Weka Explorer

Preprocess | Classify | Cluster | Associate | Select attributes | Visualize

Classifier

Choose | Id3

Test options

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

More options...

(Nom) contact-lenses

Start | Stop

Result list (right-click for options)

21:59:44 - trees.Id3

Classifier output

```
|   |   age = young: soft
|   |   age = pre-presbyopic: soft
|   |   age = presbyopic
|   |   |   spectacle-prescrip = myope: none
|   |   |   spectacle-prescrip = hypermetrope: soft
|   astigmatism = yes
|   |   spectacle-prescrip = myope: hard
|   |   spectacle-prescrip = hypermetrope
|   |   |   age = young: hard
|   |   |   age = pre-presbyopic: none
|   |   |   age = presbyopic: none

Time taken to build model: 0 seconds

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

Correctly Classified Instances          17               70.8333 %
Incorrectly Classified Instances         7               29.1667 %
Kappa statistic                          0.4381
K&B Relative Info Score               1190.5129 %
K&B Information Score                   16.3213 bits      0.6801 bits/instance
Class complexity | order 0              33.5282 bits      1.397  bits/instance
Class complexity | scheme             7518      bits    313.25   bits/instance
Complexity improvement     (Sf)      -7484.4718 bits   -311.853  bits/instance
Mean absolute error                      0.1944
Root mean squared error                  0.441
Relative absolute error                 51.4706 %
Root relative squared error            100.965  %
Total Number of Instances               24

=== Detailed Accuracy By Class ===

                 TP Rate   FP Rate   Precision   Recall  F-Measure   ROC Area  Class
                   0.8       0.053       0.8       0.8       0.8       0.874    soft
                   0.25      0.1         0.333     0.25      0.286     0.575    hard
                   0.8       0.444       0.75      0.8       0.774     0.678    none
Weighted Avg.      0.708     0.305       0.691     0.708     0.696     0.701

=== Confusion Matrix ===

  a  b  c   <-- classified as
  4  0  1 |  a = soft
  0  1  3 |  b = hard
  1  2 12 |  c = none
```

Weka Explorer

Preprocess | Classify | Cluster | Associate | Select attributes | Visualize

Classifier

Choose 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) contact-lenses

Start | Stop

Result list (right-click for options)

21:59:44 - trees.Id3

22:09:12 - trees.J48

Classifier output

```
tear-prod-rate = reduced: none (12.0)
tear-prod-rate = normal
|   astigmatism = no: soft (6.0/1.0)
|   astigmatism = yes
|   |   spectacle-prescrip = myope: hard (3.0)
|   |   spectacle-prescrip = hypermetrope: none (3.0/1.0)

Number of Leaves  :     4

Size of the tree :      7


Time taken to build model: 0 seconds

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

Correctly Classified Instances          20               83.3333 %
Incorrectly Classified Instances         4               16.6667 %
Kappa statistic                          0.71
K&B Relative Info Score               1617.6872 %
K&B Information Score                   22.1777 bits      0.9241 bits/instance
Class complexity | order 0              33.5282 bits      1.397  bits/instance
Class complexity | scheme             2155.7274 bits     89.822  bits/instance
Complexity improvement     (Sf)      -2122.1992 bits    -88.425  bits/instance
Mean absolute error                      0.15
Root mean squared error                  0.3249
Relative absolute error                 39.7059 %
Root relative squared error             74.3898 %
Total Number of Instances               24

=== Detailed Accuracy By Class ===

               TP Rate   FP Rate   Precision   Recall  F-Measure   ROC Area  Class
                 1         0.053      0.833      1         0.909      0.947    soft
                 0.75      0.1        0.6        0.75      0.667      0.813    hard
                 0.8       0.111      0.923      0.8       0.857      0.811    none
Weighted Avg.    0.833     0.097      0.851      0.833     0.836      0.84

=== Confusion Matrix ===

  a  b  c   <-- classified as
  5  0  0 |  a = soft
  0  3  1 |  b = hard
  1  2 12 |  c = none
```

Weka Explorer

Preprocess | Classify | Cluster | Associate | Select attributes | Visualize

Classifier

Choose JRip -F 3 -N 2.0 -O 2 -S 1

Test options

- (•) Use training set
- ( ) Supplied test set — Set...
- ( ) Cross-validation — Folds 10
- ( ) Percentage split — % 66

More options...

