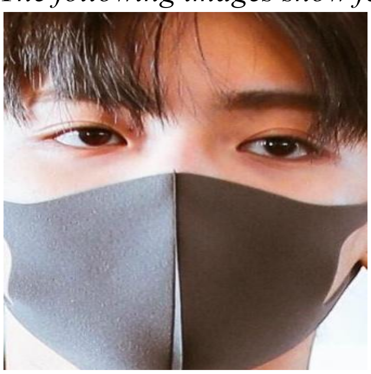
Mask vs. No-Mask classification

Ridhima Kohli, Ronak Singhvi
B19CSE071 , B19CSE072

Abstract – This paper reports our experience with building a mask vs no mask classification code. We have a dataset which consists of images of people wearing or not wearing masks. We use various classification algorithms and compare their results in this report.

I. Introduction

Face recognition is a fascinating application in the field of image recognition. However, face images with masks create hindrance .The goal of this project is to classify images of people into two classes: Mask and No-Mask based upon whether they wear a glass in the image or not. However, there is a variety in the shape, design and appearance of masks which makes it challenging. The mask vs. no mask recognition can help in applications like making sure people in public follow the pandemic guidelines and detect violators. The following images show few examples of mask vs no mask images.




Datasets

The dataset has 2 folders - mask and no mask with respective images in jpg format.
50% of the dataset was used for training and the remaining 50% for testing.

II. Methodology

Overview

There are various classification algorithms present out of which we shall implement the following

- *KNN*
- *SVM*
- *MLP*

Exploring the dataset and pre-processing

The images were given in jpg format which needed to be converted into array so as to use them in classifiers.For this the PIL and numpy libraries were used which converted the images into their RGB pixel arrays each of size (183750,3).Now , these image arrays were put into separate csv files with 2-D arrays converted to 1-D arrays by flattening.

[[r1 g1 b1],[r2 g2 b2],...] ===> [r1 ,g1 ,b1 ,r2 ,g2 ,b2,...]

Implementation of classification algorithms

- *k-NN :*

    1) the k-nearest neighbors algorithm (k-NN) is a non-parametric classification method. It is used for classification and regression. In both cases, the input consists of the k closest training examples in data set. The output depends on whether k-NN is used for classification or regression:

    2) In k-NN classification, the output is a class membership. An object is classified by a plurality vote of its neighbors, with the object being assigned to the class most common among its k nearest neighbors (k is a positive integer, typically small). If k = 1, then the object is simply assigned to the class of that single nearest neighbor.

    3) In k-NN regression, the output is the property value for the object. This value is the average of the values of k nearest neighbors.

    4) The training examples are vectors in a multidimensional feature space, each with a class label. The training phase of the algorithm consists only of storing the feature vectors and class labels of the training samples.

    5) In the classification phase, k is a user-defined constant, and an unlabeled vector (a query or test point) is classified by assigning the label which is most frequent among the k training samples nearest to that query point.

    6) A commonly used distance metric for continuous variables is Euclidean distance. For discrete variables, such as for text classification, another metric can be used, such as the overlap metric (or Hamming distance).

- ***Multi-Layer Perceptron :***

    1) A perceptron is a linear classifier; that is, it is an algorithm that classifies input by separating two categories with a straight line. Input is typically a feature vector x multiplied by weights w and added to a bias b: y = w * x + b. A 5-perceptron produces a single output based on several real-valued inputs by forming a linear combination using its input weights (and sometimes passing the output through a nonlinear activation function).

    2) A multilayer perceptron (MLP) is a deep, artificial neural network. It is composed of more than one perceptron. They are composed of an input layer to receive the signal, an output layer that makes a decision or prediction about the input, and in between those two, an arbitrary number of hidden layers that are the true computational engine of the MLP. MLPs with one hidden layer are capable of approximating any continuous function.

3) In the forward pass, the signal flow moves from the input layer through the hidden layers to the output layer, and the
decision of the output layer is measured against the ground truth labels.In the backward pass, using backpropagation and
the chain rule of calculus, partial derivatives of the error function w.r.t. the various weights and biases are back-propagated
through the MLP.

- ***Support Vector Machine :***

1)Support-vector machines (SVMs, also support-vector networks) are supervised learning models with associated learning
algorithms that analyze data for classification and regression analysis.

