EEL3090: Embedded Systems Project Report

ESE5 : DL model optimization for Lightweight Face Mask Detection

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1 Introduction

In recent years, the development of machine learning and artificial intelligence has brought forth a new era of technology that can assist us in various domains of life. The use of neural networks has become a standard technique in the field of computer vision, enabling us to recognize and detect various objects in real-world scenarios. One such application is the detection of masks on faces. With the outbreak of Covid-19, the need for face masks became necessary to prevent the spread of the virus. However, manual detection of mask-wearing can be challenging in crowded areas, and there is a need for automated systems to detect whether individuals are wearing masks or not. In this report, we will describe our neural network project that can detect masks on faces and how such technology can be useful in times of crisis such as Covid-19.

The widespread outbreak of the Covid-19 pandemic has drastically changed our lives and how we interact with one another. The primary way of preventing the spread of the virus is by wearing masks. With the increased need for mask-wearing in public places, the manual detection of whether individuals are wearing masks or not can be a challenging task for law enforcement personnel or other public officials. Furthermore, manual detection of mask-wearing is time-consuming and requires a lot of manpower, which is something that is not available nowadays. An automated system that detects mask-wearing can assist in quickly identifying individuals who are not wearing masks and enforcing mask-wearing policies. This is where our neural network project comes into play.

Our project aims to develop a real-time mask detection system using neural networks. The system uses libraries like TensorFlow, Keras, scikit learn, and OpenCV to analyze images and detect whether individuals in the images are wearing masks. The model is trained using a large dataset of images of people wearing and not wearing masks, allowing the system to classify images accurately in real time. The system is also designed to work in various lighting conditions and camera angles, making it versatile and applicable in various settings.

2 Results

2.1 Varying the Activation Functions

In this section, we see what happens to our neural network when we change the weights and number of layers. We wish to see how this affects accuracy and other parameters. Firstly let us change the activation function and see how it affects the results.

