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```
In [105... import pandas as pd
import numpy as np
import time
import matplotlib.pyplot as plt
from mlxtend.frequent_patterns import apriori
from mlxtend.frequent_patterns import fpgrowth
from mlxtend.frequent_patterns import association_rules
from mlxtend.preprocessing import TransactionEncoder
```

```
In [106... df = pd.read_csv("groceries.csv", sep="\t", header=None, engine="python")
df.head(10)
```

```
Out[106... 0
0 citrus fruit,semi-finished bread,margarine,rea...
1 tropical fruit,yogurt,coffee
2 whole milk
3 pip fruit,yogurt,cream cheese,meat spreads
4 other vegetables,whole milk,condensed milk,lon...
5 whole milk,butter,yogurt,rice,abrasive cleaner
6 rolls/buns
7 other vegetables,UHT-milk,rolls/buns,bottled b...
8 potted plants
9 whole milk,cereals
```

Xử lý dữ liệu chuỗi

```
In [107... df = df[0].str.split(',', expand=True)
```

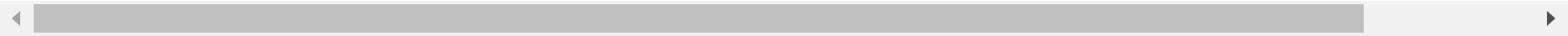
In [108...

df.head(10)

Out[108...

	0	1	2	3	4	5	6	7	8	9	...	22	23	24	25	26	27	28	
0	citrus fruit	semi-finished bread	margarine	ready soups	None	None	None	None	None	None	...	None	None	None	None	None	None	None	N
1	tropical fruit	yogurt	coffee	None	None	None	None	None	None	None	...	None	None	None	None	None	None	None	N
2	whole milk	None	None	None	None	None	None	None	None	None	...	None	None	None	None	None	None	None	N
3	pip fruit	yogurt	cream cheese	meat spreads	None	None	None	None	None	None	...	None	None	None	None	None	None	None	N
4	other vegetables	whole milk	condensed milk	long life bakery product	None	None	None	None	None	None	...	None	None	None	None	None	None	None	N
5	whole milk	butter	yogurt	rice	abrasive cleaner	None	None	None	None	None	...	None	None	None	None	None	None	None	N
6	rolls/buns	None	None	None	None	None	None	None	None	None	...	None	None	None	None	None	None	None	N
7	other vegetables	UHT-milk	rolls/buns	bottled beer	liquor (appetizer)	None	None	None	None	None	...	None	None	None	None	None	None	None	N
8	potted plants	None	None	None	None	None	None	None	None	None	...	None	None	None	None	None	None	None	N
9	whole milk	cereals	None	None	None	None	None	None	None	None	...	None	None	None	None	None	None	None	N

10 rows × 32 columns



In [109...

df.info()

```
<class 'pandas.core.frame.DataFrame'>
```

```
RangeIndex: 9835 entries, 0 to 9834
```

```
Data columns (total 32 columns):
```

#	Column	Non-Null Count	Dtype
0	0	9835 non-null	object
1	1	7676 non-null	object
2	2	6033 non-null	object
3	3	4734 non-null	object
4	4	3729 non-null	object
5	5	2874 non-null	object
6	6	2229 non-null	object
7	7	1684 non-null	object
8	8	1246 non-null	object
9	9	896 non-null	object
10	10	650 non-null	object
11	11	468 non-null	object
12	12	351 non-null	object
13	13	273 non-null	object
14	14	196 non-null	object
15	15	141 non-null	object
16	16	95 non-null	object
17	17	66 non-null	object
18	18	52 non-null	object
19	19	38 non-null	object
20	20	29 non-null	object
21	21	18 non-null	object
22	22	14 non-null	object
23	23	8 non-null	object
24	24	7 non-null	object
25	25	7 non-null	object
26	26	6 non-null	object
27	27	5 non-null	object
28	28	4 non-null	object
29	29	1 non-null	object
30	30	1 non-null	object
31	31	1 non-null	object

