CSE 601: DATA MINING AND BIOINFORMATICS

FALL 2018

PROJECT 1: PCA AND APRIORI ALGORITHM

PART 2: ASSOCIATION ANALYSIS

REPORT

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Apriori Algorithm:

Apriori algorithm is used to identify the frequent itemsets.

- It states that if an itemset is frequents all its subsets are frequent
- If a superset is infrequent itemset must also be infrequent.

Workflow:

Apriori algorithm and frequent itemset generation:

Step 1: We read the input data from the file associationruletestdata.txt and get the support threshold from the user.
Step 2: We convert the data set into desired format for processing (like adding G<n>_ prefix)
Step 3: A dictionary is used to maintain the count of the itemsets and a list of frequent itemsets is also maintained
Step 4: We start with k=1 and generate frequent itemsets of length k=1 example: [G59_Up] based on confidence
Step 5: Then for k = k+1 we generate the new itemsets by sorting and combining only the itemsets that differ by last item
Step 6: We can eliminate the ones that are not frequent based on the confidence threshold
Step 7: We continue this till we find no frequent itemsets

Rule Generation:

Step 1: We get the confidence threshold from the user.
Step 2: For every itemset in frequent itemset list we generate rules based on the confidence threshold provided by the user
Step 3: we print the total rules generated

Template Matching:

Step 1: We get the template number from the user
Step 2: Based on the template number we get the template parameters from the user.
Step 3: We generate the rules that satisfy the parameters and print the final rules and count.

Output:

Apriori algorithm and Frequent Itemset Output:

Enter the name of the file: associationruletestdata.txt
Enter the minimum support value: 70
Support is set to be 70%
number of length-1 frequent itemsets: 7
number of all lengths frequent itemsets: 7

Enter the name of the file: associationruletestdata.txt
Enter the minimum support value: 60
Support is set to be 60%
number of length-1 frequent itemsets: 34
number of length-2 frequent itemsets: 2
number of all lengths frequent itemsets: 36

Enter the name of the file: associationruletestdata.txt
Enter the minimum support value: 50
Support is set to be 50%
number of length-1 frequent itemsets: 109
number of length-2 frequent itemsets: 63
number of length-3 frequent itemsets: 2
number of all lengths frequent itemsets: 174

Enter the name of the file: associationruletestdata.txt
Enter the minimum support value: 40
Support is set to be 40%
number of length-1 frequent itemsets: 167
number of length-2 frequent itemsets: 753
number of length-3 frequent itemsets: 149
number of length-4 frequent itemsets: 7
number of length-5 frequent itemsets: 1
number of all lengths frequent itemsets: 1077

Enter the name of the file: associationruletestdata.txt
Enter the minimum support value: 30
Support is set to be 30%
number of length-1 frequent itemsets: 196
number of length-2 frequent itemsets: 5340
number of length-3 frequent itemsets: 5287
number of length-4 frequent itemsets: 1518
number of length-5 frequent itemsets: 438
number of length-6 frequent itemsets: 88
number of length-7 frequent itemsets: 11
number of length-8 frequent itemsets: 1
number of all lengths frequent itemsets: 12879

Rule Generation and Template Matching Output

- *(result11, cnt) = asso_rule.template1("RULE", "ANY", ['G59_UP'])*

Final set of rules:
{'G38_DOWN->G59_UP', 'G13_DOWN->G59_UP', 'G96_DOWN->G59_UP', 'G10_DOWN->G59_UP', 'G82_DOWN->G59_UP,G72_UP', 'G72_UP,G96_DOWN->G59_UP', 'G72_UP->G59_UP,G82_DOWN', 'G72_UP,G82_DOWN->G59_UP', 'G59_UP,G72_UP->G82_DOWN', 'G72_UP->G59_UP', 'G59_UP->G96_DOWN', 'G96_DOWN->G59_UP,G72_UP', 'G59_UP,G82_DOWN->G72_UP', 'G88_DOWN->G59_UP', 'G59_UP,G96_DOWN->G72_UP', 'G32_DOWN->G59_UP', 'G59_UP->G72_UP', 'G1_UP->G59_UP', 'G87_UP->G59_UP', 'G59_UP->G13_DOWN', 'G59_UP->G88_DOWN', 'G59_UP->G82_DOWN', 'G28_DOWN->G59_UP', 'G59_UP,G72_UP->G96_DOWN', 'G6_UP->G59_UP', 'G82_DOWN->G59_UP'}
Total number of final rules: 26

