**Question 3**

SVM with the required configuration has been run in WEKA. We have obtained the following results for the 5 runs –

**RUN 1 (PolyKernel Exponent 1.0)**

=== 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: DATASET

Instances: 846

Attributes: 37

f0

f1

f2

f3

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f7

f8

f9

f10

f11

f12

f13

f14

f15

f16

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f35

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: car, noncar

Number of kernel evaluations: 150452 (81.758% cached)

Time taken to build model: 0.15 seconds

=== Stratified cross-validation ===

=== Summary ===

Correctly Classified Instances 717 84.7518 %

Incorrectly Classified Instances 129 15.2482 %

Kappa statistic 0.6951

Mean absolute error 0.1525

Root mean squared error 0.3905

Relative absolute error 30.5024 %

Root relative squared error 78.1054 %

Total Number of Instances 846

=== Detailed Accuracy By Class ===

TP Rate FP Rate Precision Recall F-Measure MCC ROC Area PRC Area Class

0.830 0.134 0.864 0.830 0.847 0.696 0.848 0.803 car

0.866 0.170 0.832 0.866 0.848 0.696 0.848 0.786 noncar

Weighted Avg. 0.848 0.152 0.848 0.848 0.847 0.696 0.848 0.795

=== Confusion Matrix ===

a b <-- classified as

356 73 | a = car

56 361 | b = noncar

Total 810 cases have been classified correctly out of 846 cases – accuracy is 95.74%.

Only 36 cases have been classified incorrectly.

**Run 2 (PolyKernel Exponent 2.0)**

=== 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 2.0 -C 250007" -calibrator "weka.classifiers.functions.Logistic -R 1.0E-8 -M -1 -num-decimal-places 4"

Relation: DATASET

Instances: 846

Attributes: 37

f0

f1

f2

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f7

f8

f9

f10

f11

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CLASS

Test mode: 10-fold cross-validation

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

SMO

Kernel used:

Poly Kernel: K(x,y) = <x,y>^2.0

Classifier for classes: car, noncar

BinarySMO

Number of support vectors: 228

Number of kernel evaluations: 322870 (96.992% cached)

Time taken to build model: 0.56 seconds

=== Stratified cross-validation ===

=== Summary ===

Correctly Classified Instances 810 95.7447 %

Incorrectly Classified Instances 36 4.2553 %

Kappa statistic 0.9149

Mean absolute error 0.0426

Root mean squared error 0.2063

Relative absolute error 8.5123 %

Root relative squared error 41.2608 %

Total Number of Instances 846

=== Detailed Accuracy By Class ===

TP Rate FP Rate Precision Recall F-Measure MCC ROC Area PRC Area Class

0.951 0.036 0.965 0.951 0.958 0.915 0.958 0.942 car

0.964 0.049 0.950 0.964 0.957 0.915 0.958 0.934 noncar

Weighted Avg. 0.957 0.042 0.958 0.957 0.957 0.915 0.958 0.938

=== Confusion Matrix ===

a b <-- classified as

408 21 | a = car

15 402 | b = noncar

Total 810 cases have been classified correctly out of 846 cases – accuracy is 95.74%.

Only 36 cases have been classified incorrectly.

**Run 3 (PolyKernel Exponent 4.0)**

=== 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 4.0 -C 250007" -calibrator "weka.classifiers.functions.Logistic -R 1.0E-8 -M -1 -num-decimal-places 4"

Relation: DATASET

Instances: 846

Attributes: 37

f0

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f8

f9

f10

f11

f12

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CLASS

Test mode: 10-fold cross-validation

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

SMO

Kernel used:

Poly Kernel: K(x,y) = <x,y>^4.0

Classifier for classes: car, noncar

Number of support vectors: 226

Number of kernel evaluations: 290764 (98.046% cached)