(Nom) class

Start | Stop

Result list (right-click for options)

- 16:13:43 - trees.Id3
- 16:17:21 - trees.Id3
- 16:27:04 - trees.J48
- 16:41:03 - rules.JRip
- 16:43:38 - rules.JRip
- 16:44:55 - rules.JRip
- 16:45:38 - rules.JRip

Classifier output

```
               petallength
               petalwidth
               class
Test mode:evaluate on training data

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

JRIP rules:
===========

(petallength <= 1.9) => class=Iris-setosa (50.0/0.0)
(petalwidth <= 1.6) and (petallength <= 4.9) => class=Iris-versicolor (47.0/0.0)
 => class=Iris-virginica (53.0/3.0)

Number of Rules : 3


Time taken to build model: 0.02 seconds

=== Evaluation on training set ===
=== Summary ===

Correctly Classified Instances         147               98      %
Incorrectly Classified Instances         3                2      %
Kappa statistic                          0.97
Mean absolute error                      0.0252
Root mean squared error                  0.1122
Relative absolute error                  5.6604 %
Root relative squared error             23.7915 %
Total Number of Instances              150

=== Detailed Accuracy By Class ===

                 TP Rate   FP Rate   Precision   Recall  F-Measure   ROC Area  Class
                   1          0          1         1          1          1        Iris-setosa
                   0.94       0          1         0.94       0.969      0.985    Iris-versicolor
                   1          0.03       0.943     1          0.971      0.985    Iris-virginica
Weighted Avg.      0.98       0.01       0.981     0.98       0.98       0.99

=== Confusion Matrix ===

  a  b  c   <-- classified as
 50  0  0 |  a = Iris-setosa
  0 47  3 |  b = Iris-versicolor
  0  0 50 |  c = Iris-virginica
```

Weka Explorer

Preprocess | Classify | Cluster | Associate | Select attributes | Visualize

Classifier

Choose JRip -F 3 -N 2.0 -O 2 -S 1

Test options

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

More options...

(Nom) class

Start | Stop

Result list (right-click for options)

16:13:43 - trees.Id3
16:17:21 - trees.Id3
16:27:04 - trees.J48
16:41:03 - rules.JRip
16:43:38 - rules.JRip
16:44:55 - rules.JRip
16:45:38 - rules.JRip
17:34:44 - rules.JRip

Classifier output

```
               petallength
               petalwidth
               class
Test mode:10-fold cross-validation

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

JRIP rules:
===========

(petallength <= 1.9) => class=Iris-setosa (50.0/0.0)
(petalwidth <= 1.6) and (petallength <= 4.9) => class=Iris-versicolor (47.0/0.0)
 => class=Iris-virginica (53.0/3.0)

Number of Rules : 3


Time taken to build model: 0.01 seconds

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

Correctly Classified Instances         142               94.6667 %
Incorrectly Classified Instances         8                5.3333 %
Kappa statistic                          0.92
Mean absolute error                      0.0501
Root mean squared error                  0.1872
Relative absolute error                 11.2821 %
Root relative squared error             39.7033 %
Total Number of Instances              150

=== Detailed Accuracy By Class ===

                 TP Rate   FP Rate   Precision   Recall  F-Measure   ROC Area  Class
                   1         0          1         1         1          1        Iris-setosa
                   0.9       0.03       0.938     0.9       0.918      0.946    Iris-versicolor
                   0.94      0.05       0.904     0.94      0.922      0.951    Iris-virginica
Weighted Avg.      0.947     0.027      0.947     0.947     0.947      0.966

=== Confusion Matrix ===

  a  b  c   <-- classified as
 50  0  0 |  a = Iris-setosa
  0 45  5 |  b = Iris-versicolor
  0  3 47 |  c = Iris-virginica
```

Weka Explorer

Preprocess | Classify | Cluster | Associate | Select attributes | Visualize

Classifier

Choose JRip -F 3 -N 2.0 -O 2 -S 1

Test options

- Use training set
- Supplied test set — Set...
- Cross-validation — Folds 20
- Percentage split — % 66

More options...

