Classificazione

Introduzione

- I modelli di classificazione si collocano tra i metodi di apprendimento supervisionato e si rivolgono alla predizione di un attributo target categorico.
- A partire da un insieme di osservazioni riferite al passato, per le quali è nota la classe di appartenenza, si genera un modello che consente di effettuare predizioni.
- Vedremo alcuni esempi, i principali indicatori di valutazione e alcuni metodi.

Problemi di classificazione

- Si dispone di un dataset D contenete m osservazioni (*sample*), costituite da n attributi esplicativi e da un attributo target categorico (*label*).
  - Gli attributi esplicativi possono essere di qualsiasi tipo.
  - L'attributo target viene indicato anche come classe.
- Si vogliono individuare legami ricorrenti tra le variabili esplicative di osservazioni appartenenti alla stessa classe.
- I legami vengono tradotti in un modello che viene utilizzato per predire la classe di osservazioni di cui non è nota la label.

Credit card promotion database

Income Range	Life Insurance Promotion	Credit Card Insurance	Sex	Age
40–50K	No	No	Male	45
30–40K	Yes	No	Female	40
40–50K	No	No	Male	42
30–40K	Yes	Yes	Male	43
50–60K	Yes	No	Female	38
20–30K	No	No	Female	55
30–40K	Yes	Yes	Male	35
20–30K	No	No	Male	27
30–40K	No	No	Male	43
30–40K	Yes	No	Female	41
40–50K	Yes	No	Female	43
20–30K	Yes	No	Male	29
50–60K	Yes	No	Female	39
40–50K	No	No	Male	55
20–30K	Yes	Yes	Female	19

- Una società di gestione di carte di credito inserisce offerte promozionali per polizze vita nell'estratto conto mensile.
- Vuole costruire un modello di previsione per Life Insurance Promotion.
- Lo scopo è proporre l'offerta solo ai clienti che verosimilmente accetteranno.

Sviluppo di un modello

- **Training**. L'algoritmo di classificazione viene applicato agli esempi appartenenti ad un sottoinsieme T ½ D per ricavare il modello.
- **Test**. Il modello viene impiegato per classificare le osservazioni V=D – T. La classe di appartenenza viene confrontata con quella predetta.
  - Per evitare sovrastime, T e V devono essere disgiunti.
- **Predizione**. Il modello viene utilizzato per predire la classe di nuove osservazioni per cui non è nota l'appartenenza.

Tassonomia dei modelli

- **Modelli euristici**. Procedure basate su schemi semplici e intuitivi.
  - Nearest neighbor, alberi di classificazione,…
- **Modelli di separazione**. Si ricavano regioni disgiunte dello spazio che permettono di separare le osservazioni appartenenti a classi diverse.
  - Analisi discriminante, reti neurali, support vector machine
- **Modelli di regressione**. Si ipotizza una forma funzionale per la probabilità che una osservazione venga assegnata dal supervisore ad una classe target.
  - Regressione logistica.
- **Modelli probabilistici**. Si ipotizza una forma funzionale per la probabilità condizionate delle osservazioni data la classe di appartenenza.
  - Reti bayesiane.

Valutazione dei modelli

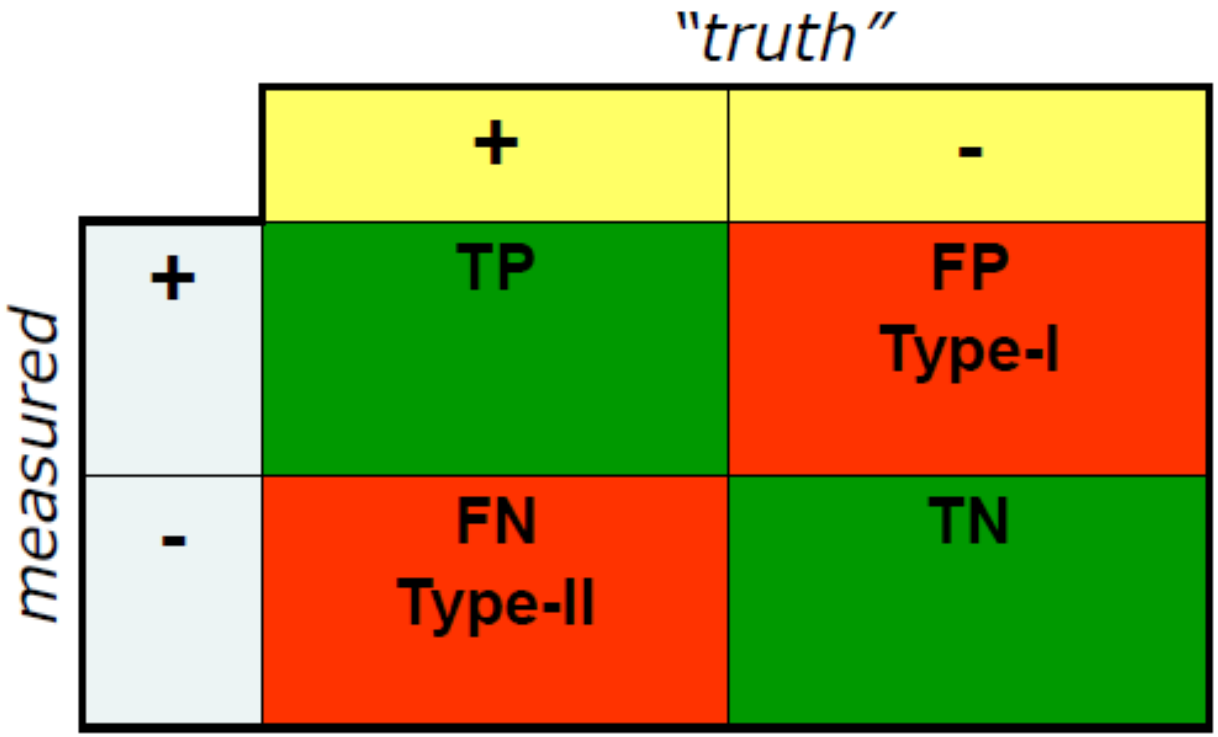
- *Accuratezza di f su* (x_i, y_i):

$$L(y_i, f(\mathbf{x_i})) = \begin{cases} 0 & se \quad y_i = f(\mathbf{x}_i) \\ 1 & se \quad y_i \neq f(\mathbf{x}_i) \end{cases},$$

$$acc_A(V) = 1 - \frac{1}{v} \sum_{i=1}^{v} L(y_i, f(\mathbf{x}_i)),$$

- *Velocità*
- *Robustezza*
- *Scalabilità*
- *Interpretabilità*

Altre misure di accuratezza



Precision / PPV :
TP / (TP+FP)

FDR:
FP / (TP+FP)

FNR:
FN / (TP+FN)

Sensitivity:
TP / (TP+FN)

FPR:
FP / (TN+FP)

Specificity:
TN / (TN+FP)

Accuracy:

(TP+TN) / (TP+FP+TN+FN)

Cross validadation

- Per valutare l'accuratezza di un metodo si suddivide l'insieme di train in k sottoinsiemi disgiunti (*fold*) $A_1, \ldots, A_k$ e prevede k iterazioni.
- In corrispondenza della r-esima iterazione si sceglie come insieme di test A_r e come train l'unione dei rimanenti A_i, $i \neq r$.
- L'accuratezza complessiva è valutata come media delle singole accuratezze.
- Per $r = m$, si ottiene il *leave one out*.

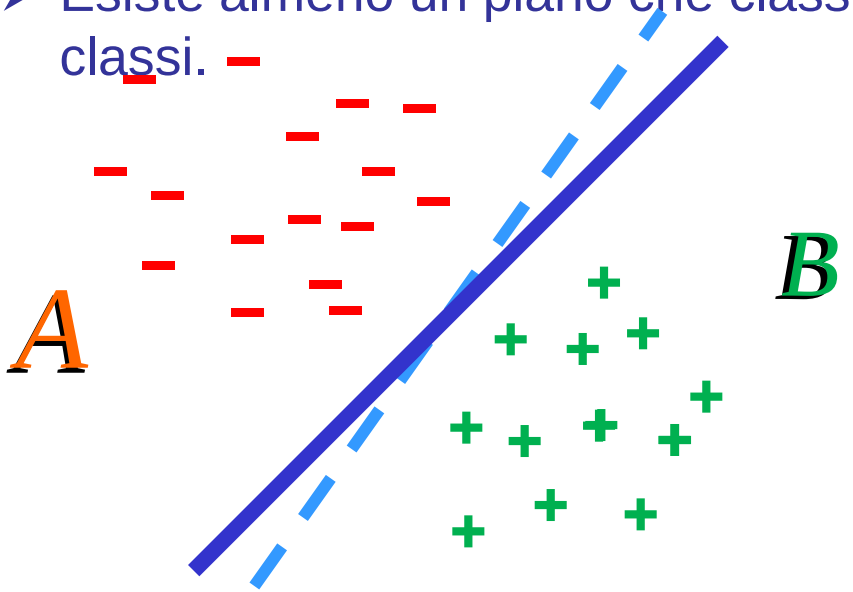
Matrice di confusione

- L'elemento sulla riga i e sulla colonna j è il numero di casi della classe "vera" i che il classificatore ha classificato nella classe j.
- Sulla diagonale ci sono i casi classificati correttamente.
  - Gli altri sono errori.

				Classe calcolata						
				A	**B**	**C**		**Totale**		
Classe vera		**A**		60	14	13		**87**		**69.0%**
		B		15	34	11		**60**		**56.7%**
		C		11	0	42		**53**		**79.2%**
		Totale		**86**	**48**	**66**		**200**		**68.0%**

Piani discriminanti

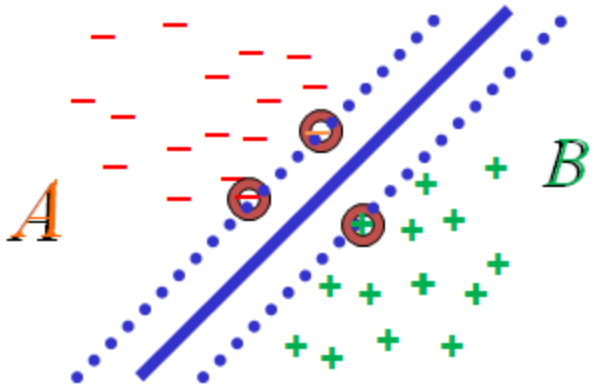
- Si consideri un problema di classificazione binaria con punti in due classi linearmente separate
  - Esiste almeno un piano che classifica tutti i punti delle due classi.



- Se ne esiste uno, ne possono esistere infiniti…

Support Vector Machine

- Vengono usate per determinare una soluzione unica al problema di classificazione.



$$\min_{\omega \neq 0} \frac{\| \omega \|^2}{2}$$

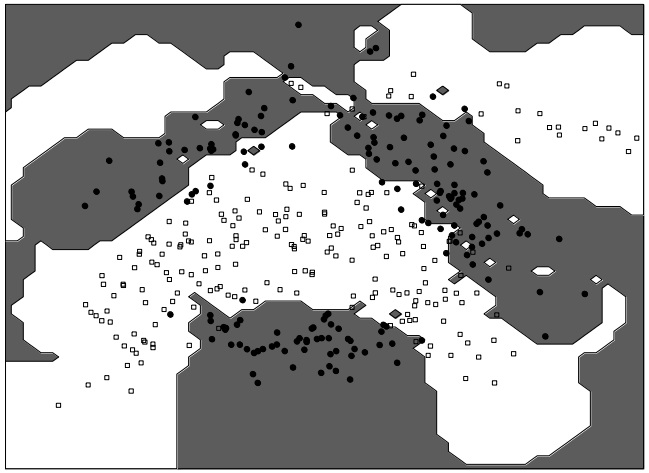
$$s.t. \quad A\omega + b < e$$

$$B\omega + b \geq -e$$

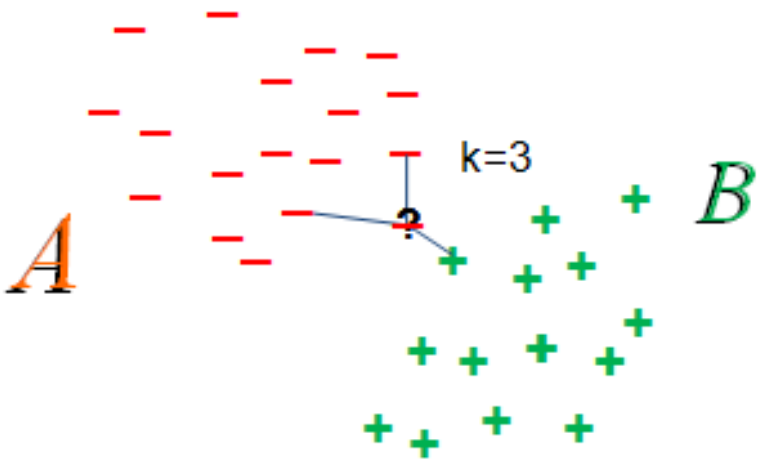
- Mangasarian (1965): i problemi di classificazione possono essere visti come problemi di ottimizzazione.

SVM non lineari

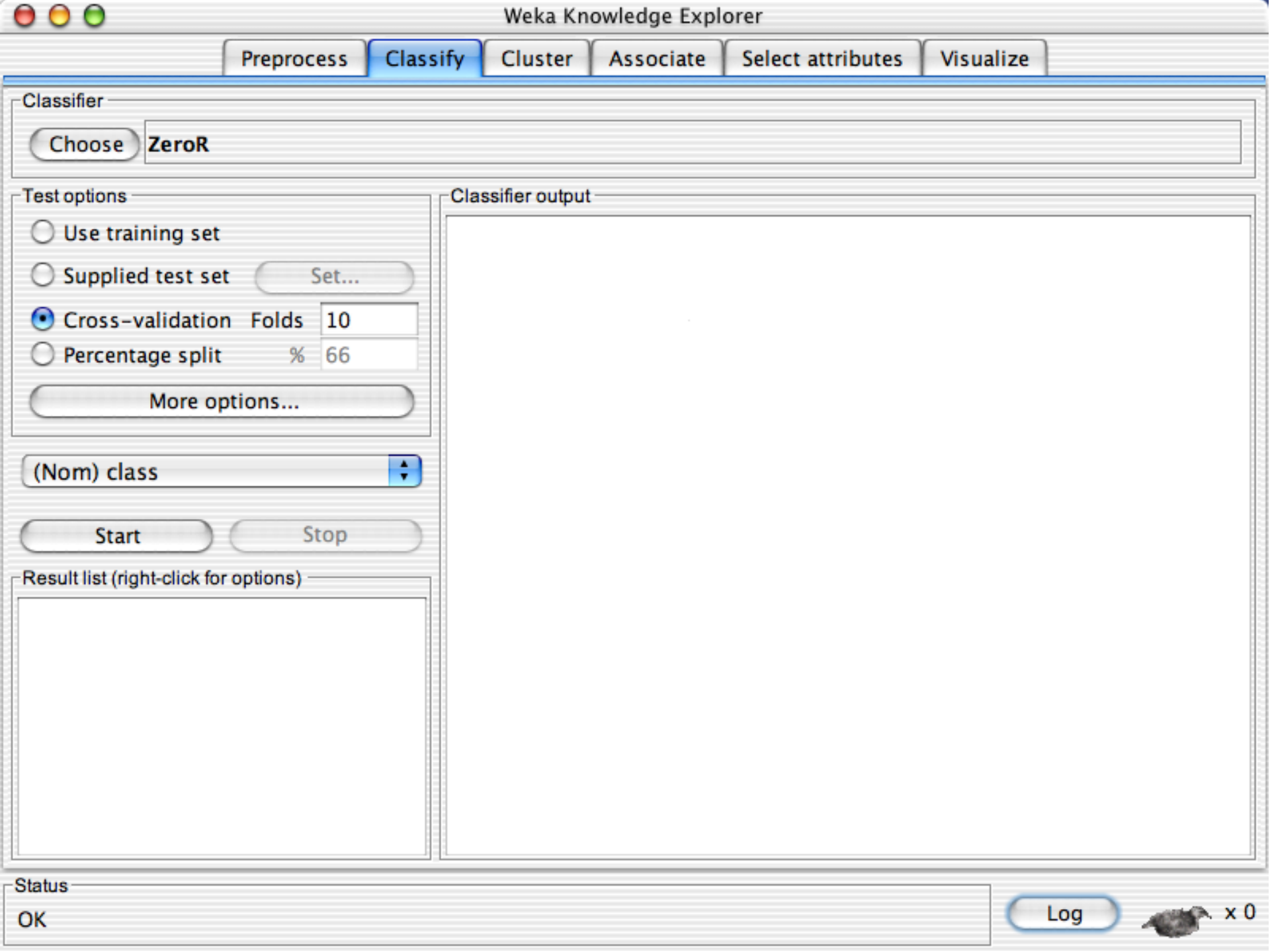
- Nel caso non esista una separazione lineare tra le classi, è possibile sostituire il prodotto scalare con una funzione non lineare.
- L'effetto è di proiettare i punti in uno spazio non lineare, in cui cercare la separazione lineare.
  - Conto: Non è possibile descrivere la superficie di separazione in maniera analitica nello spazio dei dati.
  - Pro: Si riescono a separare dati altrimenti non separabili.



