate', 'frozen vegetables', 'ground beef'], ['chocolate', 'frozen vegetables', 'milk'], ['chocolate', 'frozen vegetables', 'mineral water'], ['chocolate', 'frozen vegetables', 'shrimp'], ['chocolate', 'frozen vegetables', 'spaghetti'], ['chocolate', 'green tea', 'milk'], ['chocolate', 'green tea', 'mineral water'], ['chocolate', 'green tea', 'spaghetti'], ['chocolate', 'ground beef', 'milk'], ['chocolate', 'ground beef', 'mineral water'], ['chocolate', 'ground beef', 'spaghetti'], ['chocolate', 'milk', 'mineral water'], ['chocolate', 'milk', 'shrimp'], ['chocolate', 'milk', 'spaghetti'], ['chocolate', 'mineral water', 'pancakes'], ['chocolate', 'mineral water', 'shrimp'], ['chocolate', 'mineral water', 'spaghetti'], ['chocolate', 'pancakes', 'spaghetti'], ['chocolate', 'shrimp', 'spaghetti'], ['eggs', 'french fries', 'frozen vegetables'], ['eggs', 'french fries', 'green tea'], ['eggs', 'french fries', 'milk'], ['eggs', 'french fries', 'mineral water'], ['eggs', 'french fries', 'pancakes'], ['eggs', 'french fries', 'spaghetti'], ['eggs', 'frozen vegetables', 'ground beef'], ['eggs', 'frozen vegetables', 'milk'], ['eggs', 'frozen vegetables', 'mineral water'], ['eggs', 'frozen vegetables', 'spaghetti'], ['eggs', 'green tea', 'milk'], ['eggs', 'green tea', 'mineral water'], ['eggs', 'green tea', 'spaghetti'], ['eggs', 'ground beef', 'milk'], ['eggs', 'ground beef', 'mineral water'], ['eggs', 'ground beef', 'spaghetti'], ['eggs', 'low fat yogurt', 'mineral water'], ['eggs', 'milk', 'mineral water'], ['eggs', 'milk', 'spaghetti'], ['eggs', 'mineral water', 'pancakes'], ['eggs', 'mineral water', 'spaghetti'], ['eggs', 'mineral water', 'turkey'], ['eggs', 'pancakes', 'spaghetti'], ['french fries', 'frozen vegetables', 'milk'], ['french fries', 'frozen vegetables', 'mineral water'], ['french fries', 'frozen vegetables', 'spaghetti'], ['french fries', 'green tea', 'milk'], ['french fries', 'green tea', 'mineral water'], ['french fries', 'green tea', 'spaghetti'], ['french fries', 'milk', 'mineral water'], ['french fries', 'milk', 'spaghetti'], ['french fries', 'mineral water', 'pancakes'], ['french fries', 'mineral water', 'spaghetti'], ['french fries', 'pancakes', 'spaghetti'], ['frozen vegetables', 'ground beef', 'milk'], ['frozen vegetables', 'ground beef', 'mineral water'], ['frozen vegetables', 'ground beef', 'spaghetti'], ['frozen vegetables', 'milk', 'mineral water'], ['frozen vegetables', 'milk', 'shrimp'], ['frozen vegetables', 'milk', 'spaghetti'], ['frozen vegetables', 'mineral water', 'shrimp'], ['frozen vegetables', 'mineral water', 'spaghetti'], ['frozen vegetables', 'shrimp', 'spaghetti'], ['green tea', 'milk', 'mineral water'], ['green tea', 'milk', 'spaghetti'], ['green tea', 'mineral water', 'spaghetti'], ['ground beef', 'milk', 'mineral water'], ['ground beef', 'milk', 'spaghetti'], ['ground beef', 'mineral water', 'spaghetti'], ['milk', 'mineral water', 'olive oil'], ['milk', 'mineral water', 'shrimp'], ['milk', 'mineral water', 'spaghetti'], ['milk', 'olive oil', 'spaghetti'], ['milk', 'shrimp', 'spaghetti'], ['mineral water', 'olive oil', 'spaghetti'], ['mineral water', 'pancakes', 'spaghetti'], ['mineral water', 'shrimp', 'spaghetti'], ['mineral water', 'spaghetti', 'tomatoes']]

Candidate Set along with Count:

['burgers', 'chocolate', 'eggs'] -> 41, ['burgers', 'chocolate', 'french fries'] -> 36, ['burgers', 'chocolate', 'green tea'] -> 26, ['burgers', 'chocolate', 'milk'] -> 41, ['burgers', 'chocolate', 'mineral water'] -> 43, ['burgers', 'chocolate', 'spaghetti'] -> 48, ['burgers', 'eggs', 'french fries'] -> 68, ['burgers', 'eggs', 'green tea'] -> 45, ['burgers', 'eggs', 'milk'] -> 40, ['burgers', 'eggs', 'mineral water'] -> 59, ['burgers', 'eggs', 'spaghetti'] -> 54, ['burgers', 'french fries', 'green tea'] -> 41, ['burgers', 'french fries', 'milk'] -> 42, ['burgers', 'french fries', 'mineral water'] -> 39, ['burgers', 'french fries', 'spaghetti'] -> 42, ['burgers', 'green tea', 'milk'] -> 28, ['burgers', 'green tea', 'mineral water'] -> 26, ['burgers', 'green tea', 'spaghetti'] -> 36, ['burgers', 'milk', 'mineral water'] -> 52, ['burgers', 'milk', 'spaghetti'] -> 48, ['burgers', 'mineral water', 'spaghetti'] -> 49, ['cake', 'eggs', 'french fries'] -> 34, ['cake', 'eggs', 'mineral water'] -> 54, ['cake', 'eggs', 'spaghetti'] -> 36, ['cake', 'french fries', 'mineral water'] -> 48, ['cake', 'french fries', 'spaghetti'] -> 27, ['cake', 'mineral water', 'spaghetti'] -> 53, ['chicken', 'mineral water', 'spaghetti'] -> 52, ['chocolate', 'eggs', 'french fries'] -> 63, ['chocolate', 'eggs', 'frozen vegetables'] -> 43, ['chocolate', 'eggs', 'green tea'] -> 41, ['chocolate', 'eggs', 'ground beef'] -> 49, ['chocolate', 'eggs', 'milk'] -> 69, ['chocolate', 'eggs', 'mineral water'] -> 101, ['chocolate', 'eggs', 'pancakes'] -> 42, ['chocolate', 'eggs', 'spaghetti'] -> 79, ['chocolate', 'escalope', 'mineral water'] -> 42, ['chocolate', 'french fries', 'frozen vegetables'] -> 42, ['chocolate', 'french fries', 'green tea'] -> 39, ['chocolate', 'french fries', 'milk'] -> 55, ['chocolate', 'french fries', 'mineral water'] -> 64, ['chocolate', 'french fries', 'pancakes'] -> 41, ['chocolate', 'french fries', 'spaghetti'] -> 60, ['chocolate', 'frozen vegetables', 'ground beef'] -> 43, ['chocolate', 'frozen vegetables', 'milk'] -> 60, ['chocolate', 'frozen vegetables', 'mineral water'] -> 73, ['chocolate', 'frozen vegetables', 'shrimp'] -> 40, ['chocolate', 'frozen vegetables', 'spaghetti'] -> 59, ['chocolate', 'green tea', 'milk'] -> 35, ['chocolate', 'green tea', 'mineral water'] -> 52, ['chocolate', 'green tea', 'spaghetti'] -> 53, ['chocolate', 'ground beef', 'milk'] -> 46, ['chocolate', 'ground beef', 'mineral water'] -> 82, ['chocolate', 'ground beef', 'spaghetti'] -> 69, ['chocolate', 'milk', 'mineral water'] -> 105, ['chocolate', 'milk', 'shrimp'] -> 41, ['chocolate', 'milk', 'spaghetti'] -> 82, ['chocolate', 'mineral water', 'pancakes'] -> 70, ['chocolate', 'mineral water', 'shrimp'] -> 57, ['chocolate', 'mineral water', 'spaghetti'] -> 119, ['chocolate', 'pancakes', 'spaghetti'] -> 51, ['chocolate', 'shrimp', 'spaghetti'] -> 48, ['eggs', 'french fries', 'frozen vegetables'] -> 39, ['eggs', 'french fries', 'green tea'] -> 53, ['eggs', 'french fries', 'milk'] -> 54, ['eggs', 'french fries', 'mineral water'] -> 52, ['eggs', 'french fries', 'pancakes'] -> 36, ['eggs', 'french fries', 'spaghetti'] -> 60, ['eggs', 'frozen vegetables', 'ground beef'] -> 33, ['eggs', 'frozen vegetables', 'milk'] -> 55, ['eggs', 'frozen vegetables', 'mineral water'] -> 68, ['eggs', 'frozen vegetables', 'spaghetti'] -> 43, ['eggs', 'green tea', 'milk'] -> 29, ['eggs', 'green tea', 'mineral water'] -> 52, ['eggs', 'green tea', 'spaghetti'] -> 43, ['eggs', 'ground beef', 'milk'] -> 44, ['eggs', 'ground beef', 'mineral water'] -> 76, ['eggs', 'ground beef', 'spaghetti'] -> 67, ['eggs', 'low fat yogurt', 'mineral water'] -> 46, ['eggs', 'milk', 'mineral water'] -> 98, ['eggs', 'milk', 'spaghetti'] -> 67, ['eggs', 'mineral water', 'pancakes'] -> 59, ['eggs', 'mineral water', 'spaghetti'] -> 107, ['eggs', 'mineral water', 'turkey'] -> 42, ['eggs', 'pancakes', 'spaghetti'] -> 50, ['french fries', 'frozen vegetables', 'milk'] -> 43, ['french fries', 'frozen vegetables', 'mineral water'] -> 46, ['french fries', 'frozen vegetables', 'spaghetti'] -> 40, ['french fries', 'green tea', 'milk'] -> 30, ['french fries', 'green tea', 'mineral water'] -> 46, ['french fries', 'green tea', 'spaghetti'] -> 40, ['french fries', 'milk', 'mineral water'] -> 62, ['french fries', 'milk', 'spaghetti'] -> 48, ['french fries', 'mineral water', 'pancakes'] -> 49, ['french fries', 'mineral water', 'spaghetti'] -> 76, ['french fries', 'pancakes', 'spaghetti'] -> 43, ['frozen vegetables', 'ground beef', 'milk'] -> 43, ['frozen vegetables', 'ground beef', 'mineral water'] -> 69, ['frozen vegetables', 'ground beef', 'spaghetti'] -> 65, ['frozen vegetables', 'milk', 'mineral water'] -> 83, ['frozen vegetables', 'milk', 'shrimp'] -> 35, ['fr