(Nom) class

Start | Stop

Result list (right-click for options)

16:13:43 - trees.Id3
16:17:21 - trees.Id3
16:27:04 - trees.J48
16:41:03 - rules.JRip
16:43:38 - rules.JRip
16:44:55 - rules.JRip
16:45:38 - rules.JRip
17:34:44 - rules.JRip
17:37:07 - rules.JRip

Classifier output

```
               petallength
               petalwidth
               class
Test mode:20-fold cross-validation

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

JRIP rules:
===========

(petallength <= 1.9) => class=Iris-setosa (50.0/0.0)
(petalwidth <= 1.6) and (petallength <= 4.9) => class=Iris-versicolor (47.0/0.0)
 => class=Iris-virginica (53.0/3.0)

Number of Rules : 3


Time taken to build model: 0.03 seconds

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

Correctly Classified Instances         146               97.3333 %
Incorrectly Classified Instances         4                2.6667 %
Kappa statistic                          0.96
Mean absolute error                      0.0335
Root mean squared error                  0.1335
Relative absolute error                  7.5414 %
Root relative squared error             28.2873 %
Total Number of Instances              150

=== Detailed Accuracy By Class ===

                 TP Rate   FP Rate   Precision   Recall  F-Measure   ROC Area  Class
                   1         0          1         1         1          1        Iris-setosa
                   0.94      0.01       0.979     0.94      0.959      0.974    Iris-versicolor
                   0.98      0.03       0.942     0.98      0.961      0.975    Iris-virginica
Weighted Avg.      0.973     0.013      0.974     0.973     0.973      0.983

=== Confusion Matrix ===

  a  b  c   <-- classified as
 50  0  0 |  a = Iris-setosa
  0 47  3 |  b = Iris-versicolor
  0  1 49 |  c = Iris-virginica
```

Weka Explorer

Preprocess | Classify | Cluster | Associate | Select attributes | Visualize

Classifier

Choose NaiveBayes

Test options

- Use training set
- Supplied test set — Set...
- Cross-validation — Folds 20
- Percentage split — % 66

More options...

(Nom) class

Start | Stop

Result list (right-click for options)

16:13:43 - trees.Id3
16:17:21 - trees.Id3
16:27:04 - trees.J48
16:41:03 - rules.JRip
16:43:38 - rules.JRip
16:44:55 - rules.JRip
16:45:38 - rules.JRip
17:34:44 - rules.JRip
17:37:07 - rules.JRip
17:44:49 - bayes.NaiveBayes
18:28:08 - lazy.IBk
18:31:28 - bayes.NaiveBayes

Classifier output

```
Attribute          Iris-setosa Iris-versicolor  Iris-virginica
                        (0.33)          (0.33)          (0.33)
============================================================
petallength
  mean                  1.4694          4.2452          5.5516
  std. dev.             0.1782          0.4712          0.5529
  weight sum                50              50              50
  precision             0.1405          0.1405          0.1405

petalwidth
  mean                  0.2743          1.3097          2.0343
  std. dev.             0.1096          0.1915          0.2646
  weight sum                50              50              50
  precision             0.1143          0.1143          0.1143



Time taken to build model: 0 seconds

=== Evaluation on training set ===
=== Summary ===

Correctly Classified Instances         144               96      %
Incorrectly Classified Instances         6                4      %
Kappa statistic                          0.94
Mean absolute error                      0.0265
Root mean squared error                  0.1294
Relative absolute error                  5.9721 %
Root relative squared error             27.443  %
Total Number of Instances              150

=== Detailed Accuracy By Class ===

               TP Rate   FP Rate   Precision   Recall  F-Measure   ROC Area  Class
                 1         0          1         1         1          1        Iris-setosa
                 0.94      0.03       0.94      0.94      0.94       0.998    Iris-versicolor
                 0.94      0.03       0.94      0.94      0.94       0.998    Iris-virginica
Weighted Avg.    0.96      0.02       0.96      0.96      0.96       0.998

=== Confusion Matrix ===

  a  b  c   <-- classified as
 50  0  0 |  a = Iris-setosa
  0 47  3 |  b = Iris-versicolor
  0  3 47 |  c = Iris-virginica
```

Weka Explorer

Preprocess | Classify | Cluster | Associate | Select attributes | Visualize

Classifier

Choose IBk -K 1 -W 0 -A "weka.core.neighboursearch.LinearNNSearch -A \"weka.core.EuclideanDistance -R first-last\""

Test options

- (•) Use training set
- ( ) Supplied test set — Set...
- ( ) Cross-validation — Folds 20
- ( ) Percentage split — % 66

More options...