k – Nearest Neighbors



- Il costo computazionale dell'algoritmo è lineare rispetto alla taglia dell'insieme di addestramento ed inferiore rispetto a quello delle SVM (cubico).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Classifier output
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Result list (right-click for options)
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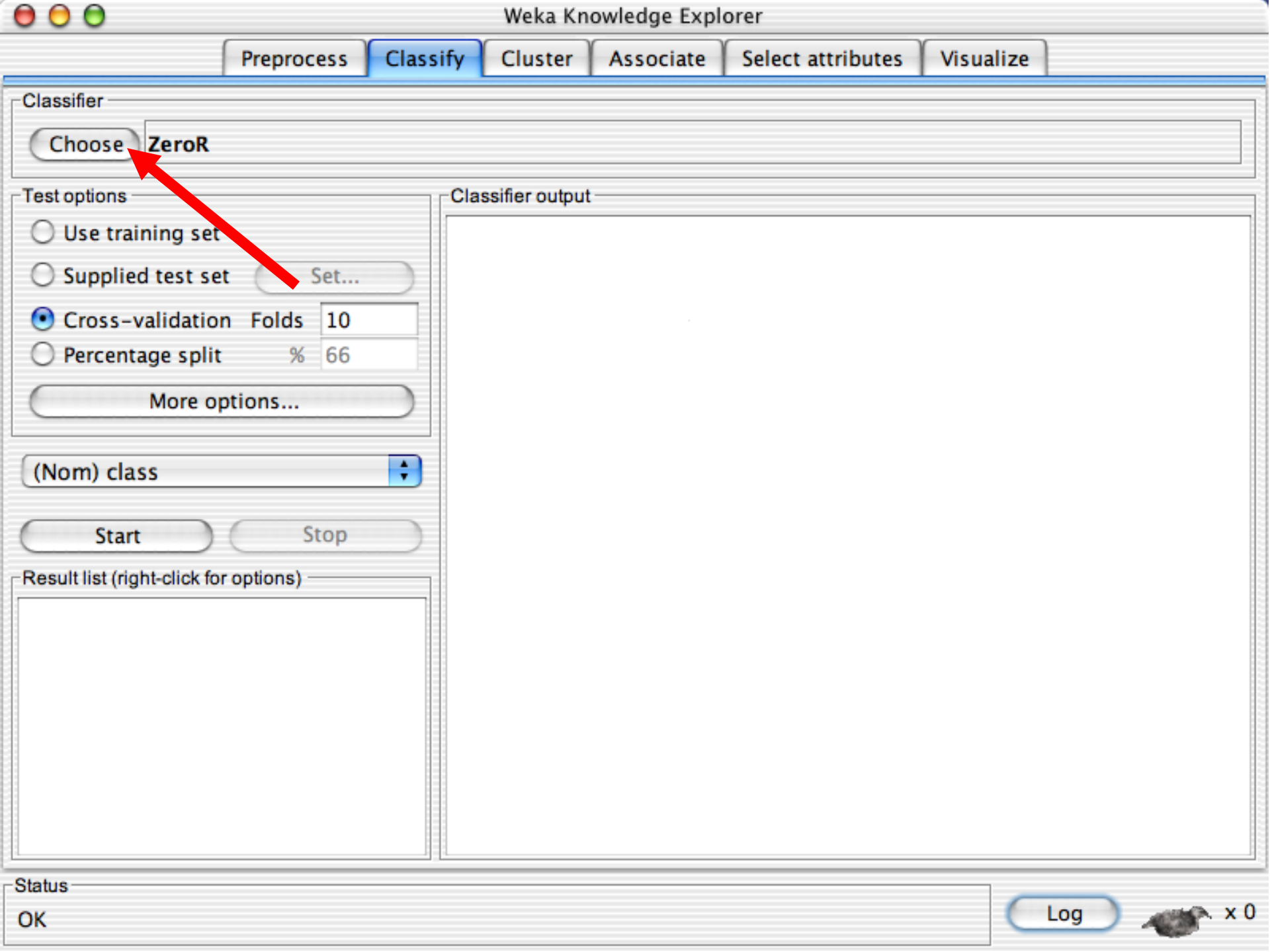
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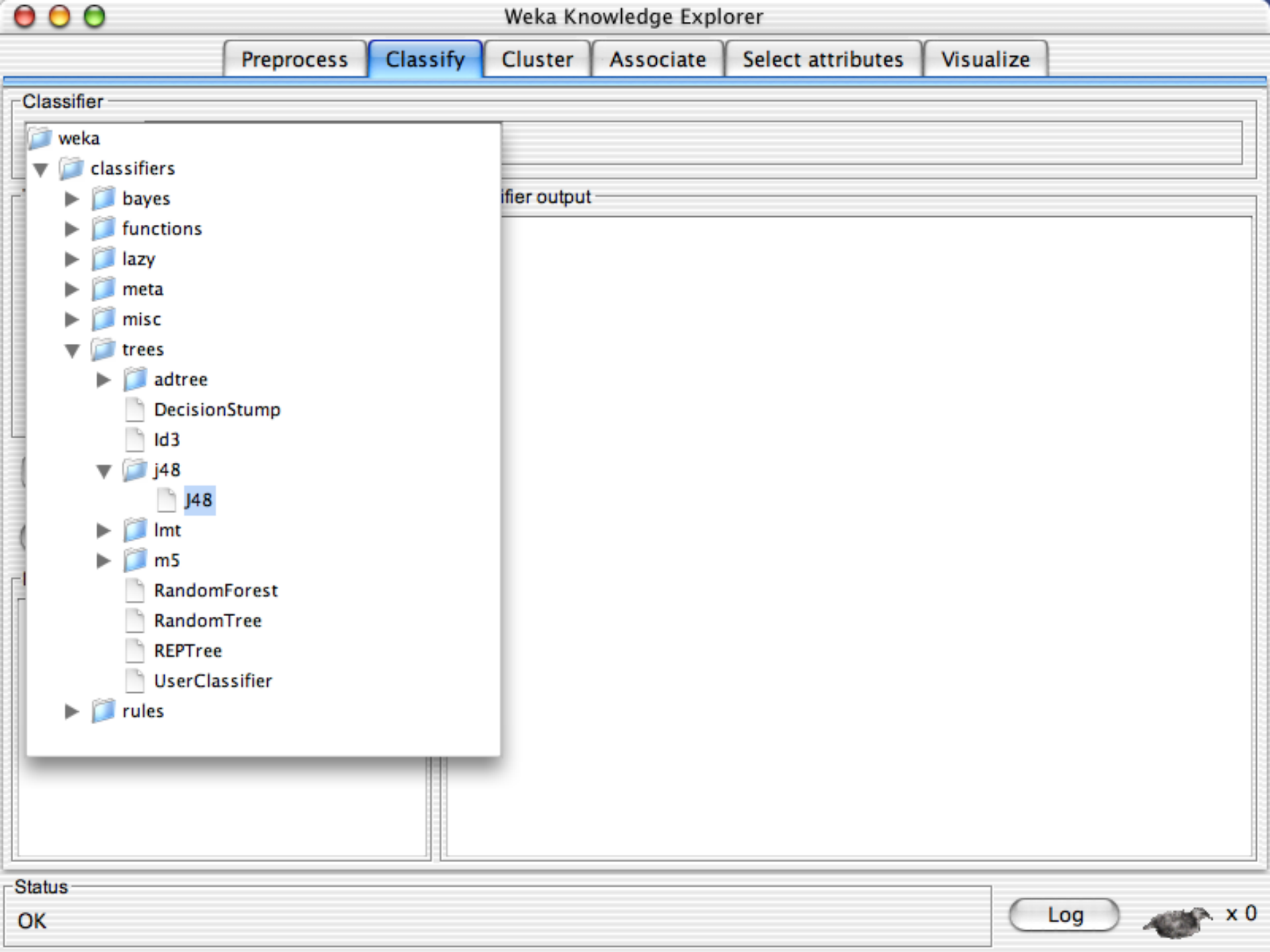
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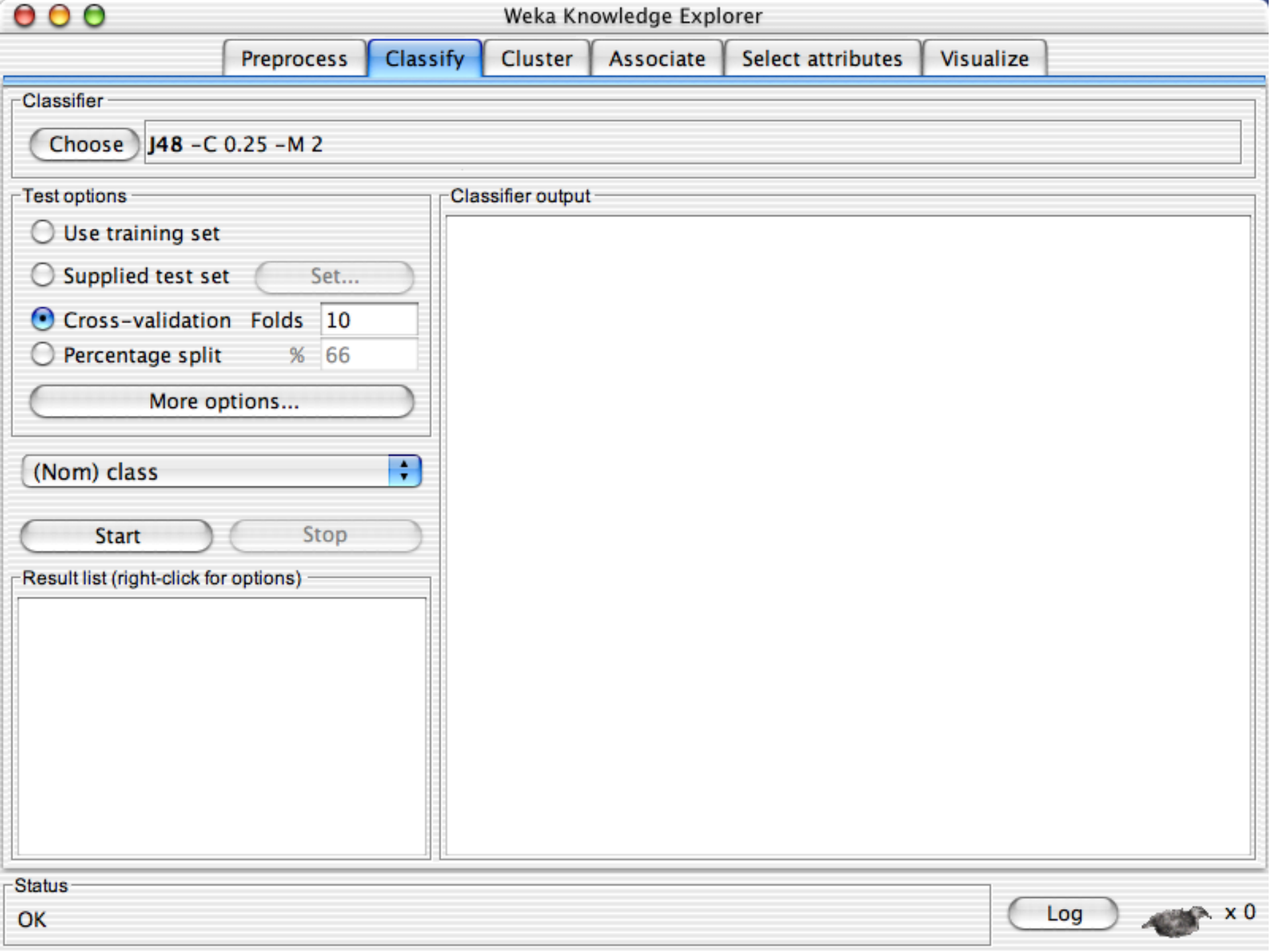
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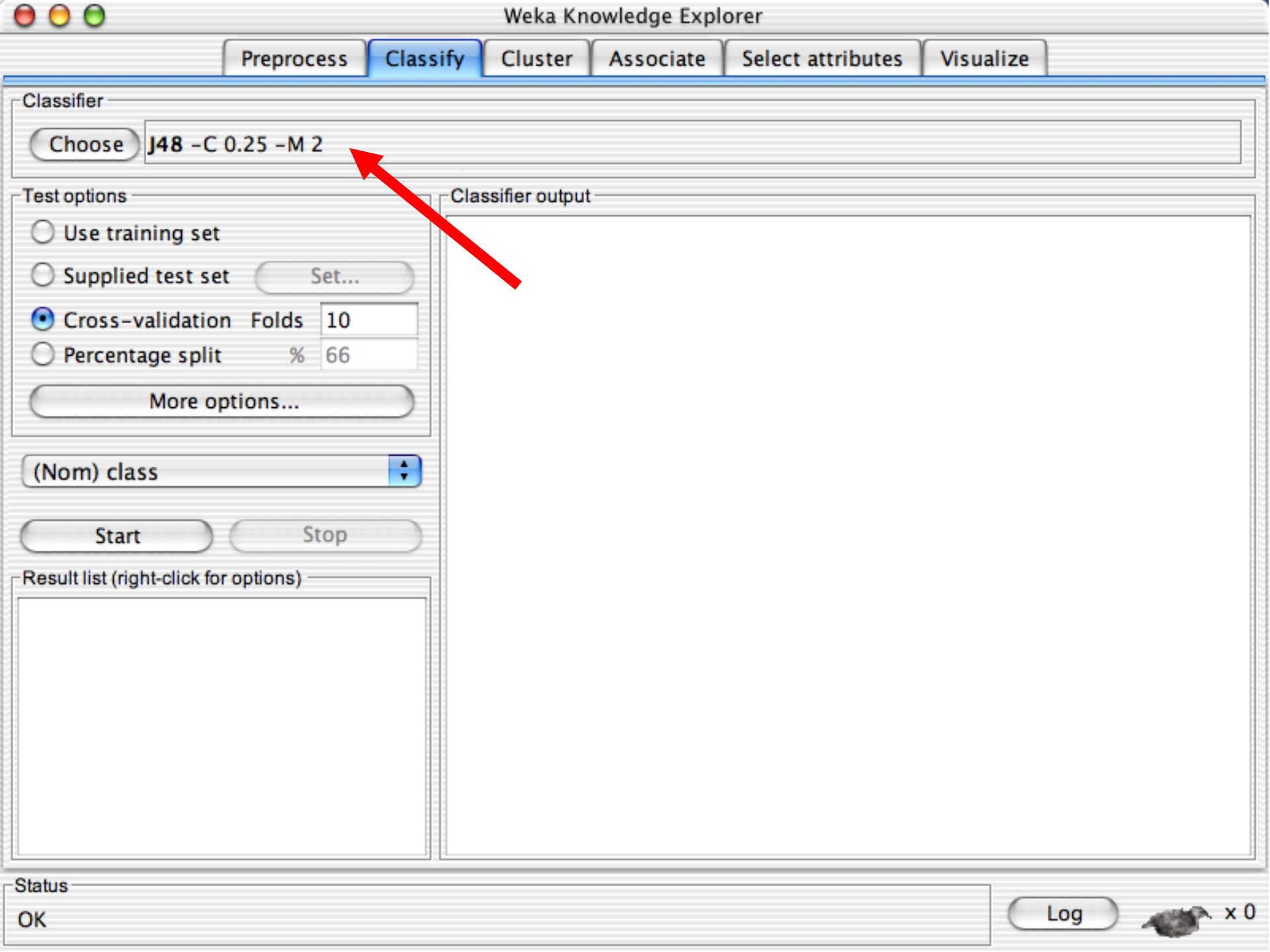
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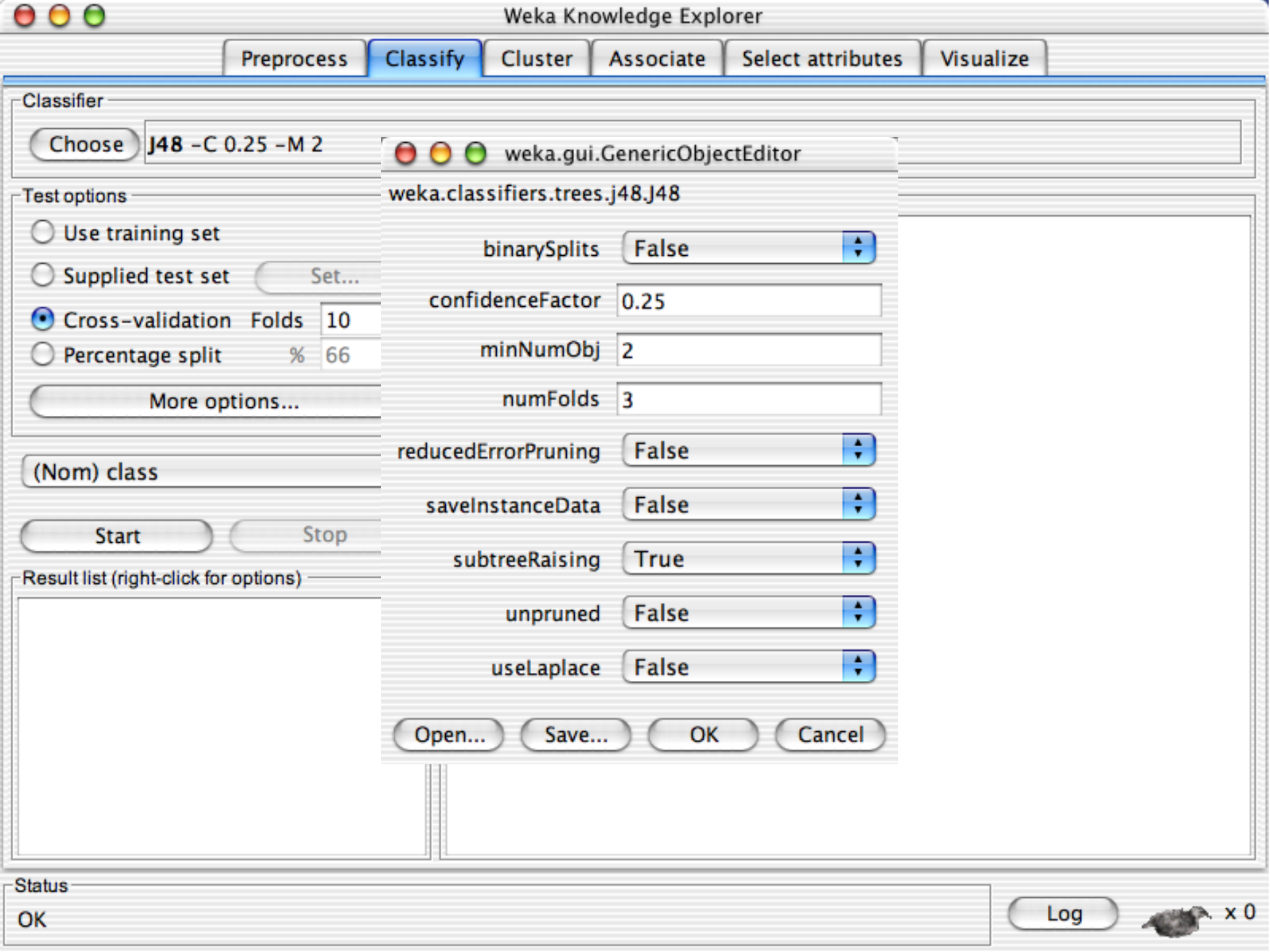
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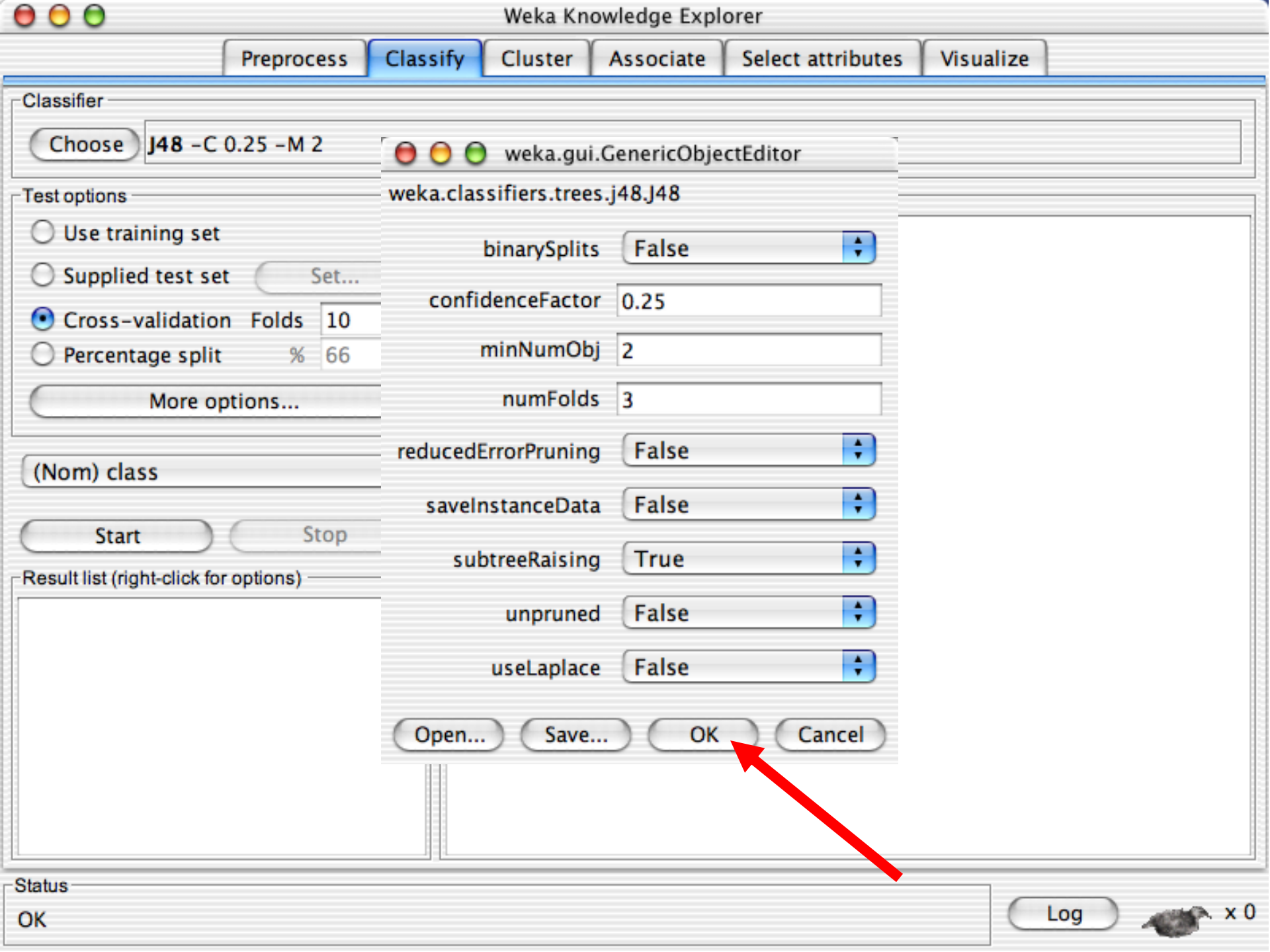
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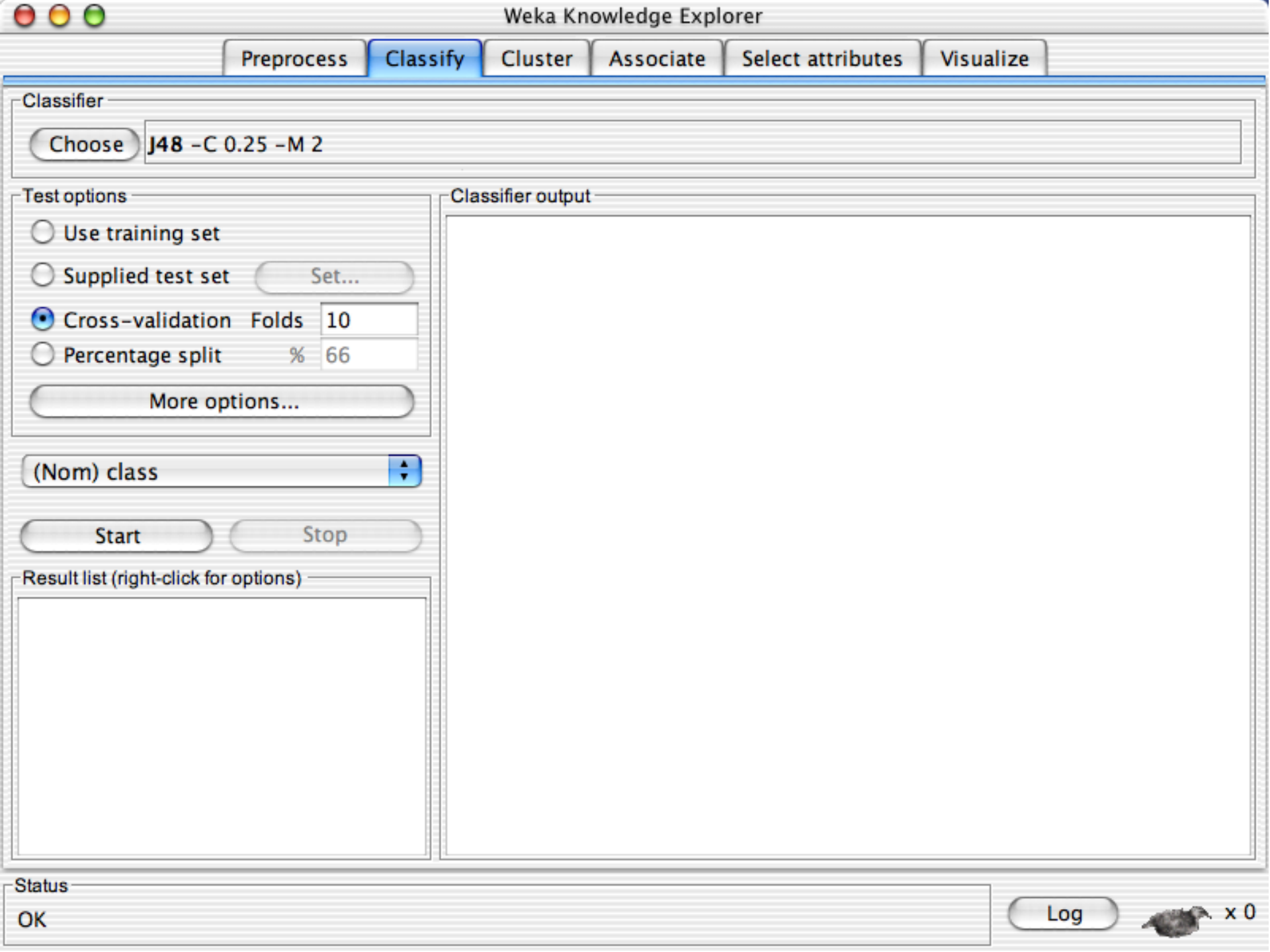
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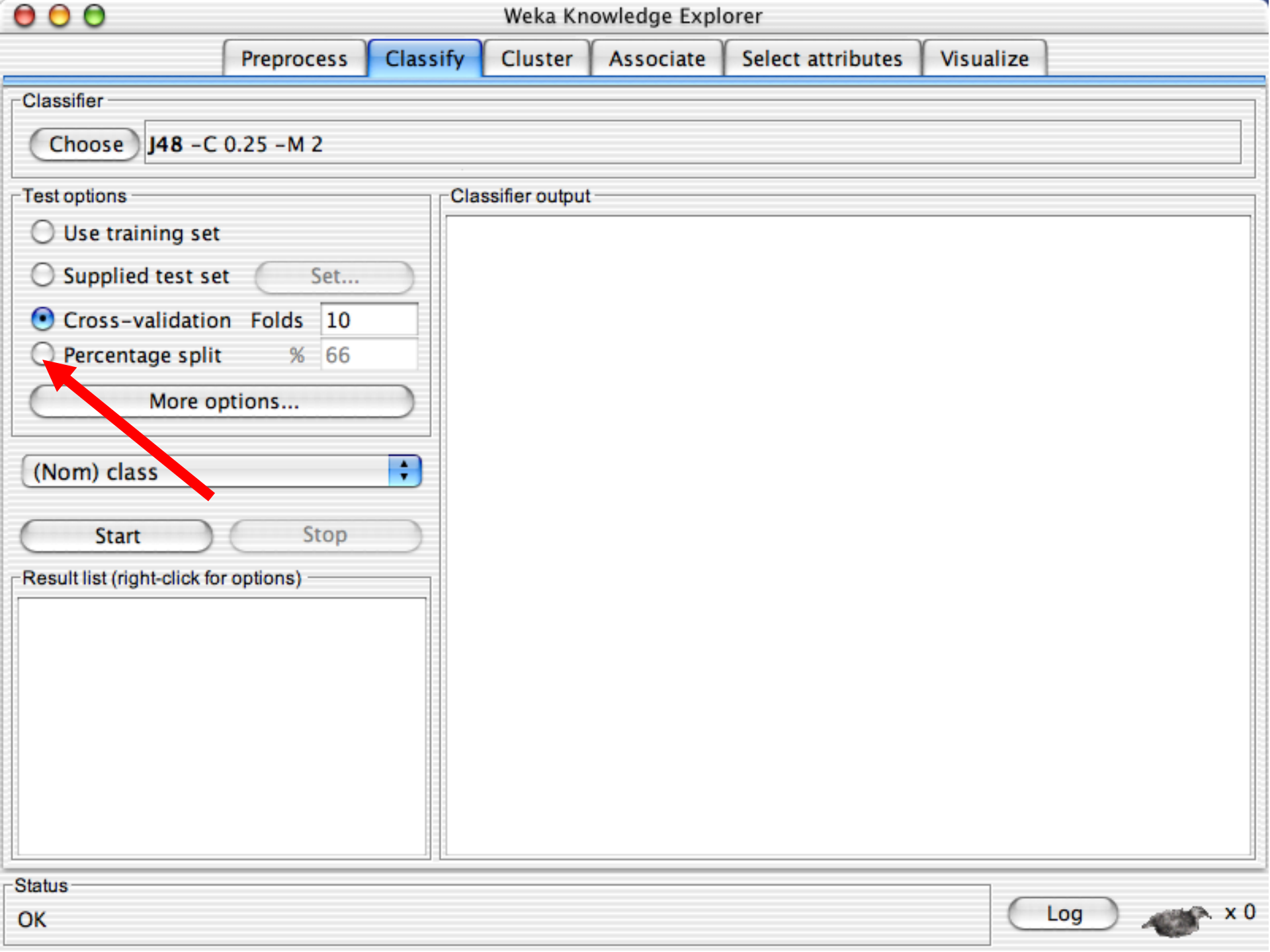