ozen vegetables', 'milk', 'spaghetti'] -> 62, ['frozen vegetables', 'mineral water', 'shrimp'] -> 54, ['frozen vegetables', 'mineral water', 'spaghetti'] -> 90, ['frozen vegetables', 'shrimp', 'spaghetti'] -> 45, ['green tea', 'milk', 'mineral water'] -> 43, ['green tea', 'milk', 'spaghetti'] -> 39, ['green tea', 'mineral water', 'spaghetti'] -> 62, ['ground beef', 'milk', 'mineral water'] -> 83, ['ground beef', 'milk', 'spaghetti'] -> 73, ['ground beef', 'mineral water', 'spaghetti'] -> 128, ['milk', 'mineral water', 'olive oil'] -> 64, ['milk', 'mineral water', 'shrimp'] -> 59, ['milk', 'mineral water', 'spaghetti'] -> 118, ['milk', 'olive oil', 'spaghetti'] -> 54, ['milk', 'shrimp', 'spaghetti'] -> 37, ['mineral water', 'olive oil', 'spaghetti'] -> 77, ['mineral water', 'pancakes', 'spaghetti'] -> 86, ['mineral water', 'shrimp', 'spaghetti'] -> 64, ['mineral water', 'spaghetti', 'tomatoes'] -> 70,

MFCS Set along with Count:

['almonds'] -> 153, ['avocado'] -> 250, ['brownies'] -> 253, ['burgers', 'chocolate', 'eggs', 'french fries', 'green tea', 'milk', 'mineral water', 'spaghetti'] -> 0, ['butter'] -> 226, ['cake', 'eggs', 'french fries', 'mineral water', 'spaghetti'] -> 3, ['cereals'] -> 193, ['champagne'] -> 351, ['chicken', 'mineral water', 'spaghetti'] -> 52, ['cookies'] -> 603, ['cooking oil', 'mineral water'] -> 151, ['cottage cheese'] -> 239, ['energy bar'] -> 203, ['energy drink'] -> 200, ['chocolate', 'escalope', 'mineral water'] -> 42, ['french wine'] -> 169, ['fresh bread'] -> 323, ['fresh tuna'] -> 167, ['frozen smoothie', 'mineral water'] -> 152, ['chocolate', 'eggs', 'frozen vegetables', 'ground beef', 'milk', 'mineral water', 'spaghetti'] -> 3, ['chocolate', 'eggs', 'french fries', 'frozen vegetables', 'milk', 'mineral water', 'spaghetti'] -> 1, ['grated cheese', 'mineral water'] -> 131, ['chocolate', 'frozen vegetables', 'milk', 'mineral water', 'shrimp', 'spaghetti'] -> 6, ['ham'] -> 199, ['herb & pepper', 'mineral water'] -> 128, ['honey'] -> 356, ['hot dogs'] -> 243, ['light mayo'] -> 204, ['eggs', 'low fat yogurt', 'mineral water'] -> 46, ['meatballs'] -> 157, ['chocolate', 'eggs', 'french fries', 'mineral water', 'pancakes', 'spaghetti'] -> 2, ['mint'] -> 131, ['muffins'] -> 181, ['mushroom cream sauce'] -> 143, ['oil'] -> 173, ['milk', 'mineral water', 'olive oil', 'spaghetti'] -> 25, ['parmesan cheese'] -> 149, ['pepper'] -> 199, ['protein bar'] -> 139, ['red wine'] -> 211, ['rice'] -> 141, ['mineral water', 'salmon'] -> 128, ['mineral water', 'soup'] -> 173, ['eggs', 'mineral water', 'turkey'] -> 42, ['mineral water', 'spaghetti', 'tomatoes'] -> 70, ['strawberries'] -> 160, ['tomato juice'] -> 228, ['mineral water', 'whole wheat rice'] -> 151, ['vegetables mix'] -> 193, ['whole wheat pasta'] -> 221, ['yogurt cake'] -> 205, MFS = [['almonds'], ['avocado'], ['brownies'], ['butter'], ['cereals'], ['champagne'], ['cookies'], ['cooking oil', 'mineral water'], ['cottage cheese'], ['energy bar'], ['energy drink'], ['french wine'], ['fresh bread'], ['fresh tuna'], ['frozen smoothie', 'mineral water'], ['grated cheese', 'mineral water'], ['ham'], ['herb & pepper', 'mineral water'], ['honey'], ['hot dogs'], ['light mayo'], ['meatballs'], ['mint'], ['muffins'], ['mushroom cream sauce'], ['oil'], ['parmesan cheese'], ['pepper'], ['protein bar'], ['red wine'], ['rice'], ['mineral water', 'salmon'], ['mineral water', 'soup'], ['strawberries'], ['tomato juice'], ['mineral water', 'whole wheat rice'], ['vegetables mix'], ['whole wheat pasta'], ['yogurt cake']]]

L3 = [['ground beef', 'mineral water', 'spaghetti']]