- *(result12, cnt) = asso_rule.template1("RULE", "NONE", ['G59_UP'])*

Final set of rules:
{'G8_UP->G88_DOWN', 'G32_DOWN->G28_DOWN', 'G28_DOWN->G52_DOWN', 'G6_UP->G32_DOWN', 'G54_UP->G24_DOWN', 'G82_DOWN->G96_DOWN', 'G38_DOWN->G32_DOWN', 'G91_UP->G38_DOWN', 'G82_DOWN->G72_UP', 'G28_DOWN->G87_UP', 'G88_DOWN->G24_DOWN', 'G67_UP->G1_UP', 'G1_UP->G54_UP', 'G38_DOWN->G10_DOWN', 'G24_DOWN->G54_UP', 'G32_DOWN->G72_UP', 'G97_DOWN->G72_UP', 'G1_UP->G38_DOWN', 'G10_DOWN->G38_DOWN', 'G28_DOWN->G38_DOWN', 'G82_DOWN->G97_DOWN', 'G72_UP->G13_DOWN', 'G65_DOWN->G38_DOWN', 'G1_UP->G70_DOWN', 'G88_DOWN->G54_UP', 'G70_DOWN->G10_DOWN', 'G28_DOWN->G10_DOWN', 'G88_DOWN->G38_DOWN', 'G1_UP->G67_UP', 'G6_UP->G38_DOWN', 'G41_DOWN->G88_DOWN', 'G1_UP->G72_UP', 'G10_DOWN->G47_UP', 'G24_DOWN->G88_DOWN', 'G13_DOWN->G82_DOWN', 'G28_DOWN->G32_DOWN', 'G96_DOWN->G72_UP', 'G38_DOWN->G91_UP', 'G32_DOWN->G38_DOWN', 'G10_DOWN->G70_DOWN', 'G47_UP->G10_DOWN', 'G87_UP->G88_DOWN', 'G41_DOWN->G38_DOWN', 'G13_DOWN->G28_DOWN', 'G88_DOWN->G28_DOWN', 'G70_DOWN->G38_DOWN', 'G32_DOWN->G6_UP', 'G94_UP->G10_DOWN', 'G6_UP->G13_DOWN', 'G72_UP->G82_DOWN', 'G38_DOWN->G47_UP', 'G28_DOWN->G47_UP', 'G38_DOWN->G52_DOWN', 'G67_UP->G38_DOWN', 'G28_DOWN->G2_DOWN', 'G13_DOWN->G72_UP', 'G88_DOWN->G41_DOWN', 'G28_DOWN->G41_DOWN', 'G41_DOWN->G28_DOWN', 'G38_DOWN->G1_UP', 'G52_DOWN->G28_DOWN', 'G87_UP->G28_DOWN', 'G10_DOWN->G28_DOWN', 'G2_DOWN->G28_DOWN', 'G2_DOWN->G38_DOWN', 'G96_DOWN->G82_DOWN', 'G54_UP->G1_UP', 'G88_DOWN->G87_UP', 'G82_DOWN->G13_DOWN', 'G38_DOWN->G70_DOWN', 'G88_DOWN->G8_UP', 'G6_UP->G28_DOWN', 'G13_DOWN->G6_UP', 'G10_DOWN->G1_UP', 'G52_DOWN->G38_DOWN', 'G47_UP->G38_DOWN', 'G1_UP->G10_DOWN', 'G94_UP->G38_DOWN', 'G10_DOWN->G94_UP', 'G10_DOWN->G88_DOWN', 'G72_UP->G1_UP', 'G38_DOWN->G28_DOWN', 'G97_DOWN->G82_DOWN', 'G70_DOWN->G1_UP', 'G54_UP->G88_DOWN', 'G28_DOWN->G13_DOWN', 'G88_DOWN->G10_DOWN', 'G28_DOWN->G88_DOWN', 'G47_UP->G28_DOWN', 'G28_DOWN->G6_UP', 'G72_UP->G96_DOWN'}
Total number of final rules: 91