```
dtypes: object(32)
```

```
memory usage: 2.4+ MB
```

Chuyển thành 2d array

```
In [110... basket = np.array(df)
```

```
In [111... basket
```

```
Out[111... array([[ 'citrus fruit', 'semi-finished bread', 'margarine', ..., None,
        None, None],
       [ 'tropical fruit', 'yogurt', 'coffee', ..., None, None, None],
       [ 'whole milk', None, None, ..., None, None, None],
       ...,
       [ 'chicken', 'citrus fruit', 'other vegetables', ..., None, None,
        None],
       [ 'semi-finished bread', 'bottled water', 'soda', ..., None, None,
        None],
       [ 'chicken', 'tropical fruit', 'other vegetables', ..., None, None,
        None]], dtype=object)
```

Loại bỏ các giá trị None

```
In [112... basket = [x for x in row if str(x) != 'None'] for row in basket]
basket
```

```
Out[112... [['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'],
['tropical fruit',
'other vegetables',
'white bread',
'bottled water',
'chocolate'],
['citrus fruit',
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'whole milk',
'butter',
'curd',
'yogurt',
'flour',
'bottled water',
'dishes'],
['beef'],
['frankfurter', 'rolls/buns', 'soda'],
['chicken', 'tropical fruit'],
['butter', 'sugar', 'fruit/vegetable juice', 'newspapers'],
['fruit/vegetable juice'],
['packaged fruit/vegetables'],
['chocolate'],
['specialty bar'],
['other vegetables'],
['butter milk', 'pastry'],
['whole milk'],
['tropical fruit',
'cream cheese',
'processed cheese',
'detergent',
'newspapers'],
```

```
['tropical fruit',  
 'root vegetables',  
 'other vegetables',  
 'frozen dessert',  
 'rolls/buns',  
 'flour',  
 'sweet spreads',  
 'salty snack',  
 'waffles',  
 'candy',  
 'bathroom cleaner'],  
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['yogurt'],  
['sausage', 'rolls/buns', 'soda', 'chocolate'],  
['other vegetables'],  
['brown bread',  
 'soda',  
 'fruit/vegetable juice',  
 'canned beer',  
 'newspapers',  
 'shopping bags'],  
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['hamburger meat',  
 'other vegetables',  
 'rolls/buns',  
 'spices',  
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 'hygiene articles',  
 'napkins'],  
['root vegetables', 'other vegetables', 'whole milk', 'beverages', 'sugar'],  
['pork',  
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 'whole milk',  
 'whipped/sour cream',  
 'artif. sweetener',  
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['fruit/vegetable juice'],  
['canned beer'],  
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 'rolls/buns',  
 'soda',  
 'canned beer',
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'rolls/buns',
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'bottled beer'],
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'hamburger meat',
'pip fruit',
'nuts/prunes',
'root vegetables',
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'whole milk',
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'frozen potato products',
'brown bread',
```

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'Instant food products',
'soda',
'fruit/vegetable juice',
'shopping bags'],
['beef',
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'herbs',
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'brown bread',
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'shopping bags'],
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['sugar'],
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'sausage',
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'yogurt',
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'soda'],
['berries', 'frozen vegetables', 'pet care', 'instant coffee'],
['bottled water', 'soda', 'chewing gum', 'napkins'],
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'soda',
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'dishes',
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'newspapers'],
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['pork',
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 'white bread',

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 'coffee',
 'bottled water',
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 'soda',
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 'brown bread',
 'napkins'],
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 'brown bread',
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 'bottled beer',
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 'newspapers'],
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['newspapers'],
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['tropical fruit', 'newspapers'],
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'yogurt',

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'berries',
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'white bread',
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['rolls/buns', 'coffee'],
['hygiene articles'],
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['curd',
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'domestic eggs',
'flour',
'misc. beverages',
'newspapers'],
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['onions',
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'dessert',
'domestic eggs',
'rolls/buns',
'white bread',
'coffee',
'bottled water'],
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'sliced cheese',
'white bread',
'fruit/vegetable juice'],
['salt', 'dog food', 'long life bakery product'],
['tropical fruit',
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'white bread',
'brown bread',
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'rum'],
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['chocolate'],
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'yogurt',

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['other vegetables', 'butter milk', 'frozen fish', 'salty snack'],
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'rolls/buns',
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['beef'],
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'yogurt',
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'soups',
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'candy',

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'salty snack',
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'bottled beer'],
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'shopping bags'],
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['whole milk', 'newspapers'],
['domestic eggs', 'hygiene articles', 'photo/film', 'flower soil/fertilizer'],
['packaged fruit/vegetables',
'dessert',
'mayonnaise',
'oil',
'soda',
'waffles',
'chocolate',
'flower (seeds)',
'shopping bags'],
['chicken',
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```
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'frozen vegetables',
'bottled water',
'long life bakery product'],
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'cream cheese',
'domestic eggs',
'white bread',
'sugar',
'baking powder',
'coffee',
'cocoa drinks',
'salty snack',
'waffles',
'candy',
'napkins'],
['citrus fruit',
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'curd',
'yogurt',
'whipped/sour cream',
'cream cheese',
'pastry',
'vinegar',
'oil',
'coffee',
'long life bakery product',
'detergent',
'cleaner',
'napkins',
'newspapers'],
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['sausage',
'curd',
'frozen meals',
'domestic eggs',
'cake bar',
'seasonal products',
'detergent',
'cleaner',
'house keeping products',
```

```

    'potted plants',
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 'pip fruit',
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 'yogurt',
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 'hard cheese',
 'frozen vegetables',
 'frozen fish',
 'domestic eggs',
 'white bread',
 'rice',
 'specialty fat',
 'dog food',
 'bottled water',
 'fruit/vegetable juice',
 'long life bakery product',
 'softener',
 'napkins',
 'cling film/bags'],
['ice cream'],
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['pork',
 'tropical fruit',
 'other vegetables',
 'yogurt',
 'semi-finished bread',
 'flour',
 'margarine',
 'artif. sweetener',
 'organic products',
 'chocolate marshmallow'],
...]

