

# HOMEWORK 2: Mining Association Rules from Gene Expression Data

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## 1. Implementation of Apriori Algorithm

Apriori is an algorithm for frequent item set mining and association rule learning over transactional databases. It proceeds by identifying the frequent individual items in the database and extending them to larger and larger item sets as long as those item sets appear sufficiently often in the database. The frequent item sets determined by Apriori can be used to determine association rules which highlight general trends in the database: this has applications in domains such as market basket analysis.

We have implemented Apriori Algorithm to find all the frequent itemsets for support of 30%, 40%, 50%, 60% and 70% respectively.

### Configure:

We created a table in Oracle DB which has the input data for this task. To categorize the samples by Up and Down, we appended UP and Down after each gene sample. So there were in total 200 Samples.

### Pseudo Code for our implementation of Apriori Algorithm:

#### Pass 1

1. Generate the candidate itemsets in C1
2. Save the frequent itemsets in L1

#### Pass k

1. Generate the candidate itemsets in C<sub>k</sub> from the frequent itemsets in L<sub>k-1</sub>
  1. Join L<sub>k-1</sub> p with L<sub>k-1</sub>q, as follows:  
insert into C<sub>k</sub>  
select p.item1, p.item2, . . . , p.item<sub>k-1</sub>, q.item<sub>k-1</sub>  
from L<sub>k-1</sub> p, L<sub>k-1</sub>q  
where p.item1 = q.item1, . . . p.item<sub>k-2</sub> = q.item<sub>k-2</sub>, p.item<sub>k-1</sub> < q.item<sub>k-1</sub>
  2. Generate all (k-1)-subsets from the candidate itemsets in C<sub>k</sub>
  3. Prune all candidate itemsets from C<sub>k</sub> where some (k-1)-subset of the candidate itemset is not in the frequent itemset L<sub>k-1</sub>
2. Scan the transaction database to determine the support for each candidate itemset in C<sub>k</sub>
3. Save the frequent itemsets in L<sub>k</sub>

### **Mining Rules:**

After obtaining the frequent item sets, we needed to generate association rules by finding the permutations of those item sets. For finding these permutations we have used binary logic. For e.g. we have 3 items A, B and C. So in all there'll be 6 permutations – 001,010,011,100,101,110. If item at '0' be positioned at LHS and item at '1' be positioned at RHS then we have AB->C, AC->B, A->BC, BC->A, B->AC, C->AB.

```
for(each frequentItemSet : setOfFrequentItemSets)
    //generate permutation of this frequentItemSet
    for(var i : (Power (2, sizeof(itemSet))))
        //generate binary representation of i
        Place the items at '0' in LHS
        Place the items at '1' in RHS
        Calculate the confidence of this generated rule
```

## **2. Templates**

We have used the following templates and their combination to obtain association rules:

1. {RULE|BODY|HEAD} HAS ({ANY|NUMBER|NONE}) OF (ITEM1, ITEM2,..., ITEMn)
2. SizeOf({BODY|HEAD|RULE}) >= NUMBER
3. HEAD HAS (1) OF (Disease) AND BODY HAS (NONE) OF (Disease)

The templates are parsed using the Java code and input queries are compared against the data fetched from table.

### **Pseudo Code:**

If query contains "AND" or "OR"

    //template 3 is found

        Parse the strings

        Split query across AND or OR

Else If query contains "HAS" and "OF"

    //template 1 is found

        Parse the strings

Else If query startsWith "SizeOf"

    //template 2 is found

        Parse the strings

return the parsed data to separate queryParsers

compare the query with individual templates and generate the data accordingly

## Results

Number of rules at 30% support = 12879

Number of rules at 40% support = 1077

Number of rules at 50% support = 174

Number of rules at 60% support = 36

Number of rules at 70% support = 7

## TEMPLATE Queries and outputs:

QUERY	No. of Rules
HEAD HAS ANY OF G1-UP	6
BODY HAS ANY OF G1-UP	7
RULE HAS ANY OF G1-UP	13
HEAD HAS NONE OF G1-UP,G38-Down,G87-UP,G88-Down,G52-Down,G72-UP	73
BODY HAS NONE OF G1-UP,G38-Down,G87-UP,G88-Down,G52-Down,G72-UP	77
RULE HAS NONE OF G1-UP,G38-Down,G87-UP,G88-Down,G52-Down,G72-UP	42
HEAD HAS 2 OF G96-Down,G72-UP,G59-UP	2
BODY HAS 2 OF G72-UP,G59-UP,G96-Down	4
RULE HAS 2 OF G96-Down,G72-UP,G59-UP	11
SIZEOF (HEAD) = 2	3
SIZEOF (BODY) = 2	6
SIZEOF (RULE) = 3	9
SIZEOF (RULE) >=2	117
SIZEOF (RULE) <=2	108
RULE HAS ANY OF G1-UP OR SIZEOF(RULE) >=3	22
RULE HAS ANY OF G1-UP AND SIZEOF (RULE) >= 2	13
HEAD HAS ANY OF G1-UP AND BODY HAS ANY OF G54-UP	1
HEAD HAS ANY OF G1-UP OR BODY HAS ANY OF G54-UP	8
HEAD HAS ANY OF G1-UP OR BODY HAS ANY OF G54-UP AND SIZEOF(RULE) >= 2	8

## TEMPLATE 1:

### RULE HAS ANY OF G1-UP

Numbers of rules retrieved : 13

[G1-UP] ==> [G67-UP] ; Support: 50 ; Confidence : 72.46

[G67-UP] ==> [G1-UP] ; Support: 50 ; Confidence : 80.65

[G72-UP] ==> [G1-UP] ; Support: 52 ; Confidence : 70.27

[G1-UP] ==> [G72-UP] ; Support: 52 ; Confidence : 75.36

[G1-UP] ==> [G70-Down] ; Support: 50 ; Confidence : 72.46

[G70-Down] ==> [G1-UP] ; Support: 50 ; Confidence : 75.76

[G1-UP] ==> [G10-Down] ; Support: 50 ; Confidence : 72.46

[G10-Down] ==> [G1-UP] ; Support: 50 ; Confidence : 71.43  
[G54-UP] ==> [G1-UP] ; Support: 50 ; Confidence : 74.63  
[G1-UP] ==> [G54-UP] ; Support: 50 ; Confidence : 72.46  
[G1-UP] ==> [G59-UP] ; Support: 53 ; Confidence : 76.81  
[G1-UP] ==> [G38-Down] ; Support: 54 ; Confidence : 78.26  
[G38-Down] ==> [G1-UP] ; Support: 54 ; Confidence : 73.97

#### **HEAD HAS ANY OF G1-UP**

Numbers of rules retrieved : 6

[G67-UP] ==> [G1-UP] ; Support: 50 ; Confidence : 80.65  
[G72-UP] ==> [G1-UP] ; Support: 52 ; Confidence : 70.27  
[G70-Down] ==> [G1-UP] ; Support: 50 ; Confidence : 75.76  
[G10-Down] ==> [G1-UP] ; Support: 50 ; Confidence : 71.43  
[G54-UP] ==> [G1-UP] ; Support: 50 ; Confidence : 74.63  
[G38-Down] ==> [G1-UP] ; Support: 54 ; Confidence : 73.97