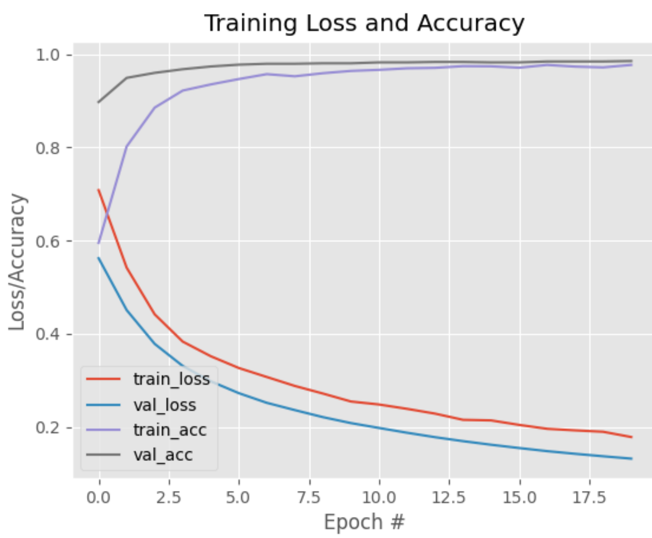


Figure 1: Sigmoid Activation

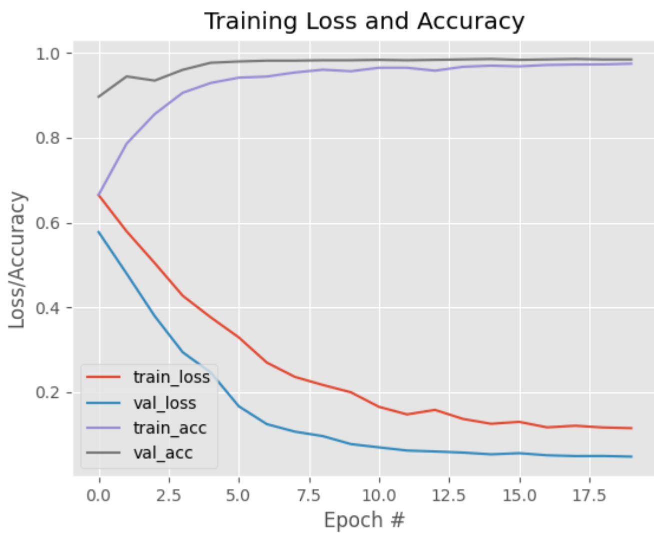


Figure 2: ReLu Activation

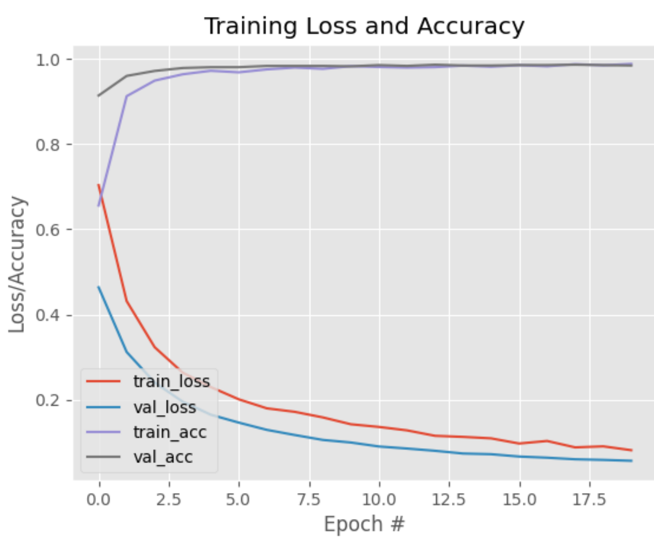


Figure 3: Tanh Activation

We observe the following differences in parameters like f1 score, recall, etc.

```
[INFO] evaluating network...
32/32 [==============================] - 11s 339ms/step
              precision    recall  f1-score   support

   with_mask       0.98      0.99      0.99       541
without_mask       0.99      0.98      0.98       482

    accuracy                           0.98      1023
   macro avg       0.98      0.98      0.98      1023
weighted avg       0.98      0.98      0.98      1023
```

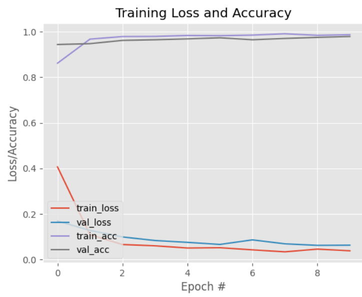
Figure 4: Tanh Activation accuracy parameters

```
[INFO] evaluating network...
32/32 [==============================] - 11s 339ms/step
              precision    recall  f1-score   support

   with_mask       0.98      0.99      0.99       541
without_mask       0.99      0.98      0.98       482

    accuracy                           0.98      1023
   macro avg       0.98      0.98      0.98      1023
weighted avg       0.98      0.98      0.98      1023
```

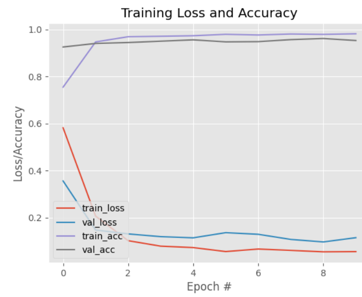
Figure 5: Sigmoid Activation accuracy parameters

2.2 Changing the parameters of the neural network

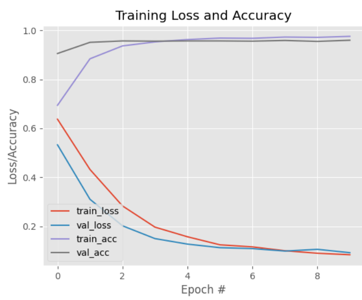
In this section, we explore how our model reacts to changes in the number of layers and nodes.



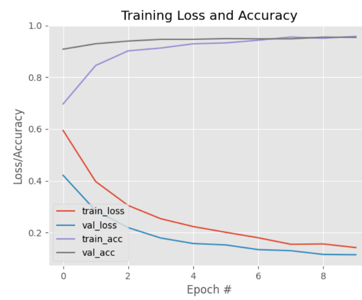
(a) 128 64 256 relu



(b) 16 64 256 relu



(c) 16 64 relu



(d) 16 relu

2.3 How does this model work?

In this section, we look into the functioning aspects of our model and the implementation procedure.