- *(result13, cnt) = asso_rule.template1("RULE", 1, ['G59_UP', 'G10_Down'])*

Final set of rules:
{'G10_DOWN->G28_DOWN', 'G38_DOWN->G59_UP', 'G96_DOWN->G59_UP', 'G59_UP->G88_DOWN', 'G72_UP,G82_DOWN->G59_UP', 'G59_UP,G96_DOWN->G72_UP', 'G10_DOWN->G1_UP', 'G6_UP->G59_UP', 'G72_UP->G59_UP', 'G28_DOWN->G59_UP', 'G10_DOWN->G70_DOWN', 'G28_DOWN->G10_DOWN', 'G96_DOWN->G59_UP,G72_UP', 'G88_DOWN->G59_UP', 'G94_UP->G10_DOWN', 'G59_UP,G72_UP->G96_DOWN', 'G10_DOWN->G88_DOWN', 'G47_UP->G10_DOWN', 'G59_UP->G72_UP', 'G82_DOWN->G59_UP,G72_UP', 'G10_DOWN->G47_UP', 'G1_UP->G10_DOWN', 'G1_UP->G59_UP', 'G72_UP->G59_UP,G82_DOWN', 'G82_DOWN->G59_UP', 'G59_UP->G82_DOWN', 'G13_DOWN->G59_UP', 'G87_UP->G59_UP', 'G59_UP->G13_DOWN', 'G72_UP,G96_DOWN->G59_UP', 'G10_DOWN->G94_UP', 'G59_UP,G72_UP->G82_DOWN', 'G59_UP->G96_DOWN', 'G32_DOWN->G59_UP', 'G59_UP,G82_DOWN->G72_UP', 'G88_DOWN->G10_DOWN', 'G70_DOWN->G10_DOWN', 'G10_DOWN->G38_DOWN', 'G38_DOWN->G10_DOWN'}
Total number of final rules: 39

- *(result14, cnt) = asso_rule.template1("HEAD", "ANY", ['G59_UP'])*

Final set of rules:
{'G59_UP->G96_DOWN', 'G59_UP,G72_UP->G96_DOWN', 'G59_UP,G72_UP->G82_DOWN', 'G59_UP->G72_UP', 'G59_UP->G82_DOWN', 'G59_UP,G82_DOWN->G72_UP', 'G59_UP->G88_DOWN', 'G59_UP,G96_DOWN->G72_UP', 'G59_UP->G13_DOWN'}
Total number of final rules: 9

- *(result15, cnt) = asso_rule.template1("HEAD", "NONE", ['G59_UP'])*

Final set of rules:
{'G38_DOWN->G1_UP', 'G1_UP->G70_DOWN', 'G8_UP->G88_DOWN', 'G13_DOWN->G82_DOWN', 'G13_DOWN->G72_UP', 'G97_DOWN->G82_DOWN', 'G38_DOWN->G59_UP', 'G70_DOWN->G10_DOWN', 'G10_DOWN->G94_UP', 'G13_DOWN->G59_UP', 'G28_DOWN->G41_DOWN', 'G82_DOWN->G59_UP,G72_UP', 'G38_DOWN->G10_DOWN', 'G96_DOWN->G59_UP,G72_UP', 'G70_DOWN->G38_DOWN', 'G88_DOWN->G87_UP', 'G88_DOWN->G59_UP', 'G6_UP->G32_DOWN', 'G54_UP->G88_DOWN', 'G10_DOWN->G38_DOWN', 'G10_DOWN->G28_DOWN', 'G72_UP->G96_DOWN', 'G88_DOWN->G24_DOWN', 'G88_DOWN->G54_UP', 'G1_UP->G10_DOWN', 'G28_DOWN->G88_DOWN', 'G52_DOWN->G28_DOWN', 'G38_DOWN->G70_DOWN', 'G28_DOWN->G59_UP', 'G13_DOWN->G6_UP', 'G72_UP->G1_UP', 'G2_DOWN->G38_DOWN', 'G88_DOWN->G41_DOWN', 'G24_DOWN->G54_UP', 'G38_DOWN->G52_DOWN', 'G28_DOWN->G2_DOWN', 'G28_DOWN->G13_DOWN', 'G38_DOWN->G91_UP', 'G96_DOWN->G72_UP', 'G82_DOWN->G72_UP', 'G94_UP->G38_DOWN', 'G88_DOWN->G38_DOWN', 'G72_UP->G82_DOWN,G59_UP', 'G47_UP->G28_DOWN', 'G28_DOWN->G87_UP', 'G47_UP->G10_DOWN', 'G1_UP->G38_DOWN', 'G65_DOWN->G38_DOWN', 'G6_UP->G13_DOWN', 'G28_DOWN->G32_DOWN', 'G96_DOWN->G82_DOWN', 'G1_UP->G67_UP', 'G82_DOWN->G59_UP', 'G28_DOWN->G38_DOWN', 'G87_UP->G59_UP', 'G28_DOWN->G6_UP', 'G88_DOWN->G10_DOWN', 'G94_UP->G10_DOWN', 'G97_DOWN->G72_UP', 'G32_DOWN->G38_DOWN', 'G72_UP,G96_DOWN->G59_UP', 'G32_DOWN->G72_UP', 'G1_UP->G72_UP', 'G1_UP->G54_UP', 'G41_DOWN->G88_DOWN', 'G28_DOWN->G52_DOWN', 'G67_UP->G1_UP', 'G32_DOWN->G59_UP', 'G38_DOWN->G32_DOWN', 'G28_DOWN->G10_DOWN', 'G41_DOWN->G38_DOWN', 'G38_DOWN->G28_DOWN', 'G82_DOWN->G13_DOWN', 'G24_DOWN->G88_DOWN', 'G2_DOWN->G28_DOWN', 'G1_UP->G59_UP', 'G54_UP->G1_UP', 'G10_DOWN->G47_UP', 'G87_UP->G88_DOWN', 'G32_DOWN->G28_DOWN', 'G6_UP->G28_DOWN', 'G13_DOWN->G28_DOWN', 'G10_DOWN->G88_DOWN', 'G88_DOWN->G28_DOWN', 'G82_DOWN->G97_DOWN', 'G82_DOWN->G96_DOWN', 'G32_DOWN->G6_UP', 'G72_UP->G13_DOWN', 'G6_UP->G38_DOWN', 'G72_UP->G59_UP', 'G10_DOWN->G1_UP', 'G47_UP->G38_DOWN', 'G72_UP->G82_DOWN', 'G87_UP->G28_DOWN', 'G96_DOWN->G59_UP', 'G91_UP->G38_DOWN', 'G38_DOWN->G47_UP', 'G41_DOWN->G28_DOWN', 'G88_DOWN->G8_UP', 'G67_UP->G38_DOWN', 'G10_DOWN->G59_UP', 'G72_UP,G82_DOWN->G59_UP', 'G54_UP->G24_DOWN', 'G70_DOWN->G1_UP', 'G52_DOWN->G38_DOWN', 'G10_DOWN->G70_DOWN', 'G6_UP->G59_UP', 'G28_DOWN->G47_UP'}
Total number of final rules: 108

