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1. Download the groceries.csv file from itslearning (also the file is in the folder homework inside the zip of this lecture)

In [1]:

```
# reading csv file and load all items in all baskets (each line is a basket)
with open("groceries.csv", "rt", encoding='latin1') as f:
    basket = []
    i = 0
    for line in f:
        line = line.replace("\n", "")
        items = line.split(",")
        basket.append(items)
    print(len(basket))
# printing first 10 baskets
for i in basket[:10]:
    print(i)
```

9835

```
['citrus fruit', 'semi-finished bread', 'margarine', 'ready soups']
['tropical fruit', 'yogurt', 'coffee']
['whole milk']
['pip fruit', 'yogurt', 'cream cheese', 'meat spreads']
['other vegetables', 'whole milk', 'condensed milk', 'long life bakery product']
['whole milk', 'butter', 'yogurt', 'rice', 'abrasive cleaner']
['rolls/buns']
['other vegetables', 'UHT-milk', 'rolls/buns', 'bottled beer', 'liquor (appetizer)']
['potted plants']
['whole milk', 'cereals']
```

Generate and count itemsets

In [2]:

```

import itertools

def readdata(k, fname="groceries.csv", report=True):
    C_k = []
    b = 0

    with open("groceries.csv", "rt", encoding='latin1') as f:
        lines = f.readlines()
        for line in lines:
            line = line.replace('\n', '') # remove newline symbol
            for i in line.split(','):
                C_k.append(i)

        # end of basket, report all itemsets
        for itemset in itertools.combinations(C_k, k):
            yield frozenset(itemset)
        C_k = []

    # report progress
    # print every 1000th element to reduce clutter
    if report:
        if b % 5000 == 0 and b > 0:
            print('processing bin ', b)
        b += 1

```

In [3]:

```

nitems = 11
for C_k in readdata(k=2):
    print(C_k)

    nitems -= 1
    if nitems == 0:
        break

```

```

frozenset({'citrus fruit', 'semi-finished bread'})
frozenset({'citrus fruit', 'margarine'})
frozenset({'citrus fruit', 'ready soups'})
frozenset({'semi-finished bread', 'margarine'})
frozenset({'semi-finished bread', 'ready soups'})
frozenset({'margarine', 'ready soups'})
frozenset({'tropical fruit', 'yogurt'})
frozenset({'tropical fruit', 'coffee'})
frozenset({'coffee', 'yogurt'})
frozenset({'yogurt', 'pip fruit'})
frozenset({'cream cheese', 'pip fruit'})

```

2. Find the frequent pair of items (2-tuples) using the naïve, A-priori and PCY algorithms. For each of these compare the time of execution and results for supports $s=10, 50, 100$. Comment your results.

Naive method

In [4]:

```
import time

def naive_method(k,s):
    t = time.time()
    C = {}
    for key in readdata(k,report=False):
        if key not in C:
            C[key] = 1
        else:
            C[key] += 1

    print("{} initial itemsets to be filtered".format(len(C)))

    L = {}
    for key, n in C.items():
        if n >= s:
            L[key] = n
    t1 = time.time() - t
    print('Naive method took {} seconds'.format(t1))
    print('{} candidates with >{} occurrences'.format(len(L), s))
    print('')
    return L
```

Apriori algorithm

In [5]:

```

def apriori(s):
    t = time.time()
    C1 = {}
    for key in readdata(1, report=False):
        if key not in C1:
            C1[key] = 1
        else:
            C1[key] += 1

    L1 = {}
    for key, count in C1.items():
        if count >= s:
            L1[key] = count

    C2_items = set([a.union(b) for a in L1.keys() for b in L1.keys()])
    C2 = {}
    for key in readdata(2, report=False):
        # filter out non-frequent tuples
        if key not in C2_items:
            continue

        # record frequent tuples
        if key not in C2:
            C2[key] = 1
        else:
            C2[key] += 1

    print("{} initial itemsets to be filtered".format(len(C2)))

    L2 = {}
    for key, count in C2.items():
        if count >= s:
            L2[key] = count
    t1 = time.time() - t

    print('Apriori algorithm took {} seconds'.format(t1))
    print('{} candidates with >{} occurances'.format(len(L2), s))
    print('')
    return L2

```

PCY improvement Apriori

In [6]:

```

import numpy as np
def pcy(s):
    t = time.time()
    max_hash1 = 15000
    H1 = np.zeros((max_hash1,), dtype=np.int)
    for key in readdata(k=2, report=False):
        hash_cell_1 = hash(key) % max_hash1
        H1[hash_cell_1] += 1

    C2 = {}
    for key in readdata(k=2, report=False):
        # hash-based filtering stage from PCY
        hash_cell_1 = hash(key) % max_hash1
        if H1[hash_cell_1] < s:
            continue

        # filter out non-frequent tuples
        # if key not in C2_items:
        #     continue

        # record frequent tuples
        if key not in C2:
            C2[key] = 1
        else:
            C2[key] += 1

    print("{} initial itemsets to be filtered".format(len(C2)))

    L2 = {}
    for key, count in C2.items():
        if count >= s:
            L2[key] = count
    t1 = time.time() - t
    print('PCY-algorithm took {} seconds'.format(t1))
    print('{} candidates with >{} occurrences'.format(len(L2), s))
    print('')
    return L2

```

In [7]:

```

#Naive method with k=1
for i in [10,50,100]:
    naive_method(1,i)

```

```
169 initial itemsets to be filtered
Naive method took 0.06696081161499023 seconds
157 candidates with >10 occurances
```

```
169 initial itemsets to be filtered
Naive method took 0.06496024131774902 seconds
120 candidates with >50 occurances
```

```
169 initial itemsets to be filtered
Naive method took 0.051969051361083984 seconds
88 candidates with >100 occurances
```

In [8]:

```
naive_method(1,100)
```

```
169 initial itemsets to be filtered
Naive method took 0.06297135353088379 seconds
88 candidates with >100 occurances
```

Out[8]:

```
{frozenset({'citrus fruit'}): 814,
 frozenset({'semi-finished bread'}): 174,
 frozenset({'margarine'}): 576,
 frozenset({'tropical fruit'}): 1032,
 frozenset({'yogurt'}): 1372,
 frozenset({'coffee'}): 571,
 frozenset({'whole milk'}): 2513,
 frozenset({'pip fruit'}): 744,
 frozenset({'cream cheese'}): 390,
 frozenset({'other vegetables'}): 1903,
 frozenset({'condensed milk'}): 101,
 frozenset({'long life bakery product'}): 368,
 frozenset({'butter'}): 545,
 frozenset({'rolls/buns'}): 1809,
 frozenset({'UHT-milk'}): 329,
 frozenset({'bottled beer'}): 792,
 frozenset({'potted plants'}): 170,
 frozenset({'white bread'}): 414,
 frozenset({'bottled water'}): 1087,
 frozenset({'chocolate'}): 488,
 frozenset({'curd'}): 524,
 frozenset({'flour'}): 171,
 frozenset({'dishes'}): 173,
 frozenset({'beef'}): 516,
 frozenset({'frankfurter'}): 580,
 frozenset({'soda'}): 1715,
 frozenset({'chicken'}): 422,
 frozenset({'sugar'}): 333,
 frozenset({'fruit/vegetable juice'}): 711,
 frozenset({'newspapers'}): 785,
 frozenset({'packaged fruit/vegetables'}): 128,
 frozenset({'specialty bar'}): 269,
 frozenset({'butter milk'}): 275,
```

```
frozenset({'pastry'}): 875,  
frozenset({'processed cheese'}): 163,  
frozenset({'detergent'}): 189,  
frozenset({'root vegetables'}): 1072,  
frozenset({'frozen dessert'}): 106,  
frozenset({'salty snack'}): 372,  
frozenset({'waffles'}): 378,  
frozenset({'candy'}): 294,  
frozenset({'canned beer'}): 764,  
frozenset({'sausage'}): 924,  
frozenset({'brown bread'}): 638,  
frozenset({'shopping bags'}): 969,  
frozenset({'beverages'}): 256,  
frozenset({'hamburger meat'}): 327,  
frozenset({'hygiene articles'}): 324,  
frozenset({'napkins'}): 515,  
frozenset({'pork'}): 567,  
frozenset({'berries'}): 327,  
frozenset({'whipped/sour cream'}): 705,  
frozenset({'grapes'}): 220,  
frozenset({'dessert'}): 365,  
frozenset({'domestic eggs'}): 624,  
frozenset({'spread cheese'}): 110,  
frozenset({'misc. beverages'}): 279,  
frozenset({'hard cheese'}): 241,  
frozenset({'cat food'}): 229,  
frozenset({'ham'}): 256,  
frozenset({'baking powder'}): 174,  
frozenset({'pickled vegetables'}): 176,  
frozenset({'oil'}): 276,  
frozenset({'chewing gum'}): 207,  
frozenset({'ice cream'}): 246,  
frozenset({'frozen vegetables'}): 473,  
frozenset({'canned fish'}): 148,  
frozenset({'seasonal products'}): 140,  
frozenset({'red/blush wine'}): 189,  
frozenset({'specialty chocolate'}): 299,  
frozenset({'flower (seeds)'}): 102,  
frozenset({'salt'}): 106,  
frozenset({'frozen meals'}): 279,  
frozenset({'canned vegetables'}): 106,  
frozenset({'onions'}): 305,  
frozenset({'herbs'}): 160,  
frozenset({'white wine'}): 187,  
frozenset({'sliced cheese'}): 241,  
frozenset({'pasta'}): 148,  
frozenset({'cling film/bags'}): 112,  
frozenset({'soft cheese'}): 168,  
frozenset({'cake bar'}): 130,  
frozenset({'frozen fish'}): 115,  
frozenset({'dish cleaner'}): 103,  
frozenset({'meat'}): 254,  
frozenset({'mustard'}): 118,
```

```
frozenset({'liquor'}): 109,  
frozenset({'roll products'}): 101}
```

In [9]:

```
# Runw ith s=10,50, 100  
for i in [10,50,100]:  
    naive_method(2,i)  
    apriori(i)  
    pcy(i)
```

```
9636 initial itemsets to be filtered  
Naive method took 0.15721344947814941 seconds  
2981 candidates with >10 occurances
```

```
9300 initial itemsets to be filtered  
Apriori algorithm took 0.31263256072998047 seconds  
2981 candidates with >10 occurances
```

```
4673 initial itemsets to be filtered  
PCY-algorithm took 0.44062209129333496 seconds  
2981 candidates with >10 occurances
```

```
9636 initial itemsets to be filtered  
Naive method took 0.18289542198181152 seconds  
605 candidates with >50 occurances
```

```
6621 initial itemsets to be filtered  
Apriori algorithm took 0.2528722286224365 seconds  
605 candidates with >50 occurances
```

```
1173 initial itemsets to be filtered  
PCY-algorithm took 0.4036295413970947 seconds  
605 candidates with >50 occurances
```

```
9636 initial itemsets to be filtered  
Naive method took 0.15890908241271973 seconds  
207 candidates with >100 occurances
```

```
3781 initial itemsets to be filtered  
Apriori algorithm took 0.23510408401489258 seconds  
207 candidates with >100 occurances
```

```
383 initial itemsets to be filtered  
PCY-algorithm took 0.38811373710632324 seconds  
207 candidates with >100 occurances
```


Comments:

1. Hash table was defined higher a little bit from 2^{169} , for example: 15000 (Ref: (Park, Jong, Chen, Ming-syan, Yu, Philip, An Effective Hash-Based Algorithm for Mining Association Rules, 1997/08/18))
2. Execution time for PCY algorithm longer than Apriori, Naive method has the shortest execution time. The reason we counted total execution time from read data to C2-->L2. We also tested if we just check time for C2-->L2, PCY algorithm is shorter than Apriori algorithm.
3. The number of pair itemsets to be filtered found in PCY algorithm less than A-Priori and Naïve method. Dimensions reduced, for example: 50% (s=10), 80% (s=50), 89% (s=100).
4. s=100: the number of frequent items found 207, s= 50: the number of frequent items found 605, s=10: the number of frequent items found 2981. The higher support value the smaller possibility to find frequent items.

Naive method frequent pairs

In [10]:

```
naive_method(2,10)
```

```
9636 initial itemsets to be filtered
Naive method took 0.13739967346191406 seconds
2981 candidates with >10 occurrences
```

Out[10]:

```
{frozenset({'citrus fruit', 'semi-finished bread'}): 24,
 frozenset({'citrus fruit', 'margarine'}): 78,
 frozenset({'margarine', 'semi-finished bread'}): 20,
 frozenset({'tropical fruit', 'yogurt'}): 288,
 frozenset({'coffee', 'tropical fruit'}): 70,
 frozenset({'coffee', 'yogurt'}): 96,
 frozenset({'pip fruit', 'yogurt'}): 177,
 frozenset({'cream cheese', 'pip fruit'}): 60,
 frozenset({'cream cheese', 'yogurt'}): 122,
 frozenset({'meat spreads', 'yogurt'}): 18,
 frozenset({'cream cheese', 'meat spreads'}): 11,
 frozenset({'other vegetables', 'whole milk'}): 736,
 frozenset({'condensed milk', 'other vegetables'}): 25,
 frozenset({'long life bakery product', 'other vegetables'}): 105,
 frozenset({'condensed milk', 'whole milk'}): 24,
 frozenset({'long life bakery product', 'whole milk'}): 133,
 frozenset({'butter', 'whole milk'}): 271,
 frozenset({'whole milk', 'yogurt'}): 551,
 frozenset({'rice', 'whole milk'}): 46,
```

```

frozenset({'abrasive cleaner', 'whole milk'}): 16,
frozenset({'butter', 'yogurt'}): 144,
frozenset({'butter', 'rice'}): 18,
frozenset({'rice', 'yogurt'}): 23,
frozenset({'abrasive cleaner', 'yogurt'}): 10,
frozenset({'UHT-milk', 'other vegetables'}): 80,
frozenset({'other vegetables', 'rolls/buns'}): 419,
frozenset({'bottled beer', 'other vegetables'}): 159,
frozenset({'liquor (appetizer)', 'other vegetables'}): 14,
frozenset({'UHT-milk', 'rolls/buns'}): 63,
frozenset({'UHT-milk', 'bottled beer'}): 24,
frozenset({'bottled beer', 'rolls/buns'}): 134,
frozenset({'bottled beer', 'liquor (appetizer)'}): 18,
frozenset({'cereals', 'whole milk'}): 36,
frozenset({'other vegetables', 'tropical fruit'}): 353,
frozenset({'tropical fruit', 'white bread'}): 86,
frozenset({'bottled water', 'tropical fruit'}): 182,
frozenset({'chocolate', 'tropical fruit'}): 80,
frozenset({'other vegetables', 'white bread'}): 135,
frozenset({'bottled water', 'other vegetables'}): 244,
frozenset({'chocolate', 'other vegetables'}): 125,
frozenset({'bottled water', 'white bread'}): 43,
frozenset({'chocolate', 'white bread'}): 42,
frozenset({'bottled water', 'chocolate'}): 57,
frozenset({'citrus fruit', 'tropical fruit'}): 196,
frozenset({'citrus fruit', 'whole milk'}): 300,
frozenset({'butter', 'citrus fruit'}): 90,
frozenset({'citrus fruit', 'curd'}): 70,
frozenset({'citrus fruit', 'yogurt'}): 213,
frozenset({'citrus fruit', 'flour'}): 32,
frozenset({'bottled water', 'citrus fruit'}): 133,
frozenset({'citrus fruit', 'dishes'}): 21,
frozenset({'tropical fruit', 'whole milk'}): 416,
frozenset({'butter', 'tropical fruit'}): 98,
frozenset({'curd', 'tropical fruit'}): 101,
frozenset({'flour', 'tropical fruit'}): 32,
frozenset({'dishes', 'tropical fruit'}): 19,
frozenset({'curd', 'whole milk'}): 257,
frozenset({'flour', 'whole milk'}): 83,
frozenset({'bottled water', 'whole milk'}): 338,
frozenset({'dishes', 'whole milk'}): 52,
frozenset({'butter', 'curd'}): 67,
frozenset({'butter', 'flour'}): 22,
frozenset({'bottled water', 'butter'}): 88,
frozenset({'butter', 'dishes'}): 15,
frozenset({'curd', 'yogurt'}): 170,
frozenset({'curd', 'flour'}): 31,
frozenset({'bottled water', 'curd'}): 60,
frozenset({'flour', 'yogurt'}): 48,
frozenset({'bottled water', 'yogurt'}): 226,
frozenset({'dishes', 'yogurt'}): 37,
frozenset({'bottled water', 'flour'}): 27,
frozenset({'bottled water', 'dishes'}): 21,

```

```

frozenset({'frankfurter', 'rolls/buns'}): 189,
frozenset({'frankfurter', 'soda'}): 111,
frozenset({'rolls/buns', 'soda'}): 377,
frozenset({'chicken', 'tropical fruit'}): 63,
frozenset({'butter', 'sugar'}): 31,
frozenset({'butter', 'fruit/vegetable juice'}): 79,
frozenset({'butter', 'newspapers'}): 57,
frozenset({'fruit/vegetable juice', 'sugar'}): 47,
frozenset({'newspapers', 'sugar'}): 31,
frozenset({'fruit/vegetable juice', 'newspapers'}): 81,
frozenset({'butter milk', 'pastry'}): 33,
frozenset({'cream cheese', 'tropical fruit'}): 71,
frozenset({'processed cheese', 'tropical fruit'}): 42,
frozenset({'detergent', 'tropical fruit'}): 33,
frozenset({'newspapers', 'tropical fruit'}): 116,
frozenset({'cream cheese', 'processed cheese'}): 14,
frozenset({'cream cheese', 'newspapers'}): 32,
frozenset({'newspapers', 'processed cheese'}): 11,
frozenset({'detergent', 'newspapers'}): 19,
frozenset({'root vegetables', 'tropical fruit'}): 207,
frozenset({'frozen dessert', 'tropical fruit'}): 26,
frozenset({'rolls/buns', 'tropical fruit'}): 242,
frozenset({'sweet spreads', 'tropical fruit'}): 13,
frozenset({'salty snack', 'tropical fruit'}): 55,
frozenset({'tropical fruit', 'waffles'}): 60,
frozenset({'candy', 'tropical fruit'}): 53,
frozenset({'other vegetables', 'root vegetables'}): 466,
frozenset({'frozen dessert', 'root vegetables'}): 24,
frozenset({'rolls/buns', 'root vegetables'}): 239,
frozenset({'flour', 'root vegetables'}): 46,
frozenset({'root vegetables', 'sweet spreads'}): 20,
frozenset({'root vegetables', 'salty snack'}): 49,
frozenset({'root vegetables', 'waffles'}): 65,
frozenset({'candy', 'root vegetables'}): 42,
frozenset({'frozen dessert', 'other vegetables'}): 36,
frozenset({'flour', 'other vegetables'}): 62,
frozenset({'other vegetables', 'sweet spreads'}): 24,
frozenset({'other vegetables', 'salty snack'}): 106,
frozenset({'other vegetables', 'waffles'}): 99,
frozenset({'candy', 'other vegetables'}): 68,
frozenset({'bathroom cleaner', 'other vegetables'}): 10,
frozenset({'frozen dessert', 'rolls/buns'}): 29,
frozenset({'flour', 'rolls/buns'}): 37,
frozenset({'rolls/buns', 'sweet spreads'}): 16,
frozenset({'rolls/buns', 'salty snack'}): 49,
frozenset({'rolls/buns', 'waffles'}): 90,
frozenset({'candy', 'rolls/buns'}): 70,
frozenset({'flour', 'salty snack'}): 17,
frozenset({'flour', 'waffles'}): 11,
frozenset({'salty snack', 'waffles'}): 38,
frozenset({'candy', 'salty snack'}): 26,
frozenset({'candy', 'waffles'}): 29,
frozenset({'bottled water', 'canned beer'}): 79,

```

```

frozenset({'rolls/buns', 'sausage'}): 301,
frozenset({'sausage', 'soda'}): 239,
frozenset({'chocolate', 'sausage'}): 65,
frozenset({'chocolate', 'rolls/buns'}): 116,
frozenset({'chocolate', 'soda'}): 133,
frozenset({'brown bread', 'soda'}): 124,
frozenset({'brown bread', 'fruit/vegetable juice'}): 82,
frozenset({'brown bread', 'canned beer'}): 47,
frozenset({'brown bread', 'newspapers'}): 75,
frozenset({'brown bread', 'shopping bags'}): 91,
frozenset({'fruit/vegetable juice', 'soda'}): 181,
frozenset({'canned beer', 'soda'}): 136,
frozenset({'newspapers', 'soda'}): 144,
frozenset({'shopping bags', 'soda'}): 242,
frozenset({'canned beer', 'fruit/vegetable juice'}): 39,
frozenset({'fruit/vegetable juice', 'shopping bags'}): 105,
frozenset({'canned beer', 'newspapers'}): 49,
frozenset({'canned beer', 'shopping bags'}): 112,
frozenset({'newspapers', 'shopping bags'}): 68,
frozenset({'beverages', 'yogurt'}): 54,
frozenset({'specialty bar', 'yogurt'}): 44,
frozenset({'beverages', 'bottled water'}): 30,
frozenset({'beverages', 'specialty bar'}): 12,
frozenset({'bottled water', 'specialty bar'}): 27,
frozenset({'hamburger meat', 'other vegetables'}): 136,
frozenset({'hamburger meat', 'rolls/buns'}): 85,
frozenset({'bottled water', 'hamburger meat'}): 29,
frozenset({'hamburger meat', 'hygiene articles'}): 25,
frozenset({'hamburger meat', 'napkins'}): 26,
frozenset({'other vegetables', 'spices'}): 19,
frozenset({'hygiene articles', 'other vegetables'}): 94,
frozenset({'napkins', 'other vegetables'}): 142,
frozenset({'rolls/buns', 'spices'}): 11,
frozenset({'bottled water', 'rolls/buns'}): 238,
frozenset({'hygiene articles', 'rolls/buns'}): 58,
frozenset({'napkins', 'rolls/buns'}): 115,
frozenset({'bottled water', 'hygiene articles'}): 56,
frozenset({'bottled water', 'napkins'}): 85,
frozenset({'hygiene articles', 'napkins'}): 60,
frozenset({'root vegetables', 'whole milk'}): 481,
frozenset({'beverages', 'root vegetables'}): 31,
frozenset({'root vegetables', 'sugar'}): 63,
frozenset({'beverages', 'other vegetables'}): 51,
frozenset({'other vegetables', 'sugar'}): 106,
frozenset({'beverages', 'whole milk'}): 67,
frozenset({'sugar', 'whole milk'}): 148,
frozenset({'berries', 'pork'}): 32,
frozenset({'other vegetables', 'pork'}): 213,
frozenset({'pork', 'whole milk'}): 218,
frozenset({'pork', 'whipped/sour cream'}): 81,
frozenset({'pork', 'soda'}): 117,
frozenset({'berries', 'other vegetables'}): 101,
frozenset({'berries', 'whole milk'}): 116,

```

```

frozenset({'berries', 'whipped/sour cream'}): 89,
frozenset({'berries', 'soda'}): 72,
frozenset({'other vegetables', 'whipped/sour cream'}): 284,
frozenset({'artif. sweetener', 'other vegetables'}): 10,
frozenset({'other vegetables', 'soda'}): 322,
frozenset({'abrasive cleaner', 'other vegetables'}): 16,
frozenset({'whipped/sour cream', 'whole milk'}): 317,
frozenset({'artif. sweetener', 'whole milk'}): 11,
frozenset({'soda', 'whole milk'}): 394,
frozenset({'soda', 'whipped/sour cream'}): 114,
frozenset({'beef', 'grapes'}): 25,
frozenset({'beef', 'detergent'}): 19,
frozenset({'detergent', 'grapes'}): 11,
frozenset({'pastry', 'soda'}): 207,
frozenset({'dessert', 'root vegetables'}): 57,
frozenset({'dessert', 'other vegetables'}): 114,
frozenset({'dessert', 'whole milk'}): 135,
frozenset({'citrus fruit', 'newspapers'}): 82,
frozenset({'canned beer', 'sausage'}): 62,
frozenset({'sausage', 'specialty bar'}): 23,
frozenset({'sausage', 'shopping bags'}): 154,
frozenset({'canned beer', 'rolls/buns'}): 111,
frozenset({'rolls/buns', 'specialty bar'}): 55,
frozenset({'rolls/buns', 'shopping bags'}): 192,
frozenset({'soda', 'specialty bar'}): 71,
frozenset({'canned beer', 'specialty bar'}): 15,
frozenset({'shopping bags', 'specialty bar'}): 34,
frozenset({'domestic eggs', 'tropical fruit'}): 112,
frozenset({'brown bread', 'tropical fruit'}): 105,
frozenset({'pastry', 'tropical fruit'}): 130,
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...}

```

In [11]:

```
naive_method(2,50)
```

```

9636 initial itemsets to be filtered
Naive method took 0.15850520133972168 seconds
605 candidates with >50 occurances

```

Out[11]:

```

{frozenset({'citrus fruit', 'margarine'}): 78,
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frozenset({'meat', 'soda'}): 54,
frozenset({'butter milk', 'tropical fruit'}): 54,
frozenset({'butter milk', 'root vegetables'}): 50,
frozenset({'hygiene articles', 'root vegetables'}): 53,
frozenset({'brown bread', 'pip fruit'}): 75,
frozenset({'margarine', 'pip fruit'}): 84,
frozenset({'hamburger meat', 'yogurt'}): 64,
frozenset({'margarine', 'yogurt'}): 140,
frozenset({'fruit/vegetable juice', 'pastry'}): 84,
frozenset({'chicken', 'whole milk'}): 173,
frozenset({'chicken', 'yogurt'}): 82,
frozenset({'chicken', 'whipped/sour cream'}): 71,
frozenset({'chicken', 'rolls/buns'}): 95,
frozenset({'chicken', 'soda'}): 82,
frozenset({'pasta', 'whole milk'}): 60,
frozenset({'pastry', 'pip fruit'}): 105,
frozenset({'bottled water', 'domestic eggs'}): 90,
frozenset({'potted plants', 'whole milk'}): 68,
frozenset({'citrus fruit', 'shopping bags'}): 96,
frozenset({'bottled water', 'chicken'}): 52,
frozenset({'chicken', 'newspapers'}): 51,
frozenset({'canned beer', 'whole milk'}): 87,
frozenset({'napkins', 'newspapers'}): 61,
frozenset({'pork', 'yogurt'}): 94,
frozenset({'oil', 'yogurt'}): 52,
frozenset({'beef', 'yogurt'}): 115,
frozenset({'napkins', 'root vegetables'}): 98,
frozenset({'canned beer', 'yogurt'}): 53,
frozenset({'beef', 'pastry'}): 62,
frozenset({'pastry', 'white bread'}): 55,
frozenset({'chicken', 'sausage'}): 52,
frozenset({'brown bread', 'pork'}): 55,
frozenset({'other vegetables', 'specialty chocolate'}): 60,
frozenset({'soda', 'specialty chocolate'}): 62,
frozenset({'meat', 'sausage'}): 52,
frozenset({'hamburger meat', 'sausage'}): 51,
frozenset({'frankfurter', 'pork'}): 58,
frozenset({'butter', 'pork'}): 54,
frozenset({'brown bread', 'butter'}): 57,
frozenset({'frankfurter', 'pastry'}): 82,
frozenset({'pastry', 'whipped/sour cream'}): 74,
frozenset({'napkins', 'pastry'}): 69,
frozenset({'cat food', 'other vegetables'}): 64,
frozenset({'cat food', 'whole milk'}): 87,
frozenset({'coffee', 'rolls/buns'}): 108,
frozenset({'butter', 'frozen vegetables'}): 57,
frozenset({'frozen vegetables', 'whipped/sour cream'}): 78,
frozenset({'long life bakery product', 'yogurt'}): 86,
frozenset({'fruit/vegetable juice', 'long life bakery product'}): 61,
frozenset({'bottled beer', 'margarine'}): 60,

```

```

frozenset({'pork', 'tropical fruit'}): 84,
frozenset({'beef', 'domestic eggs'}): 59,
frozenset({'citrus fruit', 'frozen vegetables'}): 65,
frozenset({'beef', 'newspapers'}): 63,
frozenset({'beef', 'tropical fruit'}): 75,
frozenset({'beef', 'soda'}): 80,
frozenset({'frozen vegetables', 'pork'}): 63,
frozenset({'ice cream', 'whole milk'}): 58,
frozenset({'frozen vegetables', 'sausage'}): 59,
frozenset({'butter', 'pastry'}): 75,
frozenset({'butter milk', 'pip fruit'}): 50,
frozenset({'coffee', 'pip fruit'}): 68,
frozenset({'chocolate', 'long life bakery product'}): 52,
frozenset({'frozen meals', 'soda'}): 61,
frozenset({'pip fruit', 'shopping bags'}): 92,
frozenset({'soda', 'white bread'}): 101,
frozenset({'bottled water', 'coffee'}): 72,
frozenset({'napkins', 'pork'}): 51,
frozenset({'newspapers', 'pork'}): 65,
frozenset({'salty snack', 'yogurt'}): 61,
frozenset({'shopping bags', 'white bread'}): 73,
frozenset({'frozen vegetables', 'tropical fruit'}): 86,
frozenset({'domestic eggs', 'shopping bags'}): 89,
frozenset({'hygiene articles', 'shopping bags'}): 51,
frozenset({'domestic eggs', 'pork'}): 55,
frozenset({'hard cheese', 'yogurt'}): 63,
frozenset({'bottled water', 'pork'}): 73,
frozenset({'meat', 'yogurt'}): 52,
frozenset({'newspapers', 'root vegetables'}): 113,
frozenset({'long life bakery product', 'soda'}): 75,
frozenset({'newspapers', 'pip fruit'}): 66,
frozenset({'UHT-milk', 'yogurt'}): 73,
frozenset({'beef', 'fruit/vegetable juice'}): 50,
frozenset({'other vegetables', 'processed cheese'}): 54,
frozenset({'grapes', 'tropical fruit'}): 60,
frozenset({'long life bakery product', 'tropical fruit'}): 62,
frozenset({'pastry', 'salty snack'}): 51,
frozenset({'bottled beer', 'citrus fruit'}): 60,
frozenset({'coffee', 'frankfurter'}): 50,
frozenset({'chocolate', 'root vegetables'}): 63,
frozenset({'margarine', 'soda'}): 100,
frozenset({'bottled beer', 'pork'}): 51,
frozenset({'chicken', 'pork'}): 57,
frozenset({'chicken', 'domestic eggs'}): 61,
frozenset({'chicken', 'frozen vegetables'}): 66,
frozenset({'ice cream', 'soda'}): 60,
frozenset({'newspapers', 'whipped/sour cream'}): 71,
frozenset({'chewing gum', 'whole milk'}): 50,
frozenset({'rolls/buns', 'specialty chocolate'}): 55,
frozenset({'rolls/buns', 'white bread'}): 64,
frozenset({'salty snack', 'whipped/sour cream'}): 51,
frozenset({'chocolate', 'pastry'}): 79,
frozenset({'chocolate', 'fruit/vegetable juice'}): 67,

```

```
frozenset({'butter', 'chocolate'}): 61,
frozenset({'dessert', 'tropical fruit'}): 62,
frozenset({'dessert', 'pastry'}): 53,
frozenset({'dessert', 'fruit/vegetable juice'}): 59,
frozenset({'cat food', 'yogurt'}): 61}
```

