ISCO630E-ASSIGNEMNT-7

Conclusion

By Nairit Banerjee-IIT2016505

Question

We are required to implement binary SVM to classify MNIST digits 3 and 8 using SMO Algorithm.

The dataset used is the one provided by sklearn which is imported as

from sklearn.datasets import load_digits

mnist = load_digits()

The dataset contains 1797 images out of which 357 are labelled as 3 or 8.

All images are 8*8 grayscale images.

Dataset is split into 60:20:20 ratio for training, cross validation and testing purposes respectively.

We write the SMO algorithm using following fotrmulae:

f(x) =wT.x+b **Ek=f(x(k))−y(k)**

η= ⟨x(i), x(i) + ⟨x(j), x(j)⟩ - 2 ⟨x(i), x(j)⟩ **αj:=αj+(y(j)(Ei−Ej))/η**

If y(i)!=y(j),L= max(0, αj−αi), H= min(C, C+αj−αi)

If y(i)=y(j),L= max(0, αi+αj−C), H= min(C, αi+αj)

αj:=H if αj> H **αi:=αi+y(i)y(j)(α(old)j−αj)**

αj if L≤αj≤H

L if αj< L

Three kernel function are defined:

linear kernel $$K_{\text{lin}}(\boldsymbol{x}, \boldsymbol{y}) = \sum_{i=1}^{d} x_i y_i$$

polynomial kernel $$K_{\text{pol}}(\boldsymbol{x}, \boldsymbol{y}) = \left(\sum_{i=1}^{d} x_i y_i + l \right)^p$$

RBF kernel $$K_{\text{rbf}}(\boldsymbol{x}, \boldsymbol{y}) = \exp\left(-\frac{\sum_{i=1}^{d} (x_i - y_i)^2}{\sigma^2} \right)$$

For the same dataset, all three kernels are used and ROC curves are plotted as follows:

Linear Kernel

Support vector count: 24

Converged after 4 iterations

Precision: 0.9722222222222222

Recall: 1.0

F-score: 0.9859154929577464

Accuracy: 0.9861111111111112

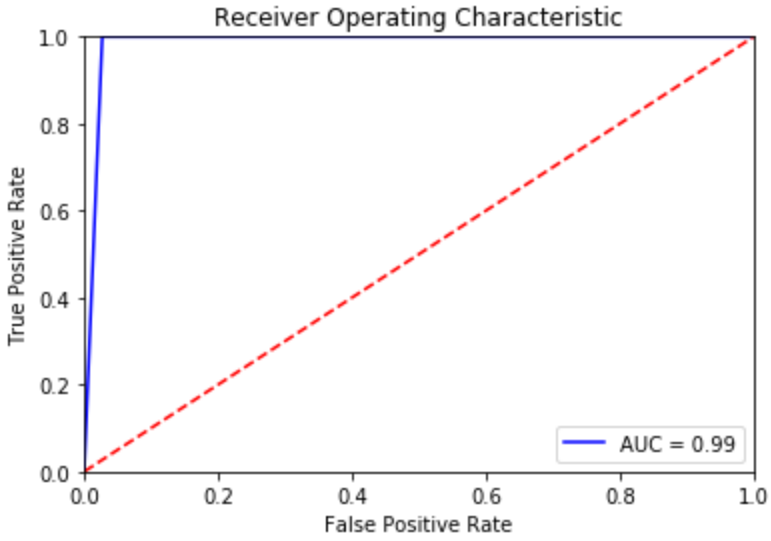
CONFUSION MATRIX :

Predicted	-1	1	All
Actual			
-1	36	1	37
1	0	35	35
All	36	36	72

3

ROC Curve :