- *(result16, cnt) = asso_rule.template1("HEAD", 1, ['G59_UP', 'G10_Down'])*

Final set of rules:
{'G10_DOWN->G94_UP', 'G10_DOWN->G59_UP', 'G10_DOWN->G88_DOWN', 'G10_DOWN->G1_UP', 'G59_UP->G72_UP', 'G59_UP->G82_DOWN', 'G59_UP,G96_DOWN->G72_UP', 'G59_UP,G82_DOWN->G72_UP', 'G10_DOWN->G38_DOWN', 'G10_DOWN->G28_DOWN', 'G59_UP->G88_DOWN', 'G59_UP->G13_DOWN', 'G10_DOWN->G70_DOWN', 'G59_UP,G72_UP->G82_DOWN', 'G59_UP,G72_UP->G96_DOWN', 'G10_DOWN->G47_UP', 'G59_UP->G96_DOWN'}
Total number of final rules: 17

- *(result17, cnt) = asso_rule.template1("BODY", "ANY", ['G59_UP'])*

Final set of rules:
{'G96_DOWN->G59_UP', 'G28_DOWN->G59_UP', 'G96_DOWN->G59_UP,G72_UP', 'G38_DOWN->G59_UP', 'G6_UP->G59_UP', 'G72_UP->G59_UP', 'G87_UP->G59_UP', 'G13_DOWN->G59_UP', 'G72_UP,G96_DOWN->G59_UP', 'G82_DOWN->G59_UP', 'G10_DOWN->G59_UP', 'G1_UP->G59_UP', 'G32_DOWN->G59_UP', 'G82_DOWN->G59_UP,G72_UP', 'G72_UP,G82_DOWN->G59_UP', 'G88_DOWN->G59_UP', 'G72_UP->G59_UP,G82_DOWN'}
Total number of final rules: 17

- *(result18, cnt) = asso_rule.template1("BODY", "NONE", ['G59_UP'])*

Final set of rules:
{'G72_UP->G82_DOWN', 'G1_UP->G10_DOWN', 'G1_UP->G54_UP', 'G88_DOWN->G28_DOWN', 'G65_DOWN->G38_DOWN', 'G38_DOWN->G47_UP', 'G38_DOWN->G1_UP', 'G59_UP->G88_DOWN', 'G88_DOWN->G87_UP',