S3 = [['burgers', 'chocolate', 'eggs'], ['burgers', 'chocolate', 'french fries'], ['burgers', 'chocolate', 'green tea'], ['burgers', 'chocolate', 'milk'], ['burgers', 'chocolate', 'mineral water'], ['burgers', 'chocolate', 'spaghetti'], ['burgers', 'eggs', 'french fries'], ['burgers', 'eggs', 'green tea'], ['burgers', 'eggs', 'milk'], ['burgers', 'eggs', 'mineral water'], ['burgers', 'eggs', 'spaghetti'], ['burgers', 'french fries', 'green tea'], ['burgers', 'french fries', 'milk'], ['burgers', 'french fries', 'mineral water'], ['burgers', 'french fries', 'spaghetti'], ['burgers', 'green tea', 'milk'], ['burgers', 'green tea', 'mineral water'], ['burgers', 'green tea', 'spaghetti'], ['burgers', 'milk', 'mineral water'], ['burgers', 'milk', 'spaghetti'], ['burgers', 'mineral water', 'spaghetti'], ['cake', 'eggs', 'french fries'], ['cake', 'eggs', 'mineral water'], ['cake', 'eggs', 'spaghetti'], ['cake', 'mineral water', 'spaghetti'], ['cake', 'milk', 'spaghetti'], ['cake', 'olive oil', 'spaghetti'], ['cake', 'shrimp', 'spaghetti'], ['cake', 'tomatoes', 'spaghetti'], ['cake', 'whole wheat rice', 'spaghetti'], ['cake', 'whole wheat pasta', 'spaghetti'], ['cake', 'yogurt cake', 'spaghetti'], ['chocolate', 'eggs', 'french fries'], ['chocolate', 'eggs', 'green tea'], ['chocolate', 'eggs', 'milk'], ['chocolate', 'eggs', 'mineral water'], ['chocolate', 'eggs', 'spaghetti'], ['chocolate', 'french fries', 'green tea'], ['chocolate', 'french fries', 'milk'], ['chocolate', 'french fries', 'mineral water'], ['chocolate', 'french fries', 'spaghetti'], ['chocolate', 'green tea', 'milk'], ['chocolate', 'green tea', 'mineral water'], ['chocolate', 'green tea', 'spaghetti'], ['chocolate', 'milk', 'mineral water'], ['chocolate', 'milk', 'spaghetti'], ['chocolate', 'mineral water', 'spaghetti'], ['chocolate', 'olive oil', 'spaghetti'], ['chocolate', 'shrimp', 'spaghetti'], ['chocolate', 'tomatoes', 'spaghetti'], ['chocolate', 'whole wheat rice', 'spaghetti'], ['chocolate', 'whole wheat pasta', 'spaghetti'], ['chocolate', 'yogurt cake', 'spaghetti'], ['cookies'], ['cottage cheese'], ['energy bar'], ['energy drink'], ['french wine'], ['fresh bread'], ['fresh tuna'], ['frozen smoothie', 'mineral water'], ['grated cheese', 'mineral water'], ['ham'], ['herb & pepper', 'mineral water'], ['honey'], ['hot dogs'], ['light mayo'], ['meatballs'], ['mint'], ['muffins'], ['mushroom cream sauce'], ['oil'], ['parmesan cheese'], ['pepper'], ['protein bar'], ['red wine'], ['rice'], ['mineral water', 'salmon'], ['mineral water', 'soup'], ['strawberries'], ['tomato juice'], ['mineral water', 'whole wheat rice'], ['vegetables mix'], ['whole wheat pasta'], ['yogurt cake']]]

al water'], ['cake', 'eggs', 'spaghetti'], ['cake', 'french fries', 'mineral water'], ['cake', 'french fries', 'spaghetti'], ['cake', 'mineral water', 'spaghetti'], ['chicken', 'mineral water', 'spaghetti'], ['chocolate', 'eggs', 'french fries'], ['chocolate', 'eggs', 'frozen vegetables'], ['chocolate', 'eggs', 'green tea'], ['chocolate', 'eggs', 'ground beef'], ['chocolate', 'eggs', 'milk'], ['chocolate', 'eggs', 'mineral water'], ['chocolate', 'eggs', 'pancakes'], ['chocolate', 'eggs', 'spaghetti'], ['chocolate', 'escalope', 'mineral water'], ['chocolate', 'french fries', 'frozen vegetables'], ['chocolate', 'french fries', 'green tea'], ['chocolate', 'french fries', 'milk'], ['chocolate', 'french fries', 'mineral water'], ['chocolate', 'french fries', 'pancakes'], ['chocolate', 'french fries', 'spaghetti'], ['chocolate', 'frozen vegetables', 'ground beef'], ['chocolate', 'frozen vegetables', 'milk'], ['chocolate', 'frozen vegetables', 'mineral water'], ['chocolate', 'frozen vegetables', 'shrimp'], ['chocolate', 'frozen vegetables', 'spaghetti'], ['chocolate', 'green tea', 'milk'], ['chocolate', 'green tea', 'mineral water'], ['chocolate', 'green tea', 'spaghetti'], ['chocolate', 'ground beef', 'milk'], ['chocolate', 'ground beef', 'mineral water'], ['chocolate', 'ground beef', 'spaghetti'], ['chocolate', 'milk', 'mineral water'], ['chocolate', 'milk', 'shrimp'], ['chocolate', 'milk', 'spaghetti'], ['chocolate', 'mineral water', 'pancakes'], ['chocolate', 'mineral water', 'shrimp'], ['chocolate', 'mineral water', 'spaghetti'], ['chocolate', 'pancakes', 'spaghetti'], ['chocolate', 'shrimp', 'spaghetti'], ['eggs', 'french fries', 'frozen vegetables'], ['eggs', 'french fries', 'green tea'], ['eggs', 'french fries', 'milk'], ['eggs', 'french fries', 'mineral water'], ['eggs', 'french fries', 'pancakes'], ['eggs', 'french fries', 'spaghetti'], ['eggs', 'frozen vegetables', 'ground beef'], ['eggs', 'frozen vegetables', 'milk'], ['eggs', 'frozen vegetables', 'mineral water'], ['eggs', 'frozen vegetables', 'spaghetti'], ['eggs', 'green tea', 'milk'], ['eggs', 'green tea', 'mineral water'], ['eggs', 'green tea', 'spaghetti'], ['eggs', 'ground beef', 'milk'], ['eggs', 'ground beef', 'mineral water'], ['eggs', 'ground beef', 'spaghetti'], ['eggs', 'low fat yogurt', 'mineral water'], ['eggs', 'milk', 'mineral water'], ['eggs', 'milk', 'spaghetti'], ['eggs', 'mineral water', 'pancakes'], ['eggs', 'mineral water', 'spaghetti'], ['eggs', 'mineral water', 'turkey'], ['eggs', 'pancakes', 'spaghetti'], ['french fries', 'frozen vegetables', 'milk'], ['french fries', 'frozen vegetables', 'mineral water'], ['french fries', 'frozen vegetables', 'spaghetti'], ['french fries', 'green tea', 'milk'], ['french fries', 'green tea', 'mineral water'], ['french fries', 'green tea', 'spaghetti'], ['french fries', 'milk', 'mineral water'], ['french fries', 'milk', 'spaghetti'], ['french fries', 'mineral water', 'pancakes'], ['french fries', 'mineral water', 'spaghetti'], ['french fries', 'pancakes', 'spaghetti'], ['frozen vegetables', 'ground beef', 'milk'], ['frozen vegetables', 'ground beef', 'mineral water'], ['frozen vegetables', 'ground beef', 'spaghetti'], ['frozen vegetables', 'milk', 'mineral water'], ['frozen vegetables', 'milk', 'shrimp'], ['frozen vegetables', 'milk', 'spaghetti'], ['frozen vegetables', 'mineral water', 'shrimp'], ['frozen vegetables', 'mineral water', 'spaghetti'], ['frozen vegetables', 'shrimp', 'spaghetti'], ['green tea', 'milk', 'mineral water'], ['green tea', 'milk', 'spaghetti'], ['green tea', 'mineral water', 'spaghetti'], ['ground beef', 'milk', 'mineral water'], ['ground beef', 'milk', 'spaghetti'], ['milk', 'mineral water', 'olive oil'], ['milk', 'mineral water', 'shrimp'], ['milk', 'mineral water', 'spaghetti'], ['milk', 'olive oil', 'spaghetti'], ['milk', 'shrimp', 'spaghetti'], ['mineral water', 'olive oil', 'spaghetti'], ['mineral water', 'pancakes', 'spaghetti'], ['mineral water', 'shrimp', 'spaghetti'], ['mineral water', 'spaghetti', 'tomatoes']]

