CSE 634 - DATA MINING PROJECT REPORT

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Classification of Bakary Data using WEKA

INTRODUCTION

The goal of this project is to use a classification tool - WEKA - to build two types of classifiers namely, a descriptive and a non-descriptive classifier and compare their results.

DATA MINING PROCESS STEPS

Step 1: Data Preparation -

Preparing the dataset: The .xls format of the dataset was converted to .csv, for WEKA to recognize the data. Also, blank sheets in the .xls dataset were deleted.

We corrected a few misspellings found in the naming of the classes - for example, Pyrate was misspelled as Pyrrite in a row. Since we need 6 classes, R. Carbonatees and R. Carbonatees impures were clubbed to a single class C1.

Now, there are 6 classes in the given dataset:
C1 - R. Carbonatees and R. Carbonatees impures
C2 : Pyrate
C3 : Charcopyrite
C4 : Galene
C5 : Spahlerite
C6 : Sediments terrigenes

Cleaning the data: We observed that the class attribute *Type de Roche* occurred twice in the given dataset (at the second and again at the last column). WEKA throws an error warning of duplicated attributes. Hence, we deleted the last column. The second row of the dataset, which was blank, was also deleted as WEKA considers even blank rows as attributes.

Additionally, one value for the Li attribute read '<0.3'. Since we cannot accept special characters, we filled in a value of 0.29 for this attribute.

Filling missing values: We observed that some attributes had <85% of their values missing, while others had >85%.

Two attributes - Mo and Co - had >85% of their values missing. Hence, we ignored these attributes during the classification. For others which had about <85% of their values

missing, we filled in the missing values by replacing them with the mean of the values over that specific attribute values using “ReplaceMissingValues” filter in Weka.

Motivation for the above steps: During the KDD process, we need noiseless and consistent data, which was the motivation to perform the above data preparation steps.

Result of this step: The clean data was loaded into WEKA and was ready was data preprocessing.

Step 2: Data Preprocessing -

Descriptive classifier: To build a descriptive classifier - a decision tree - we used two techniques of data discretization. Discretization methods reduce the number of values for continuous attributes. This is done by dividing the attribute range into intervals. This makes it easier for the learning algorithm (decision tree, in this case) to spot patterns in the data thereby making the result more accurate and faster.

Non-Descriptive classifier: For a Neural Network non-descriptive classifier, we first normalized the data using the WEKA ‘Normalize’ preprocess filter.

Step 3: Building the classifier:

For a descriptive classifier, we have used 2 types of data discretization methods:

Discretization Method 1: Equal Width Binning: It is a discretization algorithm which discretizes values by creating bins of equal width intervals.

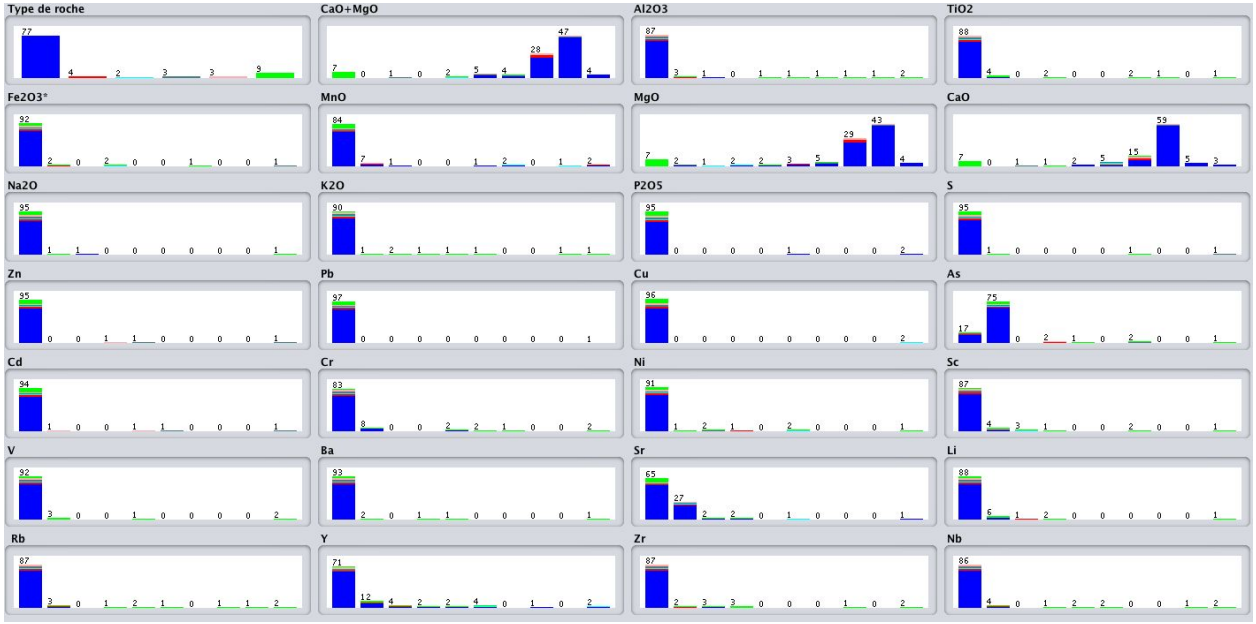
Discretization Method 2: Equal Frequency Binning: It is a discretization algorithm which discretizes values by creating bins where an equal number of values are assigned to each bin.

Additionally, while trying out various methods in WEKA, we found a *Supervised Discretization method* and observed that it fares better than the above two unsupervised discretization methods. We have also documented the results for the same. It is an algorithm which discretizes values based on classes. This ensures that it implicitly uses information gain on parameters to classify them into bins.

We have used cross validation with 10 folds method in Weka to train the model on training and validation data.
To implement the discretization, we used meta classifier to ensure that the discretization is only applied on the test data and not the data being used for validation in the 10 folds cross validation being used to train the model.

Experiment 1: Full classification: In this experiment, we have considered all the records in the dataset to perform full classification.

Here are the results for **decision tree descriptive classifier** discretization methods:



a. Equal width binning discretization method

Classifier Model J48 pruned tree
K2O_1 = '(-inf-0.1]' | Cu_1 = '(-inf-0.1]' | | CaO+MgO_3 = '(-inf-0.3]': Galene (2.0/1.0) | | CaO+MgO_3 = '(0.3-inf)' | | | Cd_1 = '(-inf-0.1]': R. Carbonatees and R. Carbonatees impures (83.0/6.0) | | | Cd_1 = '(0.1-inf)': Spahlerite (3.0/1.0) | Cu_1 = '(0.1-inf)': Charcopyrite (2.0) K2O_1 = '(0.1-inf)': Sediments terrigenes (8.0)
Number of Leaves : 5 Size of the tree : 9

Discriminant rules:

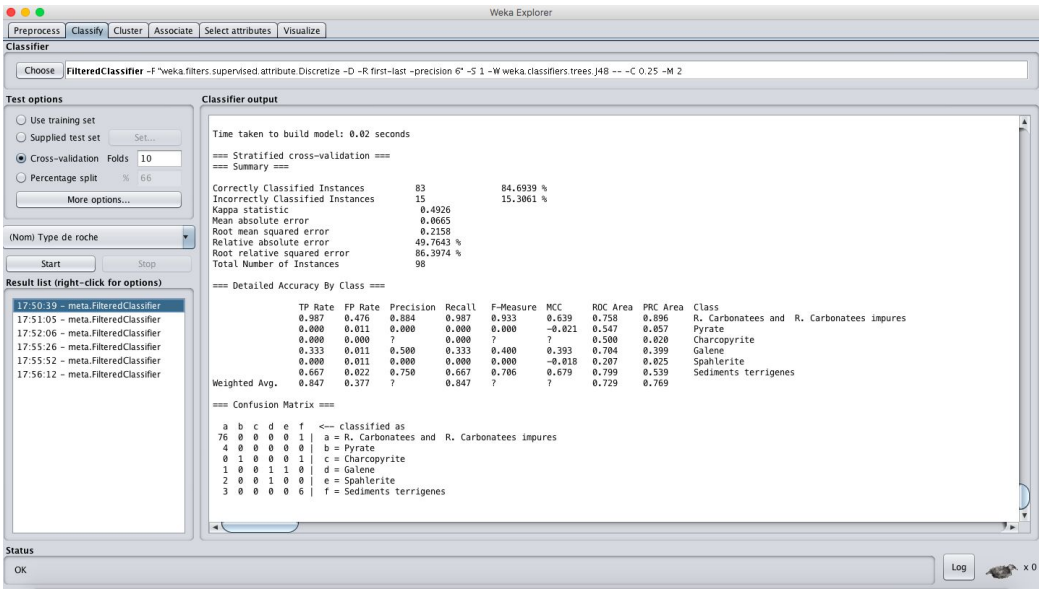
Rule 1: If the K2O and Cu attributes are both less than 0.1 and CaO+MgO is less than 0.3, then the type of rock is Galene.

Rule 2: If the K2O and Cu attributes are both less than 0.1, CaO+MgO is more than 0.3 and Cd is less than 0.1, then the type of rock is R. Carbonatees and R. Carbonatees impures.

Rule 3: If the K2O and Cu attributes are both less than 0.1, CaO+MgO is more than 0.3 and Cd is more than 0.1, then the type of rock is Spahlerite.

Rule 4: If K2O is less than 0.1 and Cu is more than 0.1, then the type of rock is Charcopyrite.

Rule 5: If K2O is more than 0.1, then the type of rock is Sediments terrigenes.



b. Equal frequency discretization method:

Classifier Model
J48 pruned tree

```
Pb_6 = '(-inf-0.053537]'
|   Cs_6 = '(-inf-0.189189]'
|   |   Fe2O3*_9 = '(-inf-0.06657]'
|   |   |   S_9 = '(-inf-0.041379]'
|   |   |   |   Cd_4 = '(-inf-0.094552]': R. Carbonatees and  R. Carbonatees impures (80.0/3.0)
|   |   |   |   Cd_4 = '(0.094552-inf)': Spahlerite (2.0)
|   |   |   S_9 = '(0.041379-inf)': Pyrate (2.0)
|   |   Fe2O3*_9 = '(0.06657-inf)': Charcopyrite (3.0/1.0)
|   Cs_6 = '(0.189189-inf)': Sediments terrigenes (8.0)
Pb_6 = '(0.053537-inf)': Galene (3.0)
```

Number of Leaves : 6
Size of the tree : 11

Discriminant rules:

Rule 1: If Pb is less than 0.0535, Cs is less than 0.189 and Fe2O3 is less than 0.066, S is less than 0.0414,Cd is less than 0.095, then the type of rock is R. Carbonatees and R. Carbonatees impures.

