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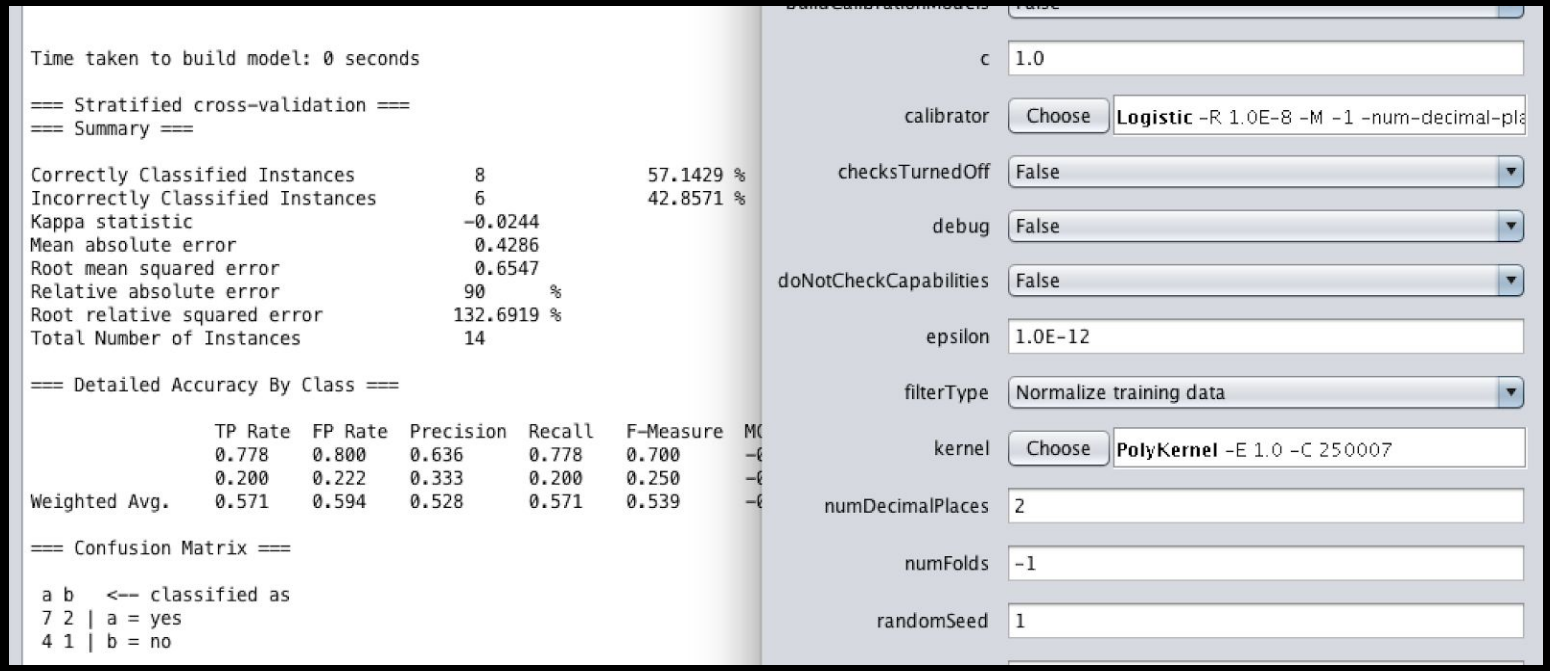
Lab #2: Support Vector Machines

UCSD Extension - Data Mining II Adv. Concepts & Techniques

1	What is a ‘support vector’? A support vector are the data points that lie closest to the decision plane
2	What is the “Kernel trick”? When data is not linearly separable in n dimensional space, the “kernel trick” transforms the problem into n+k space where k is a counting number. The “trick” part is that when transorming data to high dimensional space, we only need the inner product of each point in the higher dimensional space.
3	What is the hyperplane and how is it utilized in SVMs? The hyperplane is the region that devided the two solution spaces. Those points on one side of hyperplance are of class +1 and those on other side are class value -1.

4 Aanlyze the weather.arff data using Weka's Support Vector Machine method(Classifier.Functions.SMO)

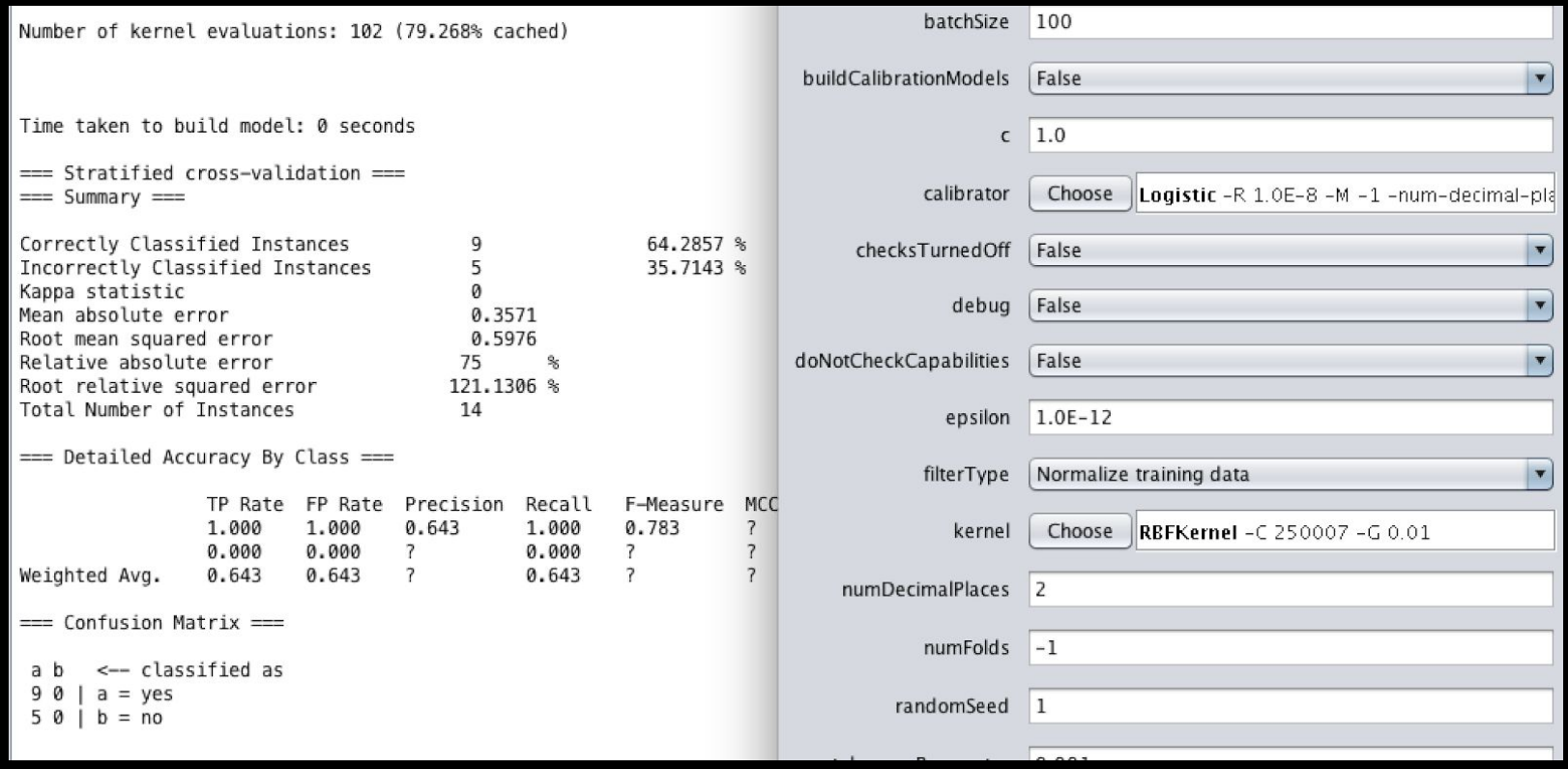
a. LNK Use PolyKernel = 1; How many support vectors were created? 6 Would you say the produced model is acceptable? NO Was it able to successfully learn both outcomes of the 'play' class attribute? NO



```
Time taken to build model: 0 seconds

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

Correctly Classified Instances           8               57.1429 %
Incorrectly Classified Instances         6               42.8571 %
Kappa statistic                         -0.0244
Mean absolute error                      0.4286
Root mean squared error                  0.6547
Relative absolute error                 90      %
Root relative squared error            132.6919 %
Total Number of Instances               14

=== Detailed Accuracy By Class ===

                 TP Rate  FP Rate  Precision  Recall   F-Measure  MC
                 0.778    0.800    0.636      0.778    0.700      -0
                 0.200    0.222    0.333      0.200    0.250      -0
Weighted Avg.    0.571    0.594    0.528      0.571    0.539      -0

=== Confusion Matrix ===

 a b   <-- classified as
 7 2 | a = yes
 4 1 | b = no
```

c	1.0
calibrator	Choose **Logistic** -R 1.0E-8 -M -1 -num-decimal-pla
checksTurnedOff	False
debug	False
doNotCheckCapabilities	False
epsilon	1.0E-12
filterType	Normalize training data
kernel	Choose **PolyKernel** -E 1.0 -C 250007
numDecimalPlaces	2
numFolds	-1
randomSeed	1