In [12]:

```
naive_method(2,100)
```

```
9636 initial itemsets to be filtered
Naive method took 0.16180920600891113 seconds
207 candidates with >100 occurrences
```

Out[12]:

```
{frozenset({'tropical fruit', 'yogurt'}): 288,
 frozenset({'pip fruit', 'yogurt'}): 177,
 frozenset({'cream cheese', 'yogurt'}): 122,
 frozenset({'other vegetables', 'whole milk'}): 736,
 frozenset({'long life bakery product', 'other vegetables'}): 105,
 frozenset({'long life bakery product', 'whole milk'}): 133,
 frozenset({'butter', 'whole milk'}): 271,
 frozenset({'whole milk', 'yogurt'}): 551,
 frozenset({'butter', 'yogurt'}): 144,
 frozenset({'other vegetables', 'rolls/buns'}): 419,
 frozenset({'bottled beer', 'other vegetables'}): 159,
 frozenset({'bottled beer', 'rolls/buns'}): 134,
 frozenset({'other vegetables', 'tropical fruit'}): 353,
 frozenset({'bottled water', 'tropical fruit'}): 182,
 frozenset({'other vegetables', 'white bread'}): 135,
 frozenset({'bottled water', 'other vegetables'}): 244,
 frozenset({'chocolate', 'other vegetables'}): 125,
 frozenset({'citrus fruit', 'tropical fruit'}): 196,
 frozenset({'citrus fruit', 'whole milk'}): 300,
 frozenset({'citrus fruit', 'yogurt'}): 213,
 frozenset({'bottled water', 'citrus fruit'}): 133,
 frozenset({'tropical fruit', 'whole milk'}): 416,
 frozenset({'curd', 'tropical fruit'}): 101,
 frozenset({'curd', 'whole milk'}): 257,
 frozenset({'bottled water', 'whole milk'}): 338,
 frozenset({'curd', 'yogurt'}): 170,
 frozenset({'bottled water', 'yogurt'}): 226,
 frozenset({'frankfurter', 'rolls/buns'}): 189,
 frozenset({'frankfurter', 'soda'}): 111,
 frozenset({'rolls/buns', 'soda'}): 377,
 frozenset({'newspapers', 'tropical fruit'}): 116,
 frozenset({'root vegetables', 'tropical fruit'}): 207,
 frozenset({'rolls/buns', 'tropical fruit'}): 242,
 frozenset({'other vegetables', 'root vegetables'}): 466,
 frozenset({'rolls/buns', 'root vegetables'}): 239,
 frozenset({'other vegetables', 'salty snack'}): 106,
 frozenset({'rolls/buns', 'sausage'}): 301,
 frozenset({'sausage', 'soda'}): 239,
 frozenset({'chocolate', 'rolls/buns'}): 116,
 frozenset({'chocolate', 'soda'}): 133,
```



```

frozenset({'brown bread', 'soda'}): 124,
frozenset({'fruit/vegetable juice', 'soda'}): 181,
frozenset({'canned beer', 'soda'}): 136,
frozenset({'newspapers', 'soda'}): 144,
frozenset({'shopping bags', 'soda'}): 242,
frozenset({'fruit/vegetable juice', 'shopping bags'}): 105,
frozenset({'canned beer', 'shopping bags'}): 112,
frozenset({'hamburger meat', 'other vegetables'}): 136,
frozenset({'napkins', 'other vegetables'}): 142,
frozenset({'bottled water', 'rolls/buns'}): 238,
frozenset({'napkins', 'rolls/buns'}): 115,
frozenset({'root vegetables', 'whole milk'}): 481,
frozenset({'other vegetables', 'sugar'}): 106,
frozenset({'sugar', 'whole milk'}): 148,
frozenset({'other vegetables', 'pork'}): 213,
frozenset({'pork', 'whole milk'}): 218,
frozenset({'pork', 'soda'}): 117,
frozenset({'berries', 'other vegetables'}): 101,
frozenset({'berries', 'whole milk'}): 116,
frozenset({'other vegetables', 'whipped/sour cream'}): 284,
frozenset({'other vegetables', 'soda'}): 322,
frozenset({'whipped/sour cream', 'whole milk'}): 317,
frozenset({'soda', 'whole milk'}): 394,
frozenset({'soda', 'whipped/sour cream'}): 114,
frozenset({'pastry', 'soda'}): 207,
frozenset({'dessert', 'other vegetables'}): 114,
frozenset({'dessert', 'whole milk'}): 135,
frozenset({'sausage', 'shopping bags'}): 154,
frozenset({'canned beer', 'rolls/buns'}): 111,
frozenset({'rolls/buns', 'shopping bags'}): 192,
frozenset({'domestic eggs', 'tropical fruit'}): 112,
frozenset({'brown bread', 'tropical fruit'}): 105,
frozenset({'pastry', 'tropical fruit'}): 130,
frozenset({'soda', 'tropical fruit'}): 205,
frozenset({'root vegetables', 'yogurt'}): 254,
frozenset({'domestic eggs', 'root vegetables'}): 141,
frozenset({'brown bread', 'root vegetables'}): 100,
frozenset({'pastry', 'root vegetables'}): 108,
frozenset({'root vegetables', 'soda'}): 183,
frozenset({'domestic eggs', 'whole milk'}): 295,
frozenset({'brown bread', 'whole milk'}): 248,
frozenset({'pastry', 'whole milk'}): 327,
frozenset({'coffee', 'whole milk'}): 184,
frozenset({'waffles', 'whole milk'}): 125,
frozenset({'domestic eggs', 'yogurt'}): 141,
frozenset({'brown bread', 'yogurt'}): 143,
frozenset({'pastry', 'yogurt'}): 174,
frozenset({'soda', 'yogurt'}): 269,
frozenset({'domestic eggs', 'soda'}): 122,
frozenset({'berries', 'yogurt'}): 104,
frozenset({'rolls/buns', 'yogurt'}): 338,
frozenset({'newspapers', 'yogurt'}): 151,
frozenset({'newspapers', 'rolls/buns'}): 194,

```

```

frozenset({'bottled water', 'soda'}): 285,
frozenset({'bottled water', 'newspapers'}): 111,
frozenset({'butter', 'root vegetables'}): 127,
frozenset({'curd', 'root vegetables'}): 107,
frozenset({'root vegetables', 'whipped/sour cream'}): 168,
frozenset({'bottled water', 'root vegetables'}): 154,
frozenset({'butter', 'other vegetables'}): 197,
frozenset({'curd', 'other vegetables'}): 169,
frozenset({'butter', 'whipped/sour cream'}): 100,
frozenset({'butter', 'rolls/buns'}): 132,
frozenset({'curd', 'whipped/sour cream'}): 103,
frozenset({'rolls/buns', 'whipped/sour cream'}): 144,
frozenset({'ham', 'whole milk'}): 113,
frozenset({'fruit/vegetable juice', 'tropical fruit'}): 135,
frozenset({'domestic eggs', 'other vegetables'}): 219,
frozenset({'brown bread', 'other vegetables'}): 184,
frozenset({'margarine', 'other vegetables'}): 194,
frozenset({'fruit/vegetable juice', 'other vegetables'}): 207,
frozenset({'beef', 'rolls/buns'}): 134,
frozenset({'pastry', 'rolls/buns'}): 206,
frozenset({'frozen vegetables', 'other vegetables'}): 175,
frozenset({'frozen vegetables', 'whole milk'}): 201,
frozenset({'salty snack', 'whole milk'}): 110,
frozenset({'pastry', 'sausage'}): 123,
frozenset({'sausage', 'whole milk'}): 294,
frozenset({'beef', 'whole milk'}): 209,
frozenset({'brown bread', 'rolls/buns'}): 124,
frozenset({'pip fruit', 'tropical fruit'}): 201,
frozenset({'pip fruit', 'whole milk'}): 296,
frozenset({'pip fruit', 'rolls/buns'}): 137,
frozenset({'rolls/buns', 'whole milk'}): 557,
frozenset({'chocolate', 'whole milk'}): 164,
frozenset({'margarine', 'whole milk'}): 238,
frozenset({'frankfurter', 'whole milk'}): 202,
frozenset({'citrus fruit', 'domestic eggs'}): 102,
frozenset({'oil', 'whole milk'}): 111,
frozenset({'newspapers', 'whole milk'}): 269,
frozenset({'butter milk', 'whole milk'}): 114,
frozenset({'bottled water', 'fruit/vegetable juice'}): 140,
frozenset({'bottled beer', 'bottled water'}): 155,
frozenset({'bottled beer', 'soda'}): 167,
frozenset({'frozen vegetables', 'root vegetables'}): 114,
frozenset({'margarine', 'root vegetables'}): 109,
frozenset({'fruit/vegetable juice', 'root vegetables'}): 118,
frozenset({'fruit/vegetable juice', 'whole milk'}): 262,
frozenset({'frozen vegetables', 'rolls/buns'}): 100,
frozenset({'domestic eggs', 'rolls/buns'}): 154,
frozenset({'margarine', 'rolls/buns'}): 145,
frozenset({'fruit/vegetable juice', 'rolls/buns'}): 143,
frozenset({'root vegetables', 'sausage'}): 147,
frozenset({'sausage', 'yogurt'}): 193,
frozenset({'citrus fruit', 'whipped/sour cream'}): 107,
frozenset({'brown bread', 'sausage'}): 105,

```

```

frozenset({'chicken', 'root vegetables'}): 107,
frozenset({'chicken', 'other vegetables'}): 176,
frozenset({'citrus fruit', 'root vegetables'}): 174,
frozenset({'citrus fruit', 'other vegetables'}): 284,
frozenset({'pork', 'rolls/buns'}): 111,
frozenset({'bottled beer', 'whole milk'}): 201,
frozenset({'napkins', 'whole milk'}): 194,
frozenset({'shopping bags', 'whole milk'}): 241,
frozenset({'fruit/vegetable juice', 'yogurt'}): 184,
frozenset({'napkins', 'yogurt'}): 121,
frozenset({'shopping bags', 'yogurt'}): 150,
frozenset({'beef', 'root vegetables'}): 171,
frozenset({'frankfurter', 'root vegetables'}): 100,
frozenset({'frankfurter', 'other vegetables'}): 162,
frozenset({'other vegetables', 'sausage'}): 265,
frozenset({'bottled water', 'margarine'}): 101,
frozenset({'hamburger meat', 'whole milk'}): 145,
frozenset({'cream cheese', 'whole milk'}): 162,
frozenset({'other vegetables', 'pastry'}): 222,
frozenset({'coffee', 'other vegetables'}): 132,
frozenset({'other vegetables', 'shopping bags'}): 228,
frozenset({'pastry', 'shopping bags'}): 117,
frozenset({'citrus fruit', 'sausage'}): 111,
frozenset({'sausage', 'tropical fruit'}): 137,
frozenset({'pip fruit', 'sausage'}): 106,
frozenset({'citrus fruit', 'pip fruit'}): 136,
frozenset({'citrus fruit', 'fruit/vegetable juice'}): 102,
frozenset({'hygiene articles', 'whole milk'}): 126,
frozenset({'other vegetables', 'pip fruit'}): 257,
frozenset({'citrus fruit', 'rolls/buns'}): 165,
frozenset({'other vegetables', 'yogurt'}): 427,
frozenset({'frozen vegetables', 'yogurt'}): 122,
frozenset({'white bread', 'whole milk'}): 168,
frozenset({'bottled water', 'shopping bags'}): 108,
frozenset({'frankfurter', 'yogurt'}): 110,
frozenset({'tropical fruit', 'whipped/sour cream'}): 136,
frozenset({'pip fruit', 'root vegetables'}): 153,
frozenset({'cream cheese', 'other vegetables'}): 135,
frozenset({'sliced cheese', 'whole milk'}): 106,
frozenset({'whipped/sour cream', 'yogurt'}): 204,
frozenset({'shopping bags', 'tropical fruit'}): 133,
frozenset({'pork', 'root vegetables'}): 134,
frozenset({'beef', 'other vegetables'}): 194,
frozenset({'butter milk', 'other vegetables'}): 102,
frozenset({'root vegetables', 'shopping bags'}): 126,
frozenset({'napkins', 'soda'}): 118,
frozenset({'bottled water', 'sausage'}): 118,
frozenset({'bottled water', 'pip fruit'}): 104,
frozenset({'citrus fruit', 'soda'}): 126,
frozenset({'newspapers', 'other vegetables'}): 190,
frozenset({'pip fruit', 'soda'}): 131,
frozenset({'onions', 'other vegetables'}): 140,
frozenset({'onions', 'whole milk'}): 119,

```

```
frozenset({'margarine', 'yogurt'}): 140,
frozenset({'chicken', 'whole milk'}): 173,
frozenset({'pastry', 'pip fruit'}): 105,
frozenset({'beef', 'yogurt'}): 115,
frozenset({'coffee', 'rolls/buns'}): 108,
frozenset({'soda', 'white bread'}): 101,
frozenset({'newspapers', 'root vegetables'}): 113,
frozenset({'margarine', 'soda'}): 100}
```

Apriori frequent pairs

In [13]: `apriori(10)`

```
9300 initial itemsets to be filtered
Apriori algorithm took 0.32376527786254883 seconds
2981 candidates with >10 occurrences
```

Out[13]:

```
{frozenset({'citrus fruit', 'semi-finished bread'}): 24,
frozenset({'citrus fruit', 'margarine'}): 78,
frozenset({'margarine', 'semi-finished bread'}): 20,
frozenset({'tropical fruit', 'yogurt'}): 288,
frozenset({'coffee', 'tropical fruit'}): 70,
frozenset({'coffee', 'yogurt'}): 96,
frozenset({'pip fruit', 'yogurt'}): 177,
frozenset({'cream cheese', 'pip fruit'}): 60,
frozenset({'cream cheese', 'yogurt'}): 122,
frozenset({'meat spreads', 'yogurt'}): 18,
frozenset({'cream cheese', 'meat spreads'}): 11,
frozenset({'other vegetables', 'whole milk'}): 736,
frozenset({'condensed milk', 'other vegetables'}): 25,
frozenset({'long life bakery product', 'other vegetables'}): 105,
frozenset({'condensed milk', 'whole milk'}): 24,
frozenset({'long life bakery product', 'whole milk'}): 133,
frozenset({'butter', 'whole milk'}): 271,
frozenset({'whole milk', 'yogurt'}): 551,
frozenset({'rice', 'whole milk'}): 46,
frozenset({'abrasive cleaner', 'whole milk'}): 16,
frozenset({'butter', 'yogurt'}): 144,
frozenset({'butter', 'rice'}): 18,
frozenset({'rice', 'yogurt'}): 23,
frozenset({'abrasive cleaner', 'yogurt'}): 10,
frozenset({'UHT-milk', 'other vegetables'}): 80,
frozenset({'other vegetables', 'rolls/buns'}): 419,
frozenset({'bottled beer', 'other vegetables'}): 159,
frozenset({'liquor (appetizer)', 'other vegetables'}): 14,
frozenset({'UHT-milk', 'rolls/buns'}): 63,
frozenset({'UHT-milk', 'bottled beer'}): 24,
frozenset({'bottled beer', 'rolls/buns'}): 134,
frozenset({'bottled beer', 'liquor (appetizer)'}): 18,
frozenset({'cereals', 'whole milk'}): 36,
frozenset({'other vegetables', 'tropical fruit'}): 353,
frozenset({'tropical fruit', 'white bread'}): 86,
```

```

frozenset({'bottled water', 'tropical fruit'}): 182,
frozenset({'chocolate', 'tropical fruit'}): 80,
frozenset({'other vegetables', 'white bread'}): 135,
frozenset({'bottled water', 'other vegetables'}): 244,
frozenset({'chocolate', 'other vegetables'}): 125,
frozenset({'bottled water', 'white bread'}): 43,
frozenset({'chocolate', 'white bread'}): 42,
frozenset({'bottled water', 'chocolate'}): 57,
frozenset({'citrus fruit', 'tropical fruit'}): 196,
frozenset({'citrus fruit', 'whole milk'}): 300,
frozenset({'butter', 'citrus fruit'}): 90,
frozenset({'citrus fruit', 'curd'}): 70,
frozenset({'citrus fruit', 'yogurt'}): 213,
frozenset({'citrus fruit', 'flour'}): 32,
frozenset({'bottled water', 'citrus fruit'}): 133,
frozenset({'citrus fruit', 'dishes'}): 21,
frozenset({'tropical fruit', 'whole milk'}): 416,
frozenset({'butter', 'tropical fruit'}): 98,
frozenset({'curd', 'tropical fruit'}): 101,
frozenset({'flour', 'tropical fruit'}): 32,
frozenset({'dishes', 'tropical fruit'}): 19,
frozenset({'curd', 'whole milk'}): 257,
frozenset({'flour', 'whole milk'}): 83,
frozenset({'bottled water', 'whole milk'}): 338,
frozenset({'dishes', 'whole milk'}): 52,
frozenset({'butter', 'curd'}): 67,
frozenset({'butter', 'flour'}): 22,
frozenset({'bottled water', 'butter'}): 88,
frozenset({'butter', 'dishes'}): 15,
frozenset({'curd', 'yogurt'}): 170,
frozenset({'curd', 'flour'}): 31,
frozenset({'bottled water', 'curd'}): 60,
frozenset({'flour', 'yogurt'}): 48,
frozenset({'bottled water', 'yogurt'}): 226,
frozenset({'dishes', 'yogurt'}): 37,
frozenset({'bottled water', 'flour'}): 27,
frozenset({'bottled water', 'dishes'}): 21,
frozenset({'frankfurter', 'rolls/buns'}): 189,
frozenset({'frankfurter', 'soda'}): 111,
frozenset({'rolls/buns', 'soda'}): 377,
frozenset({'chicken', 'tropical fruit'}): 63,
frozenset({'butter', 'sugar'}): 31,
frozenset({'butter', 'fruit/vegetable juice'}): 79,
frozenset({'butter', 'newspapers'}): 57,
frozenset({'fruit/vegetable juice', 'sugar'}): 47,
frozenset({'newspapers', 'sugar'}): 31,
frozenset({'fruit/vegetable juice', 'newspapers'}): 81,
frozenset({'butter milk', 'pastry'}): 33,
frozenset({'cream cheese', 'tropical fruit'}): 71,
frozenset({'processed cheese', 'tropical fruit'}): 42,
frozenset({'detergent', 'tropical fruit'}): 33,
frozenset({'newspapers', 'tropical fruit'}): 116,
frozenset({'cream cheese', 'processed cheese'}): 14,

```

```

frozenset({'cream cheese', 'newspapers'}): 32,
frozenset({'newspapers', 'processed cheese'}): 11,
frozenset({'detergent', 'newspapers'}): 19,
frozenset({'root vegetables', 'tropical fruit'}): 207,
frozenset({'frozen dessert', 'tropical fruit'}): 26,
frozenset({'rolls/buns', 'tropical fruit'}): 242,
frozenset({'sweet spreads', 'tropical fruit'}): 13,
frozenset({'salty snack', 'tropical fruit'}): 55,
frozenset({'tropical fruit', 'waffles'}): 60,
frozenset({'candy', 'tropical fruit'}): 53,
frozenset({'other vegetables', 'root vegetables'}): 466,
frozenset({'frozen dessert', 'root vegetables'}): 24,
frozenset({'rolls/buns', 'root vegetables'}): 239,
frozenset({'flour', 'root vegetables'}): 46,
frozenset({'root vegetables', 'sweet spreads'}): 20,
frozenset({'root vegetables', 'salty snack'}): 49,
frozenset({'root vegetables', 'waffles'}): 65,
frozenset({'candy', 'root vegetables'}): 42,
frozenset({'frozen dessert', 'other vegetables'}): 36,
frozenset({'flour', 'other vegetables'}): 62,
frozenset({'other vegetables', 'sweet spreads'}): 24,
frozenset({'other vegetables', 'salty snack'}): 106,
frozenset({'other vegetables', 'waffles'}): 99,
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frozenset({'butter', 'waffles'}): 35,
frozenset({'curd', 'soft cheese'}): 22,
frozenset({'curd', 'sliced cheese'}): 28,
frozenset({'cream cheese', 'curd'}): 50,
frozenset({'curd', 'frozen meals'}): 23,
frozenset({'curd', 'white bread'}): 34,
frozenset({'curd', 'sugar'}): 34,
frozenset({'cereals', 'curd'}): 11,
frozenset({'bottled beer', 'curd'}): 38,
frozenset({'whipped/sour cream', 'yogurt'}): 204,
frozenset({'sliced cheese', 'yogurt'}): 79,
frozenset({'frozen meals', 'yogurt'}): 61,
frozenset({'frozen fish', 'yogurt'}): 32,
frozenset({'white bread', 'yogurt'}): 89,

```

```
frozenset({'soft cheese', 'whipped/sour cream'}): 30,
frozenset({'sliced cheese', 'whipped/sour cream'}): 38,
frozenset({'cream cheese', 'whipped/sour cream'}): 63,
frozenset({'frozen meals', 'whipped/sour cream'}): 28,
frozenset({'domestic eggs', 'whipped/sour cream'}): 98,
frozenset({'whipped/sour cream', 'white bread'}): 54,
frozenset({'sugar', 'whipped/sour cream'}): 48,
frozenset({'cereals', 'whipped/sour cream'}): 10,
frozenset({'fruit/vegetable juice', 'whipped/sour cream'}): 89,
frozenset({'bottled beer', 'whipped/sour cream'}): 39,
frozenset({'sliced cheese', 'soft cheese'}): 18,
...}
```

In [14]:

```
apriori(50)
```

```
6621 initial itemsets to be filtered
Apriori algorithm took 0.26178836822509766 seconds
605 candidates with >50 occurances
```

Out[14]:

```
{frozenset({'citrus fruit', 'margarine'}): 78,
frozenset({'tropical fruit', 'yogurt'}): 288,
frozenset({'coffee', 'tropical fruit'}): 70,
frozenset({'coffee', 'yogurt'}): 96,
frozenset({'pip fruit', 'yogurt'}): 177,
frozenset({'cream cheese', 'pip fruit'}): 60,
frozenset({'cream cheese', 'yogurt'}): 122,
frozenset({'other vegetables', 'whole milk'}): 736,
frozenset({'long life bakery product', 'other vegetables'}): 105,
frozenset({'long life bakery product', 'whole milk'}): 133,
frozenset({'butter', 'whole milk'}): 271,
frozenset({'whole milk', 'yogurt'}): 551,
frozenset({'butter', 'yogurt'}): 144,
frozenset({'UHT-milk', 'other vegetables'}): 80,
frozenset({'other vegetables', 'rolls/buns'}): 419,
frozenset({'bottled beer', 'other vegetables'}): 159,
frozenset({'UHT-milk', 'rolls/buns'}): 63,
frozenset({'bottled beer', 'rolls/buns'}): 134,
frozenset({'other vegetables', 'tropical fruit'}): 353,
frozenset({'tropical fruit', 'white bread'}): 86,
frozenset({'bottled water', 'tropical fruit'}): 182,
frozenset({'chocolate', 'tropical fruit'}): 80,
frozenset({'other vegetables', 'white bread'}): 135,
frozenset({'bottled water', 'other vegetables'}): 244,
frozenset({'chocolate', 'other vegetables'}): 125,
frozenset({'bottled water', 'chocolate'}): 57,
frozenset({'citrus fruit', 'tropical fruit'}): 196,
frozenset({'citrus fruit', 'whole milk'}): 300,
frozenset({'butter', 'citrus fruit'}): 90,
frozenset({'citrus fruit', 'curd'}): 70,
frozenset({'citrus fruit', 'yogurt'}): 213,
frozenset({'bottled water', 'citrus fruit'}): 133,
frozenset({'tropical fruit', 'whole milk'}): 416,
```

```

frozenset({'butter', 'tropical fruit'}): 98,
frozenset({'curd', 'tropical fruit'}): 101,
frozenset({'curd', 'whole milk'}): 257,
frozenset({'flour', 'whole milk'}): 83,
frozenset({'bottled water', 'whole milk'}): 338,
frozenset({'dishes', 'whole milk'}): 52,
frozenset({'butter', 'curd'}): 67,
frozenset({'bottled water', 'butter'}): 88,
frozenset({'curd', 'yogurt'}): 170,
frozenset({'bottled water', 'curd'}): 60,
frozenset({'bottled water', 'yogurt'}): 226,
frozenset({'frankfurter', 'rolls/buns'}): 189,
frozenset({'frankfurter', 'soda'}): 111,
frozenset({'rolls/buns', 'soda'}): 377,
frozenset({'chicken', 'tropical fruit'}): 63,
frozenset({'butter', 'fruit/vegetable juice'}): 79,
frozenset({'butter', 'newspapers'}): 57,
frozenset({'fruit/vegetable juice', 'newspapers'}): 81,
frozenset({'cream cheese', 'tropical fruit'}): 71,
frozenset({'newspapers', 'tropical fruit'}): 116,
frozenset({'root vegetables', 'tropical fruit'}): 207,
frozenset({'rolls/buns', 'tropical fruit'}): 242,
frozenset({'salty snack', 'tropical fruit'}): 55,
frozenset({'tropical fruit', 'waffles'}): 60,
frozenset({'candy', 'tropical fruit'}): 53,
frozenset({'other vegetables', 'root vegetables'}): 466,
frozenset({'rolls/buns', 'root vegetables'}): 239,
frozenset({'root vegetables', 'waffles'}): 65,
frozenset({'flour', 'other vegetables'}): 62,
frozenset({'other vegetables', 'salty snack'}): 106,
frozenset({'other vegetables', 'waffles'}): 99,
frozenset({'candy', 'other vegetables'}): 68,
frozenset({'rolls/buns', 'waffles'}): 90,
frozenset({'candy', 'rolls/buns'}): 70,
frozenset({'bottled water', 'canned beer'}): 79,
frozenset({'rolls/buns', 'sausage'}): 301,
frozenset({'sausage', 'soda'}): 239,
frozenset({'chocolate', 'sausage'}): 65,
frozenset({'chocolate', 'rolls/buns'}): 116,
frozenset({'chocolate', 'soda'}): 133,
frozenset({'brown bread', 'soda'}): 124,
frozenset({'brown bread', 'fruit/vegetable juice'}): 82,
frozenset({'brown bread', 'newspapers'}): 75,
frozenset({'brown bread', 'shopping bags'}): 91,
frozenset({'fruit/vegetable juice', 'soda'}): 181,
frozenset({'canned beer', 'soda'}): 136,
frozenset({'newspapers', 'soda'}): 144,
frozenset({'shopping bags', 'soda'}): 242,
frozenset({'fruit/vegetable juice', 'shopping bags'}): 105,
frozenset({'canned beer', 'shopping bags'}): 112,
frozenset({'newspapers', 'shopping bags'}): 68,
frozenset({'beverages', 'yogurt'}): 54,
frozenset({'hamburger meat', 'other vegetables'}): 136,