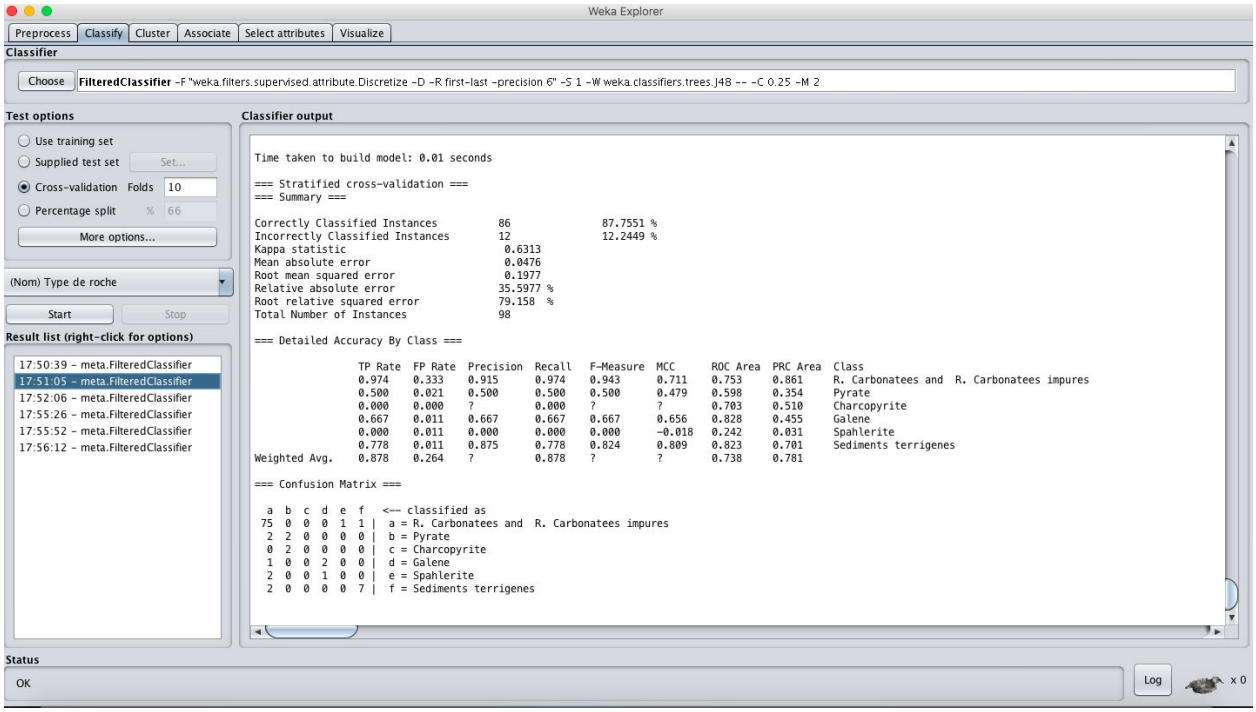
Rule 2: If Pb is less than 0.0535, Cs is less than 0.189 and Fe2O3 is less than 0.066, S is less than 0.0414,Cd is more than 0.095, then the type of rock is Spahlerite.

Rule 3: If Pb is less than 0.0535, Cs is less than 0.189 and Fe2O3 is less than 0.066, S is more than 0.0414, then the type of rock is Pyrate.

Rule 4: If Pb is less than 0.0535, Cs is less than 0.189 and Fe2O3 is more than 0.066, then the type of rock is Charcopyrite.

Rule 5: If Pb is less than 0.0535, Cs is more than 0.189, then the type of rock is Sediments terrigenes.

Rule 6: If Pb is less than 0.0535, Cs is more than 0.189, then the type of rock is Galene.


Weka Explorer
Preprocess
Classify
Cluster
Associate
Select attributes
Visualize
Classifier
Choose
FilteredClassifier -F "weka.filters.supervised.attribute.Discretize -D -R first-last -precision 6" -S 1 -W weka.classifiers.trees.J48 -- -C 0.25 -M 2
Test options
Use training set
Supplied test set
Set...
Cross-validation
Folds
10
Percentage split
%
66
More options...
(Nom) Type de roche
Start
Stop
Result list (right-click for options)
17:50:39 - meta.FilteredClassifier
17:51:05 - meta.FilteredClassifier
17:52:06 - meta.FilteredClassifier
17:55:26 - meta.FilteredClassifier
17:55:52 - meta.FilteredClassifier
17:56:12 - meta.FilteredClassifier
Classifier output
Time taken to build model: 0.01 seconds
=== Stratified cross-validation ===
=== Summary ===
Correctly Classified Instances 86 87.7551 %
Incorrectly Classified Instances 12 12.2449 %
Kappa statistic 0.6313
Mean absolute error 0.0476
Root mean squared error 0.1977
Relative absolute error 35.5977 %
Root relative squared error 79.158 %
Total Number of Instances 98
=== Detailed Accuracy By Class ===
TP Rate FP Rate Precision Recall F-Measure MCC ROC Area PRC Area Class
0.974 0.333 0.915 0.974 0.943 0.711 0.753 0.861 R. Carbonatees and R. Carbonatees impures
0.500 0.021 0.500 0.500 0.500 0.479 0.598 0.354 Pyrate
0.000 0.000 ? 0.000 ? ? 0.703 0.510 Charcopyrite
0.667 0.011 0.667 0.667 0.667 0.656 0.828 0.455 Galene
0.000 0.011 0.000 0.000 0.000 -0.018 0.242 0.031 Spahlerite
0.778 0.011 0.875 0.778 0.824 0.809 0.823 0.701 Sediments terrigenes
Weighted Avg. 0.878 0.264 ? 0.878 ? ? 0.738 0.781
=== Confusion Matrix ===
a b c d e f <-- classified as
75 0 0 0 1 1 | a = R. Carbonatees and R. Carbonatees impures
2 2 0 0 0 0 | b = Pyrate
0 2 0 0 0 0 | c = Charcopyrite
1 0 0 2 0 0 | d = Galene
2 0 0 1 0 0 | e = Spahlerite
2 0 0 0 0 7 | f = Sediments terrigenes
Status
OK
Log
x 0

c. Supervised Discretization - We also performed a supervised discretization in addition to the above 2 data discretization methods and found that we obtain a better accuracy (87.8%) here:

Classifier Model J48 pruned tree
K2O = '(-inf-0.084975]' | Pb = '(-inf-0.038576]' | | Sc = '(-inf-0.107798]' | | | Fe2O3* = '(-inf-0.010288]': R. Carbonatees and R. Carbonatees impures (74.0/1.0) | | | Fe2O3* = '(0.010288-inf)' | | | | S = '(-inf-0.00611]': R. Carbonatees and R. Carbonatees impures (4.0/1.0) | | | | S = '(0.00611-inf)': Pyrate (4.0) | | Sc = '(0.107798-inf)': Charcopyrite (3.0/1.0) | Pb = '(0.038576-0.053537]': Spahlerite (1.0) | Pb = '(0.053537-inf)': Galene (3.0) K2O = '(0.084975-inf)': Sediments terrigenes (9.0)
Number of Leaves : 7 Size of the tree : 12

Discriminant rules:

Rule 1: If K2O is less than 0.085, Pb is less than 0.0386 and Sc is less than 0.1078, Fe2O3 is less than 0.01029, then the type of rock is R. Carbonatees and R. Carbonatees impures.

Rule 2: If K2O is less than 0.085, Pb is less than 0.0386 and Sc is less than 0.1078, Fe2O3 is more than 0.01029, S is less than 0.00611, then the type of rock is R. Carbonatees and R. Carbonatees impures.

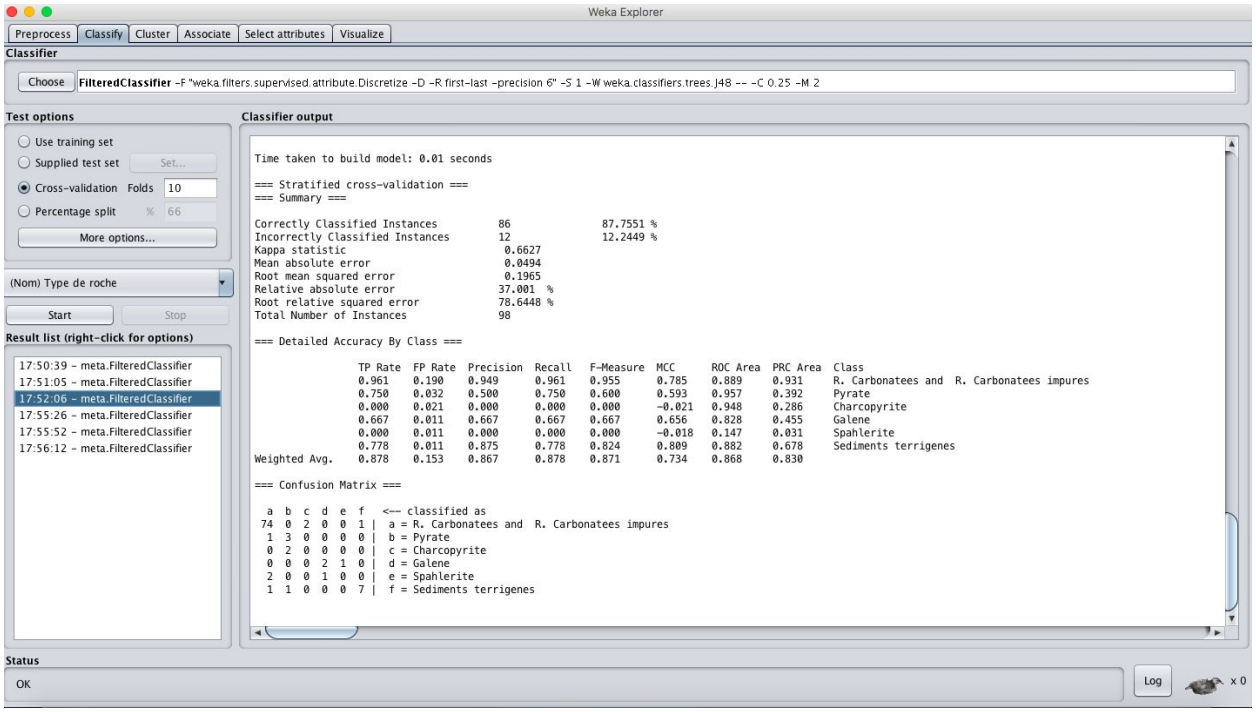
Rule 3: If K2O is less than 0.085, Pb is less than 0.0386 and Sc is less than 0.1078, Fe2O3 is more than 0.01029, S is more than 0.00611, then the type of rock is Pyrate.

