

**DATA MINING AND  
BIO-INFORMATICS (CSE-601)  
PROJECT-1**

**ASSOCIATION ANALYSIS**

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## (i)Description of Algorithms used in the tasks

Apriori Algorithm is an algorithm that is used for mining frequent itemsets for association rules.

It mainly operates on transactional databases.

First frequent individual items are identified and these are used to generate large itemsets.

Frequent Itemsets are the ones that contain the item with minimum support.

**Apriori property:**Any subset of frequent itemset must be frequent.

### **Implementation of Algorithm:**

1.Frequent itemset Generation

2.Rules Generation

### **Frequent Itemset Generation Steps:**

1.First we scan the entire dataset to get the support of each 1-itemset and then compare it with the minimum support. If the value is greater than min support then item is considered to be frequent itemset of length 1.

2.Next the frequent itemset of length 2 are generated by using this length-1 frequent itemset combinations, calculating support and comparing with minsupport. Again we remove those itemsets that do not satisfy the property i.e, support greater than minsupport.

3.Similarly we generate itemset of length n using length n-1 itemsets. We consider two frequent itemsets of length n-1 and combine those two if the first n-2 elements of both itemsets are same and later use apriori property to generate frequent itemset.

### **Rule Generation Steps**

## (ii)Results of Task-1 & Task-2

### **1.Results of Apriori Algorithm to find all frequent item-sets for different values of support.**

#### **Support is set to 30**

No.of.length 1 frequent Itemsets=196  
No.of.length 2 frequent Itemsets=5340  
No.of.length 3 frequent Itemsets=5287  
No.of.length 4 frequent Itemsets=1518  
No.of.length 5 frequent Itemsets=438  
No.of.length 6 frequent Itemsets=88  
No.of.length 7 frequent Itemsets=11  
No.of.length 8 frequent Itemsets=1

**Total Number of all itemsets: 12879**

#### **Support is set to 40**

No.of.length 1 frequent Itemsets=167  
No.of.length 2 frequent Itemsets=753  
No.of.length 3 frequent Itemsets=149  
No.of.length 4 frequent Itemsets=7

No.of.length 5 frequent Itemsets=1  
**Total Number of all itemsets: 1077**

**Support is set to 50**

No.of.length 1 frequent Itemsets=109  
No.of.length 2 frequent Itemsets=63  
No.of.length 3 frequent Itemsets=2  
**Total Number of all itemsets: 174**

**Support is set to 60**

No.of.length 1 frequent Itemsets=34  
No.of.length 2 frequent Itemsets=2  
**Total Number of all itemsets: 36**

**Support is set to 70**

No.of.length 1 frequent Itemsets=7  
**Total Number of all itemsets: 7**

**2.Generation of Association rules based on the given template.**  
**Support is set to 50% and confidence is set to 70%.**

### **TEMPLATE-1:**

**1.(result11, cnt) = asso\_rule.template1("RULE", "ANY", ['G59\_UP'])**

**The Count of the rules are 26.**

**Rules include:**

["['G1\_Up'] => ['G59\_Up']", "['G6\_Up'] => ['G59\_Up']", "['G10\_Down'] => ['G59\_Up']", "['G59\_Up'] => ['G13\_Down']", "['G13\_Down'] => ['G59\_Up']", "['G28\_Down'] => ['G59\_Up']", "['G32\_Down'] => ['G59\_Up']", "['G38\_Down'] => ['G59\_Up']", "['G72\_Up'] => ['G59\_Up']", "['G59\_Up'] => ['G72\_Up']", "['G82\_Down'] => ['G59\_Up']", "['G59\_Up'] => ['G82\_Down']", "['G87\_Up'] => ['G59\_Up']", "['G88\_Down'] => ['G59\_Up']", "['G59\_Up'] => ['G88\_Down']", "['G96\_Down'] => ['G59\_Up']", "['G59\_Up'] => ['G96\_Down']", "['G72\_Up', 'G82\_Down'] => ['G59\_Up']", "['G82\_Down'] => ['G59\_Up', 'G72\_Up']", "['G72\_Up'] => ['G59\_Up', 'G82\_Down']", "['G59\_Up', 'G82\_Down'] => ['G72\_Up']", "['G59\_Up', 'G72\_Up'] => ['G82\_Down']", "['G72\_Up', 'G96\_Down'] => ['G59\_Up']", "['G96\_Down'] => ['G59\_Up', 'G72\_Up']", "['G59\_Up', 'G96\_Down'] => ['G72\_Up']", "['G59\_Up', 'G72\_Up'] => ['G96\_Down']"]

