Hands-on Practice for FPM Module

0. Exploring properties of the dataset T10I4D100K_new.dat

Printing the head and tail of the data

In [1]:
```
!head T10I4D100K_new.dat
```

```
93 122 161 343 390 535 538 675 874 921 932
101 147 657 778 903
21 52 97 147 183 368 381 424 574 676 793 857 947
172 388 464 500 529 538 598 782 945
447 480 529 594 708 809 841 849 874
127 151 161 334 427 470 494 569
21 32 54 136 213 239 274 348 411 753 764
37 383 460 571 623 736 795 814 844 853 858 992
24 55 470 522 775 940
95 143 159 347 460 481 517 682 697 722 774 883 897 919 966
```

Question: How many items are present in the datafile T10I4D100K_new?

In [2]:
```
!awk -- '{for (i = 1; i <= NF; i++) wc[$i] += 1}; END {print length(wc)}' T10I4D1
```

```
871
```

Answer: Number of items in the data file T10I4D100K_new are 871

Question: How many transactions are present in the datafile?

In [3]:
```
!wc -l T10I4D100K_new.dat
```

```
148983 T10I4D100K_new.dat
```

Answer: Number of transactions in the data file T10I4D100K_new are 148983

1. Generating a synthetic dataset

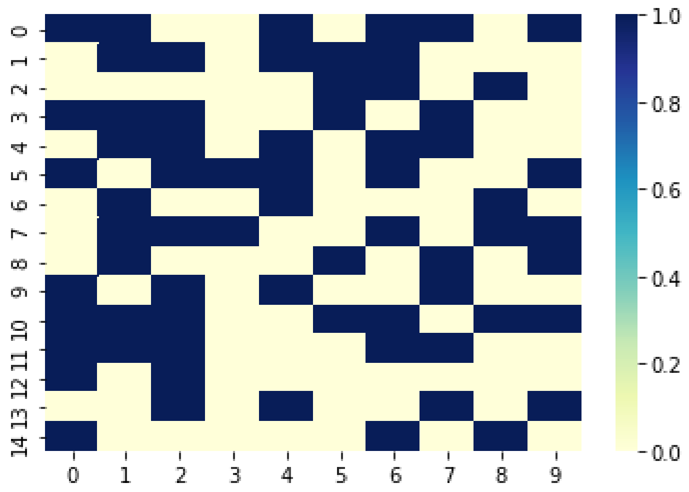
Question: Generate a random synthetic dataset with 15 transactions and 10.

In [21]:
```
import numpy as np
data = np.random.randint(2, size=(15,10))
data
```

Out[21]:
```
array([[1, 1, 0, 0, 1, 0, 1, 1, 0, 1],
       [0, 1, 1, 0, 1, 1, 1, 0, 0, 0],
       [0, 0, 0, 0, 0, 1, 1, 0, 1, 0],
       [1, 1, 1, 0, 0, 1, 0, 1, 0, 0],
       [0, 1, 1, 0, 1, 0, 1, 1, 0, 0],
       [1, 0, 1, 1, 1, 0, 1, 0, 0, 1],
       [0, 1, 0, 0, 1, 0, 0, 0, 1, 0],
       [0, 1, 1, 1, 0, 0, 1, 0, 1, 1],
       [0, 1, 0, 0, 0, 1, 0, 1, 0, 1],
       [1, 0, 1, 0, 1, 0, 0, 1, 0, 0],
       [1, 1, 1, 0, 0, 1, 1, 0, 1, 1],
       [1, 1, 1, 0, 0, 0, 1, 1, 0, 0],
       [1, 0, 1, 0, 0, 0, 0, 0, 0, 0],
       [0, 0, 1, 0, 1, 0, 0, 1, 0, 1],
       [1, 0, 0, 0, 0, 0, 1, 0, 1, 0]])
```