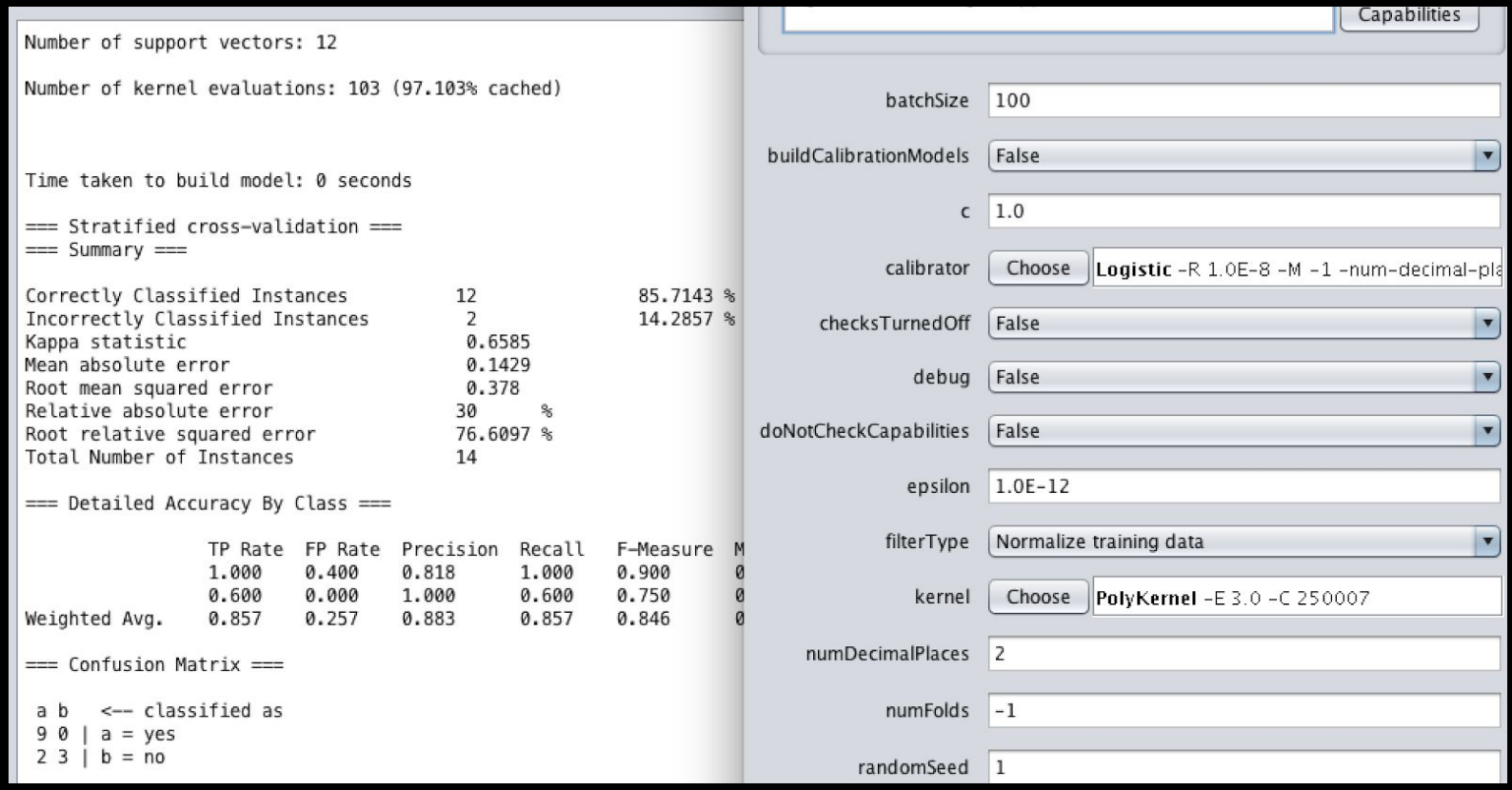
b. LNK Change the parameter Kernel to "RBF Kernel: What has changed in the output? How many support vectors? 10 Was the learning successful? NO Were both outcomes of 'play' successfully learned? NO, yes @ 64%, but NO @ 35%



```
Number of kernel evaluations: 102 (79.268% cached)



Time taken to build model: 0 seconds

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

Correctly Classified Instances           9               64.2857 %
Incorrectly Classified Instances         5               35.7143 %
Kappa statistic                          0
Mean absolute error                      0.3571
Root mean squared error                  0.5976
Relative absolute error                 75      %
Root relative squared error            121.1306 %
Total Number of Instances               14

=== Detailed Accuracy By Class ===

                 TP Rate  FP Rate  Precision  Recall   F-Measure  MCC
                 1.000    1.000    0.643      1.000    0.783      ?
                 0.000    0.000    ?          0.000    ?          ?
Weighted Avg.    0.643    0.643    ?          0.643    ?          ?

=== Confusion Matrix ===

 a b   <-- classified as
 9 0 | a = yes
 5 0 | b = no
```

batchSize	100
buildCalibrationModels	False
c	1.0
calibrator	Choose **Logistic** -R 1.0E-8 -M -1 -num-decimal-pla
checksTurnedOff	False
debug	False
doNotCheckCapabilities	False
epsilon	1.0E-12
filterType	Normalize training data
kernel	Choose **RBFKernel** -C 250007 -G 0.01
numDecimalPlaces	2
numFolds	-1
randomSeed	1

c. LNK Change the parameter Kernel to “Poly Kernel: = 2 or 3; Describe and explain the output? Using 3 as exponent I got the best performance yet. It also gave me the most number of kernel evaluations at 103 of which 97% where previously calculated(cached) How many suppport vectors were created? 12 Why was the number of kernel evaluations increased? Because the hyperplane(decision boundary) increased in number of dimensional space. Was the learning successful? No, not totally. Were both outcomes of ‘play’ successfully learned? No How accurate is the model? 85.7% accurate

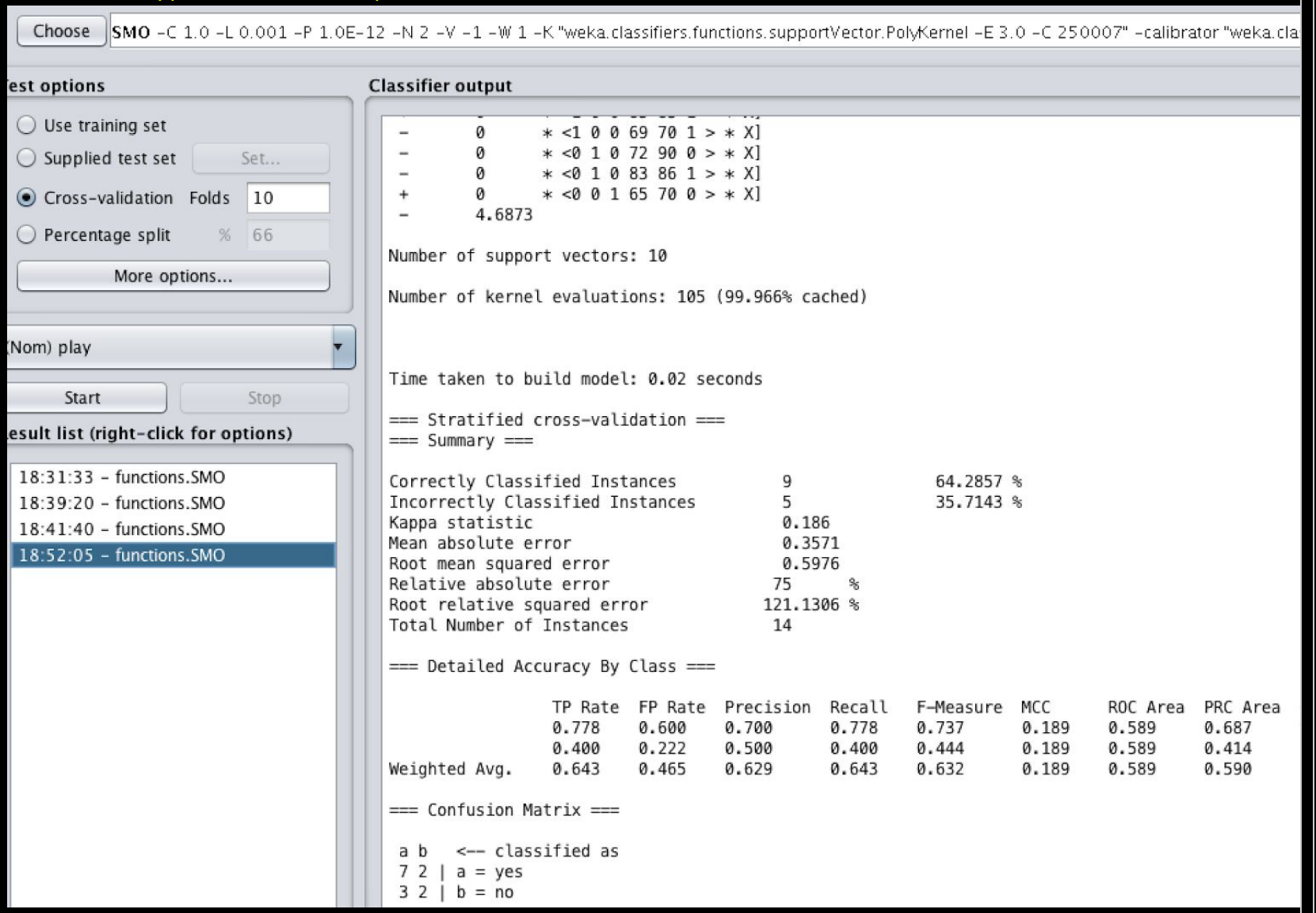


```
Number of support vectors: 12

Number of kernel evaluations: 103 (97.103% cached)



Time taken to build model: 0 seconds

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

Correctly Classified Instances          12               85.7143 %
Incorrectly Classified Instances         2               14.2857 %
Kappa statistic                          0.6585
Mean absolute error                      0.1429
Root mean squared error                  0.378
Relative absolute error                 30      %
Root relative squared error             76.6097 %
Total Number of Instances               14

=== Detailed Accuracy By Class ===

                 TP Rate  FP Rate  Precision  Recall   F-Measure  M
                 1.000    0.400    0.818      1.000    0.900      0
                 0.600    0.000    1.000      0.600    0.750      0
Weighted Avg.    0.857    0.257    0.883      0.857    0.846      0

=== Confusion Matrix ===

 a b   <-- classified as
 9 0 | a = yes
 2 3 | b = no
```

Capabilities

batchSize	100
buildCalibrationModels	False
c	1.0
calibrator	Choose **Logistic** -R 1.0E-8 -M -1 -num-decimal-pla
checksTurnedOff	False
debug	False
doNotCheckCapabilities	False
epsilon	1.0E-12
filterType	Normalize training data
kernel	Choose **PolyKernel** -E 3.0 -C 250007
numDecimalPlaces	2
numFolds	-1
randomSeed	1