(Nom) class

Start | Stop

Result list (right-click for options)

16:13:43 - trees.Id3
16:17:21 - trees.Id3
16:27:04 - trees.J48
16:41:03 - rules.JRip
16:43:38 - rules.JRip
16:44:55 - rules.JRip
16:45:38 - rules.JRip
17:34:44 - rules.JRip
17:37:07 - rules.JRip
17:44:49 - bayes.NaiveBayes
18:28:08 - lazy.IBk

Classifier output

```
=== Run information ===

Scheme:weka.classifiers.lazy.IBk -K 1 -W 0 -A "weka.core.neighboursearch.LinearNNSearch -A \"weka.core.EuclideanDistance -R first-last\""
Relation:     iris-weka.filters.unsupervised.attribute.Remove-R1-2
Instances:    150
Attributes:   3
              petallength
              petalwidth
              class
Test mode:evaluate on training data

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

IB1 instance-based classifier
using 1 nearest neighbour(s) for classification


Time taken to build model: 0 seconds

=== Evaluation on training set ===
=== Summary ===

Correctly Classified Instances         149               99.3333 %
Incorrectly Classified Instances         1                0.6667 %
Kappa statistic                          0.99
Mean absolute error                      0.0118
Root mean squared error                  0.0549
Relative absolute error                  2.6616 %
Root relative squared error             11.6437 %
Total Number of Instances              150

=== Detailed Accuracy By Class ===

               TP Rate   FP Rate   Precision   Recall  F-Measure   ROC Area  Class
                 1         0          1         1         1          1        Iris-setosa
                 0.98      0          1         0.98      0.99       1        Iris-versicolor
                 1         0.01       0.98      1         0.99       1        Iris-virginica
Weighted Avg.    0.993     0.003      0.993     0.993     0.993      1

=== Confusion Matrix ===

  a  b  c   <-- classified as
 50  0  0 |  a = Iris-setosa
  0 49  1 |  b = Iris-versicolor
  0  0 50 |  c = Iris-virginica
```

Weka Explorer

Preprocess | Classify | Cluster | Associate | Select attributes | Visualize

Classifier

Choose NaiveBayes

Test options

- Use training set
- Supplied test set — Set...
- Cross-validation — Folds 20
- Percentage split — % 66

More options...

(Nom) class

Start | Stop

Result list (right-click for options)

18:31:28 - bayes.NaiveBayes

Classifier output

```
tear-prod-rate = reduced: none
tear-prod-rate = normal
|  astigmatism = no
|  |  age = young: soft
|  |  age = pre-presbyopic: soft
|  |  age = presbyopic
|  |  |  spectacle-prescrip = myope: none
|  |  |  spectacle-prescrip = hypermetrope: soft
|  astigmatism = yes
|  |  spectacle-prescrip = myope: hard
|  |  spectacle-prescrip = hypermetrope
|  |  |  age = young: hard
|  |  |  age = pre-presbyopic: none
|  |  |  age = presbyopic: none

nds
=

        24               100      %
         0                 0      %
         1
         0
         0
         0      %
         0      %
        24

=

  Precision   Recall  F-Measure   ROC Area  Class
     1          1          1          1        soft
     1          1          1          1        hard
                                      1        none
                                      1

  5   0   0 |   a = soft
  0   4   0 |   b = hard
  0   0  15 |   c = none
```

- View in main window
- View in separate window
- Save result buffer
- Delete result buffer
- Load model
- Save model
- Re-evaluate model on current test set
- Visualize classifier errors
- Visualize tree
- Visualize margin curve
- Visualize threshold curve
- Cost/Benefit analysis
- Visualize cost curve

- Iris-setosa
- Iris-versicolor
- Iris-virginica

Weka Explorer

Preprocess | Classify | Cluster | Associate | Select attributes | Visualize

Classifier

Choose NaiveBayes

Test options

- Use training set
- Supplied test set — Set...
- Cross-validation — Folds 20
- Percentage split — % 66

More options...

(Nom) class

Start | Stop

Result list (right-click for options)

18:31:28 - bayes.NaiveBayes

Classifier output

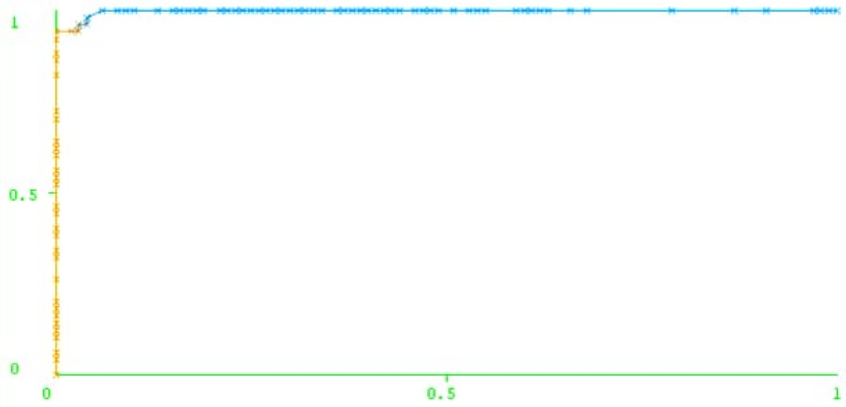
Weka Classifier Visualize: ThresholdCurve. (Class value Iris-versicolor)