AUC: 0.9864864864864865



Polynomial Kernel with degree 2

Support vector count: 16

Converged after 3 iterations

Precision: 0.9444444444444444

Recall: 0.9714285714285714

F-score: 0.9577464788732395

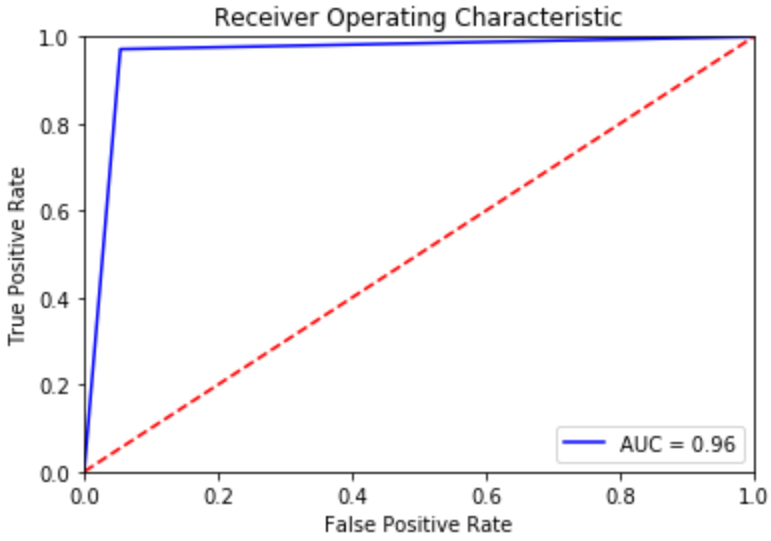
Accuracy: 0.9583333333333334

CONFUSION MATRIX :

Predicted	-1	1	All
Actual			
-1	35	2	37
1	1	34	35
All	36	36	72

ROC Curve :

AUC: 0.9586872586872587



Polynomial Kernel with degree 3

Support vector count: 23

Converged after 3 iterations

Precision: 0.9722222222222222

Recall: 1.0

F-score: 0.9859154929577464

Accuracy: 0.9861111111111112

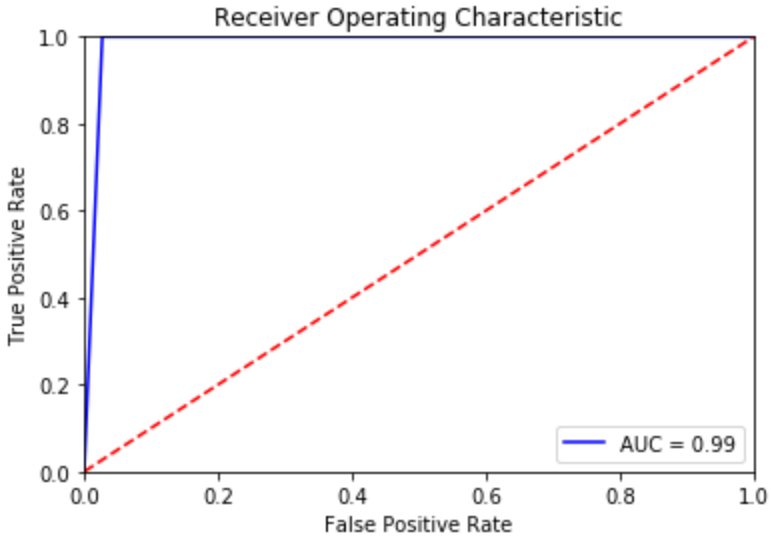
CONFUSION MATRIX :

Predicted	-1	1	All
Actual			
-1	36	1	37
1	0	35	35
All	36	36	72

5

ROC Curve :

AUC: 0.9864864864864865



RBF Kernel

Support vector count: 18

Converged after 4 iterations

Precision: 1.0

Recall: 0.9714285714285714

F-score: 0.9855072463768115

Accuracy: 0.9861111111111112

CONFUSION MATRIX :

Predicted	-1	1	All
Actual			
-1	37	0	37
1	1	34	35
All	38	34	72

ROC Curve :

AUC: 0.9857142857142858