MFCS = [['almonds'], ['avocado'], ['brownies'], ['butter'], ['cereals'], ['champagne'], ['cookies'], ['cooking oil', 'mineral water'], ['cottage cheese'], ['energy bar'], ['energy drink'], ['french wine'], ['fresh bread'], ['fresh tuna'], ['frozen smoothie', 'mineral water'], ['grated cheese', 'mineral water'], ['ham'], ['herb & pepper', 'mineral water'], ['honey'], ['hot dogs'], ['light mayo'], ['meatballs'], ['mint'], ['muffins'], ['mushroom cream sauce'], ['oil'], ['parmesan cheese'], ['pepper'], ['protein bar'], ['red wine'], ['rice'], ['mineral water', 'salmon'], ['mineral water', 'soup'], ['strawberries'], ['tomato juice'], ['mineral water', 'whole wheat rice'], ['vegetables mix'], ['whole wheat pasta'], ['yogurt cake'], ['burgers', 'chocol

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ate'], ['burgers', 'eggs'], ['burgers', 'french fries'], ['burgers', 'green tea'], ['burgers', 'milk'], ['burgers', 'spaghetti'], ['burgers', 'mineral water'], ['cake', 'eggs'], ['cake', 'french fries'], ['cake', 'spaghetti'], ['cake', 'mineral water'], ['chicken', 'spaghetti'], ['chicken', 'mineral water'], ['chocolate', 'eggs'], ['escalope', 'mineral water'], ['chocolate', 'escalope'], ['chocolate', 'french fries'], ['chocolate', 'frozen vegetables'], ['chocolate', 'green tea'], ['chocolate', 'ground beef'], ['chocolate', 'milk'], ['chocolate', 'mineral water'], ['chocolate', 'pancakes'], ['chocolate', 'spaghetti'], ['chocolate', 'shrimp'], ['eggs', 'french fries'], ['eggs', 'frozen vegetables'], ['eggs', 'green tea'], ['eggs', 'ground beef'], ['low fat yogurt', 'mineral water'], ['eggs', 'low fat yogurt'], ['eggs', 'milk'], ['mineral water', 'turkey'], ['eggs', 'turkey'], ['eggs', 'mineral water'], ['eggs', 'spaghetti'], ['eggs', 'pancakes'], ['french fries', 'frozen vegetables'], ['french fries', 'green tea'], ['french fries', 'milk'], ['french fries', 'mineral water'], ['french fries', 'spaghetti'], ['french fries', 'pancakes'], ['frozen vegetables', 'ground beef'], ['frozen vegetables', 'milk'], ['frozen vegetables', 'mineral water'], ['frozen vegetables', 'spaghetti'], ['frozen vegetables', 'shrimp'], ['green tea', 'milk'], ['green tea', 'spaghetti'], ['green tea', 'mineral water'], ['ground beef', 'mineral water', 'spaghetti'], ['ground beef', 'milk'], ['milk', 'mineral water'], ['milk', 'olive oil'], ['milk', 'spaghetti'], ['milk', 'shrimp'], ['olive oil', 'spaghetti'], ['mineral water', 'olive oil'], ['pancakes', 'spaghetti'], ['mineral water', 'pancakes'], ['shrimp', 'spaghetti'], ['mineral water', 'shrimp'], ['spaghetti', 'tomatoes'], ['mineral water', 'tomatoes']]
```

```
MFS = [['almonds'], ['avocado'], ['brownies'], ['butter'], ['cereals'], ['champagne'], ['cookies'], ['cooking oil', 'mineral water'], ['cottage cheese'], ['energy bar'], ['energy drink'], ['french wine'], ['fresh bread'], ['fresh tuna'], ['frozen smoothie', 'mineral water'], ['grated cheese', 'mineral water'], ['ham'], ['herb & pepper', 'mineral water'], ['honey'], ['hot dogs'], ['light mayo'], ['meatballs'], ['mint'], ['muffins'], ['mushroom cream sauce'], ['oil'], ['parmesan cheese'], ['pepper'], ['protein bar'], ['red wine'], ['rice'], ['mineral water', 'salmon'], ['mineral water', 'soup'], ['strawberries'], ['tomato juice'], ['mineral water', 'whole wheat rice'], ['vegetables mix'], ['whole wheat pasta'], ['yogurt cake']]
```

```
In [15]: print("MFS = {}".format(MFS))
```

```
MFS = [['almonds'], ['avocado'], ['brownies'], ['butter'], ['cereals'], ['champagne'], ['cookies'], ['cooking oil', 'mineral water'], ['cottage cheese'], ['energy bar'], ['energy drink'], ['french wine'], ['fresh bread'], ['fresh tuna'], ['frozen smoothie', 'mineral water'], ['grated cheese', 'mineral water'], ['ham'], ['herb & pepper', 'mineral water'], ['honey'], ['hot dogs'], ['light mayo'], ['meatballs'], ['mint'], ['muffins'], ['mushroom cream sauce'], ['oil'], ['parmesan cheese'], ['pepper'], ['protein bar'], ['red wine'], ['rice'], ['mineral water', 'salmon'], ['mineral water', 'soup'], ['strawberries'], ['tomato juice'], ['mineral water', 'whole wheat rice'], ['vegetables mix'], ['whole wheat pasta'], ['yogurt cake']]
```

Testing of MFI Pincer Algorithm with a fimi dataset is done along with next question to compare the efficiency of the algorithms

Question 3

Implement any one CFI or MFI algorithm not discussed in the class and test it on the same FIMI workshop dataset and make a time

comparison between the performance of Apriori, FP- growth, A close, Pincer Search and the last algorithm(the one you have implemented apart from classroom discussions) for varying support sizes over a benchmark dataset.

MFI Algorithm "Enumeration of Maximal Frequent Sets with Irredundant Dualization" is used here. Output of the algorithm along with time for various cases can be found for chess.dat fimi dataset

Case 1: Using Chess fimi dataset with min support count of 3600:

In [16]:

```
import time
chess_start = time.process_time()
chess_Min_Sup_Count=3600
chess_MFCS,chess_MFS = pincerSearch(chess, chess_Min_Sup_Count)
chess_time_taken=time.process_time() - chess_start
```

```
MFCS = [['1', '10', '11', '12', '13', '14', '15', '16', '17', '18', '19', '2', '20', '21', '22', '23', '24',
'25', '26', '27', '28', '29', '3', '30', '31', '32', '33', '34', '35', '36', '37', '38', '39', '4', '40', '4
1', '42', '43', '44', '45', '46', '47', '48', '49', '5', '50', '51', '52', '53', '54', '55', '56', '57', '58
', '59', '6', '60', '61', '62', '63', '64', '65', '66', '67', '68', '69', '7', '70', '71', '72', '73', '74',
'75', '8', '9']]
```

```
MFS = []
```

LEVEL 1:

```
C1 = [['1'], ['10'], ['11'], ['12'], ['13'], ['14'], ['15'], ['16'], ['17'], ['18'], ['19'], ['2'], ['20'],
['21'], ['22'], ['23'], ['24'], ['25'], ['26'], ['27'], ['28'], ['29'], ['3'], ['30'], ['31'], ['32'], ['33
'], ['34'], ['35'], ['36'], ['37'], ['38'], ['39'], ['4'], ['40'], ['41'], ['42'], ['43'], ['44'], ['45'],
['46'], ['47'], ['48'], ['49'], ['5'], ['50'], ['51'], ['52'], ['53'], ['54'], ['55'], ['56'], ['57'], ['58
'], ['59'], ['6'], ['60'], ['61'], ['62'], ['63'], ['64'], ['65'], ['66'], ['67'], ['68'], ['69'], ['7'], ['
70'], ['71'], ['72'], ['73'], ['74'], ['75'], ['8'], ['9']]
```

Candidate Set along with Count:

```
['1'] -> 1669, ['10'] -> 322, ['11'] -> 2129, ['12'] -> 1067, ['13'] -> 1722, ['14'] -> 1474, ['15'] -> 202
6, ['16'] -> 1170, ['17'] -> 2500, ['18'] -> 696, ['19'] -> 1980, ['2'] -> 1527, ['20'] -> 1216, ['21'] -> 2
225, ['22'] -> 971, ['23'] -> 1817, ['24'] -> 1379, ['25'] -> 2860, ['26'] -> 336, ['27'] -> 2205, ['28'] ->
991, ['29'] -> 3181, ['3'] -> 2839, ['30'] -> 15, ['31'] -> 2526, ['32'] -> 446, ['33'] -> 224, ['34'] -> 30
40, ['35'] -> 156, ['36'] -> 3099, ['37'] -> 97, ['38'] -> 2196, ['39'] -> 1000, ['4'] -> 357, ['40'] -> 317
0, ['41'] -> 26, ['42'] -> 2714, ['43'] -> 482, ['44'] -> 2612, ['45'] -> 584, ['46'] -> 2556, ['47'] -> 64
0, ['48'] -> 3013, ['49'] -> 183, ['5'] -> 2971, ['50'] -> 1975, ['51'] -> 1221, ['52'] -> 3185, ['53'] -> 1
1, ['54'] -> 2216, ['55'] -> 980, ['56'] -> 3021, ['57'] -> 175, ['58'] -> 3195, ['59'] -> 1, ['6'] -> 225,
['60'] -> 3149, ['61'] -> 47, ['62'] -> 3060, ['63'] -> 136, ['64'] -> 2631, ['65'] -> 565, ['66'] -> 3021,
['67'] -> 175, ['68'] -> 1984, ['69'] -> 1212, ['7'] -> 3076, ['70'] -> 2007, ['71'] -> 1189, ['72'] -> 234
```

```
5, ['73'] -> 851, ['74'] -> 2407, ['75'] -> 789, ['8'] -> 120, ['9'] -> 2874,
```

MFCS Set along with Count:

```
['1', '10', '11', '12', '13', '14', '15', '16', '17', '18', '19', '2', '20', '21', '22', '23', '24', '25', '26', '27', '28', '29', '3', '30', '31', '32', '33', '34', '35', '36', '37', '38', '39', '4', '40', '41', '42', '43', '44', '45', '46', '47', '48', '49', '5', '50', '51', '52', '53', '54', '55', '56', '57', '58', '59', '6', '60', '61', '62', '63', '64', '65', '66', '67', '68', '69', '7', '70', '71', '72', '73', '74', '75', '8', '9'] -> 0, MFS = []  
L1 = []  
S1 = [['1'], ['10'], ['11'], ['12'], ['13'], ['14'], ['15'], ['16'], ['17'], ['18'], ['19'], ['2'], ['20'], ['21'], ['22'], ['23'], ['24'], ['25'], ['26'], ['27'], ['28'], ['29'], ['3'], ['30'], ['31'], ['32'], ['33'], ['34'], ['35'], ['36'], ['37'], ['38'], ['39'], ['4'], ['40'], ['41'], ['42'], ['43'], ['44'], ['45'], ['46'], ['47'], ['48'], ['49'], ['5'], ['50'], ['51'], ['52'], ['53'], ['54'], ['55'], ['56'], ['57'], ['58'], ['59'], ['6'], ['60'], ['61'], ['62'], ['63'], ['64'], ['65'], ['66'], ['67'], ['68'], ['69'], ['7'], ['70'], ['71'], ['72'], ['73'], ['74'], ['75'], ['8'], ['9']]  
MFCS = [[]]
```

In [17]:

```
print("MFS = {}".format(chess_MFS))  
print("MFCS = {}".format(chess_MFCS))  
print("\n Time Taken for Mining the maximal itemset of chess dataset with min_support of "+str(chess_Min_Sup
```

```
MFS = []  
MFCS = [[]]
```

Time Taken for Mining the maximal itemset of chess dataset with min_support of 3600 = 0.16351089199999969 seconds

Case 2: Using Chess fiml dataset with min support count of 2800:

In [18]:

```
import time  
chess_start = time.process_time()  
chess_Min_Sup_Count=2800  
chess_MFCS,chess_MFS = pincerSearch(chess, chess_Min_Sup_Count)  
chess_time_taken=time.process_time() - chess_start
```

```
MFCS = [['1', '10', '11', '12', '13', '14', '15', '16', '17', '18', '19', '2', '20', '21', '22', '23', '24', '25', '26', '27', '28', '29', '3', '30', '31', '32', '33', '34', '35', '36', '37', '38', '39', '4', '40', '41', '42', '43', '44', '45', '46', '47', '48', '49', '5', '50', '51', '52', '53', '54', '55', '56', '57', '58', '59', '6', '60', '61', '62', '63', '64', '65', '66', '67', '68', '69', '7', '70', '71', '72', '73', '74', '75', '8', '9']]  
MFS = []
```

LEVEL 1:

```
C1 = [['1'], ['10'], ['11'], ['12'], ['13'], ['14'], ['15'], ['16'], ['17'], ['18'], ['19'], ['2'], ['20'],
['21'], ['22'], ['23'], ['24'], ['25'], ['26'], ['27'], ['28'], ['29'], ['3'], ['30'], ['31'], ['32'], ['33'],
['34'], ['35'], ['36'], ['37'], ['38'], ['39'], ['4'], ['40'], ['41'], ['42'], ['43'], ['44'], ['45'],
['46'], ['47'], ['48'], ['49'], ['5'], ['50'], ['51'], ['52'], ['53'], ['54'], ['55'], ['56'], ['57'], ['58'],
['59'], ['6'], ['60'], ['61'], ['62'], ['63'], ['64'], ['65'], ['66'], ['67'], ['68'], ['69'], ['7'], ['70'],
['71'], ['72'], ['73'], ['74'], ['75'], ['8'], ['9']]
```

Candidate Set along with Count:

```
['1'] -> 1669, ['10'] -> 322, ['11'] -> 2129, ['12'] -> 1067, ['13'] -> 1722, ['14'] -> 1474, ['15'] -> 202
6, ['16'] -> 1170, ['17'] -> 2500, ['18'] -> 696, ['19'] -> 1980, ['2'] -> 1527, ['20'] -> 1216, ['21'] -> 2
225, ['22'] -> 971, ['23'] -> 1817, ['24'] -> 1379, ['25'] -> 2860, ['26'] -> 336, ['27'] -> 2205, ['28'] ->
991, ['29'] -> 3181, ['3'] -> 2839, ['30'] -> 15, ['31'] -> 2526, ['32'] -> 446, ['33'] -> 224, ['34'] -> 30
40, ['35'] -> 156, ['36'] -> 3099, ['37'] -> 97, ['38'] -> 2196, ['39'] -> 1000, ['4'] -> 357, ['40'] -> 317
0, ['41'] -> 26, ['42'] -> 2714, ['43'] -> 482, ['44'] -> 2612, ['45'] -> 584, ['46'] -> 2556, ['47'] -> 64
0, ['48'] -> 3013, ['49'] -> 183, ['5'] -> 2971, ['50'] -> 1975, ['51'] -> 1221, ['52'] -> 3185, ['53'] -> 1
1, ['54'] -> 2216, ['55'] -> 980, ['56'] -> 3021, ['57'] -> 175, ['58'] -> 3195, ['59'] -> 1, ['6'] -> 225,
['60'] -> 3149, ['61'] -> 47, ['62'] -> 3060, ['63'] -> 136, ['64'] -> 2631, ['65'] -> 565, ['66'] -> 3021,
['67'] -> 175, ['68'] -> 1984, ['69'] -> 1212, ['7'] -> 3076, ['70'] -> 2007, ['71'] -> 1189, ['72'] -> 234
5, ['73'] -> 851, ['74'] -> 2407, ['75'] -> 789, ['8'] -> 120, ['9'] -> 2874,
```

MFCS Set along with Count:

```
['1', '10', '11', '12', '13', '14', '15', '16', '17', '18', '19', '2', '20', '21', '22', '23', '24', '25', '
26', '27', '28', '29', '3', '30', '31', '32', '33', '34', '35', '36', '37', '38', '39', '4', '40', '41', '42',
', '43', '44', '45', '46', '47', '48', '49', '5', '50', '51', '52', '53', '54', '55', '56', '57', '58', '59',
', '6', '60', '61', '62', '63', '64', '65', '66', '67', '68', '69', '7', '70', '71', '72', '73', '74', '75',
', '8', '9'] -> 0, MFS = []
```

```
L1 = [['25'], ['29'], ['3'], ['34'], ['36'], ['40'], ['48'], ['5'], ['52'], ['56'], ['58'], ['60'], ['62'],
['66'], ['7'], ['9']]
```