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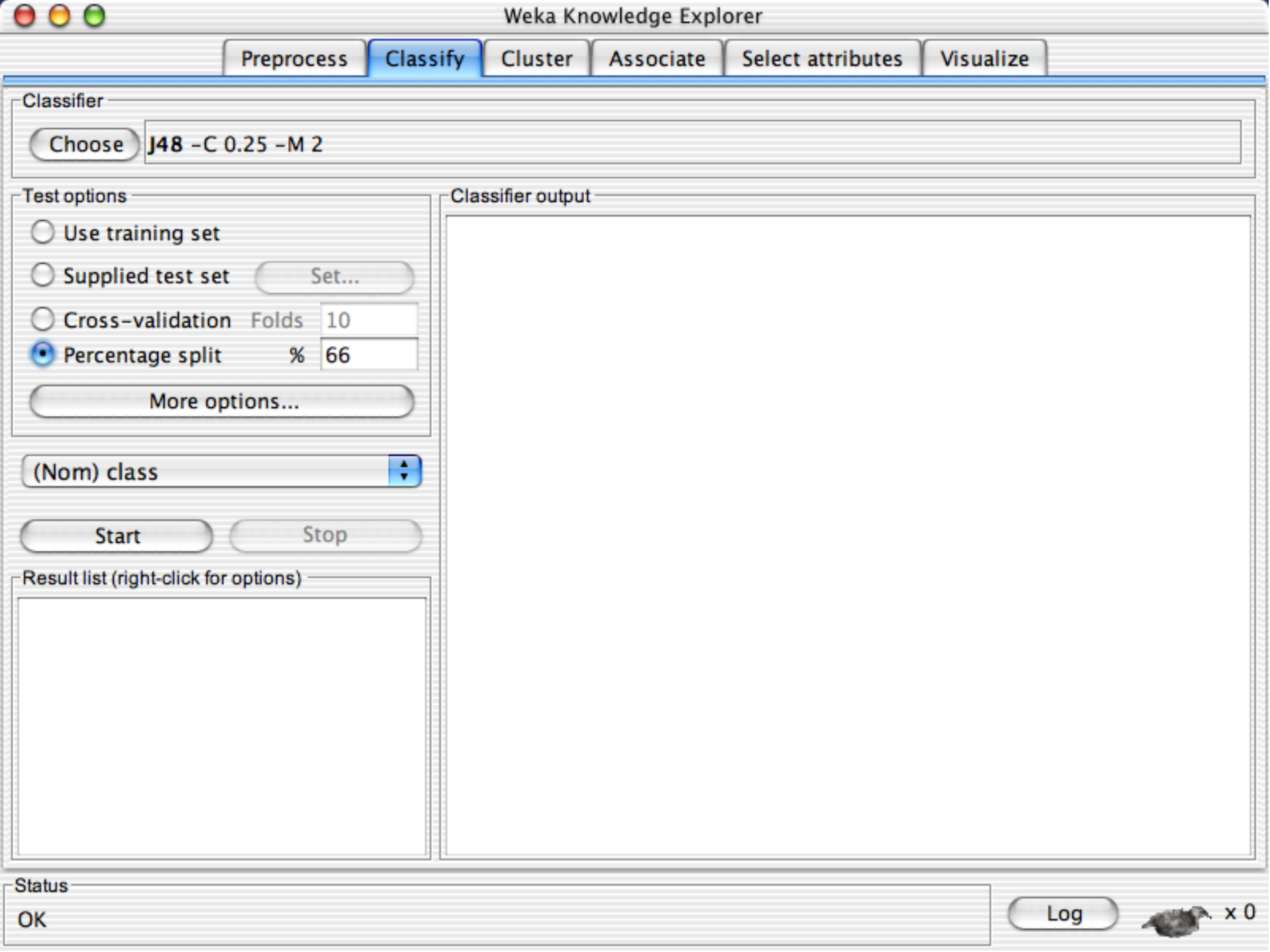
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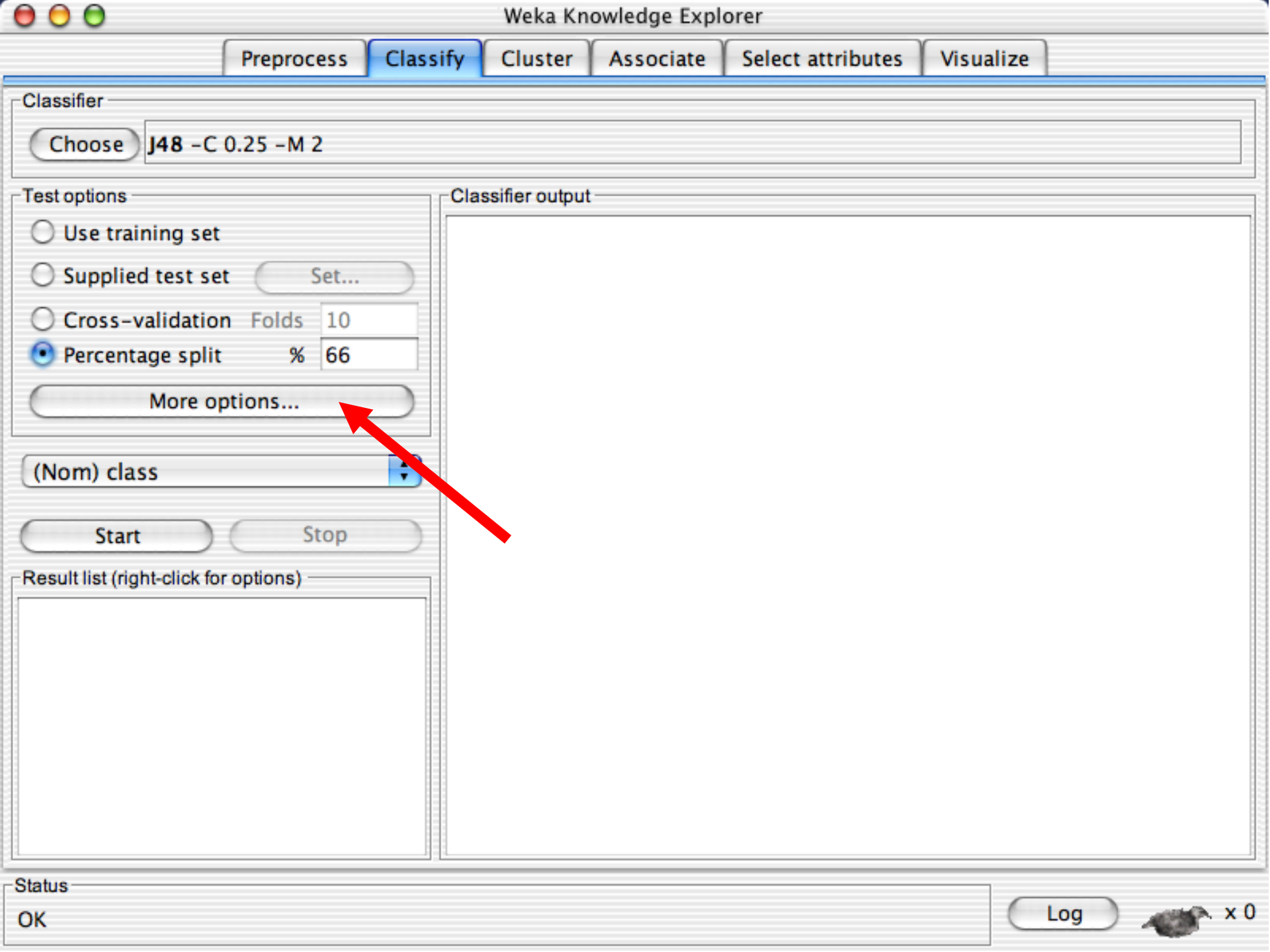
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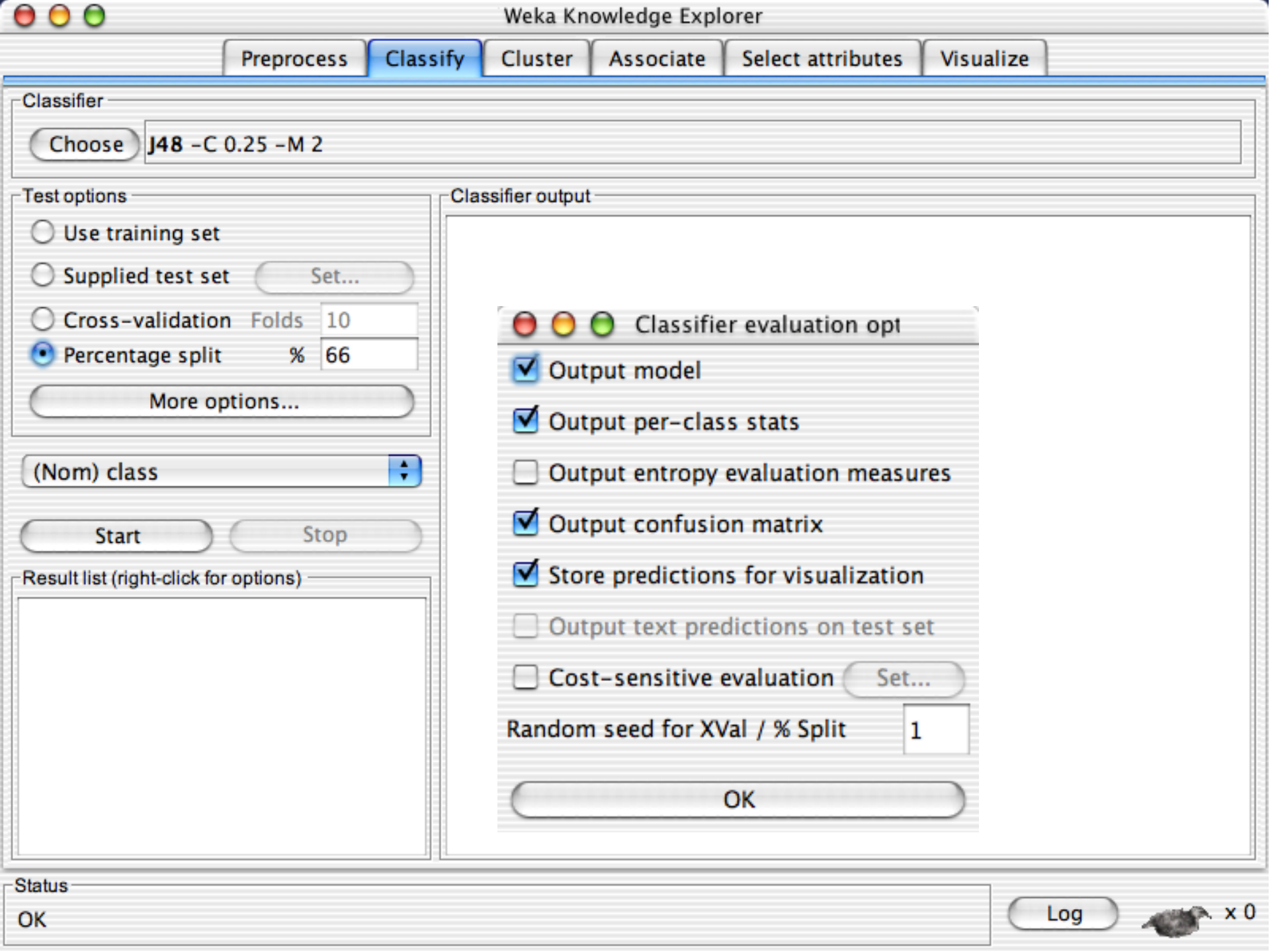
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Output per-class stats
Output entropy evaluation measures
Output confusion matrix
Store predictions for visualization
Output text predictions on test set
Cost-sensitive evaluation
Set...
Random seed for XVal / % Split
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Status
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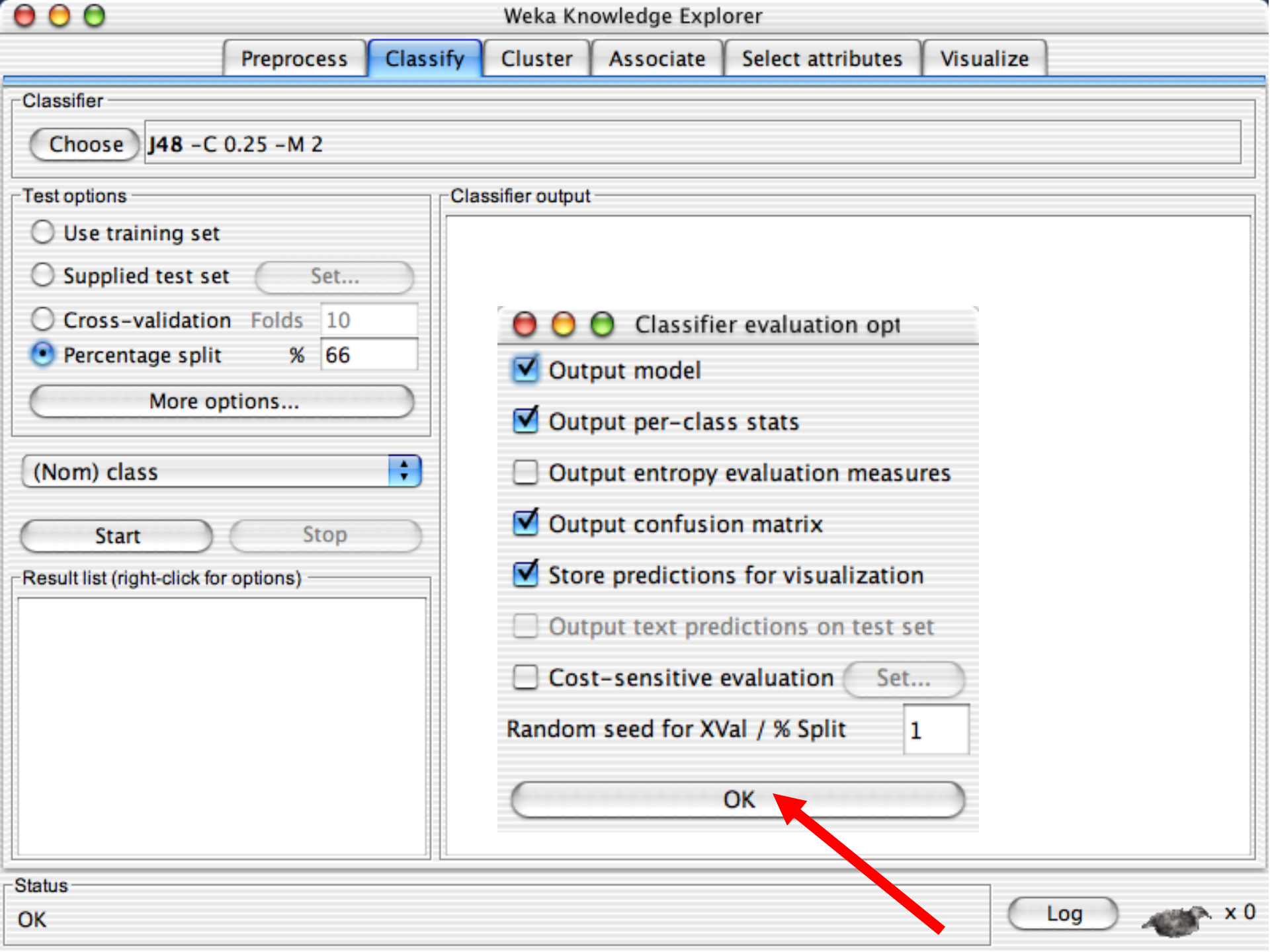
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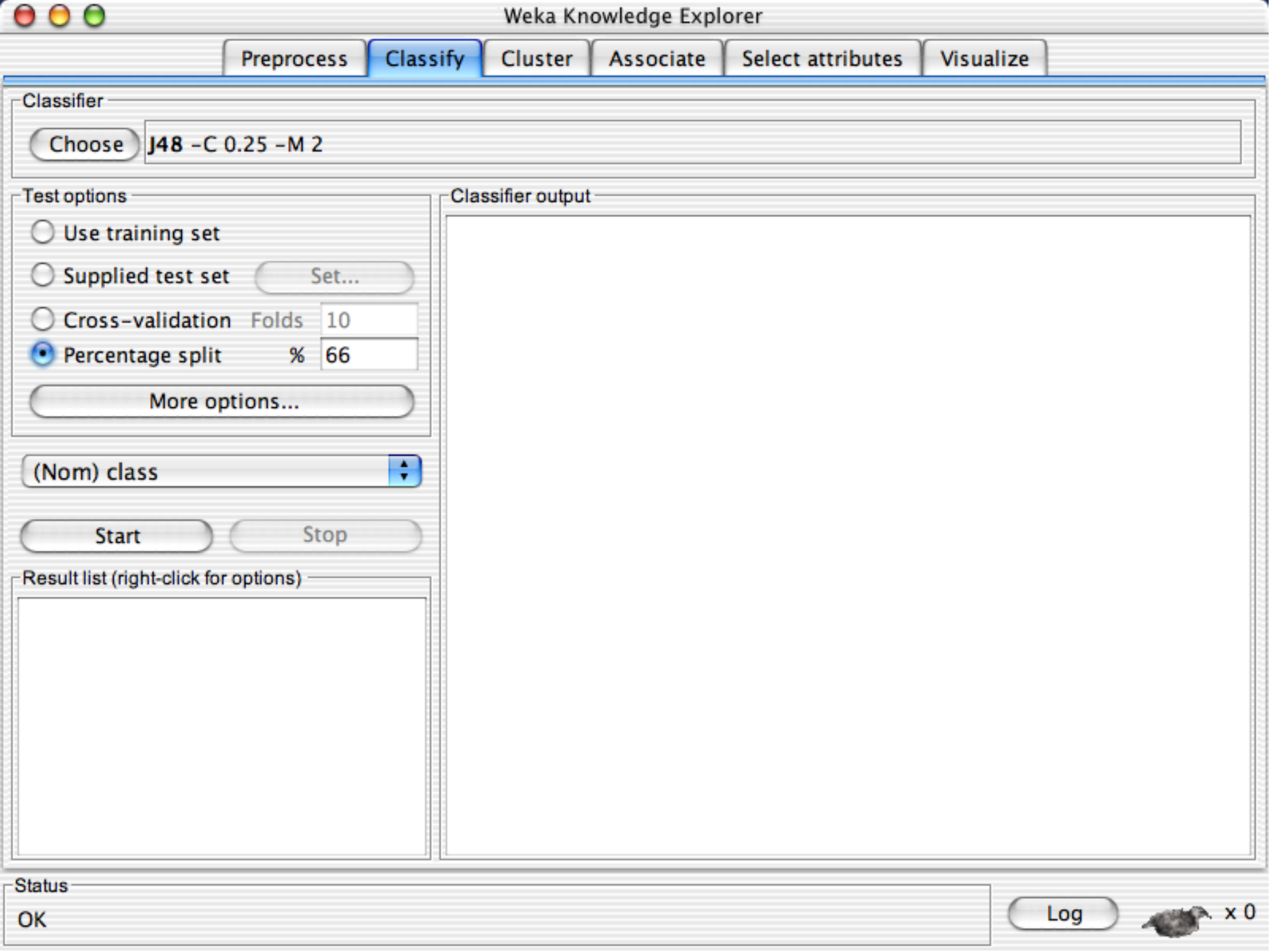
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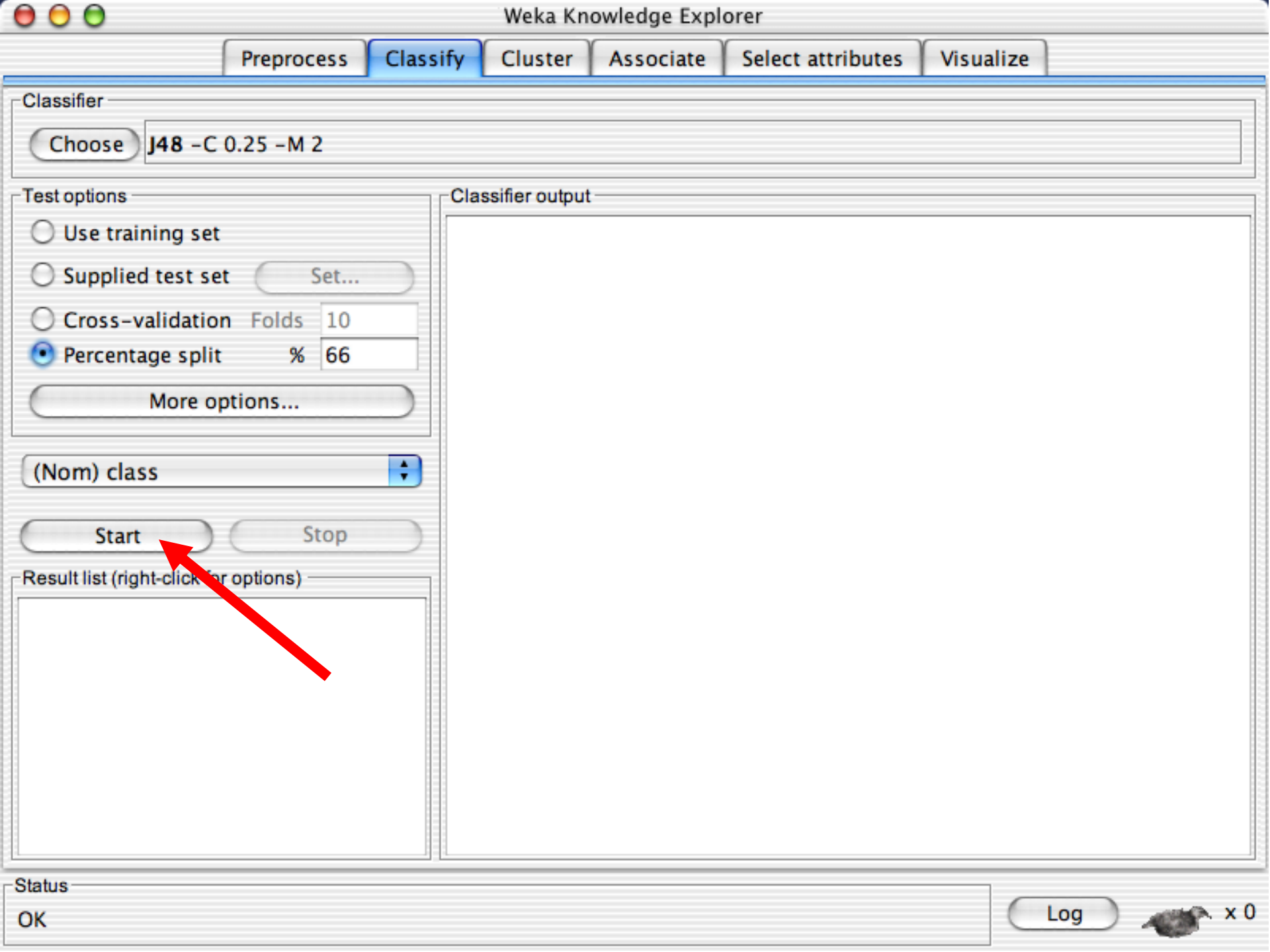
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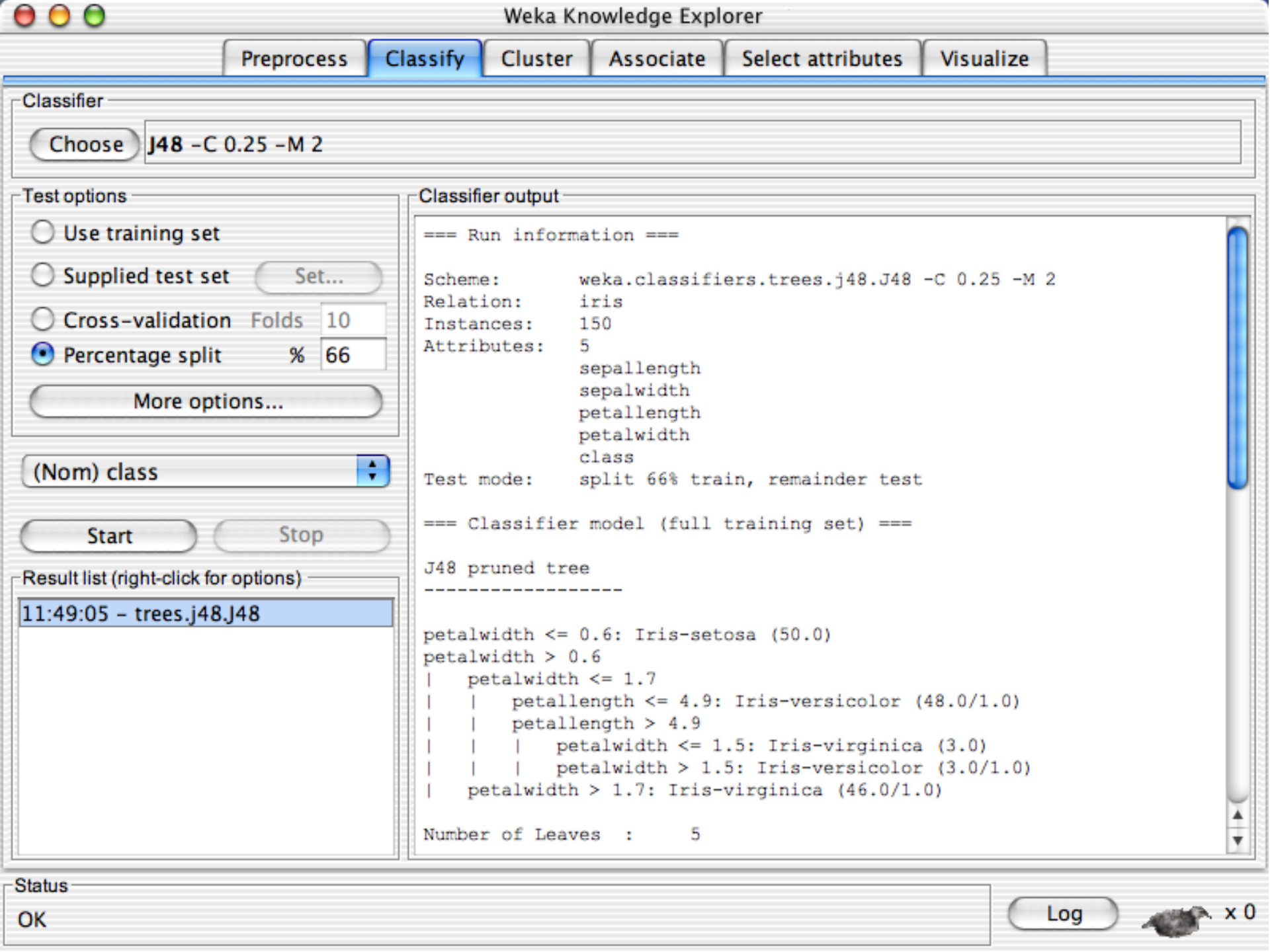
