MV_Excercise3: Deep Learning

Student

Siddesh Bramarambika Shankar

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12329513

Teacher

Dr. Markus Vincze

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For the assignment I followed the honor code:

• Rule 1: Don’t look at solutions or code of other students; everything you submit should be your own work

• Rule 2: Don’t share your solution code with others; however, discussing ideas or general strategies is fine and encouraged

• Rule 3: If you use code from somewhere you need to cite the source directly in your code (e.g., StackOverflow).

I know that I have full responsibility for what I submit. I made sure the assignment allows the teaching staff to evaluate which competences I have acquired. I am aware that plagiarism is prohibited and may lead to failure of this course.

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1 Experiment 1

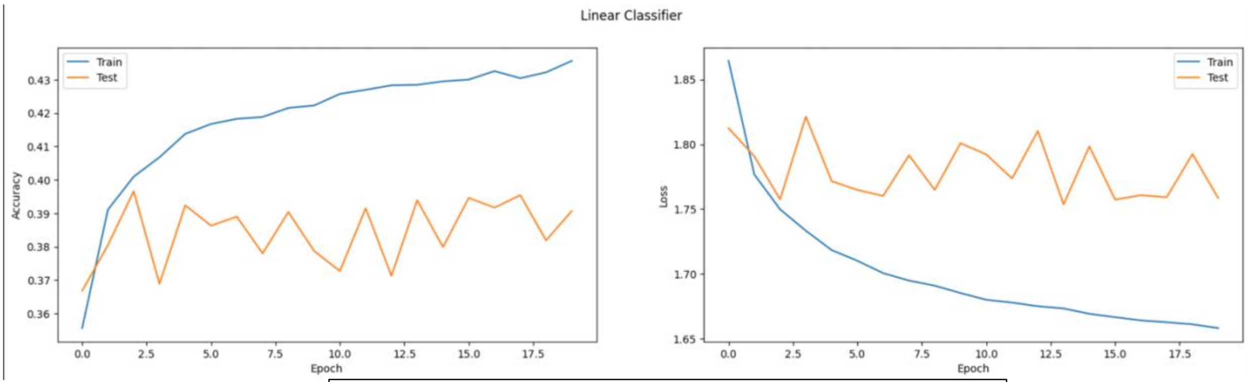

Figure 1: Training history plot of linear_classifier

The above image Fig. 1 shows the Training history plot of the linear classifier model. By analyzing accuracy plot and loss plot, it gives a clear picture of how the model is training based on the training data, learning exponentially thereby increasing its accuracy and decreasing its loss as it goes through more epochs, but the test accuracy and loss fluctuates without showing an upward and lower trend respectively, this is because the model is learning patterns specific to the training data, which do not generalize to new, unseen data, In other words, the model is showing the issue of overfitting.