Time taken to build model: 0.53 seconds

=== Stratified cross-validation ===

=== Summary ===

Correctly Classified Instances 791 93.4988 %

Incorrectly Classified Instances 55 6.5012 %

Kappa statistic 0.87

Mean absolute error 0.065

Root mean squared error 0.255

Relative absolute error 13.0049 %

Root relative squared error 50.9997 %

Total Number of Instances 846

=== Detailed Accuracy By Class ===

TP Rate FP Rate Precision Recall F-Measure MCC ROC Area PRC Area Class

0.935 0.065 0.937 0.935 0.936 0.870 0.935 0.909 car

0.935 0.065 0.933 0.935 0.934 0.870 0.935 0.905 noncar

Weighted Avg. 0.935 0.065 0.935 0.935 0.935 0.870 0.935 0.907

=== Confusion Matrix ===

a b <-- classified as

401 28 | a = car

27 390 | b = noncar

Total 791 cases have been classified correctly out of 846 cases – accuracy is 93.49%.

Only 53 cases have been classified incorrectly.

**Run 4 (RBFKernel with Gamma 0.01)**

=== 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: DATASET

Instances: 846

Attributes: 37

f0

f1

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f10

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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: car, noncar

Number of support vectors: 703

Number of kernel evaluations: 356294 (91.954% cached)

Time taken to build model: 0.27 seconds

=== Stratified cross-validation ===

=== Summary ===

Correctly Classified Instances 614 72.5768 %

Incorrectly Classified Instances 232 27.4232 %

Kappa statistic 0.4531

Mean absolute error 0.2742

Root mean squared error 0.5237

Relative absolute error 54.857 %

Root relative squared error 104.7442 %

Total Number of Instances 846

=== Detailed Accuracy By Class ===

TP Rate FP Rate Precision Recall F-Measure MCC ROC Area PRC Area Class

0.622 0.168 0.792 0.622 0.697 0.464 0.727 0.685 car

0.832 0.378 0.682 0.832 0.749 0.464 0.727 0.650 noncar

Weighted Avg. 0.726 0.271 0.738 0.726 0.723 0.464 0.727 0.668

=== Confusion Matrix ===

a b <-- classified as

267 162 | a = car

70 347 | b = noncar

Total 614 cases have been classified correctly out of 846 cases – accuracy is 72.57%.

232 cases have been classified incorrectly.

**Run 4 (RBFKernel with Gamma 1.0)**

=== 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 1.0" -calibrator "weka.classifiers.functions.Logistic -R 1.0E-8 -M -1 -num-decimal-places 4"

Relation: DATASET

Instances: 846

Attributes: 37

f0

f1

f2

f3

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f8

f9

f10

f11

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f35

CLASS

Test mode: 10-fold cross-validation

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

SMO

Kernel used:

RBF Kernel: K(x,y) = exp(-1.0\*(x-y)^2)

Classifier for classes: car, noncar

Number of support vectors: 559

Number of kernel evaluations: 339451 (89.793% cached)

Time taken to build model: 0.2 seconds

=== Stratified cross-validation ===

=== Summary ===

Correctly Classified Instances 764 90.3073 %

Incorrectly Classified Instances 82 9.6927 %

Kappa statistic 0.8063

Mean absolute error 0.0969

Root mean squared error 0.3113

Relative absolute error 19.3891 %

Root relative squared error 62.272 %

Total Number of Instances 846

=== Detailed Accuracy By Class ===

TP Rate FP Rate Precision Recall F-Measure MCC ROC Area PRC Area Class

0.869 0.062 0.935 0.869 0.901 0.808 0.904 0.879 car

0.938 0.131 0.875 0.938 0.905 0.808 0.904 0.851 noncar

Weighted Avg. 0.903 0.096 0.905 0.903 0.903 0.808 0.904 0.865

=== Confusion Matrix ===

a b <-- classified as

373 56 | a = car

26 391 | b = noncar

Total 764 cases have been classified correctly out of 846 cases – accuracy is 90.31%.

82 cases have been classified incorrectly.

The RBFKernel with Gamma value 0.01 did not work well and gave only 72% accuracy whereas all others have more than 90% accuracy.