Rule 4: If K2O is less than 0.085, Pb is less than 0.0386 and Sc is more than 0.1078, then the type of rock is Charcopyrite.

Rule 5: If K2O is less than 0.085, Pb is between than 0.038576 and 0.053537, then the type of rock is Spahlerite.

Rule 6: If K2O is less than 0.085, Pb is more than 0.053537, then the type of rock is Galene.

Rule 7: If K2O is more than 0.085, then the type of rock is Sediments terrigenes.


Weka Explorer
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Visualize
Classifier
Choose
FilteredClassifier -F "weka.filters.supervised.attribute.Discretize -D -R first-last -precision 6" -S 1 -W weka.classifiers.trees.J48 -- -C 0.25 -M 2
Test options
Use training set
Supplied test set
Set...
Cross-validation
Folds
10
Percentage split
%
66
More options...
(Nom) Type de roche
Start
Stop
Result list (right-click for options)
17:50:39 - meta.FilteredClassifier
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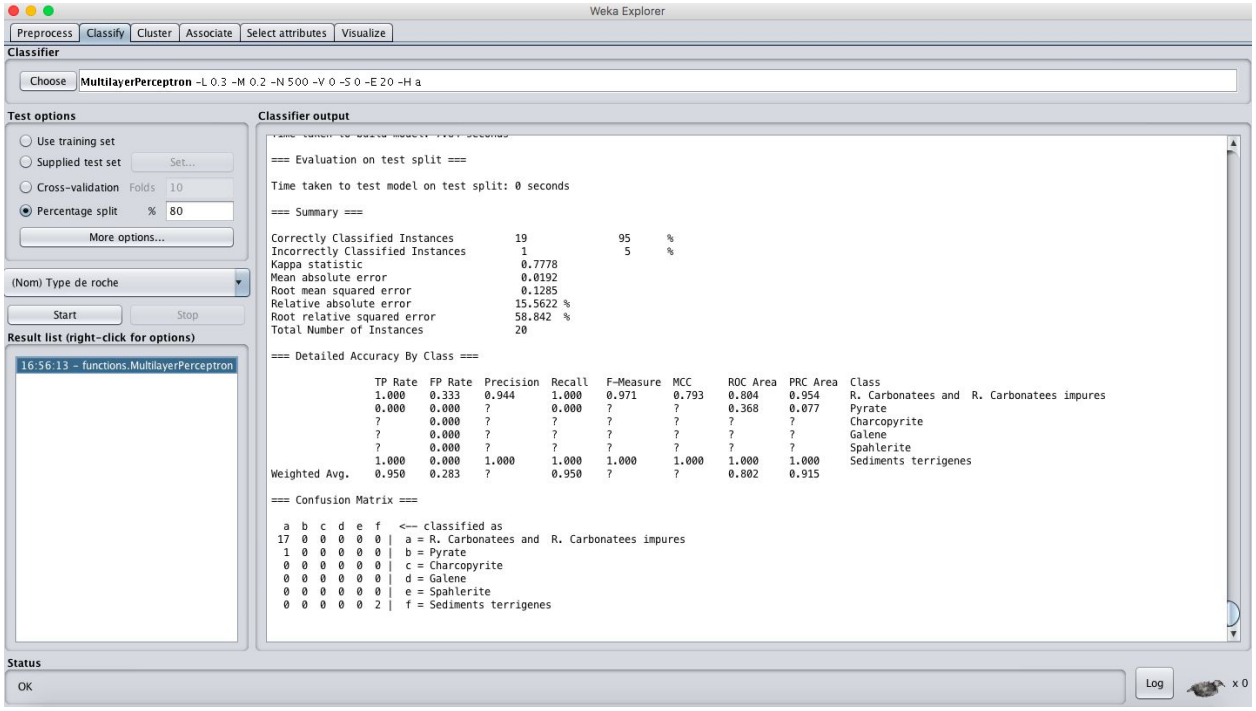
17:56:12 - meta.FilteredClassifier
Classifier output
Time taken to build model: 0.01 seconds
=== Stratified cross-validation ===
=== Summary ===
Correctly Classified Instances 86 87.7551 %
Incorrectly Classified Instances 12 12.2449 %
Kappa statistic 0.6627
Mean absolute error 0.0494
Root mean squared error 0.1965
Relative absolute error 37.001 %
Root relative squared error 78.6448 %
Total Number of Instances 98
=== Detailed Accuracy By Class ===
TP Rate FP Rate Precision Recall F-Measure MCC ROC Area PRC Area Class
0.961 0.190 0.949 0.961 0.955 0.785 0.889 0.931 R. Carbonatees and R. Carbonatees impures
0.750 0.032 0.500 0.750 0.600 0.593 0.957 0.392 Pyrate
0.000 0.021 0.000 0.000 0.000 -0.021 0.948 0.286 Charcopyrite
0.667 0.011 0.667 0.667 0.667 0.656 0.828 0.455 Galene
0.000 0.011 0.000 0.000 0.000 -0.018 0.147 0.031 Spahlerite
Weighted Avg. 0.878 0.153 0.867 0.878 0.871 0.734 0.868 0.830
=== Confusion Matrix ===
a b c d e f <-- classified as
74 0 2 0 0 1 | a = R. Carbonatees and R. Carbonatees impures
1 3 0 0 0 0 | b = Pyrate
0 2 0 0 0 0 | c = Charcopyrite
0 0 0 2 1 0 | d = Galene
2 0 0 1 0 0 | e = Spahlerite
1 1 0 0 0 7 | f = Sediments terrigenes
Status
OK
Log
x 0

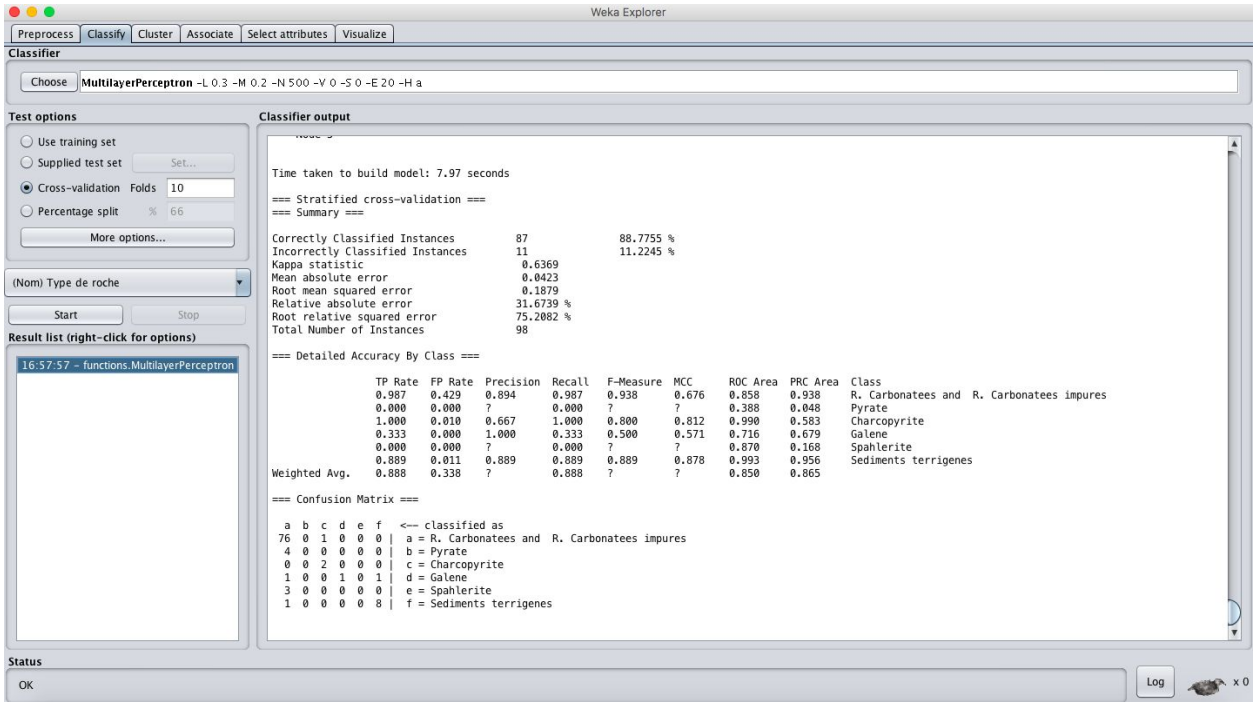
For a **non-descriptive classifier**, we have used a MultiLayer Perceptron Neural Network. We varied the hyperparameters for the network and observed the following accuracies:

Case 1:

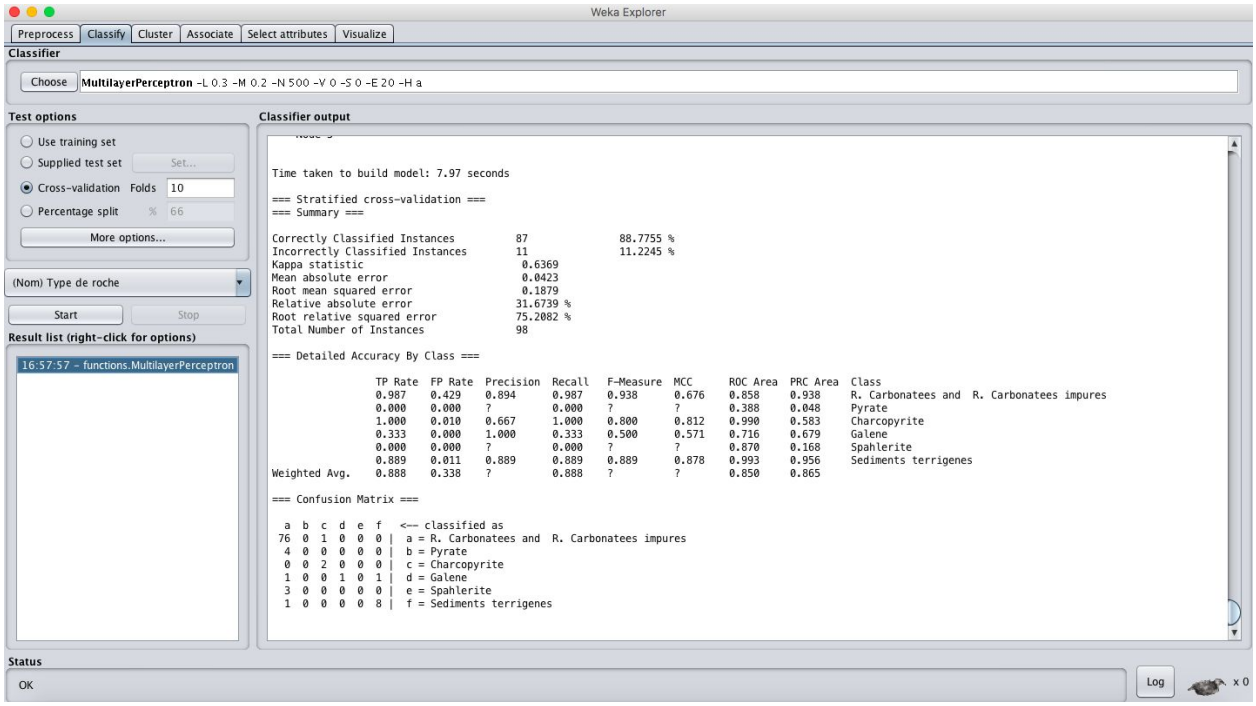
Learning rate-0.3
Momentum - 0.2
Epoch-500
Hidden layers- a (average of input and output)
Percentage split- 80%
Accuracy - 95%



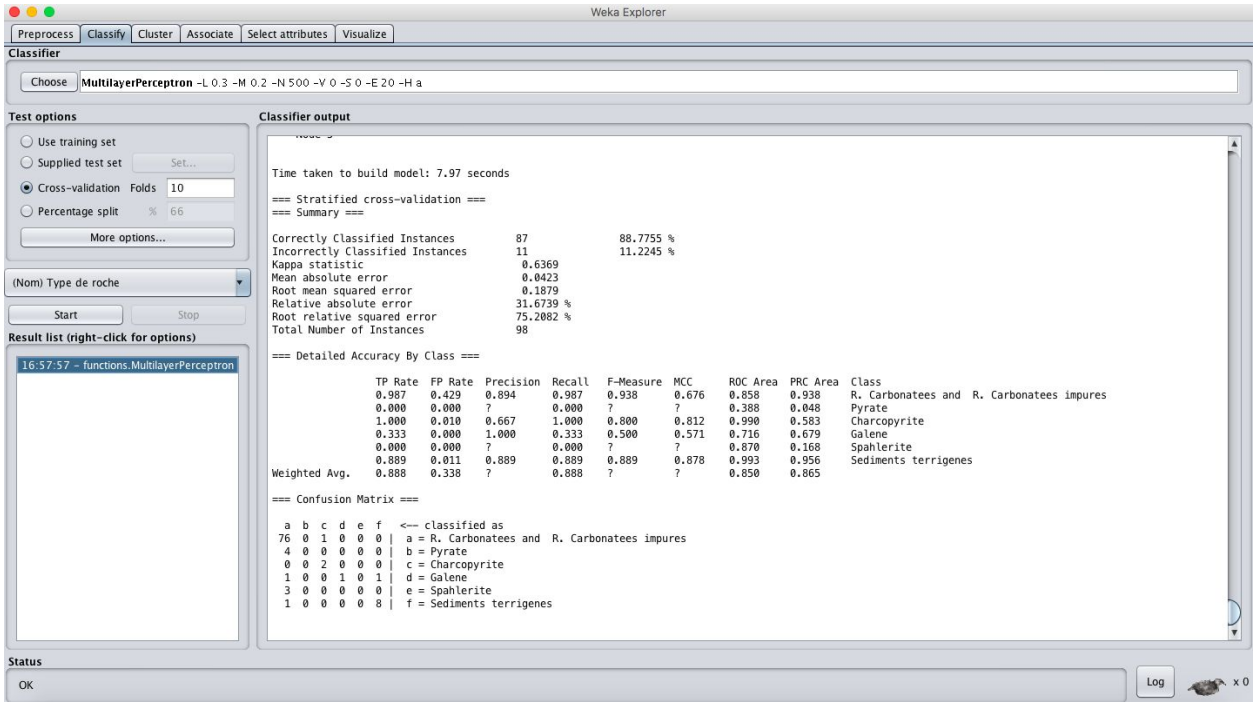
Case 2: In this case, the parameters were same as above, although we used a cross-validation algorithm of 10 folds. Accuracy - 88.755%



Case 3: Here, we maintained the same parameters as above but used 5 hidden layers. Accuracy - 87.7551%



Case 4: The parameters were same as above but the number of epochs were changed to 300 and 5,10 hidden layers. Accuracy - 85.7143%



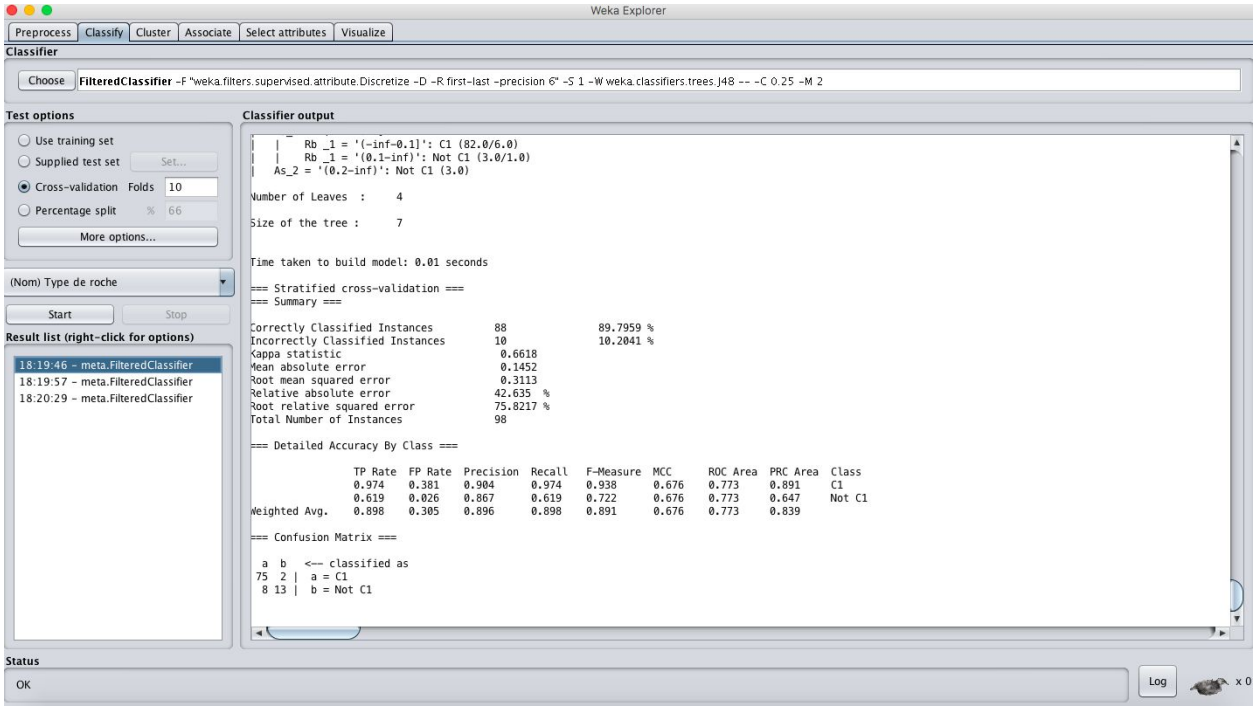
Experiment 2: Contrast classification: Here, class C1 is contrasted with all other classes(notC1).

