Machine Learning
(BITS F464)

Assignment 3
Naive Bayes Classifier

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Training the faces

The each of 70x60 pixels of each of the images were analysed and the following probabilities were computed for each pixel:

- P(‘#’ | image=face)
- P(‘#’ | image!=face)
- P(‘ ‘ | image=face)
- P(‘ ‘ | image!=face)

Also along with these probabilities, two more probabilities were computed:

- P(image=face)
- P(image!=face)

Thus after calculating these probabilities, Naive bayes Classifier was used to predict whether each of the images were faces or not by computing the following probabilities :

P(image=face | pixels) = $\left(\prod\right.$P(pixel(‘#’ or ‘ ‘) | image=face)$\left.\right)$P(image=face)

P(image!=face | pixels) = $\left(\prod\right.$P(pixel(‘#’ or ‘ ‘) | image!=face)$\left.\right)$P(image!=face)

and classifying image as face or not a face according to the greater of the two calculated probabilities.
To prevent the values of P(image=face | pixels) and P(image!=face | pixels) from reaching zero due to multiplication of individual probabilities, each of the probabilities P(pixel(‘#’ or ‘ ‘) | image=face) or P(pixel(‘#’ or ‘ ‘) | image!=face) were multiplied by a constant value of **1.42** .

Confusion Matrix :

Classification / Truth	**True**	**False**
Positive	63	6
Negetive	71	10

Accuracy: 89.33%

Examples of Misclassification

False Positive

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```

False Negetive

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```

Code:

```
import java.io.*;
class NaiveBayes
{
     public static void main(String [] args)throws IOException
     {
          double P_h1[][]=new double[70][60];//array to store
P('#'|(image=face))
          double P_h0[][]=new double[70][60];//array to store
P('#'|(image=not face))
          double P_s1[][]=new double[70][60];//array to store P('
'|(image=face))
          double P_s0[][]=new double[70][60];//array to store P('
'|(image=not face))
          double acc=0;// to store accuracy
          double s_const=1.42;// smoothing constant to prevent the
probabilities from reaching zero
          int conf_mat[][]=new int[2][2];// confusion matrix
          double P_1=0;// to store probability of face images in
the training data
          double P_0=0; // to store the probility that image is not
of a face in the training data
          double P1=1.0;// probability that image to be tested is
of a face
          double P0=1.0;// probability that image to be tested is
not of a face
          int count=0;

          for(int i=0;i<2;i++)
          for(int j=0;j<2;j++)
          conf_mat[i][j]=0;//to initialize confusion matrix
elements to zero

          for(int i=0;i<70;i++)
               for(int j=0;j<60;j++)
               {
                    P_h1[i][j]=0.0;
                    P_h0[i][j]=0.0;
                    P_s1[i][j]=0.0;
                    P_s0[i][j]=0.0;
               }// to initialize the probablities to zero before
training

          FileReader tr = new FileReader("facedatatrain");//opening
the training image file
          BufferedReader br=new BufferedReader(tr);
          String tr_img=br.readLine();//stores each line of file

          FileReader tr_label=new
FileReader("facedatatrainlabels");// opening the training result
file
          BufferedReader br1=new BufferedReader(tr_label);
          String tr_res=br1.readLine();//stores result of image

          while((tr_img)!=null && (tr_res)!=null)
          {
               if(tr_res.equals("1"))
               P_1+=1.0;
               else
               P_0+=1.0;

               for(int i=0;i<70;i++)
               {

                    for(int j=0;j<60;j++)
                    {

                         char ch=tr_img.charAt(j);

                         if(tr_res.equals("1"))
                         {
                              if(ch=='#')
                              P_h1[i][j]+=1.0;
                              else if(ch==' ')
                              P_s1[i][j]+=1.0;
                         }
                         else if(tr_res.equals("0"))
                         {
                              if(ch=='#')
                              P_h0[i][j]+=1.0;
                              else if(ch==' ')
                              P_s0[i][j]+=1.0;
                         }

                    }

                    tr_img=br.readLine();
               }//to scan each image of each image and increment
probabilities accordingly

               count++;
               tr_res=(br1.readLine());
          }

          tr.close();
          tr_label.close();

          // computing probabilities
          for(int i=0;i<70;i++)
          {
               for(int j=0;j<60;j++)
               {
                    P_h1[i][j]/=P_1;
                    P_h0[i][j]/=P_0;
                    P_s1[i][j]/=P_1;
                    P_s0[i][j]/=P_0;
               }
          }


          P_1/=count;
          P_0/=count;

          FileReader test = new
FileReader("facedatatest");//opening the training image file
```

```
          BufferedReader br2=new BufferedReader(test);
          String ts_img=br2.readLine();//stores each line of file

          FileReader test_label=new
FileReader("facedatatestlabels");// opening the image testing file
          BufferedReader br3=new BufferedReader(test_label);
          String ts_res=br3.readLine();//stores the result of the
image

          count =0;

          System.out.println("Actual Output\tClassified Output");

          while((ts_img)!=null && (ts_res)!=null)
          {
               P1=P_1;
               P0=P_0;//initializing the probailities
               int res=-1;

               for(int i=0;i<70;i++)
               {

                    for(int j=0;j<60;j++)
                    {
                         char ch=ts_img.charAt(j);
                         switch(ch)
                         {
                              case '#': P1=P1*P_h1[i][j]*s_const;
                                        P0=P0*P_h0[i][j]*s_const;
                                        break;

                              case ' ': P1=P1*P_s1[i][j]*s_const;
                                        P0=P0*P_s0[i][j]*s_const;
                                        break;
                         }


                    }//computing probabilities P(face|data) and
P(not face|data)

                    ts_img=br2.readLine();
               }

               if(P1>P0)
               res=1;
               else
               res=0;//computing result based on the probabilities

               if(res==0 && ts_res.equals("0"))
               conf_mat[0][0]++;
               else if(res==0 && ts_res.equals("1"))
               conf_mat[0][1]++;
               else if (res==1 && ts_res.equals("0"))
               conf_mat[1][0]++;
               else if (res==1 && ts_res.equals("1"))
               conf_mat[1][1]++;
               //incrementing values of the confusion matrix
```

```
     System.out.println("\t"+ts_res+"\t\t"+res);//printing results

               count++;
               ts_res=(br3.readLine());
          }

          System.out.println("True Negetives: "+conf_mat[0][0]);
          System.out.println("True Positives: "+conf_mat[1][1]);
          System.out.println("False Negetives: "+conf_mat[0][1]);
          System.out.println("False Positives: "+conf_mat[1][0]);
          // printing value of confusion matrix

          acc=(double)(conf_mat[0][0]+conf_mat[1][1])/
((double)count);//calculating accuracy
          System.out.println("Accuracy: "+acc*100+"%");

          if(count==(conf_mat[0][0]+conf_mat[0][1]+conf_mat[1]
[0]+conf_mat[1][1]))
          System.out.println("All files Read
Correctly");//Verifying that all files have been read


     }
}
```