```
S1 = [['1'], ['10'], ['11'], ['12'], ['13'], ['14'], ['15'], ['16'], ['17'], ['18'], ['19'], ['2'], ['20'],
['21'], ['22'], ['23'], ['24'], ['26'], ['27'], ['28'], ['30'], ['31'], ['32'], ['33'], ['35'], ['37'], ['38'],
['39'], ['4'], ['41'], ['42'], ['43'], ['44'], ['45'], ['46'], ['47'], ['49'], ['50'], ['51'], ['53'],
['54'], ['55'], ['57'], ['59'], ['6'], ['61'], ['63'], ['64'], ['65'], ['67'], ['68'], ['69'], ['70'], ['71'],
['72'], ['73'], ['74'], ['75'], ['8']]
```

```
MFCS = [['25', '29', '3', '34', '36', '40', '48', '5', '52', '56', '58', '60', '62', '66', '7', '9']]
```

LEVEL 2:

```
C2 = [['25', '29'], ['25', '3'], ['25', '34'], ['25', '36'], ['25', '40'], ['25', '48'], ['25', '5'], ['25',
'52'], ['25', '56'], ['25', '58'], ['25', '60'], ['25', '62'], ['25', '66'], ['25', '7'], ['25', '9'], ['29',
', '3'], ['29', '34'], ['29', '36'], ['29', '40'], ['29', '48'], ['29', '5'], ['29', '52'], ['29', '56'], ['29',
'58'], ['29', '60'], ['29', '62'], ['29', '66'], ['29', '7'], ['29', '9'], ['3', '34'], ['3', '36'], ['3',
'40'], ['3', '48'], ['3', '5'], ['3', '52'], ['3', '56'], ['3', '58'], ['3', '60'], ['3', '62'], ['3', '66'],
['3', '7'], ['3', '9'], ['34', '36'], ['34', '40'], ['34', '48'], ['34', '5'], ['34', '52'], ['34', '56'],
['34', '58'], ['34', '60'], ['34', '62'], ['34', '66'], ['34', '7'], ['34', '9'], ['36', '40'], ['36',
```


'48'], ['36', '5'], ['36', '52'], ['36', '56'], ['36', '58'], ['36', '60'], ['36', '62'], ['36', '66'], ['36', '7'], ['36', '9'], ['40', '48'], ['40', '5'], ['40', '52'], ['40', '56'], ['40', '58'], ['40', '60'], ['40', '62'], ['40', '66'], ['40', '7'], ['40', '9'], ['48', '5'], ['48', '52'], ['48', '56'], ['48', '58'], ['48', '60'], ['48', '62'], ['48', '66'], ['48', '7'], ['48', '9'], ['5', '52'], ['5', '56'], ['5', '58'], ['5', '60'], ['5', '62'], ['5', '66'], ['5', '7'], ['5', '9'], ['52', '56'], ['52', '58'], ['52', '60'], ['52', '62'], ['52', '66'], ['52', '7'], ['52', '9'], ['56', '58'], ['56', '60'], ['56', '62'], ['56', '66'], ['56', '7'], ['56', '9'], ['58', '60'], ['58', '62'], ['58', '66'], ['58', '7'], ['58', '9'], ['60', '62'], ['60', '66'], ['60', '7'], ['60', '9'], ['62', '66'], ['62', '7'], ['62', '9'], ['66', '7'], ['66', '9'], ['7', '9']]

Candidate Set along with Count:

['25', '29'] -> 2848, ['25', '3'] -> 2520, ['25', '34'] -> 2712, ['25', '36'] -> 2794, ['25', '40'] -> 2834, ['25', '48'] -> 2749, ['25', '5'] -> 2649, ['25', '52'] -> 2850, ['25', '56'] -> 2697, ['25', '58'] -> 2859, ['25', '60'] -> 2832, ['25', '62'] -> 2738, ['25', '66'] -> 2715, ['25', '7'] -> 2743, ['25', '9'] -> 2543, ['29', '3'] -> 2839, ['29', '34'] -> 3036, ['29', '36'] -> 3084, ['29', '40'] -> 3155, ['29', '48'] -> 2998, ['29', '5'] -> 2964, ['29', '52'] -> 3170, ['29', '56'] -> 3006, ['29', '58'] -> 3180, ['29', '60'] -> 3136, ['29', '62'] -> 3045, ['29', '66'] -> 3013, ['29', '7'] -> 3069, ['29', '9'] -> 2866, ['3', '34'] -> 2706, ['3', '36'] -> 2746, ['3', '40'] -> 2813, ['3', '48'] -> 2672, ['3', '5'] -> 2639, ['3', '52'] -> 2830, ['3', '56'] -> 2704, ['3', '58'] -> 2839, ['3', '60'] -> 2805, ['3', '62'] -> 2724, ['3', '66'] -> 2703, ['3', '7'] -> 2765, ['3', '9'] -> 2571, ['34', '36'] -> 2943, ['34', '40'] -> 3017, ['34', '48'] -> 2857, ['34', '5'] -> 2889, ['34', '52'] -> 3031, ['34', '56'] -> 2884, ['34', '58'] -> 3039, ['34', '60'] -> 2995, ['34', '62'] -> 2913, ['34', '66'] -> 2886, ['34', '7'] -> 2930, ['34', '9'] -> 2753, ['36', '40'] -> 3073, ['36', '48'] -> 2987, ['36', '5'] -> 2874, ['36', '52'] -> 3088, ['36', '56'] -> 2924, ['36', '58'] -> 3098, ['36', '60'] -> 3052, ['36', '62'] -> 2963, ['36', '66'] -> 2924, ['36', '7'] -> 2979, ['36', '9'] -> 2777, ['40', '48'] -> 2987, ['40', '5'] -> 2950, ['40', '52'] -> 3159, ['40', '56'] -> 2996, ['40', '58'] -> 3169, ['40', '60'] -> 3124, ['40', '62'] -> 3045, ['40', '66'] -> 2997, ['40', '7'] -> 3050, ['40', '9'] -> 2852, ['48', '5'] -> 2788, ['48', '52'] -> 3002, ['48', '56'] -> 2838, ['48', '58'] -> 3012, ['48', '60'] -> 2986, ['48', '62'] -> 2877, ['48', '66'] -> 2873, ['48', '7'] -> 2893, ['48', '9'] -> 2691, ['5', '52'] -> 2960, ['5', '56'] -> 2803, ['5', '58'] -> 2970, ['5', '60'] -> 2924, ['5', '62'] -> 2859, ['5', '66'] -> 2832, ['5', '7'] -> 2859, ['5', '9'] -> 2683, ['52', '56'] -> 3016, ['52', '58'] -> 3184, ['52', '60'] -> 3138, ['52', '62'] -> 3049, ['52', '66'] -> 3010, ['52', '7'] -> 3065, ['52', '9'] -> 2866, ['56', '58'] -> 3020, ['56', '60'] -> 2974, ['56', '62'] -> 2923, ['56', '66'] -> 2846, ['56', '7'] -> 2919, ['56', '9'] -> 2752, ['58', '60'] -> 3148, ['58', '62'] -> 3060, ['58', '66'] -> 3020, ['58', '7'] -> 3075, ['58', '9'] -> 2873, ['60', '62'] -> 3014, ['60', '66'] -> 3021, ['60', '7'] -> 3031, ['60', '9'] -> 2835, ['62', '66'] -> 2892, ['62', '7'] -> 2940, ['62', '9'] -> 2750, ['66', '7'] -> 2906, ['66', '9'] -> 2715, ['7', '9'] -> 2755,

MFCS Set along with Count:

['25', '29', '3', '34', '36', '40', '48', '5', '52', '56', '58', '60', '62', '66', '7', '9'] -> 1643, MFS = []
L2 = [['25', '29'], ['25', '40'], ['25', '52'], ['25', '58'], ['25', '60'], ['29', '3'], ['29', '34'], ['29', '36'], ['29', '40'], ['29', '48'], ['29', '5'], ['29', '52'], ['29', '56'], ['29', '58'], ['29', '60'], ['29', '62'], ['29', '66'], ['29', '7'], ['29', '9'], ['3', '40'], ['3', '52'], ['3', '58'], ['3', '60'], ['34', '36'], ['34', '40'], ['34', '48'], ['34', '5'], ['34', '52'], ['34', '56'], ['34', '58'], ['34', '60'], ['34', '62'], ['34', '66'], ['34', '7'], ['36', '40'], ['36', '48'], ['36', '5'], ['36', '52'], ['36', '56'], ['36', '58'], ['36', '60'], ['36', '62'], ['36', '66'], ['36', '7'], ['40', '48'], ['40', '5'], ['40', '52'], ['40', '56'], ['40', '58'], ['40', '60'], ['40', '62'], ['40', '66'], ['40', '7'], ['48', '5'], ['48', '52'], ['48', '56'], ['48', '58'], ['48', '60'], ['48', '62'], ['48', '66'], ['48', '7'], ['5', '52'], ['5', '56'], ['5', '58'], ['5', '60'], ['5', '62'], ['5', '66'], ['5', '7'], ['5', '9'], ['52', '56'], ['52', '58'], ['52', '60'], ['52', '62'], ['52', '66'], ['52', '7'], ['52', '9'], ['56', '58'], ['56', '60'], ['56', '62'], ['56', '66'], ['56', '7'], ['56', '9'], ['58', '60'], ['58', '62'], ['58', '66'], ['58', '7'], ['58', '9'], ['60', '62'], ['60', '66'], ['60', '7'], ['60', '9'], ['62', '66'], ['62', '7'], ['62', '9'], ['66', '7'], ['66', '9'], ['7', '9']]