```

Chuyển sang dạng OneHot Encoding

In [113...

```

te = TransactionEncoder()
encoded = te.fit_transform(basket)
encoded

```

```
Out[113...] array([[False, False, False, ..., False, False, False],
      [False, False, False, ..., False, True, False],
      [False, False, False, ..., True, False, False],
      ...,
      [False, False, False, ..., False, True, False],
      [False, False, False, ..., False, False, False],
      [False, False, False, ..., False, False, False]])
```

```
In [114...] newDf = pd.DataFrame(encoded, columns=te.columns_)
```

```
In [115...] newDf.head(10)
```

```
Out[115...]
      Instant
      food
      products  UHT-
      milk  abrasive
      cleaner  artif.
      sweetener  baby
      cosmetics  baby
      food  bags  baking
      powder  bathroom
      cleaner  beef  ...  turkey  vinegar  waffles  whipped/sour
      cream  whisk
0      False  False  False  False  False  False  False  False  False  False  False  ...  False  False  False  False  False
1      False  False  False  False  False  False  False  False  False  False  False  ...  False  False  False  False  False
2      False  False  False  False  False  False  False  False  False  False  False  ...  False  False  False  False  False
3      False  False  False  False  False  False  False  False  False  False  False  ...  False  False  False  False  False
4      False  False  False  False  False  False  False  False  False  False  False  ...  False  False  False  False  False
5      False  False  True   False  False  False  False  False  False  False  False  ...  False  False  False  False  False
6      False  False  False  False  False  False  False  False  False  False  False  ...  False  False  False  False  False
7      False  True   False  False  False  False  False  False  False  False  False  ...  False  False  False  False  False
8      False  False  False  False  False  False  False  False  False  False  False  ...  False  False  False  False  False
9      False  False  False  False  False  False  False  False  False  False  False  ...  False  False  False  False  False
```

10 rows × 169 columns



Thuật toán Apriori

```
In [116...] time_ap = []
for i in range(1, 11):
    min_supp = np.round(i/100, 2)
    print("Min_supp = ", str(min_supp))
    sTime = time.time()
```

```
fp_apri = apriori(newDf, min_support = min_supp, use_colnames=True)
eTime = time.time()
print("Thời gian chạy = ", str(eTime - sTime))
time_ap.append(eTime - sTime)
print("Tập phổ biến: \n", fp_apri)
print("-----")
```


Min_supp = 0.01
Thời gian chạy = 0.47103309631347656
Tập phổ biến:

	support	itemsets
0	0.033452	(UHT-milk)
1	0.017692	(baking powder)
2	0.052466	(beef)
3	0.033249	(berries)
4	0.026029	(beverages)
..
328	0.011998	(root vegetables, tropical fruit, whole milk)
329	0.014540	(yogurt, root vegetables, whole milk)
330	0.010473	(yogurt, soda, whole milk)
331	0.015150	(yogurt, tropical fruit, whole milk)
332	0.010880	(yogurt, whipped/sour cream, whole milk)

[333 rows x 2 columns]