#### **BODY HAS ANY OF G1-UP**

Numbers of rules retrieved : 7

[G1-UP] ==> [G67-UP] ; Support: 50 ; Confidence : 72.46  
[G1-UP] ==> [G72-UP] ; Support: 52 ; Confidence : 75.36  
[G1-UP] ==> [G70-Down] ; Support: 50 ; Confidence : 72.46  
[G1-UP] ==> [G10-Down] ; Support: 50 ; Confidence : 72.46  
[G1-UP] ==> [G54-UP] ; Support: 50 ; Confidence : 72.46  
[G1-UP] ==> [G59-UP] ; Support: 53 ; Confidence : 76.81  
[G1-UP] ==> [G38-Down] ; Support: 54 ; Confidence : 78.26

#### **RULE HAS NONE OF G1-UP,G38-Down,G87-UP,G88-Down,G52-Down,G72-UP**

Numbers of rules retrieved : 42

[G47-UP] ==> [G10-Down] ; Support: 51 ; Confidence : 77.27  
[G10-Down] ==> [G47-UP] ; Support: 51 ; Confidence : 72.86  
[G82-Down] ==> [G59-UP] ; Support: 57 ; Confidence : 83.82  
[G59-UP] ==> [G82-Down] ; Support: 57 ; Confidence : 75  
[G59-UP] ==> [G96-Down] ; Support: 61 ; Confidence : 80.26  
[G96-Down] ==> [G59-UP] ; Support: 61 ; Confidence : 85.92  
[G82-Down] ==> [G96-Down] ; Support: 52 ; Confidence : 76.47  
[G96-Down] ==> [G82-Down] ; Support: 52 ; Confidence : 73.24  
[G47-UP] ==> [G28-Down] ; Support: 51 ; Confidence : 77.27  
[G28-Down] ==> [G47-UP] ; Support: 51 ; Confidence : 71.83  
[G82-Down] ==> [G13-Down] ; Support: 51 ; Confidence : 75  
[G13-Down] ==> [G82-Down] ; Support: 51 ; Confidence : 75  
[G6-UP] ==> [G28-Down] ; Support: 50 ; Confidence : 75.76

[G28-Down] ==> [G6-UP] ; Support: 50 ; Confidence : 70.42  
 [G28-Down] ==> [G10-Down] ; Support: 51 ; Confidence : 71.83  
 [G10-Down] ==> [G28-Down] ; Support: 51 ; Confidence : 72.86  
 [G28-Down] ==> [G59-UP] ; Support: 51 ; Confidence : 71.83  
 [G54-UP] ==> [G24-Down] ; Support: 50 ; Confidence : 74.63  
 [G24-Down] ==> [G54-UP] ; Support: 50 ; Confidence : 79.37  
 [G13-Down] ==> [G59-UP] ; Support: 54 ; Confidence : 79.41  
 [G59-UP] ==> [G13-Down] ; Support: 54 ; Confidence : 71.05  
 [G6-UP] ==> [G59-UP] ; Support: 51 ; Confidence : 77.27  
 [G32-Down] ==> [G28-Down] ; Support: 50 ; Confidence : 73.53  
 [G28-Down] ==> [G32-Down] ; Support: 50 ; Confidence : 70.42  
 [G10-Down] ==> [G59-UP] ; Support: 50 ; Confidence : 71.43  
 [G28-Down] ==> [G41-Down] ; Support: 51 ; Confidence : 71.83  
 [G41-Down] ==> [G28-Down] ; Support: 51 ; Confidence : 79.69  
 [G13-Down] ==> [G28-Down] ; Support: 50 ; Confidence : 73.53  
 [G28-Down] ==> [G13-Down] ; Support: 50 ; Confidence : 70.42  
 [G32-Down] ==> [G59-UP] ; Support: 52 ; Confidence : 76.47  
 [G70-Down] ==> [G10-Down] ; Support: 50 ; Confidence : 75.76  
 [G10-Down] ==> [G70-Down] ; Support: 50 ; Confidence : 71.43  
 [G82-Down] ==> [G97-Down] ; Support: 51 ; Confidence : 75  
 [G97-Down] ==> [G82-Down] ; Support: 51 ; Confidence : 83.61  
 [G2-Down] ==> [G28-Down] ; Support: 50 ; Confidence : 75.76  
 [G28-Down] ==> [G2-Down] ; Support: 50 ; Confidence : 70.42  
 [G32-Down] ==> [G6-UP] ; Support: 50 ; Confidence : 73.53  
 [G6-UP] ==> [G32-Down] ; Support: 50 ; Confidence : 75.76  
 [G13-Down] ==> [G6-UP] ; Support: 50 ; Confidence : 73.53  
 [G6-UP] ==> [G13-Down] ; Support: 50 ; Confidence : 75.76  
 [G10-Down] ==> [G94-UP] ; Support: 50 ; Confidence : 71.43  
 [G94-UP] ==> [G10-Down] ; Support: 50 ; Confidence : 80.65

# **HEAD HAS NONE OF G1-UP,G38-Down,G87-UP,G88-Down,G52-Down,G72-UP**

Numbers of rules retrieved : 73

[G87-UP] ==> [G59-UP] ; Support: 51 ; Confidence : 76.12  
 [G47-UP] ==> [G10-Down] ; Support: 51 ; Confidence : 77.27  
 [G10-Down] ==> [G47-UP] ; Support: 51 ; Confidence : 72.86  
 [G52-Down] ==> [G28-Down] ; Support: 52 ; Confidence : 80  
 [G72-UP] ==> [G13-Down] ; Support: 53 ; Confidence : 71.62  
 [G38-Down] ==> [G91-UP] ; Support: 53 ; Confidence : 72.6  
 [G88-Down] ==> [G41-Down] ; Support: 52 ; Confidence : 73.24  
 [G38-Down] ==> [G32-Down] ; Support: 53 ; Confidence : 72.6  
 [G82-Down] ==> [G59-UP] ; Support: 57 ; Confidence : 83.82