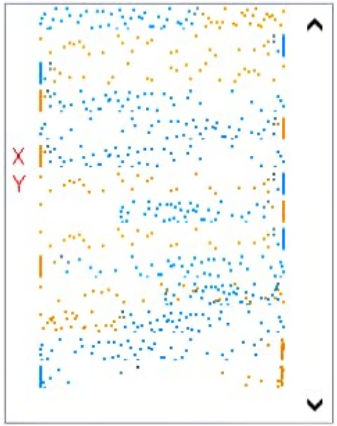
X: False Positive Rate (Num) | Y: True Positive Rate (Num)

Colour: Threshold (Num) | Select Instance

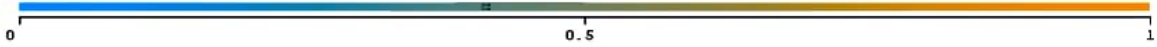
Reset | Clear | Open | Save | Jitter

Plot (Area under ROC = 0.9976)





Class colour



Weka Explorer

Preprocess | Classify | Cluster | Associate | Select attributes | Visualize

Classifier

Choose Id3

Test options

- Use training set
- Supplied test set — Set...
- Cross-validation — Folds
- Percentage split — % 66

More options...

(Nom) contact-lenses

Start | Stop

Result list (right-click for options)

19:20:23 - bayes.NaiveBayes
19:20:49 - lazy.IBk
19:21:17 - trees.Id3

Classifier output

```
tear-prod-rate = reduced: none
tear-prod-rate = normal
|  astigmatism = no
|  |  age = young: soft
|  |  age = pre-presbyopic: soft
|  |  age = presbyopic
|  |  |  spectacle-prescrip = myope: none
|  |  |  spectacle-prescrip = hypermetrope: soft
|  astigmatism = yes
|  |  spectacle-prescrip = myope: hard
|  |  spectacle-prescrip = hypermetrope
|  |  |  age = young: hard
|  |  |  age = pre-presbyopic: none
|  |  |  age = presbyopic: none

Time taken to build model: 0 seconds

=== Evaluation on training set ===
=== Summary ===

Correctly Classified Instances          24               100      %
Incorrectly Classified Instances         0                 0      %
Kappa statistic                          1
Mean absolute error                      0
Root mean squared error                  0
Relative absolute error                  0      %
Root relative squared error              0      %
Total Number of Instances               24

=== Detailed Accuracy By Class ===

               TP Rate   FP Rate   Precision   Recall  F-Measure   ROC Area  Class
                 1         0          1         1         1          1        soft
                 1         0          1         1         1          1        hard
                 1         0          1         1         1          1        none
Weighted Avg.    1         0          1         1         1          1

=== Confusion Matrix ===

  a  b  c   <-- classified as
  5  0  0 |  a = soft
  0  4  0 |  b = hard
  0  0 15 |  c = none
```

Weka Explorer

Preprocess | Classify | Cluster | Associate | Select attributes | Visualize

Classifier

Choose J48 -C 0.25 -M 2

Test options

- Use training set
- Supplied test set — Set...
- Cross-validation — Folds
- Percentage split — % 66

More options...

(Nom) contact-lenses

Start | Stop

Result list (right-click for options)

19:20:23 - bayes.NaiveBayes
19:20:49 - lazy.IBk
19:21:17 - trees.Id3
19:21:29 - trees.J48

Classifier output

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

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

tear-prod-rate = reduced: none (12.0)
tear-prod-rate = normal
|   astigmatism = no: soft (6.0/1.0)
|   astigmatism = yes
|   |   spectacle-prescrip = myope: hard (3.0)
|   |   spectacle-prescrip = hypermetrope: none (3.0/1.0)

Number of Leaves  :     4

Size of the tree :      7


Time taken to build model: 0 seconds

=== Evaluation on training set ===
=== Summary ===

Correctly Classified Instances          22               91.6667 %
Incorrectly Classified Instances         2                8.3333 %
Kappa statistic                          0.8447
Mean absolute error                      0.0833
Root mean squared error                  0.2041
Relative absolute error                 22.6257 %
Root relative squared error             48.1223 %
Total Number of Instances               24