2) Given a set of training examples, each marked as belonging to one of two categories, an SVM training algorithm builds a model that assigns new examples to one category or the other, making it a non-probabilistic binary linear classifier (although methods such as Platt scaling exist to use SVM in a probabilistic classification setting). SVM maps training examples to points in space so as to maximise the width of the gap between the two categories. New examples are then mapped into that same space and predicted to belong to a category based on which side of the gap they fall.

3) In addition to performing linear classification, SVMs can efficiently perform a non-linear classification using what is
called the kernel trick, implicitly mapping their inputs into high-dimensional feature spaces.
SVMs can be used to solve various real-world problems:

a) SVMs are helpful in text and hypertext categorization, as their application can significantly reduce the need for labeled training instances in both the standard inductive and transductive settings. Some methods for shallow semantic parsing are based on support vector machines.

b) Classification of images can also be performed using SVMs. Experimental results show that SVMs achieve signifi-cantly higher search accuracy than traditional query refinement schemes after just three to four rounds of relevance feedback. This is also true for image segmentation systems, including those using a modified version of SVM that uses the privileged approach as suggested by Vapnik.

c) Classification of satellite data like SAR data using supervised SVM.

d) Hand-written characters can be recognized using SVM.

e) The SVM algorithm has been widely applied in the biological and other sciences. They have been used to classify proteins with up to 90 percent of the compounds classified correctly. Permutation tests based on SVM weights have been suggested as a mechanism for interpretation of SVM models.Support-vector machine weights have also been used to interpret SVM models in the past.Post Hoc interpretation of support-vector machine models in order to identify features used by the model to make predictions is a relatively new area of research with special significance in the biological sciences.

III. Evaluation of models

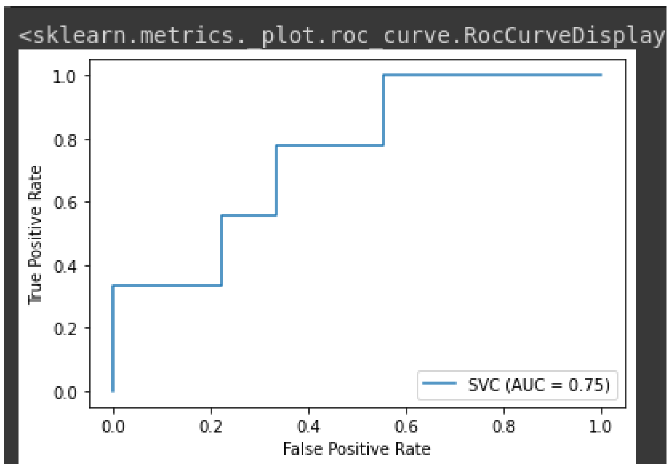
The models implemented were evaluated using techniques like - Classification report : precision , recall , f1 score and support , Confusion matrix , ROC plots , accuracy score and cross validation scores.
Table 1.1 and 1.2 contains the results obtained from the above techniques.