**2.(result12, cnt) = asso\_rule.template1("RULE", "NONE", ['G59\_UP'])**

**The Count of the rules are 91.**

**Rules include:**

["['G10\_Down'] => ['G1\_Up']", "['G1\_Up'] => ['G10\_Down']", "['G38\_Down'] => ['G1\_Up']", "['G1\_Up'] => ['G38\_Down']", "['G54\_Up'] => ['G1\_Up']", "['G1\_Up'] => ['G54\_Up']", "['G67\_Up'] => ['G1\_Up']", "['G1\_Up'] => ['G67\_Up']", "['G70\_Down'] => ['G1\_Up']", "['G1\_Up'] => ['G70\_Down']", "['G72\_Up'] => ['G1\_Up']", "['G1\_Up'] => ['G72\_Up']", "['G28\_Down'] => ['G2\_Down']", "['G2\_Down'] => ['G28\_Down']", "['G2\_Down'] =>"]

```

['G38_Down']"', "['G13_Down'] => ['G6_Up']"', "['G6_Up'] => ['G13_Down']"',
"['G28_Down'] => ['G6_Up']"', "['G6_Up'] => ['G28_Down']"', "['G32_Down']
=> ['G6_Up']"', "['G6_Up'] => ['G32_Down']"', "['G6_Up'] => ['G38_Down']"',
"['G88_Down'] => ['G8_Up']"', "['G8_Up'] => ['G88_Down']"', "['G28_Down']
=> ['G10_Down']"', "['G10_Down'] => ['G28_Down']"', "['G38_Down'] =>
['G10_Down']"', "['G10_Down'] => ['G38_Down']"', "['G47_Up'] =>
['G10_Down']"', "['G10_Down'] => ['G47_Up']"', "['G70_Down'] =>
['G10_Down']"', "['G10_Down'] => ['G70_Down']"', "['G88_Down'] =>
['G10_Down']"', "['G10_Down'] => ['G88_Down']"', "['G94_Up'] =>
['G10_Down']"', "['G10_Down'] => ['G94_Up']"', "['G28_Down'] =>
['G13_Down']"', "['G13_Down'] => ['G28_Down']"', "['G72_Up'] =>
['G13_Down']"', "['G13_Down'] => ['G72_Up']"', "['G82_Down'] =>
['G13_Down']"', "['G13_Down'] => ['G82_Down']"', "['G54_Up'] =>
['G24_Down']"', "['G24_Down'] => ['G54_Up']"', "['G88_Down'] =>
['G24_Down']"', "['G24_Down'] => ['G88_Down']"', "['G32_Down'] =>
['G28_Down']"', "['G28_Down'] => ['G32_Down']"', "['G38_Down'] =>
['G28_Down']"', "['G28_Down'] => ['G38_Down']"', "['G41_Down'] =>
['G28_Down']"', "['G28_Down'] => ['G41_Down']"', "['G47_Up'] =>
['G28_Down']"', "['G28_Down'] => ['G47_Up']"', "['G52_Down'] =>
['G28_Down']"', "['G28_Down'] => ['G52_Down']"', "['G87_Up'] =>
['G28_Down']"', "['G28_Down'] => ['G87_Up']"', "['G88_Down'] =>
['G28_Down']"', "['G28_Down'] => ['G88_Down']"', "['G38_Down'] =>
['G32_Down']"', "['G32_Down'] => ['G38_Down']"', "['G32_Down'] =>
['G72_Up']"', "['G41_Down'] => ['G38_Down']"', "['G47_Up'] =>
['G38_Down']"', "['G38_Down'] => ['G47_Up']"', "['G52_Down'] =>
['G38_Down']"', "['G38_Down'] => ['G52_Down']"', "['G65_Down'] =>
['G38_Down']"', "['G67_Up'] => ['G38_Down']"', "['G70_Down'] =>
['G38_Down']"', "['G38_Down'] => ['G70_Down']"', "['G88_Down'] =>
['G38_Down']"', "['G91_Up'] => ['G38_Down']"', "['G38_Down'] =>
['G91_Up']"', "['G94_Up'] => ['G38_Down']"', "['G88_Down'] =>
['G41_Down']"', "['G41_Down'] => ['G88_Down']"', "['G88_Down'] =>
['G54_Up']"', "['G54_Up'] => ['G88_Down']"', "['G82_Down'] => ['G72_Up']"',
"['G72_Up'] => ['G82_Down']"', "['G96_Down'] => ['G72_Up']"', "['G72_Up']
=> ['G96_Down']"', "['G97_Down'] => ['G72_Up']"', "['G96_Down'] =>
['G82_Down']"', "['G82_Down'] => ['G96_Down']"', "['G97_Down'] =>
['G82_Down']"', "['G82_Down'] => ['G97_Down']"', "['G88_Down'] =>
['G87_Up']"', "['G87_Up'] => ['G88_Down']"']

```

```

3.(result13, cnt) = asso_rule.template1("RULE", 1, ['G59_Up',
'G10_Down'])

```

**The Count of the rules are 39.**

**Rules include:**

```

["['G10_Down'] => ['G1_Up']"', "['G1_Up'] => ['G10_Down']"', "['G1_Up'] =>
['G59_Up']"', "['G6_Up'] => ['G59_Up']"', "['G28_Down'] => ['G10_Down']"',
"['G10_Down'] => ['G28_Down']"', "['G38_Down'] => ['G10_Down']"',
"['G10_Down'] => ['G38_Down']"', "['G47_Up'] => ['G10_Down']"',
"['G10_Down'] => ['G47_Up']"', "['G70_Down'] => ['G10_Down']"',
"['G10_Down'] => ['G70_Down']"', "['G88_Down'] => ['G10_Down']"',
"['G10_Down'] => ['G88_Down']"', "['G94_Up'] => ['G10_Down']"',
"['G10_Down'] => ['G94_Up']"', "['G59_Up'] => ['G13_Down']"', "['G13_Down']
=> ['G59_Up']"', "['G28_Down'] => ['G59_Up']"', "['G32_Down'] =>

```

```
['G59_Up']", "['G38_Down'] => ['G59_Up']", "['G72_Up'] => ['G59_Up']",
"['G59_Up'] => ['G72_Up']", "['G82_Down'] => ['G59_Up']", "['G59_Up'] =>
['G82_Down']", "['G87_Up'] => ['G59_Up']", "['G88_Down'] => ['G59_Up']",
"['G59_Up'] => ['G88_Down']", "['G96_Down'] => ['G59_Up']", "['G59_Up']
=> ['G96_Down']", "['G72_Up', 'G82_Down'] => ['G59_Up']", "['G82_Down']
=> ['G59_Up', 'G72_Up']", "['G72_Up'] => ['G59_Up', 'G82_Down']",
"['G59_Up', 'G82_Down'] => ['G72_Up']", "['G59_Up', 'G72_Up'] =>
['G82_Down']", "['G72_Up', 'G96_Down'] => ['G59_Up']", "['G96_Down'] =>
['G59_Up', 'G72_Up']", "['G59_Up', 'G96_Down'] => ['G72_Up']",
"['G59_Up', 'G72_Up'] => ['G96_Down']"]
```