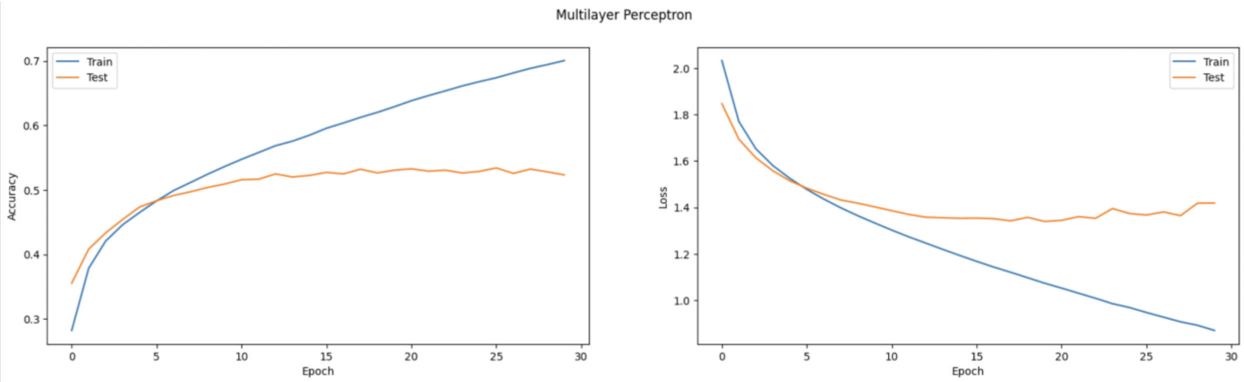

Figure 2: Training history plot of multilayer perceptron

The above image Fig. 2 shows the Training history plot of the multilayer perceptron model. By analyzing accuracy plot and loss plot, it gives a clear picture of how the model is training based on the training data, learning exponentially thereby increasing its accuracy and decreasing its loss as it goes through more epochs, but the test accuracy and loss stagnates early on, again suggesting that the model's ability to generalize to unseen data is still limited. Again, the problem here is overfitting.

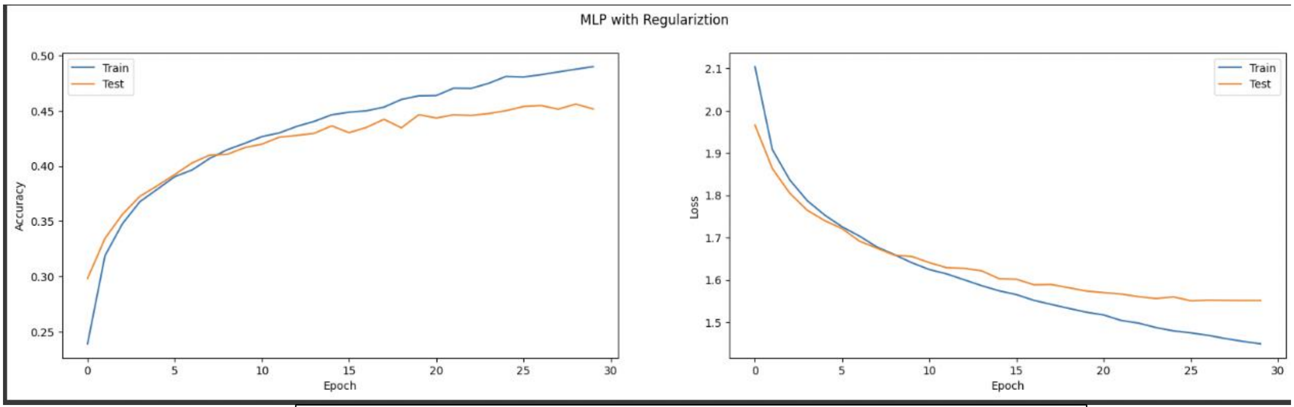

Figure 3: Training history plot of MLP with regularization

The above image Fig. 3 shows the Training history plot of the MLP model with regularization. By analyzing accuracy plot and loss plot, it shows that the test accuracy and loss following the training accuracy and loss more closely, showing a clear improvement over the previous models. Implementing regularization to the MLP model is mitigating the issue of overfitting that were present in the previous models. The test accuracy and loss despite showing improvements lags behind the training accuracy and loss, and eventually stagnates at around 46% and 1.6 respectively. Signifying that there are still improvements possible. The problem with this model is that the MLP model relies on converting the images to flat vectors which results in spatial information and thereby reducing the performance.