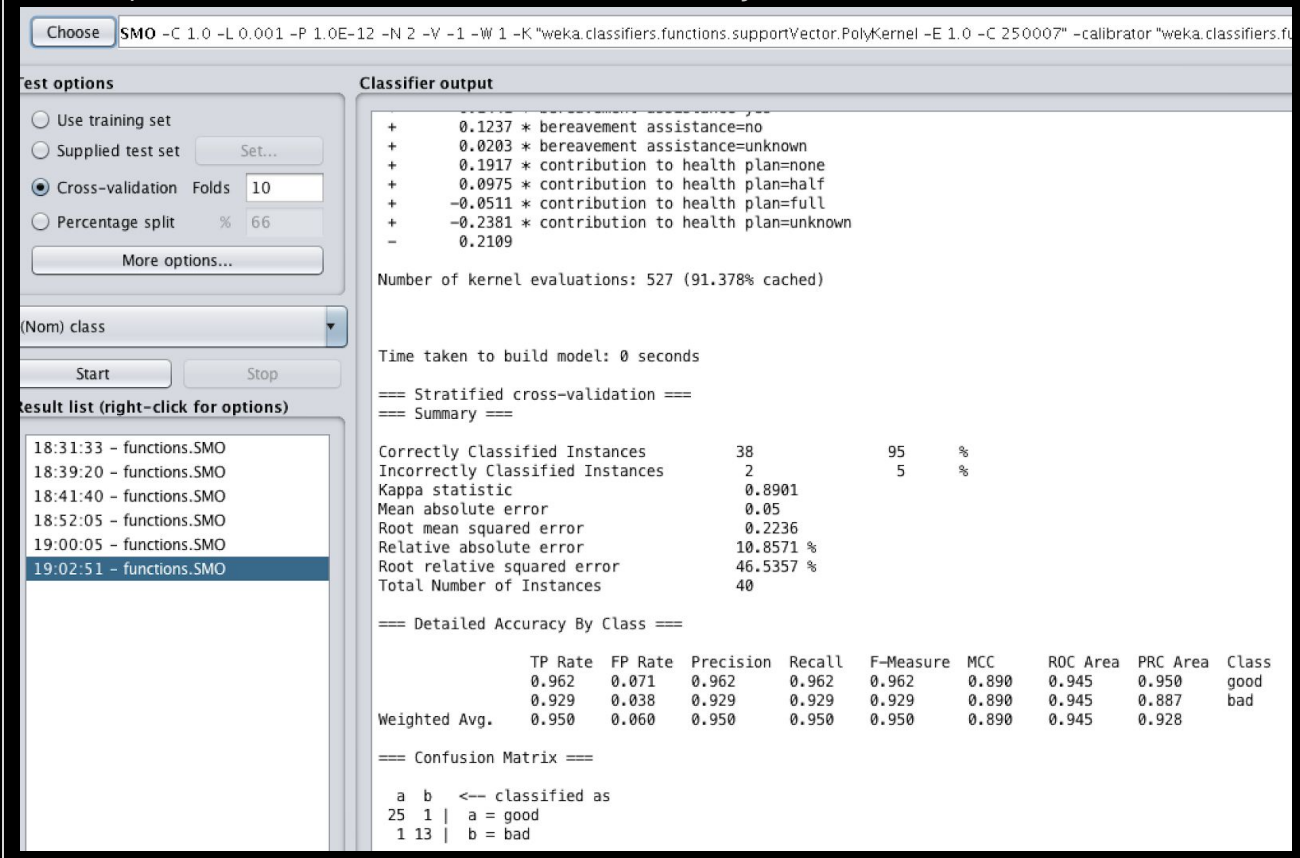
d. LNK What happens when you choose no normalization/standardization under the filter parameter? The number of support vectors drops and the model is not as accurate.



e. Which of the three models would you choose? I would choose the Poly Kernel with E=3. It is the most accurate model.

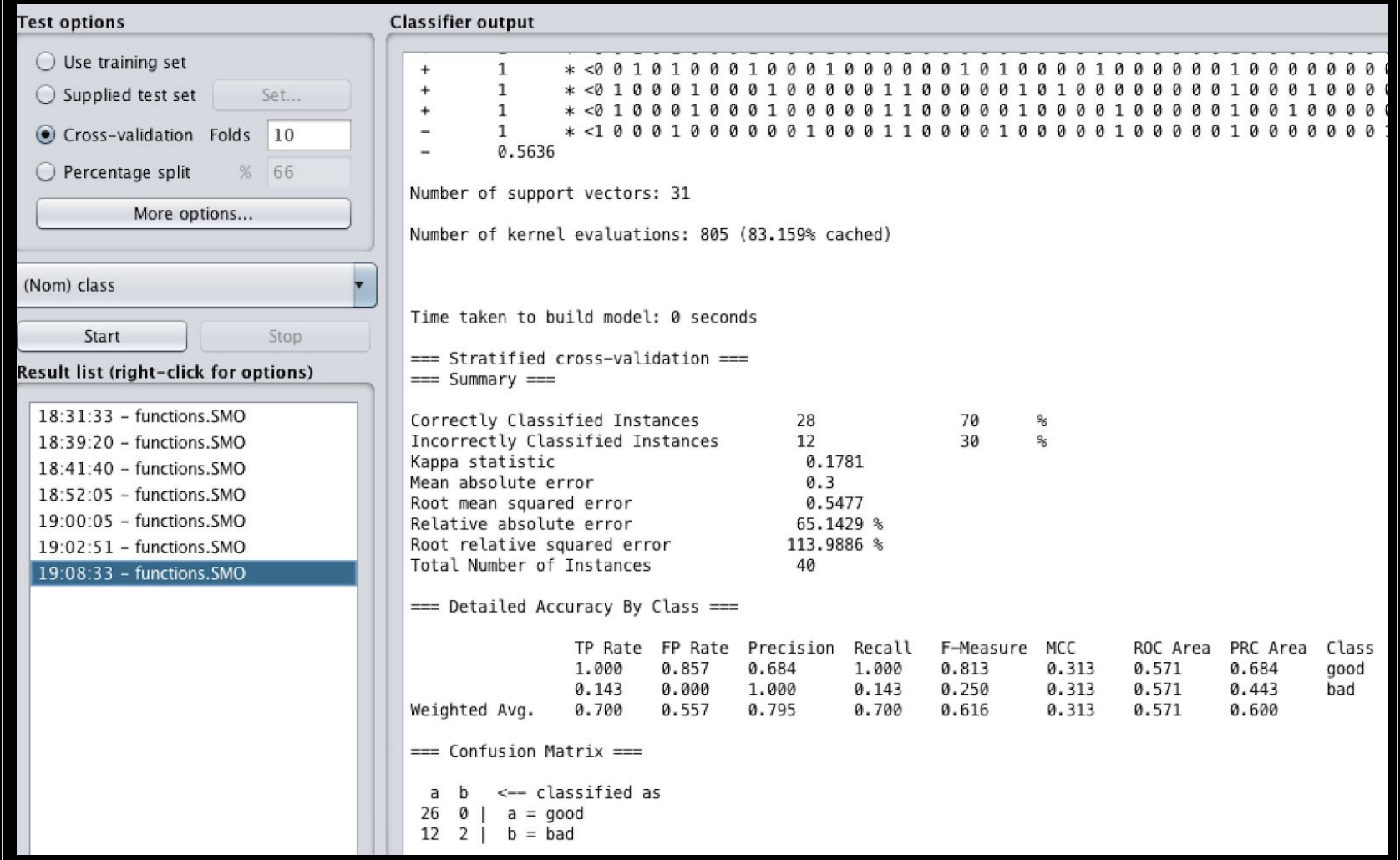
5 Perform the same analysis on the Labor data set. Compare and contrast model/output between the two training data sets. Consider the class balance and size of the training data set.

a LNK Use PolyKernel = 1; How many support vectors were created? 63 Would you say the produced model is acceptable? YES Was it able to successfully learn both outcomes of the 'class' attribute? NO



b

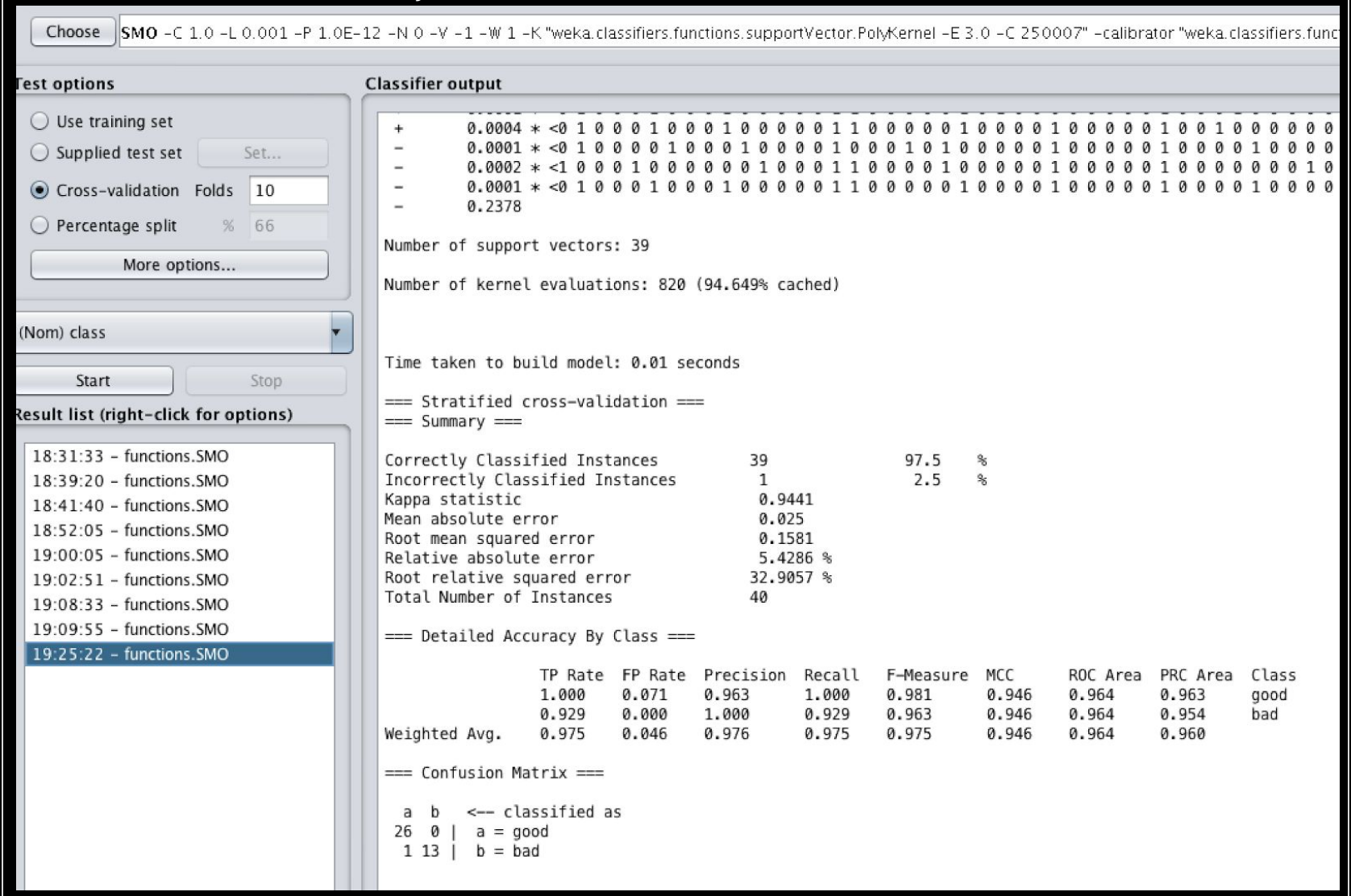
LNK Change the parameter Kernel to “RBF Kernel: What has changed in the output? The support vectors look like eigenvalues(0 or 1 coefficients) How many support vectors? 31 Was the learning successful? NO Were both outcomes of ‘class’ successfully learned? NO, good at 70% and bad at 30%



c

LNK Change the parameter Kernel to “Poly Kernel: = 2 or 3; Describe and explain the output? Using 3 as exponent I got the best performance yet. It also gave me the most number of kernel evaluations at 820 of which 94.6% where previously calculated(cached) How many suppport vectors were created? 39 Why was the number of kernel evaluations increased? Because the hyperplane(decision boundary)

increased in number of dimensional space. Was the learning successful? No, but almost. Were both outcomes of ‘class’ successfully learned? No How accurate is the model? 97.5%