- We start by preprocessing our images and creating a labeled dataset.
- sklearn.preprocessing.LabelBinarizer() was used to convert the labels into a binary value.
- Following that, we split our data into a training set and a testing set. We also keep some images for validation. The data partition into training and testing splits uses 75 percent of the data for training and the remaining 25 percent for testing.
- Following that, we perform data augmentation. This will help us create a more robust model and prevent over-fitting.
- To classify our images, we used the MobileNetV2 neural network from the Tensorflow library. We load this network and define various vari-

ables like the number of layers, the number of nodes in those layers, activation functions, etc.

- We then initialize the learning rate, number of epochs, and batch size. Now we can compile the model and train it.

- After training it, we calculate parameters like precision, accuracy, recall, etc., on a validation data set and plot the graphs.

3 Conclusion

In conclusion, our neural network project that detects masks on faces provides a viable solution to assist in the enforcement of mask-wearing policies during times of crisis such as Covid-19. Using computer vision techniques and a large dataset of images, the system can accurately detect whether individuals are wearing masks in real time.

Finally, based on our results, we saw that our model was very robust. This is substantiated by the fact that even when we changed the number of nodes and layers, the accuracy did not change much. Furthermore, the Caffe model identifies the heads very well and that helps the neural network to work more accurately. We also observed that the best activation function was tanh as it gave the best results. We used multiple layers for the neural network to obtain the best output.

Overall, our neural network project provides a robust solution for automated mask detection and can be incorporated into various applications to improve the enforcement of mask-wearing policies. As the world continues to face challenges such as the Covid-19 pandemic, the development and application of advanced technologies such as neural networks can help us overcome such challenges and create a safer and healthier future for everyone.

4 References

1. https://github.com/Karan-Malik/FaceMaskDetector

2. https://github.com/NVIDIA-AI-IOT/face-mask-detection

3. https://en.wikipedia.org/wiki/F-score

4. https://paperswithcode.com/method/mobilenetv2

5 Appendices

1. F1-Score : F1 score is a machine learning evaluation metric that measures a model's accuracy. It combines the precision and recall scores of a model. The accuracy metric computes how often a model made a correct prediction across the entire dataset. It is the harmonic mean of our recall and precision.

2. Recall : Recall measures how many relevant elements were detected. Therefore it divides true positives by the number of relevant elements.

3. Precision : Precision is one indicator of a machine learning model's performance – the quality of a positive prediction made by the model. Precision refers to the number of true positives divided by the total number of positive predictions (i.e., the number of true positives plus the number of false positives).

4. Activation Function : It's just a thing function that you use to get the output of the node. It is also known as Transfer Function.

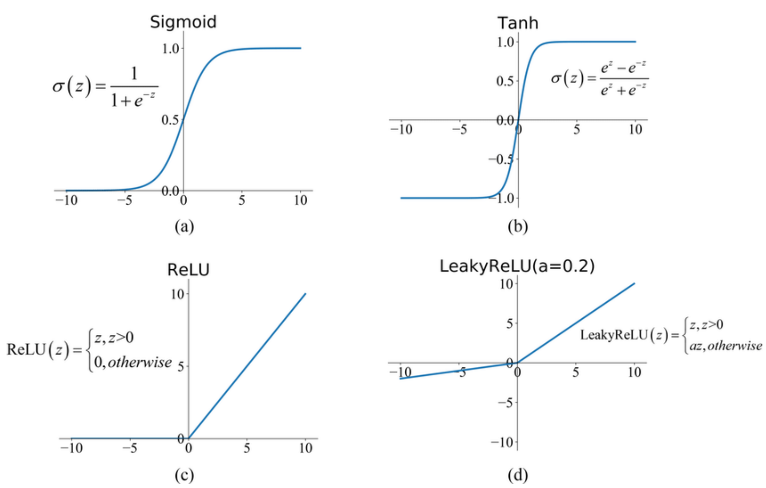


Figure 7: Different types of activation functions

5. Data Augmentation : Data augmentation is the addition of new data artificially derived from existing training data. Techniques include resizing, flipping, rotating, cropping, padding, etc. It helps to address

issues like overfitting and data scarcity, and it makes the model robust with better performance.