In [22]:
```
import seaborn as sb
sb.heatmap(data,cmap='YlGnBu')
```

Out[22]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x2af75a1dcdd0>
```



Question: Generate a synthetic dataset with 15 transactions and 10 that contains one maximal itemset with 10 supporting transactions and 8 items.

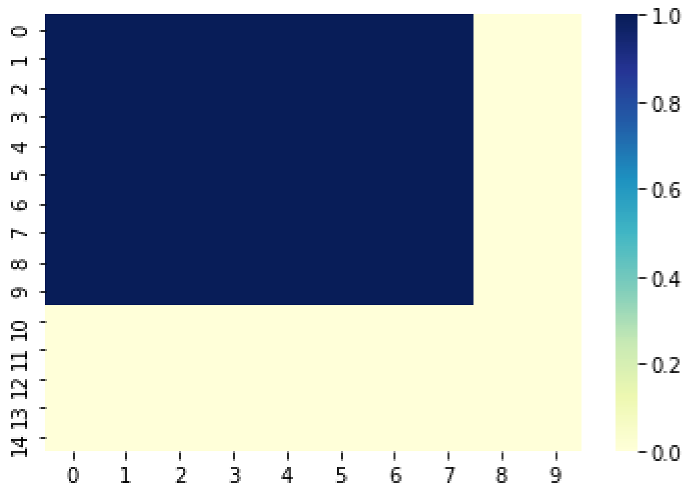
In [23]:
```
def data_matrix_generation(total_rows, total_cols, datablock_rows, datablock_cols
    count = total_rows
    data = np.zeros((total_rows,total_cols), dtype = int)
    data[0:datablock_rows,0:datablock_cols] =1
    return data
```

In [25]:
```
data = data_matrix_generation(15, 10, 10, 8)
data
```

Out[25]:
```
array([[1, 1, 1, 1, 1, 1, 1, 1, 0, 0],
       [1, 1, 1, 1, 1, 1, 1, 1, 0, 0],
       [1, 1, 1, 1, 1, 1, 1, 1, 0, 0],
       [1, 1, 1, 1, 1, 1, 1, 1, 0, 0],
       [1, 1, 1, 1, 1, 1, 1, 1, 0, 0],
       [1, 1, 1, 1, 1, 1, 1, 1, 0, 0],
       [1, 1, 1, 1, 1, 1, 1, 1, 0, 0],
       [1, 1, 1, 1, 1, 1, 1, 1, 0, 0],
       [1, 1, 1, 1, 1, 1, 1, 1, 0, 0],
       [1, 1, 1, 1, 1, 1, 1, 1, 0, 0],
       [0, 0, 0, 0, 0, 0, 0, 0, 0, 0],
       [0, 0, 0, 0, 0, 0, 0, 0, 0, 0],
       [0, 0, 0, 0, 0, 0, 0, 0, 0, 0],
       [0, 0, 0, 0, 0, 0, 0, 0, 0, 0],
       [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]])
```

In [26]:
```
import seaborn as sb
sb.heatmap(data,cmap='YlGnBu')
```

Out[26]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x2af75a2b51d0>
```



2. Generating frequent, maximal and closed itemsets using Apriori algorithm from the dataset T10I4D100K_new.dat

Download the linux executable for apriori from here: http://www.borgelt.net/apriori.html (http://www.borgelt.net/apriori.html)