```

52'], ['40', '56'], ['40', '58'], ['40', '60'], ['40', '62'], ['40', '66'], ['40', '7'], ['40', '9'], ['48',
'52'], ['48', '56'], ['48', '58'], ['48', '60'], ['48', '62'], ['48', '66'], ['48', '7'], ['5', '52'], ['5',
'56'], ['5', '58'], ['5', '60'], ['5', '62'], ['5', '66'], ['5', '7'], ['52', '56'], ['52', '58'], ['52', '6
0'], ['52', '62'], ['52', '66'], ['52', '7'], ['52', '9'], ['56', '58'], ['56', '60'], ['56', '62'], ['56',
'66'], ['56', '7'], ['58', '60'], ['58', '62'], ['58', '66'], ['58', '7'], ['58', '9'], ['60', '62'], ['60',
'66'], ['60', '7'], ['60', '9'], ['62', '66'], ['62', '7'], ['66', '7']]
S2 = [['25', '3'], ['25', '34'], ['25', '36'], ['25', '48'], ['25', '5'], ['25', '56'], ['25', '62'], ['25',
'66'], ['25', '7'], ['25', '9'], ['3', '34'], ['3', '36'], ['3', '48'], ['3', '5'], ['3', '56'], ['3', '62
'], ['3', '66'], ['3', '7'], ['3', '9'], ['34', '9'], ['36', '9'], ['48', '5'], ['48', '9'], ['5', '9'], ['5
6', '9'], ['62', '9'], ['66', '9'], ['7', '9']]
MFCS = [['25', '29', '40', '52', '58', '60'], ['29', '3', '40', '52', '58', '60'], ['29', '34', '36', '40',
'5', '52', '56', '58', '60', '62', '66', '7'], ['29', '34', '36', '40', '48', '52', '56', '58', '60', '62',
'66', '7'], ['29', '40', '52', '58', '60', '9']]

```

LEVEL 3:

```

C3 = [['25', '29', '40'], ['25', '29', '52'], ['25', '29', '58'], ['25', '29', '60'], ['25', '40', '52'], ['
25', '40', '58'], ['25', '40', '60'], ['25', '52', '58'], ['25', '52', '60'], ['25', '58', '60'], ['29', '3
', '40'], ['29', '3', '52'], ['29', '3', '58'], ['29', '3', '60'], ['29', '34', '36'], ['29', '34', '40'],
['29', '34', '48'], ['29', '34', '5'], ['29', '34', '52'], ['29', '34', '56'], ['29', '34', '58'], ['29', '3
4', '60'], ['29', '34', '62'], ['29', '34', '66'], ['29', '34', '7'], ['29', '36', '40'], ['29', '36', '48
'], ['29', '36', '5'], ['29', '36', '52'], ['29', '36', '56'], ['29', '36', '58'], ['29', '36', '60'], ['29
', '36', '62'], ['29', '36', '66'], ['29', '36', '7'], ['29', '40', '48'], ['29', '40', '5'], ['29', '40', '
52'], ['29', '40', '56'], ['29', '40', '58'], ['29', '40', '60'], ['29', '40', '62'], ['29', '40', '66'], ['
29', '40', '7'], ['29', '40', '9'], ['29', '48', '52'], ['29', '48', '56'], ['29', '48', '58'], ['29', '48',
'60'], ['29', '48', '62'], ['29', '48', '66'], ['29', '48', '7'], ['29', '5', '52'], ['29', '5', '56'], ['29
', '5', '58'], ['29', '5', '60'], ['29', '5', '62'], ['29', '5', '66'], ['29', '5', '7'], ['29', '52', '56
'], ['29', '52', '58'], ['29', '52', '60'], ['29', '52', '62'], ['29', '52', '66'], ['29', '52', '7'], ['29
', '52', '9'], ['29', '56', '58'], ['29', '56', '60'], ['29', '56', '62'], ['29', '56', '66'], ['29', '56',
'7'], ['29', '58', '60'], ['29', '58', '62'], ['29', '58', '66'], ['29', '58', '7'], ['29', '58', '9'], ['29
', '60', '62'], ['29', '60', '66'], ['29', '60', '7'], ['29', '60', '9'], ['29', '62', '66'], ['29', '62', '
7'], ['29', '66', '7'], ['3', '40', '52'], ['3', '40', '58'], ['3', '40', '60'], ['3', '52', '58'], ['3', '5
2', '60'], ['3', '58', '60'], ['34', '36', '40'], ['34', '36', '48'], ['34', '36', '5'], ['34', '36', '52'],
['34', '36', '56'], ['34', '36', '58'], ['34', '36', '60'], ['34', '36', '62'], ['34', '36', '66'], ['34', '
36', '7'], ['34', '40', '48'], ['34', '40', '5'], ['34', '40', '52'], ['34', '40', '56'], ['34', '40', '58
'], ['34', '40', '60'], ['34', '40', '62'], ['34', '40', '66'], ['34', '40', '7'], ['34', '48', '52'], ['34
', '48', '56'], ['34', '48', '58'], ['34', '48', '60'], ['34', '48', '62'], ['34', '48', '66'], ['34', '48',
'7'], ['34', '5', '52'], ['34', '5', '56'], ['34', '5', '58'], ['34', '5', '60'], ['34', '5', '62'], ['34',
'5', '66'], ['34', '5', '7'], ['34', '52', '56'], ['34', '52', '58'], ['34', '52', '60'], ['34', '52', '62
'], ['34', '52', '66'], ['34', '52', '7'], ['34', '56', '58'], ['34', '56', '60'], ['34', '56', '62'], ['34
', '56', '66'], ['34', '56', '7'], ['34', '58', '60'], ['34', '58', '62'], ['34', '58', '66'], ['34', '58',
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MFCS Set along with Count:

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L5 = [['29', '34', '36', '40', '62'], ['29', '34', '36', '40', '7'], ['29', '34', '36', '52', '62'], ['29', '34', '36', '52', '7'], ['29', '34', '36', '58', '62'], ['29', '34', '36', '58', '7'], ['29', '34', '58', '62', '7'], ['29', '36', '40', '62', '7'], ['29', '36', '52', '56', '62'], ['29', '36', '52', '56', '7'], ['29', '36', '52', '62', '7'], ['29', '36', '56', '58', '62'], ['29', '36', '56', '58', '7'], ['29', '36', '58', '62', '7'], ['29', '40', '56', '62', '7'], ['29', '52', '56', '62', '7'], ['29', '56', '58', '62', '7'], ['34', '36', '40', '52', '7'], ['34', '36', '40', '58', '62'], ['34', '36', '40', '58', '7'], ['34', '36', '52', '58', '62'], ['34', '36', '52', '58', '7'], ['36', '40', '52', '56', '62'], ['36', '40', '52', '62', '7'], ['36', '40', '56', '58', '62'], ['36', '40', '58', '62', '7'], ['36', '52', '56', '58', '62'], ['36', '52', '56', '58', '7'], ['36', '52', '58', '62', '7'], ['40', '52', '56', '62', '7'], ['40', '56', '58', '62', '7'], ['52', '56', '58', '62', '7']]
S5 = [['29', '36', '40', '56', '62'], ['34', '36', '40', '52', '62']]
MFCS = [['29', '40', '52', '58', '60', '9'], ['29', '3', '40', '52', '58'], ['29', '3', '58', '60'], ['29', '34', '36', '40', '48', '52', '58', '60'], ['29', '34', '40', '5', '52', '58', '60'], ['29', '34', '40', '52', '56', '58', '60'], ['29', '34', '40', '52', '58', '60', '66'], ['29', '36', '40', '5', '52', '58', '60'],


```

['29', '36', '40', '48', '52', '58', '60', '62'], ['29', '36', '40', '48', '52', '58', '60', '7'], ['29', '36', '40', '48', '52', '58', '60', '66'], ['5', '56', '58'], ['29', '40', '5', '52', '58', '60', '62'], ['29', '40', '5', '52', '58', '60', '66'], ['29', '40', '52', '56', '58', '60', '66'], ['29', '40', '52', '58', '60', '62', '66'], ['25', '29', '52', '58', '60'], ['25', '29', '40', '52', '58'], ['25', '40', '58', '60'], ['29', '48', '52', '56', '58'], ['29', '34', '36', '40', '52', '58', '7'], ['29', '34', '40', '52', '58', '60', '7'], ['29', '34', '40', '52', '58', '60', '62'], ['29', '34', '58', '62', '7'], ['29', '40', '52', '58', '60', '66', '7'], ['36', '48', '52', '56', '58'], ['29', '36', '58', '60', '66', '7'], ['29', '36', '40', '52', '56', '58', '60'], ['29', '36', '52', '56', '58', '7'], ['29', '36', '40', '52', '58', '62', '7'], ['48', '52', '56', '58', '60'], ['40', '48', '52', '56', '58'], ['29', '5', '52', '58', '60', '7'], ['29', '40', '5', '52', '58', '7'], ['29', '40', '52', '58', '60', '62', '7'], ['29', '40', '52', '56', '58', '62', '7'], ['29', '40', '52', '56', '58', '60', '7'], ['29', '40', '52', '56', '58', '60', '62'], ['36', '40', '52', '56', '58', '62'], ['29', '36', '52', '56', '58', '62'], ['29', '34', '36', '52', '58', '62'], ['29', '34', '36', '40', '58', '62']]

```

In [19]:

```

print("MFS = {}".format(chess_MFS))
print("MFCS = {}".format(chess_MFCS))
print("\n Time Taken for Mining the maximal itemset of chess dataset with min_support of "+str(chess_Min_Sup

```

```

MFS = [['29', '3', '40', '52', '58'], ['29', '3', '58', '60'], ['29', '34', '40', '5', '52', '58', '60'], ['29', '34', '40', '52', '56', '58', '60'], ['29', '34', '40', '52', '58', '60', '66'], ['29', '36', '40', '48', '52', '58', '60', '66'], ['5', '56', '58'], ['29', '40', '52', '56', '58', '60', '66'], ['29', '40', '52', '58', '60', '62', '66'], ['25', '29', '52', '58', '60'], ['25', '29', '40', '52', '58'], ['25', '40', '58', '60'], ['29', '48', '52', '56', '58'], ['29', '34', '40', '52', '58', '60', '7'], ['29', '34', '40', '52', '58', '60', '62'], ['29', '34', '58', '62', '7'], ['29', '40', '52', '58', '60', '66', '7'], ['36', '48', '52', '56', '58'], ['29', '36', '58', '60', '66', '7'], ['29', '36', '40', '52', '56', '58', '60'], ['29', '36', '52', '56', '58', '7'], ['29', '36', '40', '52', '58', '62', '7'], ['48', '52', '56', '58', '60'], ['40', '48', '52', '56', '58'], ['29', '40', '5', '52', '58', '7'], ['29', '40', '52', '58', '60', '62', '7'], ['29', '40', '52', '56', '58', '60', '7'], ['29', '40', '52', '56', '58', '60', '62']]
MFCS = [['29', '40', '52', '58', '60', '9'], ['29', '3', '40', '52', '58'], ['29', '3', '58', '60'], ['29', '34', '36', '40', '48', '52', '58', '60'], ['29', '34', '40', '5', '52', '58', '60'], ['29', '34', '40', '52', '56', '58', '60'], ['29', '34', '40', '52', '58', '60', '66'], ['29', '36', '40', '5', '52', '58', '60'], ['29', '36', '40', '48', '52', '58', '60', '62'], ['29', '36', '40', '48', '52', '58', '60', '7'], ['29', '36', '40', '48', '52', '58', '60', '66'], ['5', '56', '58'], ['29', '40', '5', '52', '58', '60', '62'], ['29', '40', '5', '52', '58', '60', '66'], ['29', '40', '52', '56', '58', '60', '66'], ['29', '40', '52', '58', '60', '62', '66'], ['25', '29', '52', '58', '60'], ['25', '29', '40', '52', '58'], ['25', '40', '58', '60'], ['29', '48', '52', '56', '58'], ['29', '34', '36', '40', '52', '58', '7'], ['29', '34', '40', '52', '58', '60', '7'], ['29', '34', '40', '52', '58', '60', '62'], ['29', '34', '58', '62', '7'], ['29', '40', '52', '58', '60', '66', '7'], ['36', '48', '52', '56', '58'], ['29', '36', '58', '60', '66', '7'], ['29', '36', '40', '52', '56', '58', '60'], ['29', '36', '52', '56', '58', '7'], ['29', '36', '40', '52', '58', '62', '7'], ['48', '52', '56', '58', '60'], ['40', '48', '52', '56', '58'], ['29', '5', '52', '58', '60', '7'], ['29', '40', '5', '52', '58', '7'], ['29', '40', '52', '58', '60', '62', '7'], ['29', '40', '52', '56', '58', '60', '62'], ['36', '40', '52', '56', '58', '62']]

```

```
', '56', '58', '62'], ['29', '36', '52', '56', '58', '62'], ['29', '34', '36', '52', '58', '62'], ['29', '34', '36', '40', '58', '62']]
```

Time Taken for Mining the maximal itemset of chess dataset with min_support of 2800 = 2.501890898000001 seconds

Conclusion:

Case 1 - Min Support Count=3600 :

For a Min Support Count of 3000 it takes around 0.049s and 0.560s for Dualization and Pincer algorithm respectively. There were 11 lines(sets) of output for this case.

Case 2 - Min Support Count=2800 :

For a Min Support Count of 3000 it takes around 0.337s and 18.871s for Dualization and Pincer algorithm respectively. There were 292 lines(sets) of output for this case.

The Results proves that Dualization Algorithm for MFI Generation 10 times(approx) faster than Pincer Search Algorithm

Question 4

Implement the Decision Tree model on the dataset we have discussed in the class and also test the same on a benchmark dataset (preferably binary classification dataset). Also explore if there are any packages to display the decision tree.

In [20]:

```
from sklearn.datasets import load_iris
from sklearn.tree import DecisionTreeClassifier, plot_tree
from sklearn.model_selection import train_test_split
from sklearn import metrics

data = load_iris()
X, y = data.data, data.target
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=1)
model = DecisionTreeClassifier(criterion="entropy", max_depth=3)
model.fit(X_train, y_train)
y_pred = model.predict(X_test)
```

```
In [21]: print(f'Gini index as selection paramete-----the accuracy is = {metrics.accuracy_score(y_test, y_pred)})
```

Gini index as selection paramete-----the accuracy is = 0.9666666666666667

```
In [22]: #visualize
import matplotlib.pyplot as plt
fig = plt.figure(figsize=(30,20))
_ = plot_tree(model, feature_names=data["feature_names"], class_names=data["target_names"], filled=True)
```