[G59-UP] ==> [G82-Down] ; Support: 57 ; Confidence : 75  
[G59-UP] ==> [G96-Down] ; Support: 61 ; Confidence : 80.26  
[G96-Down] ==> [G59-UP] ; Support: 61 ; Confidence : 85.92  
[G1-UP] ==> [G67-UP] ; Support: 50 ; Confidence : 72.46  
[G82-Down] ==> [G96-Down] ; Support: 52 ; Confidence : 76.47  
[G96-Down] ==> [G82-Down] ; Support: 52 ; Confidence : 73.24  
[G88-Down] ==> [G24-Down] ; Support: 50 ; Confidence : 70.42  
[G1-UP] ==> [G70-Down] ; Support: 50 ; Confidence : 72.46  
[G47-UP] ==> [G28-Down] ; Support: 51 ; Confidence : 77.27  
[G28-Down] ==> [G47-UP] ; Support: 51 ; Confidence : 71.83  
[G82-Down] ==> [G13-Down] ; Support: 51 ; Confidence : 75  
[G13-Down] ==> [G82-Down] ; Support: 51 ; Confidence : 75  
[G88-Down] ==> [G10-Down] ; Support: 52 ; Confidence : 73.24  
[G1-UP] ==> [G10-Down] ; Support: 50 ; Confidence : 72.46  
[G88-Down] ==> [G59-UP] ; Support: 55 ; Confidence : 77.46  
[G6-UP] ==> [G28-Down] ; Support: 50 ; Confidence : 75.76  
[G28-Down] ==> [G6-UP] ; Support: 50 ; Confidence : 70.42  
[G28-Down] ==> [G10-Down] ; Support: 51 ; Confidence : 71.83  
[G10-Down] ==> [G28-Down] ; Support: 51 ; Confidence : 72.86  
[G28-Down] ==> [G59-UP] ; Support: 51 ; Confidence : 71.83  
[G38-Down] ==> [G59-UP] ; Support: 53 ; Confidence : 72.6  
[G72-UP] ==> [G82-Down] ; Support: 58 ; Confidence : 78.38  
[G54-UP] ==> [G24-Down] ; Support: 50 ; Confidence : 74.63  
[G24-Down] ==> [G54-UP] ; Support: 50 ; Confidence : 79.37  
[G13-Down] ==> [G59-UP] ; Support: 54 ; Confidence : 79.41  
[G59-UP] ==> [G13-Down] ; Support: 54 ; Confidence : 71.05  
[G6-UP] ==> [G59-UP] ; Support: 51 ; Confidence : 77.27  
[G32-Down] ==> [G28-Down] ; Support: 50 ; Confidence : 73.53  
[G28-Down] ==> [G32-Down] ; Support: 50 ; Confidence : 70.42  
[G1-UP] ==> [G54-UP] ; Support: 50 ; Confidence : 72.46  
[G88-Down] ==> [G8-UP] ; Support: 51 ; Confidence : 71.83  
[G38-Down] ==> [G47-UP] ; Support: 54 ; Confidence : 73.97  
[G38-Down] ==> [G28-Down] ; Support: 55 ; Confidence : 75.34  
[G72-UP] ==> [G59-UP] ; Support: 62 ; Confidence : 83.78  
[G10-Down] ==> [G59-UP] ; Support: 50 ; Confidence : 71.43  
[G28-Down] ==> [G41-Down] ; Support: 51 ; Confidence : 71.83  
[G41-Down] ==> [G28-Down] ; Support: 51 ; Confidence : 79.69  
[G72-UP] ==> [G96-Down] ; Support: 59 ; Confidence : 79.73  
[G13-Down] ==> [G28-Down] ; Support: 50 ; Confidence : 73.53  
[G28-Down] ==> [G13-Down] ; Support: 50 ; Confidence : 70.42  
[G1-UP] ==> [G59-UP] ; Support: 53 ; Confidence : 76.81

[G32-Down] ==> [G59-UP] ; Support: 52 ; Confidence : 76.47  
 [G88-Down] ==> [G28-Down] ; Support: 52 ; Confidence : 73.24  
 [G70-Down] ==> [G10-Down] ; Support: 50 ; Confidence : 75.76  
 [G10-Down] ==> [G70-Down] ; Support: 50 ; Confidence : 71.43  
 [G38-Down] ==> [G70-Down] ; Support: 54 ; Confidence : 73.97  
 [G88-Down] ==> [G54-UP] ; Support: 52 ; Confidence : 73.24  
 [G82-Down] ==> [G97-Down] ; Support: 51 ; Confidence : 75  
 [G97-Down] ==> [G82-Down] ; Support: 51 ; Confidence : 83.61  
 [G87-UP] ==> [G28-Down] ; Support: 52 ; Confidence : 77.61  
 [G2-Down] ==> [G28-Down] ; Support: 50 ; Confidence : 75.76  
 [G28-Down] ==> [G2-Down] ; Support: 50 ; Confidence : 70.42  
 [G38-Down] ==> [G10-Down] ; Support: 53 ; Confidence : 72.6  
 [G32-Down] ==> [G6-UP] ; Support: 50 ; Confidence : 73.53  
 [G6-UP] ==> [G32-Down] ; Support: 50 ; Confidence : 75.76  
 [G13-Down] ==> [G6-UP] ; Support: 50 ; Confidence : 73.53  
 [G6-UP] ==> [G13-Down] ; Support: 50 ; Confidence : 75.76  
 [G10-Down] ==> [G94-UP] ; Support: 50 ; Confidence : 71.43  
 [G94-UP] ==> [G10-Down] ; Support: 50 ; Confidence : 80.65  
 [G72-UP G59-UP] ==> [G96-Down] ; Support: 51 ; Confidence : 82.26  
 [G72-UP G96-Down] ==> [G59-UP] ; Support: 51 ; Confidence : 86.44  
 [G72-UP] ==> [G82-Down G59-UP] ; Support: 52 ; Confidence : 70.27  
 [G72-UP G82-Down] ==> [G59-UP] ; Support: 52 ; Confidence : 89.66  
 [G72-UP G59-UP] ==> [G82-Down] ; Support: 52 ; Confidence : 83.87

# **BODY HAS NONE OF G1-UP,G38-Down,G87-UP,G88-Down,G52-Down,G72-UP**

Numbers of rules retrieved : 77

[G67-UP] ==> [G38-Down] ; Support: 51 ; Confidence : 82.26  
 [G47-UP] ==> [G10-Down] ; Support: 51 ; Confidence : 77.27  
 [G10-Down] ==> [G47-UP] ; Support: 51 ; Confidence : 72.86  
 [G28-Down] ==> [G52-Down] ; Support: 52 ; Confidence : 73.24  
 [G32-Down] ==> [G72-UP] ; Support: 50 ; Confidence : 73.53  
 [G13-Down] ==> [G72-UP] ; Support: 53 ; Confidence : 77.94  
 [G91-UP] ==> [G38-Down] ; Support: 53 ; Confidence : 81.54  
 [G97-Down] ==> [G72-UP] ; Support: 51 ; Confidence : 83.61  
 [G94-UP] ==> [G38-Down] ; Support: 51 ; Confidence : 82.26  
 [G41-Down] ==> [G88-Down] ; Support: 52 ; Confidence : 81.25  
 [G32-Down] ==> [G38-Down] ; Support: 53 ; Confidence : 77.94  
 [G82-Down] ==> [G59-UP] ; Support: 57 ; Confidence : 83.82  
 [G59-UP] ==> [G82-Down] ; Support: 57 ; Confidence : 75  
 [G59-UP] ==> [G96-Down] ; Support: 61 ; Confidence : 80.26  
 [G96-Down] ==> [G59-UP] ; Support: 61 ; Confidence : 85.92