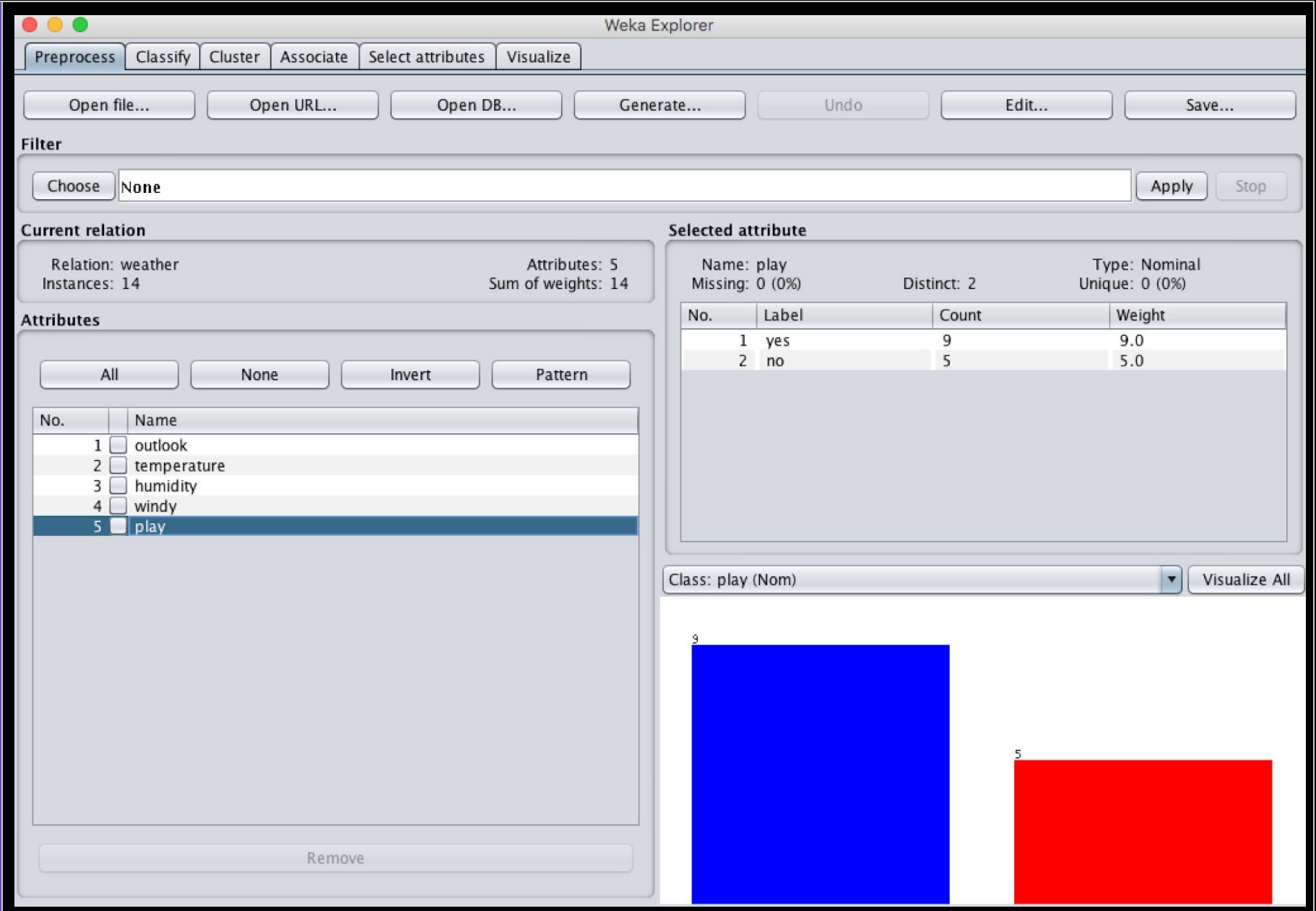
d	LNK What happens when you choose no normalization/standardization under the filter parameter? Nothing, the data must already be normalized.
e	Which of the three models would you choose? I would choose the Poly Kernel with E=3. It is the most

accurate model.

Appendix

1	This intentially left blank
2	This intentially left blank
3	This intentially left blank

4



a

```
=== Run information ===

Scheme:       weka.classifiers.functions.SMO -C 1.0 -L 0.001 -P 1.0E-12 -N 0 -V -1 -W 1 -K
```

```
"weka.classifiers.functions.supportVector.PolyKernel -E 1.0 -C 250007" -calibrator
"weka.classifiers.functions.Logistic -R 1.0E-8 -M -1 -num-decimal-places 4"
Relation:     weather
Instances:    14
Attributes:   5
              outlook
              temperature
              humidity
              windy
              play
Test mode:    10-fold cross-validation

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

SMO

Kernel used:
  Linear Kernel: K(x,y) = <x,y>

Classifier for classes: yes, no

BinarySMO

Machine linear: showing attribute weights, not support vectors.

         0.8436 * (normalized) outlook=sunny
 +      -0.9535 * (normalized) outlook=overcast
 +       0.1099 * (normalized) outlook=rainy
 +       0.5276 * (normalized) temperature
 +       0.771  * (normalized) humidity
 +      -0.8901 * (normalized) windy=FALSE
 -       0.8683

Number of kernel evaluations: 47 (67.361% cached)



Time taken to build model: 0 seconds
```

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

Correctly Classified Instances           8               57.1429 %
Incorrectly Classified Instances         6               42.8571 %
Kappa statistic                         -0.0244
Mean absolute error                      0.4286
Root mean squared error                  0.6547
Relative absolute error                 90      %
Root relative squared error            132.6919 %
Total Number of Instances               14

=== Detailed Accuracy By Class ===

                 TP Rate  FP Rate  Precision  Recall   F-Measure  MCC      ROC Area  PRC Area  Class
                 0.778    0.800    0.636      0.778    0.700      -0.026   0.489     0.638     yes
                 0.200    0.222    0.333      0.200    0.250      -0.026   0.489     0.352     no
Weighted Avg.    0.571    0.594    0.528      0.571    0.539      -0.026   0.489     0.536

=== Confusion Matrix ===

 a b   <-- classified as
 7 2 | a = yes
 4 1 | b = no
```

b

```
=== Run information ===

Scheme:       weka.classifiers.functions.SMO -C 1.0 -L 0.001 -P 1.0E-12 -N 0 -V -1 -W 1 -K
"weka.classifiers.functions.supportVector.RBFKernel -C 250007 -G 0.01" -calibrator
"weka.classifiers.functions.Logistic -R 1.0E-8 -M -1 -num-decimal-places 4"
Relation:     weather
Instances:    14
Attributes:   5
              outlook
```

```
              temperature
              humidity
              windy
              play
Test mode:    10-fold cross-validation

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

SMO

Kernel used:
  RBF Kernel: K(x,y) = exp(-0.01*(x-y)^2)

Classifier for classes: yes, no

BinarySMO

 -       1      * <0 0 1 0.52381 0.483871 1 > * X]
 +       1      * <0 0 1 0.333333 0.83871 0 > * X]
 -       1      * <1 0 0 0.52381 0.16129 0 > * X]
 +       1      * <1 0 0 0.380952 0.967742 1 > * X]
 +       1      * <1 0 0 0.761905 0.806452 0 > * X]
 -       1      * <0 0 1 0.285714 1 1 > * X]
 +       1      * <1 0 0 1 0.645161 1 > * X]
 -       1      * <1 0 0 0.238095 0.16129 1 > * X]
 -       1      * <0 1 0 0.380952 0.806452 0 > * X]
 +       1      * <0 0 1 0.047619 0.16129 0 > * X]
 -       0.9875

Number of support vectors: 10

Number of kernel evaluations: 102 (79.268% cached)



Time taken to build model: 0 seconds

=== Stratified cross-validation ===
```

```
=== Summary ===

Correctly Classified Instances           9               64.2857 %
Incorrectly Classified Instances         5               35.7143 %
Kappa statistic                          0
Mean absolute error                      0.3571
Root mean squared error                  0.5976
Relative absolute error                 75      %
Root relative squared error            121.1306 %
Total Number of Instances               14

=== Detailed Accuracy By Class ===

                 TP Rate  FP Rate  Precision  Recall   F-Measure  MCC      ROC Area  PRC Area  Class
                 1.000    1.000    0.643      1.000    0.783      ?        0.500     0.643     yes
                 0.000    0.000    ?          0.000    ?          ?        0.500     0.357     no
Weighted Avg.    0.643    0.643    ?          0.643    ?          ?        0.500     0.541

=== Confusion Matrix ===

 a b   <-- classified as
 9 0 | a = yes
 5 0 | b = no
```

c

```
=== Run information ===

Scheme:       weka.classifiers.functions.SMO -C 1.0 -L 0.001 -P 1.0E-12 -N 0 -V -1 -W 1 -K
"weka.classifiers.functions.supportVector.PolyKernel -E 3.0 -C 250007" -calibrator
"weka.classifiers.functions.Logistic -R 1.0E-8 -M -1 -num-decimal-places 4"
Relation:     weather
Instances:    14
Attributes:   5
              outlook
              temperature
              humidity
```

```
              windy
              play
Test mode:    10-fold cross-validation

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

SMO

Kernel used:
  Poly Kernel: K(x,y) = <x,y>^3.0

Classifier for classes: yes, no

BinarySMO

 -       0.0714 * <0 0 1 0.52381 0.483871 1 > * X]
 +       0.0934 * <0 0 1 0.333333 0.83871 0 > * X]
 -       0.8756 * <1 0 0 0.52381 0.16129 0 > * X]
 +       0.0276 * <1 0 0 0.380952 0.967742 1 > * X]
 -       0.3643 * <0 1 0 0 0 0 > * X]
 +       0.3659 * <1 0 0 0.761905 0.806452 0 > * X]
 -       0.0587 * <0 0 1 0.285714 1 1 > * X]
 -       0.0318 * <0 0 1 0.190476 0.483871 1 > * X]
 +       0.0529 * <1 0 0 1 0.645161 1 > * X]
 -       0.0706 * <1 0 0 0.238095 0.16129 1 > * X]
 -       0.0675 * <0 1 0 0.380952 0.806452 0 > * X]
 +       1      * <0 0 1 0.047619 0.16129 0 > * X]
 -       0.5675

Number of support vectors: 12

Number of kernel evaluations: 103 (97.103% cached)



Time taken to build model: 0 seconds

=== Stratified cross-validation ===
```

```
=== Summary ===

Correctly Classified Instances          12               85.7143 %
Incorrectly Classified Instances         2               14.2857 %
Kappa statistic                          0.6585
Mean absolute error                      0.1429
Root mean squared error                  0.378
Relative absolute error                 30      %
Root relative squared error             76.6097 %
Total Number of Instances               14

=== Detailed Accuracy By Class ===

                 TP Rate  FP Rate  Precision  Recall   F-Measure  MCC      ROC Area  PRC Area  Class
                 1.000    0.400    0.818      1.000    0.900      0.701    0.800     0.818     yes
                 0.600    0.000    1.000      0.600    0.750      0.701    0.800     0.743     no
Weighted Avg.    0.857    0.257    0.883      0.857    0.846      0.701    0.800     0.791

=== Confusion Matrix ===

 a b   <-- classified as
 9 0 | a = yes
 2 3 | b = no
```

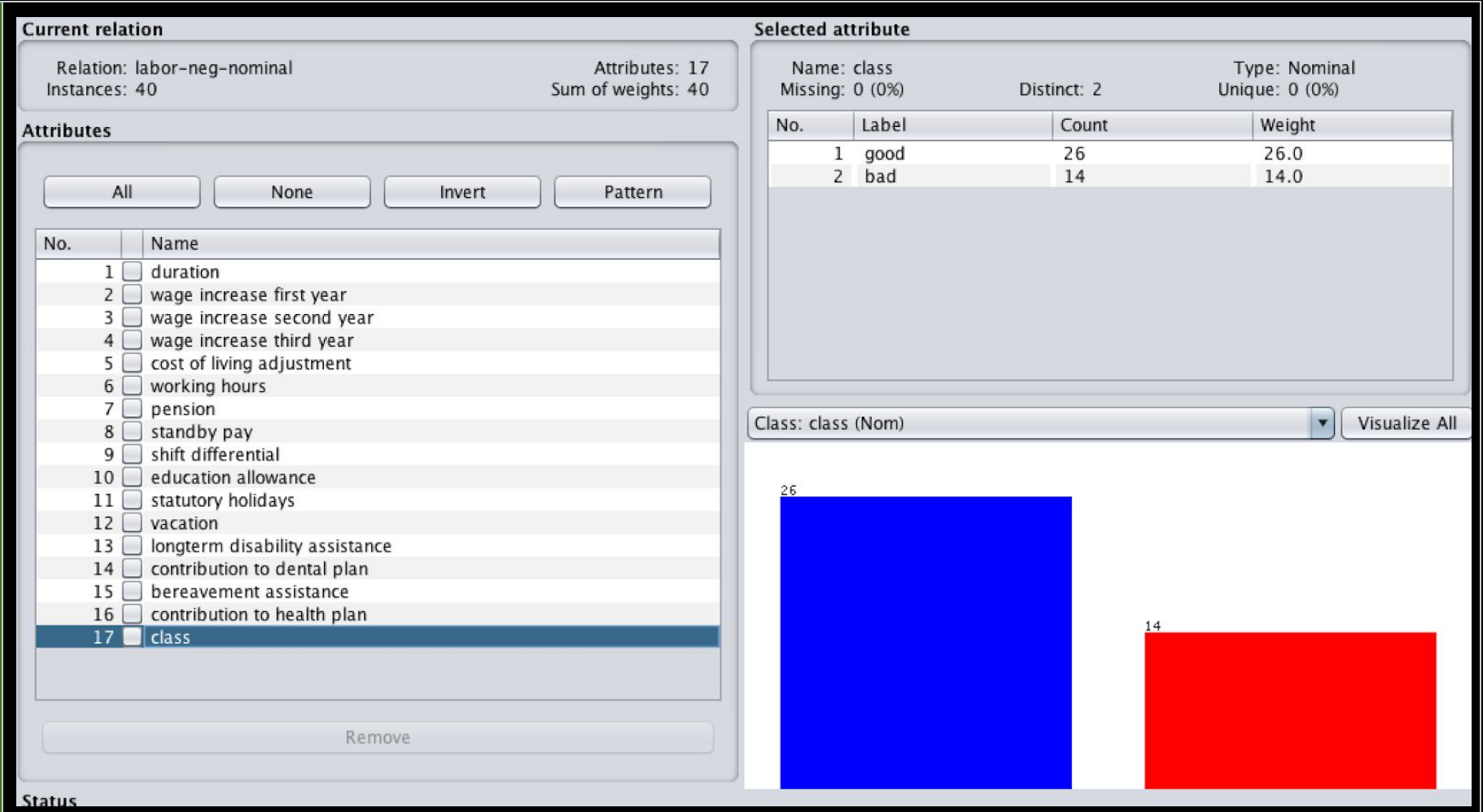
d

```
=== Run information ===

Scheme:       weka.classifiers.functions.SMO -C 1.0 -L 0.001 -P 1.0E-12 -N 2 -V -1 -W 1 -K
"weka.classifiers.functions.supportVector.PolyKernel -E 3.0 -C 250007" -calibrator
"weka.classifiers.functions.Logistic -R 1.0E-8 -M -1 -num-decimal-places 4"
Relation:     weather
Instances:    14
Attributes:   5
              outlook
              temperature
              humidity
              windy
```

```
               play
Test mode:    10-fold cross-validation

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

SMO

Kernel used:
  Poly Kernel: K(x,y) = <x,y>^3.0

Classifier for classes: yes, no

BinarySMO

 -       0      * <0 0 1 75 80 1 > * X]
 +       0      * <0 0 1 71 91 0 > * X]
 -       0      * <1 0 0 75 70 0 > * X]
 +       0      * <1 0 0 72 95 1 > * X]
 -       0      * <0 0 1 68 80 1 > * X]
 +       0      * <1 0 0 85 85 1 > * X]
 -       0      * <1 0 0 69 70 1 > * X]
 -       0      * <0 1 0 72 90 0 > * X]
 -       0      * <0 1 0 83 86 1 > * X]
 +       0      * <0 0 1 65 70 0 > * X]
 -       4.6873

Number of support vectors: 10

Number of kernel evaluations: 105 (99.966% cached)



Time taken to build model: 0.03 seconds

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

Correctly Classified Instances           9               64.2857 %
```

	Incorrectly Classified Instances 5 35.7143 % Kappa statistic 0.186 Mean absolute error 0.3571 Root mean squared error 0.5976 Relative absolute error 75 % Root relative squared error 121.1306 % Total Number of Instances 14 === Detailed Accuracy By Class === TP Rate FP Rate Precision Recall F-Measure MCC ROC Area PRC Area Class 0.778 0.600 0.700 0.778 0.737 0.189 0.589 0.687 yes 0.400 0.222 0.500 0.400 0.444 0.189 0.589 0.414 no Weighted Avg. 0.643 0.465 0.629 0.643 0.632 0.189 0.589 0.590 === Confusion Matrix === a b <-- classified as 7 2 | a = yes 3 2 | b = no
e	Intentially left blank

5




```
a   === Run information ===

    Scheme:       weka.classifiers.functions.SMO -C 1.0 -L 0.001 -P 1.0E-12 -N 2 -V -1 -W 1 -K
    "weka.classifiers.functions.supportVector.PolyKernel -E 1.0 -C 250007" -calibrator
    "weka.classifiers.functions.Logistic -R 1.0E-8 -M -1 -num-decimal-places 4"
    Relation:     labor-neg-nominal
    Instances:    40
    Attributes:   17
                  duration
```

```
              wage increase first year
              wage increase second year
              wage increase third year
              cost of living adjustment
              working hours
              pension
              standby pay
              shift differential
              education allowance
              statutory holidays
              vacation
              longterm disability assistance
              contribution to dental plan
              bereavement assistance
              contribution to health plan
              class
Test mode:    10-fold cross-validation

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

SMO

Kernel used:
  Linear Kernel: K(x,y) = <x,y>

Classifier for classes: good, bad

BinarySMO

Machine linear: showing attribute weights, not support vectors.

        -0.0474 * duration=1
 +       0.0901 * duration=2
 +       0.0279 * duration=3
 +      -0.0707 * duration=unknown
 +       0.2924 * wage increase first year=low
 +      -0.2218 * wage increase first year=medium
 +      -0.0707 * wage increase first year=unknown
```

```
+       0.3686 * wage increase second year=low
+      -0.2218 * wage increase second year=medium
+      -0.0288 * wage increase second year=high
+      -0.118  * wage increase second year=unknown
+      -0      * wage increase third year=low
+      -0.1037 * wage increase third year=medium
+       0.1037 * wage increase third year=unknown
+       0.1154 * cost of living adjustment=none
+      -0.161  * cost of living adjustment=tcf
+       0.0441 * cost of living adjustment=tc
+       0.0015 * cost of living adjustment=unknown
+      -0.167  * working hours=sub35
+       0.0532 * working hours=sub40
+       0.2748 * working hours=equal40
+      -0.161  * working hours=unknown
+       0.3537 * pension=none
+       0.0349 * pension=ret_allw
+       0.0929 * pension=empl_contr
+      -0.4815 * pension=unknown
+       0.068  * standby pay=2
+       0.0441 * standby pay=4
+      -0.0288 * standby pay=12
+      -0.0833 * standby pay=unknown
+       0.0441 * shift differential=0
+       0.1713 * shift differential=2
+       0.068  * shift differential=3
+      -0.1371 * shift differential=4
+      -0.0707 * shift differential=5
+      -0.1044 * shift differential=6
+      -0.0813 * shift differential=10
+      -0.0288 * shift differential=25
+       0.1388 * shift differential=unknown
+      -0.2602 * education allowance=yes
+       0.2562 * education allowance=no
+       0.0041 * education allowance=unknown
+       0.068  * statutory holidays=9
+       0.398  * statutory holidays=10
+      -0.1674 * statutory holidays=11
```

```
 +      -0.2987 * statutory holidays=12
 +       0.1827 * vacation=below average
 +       0.0987 * vacation=average
 +      -0.2814 * vacation=generous
 +      -0.1924 * longterm disability assistance=yes
 +       0.4528 * longterm disability assistance=no
 +      -0.2604 * longterm disability assistance=unknown
 +      -0.0372 * contribution to dental plan=none
 +       0.0568 * contribution to dental plan=half
 +      -0.149  * contribution to dental plan=full
 +       0.1295 * contribution to dental plan=unknown
 +      -0.1441 * bereavement assistance=yes
 +       0.1237 * bereavement assistance=no
 +       0.0203 * bereavement assistance=unknown
 +       0.1917 * contribution to health plan=none
 +       0.0975 * contribution to health plan=half
 +      -0.0511 * contribution to health plan=full
 +      -0.2381 * contribution to health plan=unknown
 -       0.2109

Number of kernel evaluations: 527 (91.378% cached)



Time taken to build model: 0 seconds

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

Correctly Classified Instances          38               95      %
Incorrectly Classified Instances         2                5      %
Kappa statistic                          0.8901
Mean absolute error                      0.05
Root mean squared error                  0.2236
Relative absolute error                 10.8571 %
Root relative squared error             46.5357 %
Total Number of Instances               40
```

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

                 TP Rate  FP Rate  Precision  Recall   F-Measure  MCC      ROC Area  PRC Area  Class
                 0.962    0.071    0.962      0.962    0.962      0.890    0.945     0.950     good
                 0.929    0.038    0.929      0.929    0.929      0.890    0.945     0.887     bad
Weighted Avg.    0.950    0.060    0.950      0.950    0.950      0.890    0.945     0.928

=== Confusion Matrix ===

  a  b   <-- classified as
 25  1 |  a = good
  1 13 |  b = bad
```

5b

```
=== Run information ===

Scheme:       weka.classifiers.functions.SMO -C 1.0 -L 0.001 -P 1.0E-12 -N 0 -V -1 -W 1 -K
"weka.classifiers.functions.supportVector.RBFKernel -C 250007 -G 0.01" -calibrator
"weka.classifiers.functions.Logistic -R 1.0E-8 -M -1 -num-decimal-places 4"
Relation:     labor-neg-nominal
Instances:    40
Attributes:   17
              duration
              wage increase first year
              wage increase second year
              wage increase third year
              cost of living adjustment
              working hours
              pension
              standby pay
              shift differential
              education allowance
              statutory holidays
              vacation
              longterm disability assistance
              contribution to dental plan
              bereavement assistance
```

```
              contribution to health plan
              class
Test mode:    10-fold cross-validation

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

SMO

Kernel used:
  RBF Kernel: K(x,y) = exp(-0.01*(x-y)^2)

Classifier for classes: good, bad

BinarySMO

      1      * <1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 1 1 0 0 0 0 1 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0
0 0 1 0 1 0 0 0 0 0 0 1 0 0 0 1 0 0 0 1 0 0 0 0 0 1 1 0 0 0 > * X]
 -       1      * <0 1 0 0 0 1 0 0 0 1 0 0 0 0 0 1 0 1 0 0 0 0 0 1 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0
0 1 1 0 0 0 1 0 0 0 0 0 1 0 0 0 1 0 0 1 0 0 0 0 0 0 1 0 1 0 0 > * X]
 -       1      * <0 1 0 0 0 1 0 0 0 1 0 0 0 0 0 1 1 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0
0 0 0 1 0 0 0 1 0 0 0 0 1 0 0 0 1 0 0 0 0 1 0 1 0 0 0 0 0 1 0 > * X]
 +       1      * <0 1 0 0 1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 1 0 1 0 0 0 0 1 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0
0 1 0 0 1 0 1 0 0 0 0 0 0 1 0 0 0 0 1 0 0 0 1 0 0 1 0 0 0 0 1 > * X]
 +       1      * <0 0 1 0 1 0 0 0 1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 1 0 1 0 0 0 1 0 0 0 0 0 0 0 1 0 0 0 0 0 0
0 0 0 1 0 0 1 0 0 0 0 0 1 0 0 0 0 1 0 0 1 0 0 1 0 0 0 0 1 0 > * X]
 -       1      * <0 0 1 0 0 0 1 0 0 1 0 0 1 0 0 0 0 0 0 1 0 0 1 0 0 0 0 1 0 0 0 0 0 1 0 0 0 1 0 0 0 0 0
0 0 0 0 1 0 0 0 1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 1 0 0 1 0 0 0 1 > * X]
 +       1      * <0 0 1 0 1 0 0 0 1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 1 0 1 0 0 0 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0
0 0 0 1 0 0 1 0 0 0 0 0 1 0 0 0 1 0 0 1 0 0 1 0 0 0 0 1 0 > * X]
 +       1      * <0 1 0 0 1 0 0 0 1 0 0 0 0 0 0 1 1 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
0 1 0 1 0 0 0 1 0 0 0 0 0 1 0 0 1 0 0 1 0 0 0 1 0 0 0 0 1 0 > * X]
 -       0.9347 * <1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 1 0 0 0 1 1 0 0 0 0 0 0 1 0 0 0 0 0 1 0 0 1 0 0 0 0 0
0 0 0 0 1 0 0 0 1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 1 0 0 1 0 0 0 1 > * X]
 +       1      * <0 1 0 0 1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 1 0 0 1 0 1 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
0 1 0 0 1 0 0 1 0 0 0 0 1 0 0 0 0 0 1 0 0 0 1 0 0 1 0 0 0 1 > * X]
 -       0.554  * <0 1 0 0 0 1 0 0 0 1 0 0 0 0 0 1 0 0 0 1 0 1 0 0 0 1 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0
0 1 1 0 0 0 0 1 0 0 0 0 1 0 0 0 0 0 1 0 0 1 0 0 0 1 0 0 1 0 > * X]
 -       1      * <0 0 1 0 0 1 0 0 0 1 0 0 0 1 0 0 1 0 0 0 0 0 1 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0
```

```
0 1 0 1 0 0 0 1 0 0 0 0 0 1 0 0 0 0 1 0 1 0 0 0 0 1 0 0 0 1 > * X]
 -       1      * <0 0 1 0 0 1 0 0 0 1 0 0 0 1 0 0 0 0 1 0 0 0 0 1 0 0 1 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0
0 1 0 0 1 0 0 0 1 0 0 0 0 0 1 0 1 0 0 1 0 0 0 1 0 0 0 1 0 0 > * X]
 -       0.2893 * <0 1 0 0 0 1 0 0 0 1 0 0 0 0 0 1 1 0 0 0 0 1 0 0 0 0 1 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0
0 1 0 0 1 0 0 1 0 0 0 0 0 1 0 0 0 0 1 0 0 1 0 1 0 0 0 0 0 1 > * X]
 +       1      * <1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 1 0 0 1 0 0 0 1 0 0 1 0 0 0 1 0 0 0 0 1 0 0 0 0 0 0 0
0 0 0 1 0 0 0 1 0 0 0 0 0 0 1 0 0 1 0 1 0 0 0 0 1 0 1 0 0 0 > * X]
 -       0.2976 * <0 0 1 0 0 1 0 0 0 1 0 0 0 1 0 0 0 0 0 1 0 0 1 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 0 0
0 1 0 0 1 0 0 0 1 0 0 0 0 1 0 0 0 0 1 0 1 0 0 1 0 0 0 1 0 0 > * X]
 -       1      * <0 0 0 1 0 0 0 1 0 0 0 1 0 0 0 1 0 0 0 1 0 1 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0
0 0 0 0 1 0 0 1 0 0 0 0 0 0 1 0 1 0 0 0 1 0 0 1 0 0 0 1 0 0 > * X]
 -       1      * <0 1 0 0 1 0 0 0 1 0 0 0 0 0 0 1 1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 0 0
0 1 1 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0 1 0 0 0 1 1 0 0 0 0 0 1 0 > * X]
 +       1      * <1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 1 0 0 1 0 0 0 1 0 0 1 0 0 1 0 0 0 0 0 0 0 0 1 0 0 0 0 0
0 0 0 1 0 1 0 0 0 0 0 0 1 0 0 0 1 0 0 0 1 0 0 0 0 1 1 0 0 0 > * X]
 +       1      * <0 0 1 0 1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 1 1 0 0 0 1 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0
0 1 0 0 1 0 1 0 0 0 0 0 0 1 0 0 0 0 1 0 0 0 1 1 0 0 0 0 1 0 > * X]
 -       0.9569 * <1 0 0 0 0 1 0 0 0 0 0 1 0 0 0 1 1 0 0 0 0 0 1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 0 1 0 0 0
0 0 0 0 1 0 0 1 0 0 0 0 0 0 1 0 1 0 0 0 0 1 0 0 0 1 0 0 0 1 > * X]
 -       0.149  * <1 0 0 0 0 1 0 0 0 0 0 0 1 0 0 0 1 0 0 0 1 0 0 1 0 0 0 0 1 0 0 0 0 0 1 0 0 1 0 0 0 0 0
0 0 0 0 1 0 0 1 0 0 0 0 0 0 1 0 0 0 0 1 0 0 0 1 1 0 0 0 0 0 1 > * X]
 +       1      * <1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 1 1 0 0 0 0 1 0 0 1 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0
0 1 1 0 0 0 0 1 0 0 0 0 0 1 0 0 0 1 0 1 0 0 0 0 1 0 1 0 0 0 > * X]
 -       1      * <0 1 0 0 1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 1 1 0 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 1 0 0
0 0 1 0 0 0 0 0 1 0 0 0 0 1 0 0 0 0 1 0 0 0 1 0 0 1 0 0 0 1 > * X]
 -       0.8186 * <0 1 0 0 0 1 0 0 0 1 0 0 0 0 0 1 0 0 0 1 0 0 1 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 1 0 0 0
0 0 0 0 1 0 1 0 0 0 0 0 0 0 1 0 0 0 1 0 1 0 0 0 0 1 0 0 1 0 > * X]
 -       1      * <0 1 0 0 1 0 0 0 0 0 1 0 0 0 0 1 0 0 0 1 0 1 0 0 0 0 0 1 0 0 0 1 0 0 0 0 0 0 0 0 0 0
1 0 1 0 0 0 0 1 0 0 0 0 1 0 0 0 1 0 0 0 1 0 0 1 0 0 0 0 0 1 > * X]
 +       1      * <0 0 1 0 1 0 0 0 1 0 0 0 1 0 0 0 1 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0
0 1 0 0 1 0 1 0 0 0 0 0 0 1 0 0 0 0 0 1 0 1 0 0 1 0 0 0 0 1 > * X]
 +       1      * <0 0 1 0 1 0 0 0 1 0 0 0 1 0 0 0 1 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0
0 1 0 0 1 0 1 0 0 0 0 0 0 1 0 0 0 0 1 0 0 0 1 1 0 0 1 0 0 0 > * X]
 +       1      * <0 1 0 0 0 1 0 0 0 1 0 0 0 0 0 1 1 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 1 0 0 0 1 0 0 0 0 0
0 0 0 1 0 0 1 0 0 0 0 0 1 0 0 0 0 1 0 1 0 0 0 0 0 1 1 0 0 0 > * X]
 +       1      * <0 1 0 0 0 1 0 0 0 1 0 0 0 0 0 1 1 0 0 0 0 0 1 0 0 0 0 1 0 0 0 0 0 1 0 0 1 0 0 0 0 0
0 0 0 1 0 0 1 0 0 0 0 0 1 0 0 0 0 1 0 0 1 0 0 0 0 1 0 1 0 0 > * X]
 -       1      * <1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 1 1 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 0 1 0
```

```
0 0 0 1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 1 0 0 0 1 0 0 1 0 0 0 1 > * X]
 -       0.5636

Number of support vectors: 31

Number of kernel evaluations: 805 (83.159% cached)



Time taken to build model: 0 seconds

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

Correctly Classified Instances          28               70      %
Incorrectly Classified Instances        12               30      %
Kappa statistic                          0.1781
Mean absolute error                      0.3
Root mean squared error                  0.5477
Relative absolute error                 65.1429 %
Root relative squared error            113.9886 %
Total Number of Instances               40

=== Detailed Accuracy By Class ===

                 TP Rate  FP Rate  Precision  Recall   F-Measure  MCC      ROC Area  PRC Area  Class
                 1.000    0.857    0.684      1.000    0.813      0.313    0.571     0.684     good
                 0.143    0.000    1.000      0.143    0.250      0.313    0.571     0.443     bad
Weighted Avg.    0.700    0.557    0.795      0.700    0.616      0.313    0.571     0.600

=== Confusion Matrix ===

  a  b   <-- classified as
 26  0 |  a = good
 12  2 |  b = bad
```