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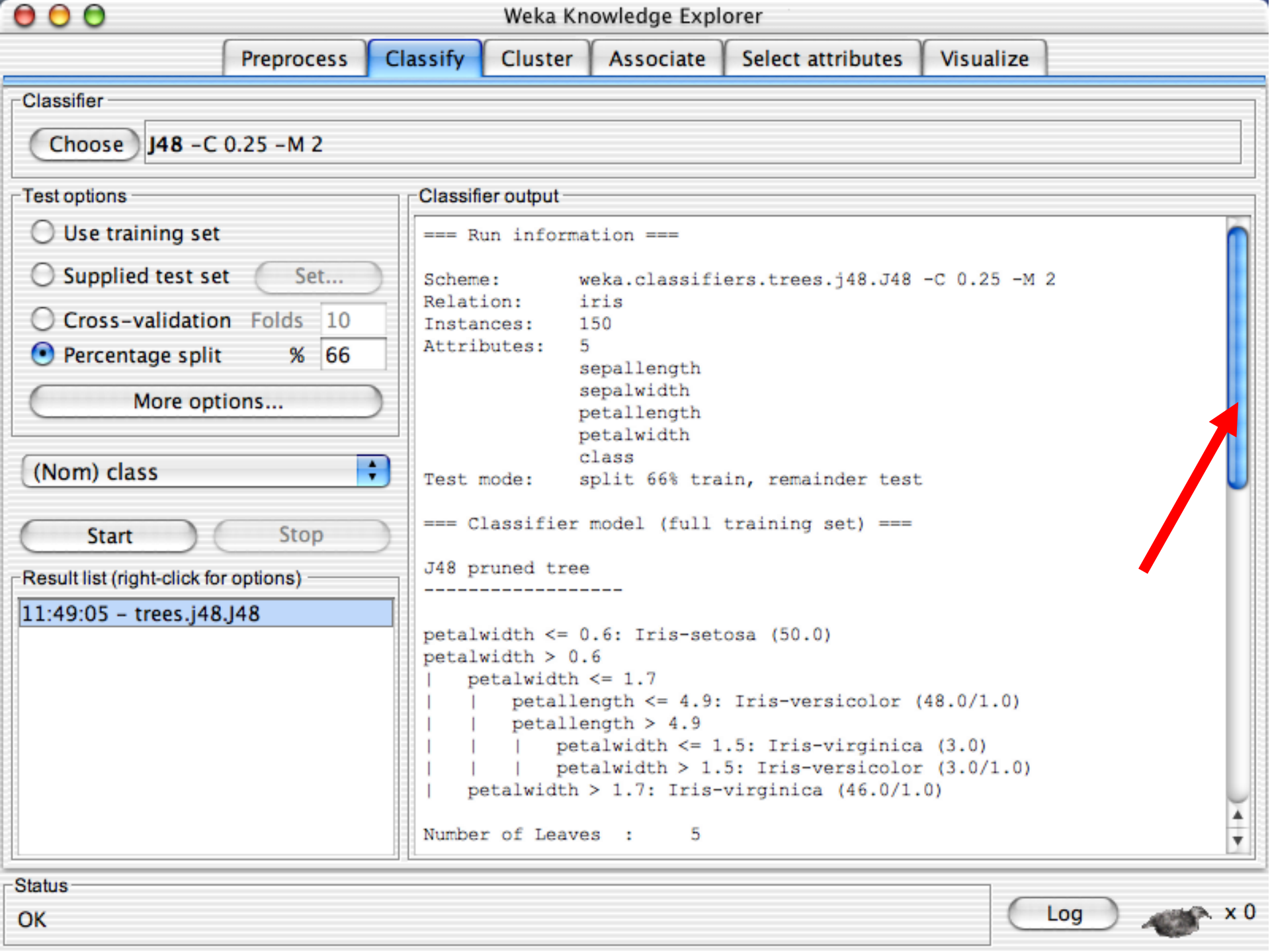
More options...
(Nom) class
Start
Stop
Result list (right-click for options)
11:49:05 - trees.j48.J48
Classifier output
=== Run information ===
Scheme: weka.classifiers.trees.j48.J48 -C 0.25 -M 2
Relation: iris
Instances: 150
Attributes: 5
sepallength
sepalwidth
petallength
petalwidth
class
Test mode: split 66% train, remainder test
=== Classifier model (full training set) ===
J48 pruned tree
petalwidth <= 0.6: Iris-setosa (50.0)
petalwidth > 0.6
| petalwidth <= 1.7
| | petallength <= 4.9: Iris-versicolor (48.0/1.0)
| | petallength > 4.9
| | | petalwidth <= 1.5: Iris-virginica (3.0)
| | | petalwidth > 1.5: Iris-versicolor (3.0/1.0)
| petalwidth > 1.7: Iris-virginica (46.0/1.0)
Number of Leaves : 5
Status
OK
Log
x 0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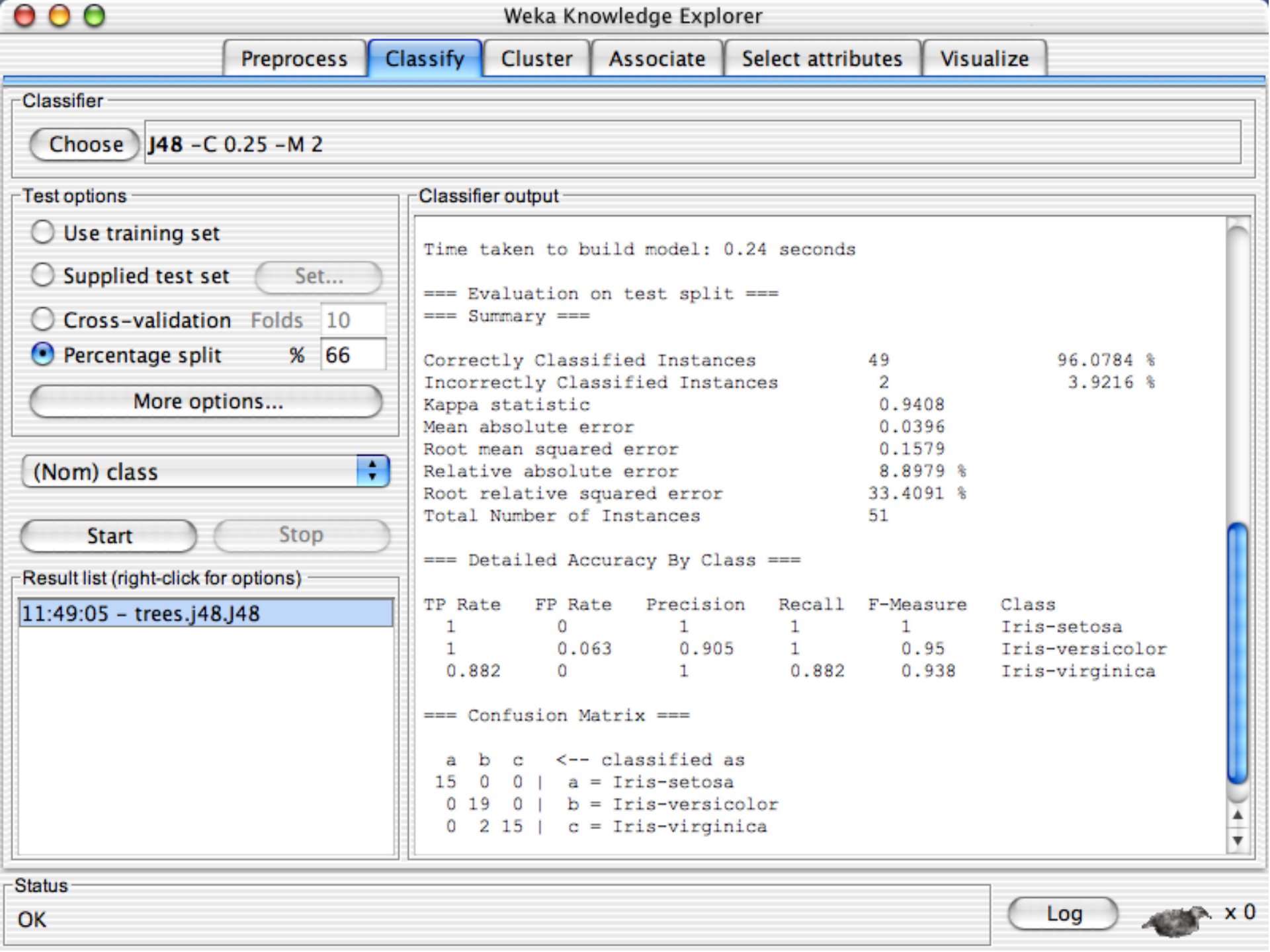
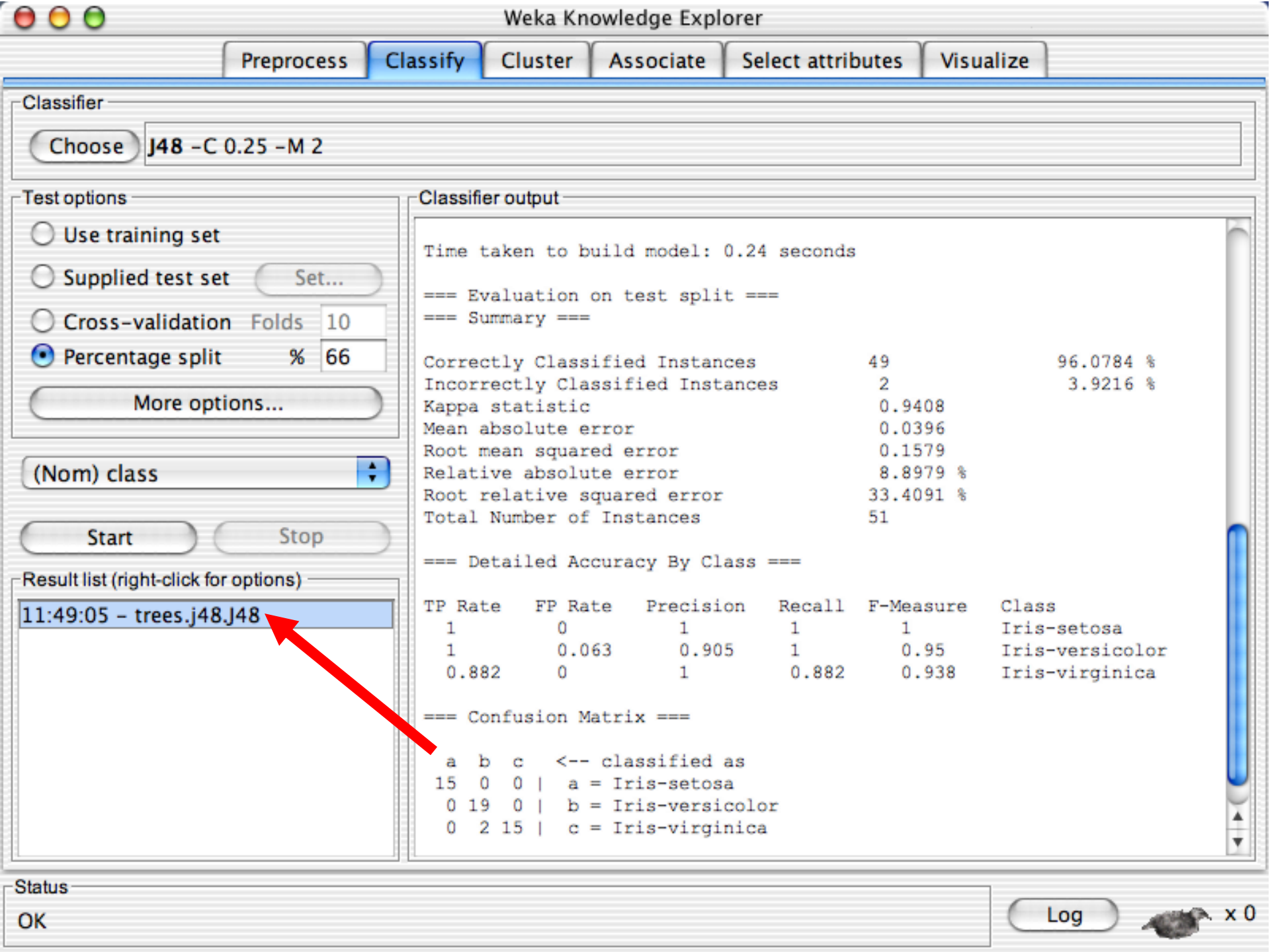
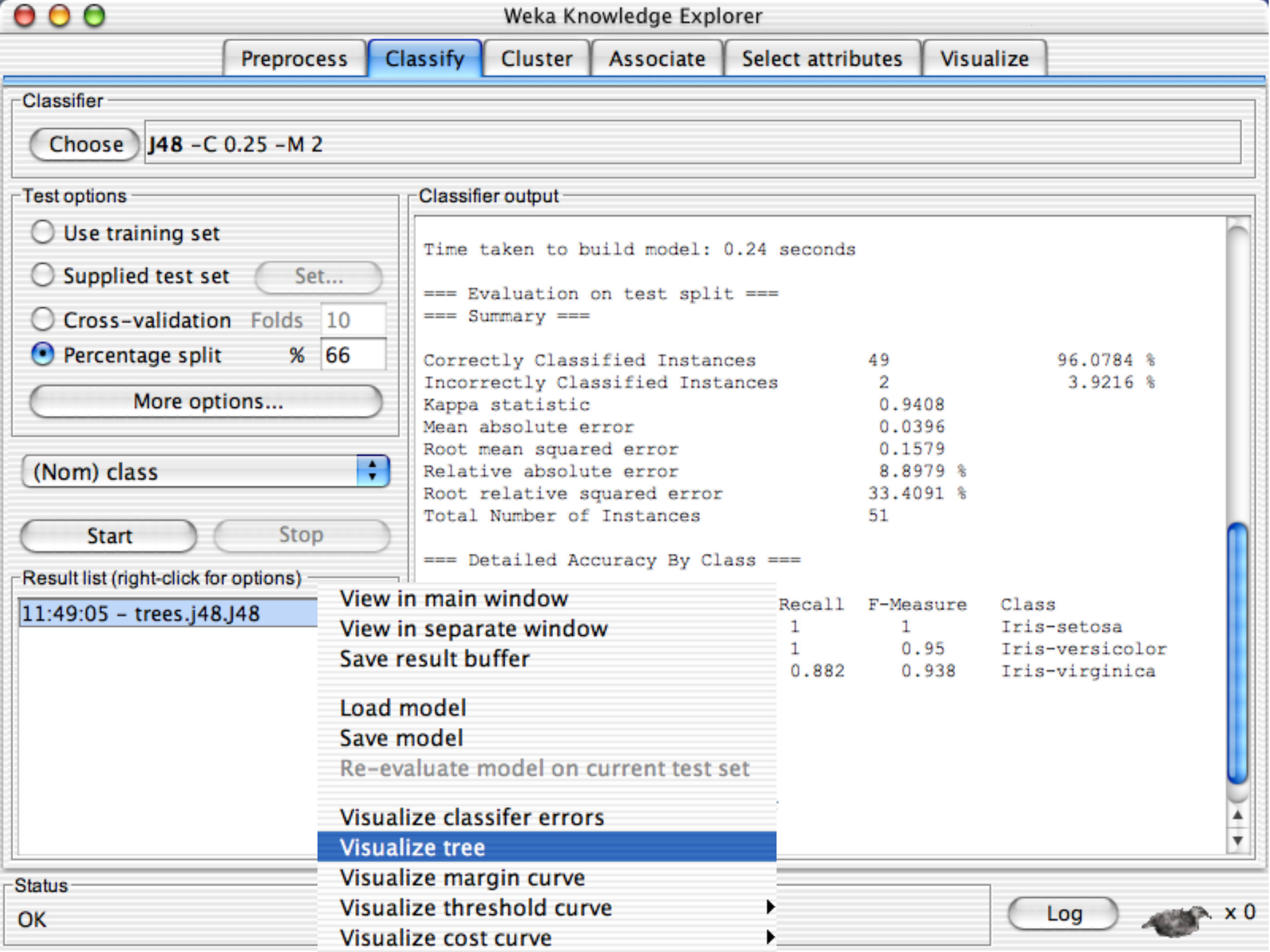
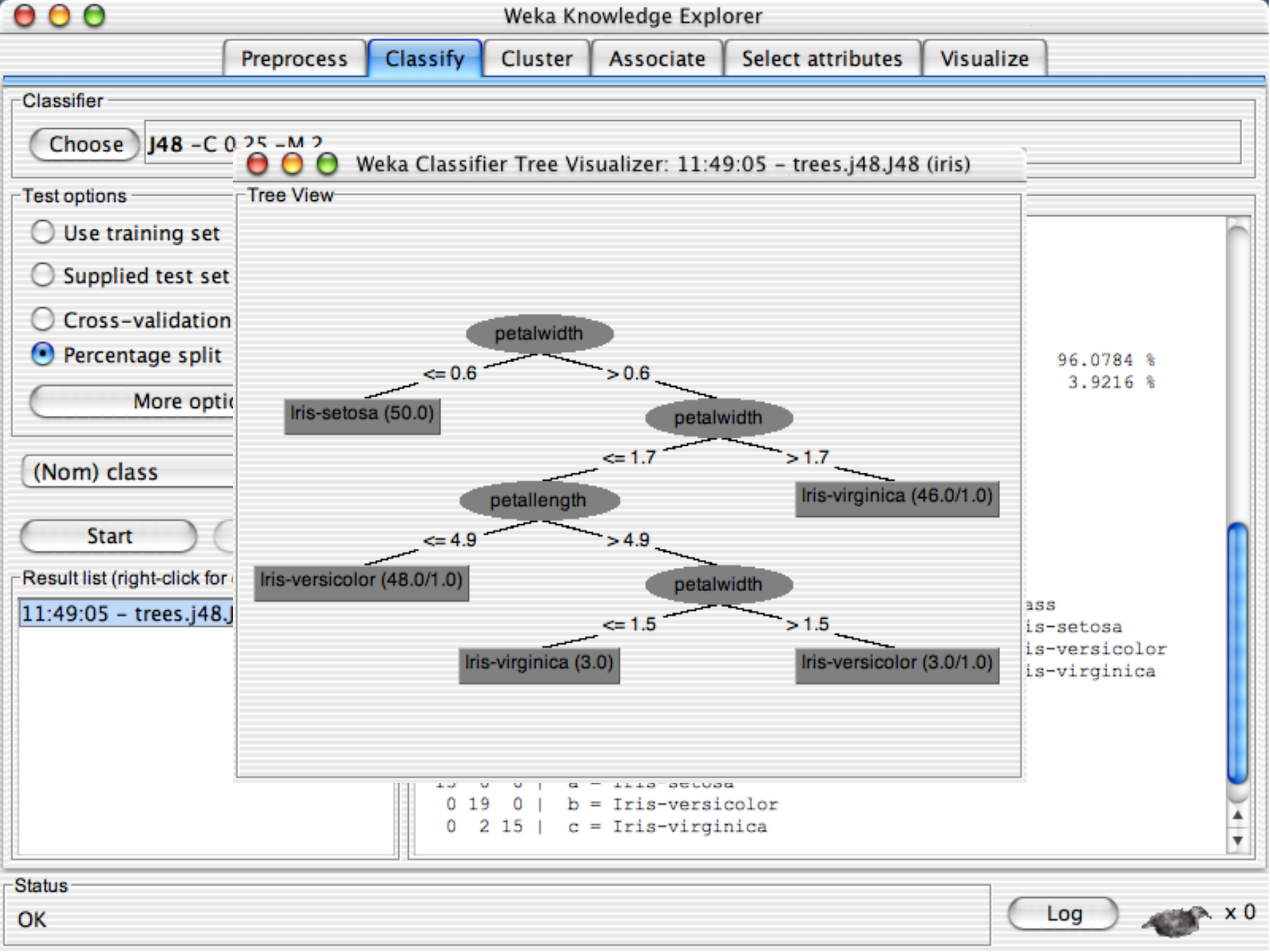
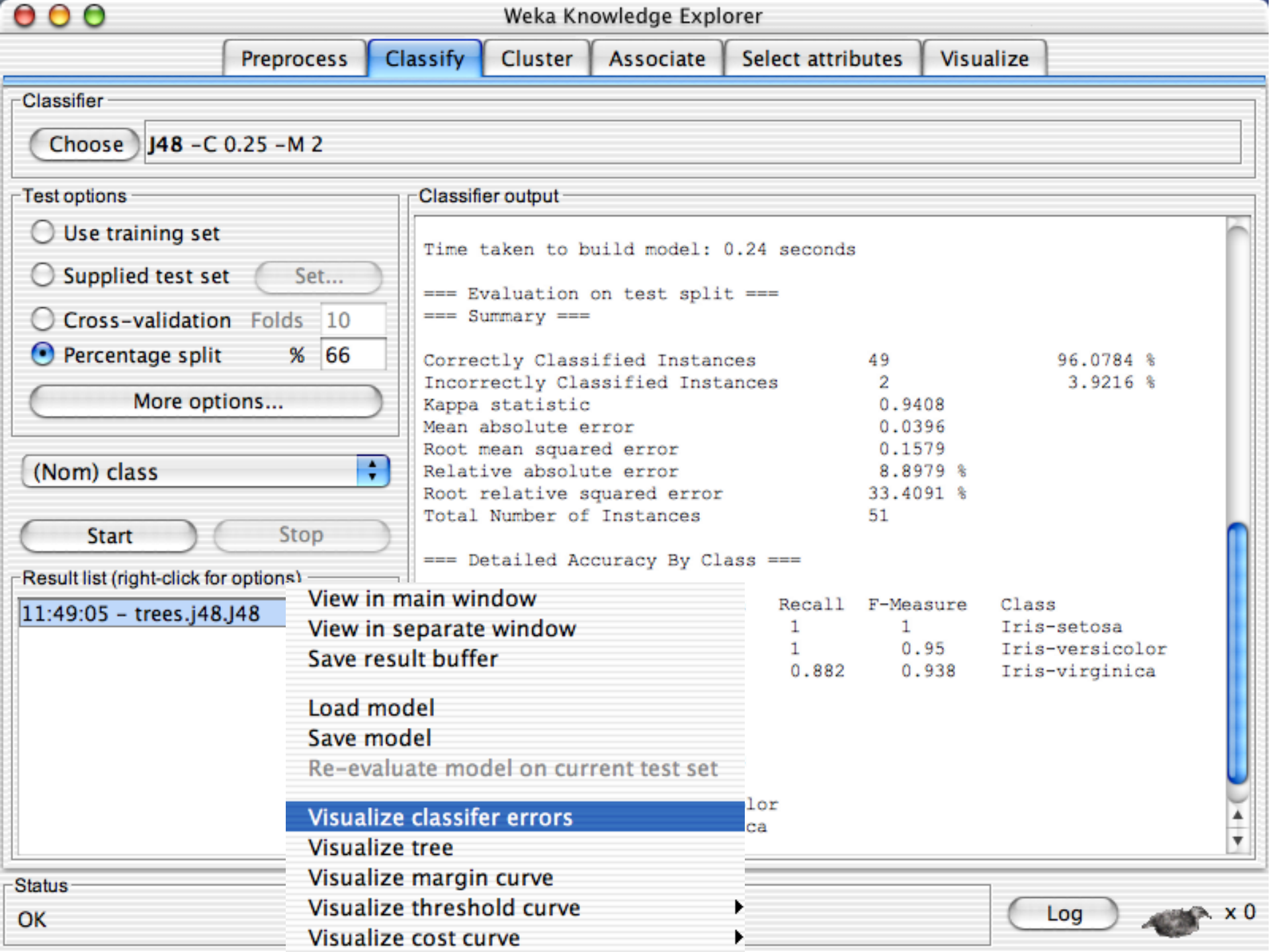
Log
x 0

