ECE 517 HW-6.3:NON-LINEAR SVM CLASSIFIER

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1 Problem

Use an SVM classifier to solve the classification problem of assignment 6.1

1. How to use the svmtrain function: If you type svmtrain you will see that the option -t 4 exists, which allows the user to compute a kernel matrix and use it as an input instead of introducing the data. We will use this option to precompute the kernel matrix and place it in the position "*training_instance_matrix*". A similar option is present in Python

2. Work out a function whose input is the data matrix X and wose output is the matrix of kernel dot products for

   (a) Linear kernel.

   (b) Order 3 polynomial kernel.

   (c) Square exponential or Gaussian kernel with variable parameter σ

   - Construct a training set of 100 samples and train a Support Vector Machine.
   - Validate the parameter of the square exponential kernel and C with a validatin set of 110 samples.
   - Construct a test set of 1000 samples. Compute the kernel matrix between training and test sets.
   - Compute the test error.

Do it for all three kernels.

Provide the following

- A draw of the classification boundary for the best values of validation parameters.
- Comments on the results.

2 Solution

We use same dataset from problem 6.1 which is show in figure below.

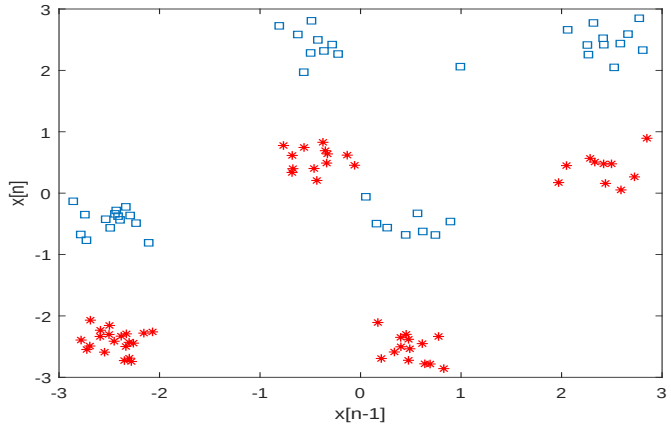

Figure 1: Training Data

2.1 Linear Kernal

we use the below equation for the linear classification.we use *kernelmatrix* function to get data for SVM from linear kernel and draw figure below.

$$k(x, y) = x^T y + C \tag{1}$$

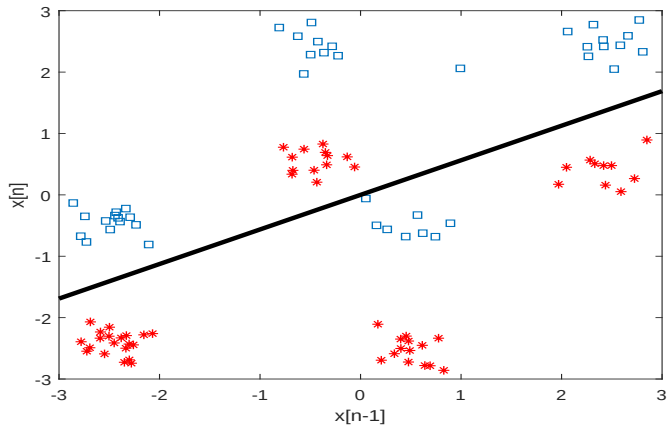

Figure 2: Linear Classifier

we obtained around 10% test error using SVM.

2.2 Polynomial Kernel

Polynomial kernel transform the given input space to the degree provided polynomial given by,

$$k(x, y) = (ax^T y + c)^d \tag{2}$$

we used *kernelmatrix* function to get data for SVM from polynomial kernel. The classifier using polynomial kernal is given below.

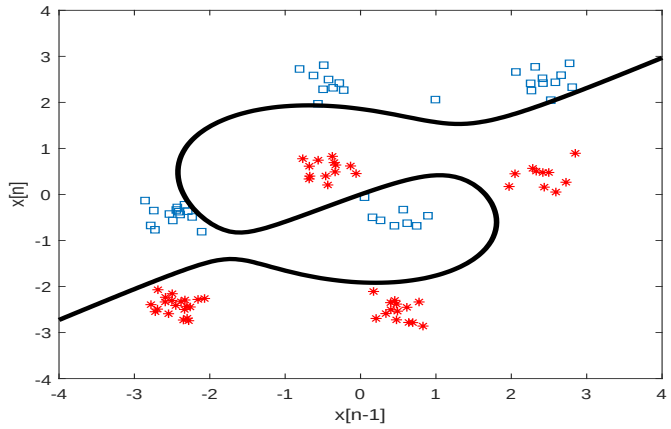

Figure 3: Polynomial Classifier

from the figure, we can say that the test is zero.

2.3 Gaussian Kernel

Gaussian kernel evaluates the radial basis function between given two vectors. from the lecture, Gaussian Kernel is defined by,

$$k(x, y) = e^{-\gamma||x-y||^2} \tag{3}$$

where x and y are input vector. we use program given by professor to create X data and then *kernelmatrix* function to get data for SVM using Gaussian kernel. The solution for the gaussian kernel classifier is given below in figure with test error as zero.

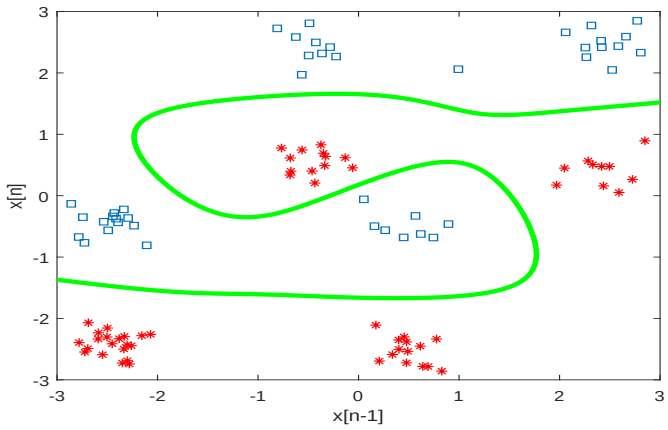

Figure 4: Gaussian Classifier