CS584 Assignment 2: Report

Gady Agam
Department of Computer Science
Illinois Institute of Technology
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Abstract

This report is for assignment in CS584. The problems that we confront Classification problem by different algorithms viz. Gaussian Discriminant Analysis - 1- Feature 2 Class, Gaussian Discriminant Analysis - N- Features 2 Class, Gaussian Discriminant Analysis- N-Feature k Class, Naïve Bayes – Bernoulli distribution, Naïve Bayes –Binomial distribution. Their performance in terms of mean squared error, confusion matrix is evaluated.

Problems Solved:

1. 1D 2-Class Gaussian Discriminant Analysis
    a. To do this analysis, I have chosen the credit_Score data set from UCI Repository. The data has been cleaned to omit the samples with missing values and equal amount of samples for both the classes (i.e. Class 0 and Class 1) have been used as Training Dataset.
    b.

The Model Parameters are μ and σ

Compute the mean and variance of samples with y=0 and y= 1 separately on X_Train

$$\mu_j = 1/m_j \sum_{i=1}^{m_j} X^{(i)}$$

$$\sigma_j^2 = 1/m_j \sum_{i=1}^{m_j} (X^{(i)} - \mu_j)^2$$

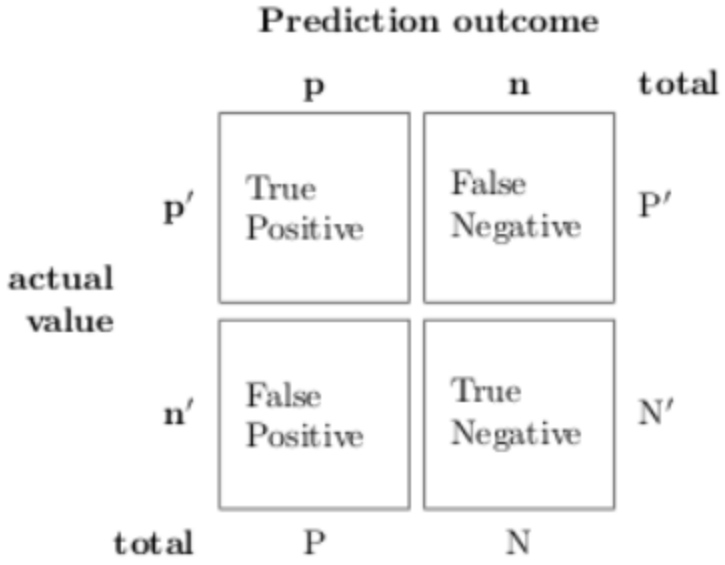
    c. From the Model Parameters we can predict the labels for the new Test Data

Univariate Gaussian Discriminant

$$g_j(X) = -log(\sigma_j) - (X - \mu_j)^2/\sigma_j^2 + log(\alpha_j)$$

using,

    d. We compute the confusion matrix using the predicted and actual classes.
    Confusion Matrix:



Mean Squared Error 0.438735177866

Evaluation Measures from Confusion Matrix for label 0.0 :
Accuracy : 0.561264822134
Recall : 0.302083333333
False Negative : 0.697916666667
Precision : 0.397260273973
False Positive : 0.28025477707
True Negative : 0.71974522293
F Square : 0.343195266272

Evaluation Measures from Confusion Matrix for label 1.0 :
Accuracy : 0.561264822134
Recall : 0.71974522293
False Negative : 0.28025477707
Precision : 0.627777777778
False Positive : 0.697916666667
True Negative : 0.302083333333
F Square : 0.670623145401

2. nD 2-Class Gaussian Discriminant Analysis

a. To do this analysis, I have chosen the credit_Score data set from UCI Repository. The data has been cleaned to omit the samples with missing values and equal

amount of samples for both the classes (i.e. Class 0 and Class 1) have been used as Training Dataset. The Training Set has 6 continuous features.

b. Model Parameter for multi feature Gaussian distribution.

$$\mu_j = 1/m_j \sum_{i=1}^{m_j} I(Y^j = i) X^{(i)}$$

$$\sum_j = 1/m_j \sum_{i=1}^{m_j} (X^{(i)} - \mu_j)(X^{(i)} - \mu_j)^T$$

c. From the computed model parameter mu and sigma, we can predict the labels for any new X. d.

$$g_j(X) = -log(|\sum_j|) - 1/2(X - \mu_j)^T \sum^{-1} (X - \mu_j) + log(\alpha_j)$$

d. Performance Evaluation:

Mean Squared Error 0.237154150198

Evaluation Measures from Confusion Matrix for label 0.0 :