Results for descriptive classifier discretization:

a. **Equal width binning discretization**

Classifier Model J48 pruned tree
CaO+MgO_5 = '(-inf-0.5]': Not C1 (10.0) CaO+MgO_5 = '(0.5-inf)' | As_2 = '(-inf-0.2]' | | Rb _1 = '(-inf-0.1]': C1 (82.0/6.0) | | Rb _1 = '(0.1-inf)': Not C1 (3.0/1.0) | As_2 = '(0.2-inf)': Not C1 (3.0)
Number of Leaves : 4 Size of the tree : 7

Discriminant rules:
Rule 1: If CaO+MgO is less than 0.5, then the type of rock is not C1, i.e not R. Carbonatees and R. Carbonatees impures.
Rule 2: If CaO+MgO is more than 0.5, As is less than 0.2 and Rb is less than 0.1, then the type of rock belongs to C1, i.e R. Carbonatees and R. Carbonatees impures.
Rule 3: If CaO+MgO is more than 0.5, As is less than 0.2 and Rb is more than 0.1, then the type of rock is not C1, i.e not R. Carbonatees and R. Carbonatees impures.
Rule 4: If CaO+MgO is more than 0.5, As is more than 0.2, then the type of rock is not C1, i.e not R. Carbonatees and R. Carbonatees impures.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Classifier
Choose
FilteredClassifier -F "weka.filters.supervised.attribute.Discretize -D -R first-last -precision 6" -S 1 -W weka.classifiers.trees.J48 -- -C 0.25 -M 2
Test options
Use training set
Supplied test set
Set...
Cross-validation
Folds
10
Percentage split
%
66
More options...
(Nom) Type de roche
Start
Stop
Result list (right-click for options)
18:19:46 - meta.FilteredClassifier
18:19:57 - meta.FilteredClassifier
18:20:29 - meta.FilteredClassifier
Classifier output
| | Rb_1 = '(-inf-0.1]': C1 (82.0/6.0)
| | Rb_1 = '(0.1-inf)': Not C1 (3.0/1.0)
| As_2 = '(0.2-inf)': Not C1 (3.0)
Number of Leaves : 4
Size of the tree : 7
Time taken to build model: 0.01 seconds
=== Stratified cross-validation ===
=== Summary ===
Correctly Classified Instances 88 89.7959 %
Incorrectly Classified Instances 10 10.2041 %
Kappa statistic 0.6618
Mean absolute error 0.1452
Root mean squared error 0.3113
Relative absolute error 42.635 %
Root relative squared error 75.8217 %
Total Number of Instances 98
=== Detailed Accuracy By Class ===
TP Rate FP Rate Precision Recall F-Measure MCC ROC Area PRC Area Class
0.974 0.381 0.904 0.974 0.938 0.676 0.773 0.891 C1
0.619 0.026 0.867 0.619 0.722 0.676 0.773 0.647 Not C1
Weighted Avg. 0.898 0.305 0.896 0.898 0.891 0.676 0.773 0.839
=== Confusion Matrix ===
a b <-- classified as
75 2 | a = C1
8 13 | b = Not C1
Status
OK
Log
x 0

b. Equal frequency discretization

Classifier Model
J48 pruned tree

```
CaO+MgO_1 = '(-inf-0.478646]': Not C1 (10.0)
CaO+MgO_1 = '(0.478646-inf)'
|   S_9 = '(-inf-0.041379]'
|   |   Pb_5 = '(-inf-0.038576]'
|   |   |   Cs_5 = '(-inf-0.121621]'
|   |   |   |   Zn_9 = '(-inf-0.013859]': C1 (73.0)
|   |   |   |   Zn_9 = '(0.013859-inf)'
|   |   |   |   |   MnO_5 = '(-inf-0.07377]': C1 (3.0)
|   |   |   |   |   MnO_5 = '(0.07377-inf)': Not C1 (2.0)
|   |   |   Cs_5 = '(0.121621-inf)': Not C1 (3.0/1.0)
|   |   Pb_5 = '(0.038576-inf)': Not C1 (2.0)
|   S_9 = '(0.041379-inf)': Not C1 (5.0)
```

Number of Leaves : 7
Size of the tree : 13

Discriminant rules:

Rule 1: If CaO+MgO is less than 0.478646, then the type of rock is not C1, i.e not R. Carbonatees and R. Carbonatees impures.

Rule 2: If CaO+MgO is more than 0.478646, S is less than 0.041379, Pb is less than 0.038576, Cs is less than 0.121621, Zn is less than 0.013859, then the type of rock belongs to C1, i.e R. Carbonatees and R. Carbonatees impures.

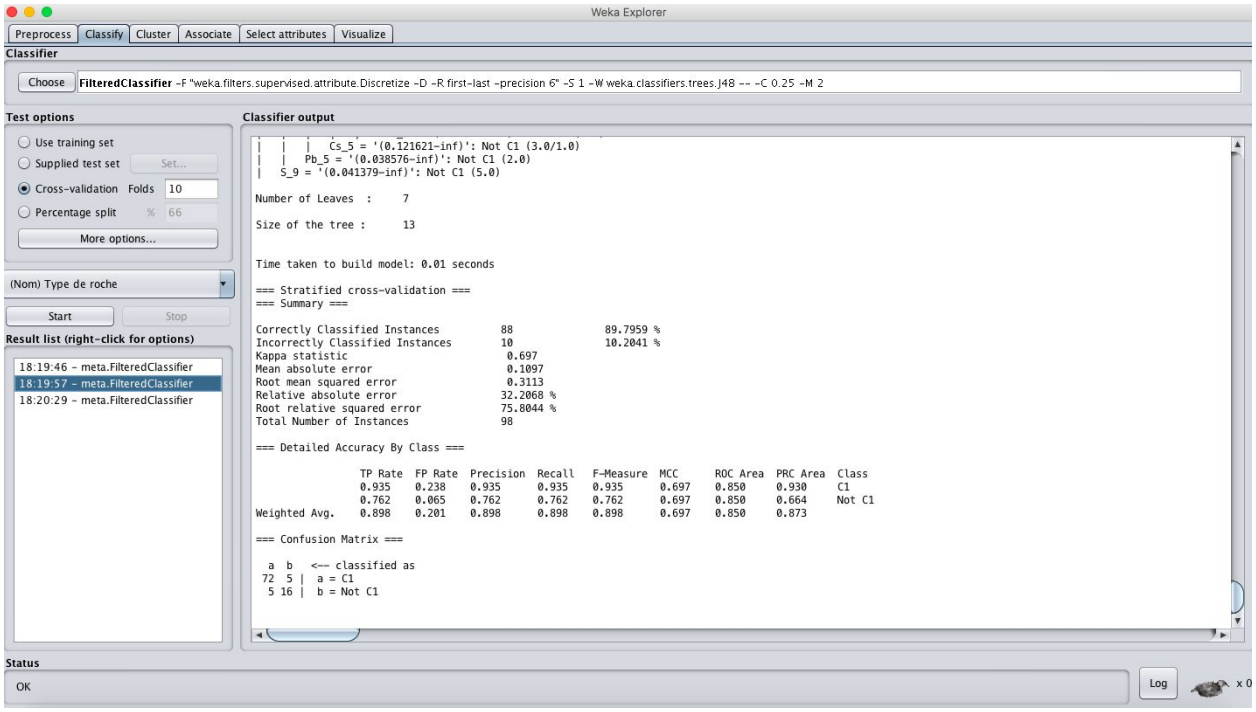
Rule 3: If CaO+MgO is more than 0.478646, S is less than 0.041379, Pb is less than 0.038576, Cs is less than 0.121621, Zn is more than 0.013859, MnO is less than 0.07377, then the type of rock belongs to C1, i.e R. Carbonatees and R. Carbonatees impures.

Rule 4: If CaO+MgO is more than 0.478646, S is less than 0.041379, Pb is less than 0.038576, Cs is less than 0.121621, Zn is more than 0.013859, MnO is more than 0.07377, then the type of rock is not C1, i.e not R. Carbonatees and R. Carbonatees impures.

Rule 5: If CaO+MgO is more than 0.478646, S is less than 0.041379, Pb is less than 0.038576, Cs is more than 0.121621, then the type of rock is not C1, i.e not R. Carbonatees and R. Carbonatees impures.

Rule 6: If CaO+MgO is more than 0.478646, S is less than 0.041379, Pb is more than 0.038576, then the type of rock is not C1, i.e not R. Carbonatees and R. Carbonatees impures.

Rule 7: Rule 4: If CaO+MgO is more than 0.478646, S is more than 0.041379, then the type of rock is not C1, i.e not R. Carbonatees and R. Carbonatees impures.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Test options
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Cross-validation
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Percentage split
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More options...
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Result list (right-click for options)
18:19:46 - meta.FilteredClassifier
18:19:57 - meta.FilteredClassifier
18:20:29 - meta.FilteredClassifier
Classifier output
| | | Cs_5 = '(0.121621-inf)': Not C1 (3.0/1.0)
| | Pb_5 = '(0.038576-inf)': Not C1 (2.0)
| S_9 = '(0.041379-inf)': Not C1 (5.0)
Number of Leaves : 7
Size of the tree : 13
Time taken to build model: 0.01 seconds
=== Stratified cross-validation ===
=== Summary ===
Correctly Classified Instances 88 89.7959 %
Incorrectly Classified Instances 10 10.2041 %
Kappa statistic 0.697
Mean absolute error 0.1097
Root mean squared error 0.3113
Relative absolute error 32.2068 %
Root relative squared error 75.8044 %
Total Number of Instances 98
=== Detailed Accuracy By Class ===
TP Rate FP Rate Precision Recall F-Measure MCC ROC Area PRC Area Class
0.935 0.238 0.935 0.935 0.935 0.697 0.850 0.930 C1
0.762 0.065 0.762 0.762 0.762 0.697 0.850 0.664 Not C1
Weighted Avg. 0.898 0.201 0.898 0.898 0.898 0.697 0.850 0.873
=== Confusion Matrix ===
a b <-- classified as
72 5 | a = C1
5 16 | b = Not C1
Status
OK
Log
x 0