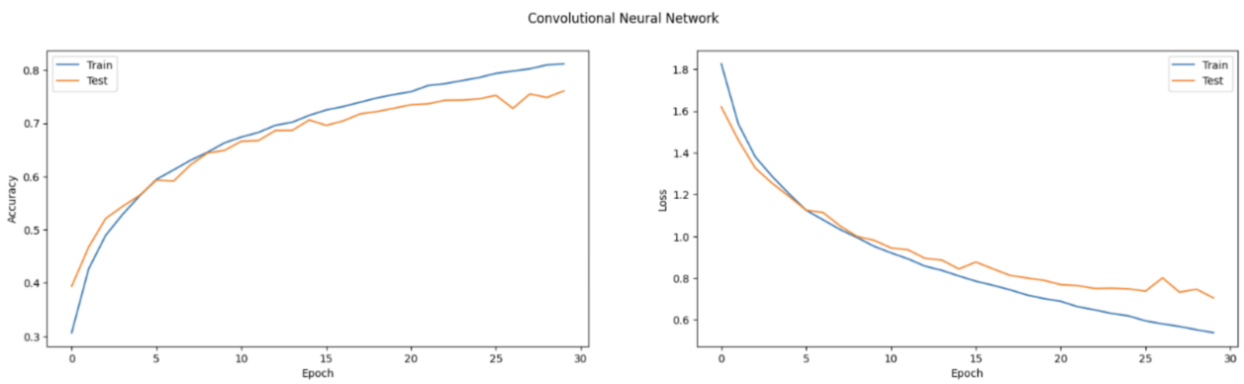

Figure 4: Training history plot of CNN model

The above image Fig. 4 shows the Training history plot of the Convolution Neural Network model. By analyzing accuracy plot and loss plot, it shows significant improvement, the test accuracy and loss follows the training accuracy and loss more closely, suggesting that the CNN model is learning features that generalizes well to unseen data. The model despite the improvements does not justify the computational power required to generate slightly better results than the MLP with regularization model.

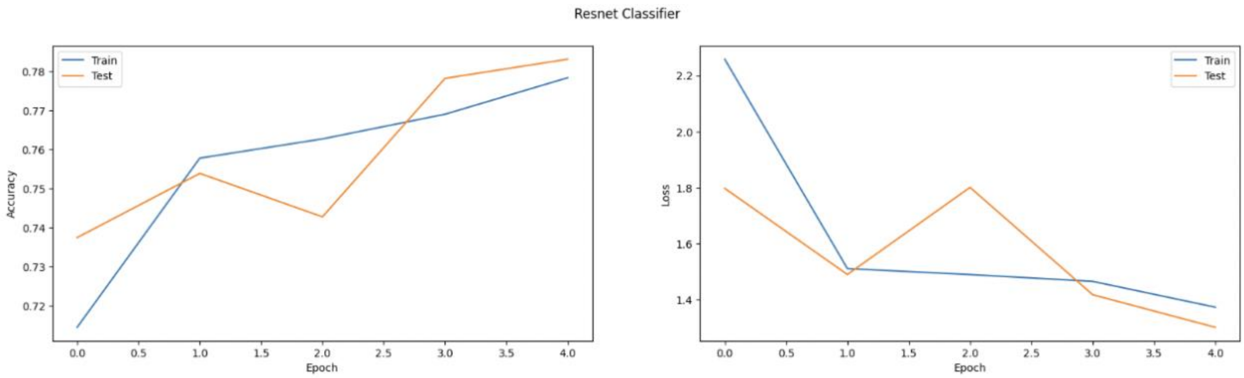

Figure 5: Training history plot of transfer learning approach (using ResNet50)

The above image Fig. 5 shows the Training history plot of transfer learning approach (using ResNet50 model). By analyzing accuracy plot and loss plot, it shows the training accuracy increases and training loss reduces very quickly, this is because as only the last layer is being retrained. Despite the use of a pre-trained model, the training accuracy and loss does not overlap with the test accuracy and loss, which suggests that the model is beginning to overfit to the training data.