```



```

frozenset({'hamburger meat', 'rolls/buns'}): 85,
frozenset({'hygiene articles', 'other vegetables'}): 94,
frozenset({'napkins', 'other vegetables'}): 142,
frozenset({'bottled water', 'rolls/buns'}): 238,
frozenset({'hygiene articles', 'rolls/buns'}): 58,
frozenset({'napkins', 'rolls/buns'}): 115,
frozenset({'bottled water', 'hygiene articles'}): 56,
frozenset({'bottled water', 'napkins'}): 85,
frozenset({'hygiene articles', 'napkins'}): 60,
frozenset({'root vegetables', 'whole milk'}): 481,
frozenset({'root vegetables', 'sugar'}): 63,
frozenset({'beverages', 'other vegetables'}): 51,
frozenset({'other vegetables', 'sugar'}): 106,
frozenset({'beverages', 'whole milk'}): 67,
frozenset({'sugar', 'whole milk'}): 148,
frozenset({'other vegetables', 'pork'}): 213,
frozenset({'pork', 'whole milk'}): 218,
frozenset({'pork', 'whipped/sour cream'}): 81,
frozenset({'pork', 'soda'}): 117,
frozenset({'berries', 'other vegetables'}): 101,
frozenset({'berries', 'whole milk'}): 116,
frozenset({'berries', 'whipped/sour cream'}): 89,
frozenset({'berries', 'soda'}): 72,
frozenset({'other vegetables', 'whipped/sour cream'}): 284,
frozenset({'other vegetables', 'soda'}): 322,
frozenset({'whipped/sour cream', 'whole milk'}): 317,
frozenset({'soda', 'whole milk'}): 394,
frozenset({'soda', 'whipped/sour cream'}): 114,
frozenset({'pastry', 'soda'}): 207,
frozenset({'dessert', 'root vegetables'}): 57,
frozenset({'dessert', 'other vegetables'}): 114,
frozenset({'dessert', 'whole milk'}): 135,
frozenset({'citrus fruit', 'newspapers'}): 82,
frozenset({'canned beer', 'sausage'}): 62,
frozenset({'sausage', 'shopping bags'}): 154,
frozenset({'canned beer', 'rolls/buns'}): 111,
frozenset({'rolls/buns', 'specialty bar'}): 55,
frozenset({'rolls/buns', 'shopping bags'}): 192,
frozenset({'soda', 'specialty bar'}): 71,
frozenset({'domestic eggs', 'tropical fruit'}): 112,
frozenset({'brown bread', 'tropical fruit'}): 105,
frozenset({'pastry', 'tropical fruit'}): 130,
frozenset({'soda', 'tropical fruit'}): 205,
frozenset({'root vegetables', 'yogurt'}): 254,
frozenset({'domestic eggs', 'root vegetables'}): 141,
frozenset({'brown bread', 'root vegetables'}): 100,
frozenset({'pastry', 'root vegetables'}): 108,
frozenset({'coffee', 'root vegetables'}): 72,
frozenset({'root vegetables', 'soda'}): 183,
frozenset({'domestic eggs', 'whole milk'}): 295,
frozenset({'brown bread', 'whole milk'}): 248,
frozenset({'pastry', 'whole milk'}): 327,
frozenset({'coffee', 'whole milk'}): 184,

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```

frozenset({'waffles', 'whole milk'}): 125,
frozenset({'candy', 'whole milk'}): 81,
frozenset({'domestic eggs', 'yogurt'}): 141,
frozenset({'brown bread', 'yogurt'}): 143,
frozenset({'pastry', 'yogurt'}): 174,
frozenset({'sugar', 'yogurt'}): 68,
frozenset({'soda', 'yogurt'}): 269,
frozenset({'waffles', 'yogurt'}): 74,
frozenset({'candy', 'yogurt'}): 54,
frozenset({'brown bread', 'domestic eggs'}): 67,
frozenset({'domestic eggs', 'pastry'}): 89,
frozenset({'domestic eggs', 'soda'}): 122,
frozenset({'brown bread', 'pastry'}): 95,
frozenset({'pastry', 'sugar'}): 51,
frozenset({'coffee', 'pastry'}): 68,
frozenset({'pastry', 'waffles'}): 69,
frozenset({'soda', 'sugar'}): 72,
frozenset({'coffee', 'soda'}): 98,
frozenset({'soda', 'waffles'}): 94,
frozenset({'candy', 'soda'}): 85,
frozenset({'berries', 'yogurt'}): 104,
frozenset({'butter milk', 'yogurt'}): 84,
frozenset({'butter milk', 'rolls/buns'}): 75,
frozenset({'rolls/buns', 'yogurt'}): 338,
frozenset({'newspapers', 'yogurt'}): 151,
frozenset({'cream cheese', 'rolls/buns'}): 98,
frozenset({'bottled water', 'cream cheese'}): 58,
frozenset({'cream cheese', 'soda'}): 67,
frozenset({'newspapers', 'rolls/buns'}): 194,
frozenset({'bottled water', 'soda'}): 285,
frozenset({'bottled water', 'newspapers'}): 111,
frozenset({'bottled water', 'pastry'}): 88,
frozenset({'butter', 'root vegetables'}): 127,
frozenset({'curd', 'root vegetables'}): 107,
frozenset({'root vegetables', 'whipped/sour cream'}): 168,
frozenset({'hard cheese', 'root vegetables'}): 55,
frozenset({'bottled water', 'root vegetables'}): 154,
frozenset({'long life bakery product', 'root vegetables'}): 52,
frozenset({'butter', 'other vegetables'}): 197,
frozenset({'curd', 'other vegetables'}): 169,
frozenset({'hard cheese', 'other vegetables'}): 93,
frozenset({'butter', 'whipped/sour cream'}): 100,
frozenset({'butter', 'rolls/buns'}): 132,
frozenset({'curd', 'whipped/sour cream'}): 103,
frozenset({'curd', 'rolls/buns'}): 99,
frozenset({'rolls/buns', 'whipped/sour cream'}): 144,
frozenset({'bottled water', 'whipped/sour cream'}): 86,
frozenset({'long life bakery product', 'whipped/sour cream'}): 57,
frozenset({'UHT-milk', 'bottled water'}): 72,
frozenset({'hard cheese', 'rolls/buns'}): 58,
frozenset({'long life bakery product', 'rolls/buns'}): 78,
frozenset({'newspapers', 'sausage'}): 79,
frozenset({'ham', 'other vegetables'}): 90,

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frozenset({'ham', 'whole milk'}): 113,
frozenset({'grapes', 'other vegetables'}): 89,
frozenset({'grapes', 'whole milk'}): 72,
frozenset({'margarine', 'tropical fruit'}): 92,
frozenset({'fruit/vegetable juice', 'tropical fruit'}): 135,
frozenset({'domestic eggs', 'other vegetables'}): 219,
frozenset({'brown bread', 'other vegetables'}): 184,
frozenset({'other vegetables', 'semi-finished bread'}): 51,
frozenset({'margarine', 'other vegetables'}): 194,
frozenset({'baking powder', 'other vegetables'}): 72,
frozenset({'fruit/vegetable juice', 'other vegetables'}): 207,
frozenset({'curd', 'domestic eggs'}): 64,
frozenset({'curd', 'margarine'}): 62,
frozenset({'domestic eggs', 'margarine'}): 82,
frozenset({'domestic eggs', 'fruit/vegetable juice'}): 79,
frozenset({'brown bread', 'margarine'}): 64,
frozenset({'fruit/vegetable juice', 'margarine'}): 61,
frozenset({'processed cheese', 'whole milk'}): 69,
frozenset({'pickled vegetables', 'whole milk'}): 70,
frozenset({'processed cheese', 'soda'}): 52,
frozenset({'curd', 'pastry'}): 74,
frozenset({'oil', 'rolls/buns'}): 50,
frozenset({'ham', 'rolls/buns'}): 68,
frozenset({'beef', 'whipped/sour cream'}): 66,
frozenset({'beef', 'rolls/buns'}): 134,
frozenset({'pastry', 'rolls/buns'}): 206,
frozenset({'rolls/buns', 'sugar'}): 69,
frozenset({'frozen vegetables', 'other vegetables'}): 175,
frozenset({'canned fish', 'other vegetables'}): 50,
frozenset({'detergent', 'other vegetables'}): 63,
frozenset({'frozen vegetables', 'whole milk'}): 201,
frozenset({'salty snack', 'whole milk'}): 110,
frozenset({'detergent', 'whole milk'}): 88,
frozenset({'pastry', 'sausage'}): 123,
frozenset({'beef', 'sausage'}): 55,
frozenset({'sausage', 'whole milk'}): 294,
frozenset({'beef', 'whole milk'}): 209,
frozenset({'frankfurter', 'tropical fruit'}): 93,
frozenset({'brown bread', 'frankfurter'}): 70,
frozenset({'brown bread', 'rolls/buns'}): 124,
frozenset({'curd', 'sausage'}): 75,
frozenset({'pip fruit', 'tropical fruit'}): 201,
frozenset({'berries', 'tropical fruit'}): 66,
frozenset({'pip fruit', 'whole milk'}): 296,
frozenset({'pip fruit', 'rolls/buns'}): 137,
frozenset({'chocolate', 'pip fruit'}): 60,
frozenset({'berries', 'rolls/buns'}): 65,
frozenset({'rolls/buns', 'whole milk'}): 557,
frozenset({'chocolate', 'whole milk'}): 164,
frozenset({'margarine', 'whole milk'}): 238,
frozenset({'specialty chocolate', 'whole milk'}): 79,
frozenset({'butter', 'margarine'}): 66,
frozenset({'citrus fruit', 'frankfurter'}): 64,

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```

frozenset({'frankfurter', 'whole milk'}): 202,
frozenset({'domestic eggs', 'frankfurter'}): 69,
frozenset({'citrus fruit', 'domestic eggs'}): 102,
frozenset({'oil', 'whole milk'}): 111,
frozenset({'newspapers', 'whole milk'}): 269,
frozenset({'domestic eggs', 'newspapers'}): 68,
frozenset({'citrus fruit', 'pastry'}): 96,
frozenset({'butter milk', 'whole milk'}): 114,
frozenset({'bottled water', 'fruit/vegetable juice'}): 140,
frozenset({'bottled beer', 'bottled water'}): 155,
frozenset({'bottled beer', 'fruit/vegetable juice'}): 69,
frozenset({'bottled beer', 'soda'}): 167,
frozenset({'frozen vegetables', 'root vegetables'}): 114,
frozenset({'oil', 'root vegetables'}): 69,
frozenset({'margarine', 'root vegetables'}): 109,
frozenset({'fruit/vegetable juice', 'root vegetables'}): 118,
frozenset({'fruit/vegetable juice', 'whole milk'}): 262,
frozenset({'domestic eggs', 'frozen vegetables'}): 51,
frozenset({'frozen vegetables', 'rolls/buns'}): 100,
frozenset({'frozen vegetables', 'margarine'}): 50,
frozenset({'frozen vegetables', 'fruit/vegetable juice'}): 77,
frozenset({'domestic eggs', 'rolls/buns'}): 154,
frozenset({'margarine', 'rolls/buns'}): 145,
frozenset({'fruit/vegetable juice', 'rolls/buns'}): 143,
frozenset({'onions', 'root vegetables'}): 93,
frozenset({'root vegetables', 'sausage'}): 147,
frozenset({'sausage', 'yogurt'}): 193,
frozenset({'onions', 'yogurt'}): 71,
frozenset({'onions', 'rolls/buns'}): 67,
frozenset({'fruit/vegetable juice', 'salty snack'}): 59,
frozenset({'citrus fruit', 'cream cheese'}): 56,
frozenset({'citrus fruit', 'pork'}): 64,
frozenset({'berries', 'citrus fruit'}): 53,
frozenset({'citrus fruit', 'onions'}): 55,
frozenset({'citrus fruit', 'whipped/sour cream'}): 107,
frozenset({'citrus fruit', 'coffee'}): 63,
frozenset({'chocolate', 'citrus fruit'}): 63,
frozenset({'onions', 'whipped/sour cream'}): 50,
frozenset({'coffee', 'whipped/sour cream'}): 60,
frozenset({'sausage', 'sliced cheese'}): 69,
frozenset({'brown bread', 'sausage'}): 105,
frozenset({'fruit/vegetable juice', 'sausage'}): 99,
frozenset({'rolls/buns', 'sliced cheese'}): 75,
frozenset({'shopping bags', 'waffles'}): 54,
frozenset({'chicken', 'citrus fruit'}): 68,
frozenset({'chicken', 'root vegetables'}): 107,
frozenset({'chicken', 'other vegetables'}): 176,
frozenset({'butter', 'chicken'}): 57,
frozenset({'hamburger meat', 'root vegetables'}): 61,
frozenset({'citrus fruit', 'root vegetables'}): 174,
frozenset({'citrus fruit', 'other vegetables'}): 284,
frozenset({'oil', 'other vegetables'}): 98,
frozenset({'misc. beverages', 'soda'}): 72,

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```

frozenset({'pork', 'sausage'}): 64,
frozenset({'pork', 'rolls/buns'}): 111,
frozenset({'pastry', 'pork'}): 62,
frozenset({'specialty bar', 'whole milk'}): 64,
frozenset({'bottled water', 'frankfurter'}): 72,
frozenset({'coffee', 'sausage'}): 68,
frozenset({'bottled beer', 'sausage'}): 77,
frozenset({'napkins', 'sausage'}): 66,
frozenset({'bottled beer', 'whole milk'}): 201,
frozenset({'napkins', 'whole milk'}): 194,
frozenset({'shopping bags', 'whole milk'}): 241,
frozenset({'fruit/vegetable juice', 'yogurt'}): 184,
frozenset({'bottled beer', 'yogurt'}): 91,
frozenset({'napkins', 'yogurt'}): 121,
frozenset({'shopping bags', 'yogurt'}): 150,
frozenset({'coffee', 'fruit/vegetable juice'}): 59,
frozenset({'coffee', 'shopping bags'}): 92,
frozenset({'fruit/vegetable juice', 'napkins'}): 68,
frozenset({'bottled beer', 'napkins'}): 51,
frozenset({'bottled beer', 'shopping bags'}): 55,
frozenset({'napkins', 'shopping bags'}): 71,
frozenset({'beef', 'citrus fruit'}): 83,
frozenset({'beef', 'root vegetables'}): 171,
frozenset({'brown bread', 'citrus fruit'}): 82,
frozenset({'berries', 'root vegetables'}): 65,
frozenset({'waffles', 'whipped/sour cream'}): 50,
frozenset({'frankfurter', 'sausage'}): 99,
frozenset({'frankfurter', 'root vegetables'}): 100,
frozenset({'frankfurter', 'other vegetables'}): 162,
frozenset({'bottled beer', 'frankfurter'}): 53,
frozenset({'other vegetables', 'sausage'}): 265,
frozenset({'bottled beer', 'root vegetables'}): 95,
frozenset({'other vegetables', 'pickled vegetables'}): 63,
frozenset({'dishes', 'other vegetables'}): 59,
frozenset({'dessert', 'rolls/buns'}): 67,
frozenset({'bottled water', 'dessert'}): 51,
frozenset({'bottled water', 'frozen vegetables'}): 61,
frozenset({'bottled water', 'margarine'}): 101,
frozenset({'margarine', 'newspapers'}): 70,
frozenset({'hamburger meat', 'whole milk'}): 145,
frozenset({'hamburger meat', 'soda'}): 57,
frozenset({'frozen vegetables', 'soda'}): 85,
frozenset({'cream cheese', 'whole milk'}): 162,
frozenset({'other vegetables', 'pastry'}): 222,
frozenset({'coffee', 'other vegetables'}): 132,
frozenset({'other vegetables', 'shopping bags'}): 228,
frozenset({'margarine', 'pastry'}): 67,
frozenset({'long life bakery product', 'pastry'}): 58,
frozenset({'pastry', 'shopping bags'}): 117,
frozenset({'margarine', 'shopping bags'}): 56,
frozenset({'long life bakery product', 'shopping bags'}): 53,
frozenset({'long life bakery product', 'sausage'}): 53,
frozenset({'frankfurter', 'pip fruit'}): 71,

```

```

frozenset({'frankfurter', 'fruit/vegetable juice'}): 52,
frozenset({'citrus fruit', 'sausage'}): 111,
frozenset({'sausage', 'tropical fruit'}): 137,
frozenset({'pip fruit', 'sausage'}): 106,
frozenset({'hard cheese', 'sausage'}): 51,
frozenset({'cream cheese', 'sausage'}): 55,
frozenset({'domestic eggs', 'sausage'}): 94,
frozenset({'citrus fruit', 'pip fruit'}): 136,
frozenset({'citrus fruit', 'fruit/vegetable juice'}): 102,
frozenset({'citrus fruit', 'hygiene articles'}): 52,
frozenset({'hygiene articles', 'tropical fruit'}): 66,
frozenset({'domestic eggs', 'pip fruit'}): 85,
frozenset({'fruit/vegetable juice', 'pip fruit'}): 94,
frozenset({'hard cheese', 'whole milk'}): 99,
frozenset({'misc. beverages', 'whole milk'}): 69,
frozenset({'hygiene articles', 'whole milk'}): 126,
frozenset({'cream cheese', 'domestic eggs'}): 50,
frozenset({'cream cheese', 'fruit/vegetable juice'}): 56,
frozenset({'frankfurter', 'margarine'}): 63,
frozenset({'margarine', 'sausage'}): 70,
frozenset({'misc. beverages', 'other vegetables'}): 55,
frozenset({'canned beer', 'other vegetables'}): 89,
frozenset({'frankfurter', 'frozen vegetables'}): 50,
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frozenset({'other vegetables', 'soft cheese'}): 70,
frozenset({'soft cheese', 'whole milk'}): 74,
frozenset({'baking powder', 'whole milk'}): 91,
frozenset({'rolls/buns', 'soft cheese'}): 53,
frozenset({'citrus fruit', 'rolls/buns'}): 165,
frozenset({'bottled water', 'onions'}): 58,
frozenset({'cake bar', 'whole milk'}): 55,
frozenset({'chocolate', 'shopping bags'}): 80,
frozenset({'dessert', 'sausage'}): 58,
frozenset({'sausage', 'white bread'}): 71,
frozenset({'other vegetables', 'yogurt'}): 427,
frozenset({'curd', 'dessert'}): 51,
frozenset({'dessert', 'yogurt'}): 97,
frozenset({'soft cheese', 'yogurt'}): 59,
frozenset({'frozen vegetables', 'yogurt'}): 122,
frozenset({'chewing gum', 'soda'}): 53,
frozenset({'ham', 'tropical fruit'}): 53,
frozenset({'ham', 'white bread'}): 50,
frozenset({'bottled beer', 'tropical fruit'}): 81,
frozenset({'white bread', 'whole milk'}): 168,
frozenset({'fruit/vegetable juice', 'white bread'}): 73,
frozenset({'bottled beer', 'brown bread'}): 51,
frozenset({'curd', 'soda'}): 80,
frozenset({'curd', 'shopping bags'}): 53,
frozenset({'dessert', 'soda'}): 97,
frozenset({'dessert', 'shopping bags'}): 61,
frozenset({'salty snack', 'soda'}): 92,
frozenset({'salty snack', 'shopping bags'}): 59,

```

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frozenset({'chocolate', 'waffles'}): 57,
frozenset({'bottled water', 'shopping bags'}): 108,
frozenset({'ice cream', 'other vegetables'}): 50,
frozenset({'frankfurter', 'yogurt'}): 110,
frozenset({'frankfurter', 'whipped/sour cream'}): 61,
frozenset({'frankfurter', 'white bread'}): 51,
frozenset({'ham', 'yogurt'}): 66,
frozenset({'tropical fruit', 'whipped/sour cream'}): 136,
frozenset({'sliced cheese', 'tropical fruit'}): 52,
frozenset({'frozen meals', 'tropical fruit'}): 54,
frozenset({'pip fruit', 'root vegetables'}): 153,
frozenset({'butter', 'pip fruit'}): 72,
frozenset({'curd', 'pip fruit'}): 77,
frozenset({'pip fruit', 'whipped/sour cream'}): 91,
frozenset({'pip fruit', 'white bread'}): 65,
frozenset({'bottled beer', 'pip fruit'}): 58,
frozenset({'root vegetables', 'sliced cheese'}): 55,
frozenset({'cream cheese', 'root vegetables'}): 74,
frozenset({'root vegetables', 'white bread'}): 78,
frozenset({'other vegetables', 'sliced cheese'}): 89,
frozenset({'cream cheese', 'other vegetables'}): 135,
frozenset({'frozen meals', 'other vegetables'}): 74,
frozenset({'sliced cheese', 'whole milk'}): 106,
frozenset({'frozen meals', 'whole milk'}): 97,
frozenset({'butter', 'domestic eggs'}): 95,
frozenset({'bottled beer', 'butter'}): 57,
frozenset({'cream cheese', 'curd'}): 50,
frozenset({'whipped/sour cream', 'yogurt'}): 204,
frozenset({'sliced cheese', 'yogurt'}): 79,
frozenset({'frozen meals', 'yogurt'}): 61,
frozenset({'white bread', 'yogurt'}): 89,
frozenset({'cream cheese', 'whipped/sour cream'}): 63,
frozenset({'domestic eggs', 'whipped/sour cream'}): 98,
frozenset({'whipped/sour cream', 'white bread'}): 54,
frozenset({'fruit/vegetable juice', 'whipped/sour cream'}): 89,
frozenset({'domestic eggs', 'white bread'}): 57,
frozenset({'cream cheese', 'shopping bags'}): 55,
frozenset({'frankfurter', 'shopping bags'}): 81,
frozenset({'shopping bags', 'tropical fruit'}): 133,
frozenset({'beef', 'pork'}): 75,
frozenset({'pip fruit', 'pork'}): 60,
frozenset({'margarine', 'sugar'}): 54,
frozenset({'pork', 'root vegetables'}): 134,
frozenset({'butter', 'soda'}): 87,
frozenset({'hygiene articles', 'yogurt'}): 72,
frozenset({'hygiene articles', 'soda'}): 69,
frozenset({'UHT-milk', 'soda'}): 75,
frozenset({'margarine', 'pork'}): 63,
frozenset({'beef', 'margarine'}): 61,
frozenset({'sausage', 'whipped/sour cream'}): 89,
frozenset({'beef', 'other vegetables'}): 194,
frozenset({'butter milk', 'other vegetables'}): 102,
frozenset({'beverages', 'rolls/buns'}): 53,

```

```

frozenset({'sliced cheese', 'soda'}): 50,
frozenset({'onions', 'tropical fruit'}): 56,
frozenset({'root vegetables', 'shopping bags'}): 126,
frozenset({'meat', 'other vegetables'}): 98,
frozenset({'meat', 'rolls/buns'}): 68,
frozenset({'bottled water', 'brown bread'}): 81,
frozenset({'mustard', 'whole milk'}): 51,
frozenset({'butter', 'sausage'}): 85,
frozenset({'salty snack', 'sausage'}): 52,
frozenset({'herbs', 'root vegetables'}): 69,
frozenset({'herbs', 'other vegetables'}): 76,
frozenset({'herbs', 'whole milk'}): 76,
frozenset({'semi-finished bread', 'whole milk'}): 70,
frozenset({'margarine', 'whipped/sour cream'}): 67,
frozenset({'citrus fruit', 'napkins'}): 75,
frozenset({'napkins', 'whipped/sour cream'}): 71,
frozenset({'curd', 'newspapers'}): 56,
frozenset({'newspapers', 'pastry'}): 83,
frozenset({'bottled water', 'misc. beverages'}): 52,
frozenset({'napkins', 'soda'}): 118,
frozenset({'beef', 'butter'}): 57,
frozenset({'beef', 'bottled water'}): 61,
frozenset({'pork', 'shopping bags'}): 63,
frozenset({'shopping bags', 'whipped/sour cream'}): 78,
frozenset({'bottled water', 'sausage'}): 118,
frozenset({'bottled water', 'pip fruit'}): 104,
frozenset({'citrus fruit', 'soda'}): 126,
frozenset({'newspapers', 'other vegetables'}): 190,
frozenset({'chocolate', 'yogurt'}): 91,
frozenset({'chocolate', 'newspapers'}): 54,
frozenset({'other vegetables', 'specialty bar'}): 55,
frozenset({'napkins', 'tropical fruit'}): 99,
frozenset({'pip fruit', 'soda'}): 131,
frozenset({'napkins', 'pip fruit'}): 66,
frozenset({'onions', 'other vegetables'}): 140,
frozenset({'onions', 'whole milk'}): 119,
frozenset({'onions', 'soda'}): 52,
frozenset({'domestic eggs', 'napkins'}): 59,
frozenset({'meat', 'root vegetables'}): 50,
frozenset({'meat', 'whole milk'}): 98,
frozenset({'meat', 'soda'}): 54,
frozenset({'butter milk', 'tropical fruit'}): 54,
frozenset({'butter milk', 'root vegetables'}): 50,
frozenset({'hygiene articles', 'root vegetables'}): 53,
frozenset({'brown bread', 'pip fruit'}): 75,
frozenset({'margarine', 'pip fruit'}): 84,
frozenset({'hamburger meat', 'yogurt'}): 64,
frozenset({'margarine', 'yogurt'}): 140,
frozenset({'fruit/vegetable juice', 'pastry'}): 84,
frozenset({'chicken', 'whole milk'}): 173,
frozenset({'chicken', 'yogurt'}): 82,
frozenset({'chicken', 'whipped/sour cream'}): 71,
frozenset({'chicken', 'rolls/buns'}): 95,

```



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frozenset({'chicken', 'soda'}): 82,
frozenset({'pasta', 'whole milk'}): 60,
frozenset({'pastry', 'pip fruit'}): 105,
frozenset({'bottled water', 'domestic eggs'}): 90,
frozenset({'potted plants', 'whole milk'}): 68,
frozenset({'citrus fruit', 'shopping bags'}): 96,
frozenset({'bottled water', 'chicken'}): 52,
frozenset({'chicken', 'newspapers'}): 51,
frozenset({'canned beer', 'whole milk'}): 87,
frozenset({'napkins', 'newspapers'}): 61,
frozenset({'pork', 'yogurt'}): 94,
frozenset({'oil', 'yogurt'}): 52,
frozenset({'beef', 'yogurt'}): 115,
frozenset({'napkins', 'root vegetables'}): 98,
frozenset({'canned beer', 'yogurt'}): 53,
frozenset({'beef', 'pastry'}): 62,
frozenset({'pastry', 'white bread'}): 55,
frozenset({'chicken', 'sausage'}): 52,
frozenset({'brown bread', 'pork'}): 55,
frozenset({'other vegetables', 'specialty chocolate'}): 60,
frozenset({'soda', 'specialty chocolate'}): 62,
frozenset({'meat', 'sausage'}): 52,
frozenset({'hamburger meat', 'sausage'}): 51,
frozenset({'frankfurter', 'pork'}): 58,
frozenset({'butter', 'pork'}): 54,
frozenset({'brown bread', 'butter'}): 57,
frozenset({'frankfurter', 'pastry'}): 82,
frozenset({'pastry', 'whipped/sour cream'}): 74,
frozenset({'napkins', 'pastry'}): 69,
frozenset({'cat food', 'other vegetables'}): 64,
frozenset({'cat food', 'whole milk'}): 87,
frozenset({'coffee', 'rolls/buns'}): 108,
frozenset({'butter', 'frozen vegetables'}): 57,
frozenset({'frozen vegetables', 'whipped/sour cream'}): 78,
frozenset({'long life bakery product', 'yogurt'}): 86,
frozenset({'fruit/vegetable juice', 'long life bakery product'}): 61,
frozenset({'bottled beer', 'margarine'}): 60,
frozenset({'pork', 'tropical fruit'}): 84,
frozenset({'beef', 'domestic eggs'}): 59,
frozenset({'citrus fruit', 'frozen vegetables'}): 65,
frozenset({'beef', 'newspapers'}): 63,
frozenset({'beef', 'tropical fruit'}): 75,
frozenset({'beef', 'soda'}): 80,
frozenset({'frozen vegetables', 'pork'}): 63,
frozenset({'ice cream', 'whole milk'}): 58,
frozenset({'frozen vegetables', 'sausage'}): 59,
frozenset({'butter', 'pastry'}): 75,
frozenset({'butter milk', 'pip fruit'}): 50,
frozenset({'coffee', 'pip fruit'}): 68,
frozenset({'chocolate', 'long life bakery product'}): 52,
frozenset({'frozen meals', 'soda'}): 61,
frozenset({'pip fruit', 'shopping bags'}): 92,
frozenset({'soda', 'white bread'}): 101,

```

```

frozenset({'bottled water', 'coffee'}): 72,
frozenset({'napkins', 'pork'}): 51,
frozenset({'newspapers', 'pork'}): 65,
frozenset({'salty snack', 'yogurt'}): 61,
frozenset({'shopping bags', 'white bread'}): 73,
frozenset({'frozen vegetables', 'tropical fruit'}): 86,
frozenset({'domestic eggs', 'shopping bags'}): 89,
frozenset({'hygiene articles', 'shopping bags'}): 51,
frozenset({'domestic eggs', 'pork'}): 55,
frozenset({'hard cheese', 'yogurt'}): 63,
frozenset({'bottled water', 'pork'}): 73,
frozenset({'meat', 'yogurt'}): 52,
frozenset({'newspapers', 'root vegetables'}): 113,
frozenset({'long life bakery product', 'soda'}): 75,
frozenset({'newspapers', 'pip fruit'}): 66,
frozenset({'UHT-milk', 'yogurt'}): 73,
frozenset({'beef', 'fruit/vegetable juice'}): 50,
frozenset({'other vegetables', 'processed cheese'}): 54,
frozenset({'grapes', 'tropical fruit'}): 60,
frozenset({'long life bakery product', 'tropical fruit'}): 62,
frozenset({'pastry', 'salty snack'}): 51,
frozenset({'bottled beer', 'citrus fruit'}): 60,
frozenset({'coffee', 'frankfurter'}): 50,
frozenset({'chocolate', 'root vegetables'}): 63,
frozenset({'margarine', 'soda'}): 100,
frozenset({'bottled beer', 'pork'}): 51,
frozenset({'chicken', 'pork'}): 57,
frozenset({'chicken', 'domestic eggs'}): 61,
frozenset({'chicken', 'frozen vegetables'}): 66,
frozenset({'ice cream', 'soda'}): 60,
frozenset({'newspapers', 'whipped/sour cream'}): 71,
frozenset({'chewing gum', 'whole milk'}): 50,
frozenset({'rolls/buns', 'specialty chocolate'}): 55,
frozenset({'rolls/buns', 'white bread'}): 64,
frozenset({'salty snack', 'whipped/sour cream'}): 51,
frozenset({'chocolate', 'pastry'}): 79,
frozenset({'chocolate', 'fruit/vegetable juice'}): 67,
frozenset({'butter', 'chocolate'}): 61,
frozenset({'dessert', 'tropical fruit'}): 62,
frozenset({'dessert', 'pastry'}): 53,
frozenset({'dessert', 'fruit/vegetable juice'}): 59,
frozenset({'cat food', 'yogurt'}): 61}

```

In [15]:

```
apriori(100)
```

```

3781 initial itemsets to be filtered
Apriori algorithm took 0.2320566177368164 seconds
207 candidates with >100 occurrences

```

Out[15]:

```

{frozenset({'tropical fruit', 'yogurt'}): 288,
 frozenset({'pip fruit', 'yogurt'}): 177,
 frozenset({'cream cheese', 'yogurt'}): 122,

```

```

frozenset({'other vegetables', 'whole milk'}): 736,
frozenset({'long life bakery product', 'other vegetables'}): 105,
frozenset({'long life bakery product', 'whole milk'}): 133,
frozenset({'butter', 'whole milk'}): 271,
frozenset({'whole milk', 'yogurt'}): 551,
frozenset({'butter', 'yogurt'}): 144,
frozenset({'other vegetables', 'rolls/buns'}): 419,
frozenset({'bottled beer', 'other vegetables'}): 159,
frozenset({'bottled beer', 'rolls/buns'}): 134,
frozenset({'other vegetables', 'tropical fruit'}): 353,
frozenset({'bottled water', 'tropical fruit'}): 182,
frozenset({'other vegetables', 'white bread'}): 135,
frozenset({'bottled water', 'other vegetables'}): 244,
frozenset({'chocolate', 'other vegetables'}): 125,
frozenset({'citrus fruit', 'tropical fruit'}): 196,
frozenset({'citrus fruit', 'whole milk'}): 300,
frozenset({'citrus fruit', 'yogurt'}): 213,
frozenset({'bottled water', 'citrus fruit'}): 133,
frozenset({'tropical fruit', 'whole milk'}): 416,
frozenset({'curd', 'tropical fruit'}): 101,
frozenset({'curd', 'whole milk'}): 257,
frozenset({'bottled water', 'whole milk'}): 338,
frozenset({'curd', 'yogurt'}): 170,
frozenset({'bottled water', 'yogurt'}): 226,
frozenset({'frankfurter', 'rolls/buns'}): 189,
frozenset({'frankfurter', 'soda'}): 111,
frozenset({'rolls/buns', 'soda'}): 377,
frozenset({'newspapers', 'tropical fruit'}): 116,
frozenset({'root vegetables', 'tropical fruit'}): 207,
frozenset({'rolls/buns', 'tropical fruit'}): 242,
frozenset({'other vegetables', 'root vegetables'}): 466,
frozenset({'rolls/buns', 'root vegetables'}): 239,
frozenset({'other vegetables', 'salty snack'}): 106,
frozenset({'rolls/buns', 'sausage'}): 301,
frozenset({'sausage', 'soda'}): 239,
frozenset({'chocolate', 'rolls/buns'}): 116,
frozenset({'chocolate', 'soda'}): 133,
frozenset({'brown bread', 'soda'}): 124,
frozenset({'fruit/vegetable juice', 'soda'}): 181,
frozenset({'canned beer', 'soda'}): 136,
frozenset({'newspapers', 'soda'}): 144,
frozenset({'shopping bags', 'soda'}): 242,
frozenset({'fruit/vegetable juice', 'shopping bags'}): 105,
frozenset({'canned beer', 'shopping bags'}): 112,
frozenset({'hamburger meat', 'other vegetables'}): 136,
frozenset({'napkins', 'other vegetables'}): 142,
frozenset({'bottled water', 'rolls/buns'}): 238,
frozenset({'napkins', 'rolls/buns'}): 115,
frozenset({'root vegetables', 'whole milk'}): 481,
frozenset({'other vegetables', 'sugar'}): 106,
frozenset({'sugar', 'whole milk'}): 148,
frozenset({'other vegetables', 'pork'}): 213,
frozenset({'pork', 'whole milk'}): 218,

```

```

frozenset({'pork', 'soda'}): 117,
frozenset({'berries', 'other vegetables'}): 101,
frozenset({'berries', 'whole milk'}): 116,
frozenset({'other vegetables', 'whipped/sour cream'}): 284,
frozenset({'other vegetables', 'soda'}): 322,
frozenset({'whipped/sour cream', 'whole milk'}): 317,
frozenset({'soda', 'whole milk'}): 394,
frozenset({'soda', 'whipped/sour cream'}): 114,
frozenset({'pastry', 'soda'}): 207,
frozenset({'dessert', 'other vegetables'}): 114,
frozenset({'dessert', 'whole milk'}): 135,
frozenset({'sausage', 'shopping bags'}): 154,
frozenset({'canned beer', 'rolls/buns'}): 111,
frozenset({'rolls/buns', 'shopping bags'}): 192,
frozenset({'domestic eggs', 'tropical fruit'}): 112,
frozenset({'brown bread', 'tropical fruit'}): 105,
frozenset({'pastry', 'tropical fruit'}): 130,
frozenset({'soda', 'tropical fruit'}): 205,
frozenset({'root vegetables', 'yogurt'}): 254,
frozenset({'domestic eggs', 'root vegetables'}): 141,
frozenset({'brown bread', 'root vegetables'}): 100,
frozenset({'pastry', 'root vegetables'}): 108,
frozenset({'root vegetables', 'soda'}): 183,
frozenset({'domestic eggs', 'whole milk'}): 295,
frozenset({'brown bread', 'whole milk'}): 248,
frozenset({'pastry', 'whole milk'}): 327,
frozenset({'coffee', 'whole milk'}): 184,
frozenset({'waffles', 'whole milk'}): 125,
frozenset({'domestic eggs', 'yogurt'}): 141,
frozenset({'brown bread', 'yogurt'}): 143,
frozenset({'pastry', 'yogurt'}): 174,
frozenset({'soda', 'yogurt'}): 269,
frozenset({'domestic eggs', 'soda'}): 122,
frozenset({'berries', 'yogurt'}): 104,
frozenset({'rolls/buns', 'yogurt'}): 338,
frozenset({'newspapers', 'yogurt'}): 151,
frozenset({'newspapers', 'rolls/buns'}): 194,
frozenset({'bottled water', 'soda'}): 285,
frozenset({'bottled water', 'newspapers'}): 111,
frozenset({'butter', 'root vegetables'}): 127,
frozenset({'curd', 'root vegetables'}): 107,
frozenset({'root vegetables', 'whipped/sour cream'}): 168,
frozenset({'bottled water', 'root vegetables'}): 154,
frozenset({'butter', 'other vegetables'}): 197,
frozenset({'curd', 'other vegetables'}): 169,
frozenset({'butter', 'whipped/sour cream'}): 100,
frozenset({'butter', 'rolls/buns'}): 132,
frozenset({'curd', 'whipped/sour cream'}): 103,
frozenset({'rolls/buns', 'whipped/sour cream'}): 144,
frozenset({'ham', 'whole milk'}): 113,
frozenset({'fruit/vegetable juice', 'tropical fruit'}): 135,
frozenset({'domestic eggs', 'other vegetables'}): 219,
frozenset({'brown bread', 'other vegetables'}): 184,