'G38_DOWN->G10_DOWN', 'G88_DOWN->G24_DOWN', 'G1_UP->G38_DOWN', 'G91_UP->G38_DOWN', 'G28_DOWN->G38_DOWN', 'G6_UP->G32_DOWN', 'G28_DOWN->G2_DOWN', 'G47_UP->G10_DOWN', 'G32_DOWN->G38_DOWN', 'G32_DOWN->G72_UP', 'G38_DOWN->G32_DOWN', 'G82_DOWN->G72_UP', 'G70_DOWN->G1_UP', 'G97_DOWN->G82_DOWN', 'G10_DOWN->G70_DOWN', 'G41_DOWN->G28_DOWN', 'G1_UP->G72_UP', 'G38_DOWN->G91_UP', 'G13_DOWN->G82_DOWN', 'G28_DOWN->G87_UP', 'G52_DOWN->G28_DOWN', 'G28_DOWN->G52_DOWN', 'G54_UP->G1_UP', 'G13_DOWN->G72_UP', 'G72_UP->G96_DOWN', 'G38_DOWN->G28_DOWN', 'G13_DOWN->G6_UP', 'G59_UP,G96_DOWN->G72_UP', 'G32_DOWN->G28_DOWN', 'G28_DOWN->G41_DOWN', 'G88_DOWN->G8_UP', 'G54_UP->G88_DOWN', 'G67_UP->G1_UP', 'G28_DOWN->G32_DOWN', 'G41_DOWN->G88_DOWN', 'G67_UP->G38_DOWN', 'G10_DOWN->G88_DOWN', 'G59_UP->G72_UP', 'G72_UP->G1_UP', 'G24_DOWN->G54_UP', 'G6_UP->G28_DOWN', 'G96_DOWN->G72_UP', 'G88_DOWN->G38_DOWN', 'G38_DOWN->G70_DOWN', 'G8_UP->G88_DOWN', 'G87_UP->G28_DOWN', 'G28_DOWN->G88_DOWN', 'G82_DOWN->G96_DOWN', 'G96_DOWN->G82_DOWN', 'G52_DOWN->G38_DOWN', 'G10_DOWN->G38_DOWN', 'G28_DOWN->G47_UP', 'G70_DOWN->G38_DOWN', 'G54_UP->G24_DOWN', 'G38_DOWN->G52_DOWN', 'G10_DOWN->G47_UP', 'G28_DOWN->G6_UP', 'G24_DOWN->G88_DOWN', 'G1_UP->G67_UP', 'G59_UP,G72_UP->G96_DOWN', 'G94_UP->G38_DOWN', 'G59_UP->G96_DOWN', 'G88_DOWN->G10_DOWN', 'G59_UP,G72_UP->G82_DOWN', 'G47_UP->G28_DOWN', 'G88_DOWN->G54_UP', 'G6_UP->G38_DOWN', 'G82_DOWN->G13_DOWN', 'G2_DOWN->G38_DOWN', 'G88_DOWN->G41_DOWN', 'G59_UP,G82_DOWN->G72_UP', 'G97_DOWN->G72_UP', 'G10_DOWN->G1_UP', 'G10_DOWN->G28_DOWN', 'G47_UP->G38_DOWN', 'G32_DOWN->G6_UP', 'G41_DOWN->G38_DOWN', 'G87_UP->G88_DOWN', 'G82_DOWN->G97_DOWN', 'G70_DOWN->G10_DOWN', 'G2_DOWN->G28_DOWN', 'G13_DOWN->G28_DOWN', 'G6_UP->G13_DOWN', 'G10_DOWN->G94_UP', 'G28_DOWN->G10_DOWN', 'G59_UP->G82_DOWN', 'G72_UP->G13_DOWN', 'G28_DOWN->G13_DOWN', 'G94_UP->G10_DOWN', 'G59_UP->G13_DOWN', 'G1_UP->G70_DOWN'}
Total number of final rules: 100

- *(result19, cnt) = asso_rule.template1("BODY", 1, ['G59_UP', 'G10_Down'])*

Final set of rules:
{'G13_DOWN->G59_UP', 'G82_DOWN->G72_UP,G59_UP', 'G38_DOWN->G10_DOWN', 'G72_UP->G59_UP,G82_DOWN', 'G87_UP->G59_UP', 'G72_UP,G96_DOWN->G59_UP', 'G82_DOWN->G59_UP', 'G47_UP->G10_DOWN', 'G6_UP->G59_UP', 'G10_DOWN->G59_UP', 'G70_DOWN->G10_DOWN', 'G72_UP->G59_UP', 'G1_UP->G59_UP', 'G28_DOWN->G59_UP', 'G96_DOWN->G72_UP,G59_UP', 'G1_UP->G10_DOWN', 'G72_UP,G82_DOWN->G59_UP', 'G88_DOWN->G59_UP', 'G38_DOWN->G59_UP', 'G88_DOWN->G10_DOWN', 'G32_DOWN->G59_UP', 'G96_DOWN->G59_UP', 'G94_UP->G10_DOWN', 'G28_DOWN->G10_DOWN'}
Total number of final rules: 24