5c

```
=== Run information ===

Scheme:       weka.classifiers.functions.SMO -C 1.0 -L 0.001 -P 1.0E-12 -N 0 -V -1 -W 1 -K
"weka.classifiers.functions.supportVector.PolyKernel -E 3.0 -C 250007" -calibrator
"weka.classifiers.functions.Logistic -R 1.0E-8 -M -1 -num-decimal-places 4"
Relation:     labor-neg-nominal
Instances:    40
Attributes:   17
              duration
              wage increase first year
              wage increase second year
              wage increase third year
              cost of living adjustment
              working hours
              pension
              standby pay
              shift differential
              education allowance
              statutory holidays
              vacation
              longterm disability assistance
              contribution to dental plan
              bereavement assistance
              contribution to health plan
              class
Test mode:    10-fold cross-validation

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

SMO

Kernel used:
  Poly Kernel: K(x,y) = <x,y>^3.0

Classifier for classes: good, bad

BinarySMO
```

```
      0.0002 * <1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 1 1 0 0 0 0 1 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0
0 0 1 0 1 0 0 0 0 0 0 1 0 0 0 1 0 0 0 1 0 0 0 0 1 1 0 0 0 > * X]
 -       0.0002 * <0 1 0 0 0 1 0 0 0 1 0 0 0 0 0 0 1 0 1 0 0 0 0 0 1 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0
0 1 1 0 0 0 1 0 0 0 0 0 1 0 0 0 1 0 0 1 0 0 0 0 0 1 0 1 0 0 > * X]
 -       0.0001 * <0 1 0 0 0 1 0 0 0 1 0 0 0 0 0 0 1 1 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0
0 0 0 1 0 0 0 1 0 0 0 0 1 0 0 0 1 0 0 0 0 0 1 0 1 0 0 0 0 1 0 > * X]
 +       0.0003 * <0 1 0 0 1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 1 0 1 0 0 0 0 1 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0
0 1 0 0 1 0 1 0 0 0 0 0 0 1 0 0 0 0 1 0 0 0 1 0 0 1 0 0 0 1 > * X]
 +       0.0001 * <0 0 1 0 1 0 0 0 1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 1 0 1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 0 0 0 0
0 0 0 1 0 0 1 0 0 0 0 0 1 0 0 0 0 0 1 0 0 1 0 0 1 0 0 0 0 1 0 > * X]
 -       0.0001 * <0 0 1 0 0 0 1 0 0 1 0 0 1 0 0 0 0 0 0 1 0 0 1 0 0 0 0 1 0 0 0 0 0 1 0 0 0 1 0 0 0 0 0
0 0 0 0 1 0 0 0 1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 1 0 0 1 0 0 0 1 > * X]
 +       0.0001 * <0 0 1 0 1 0 0 0 1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 1 0 1 0 0 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0
0 0 0 1 0 0 1 0 0 0 0 0 1 0 0 0 1 0 0 0 1 0 0 1 0 0 0 0 1 0 > * X]
 +       0.0002 * <0 1 0 0 1 0 0 0 1 0 0 0 0 0 0 1 1 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
0 1 0 1 0 0 0 1 0 0 0 0 0 1 0 0 1 0 0 1 0 0 0 1 0 0 0 0 1 0 > * X]
 -       0.0001 * <1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 1 0 0 0 1 1 0 0 0 0 0 0 1 0 0 0 0 0 1 0 0 1 0 0 0 0 0 0
0 0 0 0 1 0 0 0 1 0 0 0 1 0 0 0 0 0 1 0 0 0 1 0 0 1 0 0 0 1 > * X]
 +       0.0003 * <0 1 0 0 1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 1 0 0 1 0 1 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
0 1 0 0 1 0 0 1 0 0 0 0 1 0 0 0 0 0 1 0 0 0 1 0 0 1 0 0 0 1 > * X]
 -       0.0001 * <0 1 0 0 0 1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 1 0 1 0 0 0 1 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0
0 1 1 0 0 0 0 1 0 0 0 0 1 0 0 0 0 0 0 1 0 0 1 0 0 0 1 0 0 1 0 > * X]
 -       0.0002 * <0 0 1 0 0 1 0 0 0 1 0 0 0 1 0 0 1 0 0 0 0 0 1 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0
0 1 0 1 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 1 0 1 0 0 0 0 1 0 0 0 1 > * X]
 -       0.0001 * <0 0 1 0 0 1 0 0 0 1 0 0 0 1 0 0 0 0 1 0 0 0 0 1 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0
0 1 1 0 0 0 0 0 0 0 1 0 0 0 1 0 0 1 0 0 0 1 1 0 0 0 0 0 1 > * X]
 -       0.0001 * <0 0 1 0 0 1 0 0 0 1 0 0 0 1 0 0 0 0 1 0 0 0 0 1 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
0 1 0 0 1 0 0 0 1 0 0 0 0 0 1 0 1 0 0 1 0 0 0 1 0 0 0 1 0 0 > * X]
 -       0.0001 * <0 1 0 0 0 1 0 0 0 1 0 0 0 0 0 1 1 0 0 0 0 1 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
0 1 0 0 1 0 0 1 0 0 0 0 0 1 0 0 0 0 1 0 0 1 0 1 0 0 0 0 0 1 > * X]
 +       0.0002 * <1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 1 0 0 1 0 0 0 1 0 0 1 0 0 0 1 0 0 0 0 1 0 0 0 0 0 0 0 0
0 0 0 1 0 0 0 1 0 0 0 0 0 0 1 0 0 1 0 1 0 0 0 0 1 0 1 0 0 0 > * X]
 -       0.0001 * <1 0 0 0 0 0 1 0 0 0 0 1 0 0 0 1 0 0 0 1 0 1 0 0 0 0 0 1 0 0 1 0 0 0 0 0 1 0 0 0 0 0
0 0 0 0 1 1 0 0 0 0 0 0 0 0 1 0 0 0 1 0 0 0 1 0 0 1 0 0 0 1 > * X]
 -       0.0001 * <0 0 1 0 0 1 0 0 0 1 0 0 0 1 0 0 0 0 0 1 0 0 1 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 1 0 0 1 0 0 0 1 0 0 0 0 1 0 0 0 0 1 0 1 0 0 1 0 0 0 1 0 0 > * X]
 -       0.0002 * <0 0 0 1 0 0 0 1 0 0 0 1 0 0 0 1 0 0 0 1 0 1 0 0 0 0 1 0 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0
0 0 0 0 1 0 0 1 0 0 0 0 0 0 1 0 1 0 0 0 1 0 0 1 0 0 0 1 0 0 > * X]
```

```
 -       0.0002 * <0 1 0 0 1 0 0 0 1 0 0 0 0 0 0 1 1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0
0 1 1 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0 1 0 0 0 1 1 0 0 0 0 1 0 > * X]
 +       0.0001 * <1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 1 0 0 1 0 0 0 1 0 0 1 0 0 1 0 0 0 0 0 0 0 0 1 0 0 0 0 0
0 0 0 1 0 1 0 0 0 0 0 0 1 0 0 0 1 0 0 0 1 0 0 0 0 1 1 0 0 0 > * X]
 -       0      * <0 0 1 0 0 1 0 0 0 1 0 0 0 1 0 0 0 1 0 0 1 0 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0
0 1 0 0 1 0 0 0 0 0 0 1 0 0 0 1 0 0 1 0 0 0 1 0 0 1 0 0 0 1 > * X]
 -       0.0001 * <0 1 0 0 0 1 0 0 0 1 0 0 0 0 0 1 0 1 0 0 1 0 0 0 0 0 0 1 0 0 0 0 1 0 0 0 0 0 0 1 0 0 0
0 0 0 0 1 0 0 0 0 0 1 0 0 0 1 0 0 0 1 0 0 0 1 0 0 1 0 0 0 1 > * X]
 +       0.0002 * <0 0 1 0 1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 1 1 0 0 0 1 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0
0 1 0 0 1 0 1 0 0 0 0 0 0 1 0 0 0 0 1 0 0 0 1 1 0 0 0 0 1 0 > * X]
 -       0.0001 * <1 0 0 0 0 1 0 0 0 0 0 1 0 0 0 1 1 0 0 0 0 0 1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 0 1 0 0 0 0
0 0 0 0 1 0 0 1 0 0 0 0 0 0 1 0 1 0 0 0 0 1 0 0 0 1 0 0 0 1 > * X]
 -       0      * <0 0 1 0 0 1 0 0 0 1 0 0 0 1 0 0 0 1 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 1 0 0 0 0
0 0 0 0 0 1 0 0 0 0 1 0 0 0 0 1 0 0 0 1 0 0 1 0 1 0 0 0 0 1 0 > * X]
 -       0.0001 * <1 0 0 0 0 1 0 0 0 0 0 1 0 0 0 1 0 0 0 1 0 0 1 0 0 0 0 1 0 0 0 0 0 0 1 0 0 1 0 0 0 0 0
0 0 0 0 1 0 0 1 0 0 0 0 0 0 1 0 0 0 0 1 0 0 0 1 1 0 0 0 0 0 1 > * X]
 +       0.0002 * <1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 1 1 0 0 0 0 1 0 0 1 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0
0 1 1 0 0 0 0 1 0 0 0 0 0 1 0 0 0 1 0 1 0 0 0 0 1 0 1 0 0 0 > * X]
 -       0.0002 * <0 1 0 0 1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 1 1 0 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 1 0 0
0 0 1 0 0 0 0 0 1 0 0 0 0 1 0 0 0 0 1 0 0 0 1 0 0 1 0 0 0 1 > * X]
 -       0.0002 * <0 1 0 0 0 1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 1 0 0 1 0 0 0 0 1 0 0 0 0 0 1 0 0 0 1 0 0 0 0
0 0 0 0 1 0 1 0 0 0 0 0 0 0 1 0 0 0 1 0 1 0 0 0 0 1 0 0 1 0 > * X]
 -       0.0002 * <0 1 0 0 1 0 0 0 0 0 1 0 0 0 0 1 0 0 0 1 0 1 0 0 0 0 1 0 0 0 1 0 0 0 0 0 0 0 0 0 0
1 0 1 0 0 0 0 1 0 0 0 0 1 0 0 0 1 0 0 0 1 0 0 1 0 0 0 0 0 1 > * X]
 +       0.0001 * <0 0 1 0 1 0 0 0 1 0 0 0 1 0 0 0 1 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0
0 1 0 0 1 0 1 0 0 0 0 0 1 0 0 0 0 0 1 0 1 0 0 1 0 0 0 0 1 0 > * X]
 +       0.0001 * <0 0 1 0 1 0 0 0 1 0 0 0 1 0 0 0 0 0 0 1 0 1 0 0 0 0 1 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0
0 1 0 0 1 0 1 0 0 0 0 0 0 1 0 0 0 0 1 0 0 0 1 1 0 0 1 0 0 0 > * X]
 -       0      * <0 0 1 0 0 1 0 0 0 1 0 0 0 1 0 0 1 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 1 0 0 1 0 0 0 0 0
0 0 0 0 1 0 0 0 0 1 0 0 0 0 1 0 0 0 1 0 0 0 1 1 0 0 0 0 0 1 0 > * X]
 +       0.0001 * <0 1 0 0 0 1 0 0 0 1 0 0 0 0 0 1 1 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 1 0 0 0 1 0 0 0 0 0
0 0 0 1 0 0 1 0 0 0 0 0 1 0 1 0 0 0 0 0 1 1 0 0 0 > * X]
 +       0.0004 * <0 1 0 0 0 1 0 0 0 1 0 0 0 0 0 1 1 0 0 0 0 0 1 0 0 0 0 1 0 0 0 0 0 1 0 0 1 0 0 0 0 0
0 0 0 1 0 0 1 0 0 0 0 0 1 0 0 0 0 1 0 0 1 0 0 0 0 1 0 1 0 0 > * X]
 -       0.0001 * <0 1 0 0 0 0 1 0 0 0 1 0 0 0 0 1 0 0 0 1 0 1 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 1 0 0 0 0
0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 1 0 0 1 0 0 1 0 0 0 1 0 0 0 1 > * X]
 -       0.0002 * <1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 1 1 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 0 1 0
0 0 0 1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 1 0 0 0 1 0 0 1 0 0 0 1 > * X]
```

```
 -       0.0001 * <0 1 0 0 0 1 0 0 0 1 0 0 0 0 0 1 1 0 0 0 0 0 1 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 1 0 0 0 0
0 0 0 0 1 0 0 0 1 0 0 0 0 1 0 0 1 0 0 0 0 1 0 1 0 0 0 1 0 0 > * X]
 -       0.2378

Number of support vectors: 39

Number of kernel evaluations: 820 (94.649% cached)



Time taken to build model: 0.01 seconds

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

Correctly Classified Instances          39               97.5    %
Incorrectly Classified Instances         1                2.5    %
Kappa statistic                          0.9441
Mean absolute error                      0.025
Root mean squared error                  0.1581
Relative absolute error                  5.4286 %
Root relative squared error             32.9057 %
Total Number of Instances               40

=== Detailed Accuracy By Class ===

                 TP Rate  FP Rate  Precision  Recall   F-Measure  MCC      ROC Area  PRC Area  Class
                 1.000    0.071    0.963      1.000    0.981      0.946    0.964     0.963     good
                 0.929    0.000    1.000      0.929    0.963      0.946    0.964     0.954     bad
Weighted Avg.    0.975    0.046    0.976      0.975    0.975      0.946    0.964     0.960

=== Confusion Matrix ===

  a  b   <-- classified as
 26  0 |  a = good
  1 13 |  b = bad
```

```
5d   === Run information ===

     Scheme:       weka.classifiers.functions.SMO -C 1.0 -L 0.001 -P 1.0E-12 -N 2 -V -1 -W 1 -K
     "weka.classifiers.functions.supportVector.PolyKernel -E 3.0 -C 250007" -calibrator
     "weka.classifiers.functions.Logistic -R 1.0E-8 -M -1 -num-decimal-places 4"
     Relation:     labor-neg-nominal
     Instances:    40
     Attributes:   17
                   duration
                   wage increase first year
                   wage increase second year
                   wage increase third year
                   cost of living adjustment
                   working hours
                   pension
                   standby pay
                   shift differential
                   education allowance
                   statutory holidays
                   vacation
                   longterm disability assistance
                   contribution to dental plan
                   bereavement assistance
                   contribution to health plan
                   class
     Test mode:    10-fold cross-validation

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

     SMO

     Kernel used:
       Poly Kernel: K(x,y) = <x,y>^3.0

     Classifier for classes: good, bad

     BinarySMO
```

```
      0.0002 * <1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 1 1 0 0 0 0 1 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0
0 0 1 0 1 0 0 0 0 0 0 1 0 0 0 1 0 0 0 1 0 0 0 0 1 1 0 0 0 > * X]
 -       0.0002 * <0 1 0 0 0 1 0 0 0 1 0 0 0 0 0 0 1 0 1 0 0 0 0 0 1 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0
0 1 1 0 0 0 1 0 0 0 0 0 1 0 0 0 1 0 0 1 0 0 0 0 0 1 0 1 0 0 > * X]
 -       0.0001 * <0 1 0 0 0 1 0 0 0 1 0 0 0 0 0 0 1 1 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0
0 0 0 1 0 0 0 1 0 0 0 0 1 0 0 0 1 0 0 0 0 0 1 0 1 0 0 0 0 1 0 > * X]
 +       0.0003 * <0 1 0 0 1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 1 0 1 0 0 0 0 1 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0
0 1 0 0 1 0 1 0 0 0 0 0 0 1 0 0 0 0 1 0 0 0 1 0 0 1 0 0 0 1 > * X]
 +       0.0001 * <0 0 1 0 1 0 0 0 1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 1 0 1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 0 0 0 0
0 0 0 1 0 0 1 0 0 0 0 0 1 0 0 0 0 0 1 0 0 1 0 0 1 0 0 0 0 1 0 > * X]
 -       0.0001 * <0 0 1 0 0 0 1 0 0 1 0 0 1 0 0 0 0 0 0 1 0 0 1 0 0 0 0 1 0 0 0 0 0 1 0 0 0 1 0 0 0 0 0
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 +       0.0001 * <0 0 1 0 1 0 0 0 1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 1 0 1 0 0 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0
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 +       0.0002 * <0 1 0 0 1 0 0 0 1 0 0 0 0 0 0 1 1 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
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 -       0.0001 * <1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 1 0 0 0 1 1 0 0 0 0 0 0 1 0 0 0 0 0 1 0 0 1 0 0 0 0 0 0
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 +       0.0003 * <0 1 0 0 1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 1 0 0 1 0 1 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
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 -       0.0001 * <0 1 0 0 0 1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 1 0 1 0 0 0 1 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0
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 -       0.0002 * <0 0 1 0 0 1 0 0 0 1 0 0 0 1 0 0 1 0 0 0 0 0 1 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0
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 -       0.0001 * <0 0 1 0 0 1 0 0 0 1 0 0 0 1 0 0 0 0 1 0 0 0 0 1 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0
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 -       0.0001 * <0 0 1 0 0 1 0 0 0 1 0 0 0 1 0 0 0 0 1 0 0 0 0 1 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
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 -       0.0001 * <0 1 0 0 0 1 0 0 0 1 0 0 0 0 0 1 1 0 0 0 0 1 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
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 -       0.0001 * <1 0 0 0 0 0 1 0 0 0 0 1 0 0 0 1 0 0 0 1 0 1 0 0 0 0 0 1 0 0 1 0 0 0 0 0 1 0 0 0 0 0
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 -       0      * <0 0 1 0 0 1 0 0 0 1 0 0 0 1 0 0 0 1 0 0 1 0 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0
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 -       0.0001 * <0 1 0 0 0 1 0 0 0 1 0 0 0 0 0 1 0 1 0 0 1 0 0 0 0 0 0 1 0 0 0 0 1 0 0 0 0 0 0 1 0 0 0
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 -       0.0002 * <1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 1 1 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 0 1 0
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 -       0.0001 * <0 1 0 0 0 1 0 0 0 1 0 0 0 0 0 1 1 0 0 0 0 0 1 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 1 0 0 0 0
0 0 0 0 1 0 0 0 1 0 0 0 0 1 0 0 1 0 0 0 0 1 0 1 0 0 0 1 0 0 > * X]
 -       0.2378

Number of support vectors: 39

Number of kernel evaluations: 820 (94.649% cached)



Time taken to build model: 0 seconds

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

Correctly Classified Instances          39               97.5    %
Incorrectly Classified Instances         1                2.5    %
Kappa statistic                          0.9441
Mean absolute error                      0.025
Root mean squared error                  0.1581
Relative absolute error                  5.4286 %
Root relative squared error             32.9057 %
Total Number of Instances               40

=== Detailed Accuracy By Class ===

                 TP Rate  FP Rate  Precision  Recall   F-Measure  MCC      ROC Area  PRC Area  Class
                 1.000    0.071    0.963      1.000    0.981      0.946    0.964     0.963     good
                 0.929    0.000    1.000      0.929    0.963      0.946    0.964     0.954     bad
Weighted Avg.    0.975    0.046    0.976      0.975    0.975      0.946    0.964     0.960

=== Confusion Matrix ===

  a  b   <-- classified as
 26  0 |  a = good
  1 13 |  b = bad
```

5e	Intentionly left blank