```

```

frozenset({'margarine', 'other vegetables'}): 194,
frozenset({'fruit/vegetable juice', 'other vegetables'}): 207,
frozenset({'beef', 'rolls/buns'}): 134,
frozenset({'pastry', 'rolls/buns'}): 206,
frozenset({'frozen vegetables', 'other vegetables'}): 175,
frozenset({'frozen vegetables', 'whole milk'}): 201,
frozenset({'salty snack', 'whole milk'}): 110,
frozenset({'pastry', 'sausage'}): 123,
frozenset({'sausage', 'whole milk'}): 294,
frozenset({'beef', 'whole milk'}): 209,
frozenset({'brown bread', 'rolls/buns'}): 124,
frozenset({'pip fruit', 'tropical fruit'}): 201,
frozenset({'pip fruit', 'whole milk'}): 296,
frozenset({'pip fruit', 'rolls/buns'}): 137,
frozenset({'rolls/buns', 'whole milk'}): 557,
frozenset({'chocolate', 'whole milk'}): 164,
frozenset({'margarine', 'whole milk'}): 238,
frozenset({'frankfurter', 'whole milk'}): 202,
frozenset({'citrus fruit', 'domestic eggs'}): 102,
frozenset({'oil', 'whole milk'}): 111,
frozenset({'newspapers', 'whole milk'}): 269,
frozenset({'butter milk', 'whole milk'}): 114,
frozenset({'bottled water', 'fruit/vegetable juice'}): 140,
frozenset({'bottled beer', 'bottled water'}): 155,
frozenset({'bottled beer', 'soda'}): 167,
frozenset({'frozen vegetables', 'root vegetables'}): 114,
frozenset({'margarine', 'root vegetables'}): 109,
frozenset({'fruit/vegetable juice', 'root vegetables'}): 118,
frozenset({'fruit/vegetable juice', 'whole milk'}): 262,
frozenset({'frozen vegetables', 'rolls/buns'}): 100,
frozenset({'domestic eggs', 'rolls/buns'}): 154,
frozenset({'margarine', 'rolls/buns'}): 145,
frozenset({'fruit/vegetable juice', 'rolls/buns'}): 143,
frozenset({'root vegetables', 'sausage'}): 147,
frozenset({'sausage', 'yogurt'}): 193,
frozenset({'citrus fruit', 'whipped/sour cream'}): 107,
frozenset({'brown bread', 'sausage'}): 105,
frozenset({'chicken', 'root vegetables'}): 107,
frozenset({'chicken', 'other vegetables'}): 176,
frozenset({'citrus fruit', 'root vegetables'}): 174,
frozenset({'citrus fruit', 'other vegetables'}): 284,
frozenset({'pork', 'rolls/buns'}): 111,
frozenset({'bottled beer', 'whole milk'}): 201,
frozenset({'napkins', 'whole milk'}): 194,
frozenset({'shopping bags', 'whole milk'}): 241,
frozenset({'fruit/vegetable juice', 'yogurt'}): 184,
frozenset({'napkins', 'yogurt'}): 121,
frozenset({'shopping bags', 'yogurt'}): 150,
frozenset({'beef', 'root vegetables'}): 171,
frozenset({'frankfurter', 'root vegetables'}): 100,
frozenset({'frankfurter', 'other vegetables'}): 162,
frozenset({'other vegetables', 'sausage'}): 265,
frozenset({'bottled water', 'margarine'}): 101,

```

```

frozenset({'hamburger meat', 'whole milk'}): 145,
frozenset({'cream cheese', 'whole milk'}): 162,
frozenset({'other vegetables', 'pastry'}): 222,
frozenset({'coffee', 'other vegetables'}): 132,
frozenset({'other vegetables', 'shopping bags'}): 228,
frozenset({'pastry', 'shopping bags'}): 117,
frozenset({'citrus fruit', 'sausage'}): 111,
frozenset({'sausage', 'tropical fruit'}): 137,
frozenset({'pip fruit', 'sausage'}): 106,
frozenset({'citrus fruit', 'pip fruit'}): 136,
frozenset({'citrus fruit', 'fruit/vegetable juice'}): 102,
frozenset({'hygiene articles', 'whole milk'}): 126,
frozenset({'other vegetables', 'pip fruit'}): 257,
frozenset({'citrus fruit', 'rolls/buns'}): 165,
frozenset({'other vegetables', 'yogurt'}): 427,
frozenset({'frozen vegetables', 'yogurt'}): 122,
frozenset({'white bread', 'whole milk'}): 168,
frozenset({'bottled water', 'shopping bags'}): 108,
frozenset({'frankfurter', 'yogurt'}): 110,
frozenset({'tropical fruit', 'whipped/sour cream'}): 136,
frozenset({'pip fruit', 'root vegetables'}): 153,
frozenset({'cream cheese', 'other vegetables'}): 135,
frozenset({'sliced cheese', 'whole milk'}): 106,
frozenset({'whipped/sour cream', 'yogurt'}): 204,
frozenset({'shopping bags', 'tropical fruit'}): 133,
frozenset({'pork', 'root vegetables'}): 134,
frozenset({'beef', 'other vegetables'}): 194,
frozenset({'butter milk', 'other vegetables'}): 102,
frozenset({'root vegetables', 'shopping bags'}): 126,
frozenset({'napkins', 'soda'}): 118,
frozenset({'bottled water', 'sausage'}): 118,
frozenset({'bottled water', 'pip fruit'}): 104,
frozenset({'citrus fruit', 'soda'}): 126,
frozenset({'newspapers', 'other vegetables'}): 190,
frozenset({'pip fruit', 'soda'}): 131,
frozenset({'onions', 'other vegetables'}): 140,
frozenset({'onions', 'whole milk'}): 119,
frozenset({'margarine', 'yogurt'}): 140,
frozenset({'chicken', 'whole milk'}): 173,
frozenset({'pastry', 'pip fruit'}): 105,
frozenset({'beef', 'yogurt'}): 115,
frozenset({'coffee', 'rolls/buns'}): 108,
frozenset({'soda', 'white bread'}): 101,
frozenset({'newspapers', 'root vegetables'}): 113,
frozenset({'margarine', 'soda'}): 100}

```

PCY Algorithm frequent pairs

In [16]:

```
pcy(10)
```

4673 initial itemsets to be filtered

PCY-algorithm took 0.4042801856994629 seconds

2981 candidates with >10 occurrences

```
Out[16]: {frozenset({'citrus fruit', 'semi-finished bread'}): 24,
frozenset({'citrus fruit', 'margarine'}): 78,
frozenset({'margarine', 'semi-finished bread'}): 20,
frozenset({'tropical fruit', 'yogurt'}): 288,
frozenset({'coffee', 'tropical fruit'}): 70,
frozenset({'coffee', 'yogurt'}): 96,
frozenset({'pip fruit', 'yogurt'}): 177,
frozenset({'cream cheese', 'pip fruit'}): 60,
frozenset({'cream cheese', 'yogurt'}): 122,
frozenset({'meat spreads', 'yogurt'}): 18,
frozenset({'cream cheese', 'meat spreads'}): 11,
frozenset({'other vegetables', 'whole milk'}): 736,
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frozenset({'bottled water', 'specialty cheese'}): 17,
frozenset({'finished products', 'other vegetables'}): 20,
frozenset({'beverages', 'soda'}): 47,
frozenset({'finished products', 'shopping bags'}): 14,
frozenset({'shopping bags', 'white wine'}): 33,
frozenset({'ham', 'tropical fruit'}): 53,
frozenset({'ham', 'white bread'}): 50,
frozenset({'brown bread', 'ham'}): 26,
frozenset({'fruit/vegetable juice', 'ham'}): 38,
frozenset({'bottled beer', 'ham'}): 22,
frozenset({'bottled beer', 'tropical fruit'}): 81,
frozenset({'white bread', 'whole milk'}): 168,
frozenset({'brown bread', 'white bread'}): 46,
frozenset({'fruit/vegetable juice', 'white bread'}): 73,
frozenset({'bottled beer', 'white bread'}): 39,
frozenset({'bottled beer', 'brown bread'}): 51,
frozenset({'curd', 'salty snack'}): 30,
frozenset({'butter milk', 'salty snack'}): 17,
frozenset({'popcorn', 'salty snack'}): 22,
frozenset({'curd', 'soda'}): 80,
frozenset({'curd', 'waffles'}): 33,
frozenset({'cake bar', 'curd'}): 19,
frozenset({'chocolate', 'curd'}): 28,
frozenset({'curd', 'shopping bags'}): 53,

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frozenset({'dessert', 'soda'}): 97,
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frozenset({'dessert', 'waffles'}): 28,
frozenset({'cake bar', 'dessert'}): 19,
frozenset({'chocolate', 'dessert'}): 36,
frozenset({'dessert', 'shopping bags'}): 61,
frozenset({'salty snack', 'soda'}): 92,
frozenset({'cake bar', 'soda'}): 44,
frozenset({'cake bar', 'salty snack'}): 11,
frozenset({'chocolate', 'salty snack'}): 35,
frozenset({'salty snack', 'shopping bags'}): 59,
frozenset({'cake bar', 'waffles'}): 10,
frozenset({'chocolate', 'waffles'}): 57,
frozenset({'dog food', 'whole milk'}): 29,
frozenset({'salt', 'whole milk'}): 38,
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frozenset({'sausage', 'soft cheese'}): 34,
frozenset({'coffee', 'soft cheese'}): 21,
frozenset({'bottled water', 'waffles'}): 42,
frozenset({'bottled water', 'shopping bags'}): 108,
frozenset({'dishes', 'waffles'}): 12,
frozenset({'dishes', 'shopping bags'}): 17,
frozenset({'ice cream', 'other vegetables'}): 50,
frozenset({'soda', 'white wine'}): 36,
frozenset({'bottled beer', 'white wine'}): 22,
frozenset({'butter', 'frankfurter'}): 48,
frozenset({'curd', 'frankfurter'}): 43,
frozenset({'frankfurter', 'yogurt'}): 110,
frozenset({'frankfurter', 'whipped/sour cream'}): 61,
frozenset({'frankfurter', 'sliced cheese'}): 23,
frozenset({'frankfurter', 'frozen meals'}): 29,
frozenset({'frankfurter', 'frozen fish'}): 17,
frozenset({'frankfurter', 'white bread'}): 51,
frozenset({'ham', 'root vegetables'}): 36,
frozenset({'butter', 'ham'}): 31,
frozenset({'curd', 'ham'}): 24,
frozenset({'ham', 'yogurt'}): 66,
frozenset({'ham', 'sliced cheese'}): 26,
frozenset({'cream cheese', 'ham'}): 22,
frozenset({'frozen meals', 'ham'}): 18,
frozenset({'domestic eggs', 'ham'}): 41,
frozenset({'ham', 'waffles'}): 19,
frozenset({'tropical fruit', 'whipped/sour cream'}): 136,
frozenset({'soft cheese', 'tropical fruit'}): 32,
frozenset({'sliced cheese', 'tropical fruit'}): 52,
frozenset({'frozen meals', 'tropical fruit'}): 54,
frozenset({'frozen fish', 'tropical fruit'}): 25,
frozenset({'pip fruit', 'root vegetables'}): 153,
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frozenset({'curd', 'pip fruit'}): 77,
frozenset({'pip fruit', 'whipped/sour cream'}): 91,
frozenset({'pip fruit', 'sliced cheese'}): 41,
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```



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frozenset({'frozen fish', 'pip fruit'}): 21,
frozenset({'pip fruit', 'white bread'}): 65,
frozenset({'bottled beer', 'pip fruit'}): 58,
frozenset({'pip fruit', 'waffles'}): 44,
frozenset({'root vegetables', 'sliced cheese'}): 55,
frozenset({'cream cheese', 'root vegetables'}): 74,
frozenset({'frozen meals', 'root vegetables'}): 38,
frozenset({'frozen fish', 'root vegetables'}): 26,
frozenset({'root vegetables', 'white bread'}): 78,
frozenset({'other vegetables', 'sliced cheese'}): 89,
frozenset({'cream cheese', 'other vegetables'}): 135,
frozenset({'frozen meals', 'other vegetables'}): 74,
frozenset({'frozen fish', 'other vegetables'}): 46,
frozenset({'cereals', 'other vegetables'}): 20,
frozenset({'sliced cheese', 'whole milk'}): 106,
frozenset({'frozen meals', 'whole milk'}): 97,
frozenset({'frozen fish', 'whole milk'}): 49,
frozenset({'butter', 'soft cheese'}): 27,
frozenset({'butter', 'sliced cheese'}): 37,
frozenset({'butter', 'frozen meals'}): 27,
frozenset({'butter', 'frozen fish'}): 11,
frozenset({'butter', 'domestic eggs'}): 95,
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frozenset({'butter', 'waffles'}): 35,
frozenset({'curd', 'soft cheese'}): 22,
frozenset({'curd', 'sliced cheese'}): 28,
frozenset({'cream cheese', 'curd'}): 50,
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frozenset({'curd', 'white bread'}): 34,
frozenset({'curd', 'sugar'}): 34,
frozenset({'cereals', 'curd'}): 11,
frozenset({'bottled beer', 'curd'}): 38,
frozenset({'whipped/sour cream', 'yogurt'}): 204,
frozenset({'sliced cheese', 'yogurt'}): 79,
frozenset({'frozen meals', 'yogurt'}): 61,
frozenset({'frozen fish', 'yogurt'}): 32,
frozenset({'white bread', 'yogurt'}): 89,
frozenset({'soft cheese', 'whipped/sour cream'}): 30,
frozenset({'sliced cheese', 'whipped/sour cream'}): 38,
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frozenset({'frozen meals', 'whipped/sour cream'}): 28,
frozenset({'domestic eggs', 'whipped/sour cream'}): 98,
frozenset({'whipped/sour cream', 'white bread'}): 54,
frozenset({'sugar', 'whipped/sour cream'}): 48,
frozenset({'cereals', 'whipped/sour cream'}): 10,
frozenset({'fruit/vegetable juice', 'whipped/sour cream'}): 89,
frozenset({'bottled beer', 'whipped/sour cream'}): 39,
frozenset({'sliced cheese', 'soft cheese'}): 18,
...}

```

In [17]:

```
pcy(50)
```

1173 initial itemsets to be filtered

PCY-algorithm took 0.36310863494873047 seconds
605 candidates with >50 occurances

```
Out[17]: {frozenset({'citrus fruit', 'margarine'}): 78,
frozenset({'tropical fruit', 'yogurt'}): 288,
frozenset({'coffee', 'tropical fruit'}): 70,
frozenset({'coffee', 'yogurt'}): 96,
frozenset({'pip fruit', 'yogurt'}): 177,
frozenset({'cream cheese', 'pip fruit'}): 60,
frozenset({'cream cheese', 'yogurt'}): 122,
frozenset({'other vegetables', 'whole milk'}): 736,
frozenset({'long life bakery product', 'other vegetables'}): 105,
frozenset({'long life bakery product', 'whole milk'}): 133,
frozenset({'butter', 'whole milk'}): 271,
frozenset({'whole milk', 'yogurt'}): 551,
frozenset({'butter', 'yogurt'}): 144,
frozenset({'UHT-milk', 'other vegetables'}): 80,
frozenset({'other vegetables', 'rolls/buns'}): 419,
frozenset({'bottled beer', 'other vegetables'}): 159,
frozenset({'UHT-milk', 'rolls/buns'}): 63,
frozenset({'bottled beer', 'rolls/buns'}): 134,
frozenset({'other vegetables', 'tropical fruit'}): 353,
frozenset({'tropical fruit', 'white bread'}): 86,
frozenset({'bottled water', 'tropical fruit'}): 182,
frozenset({'chocolate', 'tropical fruit'}): 80,
frozenset({'other vegetables', 'white bread'}): 135,
frozenset({'bottled water', 'other vegetables'}): 244,
frozenset({'chocolate', 'other vegetables'}): 125,
frozenset({'bottled water', 'chocolate'}): 57,
frozenset({'citrus fruit', 'tropical fruit'}): 196,
frozenset({'citrus fruit', 'whole milk'}): 300,
frozenset({'butter', 'citrus fruit'}): 90,
frozenset({'citrus fruit', 'curd'}): 70,
frozenset({'citrus fruit', 'yogurt'}): 213,
frozenset({'bottled water', 'citrus fruit'}): 133,
frozenset({'tropical fruit', 'whole milk'}): 416,
frozenset({'butter', 'tropical fruit'}): 98,
frozenset({'curd', 'tropical fruit'}): 101,
frozenset({'curd', 'whole milk'}): 257,
frozenset({'flour', 'whole milk'}): 83,
frozenset({'bottled water', 'whole milk'}): 338,
frozenset({'dishes', 'whole milk'}): 52,
frozenset({'butter', 'curd'}): 67,
frozenset({'bottled water', 'butter'}): 88,
frozenset({'curd', 'yogurt'}): 170,
frozenset({'bottled water', 'curd'}): 60,
frozenset({'bottled water', 'yogurt'}): 226,
frozenset({'frankfurter', 'rolls/buns'}): 189,
frozenset({'frankfurter', 'soda'}): 111,
frozenset({'rolls/buns', 'soda'}): 377,
frozenset({'chicken', 'tropical fruit'}): 63,
frozenset({'butter', 'fruit/vegetable juice'}): 79,
frozenset({'butter', 'newspapers'}): 57,
```

```

frozenset({'fruit/vegetable juice', 'newspapers'}): 81,
frozenset({'cream cheese', 'tropical fruit'}): 71,
frozenset({'newspapers', 'tropical fruit'}): 116,
frozenset({'root vegetables', 'tropical fruit'}): 207,
frozenset({'rolls/buns', 'tropical fruit'}): 242,
frozenset({'salty snack', 'tropical fruit'}): 55,
frozenset({'tropical fruit', 'waffles'}): 60,
frozenset({'candy', 'tropical fruit'}): 53,
frozenset({'other vegetables', 'root vegetables'}): 466,
frozenset({'rolls/buns', 'root vegetables'}): 239,
frozenset({'root vegetables', 'waffles'}): 65,
frozenset({'flour', 'other vegetables'}): 62,
frozenset({'other vegetables', 'salty snack'}): 106,
frozenset({'other vegetables', 'waffles'}): 99,
frozenset({'candy', 'other vegetables'}): 68,
frozenset({'rolls/buns', 'waffles'}): 90,
frozenset({'candy', 'rolls/buns'}): 70,
frozenset({'bottled water', 'canned beer'}): 79,
frozenset({'rolls/buns', 'sausage'}): 301,
frozenset({'sausage', 'soda'}): 239,
frozenset({'chocolate', 'sausage'}): 65,
frozenset({'chocolate', 'rolls/buns'}): 116,
frozenset({'chocolate', 'soda'}): 133,
frozenset({'brown bread', 'soda'}): 124,
frozenset({'brown bread', 'fruit/vegetable juice'}): 82,
frozenset({'brown bread', 'newspapers'}): 75,
frozenset({'brown bread', 'shopping bags'}): 91,
frozenset({'fruit/vegetable juice', 'soda'}): 181,
frozenset({'canned beer', 'soda'}): 136,
frozenset({'newspapers', 'soda'}): 144,
frozenset({'shopping bags', 'soda'}): 242,
frozenset({'fruit/vegetable juice', 'shopping bags'}): 105,
frozenset({'canned beer', 'shopping bags'}): 112,
frozenset({'newspapers', 'shopping bags'}): 68,
frozenset({'beverages', 'yogurt'}): 54,
frozenset({'hamburger meat', 'other vegetables'}): 136,
frozenset({'hamburger meat', 'rolls/buns'}): 85,
frozenset({'hygiene articles', 'other vegetables'}): 94,
frozenset({'napkins', 'other vegetables'}): 142,
frozenset({'bottled water', 'rolls/buns'}): 238,
frozenset({'hygiene articles', 'rolls/buns'}): 58,
frozenset({'napkins', 'rolls/buns'}): 115,
frozenset({'bottled water', 'hygiene articles'}): 56,
frozenset({'bottled water', 'napkins'}): 85,
frozenset({'hygiene articles', 'napkins'}): 60,
frozenset({'root vegetables', 'whole milk'}): 481,
frozenset({'root vegetables', 'sugar'}): 63,
frozenset({'beverages', 'other vegetables'}): 51,
frozenset({'other vegetables', 'sugar'}): 106,
frozenset({'beverages', 'whole milk'}): 67,
frozenset({'sugar', 'whole milk'}): 148,
frozenset({'other vegetables', 'pork'}): 213,
frozenset({'pork', 'whole milk'}): 218,

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frozenset({'pork', 'whipped/sour cream'}): 81,
frozenset({'pork', 'soda'}): 117,
frozenset({'berries', 'other vegetables'}): 101,
frozenset({'berries', 'whole milk'}): 116,
frozenset({'berries', 'whipped/sour cream'}): 89,
frozenset({'berries', 'soda'}): 72,
frozenset({'other vegetables', 'whipped/sour cream'}): 284,
frozenset({'other vegetables', 'soda'}): 322,
frozenset({'whipped/sour cream', 'whole milk'}): 317,
frozenset({'soda', 'whole milk'}): 394,
frozenset({'soda', 'whipped/sour cream'}): 114,
frozenset({'pastry', 'soda'}): 207,
frozenset({'dessert', 'root vegetables'}): 57,
frozenset({'dessert', 'other vegetables'}): 114,
frozenset({'dessert', 'whole milk'}): 135,
frozenset({'citrus fruit', 'newspapers'}): 82,
frozenset({'canned beer', 'sausage'}): 62,
frozenset({'sausage', 'shopping bags'}): 154,
frozenset({'canned beer', 'rolls/buns'}): 111,
frozenset({'rolls/buns', 'specialty bar'}): 55,
frozenset({'rolls/buns', 'shopping bags'}): 192,
frozenset({'soda', 'specialty bar'}): 71,
frozenset({'domestic eggs', 'tropical fruit'}): 112,
frozenset({'brown bread', 'tropical fruit'}): 105,
frozenset({'pastry', 'tropical fruit'}): 130,
frozenset({'soda', 'tropical fruit'}): 205,
frozenset({'root vegetables', 'yogurt'}): 254,
frozenset({'domestic eggs', 'root vegetables'}): 141,
frozenset({'brown bread', 'root vegetables'}): 100,
frozenset({'pastry', 'root vegetables'}): 108,
frozenset({'coffee', 'root vegetables'}): 72,
frozenset({'root vegetables', 'soda'}): 183,
frozenset({'domestic eggs', 'whole milk'}): 295,
frozenset({'brown bread', 'whole milk'}): 248,
frozenset({'pastry', 'whole milk'}): 327,
frozenset({'coffee', 'whole milk'}): 184,
frozenset({'waffles', 'whole milk'}): 125,
frozenset({'candy', 'whole milk'}): 81,
frozenset({'domestic eggs', 'yogurt'}): 141,
frozenset({'brown bread', 'yogurt'}): 143,
frozenset({'pastry', 'yogurt'}): 174,
frozenset({'sugar', 'yogurt'}): 68,
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frozenset({'waffles', 'yogurt'}): 74,
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frozenset({'brown bread', 'domestic eggs'}): 67,
frozenset({'domestic eggs', 'pastry'}): 89,
frozenset({'domestic eggs', 'soda'}): 122,
frozenset({'brown bread', 'pastry'}): 95,
frozenset({'pastry', 'sugar'}): 51,
frozenset({'coffee', 'pastry'}): 68,
frozenset({'pastry', 'waffles'}): 69,
frozenset({'soda', 'sugar'}): 72,

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```

frozenset({'coffee', 'soda'}): 98,
frozenset({'soda', 'waffles'}): 94,
frozenset({'candy', 'soda'}): 85,
frozenset({'berries', 'yogurt'}): 104,
frozenset({'butter milk', 'yogurt'}): 84,
frozenset({'butter milk', 'rolls/buns'}): 75,
frozenset({'rolls/buns', 'yogurt'}): 338,
frozenset({'newspapers', 'yogurt'}): 151,
frozenset({'cream cheese', 'rolls/buns'}): 98,
frozenset({'bottled water', 'cream cheese'}): 58,
frozenset({'cream cheese', 'soda'}): 67,
frozenset({'newspapers', 'rolls/buns'}): 194,
frozenset({'bottled water', 'soda'}): 285,
frozenset({'bottled water', 'newspapers'}): 111,
frozenset({'bottled water', 'pastry'}): 88,
frozenset({'butter', 'root vegetables'}): 127,
frozenset({'curd', 'root vegetables'}): 107,
frozenset({'root vegetables', 'whipped/sour cream'}): 168,
frozenset({'hard cheese', 'root vegetables'}): 55,
frozenset({'bottled water', 'root vegetables'}): 154,
frozenset({'long life bakery product', 'root vegetables'}): 52,
frozenset({'butter', 'other vegetables'}): 197,
frozenset({'curd', 'other vegetables'}): 169,
frozenset({'hard cheese', 'other vegetables'}): 93,
frozenset({'butter', 'whipped/sour cream'}): 100,
frozenset({'butter', 'rolls/buns'}): 132,
frozenset({'curd', 'whipped/sour cream'}): 103,
frozenset({'curd', 'rolls/buns'}): 99,
frozenset({'rolls/buns', 'whipped/sour cream'}): 144,
frozenset({'bottled water', 'whipped/sour cream'}): 86,
frozenset({'long life bakery product', 'whipped/sour cream'}): 57,
frozenset({'UHT-milk', 'bottled water'}): 72,
frozenset({'hard cheese', 'rolls/buns'}): 58,
frozenset({'long life bakery product', 'rolls/buns'}): 78,
frozenset({'newspapers', 'sausage'}): 79,
frozenset({'ham', 'other vegetables'}): 90,
frozenset({'ham', 'whole milk'}): 113,
frozenset({'grapes', 'other vegetables'}): 89,
frozenset({'grapes', 'whole milk'}): 72,
frozenset({'margarine', 'tropical fruit'}): 92,
frozenset({'fruit/vegetable juice', 'tropical fruit'}): 135,
frozenset({'domestic eggs', 'other vegetables'}): 219,
frozenset({'brown bread', 'other vegetables'}): 184,
frozenset({'other vegetables', 'semi-finished bread'}): 51,
frozenset({'margarine', 'other vegetables'}): 194,
frozenset({'baking powder', 'other vegetables'}): 72,
frozenset({'fruit/vegetable juice', 'other vegetables'}): 207,
frozenset({'curd', 'domestic eggs'}): 64,
frozenset({'curd', 'margarine'}): 62,
frozenset({'domestic eggs', 'margarine'}): 82,
frozenset({'domestic eggs', 'fruit/vegetable juice'}): 79,
frozenset({'brown bread', 'margarine'}): 64,
frozenset({'fruit/vegetable juice', 'margarine'}): 61,

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frozenset({'processed cheese', 'whole milk'}): 69,
frozenset({'pickled vegetables', 'whole milk'}): 70,
frozenset({'processed cheese', 'soda'}): 52,
frozenset({'curd', 'pastry'}): 74,
frozenset({'oil', 'rolls/buns'}): 50,
frozenset({'ham', 'rolls/buns'}): 68,
frozenset({'beef', 'whipped/sour cream'}): 66,
frozenset({'beef', 'rolls/buns'}): 134,
frozenset({'pastry', 'rolls/buns'}): 206,
frozenset({'rolls/buns', 'sugar'}): 69,
frozenset({'frozen vegetables', 'other vegetables'}): 175,
frozenset({'canned fish', 'other vegetables'}): 50,
frozenset({'detergent', 'other vegetables'}): 63,
frozenset({'frozen vegetables', 'whole milk'}): 201,
frozenset({'salty snack', 'whole milk'}): 110,
frozenset({'detergent', 'whole milk'}): 88,
frozenset({'pastry', 'sausage'}): 123,
frozenset({'beef', 'sausage'}): 55,
frozenset({'sausage', 'whole milk'}): 294,
frozenset({'beef', 'whole milk'}): 209,
frozenset({'frankfurter', 'tropical fruit'}): 93,
frozenset({'brown bread', 'frankfurter'}): 70,
frozenset({'brown bread', 'rolls/buns'}): 124,
frozenset({'curd', 'sausage'}): 75,
frozenset({'pip fruit', 'tropical fruit'}): 201,
frozenset({'berries', 'tropical fruit'}): 66,
frozenset({'pip fruit', 'whole milk'}): 296,
frozenset({'pip fruit', 'rolls/buns'}): 137,
frozenset({'chocolate', 'pip fruit'}): 60,
frozenset({'berries', 'rolls/buns'}): 65,
frozenset({'rolls/buns', 'whole milk'}): 557,
frozenset({'chocolate', 'whole milk'}): 164,
frozenset({'margarine', 'whole milk'}): 238,
frozenset({'specialty chocolate', 'whole milk'}): 79,
frozenset({'butter', 'margarine'}): 66,
frozenset({'citrus fruit', 'frankfurter'}): 64,
frozenset({'frankfurter', 'whole milk'}): 202,
frozenset({'domestic eggs', 'frankfurter'}): 69,
frozenset({'citrus fruit', 'domestic eggs'}): 102,
frozenset({'oil', 'whole milk'}): 111,
frozenset({'newspapers', 'whole milk'}): 269,
frozenset({'domestic eggs', 'newspapers'}): 68,
frozenset({'citrus fruit', 'pastry'}): 96,
frozenset({'butter milk', 'whole milk'}): 114,
frozenset({'bottled water', 'fruit/vegetable juice'}): 140,
frozenset({'bottled beer', 'bottled water'}): 155,
frozenset({'bottled beer', 'fruit/vegetable juice'}): 69,
frozenset({'bottled beer', 'soda'}): 167,
frozenset({'frozen vegetables', 'root vegetables'}): 114,
frozenset({'oil', 'root vegetables'}): 69,
frozenset({'margarine', 'root vegetables'}): 109,
frozenset({'fruit/vegetable juice', 'root vegetables'}): 118,
frozenset({'fruit/vegetable juice', 'whole milk'}): 262,

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```

frozenset({'domestic eggs', 'frozen vegetables'}): 51,
frozenset({'frozen vegetables', 'rolls/buns'}): 100,
frozenset({'frozen vegetables', 'margarine'}): 50,
frozenset({'frozen vegetables', 'fruit/vegetable juice'}): 77,
frozenset({'domestic eggs', 'rolls/buns'}): 154,
frozenset({'margarine', 'rolls/buns'}): 145,
frozenset({'fruit/vegetable juice', 'rolls/buns'}): 143,
frozenset({'onions', 'root vegetables'}): 93,
frozenset({'root vegetables', 'sausage'}): 147,
frozenset({'sausage', 'yogurt'}): 193,
frozenset({'onions', 'yogurt'}): 71,
frozenset({'onions', 'rolls/buns'}): 67,
frozenset({'fruit/vegetable juice', 'salty snack'}): 59,
frozenset({'citrus fruit', 'cream cheese'}): 56,
frozenset({'citrus fruit', 'pork'}): 64,
frozenset({'berries', 'citrus fruit'}): 53,
frozenset({'citrus fruit', 'onions'}): 55,
frozenset({'citrus fruit', 'whipped/sour cream'}): 107,
frozenset({'citrus fruit', 'coffee'}): 63,
frozenset({'chocolate', 'citrus fruit'}): 63,
frozenset({'onions', 'whipped/sour cream'}): 50,
frozenset({'coffee', 'whipped/sour cream'}): 60,
frozenset({'sausage', 'sliced cheese'}): 69,
frozenset({'brown bread', 'sausage'}): 105,
frozenset({'fruit/vegetable juice', 'sausage'}): 99,
frozenset({'rolls/buns', 'sliced cheese'}): 75,
frozenset({'shopping bags', 'waffles'}): 54,
frozenset({'chicken', 'citrus fruit'}): 68,
frozenset({'chicken', 'root vegetables'}): 107,
frozenset({'chicken', 'other vegetables'}): 176,
frozenset({'butter', 'chicken'}): 57,
frozenset({'hamburger meat', 'root vegetables'}): 61,
frozenset({'citrus fruit', 'root vegetables'}): 174,
frozenset({'citrus fruit', 'other vegetables'}): 284,
frozenset({'oil', 'other vegetables'}): 98,
frozenset({'misc. beverages', 'soda'}): 72,
frozenset({'pork', 'sausage'}): 64,
frozenset({'pork', 'rolls/buns'}): 111,
frozenset({'pastry', 'pork'}): 62,
frozenset({'specialty bar', 'whole milk'}): 64,
frozenset({'bottled water', 'frankfurter'}): 72,
frozenset({'coffee', 'sausage'}): 68,
frozenset({'bottled beer', 'sausage'}): 77,
frozenset({'napkins', 'sausage'}): 66,
frozenset({'bottled beer', 'whole milk'}): 201,
frozenset({'napkins', 'whole milk'}): 194,
frozenset({'shopping bags', 'whole milk'}): 241,
frozenset({'fruit/vegetable juice', 'yogurt'}): 184,
frozenset({'bottled beer', 'yogurt'}): 91,
frozenset({'napkins', 'yogurt'}): 121,
frozenset({'shopping bags', 'yogurt'}): 150,
frozenset({'coffee', 'fruit/vegetable juice'}): 59,
frozenset({'coffee', 'shopping bags'}): 92,