In [4]:
```
!chmod u+x apriori
```

In [5]:
```
!./apriori
```

```
usage: ./apriori [options] infile [outfile]
find frequent item sets with the apriori algorithm
version 6.27 (2017.08.01)        (c) 1996-2017   Christian Borgelt
-t#      target type                              (default: s)
         (s: frequent, c: closed, m: maximal item sets,
          g: generators, r: association rules)
-m#      minimum number of items per set/rule     (default: 1)
-n#      maximum number of items per set/rule     (default: no limit)
-s#      minimum support of an item set/rule      (default: 10%)
-S#      maximum support of an item set/rule      (default: 100%)
         (positive: percentage, negative: absolute number)
-o       use original rule support definition     (body & head)
-c#      minimum confidence of an assoc. rule     (default: 80%)
-e#      additional evaluation measure            (default: none)
-a#      aggregation mode for evaluation measure  (default: none)
-d#      threshold for add. evaluation measure    (default: 10%)
-i       invalidate eval. below expected support  (default: evaluate all)
-p#      (min. size for) pruning with evaluation  (default: no pruning)
         (< 0: weak forward, > 0 strong forward, = 0: backward pruning)
-q#      sort items w.r.t. their frequency        (default: 2)
         (1: ascending, -1: descending, 0: do not sort,
          2: ascending, -2: descending w.r.t. transaction size sum)
-u#      filter unused items from transactions    (default: 0.01)
         (0: do not filter items w.r.t. usage in sets,
         <0: fraction of removed items for filtering,
         >0: take execution times ratio into account)
-x       do not prune with perfect extensions     (default: prune)
-y       a-posteriori pruning of infrequent item sets
-T       do not organize transactions as a prefix tree
-F#:#..  support border for filtering item sets   (default: none)
         (list of minimum support values, one per item set size,
         starting at the minimum size, as given with option -m#)
-R#      read item selection/appearance indicators
-P#      write a pattern spectrum to a file
-Z       print item set statistics (number of item sets per size)
-N       do not pre-format some integer numbers   (default: do)
-g       write item names in scanable form (quote certain characters)
-h#      record header  for output                (default: "")
-k#      item separator for output                (default: " ")
-I#      implication sign for association rules   (default: " <- ")
-v#      output format for set/rule information   (default: " (%S)")
-j#      sort item sets in output by their size   (default: no sorting)
         (< 0: descending, > 0: ascending order)
-w       integer transaction weight in last field (default: only items)
-r#      record/transaction separators            (default: "\n")
-f#      field /item       separators             (default: " \t,")
-b#      blank   characters                       (default: " \t\r")
-C#      comment characters                       (default: "#")
-!       print additional option information
infile   file to read transactions from           [required]
outfile  file to write item sets/assoc. rules to  [optional]
```

Question: Generate the **frequent itemsets** using apriori with minsup = 100 and write them to a file.

In [33]:
```
!./apriori -ts -s-100 T10I4D100K_new.dat T_AP_Freq_S100.txt
```

```
./apriori - find frequent item sets with the apriori algorithm
version 6.27 (2017.08.01)        (c) 1996-2017   Christian Borgelt
reading T10I4D100K_new.dat ... [870 item(s), 99936 transaction(s)] done [0.08
s].
filtering, sorting and recoding items ... [797 item(s)] done [0.00s].
sorting and reducing transactions ... [89066/99936 transaction(s)] done [0.02
s].
building transaction tree ... [112796 node(s)] done [0.01s].
checking subsets of size 1 2 3 4 5 6 7 8 9 10 done [0.32s].
writing T_AP_Freq_S100.txt ... [27523 set(s)] done [0.01s].
```

Visualizing the first 10 patterns generated with support >= 100.

In [7]:
```
!head T_AP_Freq_S100.txt
```

```
729 (102)
199 (109)
330 (102)
62 (110)
856 (109)
856 490 906 (103)
856 490 (103)
856 906 (103)
102 (109)
228 (118)
```

Visualizing the last 10 patterns generated with support >= 100.

In [8]:
```
!tail T_AP_Freq_S100.txt
```

```
766 (6261)
766 829 (321)
766 529 (317)
766 368 (503)
829 (6806)
829 529 (583)
829 368 (1193)
529 (7050)
529 368 (639)
368 (7823)
```

Question: What is the total number of frequent patterns generated using apriori with minsup = 100?

In [9]:
```
!wc -l T_AP_Freq_S100.txt
```

```
27523 T_AP_Freq_S100.txt
```

Answer: Number of frequent patterns in the file are 27523

Question: What is the number of frequent patterns generated for each itemset size?

