St. Francis Institute of Technology, Mumbai-400 103
Department Of Information Technology

A.Y. 2024-2025
Class: TE-ITA/B, Semester: VI

Subject: **Business Intelligence Lab**

Experiment – 4: To implement a classifier- Decision tree using open source tool WEKA and ORANGE

1. **Aim:** To Implement any one of the classifiers using WEKA (Decision Tree, Naïve Bayes, Random Forest)
2. **Objectives:** After study of this experiment, the students will be able to
   Understand and knew about all the three classifiers.
3. **Outcomes:** After study of this experiment, the students will be able to
   CO4: Design and Implement the appropriate data mining methods like classification, clustering or Frequent Pattern mining on large data sets.
   CO5: Define and apply metrics to measure the performance of various data mining algorithms
4. **Prerequisite:** Introduction to all the three classifiers through algorithms & Problem solving approach.
5. **Requirements:** Personal Computer, Windows XP operating system/Windows 7, Internet Connection, Microsoft Word, WEKA tool, Java/R/Python.
6. **Theory:**
   a. What is Classification Data Mining?
   b. Difference between supervised and unsupervised learning
7. **Laboratory Exercise:** Implementation of Classification Algorithm in WEKA and Orange. Take printout of related snapshots.
8. **Post-Experiments Exercise**
   a. **Extended Theory:**
      i. Explain about Decision Tree algorithm
      ii. Solve numerical on decision tree
9. **Exercise:**
   - Simple CLI execution of classification algorithm in WEKA
   - **For training:** java weka.classifiers.trees.J48 -C 0.25 -M 2 -t directory-path\bank.arff -d directory-path \bank.model
   - **For Testing:** java weka.classifiers.trees.J48 -p 9 -l directory-path\bank.model -T directory-path \bank-new.arff
10. **Conclusion:**
    a. Summary of Experiment
    b. Importance of Experiment
    c. Application of Experiment

11. **Reference:** Data Mining: Concept & Techniques, 3rd Edition, Jiawei Han, Micheline Kamber, Jian Pei, Elsevier.

8. Post-Experiments Exercise

a. Extended Theory:

Q1. What is Classification Data Mining?

Classification is a supervised learning technique in data mining used to predict the categorical class or label of an item based on its features. The model is trained using labeled data, where both input features and their corresponding class labels are known. Once trained, the model can classify new, unseen data into predefined categories.

For instance, in medical data mining, classification can be applied to predict whether a patient has a particular disease based on symptoms and medical records. The model learns from past data where the disease status (e.g., "disease" or "no disease") is labeled and then predicts the class for new patient records.

Common Classification Algorithms:

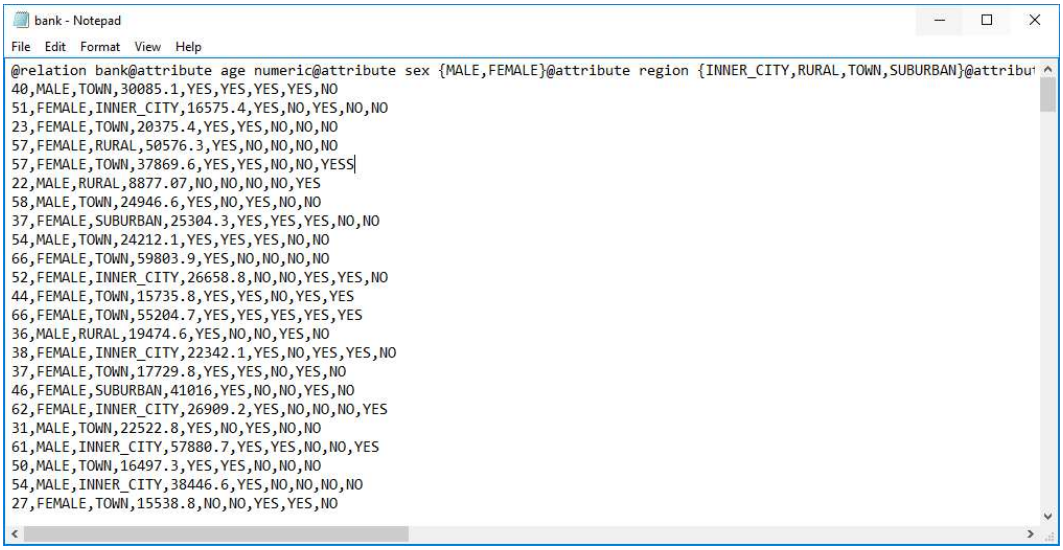
- Decision Trees (e.g., J48, C4.5)
- Naïve Bayes
- Random Forest

Q2. Difference between supervised and unsupervised learning

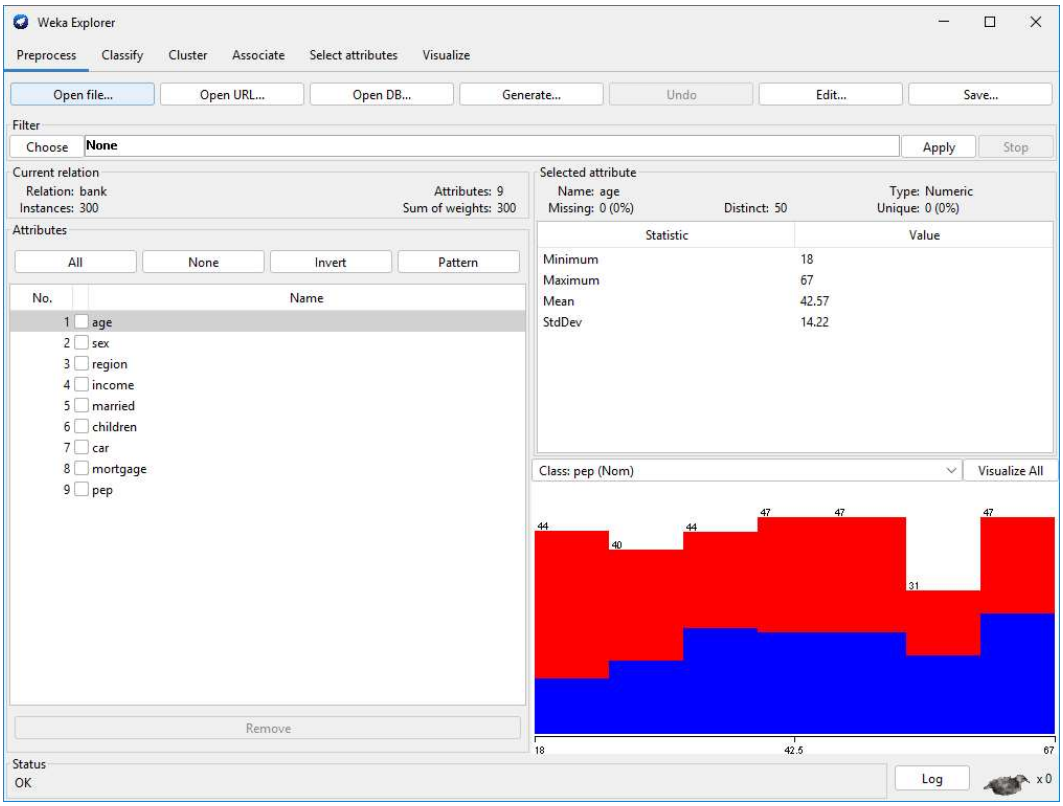
Supervised learning	Unsupervised learning
The model is trained on labeled data, where the output (class label) is known.	The model is trained on unlabeled data, and no output labels are provided.
Predict the output for new, unseen data based on past labeled data.	Identify patterns, structures, or groups in the data.
Labeled data (input-output pairs)	Unlabeled data (only inputs, no output labels).
Accuracy, Precision, Recall, F1-Score, ROC-AUC, etc.	Cluster purity, Silhouette score, etc.
Eg:Spam detection, Disease prediction, Stock price forecasting	Eg:Customer segmentation, Market basket analysis, Anomaly detection.

LABORATORY EXERCISE

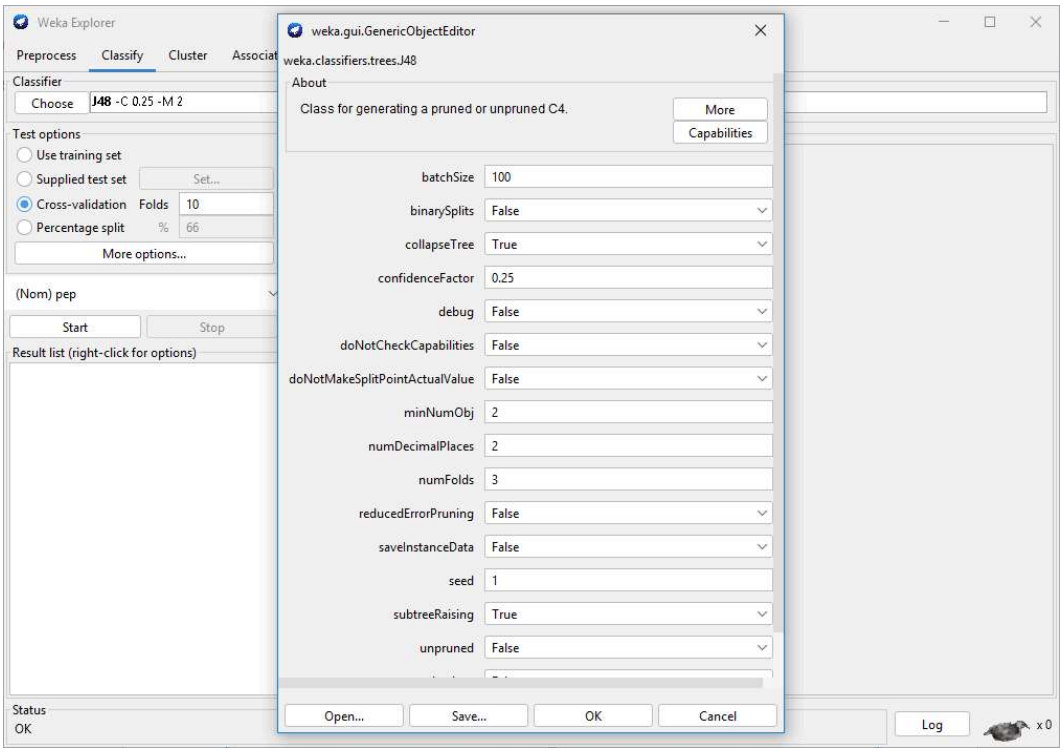
Training dataset



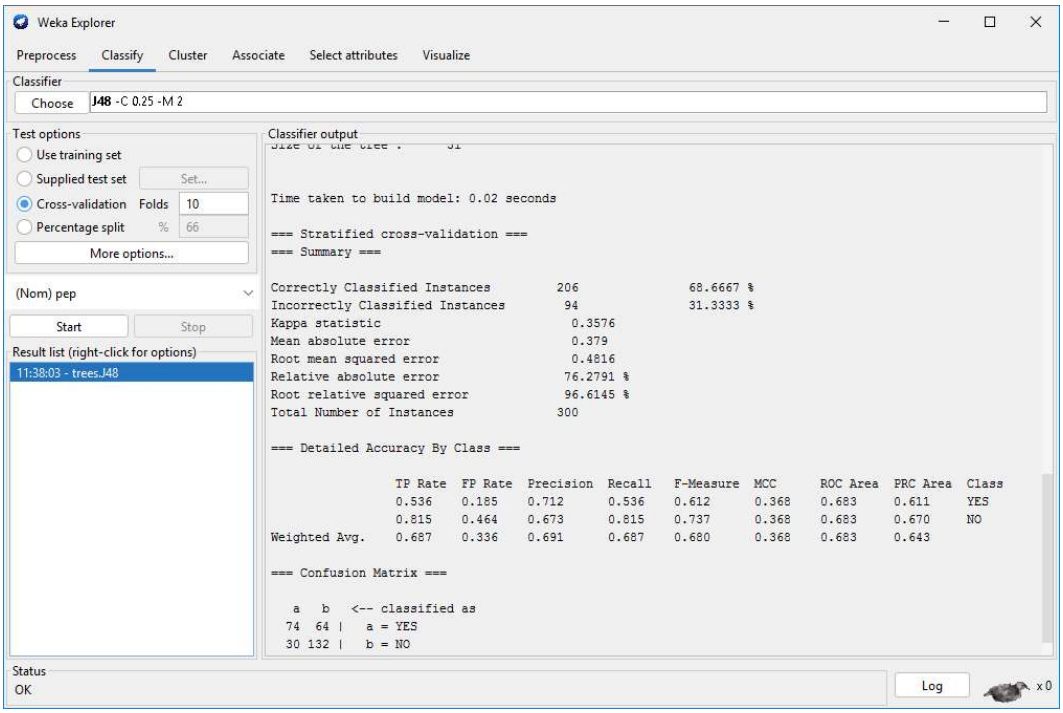
Loading dataset in WEKA



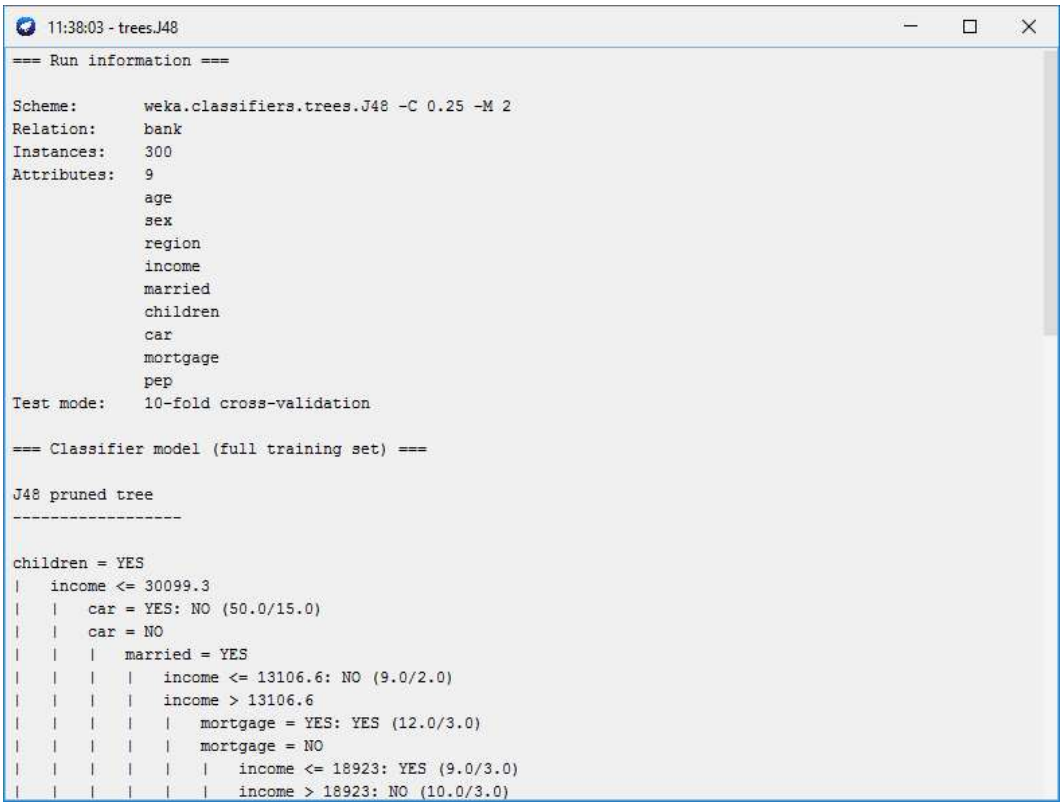
Applying J48 on training dataset



Generation of model after applying Decision tree algorithm



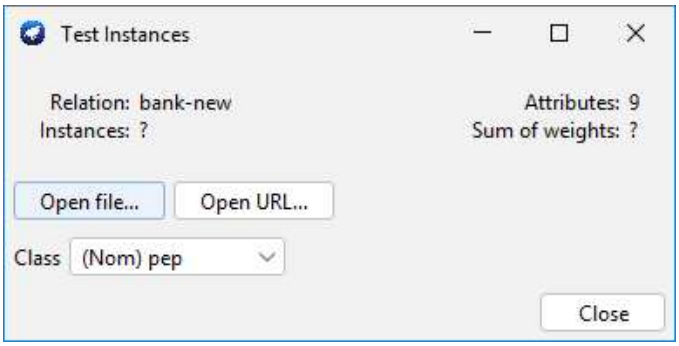
Viewing output in second window



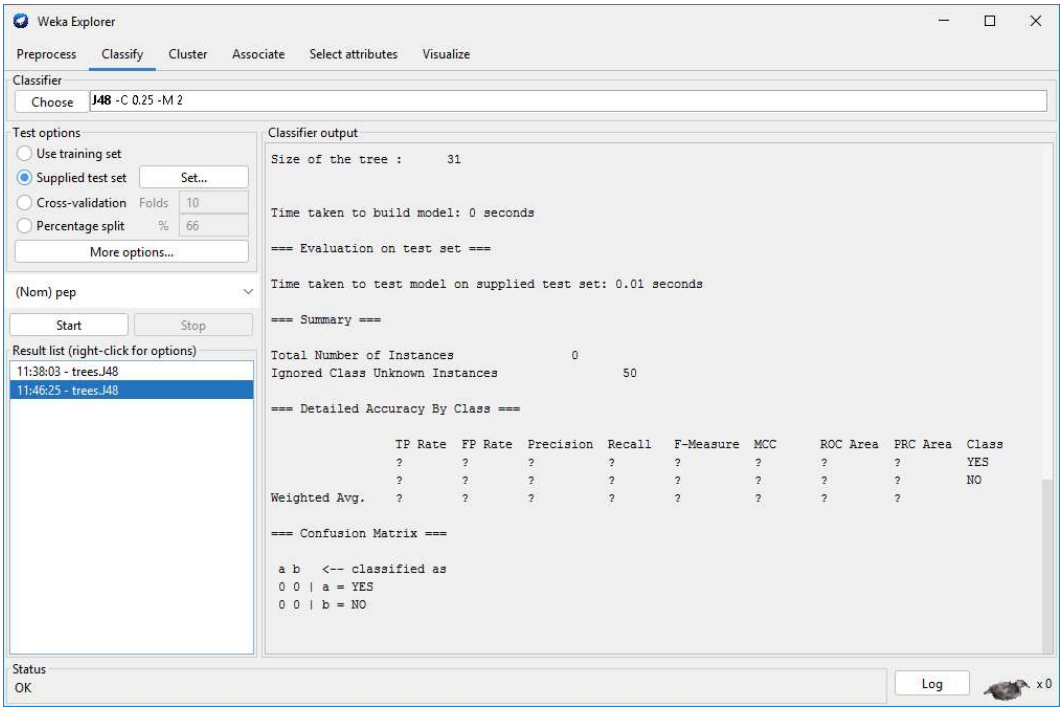
Test dataset

```
@relation bank-new

@attribute age numeric
@attribute sex {MALE,FEMALE}
@attribute region {INNER_CITY,RURAL,TOWN,SUBURBAN}
@attribute income numeric
@attribute married {YES,NO}
@attribute children {YES,NO}
@attribute car {YES,NO}
@attribute mortgage {YES,NO}
@attribute pep {YES,NO}

@data
23,MALE,INNER_CITY,18766.9,YES,NO,YES,YES,?
30,MALE,RURAL,9915.67,NO,YES,NO,YES,?
45,FEMALE,RURAL,21881.6,NO,NO,YES,NO,?
50,MALE,TOWN,46794.4,YES,YES,NO,YES,?
41,FEMALE,INNER_CITY,20721.1,YES,NO,YES,NO,?
```

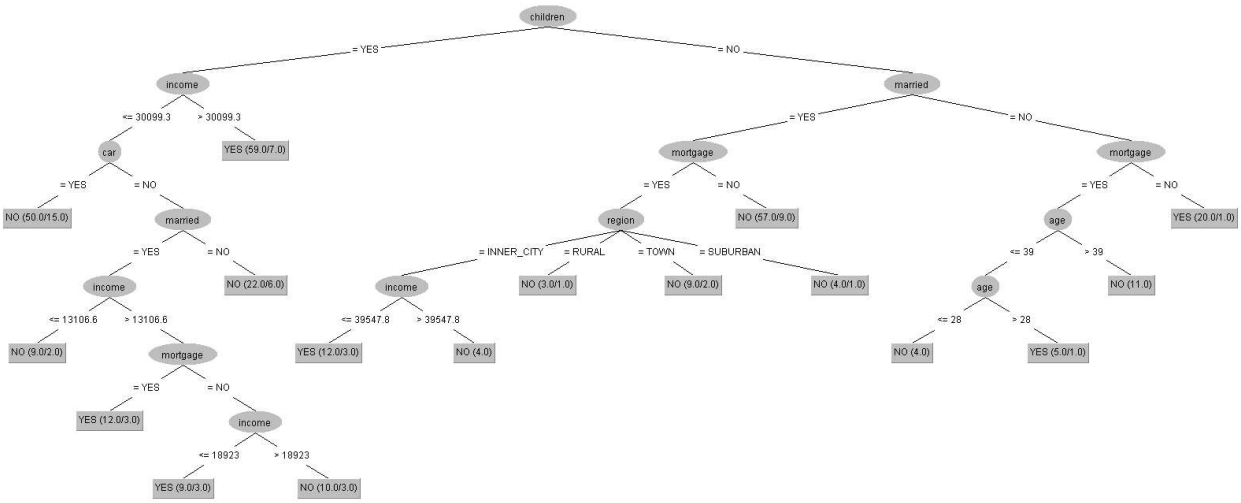
Loading test dataset in WEKA



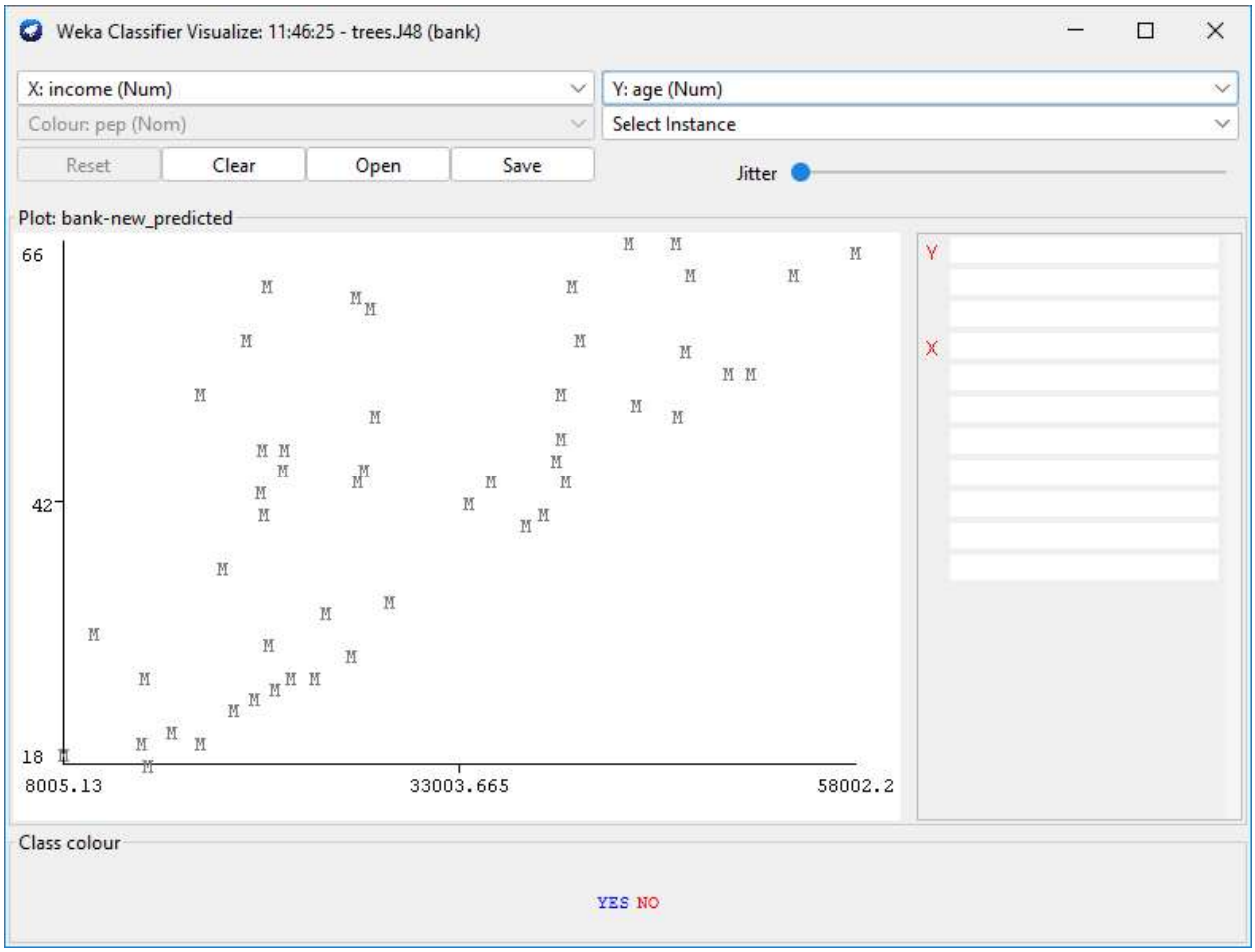
Output of the Test Dataset



Visualization of Tree



Visualization of classifiers



Predicated class values for the given test dataset

```
@relation bank-new_predicted

@attribute age numeric
@attribute sex {MALE,FEMALE}
@attribute region {INNER_CITY,RURAL,TOWN,SUBURBAN}
@attribute income numeric
@attribute married {YES,NO}
@attribute children {YES,NO}
@attribute car {YES,NO}
@attribute mortgage {YES,NO}
@attribute 'prediction margin' numeric
@attribute 'predicted pep' {YES,NO}
@attribute pep {YES,NO}

@data
23,MALE,INNER_CITY,18766.9,YES,NO,YES,YES,0.5,YES,?
30,MALE,RURAL,9915.67,NO,YES,NO,YES,-0.454545,NO,?
45,FEMALE,RURAL,21881.6,NO,NO,YES,NO,0.9,YES,?
50,MALE,TOWN,46794.4,YES,YES,NO,YES,0.762712,YES,?
```

Post experiment Exercise:

For training: java weka.classifiers.trees.J48 -C 0.25 -M 2 -t directory-path\bank.arff -d directory-path \bank.model

Training Output in WEKA Simple CLI

SimpleCLI

```
>  java weka.classifiers.trees.J48 -C 0.25 -M 2 -t C:\ShubhamMalekar\Exp4\bank.arff -d
C:\ShubhamMalekar\Exp4\bank.model


Options: -C 0.25 -M 2

=== Classifier model (full training set) ===

J48 pruned tree
------------------

children = YES
|   income <= 30099.3
|   |   car = YES: NO (50.0/15.0)
|   |   car = NO
|   |   |   married = YES
|   |   |   |   income <= 13106.6: NO (9.0/2.0)
|   |   |   |   income > 13106.6
|   |   |   |   |   mortgage = YES: YES (12.0/3.0)
|   |   |   |   |   mortgage = NO
|   |   |   |   |   |   income <= 18923: YES (9.0/3.0)
|   |   |   |   |   |   income > 18923: NO (10.0/3.0)
|   |   |   married = NO: NO (22.0/6.0)
|   income > 30099.3: YES (59.0/7.0)
children = NO
|   married = YES
|   |   mortgage = YES
|   |   |   region = INNER_CITY
|   |   |   |   income <= 39547.8: YES (12.0/3.0)
|   |   |   |   income > 39547.8: NO (4.0)
|   |   |   region = RURAL: NO (3.0/1.0)
|   |   |   region = TOWN: NO (9.0/2.0)
|   |   |   region = SUBURBAN: NO (4.0/1.0)
|   |   mortgage = NO: NO (57.0/9.0)
|   married = NO
|   |   mortgage = YES
|   |   |   age <= 39
|   |   |   |   age <= 28: NO (4.0)
|   |   |   |   age > 28: YES (5.0/1.0)
|   |   |   age > 39: NO (11.0)
|   |   mortgage = NO: YES (20.0/1.0)

Number of Leaves  :  17
```

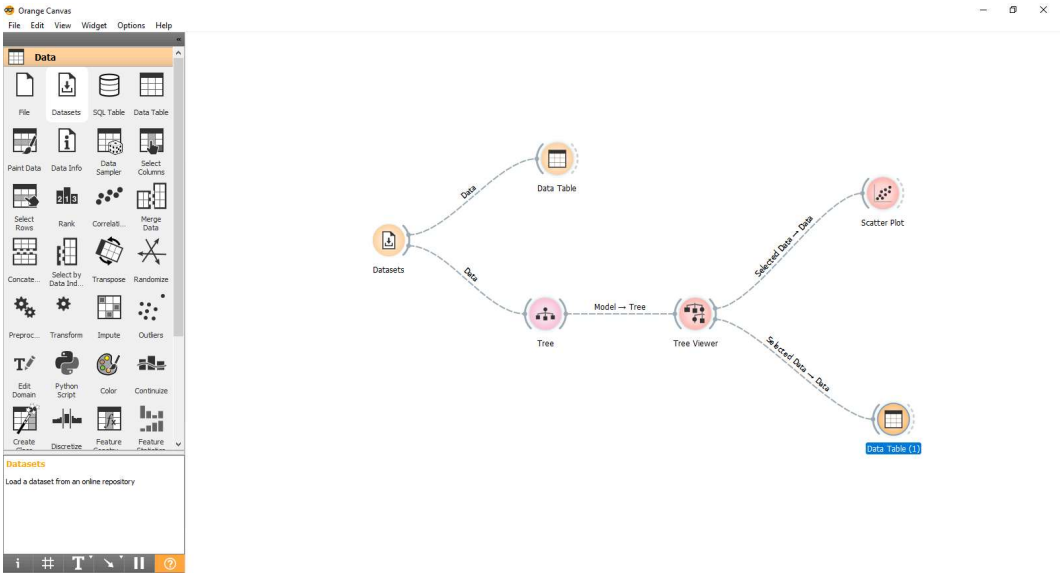
Applying test dataset on the model file to get the following results

SimpleCLI

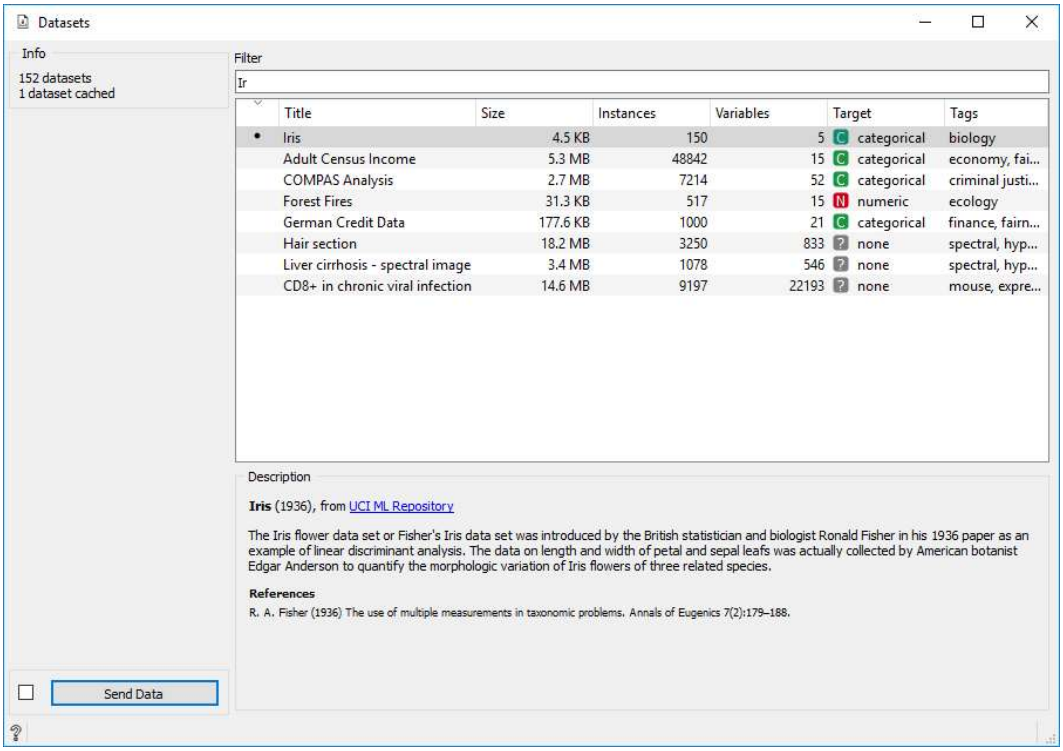
```
> java weka.classifiers.trees.J48 -p 9 -l C:\ShubhamMalekar\Exp4\bank.model
-T C:\ShubhamMalekar\Exp4\bank-new.arff


=== Predictions on test data ===

    inst#     actual  predicted error prediction ()
        1        1:?      1:YES       0.75
        2        1:?       2:NO       0.727
        3        1:?      1:YES       0.95
        4        1:?      1:YES       0.881
        5        1:?       2:NO       0.842
        6        1:?       2:NO       0.727
        7        1:?       2:NO       0.667
        8        1:?       2:NO       0.7
        9        1:?      1:YES       0.881
       10        1:?       2:NO       0.7
       11        1:?       2:NO       1
       12        1:?       2:NO       1
       13        1:?       2:NO       0.842
       14        1:?       2:NO       0.842
       15        1:?       2:NO       0.778
       16        1:?      1:YES       0.881
       17        1:?      1:YES       0.75
       18        1:?      1:YES       0.881
       19        1:?      1:YES       0.667
       20        1:?       2:NO       0.7
       21        1:?      1:YES       0.881
       22        1:?       2:NO       0.7
       23        1:?      1:YES       0.881
       24        1:?       2:NO       0.667
       25        1:?       2:NO       0.7
       26        1:?       2:NO       0.727
       27        1:?       2:NO       0.842
       28        1:?       2:NO       0.667
       29        1:?       2:NO       0.842
       30        1:?       2:NO       0.842
       31        1:?      1:YES       0.881
       32        1:?      1:YES       0.881
       33        1:?       2:NO       0.842
       34        1:?      1:YES       0.881
       35        1:?       2:NO       0.842
```

Orange

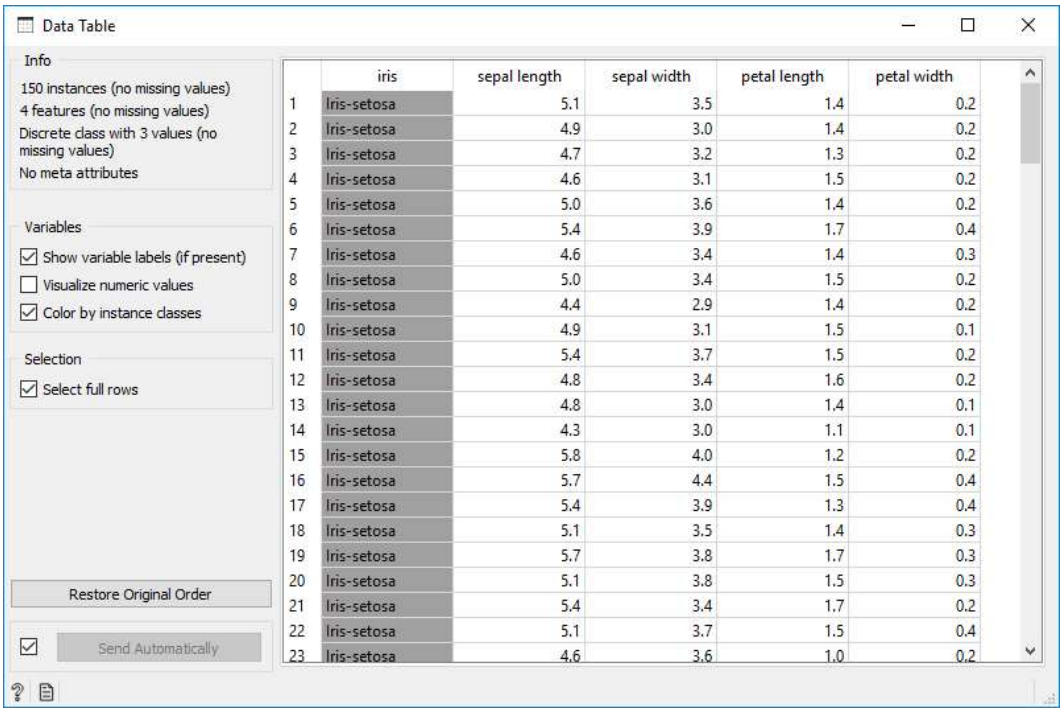
Applying tree window in orange



Applying Iris dataset

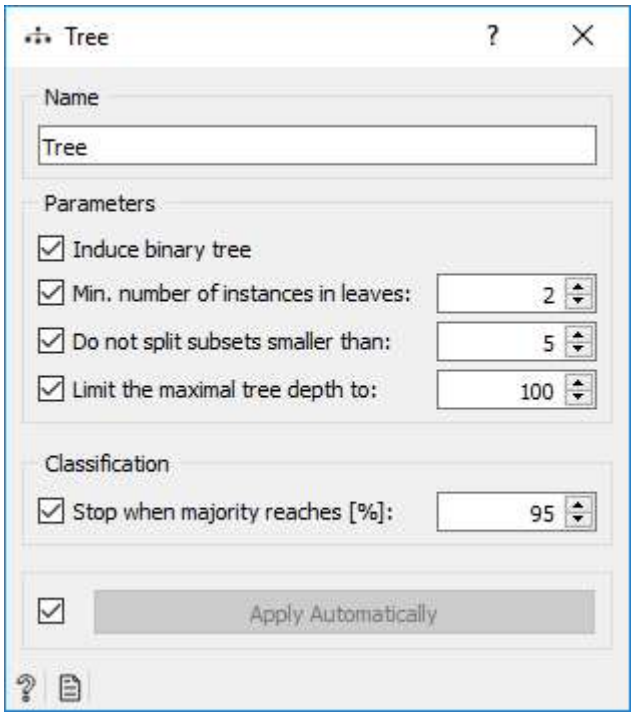


Viewing Iris dataset in data table

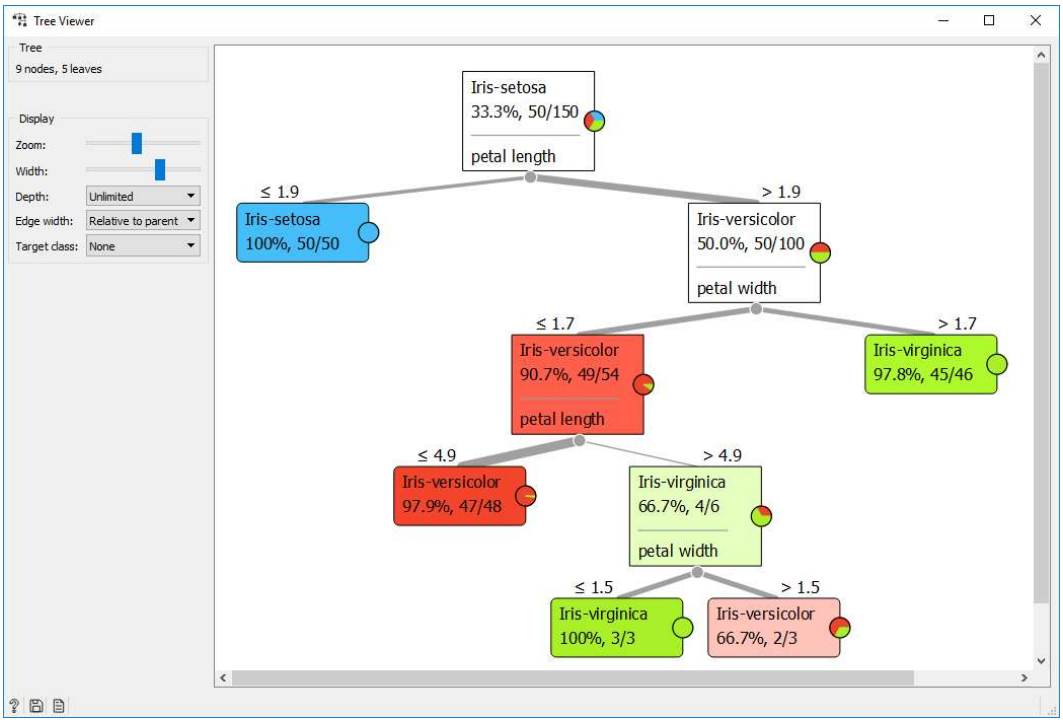


	iris	sepal length	sepal width	petal length	petal width
1	Iris-setosa	5.1	3.5	1.4	0.2
2	Iris-setosa	4.9	3.0	1.4	0.2
3	Iris-setosa	4.7	3.2	1.3	0.2
4	Iris-setosa	4.6	3.1	1.5	0.2
5	Iris-setosa	5.0	3.6	1.4	0.2
6	Iris-setosa	5.4	3.9	1.7	0.4
7	Iris-setosa	4.6	3.4	1.4	0.3
8	Iris-setosa	5.0	3.4	1.5	0.2
9	Iris-setosa	4.4	2.9	1.4	0.2
10	Iris-setosa	4.9	3.1	1.5	0.1
11	Iris-setosa	5.4	3.7	1.5	0.2
12	Iris-setosa	4.8	3.4	1.6	0.2
13	Iris-setosa	4.8	3.0	1.4	0.1
14	Iris-setosa	4.3	3.0	1.1	0.1
15	Iris-setosa	5.8	4.0	1.2	0.2
16	Iris-setosa	5.7	4.4	1.5	0.4
17	Iris-setosa	5.4	3.9	1.3	0.4
18	Iris-setosa	5.1	3.5	1.4	0.3
19	Iris-setosa	5.7	3.8	1.7	0.3
20	Iris-setosa	5.1	3.8	1.5	0.3
21	Iris-setosa	5.4	3.4	1.7	0.2
22	Iris-setosa	5.1	3.7	1.5	0.4
23	Iris-setosa	4.6	3.6	1.0	0.2

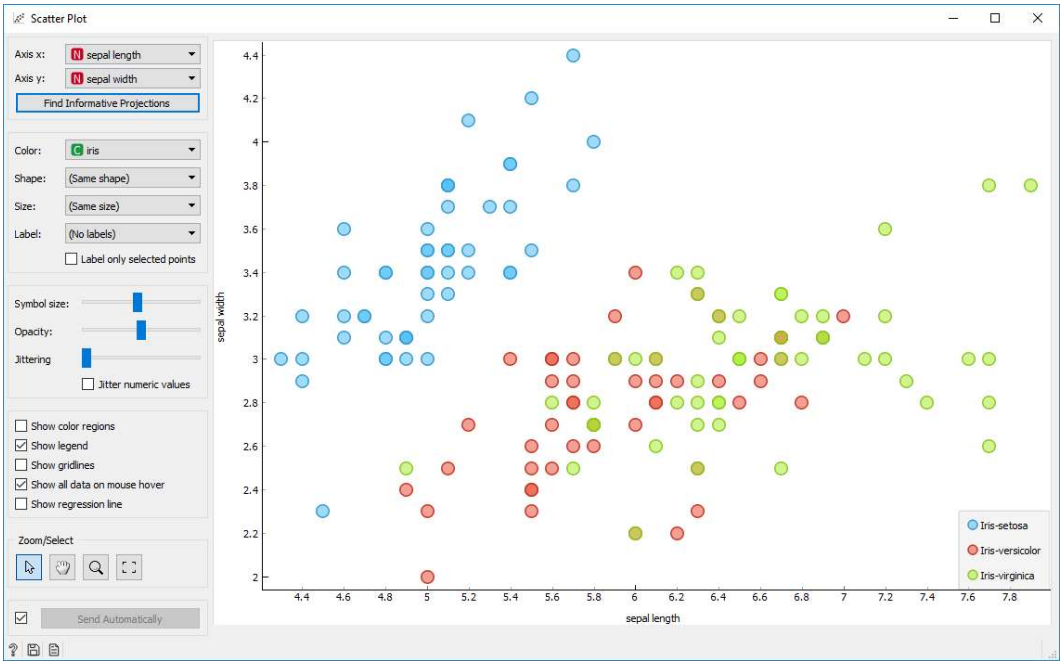
Applying tree Algorithm on Iris dataset



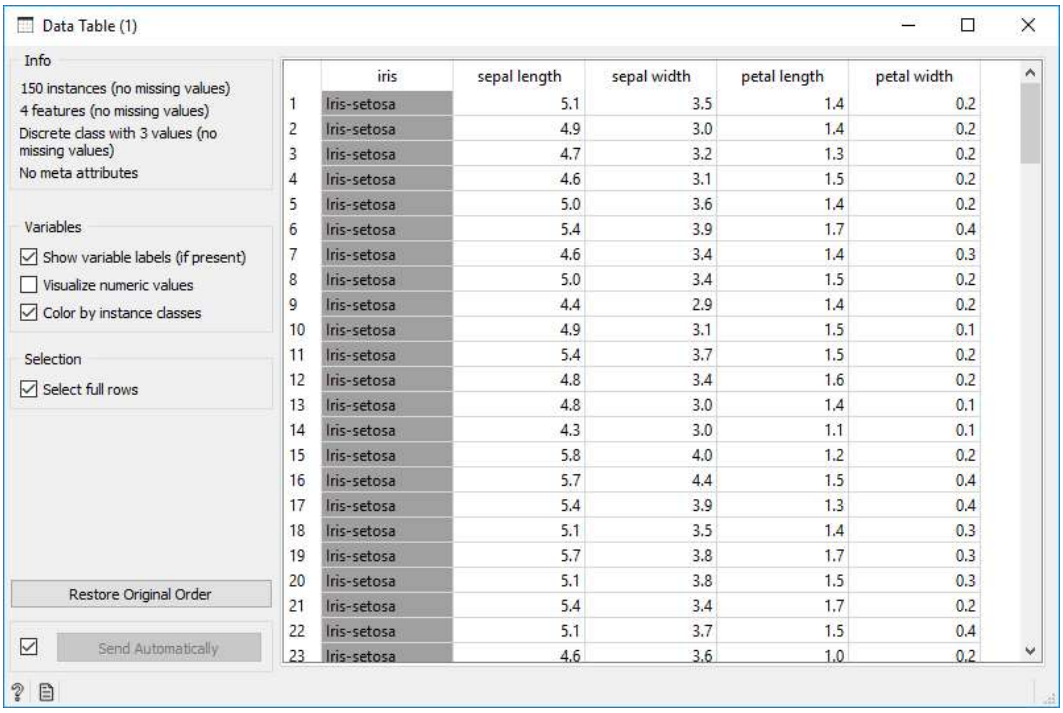
Tree visible in Tree Viewer



Scatter plot based on the Root node



Tuples visible in data Table based on node selected in decision tree



	iris	sepal length	sepal width	petal length	petal width
1	Iris-setosa	5.1	3.5	1.4	0.2
2	Iris-setosa	4.9	3.0	1.4	0.2
3	Iris-setosa	4.7	3.2	1.3	0.2
4	Iris-setosa	4.6	3.1	1.5	0.2
5	Iris-setosa	5.0	3.6	1.4	0.2
6	Iris-setosa	5.4	3.9	1.7	0.4
7	Iris-setosa	4.6	3.4	1.4	0.3
8	Iris-setosa	5.0	3.4	1.5	0.2
9	Iris-setosa	4.4	2.9	1.4	0.2
10	Iris-setosa	4.9	3.1	1.5	0.1
11	Iris-setosa	5.4	3.7	1.5	0.2
12	Iris-setosa	4.8	3.4	1.6	0.2
13	Iris-setosa	4.8	3.0	1.4	0.1
14	Iris-setosa	4.3	3.0	1.1	0.1
15	Iris-setosa	5.8	4.0	1.2	0.2
16	Iris-setosa	5.7	4.4	1.5	0.4
17	Iris-setosa	5.4	3.9	1.3	0.4
18	Iris-setosa	5.1	3.5	1.4	0.3
19	Iris-setosa	5.7	3.8	1.7	0.3
20	Iris-setosa	5.1	3.8	1.5	0.3
21	Iris-setosa	5.4	3.4	1.7	0.2
22	Iris-setosa	5.1	3.7	1.5	0.4
23	Iris-setosa	4.6	3.6	1.0	0.2