2 Experiment 2.1

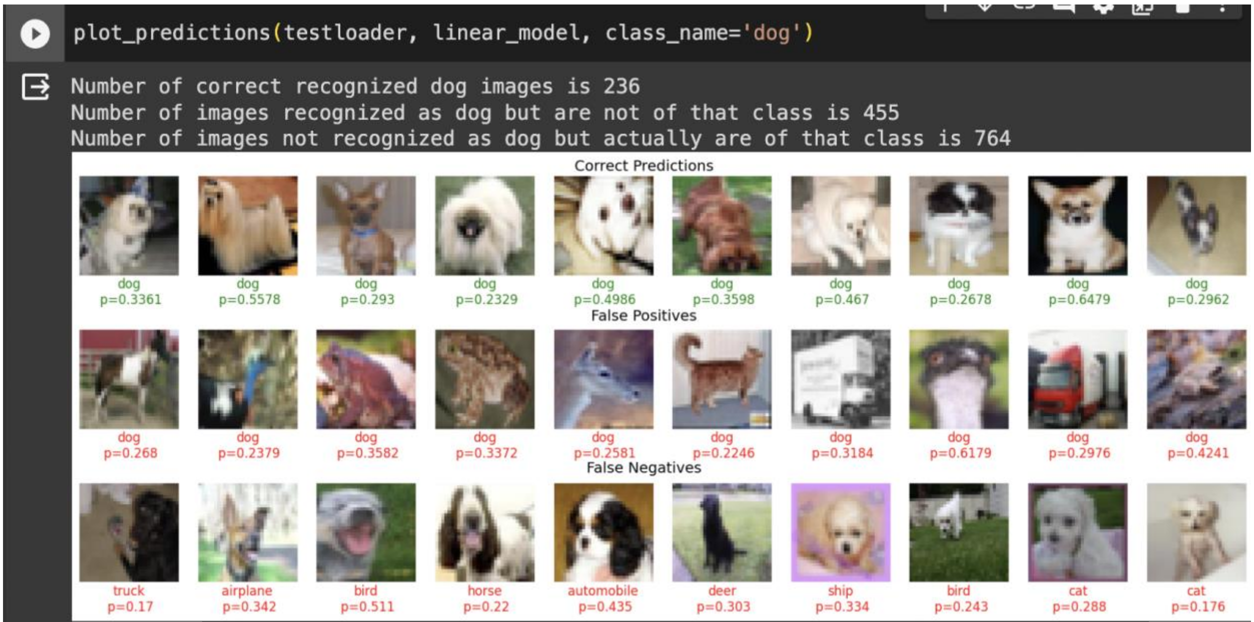

Figure 6: Predictions of dog images of the test set with a linear model.

The above image Fig. 6 shows the predictions of dog images of the test set with a linear model. The above image shows that the number of correct predictions of dog images are only 236, while false positives are about 455 and false negatives of 764. This is because the linear model is not able to generalize completely to unseen data and thus the low performance.