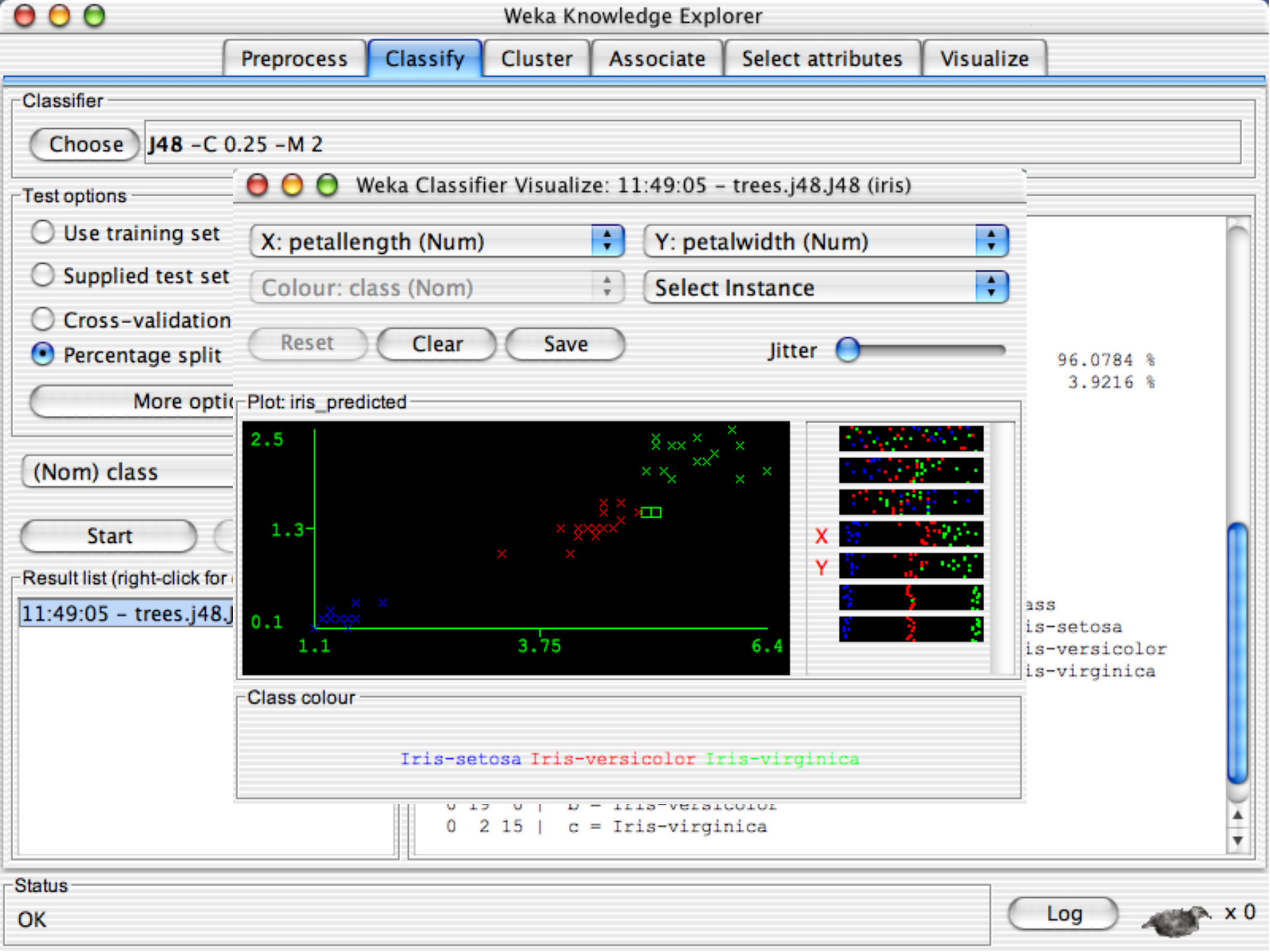

Weka Knowledge Explorer
Preprocess
Classify
Cluster
Associate
Select attributes
Visualize
Classifier
Choose
J48 -C 0.25 -M 2
Test options
Use training set
Supplied test set
Set...
Cross-validation
Folds
10
Percentage split
%
66
More options...
(Nom) class
Start
Stop
Result list (right-click for options)
11:49:05 - trees.j48.J48
Classifier output
Time taken to build model: 0.24 seconds
=== Evaluation on test split ===
=== Summary ===
Correctly Classified Instances 49 96.0784 %
Incorrectly Classified Instances 2 3.9216 %
Kappa statistic 0.9408
Mean absolute error 0.0396
Root mean squared error 0.1579
Relative absolute error 8.8979 %
Root relative squared error 33.4091 %
Total Number of Instances 51
=== Detailed Accuracy By Class ===
TP Rate FP Rate Precision Recall F-Measure Class
1 0 1 1 1 Iris-setosa
1 0.063 0.905 1 0.95 Iris-versicolor
0.882 0 1 0.882 0.938 Iris-virginica
=== Confusion Matrix ===
a b c <-- classified as
15 0 0 | a = Iris-setosa
0 19 0 | b = Iris-versicolor
0 2 15 | c = Iris-virginica
Status
OK
Log
x 0

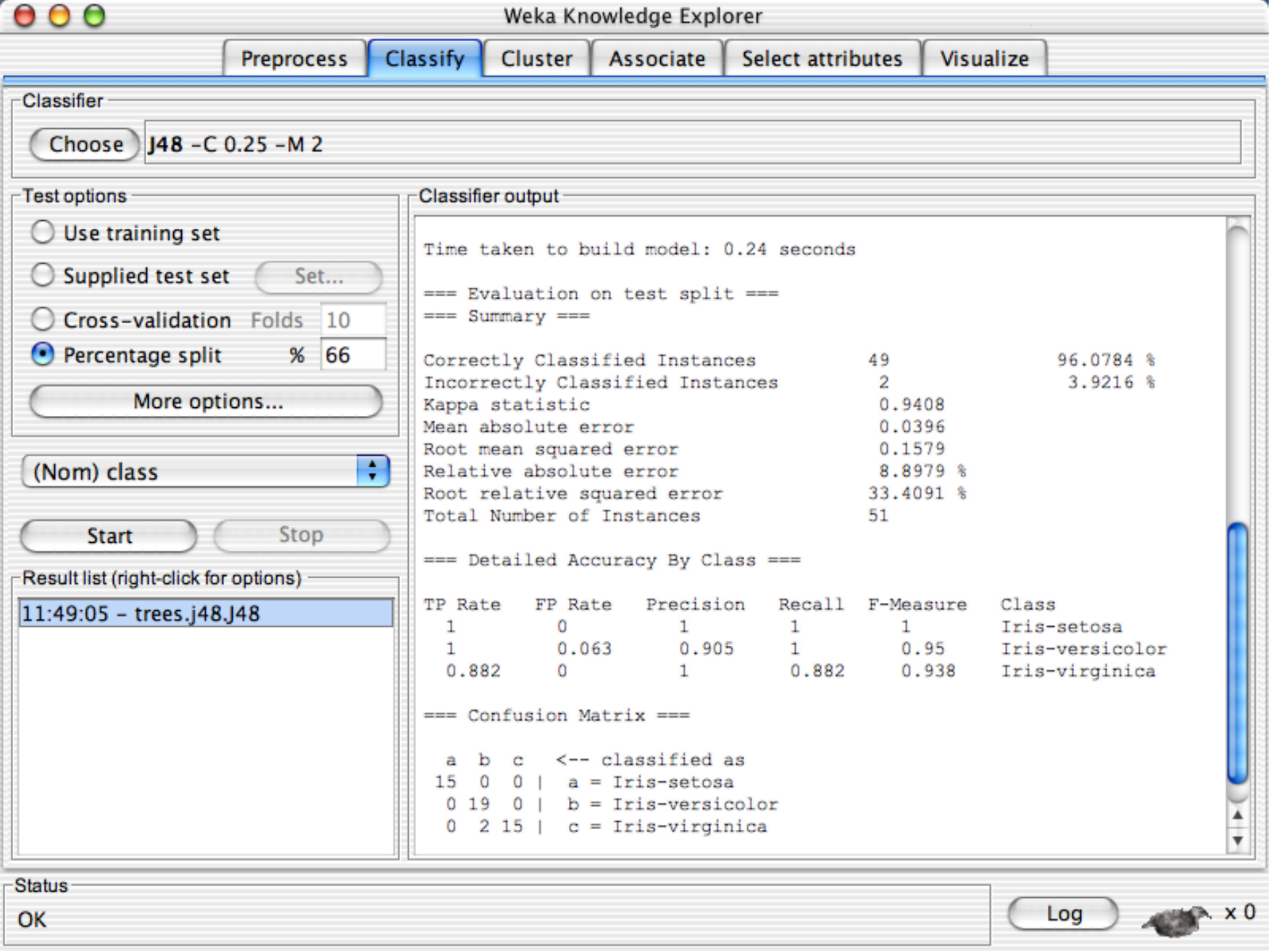

Weka Knowledge Explorer
Preprocess
Classify
Cluster
Associate
Select attributes
Visualize
Classifier
Choose
J48 -C 0.25 -M 2
Test options
Use training set
Supplied test set
Set...
Cross-validation
Folds
10
Percentage split
%
66
More options...
(Nom) class
Start
Stop
Result list (right-click for options)
11:49:05 - trees.j48.J48
Classifier output
Time taken to build model: 0.24 seconds
=== Evaluation on test split ===
=== Summary ===
Correctly Classified Instances 49 96.0784 %
Incorrectly Classified Instances 2 3.9216 %
Kappa statistic 0.9408
Mean absolute error 0.0396
Root mean squared error 0.1579
Relative absolute error 8.8979 %
Root relative squared error 33.4091 %
Total Number of Instances 51
=== Detailed Accuracy By Class ===
TP Rate FP Rate Precision Recall F-Measure Class
1 0 1 1 1 Iris-setosa
1 0.063 0.905 1 0.95 Iris-versicolor
0.882 0 1 0.882 0.938 Iris-virginica
=== Confusion Matrix ===
a b c <-- classified as
15 0 0 | a = Iris-setosa
0 19 0 | b = Iris-versicolor
0 2 15 | c = Iris-virginica
Status
OK
Log
x 0

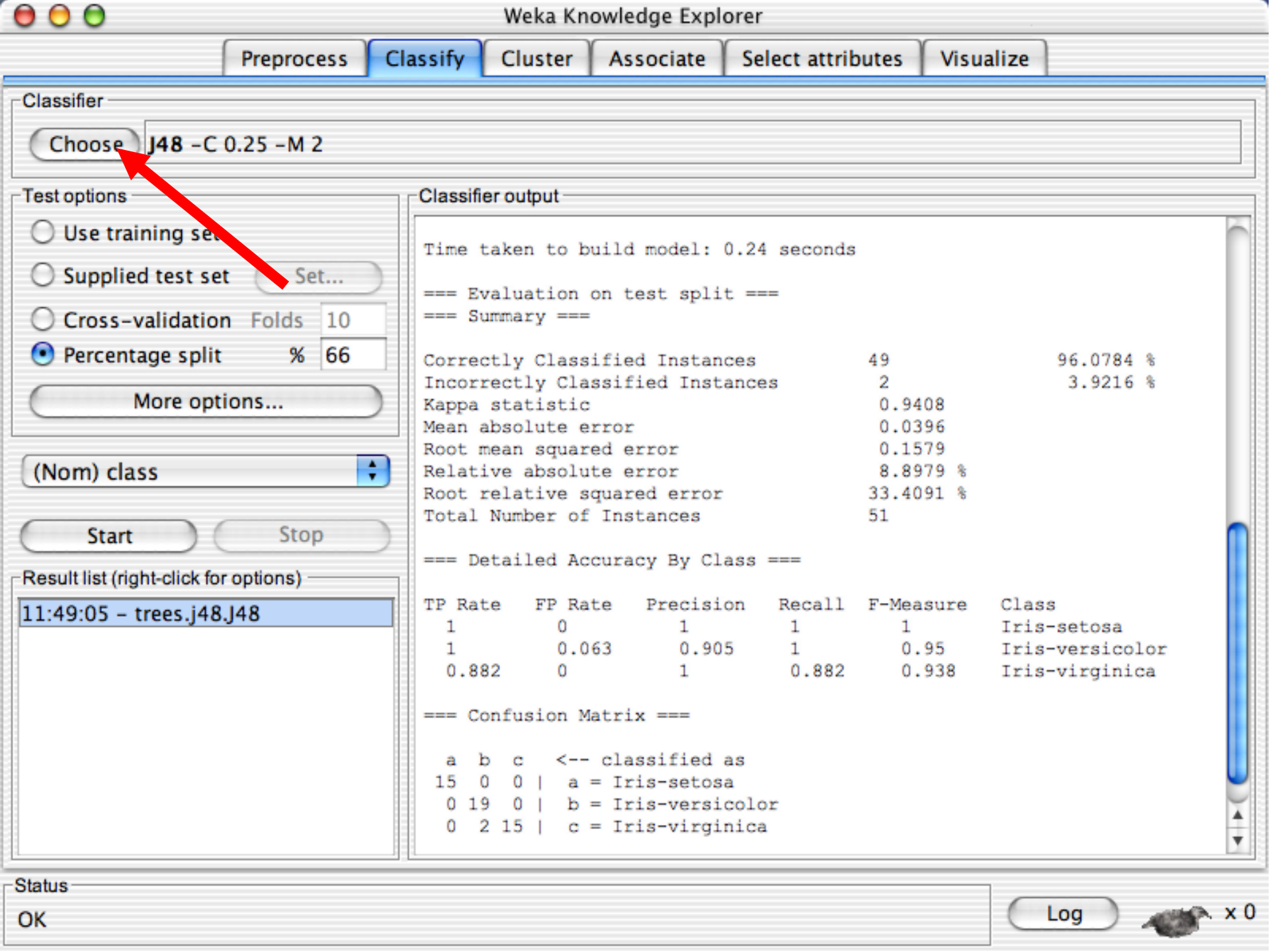

Weka Knowledge Explorer
Preprocess
Classify
Cluster
Associate
Select attributes
Visualize
Classifier
Choose
J48 -C 0.25 -M 2
Test options
Use training set
Supplied test set
Set...
Cross-validation
Folds
10
Percentage split
%
66
More options...
(Nom) class
Start
Stop
Result list (right-click for options)
11:49:05 - trees.j48.J48
Classifier output
Time taken to build model: 0.24 seconds
=== Evaluation on test split ===
=== Summary ===
Correctly Classified Instances 49 96.0784 %
Incorrectly Classified Instances 2 3.9216 %
Kappa statistic 0.9408
Mean absolute error 0.0396
Root mean squared error 0.1579
Relative absolute error 8.8979 %
Root relative squared error 33.4091 %
Total Number of Instances 51
=== Detailed Accuracy By Class ===
Recall F-Measure Class
1 1 Iris-setosa
1 0.95 Iris-versicolor
0.882 0.938 Iris-virginica
View in main window
View in separate window
Save result buffer
Load model
Save model
Re-evaluate model on current test set
Visualize classifer errors
Visualize tree
Visualize margin curve
Visualize threshold curve
Visualize cost curve
Status
OK
Log
x 0

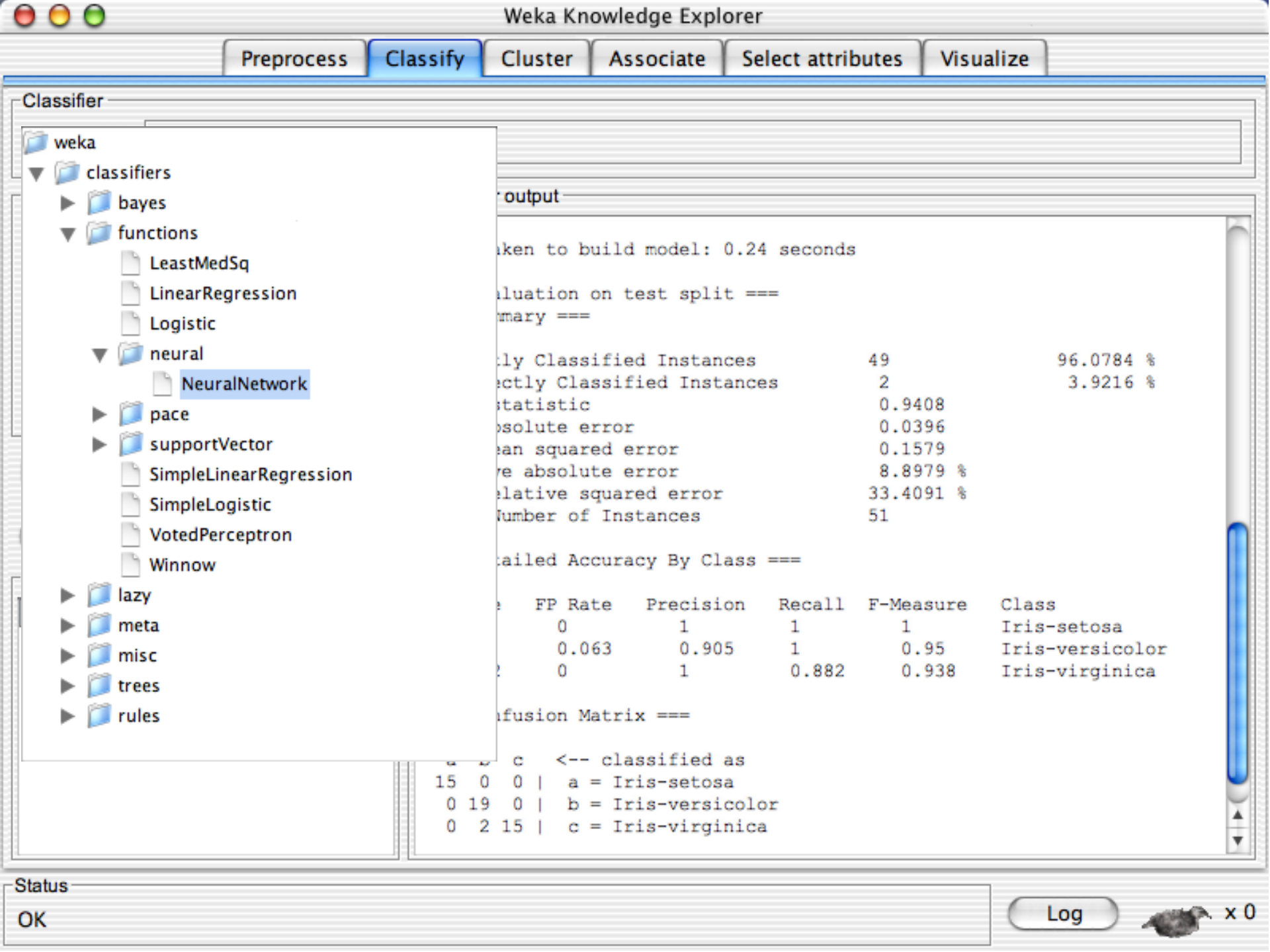

Weka Knowledge Explorer
Preprocess
Classify
Cluster
Associate
Select attributes
Visualize
Classifier
Choose
J48 -C 0.25 -M 2
Weka Classifier Tree Visualizer: 11:49:05 - trees.j48.J48 (iris)
Tree View
petalwidth
<= 0.6
> 0.6
Iris-setosa (50.0)
petalwidth
<= 1.7
> 1.7
petallength
Iris-virginica (46.0/1.0)
<= 4.9
> 4.9
Iris-versicolor (48.0/1.0)
petalwidth
<= 1.5
> 1.5
Iris-virginica (3.0)
Iris-versicolor (3.0/1.0)
Test options
Use training set
Supplied test set
Cross-validation
Percentage split
More optic
(Nom) class
Start
Result list (right-click for
11:49:05 - trees.j48.J
96.0784 %
3.9216 %
ass
is-setosa
is-versicolor
is-virginica
0 19 0 | b = Iris-versicolor
0 2 15 | c = Iris-virginica
Status
OK
Log
x 0


Weka Knowledge 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) class
Start
Stop
Result list (right-click for options)
11:49:05 - trees.j48.J48
Classifier output
Time taken to build model: 0.24 seconds
=== Evaluation on test split ===
=== Summary ===
Correctly Classified Instances 49 96.0784 %
Incorrectly Classified Instances 2 3.9216 %
Kappa statistic 0.9408
Mean absolute error 0.0396
Root mean squared error 0.1579
Relative absolute error 8.8979 %
Root relative squared error 33.4091 %
Total Number of Instances 51
=== Detailed Accuracy By Class ===
Recall F-Measure Class
1 1 Iris-setosa
1 0.95 Iris-versicolor
0.882 0.938 Iris-virginica
View in main window
View in separate window
Save result buffer
Load model
Save model
Re-evaluate model on current test set
Visualize classifer errors
Visualize tree
Visualize margin curve
Visualize threshold curve
Visualize cost curve
Status
OK
Log
x 0


Weka Knowledge Explorer
Preprocess
Classify
Cluster
Associate
Select attributes
Visualize
Classifier
Choose
J48 -C 0.25 -M 2
Test options
Use training set
Supplied test set
Cross-validation
Percentage split
More optic
(Nom) class
Start
Result list (right-click for
11:49:05 - trees.j48.J
Weka Classifier Visualize: 11:49:05 - trees.j48.J48 (iris)
X: petallength (Num)
Y: petalwidth (Num)
Colour: class (Nom)
Select Instance
Reset
Clear
Save
Jitter
Plot: iris_predicted
2.5
1.3
0.1
1.1
3.75
6.4
X
Y
Class colour
Iris-setosa Iris-versicolor Iris-virginica
96.0784 %
3.9216 %
ass
is-setosa
is-versicolor
is-virginica
0 2 15 | c = Iris-virginica
Status
OK
Log
x 0


Weka Knowledge 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) class
Start
Stop
Result list (right-click for options)
11:49:05 - trees.j48.J48
Classifier output
Time taken to build model: 0.24 seconds
=== Evaluation on test split ===
=== Summary ===
Correctly Classified Instances 49 96.0784 %
Incorrectly Classified Instances 2 3.9216 %
Kappa statistic 0.9408
Mean absolute error 0.0396
Root mean squared error 0.1579
Relative absolute error 8.8979 %
Root relative squared error 33.4091 %
Total Number of Instances 51
=== Detailed Accuracy By Class ===
TP Rate FP Rate Precision Recall F-Measure Class
1 0 1 1 1 Iris-setosa
1 0.063 0.905 1 0.95 Iris-versicolor
0.882 0 1 0.882 0.938 Iris-virginica
=== Confusion Matrix ===
a b c <-- classified as
15 0 0 | a = Iris-setosa
0 19 0 | b = Iris-versicolor
0 2 15 | c = Iris-virginica
Status
OK
Log
x 0


Weka Knowledge 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) class
Start
Stop
Result list (right-click for options)
11:49:05 - trees.j48.J48
Classifier output
Time taken to build model: 0.24 seconds
=== Evaluation on test split ===
=== Summary ===
Correctly Classified Instances 49 96.0784 %
Incorrectly Classified Instances 2 3.9216 %
Kappa statistic 0.9408
Mean absolute error 0.0396
Root mean squared error 0.1579
Relative absolute error 8.8979 %
Root relative squared error 33.4091 %
Total Number of Instances 51
=== Detailed Accuracy By Class ===
TP Rate FP Rate Precision Recall F-Measure Class
1 0 1 1 1 Iris-setosa
1 0.063 0.905 1 0.95 Iris-versicolor
0.882 0 1 0.882 0.938 Iris-virginica
=== Confusion Matrix ===
a b c <-- classified as
15 0 0 | a = Iris-setosa
0 19 0 | b = Iris-versicolor
0 2 15 | c = Iris-virginica
Status
OK
Log
x 0


Weka Knowledge Explorer
Preprocess
Classify
Cluster
Associate
Select attributes
Visualize
Classifier
weka
classifiers
bayes
functions
LeastMedSq
LinearRegression
Logistic
neural
NeuralNetwork
pace
supportVector
SimpleLinearRegression
SimpleLogistic
VotedPerceptron
Winnow
lazy
meta
misc
trees
rules
output
ken to build model: 0.24 seconds
luation on test split ===
mary ===
ly Classified Instances 49 96.0784 %
ctly Classified Instances 2 3.9216 %
statistic 0.9408
solute error 0.0396
an squared error 0.1579
e absolute error 8.8979 %
lative squared error 33.4091 %
Number of Instances 51
ailed Accuracy By Class ===
FP Rate Precision Recall F-Measure Class
0 1 1 1 Iris-setosa
0.063 0.905 1 0.95 Iris-versicolor
0 1 0.882 0.938 Iris-virginica
fusion Matrix ===
c <-- classified as
15 0 0 | a = Iris-setosa
0 19 0 | b = Iris-versicolor
0 2 15 | c = Iris-virginica
Status
OK
Log
x 0

Weka Knowledge Explorer

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

Classifier

Choose **NeuralNetwork** -L 0.3 -M 0.2 -N 500 -V 0 -S 0 -E 20 -H a

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)

11:49:05 - trees.j48.J48

Classifier output

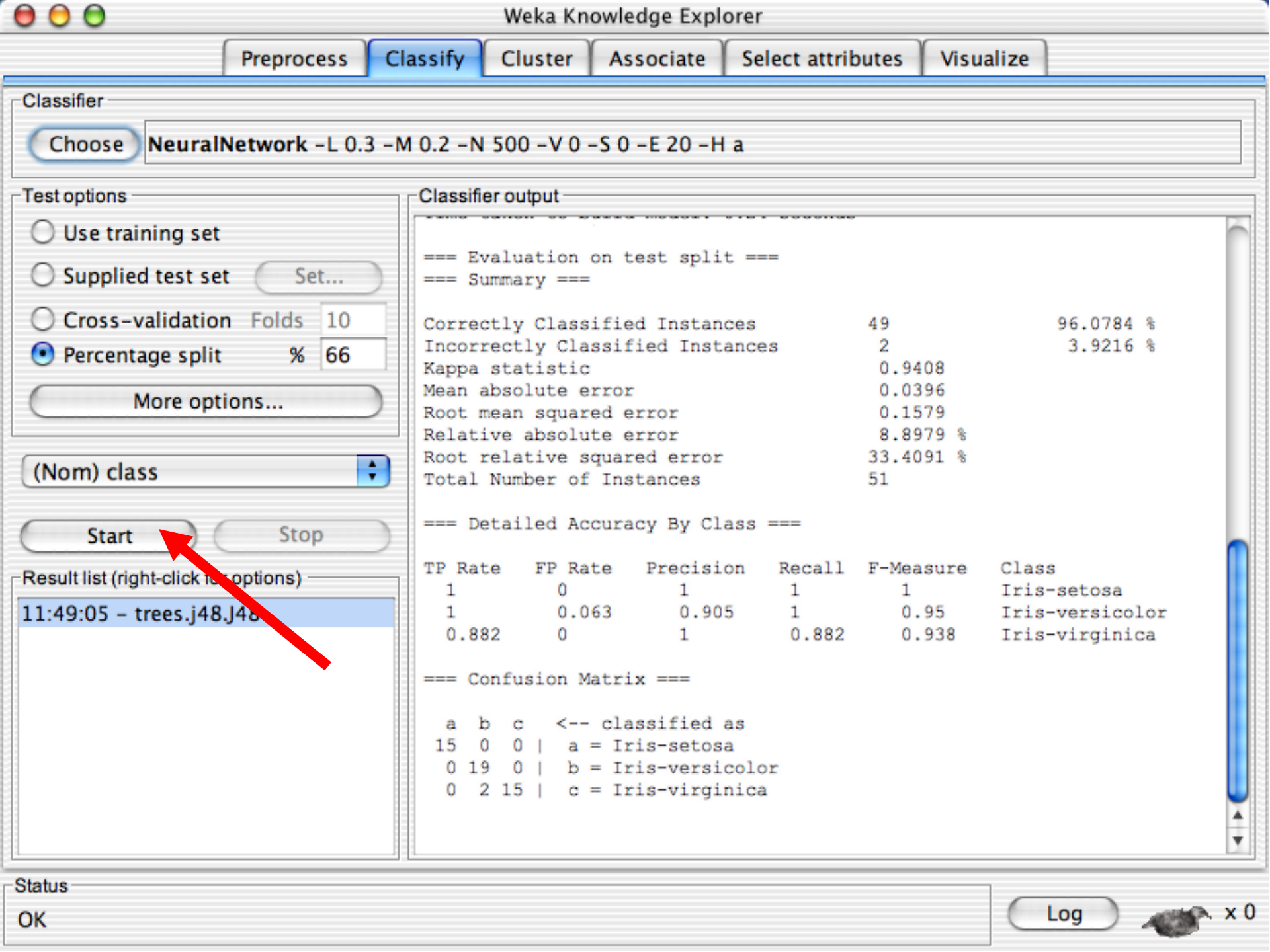
```
=== Evaluation on test split ===
=== Summary ===

Correctly Classified Instances          49               96.0784 %
Incorrectly Classified Instances         2                3.9216 %
Kappa statistic                          0.9408
Mean absolute error                      0.0396
Root mean squared error                  0.1579
Relative absolute error                  8.8979 %
Root relative squared error             33.4091 %
Total Number of Instances               51

=== Detailed Accuracy By Class ===

TP Rate   FP Rate   Precision   Recall  F-Measure   Class
  1          0          1          1          1        Iris-setosa
  1          0.063      0.905      1          0.95     Iris-versicolor
  0.882      0          1          0.882      0.938    Iris-virginica

=== Confusion Matrix ===

  a  b  c   <-- classified as
 15  0  0 |  a = Iris-setosa
  0 19  0 |  b = Iris-versicolor
  0  2 15 |  c = Iris-virginica
```

Status

OK

Log

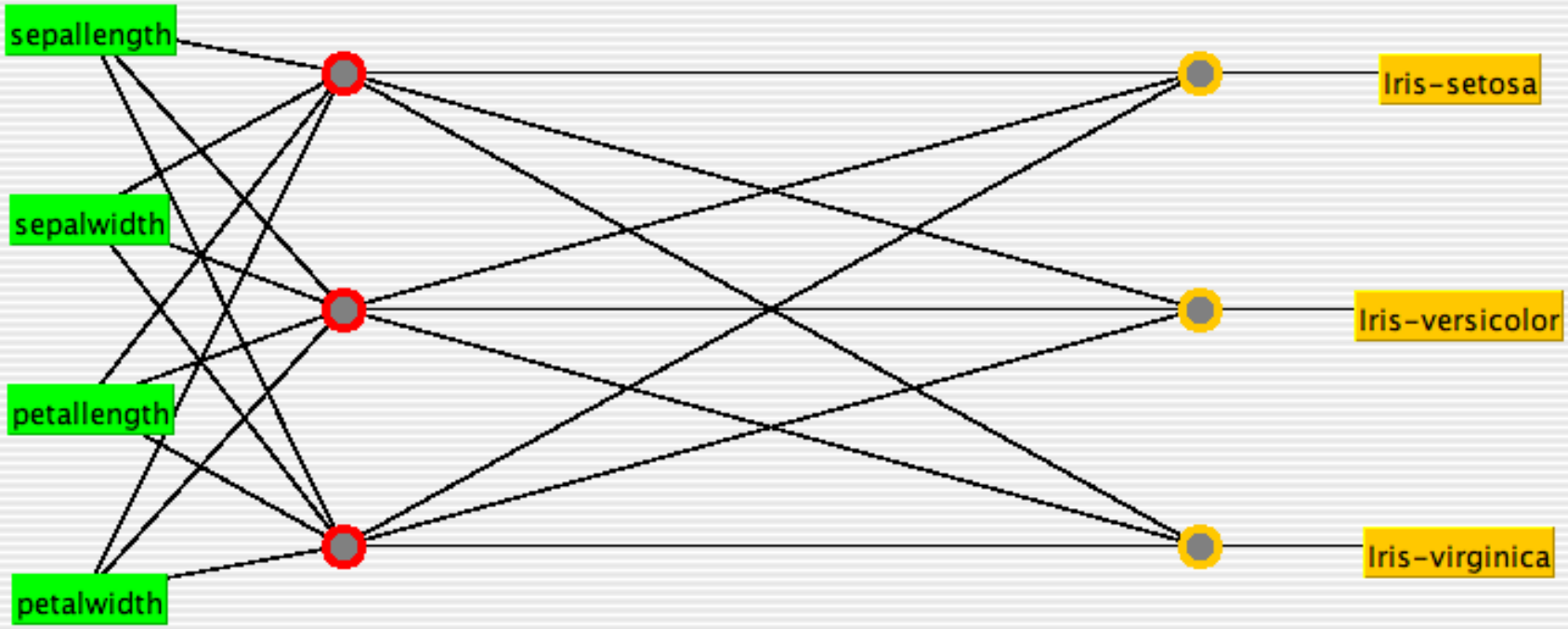
x 0


Weka Knowledge Explorer
Preprocess
Classify
Cluster
Associate
Select attributes
Visualize
Classifier
Choose
NeuralNetwork -L 0.3 -M 0.2 -N 500 -V 0 -S 0 -E 20 -H a
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)
11:49:05 - trees.j48.J48
Classifier output
=== Evaluation on test split ===
=== Summary ===
Correctly Classified Instances 49 96.0784 %
Incorrectly Classified Instances 2 3.9216 %
Kappa statistic 0.9408
Mean absolute error 0.0396
Root mean squared error 0.1579
Relative absolute error 8.8979 %
Root relative squared error 33.4091 %
Total Number of Instances 51
=== Detailed Accuracy By Class ===
TP Rate FP Rate Precision Recall F-Measure Class
1 0 1 1 1 Iris-setosa
1 0.063 0.905 1 0.95 Iris-versicolor
0.882 0 1 0.882 0.938 Iris-virginica
=== Confusion Matrix ===
a b c <-- classified as
15 0 0 | a = Iris-setosa
0 19 0 | b = Iris-versicolor
0 2 15 | c = Iris-virginica
Status
OK
Log
x 0

Weka Knowledge Explorer

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

Neural Network



Controls

Start

Accept

Epoch 0

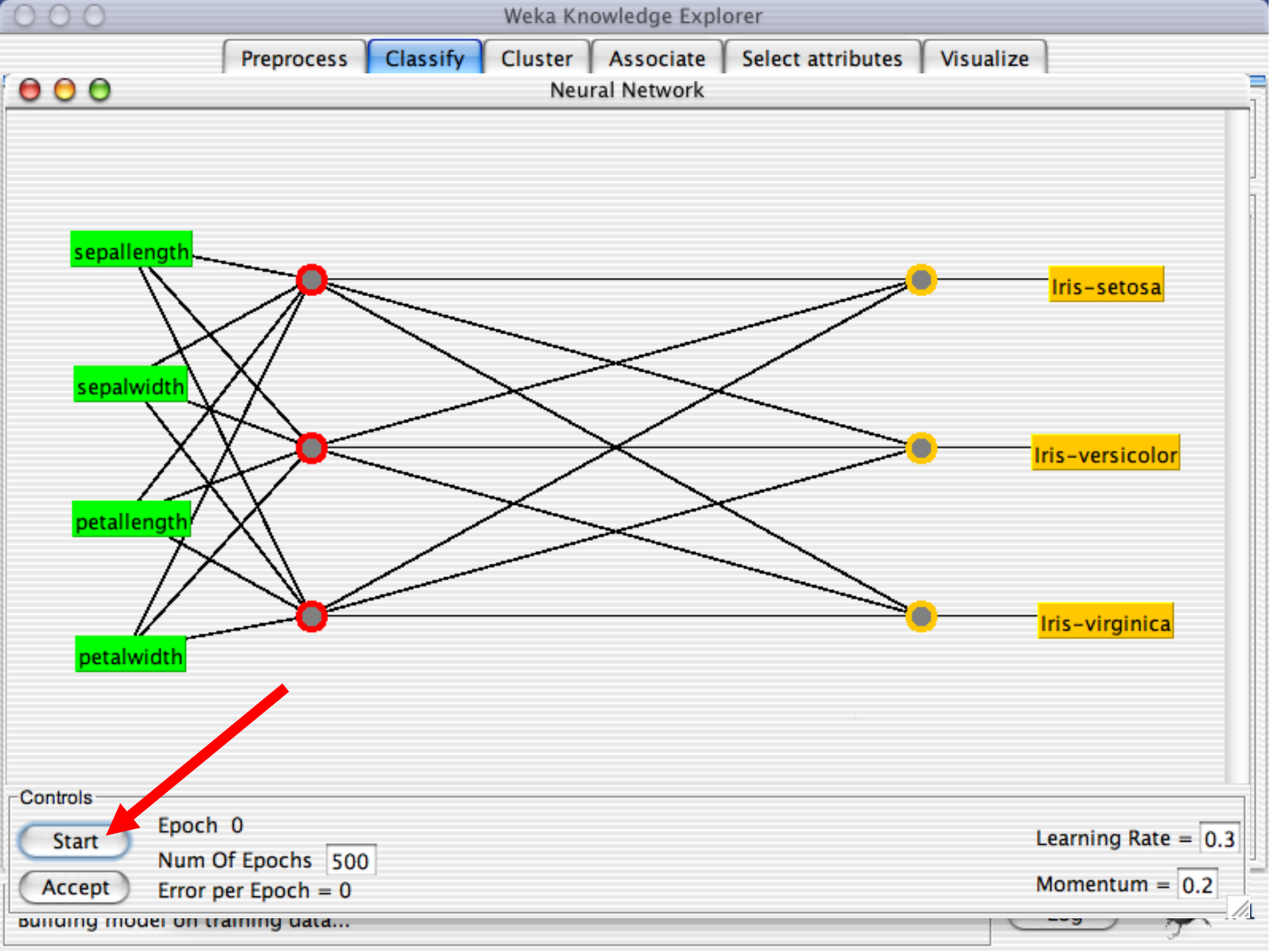
Num Of Epochs 500

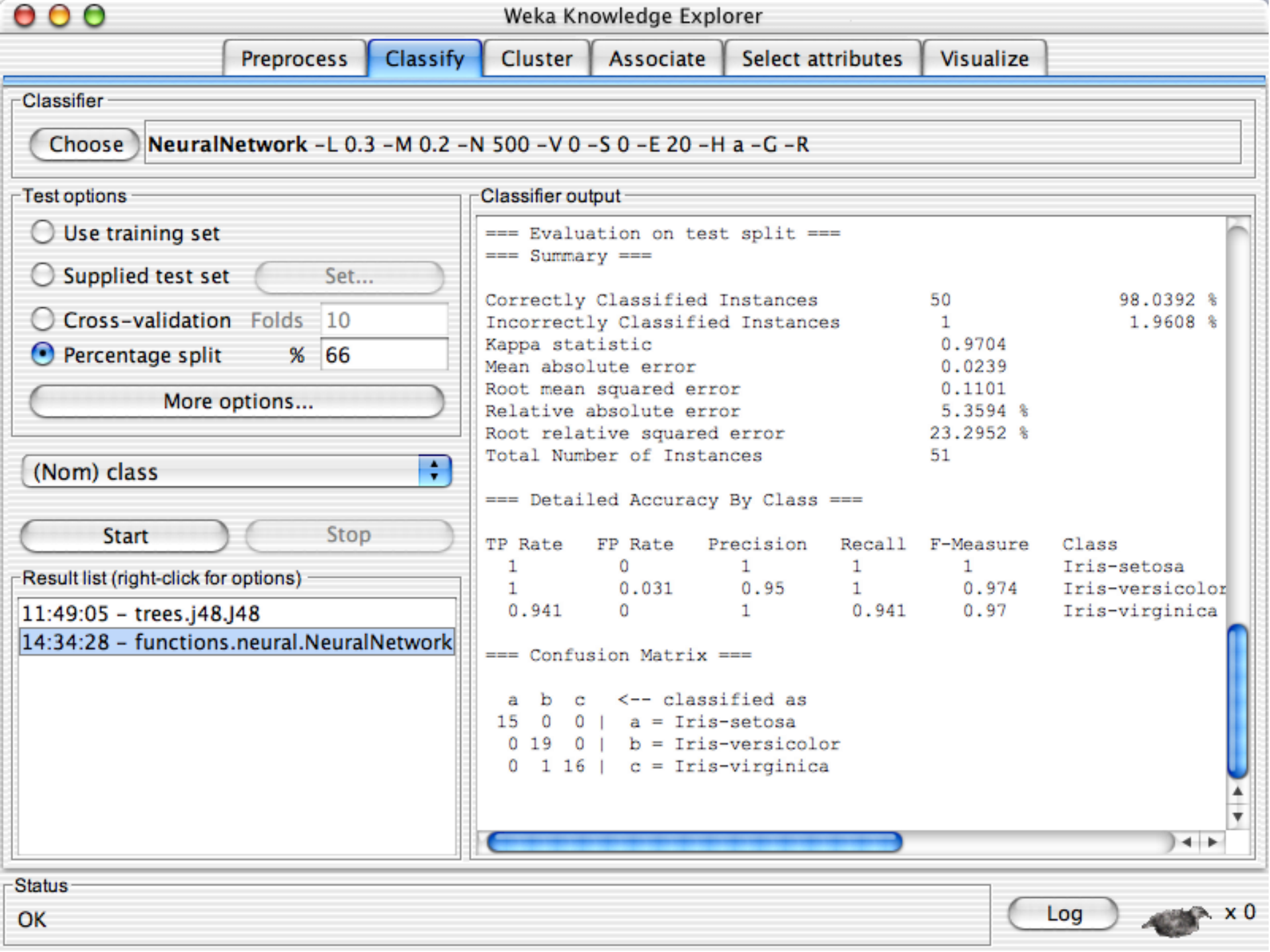
Error per Epoch = 0

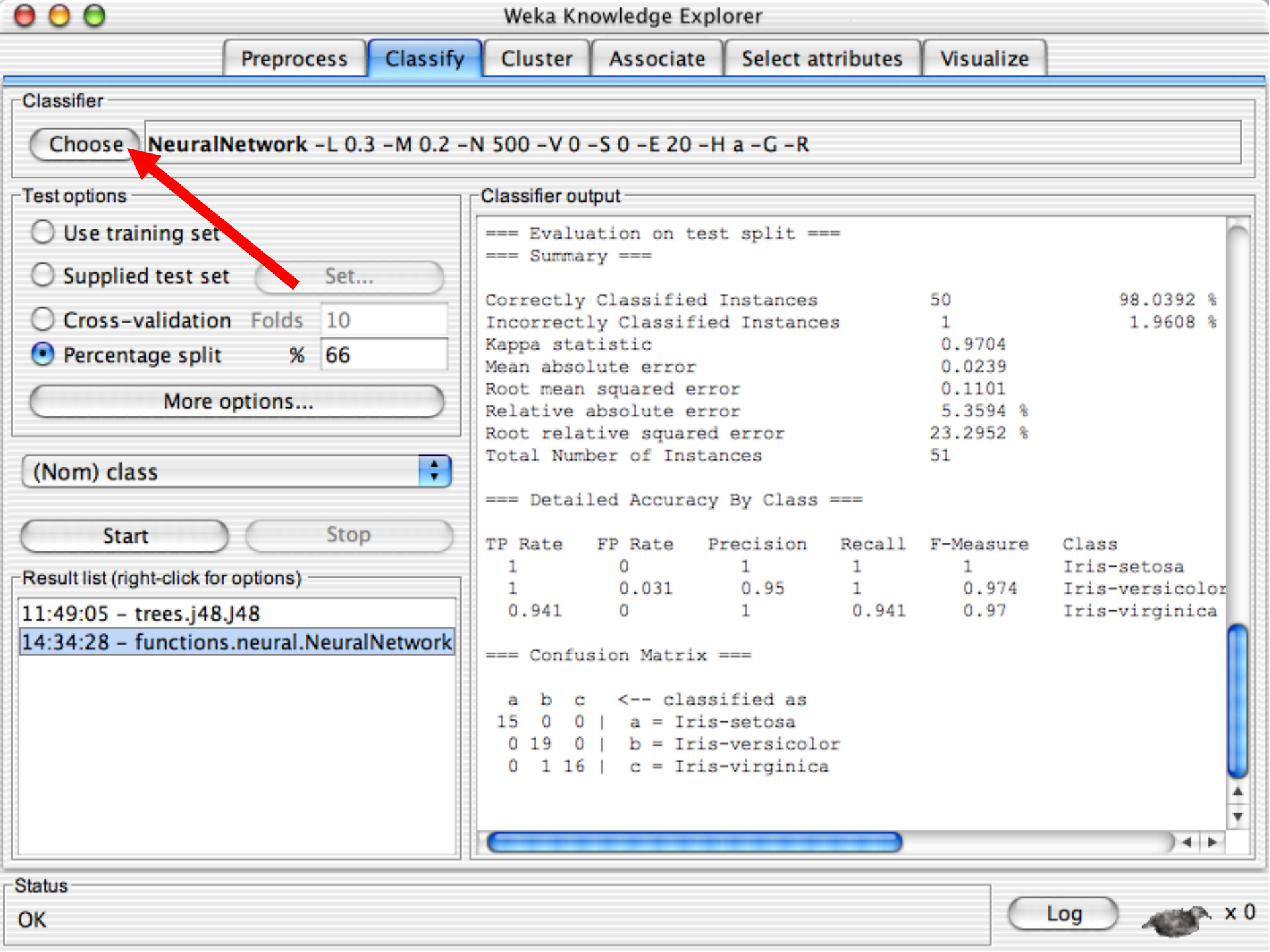
Learning Rate = 0.3

Momentum = 0.2

Building model on training data...


Weka Knowledge Explorer
Preprocess
Classify
Cluster
Associate
Select attributes
Visualize
Neural Network
sepallength
sepalwidth
petallength
petalwidth
Iris-setosa
Iris-versicolor
Iris-virginica
Controls
Start
Accept
Epoch 0
Num Of Epochs 500
Error per Epoch = 0
Learning Rate = 0.3
Momentum = 0.2


Weka Knowledge Explorer
Preprocess
Classify
Cluster
Associate
Select attributes
Visualize
Classifier
Choose
NeuralNetwork -L 0.3 -M 0.2 -N 500 -V 0 -S 0 -E 20 -H a -G -R
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)
11:49:05 - trees.j48.J48
14:34:28 - functions.neural.NeuralNetwork
Classifier output
=== Evaluation on test split ===
=== Summary ===
Correctly Classified Instances 50 98.0392 %
Incorrectly Classified Instances 1 1.9608 %
Kappa statistic 0.9704
Mean absolute error 0.0239
Root mean squared error 0.1101
Relative absolute error 5.3594 %
Root relative squared error 23.2952 %
Total Number of Instances 51
=== Detailed Accuracy By Class ===
TP Rate FP Rate Precision Recall F-Measure Class
1 0 1 1 1 Iris-setosa
1 0.031 0.95 1 0.974 Iris-versicolor
0.941 0 1 0.941 0.97 Iris-virginica
=== Confusion Matrix ===
a b c <-- classified as
15 0 0 | a = Iris-setosa
0 19 0 | b = Iris-versicolor
0 1 16 | c = Iris-virginica
Status
OK
Log
x 0


Weka Knowledge Explorer
Preprocess
Classify
Cluster
Associate
Select attributes
Visualize
Classifier
Choose
NeuralNetwork -L 0.3 -M 0.2 -N 500 -V 0 -S 0 -E 20 -H a -G -R
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)
11:49:05 - trees.j48.J48
14:34:28 - functions.neural.NeuralNetwork
Classifier output
=== Evaluation on test split ===
=== Summary ===
Correctly Classified Instances 50 98.0392 %
Incorrectly Classified Instances 1 1.9608 %
Kappa statistic 0.9704
Mean absolute error 0.0239
Root mean squared error 0.1101
Relative absolute error 5.3594 %
Root relative squared error 23.2952 %
Total Number of Instances 51
=== Detailed Accuracy By Class ===
TP Rate FP Rate Precision Recall F-Measure Class
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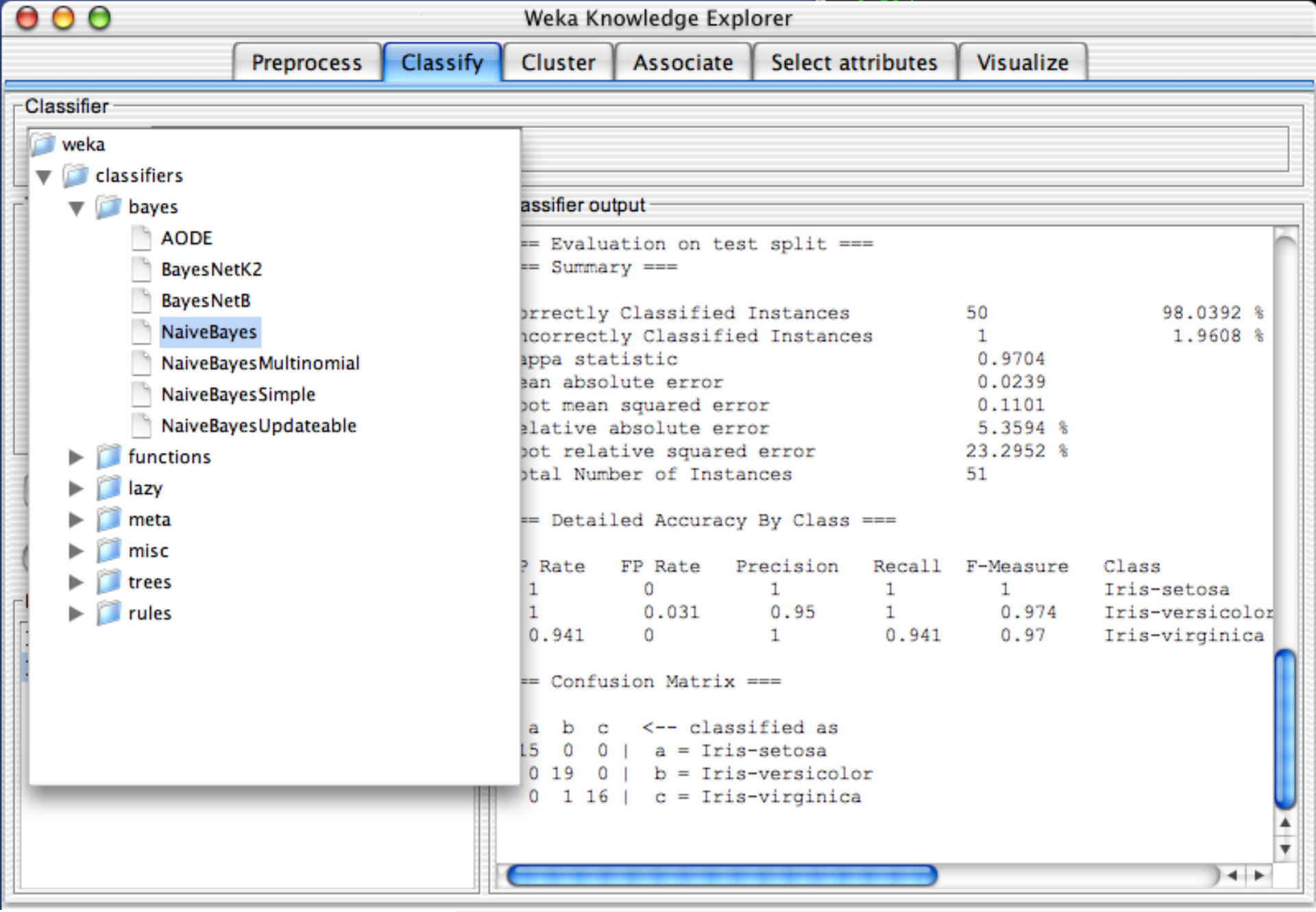
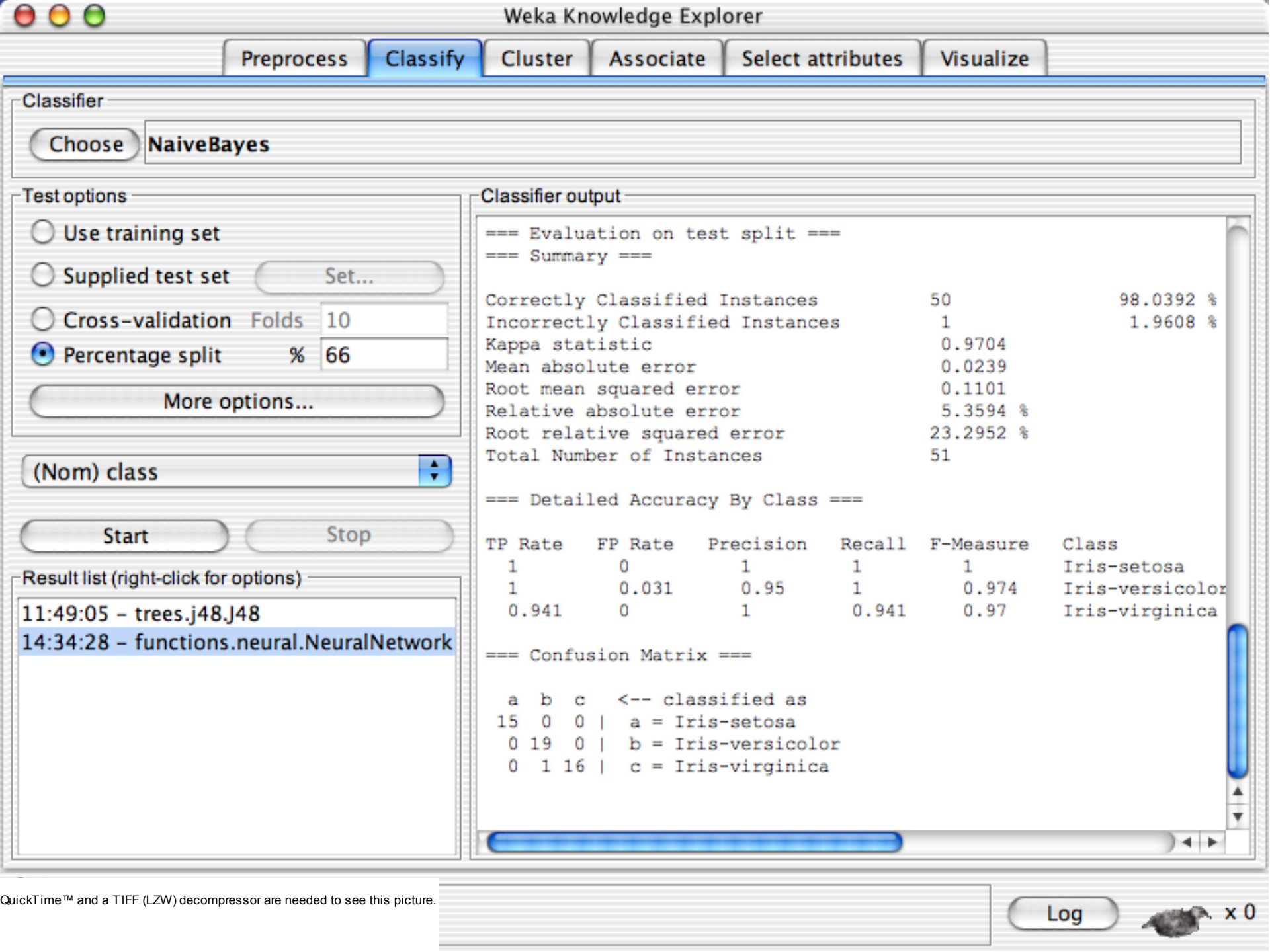
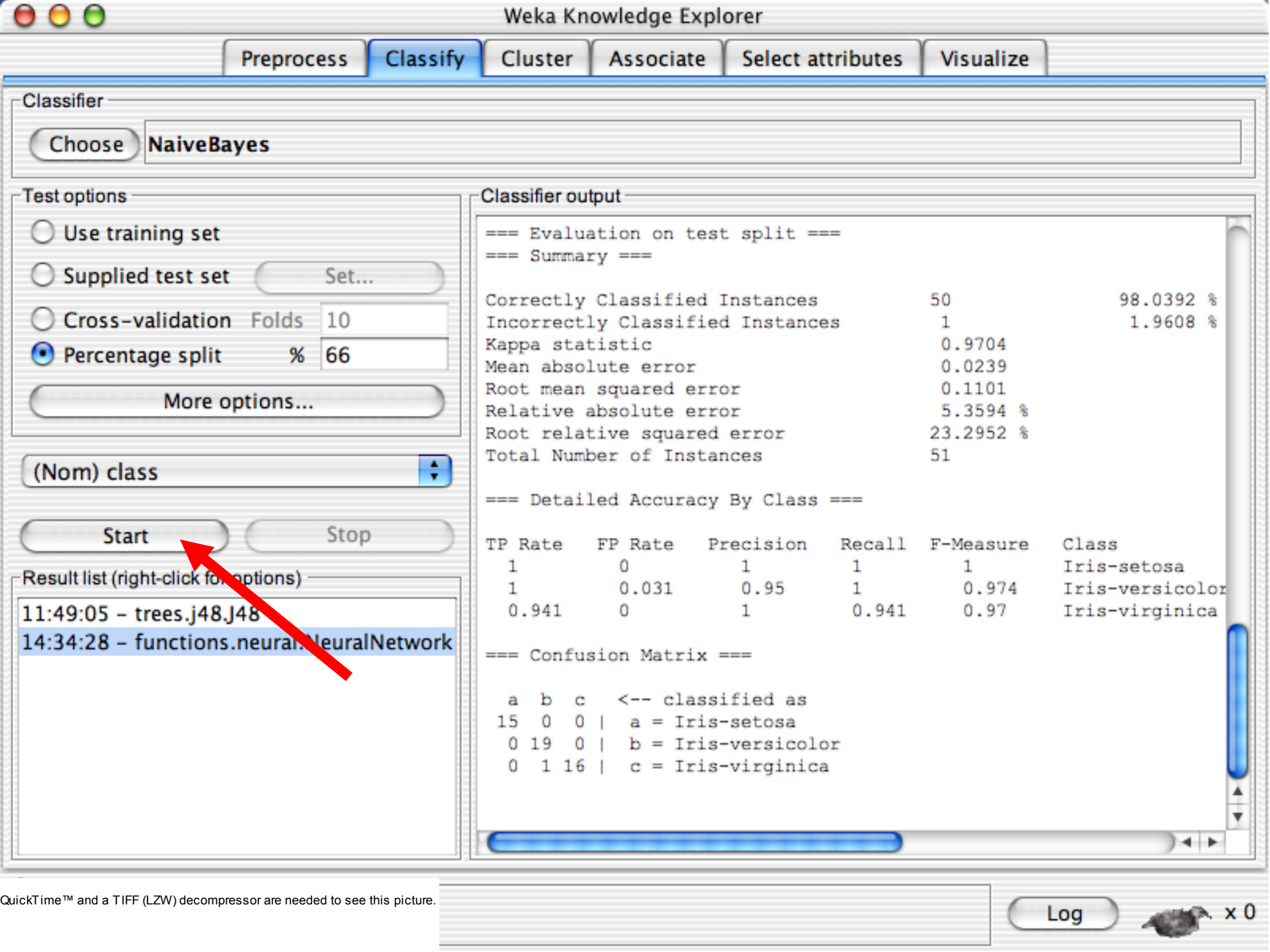
0.941 0 1 0.941 0.97 Iris-virginica
=== Confusion Matrix ===
a b c <-- classified as
15 0 0 | a = Iris-setosa
0 19 0 | b = Iris-versicolor
0 1 16 | c = Iris-virginica
Status
OK
Log
x 0

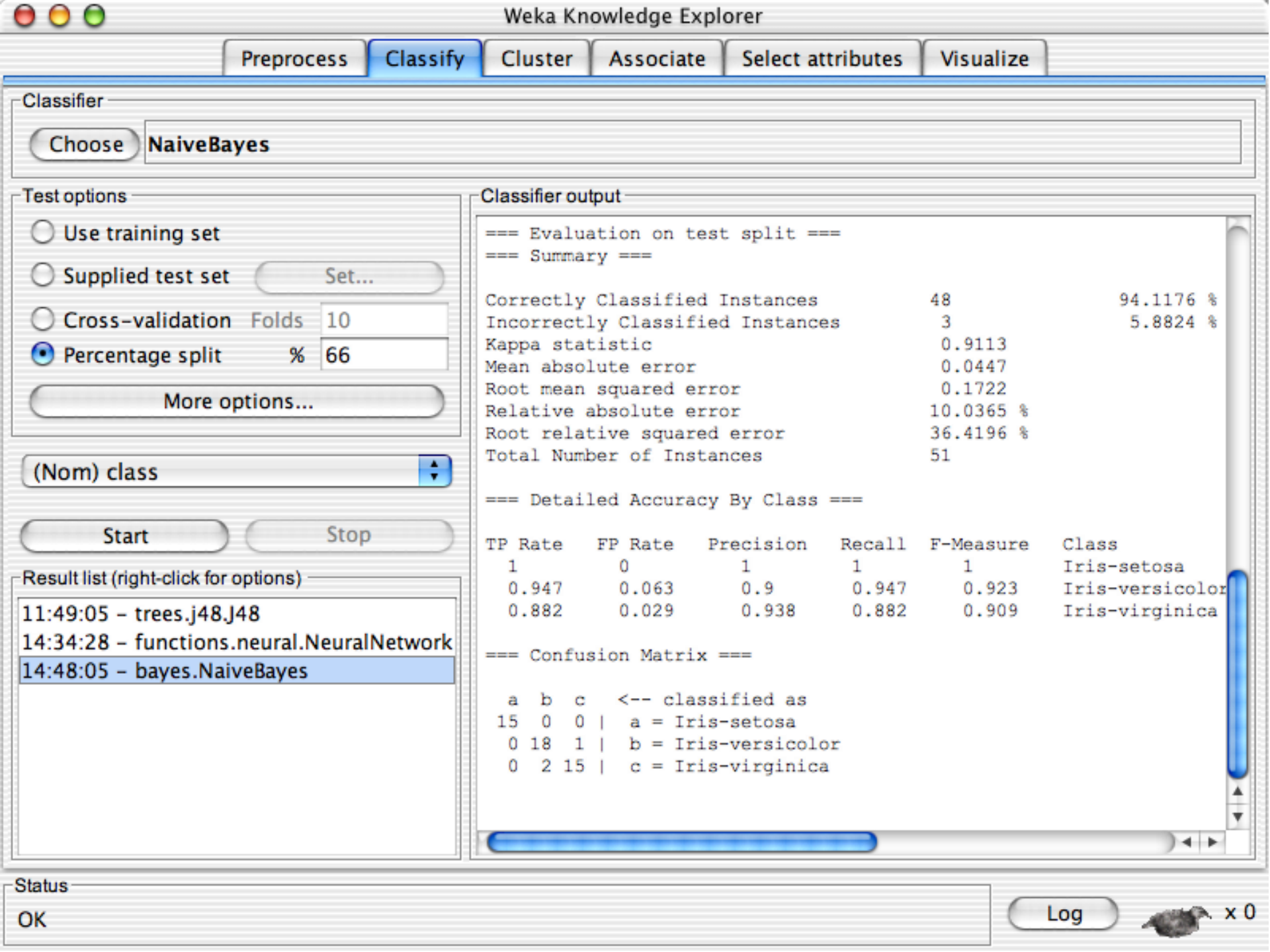


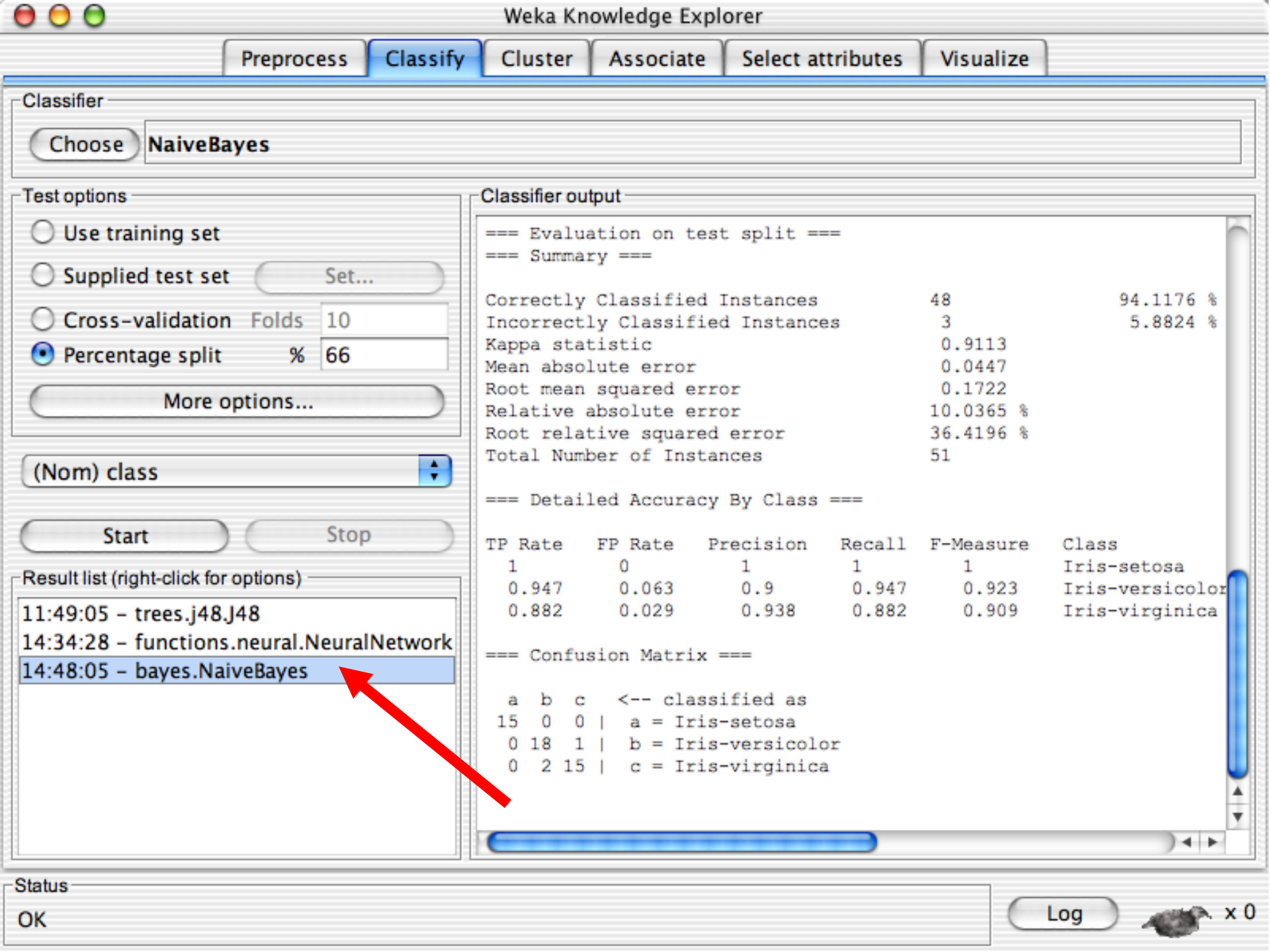
QuickTime™ and a TIFF (LZW) decompressor are needed to see this picture.


Weka Knowledge Explorer
Preprocess
Classify
Cluster
Associate
Select attributes
Visualize
Classifier
Choose
NaiveBayes
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)
11:49:05 - trees.j48.J48
14:34:28 - functions.neural.NeuralNetwork
Classifier output
=== Evaluation on test split ===
=== Summary ===
Correctly Classified Instances 50 98.0392 %
Incorrectly Classified Instances 1 1.9608 %
Kappa statistic 0.9704
Mean absolute error 0.0239
Root mean squared error 0.1101
Relative absolute error 5.3594 %
Root relative squared error 23.2952 %
Total Number of Instances 51
=== Detailed Accuracy By Class ===
TP Rate FP Rate Precision Recall F-Measure Class
1 0 1 1 1 Iris-setosa
1 0.031 0.95 1 0.974 Iris-versicolor
0.941 0 1 0.941 0.97 Iris-virginica
=== Confusion Matrix ===
a b c <-- classified as
15 0 0 | a = Iris-setosa
0 19 0 | b = Iris-versicolor
0 1 16 | c = Iris-virginica
QuickTime™ and a TIFF (LZW) decompressor are needed to see this picture.
Log
x 0



QuickTime™ and a TIFF (LZW) decompressor are needed to see this picture.


Weka Knowledge Explorer
Preprocess
Classify
Cluster
Associate
Select attributes
Visualize
Classifier
Choose
NaiveBayes
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)
11:49:05 - trees.j48.J48
14:34:28 - functions.neural.NeuralNetwork
14:48:05 - bayes.NaiveBayes
Classifier output
=== Evaluation on test split ===
=== Summary ===
Correctly Classified Instances 48 94.1176 %
Incorrectly Classified Instances 3 5.8824 %
Kappa statistic 0.9113
Mean absolute error 0.0447
Root mean squared error 0.1722
Relative absolute error 10.0365 %
Root relative squared error 36.4196 %
Total Number of Instances 51
=== Detailed Accuracy By Class ===
TP Rate FP Rate Precision Recall F-Measure Class
1 0 1 1 1 Iris-setosa
0.947 0.063 0.9 0.947 0.923 Iris-versicolor
0.882 0.029 0.938 0.882 0.909 Iris-virginica
=== Confusion Matrix ===
a b c <-- classified as
15 0 0 | a = Iris-setosa
0 18 1 | b = Iris-versicolor
0 2 15 | c = Iris-virginica
Status
OK
Log
x 0


Weka Knowledge Explorer
Preprocess
Classify
Cluster
Associate
Select attributes
Visualize
Classifier
Choose
NaiveBayes
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)
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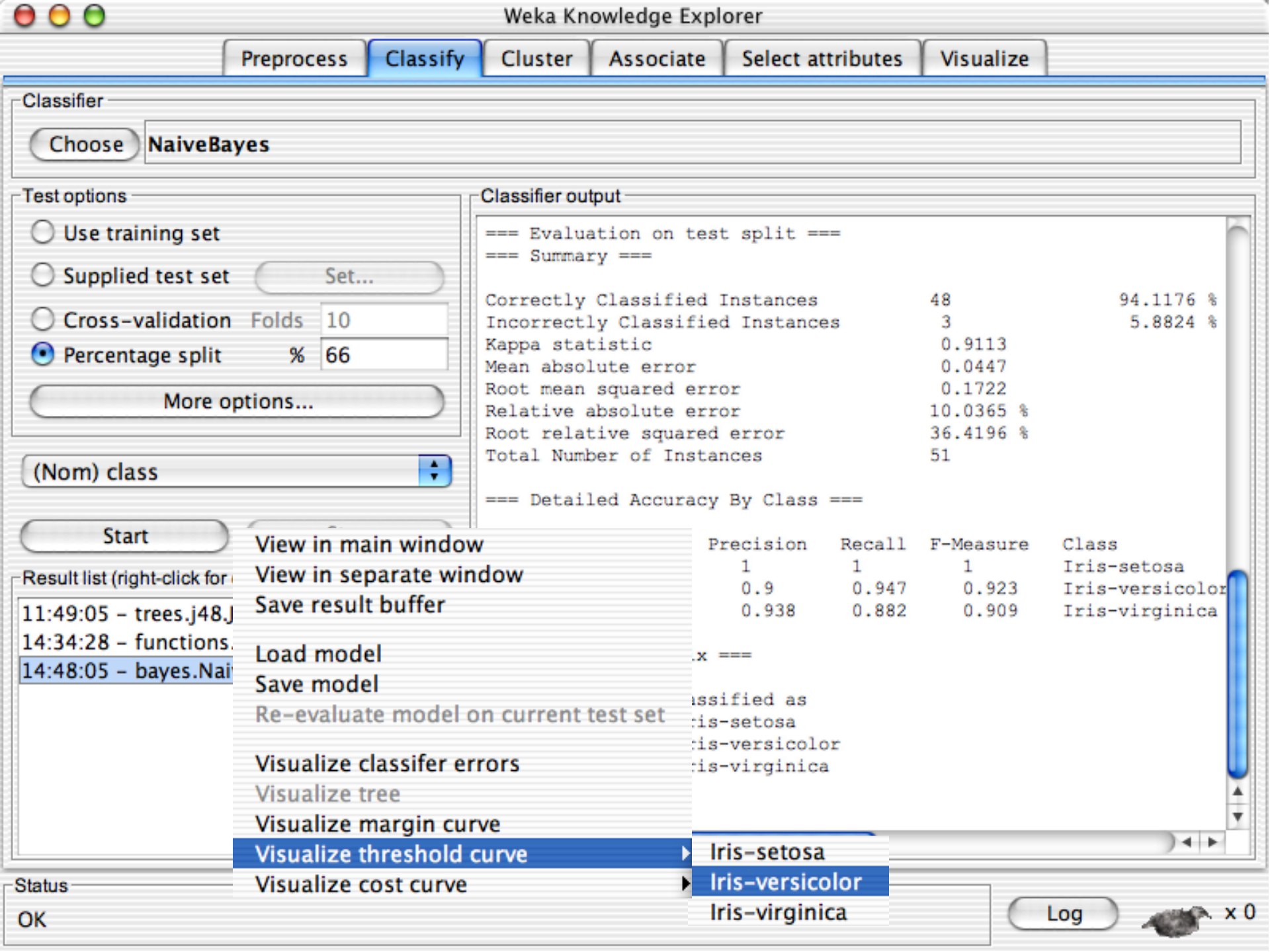
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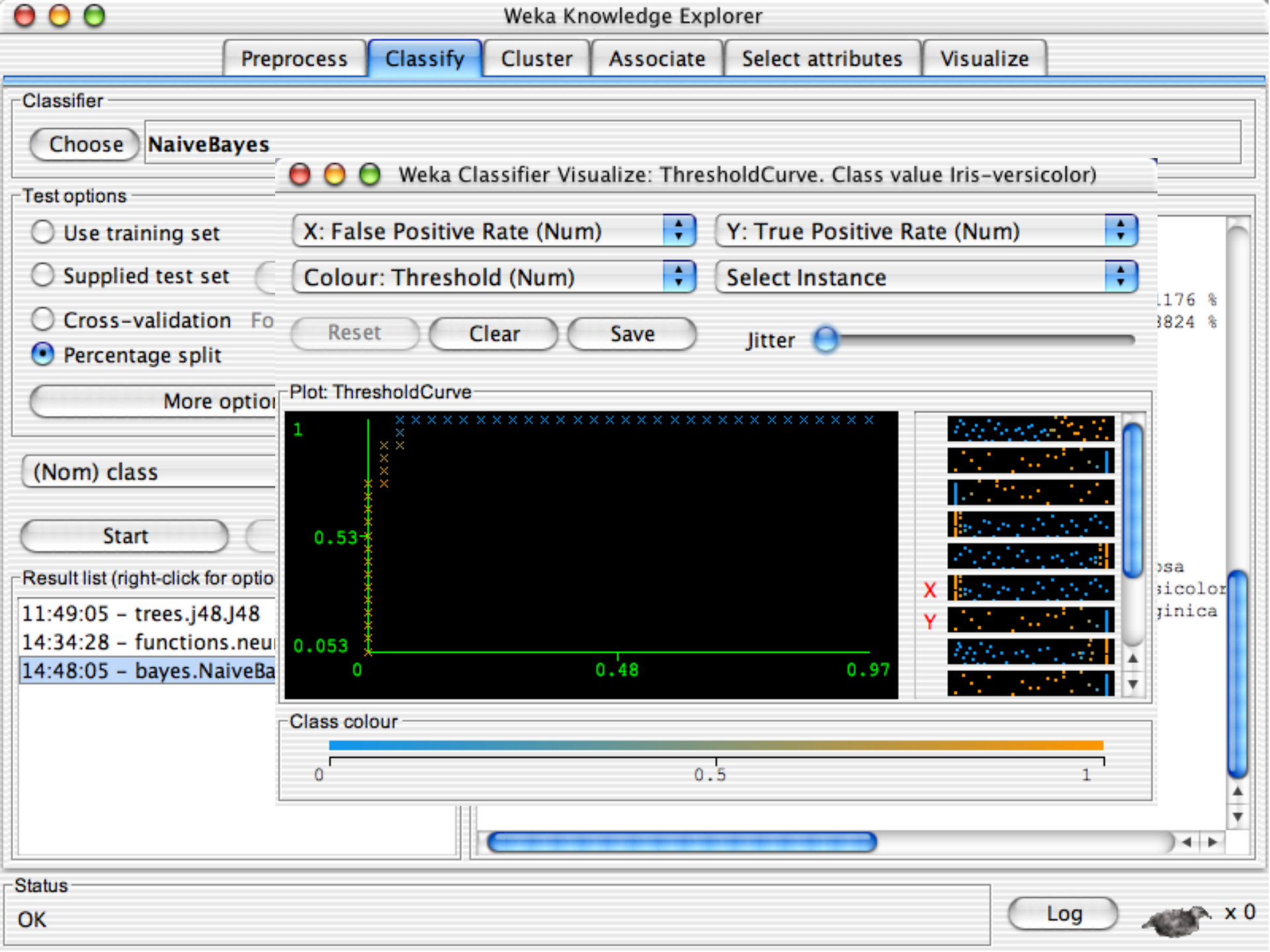
(Nom) class
Start
Result list (right-click for
11:49:05 - trees.j48.J
14:34:28 - functions.
14:48:05 - bayes.Nai
View in main window
View in separate window
Save result buffer
Load model
Save model
Re-evaluate model on current test set
Visualize classifer errors
Visualize tree
Visualize margin curve
Visualize threshold curve
Visualize cost curve
Iris-setosa
Iris-versicolor
Iris-virginica
Status
OK
Log
x 0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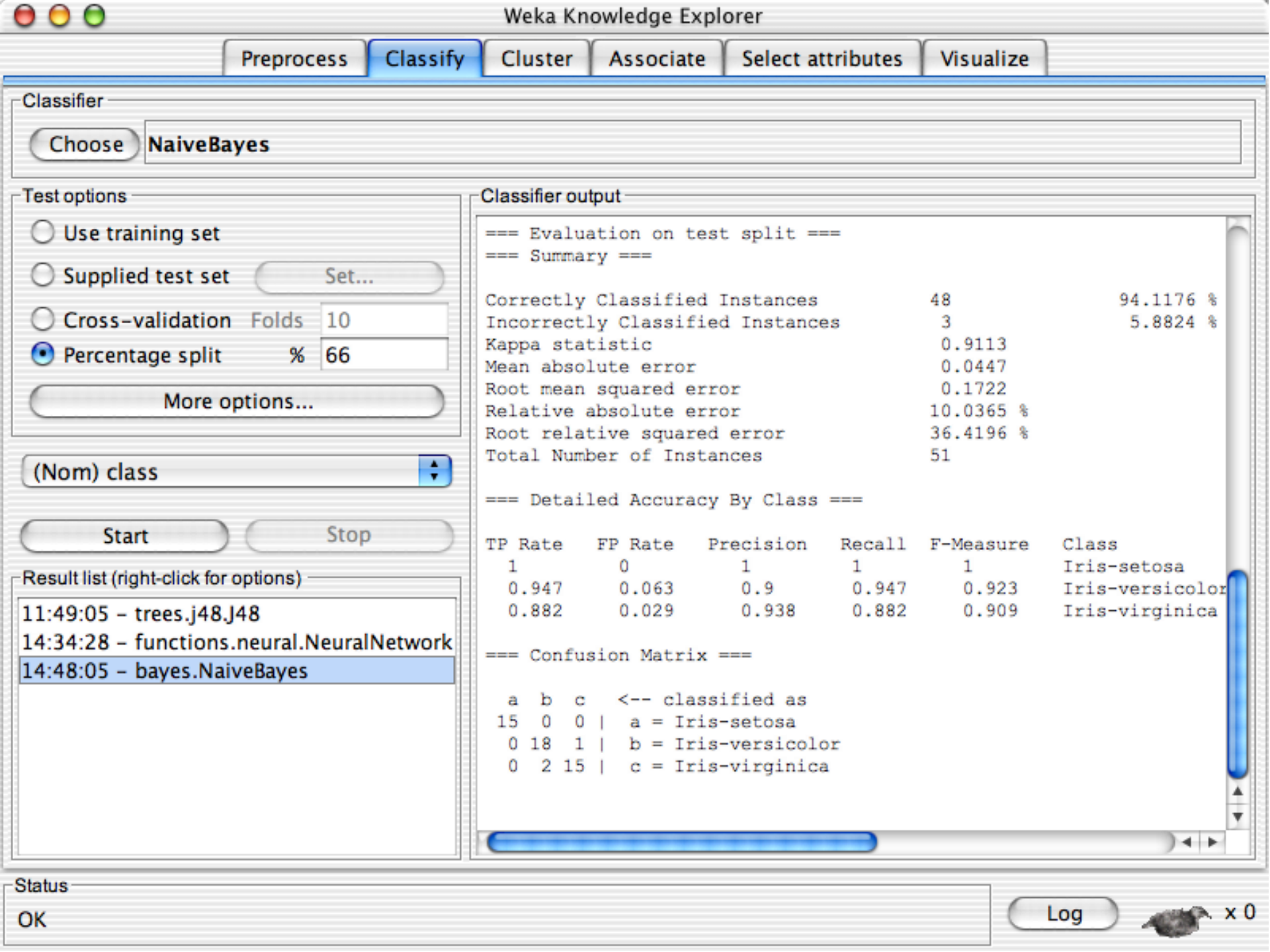
Percentage split
More optio
(Nom) class
Start
Result list (right-click for optio
11:49:05 - trees.j48.J48
14:34:28 - functions.neu
14:48:05 - bayes.NaiveBa
Weka Classifier Visualize: ThresholdCurve. Class value Iris-versicolor)
X: False Positive Rate (Num)
Y: True Positive Rate (Num)
Colour: Threshold (Num)
Select Instance
Reset
Clear
Save
Jitter
Plot: ThresholdCurve
1
0.53
0.053
0
0.48
0.97
X
Y
Class colour
0
0.5
1
Status
OK
Log
x 0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