=== Detailed Accuracy By Class ===

               TP Rate   FP Rate   Precision   Recall  F-Measure   ROC Area  Class
                 1         0.053      0.833      1         0.909      0.974    soft
                 0.75      0          1          0.75      0.857      0.988    hard
                 0.933     0.111      0.933      0.933     0.933      0.967    none
Weighted Avg.    0.917     0.08       0.924      0.917     0.916      0.972

=== Confusion Matrix ===

  a  b  c   <-- classified as
  5  0  0 |  a = soft
  0  3  1 |  b = hard
  1  0 14 |  c = none
```

Weka Explorer

Preprocess | Classify | Cluster | Associate | Select attributes | Visualize

Classifier

Choose NaiveBayes

Test options

- (•) Use training set
- ( ) Supplied test set — Set...
- ( ) Cross-validation — Folds
- ( ) Percentage split — % 66

More options...

(Nom) contact-lenses

Start | Stop

Result list (right-click for options)

19:20:23 - bayes.NaiveBayes

Classifier output

```
spectacle-prescrip
  myope                3.0     4.0     8.0
  hypermetrope         4.0     2.0     9.0
  [total]              7.0     6.0    17.0

astigmatism
  no                   6.0     1.0     8.0
  yes                  1.0     5.0     9.0
  [total]              7.0     6.0    17.0

tear-prod-rate
  reduced              1.0     1.0    13.0
  normal               6.0     5.0     4.0
  [total]              7.0     6.0    17.0



Time taken to build model: 0.09 seconds

=== Evaluation on training set ===
=== Summary ===

Correctly Classified Instances          23               95.8333 %
Incorrectly Classified Instances         1                4.1667 %
Kappa statistic                          0.925
Mean absolute error                      0.1809
Root mean squared error                  0.2357
Relative absolute error                 49.1098 %
Root relative squared error             55.5663 %
Total Number of Instances               24

=== Detailed Accuracy By Class ===

               TP Rate   FP Rate   Precision   Recall  F-Measure   ROC Area  Class
                 1         0.053      0.833      1         0.909      1        soft
                 1         0          1          1         1          1        hard
                 0.933     0          1          0.933     0.966      1        none
Weighted Avg.    0.958     0.011      0.965      0.958     0.96       1

=== Confusion Matrix ===

  a  b  c   <-- classified as
  5  0  0 |  a = soft
  0  4  0 |  b = hard
  1  0 14 |  c = none
```

Weka Explorer

Preprocess | Classify | Cluster | Associate | Select attributes | Visualize

Classifier

Choose: IBk -K 1 -W 0 -A "weka.core.neighboursearch.LinearNNSearch -A \"weka.core.EuclideanDistance -R first-last\""

Test options

- (•) Use training set
- ( ) Supplied test set — Set...
- ( ) Cross-validation — Folds
- ( ) Percentage split — % 66

More options...

(Nom) contact-lenses

Start | Stop

Result list (right-click for options)

19:20:23 - bayes.NaiveBayes
19:20:49 - lazy.IBk

Classifier output

```
Scheme:weka.classifiers.lazy.IBk -K 1 -W 0 -A "weka.core.neighboursearch.LinearNNSearch -A \"weka.core.EuclideanDistance -R first-last\""
Relation:     contact-lenses
Instances:    24
Attributes:   5
              age
              spectacle-prescrip
              astigmatism
              tear-prod-rate
              contact-lenses
Test mode:evaluate on training data

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

IB1 instance-based classifier
using 1 nearest neighbour(s) for classification


Time taken to build model: 0 seconds

=== Evaluation on training set ===
=== Summary ===

Correctly Classified Instances          24               100      %
Incorrectly Classified Instances         0                 0      %
Kappa statistic                          1
Mean absolute error                      0.0494
Root mean squared error                  0.0524
Relative absolute error                 13.4078 %
Root relative squared error             12.3482 %
Total Number of Instances               24

=== Detailed Accuracy By Class ===

               TP Rate   FP Rate   Precision   Recall  F-Measure   ROC Area  Class
                 1         0          1         1         1          1        soft
                 1         0          1         1         1          1        hard
                 1         0          1         1         1          1        none
Weighted Avg.    1         0          1         1         1          1

=== Confusion Matrix ===

  a  b  c   <-- classified as
  5  0  0 |  a = soft
  0  4  0 |  b = hard
  0  0 15 |  c = none
```