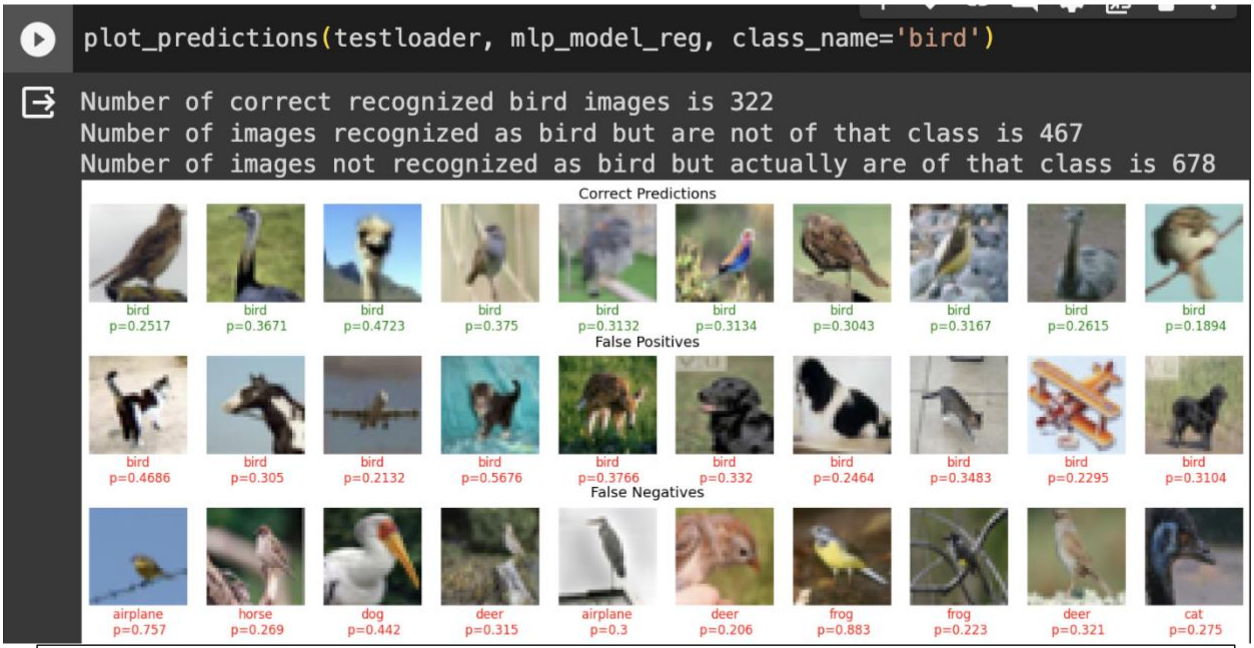

Figure 7: Predictions of bird images of the test set with a MLP with regularization model.

The above image Fig. 7 shows the predictions of bird images of the test set with a linear model. The above image shows that the number of correct predictions of bird images are only 322, while false positives are about 467 and false negatives of 678. This increase in the correct predictions and reduced false negatives, this is because the improved test accuracy and loss and lower overfitting.

- Top 5 predictions by using CNN_Model

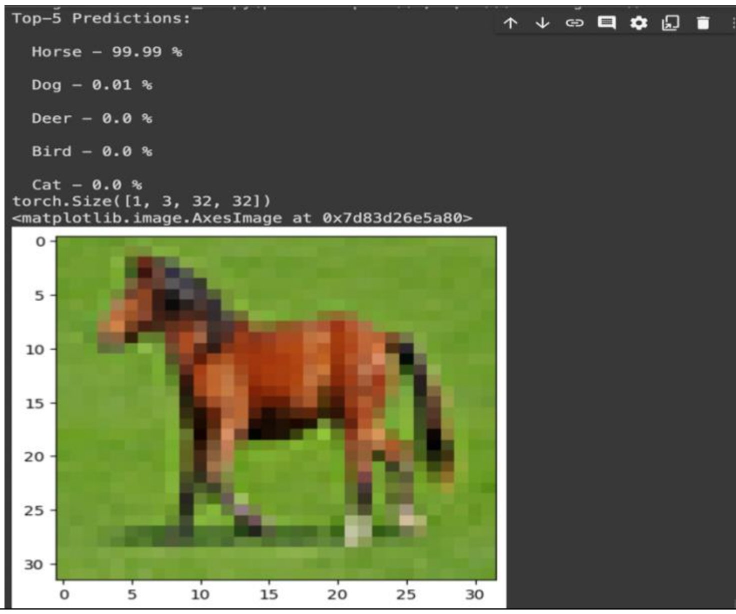

Figure 8: Top-5 predictions by using CNN_model for a horse image.

The above image Fig.8 shows the Top-5 predictions by using CNN_model for a horse image. The CNN model is predicting the horse image with greater precision as the model test accuracy is almost 80% and the image as well provides clear picture with all the features of a horse, which gives a very good prediction.

- Top 5 predictions by using ResNet50_Model

Figure 9: Top-5 predictions by using ResNet50 model for a dog image.

The above image Fig.9 shows the Top-5 predictions by using ResNet50_model for a dog image. The ResNet model is predicting the dog image with greater precision but wrongly as the model test accuracy is almost 80% but the image is not providing a clear picture with all the features of a dog, and also maybe because of the green background and the small size of the animal, the model gives a negative prediction with greater confidence.