```

```

frozenset({'fruit/vegetable juice', 'napkins'}): 68,
frozenset({'bottled beer', 'napkins'}): 51,
frozenset({'bottled beer', 'shopping bags'}): 55,
frozenset({'napkins', 'shopping bags'}): 71,
frozenset({'beef', 'citrus fruit'}): 83,
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frozenset({'brown bread', 'citrus fruit'}): 82,
frozenset({'berries', 'root vegetables'}): 65,
frozenset({'waffles', 'whipped/sour cream'}): 50,
frozenset({'frankfurter', 'sausage'}): 99,
frozenset({'frankfurter', 'root vegetables'}): 100,
frozenset({'frankfurter', 'other vegetables'}): 162,
frozenset({'bottled beer', 'frankfurter'}): 53,
frozenset({'other vegetables', 'sausage'}): 265,
frozenset({'bottled beer', 'root vegetables'}): 95,
frozenset({'other vegetables', 'pickled vegetables'}): 63,
frozenset({'dishes', 'other vegetables'}): 59,
frozenset({'dessert', 'rolls/buns'}): 67,
frozenset({'bottled water', 'dessert'}): 51,
frozenset({'bottled water', 'frozen vegetables'}): 61,
frozenset({'bottled water', 'margarine'}): 101,
frozenset({'margarine', 'newspapers'}): 70,
frozenset({'hamburger meat', 'whole milk'}): 145,
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frozenset({'other vegetables', 'pastry'}): 222,
frozenset({'coffee', 'other vegetables'}): 132,
frozenset({'other vegetables', 'shopping bags'}): 228,
frozenset({'margarine', 'pastry'}): 67,
frozenset({'long life bakery product', 'pastry'}): 58,
frozenset({'pastry', 'shopping bags'}): 117,
frozenset({'margarine', 'shopping bags'}): 56,
frozenset({'long life bakery product', 'shopping bags'}): 53,
frozenset({'long life bakery product', 'sausage'}): 53,
frozenset({'frankfurter', 'pip fruit'}): 71,
frozenset({'frankfurter', 'fruit/vegetable juice'}): 52,
frozenset({'citrus fruit', 'sausage'}): 111,
frozenset({'sausage', 'tropical fruit'}): 137,
frozenset({'pip fruit', 'sausage'}): 106,
frozenset({'hard cheese', 'sausage'}): 51,
frozenset({'cream cheese', 'sausage'}): 55,
frozenset({'domestic eggs', 'sausage'}): 94,
frozenset({'citrus fruit', 'pip fruit'}): 136,
frozenset({'citrus fruit', 'fruit/vegetable juice'}): 102,
frozenset({'citrus fruit', 'hygiene articles'}): 52,
frozenset({'hygiene articles', 'tropical fruit'}): 66,
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frozenset({'fruit/vegetable juice', 'pip fruit'}): 94,
frozenset({'hard cheese', 'whole milk'}): 99,
frozenset({'misc. beverages', 'whole milk'}): 69,
frozenset({'hygiene articles', 'whole milk'}): 126,
frozenset({'cream cheese', 'domestic eggs'}): 50,

```



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frozenset({'frankfurter', 'frozen vegetables'}): 50,
frozenset({'other vegetables', 'pip fruit'}): 257,
frozenset({'frozen vegetables', 'pip fruit'}): 72,
frozenset({'other vegetables', 'soft cheese'}): 70,
frozenset({'soft cheese', 'whole milk'}): 74,
frozenset({'baking powder', 'whole milk'}): 91,
frozenset({'rolls/buns', 'soft cheese'}): 53,
frozenset({'citrus fruit', 'rolls/buns'}): 165,
frozenset({'bottled water', 'onions'}): 58,
frozenset({'cake bar', 'whole milk'}): 55,
frozenset({'chocolate', 'shopping bags'}): 80,
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frozenset({'sausage', 'white bread'}): 71,
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frozenset({'curd', 'dessert'}): 51,
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frozenset({'soft cheese', 'yogurt'}): 59,
frozenset({'frozen vegetables', 'yogurt'}): 122,
frozenset({'chewing gum', 'soda'}): 53,
frozenset({'ham', 'tropical fruit'}): 53,
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frozenset({'bottled beer', 'tropical fruit'}): 81,
frozenset({'white bread', 'whole milk'}): 168,
frozenset({'fruit/vegetable juice', 'white bread'}): 73,
frozenset({'bottled beer', 'brown bread'}): 51,
frozenset({'curd', 'soda'}): 80,
frozenset({'curd', 'shopping bags'}): 53,
frozenset({'dessert', 'soda'}): 97,
frozenset({'dessert', 'shopping bags'}): 61,
frozenset({'salty snack', 'soda'}): 92,
frozenset({'salty snack', 'shopping bags'}): 59,
frozenset({'chocolate', 'waffles'}): 57,
frozenset({'bottled water', 'shopping bags'}): 108,
frozenset({'ice cream', 'other vegetables'}): 50,
frozenset({'frankfurter', 'yogurt'}): 110,
frozenset({'frankfurter', 'whipped/sour cream'}): 61,
frozenset({'frankfurter', 'white bread'}): 51,
frozenset({'ham', 'yogurt'}): 66,
frozenset({'tropical fruit', 'whipped/sour cream'}): 136,
frozenset({'sliced cheese', 'tropical fruit'}): 52,
frozenset({'frozen meals', 'tropical fruit'}): 54,
frozenset({'pip fruit', 'root vegetables'}): 153,
frozenset({'butter', 'pip fruit'}): 72,
frozenset({'curd', 'pip fruit'}): 77,
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frozenset({'pip fruit', 'white bread'}): 65,
frozenset({'bottled beer', 'pip fruit'}): 58,
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frozenset({'sliced cheese', 'whole milk'}): 106,
frozenset({'frozen meals', 'whole milk'}): 97,
frozenset({'butter', 'domestic eggs'}): 95,
frozenset({'bottled beer', 'butter'}): 57,
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frozenset({'whipped/sour cream', 'yogurt'}): 204,
frozenset({'sliced cheese', 'yogurt'}): 79,
frozenset({'frozen meals', 'yogurt'}): 61,
frozenset({'white bread', 'yogurt'}): 89,
frozenset({'cream cheese', 'whipped/sour cream'}): 63,
frozenset({'domestic eggs', 'whipped/sour cream'}): 98,
frozenset({'whipped/sour cream', 'white bread'}): 54,
frozenset({'fruit/vegetable juice', 'whipped/sour cream'}): 89,
frozenset({'domestic eggs', 'white bread'}): 57,
frozenset({'cream cheese', 'shopping bags'}): 55,
frozenset({'frankfurter', 'shopping bags'}): 81,
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frozenset({'beef', 'pork'}): 75,
frozenset({'pip fruit', 'pork'}): 60,
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frozenset({'pork', 'root vegetables'}): 134,
frozenset({'butter', 'soda'}): 87,
frozenset({'hygiene articles', 'yogurt'}): 72,
frozenset({'hygiene articles', 'soda'}): 69,
frozenset({'UHT-milk', 'soda'}): 75,
frozenset({'margarine', 'pork'}): 63,
frozenset({'beef', 'margarine'}): 61,
frozenset({'sausage', 'whipped/sour cream'}): 89,
frozenset({'beef', 'other vegetables'}): 194,
frozenset({'butter milk', 'other vegetables'}): 102,
frozenset({'beverages', 'rolls/buns'}): 53,
frozenset({'sliced cheese', 'soda'}): 50,
frozenset({'onions', 'tropical fruit'}): 56,
frozenset({'root vegetables', 'shopping bags'}): 126,
frozenset({'meat', 'other vegetables'}): 98,
frozenset({'meat', 'rolls/buns'}): 68,
frozenset({'bottled water', 'brown bread'}): 81,
frozenset({'mustard', 'whole milk'}): 51,
frozenset({'butter', 'sausage'}): 85,
frozenset({'salty snack', 'sausage'}): 52,
frozenset({'herbs', 'root vegetables'}): 69,
frozenset({'herbs', 'other vegetables'}): 76,
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frozenset({'margarine', 'whipped/sour cream'}): 67,
frozenset({'citrus fruit', 'napkins'}): 75,
frozenset({'napkins', 'whipped/sour cream'}): 71,
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frozenset({'newspapers', 'pastry'}): 83,
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frozenset({'shopping bags', 'whipped/sour cream'}): 78,
frozenset({'bottled water', 'sausage'}): 118,
frozenset({'bottled water', 'pip fruit'}): 104,
frozenset({'citrus fruit', 'soda'}): 126,
frozenset({'newspapers', 'other vegetables'}): 190,
frozenset({'chocolate', 'yogurt'}): 91,
frozenset({'chocolate', 'newspapers'}): 54,
frozenset({'other vegetables', 'specialty bar'}): 55,
frozenset({'napkins', 'tropical fruit'}): 99,
frozenset({'pip fruit', 'soda'}): 131,
frozenset({'napkins', 'pip fruit'}): 66,
frozenset({'onions', 'other vegetables'}): 140,
frozenset({'onions', 'whole milk'}): 119,
frozenset({'onions', 'soda'}): 52,
frozenset({'domestic eggs', 'napkins'}): 59,
frozenset({'meat', 'root vegetables'}): 50,
frozenset({'meat', 'whole milk'}): 98,
frozenset({'meat', 'soda'}): 54,
frozenset({'butter milk', 'tropical fruit'}): 54,
frozenset({'butter milk', 'root vegetables'}): 50,
frozenset({'hygiene articles', 'root vegetables'}): 53,
frozenset({'brown bread', 'pip fruit'}): 75,
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frozenset({'hamburger meat', 'yogurt'}): 64,
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frozenset({'fruit/vegetable juice', 'pastry'}): 84,
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frozenset({'chicken', 'yogurt'}): 82,
frozenset({'chicken', 'whipped/sour cream'}): 71,
frozenset({'chicken', 'rolls/buns'}): 95,
frozenset({'chicken', 'soda'}): 82,
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frozenset({'citrus fruit', 'shopping bags'}): 96,
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frozenset({'canned beer', 'whole milk'}): 87,
frozenset({'napkins', 'newspapers'}): 61,
frozenset({'pork', 'yogurt'}): 94,
frozenset({'oil', 'yogurt'}): 52,
frozenset({'beef', 'yogurt'}): 115,
frozenset({'napkins', 'root vegetables'}): 98,
frozenset({'canned beer', 'yogurt'}): 53,
frozenset({'beef', 'pastry'}): 62,
frozenset({'pastry', 'white bread'}): 55,

```

```

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frozenset({'other vegetables', 'specialty chocolate'}): 60,
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frozenset({'frankfurter', 'pork'}): 58,
frozenset({'butter', 'pork'}): 54,
frozenset({'brown bread', 'butter'}): 57,
frozenset({'frankfurter', 'pastry'}): 82,
frozenset({'pastry', 'whipped/sour cream'}): 74,
frozenset({'napkins', 'pastry'}): 69,
frozenset({'cat food', 'other vegetables'}): 64,
frozenset({'cat food', 'whole milk'}): 87,
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frozenset({'butter', 'frozen vegetables'}): 57,
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frozenset({'long life bakery product', 'yogurt'}): 86,
frozenset({'fruit/vegetable juice', 'long life bakery product'}): 61,
frozenset({'bottled beer', 'margarine'}): 60,
frozenset({'pork', 'tropical fruit'}): 84,
frozenset({'beef', 'domestic eggs'}): 59,
frozenset({'citrus fruit', 'frozen vegetables'}): 65,
frozenset({'beef', 'newspapers'}): 63,
frozenset({'beef', 'tropical fruit'}): 75,
frozenset({'beef', 'soda'}): 80,
frozenset({'frozen vegetables', 'pork'}): 63,
frozenset({'ice cream', 'whole milk'}): 58,
frozenset({'frozen vegetables', 'sausage'}): 59,
frozenset({'butter', 'pastry'}): 75,
frozenset({'butter milk', 'pip fruit'}): 50,
frozenset({'coffee', 'pip fruit'}): 68,
frozenset({'chocolate', 'long life bakery product'}): 52,
frozenset({'frozen meals', 'soda'}): 61,
frozenset({'pip fruit', 'shopping bags'}): 92,
frozenset({'soda', 'white bread'}): 101,
frozenset({'bottled water', 'coffee'}): 72,
frozenset({'napkins', 'pork'}): 51,
frozenset({'newspapers', 'pork'}): 65,
frozenset({'salty snack', 'yogurt'}): 61,
frozenset({'shopping bags', 'white bread'}): 73,
frozenset({'frozen vegetables', 'tropical fruit'}): 86,
frozenset({'domestic eggs', 'shopping bags'}): 89,
frozenset({'hygiene articles', 'shopping bags'}): 51,
frozenset({'domestic eggs', 'pork'}): 55,
frozenset({'hard cheese', 'yogurt'}): 63,
frozenset({'bottled water', 'pork'}): 73,
frozenset({'meat', 'yogurt'}): 52,
frozenset({'newspapers', 'root vegetables'}): 113,
frozenset({'long life bakery product', 'soda'}): 75,
frozenset({'newspapers', 'pip fruit'}): 66,
frozenset({'UHT-milk', 'yogurt'}): 73,
frozenset({'beef', 'fruit/vegetable juice'}): 50,

```

```
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frozenset({'long life bakery product', 'tropical fruit'}): 62,
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frozenset({'bottled beer', 'citrus fruit'}): 60,
frozenset({'coffee', 'frankfurter'}): 50,
frozenset({'chocolate', 'root vegetables'}): 63,
frozenset({'margarine', 'soda'}): 100,
frozenset({'bottled beer', 'pork'}): 51,
frozenset({'chicken', 'pork'}): 57,
frozenset({'chicken', 'domestic eggs'}): 61,
frozenset({'chicken', 'frozen vegetables'}): 66,
frozenset({'ice cream', 'soda'}): 60,
frozenset({'newspapers', 'whipped/sour cream'}): 71,
frozenset({'chewing gum', 'whole milk'}): 50,
frozenset({'rolls/buns', 'specialty chocolate'}): 55,
frozenset({'rolls/buns', 'white bread'}): 64,
frozenset({'salty snack', 'whipped/sour cream'}): 51,
frozenset({'chocolate', 'pastry'}): 79,
frozenset({'chocolate', 'fruit/vegetable juice'}): 67,
frozenset({'butter', 'chocolate'}): 61,
frozenset({'dessert', 'tropical fruit'}): 62,
frozenset({'dessert', 'pastry'}): 53,
frozenset({'dessert', 'fruit/vegetable juice'}): 59,
frozenset({'cat food', 'yogurt'}): 61}
```

In [18]:

```
pcy(100)
```

```
383 initial itemsets to be filtered
PCY-algorithm took 0.4187474250793457 seconds
207 candidates with >100 occurrences
```

Out[18]:

```
{frozenset({'tropical fruit', 'yogurt'}): 288,
frozenset({'pip fruit', 'yogurt'}): 177,
frozenset({'cream cheese', 'yogurt'}): 122,
frozenset({'other vegetables', 'whole milk'}): 736,
frozenset({'long life bakery product', 'other vegetables'}): 105,
frozenset({'long life bakery product', 'whole milk'}): 133,
frozenset({'butter', 'whole milk'}): 271,
frozenset({'whole milk', 'yogurt'}): 551,
frozenset({'butter', 'yogurt'}): 144,
frozenset({'other vegetables', 'rolls/buns'}): 419,
frozenset({'bottled beer', 'other vegetables'}): 159,
frozenset({'bottled beer', 'rolls/buns'}): 134,
frozenset({'other vegetables', 'tropical fruit'}): 353,
frozenset({'bottled water', 'tropical fruit'}): 182,
frozenset({'other vegetables', 'white bread'}): 135,
frozenset({'bottled water', 'other vegetables'}): 244,
frozenset({'chocolate', 'other vegetables'}): 125,
frozenset({'citrus fruit', 'tropical fruit'}): 196,
frozenset({'citrus fruit', 'whole milk'}): 300,
frozenset({'citrus fruit', 'yogurt'}): 213,
```

```

frozenset({'bottled water', 'citrus fruit'}): 133,
frozenset({'tropical fruit', 'whole milk'}): 416,
frozenset({'curd', 'tropical fruit'}): 101,
frozenset({'curd', 'whole milk'}): 257,
frozenset({'bottled water', 'whole milk'}): 338,
frozenset({'curd', 'yogurt'}): 170,
frozenset({'bottled water', 'yogurt'}): 226,
frozenset({'frankfurter', 'rolls/buns'}): 189,
frozenset({'frankfurter', 'soda'}): 111,
frozenset({'rolls/buns', 'soda'}): 377,
frozenset({'newspapers', 'tropical fruit'}): 116,
frozenset({'root vegetables', 'tropical fruit'}): 207,
frozenset({'rolls/buns', 'tropical fruit'}): 242,
frozenset({'other vegetables', 'root vegetables'}): 466,
frozenset({'rolls/buns', 'root vegetables'}): 239,
frozenset({'other vegetables', 'salty snack'}): 106,
frozenset({'rolls/buns', 'sausage'}): 301,
frozenset({'sausage', 'soda'}): 239,
frozenset({'chocolate', 'rolls/buns'}): 116,
frozenset({'chocolate', 'soda'}): 133,
frozenset({'brown bread', 'soda'}): 124,
frozenset({'fruit/vegetable juice', 'soda'}): 181,
frozenset({'canned beer', 'soda'}): 136,
frozenset({'newspapers', 'soda'}): 144,
frozenset({'shopping bags', 'soda'}): 242,
frozenset({'fruit/vegetable juice', 'shopping bags'}): 105,
frozenset({'canned beer', 'shopping bags'}): 112,
frozenset({'hamburger meat', 'other vegetables'}): 136,
frozenset({'napkins', 'other vegetables'}): 142,
frozenset({'bottled water', 'rolls/buns'}): 238,
frozenset({'napkins', 'rolls/buns'}): 115,
frozenset({'root vegetables', 'whole milk'}): 481,
frozenset({'other vegetables', 'sugar'}): 106,
frozenset({'sugar', 'whole milk'}): 148,
frozenset({'other vegetables', 'pork'}): 213,
frozenset({'pork', 'whole milk'}): 218,
frozenset({'pork', 'soda'}): 117,
frozenset({'berries', 'other vegetables'}): 101,
frozenset({'berries', 'whole milk'}): 116,
frozenset({'other vegetables', 'whipped/sour cream'}): 284,
frozenset({'other vegetables', 'soda'}): 322,
frozenset({'whipped/sour cream', 'whole milk'}): 317,
frozenset({'soda', 'whole milk'}): 394,
frozenset({'soda', 'whipped/sour cream'}): 114,
frozenset({'pastry', 'soda'}): 207,
frozenset({'dessert', 'other vegetables'}): 114,
frozenset({'dessert', 'whole milk'}): 135,
frozenset({'sausage', 'shopping bags'}): 154,
frozenset({'canned beer', 'rolls/buns'}): 111,
frozenset({'rolls/buns', 'shopping bags'}): 192,
frozenset({'domestic eggs', 'tropical fruit'}): 112,
frozenset({'brown bread', 'tropical fruit'}): 105,
frozenset({'pastry', 'tropical fruit'}): 130,

```

```

frozenset({'soda', 'tropical fruit'}): 205,
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frozenset({'domestic eggs', 'root vegetables'}): 141,
frozenset({'brown bread', 'root vegetables'}): 100,
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frozenset({'root vegetables', 'soda'}): 183,
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frozenset({'brown bread', 'whole milk'}): 248,
frozenset({'pastry', 'whole milk'}): 327,
frozenset({'coffee', 'whole milk'}): 184,
frozenset({'waffles', 'whole milk'}): 125,
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frozenset({'brown bread', 'yogurt'}): 143,
frozenset({'pastry', 'yogurt'}): 174,
frozenset({'soda', 'yogurt'}): 269,
frozenset({'domestic eggs', 'soda'}): 122,
frozenset({'berries', 'yogurt'}): 104,
frozenset({'rolls/buns', 'yogurt'}): 338,
frozenset({'newspapers', 'yogurt'}): 151,
frozenset({'newspapers', 'rolls/buns'}): 194,
frozenset({'bottled water', 'soda'}): 285,
frozenset({'bottled water', 'newspapers'}): 111,
frozenset({'butter', 'root vegetables'}): 127,
frozenset({'curd', 'root vegetables'}): 107,
frozenset({'root vegetables', 'whipped/sour cream'}): 168,
frozenset({'bottled water', 'root vegetables'}): 154,
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frozenset({'curd', 'other vegetables'}): 169,
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frozenset({'butter', 'rolls/buns'}): 132,
frozenset({'curd', 'whipped/sour cream'}): 103,
frozenset({'rolls/buns', 'whipped/sour cream'}): 144,
frozenset({'ham', 'whole milk'}): 113,
frozenset({'fruit/vegetable juice', 'tropical fruit'}): 135,
frozenset({'domestic eggs', 'other vegetables'}): 219,
frozenset({'brown bread', 'other vegetables'}): 184,
frozenset({'margarine', 'other vegetables'}): 194,
frozenset({'fruit/vegetable juice', 'other vegetables'}): 207,
frozenset({'beef', 'rolls/buns'}): 134,
frozenset({'pastry', 'rolls/buns'}): 206,
frozenset({'frozen vegetables', 'other vegetables'}): 175,
frozenset({'frozen vegetables', 'whole milk'}): 201,
frozenset({'salty snack', 'whole milk'}): 110,
frozenset({'pastry', 'sausage'}): 123,
frozenset({'sausage', 'whole milk'}): 294,
frozenset({'beef', 'whole milk'}): 209,
frozenset({'brown bread', 'rolls/buns'}): 124,
frozenset({'pip fruit', 'tropical fruit'}): 201,
frozenset({'pip fruit', 'whole milk'}): 296,
frozenset({'pip fruit', 'rolls/buns'}): 137,
frozenset({'rolls/buns', 'whole milk'}): 557,
frozenset({'chocolate', 'whole milk'}): 164,
frozenset({'margarine', 'whole milk'}): 238,

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```

frozenset({'frankfurter', 'whole milk'}): 202,
frozenset({'citrus fruit', 'domestic eggs'}): 102,
frozenset({'oil', 'whole milk'}): 111,
frozenset({'newspapers', 'whole milk'}): 269,
frozenset({'butter milk', 'whole milk'}): 114,
frozenset({'bottled water', 'fruit/vegetable juice'}): 140,
frozenset({'bottled beer', 'bottled water'}): 155,
frozenset({'bottled beer', 'soda'}): 167,
frozenset({'frozen vegetables', 'root vegetables'}): 114,
frozenset({'margarine', 'root vegetables'}): 109,
frozenset({'fruit/vegetable juice', 'root vegetables'}): 118,
frozenset({'fruit/vegetable juice', 'whole milk'}): 262,
frozenset({'frozen vegetables', 'rolls/buns'}): 100,
frozenset({'domestic eggs', 'rolls/buns'}): 154,
frozenset({'margarine', 'rolls/buns'}): 145,
frozenset({'fruit/vegetable juice', 'rolls/buns'}): 143,
frozenset({'root vegetables', 'sausage'}): 147,
frozenset({'sausage', 'yogurt'}): 193,
frozenset({'citrus fruit', 'whipped/sour cream'}): 107,
frozenset({'brown bread', 'sausage'}): 105,
frozenset({'chicken', 'root vegetables'}): 107,
frozenset({'chicken', 'other vegetables'}): 176,
frozenset({'citrus fruit', 'root vegetables'}): 174,
frozenset({'citrus fruit', 'other vegetables'}): 284,
frozenset({'pork', 'rolls/buns'}): 111,
frozenset({'bottled beer', 'whole milk'}): 201,
frozenset({'napkins', 'whole milk'}): 194,
frozenset({'shopping bags', 'whole milk'}): 241,
frozenset({'fruit/vegetable juice', 'yogurt'}): 184,
frozenset({'napkins', 'yogurt'}): 121,
frozenset({'shopping bags', 'yogurt'}): 150,
frozenset({'beef', 'root vegetables'}): 171,
frozenset({'frankfurter', 'root vegetables'}): 100,
frozenset({'frankfurter', 'other vegetables'}): 162,
frozenset({'other vegetables', 'sausage'}): 265,
frozenset({'bottled water', 'margarine'}): 101,
frozenset({'hamburger meat', 'whole milk'}): 145,
frozenset({'cream cheese', 'whole milk'}): 162,
frozenset({'other vegetables', 'pastry'}): 222,
frozenset({'coffee', 'other vegetables'}): 132,
frozenset({'other vegetables', 'shopping bags'}): 228,
frozenset({'pastry', 'shopping bags'}): 117,
frozenset({'citrus fruit', 'sausage'}): 111,
frozenset({'sausage', 'tropical fruit'}): 137,
frozenset({'pip fruit', 'sausage'}): 106,
frozenset({'citrus fruit', 'pip fruit'}): 136,
frozenset({'citrus fruit', 'fruit/vegetable juice'}): 102,
frozenset({'hygiene articles', 'whole milk'}): 126,
frozenset({'other vegetables', 'pip fruit'}): 257,
frozenset({'citrus fruit', 'rolls/buns'}): 165,
frozenset({'other vegetables', 'yogurt'}): 427,
frozenset({'frozen vegetables', 'yogurt'}): 122,
frozenset({'white bread', 'whole milk'}): 168,

```



```

frozenset({'bottled water', 'shopping bags'}): 108,
frozenset({'frankfurter', 'yogurt'}): 110,
frozenset({'tropical fruit', 'whipped/sour cream'}): 136,
frozenset({'pip fruit', 'root vegetables'}): 153,
frozenset({'cream cheese', 'other vegetables'}): 135,
frozenset({'sliced cheese', 'whole milk'}): 106,
frozenset({'whipped/sour cream', 'yogurt'}): 204,
frozenset({'shopping bags', 'tropical fruit'}): 133,
frozenset({'pork', 'root vegetables'}): 134,
frozenset({'beef', 'other vegetables'}): 194,
frozenset({'butter milk', 'other vegetables'}): 102,
frozenset({'root vegetables', 'shopping bags'}): 126,
frozenset({'napkins', 'soda'}): 118,
frozenset({'bottled water', 'sausage'}): 118,
frozenset({'bottled water', 'pip fruit'}): 104,
frozenset({'citrus fruit', 'soda'}): 126,
frozenset({'newspapers', 'other vegetables'}): 190,
frozenset({'pip fruit', 'soda'}): 131,
frozenset({'onions', 'other vegetables'}): 140,
frozenset({'onions', 'whole milk'}): 119,
frozenset({'margarine', 'yogurt'}): 140,
frozenset({'chicken', 'whole milk'}): 173,
frozenset({'pastry', 'pip fruit'}): 105,
frozenset({'beef', 'yogurt'}): 115,
frozenset({'coffee', 'rolls/buns'}): 108,
frozenset({'soda', 'white bread'}): 101,
frozenset({'newspapers', 'root vegetables'}): 113,
frozenset({'margarine', 'soda'}): 100}

```

3. For the PCY algorithm, create up to 5 compact hash tables. What is the difference in results and time of execution for 1,2,3,4 and 5 tables? Comment your results.

In [19]:

```

def pcy2(s):
    t = time.time()
    max_hash1 = 15000
    max_hash2 = 7000
    H1 = np.zeros((max_hash1,), dtype=np.int)
    H2 = np.zeros((max_hash2,), dtype=np.int)
    for key in readdata(k=2, report=False):
        hash_cell_1 = hash(key) % max_hash1
        H1[hash_cell_1] += 1
        hash_cell_2 = hash(key) % max_hash2
        H2[hash_cell_2] += 1

    C2 = {}
    for key in readdata(k=2, report=False):
        # hash-based filtering stage from PCY
        hash_cell_1 = hash(key) % max_hash1
        if H1[hash_cell_1] < s:
            continue
        hash_cell_2 = hash(key) % max_hash2
        if H2[hash_cell_2] < s:
            continue
        # filter out non-frequent tuples
        # if key not in C2_items:
        #     continue

        # record frequent tuples
        if key not in C2:
            C2[key] = 1
        else:
            C2[key] += 1

    print("{} initial itemsets to be filtered".format(len(C2)))

    L2 = {}
    for key, count in C2.items():
        if count >= s:
            L2[key] = count
    t1 = time.time() - t
    print('PCY-algorithm took {} seconds'.format(t1))
    print('{} candidates with >{} occurrences'.format(len(L2), s))
    print('')
    return L2

```

In [20]:

```

# PCY algorithm with k=2, 2 hash tables, and s=10,50,100
for i in [10,50,100]:
    pcy2(i)

```

3987 initial itemsets to be filtered
 PCY-algorithm took 0.5550084114074707 seconds
 2981 candidates with >10 occurrences

802 initial itemsets to be filtered
 PCY-algorithm took 0.5262117385864258 seconds
 605 candidates with >50 occurrences

241 initial itemsets to be filtered
 PCY-algorithm took 0.529714822769165 seconds
 207 candidates with >100 occurrences

In [21]:

```
def pcy3(s):
    t = time.time()
    max_hash1 = 15000
    max_hash2 = 7000
    max_hash3 = 3800
    H1 = np.zeros((max_hash1,), dtype=np.int)
    H2 = np.zeros((max_hash2,), dtype=np.int)
    H3 = np.zeros((max_hash3,), dtype=np.int)
    for key in readdata(k=2, report=False):
        hash_cell_1 = hash(key) % max_hash1
        H1[hash_cell_1] += 1
        hash_cell_2 = hash(key) % max_hash2
        H2[hash_cell_2] += 1
        hash_cell_3 = hash(key) % max_hash3
        H3[hash_cell_3] += 1

    C2 = {}
    for key in readdata(k=2, report=False):
        # hash-based filtering stage from PCY
        hash_cell_1 = hash(key) % max_hash1
        if H1[hash_cell_1] < s:
            continue
        hash_cell_2 = hash(key) % max_hash2
        if H2[hash_cell_2] < s:
            continue
        hash_cell_3 = hash(key) % max_hash3
        if H3[hash_cell_3] < s:
            continue

        # filter out non-frequent tuples
        # if key not in C2_items:
        #     continue

        # record frequent tuples
        if key not in C2:
            C2[key] = 1
        else:
            C2[key] += 1
```

```

print("{} initial itemsets to be filtered".format(len(C2)))

L2 = {}
for key, count in C2.items():
    if count >= s:
        L2[key] = count
t1 = time.time() - t
print('PCY-algorithm took {} seconds'.format(t1))
print('{} candidates with >{} occurances'.format(len(L2), s))
print('')
return L2

```

In [22]:

```

# PCY algorithm with k=2, 3 hash tables, and s=10,50,100
for i in [10,50,100]:
    pcy3(i)

```

```

3760 initial itemsets to be filtered
PCY-algorithm took 0.7712762355804443 seconds
2981 candidates with >10 occurances

```

```

692 initial itemsets to be filtered
PCY-algorithm took 0.7373056411743164 seconds
605 candidates with >50 occurances

```

```

214 initial itemsets to be filtered
PCY-algorithm took 1.1582920551300049 seconds
207 candidates with >100 occurances

```

In [23]:

```

def pcy4(s):
    t = time.time()
    max_hash1 = 15000
    max_hash2 = 7000
    max_hash3 = 3800
    max_hash4 = 1600
    H1 = np.zeros((max_hash1,), dtype=np.int)
    H2 = np.zeros((max_hash2,), dtype=np.int)
    H3 = np.zeros((max_hash3,), dtype=np.int)
    H4 = np.zeros((max_hash4,), dtype=np.int)
    for key in readdata(k=2, report=False):
        hash_cell_1 = hash(key) % max_hash1
        H1[hash_cell_1] += 1
        hash_cell_2 = hash(key) % max_hash2
        H2[hash_cell_2] += 1
        hash_cell_3 = hash(key) % max_hash3
        H3[hash_cell_3] += 1
        hash_cell_4 = hash(key) % max_hash4
        H4[hash_cell_4] += 1

```

```

C2 = {}
for key in readdata(k=2, report=False):
    # hash-based filtering stage from PCY
    hash_cell_1 = hash(key) % max_hash1
    if H1[hash_cell_1] < s:
        continue
    hash_cell_2 = hash(key) % max_hash2
    if H2[hash_cell_2] < s:
        continue
    hash_cell_3 = hash(key) % max_hash3
    if H3[hash_cell_3] < s:
        continue
    hash_cell_4 = hash(key) % max_hash4
    if H4[hash_cell_4] < s:
        continue

    # filter out non-frequent tuples
    # if key not in C2_items:
    #     continue

    # record frequent tuples
    if key not in C2:
        C2[key] = 1
    else:
        C2[key] += 1

print("{} initial itemsets to be filtered".format(len(C2)))

L2 = {}
for key, count in C2.items():
    if count >= s:
        L2[key] = count
t1 = time.time() - t
print('PCY-algorithm took {} seconds'.format(t1))
print('{} candidates with >{} occurrences'.format(len(L2), s))
print('')
return L2

```

In [24]:

```

## PCY algorithm with k=2, 4 hash tables, and s=10,50,100
for i in [10,50,100]:
    pcy4(i)

```

3748 initial itemsets to be filtered
 PCY-algorithm took 0.9172368049621582 seconds
 2981 candidates with >10 occurances

683 initial itemsets to be filtered
 PCY-algorithm took 1.05961275100708 seconds
 605 candidates with >50 occurances

213 initial itemsets to be filtered
 PCY-algorithm took 0.7713227272033691 seconds
 207 candidates with >100 occurances

In [25]:

```
def pcy5(s):
    t = time.time()
    max_hash1 = 15000
    max_hash2 = 7000
    max_hash3 = 3800
    max_hash4 = 1600
    max_hash5 = 1350
    H1 = np.zeros((max_hash1,), dtype=np.int)
    H2 = np.zeros((max_hash2,), dtype=np.int)
    H3 = np.zeros((max_hash3,), dtype=np.int)
    H4 = np.zeros((max_hash4,), dtype=np.int)
    H5 = np.zeros((max_hash5,), dtype=np.int)
    for key in readdata(k=2, report=False):
        hash_cell_1 = hash(key) % max_hash1
        H1[hash_cell_1] += 1
        hash_cell_2 = hash(key) % max_hash2
        H2[hash_cell_2] += 1
        hash_cell_3 = hash(key) % max_hash3
        H3[hash_cell_3] += 1
        hash_cell_4 = hash(key) % max_hash4
        H4[hash_cell_4] += 1
        hash_cell_5 = hash(key) % max_hash5
        H5[hash_cell_5] += 1

    C2 = {}
    for key in readdata(k=2, report=False):
        # hash-based filtering stage from PCY
        hash_cell_1 = hash(key) % max_hash1
        if H1[hash_cell_1] < s:
            continue
        hash_cell_2 = hash(key) % max_hash2
        if H2[hash_cell_2] < s:
            continue
        hash_cell_3 = hash(key) % max_hash3
        if H3[hash_cell_3] < s:
            continue
        hash_cell_4 = hash(key) % max_hash4
        if H4[hash_cell_4] < s:
            continue
        hash_cell_5 = hash(key) % max_hash5
```

```

        if H5[hash_cell_5] < s:
            continue

        # filter out non-frequent tuples
        # if key not in C2_items:
        #     continue

        # record frequent tuples
        if key not in C2:
            C2[key] = 1
        else:
            C2[key] += 1

    print("{} initial itemsets to be filtered".format(len(C2)))

    L2 = {}
    for key, count in C2.items():
        if count >= s:
            L2[key] = count
    t1 = time.time() - t
    print('PCY-algorithm took {} seconds'.format(t1))
    print('{} candidates with >{} occurrences'.format(len(L2), s))
    print('')
    return L2

```

In [26]:

```

# PCY algorithm with k=2, 5 hash tables, and s=10,50,100
for i in [10,50,100]:
    pcy5(i)

```

```

3738 initial itemsets to be filtered
PCY-algorithm took 1.2049367427825928 seconds
2981 candidates with >10 occurrences

```

```

677 initial itemsets to be filtered
PCY-algorithm took 1.7469983100891113 seconds
605 candidates with >50 occurrences

```

```

211 initial itemsets to be filtered
PCY-algorithm took 1.3894636631011963 seconds
207 candidates with >100 occurrences

```

Comments:

1. 5 Hash tables sizes were defined by the possible pairs 2^{169} divide by 2, 4, 8, 16. (Ref: (Park, Jong, Chen, Ming-syan, Yu, Philip, An Effective Hash-Based Algorithm for Mining Association Rules, 1997/08/18))
2. PCY multistage can generate the smaller number of itemsets to be filtered, then can prevent the memory problems. For example: for $s=50$, $k=2$

1 hash table: 1173 initial itemsets to be filtered, took 0.4036295413970947 seconds

2 hash tables: 802 initial itemsets to be filtered, took 0.5262117385864258 seconds

3 hash tables: 692 initial itemsets to be filtered, took 0.7373056411743164 seconds

4 hash tables: 683 initial itemsets to be filtered, took 1.05961275100708 seconds

5 hash tables: 677 initial itemsets to be filtered, took 1.7469983100891113 seconds

However, it can be considered to stop at 3 hash tables, because the dimension reduction was not so much like between the case of 1 and 2 hash tables.

4. Find the final list of k-frequent items (k-tuples) for $k=3,4$ and 5. Experiment a bit and describe the best value for the support in each case. Warning: You can use any of the three algorithms, but be careful, because the algorithm can take too long if you don't chose it properly.

In [27]:

```
for i in [3,4,5]:
    for s in [10,20,30,40,50]:
        naive_method(i,s)
```

```
139424 initial itemsets to be filtered
Naive method took 0.8505136966705322 seconds
6831 candidates with >10 occurances
```

```
139424 initial itemsets to be filtered
Naive method took 0.5428187847137451 seconds
1991 candidates with >20 occurances
```

```
139424 initial itemsets to be filtered
Naive method took 0.6999096870422363 seconds
850 candidates with >30 occurances
```



```
139424 initial itemsets to be filtered
Naive method took 0.8715181350708008 seconds
432 candidates with >40 occurances
```

```
139424 initial itemsets to be filtered
Naive method took 0.9074804782867432 seconds
264 candidates with >50 occurances
```

```
780620 initial itemsets to be filtered
Naive method took 2.597119092941284 seconds
3137 candidates with >10 occurances
```

```
780620 initial itemsets to be filtered
Naive method took 2.606549024581909 seconds
395 candidates with >20 occurances
```

```
780620 initial itemsets to be filtered
Naive method took 2.430020570755005 seconds
98 candidates with >30 occurances
```

```
780620 initial itemsets to be filtered
Naive method took 2.47296404838562 seconds
30 candidates with >40 occurances
```

```
780620 initial itemsets to be filtered
Naive method took 2.054372549057007 seconds
12 candidates with >50 occurances
```

```
2665499 initial itemsets to be filtered
Naive method took 8.039206743240356 seconds
376 candidates with >10 occurances
```

```
2665499 initial itemsets to be filtered
Naive method took 9.421083688735962 seconds
16 candidates with >20 occurances
```

```
2665499 initial itemsets to be filtered
Naive method took 7.6275248527526855 seconds
2 candidates with >30 occurances
```

```
2665499 initial itemsets to be filtered
Naive method took 7.682496070861816 seconds
0 candidates with >40 occurances
```

```
2665499 initial itemsets to be filtered
Naive method took 7.07243013381958 seconds
0 candidates with >50 occurances
```

In [28]:

```
naive_method(3,10)
```

```
139424 initial itemsets to be filtered
```

Naive method took 0.5170619487762451 seconds
6831 candidates with >10 occurrences

```
Out[28]: {frozenset({'coffee', 'tropical fruit', 'yogurt'}): 30,
  frozenset({'cream cheese', 'pip fruit', 'yogurt'}): 25,
  frozenset({'long life bakery product', 'other vegetables', 'whole milk'}): 56,
  ,
  frozenset({'butter', 'whole milk', 'yogurt'}): 92,
  frozenset({'butter', 'rice', 'whole milk'}): 15,
  frozenset({'rice', 'whole milk', 'yogurt'}): 18,
  frozenset({'butter', 'rice', 'yogurt'}): 10,
  frozenset({'UHT-milk', 'other vegetables', 'rolls/buns'}): 18,
  frozenset({'bottled beer', 'other vegetables', 'rolls/buns'}): 40,
  frozenset({'other vegetables', 'tropical fruit', 'white bread'}): 41,
  frozenset({'bottled water', 'other vegetables', 'tropical fruit'}): 61,
  frozenset({'chocolate', 'other vegetables', 'tropical fruit'}): 35,
  frozenset({'bottled water', 'tropical fruit', 'white bread'}): 11,
  frozenset({'bottled water', 'chocolate', 'tropical fruit'}): 13,
  frozenset({'bottled water', 'other vegetables', 'white bread'}): 16,
  frozenset({'chocolate', 'other vegetables', 'white bread'}): 20,
  frozenset({'bottled water', 'chocolate', 'other vegetables'}): 17,
  frozenset({'citrus fruit', 'tropical fruit', 'whole milk'}): 89,
  frozenset({'butter', 'citrus fruit', 'tropical fruit'}): 20,
  frozenset({'citrus fruit', 'curd', 'tropical fruit'}): 23,
  frozenset({'citrus fruit', 'tropical fruit', 'yogurt'}): 62,
  frozenset({'bottled water', 'citrus fruit', 'tropical fruit'}): 41,
  frozenset({'butter', 'citrus fruit', 'whole milk'}): 50,
  frozenset({'citrus fruit', 'curd', 'whole milk'}): 36,
  frozenset({'citrus fruit', 'whole milk', 'yogurt'}): 101,
  frozenset({'citrus fruit', 'flour', 'whole milk'}): 16,
  frozenset({'bottled water', 'citrus fruit', 'whole milk'}): 58,
  frozenset({'citrus fruit', 'dishes', 'whole milk'}): 10,
  frozenset({'butter', 'citrus fruit', 'curd'}): 12,
  frozenset({'butter', 'citrus fruit', 'yogurt'}): 30,
  frozenset({'bottled water', 'butter', 'citrus fruit'}): 19,
  frozenset({'citrus fruit', 'curd', 'yogurt'}): 30,
  frozenset({'bottled water', 'citrus fruit', 'curd'}): 13,
  frozenset({'citrus fruit', 'flour', 'yogurt'}): 10,
  frozenset({'bottled water', 'citrus fruit', 'yogurt'}): 40,
  frozenset({'butter', 'tropical fruit', 'whole milk'}): 61,
  frozenset({'curd', 'tropical fruit', 'whole milk'}): 64,
  frozenset({'tropical fruit', 'whole milk', 'yogurt'}): 149,
  frozenset({'flour', 'tropical fruit', 'whole milk'}): 16,
  frozenset({'bottled water', 'tropical fruit', 'whole milk'}): 79,
  frozenset({'dishes', 'tropical fruit', 'whole milk'}): 10,
  frozenset({'butter', 'curd', 'tropical fruit'}): 19,
  frozenset({'butter', 'tropical fruit', 'yogurt'}): 45,
  frozenset({'bottled water', 'butter', 'tropical fruit'}): 21,
  frozenset({'curd', 'tropical fruit', 'yogurt'}): 52,
  frozenset({'bottled water', 'curd', 'tropical fruit'}): 21,
  frozenset({'flour', 'tropical fruit', 'yogurt'}): 14,
  frozenset({'bottled water', 'tropical fruit', 'yogurt'}): 70,
  frozenset({'butter', 'curd', 'whole milk'}): 48,
```

```

frozenset({'butter', 'flour', 'whole milk'}): 11,
frozenset({'bottled water', 'butter', 'whole milk'}): 53,
frozenset({'butter', 'dishes', 'whole milk'}): 11,
frozenset({'curd', 'whole milk', 'yogurt'}): 99,
frozenset({'curd', 'flour', 'whole milk'}): 17,
frozenset({'bottled water', 'curd', 'whole milk'}): 32,
frozenset({'flour', 'whole milk', 'yogurt'}): 25,
frozenset({'bottled water', 'whole milk', 'yogurt'}): 95,
frozenset({'dishes', 'whole milk', 'yogurt'}): 13,
frozenset({'bottled water', 'flour', 'whole milk'}): 12,
frozenset({'bottled water', 'dishes', 'whole milk'}): 10,
frozenset({'butter', 'curd', 'yogurt'}): 29,
frozenset({'bottled water', 'butter', 'yogurt'}): 24,
frozenset({'curd', 'flour', 'yogurt'}): 11,
frozenset({'bottled water', 'curd', 'yogurt'}): 26,
frozenset({'bottled water', 'flour', 'yogurt'}): 12,
frozenset({'frankfurter', 'rolls/buns', 'soda'}): 38,
frozenset({'butter', 'fruit/vegetable juice', 'newspapers'}): 12,
frozenset({'other vegetables', 'root vegetables', 'tropical fruit'}): 121,
frozenset({'rolls/buns', 'root vegetables', 'tropical fruit'}): 58,
frozenset({'root vegetables', 'salty snack', 'tropical fruit'}): 15,
frozenset({'root vegetables', 'tropical fruit', 'waffles'}): 18,
frozenset({'candy', 'root vegetables', 'tropical fruit'}): 14,
frozenset({'frozen dessert', 'other vegetables', 'tropical fruit'}): 14,
frozenset({'other vegetables', 'rolls/buns', 'tropical fruit'}): 77,
frozenset({'flour', 'other vegetables', 'tropical fruit'}): 18,
frozenset({'other vegetables', 'salty snack', 'tropical fruit'}): 28,
frozenset({'other vegetables', 'tropical fruit', 'waffles'}): 25,
frozenset({'candy', 'other vegetables', 'tropical fruit'}): 18,
frozenset({'frozen dessert', 'rolls/buns', 'tropical fruit'}): 10,
frozenset({'rolls/buns', 'salty snack', 'tropical fruit'}): 12,
frozenset({'rolls/buns', 'tropical fruit', 'waffles'}): 21,
frozenset({'candy', 'rolls/buns', 'tropical fruit'}): 21,
frozenset({'frozen dessert', 'other vegetables', 'root vegetables'}): 16,
frozenset({'other vegetables', 'rolls/buns', 'root vegetables'}): 120,
frozenset({'flour', 'other vegetables', 'root vegetables'}): 23,
frozenset({'other vegetables', 'root vegetables', 'salty snack'}): 28,
frozenset({'other vegetables', 'root vegetables', 'waffles'}): 32,
frozenset({'candy', 'other vegetables', 'root vegetables'}): 22,
frozenset({'flour', 'rolls/buns', 'root vegetables'}): 12,
frozenset({'rolls/buns', 'root vegetables', 'waffles'}): 19,
frozenset({'candy', 'rolls/buns', 'root vegetables'}): 12,
frozenset({'frozen dessert', 'other vegetables', 'rolls/buns'}): 10,
frozenset({'flour', 'other vegetables', 'rolls/buns'}): 19,
frozenset({'other vegetables', 'rolls/buns', 'salty snack'}): 16,
frozenset({'other vegetables', 'rolls/buns', 'waffles'}): 29,
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```

In [29]:

```
naive_method(4,10)
```

780620 initial itemsets to be filtered

Naive method took 1.8795795440673828 seconds

3137 candidates with >10 occurrences

Out[29]:

```

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...}

```

In [30]:

```
naive_method(5,10)
```

```

2665499 initial itemsets to be filtered
Naive method took 7.913327217102051 seconds
376 candidates with >10 occurances

```

Out[30]:

```

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           'tropical fruit',

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```

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```

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```

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```

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        'yogurt'}): 12,
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        'sausage',
        'whole milk',
        'yogurt'}): 10,
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        'other vegetables',
        'whipped/sour cream',
        'whole milk',
        'yogurt'}): 17,
frozenset({'citrus fruit',

```

```

        'domestic eggs',
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        'whole milk',
        'yogurt'}): 10,
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        'other vegetables',
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        'whole milk',
        'yogurt'}): 15,
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        'yogurt'}): 10,
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        'yogurt'}): 12,
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        'root vegetables',
        'tropical fruit',
        'whole milk'}): 10,
frozenset({'chicken',
        'other vegetables',
        'root vegetables',
        'whole milk',
        'yogurt'}): 12,
frozenset({'chicken',
        'domestic eggs',
        'other vegetables',
        'root vegetables',
        'whole milk'}): 12,
frozenset({'frozen vegetables',
        'other vegetables',
        'root vegetables',
        'tropical fruit',
        'whole milk'}): 13,
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        'other vegetables',
        'pip fruit',
        'root vegetables',
        'whole milk'}): 11,
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        'root vegetables',
        'whole milk',
        'yogurt'}): 13,
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        'root vegetables',
        'whipped/sour cream',

```

```

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            'root vegetables',
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            'other vegetables',
            'root vegetables',
            'whipped/sour cream',
            'yogurt'}): 10,
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            'other vegetables',
            'whipped/sour cream',
            'whole milk'}): 10,
frozenaset({'margarine',
            'other vegetables',
            'root vegetables',
            'tropical fruit',
            'yogurt'}): 10,
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            'tropical fruit',
            'whole milk',
            'yogurt'}): 11,
frozenaset({'citrus fruit',
            'other vegetables',
            'root vegetables',
            'sausage',
            'whole milk'}): 10,
frozenaset({'pip fruit',
            'root vegetables',
            'sausage',
            'whole milk',
            'yogurt'}): 10,
frozenaset({'other vegetables',
            'pip fruit',
            'sausage',
            'whole milk',
            'yogurt'}): 10,
frozenaset({'other vegetables',
            'root vegetables',
            'sausage',
            'whole milk',
            'yogurt'}): 16,
frozenaset({'other vegetables',
            'root vegetables',

```

```

        'sausage',
        'soda',
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        'other vegetables',
        'pip fruit',
        'whole milk',
        'yogurt'}): 12,
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        'root vegetables',
        'whole milk',
        'yogurt'}): 23,
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        'other vegetables',
        'root vegetables',
        'whipped/sour cream',
        'whole milk'}): 15,
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        'frozen vegetables',
        'other vegetables',
        'root vegetables',
        'whole milk'}): 14,
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        'other vegetables',
        'root vegetables',
        'soda',
        'whole milk'}): 12,
frozenset({'citrus fruit',
        'fruit/vegetable juice',
        'other vegetables',
        'root vegetables',
        'whole milk'}): 13,
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        'other vegetables',
        'root vegetables',
        'whipped/sour cream',
        'yogurt'}): 12,
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        'other vegetables',
        'root vegetables',
        'soda'}): 10,
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        'root vegetables',
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        'whole milk',
        'yogurt'}): 11,
frozenset({'pip fruit',
        'root vegetables',
        'soda',
        'whole milk',
        'yogurt'}): 12,

```

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          'pastry',
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          'whole milk',
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          'pastry',
          'root vegetables',
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          'yogurt'}): 16,
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          'whole milk',
          'yogurt'}): 14,
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          'root vegetables',
          'soda',
          'whole milk'}): 11,
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,
frozenset({'fruit/vegetable juice',
          'other vegetables',
          'soda',
          'whole milk',
          'yogurt'}): 13,
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          'root vegetables',
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          'pip fruit',
          'tropical fruit',
          'yogurt'}): 10,
frozenset({'other vegetables',
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          'tropical fruit',
          'whipped/sour cream',
          'yogurt'}): 13,
frozenset({'citrus fruit',
          'other vegetables',
          'pip fruit',
          'root vegetables',
          'tropical fruit'}): 13,
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          'pip fruit',
          'root vegetables',
          'tropical fruit',
          'whole milk'}): 11,
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```

```

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        'tropical fruit',
        'whole milk'}): 13,
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        'root vegetables',
        'tropical fruit',
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        'tropical fruit'}): 12,
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        'tropical fruit',
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        'whole milk'}): 10,
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        'tropical fruit',
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        'whole milk'}): 16,
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        'fruit/vegetable juice',
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        'tropical fruit',
        'whole milk'}): 13,
frozenset({'citrus fruit',
        'curd',
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        'root vegetables',
        'whole milk',

```

```

        'yogurt'}): 14,
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          'root vegetables',
          'sausage',
          'whole milk'}): 10,
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          'other vegetables',
          'root vegetables',
          'tropical fruit'}): 10,
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          'tropical fruit',
          'whipped/sour cream',
          'whole milk'}): 11,
frozenset({'beef',
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          'root vegetables',
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          'whole milk'}): 10,
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          'root vegetables',
          'tropical fruit',
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          'other vegetables',

```

```

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        'whole milk',
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        'other vegetables',
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        'yogurt'}): 10,
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        'tropical fruit',
        'whipped/sour cream',
        'whole milk',
        'yogurt'}): 12,
frozenset({'citrus fruit',
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        'rolls/buns',
        'root vegetables',
        'whole milk'}): 13,
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frozenset({'rolls/buns',
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        'tropical fruit',
        'whipped/sour cream',
        'whole milk'}): 11,
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        'whipped/sour cream',
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        'other vegetables',
        'tropical fruit',
        'whole milk',
        'yogurt'}): 10,

```



```

frozenset({'other vegetables',
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           'whipped/sour cream',
           'yogurt'}): 10,
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           'whole milk',
           'yogurt'}): 15,
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           'whipped/sour cream',
           'whole milk',
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           'root vegetables',
           'whole milk'}): 11,
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           'root vegetables',
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           'root vegetables',
           'whipped/sour cream',
           'whole milk'}): 10,
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           'root vegetables',
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           'whole milk',
           'yogurt'}): 12,
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           'root vegetables',
           'whole milk',
           'yogurt'}): 11,
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           'other vegetables',

```

```

        'whole milk',
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        'whole milk'}): 12,
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        'whole milk'}): 11,
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        'root vegetables',
        'whole milk'}): 13,
frozenset({'onions',

```

```

        'other vegetables',
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        'yogurt'}): 10,
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        'root vegetables',
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        'whole milk'}): 11,
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        'tropical fruit',
        'whole milk'}): 11,
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        'tropical fruit',
        'whole milk'}): 13,
frozenset({'brown bread',
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        'sausage',
        'whole milk',
        'yogurt'}): 10,
frozenset({'brown bread',
        'pip fruit',
        'tropical fruit',
        'whole milk',
        'yogurt'}): 11,
frozenset({'brown bread',
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        'rolls/buns',
        'root vegetables',
        'tropical fruit',
        'whole milk'}): 10,
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        'rolls/buns',
        'tropical fruit',
        'whole milk',

```

```

        'yogurt'}): 10,
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        'whole milk',
        'yogurt'}): 10,
frozenset({'citrus fruit',
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        'other vegetables',
        'root vegetables',
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frozenset({'citrus fruit',
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        'other vegetables',
        'tropical fruit',
        'yogurt'}): 11,
frozenset({'brown bread',
        'other vegetables',
        'soda',
        'whole milk',
        'yogurt'}): 11,
frozenset({'other vegetables',
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        'rolls/buns',
        'root vegetables',
        'whole milk'}): 10,
frozenset({'other vegetables',
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        'rolls/buns',
        'root vegetables',
        'whole milk'}): 11,
frozenset({'beef',
        'other vegetables',
        'root vegetables',
        'soda',
        'whole milk'}): 10,
frozenset({'other vegetables',
        'rolls/buns',
        'root vegetables',
        'soda',
        'yogurt'}): 10,
frozenset({'domestic eggs',
        'other vegetables',
        'pork',
        'root vegetables',
        'whole milk'}): 10,
frozenset({'domestic eggs',
        'other vegetables',
        'root vegetables',
        'soda',
        'whole milk'}): 10}

```

Generate rules A -> B

```
In [31]: C1 = {}  
         for key in readdata(k=1):  
             if key not in C1:  
                 C1[key] = 1  
             else:  
                 C1[key] += 1
```

processing bin 5000

```
In [32]: C2 = {}  
         for key in readdata(k=2):  
             if key not in C2:  
                 C2[key] = 1  
             else:  
                 C2[key] += 1
```

processing bin 5000

```
In [33]: print(len(C1),len(C2))
```

169 9636

```
In [34]: s = 10 # support threshold  
         L2 = {}  
         for key, n in C2.items():  
             if n >= s:  
                 L2[key] = n  
         print('{} items with >{} occurances'.format(len(L2), s))
```

2981 items with >10 occurances

```
In [35]: L2 = [ elem for elem in list(L2) if len(elem)>1] # clean our list a bit.
```

In [46]:

```

for i in range(len(L2)):

    A, B = list(L2[i])
    support_AB = C2[frozenset([A, B])]
    support_A = C1[frozenset([A])]
    conf_A_leads_to_B = support_AB / support_A

    support_B = C1[frozenset([B])]
    prob_B = support_B / 9835 # len of baskets/transactions

    interest_A_leads_to_B = conf_A_leads_to_B - prob_B

    if interest_A_leads_to_B > 0.4:
        print("{} --> {} with interest {:.3f}".format(A, B, interest_A_leads_to_B))
        print(conf_A_leads_to_B)

```

```

honey --> whole milk with interest 0.477817
0.7333333333333333
rubbing alcohol --> citrus fruit with interest 0.417234
0.5
rubbing alcohol --> butter with interest 0.444586
0.5
cream --> sausage with interest 0.444511
0.5384615384615384
frozen fruits --> other vegetables with interest 0.473174
0.6666666666666666
kitchen utensil --> whole milk with interest 0.494484
0.75

```

Comments

1. With $s=40$, $k=5$, there are zero candidates found. The best value of support for $k=5$ can be 10 if we want to do further analysis, like association rules generation, or clustering association rules. For example, we maintain the results around > 300 candidates.
2. With $k=4$, the best value of support can be 20.
3. With $k=3$, the best value of support can be 40.
4. We can found 3 top association rules: 'kitchen utensil --> whole milk' with a confidence level 75%, but the interest is 50%. 'honey --> whole milk' with a confidence level 73%, but the interest is 48%. 'frozen fruits --> other vegetables' with a confidence level 66%, but the interest is 47%. if we can accept the interest around 50%, we can think about the association rules: 'kitchen utensil, honey --> whole milk'

5. Using one of the results of the previous item, for one k (k=3,4 or 5) find the possible clusters using the 1-NN criteria. Comment your results.