In [34]:
```
!awk '{print NF-1}' T_AP_Freq_S100.txt|sort -n|uniq -c
```

```
    797 1
   8826 2
   7128 3
   5499 4
   3187 5
   1429 6
    503 7
    129 8
     23 9
      2 10
```

Question: Determine the time taken by apriori to generate frequent patterns. Do not write the patterns to a file to get the best estimate of time taken to discover frequent patterns.

In [35]:
```
import datetime
start = datetime.datetime.now()
!./apriori -ts -s-100 T10I4D100K_new.dat
end = datetime.datetime.now()
elapsed = end - start
print(elapsed.seconds,"secs ",elapsed.microseconds,"microsecs");
```

```
./apriori - find frequent item sets with the apriori algorithm
version 6.27 (2017.08.01)        (c) 1996-2017   Christian Borgelt
reading T10I4D100K_new.dat ... [870 item(s), 99936 transaction(s)] done [0.07
s].
filtering, sorting and recoding items ... [797 item(s)] done [0.00s].
sorting and reducing transactions ... [89066/99936 transaction(s)] done [0.01
s].
building transaction tree ... [112796 node(s)] done [0.01s].
checking subsets of size 1 2 3 4 5 6 7 8 9 10 done [0.33s].
writing <null> ... [27523 set(s)] done [0.00s].
(0, 'secs ', 673239, 'microsecs')
```

Answer: Time taken by apriori to generate frequent itemsets with minsup = 100 is 1.1800 secs.

Question: Generate the **maximal frequent itemsets** with minsup = 100. Use **-tm** for *maximal* itemsets and report the number of maximal itemsets.

In [36]:
```
!./apriori -tm -s-100 T10I4D100K_new.dat T_AP_Maximal_S100.txt
```

```
./apriori - find frequent item sets with the apriori algorithm
version 6.27 (2017.08.01)        (c) 1996-2017   Christian Borgelt
reading T10I4D100K_new.dat ... [870 item(s), 99936 transaction(s)] done [0.07
s].
filtering, sorting and recoding items ... [797 item(s)] done [0.00s].
sorting and reducing transactions ... [89066/99936 transaction(s)] done [0.02
s].
building transaction tree ... [112796 node(s)] done [0.00s].
checking subsets of size 1 2 3 4 5 6 7 8 9 10 done [0.34s].
filtering for maximal item sets ... done [0.04s].
writing T_AP_Maximal_S100.txt ... [4061 set(s)] done [0.00s].
```

Answer: There are 4061 maximal itemsets

Question: Generate the **closed itemsets** with minsup = 100. Use **-tc** for *closed* itemsets and report the number of closed itemsets.

In [37]:
```
!./apriori -tc -s-100 T10I4D100K_new.dat T_AP_Closed_S100.txt
```

```
./apriori - find frequent item sets with the apriori algorithm
version 6.27 (2017.08.01)        (c) 1996-2017   Christian Borgelt
reading T10I4D100K_new.dat ... [870 item(s), 99936 transaction(s)] done [0.07
s].
filtering, sorting and recoding items ... [797 item(s)] done [0.00s].
sorting and reducing transactions ... [89066/99936 transaction(s)] done [0.02
s].
building transaction tree ... [112796 node(s)] done [0.01s].
checking subsets of size 1 2 3 4 5 6 7 8 9 10 done [0.32s].
filtering for closed item sets ... done [0.17s].
writing T_AP_Closed_S100.txt ... [26797 set(s)] done [0.00s].
```

Answer: There are 26797 closed itemsets

3. Generating frequent, maximal and closed itemsets using ECLAT algorithm from the dataset T10I4D100K_new.dat

Download the linux executable for ECLAT from here: http://www.borgelt.net/eclat.html (http://www.borgelt.net/eclat.html)

