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INTRODUCTION

❑ SVM Classifier

Support Vector Machine(SVM) is a supervised machine learning algorithm which can be used for both classification or regression challenges. However, it is mostly used in classification problems. The support vector uses a mathematical function, often called a kernel function which is a math function that matches the new data to the best image from the training data in order to predict the unknown picture's label. Following libraries are widely used in the project:

➔ Library idx2numpy

idx2numpy package provides a tool for converting files to and from IDX format to numpy. ndarray . You can meet files in IDX format.

➔ Library Numpy

NumPy is the core library for computation.it provides high performance with multi-dimensional arrays. I have used this library to calculate the distance in the two-dimensional array and to calculate the mean/average of clustered points.

➔ Library Sklearn

Scikit-learn is probably the most useful library for machine learning in Python. The sklearn library contains a lot of efficient tools for machine learning and statistical modeling including classification, regression, clustering and dimensionality reduction.

PROGRAM OUTLINE

➔ Methodology

- Normalization
- Grid Search
- Training
- Performance Measure
- Grayscale to binary

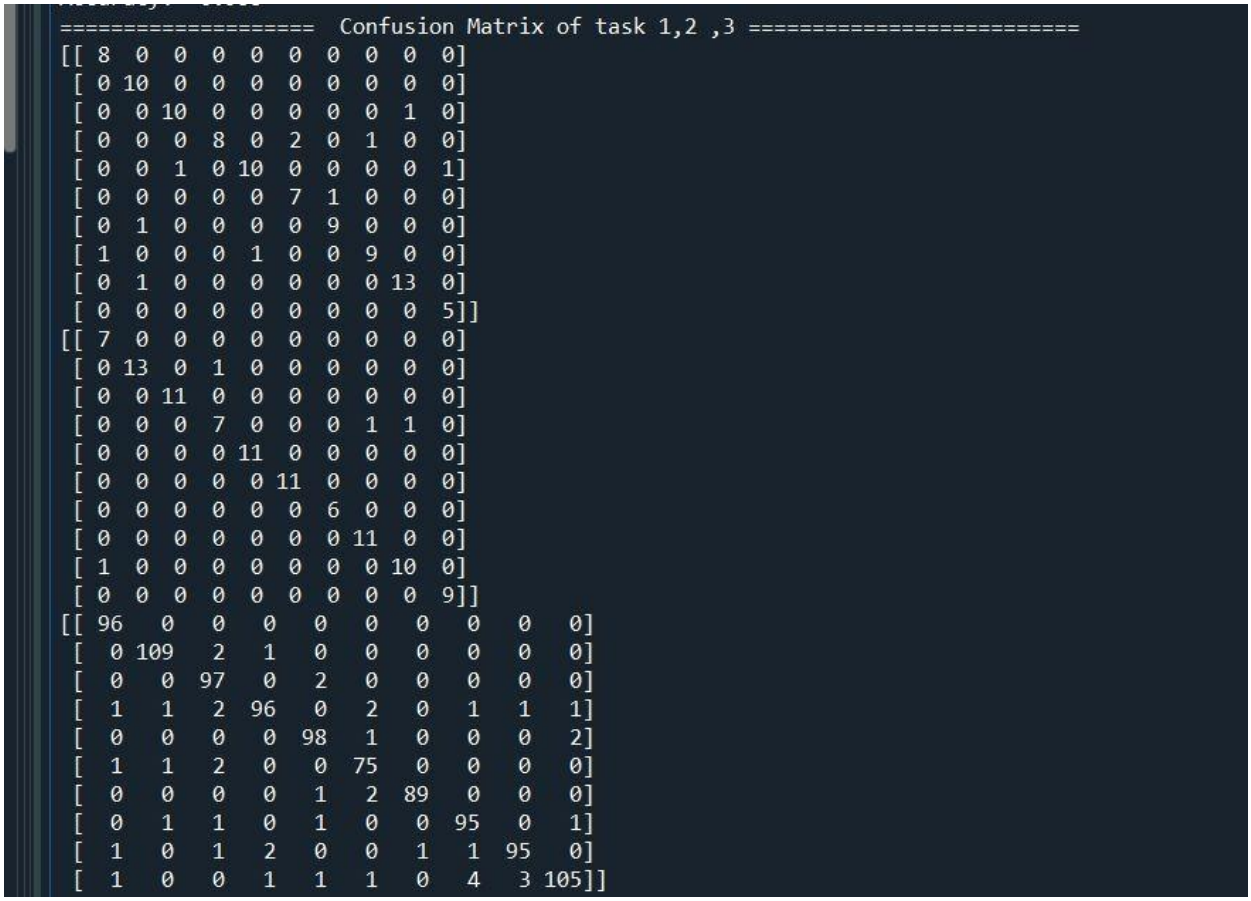
RESULTS

Accuracy Table:

MODEL	ACCURACY
Task 1 - Linear SVM	0.89
Task 2 - Linear SVM	0.96
Task 3 - Linear SVM	0.955
Task 4 - POLY Kernel	0.94

Confusion Matrix:

➔ **Plot the confusion matrix for task 1, 2, 3**



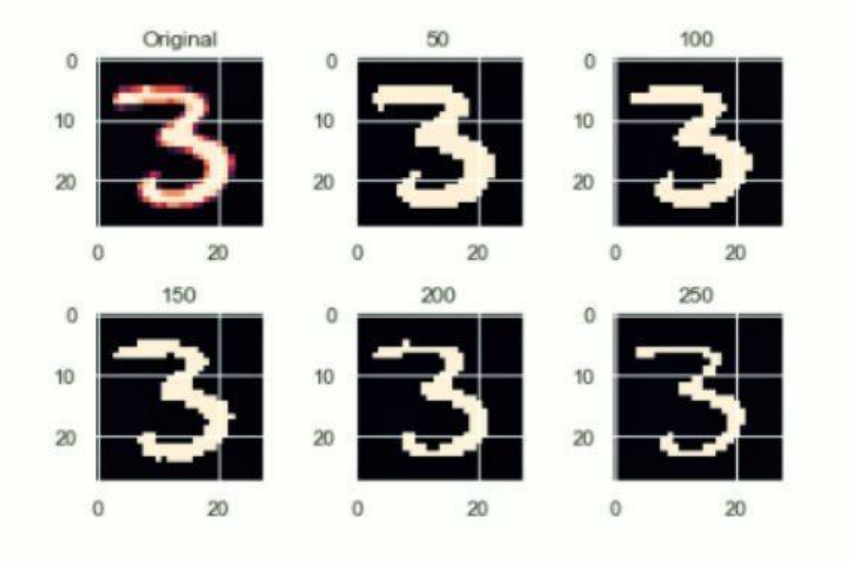
```
==========  Confusion Matrix of task 1,2 ,3 ==========
[[ 8  0  0  0  0  0  0  0  0  0]
 [ 0 10  0  0  0  0  0  0  0  0]
 [ 0  0 10  0  0  0  0  0  1  0]
 [ 0  0  0  8  0  2  0  1  0  0]
 [ 0  0  1  0 10  0  0  0  0  1]
 [ 0  0  0  0  0  7  1  0  0  0]
 [ 0  1  0  0  0  0  9  0  0  0]
 [ 1  0  0  0  1  0  0  9  0  0]
 [ 0  1  0  0  0  0  0  0 13  0]
 [ 0  0  0  0  0  0  0  0  0  5]]
[[ 7  0  0  0  0  0  0  0  0  0]
 [ 0 13  0  1  0  0  0  0  0  0]
 [ 0  0 11  0  0  0  0  0  0  0]
 [ 0  0  0  7  0  0  0  1  1  0]
 [ 0  0  0  0 11  0  0  0  0  0]
 [ 0  0  0  0  0 11  0  0  0  0]
 [ 0  0  0  0  0  0  6  0  0  0]
 [ 0  0  0  0  0  0  0 11  0  0]
 [ 1  0  0  0  0  0  0  0 10  0]
 [ 0  0  0  0  0  0  0  0  0  9]]
[[ 96   0   0   0   0   0   0   0   0   0]
 [  0 109   2   1   0   0   0   0   0   0]
 [  0   0  97   0   2   0   0   0   0   0]
 [  1   1   2  96   0   2   0   1   1   1]
 [  0   0   0   0  98   1   0   0   0   2]
 [  1   1   2   0   0  75   0   0   0   0]
 [  0   0   0   0   1   2  89   0   0   0]
 [  0   1   1   0   1   0   0  95   0   1]
 [  1   0   1   2   0   0   1   1  95   0]
 [  1   0   0   1   1   1   0   4   3 105]]
```

➔Using Different Kernel Functions:

```
Compute predictions
====================  task-4 ==========================
Accuracy:  0.949
[[ 96   0   0   0   0   0   0   0   0   0]
 [  0 109   2   1   0   0   0   0   0   0]
 [  0   0  97   0   2   0   0   0   0   0]
 [  1   1   3  95   0   2   0   1   1   1]
 [  0   0   0   0  96   0   0   1   1   3]
 [  1   2   1   0   0  75   0   0   0   0]
 [  0   1   0   0   1   1  88   0   1   0]
 [  0   1   1   0   1   0   0  95   0   1]
 [  1   0   1   2   0   2   1   2  92   0]
 [  2   1   0   0   1   1   0   4   1 106]]
(60000, 784)
Train model
Compute predictions
====================  task-5 ==========================
Accuracy:  0.943
[[ 96   0   0   0   0   0   0   0   0   0]
 [  0 108   2   1   0   0   0   0   0   1]
 [  0   0  96   0   2   0   0   1   0   0]
 [  0   3   3  95   0   2   0   0   1   1]
 [  0   0   0   0  94   0   0   1   1   5]
 [  2   2   1   1   0  73   0   0   0   0]
 [  1   0   0   0   1   2  88   0   0   0]
 [  0   1   1   0   0   0   0  97   0   0]
 [  1   0   1   1   0   2   1   1  94   0]
 [  3   1   0   0   1   1   1   5   2 102]]
```

➔Binary Images:

In binary images, as the threshold value increases, the accuracy of the model decreases.



CONCLUSION:

In conclusion, the accuracy was slightly higher for kernel='rbf' than kernel='poly'. This is because the squared exponential kernel is generally more flexible than the linear or polynomial kernels in that you can model a whole lot more functions with its function space.

Also, it is noticed that the accuracy decreases when a threshold is used, that is when compared to the result obtained in part 3, it seemed to be lesser.

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