- *(result21, cnt) = asso_rule.template2("RULE", 3)*

{'G72_UP,G82_DOWN->G59_UP', 'G59_UP,G82_DOWN->G72_UP', 'G59_UP,G72_UP->G96_DOWN', 'G96_DOWN->G72_UP,G59_UP', 'G59_UP,G96_DOWN->G72_UP', 'G72_UP->G59_UP,G82_DOWN', 'G59_UP,G72_UP->G82_DOWN', 'G72_UP,G96_DOWN->G59_UP', 'G82_DOWN->G72_UP,G59_UP'}
Total number of final rules: 9

- *(result22, cnt) = asso_rule.template2("HEAD", 2)*

Final set of rules:
{'G59_UP,G82_DOWN->G72_UP', 'G59_UP,G72_UP->G82_DOWN', 'G72_UP,G96_DOWN->G59_UP', 'G72_UP,G82_DOWN->G59_UP', 'G59_UP,G72_UP->G96_DOWN', 'G59_UP,G96_DOWN->G72_UP'}
Total number of final rules: 6

- *(result23, cnt) = asso_rule.template2("BODY", 1)*

Final set of rules:
{'G94_UP->G38_DOWN', 'G59_UP,G72_UP->G96_DOWN', 'G2_DOWN->G38_DOWN', 'G87_UP->G28_DOWN', 'G1_UP->G59_UP', 'G28_DOWN->G6_UP', 'G97_DOWN->G82_DOWN', 'G28_DOWN->G47_UP', 'G70_DOWN->G38_DOWN', 'G82_DOWN->G59_UP', 'G28_DOWN->G13_DOWN', 'G2_DOWN->G28_DOWN', 'G38_DOWN->G52_DOWN', 'G67_UP-

>G38_DOWN', 'G41_DOWN->G88_DOWN', 'G52_DOWN->G38_DOWN', 'G88_DOWN->G28_DOWN', 'G1_UP->G54_UP', 'G59_UP,G82_DOWN->G72_UP', 'G41_DOWN->G38_DOWN', 'G72_UP->G13_DOWN', 'G1_UP->G67_UP', 'G70_DOWN->G1_UP', 'G88_DOWN->G59_UP', 'G6_UP->G32_DOWN', 'G38_DOWN->G91_UP', 'G47_UP->G10_DOWN', 'G13_DOWN->G82_DOWN', 'G88_DOWN->G87_UP', 'G10_DOWN->G59_UP', 'G1_UP->G38_DOWN', 'G28_DOWN->G59_UP', 'G6_UP->G13_DOWN', 'G88_DOWN->G8_UP', 'G28_DOWN->G32_DOWN', 'G59_UP->G88_DOWN', 'G88_DOWN->G24_DOWN', 'G28_DOWN->G52_DOWN', 'G1_UP->G70_DOWN', 'G28_DOWN->G10_DOWN', 'G38_DOWN->G32_DOWN', 'G6_UP->G59_UP', 'G28_DOWN->G87_UP', 'G10_DOWN->G1_UP', 'G10_DOWN->G70_DOWN', 'G96_DOWN->G82_DOWN', 'G1_UP->G72_UP', 'G28_DOWN->G2_DOWN', 'G72_UP->G96_DOWN', 'G72_UP->G82_DOWN', 'G88_DOWN->G38_DOWN', 'G38_DOWN->G28_DOWN', 'G28_DOWN->G38_DOWN', 'G28_DOWN->G41_DOWN', 'G88_DOWN->G54_UP', 'G54_UP->G88_DOWN', 'G72_UP,G82_DOWN->G59_UP', 'G38_DOWN->G1_UP', 'G96_DOWN->G59_UP', 'G70_DOWN->G10_DOWN', 'G96_DOWN->G72_UP,G59_UP', 'G10_DOWN->G38_DOWN', 'G82_DOWN->G72_UP', 'G32_DOWN->G28_DOWN', 'G87_UP->G59_UP', 'G82_DOWN->G72_UP,G59_UP', 'G10_DOWN->G28_DOWN', 'G6_UP->G28_DOWN', 'G72_UP->G59_UP', 'G1_UP->G10_DOWN', 'G82_DOWN->G13_DOWN', 'G28_DOWN->G88_DOWN', 'G88_DOWN->G41_DOWN', 'G54_UP->G24_DOWN', 'G88_DOWN->G10_DOWN', 'G47_UP->G38_DOWN', 'G38_DOWN->G59_UP', 'G38_DOWN->G70_DOWN', 'G13_DOWN->G28_DOWN', 'G10_DOWN->G47_UP', 'G59_UP->G82_DOWN', 'G32_DOWN->G59_UP', 'G96_DOWN->G72_UP', 'G10_DOWN->G94_UP', 'G52_DOWN->G28_DOWN', 'G24_DOWN->G88_DOWN', 'G32_DOWN->G38_DOWN', 'G38_DOWN->G10_DOWN', 'G72_UP->G82_DOWN,G59_UP', 'G82_DOWN->G97_DOWN', 'G41_DOWN->G28_DOWN', 'G8_UP->G88_DOWN', 'G59_UP,G96_DOWN->G72_UP', 'G72_UP,G96_DOWN->G59_UP', 'G47_UP->G28_DOWN', 'G59_UP,G72_UP->G82_DOWN', 'G91_UP->G38_DOWN', 'G59_UP->G96_DOWN', 'G32_DOWN->G6_UP', 'G32_DOWN->G72_UP', 'G67_UP->G1_UP', 'G13_DOWN->G6_UP', 'G87_UP->G88_DOWN', 'G97_DOWN->G72_UP', 'G6_UP->G38_DOWN', 'G59_UP->G72_UP', 'G38_DOWN->G47_UP', 'G65_DOWN->G38_DOWN', 'G13_DOWN->G72_UP', 'G82_DOWN->G96_DOWN', 'G94_UP->G10_DOWN', 'G72_UP->G1_UP', 'G24_DOWN->G54_UP', 'G54_UP->G1_UP', 'G13_DOWN->G59_UP', 'G59_UP->G13_DOWN', 'G10_DOWN->G88_DOWN'}
Total number of final rules: 117