In [38]:
```
!chmod u+x eclat
```

In [15]:
```
!./eclat
```

```
usage: ./eclat [options] infile [outfile]
find frequent item sets with the eclat algorithm
version 5.20 (2017.05.30)        (c) 2002-2017   Christian Borgelt
-t#      target type                              (default: s)
         (s: frequent, c: closed, m: maximal item sets,
          g: generators, r: association rules)
-m#      minimum number of items per set/rule     (default: 1)
-n#      maximum number of items per set/rule     (default: no limit)
-s#      minimum support of an item set/rule      (default: 10%)
-S#      maximum support of an item set/rule      (default: 100%)
         (positive: percentage, negative: absolute number)
-o       use original rule support definition     (body & head)
-c#      minimum confidence of an assoc. rule     (default: 80%)
-e#      additional evaluation measure            (default: none)
-a#      aggregation mode for evaluation measure  (default: none)
-d#      threshold for add. evaluation measure    (default: 10%)
-i       invalidate eval. below expected support  (default: evaluate all)
-p#      (min. size for) pruning with evaluation  (default: no pruning)
         (< 0: weak forward, > 0 strong forward, = 0: backward pruning)
-q#      sort items w.r.t. their frequency        (default: 2)
         (1: ascending, -1: descending, 0: do not sort,
          2: ascending, -2: descending w.r.t. transaction size sum)
-A#      variant of the eclat algorithm to use    (default: 'a')
-x       do not prune with perfect extensions     (default: prune)
-l#      number of items for k-items machine      (default: 16)
         (only for algorithm variants i,r,o,   options -Ai/-Ar/-Ao)
-j       do not sort items w.r.t. cond. support   (default: sort)
         (only for algorithm variants i,b,t,d, options -Ai/-Ab/-At/-Ad)
-y#      check extensions for closed/maximal sets (default: repository)
         (0: horizontal, > 0: vertical representation)
         (only with improved tid lists variant, option -Ai)
-u       do not use head union tail (hut) pruning (default: use hut)
         (only for maximal item sets, option -tm, not with option -Ab)
-F#:#..  support border for filtering item sets   (default: none)
         (list of minimum support values, one per item set size,
         starting at the minimum size, as given with option -m#)
-R#      read item selection/appearance indicators
-P#      write a pattern spectrum to a file
-Z       print item set statistics (number of item sets per size)
-N       do not pre-format some integer numbers   (default: do)
-g       write output in scanable form (quote certain characters)
-h#      record header  for output                (default: "")
-k#      item separator for output                (default: " ")
-I#      implication sign for association rules   (default: " <- ")
-v#      output format for item set information   (default: " (%S)")
-w       transaction weight in last field         (default: only items)
-r#      record/transaction separators            (default: "\n")
-f#      field /item        separators            (default: " \t,")
-b#      blank   characters                       (default: " \t\r")
-C#      comment characters                       (default: "#")
-T#      file to write transaction identifiers to (default: none)
-!       print additional option information
infile   file to read transactions from           [required]
outfile  file to write item sets/assoc.rules to   [optional]
```

Question: Generate **Frequent Itemsets** using eclat with minsup = 100 and and report the number of frequent itemsets.

In [16]:
```
!./eclat -ts -s-100 T10I4D100K_new.dat T_EC_Freq_S100.txt
```

```
./eclat - find frequent item sets with the eclat algorithm
version 5.20 (2017.05.30)        (c) 2002-2017   Christian Borgelt
reading T10I4D100K_new.dat ... [870 item(s), 99936 transaction(s)] done [0.07
s].
filtering, sorting and recoding items ... [797 item(s)] done [0.00s].
sorting and reducing transactions ... [89066/99936 transaction(s)] done [0.02
s].
writing T_EC_Freq_S100.txt ... [27523 set(s)] done [0.12s].
```

Answer: Number of frequent patterns in the file are 27523

Question: Generate the **Maximal Itemsets** using eclat with minsup = 100 and report the number of maximal itemsets.

In [17]:
```
!./eclat -tm -s-100 T10I4D100K_new.dat T_EC_Maximal_S100.txt
```

```
./eclat - find frequent item sets with the eclat algorithm
version 5.20 (2017.05.30)        (c) 2002-2017   Christian Borgelt
reading T10I4D100K_new.dat ... [870 item(s), 99936 transaction(s)] done [0.08
s].
filtering, sorting and recoding items ... [797 item(s)] done [0.00s].
sorting and reducing transactions ... [89066/99936 transaction(s)] done [0.03
s].
writing T_EC_Maximal_S100.txt ... [4061 set(s)] done [0.14s].
```

Answer: There are 4061 maximal itemsets

Question: Generate the **Closed Itemsets** with minsup = 100 and report the number of closed itemsets.

In [18]:
```
!./eclat -tc -s-100 T10I4D100K_new.dat T_EC_Closed_S100.txt
```

```
./eclat - find frequent item sets with the eclat algorithm
version 5.20 (2017.05.30)        (c) 2002-2017   Christian Borgelt
reading T10I4D100K_new.dat ... [870 item(s), 99936 transaction(s)] done [0.05
s].
filtering, sorting and recoding items ... [797 item(s)] done [0.01s].
sorting and reducing transactions ... [89066/99936 transaction(s)] done [0.03
s].
writing T_EC_Closed_S100.txt ... [26797 set(s)] done [0.10s].
```

Answer: There are 26797 closed itemsets

4. Generating frequent, maximal and closed itemsets using FPGrowth

algorithm from the dataset T10I4D100K_new.dat

Download the linux executable for FPGrowth from here: [http://www.borgelt.net/fpgrowth.html (http://www.borgelt.net/fpgrowth.html)](http://www.borgelt.net/fpgrowth.html)

In [19]:
```
!chmod u+x fpgrowth
```

In [20]:
```
!./fpgrowth
```

```
usage: ./fpgrowth [options] infile [outfile]
find frequent item sets with the fpgrowth algorithm
version 6.17 (2017.05.30)        (c) 2004-2017   Christian Borgelt
-t#      target type                              (default: s)
         (s: frequent, c: closed, m: maximal item sets,
          g: generators, r: association rules)
-m#      minimum number of items per set/rule     (default: 1)
-n#      maximum number of items per set/rule     (default: no limit)
-s#      minimum support of an item set/rule      (default: 10%)
-S#      maximum support of an item set/rule      (default: 100%)
         (positive: percentage, negative: absolute number)
-o       use original rule support definition     (body & head)
-c#      minimum confidence of an assoc. rule     (default: 80%)
-e#      additional evaluation measure            (default: none)
-a#      aggregation mode for evaluation measure  (default: none)
-d#      threshold for add. evaluation measure    (default: 10%)
-i       invalidate eval. below expected support  (default: evaluate all)
-p#      (min. size for) pruning with evaluation  (default: no pruning)
         (< 0: weak forward, > 0 strong forward, = 0: backward pruning)
```

Question: Generate **frequent Itemsets** using fpgrowth with minsup = 100 and report the number of frequent itemsets.

In [21]:
```
!./fpgrowth -ts -s-100 T10I4D100K_new.dat T_FP_Freq_S100.txt
```

```
./fpgrowth - find frequent item sets with the fpgrowth algorithm
version 6.17 (2017.05.30)        (c) 2004-2017   Christian Borgelt
reading T10I4D100K_new.dat ... [870 item(s), 99936 transaction(s)] done [0.07
s].
filtering, sorting and recoding items ... [797 item(s)] done [0.00s].
sorting and reducing transactions ... [89066/99936 transaction(s)] done [0.02
s].
writing T_FP_Freq_S100.txt ... [27523 set(s)] done [0.17s].
```

Answer: Number of frequent patterns in the file are 27523

Question: Generate the **maximal Itemsets** with minsup = 100 and report the number of maximal itemsets.

In [22]:
```
!./fpgrowth -tm -s-100 T10I4D100K_new.dat T_FP_Maximal_S100.txt
```

```
./fpgrowth - find frequent item sets with the fpgrowth algorithm
version 6.17 (2017.05.30)        (c) 2004-2017   Christian Borgelt
reading T10I4D100K_new.dat ... [870 item(s), 99936 transaction(s)] done [0.06
s].
filtering, sorting and recoding items ... [797 item(s)] done [0.00s].
sorting and reducing transactions ... [89066/99936 transaction(s)] done [0.02
s].
writing T_FP_Maximal_S100.txt ... [4061 set(s)] done [0.17s].
```

Answer: There are 4061 maximal itemsets

Question: Generate the **closed Itemsets** with minsup = 100 and report the number of closed itemsets.

In [23]:
```
!./fpgrowth -tc -s-100 T10I4D100K_new.dat T_FP_Closed_S100.txt
```

```
./fpgrowth - find frequent item sets with the fpgrowth algorithm
version 6.17 (2017.05.30)        (c) 2004-2017   Christian Borgelt
reading T10I4D100K_new.dat ... [870 item(s), 99936 transaction(s)] done [0.06
s].
filtering, sorting and recoding items ... [797 item(s)] done [0.00s].
sorting and reducing transactions ... [89066/99936 transaction(s)] done [0.02
s].
writing T_FP_Closed_S100.txt ... [26797 set(s)] done [0.17s].
```

Answer: There are 26797 closed itemsets

Question: Determine the number of Frequent Itemsets generated for different minsup 10,100,1000.

Answer:

Frequency Count	Itemsets Generated
10	?
100	27523
1000	?

Question: Compute the run time for the three algorithms: Apriori, ECLAT, FPGrowth. Consider minsup=10,100, and 1000.

Answer:

Algorithm	minsup=10	minsup=100	minsup=1000
Apriori	1.88	0.68	0.32
Eclat	0.68	0.46	0.33
FPGrowth	0.86	0.57	0.40

5. Sequence Mining: Finding subsequences that are frequent

PrefixSpan is another name for the projection based approach for discovering frequent subsequences. The implementation of prefixspan is available here: https://code.google.com/archive/p/prefixspan/ (https://code.google.com/archive/p/prefixspan/)

In [24]:
```
!chmod u+x prefixspan
```

In [26]:
```
!./prefixspan
```

```
PrefixSpan version 1.00 - Sequential Pattern Miner
Written by Yasuo Tabei


Usage: prefixspan [OPTION]... INFILE

       where [OPTION]...  is a list of zero or more optional arguments
             INFILE(s)    is the name of the input transaction database

Additional arguments (at most one input file may be specified):
       -min_sup [minimum support]
       -max_pat [maximum pattern]
```

Question: Using a sequence database: ABCAB, CBABA, ABABC, ACABC, BAACB, ACACC, find frequent sequences using a level-wise approach. Use minsup=3.

In [29]:
```
!cat activities_data.dat
```

```
1 2 3 1 2
3 2 1 2 1
1 2 1 2 3
1 3 1 2 3
2 1 1 3 2
1 3 1 3 3
```

In [30]:
```
!./prefixspan -min_sup 3 activities_data.dat
```

```
PrefixSpan version 1.00 - Sequential Pattern Miner
Written by Yasuo Tabei


( 0 1 2 3 4 5 ) : 6
1
( 0 1 2 3 4 5 ) : 6
1 1
( 0 1 2 3 4 5 ) : 6
1 1 2
( 0 2 3 4 ) : 4
1 1 3
( 2 3 4 5 ) : 4
1 2
( 0 1 2 3 4 ) : 5
1 2 1
( 0 1 2 ) : 3
1 2 3
( 0 2 3 ) : 3
1 3
( 0 2 3 4 5 ) : 5
1 3 1
( 0 3 5 ) : 3
1 3 2
( 0 3 4 ) : 3
2
( 0 1 2 3 4 ) : 5
2 1
( 0 1 2 4 ) : 4
2 1 2
( 0 1 2 4 ) : 4
2 2
( 0 1 2 4 ) : 4
2 3
( 0 2 3 4 ) : 4
3
( 0 1 2 3 4 5 ) : 6
3 1
( 0 1 3 5 ) : 4
3 1 2
( 0 1 3 ) : 3
3 2
( 0 1 3 4 ) : 4
```