[G67-UP] ==> [G1-UP] ; Support: 50 ; Confidence : 80.65  
[G82-Down] ==> [G96-Down] ; Support: 52 ; Confidence : 76.47  
[G96-Down] ==> [G82-Down] ; Support: 52 ; Confidence : 73.24  
[G24-Down] ==> [G88-Down] ; Support: 50 ; Confidence : 79.37  
[G70-Down] ==> [G1-UP] ; Support: 50 ; Confidence : 75.76  
[G47-UP] ==> [G28-Down] ; Support: 51 ; Confidence : 77.27  
[G28-Down] ==> [G47-UP] ; Support: 51 ; Confidence : 71.83  
[G82-Down] ==> [G13-Down] ; Support: 51 ; Confidence : 75  
[G13-Down] ==> [G82-Down] ; Support: 51 ; Confidence : 75  
[G10-Down] ==> [G88-Down] ; Support: 52 ; Confidence : 74.29  
[G10-Down] ==> [G1-UP] ; Support: 50 ; Confidence : 71.43  
[G59-UP] ==> [G88-Down] ; Support: 55 ; Confidence : 72.37  
[G6-UP] ==> [G28-Down] ; Support: 50 ; Confidence : 75.76  
[G28-Down] ==> [G6-UP] ; Support: 50 ; Confidence : 70.42  
[G28-Down] ==> [G10-Down] ; Support: 51 ; Confidence : 71.83  
[G10-Down] ==> [G28-Down] ; Support: 51 ; Confidence : 72.86  
[G28-Down] ==> [G59-UP] ; Support: 51 ; Confidence : 71.83  
[G2-Down] ==> [G38-Down] ; Support: 50 ; Confidence : 75.76  
[G82-Down] ==> [G72-UP] ; Support: 58 ; Confidence : 85.29  
[G54-UP] ==> [G24-Down] ; Support: 50 ; Confidence : 74.63  
[G24-Down] ==> [G54-UP] ; Support: 50 ; Confidence : 79.37  
[G13-Down] ==> [G59-UP] ; Support: 54 ; Confidence : 79.41  
[G59-UP] ==> [G13-Down] ; Support: 54 ; Confidence : 71.05  
[G6-UP] ==> [G59-UP] ; Support: 51 ; Confidence : 77.27  
[G32-Down] ==> [G28-Down] ; Support: 50 ; Confidence : 73.53  
[G28-Down] ==> [G32-Down] ; Support: 50 ; Confidence : 70.42  
[G54-UP] ==> [G1-UP] ; Support: 50 ; Confidence : 74.63  
[G8-UP] ==> [G88-Down] ; Support: 51 ; Confidence : 77.27  
[G47-UP] ==> [G38-Down] ; Support: 54 ; Confidence : 81.82  
[G28-Down] ==> [G38-Down] ; Support: 55 ; Confidence : 77.46  
[G59-UP] ==> [G72-UP] ; Support: 62 ; Confidence : 81.58  
[G10-Down] ==> [G59-UP] ; Support: 50 ; Confidence : 71.43  
[G28-Down] ==> [G41-Down] ; Support: 51 ; Confidence : 71.83  
[G41-Down] ==> [G28-Down] ; Support: 51 ; Confidence : 79.69  
[G65-Down] ==> [G38-Down] ; Support: 50 ; Confidence : 81.97  
[G96-Down] ==> [G72-UP] ; Support: 59 ; Confidence : 83.1  
[G13-Down] ==> [G28-Down] ; Support: 50 ; Confidence : 73.53  
[G28-Down] ==> [G13-Down] ; Support: 50 ; Confidence : 70.42  
[G6-UP] ==> [G38-Down] ; Support: 50 ; Confidence : 75.76  
[G32-Down] ==> [G59-UP] ; Support: 52 ; Confidence : 76.47  
[G28-Down] ==> [G88-Down] ; Support: 52 ; Confidence : 73.24



[G41-Down] ==> [G38-Down] ; Support: 50 ; Confidence : 78.12  
 [G70-Down] ==> [G10-Down] ; Support: 50 ; Confidence : 75.76  
 [G10-Down] ==> [G70-Down] ; Support: 50 ; Confidence : 71.43  
 [G70-Down] ==> [G38-Down] ; Support: 54 ; Confidence : 81.82  
 [G54-UP] ==> [G88-Down] ; Support: 52 ; Confidence : 77.61  
 [G82-Down] ==> [G97-Down] ; Support: 51 ; Confidence : 75  
 [G97-Down] ==> [G82-Down] ; Support: 51 ; Confidence : 83.61  
 [G28-Down] ==> [G87-UP] ; Support: 52 ; Confidence : 73.24  
 [G2-Down] ==> [G28-Down] ; Support: 50 ; Confidence : 75.76  
 [G28-Down] ==> [G2-Down] ; Support: 50 ; Confidence : 70.42  
 [G10-Down] ==> [G38-Down] ; Support: 53 ; Confidence : 75.71  
 [G32-Down] ==> [G6-UP] ; Support: 50 ; Confidence : 73.53  
 [G6-UP] ==> [G32-Down] ; Support: 50 ; Confidence : 75.76  
 [G13-Down] ==> [G6-UP] ; Support: 50 ; Confidence : 73.53  
 [G6-UP] ==> [G13-Down] ; Support: 50 ; Confidence : 75.76  
 [G10-Down] ==> [G94-UP] ; Support: 50 ; Confidence : 71.43  
 [G94-UP] ==> [G10-Down] ; Support: 50 ; Confidence : 80.65  
 [G96-Down] ==> [G72-UP G59-UP] ; Support: 51 ; Confidence : 71.83  
 [G59-UP G96-Down] ==> [G72-UP] ; Support: 51 ; Confidence : 83.61  
 [G82-Down] ==> [G72-UP G59-UP] ; Support: 52 ; Confidence : 76.47  
 [G82-Down G59-UP] ==> [G72-UP] ; Support: 52 ; Confidence : 91.23

#### **RULE HAS 2 OF G96-Down,G72-UP,G59-UP**

Numbers of rules retrieved : 11

[G96-Down] ==> [G59-UP] ; Support: 61 ; Confidence : 85.92  
 [G72-UP] ==> [G59-UP] ; Support: 62 ; Confidence : 83.78  
 [G96-Down] ==> [G72-UP] ; Support: 59 ; Confidence : 83.1  
 [G72-UP G59-UP] ==> [G96-Down] ; Support: 51 ; Confidence : 82.26  
 [G96-Down] ==> [G72-UP G59-UP] ; Support: 51 ; Confidence : 71.83  
 [G72-UP G96-Down] ==> [G59-UP] ; Support: 51 ; Confidence : 86.44  
 [G59-UP G96-Down] ==> [G72-UP] ; Support: 51 ; Confidence : 83.61  
 [G72-UP] ==> [G82-Down G59-UP] ; Support: 52 ; Confidence : 70.27  
 [G82-Down] ==> [G72-UP G59-UP] ; Support: 52 ; Confidence : 76.47  
 [G72-UP G82-Down] ==> [G59-UP] ; Support: 52 ; Confidence : 89.66  
 [G72-UP G59-UP] ==> [G82-Down] ; Support: 52 ; Confidence : 83.87

#### **HEAD HAS 2 OF G96-Down,G72-UP,G59-UP**

Numbers of rules retrieved : 2

[G96-Down] ==> [G72-UP G59-UP] ; Support: 51 ; Confidence : 71.83  
 [G82-Down] ==> [G72-UP G59-UP] ; Support: 52 ; Confidence : 76.47

### **BODY HAS 2 OF G72-UP,G59-UP,G96-Down**

Numbers of rules retrieved : 4

[G72-UP G59-UP] ==> [G96-Down] ; Support: 51 ; Confidence : 82.26  
[G72-UP G96-Down] ==> [G59-UP] ; Support: 51 ; Confidence : 86.44  
[G59-UP G96-Down] ==> [G72-UP] ; Support: 51 ; Confidence : 83.61  
[G72-UP G59-UP] ==> [G82-Down] ; Support: 52 ; Confidence : 83.87