- Top 5 predictions by using MLP_Model with Regularization

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Top-5 Predictions:

  Airplane - 19.21 %

  Automobile - 16.2 %

  Truck - 12.76 %

  Bird - 12.1 %

  Ship - 10.4 %
torch.Size([1, 3, 32, 32])
<matplotlib.image.AxesImage at 0x7d83c8101bd0>
```

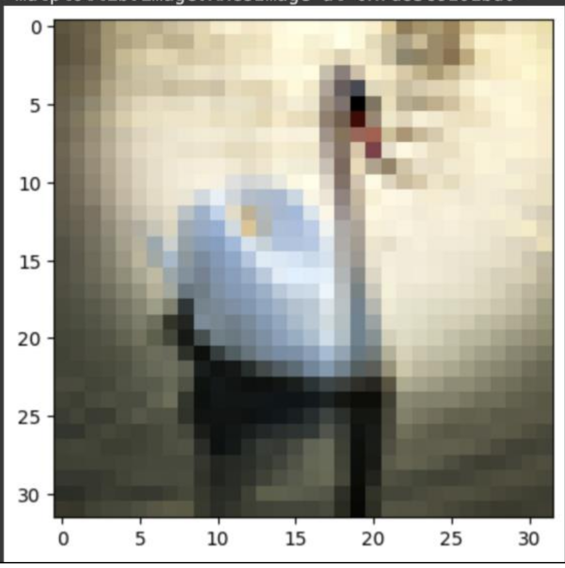

Figure 10: Top-5 predictions by using mlp_model_reg for a bird image.

The above image Fig.10 shows the Top-5 predictions by using mlp_model_reg for a bird image. The mlp_model_reg model is predicting the bird image without any precision without any precision because the model's accuracy is about 46% which is not that high and also the image does not give a clear picture with the clear features of a bird and therefore the model predicting the bird image with less precision and making mostly a guess based on the features.

3 Experiment 2.2

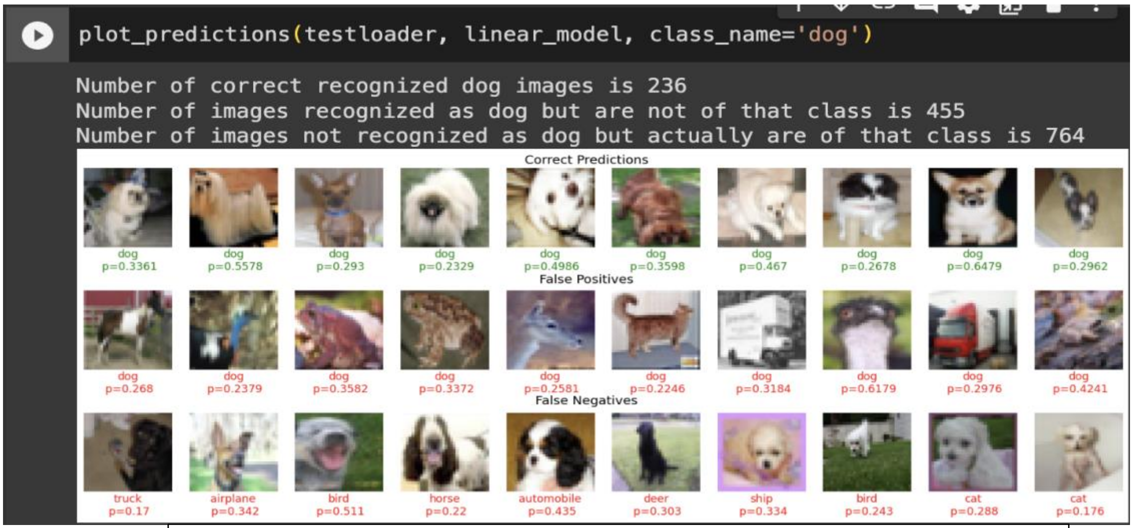

Figure 11: Plot_predictions using linear model with the dog class.

The above image Fig. 11 shows the Plot_predicitions using linear model with the dog class. The model is predicting 236 images correctly as these images have clear, distinct features that are unique to a dog. Moreover, the clear background also aids the model to easily distinguish the class.

Figure 12: Plot_predictions using CNN model with the dog class.

The above image Fig. 12 shows the Plot_predicitions using CNN model with the dog class. The CNN model is predicting 686 images correctly which is greater than the linear model as the test accuracy is great compared to the linear model and also because the CNN model preserves the spatial relationships between the pixels through the use of convolutional filters, which is crucial for recognizing shapes and patterns in images. Hierarchical learning is also one reason why CNN works better.