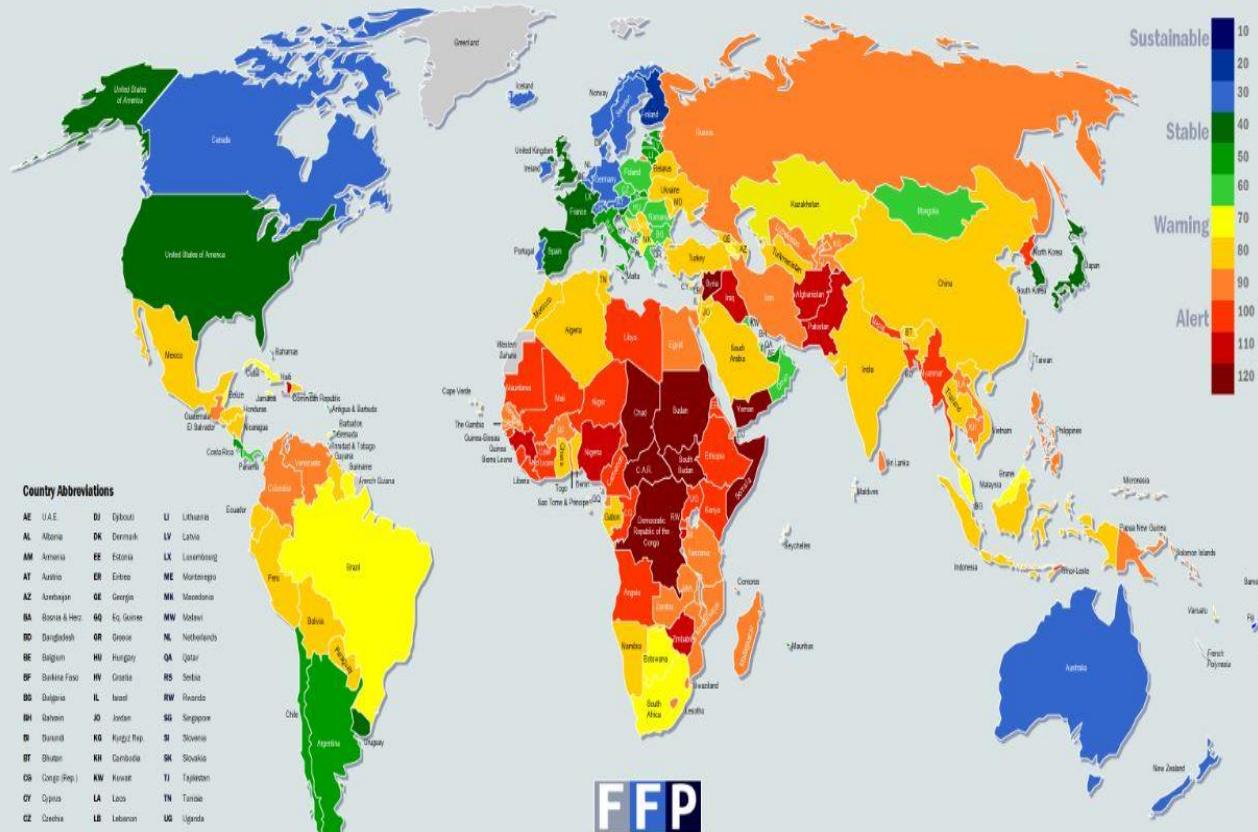


Fragile States Index: Fragility in the World 2016



A STUDY ON FRAGILE STATE INDEX

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DEFINITION

Fragile States Index is an annual report published which aims to evaluate the state's vulnerability to conflict or collapse. This Indexing takes 12 indicators of state vulnerability grouped by category such as Social, Economic and Political factors. Scores are obtained via a process comprising content analysis, quantitative data and qualitative review. Post analysis, all the countries with similar characteristics with fragile class.

FSI has 4 types of fragile classes.

- Alert (union of Very high alert, High Alert and Alert)
- Warning (High warning, Elevated warning, and Warning)
- Stable (Very stable, high stable and Stable)
- Sustainable (Very sustainable, Sustainable)

These fragile classes help the country's governance to take proper action to move to a lower level of fragility. In this report, we are adding 6 new features along with the 12 indicators of FSI. The data for these new features have been taken from the World Bank website. We have selected these new features based on the weight they add to the existing data. Very critical parameters have been intensely studied and chosen to determine the best precision.

WHAT ARE THESE NEW FEATURES?

The features are as follows:

1. Life expectancy at birth
2. Total unemployment rate
3. Education Index
4. Homeless People due to Natural Disaster
5. Global Terrorism Index (GTI)
6. Prison Population

WHY WE CHOOSE THESE FEATURES?

1. Life expectancy at birth -

The average number of years that a newborn could expect to live if he or she were to pass through life subject to the age-specific death rates of a given period is termed as life expectancy.

Life expectancy is included as a basic indicator of health and social development.

2. Total unemployment rate -

Unemployment is the factor that is directly proportional to the fragile state index of a country and hence this feature is added as it gives the total number of people who are unemployed in the country.

3. Education Index -

Education plays an important role in the development of the country. United nation has also published the human development index which consists of this particular parameter. Education index is calculated as the ratio of the number of expected years a child spends in a given level of education to the average number of completed years of education of people.

4. Homeless People due to Natural Disaster -

Natural calamities affect FSI adversely. This leads people to lose shelter and carry their belonging along with them due to natural disasters like earthquake, Tsunami, etc. Hence we have included this index while calculating the FSI.

5. Global Terrorism Index -

Terrorism affects the FSI of the country and hence we have added this feature in the calculation. This feature represents the ranking of the countries which is based on the terrorist activities happened over a period of time.

6. Prison Population -

It is the number of prisoners present in prison per 1 million people. If the prison population is increasing then it might affect the FSI inversely and hence we decided to add this particular feature.

SOURCE OF THESE FEATURE DATA

1. <https://databank.worldbank.org/data/reports.aspx?source=2&Topic=7>
2. <http://fundforpeace.org/fsi/2017/05/13/fragile-states-index-and-cast-framework-methodology/>
3. <http://hdr.undp.org/en>

DATA GATHERING AND EXTRACTION

As listed above, these new 6 features were added to the original data obtained from the Fragile State Index site. We used WEKA tool to classify the dataset obtained for four consecutive years namely 2014, 2015 and 2016.

On completion of this, we tried and tested a lot of classifiers in WEKA tool to get the classifier for our data. Few of the tested classifiers are as follows:

LMT (Logistic Model Trees), RandomForest, RandomTree, Hoeffding Tree, etc.

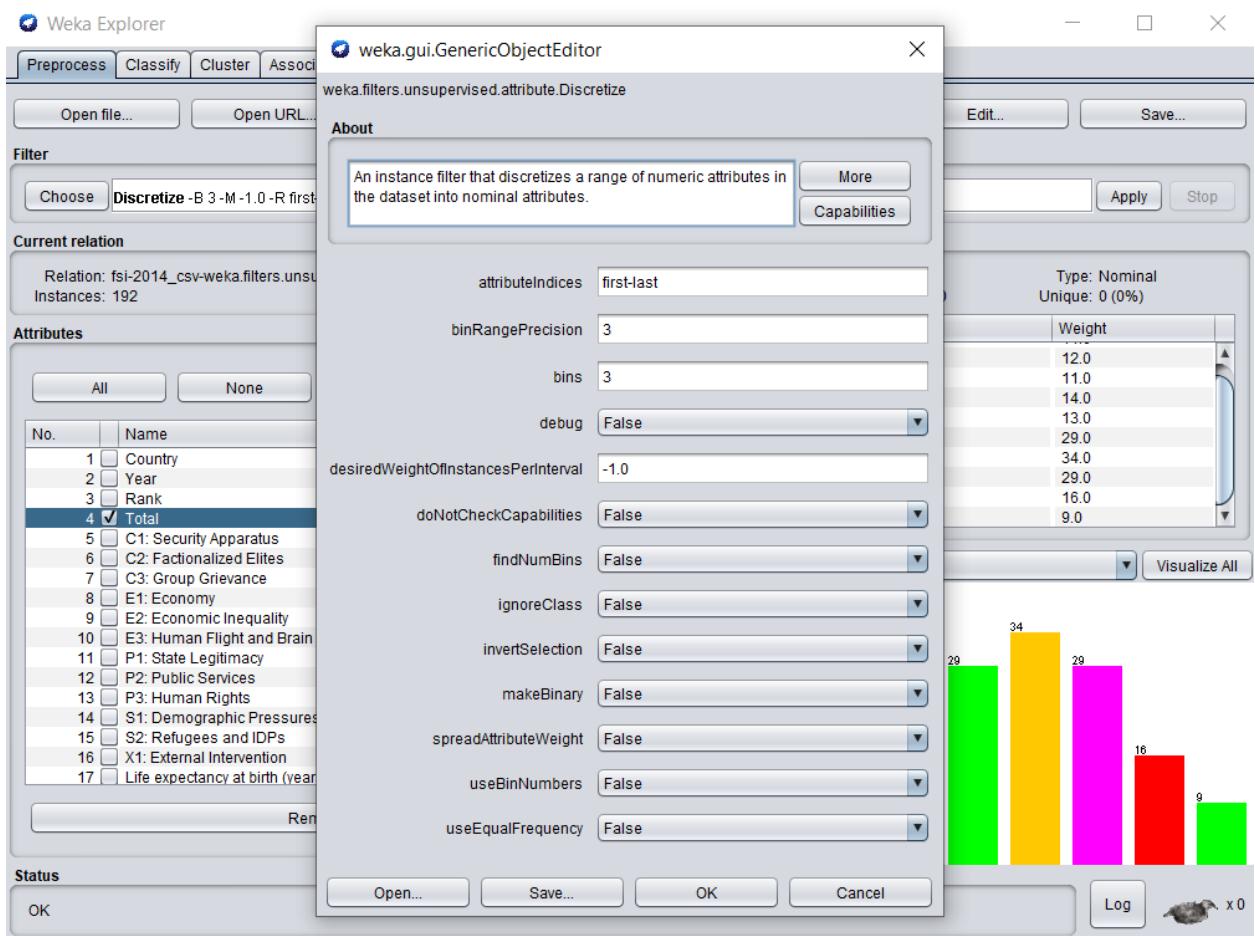
Each classifier gave a different set of results for a different type of test options.

DATA Pre-Processing and Discretization:-

We used WEKA to process the data sets for the years 2014 to 2016. Data Processing was done in the following steps.

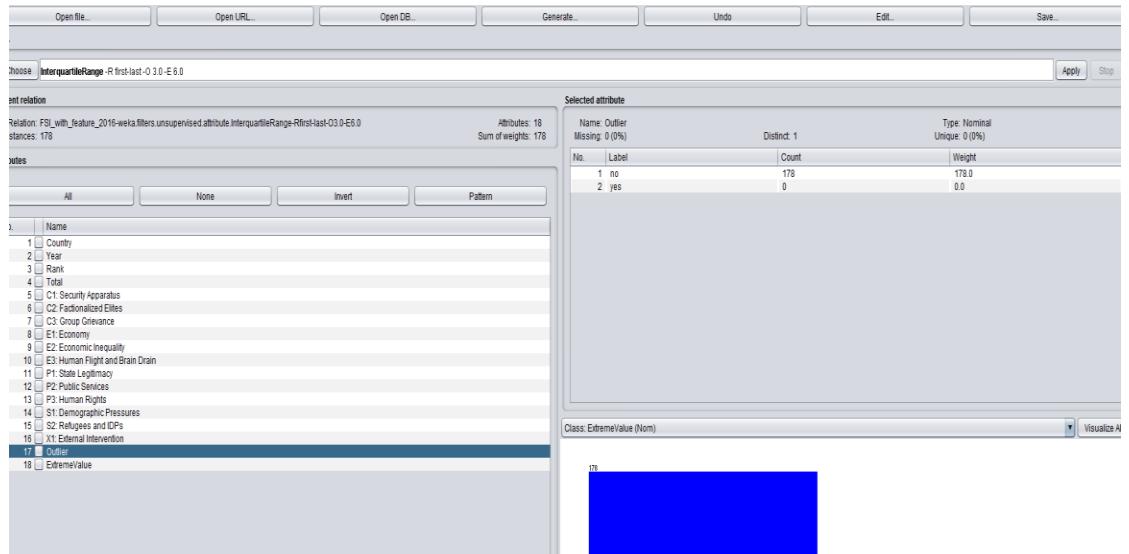
1. Data Pre-Processing:-

- Data downloaded from the FSI website was not suitable for the classification and hence some data cleaning and pre-processing was required. We performed the data cleaning and pre-processing on the downloaded data.



- We performed below task in the process of data pre-processing:-
 1. Removal of special characters so that csv files can be imported successfully in weka.
 2. Fill up the missing values by the mean value of that column.
 3. We also deleted the empty rows from the data so that analysis can be done on the data.
 4. Converting each numeric column value in the range of 0 to 10.

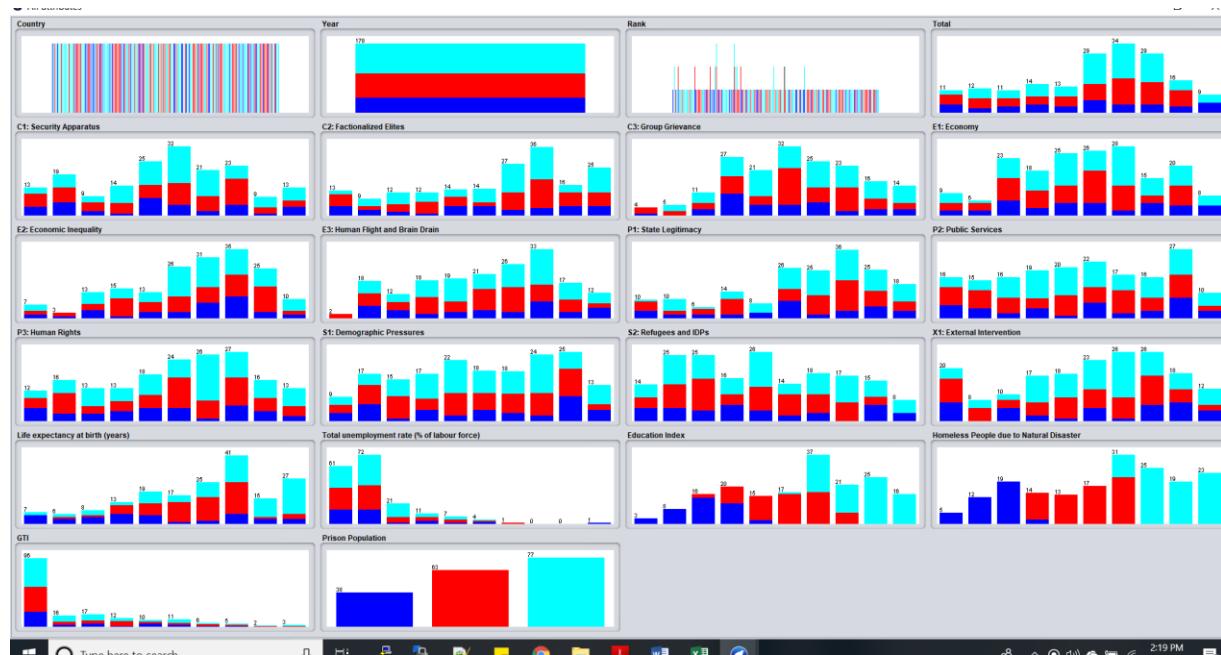
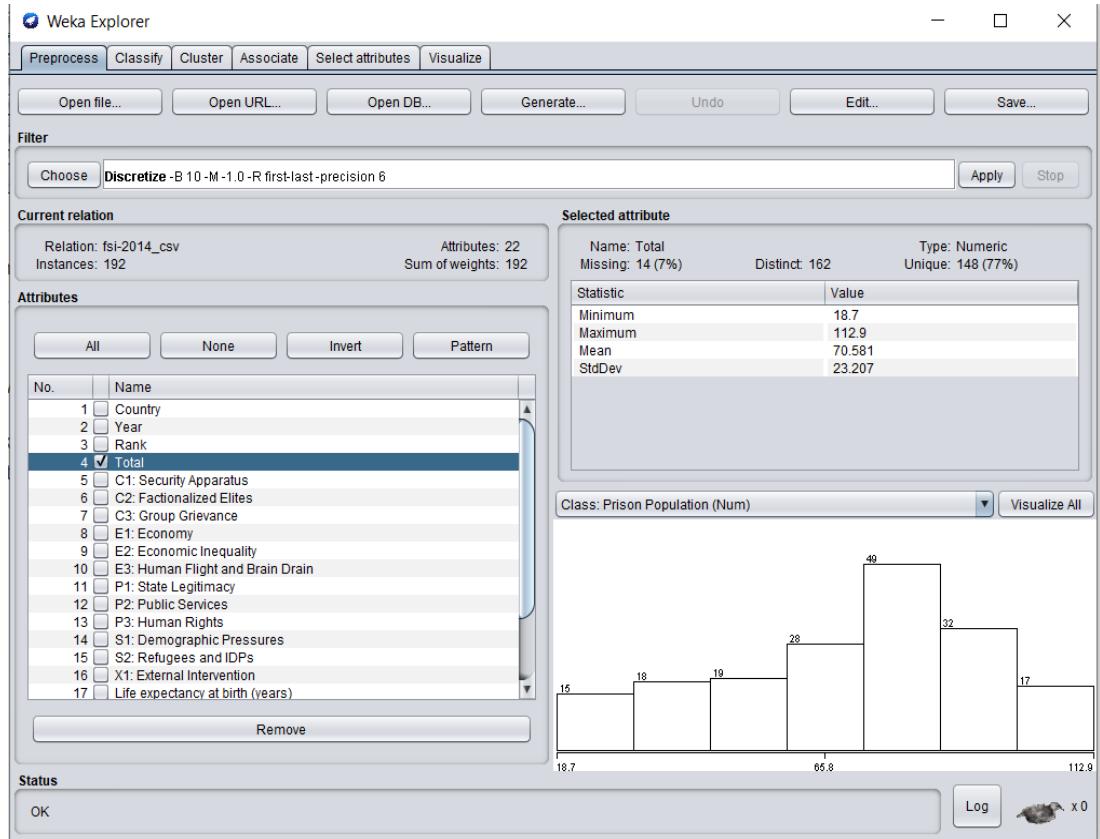
5. Removal of outliers from the data so that data will be properly distributed and will perform better on the classifiers.

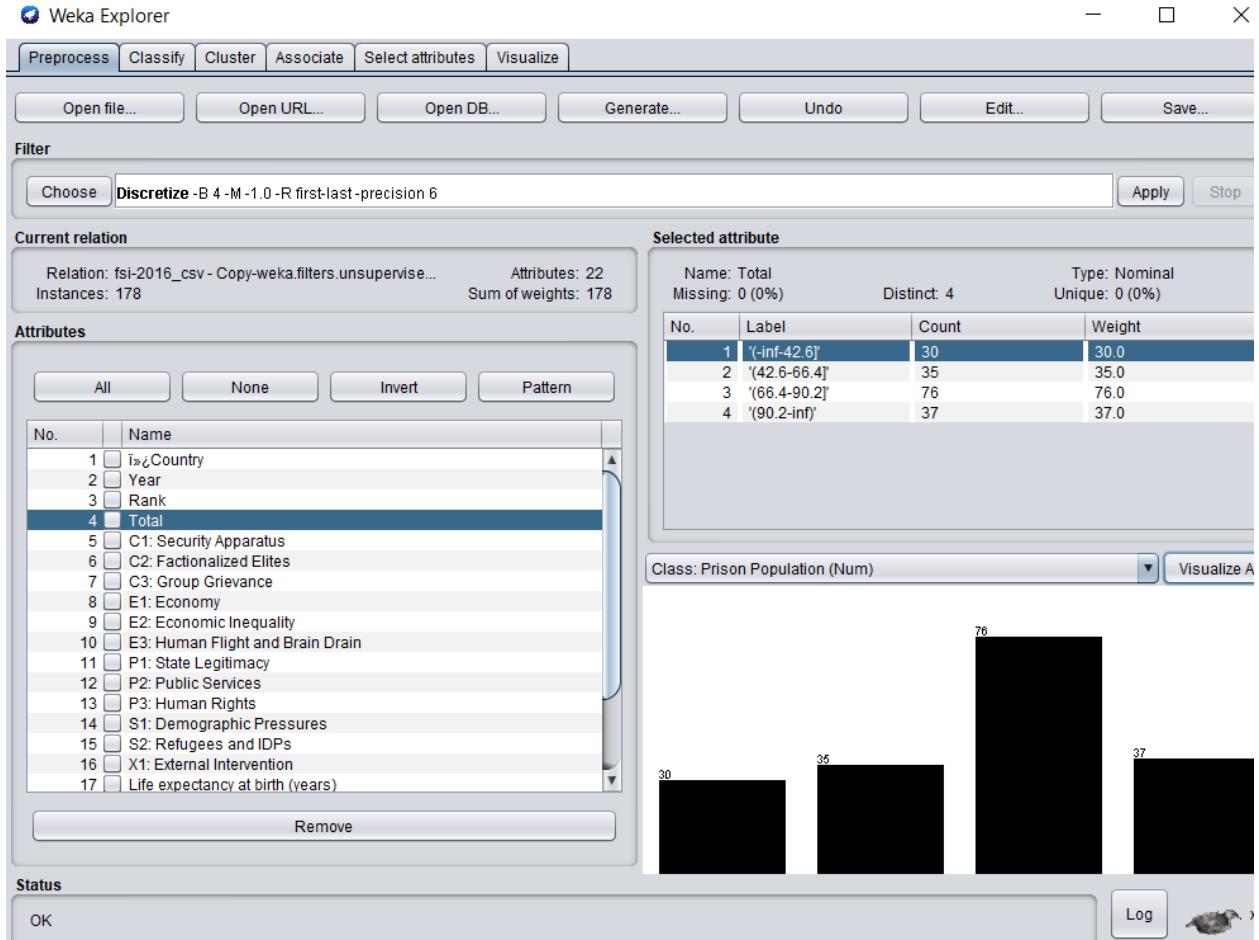


Above image shows the distribution of data, after the removal of outliers.

2. Data Discretization:-

- Discretization is the process of converting the partitioning attributed to discretized or nominal attributes. In our case, we are performing discretization on Total column to replace numerical values of the total with below-mentioned values.
- We are replacing the specific range into below sectors:-
 1. Alert (union of Very High Alert, High Alert, Alert)
 2. Warning (union of High Warning, Elevated Warning, Warning).
 3. Stable (union of Stable, More Stable, Very Stable).
 4. Sustainable (union of Sustainable, Very Sustainable).





3. Data Classification

On completion of this, we tried and tested a lot of classifiers in WEKA tool to get the best-suited classifier for our data. Few of the tested classifiers are as follows:
LMT (Logistic Model Trees), RandomTree,

Classifier:-

1. **Logistic Model Tree (LMT)** - Logistic Model Tree is a combination of the logistic regression and the decision tree. This classifier is optimal most of the times which the decision is binary in the dataset.

Below are the screenshots of the results for the year 2014-2016:-

Year - 2014

1. Without Additional Parameters:

```
Class Sustainable :  
11.65 +  
[C1: Security Apparatus] * -0.67 +  
[C2: Group Grievance] * 0.44 +  
[P1: State Legitimacy] * -1.05 +  
[S2: Refugees and IDPs] * -0.55  
  
Time taken to build model: 1.5 seconds  
==== Stratified cross-validation ====  
==== Summary ====  
Correctly Classified Instances 150 84.2697 %  
Incorrectly Classified Instances 25 15.7303 %  
Kappa statistic 0.7201  
Mean absolute error 0.0933  
Root mean squared error 0.2437  
Relative absolute error 31.856 %  
Root relative squared error 65.9034 %  
Total Number of Instances 175  
  
==== Detailed Accuracy By Class ====  


| TP Rate       | FP Rate | Precision | Recall | F-Measure | MCC   | ROC Area | FPR Area | Class       |
|---------------|---------|-----------|--------|-----------|-------|----------|----------|-------------|
| 0.727         | 0.006   | 0.889     | 0.727  | 0.800     | 0.793 | 0.956    | 0.779    | Alert       |
| 0.159         | 0.073   | 0.730     | 0.620  | 0.692     | 0.608 | 0.926    | 0.803    | Stable      |
| 0.943         | 0.171   | 0.846     | 0.943  | 0.908     | 0.845 | 0.945    | 0.942    | Warning     |
| 0.762         | 0.019   | 0.842     | 0.762  | 0.800     | 0.776 | 0.988    | 0.902    | Sustainable |
| Weighted Avg. | 0.843   | 0.133     | 0.839  | 0.843     | 0.839 | 0.733    | 0.947    | 0.895       |

  
==== Confusion Matrix ====  


| a | b  | c  | d  | <-- classified as |
|---|----|----|----|-------------------|
| 8 | 0  | 1  | 0  | a = Alert         |
| 0 | 27 | 11 | 0  | b = Stable        |
| 1 | 5  | 99 | 0  | c = Warning       |
| 0 | 5  | 0  | 16 | d = Sustainable   |


```

Accuracy Observed - 84.26%

2. With Additional Parameters:

```
Class Sustainable :  
12.53 +  
[C1: Security Apparatus] * -1.51 +  
[C3: Group Grievance] * -0.44 +  
[P1: State Legitimacy] * -1.46 +  
[S2: Refugees and IDPs] * -0.55  
  
Time taken to build model: 2.53 seconds  
==== Stratified cross-validation ====  
==== Summary ====  
Correctly Classified Instances 153 85.9551 %  
Incorrectly Classified Instances 25 14.0449 %  
Kappa statistic 0.7499  
Mean absolute error 0.0831  
Root mean squared error 0.2261  
Relative absolute error 28.3758 %  
Root relative squared error 59.2882 %  
Total Number of Instances 178  
  
==== Detailed Accuracy By Class ====  


| TP Rate       | FP Rate | Precision | Recall | F-Measure | MCC   | ROC Area | FPR Area | Class       |
|---------------|---------|-----------|--------|-----------|-------|----------|----------|-------------|
| 0.636         | 0.006   | 0.875     | 0.636  | 0.737     | 0.733 | 0.941    | 0.755    | Alert       |
| 0.707         | 0.058   | 0.784     | 0.707  | 0.744     | 0.673 | 0.946    | 0.873    | Stable      |
| 0.952         | 0.178   | 0.885     | 0.952  | 0.917     | 0.791 | 0.941    | 0.932    | Warning     |
| 0.810         | 0.019   | 0.850     | 0.810  | 0.829     | 0.807 | 0.994    | 0.958    | Sustainable |
| Weighted Avg. | 0.860   | 0.121     | 0.857  | 0.860     | 0.856 | 0.762    | 0.949    | 0.910       |

  
==== Confusion Matrix ====  


| a | b  | c   | d  | <-- classified as |
|---|----|-----|----|-------------------|
| 7 | 0  | 4   | 0  | a = Alert         |
| 0 | 29 | 9   | 3  | b = Stable        |
| 1 | 4  | 100 | 0  | c = Warning       |
| 0 | 4  | 0   | 17 | d = Sustainable   |


```

Accuracy Observed - 85.95%

Year 2015

1. Without Additional Parameters:

```
Result list (right-click for options)
18:50:27 - trees.LMT

Time taken to build model: 3.69 seconds

==== Stratified cross-validation ====
==== Summary ====

Correctly Classified Instances      154          86.5169 %
Incorrectly Classified Instances    24           13.4831 %
Kappa statistic                   0.7606
Mean absolute error               0.0753
Root mean squared error          0.224
Relative absolute error           25.7108 %
Root relative squared error     58.7501 %
Total Number of Instances        178

==== Detailed Accuracy By Class ====

      TP Rate   FP Rate   Precision   Recall   F-Measure   MCC   ROC Area
0  0.727     0.006     0.889     0.727     0.800     0.793     0.985
0  0.732     0.066     0.769     0.732     0.750     0.678     0.940
0  0.952     0.164     0.893     0.952     0.922     0.802     0.964
0  0.762     0.013     0.889     0.762     0.821     0.802     0.979
Weighted Avg.  0.865     0.114     0.864     0.865     0.863     0.773     0.962

==== Confusion Matrix ====

a   b   c   d  <-- classified as
8   0   3   0 |  a = Alert
0  30   9   2 |  b = Stable
1   4  100   0 |  c = Warning
0   5   0  16 |  d = Sustainable
```

Accuracy Observed - 86.51%

2. With Additional Parameters:

```
Result list (right-click for options)
18:42:05 - trees.LMT

Time taken to build model: 3.58 seconds

==== Stratified cross-validation ====
==== Summary ====

Correctly Classified Instances      156          87.6404 %
Incorrectly Classified Instances    22           12.3596 %
Kappa statistic                   0.78
Mean absolute error               0.0737
Root mean squared error          0.2166
Relative absolute error           25.1808 %
Root relative squared error     56.8026 %
Total Number of Instances        178

==== Detailed Accuracy By Class ====

      TP Rate   FP Rate   Precision   Recall   F-Measure   MCC   ROC Area   FRC Area   Class
0  0.818     0.000     1.000     0.818     0.900     0.899     0.986     0.937     Alert
0  0.707     0.058     0.784     0.707     0.744     0.673     0.940     0.772     Stable
0  0.962     0.164     0.894     0.962     0.927     0.815     0.967     0.966     Warning
0  0.810     0.013     0.895     0.810     0.850     0.832     0.983     0.892     Sustainable
Weighted Avg.  0.876     0.112     0.875     0.876     0.874     0.789     0.964     0.911

==== Confusion Matrix ====

a   b   c   d  <-- classified as
9   0   2   0 |  a = Alert
0  29   10   2 |  b = Stable
0   4  101   0 |  c = Warning
0   4   0  17 |  d = Sustainable
```

Accuracy Observed - 87.64%

Year 2016

1. Without Additional Parameters:

The screenshot shows the Weka Explorer interface with the 'Classify' tab selected. A classifier named 'LMT -I-1-M 15-W 0.0' is chosen. In the 'Test options' panel, 'Cross-validation Folds 10' is selected. The 'Classifier output' panel displays the following text:

```

Class sustainable :
81.57 +
[1*]:[Country=Japan] * -1.35 +
[1*]:[Country=United Kingdom] * -1.33 +
[01: Security Apparatus] * -3.51 +
[03: Group Grievance] * -1.63 +
[02: Economic Inequality] * -5.97 +
[03: Human Flight and Brain Drain] * -3.36 +
[01: State Legitimacy] * -4.28 +
[03: Human Rights] * -4.18 +
[01: Demographic Pressures] * -5.5

```

Time taken to build model: 4.74 seconds

```

==== Stratified cross-validation ====
==== Summary ====

Correctly Classified Instances      163          91.573 %
Incorrectly Classified Instances    15           8.427 %
Kappa statistic                      0.8719
Mean absolute error                  0.0535
Root mean squared error              0.1794
Relative absolute error              16.0417 %
Root relative squared error         44.0135 %
Total Number of Instances           178

==== Detailed Accuracy By Class ====

      TP Rate   FP Rate   Precision   Recall   F-Measure   MCC   ROC Area   PRC Area   Class
0.895     0.014     0.944     0.895     0.919     0.898     0.995     0.981     Alert
0.954     0.099     0.902     0.954     0.927     0.855     0.983     0.981     warning
0.811     0.014     0.938     0.811     0.870     0.842     0.976     0.948     stable
1.000     0.012     0.889     1.000     0.941     0.937     0.996     0.948     sustainable
Weighted Avg.   0.916     0.055     0.917     0.916     0.915     0.869     0.985     0.972

==== Confusion Matrix ====

a b c d  <-- classified as
34 4 0 0 | a = Alert
2 83 2 0 | b = warning
0 5 30 2 | c = stable
0 0 0 16 | d = sustainable

```

Accuracy Observed - 91.57%

2. With Additional Parameters:

The screenshot shows the Weka Explorer interface with the 'Classify' tab selected. A classifier named 'LMT -I-1-M 15-W 0.0' is chosen. In the 'Test options' panel, 'Cross-validation Folds 10' is selected. The 'Classifier output' panel displays the following text:

```

Time taken to build model: 4.09 seconds
==== Stratified cross-validation ====
==== Summary ====

Correctly Classified Instances      166          93.2584 %
Incorrectly Classified Instances    12           6.7416 %
Kappa statistic                      0.8973
Mean absolute error                  0.0525
Root mean squared error              0.1739
Relative absolute error              15.7539 %
Root relative squared error         42.6588 %
Total Number of Instances           178

==== Detailed Accuracy By Class ====

      TP Rate   FP Rate   Precision   Recall   F-Measure   MCC   ROC Area   PRC Area   Class
0.895     0.007     0.971     0.895     0.932     0.915     0.994     0.978     Alert
0.977     0.088     0.914     0.977     0.944     0.890     0.984     0.983     warning
0.838     0.007     0.969     0.838     0.899     0.878     0.977     0.955     stable
1.000     0.012     0.889     1.000     0.941     0.937     0.995     0.945     sustainable
Weighted Avg.   0.933     0.047     0.935     0.933     0.932     0.897     0.986     0.973

==== Confusion Matrix ====

a b c d  <-- classified as
34 4 0 0 | a = Alert
1 85 1 0 | b = warning
0 4 31 2 | c = stable
0 0 0 16 | d = sustainable

```

Accuracy Observed - 93.25%

2. Random Tree: -A random tree is a tree formed by a stochastic process which is a collection of random variables indexed by time. We used this classifier to understand and analyze our data deeply. Random Tree is more accurate than that of logistic model tree. Now let us analyze the result on the data with Random Tree Classifier:-

Year - 2014

1. Without Additional Parameters:

```

(Nom) Total
Start Stop
Result list (right-click for options)
15.07.51 - trees.LMT
16.48.28 - trees.RandomTree

Country = Yemen : Alert (1/0)
Country = Zambia : Alert (0/0)
Country = Zimbabwe : Alert (0/0)

Size of the tree : 523
Time taken to build model: 0.01 seconds
*** Stratified cross-validation ***
*** Summary ***

Correctly Classified Instances      112          62.9213 %
Incorrectly Classified Instances    66          37.0787 %
Kappa statistic                   0.2302
Mean absolute error               0.2296
Root mean squared error           0.3575
Relative absolute error            78.4115 %
Root relative squared error       93.7402 %
Total Number of Instances         178

*** Detailed Accuracy By Class ***
      TP Rate   FP Rate   Precision   Recall   F-Measure   MCC   ROC Area   PRC Area   Class
0.091     0.018     0.250     0.091     0.133     0.119     0.636     0.108     Alert
0.293     0.080     0.522     0.293     0.375     0.267     0.704     0.445     Stable
0.905     0.699     0.651     0.905     0.757     0.264     0.724     0.769     Warning
0.190     0.006     0.800     0.190     0.308     0.359     0.800     0.369     Sustainable
Weighted Avg.   0.629     0.432     0.614     0.629     0.577     0.267     0.723     0.606

*** Confusion Matrix ***
a b c d <-- classified as
1 0 10 0 | a = Alert
0 12 28 1 | b = Stable
3 7 95 0 | c = Warning
0 4 13 4 | d = Sustainable

Status
OK

```

Accuracy Observed - 62.9213%

2. With Additional Parameters:

```

(Nom) Total
Start Stop
Result list (right-click for options)
17.06.36 - trees.LMT
17.14.33 - trees.RandomTree

Country = Yemen : Alert (1/0)
Country = Zambia : Warning (1/0)
Country = Zimbabwe : Warning (1/0)

Size of the tree : 179
Time taken to build model: 0 seconds
*** Stratified cross-validation ***
*** Summary ***

Correctly Classified Instances      123          69.1011 %
Incorrectly Classified Instances    55          30.8989 %
Kappa statistic                   0.351
Mean absolute error               0.2224
Root mean squared error           0.3399
Relative absolute error            75.9775 %
Root relative squared error       89.1332 %
Total Number of Instances         178

*** Detailed Accuracy By Class ***
      TP Rate   FP Rate   Precision   Recall   F-Measure   MCC   ROC Area   PRC Area   Class
0.182     0.006     0.667     0.182     0.286     0.329     0.770     0.216     Alert
0.366     0.058     0.652     0.366     0.469     0.386     0.720     0.480     Stable
0.981     0.616     0.696     0.981     0.814     0.479     0.767     0.796     Warning
0.143     0.006     0.750     0.143     0.240     0.297     0.741     0.315     Sustainable
Weighted Avg.   0.691     0.378     0.690     0.691     0.634     0.427     0.753     0.631

*** Confusion Matrix ***
a b c d <-- classified as
2 0 9 0 | a = Alert
0 15 25 1 | b = Stable
1 1 103 0 | c = Warning
0 7 11 3 | d = Sustainable

Status
OK

```

Accuracy Observed - 69.101%

Year - 2015

1. Without Additional Parameters:

The screenshot shows the Weka interface for a classification task. The classifier chosen is HoeffdingTree. The test options include 'Cross-validation Folds 10' and 'Percentage split % 66'. The result list shows '18:47:42 - trees.RandomTree' selected. The classifier output window displays various performance metrics and a confusion matrix. The accuracy is 66.2921%.

```

18:42:05 - trees.LMT
18:47:42 - trees.RandomTree
18:48:10 - trees.RandomForest
18:48:34 - trees.HoeffdingTree

Size of the tree : 179
Time taken to build model: 0 seconds
*** Stratified cross-validation ***
*** Summary ***
Correctly Classified Instances      118      66.2921 %
Incorrectly Classified Instances    60      33.7079 %
Kappa statistic                      0.304
Mean absolute error                  0.2239
Root mean squared error              0.3454
Relative absolute error              76.4972 %
Root relative squared error         90.5847 %
Total Number of Instances           178

*** Detailed Accuracy By Class ***

TP Rate   FP Rate   Precision   Recall   F-Measure   MCC   ROC Area   PRC Area   Class
0.182     0.006     0.667     0.182     0.286     0.329     0.733     0.207     Alert
0.390     0.109     0.516     0.390     0.444     0.312     0.720     0.444     Stable
0.943     0.603     0.692     0.943     0.798     0.421     0.771     0.816     Warning
0.048     0.000     1.000     0.048     0.091     0.206     0.807     0.379     Sustainable
Weighted Avg.  0.663     0.381     0.686     0.663     0.602     0.365     0.761     0.641

*** Confusion Matrix ***

a b c d  <-- classified as
2 0 9 0 | a = Alert
0 16 25 0 | b = Stable
1 5 99 0 | c = Warning
0 10 10 1 | d = Sustainable

```

Status: OK

Accuracy Observed - 66.29%

2. With Additional Parameters:

The screenshot shows the Weka interface for a classification task. The classifier chosen is HoeffdingTree. The test options include 'Cross-validation Folds 10' and 'Percentage split % 66'. The result list shows '18:51:37 - trees.RandomTree' selected. The classifier output window displays various performance metrics and a confusion matrix. The accuracy is 78.6517%.

```

18:50:27 - trees.LMT
18:51:37 - trees.RandomTree
18:55:05 - trees.RandomForest
18:55:30 - trees.HoeffdingTree

Size of the tree : 893
Time taken to build model: 0 seconds
*** Stratified cross-validation ***
*** Summary ***
Correctly Classified Instances      140      78.6517 %
Incorrectly Classified Instances    38      21.3483 %
Kappa statistic                      0.6125
Mean absolute error                  0.14
Root mean squared error              0.2961
Relative absolute error              50.0225 %
Root relative squared error         77.6466 %
Total Number of Instances           178

*** Detailed Accuracy By Class ***

TP Rate   FP Rate   Precision   Recall   F-Measure   MCC   ROC Area   PRC Area   Class
0.693     0.006     0.667     0.693     0.628     0.629     0.795     0.317     Alert
0.693     0.109     0.651     0.693     0.667     0.564     0.821     0.590     Stable
0.924     0.247     0.843     0.924     0.852     0.697     0.879     0.894     Warning
0.619     0.025     0.765     0.619     0.684     0.651     0.897     0.642     Sustainable
Weighted Avg.  0.787     0.174     0.779     0.787     0.772     0.638     0.863     0.759

*** Confusion Matrix ***

a b c d  <-- classified as
2 0 9 0 | a = Alert
0 28 9 4 | b = Stable
1 7 97 0 | c = Warning
0 8 0 13 | d = Sustainable

```

Status:

Accuracy Observed - 78.65%

Year 2016

1. Without Additional Parameters:

```

Size of the tree : 686
Time taken to build model: 0.01 seconds
*** Stratified cross-validation ***
*** Summary ***

Correctly Classified Instances      120      67.4157 %
Incorrectly Classified Instances   58      32.5843 %
Kappa statistic                   0.4774
Mean absolute error               0.2064
Root mean squared error           0.3347
Relative absolute error            61.9298 %
Root relative squared error       82.1011 %
Total Number of Instances         178

*** Detailed Accuracy By Class ***

      TP Rate  FP Rate  Precision  Recall   F-Measure  MCC    ROC Area  PRC Area  Class
      0.395   0.029   0.789   0.395   0.526   0.486   0.853   0.585   Alert
      0.839   0.396   0.670   0.839   0.745   0.455   0.808   0.800   warning
      0.703   0.128   0.591   0.703   0.642   0.541   0.880   0.639   stable
      0.375   0.000   1.000   0.375   0.545   0.594   0.925   0.620   sustainable
Weighted Avg.                     0.674   0.226   0.709   0.674   0.659   0.492   0.843   0.704

*** Confusion Matrix ***

a b c d  <-- classified as
15 22 1 0 | a = Alert
4 73 10 0 | b = warning
0 11 26 0 | c = stable
0 3 7 6 | d = sustainable

```

Accuracy Observed - 67.41%

2. With Additional Parameters:

```

Test options
 Use training set
 Supplied test set Set...
 Cross-validation Folds: 10
 Percentage split %: 66
More options...

Classifier output
Choose RandomTree -K 0 -M 1.0 -V 0.001 -S 1

Result list (right-click for options)
19:19:32 - trees.LMT
19:23:56 - trees.RandomTree

Time taken to build model: 0.01 seconds
*** Stratified cross-validation ***
*** Summary ***

Correctly Classified Instances      121      67.9775 %
Incorrectly Classified Instances   57      32.0225 %
Kappa statistic                   0.496
Mean absolute error               0.1938
Root mean squared error           0.3388
Relative absolute error            58.156 %
Root relative squared error       83.0885 %
Total Number of Instances         178

*** Detailed Accuracy By Class ***

      TP Rate  FP Rate  Precision  Recall   F-Measure  MCC    ROC Area  PRC Area  Class
      0.658   0.071   0.714   0.658   0.695   0.605   0.880   0.684   Alert
      0.793   0.363   0.676   0.793   0.730   0.435   0.808   0.779   warning
      0.541   0.092   0.606   0.541   0.571   0.468   0.831   0.593   stable
      0.438   0.006   0.875   0.438   0.583   0.595   0.911   0.621   sustainable
Weighted Avg.                     0.680   0.212   0.688   0.680   0.674   0.493   0.838   0.706

*** Confusion Matrix ***

a b c d  <-- classified as
25 13 0 0 | a = Alert
10 69 8 0 | b = warning
0 16 20 1 | c = stable
0 4 5 7 | d = sustainable

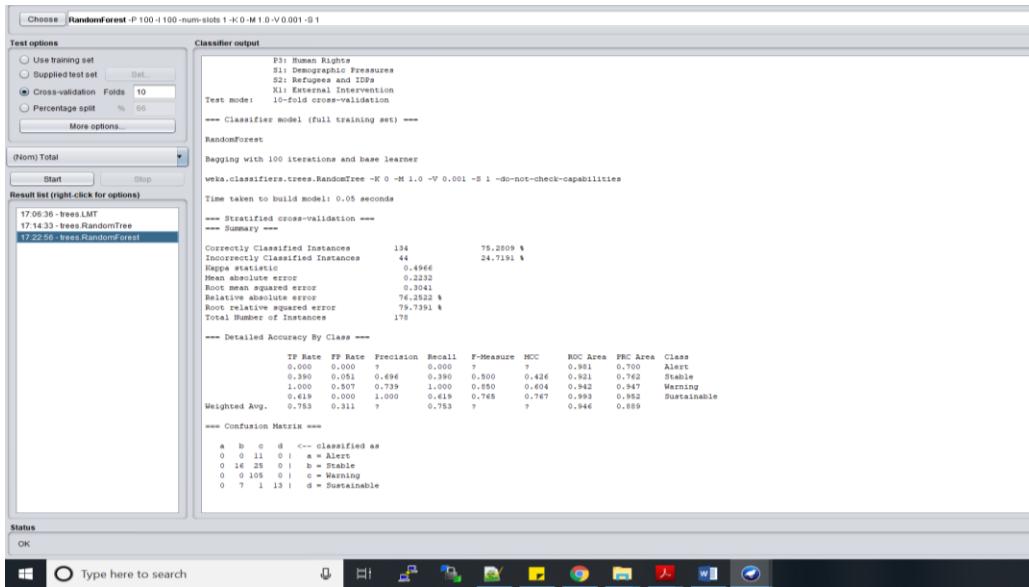
```

Accuracy Observed - 67.97%

3. Random Forest:- Random forest is like a bootstrapping algorithm with Decision tree (CART) model. Final prediction can simply be the mean of each prediction. Random forest is chosen for the implementation as it gives better results with the use of default hyperparameters. Also, it is a very fast algorithm and hence the efficiency of the will also get increase due to Random Forest. Hence we implemented a random forest algorithm. Below are the results of the Random Forest algorithm during each year.

Year 2014

1. Without Additional Parameters:



```

Choose RandomForest -P 100 -I 100 -num-slots 1 -K 0 -M 1.0 -V 0.001 -S 1

Test options
 Use training set
 Supplied test set Set...
 Cross-validation Folds 10
 Percentage split % 66
More options...

(Nom) Total
Start Stop
Result list (right-click for options)
17.06.36-trees.LMT
17.14.33-trees.RandomTree
17.22.56-trees.RandomForest

Classifier output
F3: Human Rights
S1: Demographic Pressures
S2: Economic Pressures
X1: External Intervention

Test mode: 10-fold cross-validation

==== Classifier model (full training set) ====
RandomForest
Bagging with 100 iterations and base learner
weka.classifiers.trees.RandomTree -K 0 -M 1.0 -V 0.001 -S 1 -do-not-check-capabilities

Time taken to build model: 0.05 seconds

==== Stratified cross-validation ====
==== Summary ====
Correctly Classified Instances 134 75.2809 %
Incorrectly Classified Instances 44 24.7191 %
Kappa statistic 0.1666
Mean absolute error 0.2323
Root mean squared error 0.3041
Relative absolute error 76.2822 %
Root relative squared error 79.7391 %
Total Number of Instances 178

==== Detailed Accuracy By Class ====


|               | TP Rate | FP Rate | Precision | Recall | F-Measure | MCC   | ROC Area | PRC Area | Class       |
|---------------|---------|---------|-----------|--------|-----------|-------|----------|----------|-------------|
| 0.000         | 0.000   | 1       | 0.000     | 7      | 0.000     | 0.991 | 0.700    | 0.817    | Alert       |
| 0.486         | 0.486   | 0.500   | 0.486     | 1      | 0.486     | 0.667 | 0.714    | 0.822    | Stable      |
| 1.000         | 0.507   | 0.739   | 1.000     | 0.750  | 0.604     | 0.942 | 0.947    | 0.955    | Warning     |
| 0.619         | 0.000   | 1.000   | 0.619     | 0.765  | 0.767     | 0.993 | 0.952    | 0.956    | Sustainable |
| Weighted Avg. | 0.753   | 0.311   | ?         | 0.753  | ?         | 0.946 | 0.889    |          |             |



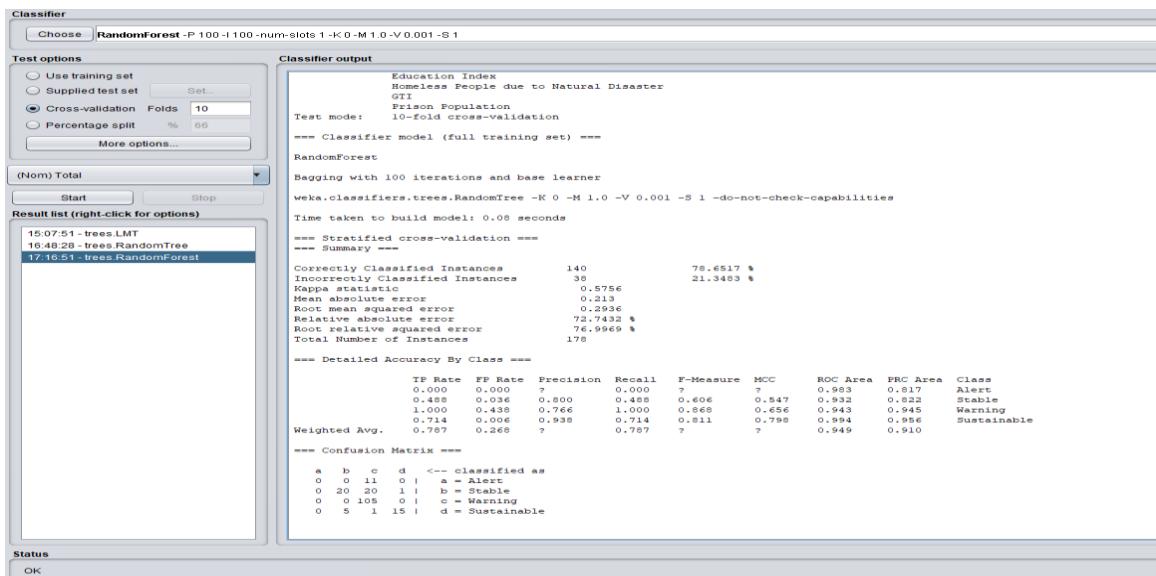
==== Confusion Matrix ====


| a | b  | c   | d  | <-- classified as |
|---|----|-----|----|-------------------|
| 0 | 0  | 11  | 0  | a = Alert         |
| 0 | 16 | 25  | 0  | b = Stable        |
| 0 | 0  | 105 | 0  | c = Warning       |
| 0 | 7  | 1   | 13 | d = Sustainable   |


```

Accuracy Observed - 75.28%

2. With Additional Parameters:



```

Choose RandomForest -P 100 -I 100 -num-slots 1 -K 0 -M 1.0 -V 0.001 -S 1

Test options
 Use training set
 Supplied test set Set...
 Cross-validation Folds 10
 Percentage split % 66
More options...

(Nom) Total
Start Stop
Result list (right-click for options)
15.07.51-trees.LMT
16.46.28-trees.RandomTree
17.10.51-trees.RandomForest

Classifier output
Education Index
Homeless People due to Natural Disaster
GPI
Prison Population

Test mode: 10-fold cross-validation

==== Classifier model (full training set) ====
RandomForest
Bagging with 100 iterations and base learner
weka.classifiers.trees.RandomTree -K 0 -M 1.0 -V 0.001 -S 1 -do-not-check-capabilities

Time taken to build model: 0.06 seconds

==== Stratified cross-validation ====
==== Summary ====
Correctly Classified Instances 140 78.6517 %
Incorrectly Classified Instances 38 21.3483 %
Kappa statistic 0.5766
Mean absolute error 0.1313
Root mean squared error 0.2936
Relative absolute error 72.7432 %
Root relative squared error 76.9969 %
Total Number of Instances 178

==== Detailed Accuracy By Class ====


|               | TP Rate | FP Rate | Precision | Recall | F-Measure | MCC   | ROC Area | PRC Area | Class       |
|---------------|---------|---------|-----------|--------|-----------|-------|----------|----------|-------------|
| 0.000         | 0.000   | 1       | 0.000     | 7      | 0.000     | 0.983 | 0.817    | 0.817    | Alert       |
| 0.488         | 0.488   | 0.500   | 0.488     | 1      | 0.488     | 0.646 | 0.547    | 0.932    | Stable      |
| 1.000         | 0.434   | 0.766   | 1.000     | 0.750  | 0.665     | 0.956 | 0.956    | 0.955    | Warning     |
| 0.714         | 0.006   | 0.998   | 0.714     | 0.811  | 0.798     | 0.994 | 0.956    | 0.956    | Sustainable |
| Weighted Avg. | 0.787   | 0.268   | ?         | 0.787  | ?         | 0.949 | 0.910    |          |             |



==== Confusion Matrix ====


| a | b  | c   | d  | <-- classified as |
|---|----|-----|----|-------------------|
| 0 | 11 | 1   | 1  | a = Alert         |
| 0 | 20 | 20  | 1  | b = Stable        |
| 0 | 0  | 105 | 0  | c = Warning       |
| 0 | 5  | 1   | 15 | d = Sustainable   |


```

Accuracy Observed - 78.68%

Year 2015

1. Without Additional Parameters:

The screenshot shows the Weka interface with the following details:

- Start/Stop Buttons:** Start, Stop.
- Result list:** A list of classifiers: trees.LMT, trees.RandomTree, **trees.RandomForest**, and trees.HoeffdingTree. The RandomForest entry is highlighted.
- Output Window:** Displays the command used: weka.classifiers.trees.RandomTree -K 0 -M 1.0 -V 0.001 -S 1 -do-not-check-capabilities. It also shows the time taken to build the model (0.06 seconds), stratified cross-validation statistics, and a detailed accuracy table by class. The overall accuracy is 77.5281%.
- Status Bar:** Shows "Status OK".
- Taskbar:** Shows the Windows taskbar with various pinned icons like File Explorer, Edge, and File Manager.

Accuracy Observed - 77.52%

2. With Additional Parameters:

The screenshot shows the Weka interface with the following details:

- Start/Stop Buttons:** Start, Stop.
- Result list:** A list of classifiers: trees.LMT, trees.RandomTree, **trees.RandomForest**, and trees.HoeffdingTree. The RandomForest entry is highlighted.
- Output Window:** Displays the command used: weka.classifiers.trees.RandomTree -K 0 -M 1.0 -V 0.001 -S 1 -do-not-check-capabilities. It also shows the time taken to build the model (0.07 seconds), stratified cross-validation statistics, and a detailed accuracy table by class. The overall accuracy is 78.0899%.
- Status Bar:** Shows "Status OK".

Accuracy Observed -78.08%

Year 2016

1. Without Additional Parameters:

The screenshot shows the Weka interface with the 'Classifier' tab selected. The 'Choose' button is set to 'RandomForest -P 100 -I 100 -num-slots 1 -K 0 -M 1.0 -V 0.001 -S 1'. The 'Test options' panel shows 'Cross-validation Folds 10' selected. The 'Classifier output' panel displays the following text:

```

P3: Human Rights
S1: Demographic Pressures
S2: Refugees and IDPs
X1: External Intervention
Test mode: 10-fold cross-validation

== Classifier model (full training set) ==

RandomForest

Bagging with 100 iterations and base learner
weka.classifiers.trees.RandomTree -K 0 -M 1.0 -V 0.001 -S 1 -do-not-check-capabilities

Time taken to build model: 0.08 seconds

== Stratified cross-validation ==
== Summary ==

Correctly Classified Instances      134      75.2809 %
Incorrectly Classified Instances   44       24.7191 %
Kappa statistic                   0.5888
Mean absolute error               0.2547
Root mean squared error          0.3209
Relative absolute error           76.4038 %
Root relative squared error     78.6992 %
Total Number of Instances        178

== Detailed Accuracy By Class ==

      TP Rate  FP Rate  Precision  Recall  F-Measure  MCC    ROC Area  PRC Area  Class
0  0.263   0.000   1.000    0.263   0.417    0.468   0.978   0.934   Alert
1  1.000   0.418   0.696    1.000   0.821    0.637   0.947   0.933   warning
2  0.730   0.043   0.818    0.730   0.771    0.718   0.975   0.938   stable
3  0.625   0.000   1.000    0.625   0.769    0.776   0.996   0.966   sustainable

Weighted Avg.  0.753   0.213   0.814    0.753   0.720    0.630   0.964   0.937

== Confusion Matrix ==

a b c d  <-- classified as
10 28 0 0 | a = Alert
0 87 0 0 | b = warning
0 10 27 0 | c = stable
0 0 6 10 | d = sustainable

```

Accuracy Observed - 75.28%

2. With Additional Parameters:

The screenshot shows the Weka interface with the 'Classifier' tab selected. The 'Choose' button is set to 'RandomForest -P 100 -I 100 -num-slots 1 -K 0 -M 1.0 -V 0.001 -S 1 -do-not-check-capabilities'. The 'Test options' panel shows 'Cross-validation Folds 10' selected. The 'Classifier output' panel displays the following text:

```

PRISON Population
Test mode: 10-fold cross-validation

== Classifier model (full training set) ==

RandomForest

Bagging with 100 iterations and base learner
weka.classifiers.trees.RandomTree -K 0 -M 1.0 -V 0.001 -S 1 -do-not-check-capabilities

Time taken to build model: 0.06 seconds

== Stratified cross-validation ==
== Summary ==

Correctly Classified Instances      139      78.0899 %
Incorrectly Classified Instances   39       21.9101 %
Kappa statistic                   0.6382
Mean absolute error               0.2481
Root mean squared error          0.3149
Relative absolute error           74.4378 %
Root relative squared error     77.2462 %
Total Number of Instances        178

== Detailed Accuracy By Class ==

      TP Rate  FP Rate  Precision  Recall  F-Measure  MCC    ROC Area  PRC Area  Class
0  0.342   0.000   1.000    0.342   0.510    0.539   0.985   0.952   Alert
1  1.000   0.396   0.707    1.000   0.829    0.654   0.952   0.940   warning
2  0.730   0.021   0.900    0.730   0.806    0.768   0.971   0.925   stable
3  0.750   0.000   1.000    0.750   0.857    0.856   0.998   0.985   sustainable

Weighted Avg.  0.781   0.198   0.836    0.781   0.758    0.671   0.967   0.943

== Confusion Matrix ==

a b c d  <-- classified as
13 25 0 0 | a = Alert
0 87 0 0 | b = warning
0 10 27 0 | c = stable
0 1 3 12 | d = sustainable

```

Accuracy Observed -78.08%

4. Hoeffding Tree:- A Hoeffding tree is useful in case of the large data set. It is mainly used in mining high-speed data streams. As it is of incremental type. accuracy of this algorithm seems to be more on the dataset. Hence we chose this particular method of classification. Also, the memory requirement of this algorithm is also very small and hence can be easily implemented on our dataset. This is one of the classifiers used for classification of our data.

Year 2014

1. Without Additional Parameters:

```

m) Total
Start Stop
List (right-click for options)
107:51 - trees.LMT
148:28 - trees.RandomTree
165:51 - trees.RandomForest
19:02 - trees.HoeffdingTree

--- Classifier model (full training set) ---
Warning (106.000) NB1 NB adaptive
Time taken to build model: 0.03 seconds
--- Stratified cross-validation ---
--- Summary ---

Correctly Classified Instances      150      84.2697 %
Incorrectly Classified Instances    28      15.7303 %
Kappa statistic                      0.738
Mean absolute error                  0.0777
Root mean squared error              0.2622
Relative absolute error              26.556 %
Root relative squared error         68.7624 %
Total Number of Instances           178

--- Detailed Accuracy By Class ---
          TP Rate  FP Rate  Precision  Recall   F-Measure  MCC     ROC Area  PRC Area  Class
          0.818    0.048    0.529    0.818    0.643    0.631    0.946    0.826    Alert
          0.805    0.073    0.767    0.805    0.786    0.720    0.958    0.817    Stable
          0.867    0.096    0.929    0.867    0.897    0.762    0.953    0.939    Warning
          0.810    0.019    0.850    0.810    0.829    0.807    0.963    0.931    Sustainable
Weighted Avg.    0.843    0.079    0.858    0.843    0.847    0.750    0.957    0.903

--- Confusion Matrix ---
a b c d  <-- classified as
9 0 2 0 | a = Alert
0 33 5 3 | b = Stable
8 6 91 0 | c = Warning
0 4 0 17 | d = Sustainable

```

Accuracy Observed - 84.26%

2. With Additional Parameters:

```

Start Stop
right-click for options)
-trees.LMT
-trees.RandomTree
-trees.RandomForest
-trees.HoeffdingTree

Warning (106.000) NB1 NB adaptive
Time taken to build model: 0.01 seconds
--- Stratified cross-validation ---
--- Summary ---

Correctly Classified Instances      152      85.3933 %
Incorrectly Classified Instances    26      14.6067 %
Kappa statistic                      0.7598
Mean absolute error                  0.0735
Root mean squared error              0.2555
Relative absolute error              25.0942 %
Root relative squared error         67.0054 %
Total Number of Instances           178

--- Detailed Accuracy By Class ---
          TP Rate  FP Rate  Precision  Recall   F-Measure  MCC     ROC Area  PRC Area  Class
          0.818    0.054    0.500    0.818    0.621    0.610    0.947    0.830    Alert
          0.854    0.066    0.795    0.854    0.824    0.769    0.966    0.893    Stable
          0.857    0.068    0.947    0.857    0.900    0.778    0.955    0.940    Warning
          0.857    0.019    0.857    0.857    0.857    0.838    0.995    0.967    Sustainable
Weighted Avg.    0.854    0.061    0.874    0.854    0.860    0.772    0.961    0.925

--- Confusion Matrix ---
a b c d  <-- classified as
9 0 2 0 | a = Alert
0 35 3 3 | b = Stable
9 6 90 0 | c = Warning
0 3 0 18 | d = Sustainable

```

Accuracy Observed - 85.39%

Year 2015

1. Without Additional Parameters:

```
(Nom) Total
Start Stop
Result list (right-click for options)
18:50:27 - trees.LMT
18:54:37 - trees.RandomTree
18:55:05 - trees.RandomForest
18:55:30 - trees.HoeffdingTree

==== Classifier model (full training set) ====
Warning (106.000) NB1 NB adaptivel
Time taken to build model: 0.03 seconds

==== Stratified cross-validation ====
==== Summary ===

Correctly Classified Instances      154          86.5169 %
Incorrectly Classified Instances   24           13.4831 %
Kappa statistic                   0.7763
Mean absolute error               0.0657
Root mean squared error          0.2386
Relative absolute error          22.4267 %
Root relative squared error     62.5593 %
Total Number of Instances        178

==== Detailed Accuracy By Class ===

      TP Rate  FP Rate  Precision  Recall  F-Measure  MCC  ROC Area  PRC Area  Class
0.909    0.048    0.556    0.909    0.690    0.688    0.980    0.907    Alert
0.854    0.066    0.795    0.854    0.824    0.769    0.959    0.807    Stable
0.876    0.068    0.948    0.876    0.911    0.798    0.967    0.955    Warning
0.810    0.013    0.895    0.810    0.850    0.832    0.982    0.924    Sustainable
Weighted Avg.  0.865    0.060    0.883    0.865    0.870    0.788    0.968    0.914

==== Confusion Matrix ====

a b c d  <-- classified as
10 0 1 0 | a = Alert
0 35 4 2 | b = Stable
8 5 92 0 | c = Warning
0 4 0 17 | d = Sustainable
```

Accuracy Observed - 86.51%

2. With Additional Parameters:

```
Result list (right-click for options)
Time taken to build model: 0.01 seconds

==== Stratified cross-validation ====
==== Summary ===

Correctly Classified Instances      157          88.2022 %
Incorrectly Classified Instances   21           11.7978 %
Kappa statistic                   0.8022
Mean absolute error               0.0591
Root mean squared error          0.2254
Relative absolute error          20.1779 %
Root relative squared error     59.1173 %
Total Number of Instances        178

==== Detailed Accuracy By Class ===

      TP Rate  FP Rate  Precision  Recall  F-Measure  MCC  ROC Area  PRC Area  Class
0.909    0.030    0.667    0.909    0.769    0.762    0.981    0.924    Alert
0.854    0.066    0.795    0.854    0.824    0.769    0.967    0.884    Stable
0.895    0.068    0.949    0.895    0.922    0.818    0.969    0.955    Warning
0.857    0.013    0.900    0.857    0.878    0.863    0.993    0.958    Sustainable
Weighted Avg.  0.882    0.059    0.891    0.882    0.884    0.809    0.972    0.937

==== Confusion Matrix ====

a b c d  <-- classified as
10 0 1 0 | a = Alert
0 35 4 2 | b = Stable
5 6 94 0 | c = Warning
0 3 0 18 | d = Sustainable
```

Accuracy Observed - 88.20%

Year 2016

1. Without Additional Parameters:



```
==== Classifier model (full training set) ====
warning (88.000) NB1 NB adaptive

Time taken to build model: 0.03 seconds

==== Stratified cross-validation ====
==== Summary ===

Correctly Classified Instances      166      93.2584 %
Incorrectly Classified Instances   12       6.7416 %
Kappa statistic                   0.8969
Mean absolute error               0.0361
Root mean squared error           0.1694
Relative absolute error            10.8412 %
Root relative squared error      41.5385 %
Total Number of Instances         178

==== Detailed Accuracy By Class ===

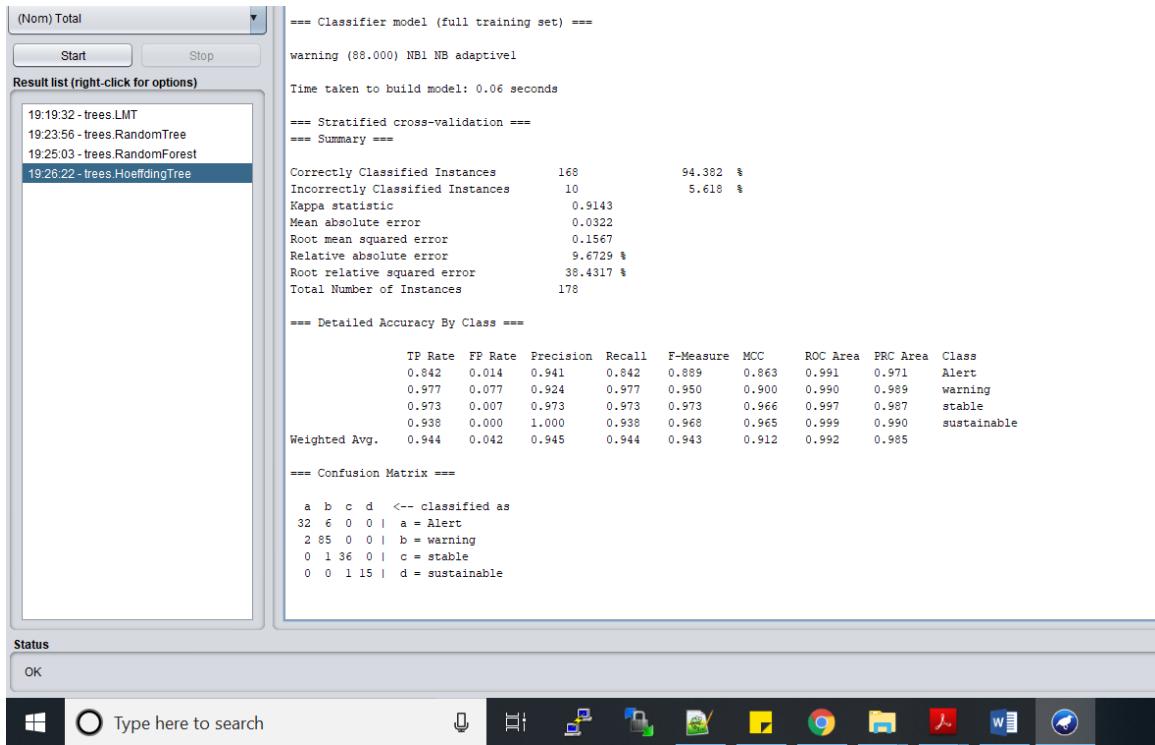
      TP Rate  FP Rate  Precision  Recall  F-Measure  MCC    ROC Area  PRC Area  Class
0.816     0.014    0.939     0.816    0.873     0.845    0.990    0.970    Alert
0.977     0.088    0.914     0.977    0.944     0.890    0.990    0.988    warning
0.973     0.014    0.947     0.973    0.960     0.949    0.989    0.997    stable
0.875     0.000    1.000     0.875    0.933     0.930    0.993    0.958    sustainable
Weighted Avg.  0.933    0.049    0.934    0.933    0.931     0.896    0.990    0.963

==== Confusion Matrix ====

a b c d  <-- Classified as
31 7 0 0 | a = Alert
2 85 0 0 | b = warning
0 1 36 0 | c = stable
0 0 2 14 | d = sustainable
```

Accuracy Observed - 93.25%

2. With Additional Parameters:



```
(Nom) Total
Start Stop
Result list (right-click for options)
19:19:32 - trees.LMT
19:23:56 - trees.RandomTree
19:25:03 - trees.RandomForest
19:26:22 - trees.HoeffdingTree
==== Classifier model (full training set) ====
warning (88.000) NB1 NB adaptive

Time taken to build model: 0.06 seconds

==== Stratified cross-validation ====
==== Summary ===

Correctly Classified Instances      168      94.382 %
Incorrectly Classified Instances   10       5.618 %
Kappa statistic                   0.9143
Mean absolute error               0.0322
Root mean squared error           0.1567
Relative absolute error            9.6729 %
Root relative squared error      38.4317 %
Total Number of Instances         178

==== Detailed Accuracy By Class ===

      TP Rate  FP Rate  Precision  Recall  F-Measure  MCC    ROC Area  PRC Area  Class
0.842     0.014    0.941     0.842    0.889     0.863    0.991    0.971    Alert
0.977     0.077    0.924     0.977    0.950     0.900    0.990    0.989    warning
0.973     0.007    0.973     0.973    0.973     0.966    0.997    0.987    stable
0.938     0.000    1.000     0.938    0.968     0.965    0.999    0.990    sustainable
Weighted Avg.  0.944    0.042    0.945    0.944    0.943     0.912    0.992    0.985

==== Confusion Matrix ====

a b c d  <-- classified as
32 6 0 0 | a = Alert
2 85 0 0 | b = warning
0 1 36 0 | c = stable
0 0 1 15 | d = sustainable
```

Accuracy Observed - 94.38%

BEST CLASSIFIER:-

From the above results, it can be inferred that our data set is best suited for the **Hoeffding Tree** Classifier. Hoeffding tree is an incremental algorithm and hence the accuracy achieved from this classifier is maximum. It has an effective method for estimating missing data and maintains accuracy when a large proportion of the data are missing. It can also be observed that our newly added features are helping to achieve the high accuracy of the model. Hence we can conclude that the parameters which we have added are relevant and are leading to better results.

LISp-Miner – Action Rule

LISp-Miner in our project is used to generate action rules. This is achieved using Ac4ft-Miner task. Below is the process for creating a table for data and also initializing attributes of the data.

Year 2014

Step 1: Importing CSV file into a table in Lisp Miner

Text file import into database

Source file: C:\Users\PratikParekh\Desktop\fsi-2014_csv.csv
Destination file: <currently opened database>

Database table: fsi_2014.csv

Column separator: Comma (',')
Thousands separator: ,

Sample data:

| Country | Year | Rank | Total | C1: Security App... | C2: Fractionaliz... | C3: Gr... |
|---------------------|------|-------|-------------|---------------------|---------------------|-----------|
| Afghanistan | 2014 | 7th | Alert | 10 | 9.4 | 8.7 |
| Albania | 2014 | 123rd | Stable | 5 | 6.2 | 4.7 |
| Algeria | 2014 | 71st | Warning | 7.5 | 7.3 | 7.9 |
| Angola | 2014 | 43rd | Warning | 5.8 | 7.2 | 7.1 |
| Antigua and Barbuda | 2014 | 127th | Stable | 4.9 | 3.7 | 4.1 |
| Argentina | 2014 | 144th | Stable | 3.3 | 2.8 | 5.3 |
| Armenia | 2014 | 104th | Warning | 5.6 | 7.4 | 5.7 |
| Australia | 2014 | 169th | Sustainable | 2 | 1.6 | 3.9 |
| Austria | 2014 | 167th | Sustainable | 1.4 | 2.7 | 4.6 |
| Azerbaijan | 2014 | 76th | Warning | 7 | 7.9 | 6.7 |

Imported data must be in the single-byte character format. UNICODE or UTF texts are not supported!

Import options:

- First line is a title line with names of columns
- Add primary key column (ID_LM)
- Store dates in MM-DD-YYYY format
- Convert to ASCII (remove Czech accents)

Import restriction:

- Limit number of rows up to: 5000
- Randomly selected rows
- Column value filter

Col Flag Name DataType

| 1 | Country | Text |
|----|---------------------------------|----------------|
| 2 | Year_ | Integer number |
| 3 | Rank_ | Text |
| 4 | Total | Text |
| 5 | C1_Security_Apparatus | Decimal number |
| 6 | C2_Fractionalized_Elites | Decimal number |
| 7 | C3_Group_Grievance | Decimal number |
| 8 | E1_Economy | Decimal number |
| 9 | E2_Economic_Inequality | Decimal number |
| 10 | E3_Human_Flight_and_Brain_Drain | Decimal number |
| 11 | P1_State_Legitimacy | Decimal number |
| 12 | P2_Public_Services | Decimal number |
| 13 | P3_Human_Rights | Decimal number |
| 14 | S1_Demographic_Pressures | Decimal number |
| 15 | S2_Deforestation_and_IDP_ | Decimal number |

IMPORT DATA

Cancel Detail Columns names Update columns Export columns Data Statistics

Step 2: Selection of attributes from data

The screenshot shows the LISp-Miner Workspace module interface. The title bar reads "LM fsi-2014_csv MB - LISp-Miner Workspace module - 27.18.03". The menu bar includes File, Data Introduction, Preprocessing, Interactive Analysis, Data-mining Tasks, Domain Knowledge, Window, and Help. The left sidebar has a "Tab Tree" with sections A. Data Introduction, B. Data Preprocessing, C. Interactive Analysis, D. Data-mining Tasks, E. Domain knowledge, and W. Workspace. The main area has tabs for Tables, Attributes, and Tasks Overview. The "Attributes" tab is selected, showing a matrix for "fsi_2014_csv". The "Groups of attributes tree" section shows the "Root group of attributes". The main table lists attributes with columns: Attribute, Used, DBColumn, Categories, XCat, and Sample cat. Some attributes listed include C3_Group_Grievance, Country, E1_Economy, E2_Economic_Inequality, E3_Human_Flight_and_Brain_Drain, Education_Index, Gti, Homeless_People_due_to_Natural_Disaster, Life_expectancy_at_birth_years, P1_State_Legitimacy, P2_Public_Services, P3_Human_Rights, Prison_Population, Rank_, S1_Demographic_Pressures, S2_Refugees_and_IDPs, Total, Year, and various numerical values like 68, 178, 65, etc.

Step 3: Selecting Ac4ft Miner task to create association rules.

The screenshot shows the LISp-Miner Workspace module interface with the "Data-mining Tasks" tab selected. A "New Task" dialog box is open, titled "Type of task to be created:". It lists several tasks with icons: 4ft-Miner, CF-Miner, KL-Miner, ETree-Miner, SD4ft-Miner, SDCF-Miner, SDKL-Miner, and MCluster-Miner. The "Ac4ft-Miner" task is highlighted with a blue border. Below the tasks, a note says "Ac4ft-Miner task for 4ft-action rules". At the bottom of the dialog are "OK" and "Cancel" buttons. The background shows the same LISp-Miner interface as the previous screenshot.

Step 4: Set antecedent, succedent and quantifiers values.

LM fsi-2014.csv MB - LiSp-Miner Workspace module - 27.18.03

Data Introduction Preprocessing Interactive Analysis Data-mining Tasks Domain Knowledge Window Help

Tree Hide

- A. Data Introduction
- B. Data Preprocessing
- C. Interactive Analysis
- D. Data-mining Tasks
- E. Domain knowledge
- F. Workspace

Tables Attributes Tasks Overview Task - 1

Name: Task - 1
Comment: -
Taskgroup: Default group of tasks
Task type: Ac4t-Miner Data matrix: fsi_2014.csv ID: 2

ANTECEDENT STABLE PART

| Default Partial Cedent | Con, 1 - 5 | Type | Rel. | Value | Units |
|-----------------------------------------------------------|------------|-----------------|------|-------|-------|
| » Country (subset), 1 - 1 | B, pos | a (BASE) Before | >= | 2.00 | Abs |
| » Homeless_People_due_to_Natural_Disaster (subset), 1 - 1 | B, pos | a (BASE) After | >= | 2.00 | Abs |
| » Year_(subset), 1 - 1 | B, pos | | | | |

Total length: 0 - 5 {1 - 5}

QUANTIFIERS

| Type | Rel. | Value | Units |
|-----------------|------|-------|-------|
| a (BASE) Before | >= | 2.00 | Abs |
| a (BASE) After | >= | 2.00 | Abs |

SUCCEDENT STABLE PART

| Default Partial Cedent | Con, 0 - 5 |
|------------------------|------------|
| | |

Total length: 0

(1) ANTECEDENT VARIABLE PART

| Default Partial Cedent | Con, 1 - 5 | Condition | Default Partial Cedent | Con, 0 - 5 | (2) SUCCEDENT VARIABLE PART |
|-----------------------------------------------------------|------------|-----------|------------------------|------------|-----------------------------|
| » C1_Security_Apparatus (subset), 1 - 1 | B, pos | | | | Default Partial Cedent |
| » Homeless_People_due_to_Natural_Disaster (subset), 1 - 1 | B, pos | | | | » Total(Alert -> Warning) |
| » P2_Public_Services (subset), 1 - 1 | B, pos | | | | |
| » P3_Human_Rights (subset), 1 - 1 | B, pos | | | | |

Total length: 0 - 5 {1 - 5} Total length: 0 Total length: 1

Task parameters

Strict action: States must be represented by the same sets of attributes which differ in coefficients only (the strict meaning of an action)
Sets overlapping: Sets must differ in all rows (i.e. not overlapping sets)
Maximal number of hypotheses: 1000

Params Switch Validate Task Clone
Run Bkgrnd Run Grid Run Show Results

4ft Variable antecedent Partial cedent Settings

Basic parameters

Name: Default Partial Cedent
Min. length: 1 Max. length: 5 Literals boolean operation type: Conjunction
Comment: - Edit

Options

Allow only a consecutive sequence of literals in cedent (only neighbouring literals): No
Linked coefficients (all literals must have the same coefficient as in the first one): No

Literals Settings

| Underlying attribute | Categories | X-cat | Coefficient type | Length | +/- | B/R | Class of equiv. |
|-----------------------------------------|------------|-------|------------------|--------|-----|-------|-----------------|
| C1_Security_Apparatus | 73 | No | Subsets | 1 - 1 | pos | Basic | - |
| Homeless_People_due_to_Natural_Disaster | 151 | No | Subsets | 1 - 1 | pos | Basic | - |
| P2_Public_Services | 77 | No | Subsets | 1 - 1 | pos | Basic | - |
| P3_Human_Rights | 80 | No | Subsets | 1 - 1 | pos | Basic | - |
| S2_Refugees_and_IDPs | 78 | No | Subsets | 1 - 1 | pos | Basic | - |
| X1_External_Intervention | 66 | No | Subsets | 1 - 1 | pos | Basic | - |

Literal Coefficient Eq. Class Add Del Up Down

Close Partial cedents list

The above screenshot shows the attributes chosen for the antecedent stable part, antecedent variable part and succedent variable part.

Below are the flexible attributes we have chosen for Antecedent variable part:-

Homeless people due to natural disaster

Public services

Human rights

Refugees and IDPs

External intervention

Explanation:-

Homeless people due to natural disaster, Public services, Human rights, Refugees and IDPs, External intervention are chosen as antecedent variable part because these attributes are showing large variation between the alert state to warning state of the total. And hence action rules stating the actions needs to be taken in order to change the output from alert to warning can be found easily.

Below are the stable attributes used as an antecedent stable part:-

Country

Rank

Year

4ft Antecedent Partial cedent Settings

Basic parameters

Name: Default Partial Cedent

Min. length: 1 Max. length: 5 Literals boolean operation type: Conjunction Edit

Comment: -

Options

Allow only a consecutive sequence of literals in cedent (only neighbouring literals): No

Linked coefficients (all literals must have the same coefficient as in the first one): No

Literals Settings

| Underlying attribute | Categories | X-cat | Coefficient type | Length | +/- | B/R | Class of equiv. |
|----------------------|------------|-------|------------------|--------|-----|-------|-----------------|
| Country | 178 | No | Subsets | 1 - 1 | pos | Basic | - |
| Rank_ | 162 | No | Subsets | 1 - 1 | pos | Basic | - |
| Year_ | 1 | No | Subsets | 1 - 1 | pos | Basic | - |

Literal Coefficient Eq. Class Add Del Up Down

Close **Partial cedents list**

Explanation:-

We chose these attributes as stable attributes as the succendent variable total is varying according to these attributes. Actions will mainly vary according to the year but to analyze the results we have added country as well as the year attribute.

Below is the Succedent variable part:-

Total(Alert -> Warning)

Note - This is a nominal type of attribute with one category as coefficient type.

4ft Variable succedent Partial cedent Settings

Basic parameters

Name: Default Partial Cedent

Min. length: 1 Max. length: 5 Literals boolean operation type: Conjunction

Comment: -

Edit

Options

Allow only a consecutive sequence of literals in cedent (only neighbouring literals): No

Linked coefficients (all literals must have the same coefficient as in the first one): No

Literals Settings

| Underlying attribute | Categories | X-cat | Coefficient type | Length | +/- | B/R | Class of equiv. |
|----------------------|------------|-------|------------------|--------|-----|-------|-----------------|
| Total | 4 | No | One category | 1 | pos | Basic | - |

Literal Coefficient Eq. Class Add Del Up Down

Close Partial cedents list

Explanation:-

Total is the target variable and action rules stating the change in the total needs to be found out. This attribute was chosen as a decision attribute which had four categories namely- alert, stable, sustainable and warning. As a result, these attributes are chosen as succedent variable part with Statebefore as Alert and StateAfter as Warning to analyze the action rule.

| List of Ac4ft quantifiers settings | | | | | |
|------------------------------------|--------|------|-------|-----------------|--|
| Task: Task - 1 | | | | | |
| Type | Mode | Rel. | Value | Units | |
| a-frequency | Before | >= | 2.00 | Absolute number | |
| a-frequency | After | >= | 2.00 | Absolute number | |

| | |
|----------------------------|-----------------------------------|
| Add statistical quantifier | Add simple frequencies quantifier |
|----------------------------|-----------------------------------|

Quantifiers used:-

a(Base) before - 2.00
 a(Base) after - 2.00

Action Rules for the year 2014:-

- Decision attribute used - Total(Alert -> Warning)

File Data Introduction Preprocessing Interactive Analysis Data-mining Task Domain Knowledge Window Help

Tab Tree Hide

- A. Data Introduction
- B. Data Preprocessing
- C. Interactive Analysis
- D. Data-mining Tasks
- E. Domain knowledge
- F. Workspace

Tables Attributes Tasks Overview Task - 1 Hypothesis (3)

Task: Task - 1
Comment: -
Taskgroup: Default group of tasks
Data matrix: fsi_2014_csv
Task type: Ac4ft-Miner

Task run:
Start: 2.5.2019 15:17:38 Total time: 0h 0m 27s
Number of verifications: 13926 Number of hypotheses: 221 Mode: Standard

Show all Show not in group Highlight

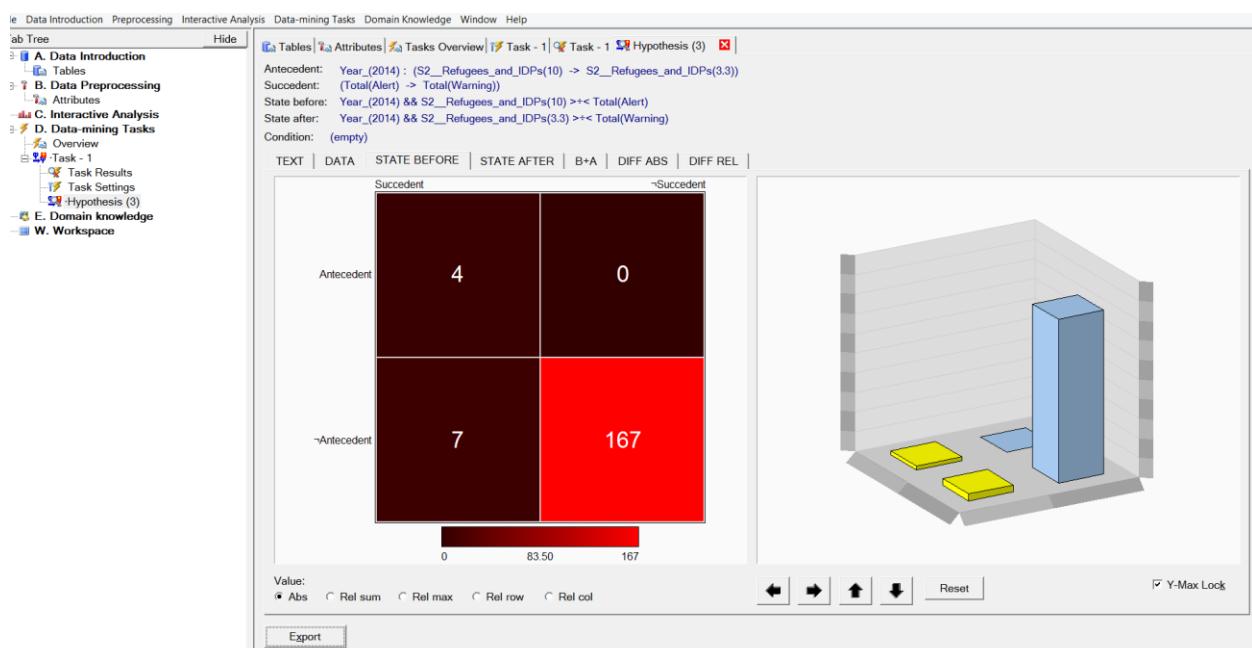
Add group Del group Edit group Delete hypotheses

Actual group of hypotheses: All hypotheses
Hypotheses in group: 221 Shown hypotheses: 221 Highlighted: 0

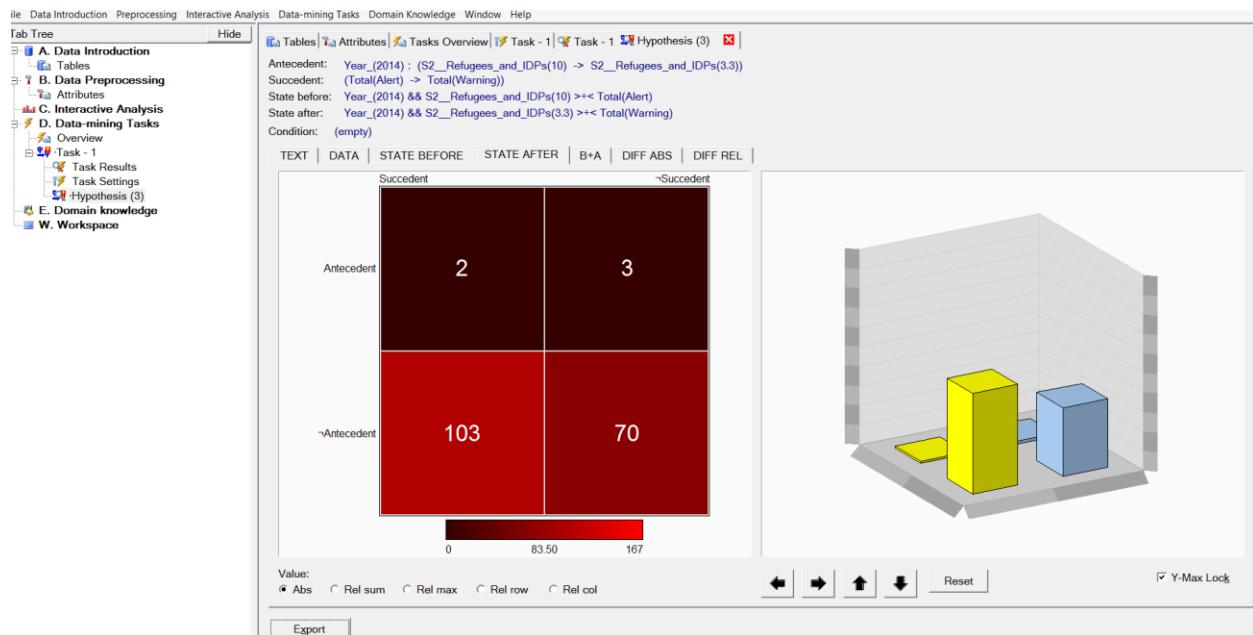
| Nr. | Id | D1-Conf | B1-Conf | A1-Conf | Hypothesis |
|-----|-----|---------|---------|---------|-----------------------------------------------------------------------------------------------------------------------------|
| 1 | 3 | 0.600 | 1.000 | 0.400 | Year_(2014) : (S2_Refugees_and_IDPs(10) → S2_Refugees_and_IDPs(3,3)) >=< (empty) : (Total(Alert) → Total(Warning)) |
| 2 | 200 | 0.500 | 1.000 | 0.500 | Year_(2014) : (C1_Security_Apparatus(2,4) → C1_Security_Apparatus(5,5)) >=< (empty) : (Total(Alert) → Total(Warning)) |
| 3 | 163 | 0.500 | 1.000 | 0.500 | Year_(2014) : (P3_Human_Rights(2,9) → P3_Human_Rights(6,9)) >=< (empty) : (Total(Alert) → Total(Warning)) |
| 4 | 42 | 0.500 | 1.000 | 0.500 | Year_(2014) : (X1_External_Intervention(2,9) → X1_External_Intervention(5,6)) >=< (empty) : (Total(Alert) → Total(Warning)) |
| 5 | 157 | 0.400 | 1.000 | 0.600 | Year_(2014) : (P3_Human_Rights(2,9) → P3_Human_Rights(7,4)) >=< (empty) : (Total(Alert) → Total(Warning)) |
| 6 | 164 | 0.333 | 1.000 | 0.667 | Year_(2014) : (P3_Human_Rights(2,9) → P3_Human_Rights(9,3)) >=< (empty) : (Total(Alert) → Total(Warning)) |
| 7 | 165 | 0.333 | 1.000 | 0.667 | Year_(2014) : (P3_Human_Rights(2,9) → P3_Human_Rights(8,3)) >=< (empty) : (Total(Alert) → Total(Warning)) |
| 8 | 169 | 0.333 | 1.000 | 0.667 | Year_(2014) : (P3_Human_Rights(2,9) → P3_Human_Rights(7,3)) >=< (empty) : (Total(Alert) → Total(Warning)) |
| 9 | 170 | 0.333 | 1.000 | 0.667 | Year_(2014) : (P3_Human_Rights(2,9) → P3_Human_Rights(8,3)) >=< (empty) : (Total(Alert) → Total(Warning)) |
| 10 | 172 | 0.333 | 1.000 | 0.667 | Year_(2014) : (P3_Human_Rights(2,9) → P3_Human_Rights(5,9)) >=< (empty) : (Total(Alert) → Total(Warning)) |
| 11 | 174 | 0.333 | 1.000 | 0.667 | Year_(2014) : (P3_Human_Rights(2,9) → P3_Human_Rights(4,8)) >=< (empty) : (Total(Alert) → Total(Warning)) |
| 12 | 175 | 0.333 | 1.000 | 0.667 | Year_(2014) : (P3_Human_Rights(2,9) → P3_Human_Rights(4,7)) >=< (empty) : (Total(Alert) → Total(Warning)) |
| 13 | 10 | 0.333 | 1.000 | 0.667 | Year_(2014) : (S2_Refugees_and_IDPs(10) → S2_Refugees_and_IDPs(3,3)) >=< (empty) : (Total(Alert) → Total(Warning)) |
| 14 | 17 | 0.333 | 1.000 | 0.667 | Year_(2014) : (S2_Refugees_and_IDPs(10) → S2_Refugees_and_IDPs(4,4)) >=< (empty) : (Total(Alert) → Total(Warning)) |
| 15 | 18 | 0.333 | 1.000 | 0.667 | Year_(2014) : (S2_Refugees_and_IDPs(10) → S2_Refugees_and_IDPs(3,6)) >=< (empty) : (Total(Alert) → Total(Warning)) |
| 16 | 32 | 0.333 | 1.000 | 0.667 | Year_(2014) : (X1_External_Intervention(2,9) → X1_External_Intervention(6,2)) >=< (empty) : (Total(Alert) → Total(Warning)) |
| 17 | 45 | 0.333 | 1.000 | 0.667 | Year_(2014) : (X1_External_Intervention(2,9) → X1_External_Intervention(2,3)) >=< (empty) : (Total(Alert) → Total(Warning)) |
| 18 | 46 | 0.333 | 1.000 | 0.667 | Year_(2014) : (X1_External_Intervention(2,9) → X1_External_Intervention(7,2)) >=< (empty) : (Total(Alert) → Total(Warning)) |
| 19 | 48 | 0.333 | 1.000 | 0.667 | Year_(2014) : (X1_External_Intervention(2,9) → X1_External_Intervention(6,6)) >=< (empty) : (Total(Alert) → Total(Warning)) |
| 20 | 51 | 0.333 | 1.000 | 0.667 | Year_(2014) : (X1_External_Intervention(2,9) → X1_External_Intervention(5,7)) >=< (empty) : (Total(Alert) → Total(Warning)) |
| 21 | 53 | 0.333 | 1.000 | 0.667 | Year_(2014) : (X1_External_Intervention(2,9) → X1_External_Intervention(5,3)) >=< (empty) : (Total(Alert) → Total(Warning)) |

Detail Goto ID Copy Remove Filter Sorting Export

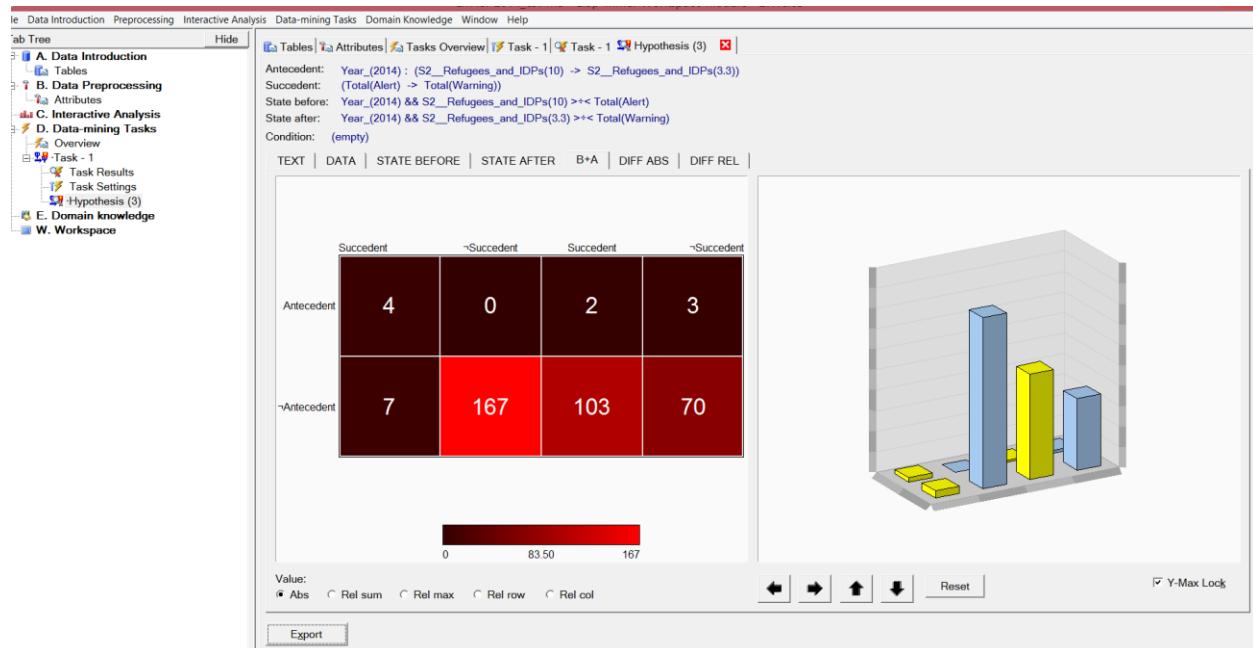
State Before:-



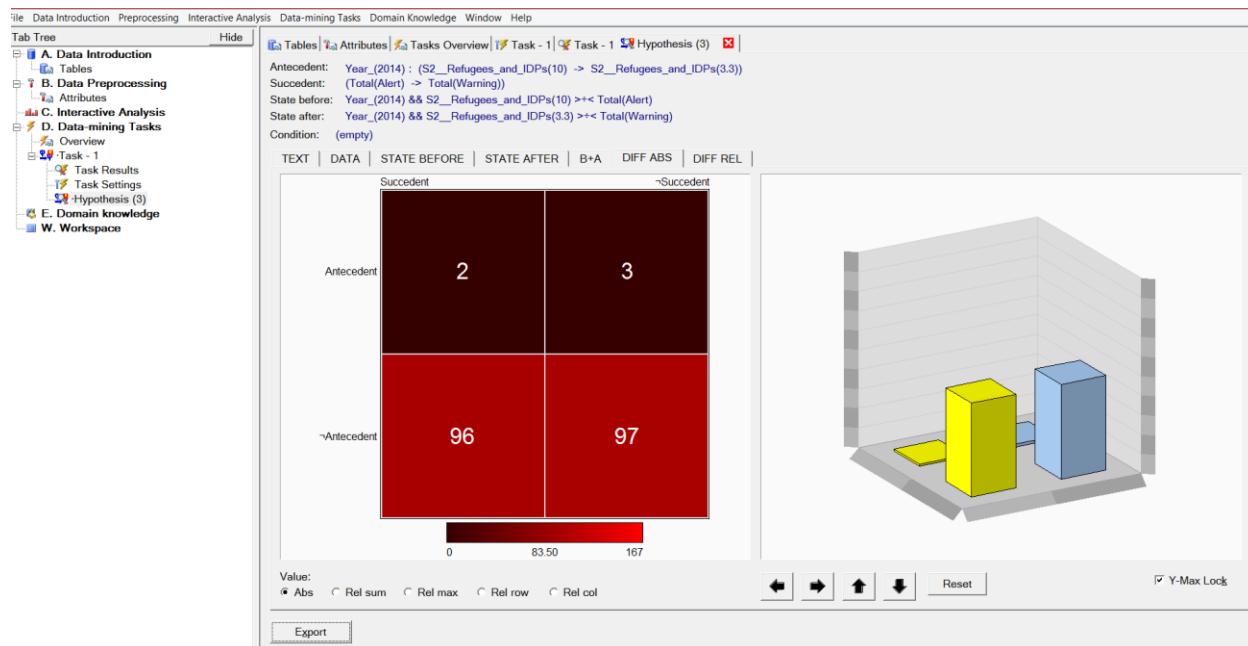
State After:-



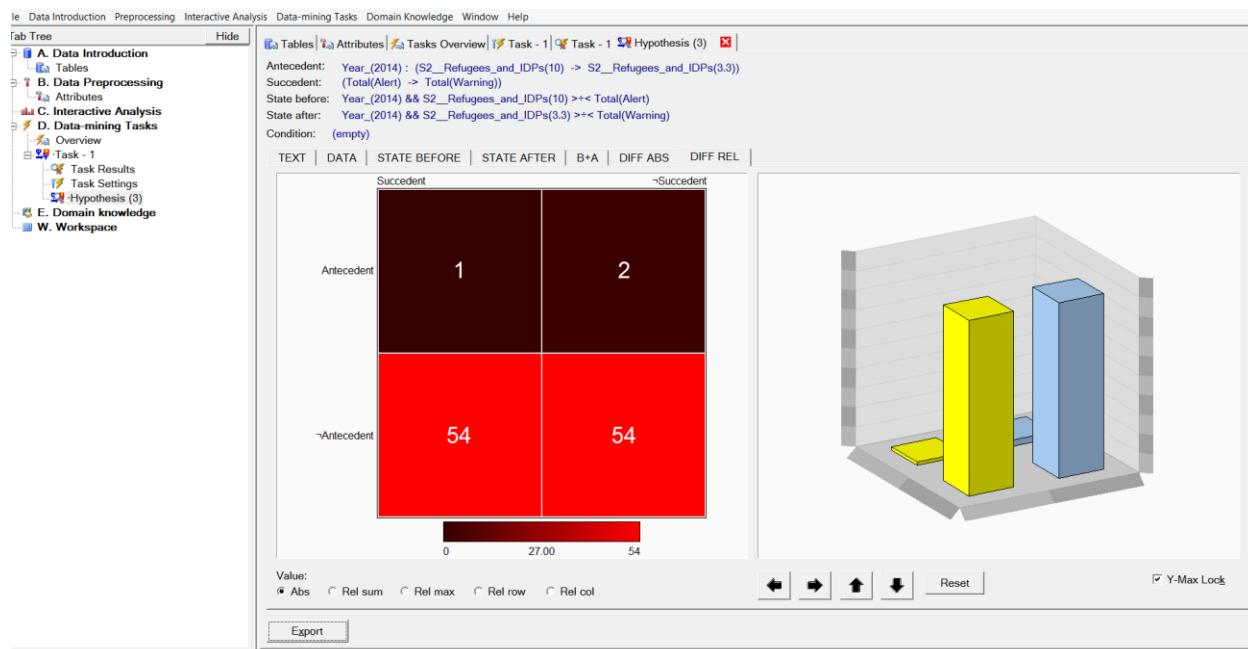
B+A(Before+After):-



Diff Abs:-



Diff Rel:-



Action Rules:-

- For the action rules, please go through the attached txt files.
- Below are some actions rules and explanation:-

**1. ($S2_{\text{Refugees_and_IDPs}}(10) \rightarrow S2_{\text{Refugees_and_IDPs}}(3.3)$) $> \div <$
 $(\text{Total(Alert)} \rightarrow \text{Total(Warning)})$**

Refugees and IDPs define the immigration of the general population that can affect security and other resources. If this value is changed from 10 to 3.3 then there is a 60% chance that the fragile state of a country will get change from Alert to Warning.

**2. ($C1_{\text{Security_Apparatus}}(9.4) \rightarrow C1_{\text{Security_Apparatus}}(5.5)$) $> \div <$
 $(\text{Total(Alert)} \rightarrow \text{Total(Warning)})$**

Security Apparatus denotes the emergence of an elite that operates with impunity challenges the security apparatus' monopoly on the use of force, weakening the social contract. Hence lowering this number from 9.4 to 5.5 will give 50% chance to change the countries state from Alert to Warning.

3. ($P3_{\text{Human_Rights}}(9.9) \rightarrow P3_{\text{Human_Rights}}(6.9)$) $> \div <$ ($\text{Total(Alert)} \rightarrow \text{Total(Warning)}$)

Human Rights suggest the weak protection of basic rights indicates the failure of a state to perform its primary responsibility. If these number changes from 9.9 to 6.9 then there is 50% chance that the country will change its state from Alert to Warning.

**4. ($X1_{\text{External_Intervention}}(9.9) \rightarrow X1_{\text{External_Intervention}}(5.6)$) $> \div <$
 $(\text{Total(Alert)} \rightarrow \text{Total(Warning)})$**

External Intervention is measured by foreign assistance, foreign military intervention, sanctions. Lowering the external interventions from 9.9 to 5.6 will change the state from Alert to Warning with 50% chance.

Year 2015

Step 1 : Importing csv file into a table in Lisp Miner

Text file import into database

Source file: C:\Users\jogle\Desktop\fsi-2015_csv.csv
 Destination file: C:\Users\jogle\Desktop\fsi-2015_csv.Data.mdb

Database table: fsi_2015_csv

Column separator: Comma (',')
 Thousands separator: ,

Sample data:

| fsi&Country | Year | Rank | Total | C1: Security Ap... | C2: Factionaliz... | C3: Gr... |
|--------------------|------|-------|-------------|--------------------|--------------------|-----------|
| Afghanistan | 2015 | 8th | Alert | 10 | 9.3 | 8.9 |
| Albania | 2015 | 125th | Stable | 4.7 | 6.2 | 5 |
| Algeria | 2015 | 67th | Warning | 8 | 7.7 | 8.2 |
| Angola | 2015 | 42nd | Warning | 6 | 7.2 | 7.3 |
| Antigua and Bar... | 2015 | 127th | Stable | 5.2 | 3.7 | 3.9 |
| Argentina | 2015 | 141st | Stable | 3.6 | 2.8 | 5 |
| Armenia | 2015 | 108th | Warning | 5.3 | 7 | 5.4 |
| Australia | 2015 | 170th | Sustainable | 2.1 | 1.6 | 4.4 |
| Austria | 2015 | 167th | Sustainable | 1.1 | 2.7 | 4.3 |
| Azerbaijan | 2015 | 80th | Warning | 6.7 | 7.9 | 6.4 |

Imported data must be in the single-byte character format. UNICODE or UTF texts are not supported!

Import options:

- First line is a title line with names of columns
- Add primary key column (ID_LM)
- Store dates in MM-DD-YYYY format
- Convert to ASCII (remove Czech accents)

Import restriction:

- Limit number of rows up to: 5000
- Randomly selected rows
- Column value filter

Col Flag Name DataType

| | | |
|----|---------------------------------|----------------|
| 1 | d_Country | Text |
| 2 | Year_ | Integer number |
| 3 | Rank_ | Text |
| 4 | Total | Text |
| 5 | C1_Security_Apparatus | Decimal number |
| 6 | C2_Factionalized_Elites | Decimal number |
| 7 | C3_Group_Grievance | Decimal number |
| 8 | E1_Economy | Decimal number |
| 9 | E2_Economic_Inequality | Decimal number |
| 10 | E3_Human_Flight_and_Brain_Drain | Decimal number |
| 11 | P1_State_Legitimacy | Decimal number |
| 12 | P2_Public_Services | Decimal number |
| 13 | P3_Human_Rights | Decimal number |
| 14 | S1_Demographic_Pressures | Decimal number |
| 15 | S2_Refugees_and_IDPs | Decimal number |

IMPORT DATA Detail Columns names Update columns Export columns Data Statistics

Step 2: Selection of attributes from data

LM fsi-2015_csv MB - Lisp-Miner Workspace module - 27.18.03

File Data Introduction Preprocessing Interactive Analysis Data-mining Tasks Domain Knowledge Window Help

Tab Tree Hide

Table Attributes Tasks Overview

Matrix: fsi_2015_csv

Groups of attributes tree

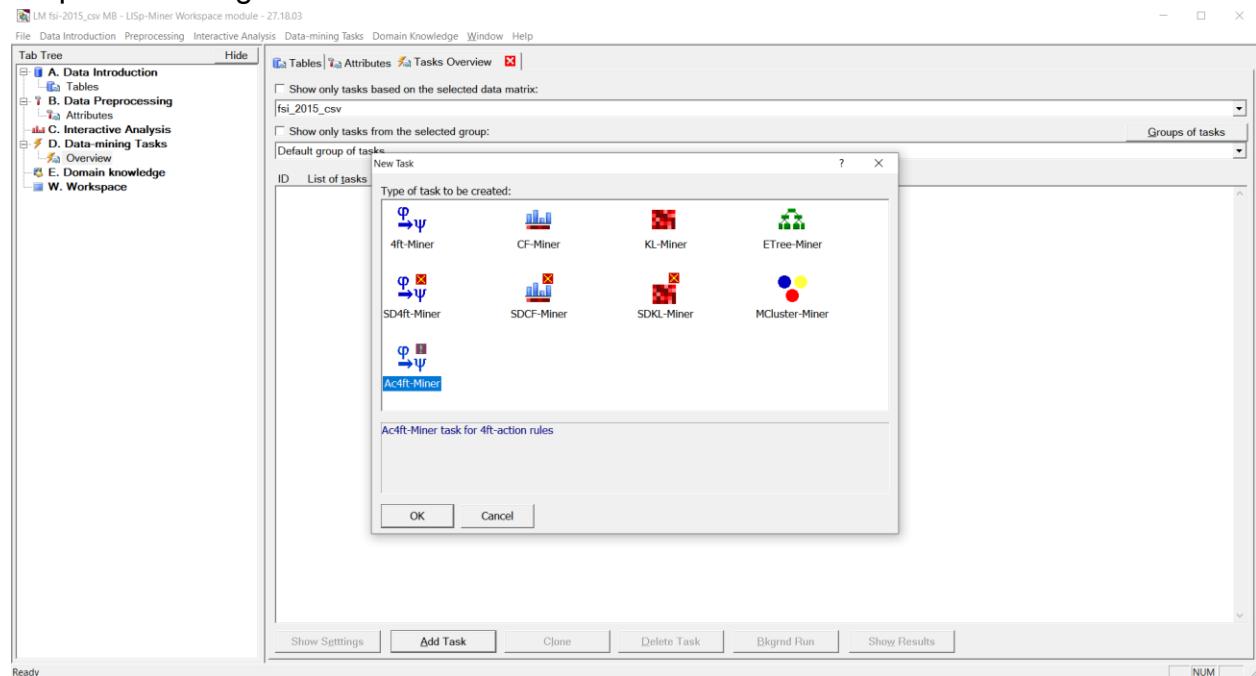
| Attribute | Used DBColumn | Categories XCat | Sample categories |
|-----------------------------------------|-----------------------|-----------------|------------------------------------------------------------------------------|
| C1_Security_Apparatus | C1_Security_Apparatus | 76 | 1, 1, 1, 14, 15, 16, 18, 2, 21, 22, 23... |
| C2_Factionalized_Elites | C2_Factionalized_E | 76 | 1, 1, 13, 14, 16, 17, 18, 19, 2, 25... |
| C3_Group_Grievance | C3_Group_Grievan | 65 | 1, 3, 1, 6, 19, 2, 6, 3, 31, 3, 4, 3, 6, 3, 7, 3... |
| d_Country | d_Country | 178 | Afghanistan, Albania, Algeria, Angola, Antigua and Barbuda, Argentina, Ar... |
| E1_Economy | E1_Economy | 69 | 1, 5, 1, 7, 1, 8, 2, 21, 22, 23, 2, 26, 2, 28... |
| E2_Economic_Inequality | E2_Economic_Ineq. | 70 | 1, 1, 5, 18, 18, 19, 2, 21, 27, 28, 29... |
| E3_Human_Flight_and_Brain_Drain | E3_Human_Flight_a | 70 | 1, 1, 5, 16, 19, 2, 21, 22, 23, 24, 25... |
| Education_Index | Education_Index | 152 | 0,206, 0,261, 0,267, 0,28, 0,297, 0,31, 0,312, 0,315, 0,318, 0,33... |
| G1 | G1 | 104 | 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 14, 0, 16... |
| Homeless_People_due_to_Natural_Disaster | Homeless_People_d | 151 | 0,347, 0,351, 0,394, 0,399, 0,406, 0,414, 0,418, 0,421, 0,425, 0,427... |
| Life_expectancy_at_birth_years_ | Life_expectancy_at_t | 129 | 4, 9, 4, 9, 5, 0, 7, 5, 0, 9, 5, 15, 5, 16, 5, 23, 5, 28, 5, 51, 5, 52... |
| P1_State_Legitimacy | P1_State_Legitim | 77 | 0, 4, 0, 5, 0, 9, 1, 1, 1, 2, 1, 3, 1, 4, 1, 5, 1, 7... |
| P2_Public_Services | P2_Public_Servic | 81 | 1, 2, 1, 3, 1, 4, 1, 5, 1, 6, 1, 7, 1, 8, 1, 9, 2, 2, 1... |
| P3_Human_Rights | P3_Human_Rights | 80 | 0, 9, 1, 1, 1, 2, 1, 3, 1, 5, 1, 7, 1, 8, 1, 9, 2, 2... |
| Prison_Population | Prison_Population | 151 | 0,347, 0,351, 0,394, 0,399, 0,406, 0,414, 0,418, 0,421, 0,425, 0,427... |
| Rank_ | Rank_ | 164 | 100th, 101st, 102nd, 103rd, 104th, 106th, 107th, 108th, 109th... |
| S1_Demographic_Pressures | S1_Demographic_P | 73 | 1, 5, 1, 6, 1, 7, 1, 8, 1, 9, 2, 22, 2, 24, 2, 25... |
| S2_Refugees_and_IDPs | S2_Refugees_and_I | 76 | 1, 1, 14, 15, 16, 1, 7, 1, 8, 1, 9, 2, 21, 2, 22... |
| Total | Total | 4 | Alert, Stable, Sustainable, Warning |
| Total_unemployment_rate_of_labour_forc | Total_unemployment | 116 | 0,04, 0,08, 0,16, 0,22, 0,24, 0,3, 0,32, 0,34, 0,36, 0,38... |
| X1_External_Intervention | X1_External_Interve | 77 | 1, 1, 1, 12, 1, 13, 1, 4, 1, 5, 1, 6, 1, 7, 1, 9, 2, 2... |
| Year_ | Year | 1 | 2015 |

Show Attribute Show Matrix Add attribute Del Attribute Clone

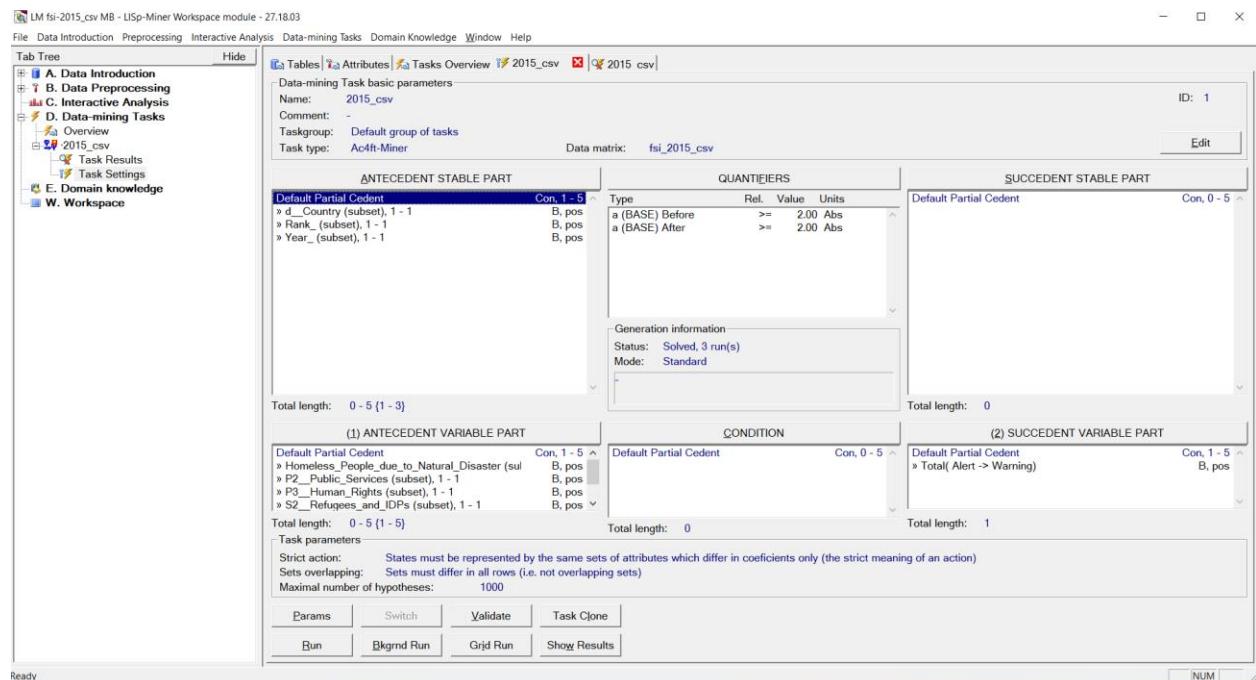
Export Group detail Quick Assign Add group Del group

Ready

Step 3: Selecting Ac4ft Miner task to create association rules.



Step 4: Set antecedent , succedent and quantifiers values.



The above screenshot shows the attributes chosen for the antecedent stable part, antecedent variable part and succedent variable part.

Below are the flexible attributes we have chosen for Antecedent variable part:-

- Homeless people due to natural disaster
- Public services
- Human rights
- Refugees and IDPs
- External intervention

4ft Variable antecedent Partial cedent Settings

Basic parameters

Name: Default Partial Cedent

Min. length: 1 Max. length: 5 Literals boolean operation type: Conjunction

Comment: -

Options

Allow only a consecutive sequence of literals in cedent (only neighbouring literals): No

Linked coefficients (all literals must have the same coefficient as in the first one): No

Literals Settings

| Underlying attribute | Categories | X-cat | Coefficient type | Length | +/- | B/R | Class of equiv. |
|------------------------------------|------------|-------|------------------|--------|-----|-------|-----------------|
| Homeless_People_due_to_Natural_Dis | 151 | No | Subsets | 1 - 1 | pos | Basic | - |
| P2_Public_Services | 81 | No | Subsets | 1 - 1 | pos | Basic | - |
| P3_Human_Rights | 80 | No | Subsets | 1 - 1 | pos | Basic | - |
| S2_Refugees_and_IDPs | 76 | No | Subsets | 1 - 1 | pos | Basic | - |
| X1_External_Intervention | 77 | No | Subsets | 1 - 1 | pos | Basic | - |

Literal Coefficient Eq. Class Add Del Up Down

Close Partial cedents list

Explanation:-

Homeless people due to natural disaster, Public services, Human rights, Refugees and IDPs, External intervention are chosen as antecedent variable part because these attributes are showing large variation between the alert state to warning state of the total. And hence action rules stating the actions needs to be taken in order to change the output from alert to warning can be found easily.

Below are the stable attributes used as a antecedent stable part:-

- Country
- Rank
- Year

4ft Antecedent Partial cedent Settings

Basic parameters

Name: Default Partial Cedent

Min. length: 1 Max. length: 5 Literals boolean operation type: Conjunction

Comment: -

Options

Allow only a consecutive sequence of literals in cedent (only neighbouring literals): No

Linked coefficients (all literals must have the same coefficient as in the first one): No

Literals Settings

| Underlying attribute | Categories | X-cat | Coefficient type | Length | +/- | B/R | Class of equiv. |
|----------------------|------------|-------|------------------|--------|-----|-------|-----------------|
| d_Country | 178 | No | Subsets | 1 - 1 | pos | Basic | - |
| Rank_ | 164 | No | Subsets | 1 - 1 | pos | Basic | - |
| Year_ | 1 | No | Subsets | 1 - 1 | pos | Basic | - |

Literal Coefficient Eq. Class Add Del Up Down

Close **Partial cedents list**

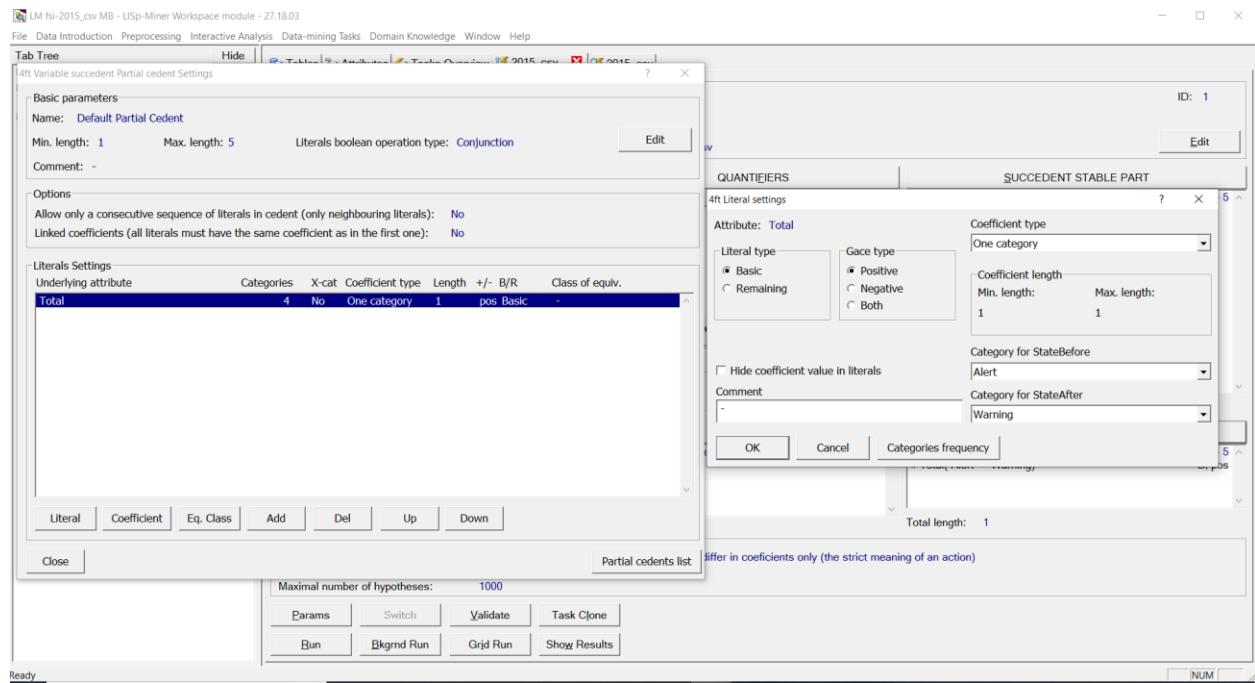
Explanation:-

We chose these attributes as stable attributes as the succedent variable total is varying according to these attributes.

Below is the Succedent variable part:-

Total(Alert -> Warning)

Note - This is a nominal type of attribute with one category as coefficient type



Explanation:-

Total is the target variable and action rules stating the change in the total needs to be found out. This attribute was chosen as a decision attribute which had four categories namely- alert, stable, sustainable and warning. As a result, these attributes are chosen as succedent variable part with Statebefore as Alert and StateAfter as Warning to analyze the action rule.

Quantifiers used:-

a(Base) before - 2.00
 a(Base) after - 2.00

Action Rules for the year 2015:-

- Decision attribute used - Total(Alert -> Warning)

LM fsi-2015.csv MB - LISp-Miner Workspace module - 27.18.03

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- E. Domain knowledge
- W. Workspace

Tables Attributes Tasks Overview 2015.csv 2015.csv Hypothesis (283)

Task: 2015.csv
Comment: -
Taskgroup: Default group of tasks
Data matrix: fsi_2015.csv
Task type: Ac4t-Miner

Task run
Start: 5.2.2019 15:15:31 Total time: 0h 0m 20s
Number of verifications: 11982
Number of hypotheses: 283 Mode: Standard

Show all Show not in group Highlight
Show hypotheses just from group:

Add group Del group Edit group

Actual group of hypotheses: All hypotheses
Hypotheses in group: 283 Shown hypotheses: 283 Highlighted: 0

Delete hypotheses

| Nr. | Id | D-Conf | B-Conf | A-Conf | Hypothesis |
|-----|-----|--------|--------|--------|------------------------------------------------------------------------------------------------------------------------------|
| 1 | 258 | 0.600 | 1.000 | 0.400 | Year_(2015) : (P2_Public_Services(8,2) >= < (empty) : (Total,Alert) > Total(Warning)) |
| 2 | 195 | 0.600 | 1.000 | 0.400 | Year_(2015) : (P2_Public_Services(8,7) > P2_Public_Services(4,5)) >= < (empty) : (Total,Alert) > Total(Warning)) |
| 3 | 2 | 0.600 | 1.000 | 0.400 | Year_(2015) : (S2_Refugees_and_IDPs(10) > S2_Refugees_and_IDPs(3)) >= < (empty) : (Total,Alert) > Total(Warning)) |
| 4 | 250 | 0.500 | 1.000 | 0.500 | Year_(2015) : (P2_Public_Services(8,2) >= < (empty) : (Total,Alert) > Total(Warning)) |
| 5 | 196 | 0.500 | 1.000 | 0.500 | Year_(2015) : (P2_Public_Services(8,7) > P2_Public_Services(9,3)) >= < (empty) : (Total,Alert) > Total(Warning)) |
| 6 | 38 | 0.500 | 1.000 | 0.500 | Year_(2015) : (P3_Human_Rights(10) > P3_Human_Rights(7,3)) >= < (empty) : (Total,Alert) > Total(Warning)) |
| 7 | 6 | 0.500 | 1.000 | 0.500 | Year_(2015) : (S2_Refugees_and_IDPs(10) > S2_Refugees_and_IDPs(4,5)) >= < (empty) : (Total,Alert) > Total(Warning)) |
| 8 | 74 | 0.500 | 1.000 | 0.500 | Year_(2015) : (X1_External_Intervention(9,8) > X1_External_Intervention(5,4)) >= < (empty) : (Total,Alert) > Total(Warning)) |
| 9 | 230 | 0.500 | 1.000 | 0.500 | Year_(2015) : (X1_External_Intervention(10) > X1_External_Intervention(5,4)) >= < (empty) : (Total,Alert) > Total(Warning)) |
| 10 | 69 | 0.400 | 1.000 | 0.600 | Year_(2015) : (X1_External_Intervention(9,8) > P2_Public_Services(9,3)) >= < (empty) : (Total,Alert) > Total(Warning)) |
| 11 | 225 | 0.400 | 1.000 | 0.600 | Year_(2015) : (X1_External_Intervention(10) > X1_External_Intervention(5,9)) >= < (empty) : (Total,Alert) > Total(Warning)) |
| 12 | 255 | 0.333 | 1.000 | 0.667 | Year_(2015) : (P2_Public_Services(8,2) > P2_Public_Services(4,7)) >= < (empty) : (Total,Alert) > Total(Warning)) |
| 13 | 273 | 0.333 | 1.000 | 0.667 | Year_(2015) : (P2_Public_Services(8,2) > P2_Public_Services(8,1)) >= < (empty) : (Total,Alert) > Total(Warning)) |
| 14 | 274 | 0.333 | 1.000 | 0.667 | Year_(2015) : (P2_Public_Services(8,2) > P2_Public_Services(5,7)) >= < (empty) : (Total,Alert) > Total(Warning)) |
| 15 | 192 | 0.333 | 1.000 | 0.667 | Year_(2015) : (P2_Public_Services(8,7) > P2_Public_Services(4,7)) >= < (empty) : (Total,Alert) > Total(Warning)) |
| 16 | 210 | 0.333 | 1.000 | 0.667 | Year_(2015) : (P2_Public_Services(8,7) > P2_Public_Services(8,0)) >= < (empty) : (Total,Alert) > Total(Warning)) |
| 17 | 211 | 0.333 | 1.000 | 0.667 | Year_(2015) : (P2_Public_Services(8,7) > P2_Public_Services(5,7)) >= < (empty) : (Total,Alert) > Total(Warning)) |
| 18 | 45 | 0.333 | 1.000 | 0.667 | Year_(2015) : (P3_Human_Rights(10) > P3_Human_Rights(7,5)) >= < (empty) : (Total,Alert) > Total(Warning)) |
| 19 | 49 | 0.333 | 1.000 | 0.667 | Year_(2015) : (P3_Human_Rights(10) > P3_Human_Rights(3,9)) >= < (empty) : (Total,Alert) > Total(Warning)) |
| 20 | 16 | 0.333 | 1.000 | 0.667 | Year_(2015) : (S2_Refugees_and_IDPs(10) > S2_Refugees_and_IDPs(4,4)) >= < (empty) : (Total,Alert) > Total(Warning)) |
| 21 | 17 | 0.333 | 1.000 | 0.667 | Year_(2015) : (S2_Refugees_and_IDPs(10) > S2_Refugees_and_IDPs(3,9)) >= < (empty) : (Total,Alert) > Total(Warning)) |

Detail Goto ID Copy Remove Filter Sorting Export

Ready NUM

State Before:-

LM fsi-2015.csv MB - LISp-Miner Workspace module - 27.18.03

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Tables Attributes Tasks Overview 2015.csv 2015.csv Hypothesis (258)

Antecedent: Year_(2015) : (P2_Public_Services(8,2) > P2_Public_Services(4,5))
 Succedent: (Total,Alert) > Total(Warning)
 State before: Year_(2015) && P2_Public_Services(8,2) >= < Total(Alert)
 State after: Year_(2015) && P2_Public_Services(4,5) >= < Total(Warning)
 Condition: (empty)

TEXT DATA STATE BEFORE STATE AFTER | B+A | DIFF ABS | DIFF REL |

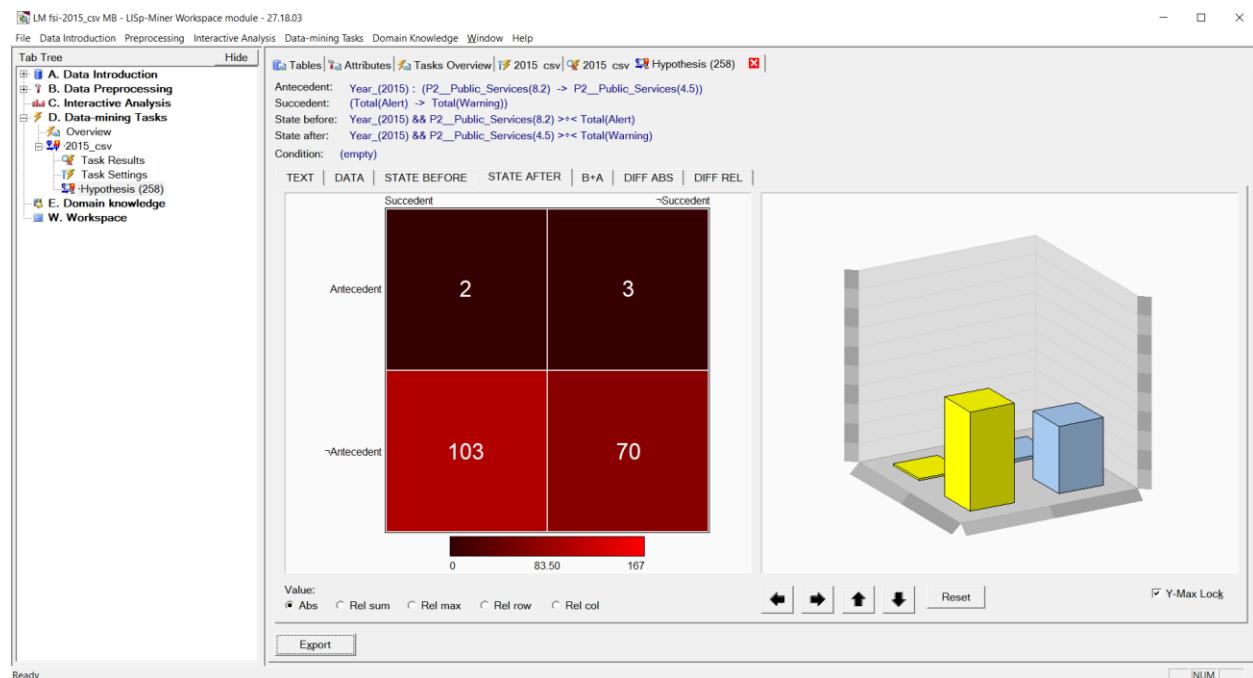
| | | Succedent | ~Succedent | | | |
|-------------|--|------------|-------------|---|-------|-----|
| | | Antecedent | ~Antecedent | | | |
| Antecedent | | 2 | 0 | | | |
| ~Antecedent | | 9 | 167 | | | |
| | | | | 0 | 83.50 | 167 |

Value:
 Abs Rel sum Rel max Rel row Rel col

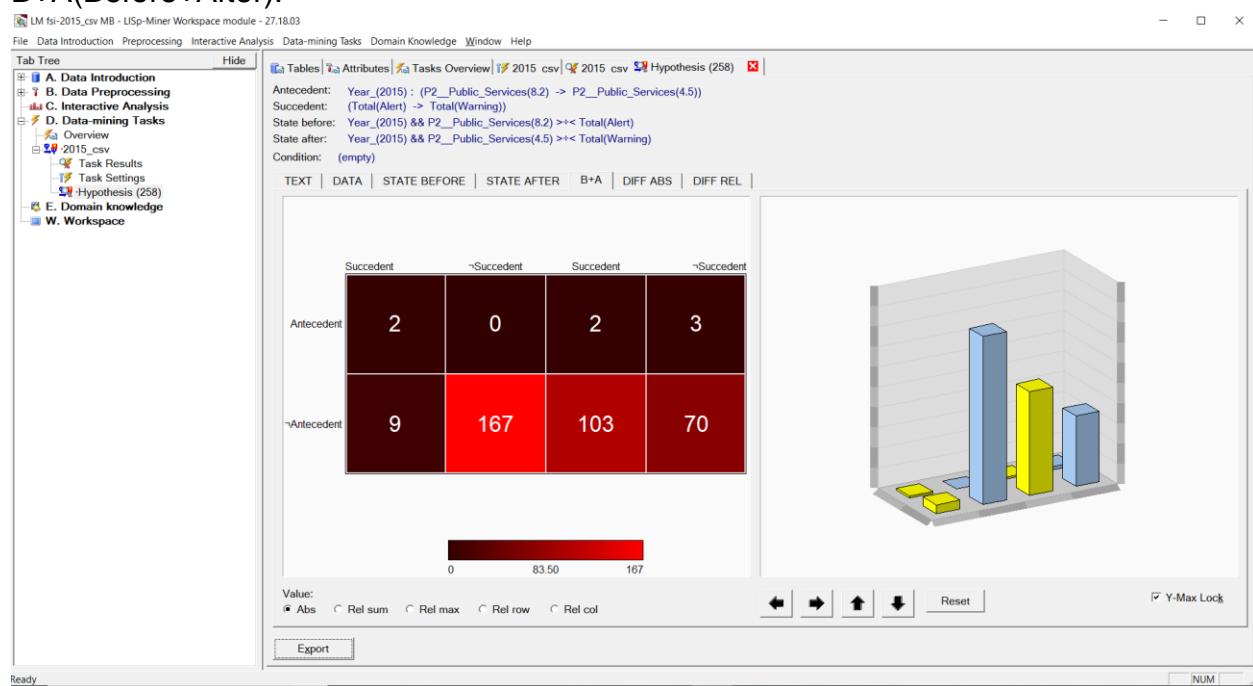
Export

Reset Y-Max Lock

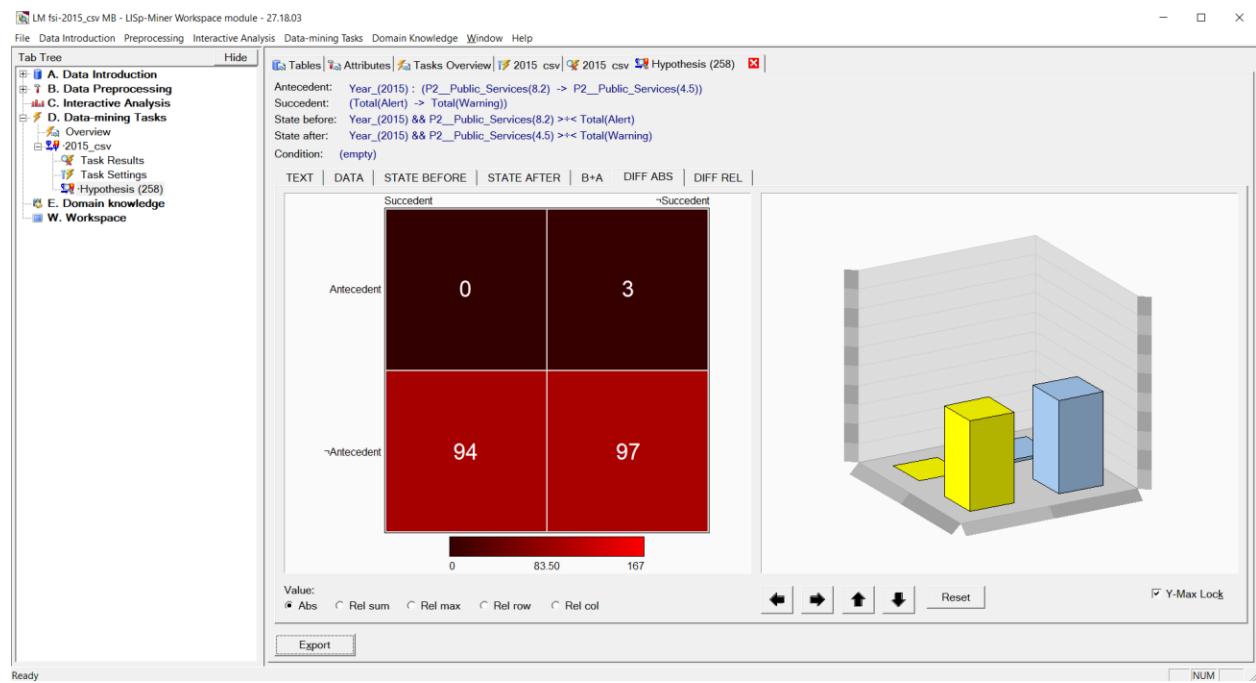
State After:-



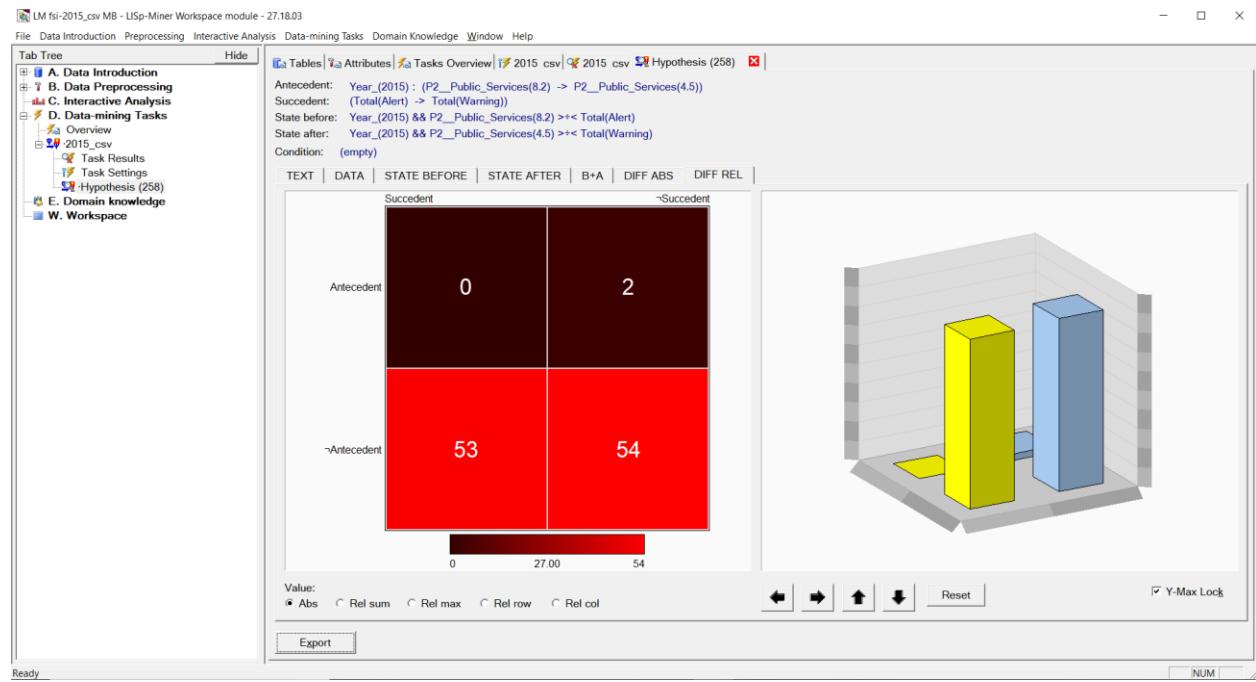
B+A(Before+After):-



Diff Abs:-



Diff Rel:-



Action Rules:-

- For the action rules, please go through the attached txt files.
- Below are some actions rules and explanation:-

**1. Year_(2015) : (P2_Public_Services(8.2) -> P2_Public_Services(4.5)) >÷<
(Total(Alert) -> Total(Warning))**

Above rule show that in the year 2015 if the Public Services which denotes the lack of important services like healthcare, education, cleanliness, transportation that affects the performance of a country went down to 4.5 then the state of the country will get change from Alert to Warning with 60% chance.

**2. Year_(2015) : (P2_Public_Services(9.7) -> P2_Public_Services(4.5)) >÷<
(Total(Alert) -> Total(Warning))**

Above rule show that in the year 2015 if the Public Services which denotes the lack of important services like healthcare, education, cleanliness, transportation that affects the performance of a state changed from 9.7 to 4.5 then there is 60% chance that Total attribute will get changed from Alert to Warning.

**3. Year_(2015) : (S2_Refugees_and_IDPs(10) ->
S2_Refugees_and_IDPs(3)) >÷< (Total(Alert) -> Total(Warning))**

Refugees and IDPs denote the immigration of the general population that can affect security and other resources. If this parameter is changed from 10 to 3 then also the succedent variable will get change from Alert to Warning with 60% chance.

**4. Year_(2015) : (P3_Human_Rights(10) -> P3_Human_Rights(7.3)) >÷<
(Total(Alert) -> Total(Warning))**

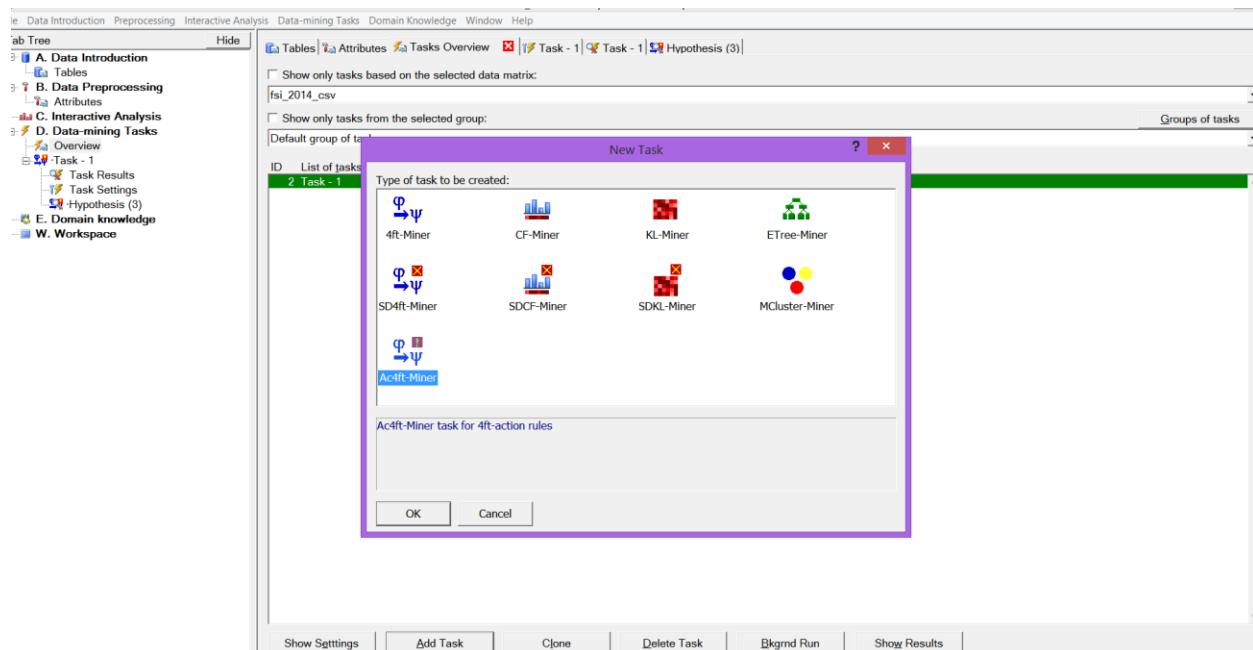
Human Rights defines the weak protection of basic rights indicates the failure of a state to perform its primary responsibility. Hence if the value of human rights changed from 10 to 7.3 then there is a 50% chance that the total will get change from Alert to Warning

Year 2016

Step 1: Importing CSV file into a table in Lisp Miner

Step 2: Selection of attributes from data

Step 3: Selecting Ac4ft Miner task to create association rules.



Step 4: Set antecedent , succedent and quantifiers values.

The above screenshot shows the attributes chosen for the antecedent stable part, antecedent variable part and succedent variable part.

Below are the flexible attributes we have chosen for Antecedent variable part:-

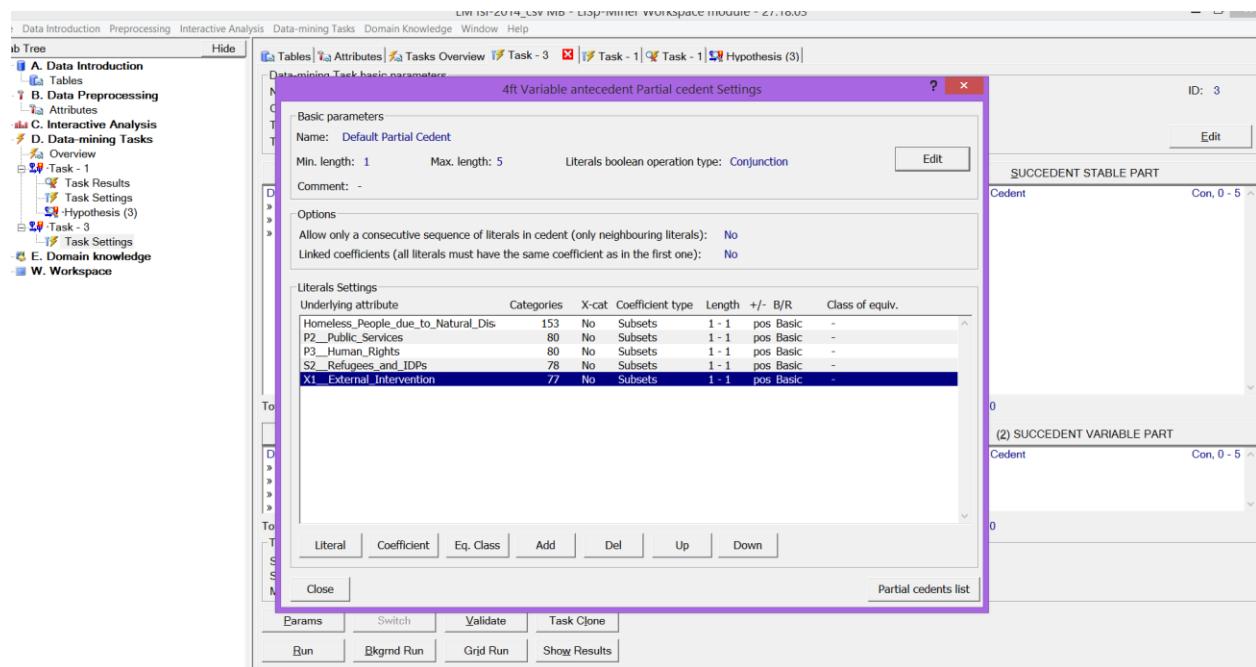
Homeless people due to natural disaster

Public services

Human rights

Refugees and IDPs

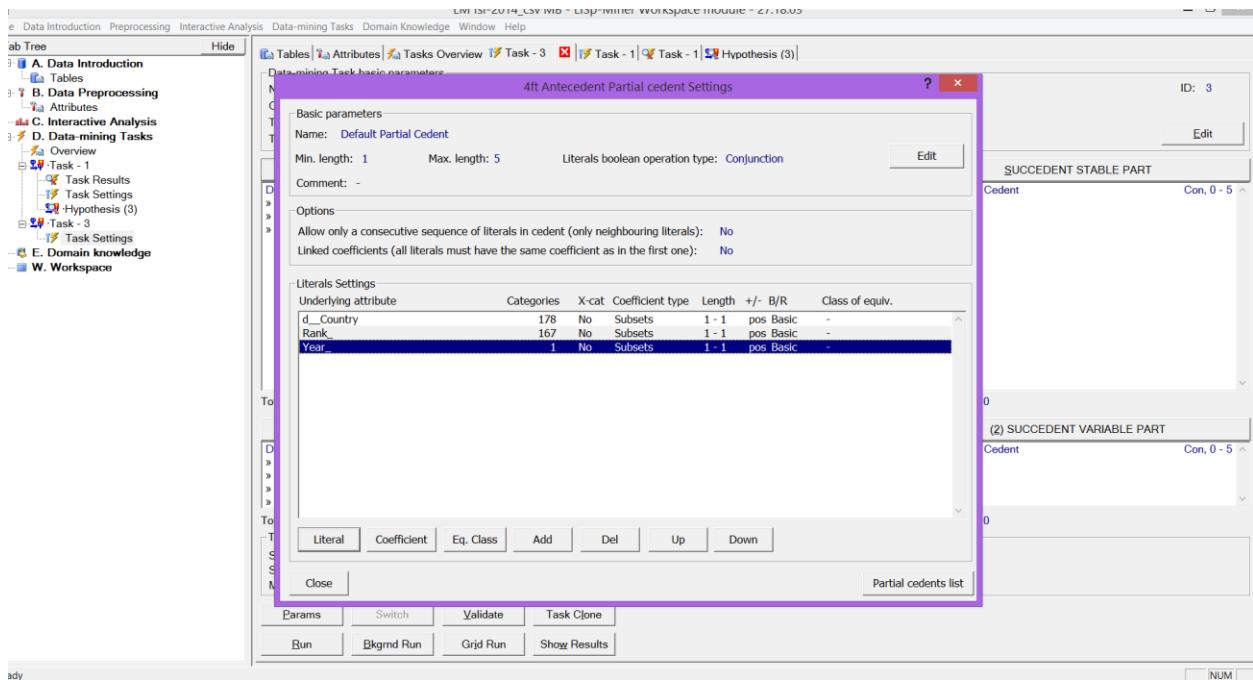
External intervention



Explanation:-

Homeless people due to natural disaster, Public services, Human rights, Refugees and IDPs, External intervention are chosen as antecedent variable part because these attributes are showing large variation between the alert state to warning state of the total. And hence action rules stating the actions needs to be taken in order to change the output from alert to warning can be found easily.

Below are the stable attributes used as a antecedent stable part:-



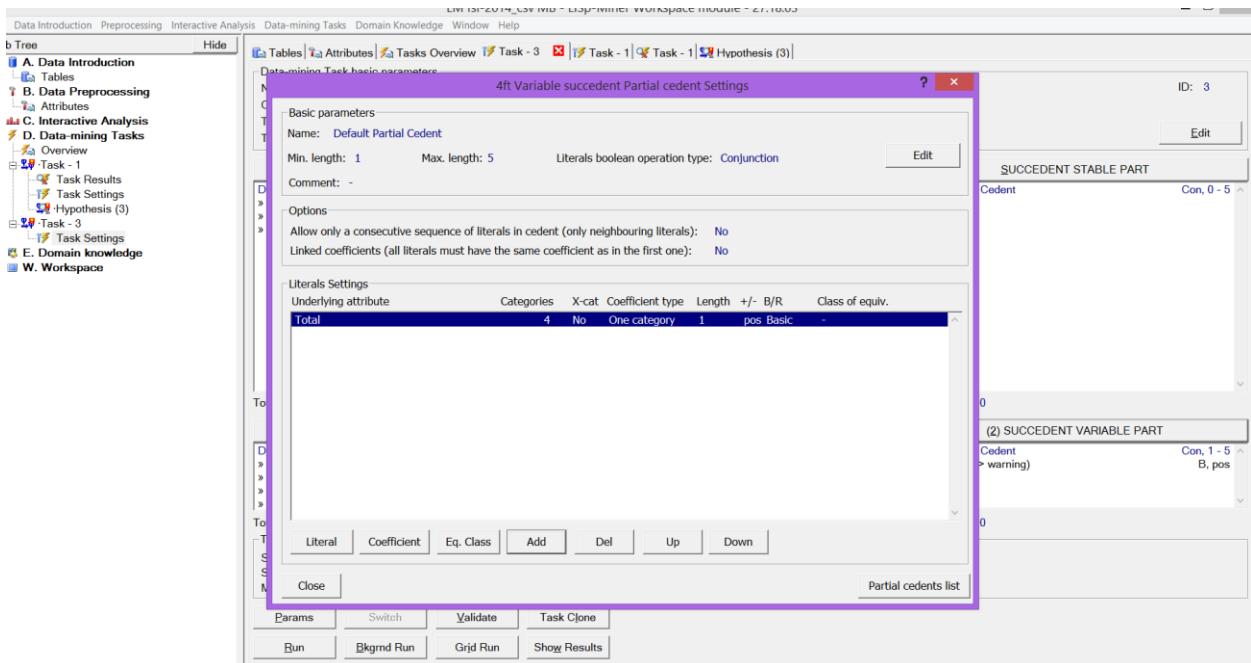
Explanation:-

We chose these attributes as stable attributes as the succedent variable total is varying according to these attributes.

Below is the Succedent variable part:-

Total(Alert -> Warning)

Note - This is a nominal type of attribute with one category as coefficient type



Explanation:-

Total is the target variable and action rules stating the change in the total needs to be found out. This attribute was chosen as a decision attribute which had four categories namely- alert, stable, sustainable and warning. As a result, these attributes are chosen as succedent variable part with Statebefore as Alert and StateAfter as Warning to analyze the action rule.

Quantifiers used:-

a(Base) before - 2.00
a(Base) after - 2.00

Action Rules for the year 2015:-

- Decision attribute used - Total(Alert -> Warning)

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Tables | Attributes | Tasks Overview | Task - 3 | Task - 1 | Hypothesis (3)

Task: Task - 3
Comment: -
Taskgroup: Default group of tasks
Data matrix: fsi_2016_csv
Task type: Ao4R-Miner

Task run:
Start: 2.5.2019 16:28:30 Total time: 0h 0m 15s
Number of verifications: 9966
Number of hypotheses: 930 Mode: Standard

Show all Show not in group Highlight
Show hypotheses just from group:

Add group Del group Edit group

Actual group of hypotheses: All hypotheses
Hypotheses in group: 930 Shown hypotheses: 930 Highlighted: 0

Delete hypotheses

| Nr. Id | Df-Corr | B/Corr | A/Corr | Hypothesis |
|--------|---------|--------|--------|-------------------------------------------------------------------------------------------------|
| 1 | 590 | 0.714 | 1.000 | 0.286 Year_(2016) : (P2_Public_Services(8,2) >< (empty) : (Total(Alert) > Total(warning)) |
| 2 | 901 | 0.714 | 1.000 | 0.286 Year_(2016) : (P2_Public_Services(8,5) >< (empty) : (Total(Alert) > Total(warning)) |
| 3 | 565 | 0.714 | 1.000 | 0.286 Year_(2016) : (P2_Public_Services(8,7) >< (empty) : (Total(Alert) > Total(warning)) |
| 4 | 540 | 0.714 | 1.000 | 0.286 Year_(2016) : (P2_Public_Services(9) >< (empty) : (Total(Alert) > Total(warning)) |
| 5 | 876 | 0.714 | 1.000 | 0.286 Year_(2016) : (P2_Public_Services(9,4) >< (empty) : (Total(Alert) > Total(warning)) |
| 6 | 851 | 0.714 | 1.000 | 0.286 Year_(2016) : (P2_Public_Services(9,5) >< (empty) : (Total(Alert) > Total(warning)) |
| 7 | 822 | 0.714 | 1.000 | 0.286 Year_(2016) : (P2_Public_Services(10) >< (empty) : (Total(Alert) > Total(warning)) |
| 8 | 591 | 0.667 | 1.000 | 0.333 Year_(2016) : (P2_Public_Services(8,2) >< (empty) : (Total(Alert) > Total(warning)) |
| 9 | 900 | 0.667 | 1.000 | 0.333 Year_(2016) : (P2_Public_Services(8,5) >< (empty) : (Total(Alert) > Total(warning)) |
| 10 | 568 | 0.667 | 1.000 | 0.333 Year_(2016) : (P2_Public_Services(8,7) >< (empty) : (Total(Alert) > Total(warning)) |
| 11 | 541 | 0.667 | 1.000 | 0.333 Year_(2016) : (P2_Public_Services(9) >< (empty) : (Total(Alert) > Total(warning)) |
| 12 | 877 | 0.667 | 1.000 | 0.333 Year_(2016) : (P2_Public_Services(9,4) >< (empty) : (Total(Alert) > Total(warning)) |
| 13 | 852 | 0.667 | 1.000 | 0.333 Year_(2016) : (P2_Public_Services(9,5) >< (empty) : (Total(Alert) > Total(warning)) |
| 14 | 827 | 0.667 | 1.000 | 0.333 Year_(2016) : (P2_Public_Services(10) >< (empty) : (Total(Alert) > Total(warning)) |
| 15 | 803 | 0.600 | 1.000 | 0.400 Year_(2016) : (P3_Human_Rights(5,5) >< (empty) : (Total(Alert) > Total(warning)) |
| 16 | 778 | 0.600 | 1.000 | 0.400 Year_(2016) : (P3_Human_Rights(6,7) >< (empty) : (Total(Alert) > Total(warning)) |
| 17 | 442 | 0.600 | 1.000 | 0.400 Year_(2016) : (P3_Human_Rights(9,3) >< (empty) : (Total(Alert) > Total(warning)) |
| 18 | 417 | 0.600 | 1.000 | 0.400 Year_(2016) : (P3_Human_Rights(9,7) >< (empty) : (Total(Alert) > Total(warning)) |
| 19 | 699 | 0.600 | 1.000 | 0.400 Year_(2016) : (X1_External_Intervention(8,1) >< (empty) : (Total(Alert) > Total(warning)) |
| 20 | 667 | 0.600 | 1.000 | 0.400 Year_(2016) : (X1_External_Intervention(8,5) >< (empty) : (Total(Alert) > Total(warning)) |
| 21 | 305 | 0.600 | 1.000 | 0.400 Year_(2016) : (X1_External_Intervention(9,5) >< (empty) : (Total(Alert) > Total(warning)) |

Detail Goto ID Copy Remove Filter Sorting Export NUM

State Before:-

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 - Task - 3
 - Task Results
 - Task Settings
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Tables | Attributes | Tasks Overview | Task - 3 | Task - 1 | Hypothesis (811)

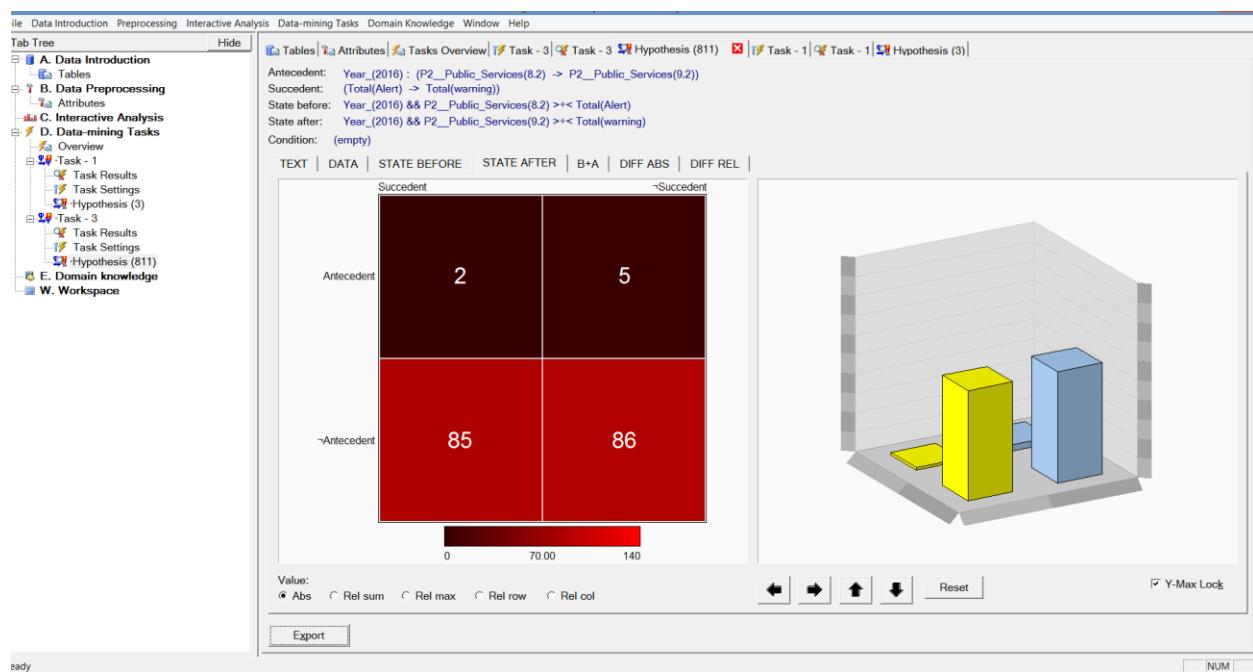
Antecedent: Year_(2016) : (P2_Public_Services(8,2) > P2_Public_Services(9,2))
 Succedent: (Total(Alert) > Total(warning))
 State before: Year_(2016) && P2_Public_Services(8,2) >< Total(Alert)
 State after: Year_(2016) && P2_Public_Services(9,2) >< Total(warning)
 Condition: (empty)

TEXT | DATA STATE BEFORE | STATE AFTER | B+A | DIFF ABS | DIFF REL

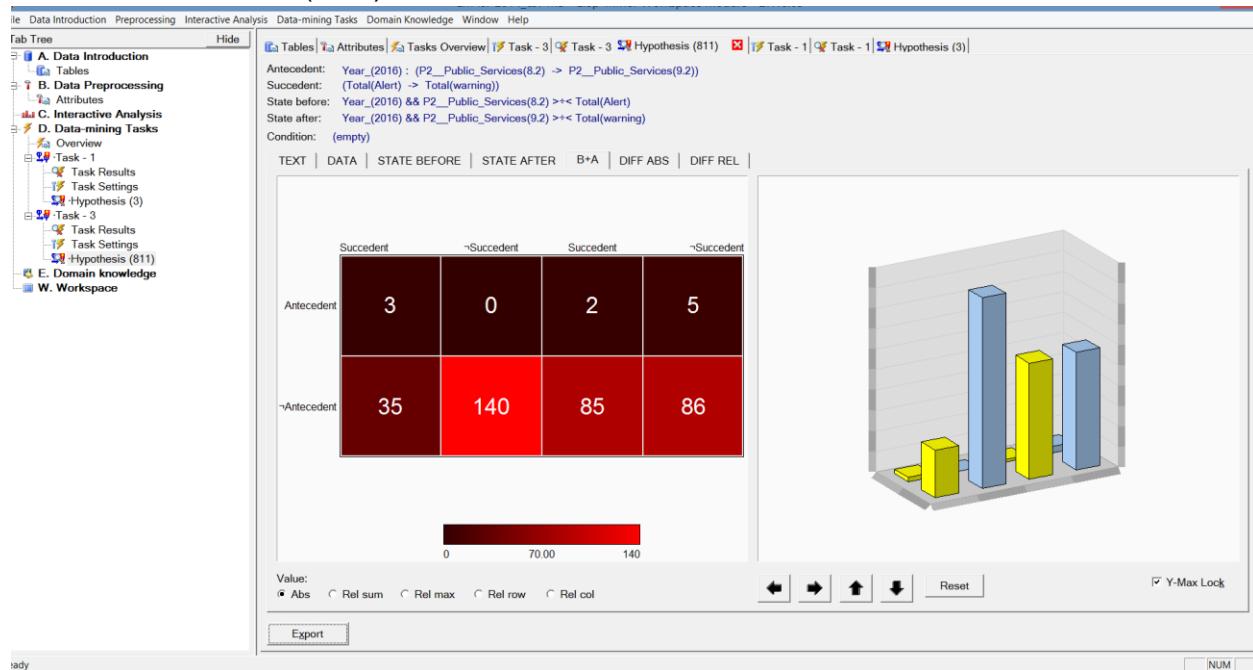
| Succedent | | ~Succedent | | | |
|-------------|--------------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|
| Antecedent | | 3 | 0 | | |
| ~Antecedent | | 35 | 140 | | |
| Value: | <input checked="" type="radio"/> Abs | <input type="radio"/> Rel sum | <input type="radio"/> Rel max | <input type="radio"/> Rel row | <input type="radio"/> Rel col |

Export

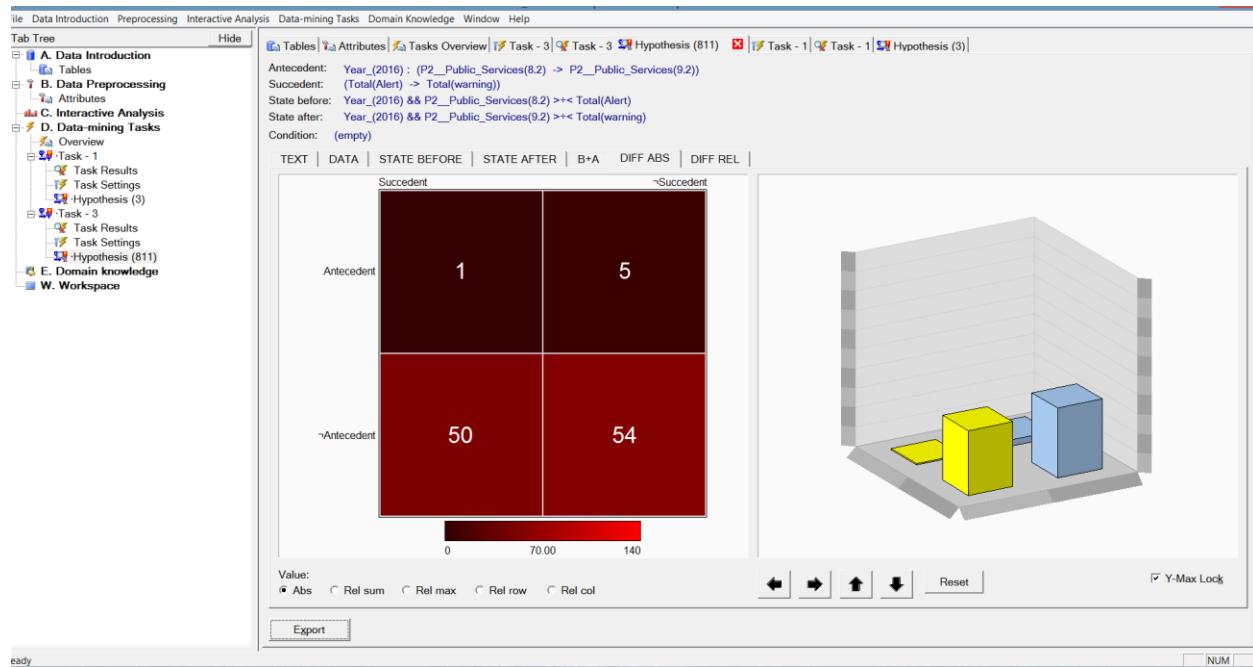
State After:-



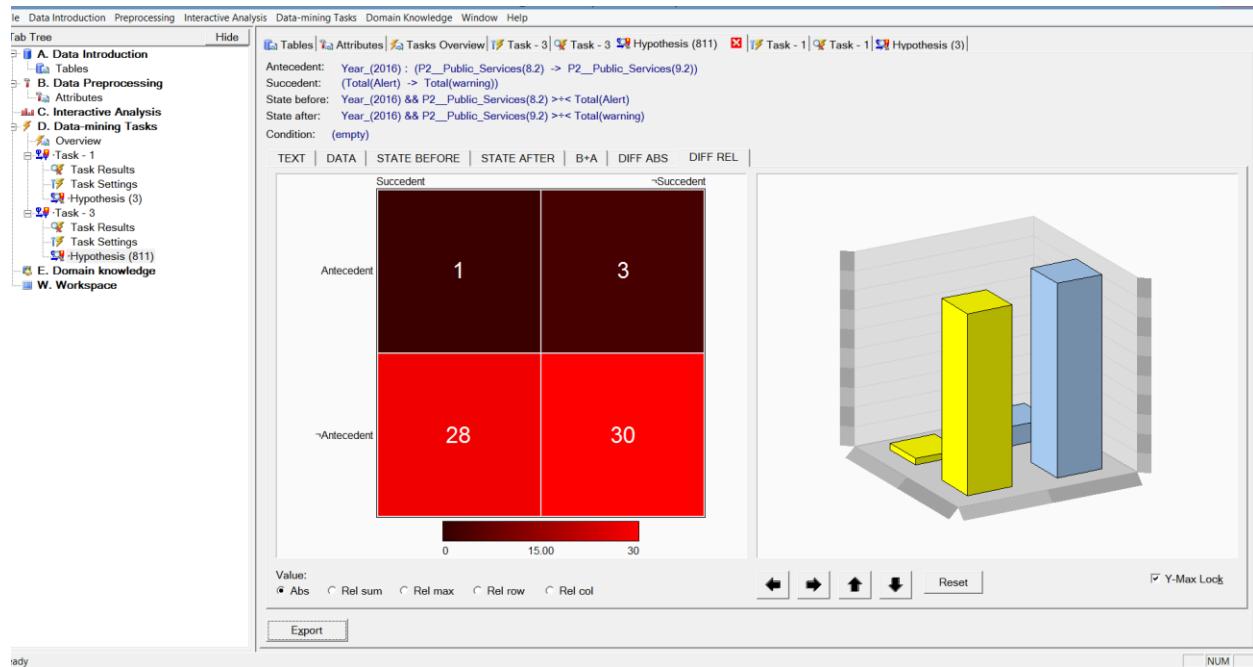
State Before + After (B+A):-



Diff Abs:-



Diff Rel:-



Action Rules:-

- For the action rules, please go through the attached txt files.
- Below are some actions rules and explanation:-

1. Year_(2015) : (P2_Public_Services(9.5) -> P2_Public_Services(4)) >÷< (Total(Alert) -> Total(Warning))

Above rule show that in the year 2016 if the Public Services which denotes the lack of important services like healthcare, education, cleanliness, transportation that affects the performance of a state went down to 4 then the state of the states will get change from Alert to Warning with 66.67% chance.

2. Year_(2015) : (P3_Human_Rights(9.1) -> P3_Human_Rights(7.5)) >÷< (Total(Alert) -> Total(Warning))

Human Rights defines the weak protection of basic rights indicates the failure of a state to perform its primary responsibility. Hence if the value of human rights changed from 9.1 to 7.5 then there is a 60% chance that the total will get change from Alert to Warning

3. Year_(2015) : (X1_External_Intervention(8.5) -> X1_External_Intervention(4.3)) >÷< (Total(Alert) -> Total(Warning))

Measured by foreign assistance, presence of peacekeepers or UN missions, foreign military intervention, sanctions, and credit ratings
If this parameter is changed from 8.5 to 4.3 then also the succedent variable will get change from Alert to Warning with 60% chance.

4. Year_(2015) : (S2_Refugees_and_IDPs(9.3) -> S2_Refugees_and_IDPs(7.5)) >÷< (Total(Alert) -> Total(Warning))

Refugees and IDPs denote the immigration of the general population that can affect security and other resources. If this parameter is changed from 9.3 to 7.5 then also the succedent variable will get change from Alert to Warning with 60% chance.

References:-

1. The World Bank Group. World Bank Open Data. Retrieved from <https://data.worldbank.org/Data%20for%20indicators%20sourced%20from%20this%20site%20or%20the%20years%202012%20through%202015>
2. Spreadsheets used in Weka are attached to the mail.
3. LISp-Miner Workspace module vesion 27.18.01 by M. Simunek & J. Rauch