### **TEMPLATE 2:**

#### **SIZEOF (RULE) = 3**

Numbers of rules retrieved : 9

[G72-UP G59-UP] ==> [G96-Down] ; Support: 51 ; Confidence : 82.26  
[G96-Down] ==> [G72-UP G59-UP] ; Support: 51 ; Confidence : 71.83  
[G72-UP G96-Down] ==> [G59-UP] ; Support: 51 ; Confidence : 86.44  
[G59-UP G96-Down] ==> [G72-UP] ; Support: 51 ; Confidence : 83.61  
[G72-UP] ==> [G82-Down G59-UP] ; Support: 52 ; Confidence : 70.27  
[G82-Down] ==> [G72-UP G59-UP] ; Support: 52 ; Confidence : 76.47  
[G72-UP G82-Down] ==> [G59-UP] ; Support: 52 ; Confidence : 89.66  
[G72-UP G59-UP] ==> [G82-Down] ; Support: 52 ; Confidence : 83.87  
[G82-Down G59-UP] ==> [G72-UP] ; Support: 52 ; Confidence : 91.23

#### **SIZEOF (BODY) = 2**

Numbers of rules retrieved : 6

[G72-UP G59-UP] ==> [G96-Down] ; Support: 51 ; Confidence : 82.26  
[G72-UP G96-Down] ==> [G59-UP] ; Support: 51 ; Confidence : 86.44  
[G59-UP G96-Down] ==> [G72-UP] ; Support: 51 ; Confidence : 83.61  
[G72-UP G82-Down] ==> [G59-UP] ; Support: 52 ; Confidence : 89.66  
[G72-UP G59-UP] ==> [G82-Down] ; Support: 52 ; Confidence : 83.87  
[G82-Down G59-UP] ==> [G72-UP] ; Support: 52 ; Confidence : 91.23

#### **SIZEOF (HEAD) = 2**

Numbers of rules retrieved : 3

[G96-Down] ==> [G72-UP G59-UP] ; Support: 51 ; Confidence : 71.83  
[G72-UP] ==> [G82-Down G59-UP] ; Support: 52 ; Confidence : 70.27  
[G82-Down] ==> [G72-UP G59-UP] ; Support: 52 ; Confidence : 76.47

#### **SIZEOF (RULE) <=2**

Numbers of rules retrieved : 108

[G67-UP] ==> [G38-Down] ; Support: 51 ; Confidence : 82.26

[G87-UP] ==> [G59-UP] ; Support: 51 ; Confidence : 76.12  
[G47-UP] ==> [G10-Down] ; Support: 51 ; Confidence : 77.27  
[G10-Down] ==> [G47-UP] ; Support: 51 ; Confidence : 72.86  
[G52-Down] ==> [G28-Down] ; Support: 52 ; Confidence : 80  
[G28-Down] ==> [G52-Down] ; Support: 52 ; Confidence : 73.24  
[G32-Down] ==> [G72-UP] ; Support: 50 ; Confidence : 73.53  
[G72-UP] ==> [G13-Down] ; Support: 53 ; Confidence : 71.62  
[G13-Down] ==> [G72-UP] ; Support: 53 ; Confidence : 77.94  
[G38-Down] ==> [G91-UP] ; Support: 53 ; Confidence : 72.6  
[G91-UP] ==> [G38-Down] ; Support: 53 ; Confidence : 81.54  
[G97-Down] ==> [G72-UP] ; Support: 51 ; Confidence : 83.61  
[G94-UP] ==> [G38-Down] ; Support: 51 ; Confidence : 82.26  
[G41-Down] ==> [G88-Down] ; Support: 52 ; Confidence : 81.25  
[G88-Down] ==> [G41-Down] ; Support: 52 ; Confidence : 73.24  
[G32-Down] ==> [G38-Down] ; Support: 53 ; Confidence : 77.94  
[G38-Down] ==> [G32-Down] ; Support: 53 ; Confidence : 72.6  
[G82-Down] ==> [G59-UP] ; Support: 57 ; Confidence : 83.82  
[G59-UP] ==> [G82-Down] ; Support: 57 ; Confidence : 75  
[G59-UP] ==> [G96-Down] ; Support: 61 ; Confidence : 80.26  
[G96-Down] ==> [G59-UP] ; Support: 61 ; Confidence : 85.92  
[G1-UP] ==> [G67-UP] ; Support: 50 ; Confidence : 72.46  
[G67-UP] ==> [G1-UP] ; Support: 50 ; Confidence : 80.65  
[G52-Down] ==> [G38-Down] ; Support: 55 ; Confidence : 84.62  
[G38-Down] ==> [G52-Down] ; Support: 55 ; Confidence : 75.34  
[G82-Down] ==> [G96-Down] ; Support: 52 ; Confidence : 76.47  
[G96-Down] ==> [G82-Down] ; Support: 52 ; Confidence : 73.24  
[G72-UP] ==> [G1-UP] ; Support: 52 ; Confidence : 70.27  
[G1-UP] ==> [G72-UP] ; Support: 52 ; Confidence : 75.36  
[G24-Down] ==> [G88-Down] ; Support: 50 ; Confidence : 79.37  
[G88-Down] ==> [G24-Down] ; Support: 50 ; Confidence : 70.42  
[G1-UP] ==> [G70-Down] ; Support: 50 ; Confidence : 72.46  
[G70-Down] ==> [G1-UP] ; Support: 50 ; Confidence : 75.76  
[G47-UP] ==> [G28-Down] ; Support: 51 ; Confidence : 77.27  
[G28-Down] ==> [G47-UP] ; Support: 51 ; Confidence : 71.83  
[G87-UP] ==> [G88-Down] ; Support: 54 ; Confidence : 80.6  
[G88-Down] ==> [G87-UP] ; Support: 54 ; Confidence : 76.06  
[G82-Down] ==> [G13-Down] ; Support: 51 ; Confidence : 75  
[G13-Down] ==> [G82-Down] ; Support: 51 ; Confidence : 75  
[G10-Down] ==> [G88-Down] ; Support: 52 ; Confidence : 74.29  
[G88-Down] ==> [G10-Down] ; Support: 52 ; Confidence : 73.24  
[G1-UP] ==> [G10-Down] ; Support: 50 ; Confidence : 72.46