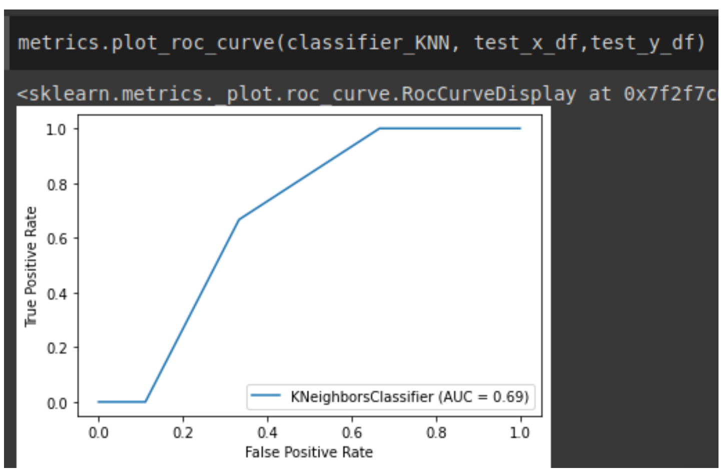
Table 1.1

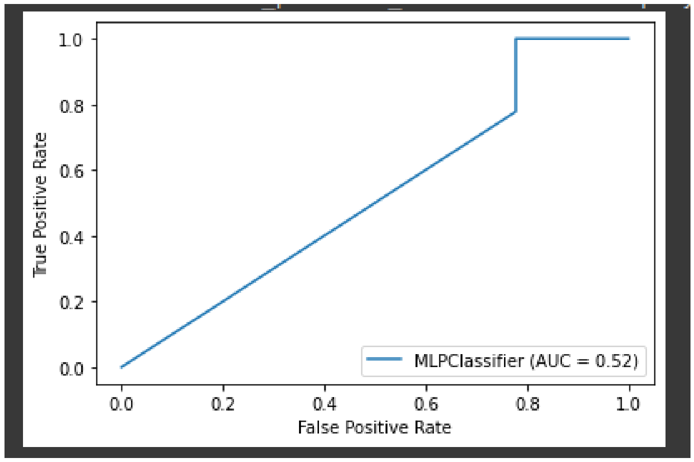
MODEL	*SVM*	*KNN*	*MLP*
accuracy score	*0.55*	*0.55*	*1.0*
CV Score	*[1. , 1. , 1. , 0.5, 1.]*	*[1. , 1. , 0.75, 0.75, 1.]*	*[0.5 ,0.5 , 0.125, 0.75 , 1.]*

Plots : SVM , KNN,MLP

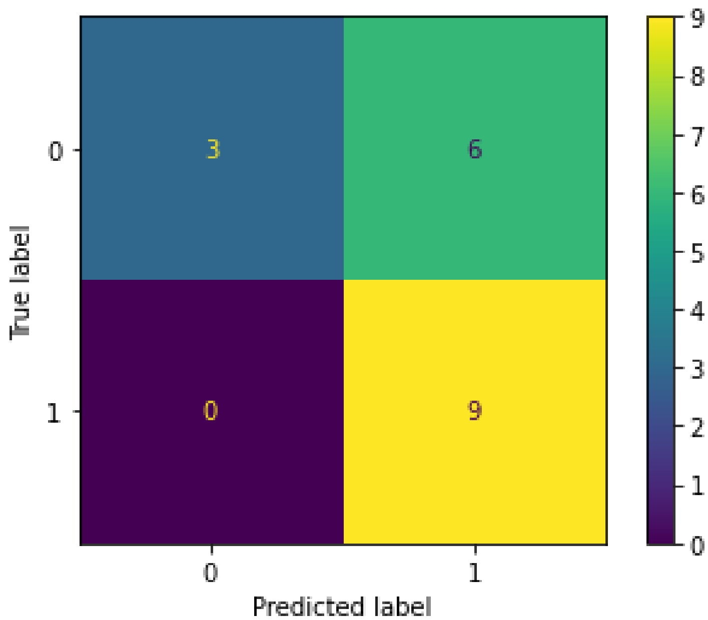
1. ***ROCs***

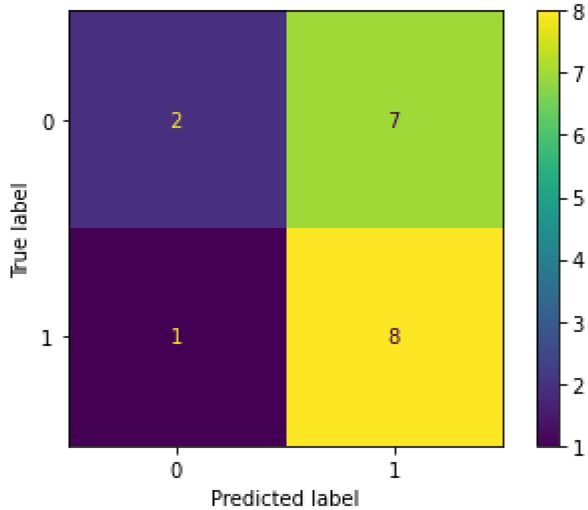






2. Confusion matrix





VI. Results and Analysis

The table and ROCs show that all classifiers had nearly equally efficient performance.
The dataset was very large and took a lot of time in training.

Contributions

The learning and planning was done as a team.The individual contributions are as given

- Ridhima Kohli (B19CSE071):Pre-processing, SVM , Report
- Ronak Singhvi (B19CSE072):KNN, MLP, Report

References

[1] K Nearest Neighbor | KNN Algorithm | KNN in Python & R (analyticsvidhya.com)

[2] Support Vector Machine — Introduction to Machine Learning Algorithms | by Rohith Gandhi | Towards Data Science

[3] Pattern Classification -Book by David G. Stork, Peter E. Hart, and Richard O. Dud

[4] https://opencv-python-tutroals.readthedocs.io/en/latest/py_tutorials/py_core/py_basic_ops/py_basic_ops.html