Printing only the subsequences without the supporting transactions

In [29]:
```
!./prefixspan -min_sup 3 activities_data.dat| sed -n 'p;n'
```

```
PrefixSpan version 1.00 - Sequential Pattern Miner
Written by Yasuo Tabei


1
1 1
1 2
1 2 1
1 3
2
2 1
2 1 1
2 2
2 3
3
3 1
3 1 1
3 2
3 2 1
3 3
```

Writing the frequent subsequences to a file

In [30]:
```
!./prefixspan -min_sup 3 activities_data.dat| sed -n 'p;n'> subseq_activities_dat
```

```
PrefixSpan version 1.00 - Sequential Pattern Miner
Written by Yasuo Tabei
```

In [31]:
```
!tail subseq_activities_data_minsup_3
```

```
2 1
2 1 1
2 2
2 3
3
3 1
3 1 1
3 2
3 2 1
3 3
```

6. Sequence Mining: discovering frequent substrings

Substring mining code is available here: http://www.borgelt.net/seqwog.html (http://www.borgelt.net/seqwog.html)

In [32]:
```
!chmod u+x seqwog
```

In [33]:
```
!./seqwog
```

```
usage: ./seqwog [options] infile [outfile]
find frequent sequences without gaps
version 3.16 (2016.10.15)        (c) 2010-2016   Christian Borgelt
-t#      target type                              (default: s)
         (s: frequent, c: closed, m: maximal sequences, r: rules)
         (target type 'r' implies -a (all occurrences))
-m#      minimum number of items per sequence     (default: 1)
-n#      maximum number of items per sequence     (default: no limit)
-s#      minimum support of a sequence            (default: 10%)
         (positive: percentage, negative: absolute number)
-o       use original rule support definition     (body & head)
-c#      minimum confidence of a     rule         (default: 80%)
-a       count all occurrences of a pattern       (default: #sequences)
-F#:#..  support border for filtering item sets   (default: none)
         (list of minimum support values, one per item set size,
         starting at the minimum size, as given with option -m#)
-P#      write pattern spectrum to a file
-Z       print item set statistics (number of item sets per size)
-g       write output in scanable form (quote certain characters)
-h#      record header  for output                (default: "")
-k#      item separator for output                (default: " ")
-I#      implication sign for sequence rules      (default: " -> ")
-v#      output format for sequence information   (default: " (%S)")
-w       integer transaction weight in last field (default: only items)
-r#      record/transaction separators            (default: "\n")
-f#      field /item       separators             (default: " \t,")
-b#      blank   characters                       (default: " \t\r")
-C#      comment characters                       (default: "#")
-!       print additional option information
infile   file to read transactions from           [required]
outfile  file to write frequent sequences to      [optional]
```

Question: Using a sequence database: ABCAB, CBABA, ABABC, ACABC, BAACB, ACACC, find frequent substrings using minsup=3.

In [31]:
```
!./seqwog -ts -s-3 activities_data.dat substring_result
```

```
./seqwog - find frequent sequences without gaps
version 3.16 (2016.10.15)        (c) 2010-2016   Christian Borgelt
reading activities_data.dat ... [3 item(s), 6 transaction(s)] done [0.00s].
recoding items ... [3 item(s)] done [0.00s].
reducing and triming transactions ... [6 transaction(s)] done [0.00s].
writing substring_result ... [9 sequence(s)] done [0.00s].
```

```
In [32]: !cat substring_result
```

```
3 1 (3)
3 (6)
2 1 (3)
2 3 (3)
2 (5)
1 2 3 (3)
1 2 (4)
1 3 (3)
1 (6)
```

```
In [ ]:
```