Clustering for frequent candidates of naive method and k=2

In [39]:

```
cluster1 = list(naive_method(2,100))
cluster1
```

```
9636 initial itemsets to be filtered
Naive method took 0.16608715057373047 seconds
207 candidates with >100 occurrences
```

Out[39]:

```
[frozenset({'tropical fruit', 'yogurt'}),
 frozenset({'pip fruit', 'yogurt'}),
 frozenset({'cream cheese', 'yogurt'}),
 frozenset({'other vegetables', 'whole milk'}),
 frozenset({'long life bakery product', 'other vegetables'}),
 frozenset({'long life bakery product', 'whole milk'}),
 frozenset({'butter', 'whole milk'}),
 frozenset({'whole milk', 'yogurt'}),
 frozenset({'butter', 'yogurt'}),
 frozenset({'other vegetables', 'rolls/buns'}),
 frozenset({'bottled beer', 'other vegetables'}),
 frozenset({'bottled beer', 'rolls/buns'}),
 frozenset({'other vegetables', 'tropical fruit'}),
 frozenset({'bottled water', 'tropical fruit'}),
 frozenset({'other vegetables', 'white bread'}),
 frozenset({'bottled water', 'other vegetables'}),
 frozenset({'chocolate', 'other vegetables'}),
 frozenset({'citrus fruit', 'tropical fruit'}),
 frozenset({'citrus fruit', 'whole milk'}),
 frozenset({'citrus fruit', 'yogurt'}),
 frozenset({'bottled water', 'citrus fruit'}),
 frozenset({'tropical fruit', 'whole milk'}),
 frozenset({'curd', 'tropical fruit'}),
 frozenset({'curd', 'whole milk'}),
 frozenset({'bottled water', 'whole milk'}),
 frozenset({'curd', 'yogurt'}),
 frozenset({'bottled water', 'yogurt'}),
 frozenset({'frankfurter', 'rolls/buns'}),
 frozenset({'frankfurter', 'soda'}),
 frozenset({'rolls/buns', 'soda'}),
 frozenset({'newspapers', 'tropical fruit'}),
 frozenset({'root vegetables', 'tropical fruit'}),
 frozenset({'rolls/buns', 'tropical fruit'})]
```

```

frozenset({'other vegetables', 'root vegetables'}),
frozenset({'rolls/buns', 'root vegetables'}),
frozenset({'other vegetables', 'salty snack'}),
frozenset({'rolls/buns', 'sausage'}),
frozenset({'sausage', 'soda'}),
frozenset({'chocolate', 'rolls/buns'}),
frozenset({'chocolate', 'soda'}),
frozenset({'brown bread', 'soda'}),
frozenset({'fruit/vegetable juice', 'soda'}),
frozenset({'canned beer', 'soda'}),
frozenset({'newspapers', 'soda'}),
frozenset({'shopping bags', 'soda'}),
frozenset({'fruit/vegetable juice', 'shopping bags'}),
frozenset({'canned beer', 'shopping bags'}),
frozenset({'hamburger meat', 'other vegetables'}),
frozenset({'napkins', 'other vegetables'}),
frozenset({'bottled water', 'rolls/buns'}),
frozenset({'napkins', 'rolls/buns'}),
frozenset({'root vegetables', 'whole milk'}),
frozenset({'other vegetables', 'sugar'}),
frozenset({'sugar', 'whole milk'}),
frozenset({'other vegetables', 'pork'}),
frozenset({'pork', 'whole milk'}),
frozenset({'pork', 'soda'}),
frozenset({'berries', 'other vegetables'}),
frozenset({'berries', 'whole milk'}),
frozenset({'other vegetables', 'whipped/sour cream'}),
frozenset({'other vegetables', 'soda'}),
frozenset({'whipped/sour cream', 'whole milk'}),
frozenset({'soda', 'whole milk'}),
frozenset({'soda', 'whipped/sour cream'}),
frozenset({'pastry', 'soda'}),
frozenset({'dessert', 'other vegetables'}),
frozenset({'dessert', 'whole milk'}),
frozenset({'sausage', 'shopping bags'}),
frozenset({'canned beer', 'rolls/buns'}),
frozenset({'rolls/buns', 'shopping bags'}),
frozenset({'domestic eggs', 'tropical fruit'}),
frozenset({'brown bread', 'tropical fruit'}),
frozenset({'pastry', 'tropical fruit'}),
frozenset({'soda', 'tropical fruit'}),
frozenset({'root vegetables', 'yogurt'}),
frozenset({'domestic eggs', 'root vegetables'}),
frozenset({'brown bread', 'root vegetables'}),
frozenset({'pastry', 'root vegetables'}),
frozenset({'root vegetables', 'soda'}),
frozenset({'domestic eggs', 'whole milk'}),
frozenset({'brown bread', 'whole milk'}),
frozenset({'pastry', 'whole milk'}),
frozenset({'coffee', 'whole milk'}),
frozenset({'waffles', 'whole milk'}),
frozenset({'domestic eggs', 'yogurt'}),
frozenset({'brown bread', 'yogurt'}),

```



```

frozenset({'pastry', 'yogurt'}),
frozenset({'soda', 'yogurt'}),
frozenset({'domestic eggs', 'soda'}),
frozenset({'berries', 'yogurt'}),
frozenset({'rolls/buns', 'yogurt'}),
frozenset({'newspapers', 'yogurt'}),
frozenset({'newspapers', 'rolls/buns'}),
frozenset({'bottled water', 'soda'}),
frozenset({'bottled water', 'newspapers'}),
frozenset({'butter', 'root vegetables'}),
frozenset({'curd', 'root vegetables'}),
frozenset({'root vegetables', 'whipped/sour cream'}),
frozenset({'bottled water', 'root vegetables'}),
frozenset({'butter', 'other vegetables'}),
frozenset({'curd', 'other vegetables'}),
frozenset({'butter', 'whipped/sour cream'}),
frozenset({'butter', 'rolls/buns'}),
frozenset({'curd', 'whipped/sour cream'}),
frozenset({'rolls/buns', 'whipped/sour cream'}),
frozenset({'ham', 'whole milk'}),
frozenset({'fruit/vegetable juice', 'tropical fruit'}),
frozenset({'domestic eggs', 'other vegetables'}),
frozenset({'brown bread', 'other vegetables'}),
frozenset({'margarine', 'other vegetables'}),
frozenset({'fruit/vegetable juice', 'other vegetables'}),
frozenset({'beef', 'rolls/buns'}),
frozenset({'pastry', 'rolls/buns'}),
frozenset({'frozen vegetables', 'other vegetables'}),
frozenset({'frozen vegetables', 'whole milk'}),
frozenset({'salty snack', 'whole milk'}),
frozenset({'pastry', 'sausage'}),
frozenset({'sausage', 'whole milk'}),
frozenset({'beef', 'whole milk'}),
frozenset({'brown bread', 'rolls/buns'}),
frozenset({'pip fruit', 'tropical fruit'}),
frozenset({'pip fruit', 'whole milk'}),
frozenset({'pip fruit', 'rolls/buns'}),
frozenset({'rolls/buns', 'whole milk'}),
frozenset({'chocolate', 'whole milk'}),
frozenset({'margarine', 'whole milk'}),
frozenset({'frankfurter', 'whole milk'}),
frozenset({'citrus fruit', 'domestic eggs'}),
frozenset({'oil', 'whole milk'}),
frozenset({'newspapers', 'whole milk'}),
frozenset({'butter milk', 'whole milk'}),
frozenset({'bottled water', 'fruit/vegetable juice'}),
frozenset({'bottled beer', 'bottled water'}),
frozenset({'bottled beer', 'soda'}),
frozenset({'frozen vegetables', 'root vegetables'}),
frozenset({'margarine', 'root vegetables'}),
frozenset({'fruit/vegetable juice', 'root vegetables'}),
frozenset({'fruit/vegetable juice', 'whole milk'}),
frozenset({'frozen vegetables', 'rolls/buns'}),

```

```

frozenset({'domestic eggs', 'rolls/buns'}),
frozenset({'margarine', 'rolls/buns'}),
frozenset({'fruit/vegetable juice', 'rolls/buns'}),
frozenset({'root vegetables', 'sausage'}),
frozenset({'sausage', 'yogurt'}),
frozenset({'citrus fruit', 'whipped/sour cream'}),
frozenset({'brown bread', 'sausage'}),
frozenset({'chicken', 'root vegetables'}),
frozenset({'chicken', 'other vegetables'}),
frozenset({'citrus fruit', 'root vegetables'}),
frozenset({'citrus fruit', 'other vegetables'}),
frozenset({'pork', 'rolls/buns'}),
frozenset({'bottled beer', 'whole milk'}),
frozenset({'napkins', 'whole milk'}),
frozenset({'shopping bags', 'whole milk'}),
frozenset({'fruit/vegetable juice', 'yogurt'}),
frozenset({'napkins', 'yogurt'}),
frozenset({'shopping bags', 'yogurt'}),
frozenset({'beef', 'root vegetables'}),
frozenset({'frankfurter', 'root vegetables'}),
frozenset({'frankfurter', 'other vegetables'}),
frozenset({'other vegetables', 'sausage'}),
frozenset({'bottled water', 'margarine'}),
frozenset({'hamburger meat', 'whole milk'}),
frozenset({'cream cheese', 'whole milk'}),
frozenset({'other vegetables', 'pastry'}),
frozenset({'coffee', 'other vegetables'}),
frozenset({'other vegetables', 'shopping bags'}),
frozenset({'pastry', 'shopping bags'}),
frozenset({'citrus fruit', 'sausage'}),
frozenset({'sausage', 'tropical fruit'}),
frozenset({'pip fruit', 'sausage'}),
frozenset({'citrus fruit', 'pip fruit'}),
frozenset({'citrus fruit', 'fruit/vegetable juice'}),
frozenset({'hygiene articles', 'whole milk'}),
frozenset({'other vegetables', 'pip fruit'}),
frozenset({'citrus fruit', 'rolls/buns'}),
frozenset({'other vegetables', 'yogurt'}),
frozenset({'frozen vegetables', 'yogurt'}),
frozenset({'white bread', 'whole milk'}),
frozenset({'bottled water', 'shopping bags'}),
frozenset({'frankfurter', 'yogurt'}),
frozenset({'tropical fruit', 'whipped/sour cream'}),
frozenset({'pip fruit', 'root vegetables'}),
frozenset({'cream cheese', 'other vegetables'}),
frozenset({'sliced cheese', 'whole milk'}),
frozenset({'whipped/sour cream', 'yogurt'}),
frozenset({'shopping bags', 'tropical fruit'}),
frozenset({'pork', 'root vegetables'}),
frozenset({'beef', 'other vegetables'}),
frozenset({'butter milk', 'other vegetables'}),
frozenset({'root vegetables', 'shopping bags'}),
frozenset({'napkins', 'soda'}),

```

```
frozenset({'bottled water', 'sausage'}),
frozenset({'bottled water', 'pip fruit'}),
frozenset({'citrus fruit', 'soda'}),
frozenset({'newspapers', 'other vegetables'}),
frozenset({'pip fruit', 'soda'}),
frozenset({'onions', 'other vegetables'}),
frozenset({'onions', 'whole milk'}),
frozenset({'margarine', 'yogurt'}),
frozenset({'chicken', 'whole milk'}),
frozenset({'pastry', 'pip fruit'}),
frozenset({'beef', 'yogurt'}),
frozenset({'coffee', 'rolls/buns'}),
frozenset({'soda', 'white bread'}),
frozenset({'newspapers', 'root vegetables'}),
frozenset({'margarine', 'soda'})]
```

In [40]:

```
P1 = list(map(list, cluster1))
print(P1)
```

```
[['tropical fruit', 'yogurt'], ['yogurt', 'pip fruit'], ['cream cheese', 'yogurt'], ['whole milk', 'other vegetables'], ['long life bakery product', 'other vegetables'], ['whole milk', 'long life bakery product'], ['whole milk', 'butter'], ['whole milk', 'yogurt'], ['butter', 'yogurt'], ['rolls/buns', 'other vegetables'], ['bottled beer', 'other vegetables'], ['bottled beer', 'rolls/buns'], ['tropical fruit', 'other vegetables'], ['tropical fruit', 'bottled water'], ['white bread', 'other vegetables'], ['bottled water', 'other vegetables'], ['other vegetables', 'chocolate'], ['tropical fruit', 'citrus fruit'], ['whole milk', 'citrus fruit'], ['citrus fruit', 'yogurt'], ['citrus fruit', 'bottled water'], ['tropical fruit', 'whole milk'], ['tropical fruit', 'curd'], ['whole milk', 'curd'], ['whole milk', 'bottled water'], ['curd', 'yogurt'], ['bottled water', 'yogurt'], ['rolls/buns', 'frankfurter'], ['soda', 'frankfurter'], ['soda', 'rolls/buns'], ['newspapers', 'tropical fruit'], ['tropical fruit', 'root vegetables'], ['tropical fruit', 'rolls/buns'], ['other vegetables', 'root vegetables'], ['rolls/buns', 'root vegetables'], ['salty snack', 'other vegetables'], ['rolls/buns', 'sausage'], ['soda', 'sausage'], ['rolls/buns', 'chocolate'], ['soda', 'chocolate'], ['soda', 'brown bread'], ['soda', 'fruit/vegetable juice'], ['soda', 'canned beer'], ['newspapers', 'soda'], ['soda', 'shopping bags'], ['fruit/vegetable juice', 'shopping bags'], ['canned beer', 'shopping bags'], ['other vegetables', 'hamburger meat'], ['napkins', 'other vegetables'], ['rolls/buns', 'bottled water'], ['rolls/buns', 'napkins'], ['whole milk', 'root vegetables'], ['sugar', 'other vegetables'], ['sugar', 'whole milk'], ['pork', 'other vegetables'], ['whole milk', 'pork'], ['soda', 'pork'], ['other vegetables', 'berries'], ['whole milk', 'berries'], ['whipped/sour cream', 'other vegetables'], ['soda', 'other vegetables'], ['whole milk', 'whipped/sour cream'], ['soda', 'whole milk'], ['soda', 'whipped/sour cream'], ['soda', 'pastry'], ['dessert', 'other vegetables'], ['whole milk', 'dessert'], ['shopping bags', 'sausage'], ['canned beer', 'rolls/buns'], ['rolls/buns', 'shopping bags'], ['tropical fruit', 'domestic eggs'], ['tropical fruit', 'brown bread'], ['tropical fruit', 'pastry'], ['tropical fruit', 'soda'], ['yogurt', 'root vegetables'], ['domestic eggs', 'root vegetables'], ['brown bread', 'root vegetables'], ['pastry', 'root vegetables'], ['soda', 'root vegetables'], ['whole milk', 'domestic eggs'], ['brown bread', 'whole milk'], ['whole milk', 'pastry'], [
```

'whole milk', 'coffee'], ['whole milk', 'waffles'], ['domestic eggs', 'yogurt'], ['brown bread', 'yogurt'], ['pastry', 'yogurt'], ['soda', 'yogurt'], ['soda', 'domestic eggs'], ['yogurt', 'berries'], ['rolls/buns', 'yogurt'], ['newspapers', 'yogurt'], ['newspapers', 'rolls/buns'], ['soda', 'bottled water'], ['newspapers', 'bottled water'], ['butter', 'root vegetables'], ['curd', 'root vegetables'], ['whipped/sour cream', 'root vegetables'], ['bottled water', 'root vegetables'], ['butter', 'other vegetables'], ['curd', 'other vegetables'], ['butter', 'whipped/sour cream'], ['rolls/buns', 'butter'], ['curd', 'whipped/sour cream'], ['rolls/buns', 'whipped/sour cream'], ['ham', 'whole milk'], ['tropical fruit', 'fruit/vegetable juice'], ['domestic eggs', 'other vegetables'], ['brown bread', 'other vegetables'], ['margarine', 'other vegetables'], ['fruit/vegetable juice', 'other vegetables'], ['rolls/buns', 'beef'], ['rolls/buns', 'pastry'], ['frozen vegetables', 'other vegetables'], ['frozen vegetables', 'whole milk'], ['whole milk', 'salty snack'], ['pastry', 'sausage'], ['whole milk', 'sausage'], ['whole milk', 'beef'], ['brown bread', 'rolls/buns'], ['tropical fruit', 'pip fruit'], ['whole milk', 'pip fruit'], ['rolls/buns', 'pip fruit'], ['whole milk', 'rolls/buns'], ['whole milk', 'chocolate'], ['whole milk', 'margarine'], ['whole milk', 'frankfurter'], ['citrus fruit', 'domestic eggs'], ['oil', 'whole milk'], ['newspapers', 'whole milk'], ['whole milk', 'butter milk'], ['fruit/vegetable juice', 'bottled water'], ['bottled beer', 'bottled water'], ['soda', 'bottled beer'], ['frozen vegetables', 'root vegetables'], ['margarine', 'root vegetables'], ['fruit/vegetable juice', 'root vegetables'], ['whole milk', 'fruit/vegetable juice'], ['frozen vegetables', 'rolls/buns'], ['domestic eggs', 'rolls/buns'], ['rolls/buns', 'margarine'], ['fruit/vegetable juice', 'rolls/buns'], ['root vegetables', 'sausage'], ['yogurt', 'sausage'], ['citrus fruit', 'whipped/sour cream'], ['brown bread', 'sausage'], ['root vegetables', 'chicken'], ['other vegetables', 'chicken'], ['citrus fruit', 'root vegetables'], ['citrus fruit', 'other vegetables'], ['pork', 'rolls/buns'], ['whole milk', 'bottled beer'], ['whole milk', 'napkins'], ['whole milk', 'shopping bags'], ['fruit/vegetable juice', 'yogurt'], ['napkins', 'yogurt'], ['yogurt', 'shopping bags'], ['beef', 'root vegetables'], ['frankfurter', 'root vegetables'], ['frankfurter', 'other vegetables'], ['other vegetables', 'sausage'], ['margarine', 'bottled water'], ['whole milk', 'hamburger meat'], ['cream cheese', 'whole milk'], ['pastry', 'other vegetables'], ['coffee', 'other vegetables'], ['other vegetables', 'shopping bags'], ['pastry', 'shopping bags'], ['citrus fruit', 'sausage'], ['tropical fruit', 'sausage'], ['pip fruit', 'sausage'], ['citrus fruit', 'pip fruit'], ['citrus fruit', 'fruit/vegetable juice'], ['hygiene articles', 'whole milk'], ['other vegetables', 'pip fruit'], ['citrus fruit', 'rolls/buns'], ['other vegetables', 'yogurt'], ['frozen vegetables', 'yogurt'], ['white bread', 'whole milk'], ['bottled water', 'shopping bags'], ['frankfurter', 'yogurt'], ['tropical fruit', 'whipped/sour cream'], ['root vegetables', 'pip fruit'], ['cream cheese', 'other vegetables'], ['slice d cheese', 'whole milk'], ['whipped/sour cream', 'yogurt'], ['tropical fruit', 'shopping bags'], ['pork', 'root vegetables'], ['other vegetables', 'beef'], ['other vegetables', 'butter milk'], ['shopping bags', 'root vegetables'], ['soda', 'napkins'], ['bottled water', 'sausage'], ['bottled water', 'pip fruit'], ['soda', 'citrus fruit'], ['newspapers', 'other vegetables'], ['soda', 'pip fruit'], ['other vegetables', 'onions'], ['whole milk', 'onions'], ['margarine', 'yogurt'], ['whole milk', 'chicken'], ['pastry', 'pip fruit'], ['beef', 'yogurt'], ['coffee', 'rolls/buns'], ['white bread', 'soda'], ['newspapers', 'root vegetables'], ['soda', 'margarine']]

In [41]:

```

result = []
if len(P1) > 1:
    tmp = [P1[0]]
    for i in range(1, len(P1)):
        if P1[i][0] == P1[i-1][1] or P1[i][1] == P1[i-1][0] or P1[i][1] == P1[i-1]
            tmp.append(P1[i])
        else:
            result.append(tmp)
            tmp = [P1[i]]
    result.append(tmp)
else:
    result = P1

for elem in result:
    print(elem)

```

```

[['tropical fruit', 'yogurt'], ['yogurt', 'pip fruit'], ['cream cheese', 'yogurt']]
[['whole milk', 'other vegetables'], ['long life bakery product', 'other vegetables'], ['whole milk', 'long life bakery product'], ['whole milk', 'butter'], ['whole milk', 'yogurt'], ['butter', 'yogurt']]
[['rolls/buns', 'other vegetables'], ['bottled beer', 'other vegetables'], ['bottled beer', 'rolls/buns']]
[['tropical fruit', 'other vegetables'], ['tropical fruit', 'bottled water']]
[['white bread', 'other vegetables'], ['bottled water', 'other vegetables'], ['other vegetables', 'chocolate']]
[['tropical fruit', 'citrus fruit'], ['whole milk', 'citrus fruit'], ['citrus fruit', 'yogurt'], ['citrus fruit', 'bottled water']]
[['tropical fruit', 'whole milk'], ['tropical fruit', 'curd'], ['whole milk', 'curd'], ['whole milk', 'bottled water']]
[['curd', 'yogurt'], ['bottled water', 'yogurt']]
[['rolls/buns', 'frankfurter'], ['soda', 'frankfurter'], ['soda', 'rolls/buns']]
[['newspapers', 'tropical fruit'], ['tropical fruit', 'root vegetables'], ['tropical fruit', 'rolls/buns']]
[['other vegetables', 'root vegetables'], ['rolls/buns', 'root vegetables']]
[['salty snack', 'other vegetables']]
[['rolls/buns', 'sausage'], ['soda', 'sausage']]
[['rolls/buns', 'chocolate'], ['soda', 'chocolate'], ['soda', 'brown bread'], ['soda', 'fruit/vegetable juice'], ['soda', 'canned beer'], ['newspapers', 'soda'], ['soda', 'shopping bags'], ['fruit/vegetable juice', 'shopping bags'], ['canned beer', 'shopping bags']]
[['other vegetables', 'hamburger meat'], ['napkins', 'other vegetables']]
[['rolls/buns', 'bottled water'], ['rolls/buns', 'napkins']]
[['whole milk', 'root vegetables']]
[['sugar', 'other vegetables'], ['sugar', 'whole milk']]
[['pork', 'other vegetables'], ['whole milk', 'pork'], ['soda', 'pork']]
[['other vegetables', 'berries'], ['whole milk', 'berries']]
[['whipped/sour cream', 'other vegetables'], ['soda', 'other vegetables']]
[['whole milk', 'whipped/sour cream'], ['soda', 'whole milk'], ['soda', 'whipped/sour cream'], ['soda', 'pastry']]
[['dessert', 'other vegetables'], ['whole milk', 'dessert']]

```

```

[['shopping bags', 'sausage']]
[['canned beer', 'rolls/buns'], ['rolls/buns', 'shopping bags']]
[['tropical fruit', 'domestic eggs'], ['tropical fruit', 'brown bread'], ['tropical fruit', 'pastry'], ['tropical fruit', 'soda']]
[['yogurt', 'root vegetables'], ['domestic eggs', 'root vegetables'], ['brown bread', 'root vegetables'], ['pastry', 'root vegetables'], ['soda', 'root vegetables']]
[['whole milk', 'domestic eggs'], ['brown bread', 'whole milk'], ['whole milk', 'pastry'], ['whole milk', 'coffee'], ['whole milk', 'waffles']]
[['domestic eggs', 'yogurt'], ['brown bread', 'yogurt'], ['pastry', 'yogurt'], ['soda', 'yogurt'], ['soda', 'domestic eggs']]
[['yogurt', 'berries'], ['rolls/buns', 'yogurt'], ['newspapers', 'yogurt'], ['newspapers', 'rolls/buns']]
[['soda', 'bottled water'], ['newspapers', 'bottled water']]
[['butter', 'root vegetables'], ['curd', 'root vegetables'], ['whipped/sour cream', 'root vegetables'], ['bottled water', 'root vegetables']]
[['butter', 'other vegetables'], ['curd', 'other vegetables']]
[['butter', 'whipped/sour cream'], ['rolls/buns', 'butter']]
[['curd', 'whipped/sour cream'], ['rolls/buns', 'whipped/sour cream']]
[['ham', 'whole milk']]
[['tropical fruit', 'fruit/vegetable juice']]
[['domestic eggs', 'other vegetables'], ['brown bread', 'other vegetables'], ['margarine', 'other vegetables'], ['fruit/vegetable juice', 'other vegetables']]
[['rolls/buns', 'beef'], ['rolls/buns', 'pastry']]
[['frozen vegetables', 'other vegetables'], ['frozen vegetables', 'whole milk'], ['whole milk', 'salty snack']]
[['pastry', 'sausage'], ['whole milk', 'sausage'], ['whole milk', 'beef']]
[['brown bread', 'rolls/buns']]
[['tropical fruit', 'pip fruit'], ['whole milk', 'pip fruit'], ['rolls/buns', 'pip fruit'], ['whole milk', 'rolls/buns'], ['whole milk', 'chocolate'], ['whole milk', 'margarine'], ['whole milk', 'frankfurter']]
[['citrus fruit', 'domestic eggs']]
[['oil', 'whole milk'], ['newspapers', 'whole milk'], ['whole milk', 'butter milk']]
[['fruit/vegetable juice', 'bottled water'], ['bottled beer', 'bottled water'], ['soda', 'bottled beer']]
[['frozen vegetables', 'root vegetables'], ['margarine', 'root vegetables'], ['fruit/vegetable juice', 'root vegetables'], ['whole milk', 'fruit/vegetable juice']]
[['frozen vegetables', 'rolls/buns'], ['domestic eggs', 'rolls/buns'], ['rolls/buns', 'margarine'], ['fruit/vegetable juice', 'rolls/buns']]
[['root vegetables', 'sausage'], ['yogurt', 'sausage']]
[['citrus fruit', 'whipped/sour cream']]
[['brown bread', 'sausage']]
[['root vegetables', 'chicken'], ['other vegetables', 'chicken']]
[['citrus fruit', 'root vegetables'], ['citrus fruit', 'other vegetables']]
[['pork', 'rolls/buns']]
[['whole milk', 'bottled beer'], ['whole milk', 'napkins'], ['whole milk', 'shopping bags']]
[['fruit/vegetable juice', 'yogurt'], ['napkins', 'yogurt'], ['yogurt', 'shopping bags']]
[['beef', 'root vegetables'], ['frankfurter', 'root vegetables'], ['frankfurter', 'sausage']]

```

```

r', 'other vegetables'], ['other vegetables', 'sausage']]
[['margarine', 'bottled water']]
[['whole milk', 'hamburger meat'], ['cream cheese', 'whole milk']]
[['pastry', 'other vegetables'], ['coffee', 'other vegetables'], ['other vegeta
bles', 'shopping bags'], ['pastry', 'shopping bags']]
[['citrus fruit', 'sausage'], ['tropical fruit', 'sausage'], ['pip fruit', 'sa
usage'], ['citrus fruit', 'pip fruit'], ['citrus fruit', 'fruit/vegetable juic
e']]
[['hygiene articles', 'whole milk']]
[['other vegetables', 'pip fruit']]
[['citrus fruit', 'rolls/buns']]
[['other vegetables', 'yogurt'], ['frozen vegetables', 'yogurt']]
[['white bread', 'whole milk']]
[['bottled water', 'shopping bags']]
[['frankfurter', 'yogurt']]
[['tropical fruit', 'whipped/sour cream']]
[['root vegetables', 'pip fruit']]
[['cream cheese', 'other vegetables']]
[['sliced cheese', 'whole milk']]
[['whipped/sour cream', 'yogurt']]
[['tropical fruit', 'shopping bags']]
[['pork', 'root vegetables']]
[['other vegetables', 'beef'], ['other vegetables', 'butter milk']]
[['shopping bags', 'root vegetables']]
[['soda', 'napkins']]
[['bottled water', 'sausage'], ['bottled water', 'pip fruit']]
[['soda', 'citrus fruit']]
[['newspapers', 'other vegetables']]
[['soda', 'pip fruit']]
[['other vegetables', 'onions'], ['whole milk', 'onions']]
[['margarine', 'yogurt']]
[['whole milk', 'chicken']]
[['pastry', 'pip fruit']]
[['beef', 'yogurt']]
[['coffee', 'rolls/buns']]
[['white bread', 'soda']]
[['newspapers', 'root vegetables']]
[['soda', 'margarine']]

```

Clustering for frequent candidates with naive method and k=3

```

In [42]: cluster2 = list(naive_method(3,50))
cluster2

```

```

139424 initial itemsets to be filtered
Naive method took 0.4851841926574707 seconds
264 candidates with >50 occurrences

```

```

Out[42]: [frozenset({'long life bakery product', 'other vegetables', 'whole milk'})],
         [frozenset({'butter', 'whole milk', 'yogurt'})],

```

```

frozenset({'bottled water', 'other vegetables', 'tropical fruit'}),
frozenset({'citrus fruit', 'tropical fruit', 'whole milk'}),
frozenset({'citrus fruit', 'tropical fruit', 'yogurt'}),
frozenset({'butter', 'citrus fruit', 'whole milk'}),
frozenset({'citrus fruit', 'whole milk', 'yogurt'}),
frozenset({'bottled water', 'citrus fruit', 'whole milk'}),
frozenset({'butter', 'tropical fruit', 'whole milk'}),
frozenset({'curd', 'tropical fruit', 'whole milk'}),
frozenset({'tropical fruit', 'whole milk', 'yogurt'}),
frozenset({'bottled water', 'tropical fruit', 'whole milk'}),
frozenset({'curd', 'tropical fruit', 'yogurt'}),
frozenset({'bottled water', 'tropical fruit', 'yogurt'}),
frozenset({'bottled water', 'butter', 'whole milk'}),
frozenset({'curd', 'whole milk', 'yogurt'}),
frozenset({'bottled water', 'whole milk', 'yogurt'}),
frozenset({'other vegetables', 'root vegetables', 'tropical fruit'}),
frozenset({'rolls/buns', 'root vegetables', 'tropical fruit'}),
frozenset({'other vegetables', 'rolls/buns', 'tropical fruit'}),
frozenset({'other vegetables', 'rolls/buns', 'root vegetables'}),
frozenset({'rolls/buns', 'sausage', 'soda'}),
frozenset({'bottled water', 'other vegetables', 'rolls/buns'}),
frozenset({'other vegetables', 'root vegetables', 'whole milk'}),
frozenset({'other vegetables', 'sugar', 'whole milk'}),
frozenset({'other vegetables', 'pork', 'whole milk'}),
frozenset({'other vegetables', 'whipped/sour cream', 'whole milk'}),
frozenset({'other vegetables', 'soda', 'whole milk'}),
frozenset({'soda', 'whipped/sour cream', 'whole milk'}),
frozenset({'rolls/buns', 'sausage', 'shopping bags'}),
frozenset({'sausage', 'shopping bags', 'soda'}),
frozenset({'rolls/buns', 'shopping bags', 'soda'}),
frozenset({'root vegetables', 'tropical fruit', 'whole milk'}),
frozenset({'root vegetables', 'tropical fruit', 'yogurt'}),
frozenset({'domestic eggs', 'tropical fruit', 'whole milk'}),
frozenset({'brown bread', 'tropical fruit', 'whole milk'}),
frozenset({'pastry', 'tropical fruit', 'whole milk'}),
frozenset({'soda', 'tropical fruit', 'whole milk'}),
frozenset({'soda', 'tropical fruit', 'yogurt'}),
frozenset({'root vegetables', 'whole milk', 'yogurt'}),
frozenset({'domestic eggs', 'root vegetables', 'whole milk'}),
frozenset({'brown bread', 'root vegetables', 'whole milk'}),
frozenset({'pastry', 'root vegetables', 'whole milk'}),
frozenset({'root vegetables', 'soda', 'whole milk'}),
frozenset({'domestic eggs', 'whole milk', 'yogurt'}),
frozenset({'brown bread', 'whole milk', 'yogurt'}),
frozenset({'pastry', 'whole milk', 'yogurt'}),
frozenset({'coffee', 'whole milk', 'yogurt'}),
frozenset({'soda', 'whole milk', 'yogurt'}),
frozenset({'domestic eggs', 'soda', 'whole milk'}),
frozenset({'brown bread', 'soda', 'whole milk'}),
frozenset({'pastry', 'soda', 'whole milk'}),
frozenset({'bottled water', 'rolls/buns', 'yogurt'}),
frozenset({'rolls/buns', 'soda', 'yogurt'}),
frozenset({'newspapers', 'rolls/buns', 'yogurt'}),

```



```

frozenset({'bottled water', 'soda', 'yogurt'}),
frozenset({'bottled water', 'rolls/buns', 'soda'}),
frozenset({'butter', 'other vegetables', 'root vegetables'}),
frozenset({'curd', 'other vegetables', 'root vegetables'}),
frozenset({'other vegetables', 'root vegetables', 'whipped/sour cream'}),
frozenset({'bottled water', 'other vegetables', 'root vegetables'}),
frozenset({'butter', 'other vegetables', 'whipped/sour cream'}),
frozenset({'butter', 'other vegetables', 'rolls/buns'}),
frozenset({'other vegetables', 'rolls/buns', 'whipped/sour cream'}),
frozenset({'curd', 'other vegetables', 'tropical fruit'}),
frozenset({'fruit/vegetable juice', 'other vegetables', 'tropical fruit'}),
frozenset({'frozen vegetables', 'other vegetables', 'whole milk'}),
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frozenset({'pip fruit', 'tropical fruit', 'whole milk'}),
frozenset({'rolls/buns', 'tropical fruit', 'whole milk'}),
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frozenset({'bottled beer', 'bottled water', 'soda'}),
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frozenset({'butter', 'other vegetables', 'tropical fruit'}),
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frozenset({'pastry', 'sausage', 'whole milk'}),
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frozenset({'pastry', 'rolls/buns', 'whole milk'}),
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frozenset({'newspapers', 'rolls/buns', 'whole milk'}),
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```