[G10-Down] ==> [G1-UP] ; Support: 50 ; Confidence : 71.43  
[G59-UP] ==> [G88-Down] ; Support: 55 ; Confidence : 72.37  
[G88-Down] ==> [G59-UP] ; Support: 55 ; Confidence : 77.46  
[G6-UP] ==> [G28-Down] ; Support: 50 ; Confidence : 75.76  
[G28-Down] ==> [G6-UP] ; Support: 50 ; Confidence : 70.42  
[G28-Down] ==> [G10-Down] ; Support: 51 ; Confidence : 71.83  
[G10-Down] ==> [G28-Down] ; Support: 51 ; Confidence : 72.86  
[G28-Down] ==> [G59-UP] ; Support: 51 ; Confidence : 71.83  
[G2-Down] ==> [G38-Down] ; Support: 50 ; Confidence : 75.76  
[G38-Down] ==> [G59-UP] ; Support: 53 ; Confidence : 72.6  
[G72-UP] ==> [G82-Down] ; Support: 58 ; Confidence : 78.38  
[G82-Down] ==> [G72-UP] ; Support: 58 ; Confidence : 85.29  
[G54-UP] ==> [G24-Down] ; Support: 50 ; Confidence : 74.63  
[G24-Down] ==> [G54-UP] ; Support: 50 ; Confidence : 79.37  
[G13-Down] ==> [G59-UP] ; Support: 54 ; Confidence : 79.41  
[G59-UP] ==> [G13-Down] ; Support: 54 ; Confidence : 71.05  
[G6-UP] ==> [G59-UP] ; Support: 51 ; Confidence : 77.27  
[G32-Down] ==> [G28-Down] ; Support: 50 ; Confidence : 73.53  
[G28-Down] ==> [G32-Down] ; Support: 50 ; Confidence : 70.42  
[G88-Down] ==> [G38-Down] ; Support: 50 ; Confidence : 70.42  
[G54-UP] ==> [G1-UP] ; Support: 50 ; Confidence : 74.63  
[G1-UP] ==> [G54-UP] ; Support: 50 ; Confidence : 72.46  
[G8-UP] ==> [G88-Down] ; Support: 51 ; Confidence : 77.27  
[G88-Down] ==> [G8-UP] ; Support: 51 ; Confidence : 71.83  
[G47-UP] ==> [G38-Down] ; Support: 54 ; Confidence : 81.82  
[G38-Down] ==> [G47-UP] ; Support: 54 ; Confidence : 73.97  
[G28-Down] ==> [G38-Down] ; Support: 55 ; Confidence : 77.46  
[G38-Down] ==> [G28-Down] ; Support: 55 ; Confidence : 75.34  
[G72-UP] ==> [G59-UP] ; Support: 62 ; Confidence : 83.78  
[G59-UP] ==> [G72-UP] ; Support: 62 ; Confidence : 81.58  
[G10-Down] ==> [G59-UP] ; Support: 50 ; Confidence : 71.43  
[G28-Down] ==> [G41-Down] ; Support: 51 ; Confidence : 71.83  
[G41-Down] ==> [G28-Down] ; Support: 51 ; Confidence : 79.69  
[G65-Down] ==> [G38-Down] ; Support: 50 ; Confidence : 81.97  
[G72-UP] ==> [G96-Down] ; Support: 59 ; Confidence : 79.73  
[G96-Down] ==> [G72-UP] ; Support: 59 ; Confidence : 83.1  
[G13-Down] ==> [G28-Down] ; Support: 50 ; Confidence : 73.53  
[G28-Down] ==> [G13-Down] ; Support: 50 ; Confidence : 70.42  
[G6-UP] ==> [G38-Down] ; Support: 50 ; Confidence : 75.76  
[G1-UP] ==> [G59-UP] ; Support: 53 ; Confidence : 76.81  
[G32-Down] ==> [G59-UP] ; Support: 52 ; Confidence : 76.47

[G28-Down] ==> [G88-Down] ; Support: 52 ; Confidence : 73.24  
[G88-Down] ==> [G28-Down] ; Support: 52 ; Confidence : 73.24  
[G41-Down] ==> [G38-Down] ; Support: 50 ; Confidence : 78.12  
[G70-Down] ==> [G10-Down] ; Support: 50 ; Confidence : 75.76  
[G10-Down] ==> [G70-Down] ; Support: 50 ; Confidence : 71.43  
[G70-Down] ==> [G38-Down] ; Support: 54 ; Confidence : 81.82  
[G38-Down] ==> [G70-Down] ; Support: 54 ; Confidence : 73.97  
[G54-UP] ==> [G88-Down] ; Support: 52 ; Confidence : 77.61  
[G88-Down] ==> [G54-UP] ; Support: 52 ; Confidence : 73.24  
[G82-Down] ==> [G97-Down] ; Support: 51 ; Confidence : 75  
[G97-Down] ==> [G82-Down] ; Support: 51 ; Confidence : 83.61  
[G87-UP] ==> [G28-Down] ; Support: 52 ; Confidence : 77.61  
[G28-Down] ==> [G87-UP] ; Support: 52 ; Confidence : 73.24  
[G2-Down] ==> [G28-Down] ; Support: 50 ; Confidence : 75.76  
[G28-Down] ==> [G2-Down] ; Support: 50 ; Confidence : 70.42  
[G38-Down] ==> [G10-Down] ; Support: 53 ; Confidence : 72.6  
[G10-Down] ==> [G38-Down] ; Support: 53 ; Confidence : 75.71  
[G1-UP] ==> [G38-Down] ; Support: 54 ; Confidence : 78.26  
[G38-Down] ==> [G1-UP] ; Support: 54 ; Confidence : 73.97  
[G32-Down] ==> [G6-UP] ; Support: 50 ; Confidence : 73.53  
[G6-UP] ==> [G32-Down] ; Support: 50 ; Confidence : 75.76  
[G13-Down] ==> [G6-UP] ; Support: 50 ; Confidence : 73.53  
[G6-UP] ==> [G13-Down] ; Support: 50 ; Confidence : 75.76  
[G10-Down] ==> [G94-UP] ; Support: 50 ; Confidence : 71.43  
[G94-UP] ==> [G10-Down] ; Support: 50 ; Confidence : 80.65

#### **SIZEOF (RULE) >=2**

Numbers of rules retrieved : 117

[G67-UP] ==> [G38-Down] ; Support: 51 ; Confidence : 82.26  
[G87-UP] ==> [G59-UP] ; Support: 51 ; Confidence : 76.12  
[G47-UP] ==> [G10-Down] ; Support: 51 ; Confidence : 77.27  
[G10-Down] ==> [G47-UP] ; Support: 51 ; Confidence : 72.86  
[G52-Down] ==> [G28-Down] ; Support: 52 ; Confidence : 80  
[G28-Down] ==> [G52-Down] ; Support: 52 ; Confidence : 73.24  
[G32-Down] ==> [G72-UP] ; Support: 50 ; Confidence : 73.53  
[G72-UP] ==> [G13-Down] ; Support: 53 ; Confidence : 71.62  
[G13-Down] ==> [G72-UP] ; Support: 53 ; Confidence : 77.94  
[G38-Down] ==> [G91-UP] ; Support: 53 ; Confidence : 72.6  
[G91-UP] ==> [G38-Down] ; Support: 53 ; Confidence : 81.54  
[G97-Down] ==> [G72-UP] ; Support: 51 ; Confidence : 83.61  
[G94-UP] ==> [G38-Down] ; Support: 51 ; Confidence : 82.26