Accuracy : 0.762845849802
Recall : 0.552083333333
False Negative : 0.447916666667
Precision : 0.757142857143
False Positive : 0.108280254777
True Negative : 0.891719745223
F Square : 0.638554216867

Evaluation Measures from Confusion Matrix for label 1.0 :

Accuracy : 0.762845849802
Recall : 0.891719745223
False Negative : 0.108280254777
Precision : 0.765027322404
False Positive : 0.447916666667
True Negative : 0.552083333333
F Square : 0.823529411765

Area Under the PR Curve using Trapezium rule 7.34445326274

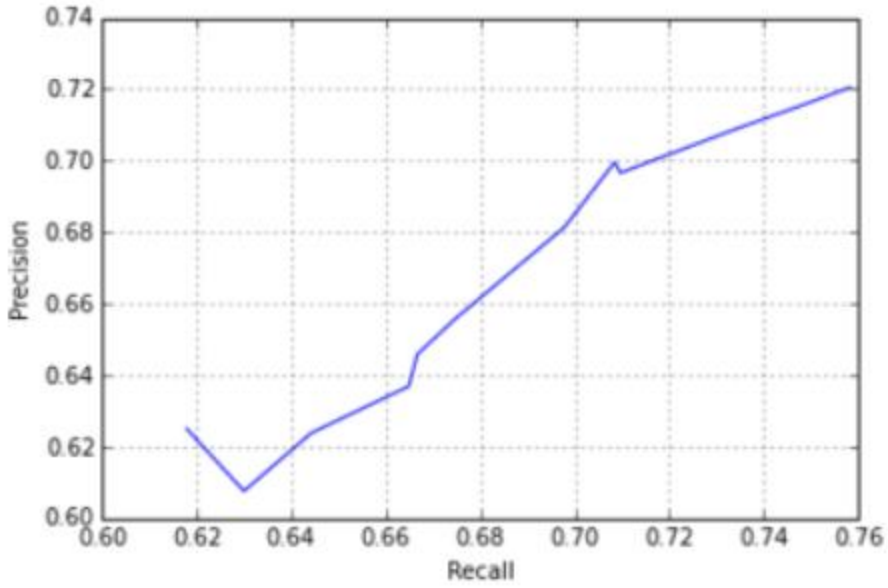


Fig1. Precision Recall Curve – using averages.

3. a.

nD k-Class Gaussian Discriminant Analysis

Compute the mean and variance of samples with y=0 and y= 1 separately on X_Train

$$\mu_j = 1/m_j \sum_{i=1}^{m_j} I(Y^j = i) X^{(i)}$$

$$\sum_j = 1/m_j \sum_{i=1}^{m_j} (X^{(i)} - \mu_j)(X^{(i)} - \mu_j)^T$$

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b. From the computed model parameter mu and sigma, we can predict the labels for any new X.

$$g_j(X) = -log(|\sum_j|) - 1/2(X - \mu_j)^T \sum^{-1} (X - \mu_j) + log(\alpha_j)$$

c. Performance Evaluation:

Mean Squared Error 1.36082474227

Evaluation Measures from Confusion Matrix for label 0.0 :

Accuracy : 0.701030927835
Recall : 0.702127659574
False Negative : 0.297872340426

Precision : 0.6875
False Positive : 0.3
True Negative : 0.7
F Square : 0.694736842105

Evaluation Measures from Confusion Matrix for label 1.0 :

Accuracy : 0.711340206186
Recall : 0.8125
False Negative : 0.1875
Precision : 0.833333333333
False Positive : 0.764705882353
True Negative : 0.235294117647
F Square : 0.822784810127

Evaluation Measures from Confusion Matrix for label 2.0 :

Accuracy : 0.752577319588
Recall : 0.853658536585
False Negative : 0.146341463415
Precision : 0.853658536585
False Positive : 0.8
True Negative : 0.2
F Square : 0.853658536585

Evaluation Measures from Confusion Matrix for label 3.0 :

Accuracy : 0.835051546392
Recall : 0.894117647059
False Negative : 0.105882352941
Precision : 0.915662650602
False Positive : 0.583333333333
True Negative : 0.416666666667
F Square : 0.904761904762

Evaluation Measures from Confusion Matrix for label 4.0 :

Accuracy : 0.969072164948
Recall : 1.0
False Negative : 0.0
Precision : 0.969072164948
False Positive : 1.0
True Negative : 0.0
F Square : 0.984293193717