- *(result31, cnt) = asso_rule.template3("1or1", "HEAD", "ANY", ['G10_Down'],"BODY", 1, ['G59_UP'])*

Final set of rules:
{'G72_UP,G96_DOWN->G59_UP', 'G10_DOWN->G47_UP', 'G82_DOWN->G59_UP,G72_UP', 'G87_UP->G59_UP', 'G1_UP->G59_UP', 'G28_DOWN->G59_UP', 'G10_DOWN->G88_DOWN', 'G10_DOWN->G1_UP', 'G13_DOWN->G59_UP', 'G82_DOWN->G59_UP', 'G72_UP->G82_DOWN,G59_UP', 'G10_DOWN->G70_DOWN', 'G72_UP->G59_UP', 'G10_DOWN->G94_UP', 'G96_DOWN->G59_UP', 'G88_DOWN->G59_UP', 'G10_DOWN->G28_DOWN', 'G72_UP,G82_DOWN->G59_UP', 'G10_DOWN->G59_UP', 'G96_DOWN->G59_UP,G72_UP', 'G6_UP->G59_UP', 'G38_DOWN->G59_UP', 'G10_DOWN->G38_DOWN', 'G32_DOWN->G59_UP'}
Total number of final rules: 24

- *result32, cnt) = asso_rule.template3("1and1", "HEAD", "ANY",['G10_Down'], "BODY", 1, ['G59_UP'])*

Final set of rules:
{'G10_DOWN->G59_UP'}
Total number of final rules: 1

- *(result33, cnt) = asso_rule.template3("1or2", "HEAD", "ANY", ['G10_Down'],"BODY", 2)*

Final set of rules:
{'G10_DOWN->G38_DOWN', 'G10_DOWN->G70_DOWN', 'G82_DOWN->G59_UP,G72_UP', 'G10_DOWN->G28_DOWN', 'G96_DOWN->G59_UP,G72_UP', 'G10_DOWN->G47_UP', 'G10_DOWN->G88_DOWN', 'G10_DOWN->G59_UP', 'G10_DOWN->G1_UP', 'G72_UP->G59_UP,G82_DOWN', 'G10_DOWN->G94_UP'}
Total number of final rules: 11

- *(result34, cnt) = asso_rule.template3("1and2", "HEAD", "ANY",['G10_Down'], "BODY", 2)*