[G41-Down] ==> [G88-Down] ; Support: 52 ; Confidence : 81.25  
[G88-Down] ==> [G41-Down] ; Support: 52 ; Confidence : 73.24  
[G32-Down] ==> [G38-Down] ; Support: 53 ; Confidence : 77.94  
[G38-Down] ==> [G32-Down] ; Support: 53 ; Confidence : 72.6  
[G82-Down] ==> [G59-UP] ; Support: 57 ; Confidence : 83.82  
[G59-UP] ==> [G82-Down] ; Support: 57 ; Confidence : 75  
[G59-UP] ==> [G96-Down] ; Support: 61 ; Confidence : 80.26  
[G96-Down] ==> [G59-UP] ; Support: 61 ; Confidence : 85.92  
[G1-UP] ==> [G67-UP] ; Support: 50 ; Confidence : 72.46  
[G67-UP] ==> [G1-UP] ; Support: 50 ; Confidence : 80.65  
[G52-Down] ==> [G38-Down] ; Support: 55 ; Confidence : 84.62  
[G38-Down] ==> [G52-Down] ; Support: 55 ; Confidence : 75.34  
[G82-Down] ==> [G96-Down] ; Support: 52 ; Confidence : 76.47  
[G96-Down] ==> [G82-Down] ; Support: 52 ; Confidence : 73.24  
[G72-UP] ==> [G1-UP] ; Support: 52 ; Confidence : 70.27  
[G1-UP] ==> [G72-UP] ; Support: 52 ; Confidence : 75.36  
[G24-Down] ==> [G88-Down] ; Support: 50 ; Confidence : 79.37  
[G88-Down] ==> [G24-Down] ; Support: 50 ; Confidence : 70.42  
[G1-UP] ==> [G70-Down] ; Support: 50 ; Confidence : 72.46  
[G70-Down] ==> [G1-UP] ; Support: 50 ; Confidence : 75.76  
[G47-UP] ==> [G28-Down] ; Support: 51 ; Confidence : 77.27  
[G28-Down] ==> [G47-UP] ; Support: 51 ; Confidence : 71.83  
[G87-UP] ==> [G88-Down] ; Support: 54 ; Confidence : 80.6  
[G88-Down] ==> [G87-UP] ; Support: 54 ; Confidence : 76.06  
[G82-Down] ==> [G13-Down] ; Support: 51 ; Confidence : 75  
[G13-Down] ==> [G82-Down] ; Support: 51 ; Confidence : 75  
[G10-Down] ==> [G88-Down] ; Support: 52 ; Confidence : 74.29  
[G88-Down] ==> [G10-Down] ; Support: 52 ; Confidence : 73.24  
[G1-UP] ==> [G10-Down] ; Support: 50 ; Confidence : 72.46  
[G10-Down] ==> [G1-UP] ; Support: 50 ; Confidence : 71.43  
[G59-UP] ==> [G88-Down] ; Support: 55 ; Confidence : 72.37  
[G88-Down] ==> [G59-UP] ; Support: 55 ; Confidence : 77.46  
[G6-UP] ==> [G28-Down] ; Support: 50 ; Confidence : 75.76  
[G28-Down] ==> [G6-UP] ; Support: 50 ; Confidence : 70.42  
[G28-Down] ==> [G10-Down] ; Support: 51 ; Confidence : 71.83  
[G10-Down] ==> [G28-Down] ; Support: 51 ; Confidence : 72.86  
[G28-Down] ==> [G59-UP] ; Support: 51 ; Confidence : 71.83  
[G2-Down] ==> [G38-Down] ; Support: 50 ; Confidence : 75.76  
[G38-Down] ==> [G59-UP] ; Support: 53 ; Confidence : 72.6  
[G72-UP] ==> [G82-Down] ; Support: 58 ; Confidence : 78.38  
[G82-Down] ==> [G72-UP] ; Support: 58 ; Confidence : 85.29

[G54-UP] ==> [G24-Down] ; Support: 50 ; Confidence : 74.63  
[G24-Down] ==> [G54-UP] ; Support: 50 ; Confidence : 79.37  
[G13-Down] ==> [G59-UP] ; Support: 54 ; Confidence : 79.41  
[G59-UP] ==> [G13-Down] ; Support: 54 ; Confidence : 71.05  
[G6-UP] ==> [G59-UP] ; Support: 51 ; Confidence : 77.27  
[G32-Down] ==> [G28-Down] ; Support: 50 ; Confidence : 73.53  
[G28-Down] ==> [G32-Down] ; Support: 50 ; Confidence : 70.42  
[G88-Down] ==> [G38-Down] ; Support: 50 ; Confidence : 70.42  
[G54-UP] ==> [G1-UP] ; Support: 50 ; Confidence : 74.63  
[G1-UP] ==> [G54-UP] ; Support: 50 ; Confidence : 72.46  
[G8-UP] ==> [G88-Down] ; Support: 51 ; Confidence : 77.27  
[G88-Down] ==> [G8-UP] ; Support: 51 ; Confidence : 71.83  
[G47-UP] ==> [G38-Down] ; Support: 54 ; Confidence : 81.82  
[G38-Down] ==> [G47-UP] ; Support: 54 ; Confidence : 73.97  
[G28-Down] ==> [G38-Down] ; Support: 55 ; Confidence : 77.46  
[G38-Down] ==> [G28-Down] ; Support: 55 ; Confidence : 75.34  
[G72-UP] ==> [G59-UP] ; Support: 62 ; Confidence : 83.78  
[G59-UP] ==> [G72-UP] ; Support: 62 ; Confidence : 81.58  
[G10-Down] ==> [G59-UP] ; Support: 50 ; Confidence : 71.43  
[G28-Down] ==> [G41-Down] ; Support: 51 ; Confidence : 71.83  
[G41-Down] ==> [G28-Down] ; Support: 51 ; Confidence : 79.69  
[G65-Down] ==> [G38-Down] ; Support: 50 ; Confidence : 81.97  
[G72-UP] ==> [G96-Down] ; Support: 59 ; Confidence : 79.73  
[G96-Down] ==> [G72-UP] ; Support: 59 ; Confidence : 83.1  
[G13-Down] ==> [G28-Down] ; Support: 50 ; Confidence : 73.53  
[G28-Down] ==> [G13-Down] ; Support: 50 ; Confidence : 70.42  
[G6-UP] ==> [G38-Down] ; Support: 50 ; Confidence : 75.76  
[G1-UP] ==> [G59-UP] ; Support: 53 ; Confidence : 76.81  
[G32-Down] ==> [G59-UP] ; Support: 52 ; Confidence : 76.47  
[G28-Down] ==> [G88-Down] ; Support: 52 ; Confidence : 73.24  
[G88-Down] ==> [G28-Down] ; Support: 52 ; Confidence : 73.24  
[G41-Down] ==> [G38-Down] ; Support: 50 ; Confidence : 78.12  
[G70-Down] ==> [G10-Down] ; Support: 50 ; Confidence : 75.76  
[G10-Down] ==> [G70-Down] ; Support: 50 ; Confidence : 71.43  
[G70-Down] ==> [G38-Down] ; Support: 54 ; Confidence : 81.82  
[G38-Down] ==> [G70-Down] ; Support: 54 ; Confidence : 73.97  
[G54-UP] ==> [G88-Down] ; Support: 52 ; Confidence : 77.61  
[G88-Down] ==> [G54-UP] ; Support: 52 ; Confidence : 73.24  
[G82-Down] ==> [G97-Down] ; Support: 51 ; Confidence : 75  
[G97-Down] ==> [G82-Down] ; Support: 51 ; Confidence : 83.61  
[G87-UP] ==> [G28-Down] ; Support: 52 ; Confidence : 77.61