Min_supp = 0.02
Thời gian chạy = 0.14196372032165527
Tập phổ biến:

	support	itemsets
0	0.033452	(UHT-milk)
1	0.052466	(beef)
2	0.033249	(berries)
3	0.026029	(beverages)
4	0.080529	(bottled beer)
..
117	0.032232	(whipped/sour cream, whole milk)
118	0.020742	(yogurt, whipped/sour cream)
119	0.056024	(yogurt, whole milk)
120	0.023183	(root vegetables, whole milk, other vegetables)
121	0.022267	(yogurt, whole milk, other vegetables)

[122 rows x 2 columns]

Min_supp = 0.03
Thời gian chạy = 0.09699726104736328
Tập phổ biến:

	support	itemsets
0	0.033452	(UHT-milk)
1	0.052466	(beef)
2	0.033249	(berries)
3	0.080529	(bottled beer)
4	0.110524	(bottled water)
..
58	0.048907	(root vegetables, whole milk)
59	0.040061	(soda, whole milk)

```
60 0.042298      (tropical fruit, whole milk)
61 0.032232      (whipped/sour cream, whole milk)
62 0.056024      (yogurt, whole milk)
```

```
[63 rows x 2 columns]
```

```
-----
Min_supp = 0.04
```

```
Thời gian chạy = 0.042001962661743164
```

```
Tập phổ biến:
```

	support	itemsets
0	0.052466	(beef)
1	0.080529	(bottled beer)
2	0.110524	(bottled water)
3	0.064870	(brown bread)
4	0.055414	(butter)
5	0.077682	(canned beer)
6	0.042908	(chicken)
7	0.049619	(chocolate)
8	0.082766	(citrus fruit)
9	0.058058	(coffee)
10	0.053279	(curd)
11	0.063447	(domestic eggs)
12	0.058973	(frankfurter)
13	0.048094	(frozen vegetables)
14	0.072293	(fruit/vegetable juice)
15	0.058566	(margarine)
16	0.052364	(napkins)
17	0.079817	(newspapers)
18	0.193493	(other vegetables)
19	0.088968	(pastry)
20	0.075648	(pip fruit)
21	0.057651	(pork)
22	0.183935	(rolls/buns)
23	0.108998	(root vegetables)
24	0.093950	(sausage)
25	0.098526	(shopping bags)
26	0.174377	(soda)
27	0.104931	(tropical fruit)
28	0.071683	(whipped/sour cream)
29	0.042095	(white bread)
30	0.255516	(whole milk)
31	0.139502	(yogurt)
32	0.042603	(other vegetables, rolls/buns)
33	0.047382	(root vegetables, other vegetables)
34	0.074835	(whole milk, other vegetables)
35	0.043416	(yogurt, other vegetables)
36	0.056634	(whole milk, rolls/buns)
37	0.048907	(root vegetables, whole milk)

```
38 0.040061 (soda, whole milk)
39 0.042298 (tropical fruit, whole milk)
40 0.056024 (yogurt, whole milk)
```

Min_supp = 0.05

Thời gian chạy = 0.03299999237060547

Tập phổ biến:

	support	itemsets
0	0.052466	(beef)
1	0.080529	(bottled beer)
2	0.110524	(bottled water)
3	0.064870	(brown bread)
4	0.055414	(butter)
5	0.077682	(canned beer)
6	0.082766	(citrus fruit)
7	0.058058	(coffee)
8	0.053279	(curd)
9	0.063447	(domestic eggs)
10	0.058973	(frankfurter)
11	0.072293	(fruit/vegetable juice)
12	0.058566	(margarine)
13	0.052364	(napkins)
14	0.079817	(newspapers)
15	0.193493	(other vegetables)
16	0.088968	(pastry)
17	0.075648	(pip fruit)
18	0.057651	(pork)
19	0.183935	(rolls/buns)
20	0.108998	(root vegetables)
21	0.093950	(sausage)
22	0.098526	(shopping bags)
23	0.174377	(soda)
24	0.104931	(tropical fruit)
25	0.071683	(whipped/sour cream)
26	0.255516	(whole milk)
27	0.139502	(yogurt)
28	0.074835	(whole milk, other vegetables)
29	0.056634	(whole milk, rolls/buns)
30	0.056024	(yogurt, whole milk)

Min_supp = 0.06

Thời gian chạy = 0.01900339126586914

Tập phổ biến:

	support	itemsets
0	0.080529	(bottled beer)
1	0.110524	(bottled water)
2	0.064870	(brown bread)
3	0.077682	(canned beer)

4	0.082766	(citrus fruit)
5	0.063447	(domestic eggs)
6	0.072293	(fruit/vegetable juice)
7	0.079817	(newspapers)
8	0.193493	(other vegetables)
9	0.088968	(pastry)
10	0.075648	(pip fruit)
11	0.183935	(rolls/buns)
12	0.108998	(root vegetables)
13	0.093950	(sausage)
14	0.098526	(shopping bags)
15	0.174377	(soda)
16	0.104931	(tropical fruit)
17	0.071683	(whipped/sour cream)
18	0.255516	(whole milk)
19	0.139502	(yogurt)
20	0.074835	(whole milk, other vegetables)

Min_supp = 0.07

Thời gian chạy = 0.017961978912353516

Tập phổ biến:

	support	itemsets
0	0.080529	(bottled beer)
1	0.110524	(bottled water)
2	0.077682	(canned beer)
3	0.082766	(citrus fruit)
4	0.072293	(fruit/vegetable juice)
5	0.079817	(newspapers)
6	0.193493	(other vegetables)
7	0.088968	(pastry)
8	0.075648	(pip fruit)
9	0.183935	(rolls/buns)
10	0.108998	(root vegetables)
11	0.093950	(sausage)
12	0.098526	(shopping bags)
13	0.174377	(soda)
14	0.104931	(tropical fruit)
15	0.071683	(whipped/sour cream)
16	0.255516	(whole milk)
17	0.139502	(yogurt)
18	0.074835	(whole milk, other vegetables)

Min_supp = 0.08

Thời gian chạy = 0.012054681777954102

Tập phổ biến:

	support	itemsets
0	0.080529	(bottled beer)
1	0.110524	(bottled water)

```

2  0.082766      (citrus fruit)
3  0.193493      (other vegetables)
4  0.088968      (pastry)
5  0.183935      (rolls/buns)
6  0.108998      (root vegetables)
7  0.093950      (sausage)
8  0.098526      (shopping bags)
9  0.174377      (soda)
10 0.104931      (tropical fruit)
11 0.255516      (whole milk)
12 0.139502      (yogurt)

```

```

Min_supp = 0.09
Thời gian chạy = 0.008946418762207031
Tập phổ biến:

```

```

      support      itemsets
0  0.110524      (bottled water)
1  0.193493      (other vegetables)
2  0.183935      (rolls/buns)
3  0.108998      (root vegetables)
4  0.093950      (sausage)
5  0.098526      (shopping bags)
6  0.174377      (soda)
7  0.104931      (tropical fruit)
8  0.255516      (whole milk)
9  0.139502      (yogurt)

```

```

Min_supp = 0.1
Thời gian chạy = 0.007041454315185547
Tập phổ biến:

```

```

      support      itemsets
0  0.110524      (bottled water)
1  0.193493      (other vegetables)
2  0.183935      (rolls/buns)
3  0.108998      (root vegetables)
4  0.174377      (soda)
5  0.104931      (tropical fruit)
6  0.255516      (whole milk)
7  0.139502      (yogurt)

```

Thuật toán FP-Growth

In [117...

```

time_fp = []
for i in range(1, 11):
    min_supp = np.round(i/100, 2)

```

```
print("Min_supp = ", str(min_supp))
sTime = time.time()
fp_fpgrowth = fpgrowth(newDf, min_support = min_supp, use_colnames=True)
eTime = time.time()
print("Thời gian chạy = ", str(eTime - sTime))
time_fp.append(eTime - sTime)
print("Tập phổ biến: \n", fp_fpgrowth)
print("-----")
```

Min_supp = 0.01
Thời gian chạy = 0.23899197578430176
Tập phổ biến:

	support	itemsets
0	0.082766	(citrus fruit)
1	0.058566	(margarine)
2	0.017692	(semi-finished bread)
3	0.139502	(yogurt)
4	0.104931	(tropical fruit)
..
328	0.010168	(frozen vegetables, rolls/buns)
329	0.012405	(yogurt, frozen vegetables)
330	0.014235	(onions, other vegetables)
331	0.012100	(onions, whole milk)
332	0.010778	(sliced cheese, whole milk)

[333 rows x 2 columns]

Min_supp = 0.02
Thời gian chạy = 0.16100335121154785
Tập phổ biến:

	support	itemsets
0	0.082766	(citrus fruit)
1	0.058566	(margarine)
2	0.139502	(yogurt)
3	0.104931	(tropical fruit)
4	0.058058	(coffee)
..
117	0.022166	(pork, whole milk)
118	0.021657	(pork, other vegetables)
119	0.029995	(domestic eggs, whole milk)
120	0.022267	(domestic eggs, other vegetables)
121	0.020437	(frozen vegetables, whole milk)

[122 rows x 2 columns]

Min_supp = 0.03
Thời gian chạy = 0.12896037101745605
Tập phổ biến:

	support	itemsets
0	0.082766	(citrus fruit)
1	0.058566	(margarine)
2	0.139502	(yogurt)
3	0.104931	(tropical fruit)
4	0.058058	(coffee)
..
58	0.033249	(pastry, whole milk)
59	0.047382	(root vegetables, other vegetables)

```
60 0.048907 (root vegetables, whole milk)
61 0.030605 (sausage, rolls/buns)
62 0.032232 (whipped/sour cream, whole milk)
```

[63 rows x 2 columns]

Min_supp = 0.04

Thời gian chạy = 0.3129761219024658

Tập phổ biến:

	support	itemsets
0	0.082766	(citrus fruit)
1	0.058566	(margarine)
2	0.139502	(yogurt)
3	0.104931	(tropical fruit)
4	0.058058	(coffee)
5	0.255516	(whole milk)
6	0.075648	(pip fruit)
7	0.193493	(other vegetables)
8	0.055414	(butter)
9	0.183935	(rolls/buns)
10	0.080529	(bottled beer)
11	0.110524	(bottled water)
12	0.049619	(chocolate)
13	0.042095	(white bread)
14	0.053279	(curd)
15	0.052466	(beef)
16	0.174377	(soda)
17	0.058973	(frankfurter)
18	0.042908	(chicken)
19	0.079817	(newspapers)
20	0.072293	(fruit/vegetable juice)
21	0.088968	(pastry)
22	0.108998	(root vegetables)
23	0.077682	(canned beer)
24	0.093950	(sausage)
25	0.098526	(shopping bags)
26	0.064870	(brown bread)
27	0.052364	(napkins)
28	0.071683	(whipped/sour cream)
29	0.057651	(pork)
30	0.063447	(domestic eggs)
31	0.048094	(frozen vegetables)
32	0.056024	(yogurt, whole milk)
33	0.043416	(yogurt, other vegetables)
34	0.042298	(tropical fruit, whole milk)
35	0.074835	(whole milk, other vegetables)
36	0.042603	(other vegetables, rolls/buns)
37	0.056634	(whole milk, rolls/buns)


```
38 0.040061 (soda, whole milk)
39 0.047382 (root vegetables, other vegetables)
40 0.048907 (root vegetables, whole milk)
```

Min_supp = 0.05

Thời gian chạy = 0.10703563690185547

Tập phổ biến:

	support	itemsets
0	0.082766	(citrus fruit)
1	0.058566	(margarine)
2	0.139502	(yogurt)
3	0.104931	(tropical fruit)
4	0.058058	(coffee)
5	0.255516	(whole milk)
6	0.075648	(pip fruit)
7	0.193493	(other vegetables)
8	0.055414	(butter)
9	0.183935	(rolls/buns)
10	0.080529	(bottled beer)
11	0.110524	(bottled water)
12	0.053279	(curd)
13	0.052466	(beef)
14	0.174377	(soda)
15	0.058973	(frankfurter)
16	0.079817	(newspapers)
17	0.072293	(fruit/vegetable juice)
18	0.088968	(pastry)
19	0.108998	(root vegetables)
20	0.077682	(canned beer)
21	0.093950	(sausage)
22	0.098526	(shopping bags)
23	0.064870	(brown bread)
24	0.052364	(napkins)
25	0.071683	(whipped/sour cream)
26	0.057651	(pork)
27	0.063447	(domestic eggs)
28	0.056024	(yogurt, whole milk)
29	0.074835	(whole milk, other vegetables)
30	0.056634	(whole milk, rolls/buns)

Min_supp = 0.06

Thời gian chạy = 0.08400964736938477

Tập phổ biến:

	support	itemsets
0	0.082766	(citrus fruit)
1	0.139502	(yogurt)
2	0.104931	(tropical fruit)
3	0.255516	(whole milk)

4	0.075648	(pip fruit)
5	0.193493	(other vegetables)
6	0.183935	(rolls/buns)
7	0.080529	(bottled beer)
8	0.110524	(bottled water)
9	0.174377	(soda)
10	0.079817	(newspapers)
11	0.072293	(fruit/vegetable juice)
12	0.088968	(pastry)
13	0.108998	(root vegetables)
14	0.077682	(canned beer)
15	0.093950	(sausage)
16	0.098526	(shopping bags)
17	0.064870	(brown bread)
18	0.071683	(whipped/sour cream)
19	0.063447	(domestic eggs)
20	0.074835	(whole milk, other vegetables)

Min_supp = 0.07

Thời gian chạy = 0.07200360298156738

Tập phổ biến:

	support	itemsets
0	0.082766	(citrus fruit)
1	0.139502	(yogurt)
2	0.104931	(tropical fruit)
3	0.255516	(whole milk)
4	0.075648	(pip fruit)
5	0.193493	(other vegetables)
6	0.183935	(rolls/buns)
7	0.080529	(bottled beer)
8	0.110524	(bottled water)
9	0.174377	(soda)
10	0.079817	(newspapers)
11	0.072293	(fruit/vegetable juice)
12	0.088968	(pastry)
13	0.108998	(root vegetables)
14	0.077682	(canned beer)
15	0.093950	(sausage)
16	0.098526	(shopping bags)
17	0.071683	(whipped/sour cream)
18	0.074835	(whole milk, other vegetables)

Min_supp = 0.08

Thời gian chạy = 0.11103439331054688

Tập phổ biến:

	support	itemsets
0	0.082766	(citrus fruit)
1	0.139502	(yogurt)

```

2  0.104931 (tropical fruit)
3  0.255516 (whole milk)
4  0.193493 (other vegetables)
5  0.183935 (rolls/buns)
6  0.080529 (bottled beer)
7  0.110524 (bottled water)
8  0.174377 (soda)
9  0.088968 (pastry)
10 0.108998 (root vegetables)
11 0.093950 (sausage)
12 0.098526 (shopping bags)

```

```

Min_supp = 0.09
Thời gian chạy = 0.07200407981872559
Tập phổ biến:

```

```

      support      itemsets
0  0.139502      (yogurt)
1  0.104931 (tropical fruit)
2  0.255516 (whole milk)
3  0.193493 (other vegetables)
4  0.183935 (rolls/buns)
5  0.110524 (bottled water)
6  0.174377 (soda)
7  0.108998 (root vegetables)
8  0.093950 (sausage)
9  0.098526 (shopping bags)

```

```

Min_supp = 0.1
Thời gian chạy = 0.059010982513427734
Tập phổ biến:

```

```

      support      itemsets
0  0.139502      (yogurt)
1  0.104931 (tropical fruit)
2  0.255516 (whole milk)
3  0.193493 (other vegetables)
4  0.183935 (rolls/buns)
5  0.110524 (bottled water)
6  0.174377 (soda)
7  0.108998 (root vegetables)

```

Bảng thời gian thực thi

```

In [118... detail_exe = {'Min_supp': [np.round(i/100, 2) for i in range(1, 11)], 'Executive time of Apriori': time_ap, 'Executive time of FP-G
table = pd.DataFrame(detail_exe)
table

```

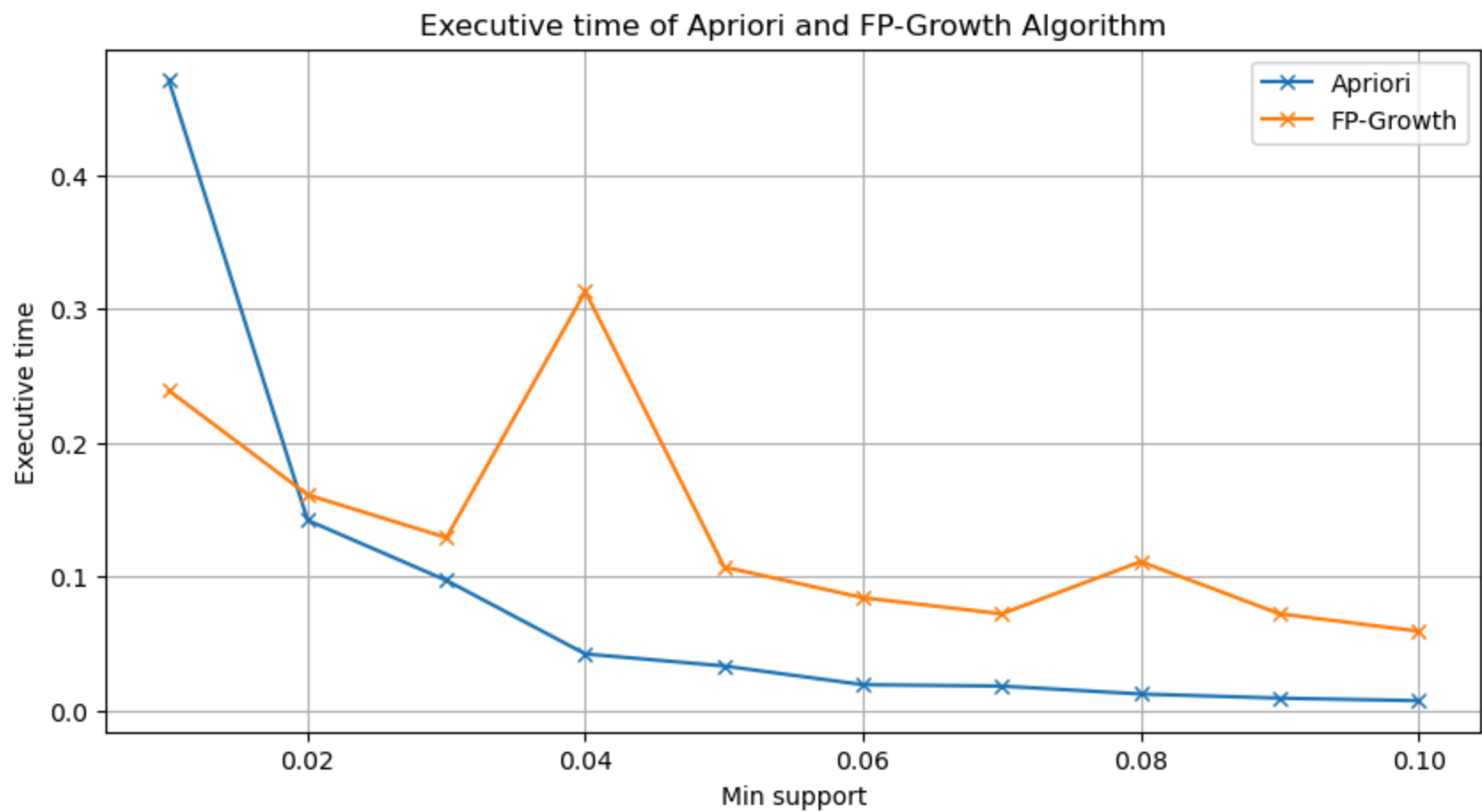
Out[118...

	Min_supp	Executive time of Apriori	Executive time of FP-Growth
0	0.01	0.471033	0.238992
1	0.02	0.141964	0.161003
2	0.03	0.096997	0.128960
3	0.04	0.042002	0.312976
4	0.05	0.033000	0.107036
5	0.06	0.019003	0.084010
6	0.07	0.017962	0.072004
7	0.08	0.012055	0.111034
8	0.09	0.008946	0.072004
9	0.10	0.007041	0.059011

Vẽ biểu đồ so sánh thời gian chạy

In [119...

```
plt.figure(figsize=(10,5))
plt.plot(table['Min_supp'], table['Executive time of Apriori'], label='Apriori', marker='x')
plt.plot(table['Min_supp'], table['Executive time of FP-Growth'], label='FP-Growth', marker='x')
plt.xlabel('Min support')
plt.ylabel('Executive time')
plt.title('Executive time of Apriori and FP-Growth Algorithm')
plt.legend()
plt.grid(True)
plt.show()
```



Nhận xét:

- Min_supp càng tăng thì thời gian thực hiện của 2 thuật toán đều có xu hướng giảm
- Thời gian chạy trung bình của thuật toán Apriori nhanh hơn so với FP-Growth

Giải thích:

- Apriori xét trên tất cả tập con có thể để tìm tập phổ biến - sẽ chạy càng lâu do nó phải xét trên tất cả tập con.
- FP-growth tìm tập phổ biến bằng cách xét trên cây tăng trưởng mục tiêu - sẽ chạy nhanh hơn hẳn do không phải xét trên tất cả các tập con.