Data Mining - Homework 2

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Discovery of Frequent Itemsets and Association Rules

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Task

- **(1) Write a program that implements the A-Priori algorithm for finding frequent itemsets with support at least s in a dataset of sales transactions.**
- **(2) <u>BONUS TASK:</u> Develop and implement an algorithm for generating association rules between frequent itemsets discovered with the A-Priori algorithm. The rules must have support at least s and confidence at least c, where s and c are given as input parameters.**

1 Detailed Information

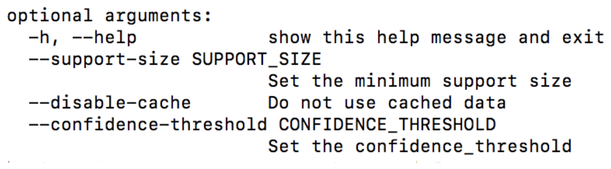
Apache Spark was used.

- Our implementation of (1) does the following:
  1. Counts frequent singleton occurrences with support s.
  2. Recursively calls a function called “gather_all_groups”, which counts frequent doubletons, tripletons...(etc.) with support size s. The creation of larger groups is done with a DataFrame which consists of the frequent singletons joined with the baskets in which they are included.
     Result is first shown with a spark DataFrame where each item is represented by a group (column: “group”; the occurrences are stored in column: “occurrences”).
     Result is then also shown in a second DataFrame which displays the group_sizes that exist with the given support size s, and their associated group_size counts (i.e. there exists 9 doubletons”).
  3. Cached solutions for values of support-size $s = \{700, 1000, 2000\}$ can be found in the “datafolder.
- **BONUS:** Our implementation of (2) does the following:
  1. Finds all of the possible association rules which correspond to the frequent item groups (double-tons, triple-tons etc.). This is achieved with the itertools permutations function.
  2. Confidence is computed for all of these association rules. The rules which have confidence c or higher are kept, others are discarded.

Instructions on how to build and run the program

- pip install pyspark
- spark-submit frequent_items.py

Figure 1 shows information about optional command line parameters:



```
optional arguments:
  -h, --help            show this help message and exit
  --support-size SUPPORT_SIZE
                        Set the minimum support size
  --disable-cache       Do not use cached data
  --confidence-threshold CONFIDENCE_THRESHOLD
                        Set the confidence_threshold
```

Figur 1: Optional arguments

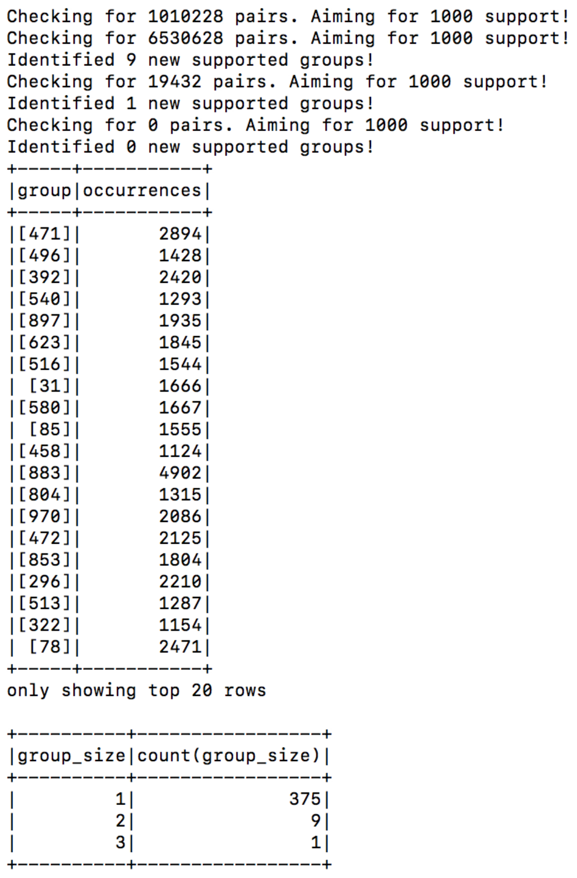
Since the implementation of our A-priori algorithm is slow for certain values of support values s (i.e s = 700), we included the option to enable/ disable the cache. This means that the program can use previously cached data in order to perform the Bonus task. By default, the cache is enabled.