[G28-Down] ==> [G87-UP] ; Support: 52 ; Confidence : 73.24  
 [G2-Down] ==> [G28-Down] ; Support: 50 ; Confidence : 75.76  
 [G28-Down] ==> [G2-Down] ; Support: 50 ; Confidence : 70.42  
 [G38-Down] ==> [G10-Down] ; Support: 53 ; Confidence : 72.6  
 [G10-Down] ==> [G38-Down] ; Support: 53 ; Confidence : 75.71  
 [G1-UP] ==> [G38-Down] ; Support: 54 ; Confidence : 78.26  
 [G38-Down] ==> [G1-UP] ; Support: 54 ; Confidence : 73.97  
 [G32-Down] ==> [G6-UP] ; Support: 50 ; Confidence : 73.53  
 [G6-UP] ==> [G32-Down] ; Support: 50 ; Confidence : 75.76  
 [G13-Down] ==> [G6-UP] ; Support: 50 ; Confidence : 73.53  
 [G6-UP] ==> [G13-Down] ; Support: 50 ; Confidence : 75.76  
 [G10-Down] ==> [G94-UP] ; Support: 50 ; Confidence : 71.43  
 [G94-UP] ==> [G10-Down] ; Support: 50 ; Confidence : 80.65  
 [G72-UP G59-UP] ==> [G96-Down] ; Support: 51 ; Confidence : 82.26  
 [G96-Down] ==> [G72-UP G59-UP] ; Support: 51 ; Confidence : 71.83  
 [G72-UP G96-Down] ==> [G59-UP] ; Support: 51 ; Confidence : 86.44  
 [G59-UP G96-Down] ==> [G72-UP] ; Support: 51 ; Confidence : 83.61  
 [G72-UP] ==> [G82-Down G59-UP] ; Support: 52 ; Confidence : 70.27  
 [G82-Down] ==> [G72-UP G59-UP] ; Support: 52 ; Confidence : 76.47  
 [G72-UP G82-Down] ==> [G59-UP] ; Support: 52 ; Confidence : 89.66  
 [G72-UP G59-UP] ==> [G82-Down] ; Support: 52 ; Confidence : 83.87  
 [G82-Down G59-UP] ==> [G72-UP] ; Support: 52 ; Confidence : 91.23

### TEMPLATE 3:

#### RULE HAS ANY OF G1-UP AND SIZEOF (RULE) >= 2

Numbers of rules retrieved : 13

[G1-UP] ==> [G67-UP] ; Support: 50 ; Confidence : 72.46  
 [G67-UP] ==> [G1-UP] ; Support: 50 ; Confidence : 80.65  
 [G72-UP] ==> [G1-UP] ; Support: 52 ; Confidence : 70.27  
 [G1-UP] ==> [G72-UP] ; Support: 52 ; Confidence : 75.36  
 [G1-UP] ==> [G70-Down] ; Support: 50 ; Confidence : 72.46  
 [G70-Down] ==> [G1-UP] ; Support: 50 ; Confidence : 75.76  
 [G1-UP] ==> [G10-Down] ; Support: 50 ; Confidence : 72.46  
 [G10-Down] ==> [G1-UP] ; Support: 50 ; Confidence : 71.43  
 [G54-UP] ==> [G1-UP] ; Support: 50 ; Confidence : 74.63  
 [G1-UP] ==> [G54-UP] ; Support: 50 ; Confidence : 72.46  
 [G1-UP] ==> [G59-UP] ; Support: 53 ; Confidence : 76.81  
 [G1-UP] ==> [G38-Down] ; Support: 54 ; Confidence : 78.26  
 [G38-Down] ==> [G1-UP] ; Support: 54 ; Confidence : 73.97



### **RULE HAS ANY OF G1-UP OR SIZEOF(RULE) >=3**

Numbers of rules retrieved : 22

[G1-UP] ==> [G67-UP] ; Support: 50 ; Confidence : 72.46  
[G67-UP] ==> [G1-UP] ; Support: 50 ; Confidence : 80.65  
[G72-UP] ==> [G1-UP] ; Support: 52 ; Confidence : 70.27  
[G1-UP] ==> [G72-UP] ; Support: 52 ; Confidence : 75.36  
[G1-UP] ==> [G70-Down] ; Support: 50 ; Confidence : 72.46  
[G70-Down] ==> [G1-UP] ; Support: 50 ; Confidence : 75.76  
[G1-UP] ==> [G10-Down] ; Support: 50 ; Confidence : 72.46  
[G10-Down] ==> [G1-UP] ; Support: 50 ; Confidence : 71.43  
[G54-UP] ==> [G1-UP] ; Support: 50 ; Confidence : 74.63  
[G1-UP] ==> [G54-UP] ; Support: 50 ; Confidence : 72.46  
[G1-UP] ==> [G59-UP] ; Support: 53 ; Confidence : 76.81  
[G1-UP] ==> [G38-Down] ; Support: 54 ; Confidence : 78.26  
[G38-Down] ==> [G1-UP] ; Support: 54 ; Confidence : 73.97  
[G72-UP G59-UP] ==> [G96-Down] ; Support: 51 ; Confidence : 82.26  
[G96-Down] ==> [G72-UP G59-UP] ; Support: 51 ; Confidence : 71.83  
[G72-UP G96-Down] ==> [G59-UP] ; Support: 51 ; Confidence : 86.44  
[G59-UP G96-Down] ==> [G72-UP] ; Support: 51 ; Confidence : 83.61  
[G72-UP] ==> [G82-Down G59-UP] ; Support: 52 ; Confidence : 70.27  
[G82-Down] ==> [G72-UP G59-UP] ; Support: 52 ; Confidence : 76.47  
[G72-UP G82-Down] ==> [G59-UP] ; Support: 52 ; Confidence : 89.66  
[G72-UP G59-UP] ==> [G82-Down] ; Support: 52 ; Confidence : 83.87  
[G82-Down G59-UP] ==> [G72-UP] ; Support: 52 ; Confidence : 91.23

### **HEAD HAS ANY OF G1-UP AND BODY HAS ANY OF G54-UP**

Numbers of rules retrieved : 1

[G54-UP] ==> [G1-UP] ; Support: 50 ; Confidence : 74.63

### **HEAD HAS ANY OF G1-UP OR BODY HAS ANY OF G54-UP**

Numbers of rules retrieved : 8

[G67-UP] ==> [G1-UP] ; Support: 50 ; Confidence : 80.65  
[G72-UP] ==> [G1-UP] ; Support: 52 ; Confidence : 70.27  
[G70-Down] ==> [G1-UP] ; Support: 50 ; Confidence : 75.76  
[G10-Down] ==> [G1-UP] ; Support: 50 ; Confidence : 71.43  
[G54-UP] ==> [G1-UP] ; Support: 50 ; Confidence : 74.63  
[G38-Down] ==> [G1-UP] ; Support: 54 ; Confidence : 73.97  
[G54-UP] ==> [G24-Down] ; Support: 50 ; Confidence : 74.63  
[G54-UP] ==> [G88-Down] ; Support: 52 ; Confidence : 77.61

**HEAD HAS ANY OF G1-UP OR BODY HAS ANY OF G54-UP AND SIZEOF(RULE) >= 2**

Numbers of rules retrieved : 8

[G67-UP] ==> [G1-UP] ; Support: 50 ; Confidence : 80.65

[G72-UP] ==> [G1-UP] ; Support: 52 ; Confidence : 70.27

[G70-Down] ==> [G1-UP] ; Support: 50 ; Confidence : 75.76

[G10-Down] ==> [G1-UP] ; Support: 50 ; Confidence : 71.43

[G54-UP] ==> [G1-UP] ; Support: 50 ; Confidence : 74.63

[G38-Down] ==> [G1-UP] ; Support: 54 ; Confidence : 73.97

[G54-UP] ==> [G24-Down] ; Support: 50 ; Confidence : 74.63

[G54-UP] ==> [G88-Down] ; Support: 52 ; Confidence : 77.61