c. Supervised discretization

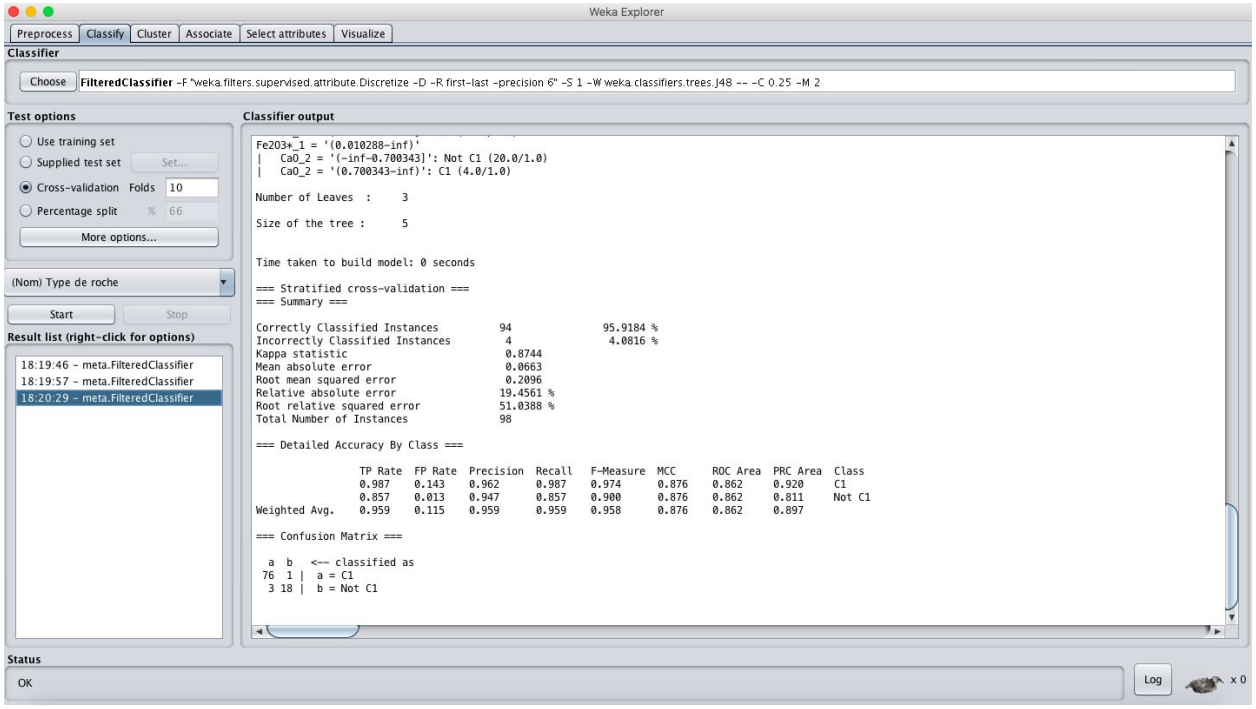
Classifier Model J48 pruned tree
Fe2O3*_1 = '(-inf-0.010288]': C1 (74.0/1.0) Fe2O3*_1 = '(0.010288-inf)' | CaO_2 = '(-inf-0.700343]': Not C1 (20.0/1.0) | CaO_2 = '(0.700343-inf)': C1 (4.0/1.0)
Number of Leaves : 3 Size of the tree : 5

Discriminant rules:

Rule 1: If Fe2O3 is less than 0.010288, then the type of rock is C1, i.e R. Carbonatees and R. Carbonatees impures.

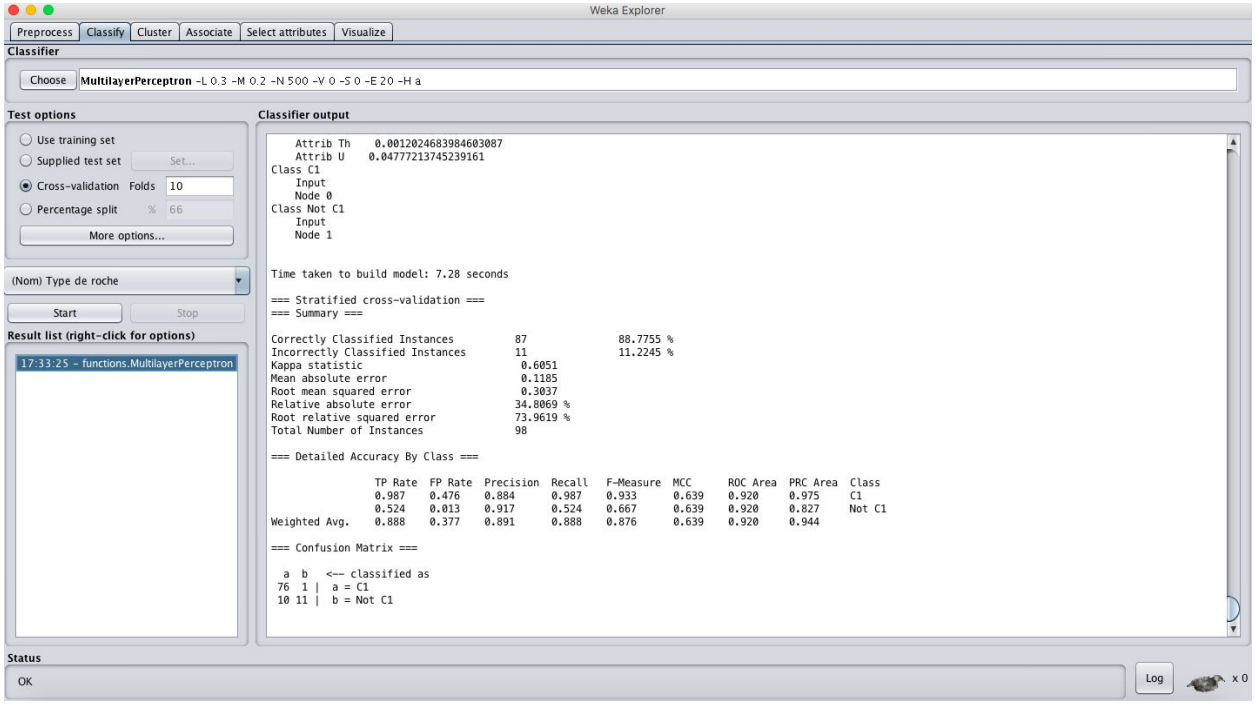
Rule 2: If Fe2O3 is more than 0.010288, CaO is less than 0.700343, then the type of rock is not C1, i.e not R. Carbonatees and R. Carbonatees impures.

Rule 3: If Fe2O3 is more than 0.010288, CaO is more than 0.700343, then the type of rock is C1.



For **non-descriptive classifier- Neural network**:

Learning rate-0.3
Momentum - 0.2
Epoch-500
Hidden layers- a (average of input and output)
Cross validation 10 folds
Accuracy - 88.7755%



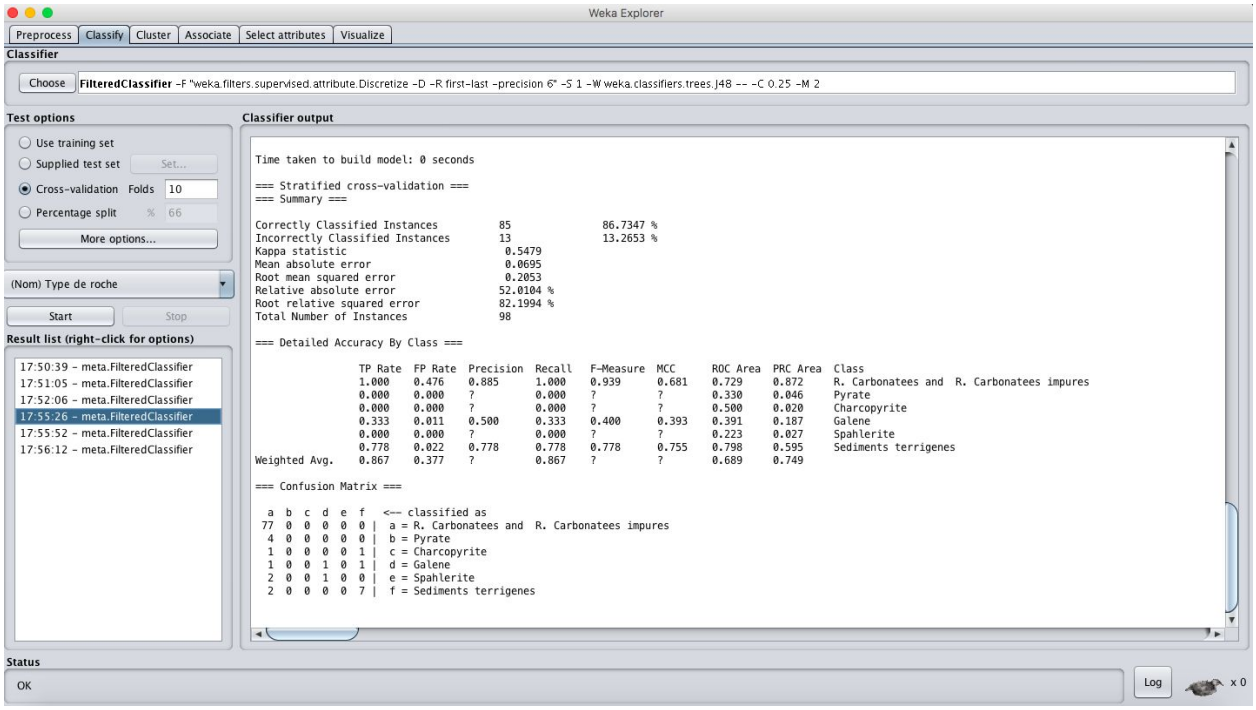
Experiment 3: Classification using important attributes only: Here, we have only used the 8 attributes, important as per the experts - S, Zn, Pb, Cu, CaO+MgO, CaO, MgO, Fe2O3.

Descriptive classifier:

a. **Equal width discretization using only important attributes**

Classifier Model J48 pruned tree
CaO_4 = '(-inf-0.4]': Sediments terrigenes (9.0/1.0) CaO_4 = '(0.4-inf)' | Cu_1 = '(-inf-0.1]' | | Zn_1 = '(-inf-0.1]': R. Carbonatees and R. Carbonatees impures (85.0/8.0) | | Zn_1 = '(0.1-inf)': Galene (2.0/1.0) | Cu_1 = '(0.1-inf)': Charcopyrite (2.0)
Number of Leaves : 4 Size of the tree : 7

Discriminant rules:
Rule 1: If CaO is less than 0.4, then the type of rock is Sediments terrigenes.
Rule 2: If CaO is more than 0.4, Cu is less than 0.1, Zn is less than 0.1, then the type of rock is R. Carbonatees and R. Carbonatees impures.
Rule 3: If CaO is more than 0.4, Cu is less than 0.1, Zn is more than 0.1, then the type of rock is Galene.
Rule 4: If CaO is more than 0.4, Cu is more than 0.1,then the type of rock is Charcopyrite.


Weka Explorer
Preprocess
Classify
Cluster
Associate
Select attributes
Visualize
Classifier
Choose
FilteredClassifier -F "weka.filters.supervised.attribute.Discretize -D -R first-last -precision 6" -S 1 -W weka.classifiers.trees.J48 -- -C 0.25 -M 2
Test options
Use training set
Supplied test set
Set...
Cross-validation
Folds
10
Percentage split
%
66
More options...
(Nom) Type de roche
Start
Stop
Result list (right-click for options)
17:50:39 - meta.FilteredClassifier
17:51:05 - meta.FilteredClassifier
17:52:06 - meta.FilteredClassifier
17:55:26 - meta.FilteredClassifier
17:55:52 - meta.FilteredClassifier
17:56:12 - meta.FilteredClassifier
Classifier output
Time taken to build model: 0 seconds
=== Stratified cross-validation ===
=== Summary ===
Correctly Classified Instances 85 86.7347 %
Incorrectly Classified Instances 13 13.2653 %
Kappa statistic 0.5479
Mean absolute error 0.0695
Root mean squared error 0.2053
Relative absolute error 52.0104 %
Root relative squared error 82.1994 %
Total Number of Instances 98
=== Detailed Accuracy By Class ===
TP Rate FP Rate Precision Recall F-Measure MCC ROC Area PRC Area Class
1.000 0.476 0.885 1.000 0.939 0.681 0.729 0.872 R. Carbonatees and R. Carbonatees impures
0.000 0.000 ? 0.000 ? ? 0.330 0.046 Pyrate
0.000 0.000 ? 0.000 ? ? 0.500 0.020 Charcopyrite
0.333 0.011 0.500 0.333 0.400 0.393 0.391 0.187 Galene
0.000 0.000 ? 0.000 ? ? 0.223 0.027 Spahlerite
0.778 0.022 0.778 0.778 0.778 0.755 0.798 0.595 Sediments terrigenes
Weighted Avg. 0.867 0.377 ? 0.867 ? ? 0.689 0.749
=== Confusion Matrix ===
a b c d e f <-- classified as
77 0 0 0 0 0 | a = R. Carbonatees and R. Carbonatees impures
4 0 0 0 0 0 | b = Pyrate
1 0 0 0 0 1 | c = Charcopyrite
1 0 0 1 0 1 | d = Galene
2 0 0 1 0 0 | e = Spahlerite
2 0 0 0 0 7 | f = Sediments terrigenes
Status
OK
Log
x 0

b. Equal frequency discretization using only important attributes

Classifier Model
J48 pruned tree

```
Pb_6 = '(-inf-0.053537]'
|   CaO+MgO_1 = '(-inf-0.478646]': Sediments terrigenes (9.0/1.0)
|   CaO+MgO_1 = '(0.478646-inf)'
|   |   S_9 = '(-inf-0.041379]'
|   |   |   Zn_9 = '(-inf-0.013859]': R. Carbonatees and  R. Carbonatees impures (76.0/2.0)
|   |   |   Zn_9 = '(0.013859-inf)'
|   |   |   |   Fe2O3*_5 = '(-inf-0.004962]': R. Carbonatees and  R. Carbonatees impures (2.0)
|   |   |   |   Fe2O3*_5 = '(0.004962-inf)': Spahlerite (4.0/1.0)
|   |   S_9 = '(0.041379-inf)': Pyrate (4.0/1.0)
Pb_6 = '(0.053537-inf)': Galene (3.0)
```

Number of Leaves : 6
Size of the tree : 11

Discriminant rules:

Rule 1: If Pb is less than 0.053537, CaO+MgO is less than 0.478646, then the type of rock is Sediments terrigenes.

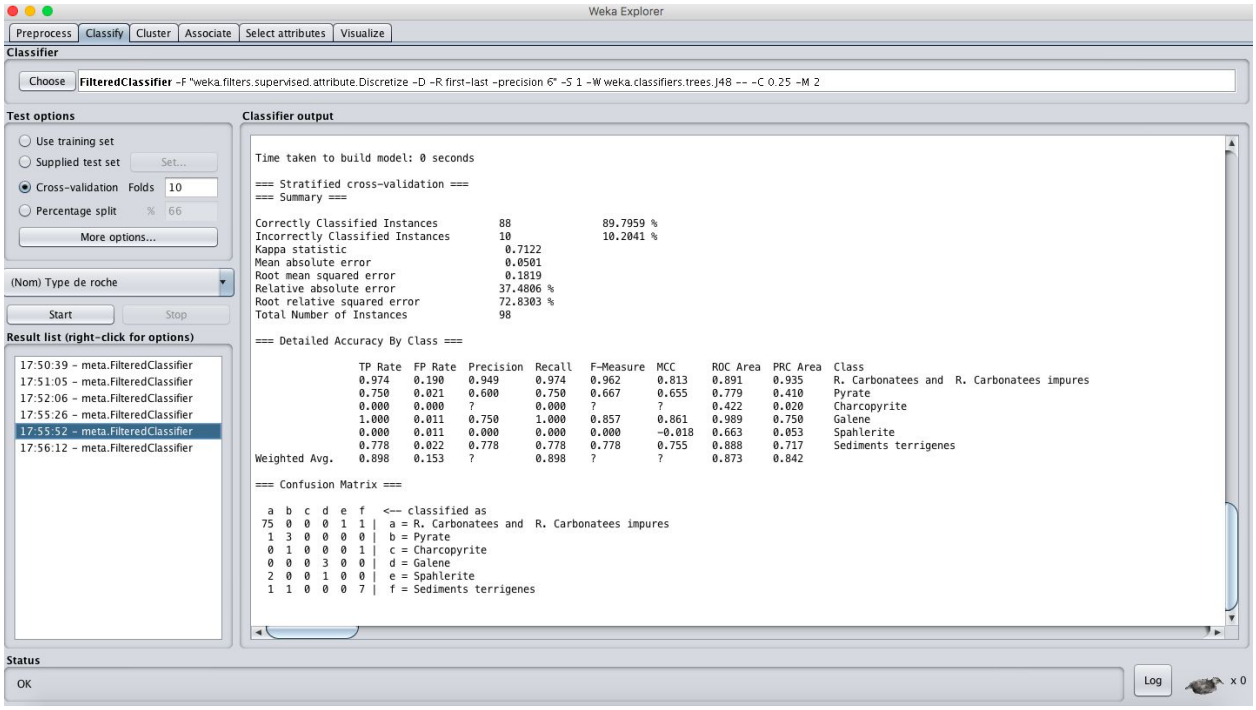
Rule 2: If Pb is less than 0.053537, CaO+MgO is more than 0.478646, S is less than 0.041379, Zn is less than 0.013859, then the type of rock is R. Carbonatees and R. Carbonatees impures.

Rule 3: If Pb is less than 0.053537, CaO+MgO is more than 0.478646, S is less than 0.041379, Zn is more than 0.013859, Fe2O3 is less than 0.004962, then the type of rock is R. Carbonatees and R. Carbonatees impures.

Rule 4: If Pb is less than 0.053537, CaO+MgO is more than 0.478646, S is less than 0.041379, Zn is more than 0.013859, Fe2O3 is more than 0.004962, then the type of rock is Spahlerite.

Rule 5: If Pb is less than 0.053537, CaO+MgO is more than 0.478646, S is more than 0.041379, then the type of rock is Pyrate .

Rule 6: If Pb is more than 0.053537, then the type of rock is Galene.


Weka Explorer
Preprocess
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Cluster
Associate
Select attributes
Visualize
Classifier
Choose
FilteredClassifier -F "weka.filters.supervised.attribute.Discretize -D -R first-last -precision 6" -S 1 -W weka.classifiers.trees.J48 -- -C 0.25 -M 2
Test options
Use training set
Supplied test set
Set...
Cross-validation
Folds
10
Percentage split
%
66
More options...
(Nom) Type de roche
Start
Stop
Result list (right-click for options)
17:50:39 - meta.FilteredClassifier
17:51:05 - meta.FilteredClassifier
17:52:06 - meta.FilteredClassifier
17:55:26 - meta.FilteredClassifier
17:55:52 - meta.FilteredClassifier
17:56:12 - meta.FilteredClassifier
Classifier output
Time taken to build model: 0 seconds
=== Stratified cross-validation ===
=== Summary ===
Correctly Classified Instances 88 89.7959 %
Incorrectly Classified Instances 10 10.2041 %
Kappa statistic 0.7122
Mean absolute error 0.0501
Root mean squared error 0.1819
Relative absolute error 37.4806 %
Root relative squared error 72.8303 %
Total Number of Instances 98
=== Detailed Accuracy By Class ===
TP Rate FP Rate Precision Recall F-Measure MCC ROC Area PRC Area Class
0.974 0.190 0.949 0.974 0.962 0.813 0.891 0.935 R. Carbonatees and R. Carbonatees impures
0.750 0.021 0.600 0.750 0.667 0.655 0.779 0.410 Pyrate
0.000 0.000 ? 0.000 ? ? 0.422 0.020 Charcopyrite
1.000 0.011 0.750 1.000 0.857 0.861 0.989 0.750 Galene
0.000 0.011 0.000 0.000 0.000 -0.018 0.663 0.053 Spahlerite
0.778 0.022 0.778 0.778 0.778 0.755 0.888 0.717 Sediments terrigenes
Weighted Avg. 0.898 0.153 ? 0.898 ? ? 0.873 0.842
=== Confusion Matrix ===
a b c d e f <-- classified as
75 0 0 0 1 1 | a = R. Carbonatees and R. Carbonatees impures
1 3 0 0 0 0 | b = Pyrate
0 1 0 0 0 1 | c = Charcopyrite
0 0 0 3 0 0 | d = Galene
2 0 0 1 0 0 | e = Spahlerite
1 1 0 0 0 7 | f = Sediments terrigenes
Status
OK
Log
x 0

c. Supervised important attributes

Classifier Model
J48 pruned tree

```
Fe2O3*_1 = '(-inf-0.010288]': R. Carbonatees and  R. Carbonatees impures (74.0/1.0)
Fe2O3*_1 = '(0.010288-inf)'
|   Zn_2 = '(-inf-0.040932]'
|   |   CaO_1 = '(-inf-0.624637]': Sediments terrigenes (12.0/3.0)
|   |   CaO_1 = '(0.624637-inf)'
|   |   |   S_1 = '(-inf-0.00611]': R. Carbonatees and  R. Carbonatees impures (4.0)
|   |   |   S_1 = '(0.00611-inf)': Pyrate (3.0)
|   Zn_2 = '(0.040932-inf)'
|   |   Pb_2 = '(-inf-0.053537]': Spahlerite (2.0)
|   |   Pb_2 = '(0.053537-inf)': Galene (3.0)
```

Number of Leaves : 6
Size of the tree : 11

Discriminant rules:

Rule 1: If Fe2O3 is less than 0.010288, then the type of rock isR. Carbonatees and R. Carbonatees impures..

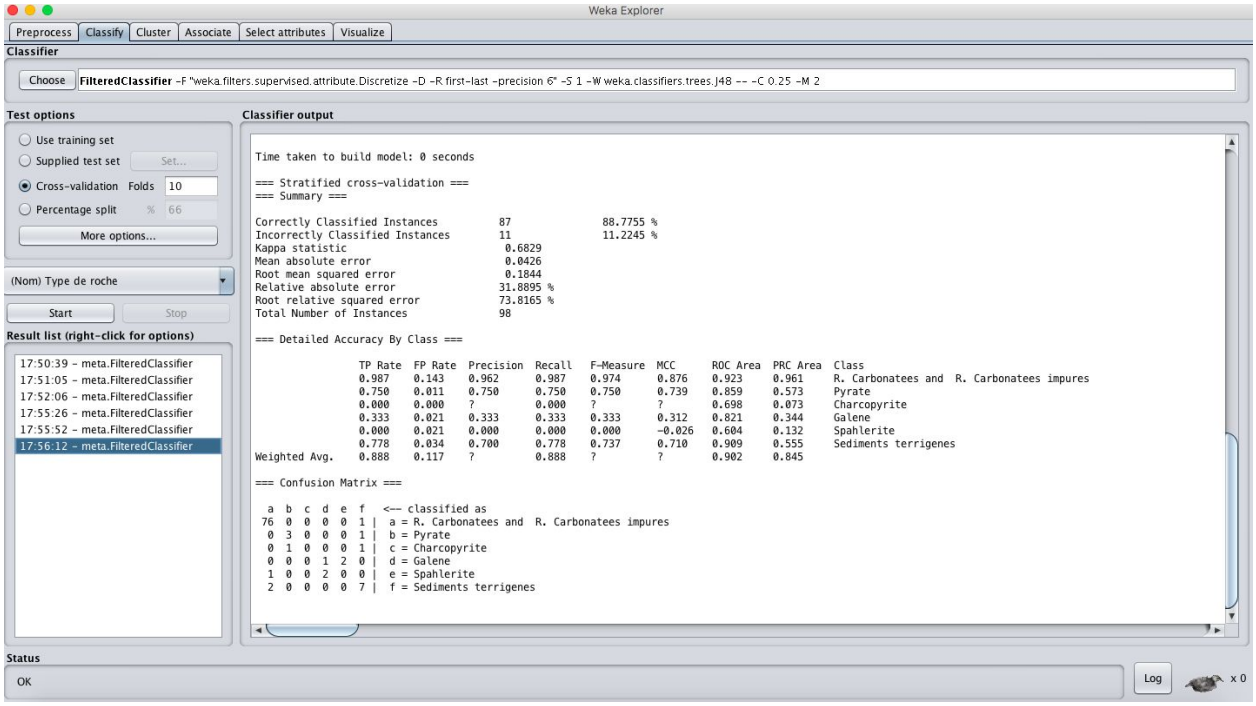
Rule 2: If Fe2O3 is more than 0.010288, Zn is less than 0.040932, CaO is less than 0.624637, then the type of rock is Sediments terrigenes.

Rule 3: If Fe2O3 is more than 0.010288, Zn is less than 0.040932, CaO is more than 0.624637, S is less than 0.00611, then the type of rock is R. Carbonatees and R. Carbonatees impures.

Rule 4: If Fe2O3 is more than 0.010288, Zn is less than 0.040932, CaO is more than 0.624637, S is more than 0.00611, then the type of rock is Pyrate.

Rule 5: If Fe2O3 is more than 0.010288, Zn is more than 0.040932, Pb is less than 0.053537,
then the type of rock is Spahlerite.

Rule 6: If Fe2O3 is more than 0.010288, Zn is more than 0.040932, Pb is more than 0.053537, then the type of rock is Galene.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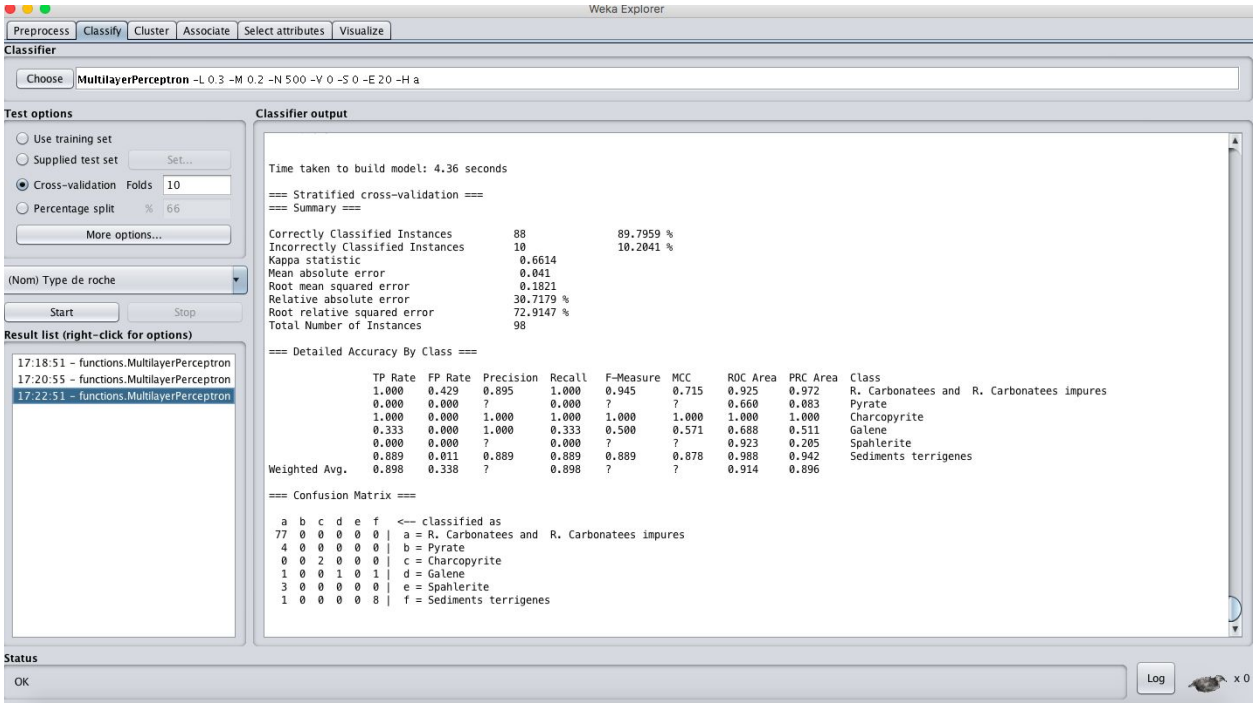
17:55:26 - meta.FilteredClassifier
17:55:52 - meta.FilteredClassifier
17:56:12 - meta.FilteredClassifier
Classifier output
Time taken to build model: 0 seconds
=== Stratified cross-validation ===
=== Summary ===
Correctly Classified Instances 87 88.7755 %
Incorrectly Classified Instances 11 11.2245 %
Kappa statistic 0.6829
Mean absolute error 0.0426
Root mean squared error 0.1844
Relative absolute error 31.8895 %
Root relative squared error 73.8165 %
Total Number of Instances 98
=== Detailed Accuracy By Class ===
TP Rate FP Rate Precision Recall F-Measure MCC ROC Area PRC Area Class
0.987 0.143 0.962 0.987 0.974 0.876 0.923 0.961 R. Carbonatees and R. Carbonatees impures
0.750 0.011 0.750 0.750 0.750 0.739 0.859 0.573 Pyrate
0.000 0.000 ? 0.000 ? ? 0.698 0.073 Charcopyrite
0.333 0.021 0.333 0.333 0.333 0.312 0.821 0.344 Galene
0.000 0.021 0.000 0.000 0.000 -0.026 0.604 0.132 Spahlerite
0.778 0.034 0.700 0.778 0.737 0.710 0.909 0.555 Sediments terrigenes
Weighted Avg. 0.888 0.117 ? 0.888 ? ? 0.902 0.845
=== Confusion Matrix ===
a b c d e f <-- classified as
76 0 0 0 0 1 | a = R. Carbonatees and R. Carbonatees impures
0 3 0 0 0 1 | b = Pyrate
0 1 0 0 0 1 | c = Charcopyrite
0 0 0 1 2 0 | d = Galene
1 0 0 2 0 0 | e = Spahlerite
2 0 0 0 0 7 | f = Sediments terrigenes
Status
OK
Log
x 0

For the **non-descriptive classifier**, the neural network, we have used the following parameters:

Learning rate-0.3
Momentum - 0.2
Epoch-500
Hidden layers- a (average of input and output)
Cross validation 10 folds
Accuracy - 89.7959%



CONCLUSION

We have successfully used WEKA to classify our data and found the following accuracies for the descriptive and non-descriptive classifiers:

Analysis: For Decision Trees -

	Unsupervised Equal Width Binning	Unsupervised Equal Frequency Binning	Supervised Discretization
Experiment 1	**84.6939%**	**87.7551%**	**87.7551%**
Experiment 2	**89.7959%**	**89.7959%**	**95.9%**
Experiment 3	**86.7347%**	**89.7959%**	**88.7755%**

For Neural Network -

	Accuracy
Experiment 1	**88.7755%**
Experiment 2	**88.7755%**
Experiment 3	**89.7959%**