**4.(result14, cnt) = asso\_rule.template1("HEAD", "ANY", ['G59\_UP'])**

**The Count of the rules are 9**

**Rules include:**

```
["['G59_Up'] => ['G13_Down']", "['G59_Up'] => ['G72_Up']", "['G59_Up'] =>
['G82_Down']", "['G59_Up'] => ['G88_Down']", "['G59_Up'] =>
['G96_Down']", "['G59_Up', 'G82_Down'] => ['G72_Up']", "['G59_Up',
'G72_Up'] => ['G82_Down']", "['G59_Up', 'G96_Down'] => ['G72_Up']",
"['G59_Up', 'G72_Up'] => ['G96_Down']"]
```

**5.(result15, cnt) = asso\_rule.template1("HEAD", "NONE", ['G59\_UP'])**

**The Count of the rules are 108**

**Rules include:**

```
["['G10_Down'] => ['G1_Up']", "['G1_Up'] => ['G10_Down']", "['G38_Down']
=> ['G1_Up']", "['G1_Up'] => ['G38_Down']", "['G54_Up'] => ['G1_Up']",
"['G1_Up'] => ['G54_Up']", "['G1_Up'] => ['G59_Up']", "['G67_Up'] =>
['G1_Up']", "['G1_Up'] => ['G67_Up']", "['G70_Down'] => ['G1_Up']",
"['G1_Up'] => ['G70_Down']", "['G72_Up'] => ['G1_Up']", "['G1_Up'] =>
['G72_Up']", "['G28_Down'] => ['G2_Down']", "['G2_Down'] =>
['G28_Down']", "['G2_Down'] => ['G38_Down']", "['G13_Down'] =>
['G6_Up']", "['G6_Up'] => ['G13_Down']", "['G28_Down'] => ['G6_Up']",
"['G6_Up'] => ['G28_Down']", "['G32_Down'] => ['G6_Up']", "['G6_Up'] =>
['G32_Down']", "['G6_Up'] => ['G38_Down']", "['G6_Up'] => ['G59_Up']",
"['G88_Down'] => ['G8_Up']", "['G8_Up'] => ['G88_Down']", "['G28_Down']
=> ['G10_Down']", "['G10_Down'] => ['G28_Down']", "['G38_Down'] =>
['G10_Down']", "['G10_Down'] => ['G38_Down']", "['G47_Up'] =>
['G10_Down']", "['G10_Down'] => ['G47_Up']", "['G10_Down'] =>
['G59_Up']", "['G70_Down'] => ['G10_Down']", "['G10_Down'] =>
['G70_Down']", "['G88_Down'] => ['G10_Down']", "['G10_Down'] =>
['G88_Down']", "['G94_Up'] => ['G10_Down']", "['G10_Down'] =>
['G94_Up']", "['G28_Down'] => ['G13_Down']", "['G13_Down'] =>
['G28_Down']", "['G13_Down'] => ['G59_Up']", "['G72_Up'] =>
['G13_Down']", "['G13_Down'] => ['G72_Up']", "['G82_Down'] =>
['G13_Down']", "['G13_Down'] => ['G82_Down']", "['G54_Up'] =>
['G24_Down']", "['G24_Down'] => ['G54_Up']", "['G88_Down'] =>
['G24_Down']", "['G24_Down'] => ['G88_Down']", "['G32_Down'] =>
['G28_Down']", "['G28_Down'] => ['G32_Down']", "['G38_Down'] =>
['G28_Down']", "['G28_Down'] => ['G38_Down']", "['G41_Down'] =>
['G28_Down']", "['G28_Down'] => ['G41_Down']", "['G47_Up'] =>
```

```

['G28_Down']"', "['G28_Down'] => ['G47_Up']"', "['G52_Down'] =>
['G28_Down']"', "['G28_Down'] => ['G52_Down']"', "['G28_Down'] =>
['G59_Up']"', "['G87_Up'] => ['G28_Down']"', "['G28_Down'] => ['G87_Up']"',
"['G88_Down'] => ['G28_Down']"', "['G28_Down'] => ['G88_Down']"',
"['G38_Down'] => ['G32_Down']"', "['G32_Down'] => ['G38_Down']"',
"['G32_Down'] => ['G59_Up']"', "['G32_Down'] => ['G72_Up']"', "['G41_Down']
=> ['G38_Down']"', "['G47_Up'] => ['G38_Down']"', "['G38_Down'] =>
['G47_Up']"', "['G52_Down'] => ['G38_Down']"', "['G38_Down'] =>
['G52_Down']"', "['G38_Down'] => ['G59_Up']"', "['G65_Down'] =>
['G38_Down']"', "['G67_Up'] => ['G38_Down']"', "['G70_Down'] =>
['G38_Down']"', "['G38_Down'] => ['G70_Down']"', "['G88_Down'] =>
['G38_Down']"', "['G91_Up'] => ['G38_Down']"', "['G38_Down'] =>
['G91_Up']"', "['G94_Up'] => ['G38_Down']"', "['G88_Down'] =>
['G41_Down']"', "['G41_Down'] => ['G88_Down']"', "['G88_Down'] =>
['G54_Up']"', "['G54_Up'] => ['G88_Down']"', "['G72_Up'] => ['G59_Up']"',
"['G82_Down'] => ['G59_Up']"', "['G87_Up'] => ['G59_Up']"', "['G88_Down']
=> ['G59_Up']"', "['G96_Down'] => ['G59_Up']"', "['G82_Down'] =>
['G72_Up']"', "['G72_Up'] => ['G82_Down']"', "['G96_Down'] => ['G72_Up']"',
"['G72_Up'] => ['G96_Down']"', "['G97_Down'] => ['G72_Up']"', "['G96_Down']
=> ['G82_Down']"', "['G82_Down'] => ['G96_Down']"', "['G97_Down'] =>
['G82_Down']"', "['G82_Down'] => ['G97_Down']"', "['G88_Down'] =>
['G87_Up']"', "['G87_Up'] => ['G88_Down']"', "['G72_Up', 'G82_Down'] =>
['G59_Up']"', "['G82_Down'] => ['G59_Up', 'G72_Up']"', "['G72_Up'] =>
['G59_Up', 'G82_Down']"', "['G72_Up', 'G96_Down'] => ['G59_Up']"',
"['G96_Down'] => ['G59_Up', 'G72_Up']"']

```

```

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

```

**The Count of the rules are 17**

**Rules include:**

```

["['G10_Down'] => ['G1_Up']"', "['G10_Down'] => ['G28_Down']"',
"['G10_Down'] => ['G38_Down']"', "['G10_Down'] => ['G47_Up']"',
"['G10_Down'] => ['G59_Up']"', "['G10_Down'] => ['G70_Down']"',
"['G10_Down'] => ['G88_Down']"', "['G10_Down'] => ['G94_Up']"', "['G59_Up']
=> ['G13_Down']"', "['G59_Up'] => ['G72_Up']"', "['G59_Up'] =>
['G82_Down']"', "['G59_Up'] => ['G88_Down']"', "['G59_Up'] =>
['G96_Down']"', "['G59_Up', 'G82_Down'] => ['G72_Up']"', "['G59_Up',
'G72_Up'] => ['G82_Down']"', "['G59_Up', 'G96_Down'] => ['G72_Up']"',
"['G59_Up', 'G72_Up'] => ['G96_Down']"']

```

```

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

```

**The Count of the rules are 17**

**Rules include:**

```

["['G1_Up'] => ['G59_Up']"', "['G6_Up'] => ['G59_Up']"', "['G10_Down'] =>
['G59_Up']"', "['G13_Down'] => ['G59_Up']"', "['G28_Down'] => ['G59_Up']"',
"['G32_Down'] => ['G59_Up']"', "['G38_Down'] => ['G59_Up']"', "['G72_Up']
=> ['G59_Up']"', "['G82_Down'] => ['G59_Up']"', "['G87_Up'] => ['G59_Up']"',
"['G88_Down'] => ['G59_Up']"', "['G96_Down'] => ['G59_Up']"', "['G72_Up',
'G82_Down'] => ['G59_Up']"', "['G82_Down'] => ['G59_Up', 'G72_Up']"',
"['G72_Up'] => ['G59_Up', 'G82_Down']"', "['G72_Up', 'G96_Down'] =>

```

```
['G59_Up']]", "['G96_Down'] => ['G59_Up', 'G72_Up']"]
```

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

**The Count of the rules are 100**

**Rules include:**

```
["['G10_Down'] => ['G1_Up']]", "['G1_Up'] => ['G10_Down']]", "['G38_Down']  
=> ['G1_Up']]", "['G1_Up'] => ['G38_Down']]", "['G54_Up'] => ['G1_Up']]",  
"['G1_Up'] => ['G54_Up']]", "['G67_Up'] => ['G1_Up']]", "['G1_Up'] =>  
['G67_Up']]", "['G70_Down'] => ['G1_Up']]", "['G1_Up'] => ['G70_Down']]",  
"['G72_Up'] => ['G1_Up']]", "['G1_Up'] => ['G72_Up']]", "['G28_Down'] =>  
['G2_Down']]", "['G2_Down'] => ['G28_Down']]", "['G2_Down'] =>  
['G38_Down']]", "['G13_Down'] => ['G6_Up']]", "['G6_Up'] => ['G13_Down']]",  
"['G28_Down'] => ['G6_Up']]", "['G6_Up'] => ['G28_Down']]", "['G32_Down']  
=> ['G6_Up']]", "['G6_Up'] => ['G32_Down']]", "['G6_Up'] => ['G38_Down']]",  
"['G88_Down'] => ['G8_Up']]", "['G8_Up'] => ['G88_Down']]", "['G28_Down']  
=> ['G10_Down']]", "['G10_Down'] => ['G28_Down']]", "['G38_Down'] =>  
['G10_Down']]", "['G10_Down'] => ['G38_Down']]", "['G47_Up'] =>  
['G10_Down']]", "['G10_Down'] => ['G47_Up']]", "['G70_Down'] =>  
['G10_Down']]", "['G10_Down'] => ['G70_Down']]", "['G88_Down'] =>  
['G10_Down']]", "['G10_Down'] => ['G88_Down']]", "['G94_Up'] =>  
['G10_Down']]", "['G10_Down'] => ['G94_Up']]", "['G28_Down'] =>  
['G13_Down']]", "['G13_Down'] => ['G28_Down']]", "['G59_Up'] =>  
['G13_Down']]", "['G72_Up'] => ['G13_Down']]", "['G13_Down'] =>  
['G72_Up']]", "['G82_Down'] => ['G13_Down']]", "['G13_Down'] =>  
['G82_Down']]", "['G54_Up'] => ['G24_Down']]", "['G24_Down'] =>  
['G54_Up']]", "['G88_Down'] => ['G24_Down']]", "['G24_Down'] =>  
['G88_Down']]", "['G32_Down'] => ['G28_Down']]", "['G28_Down'] =>  
['G32_Down']]", "['G38_Down'] => ['G28_Down']]", "['G28_Down'] =>  
['G38_Down']]", "['G41_Down'] => ['G28_Down']]", "['G28_Down'] =>  
['G41_Down']]", "['G47_Up'] => ['G28_Down']]", "['G28_Down'] =>  
['G47_Up']]", "['G52_Down'] => ['G28_Down']]", "['G28_Down'] =>  
['G52_Down']]", "['G87_Up'] => ['G28_Down']]", "['G28_Down'] =>  
['G87_Up']]", "['G88_Down'] => ['G28_Down']]", "['G28_Down'] =>  
['G88_Down']]", "['G38_Down'] => ['G32_Down']]", "['G32_Down'] =>  
['G38_Down']]", "['G32_Down'] => ['G72_Up']]", "['G41_Down'] =>  
['G38_Down']]", "['G47_Up'] => ['G38_Down']]", "['G38_Down'] =>  
['G47_Up']]", "['G52_Down'] => ['G38_Down']]", "['G38_Down'] =>  
['G52_Down']]", "['G65_Down'] => ['G38_Down']]", "['G67_Up'] =>  
['G38_Down']]", "['G70_Down'] => ['G38_Down']]", "['G38_Down'] =>  
['G70_Down']]", "['G88_Down'] => ['G38_Down']]", "['G91_Up'] =>  
['G38_Down']]", "['G38_Down'] => ['G91_Up']]", "['G94_Up'] =>  
['G38_Down']]", "['G88_Down'] => ['G41_Down']]", "['G41_Down'] =>  
['G88_Down']]", "['G88_Down'] => ['G54_Up']]", "['G54_Up'] =>  
['G88_Down']]", "['G59_Up'] => ['G72_Up']]", "['G59_Up'] => ['G82_Down']]",  
"['G59_Up'] => ['G88_Down']]", "['G59_Up'] => ['G96_Down']]", "['G82_Down']  
=> ['G72_Up']]", "['G72_Up'] => ['G82_Down']]", "['G96_Down'] =>  
['G72_Up']]", "['G72_Up'] => ['G96_Down']]", "['G97_Down'] => ['G72_Up']]",  
"['G96_Down'] => ['G82_Down']]", "['G82_Down'] => ['G96_Down']]",  
"['G97_Down'] => ['G82_Down']]", "['G82_Down'] => ['G97_Down']]",  
"['G88_Down'] => ['G87_Up']]", "['G87_Up'] => ['G88_Down']]", "['G59_Up',  
'G82_Down'] => ['G72_Up']]", "['G59_Up', 'G72_Up'] => ['G82_Down']]",
```

```
"['G59_Up', 'G96_Down'] => ['G72_Up']", "['G59_Up', 'G72_Up'] =>
['G96_Down']"]
```

```
9.(result19, cnt) = asso_rule.template1("BODY", 1, ['G59_Up',
'G10_Down'])
```

**The Count of the rules are 24**

**Rules include:**

```
["['G1_Up'] => ['G10_Down']", "['G1_Up'] => ['G59_Up']", "['G6_Up'] =>
['G59_Up']", "['G28_Down'] => ['G10_Down']", "['G38_Down'] =>
['G10_Down']", "['G47_Up'] => ['G10_Down']", "['G10_Down'] =>
['G59_Up']", "['G70_Down'] => ['G10_Down']", "['G88_Down'] =>
['G10_Down']", "['G94_Up'] => ['G10_Down']", "['G13_Down'] =>
['G59_Up']", "['G28_Down'] => ['G59_Up']", "['G32_Down'] => ['G59_Up']",
"['G38_Down'] => ['G59_Up']", "['G72_Up'] => ['G59_Up']", "['G82_Down']
=> ['G59_Up']", "['G87_Up'] => ['G59_Up']", "['G88_Down'] => ['G59_Up']",
"['G96_Down'] => ['G59_Up']", "['G72_Up', 'G82_Down'] => ['G59_Up']",
"['G82_Down'] => ['G59_Up', 'G72_Up']", "['G72_Up'] => ['G59_Up',
'G82_Down']", "['G72_Up', 'G96_Down'] => ['G59_Up']", "['G96_Down'] =>
['G59_Up', 'G72_Up']"]
```

## TEMPLATE-2:

```
1.(result21, cnt) = asso_rule.template2("RULE", 3)
```

**The Count of the rules are 9**

**Rules include:**

```
["['G72_Up', 'G82_Down'] => ['G59_Up']", "['G82_Down'] => ['G59_Up',
'G72_Up']", "['G72_Up'] => ['G59_Up', 'G82_Down']", "['G59_Up',
'G82_Down'] => ['G72_Up']", "['G59_Up', 'G72_Up'] => ['G82_Down']",
"['G72_Up', 'G96_Down'] => ['G59_Up']", "['G96_Down'] => ['G59_Up',
'G72_Up']", "['G59_Up', 'G96_Down'] => ['G72_Up']", "['G59_Up', 'G72_Up']
=> ['G96_Down']"]
```

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

**The Count of the rules are 6**

**Rules include:**

```
["['G72_Up', 'G82_Down'] => ['G59_Up']", "['G59_Up', 'G82_Down'] =>
['G72_Up']", "['G59_Up', 'G72_Up'] => ['G82_Down']", "['G72_Up',
'G96_Down'] => ['G59_Up']", "['G59_Up', 'G96_Down'] => ['G72_Up']",
"['G59_Up', 'G72_Up'] => ['G96_Down']"]
```

```
3.(result23, cnt) = asso_rule.template2("BODY", 1)
```

**The Count of the rules are 117**

**Results include:**

```
["['G10_Down'] => ['G1_Up']", "['G1_Up'] => ['G10_Down']", "['G38_Down']
```



=> ['G1\_Up']", "['G1\_Up'] => ['G38\_Down']", "['G54\_Up'] => ['G1\_Up']",  
"['G1\_Up'] => ['G54\_Up']", "['G1\_Up'] => ['G59\_Up']", "['G67\_Up'] =>  
['G1\_Up']", "['G1\_Up'] => ['G67\_Up']", "['G70\_Down'] => ['G1\_Up']",  
"['G1\_Up'] => ['G70\_Down']", "['G72\_Up'] => ['G1\_Up']", "['G1\_Up'] =>  
['G72\_Up']", "['G28\_Down'] => ['G2\_Down']", "['G2\_Down'] =>  
['G28\_Down']", "['G2\_Down'] => ['G38\_Down']", "['G13\_Down'] =>  
['G6\_Up']", "['G6\_Up'] => ['G13\_Down']", "['G28\_Down'] => ['G6\_Up']",  
"['G6\_Up'] => ['G28\_Down']", "['G32\_Down'] => ['G6\_Up']", "['G6\_Up'] =>  
['G32\_Down']", "['G6\_Up'] => ['G38\_Down']", "['G6\_Up'] => ['G59\_Up']",  
"['G88\_Down'] => ['G8\_Up']", "['G8\_Up'] => ['G88\_Down']", "['G28\_Down']  
=> ['G10\_Down']", "['G10\_Down'] => ['G28\_Down']", "['G38\_Down'] =>  
['G10\_Down']", "['G10\_Down'] => ['G38\_Down']", "['G47\_Up'] =>  
['G10\_Down']", "['G10\_Down'] => ['G47\_Up']", "['G10\_Down'] =>  
['G59\_Up']", "['G70\_Down'] => ['G10\_Down']", "['G10\_Down'] =>  
['G70\_Down']", "['G88\_Down'] => ['G10\_Down']", "['G10\_Down'] =>  
['G88\_Down']", "['G94\_Up'] => ['G10\_Down']", "['G10\_Down'] =>  
['G94\_Up']", "['G28\_Down'] => ['G13\_Down']", "['G13\_Down'] =>  
['G28\_Down']", "['G59\_Up'] => ['G13\_Down']", "['G13\_Down'] =>  
['G59\_Up']", "['G72\_Up'] => ['G13\_Down']", "['G13\_Down'] => ['G72\_Up']",  
"['G82\_Down'] => ['G13\_Down']", "['G13\_Down'] => ['G82\_Down']",  
"['G54\_Up'] => ['G24\_Down']", "['G24\_Down'] => ['G54\_Up']", "['G88\_Down']  
=> ['G24\_Down']", "['G24\_Down'] => ['G88\_Down']", "['G32\_Down'] =>  
['G28\_Down']", "['G28\_Down'] => ['G32\_Down']", "['G38\_Down'] =>  
['G28\_Down']", "['G28\_Down'] => ['G38\_Down']", "['G41\_Down'] =>  
['G28\_Down']", "['G28\_Down'] => ['G41\_Down']", "['G47\_Up'] =>  
['G28\_Down']", "['G28\_Down'] => ['G47\_Up']", "['G52\_Down'] =>  
['G28\_Down']", "['G28\_Down'] => ['G52\_Down']", "['G28\_Down'] =>  
['G59\_Up']", "['G87\_Up'] => ['G28\_Down']", "['G28\_Down'] => ['G87\_Up']",  
"['G88\_Down'] => ['G28\_Down']", "['G28\_Down'] => ['G88\_Down']",  
"['G38\_Down'] => ['G32\_Down']", "['G32\_Down'] => ['G38\_Down']",  
"['G32\_Down'] => ['G59\_Up']", "['G32\_Down'] => ['G72\_Up']", "['G41\_Down']  
=> ['G38\_Down']", "['G47\_Up'] => ['G38\_Down']", "['G38\_Down'] =>  
['G47\_Up']", "['G52\_Down'] => ['G38\_Down']", "['G38\_Down'] =>  
['G52\_Down']", "['G38\_Down'] => ['G59\_Up']", "['G65\_Down'] =>  
['G38\_Down']", "['G67\_Up'] => ['G38\_Down']", "['G70\_Down'] =>  
['G38\_Down']", "['G38\_Down'] => ['G70\_Down']", "['G88\_Down'] =>  
['G38\_Down']", "['G91\_Up'] => ['G38\_Down']", "['G38\_Down'] =>  
['G91\_Up']", "['G94\_Up'] => ['G38\_Down']", "['G88\_Down'] =>  
['G41\_Down']", "['G41\_Down'] => ['G88\_Down']", "['G88\_Down'] =>  
['G54\_Up']", "['G54\_Up'] => ['G88\_Down']", "['G72\_Up'] => ['G59\_Up']",  
"['G59\_Up'] => ['G72\_Up']", "['G82\_Down'] => ['G59\_Up']", "['G59\_Up'] =>  
['G82\_Down']", "['G87\_Up'] => ['G59\_Up']", "['G88\_Down'] => ['G59\_Up']",  
"['G59\_Up'] => ['G88\_Down']", "['G96\_Down'] => ['G59\_Up']", "['G59\_Up']  
=> ['G96\_Down']", "['G82\_Down'] => ['G72\_Up']", "['G72\_Up'] =>  
['G82\_Down']", "['G96\_Down'] => ['G72\_Up']", "['G72\_Up'] =>  
['G96\_Down']", "['G97\_Down'] => ['G72\_Up']", "['G96\_Down'] =>  
['G82\_Down']", "['G82\_Down'] => ['G96\_Down']", "['G97\_Down'] =>  
['G82\_Down']", "['G82\_Down'] => ['G97\_Down']", "['G88\_Down'] =>  
['G87\_Up']", "['G87\_Up'] => ['G88\_Down']", "['G72\_Up', 'G82\_Down'] =>  
['G59\_Up']", "['G82\_Down'] => ['G59\_Up', 'G72\_Up']", "['G72\_Up'] =>  
['G59\_Up', 'G82\_Down']", "['G59\_Up', 'G82\_Down'] => ['G72\_Up']",  
"['G59\_Up', 'G72\_Up'] => ['G82\_Down']", "['G72\_Up', 'G96\_Down'] =>

```
['G59_Up']]", "['G96_Down'] => ['G59_Up', 'G72_Up']]", "['G59_Up',  
'G96_Down'] => ['G72_Up']]", "['G59_Up', 'G72_Up'] => ['G96_Down']"]
```

### **TEMPLATE-3:**

```
1.(result31, cnt) = asso_rule.template3("lor1", "HEAD", "ANY",  
['G10_Down'], "BODY", 1, ['G59_Up'])
```

**The Count of the rules are 24**

**Rules include:**

```
{ "['G10_Down', ['G47_Up']] => ['G47_Up']]", "['G10_Down', ['G38_Down']] =>  
['G38_Down']]", "['G28_Down', ['G59_Up']] => ['G59_Up']]", "['G72_Up',  
'G96_Down', ['G59_Up']] => ['G59_Up']]", "['G10_Down', ['G1_Up']] =>  
['G1_Up']]", "['G87_Up', ['G59_Up']] => ['G59_Up']]", "['G88_Down',  
['G59_Up']] => ['G59_Up']]", "['G13_Down', ['G59_Up']] => ['G59_Up']]",  
"['G10_Down', ['G88_Down']] => ['G88_Down']]", "['G1_Up', ['G59_Up']] =>  
['G59_Up']]", "['G10_Down', ['G28_Down']] => ['G28_Down']]", "['G82_Down',  
['G59_Up', 'G72_Up']] => ['G59_Up', 'G72_Up']]", "['G72_Up', ['G59_Up']]  
=> ['G59_Up']]", "['G96_Down', ['G59_Up', 'G72_Up']] => ['G59_Up',  
'G72_Up']]", "['G10_Down', ['G94_Up']] => ['G94_Up']]", "['G6_Up',  
['G59_Up']] => ['G59_Up']]", "['G96_Down', ['G59_Up']] => ['G59_Up']]",  
"['G10_Down', ['G70_Down']] => ['G70_Down']]", "['G10_Down', ['G59_Up']]  
=> ['G59_Up']]", "['G72_Up', 'G82_Down', ['G59_Up']] => ['G59_Up']]",  
"['G72_Up', ['G59_Up', 'G82_Down']] => ['G59_Up', 'G82_Down']]",  
"['G32_Down', ['G59_Up']] => ['G59_Up']]", "['G38_Down', ['G59_Up']] =>  
['G59_Up']]", "['G82_Down', ['G59_Up']] => ['G59_Up']]" }
```

```
2.(result32, cnt) = asso_rule.template3("land1", "HEAD", "ANY",  
['G10_Down'], "BODY", 1, ['G59_Up'])
```

**The Count of the rules are 1**

**Rules include:**

```
{ "['G10_Down', ['G59_Up']] => ['G59_Up']]" }
```

```
3.(result33, cnt) = asso_rule.template3("lor2", "HEAD", "ANY",  
['G10_Down'], "BODY", 2)
```

**The Count of the rules are 11**

**Rules include:**

```
{ "['G10_Down', ['G47_Up']] => ['G47_Up']]", "['G10_Down', ['G38_Down']] =>  
['G38_Down']]", "['G96_Down', ['G59_Up', 'G72_Up']] => ['G59_Up',  
'G72_Up']]", "['G10_Down', ['G94_Up']] => ['G94_Up']]", "['G72_Up',  
['G59_Up', 'G82_Down']] => ['G59_Up', 'G82_Down']]", "['G10_Down',  
['G70_Down']] => ['G70_Down']]", "['G10_Down', ['G59_Up']] => ['G59_Up']]",  
"['G10_Down', ['G1_Up']] => ['G1_Up']]", "['G10_Down', ['G88_Down']] =>  
['G88_Down']]", "['G10_Down', ['G28_Down']] => ['G28_Down']]",  
"['G82_Down', ['G59_Up', 'G72_Up']] => ['G59_Up', 'G72_Up']]" }
```

```
4.(result34, cnt) = asso_rule.template3("land2", "HEAD", "ANY",  
['G10_Down'], "BODY", 2)
```

The Count of the rules are 0

Rules include:

None()

5.(result35, cnt) = asso\_rule.template3("2or2", "HEAD", 1, "BODY", 2)

The Count of the rules are 117

Rules include:

```
{["'G65_Down', ['G38_Down']] => ['G38_Down'], ["'G38_Down',
['G28_Down']] => ['G28_Down'], ["'G54_Up', ['G1_Up']] => ['G1_Up'],
["'G1_Up', ['G38_Down']] => ['G38_Down'], ["'G6_Up', ['G32_Down']] =>
['G32_Down'], ["'G72_Up', 'G96_Down', ['G59_Up']] => ['G59_Up'],
["'G10_Down', ['G1_Up']] => ['G1_Up'], ["'G32_Down', ['G38_Down']] =>
['G38_Down'], ["'G13_Down', ['G59_Up']] => ['G59_Up'], ["'G38_Down',
['G47_Up']] => ['G47_Up'], ["'G10_Down', ['G88_Down']] => ['G88_Down'],
["'G38_Down', ['G70_Down']] => ['G70_Down'], ["'G38_Down', ['G52_Down']]
=> ['G52_Down'], ["'G1_Up', ['G10_Down']] => ['G10_Down'],
["'G13_Down', ['G72_Up']] => ['G72_Up'], ["'G2_Down', ['G38_Down']] =>
['G38_Down'], ["'G10_Down', ['G94_Up']] => ['G94_Up'], ["'G96_Down',
['G59_Up']] => ['G59_Up'], ["'G2_Down', ['G28_Down']] => ['G28_Down'],
["'G13_Down', ['G82_Down']] => ['G82_Down'], ["'G6_Up', ['G13_Down']] =>
['G13_Down'], ["'G72_Up', ['G13_Down']] => ['G13_Down'], ["'G72_Up',
['G96_Down']] => ['G96_Down'], ["'G41_Down', ['G88_Down']] =>
['G88_Down'], ["'G72_Up', ['G1_Up']] => ['G1_Up'], ["'G82_Down',
['G13_Down']] => ['G13_Down'], ["'G88_Down', ['G28_Down']] =>
['G28_Down'], ["'G96_Down', ['G72_Up']] => ['G72_Up'], ["'G54_Up',
['G88_Down']] => ['G88_Down'], ["'G38_Down', ['G10_Down']] =>
['G10_Down'], ["'G70_Down', ['G1_Up']] => ['G1_Up'], ["'G67_Up',
['G38_Down']] => ['G38_Down'], ["'G94_Up', ['G10_Down']] =>
['G10_Down'], ["'G59_Up', ['G88_Down']] => ['G88_Down'], ["'G87_Up',
['G59_Up']] => ['G59_Up'], ["'G54_Up', ['G24_Down']] => ['G24_Down'],
["'G59_Up', ['G72_Up']] => ['G72_Up'], ["'G88_Down', ['G59_Up']] =>
['G59_Up'], ["'G59_Up', 'G82_Down', ['G72_Up']] => ['G72_Up'],
["'G6_Up', ['G28_Down']] => ['G28_Down'], ["'G28_Down', ['G38_Down']] =>
['G38_Down'], ["'G88_Down', ['G8_Up']] => ['G8_Up'], ["'G38_Down',
['G32_Down']] => ['G32_Down'], ["'G47_Up', ['G28_Down']] =>
['G28_Down'], ["'G82_Down', ['G72_Up']] => ['G72_Up'], ["'G8_Up',
['G88_Down']] => ['G88_Down'], ["'G70_Down', ['G38_Down']] =>
['G38_Down'], ["'G32_Down', ['G72_Up']] => ['G72_Up'], ["'G6_Up',
['G38_Down']] => ['G38_Down'], ["'G38_Down', ['G59_Up']] => ['G59_Up'],
["'G13_Down', ['G28_Down']] => ['G28_Down'], ["'G41_Down', ['G28_Down']]
=> ['G28_Down'], ["'G38_Down', ['G91_Up']] => ['G91_Up'], ["'G28_Down',
['G32_Down']] => ['G32_Down'], ["'G88_Down', ['G38_Down']] =>
['G38_Down'], ["'G59_Up', 'G72_Up', ['G82_Down']] => ['G82_Down'],
["'G96_Down', ['G82_Down']] => ['G82_Down'], ["'G28_Down', ['G13_Down']]
=> ['G13_Down'], ["'G28_Down', ['G41_Down']] => ['G41_Down'],
["'G38_Down', ['G1_Up']] => ['G1_Up'], ["'G59_Up', ['G96_Down']] =>
['G96_Down'], ["'G28_Down', ['G59_Up']] => ['G59_Up'], ["'G28_Down',
['G88_Down']] => ['G88_Down'], ["'G28_Down', ['G6_Up']] => ['G6_Up'],
["'G88_Down', ['G87_Up']] => ['G87_Up'], ["'G82_Down', ['G97_Down']] =>
['G97_Down'], ["'G70_Down', ['G10_Down']] => ['G10_Down'], ["'G1_Up',
```

```

['G72_Up']] => ['G72_Up']", "['G67_Up', ['G1_Up']] => ['G1_Up']",
"['G28_Down', ['G2_Down']] => ['G2_Down']", "['G1_Up', ['G59_Up']] =>
['G59_Up']", "['G47_Up', ['G38_Down']] => ['G38_Down']", "['G72_Up',
['G82_Down']] => ['G82_Down']", "['G72_Up', ['G59_Up']] => ['G59_Up']",
"['G28_Down', ['G10_Down']] => ['G10_Down']", "['G88_Down', ['G41_Down']]
=> ['G41_Down']", "['G88_Down', ['G54_Up']] => ['G54_Up']", "['G94_Up',
['G38_Down']] => ['G38_Down']", "['G10_Down', ['G70_Down']] =>
['G70_Down']", "['G52_Down', ['G38_Down']] => ['G38_Down']",
"['G24_Down', ['G88_Down']] => ['G88_Down']", "['G41_Down', ['G38_Down']]
=> ['G38_Down']", "['G52_Down', ['G28_Down']] => ['G28_Down']",
"['G87_Up', ['G28_Down']] => ['G28_Down']", "['G32_Down', ['G59_Up']] =>
['G59_Up']", "['G59_Up', 'G96_Down', ['G72_Up']] => ['G72_Up']",
"['G1_Up', ['G54_Up']] => ['G54_Up']", "['G10_Down', ['G47_Up']] =>
['G47_Up']", "['G10_Down', ['G38_Down']] => ['G38_Down']", "['G97_Down',
['G72_Up']] => ['G72_Up']", "['G13_Down', ['G6_Up']] => ['G6_Up']",
"['G28_Down', ['G52_Down']] => ['G52_Down']", "['G1_Up', ['G67_Up']] =>
['G67_Up']", "['G87_Up', ['G88_Down']] => ['G88_Down']", "['G82_Down',
['G96_Down']] => ['G96_Down']", "['G97_Down', ['G82_Down']] =>
['G82_Down']", "['G59_Up', ['G13_Down']] => ['G13_Down']", "['G10_Down',
['G28_Down']] => ['G28_Down']", "['G91_Up', ['G38_Down']] =>
['G38_Down']", "['G88_Down', ['G10_Down']] => ['G10_Down']", "['G47_Up',
['G10_Down']] => ['G10_Down']", "['G88_Down', ['G24_Down']] =>
['G24_Down']", "['G96_Down', ['G59_Up', 'G72_Up']] => ['G59_Up',
'G72_Up']", "['G28_Down', ['G87_Up']] => ['G87_Up']", "['G1_Up',
['G70_Down']] => ['G70_Down']", "['G59_Up', ['G82_Down']] =>
['G82_Down']", "['G82_Down', ['G59_Up', 'G72_Up']] => ['G59_Up',
'G72_Up']", "['G32_Down', ['G28_Down']] => ['G28_Down']", "['G6_Up',
['G59_Up']] => ['G59_Up']", "['G32_Down', ['G6_Up']] => ['G6_Up']",
"['G72_Up', ['G59_Up', 'G82_Down']] => ['G59_Up', 'G82_Down']",
"['G10_Down', ['G59_Up']] => ['G59_Up']", "['G28_Down', ['G47_Up']] =>
['G47_Up']", "['G72_Up', 'G82_Down', ['G59_Up']] => ['G59_Up']",
"['G24_Down', ['G54_Up']] => ['G54_Up']", "['G82_Down', ['G59_Up']] =>
['G59_Up']", "['G59_Up', 'G72_Up', ['G96_Down']] => ['G96_Down']"

```

```

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

```

**The Count of the rules are 3**

**Rules include:**

```

{"['G72_Up', ['G59_Up', 'G82_Down']] => ['G59_Up', 'G82_Down']",
"['G96_Down', ['G59_Up', 'G72_Up']] => ['G59_Up', 'G72_Up']",
"['G82_Down', ['G59_Up', 'G72_Up']] => ['G59_Up', 'G72_Up']"}

```