2 Results

The results shown below are found with command line parameters:

- *support_size = 1000* (default value)
- *confidence_threshold = 0.6* (default value)
- - - disablecache

The run time of task1 and task2 was 15:44 minutes.
Task 1:

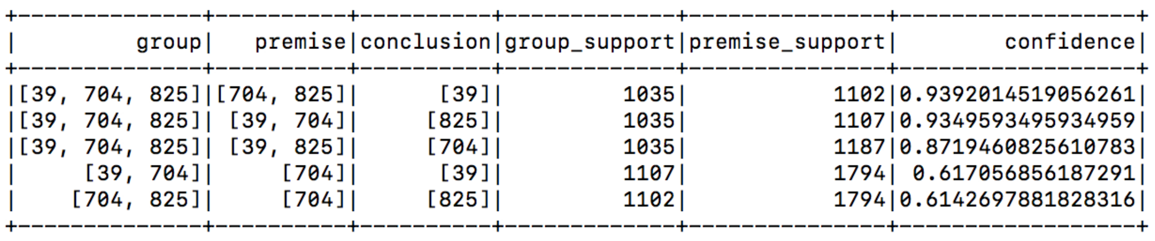


```
Checking for 1010228 pairs. Aiming for 1000 support!
Checking for 6530628 pairs. Aiming for 1000 support!
Identified 9 new supported groups!
Checking for 19432 pairs. Aiming for 1000 support!
Identified 1 new supported groups!
Checking for 0 pairs. Aiming for 1000 support!
Identified 0 new supported groups!
+-----+-----------+
|group|occurrences|
+-----+-----------+
|[471]|       2894|
|[496]|       1428|
|[392]|       2420|
|[540]|       1293|
|[897]|       1935|
|[623]|       1845|
|[516]|       1544|
| [31]|       1666|
|[580]|       1667|
| [85]|       1555|
|[458]|       1124|
|[883]|       4902|
|[804]|       1315|
|[970]|       2086|
|[472]|       2125|
|[853]|       1804|
|[296]|       2210|
|[513]|       1287|
|[322]|       1154|
| [78]|       2471|
+-----+-----------+
only showing top 20 rows

+----------+-----------------+
|group_size|count(group_size)|
+----------+-----------------+
|         1|              375|
|         2|                9|
|         3|                1|
+----------+-----------------+
```

Figur 2: Spark DataFrame output for task 1, with support-size = 1000

Task 2 (bonus):



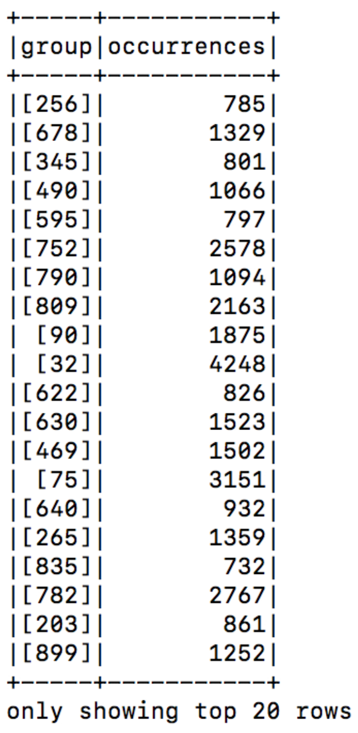
```
+--------------+----------+----------+-------------+---------------+------------------+
|         group|   premise|conclusion|group_support|premise_support|        confidence|
+--------------+----------+----------+-------------+---------------+------------------+
|[39, 704, 825]|[704, 825]|      [39]|         1035|           1102|0.9392014519056261|
|[39, 704, 825]| [39, 704]|     [825]|         1035|           1107|0.9349593495934959|
|[39, 704, 825]| [39, 825]|     [704]|         1035|           1187|0.8719460825610783|
|     [39, 704]|     [704]|      [39]|         1107|           1794| 0.617056856187291|
|    [704, 825]|     [704]|     [825]|         1102|           1794|0.6142697881828316|
+--------------+----------+----------+-------------+---------------+------------------+
```

Figur 3: Spark DataFrame output for task 2, with support-size = 1000

The results shown below are found with command line parameters:

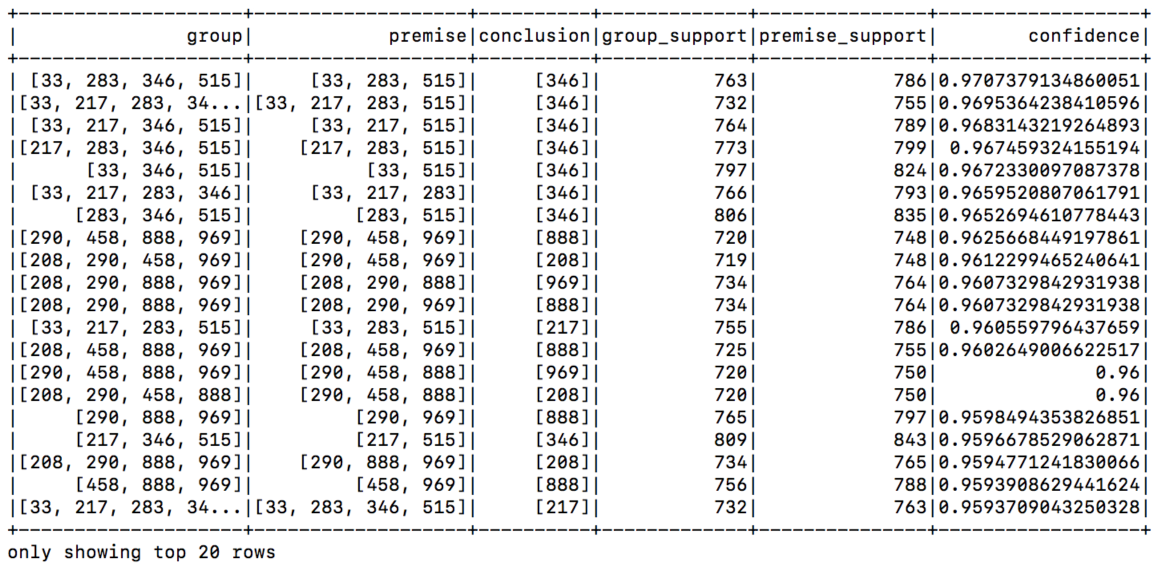
- *support_size* = 700
- *confidence_threshold* = 0.6
- cache_enabled = True (default)

Task 2 output:



```
+-----+-----------+
|group|occurrences|
+-----+-----------+
|[256]|        785|
|[678]|       1329|
|[345]|        801|
|[490]|       1066|
|[595]|        797|
|[752]|       2578|
|[790]|       1094|
|[809]|       2163|
| [90]|       1875|
| [32]|       4248|
|[622]|        826|
|[630]|       1523|
|[469]|       1502|
| [75]|       3151|
|[640]|        932|
|[265]|       1359|
|[835]|        732|
|[782]|       2767|
|[203]|        861|
|[899]|       1252|
+-----+-----------+
only showing top 20 rows
```

Figur 4: Spark DataFrame output for task 2 with support_size = 700 and cache enabled



```
+--------------------+-------------------+----------+-------------+---------------+------------------+
|               group|            premise|conclusion|group_support|premise_support|        confidence|
+--------------------+-------------------+----------+-------------+---------------+------------------+
| [33, 283, 346, 515]|     [33, 283, 515]|     [346]|          763|            786|0.9707379134860051|
|[33, 217, 283, 34...|[33, 217, 283, 515]|     [346]|          732|            755|0.9695364238410596|
| [33, 217, 346, 515]|     [33, 217, 515]|     [346]|          764|            789|0.9683143219264893|
|[217, 283, 346, 515]|    [217, 283, 515]|     [346]|          773|            799| 0.967459324155194|
|      [33, 346, 515]|          [33, 515]|     [346]|          797|            824|0.9672330097087378|
| [33, 217, 283, 346]|     [33, 217, 283]|     [346]|          766|            793|0.9659520807061791|
|     [283, 346, 515]|         [283, 515]|     [346]|          806|            835|0.9652694610778443|
|[290, 458, 888, 969]|    [290, 458, 969]|     [888]|          720|            748|0.9625668449197861|
|[208, 290, 458, 969]|    [290, 458, 969]|     [208]|          719|            748|0.9612299465240641|
|[208, 290, 888, 969]|    [208, 290, 888]|     [969]|          734|            764|0.9607329842931938|
|[208, 290, 888, 969]|    [208, 290, 969]|     [888]|          734|            764|0.9607329842931938|
| [33, 217, 283, 515]|     [33, 283, 515]|     [217]|          755|            786| 0.960559796437659|
|[208, 458, 888, 969]|    [208, 458, 969]|     [888]|          725|            755|0.9602649006622517|
|[290, 458, 888, 969]|    [290, 458, 888]|     [969]|          720|            750|              0.96|
|[208, 290, 458, 888]|    [290, 458, 888]|     [208]|          720|            750|              0.96|
|     [290, 888, 969]|         [290, 969]|     [888]|          765|            797|0.9598494353826851|
|     [217, 346, 515]|         [217, 515]|     [346]|          809|            843|0.9596678529062871|
|[208, 290, 888, 969]|    [290, 888, 969]|     [208]|          734|            765|0.9594771241830066|
|     [458, 888, 969]|         [458, 969]|     [888]|          756|            788|0.9593908629441624|
|[33, 217, 283, 34...|[33, 283, 346, 515]|     [217]|          732|            763|0.9593709043250328|
+--------------------+-------------------+----------+-------------+---------------+------------------+
only showing top 20 rows
```

Figur 5: Spark DataFrame output for task 2 support_size = 700 and cache enabled