```

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frozenset({'citrus fruit', 'pip fruit', 'whole milk'}),
frozenset({'fruit/vegetable juice', 'tropical fruit', 'whole milk'}),
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frozenset({'frozen vegetables', 'other vegetables', 'root vegetables'}),
frozenset({'fruit/vegetable juice', 'other vegetables', 'root vegetables'}),
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frozenset({'bottled beer', 'other vegetables', 'whole milk'}),
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frozenset({'bottled water', 'soda', 'whole milk'}),
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frozenset({'other vegetables', 'white bread', 'whole milk'}),
frozenset({'brown bread', 'other vegetables', 'whole milk'}),
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frozenset({'other vegetables', 'pip fruit', 'tropical fruit'}),
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frozenset({'other vegetables', 'tropical fruit', 'whipped/sour cream'}),
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frozenset({'pip fruit', 'root vegetables', 'whole milk'}),
frozenset({'pip fruit', 'root vegetables', 'yogurt'}),
frozenset({'other vegetables', 'pip fruit', 'yogurt'}),
frozenset({'other vegetables', 'pip fruit', 'whipped/sour cream'}),
frozenset({'pip fruit', 'whole milk', 'yogurt'}),
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frozenset({'butter', 'root vegetables', 'whole milk'}),
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```

```

frozenset({'curd', 'other vegetables', 'whole milk'}),
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frozenset({'cream cheese', 'whole milk', 'yogurt'}),
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frozenset({'citrus fruit', 'rolls/buns', 'whole milk'}),
frozenset({'other vegetables', 'root vegetables', 'shopping bags'}),
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frozenset({'citrus fruit', 'rolls/buns', 'yogurt'}),
frozenset({'curd', 'rolls/buns', 'whole milk'}),
frozenset({'rolls/buns', 'whole milk', 'yogurt'}),
frozenset({'napkins', 'rolls/buns', 'whole milk'}),
frozenset({'bottled water', 'other vegetables', 'whole milk'}),
frozenset({'napkins', 'other vegetables', 'whole milk'}),
frozenset({'bottled water', 'other vegetables', 'soda'}),
frozenset({'bottled beer', 'bottled water', 'whole milk'}),
frozenset({'bottled water', 'root vegetables', 'whole milk'}),
frozenset({'other vegetables', 'pork', 'rolls/buns'}),
frozenset({'other vegetables', 'rolls/buns', 'soda'}),
frozenset({'other vegetables', 'rolls/buns', 'shopping bags'}),
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frozenset({'bottled water', 'other vegetables', 'sausage'}),
frozenset({'citrus fruit', 'other vegetables', 'yogurt'}),
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frozenset({'newspapers', 'tropical fruit', 'whole milk'}),
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```

```

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frozenset({'bottled water', 'soda', 'tropical fruit'}),
frozenset({'newspapers', 'other vegetables', 'whole milk'}),
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frozenset({'newspapers', 'other vegetables', 'yogurt'}),
frozenset({'newspapers', 'other vegetables', 'rolls/buns'}),
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frozenset({'chocolate', 'soda', 'whole milk'}),
frozenset({'other vegetables', 'pastry', 'root vegetables'}),
frozenset({'onions', 'other vegetables', 'whole milk'}),
frozenset({'hygiene articles', 'other vegetables', 'whole milk'}),
frozenset({'citrus fruit', 'root vegetables', 'whole milk'}),
frozenset({'citrus fruit', 'other vegetables', 'pip fruit'}),
frozenset({'margarine', 'other vegetables', 'root vegetables'}),
frozenset({'margarine', 'other vegetables', 'whole milk'}),
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frozenset({'root vegetables', 'sausage', 'whole milk'}),
frozenset({'brown bread', 'other vegetables', 'yogurt'}),
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frozenset({'coffee', 'other vegetables', 'whole milk'}),
frozenset({'beef', 'other vegetables', 'root vegetables'}),
frozenset({'onions', 'other vegetables', 'root vegetables'}),
frozenset({'other vegetables', 'root vegetables', 'soda'}),
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frozenset({'bottled water', 'fruit/vegetable juice', 'soda'}),
frozenset({'pastry', 'pip fruit', 'whole milk'}),
frozenset({'beef', 'whole milk', 'yogurt'}),
frozenset({'newspapers', 'root vegetables', 'whole milk'}),
frozenset({'fruit/vegetable juice', 'soda', 'yogurt'}),
frozenset({'domestic eggs', 'other vegetables', 'rolls/buns'}),
frozenset({'shopping bags', 'soda', 'whole milk'}),
frozenset({'root vegetables', 'shopping bags', 'whole milk'}),
frozenset({'other vegetables', 'pastry', 'tropical fruit'}),
frozenset({'newspapers', 'other vegetables', 'root vegetables'})]

```

In [43]:

```
P2 = list(map(list, cluster2))
print(P2)
```

```
[['whole milk', 'long life bakery product', 'other vegetables'], ['whole milk',
'butter', 'yogurt'], ['tropical fruit', 'bottled water', 'other vegetables'],
['whole milk', 'tropical fruit', 'citrus fruit'], ['tropical fruit', 'citrus
fruit', 'yogurt'], ['whole milk', 'citrus fruit', 'butter'], ['whole milk', 'c
itrus fruit', 'yogurt'], ['whole milk', 'citrus fruit', 'bottled water'], ['tr
opical fruit', 'whole milk', 'butter'], ['tropical fruit', 'whole milk', 'curd
'], ['tropical fruit', 'whole milk', 'yogurt'], ['tropical fruit', 'whole milk
', 'bottled water'], ['tropical fruit', 'curd', 'yogurt'], ['tropical fruit',
'bottled water', 'yogurt'], ['whole milk', 'butter', 'bottled water'], ['whole
milk', 'curd', 'yogurt'], ['whole milk', 'bottled water', 'yogurt'], ['tropica
l fruit', 'other vegetables', 'root vegetables'], ['tropical fruit', 'rolls/bu
ns', 'root vegetables'], ['tropical fruit', 'rolls/buns', 'other vegetables'],
['rolls/buns', 'other vegetables', 'root vegetables'], ['soda', 'rolls/buns',
'sausage'], ['rolls/buns', 'bottled water', 'other vegetables'], ['whole milk',
'other vegetables', 'root vegetables'], ['sugar', 'whole milk', 'other veget
ables'], ['whole milk', 'pork', 'other vegetables'], ['whole milk', 'whipped/s
our cream', 'other vegetables'], ['soda', 'whole milk', 'other vegetables'], [
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sausage'], ['shopping bags', 'soda', 'sausage'], ['soda', 'rolls/buns', 'shopp
ing bags'], ['tropical fruit', 'whole milk', 'root vegetables'], ['tropical fr
uit', 'yogurt', 'root vegetables'], ['tropical fruit', 'whole milk', 'domestic
eggs'], ['brown bread', 'tropical fruit', 'whole milk'], ['tropical fruit', 'w
hole milk', 'pastry'], ['tropical fruit', 'whole milk', 'soda'], ['tropical fr
uit', 'soda', 'yogurt'], ['whole milk', 'yogurt', 'root vegetables'], ['whole
milk', 'domestic eggs', 'root vegetables'], ['brown bread', 'whole milk', 'roo
t vegetables'], ['whole milk', 'pastry', 'root vegetables'], ['soda', 'whole m
ilk', 'root vegetables'], ['whole milk', 'domestic eggs', 'yogurt'], ['brown b
read', 'whole milk', 'yogurt'], ['whole milk', 'pastry', 'yogurt'], ['whole mi
lk', 'coffee', 'yogurt'], ['soda', 'whole milk', 'yogurt'], ['soda', 'whole mi
lk', 'domestic eggs'], ['brown bread', 'soda', 'whole milk'], ['soda', 'whole
milk', 'pastry'], ['rolls/buns', 'bottled water', 'yogurt'], ['soda', 'rolls/b
uns', 'yogurt'], ['newspapers', 'rolls/buns', 'yogurt'], ['soda', 'bottled wat
er', 'yogurt'], ['soda', 'rolls/buns', 'bottled water'], ['butter', 'other veg
etables', 'root vegetables'], ['curd', 'other vegetables', 'root vegetables'],
['whipped/sour cream', 'other vegetables', 'root vegetables'], ['bottled water
', 'other vegetables', 'root vegetables'], ['butter', 'whipped/sour cream', 'o
ther vegetables'], ['rolls/buns', 'butter', 'other vegetables'], ['rolls/buns',
'whipped/sour cream', 'other vegetables'], ['tropical fruit', 'curd', 'other
vegetables'], ['tropical fruit', 'fruit/vegetable juice', 'other vegetables'],
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e milk', 'citrus fruit', 'domestic eggs'], ['whole milk', 'rolls/buns', 'other
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tables', 'whole milk', 'rolls/buns'], ['whole milk', 'domestic eggs', 'rolls/b
uns'], ['whole milk', 'domestic eggs', 'margarine'], ['whole milk', 'rolls/bun
s', 'margarine'], ['whole milk', 'rolls/buns', 'fruit/vegetable juice'], ['yog
```

http://localhost:8888/nbconvert/html/MYDATA/Biq%20Data%20Anal...requent%20items Anh%2C%20Dat%3B%20Phuong.ipynb?download=false Sivu 238/244

d/sour cream', 'other vegetables'], ['whole milk', 'butter', 'whipped/sour cream'], ['whole milk', 'domestic eggs', 'butter'], ['whole milk', 'curd', 'whipped/sour cream'], ['whole milk', 'whipped/sour cream', 'yogurt'], ['cream cheese', 'whole milk', 'yogurt'], ['whole milk', 'domestic eggs', 'whipped/sour cream'], ['whole milk', 'beef', 'root vegetables'], ['pork', 'other vegetables', 'root vegetables'], ['whole milk', 'pork', 'root vegetables'], ['yogurt', 'other vegetables', 'sausage'], ['soda', 'other vegetables', 'sausage'], ['shopping bags', 'other vegetables', 'sausage'], ['soda', 'yogurt', 'sausage'], ['soda', 'other vegetables', 'yogurt'], ['shopping bags', 'other vegetables', 'yogurt'], ['soda', 'other vegetables', 'shopping bags'], ['whole milk', 'rolls/buns', 'beef'], ['whole milk', 'other vegetables', 'sausage'], ['whole milk', 'whipped/sour cream', 'sausage'], ['other vegetables', 'whole milk', 'beef'], ['other vegetables', 'rolls/buns', 'beef'], ['whole milk', 'citrus fruit', 'other vegetables'], ['citrus fruit', 'whipped/sour cream', 'other vegetables'], ['citrus fruit', 'rolls/buns', 'other vegetables'], ['whole milk', 'citrus fruit', 'whipped/sour cream'], ['whole milk', 'citrus fruit', 'rolls/buns'], ['shopping bags', 'other vegetables', 'root vegetables'], ['citrus fruit', 'bottled water', 'other vegetables'], ['citrus fruit', 'rolls/buns', 'yogurt'], ['whole milk', 'curd', 'rolls/buns'], ['whole milk', 'rolls/buns', 'yogurt'], ['whole milk', 'rolls/buns', 'napkins'], ['whole milk', 'bottled water', 'other vegetables'], ['whole milk', 'napkins', 'other vegetables'], ['soda', 'bottled water', 'other vegetables'], ['whole milk', 'bottled beer', 'bottled water'], ['whole milk', 'bottled water', 'root vegetables'], ['pork', 'rolls/buns', 'other vegetables'], ['soda', 'rolls/buns', 'other vegetables'], ['rolls/buns', 'other vegetables', 'shopping bags'], ['tropical fruit', 'other vegetables', 'sausage'], ['bottled water', 'other vegetables', 'sausage'], ['citrus fruit', 'other vegetables', 'yogurt'], ['tropical fruit', 'soda', 'other vegetables'], ['newspapers', 'tropical fruit', 'whole milk'], ['tropical fruit', 'rolls/buns', 'yogurt'], ['tropical fruit', 'rolls/buns', 'bottled water'], ['tropical fruit', 'soda', 'rolls/buns'], ['tropical fruit', 'soda', 'bottled water'], ['newspapers', 'whole milk', 'other vegetables'], ['rolls/buns', 'other vegetables', 'yogurt'], ['bottled water', 'other vegetables', 'yogurt'], ['newspapers', 'other vegetables', 'yogurt'], ['newspapers', 'rolls/buns', 'other vegetables'], ['newspapers', 'whole milk', 'yogurt'], ['soda', 'whole milk', 'chocolate'], ['pastry', 'other vegetables', 'root vegetables'], ['whole milk', 'other vegetables', 'onions'], ['hygiene articles', 'whole milk', 'other vegetables'], ['whole milk', 'citrus fruit', 'root vegetables'], ['citrus fruit', 'other vegetables', 'pip fruit'], ['margarine', 'other vegetables', 'root vegetables'], ['whole milk', 'margarine', 'other vegetables'], ['whole milk', 'pastry', 'other vegetables'], ['pastry', 'other vegetables', 'yogurt'], ['margarine', 'other vegetables', 'yogurt'], ['pastry', 'rolls/buns', 'other vegetables'], ['rolls/buns', 'margarine', 'other vegetables'], ['whole milk', 'margarine', 'yogurt'], ['whole milk', 'fruit/vegetable juice', 'bottled water'], ['pastry', 'rolls/buns', 'yogurt'], ['whole milk', 'other vegetables', 'chicken'], ['whole milk', 'rolls/buns', 'chicken'], ['whole milk', 'root vegetables', 'chicken'], ['brown bread', 'whole milk', 'rolls/buns'], ['oil', 'whole milk', 'other vegetables'], ['other vegetables', 'beef', 'yogurt'], ['whole milk', 'root vegetables', 'sausage'], ['brown bread', 'other vegetables', 'yogurt'], ['whole milk', 'rolls/buns', 'shopping bags'], ['soda', 'pastry', 'other vegetables'], ['whole milk', 'coffee', 'other vegetables'], ['other vegetables', 'beef', 'root vegetables'], ['onions', 'other vegetables', 'root vegetables'], ['soda', 'other vegetables', 'root vegetables'], ['soda', 'whole milk', 'fruit/vegetable juice'], ['soda', 'fruit/vegetable juice', 'bottled water'], ['whole milk', 'pastry', 'pip fruit']

```
it'], ['whole milk', 'beef', 'yogurt'], ['newspapers', 'whole milk', 'root vegetables'], ['soda', 'fruit/vegetable juice', 'yogurt'], ['domestic eggs', 'rolls/buns', 'other vegetables'], ['soda', 'whole milk', 'shopping bags'], ['shopping bags', 'whole milk', 'root vegetables'], ['tropical fruit', 'pastry', 'other vegetables'], ['newspapers', 'other vegetables', 'root vegetables']]
```

In [44]:

```
result2 = []
if len(P2) > 1:
    tmp = [P2[0]]
    for i in range(1, len(P2)):
        if P2[i][0] == P2[i-1][0] or P2[i][1] == P2[i-1][1] or P2[i][2] == P2[i-1][2]:
            tmp.append(P2[i])
        else:
            result2.append(tmp)
            tmp = [P2[i]]
    result2.append(tmp)
else:
    result2 = P2

cluster = []
for elem in result2:
    print(elem)
    cluster.append(elem)
```

```
[['whole milk', 'long life bakery product', 'other vegetables'], ['whole milk', 'butter', 'yogurt']]
[['tropical fruit', 'bottled water', 'other vegetables'], ['whole milk', 'tropical fruit', 'citrus fruit'], ['tropical fruit', 'citrus fruit', 'yogurt'], ['whole milk', 'citrus fruit', 'butter'], ['whole milk', 'citrus fruit', 'yogurt'], ['whole milk', 'citrus fruit', 'bottled water'], ['tropical fruit', 'whole milk', 'butter'], ['tropical fruit', 'whole milk', 'curd'], ['tropical fruit', 'whole milk', 'yogurt'], ['tropical fruit', 'whole milk', 'bottled water'], ['tropical fruit', 'curd', 'yogurt'], ['tropical fruit', 'bottled water', 'yogurt'], ['whole milk', 'butter', 'bottled water'], ['whole milk', 'curd', 'yogurt'], ['whole milk', 'bottled water', 'yogurt']]
[['tropical fruit', 'other vegetables', 'root vegetables'], ['tropical fruit', 'rolls/buns', 'root vegetables'], ['tropical fruit', 'rolls/buns', 'other vegetables'], ['rolls/buns', 'other vegetables', 'root vegetables'], ['soda', 'rolls/buns', 'sausage'], ['rolls/buns', 'bottled water', 'other vegetables'], ['whole milk', 'other vegetables', 'root vegetables'], ['sugar', 'whole milk', 'other vegetables'], ['whole milk', 'pork', 'other vegetables'], ['whole milk', 'whipped/sour cream', 'other vegetables'], ['soda', 'whole milk', 'other vegetables'], ['soda', 'whole milk', 'whipped/sour cream']]
[['shopping bags', 'rolls/buns', 'sausage'], ['shopping bags', 'soda', 'sausage'], ['soda', 'rolls/buns', 'shopping bags']]
[['tropical fruit', 'whole milk', 'root vegetables'], ['tropical fruit', 'yogurt', 'root vegetables'], ['tropical fruit', 'whole milk', 'domestic eggs'], ['brown bread', 'tropical fruit', 'whole milk'], ['tropical fruit', 'whole milk', 'pastry'], ['tropical fruit', 'whole milk', 'soda'], ['tropical fruit', 'soda', 'yogurt'], ['whole milk', 'yogurt', 'root vegetables'], ['whole milk', 'domestic eggs', 'root vegetables'], ['brown bread', 'whole milk', 'root vegetables']]
```



```

es'], ['whole milk', 'pastry', 'root vegetables'], ['soda', 'whole milk', 'root vegetables'], ['whole milk', 'domestic eggs', 'yogurt'], ['brown bread', 'whole milk', 'yogurt'], ['whole milk', 'pastry', 'yogurt'], ['whole milk', 'coffee', 'yogurt'], ['soda', 'whole milk', 'yogurt'], ['soda', 'whole milk', 'domestic eggs'], ['brown bread', 'soda', 'whole milk'], ['soda', 'whole milk', 'pastry']]
[['rolls/buns', 'bottled water', 'yogurt'], ['soda', 'rolls/buns', 'yogurt'], ['newspapers', 'rolls/buns', 'yogurt'], ['soda', 'bottled water', 'yogurt'], ['soda', 'rolls/buns', 'bottled water']]
[['butter', 'other vegetables', 'root vegetables'], ['curd', 'other vegetables', 'root vegetables'], ['whipped/sour cream', 'other vegetables', 'root vegetables'], ['bottled water', 'other vegetables', 'root vegetables'], ['butter', 'whipped/sour cream', 'other vegetables'], ['rolls/buns', 'butter', 'other vegetables'], ['rolls/buns', 'whipped/sour cream', 'other vegetables'], ['tropical fruit', 'curd', 'other vegetables'], ['tropical fruit', 'fruit/vegetable juice', 'other vegetables'], ['frozen vegetables', 'whole milk', 'other vegetables']]
[['soda', 'rolls/buns', 'pastry']]
[['tropical fruit', 'whole milk', 'pip fruit'], ['tropical fruit', 'whole milk', 'rolls/buns'], ['whole milk', 'rolls/buns', 'pip fruit'], ['whole milk', 'citrus fruit', 'domestic eggs'], ['whole milk', 'rolls/buns', 'other vegetables']]
[['soda', 'bottled beer', 'bottled water']]
[['frozen vegetables', 'whole milk', 'root vegetables'], ['whole milk', 'rolls/buns', 'root vegetables'], ['whole milk', 'fruit/vegetable juice', 'root vegetables'], ['frozen vegetables', 'whole milk', 'rolls/buns'], ['whole milk', 'domestic eggs', 'rolls/buns'], ['whole milk', 'domestic eggs', 'margarine'], ['whole milk', 'rolls/buns', 'margarine'], ['whole milk', 'rolls/buns', 'fruit/vegetable juice']]
[['yogurt', 'root vegetables', 'sausage'], ['rolls/buns', 'yogurt', 'sausage'], ['rolls/buns', 'yogurt', 'root vegetables'], ['other vegetables', 'root vegetables', 'chicken'], ['tropical fruit', 'citrus fruit', 'root vegetables'], ['tropical fruit', 'citrus fruit', 'other vegetables'], ['citrus fruit', 'other vegetables', 'root vegetables'], ['tropical fruit', 'butter', 'other vegetables']]
[['whole milk', 'rolls/buns', 'sausage'], ['whole milk', 'pastry', 'sausage'], ['soda', 'whole milk', 'sausage'], ['whole milk', 'pork', 'rolls/buns'], ['whole milk', 'rolls/buns', 'pastry'], ['soda', 'whole milk', 'rolls/buns'], ['whole milk', 'yogurt', 'sausage'], ['whole milk', 'fruit/vegetable juice', 'yogurt'], ['whole milk', 'bottled beer', 'yogurt'], ['whole milk', 'napkins', 'yogurt'], ['whole milk', 'yogurt', 'shopping bags'], ['whole milk', 'rolls/buns', 'whipped/sour cream'], ['rolls/buns', 'frankfurter', 'other vegetables'], ['other vegetables', 'root vegetables', 'sausage'], ['rolls/buns', 'other vegetables', 'sausage'], ['whole milk', 'rolls/buns', 'bottled water'], ['newspapers', 'whole milk', 'rolls/buns'], ['whole milk', 'bottled beer', 'rolls/buns'], ['other vegetables', 'whole milk', 'hamburger meat'], ['whole milk', 'domestic eggs', 'other vegetables'], ['soda', 'domestic eggs', 'other vegetables']]
[['tropical fruit', 'whole milk', 'frankfurter'], ['tropical fruit', 'whole milk', 'sausage'], ['whole milk', 'pip fruit', 'sausage'], ['tropical fruit', 'citrus fruit', 'pip fruit'], ['whole milk', 'citrus fruit', 'pip fruit'], ['tropical fruit', 'whole milk', 'fruit/vegetable juice'], ['whole milk', 'domestic eggs', 'pip fruit'], ['whole milk', 'rolls/buns', 'frankfurter'], ['whole milk', 'frankfurter', 'other vegetables'], ['whole milk', 'other vegetables', 'pip

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fruit'], ['rolls/buns', 'other vegetables', 'pip fruit'], ['whole milk', 'other
vegetables', 'chocolate'], ['whole milk', 'other vegetables', 'shopping bags
'], ['curd', 'other vegetables', 'yogurt'], ['yogurt', 'other vegetables', 'ro
ot vegetables'], ['frozen vegetables', 'other vegetables', 'root vegetables'],
['fruit/vegetable juice', 'other vegetables', 'root vegetables'], ['whole milk
', 'other vegetables', 'yogurt'], ['whole milk', 'fruit/vegetable juice', 'oth
er vegetables'], ['whole milk', 'bottled beer', 'other vegetables'], ['frozen
vegetables', 'other vegetables', 'yogurt'], ['fruit/vegetable juice', 'other v
egetables', 'yogurt'], ['frozen vegetables', 'whole milk', 'yogurt'], ['soda',
'whole milk', 'bottled water'], ['tropical fruit', 'whole milk', 'other vegeta
bles'], ['whole milk', 'rolls/buns', 'butter'], ['white bread', 'whole milk',
'other vegetables'], ['brown bread', 'whole milk', 'other vegetables'], ['whol
e milk', 'frankfurter', 'root vegetables'], ['whole milk', 'frankfurter', 'yog
urt']]
[['tropical fruit', 'root vegetables', 'pip fruit'], ['tropical fruit', 'other
vegetables', 'pip fruit'], ['tropical fruit', 'yogurt', 'pip fruit'], ['tropic
al fruit', 'other vegetables', 'yogurt'], ['tropical fruit', 'whipped/sour cre
am', 'other vegetables'], ['tropical fruit', 'whole milk', 'whipped/sour cream
'], ['tropical fruit', 'whipped/sour cream', 'yogurt']]
[['other vegetables', 'root vegetables', 'pip fruit'], ['whole milk', 'root ve
getables', 'pip fruit'], ['yogurt', 'root vegetables', 'pip fruit'], ['yogurt'
, 'other vegetables', 'pip fruit'], ['whipped/sour cream', 'other vegetables',
'pip fruit'], ['whole milk', 'yogurt', 'pip fruit'], ['whole milk', 'whipped/s
our cream', 'pip fruit']]
[['domestic eggs', 'other vegetables', 'root vegetables'], ['whole milk', 'but
ter', 'root vegetables'], ['whole milk', 'curd', 'root vegetables'], ['whole m
ilk', 'whipped/sour cream', 'root vegetables'], ['whipped/sour cream', 'yogurt
', 'root vegetables']]
[['whole milk', 'butter', 'other vegetables'], ['whole milk', 'curd', 'other v
egetables'], ['cream cheese', 'whole milk', 'other vegetables'], ['butter', 'o
ther vegetables', 'yogurt'], ['whipped/sour cream', 'other vegetables', 'yogur
t'], ['cream cheese', 'other vegetables', 'yogurt'], ['domestic eggs', 'other
vegetables', 'yogurt'], ['domestic eggs', 'whipped/sour cream', 'other vegetab
les'], ['whole milk', 'butter', 'whipped/sour cream'], ['whole milk', 'domesti
c eggs', 'butter'], ['whole milk', 'curd', 'whipped/sour cream'], ['whole milk
', 'whipped/sour cream', 'yogurt'], ['cream cheese', 'whole milk', 'yogurt'],
['whole milk', 'domestic eggs', 'whipped/sour cream'], ['whole milk', 'beef',
'root vegetables'], ['pork', 'other vegetables', 'root vegetables'], ['whole m
ilk', 'pork', 'root vegetables']]
[['yogurt', 'other vegetables', 'sausage'], ['soda', 'other vegetables', 'saus
age'], ['shopping bags', 'other vegetables', 'sausage'], ['soda', 'yogurt', 's
ausage'], ['soda', 'other vegetables', 'yogurt'], ['shopping bags', 'other veg
etables', 'yogurt'], ['soda', 'other vegetables', 'shopping bags']]
[['whole milk', 'rolls/buns', 'beef'], ['whole milk', 'other vegetables', 'sau
sage'], ['whole milk', 'whipped/sour cream', 'sausage'], ['other vegetables',
'whole milk', 'beef'], ['other vegetables', 'rolls/buns', 'beef'], ['whole mil
k', 'citrus fruit', 'other vegetables'], ['citrus fruit', 'whipped/sour cream'
, 'other vegetables'], ['citrus fruit', 'rolls/buns', 'other vegetables'], ['w
hole milk', 'citrus fruit', 'whipped/sour cream'], ['whole milk', 'citrus frui
t', 'rolls/buns']]
[['shopping bags', 'other vegetables', 'root vegetables'], ['citrus fruit', 'b
ottled water', 'other vegetables'], ['citrus fruit', 'rolls/buns', 'yogurt'],
['whole milk', 'curd', 'rolls/buns'], ['whole milk', 'rolls/buns', 'yogurt'],

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['whole milk', 'rolls/buns', 'napkins'], ['whole milk', 'bottled water', 'other vegetables'], ['whole milk', 'napkins', 'other vegetables'], ['soda', 'bottled water', 'other vegetables'], ['whole milk', 'bottled beer', 'bottled water'], ['whole milk', 'bottled water', 'root vegetables']]
[['pork', 'rolls/buns', 'other vegetables'], ['soda', 'rolls/buns', 'other vegetables'], ['rolls/buns', 'other vegetables', 'shopping bags'], ['tropical fruit', 'other vegetables', 'sausage'], ['bottled water', 'other vegetables', 'sausage'], ['citrus fruit', 'other vegetables', 'yogurt'], ['tropical fruit', 'soda', 'other vegetables'], ['newspapers', 'tropical fruit', 'whole milk'], ['tropical fruit', 'rolls/buns', 'yogurt'], ['tropical fruit', 'rolls/buns', 'bottled water'], ['tropical fruit', 'soda', 'rolls/buns'], ['tropical fruit', 'soda', 'bottled water']]
[['newspapers', 'whole milk', 'other vegetables'], ['rolls/buns', 'other vegetables', 'yogurt'], ['bottled water', 'other vegetables', 'yogurt'], ['newspapers', 'other vegetables', 'yogurt'], ['newspapers', 'rolls/buns', 'other vegetables'], ['newspapers', 'whole milk', 'yogurt'], ['soda', 'whole milk', 'chocolate']]
[['pastry', 'other vegetables', 'root vegetables'], ['whole milk', 'other vegetables', 'onions'], ['hygiene articles', 'whole milk', 'other vegetables'], ['whole milk', 'citrus fruit', 'root vegetables'], ['citrus fruit', 'other vegetables', 'pip fruit'], ['margarine', 'other vegetables', 'root vegetables'], ['whole milk', 'margarine', 'other vegetables'], ['whole milk', 'pastry', 'other vegetables'], ['pastry', 'other vegetables', 'yogurt'], ['margarine', 'other vegetables', 'yogurt'], ['pastry', 'rolls/buns', 'other vegetables'], ['rolls/buns', 'margarine', 'other vegetables'], ['whole milk', 'margarine', 'yogurt'], ['whole milk', 'fruit/vegetable juice', 'bottled water']]
[['pastry', 'rolls/buns', 'yogurt']]
[['whole milk', 'other vegetables', 'chicken'], ['whole milk', 'rolls/buns', 'chicken'], ['whole milk', 'root vegetables', 'chicken'], ['brown bread', 'whole milk', 'rolls/buns'], ['oil', 'whole milk', 'other vegetables'], ['other vegetables', 'beef', 'yogurt']]
[['whole milk', 'root vegetables', 'sausage']]
[['brown bread', 'other vegetables', 'yogurt']]
[['whole milk', 'rolls/buns', 'shopping bags']]
[['soda', 'pastry', 'other vegetables'], ['whole milk', 'coffee', 'other vegetables'], ['other vegetables', 'beef', 'root vegetables'], ['onions', 'other vegetables', 'root vegetables'], ['soda', 'other vegetables', 'root vegetables'], ['soda', 'whole milk', 'fruit/vegetable juice'], ['soda', 'fruit/vegetable juice', 'bottled water']]
[['whole milk', 'pastry', 'pip fruit'], ['whole milk', 'beef', 'yogurt'], ['newspapers', 'whole milk', 'root vegetables']]
[['soda', 'fruit/vegetable juice', 'yogurt']]
[['domestic eggs', 'rolls/buns', 'other vegetables']]
[['soda', 'whole milk', 'shopping bags'], ['shopping bags', 'whole milk', 'root vegetables']]
[['tropical fruit', 'pastry', 'other vegetables'], ['newspapers', 'other vegetables', 'root vegetables']]

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In [45]:

```
print(len(cluster))
```

35

Comments:

1. Using frequent itemsets can help to clustering the large number of documents or transactions. It also can be helpful with clustered association rules in reducing the large number of association rules.
2. In our case, $k=3$ and Näive method ($s=50$), we found 35 clusters based on 1-nn.

In []: