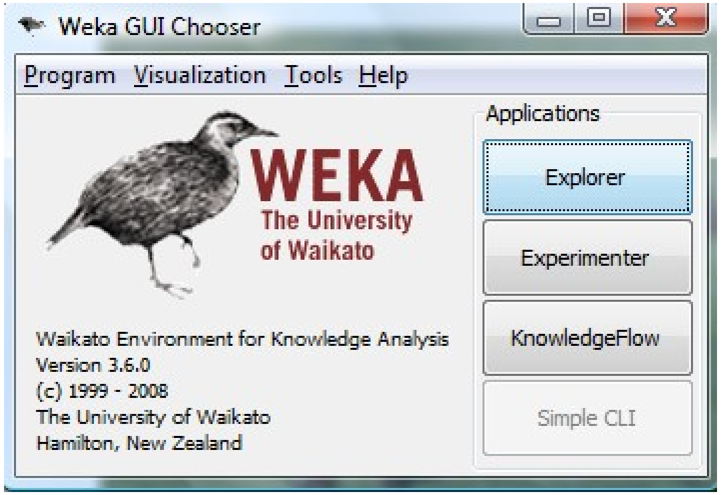
Introduction to Weka

WEKA
The University
of Waikato



Waikato Environment for Knowledge Analysis
Version 3.6.0
(c) 1999 - 2008
The University of Waikato
Hamilton, New Zealand

Overview

- What is Weka?
- Where to find Weka?
- Command Line Vs GUI
- Datasets in Weka
- ARFF Files
- Classifiers in Weka
- Filters

What is Weka?

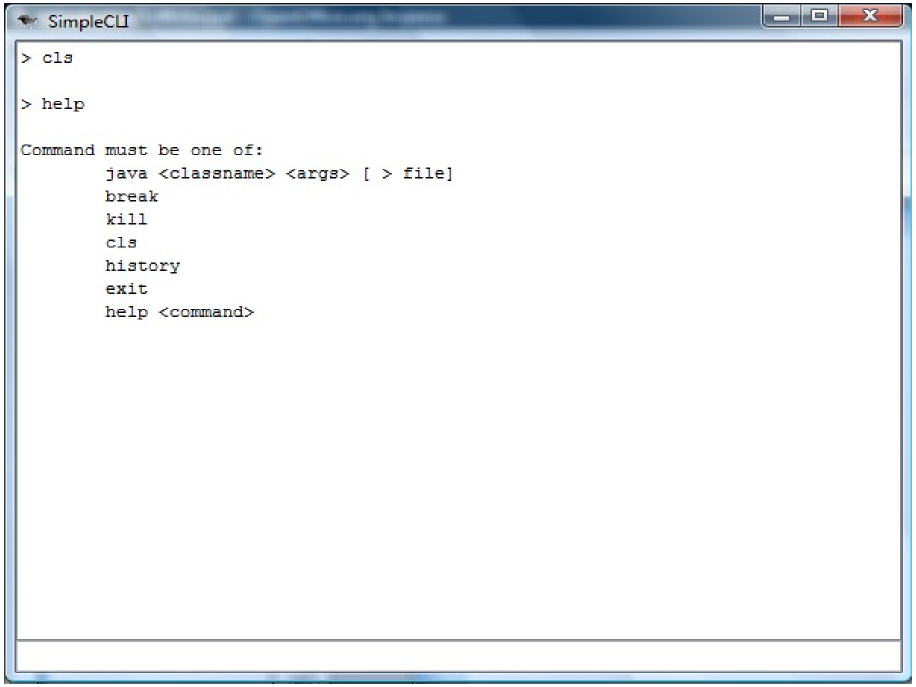
- Weka is a collection of machine learning algorithms for data mining tasks. The algorithms can either be applied directly to a dataset or called from your own Java code. Weka contains tools for data pre-processing, classification, regression, clustering, association rules, and visualization. It is also well-suited for developing new machine learning schemes.

Where to find Weka

- Weka website (Latest version 3.6):
  - http://www.cs.waikato.ac.nz/ml/weka/

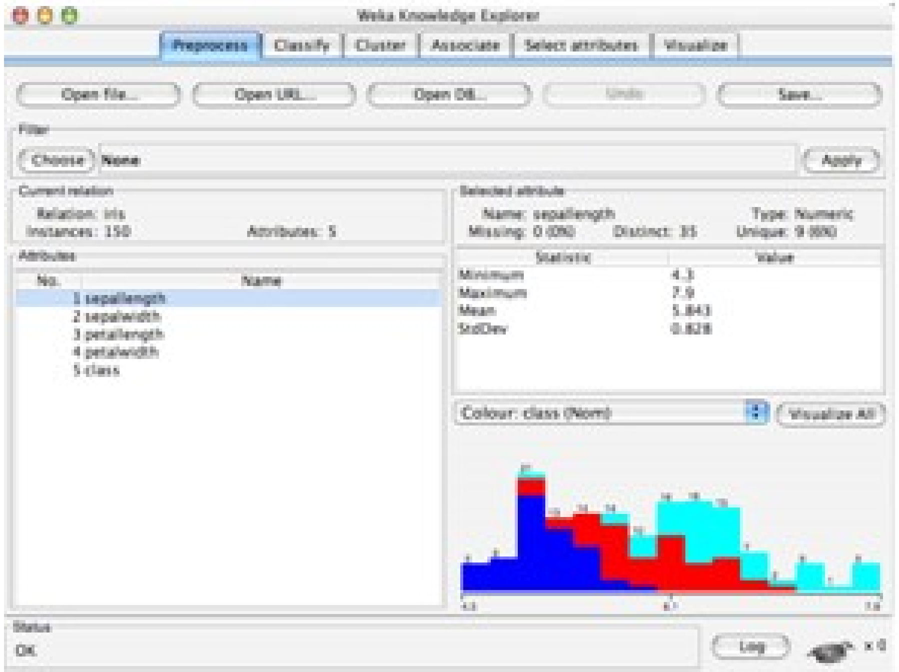
- Weka Manual:
  - http://transact.dl.sourceforge.net/sourceforge/weka/WekaManual-3.6.0.pdf

CLI Vs GUI



```
> cls

> help

Command must be one of:
        java <classname> <args> [ > file]
        break
        kill
        cls
        history
        exit
        help <command>
```

- Recommended for in-depth usage
- Offers some functionality not available via the GUI



Filter: None

Current relation
Relation: iris
Instances: 150
Attributes: 5

Attributes

No.	Name
1	sepallength
2	sepalwidth
3	petallength
4	petalwidth
5	class

Selected attribute
Name: sepallength
Type: Numeric
Missing: 0 (0%)
Distinct: 35
Unique: 9 (6%)

Statistic	Value
Minimum	4.3
Maximum	7.9
Mean	5.843
StdDev	0.828

Colour: class (Nom)

Status
OK

- Explorer
- Experimenter
- Knowledge Flow

Datasets in Weka

- Each entry in a dataset is an instance of the java class:
  - weka.core.Instance
- Each instance consists of a number of attributes

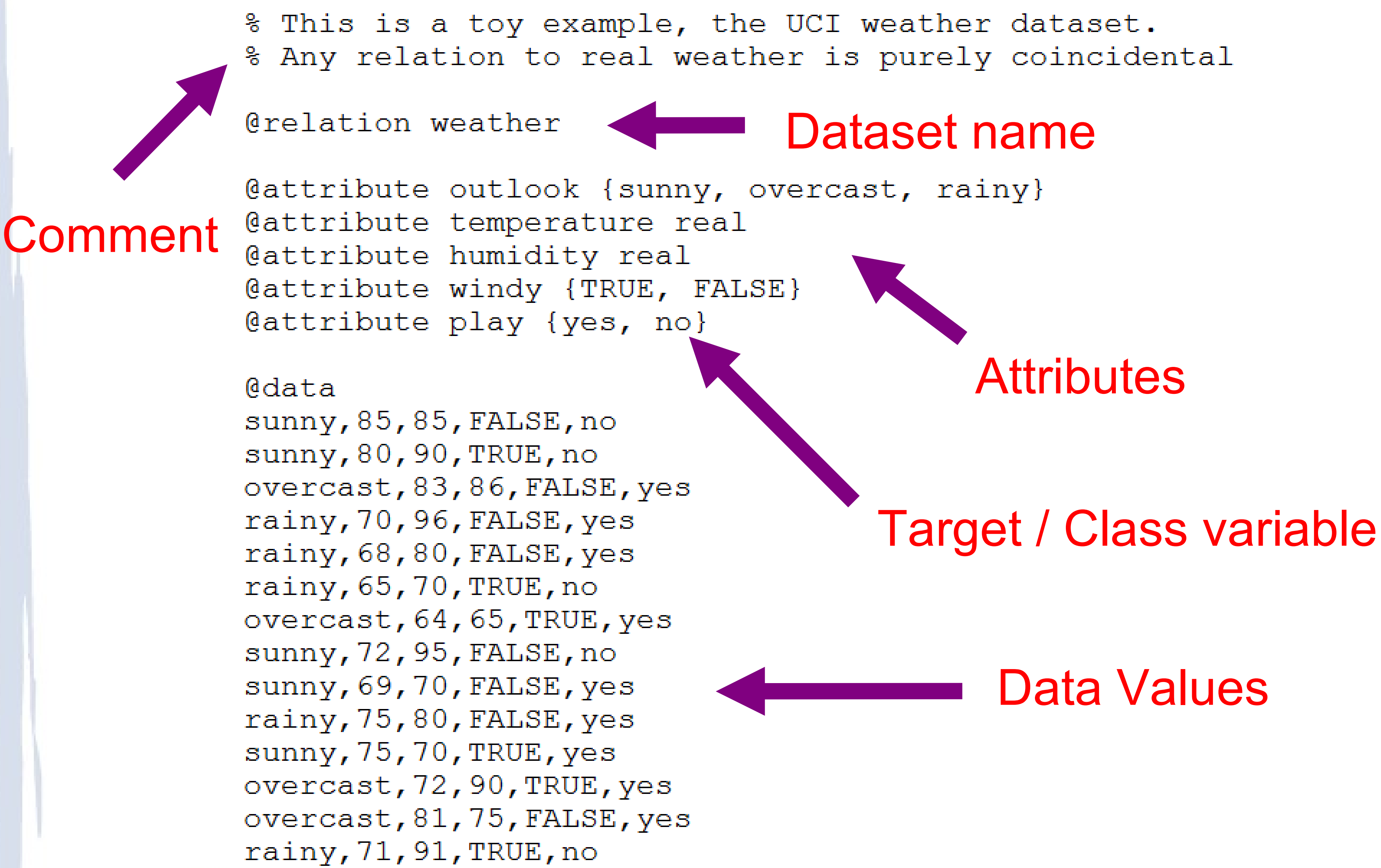
Attributes

- *Nominal*: one of a predefined list of values
  - e.g. red, green, blue
- *Numeric*: A real or integer number
- *String:* Enclosed in “double quotes”
- *Date*
- *Relational*

ARFF Files

- The external representation of an Instances class
- Consists of:
  - A header: Describes the attribute types
  - Data section: Comma separated list of data

ARFF File Example



```
% This is a toy example, the UCI weather dataset.
% Any relation to real weather is purely coincidental

@relation weather

@attribute outlook {sunny, overcast, rainy}
@attribute temperature real
@attribute humidity real
@attribute windy {TRUE, FALSE}
@attribute play {yes, no}

@data
sunny,85,85,FALSE,no
sunny,80,90,TRUE,no
overcast,83,86,FALSE,yes
rainy,70,96,FALSE,yes
rainy,68,80,FALSE,yes
rainy,65,70,TRUE,no
overcast,64,65,TRUE,yes
sunny,72,95,FALSE,no
sunny,69,70,FALSE,yes
rainy,75,80,FALSE,yes
sunny,75,70,TRUE,yes
overcast,72,90,TRUE,yes
overcast,81,75,FALSE,yes
rainy,71,91,TRUE,no
```

Comment

Dataset name

Attributes

Target / Class variable

Data Values

Assignment ARFF Files

- Credit-g
- Heart-c
- Hepatitis
- Vowel
- Zoo

- http://www.cs.auckland.ac.nz/~pat/weka/

ARFF Files

- Basic statistics and validation by running:

  -
    ```
    java weka.core.Instances data/soybean.arff
    ```

Classifiers in Weka

- Learning algorithms in Weka are derived from the abstract class:
  - weka.classifiers.Classifier
- Simple classifier: ZeroR
  - Just determines the most common class
  - Or the median (in the case of numeric values)
  - Tests how well the class can be predicted without considering other attributes
  - Can be used as a Lower Bound on Performance.

Classifiers in Weka

- Simple Classifier Example

  ```
  java weka.classifiers.rules.ZeroR -t data/weather.arff
  ```

  ```
  java weka.classifiers.trees.J48 -t data/weather.arff
  ```

- Help Command

  ```
  java weka.classifiers.trees.J48 -h
  ```

Classifiers in Weka

- **Soybean.arff** split into train and test set
  - Soybean-train.arff
  - Soybean-test.arff
- Input command:

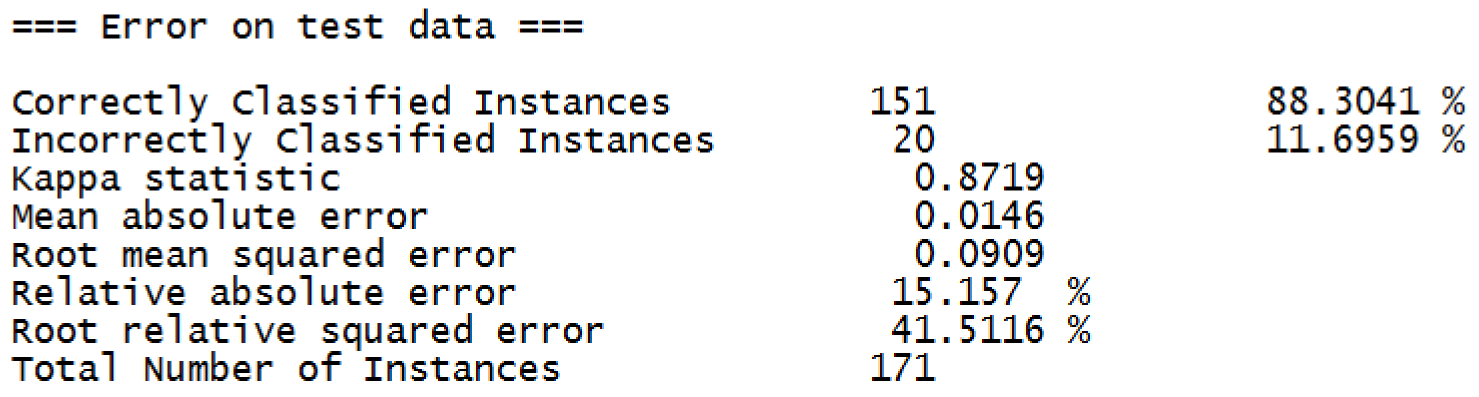
  -
    ```
    java weka.classifiers.trees.J48 -t soybean-train.arff -T soybean-test.arff -i
    ```

Training data

Test data

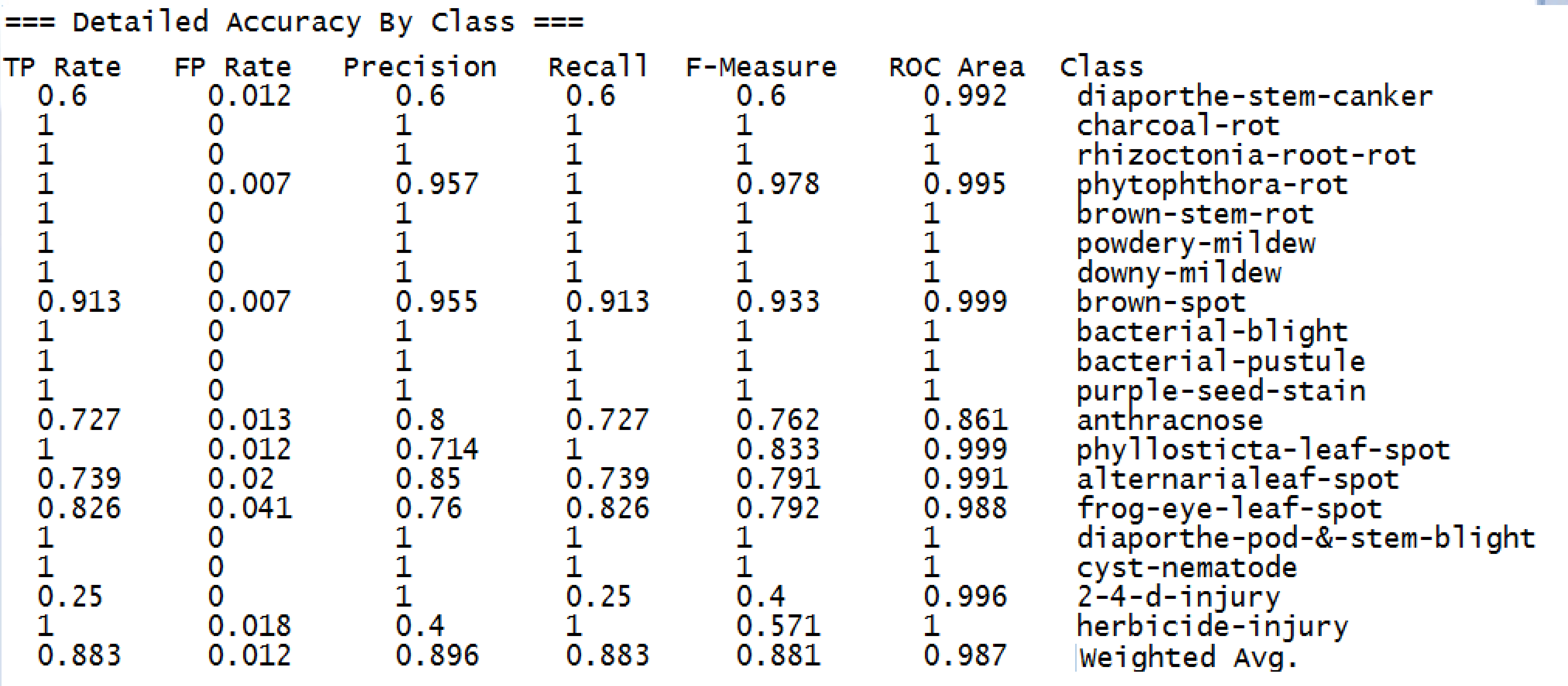
Provides more detailed output

Soybean Results



```
=== Error on test data ===

Correctly Classified Instances         151               88.3041 %
Incorrectly Classified Instances        20               11.6959 %
Kappa statistic                          0.8719
Mean absolute error                      0.0146
Root mean squared error                  0.0909
Relative absolute error                 15.157  %
Root relative squared error             41.5116 %
Total Number of Instances              171
```

Soybean Results (cont...)



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

TP Rate    FP Rate    Precision    Recall   F-Measure    ROC Area   Class
  0.6        0.012       0.6        0.6       0.6          0.992     diaporthe-stem-canker
  1          0           1          1         1            1         charcoal-rot
  1          0           1          1         1            1         rhizoctonia-root-rot
  1          0.007       0.957      1         0.978        0.995     phytophthora-rot
  1          0           1          1         1            1         brown-stem-rot
  1          0           1          1         1            1         powdery-mildew
  1          0           1          1         1            1         downy-mildew
  0.913      0.007       0.955      0.913     0.933        0.999     brown-spot
  1          0           1          1         1            1         bacterial-blight
  1          0           1          1         1            1         bacterial-pustule
  1          0           1          1         1            1         purple-seed-stain
  0.727      0.013       0.8        0.727     0.762        0.861     anthracnose
  1          0.012       0.714      1         0.833        0.999     phyllosticta-leaf-spot
  0.739      0.02        0.85       0.739     0.791        0.991     alternarialeaf-spot
  0.826      0.041       0.76       0.826     0.792        0.988     frog-eye-leaf-spot
  1          0           1          1         1            1         diaporthe-pod-&-stem-blight
  1          0           1          1         1            1         cyst-nematode
  0.25       0           1          0.25      0.4          0.996     2-4-d-injury
  1          0.018       0.4        1         0.571        1         herbicide-injury
  0.883      0.012       0.896      0.883     0.881        0.987     Weighted Avg.
```

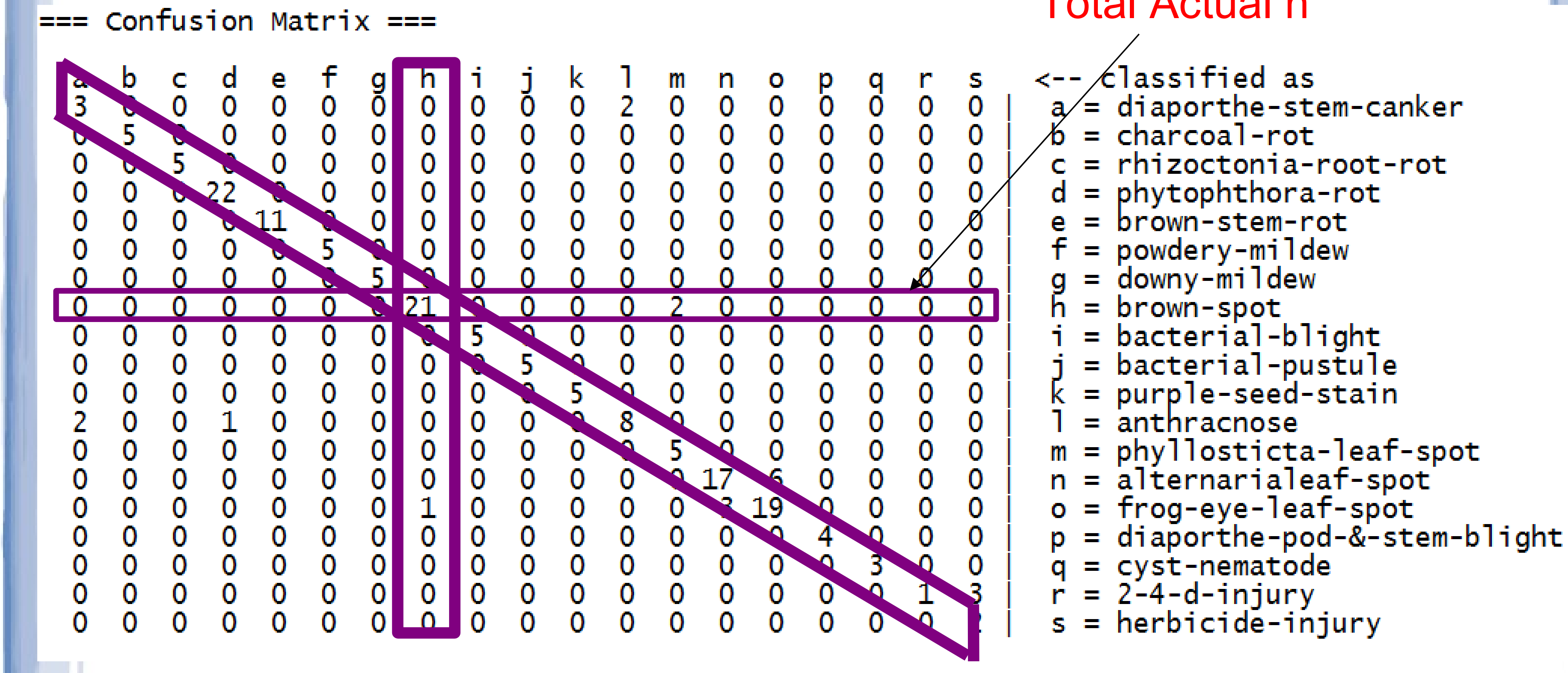
Soybean Results (cont...)

- True Positive (*TP*)
  - Proportion classified as class x / Actual total in class x
  - Equivalent to Recall
- False Positive (*FP*)
  - Proportion incorrectly classified as class x / Actual total of all classes, except x

Soybean Results (cont...)

- Precision:
  - Proportion of the examples which truly have class x / Total classified as class x
- F-measure:
  - 2*Precision*Recall / (Precision + Recall)
  - i.e. A combined measure for precision and recall

Soybean Results (cont...)



```
=== Confusion Matrix ===

  a  b  c  d  e  f  g  h  i  j  k  l  m  n  o  p  q  r  s   <-- classified as
  3  0  0  0  0  0  0  0  0  0  0  2  0  0  0  0  0  0  0 |  a = diaporthe-stem-canker
  0  5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0 |  b = charcoal-rot
  0  0  5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0 |  c = rhizoctonia-root-rot
  0  0  0 22  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0 |  d = phytophthora-rot
  0  0  0  0 11  0  0  0  0  0  0  0  0  0  0  0  0  0  0 |  e = brown-stem-rot
  0  0  0  0  0  5  0  0  0  0  0  0  0  0  0  0  0  0  0 |  f = powdery-mildew
  0  0  0  0  0  0  5  0  0  0  0  0  0  0  0  0  0  0  0 |  g = downy-mildew
  0  0  0  0  0  0  0 21  0  0  0  0  2  0  0  0  0  0  0 |  h = brown-spot
  0  0  0  0  0  0  0  0  5  0  0  0  0  0  0  0  0  0  0 |  i = bacterial-blight
  0  0  0  0  0  0  0  0  0  5  0  0  0  0  0  0  0  0  0 |  j = bacterial-pustule
  0  0  0  0  0  0  0  0  0  0  5  0  0  0  0  0  0  0  0 |  k = purple-seed-stain
  2  0  0  1  0  0  0  0  0  0  0  8  0  0  0  0  0  0  0 |  l = anthracnose
  0  0  0  0  0  0  0  0  0  0  0  0  5  0  0  0  0  0  0 |  m = phyllosticta-leaf-spot
  0  0  0  0  0  0  0  0  0  0  0  0  0 17  6  0  0  0  0 |  n = alternarialeaf-spot
  0  0  0  0  0  0  0  1  0  0  0  0  0  3 19  0  0  0  0 |  o = frog-eye-leaf-spot
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  4  0  0  0 |  p = diaporthe-pod-&-stem-blight
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  3  0  0 |  q = cyst-nematode
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  3 |  r = 2-4-d-injury
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  2 |  s = herbicide-injury
```

Total Actual h

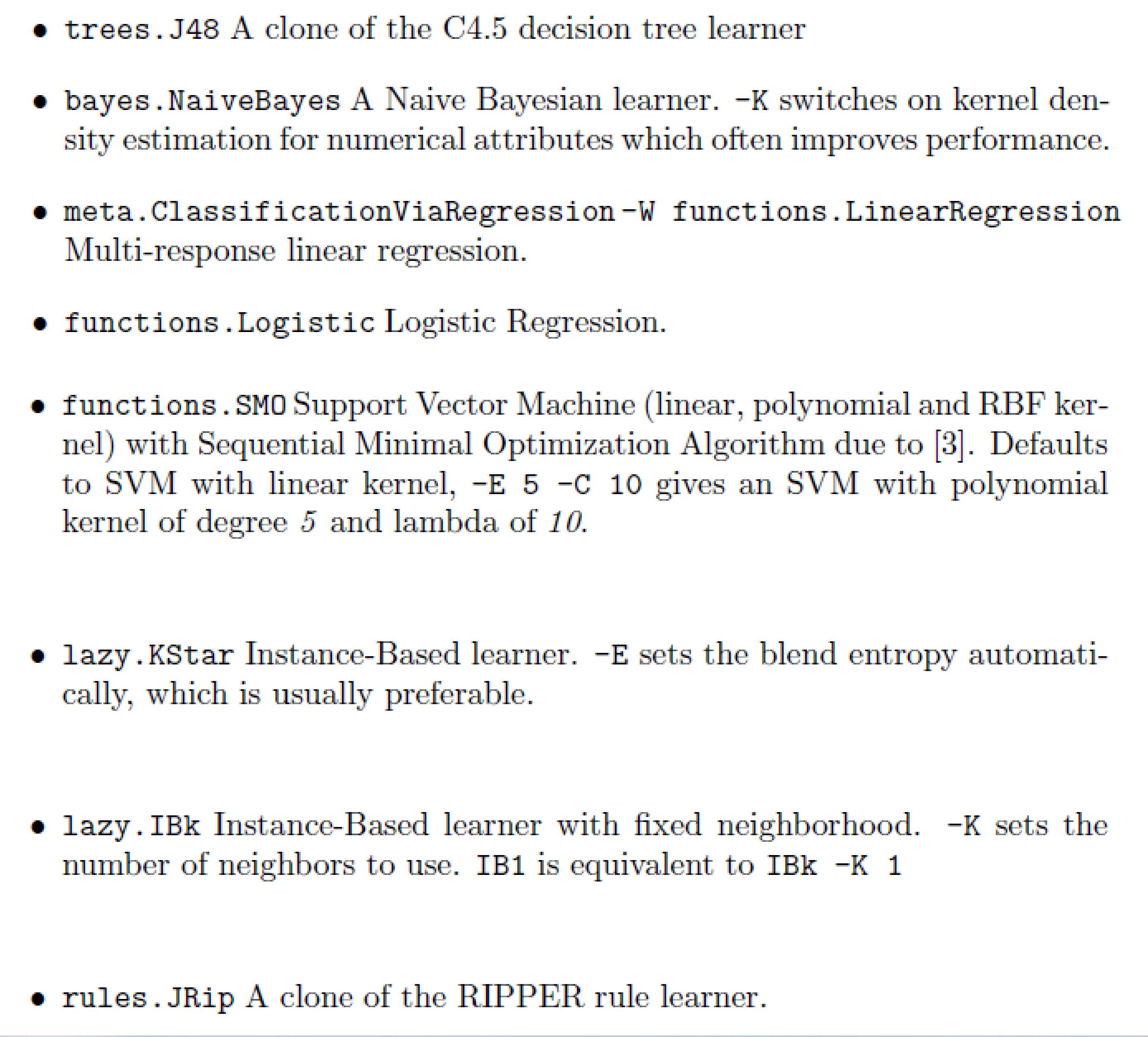
Total Classified as h

Total Correct

Filters

- weka.filters package
- Transform datasets
- Support for data preprocessing
  - e.g. Removing/Adding Attributes
  - e.g. Discretize numeric attributes into nominal ones
- More info in Weka Manual p. 15 & 16.

More Classifiers



- `trees.J48` A clone of the C4.5 decision tree learner

- `bayes.NaiveBayes` A Naive Bayesian learner. `-K` switches on kernel density estimation for numerical attributes which often improves performance.

- `meta.ClassificationViaRegression -W functions.LinearRegression` Multi-response linear regression.

- `functions.Logistic` Logistic Regression.

- `functions.SMO` Support Vector Machine (linear, polynomial and RBF kernel) with Sequential Minimal Optimization Algorithm due to [3]. Defaults to SVM with linear kernel, `-E 5 -C 10` gives an SVM with polynomial kernel of degree *5* and lambda of *10*.

- `lazy.KStar` Instance-Based learner. `-E` sets the blend entropy automatically, which is usually preferable.

- `lazy.IBk` Instance-Based learner with fixed neighborhood. `-K` sets the number of neighbors to use. `IB1` is equivalent to `IBk -K 1`

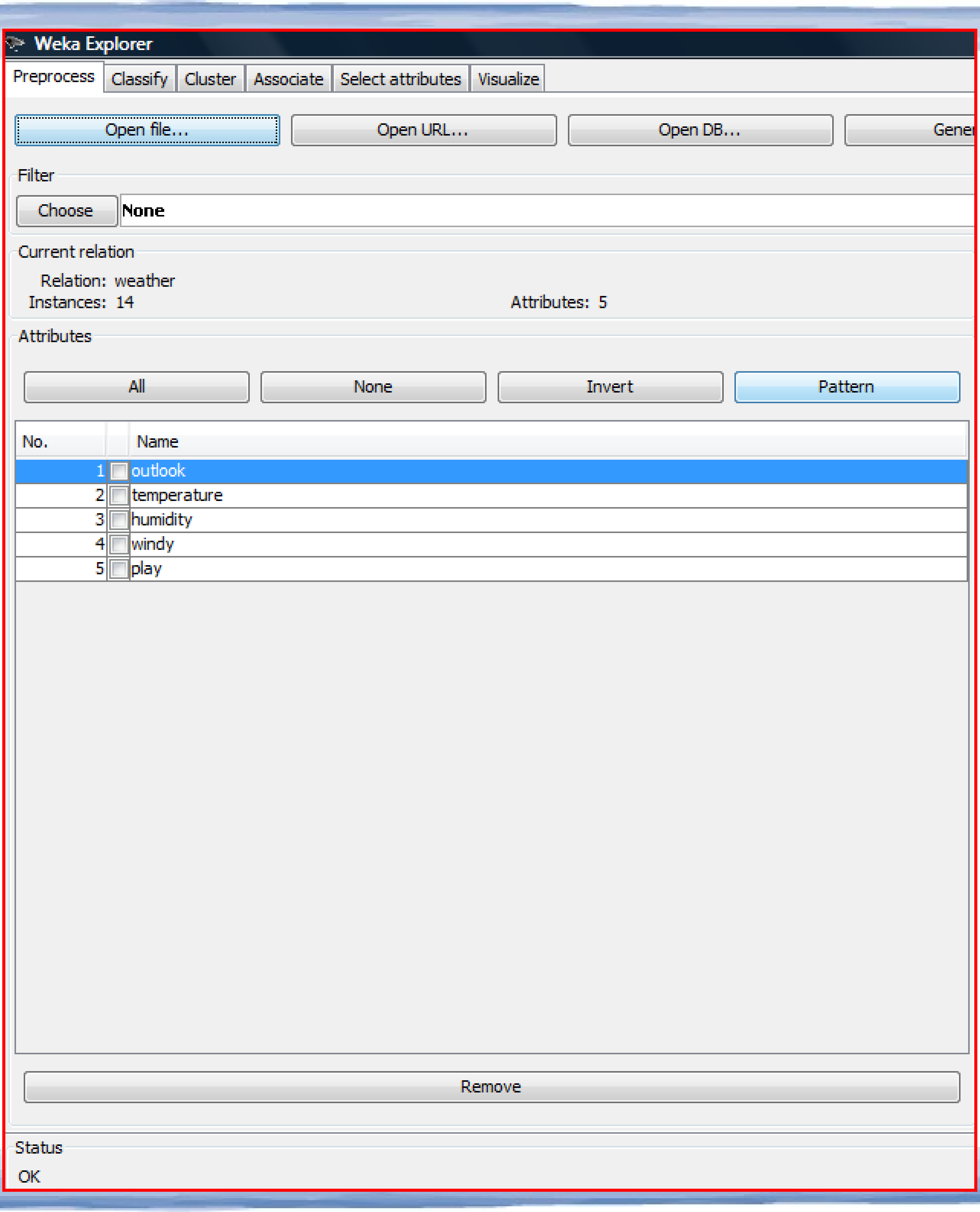
- `rules.JRip` A clone of the RIPPER rule learner.

Explorer

- Preprocess
- Classify
- Cluster
- Associate
- Select attributes
- Visualize

Preprocess

- Load Data
- Preprocess Data
- Analyse Attributes



Filter

None

Current relation

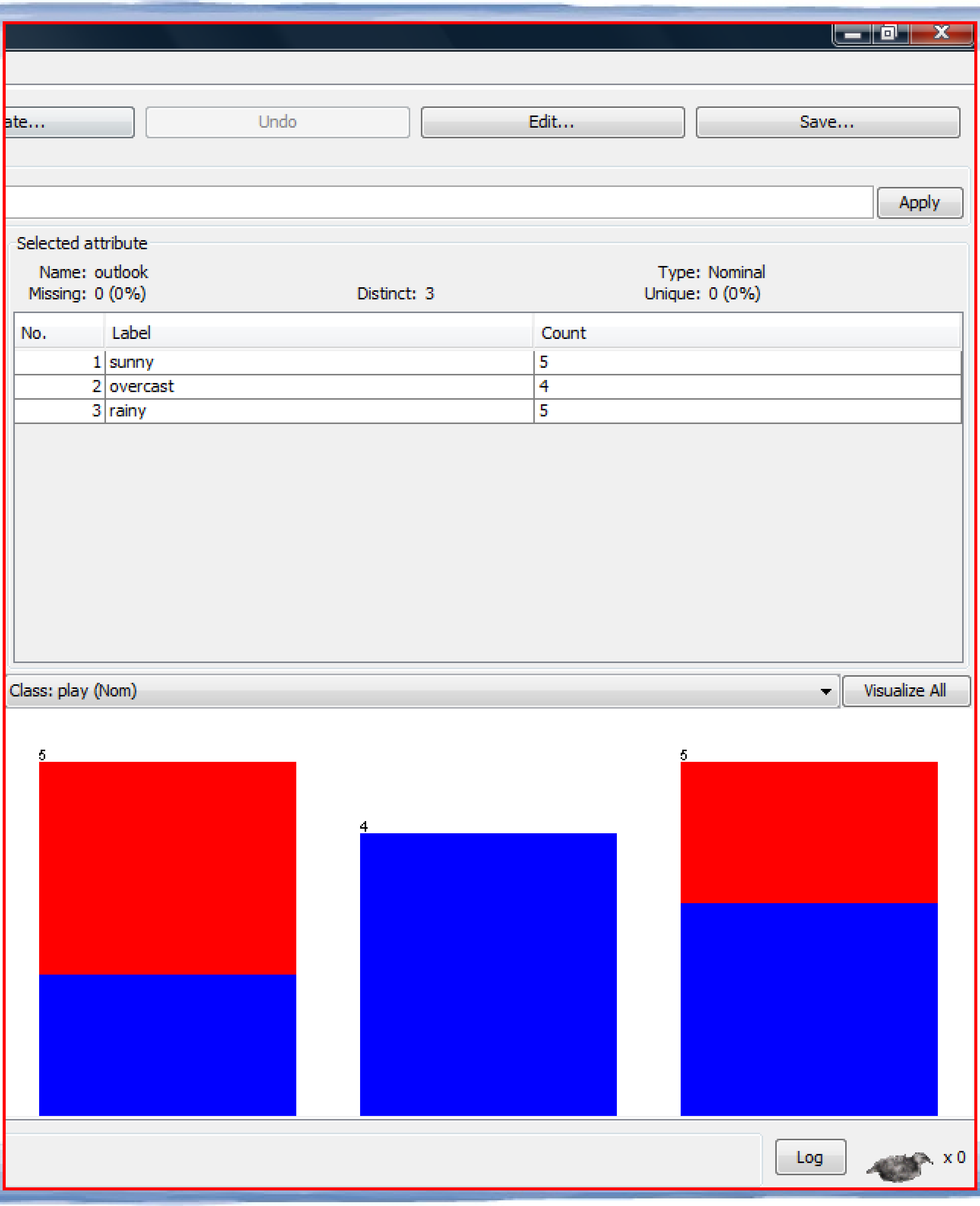
Relation: weather
Instances: 14
Attributes: 5

Attributes

No.		Name
1	□	outlook
2	□	temperature
3	□	humidity
4	□	windy
5	□	play

Status

OK



Selected attribute

Name: outlook
Type: Nominal
Missing: 0 (0%)
Distinct: 3
Unique: 0 (0%)

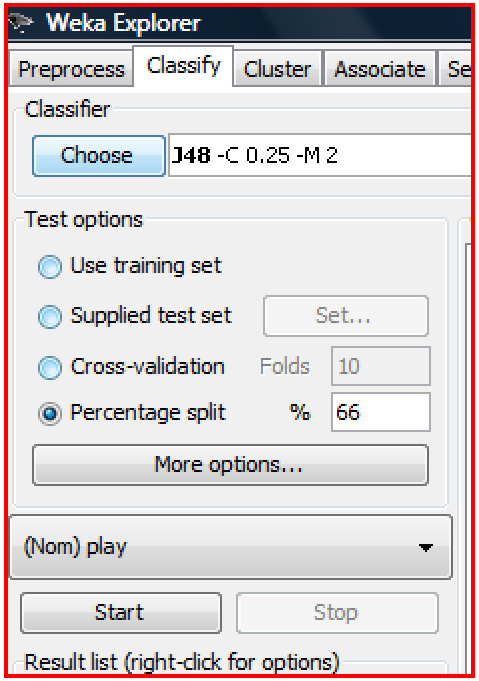
No.	Label	Count
1	sunny	5
2	overcast	4
3	rainy	5

Class: play (Nom)

Classify

- Select Test Options e.g:
  - Use Training Set
  - % Split,
  - Cross Validation...
- Run classifiers
- View results

Classify



Classifier

J48 -C 0.25 -M 2

Test options

○ Use training set

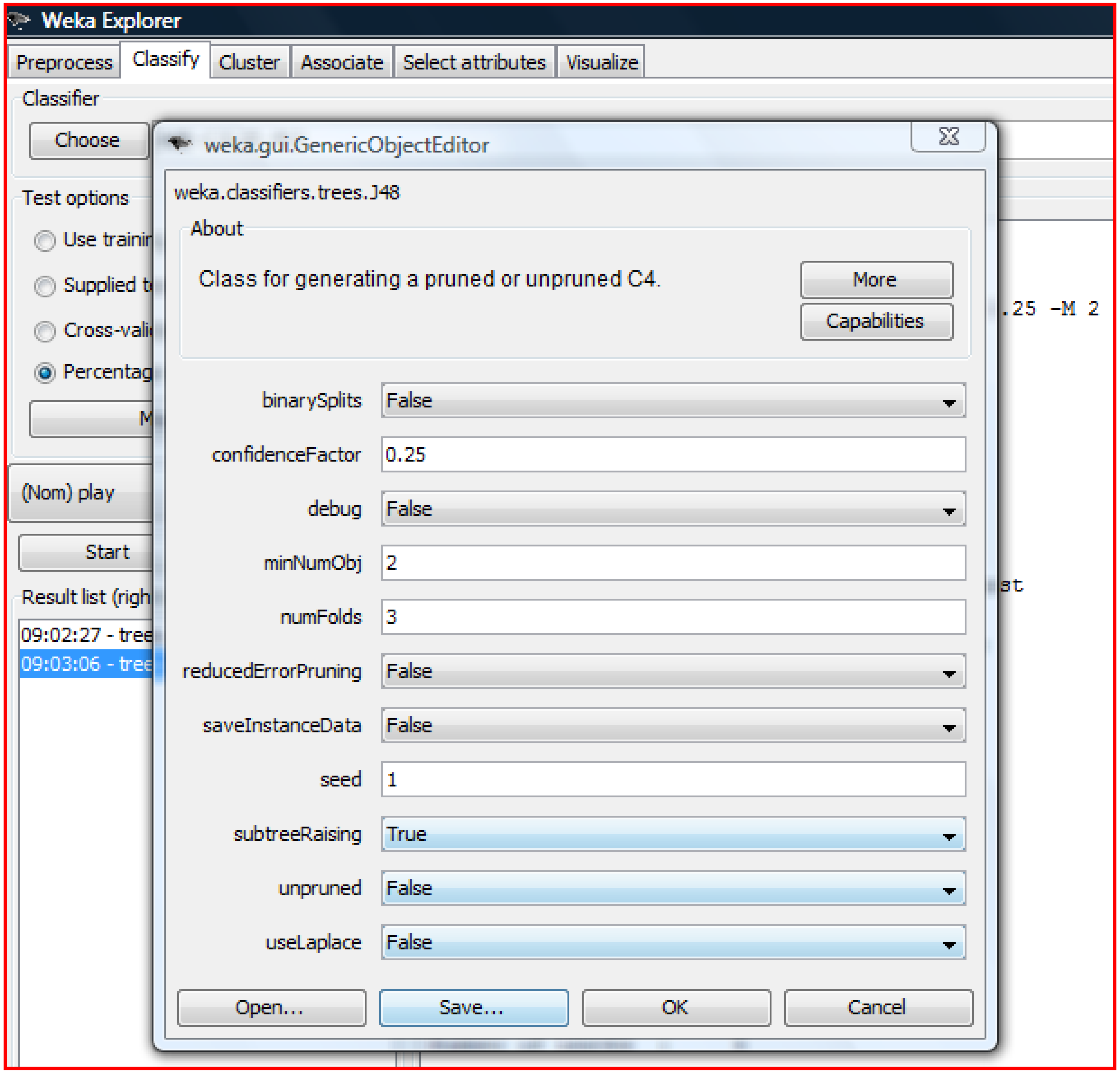
○ Supplied test set

○ Cross-validation Folds 10

● Percentage split % 66

(Nom) play

Result list (right-click for options)



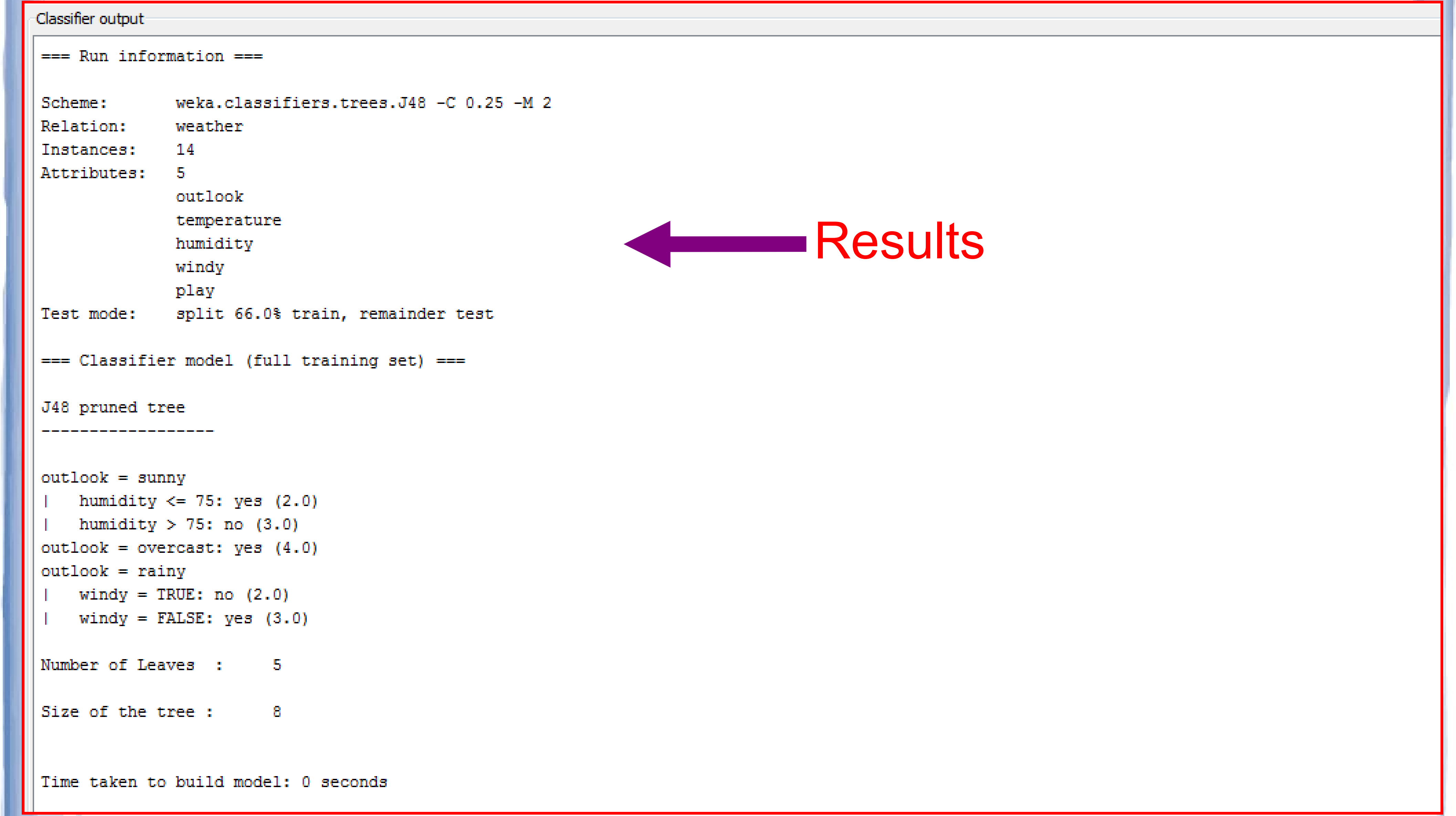
weka.gui.GenericObjectEditor

weka.classifiers.trees.J48

About

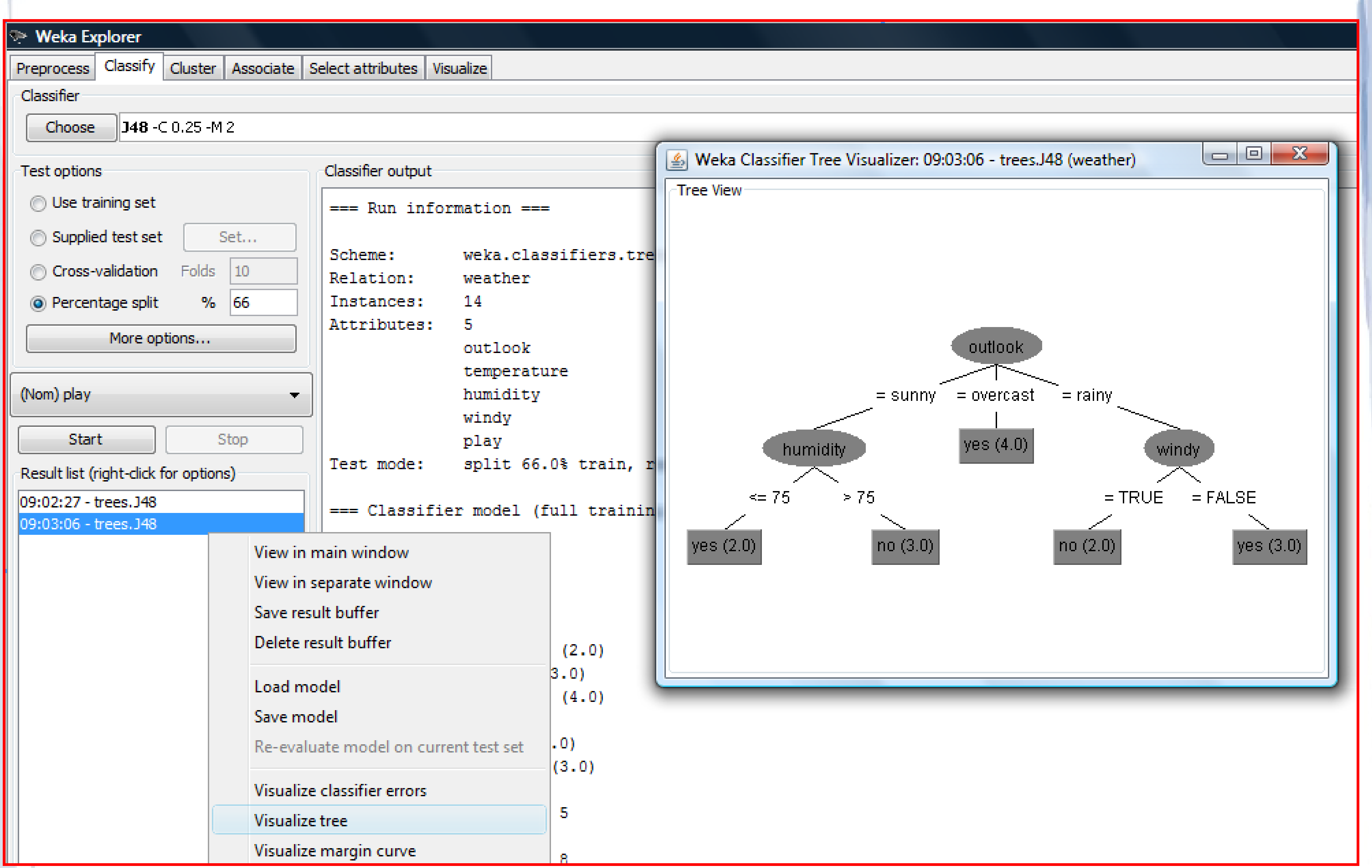
Class for generating a pruned or unpruned C4.

binarySplits	False
confidenceFactor	0.25
debug	False
minNumObj	2
numFolds	3
reducedErrorPruning	False
saveInstanceData	False
seed	1
subtreeRaising	True
unpruned	False
useLaplace	False



```
=== Run information ===

Scheme:       weka.classifiers.trees.J48 -C 0.25 -M 2
Relation:     weather
Instances:    14
Attributes:   5
              outlook
              temperature
              humidity
              windy
              play
Test mode:    split 66.0% train, remainder test

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

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

outlook = sunny
|   humidity <= 75: yes (2.0)
|   humidity > 75: no (3.0)
outlook = overcast: yes (4.0)
outlook = rainy
|   windy = TRUE: no (2.0)
|   windy = FALSE: yes (3.0)

Number of Leaves  :     5

Size of the tree :      8


Time taken to build model: 0 seconds
```

Results



Classifier

J48 -C 0.25 -M 2

Test options

○ Use training set

○ Supplied test set

○ Cross-validation Folds 10

● Percentage split % 66

(Nom) play

Result list (right-click for options)

09:02:27 - trees.J48

09:03:06 - trees.J48

Classifier output

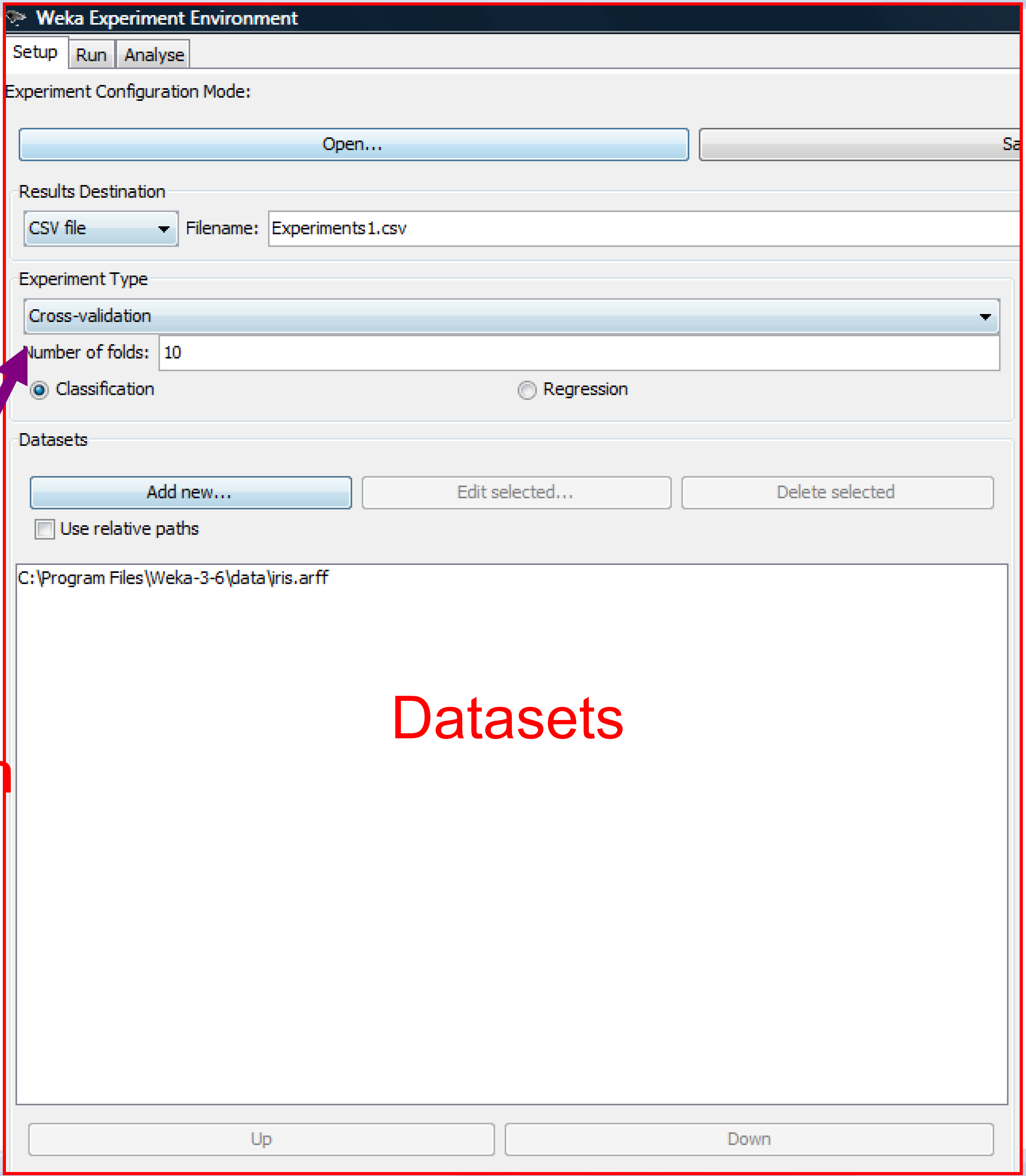
```
=== Run information ===

Scheme:       weka.classifiers.tre
Relation:     weather
Instances:    14
Attributes:   5
              outlook
              temperature
              humidity
              windy
              play
Test mode:    split 66.0% train, r

=== Classifier model (full trainin

                                  (2.0)
                                 3.0)
                                  (4.0)

                                 .0)
                                 (3.0)

                                 5

                                 8
```

Experimenter

- Allows users to create, run, modify and analyse experiments in a more convenient manner than when processing individually.
  - Setup
  - Run
  - Analyse

Experimenter: Setup

- Simple/Advanced
- Results Destinations
  - ARFF
  - CSV
  - JDBC Database



Experiment Configuration Mode:

Results Destination

CSV file Filename: Experiments1.csv

Experiment Type

Cross-validation

Number of folds: 10

● Classification ○ Regression

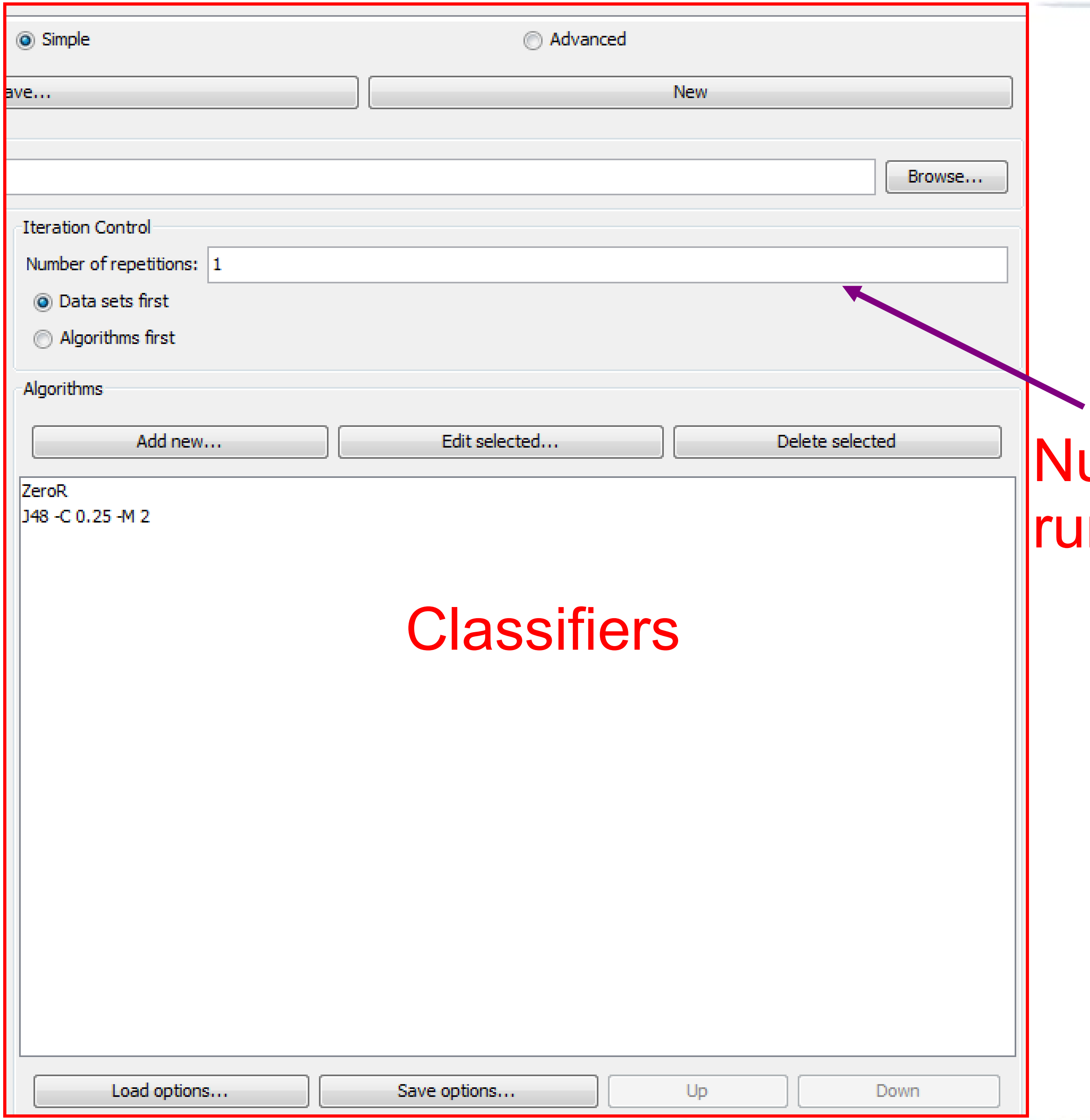
Datasets

□ Use relative paths

C:\Program Files\Weka-3-6\data\iris.arff

10-fold Cross Validation

Datasets



● Simple ○ Advanced

Number of repetitions: 1

● Data sets first

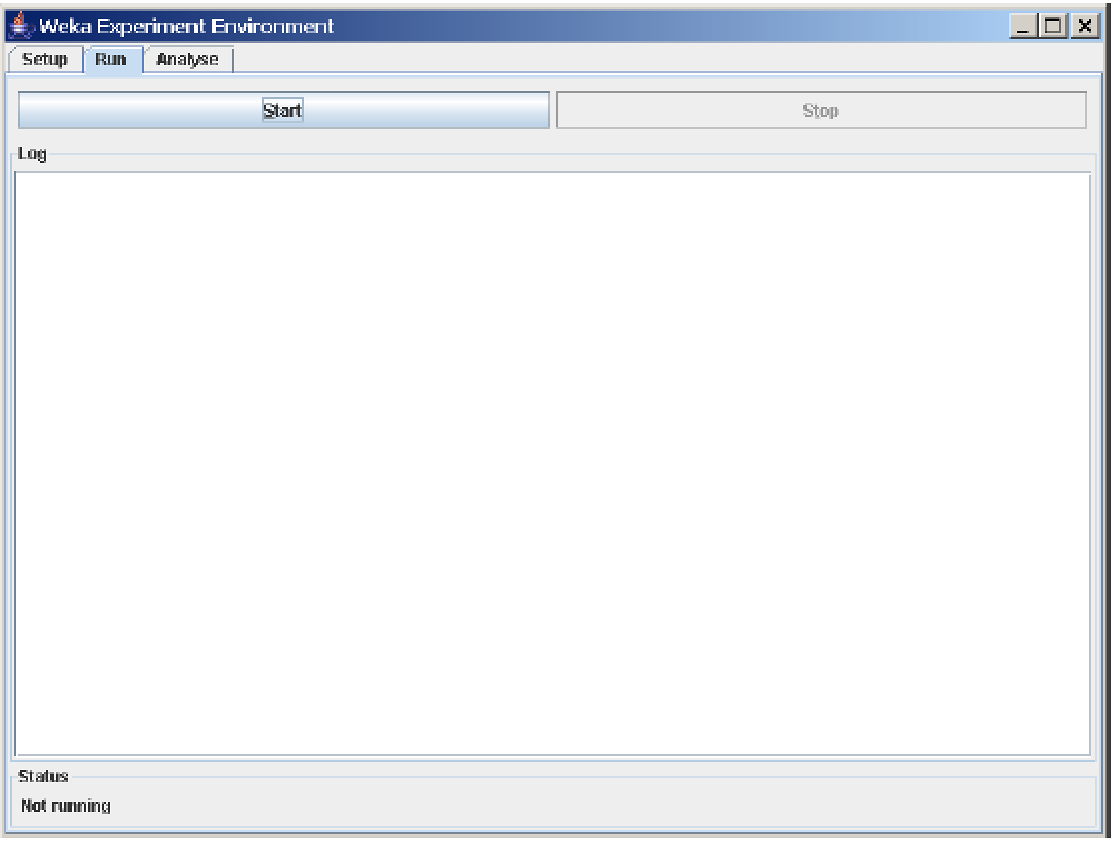
○ Algorithms first

ZeroR
J48 -C 0.25 -M 2

Num of runs

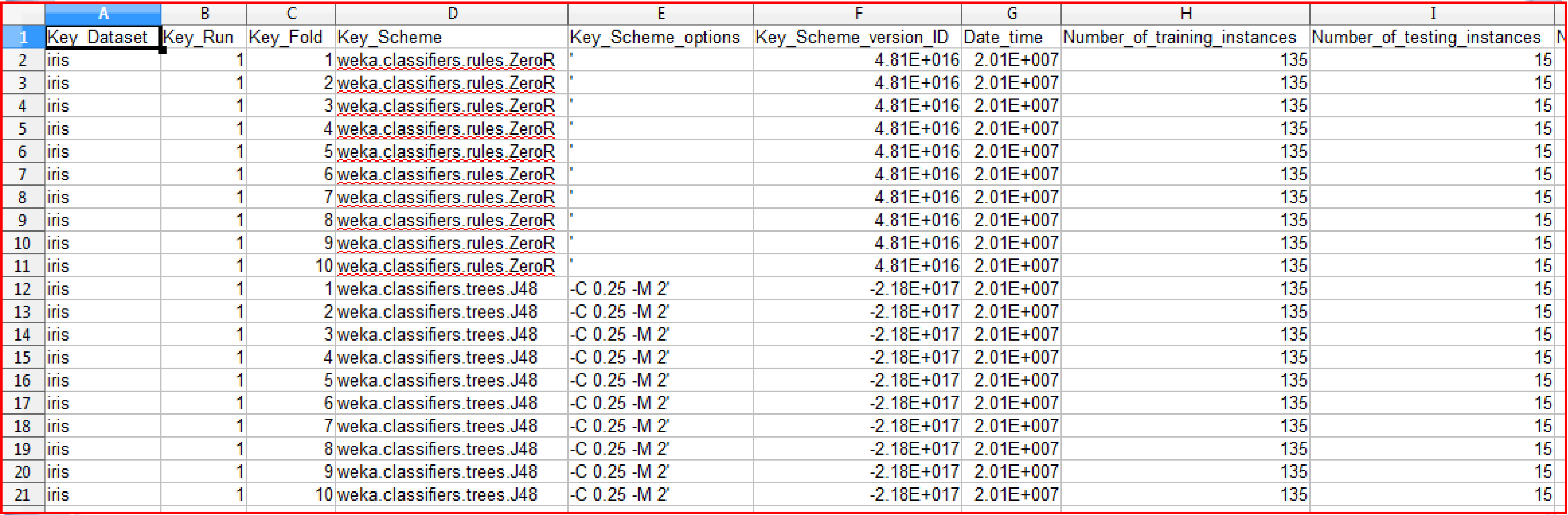
Classifiers

Run Simple Experiment



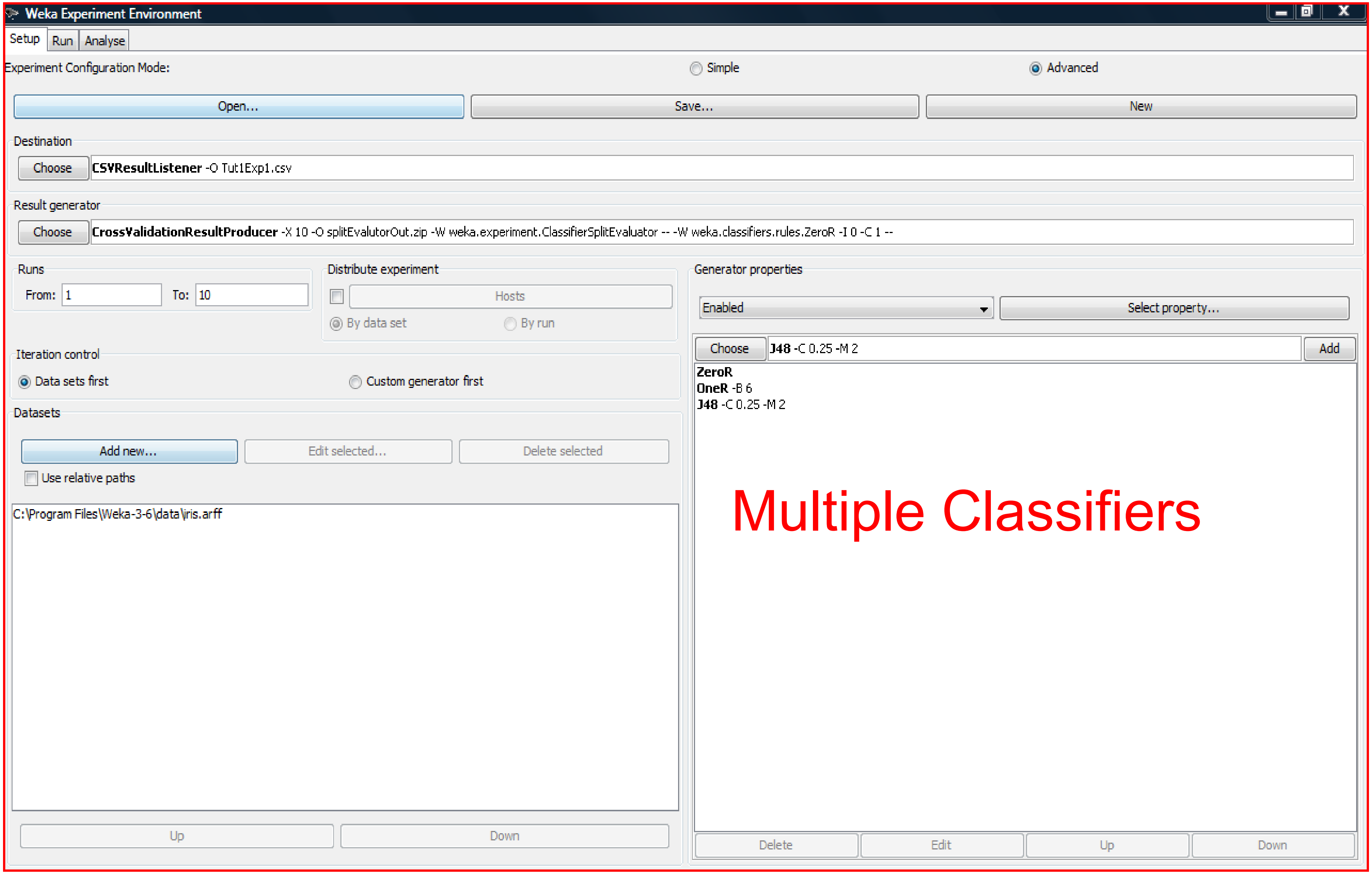
Not running

Results



	A	B	C	D	E	F	G	H	I	
1	Key_Dataset	Key_Run	Key_Fold	Key_Scheme	Key_Scheme_options	Key_Scheme_version_ID	Date_time	Number_of_training_instances	Number_of_testing_instances	N
2	iris	1	1	weka.classifiers.rules.ZeroR	'	4.81E+016	2.01E+007	135	15	
3	iris	1	2	weka.classifiers.rules.ZeroR	'	4.81E+016	2.01E+007	135	15	
4	iris	1	3	weka.classifiers.rules.ZeroR	'	4.81E+016	2.01E+007	135	15	
5	iris	1	4	weka.classifiers.rules.ZeroR	'	4.81E+016	2.01E+007	135	15	
6	iris	1	5	weka.classifiers.rules.ZeroR	'	4.81E+016	2.01E+007	135	15	
7	iris	1	6	weka.classifiers.rules.ZeroR	'	4.81E+016	2.01E+007	135	15	
8	iris	1	7	weka.classifiers.rules.ZeroR	'	4.81E+016	2.01E+007	135	15	
9	iris	1	8	weka.classifiers.rules.ZeroR	'	4.81E+016	2.01E+007	135	15	
10	iris	1	9	weka.classifiers.rules.ZeroR	'	4.81E+016	2.01E+007	135	15	
11	iris	1	10	weka.classifiers.rules.ZeroR	'	4.81E+016	2.01E+007	135	15	
12	iris	1	1	weka.classifiers.trees.J48	-C 0.25 -M 2'	-2.18E+017	2.01E+007	135	15	
13	iris	1	2	weka.classifiers.trees.J48	-C 0.25 -M 2'	-2.18E+017	2.01E+007	135	15	
14	iris	1	3	weka.classifiers.trees.J48	-C 0.25 -M 2'	-2.18E+017	2.01E+007	135	15	
15	iris	1	4	weka.classifiers.trees.J48	-C 0.25 -M 2'	-2.18E+017	2.01E+007	135	15	
16	iris	1	5	weka.classifiers.trees.J48	-C 0.25 -M 2'	-2.18E+017	2.01E+007	135	15	
17	iris	1	6	weka.classifiers.trees.J48	-C 0.25 -M 2'	-2.18E+017	2.01E+007	135	15	
18	iris	1	7	weka.classifiers.trees.J48	-C 0.25 -M 2'	-2.18E+017	2.01E+007	135	15	
19	iris	1	8	weka.classifiers.trees.J48	-C 0.25 -M 2'	-2.18E+017	2.01E+007	135	15	
20	iris	1	9	weka.classifiers.trees.J48	-C 0.25 -M 2'	-2.18E+017	2.01E+007	135	15	
21	iris	1	10	weka.classifiers.trees.J48	-C 0.25 -M 2'	-2.18E+017	2.01E+007	135	15	

Advanced Example



Experiment Configuration Mode: ○ Simple ● Advanced

Destination: CSVResultListener -O Tut1Exp1.csv

Result generator: CrossValidationResultProducer -X 10 -O splitEvalutorOut.zip -W weka.experiment.ClassifierSplitEvaluator -- -W weka.classifiers.rules.ZeroR -I 0 -C 1 --

Runs: From: 1 To: 10

Distribute experiment: □ Hosts ● By data set ○ By run

Iteration control: ● Data sets first ○ Custom generator first

Datasets: □ Use relative paths

C:\Program Files\Weka-3-6\data\iris.arff

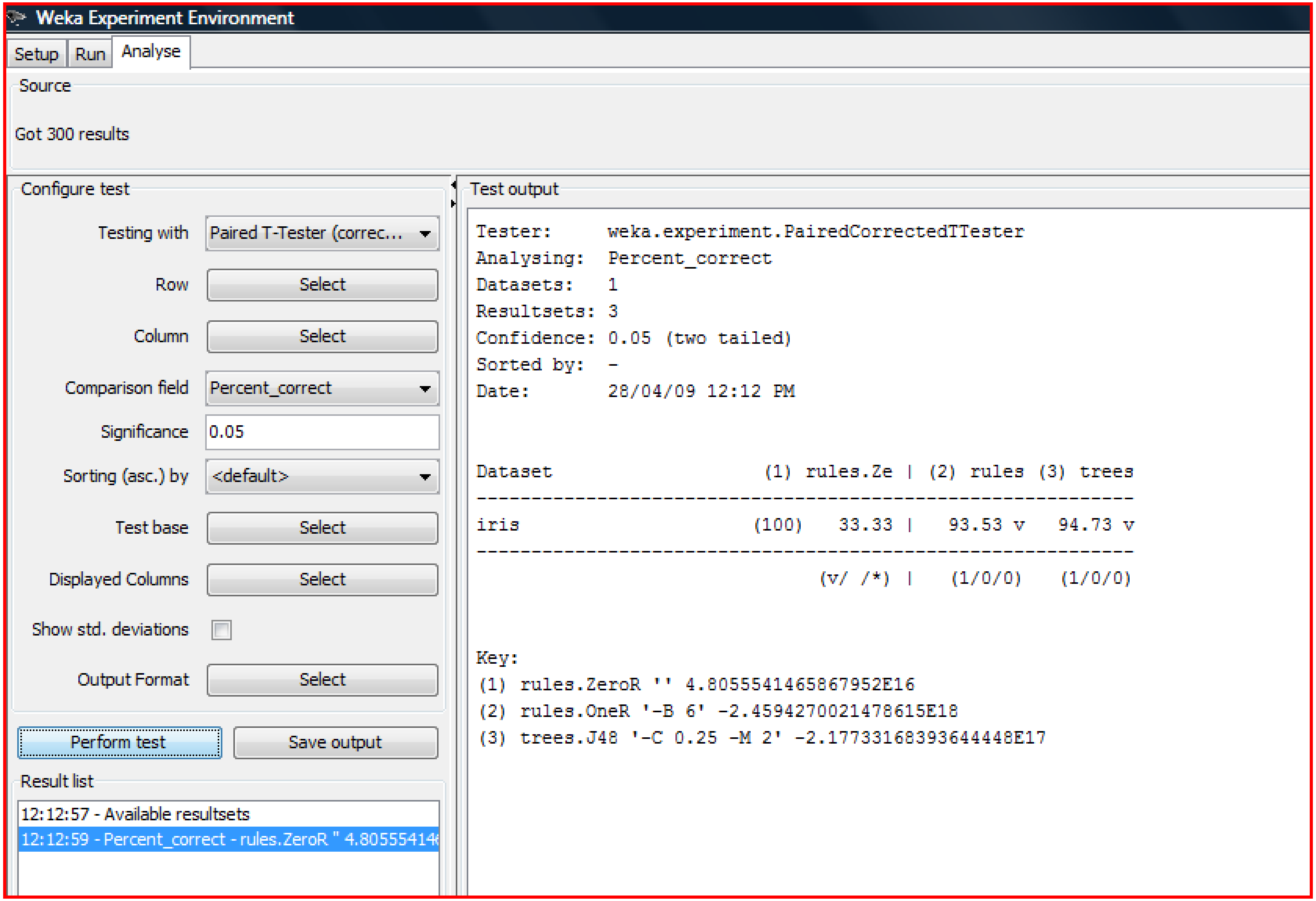
Generator properties: Enabled

J48 -C 0.25 -M 2

ZeroR
OneR -B 6
J48 -C 0.25 -M 2

Multiple Classifiers

Advanced Example



Got 300 results

Testing with: Paired T-Tester (correc...

Comparison field: Percent_correct

Significance: 0.05

Sorting (asc.) by: <default>

Show std. deviations: □

12:12:57 - Available resultsets

12:12:59 - Percent_correct - rules.ZeroR '' 4.80555414

```
Tester:     weka.experiment.PairedCorrectedTTester
Analysing:  Percent_correct
Datasets:   1
Resultsets: 3
Confidence: 0.05 (two tailed)
Sorted by:  -
Date:       28/04/09 12:12 PM


Dataset                    (1) rules.Ze | (2) rules (3) trees
------------------------------------------------------------
iris                      (100)   33.33 |   93.53 v   94.73 v
------------------------------------------------------------
                                (v/ /*) |   (1/0/0)   (1/0/0)


Key:
(1) rules.ZeroR '' 4.805554146586795 2E16
(2) rules.OneR '-B 6' -2.459427002147861 5E18
(3) trees.J48 '-C 0.25 -M 2' -2.17733168393644448E17
```