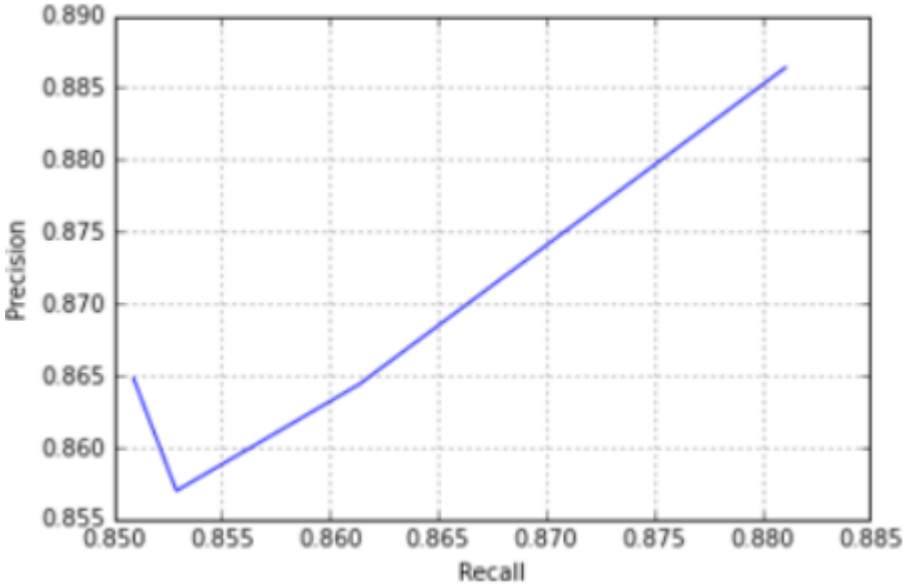

Fig2. Precision – Recall curve.

4. Naive Bayes with Bernoulli Features.
   a. The credit_Score data set of UCI, has been used in this experiment. It has two classes (ie. Good Credit: 1 Bad Credit: 0). The dataset contains text categorical values as 0s and 1s.

   b. Model Parameter:

$$\alpha_{p|y=1} = 1/m_j \sum_{i=1}^{m_j} X_p^i$$

$$Prior_i = 1/m_j \sum_{i=1}^{m_j} I(Y^j = i)$$

   c.

Membership Function

$$g_l(X) = \sum_{j=1}^{n} log(\binom{P}{X_j} \alpha_{j/y=l}^{X_j} (1 - \alpha_{j/y=l})^{p - X_j}) + log(\alpha_l)$$

Classification: $\hat{y} = \arg\max_l g_l(X)$

   d. Performance Evaluation:
   Mean Squared Error 0.399209486166

Evaluation Measures from Confusion Matrix for label 0. :

Accuracy : 0.600790513834
Recall : 0.202380952381
False Negative : 0.797619047619
Precision : 0.333333333333
False Positive : 0.201183431953
True Negative : 0.798816568047
F Square : 0.251851851852

Evaluation Measures from Confusion Matrix for label 1.0:

Accuracy : 0.600790513834
Recall : 0.798816568047
False Negative : 0.201183431953
Precision : 0.668316831683
False Positive : 0.797619047619
True Negative : 0.202380952381
F Square : 0.727762803235

5. Naive Bayes – Binomial Features.
   a. Used a new Text based Dataset – Spmbase.csv , it contains the frequency of the words , as a part of Data Cleaning , the frequencies are converted into whole numbers and the features. The two classes are 0 (not spam) and 1(spam).

   b. Model Parameter

$$\alpha_{j/y=l} = (\sum_{i=1}^{m} I(Y^i = l) X_j^i) / (\sum_{i=1}^{m} I(Y^i = l) P^i)$$

Membership Function

$$g_l(X) = \sum_{j=1}^{n} log(\binom{P}{X_j} \alpha_{j/y=l}^{X_j} (1 - \alpha_{j/y=l})^{P - X_j}) + log(\alpha_l)$$

Classification: $\hat{y} = \arg\max_l g_l(X)$

   c.
   d. Performance Evaluation:

Mean Squared Error 0.15

Evaluation Measures from Confusion Matrix for label 0.0:

Accuracy : 0.85
Recall : 0.626666666667
False Negative : 0.373333333333
Precision : 0.959183673469
False Positive : 0.016
True Negative : 0.984
F Square : 0.758064516129

Evaluation Measures from Confusion Matrix for label 1.0:

Accuracy : 0.85
Recall : 0.984
False Negative : 0.016
Precision : 0.814569536424
False Positive : 0.373333333333
True Negative : 0.626666666667
F Square : 0.891304347826