Final set of rules:
set()
Total number of final rules: 0

- *(result35, cnt) = asso_rule.template3("2or2", "HEAD", 1, "BODY", 2)*

Final set of rules:
{'G72_UP,G82_DOWN->G59_UP', 'G41_DOWN->G38_DOWN', 'G32_DOWN->G6_UP', 'G82_DOWN->G72_UP', 'G10_DOWN->G70_DOWN', 'G59_UP,G82_DOWN->G72_UP', 'G94_UP->G10_DOWN', 'G24_DOWN->G88_DOWN', 'G2_DOWN->G38_DOWN', 'G59_UP->G82_DOWN', 'G28_DOWN->G88_DOWN', 'G72_UP->G13_DOWN', 'G28_DOWN->G13_DOWN', 'G6_UP->G32_DOWN', 'G10_DOWN->G47_UP', 'G88_DOWN->G10_DOWN', 'G13_DOWN->G59_UP', 'G38_DOWN->G1_UP', 'G96_DOWN->G82_DOWN', 'G28_DOWN->G2_DOWN', 'G72_UP->G82_DOWN', 'G6_UP->G59_UP', 'G24_DOWN->G54_UP', 'G38_DOWN->G52_DOWN', 'G38_DOWN->G32_DOWN', 'G13_DOWN->G28_DOWN', 'G91_UP->G38_DOWN', 'G38_DOWN->G59_UP', 'G32_DOWN->G72_UP', 'G47_UP->G10_DOWN', 'G59_UP,G96_DOWN->G72_UP', 'G28_DOWN->G87_UP', 'G10_DOWN->G1_UP', 'G1_UP->G70_DOWN', 'G28_DOWN->G41_DOWN', 'G88_DOWN->G28_DOWN', 'G82_DOWN->G59_UP', 'G70_DOWN->G1_UP', 'G28_DOWN->G59_UP', 'G28_DOWN->G32_DOWN', 'G2_DOWN->G28_DOWN', 'G38_DOWN->G47_UP', 'G38_DOWN->G91_UP', 'G72_UP->G59_UP,G82_DOWN', 'G28_DOWN->G10_DOWN', 'G52_DOWN->G28_DOWN', 'G82_DOWN->G96_DOWN', 'G72_UP->G59_UP', 'G10_DOWN->G94_UP', 'G96_DOWN->G59_UP', 'G6_UP->G38_DOWN', 'G82_DOWN->G59_UP,G72_UP', 'G72_UP,G96_DOWN->G59_UP', 'G70_DOWN->G38_DOWN', 'G59_UP->G88_DOWN', 'G59_UP,G72_UP->G96_DOWN', 'G72_UP->G1_UP', 'G1_UP->G54_UP', 'G10_DOWN->G28_DOWN', 'G70_DOWN->G10_DOWN', 'G6_UP->G28_DOWN', 'G65_DOWN->G38_DOWN', 'G88_DOWN->G87_UP', 'G72_UP->G96_DOWN', 'G54_UP->G88_DOWN', 'G59_UP->G72_UP', 'G1_UP->G67_UP', 'G47_UP->G28_DOWN', 'G10_DOWN->G38_DOWN', 'G88_DOWN->G54_UP', 'G54_UP->G24_DOWN', 'G32_DOWN->G59_UP', 'G96_DOWN->G72_UP', 'G82_DOWN->G97_DOWN', 'G88_DOWN->G24_DOWN', 'G87_UP->G59_UP', 'G13_DOWN->G6_UP', 'G67_UP->G1_UP', 'G1_UP->G38_DOWN', 'G88_DOWN->G8_UP', 'G28_DOWN->G52_DOWN', 'G97_DOWN->G72_UP', 'G52_DOWN->G38_DOWN', 'G38_DOWN->G70_DOWN', 'G28_DOWN->G47_UP', 'G38_DOWN->G10_DOWN', 'G8_UP->G88_DOWN', 'G59_UP,G72_UP->G82_DOWN', 'G28_DOWN->G38_DOWN', 'G54_UP->G1_UP', 'G13_DOWN->G72_UP', 'G10_DOWN->G88_DOWN', 'G6_UP->G13_DOWN', 'G88_DOWN->G41_DOWN', 'G10_DOWN->G59_UP', 'G32_DOWN->G28_DOWN', 'G1_UP->G72_UP', 'G32_DOWN->G38_DOWN', 'G94_UP->G38_DOWN', 'G47_UP->G38_DOWN', 'G87_UP->G88_DOWN', 'G38_DOWN->G28_DOWN', 'G59_UP->G96_DOWN', 'G28_DOWN->G6_UP', 'G88_DOWN->G59_UP', 'G13_DOWN->G82_DOWN', 'G88_DOWN->G38_DOWN', 'G59_UP->G13_DOWN', 'G67_UP->G38_DOWN', 'G1_UP->G10_DOWN', 'G41_DOWN->G28_DOWN', 'G87_UP->G28_DOWN', 'G1_UP->G59_UP', 'G82_DOWN->G13_DOWN', 'G96_DOWN->G59_UP,G72_UP', 'G41_DOWN->G88_DOWN', 'G97_DOWN->G82_DOWN'}
Total number of final rules: 117

- *(result36, cnt) = asso_rule.template3("2and2", "HEAD", 1, "BODY", 2)*

Final set of rules:
{'G72_UP->G82_DOWN,G59_UP', 'G82_DOWN->G72_UP,G59_UP', 'G96_DOWN->G72_UP,G59_UP'}
Total number of final rules: 3