Module 7 Neural Network Report

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1. Objective

As someone who has witnessed a loved one suffer from Alzheimer's disease, I am very interested in how Artificial Intelligence (AI) can be used to help battle that disease. I chose the Alzheimer Dataset from Kaggle for my final model to explore how accurately AI can classify different stages of the disease based on the brain scans of affected patients. While no cure for Alzheimer's exists, early diagnosis is key to mitigating the disease and allowing the patient to have as many years of health and dignity as possible. Several studies are already available online that point to the effectiveness of AI models to detect Alzheimer's based on brain scans, and research continues to try to improve the effectiveness of the models and train them to perform early diagnosis. I aim to train and test a model to classify several stages of the disease in the brain.

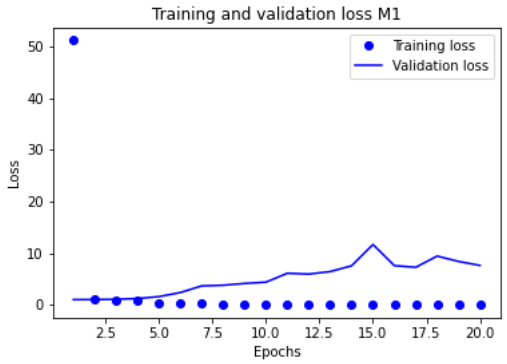
2. Dataset

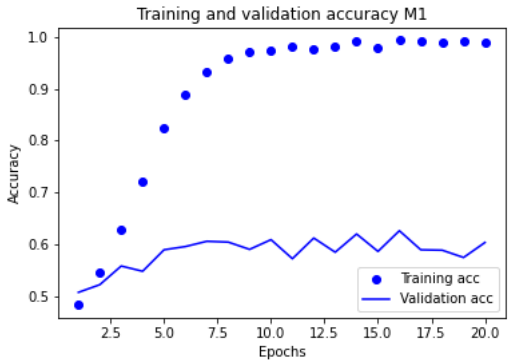
The dataset consists of training and test folders that contain 5,121 and 1279 .jpg images, respectively. Each folder is further broken down into Non-Demented, Very Mild Demented, Mild Demented, and Moderated Demented folders. These sub folders contain images relating to that stage of the disease and the folder names will be used as the labels for classifying the images. Each image is grayscale and is 176 x 208 pixels.

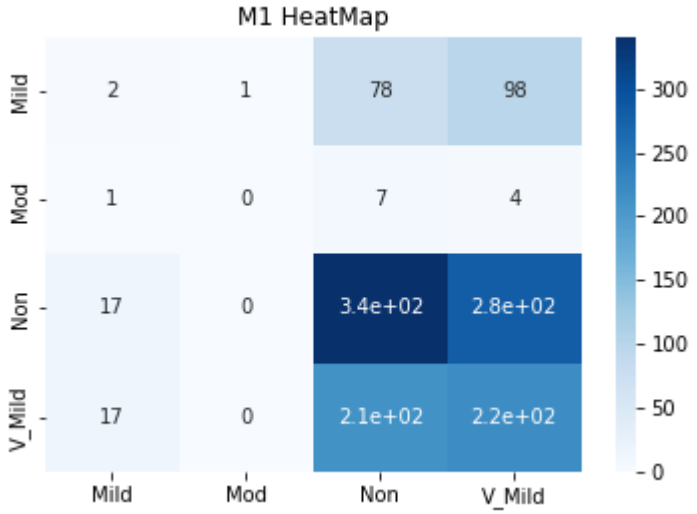
URL: https://www.kaggle.com/yasserhessein/dataset-alzheimer

3. Model 1

The first model that was tested consisted of three hidden convolutional layers with 32, 64, and 128 units respectively. No image preprocessing was performed. Categorical cross entropy was used as the loss function and classification accuracy was used as the performance metric. The model was run for 20 epochs because the initial test showed that model performance did not increase past 20 epochs.



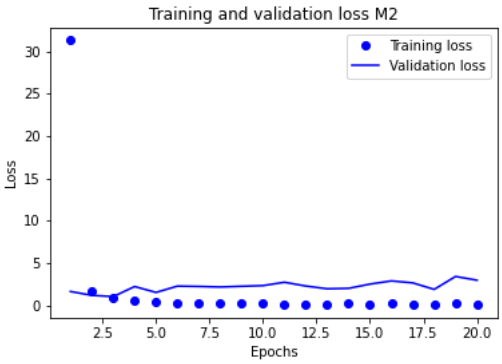


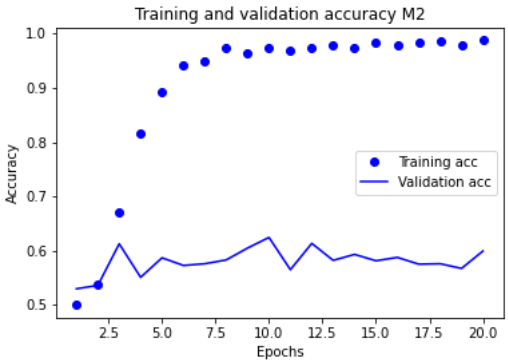


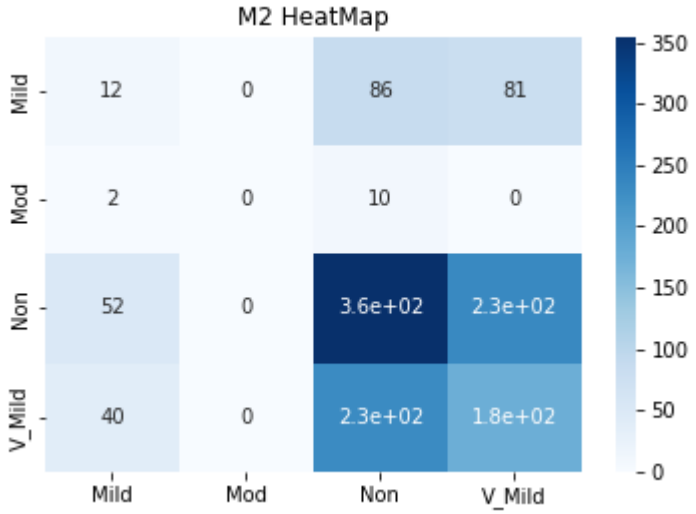
Based on the loss and accuracy graphs it can be seen that the model has a significant problem with overfitting. The overall accuracy of the model on the test set was 0.5731. From the heat map above it seems like the model is heavily skewed towards classifying scans as Non Demented or Very Mild Demented. Several methods can be employed to combat model overfitting. In the next two models, different methods will be applied to try and reduce overfitting while improving model accuracy.

4. Model 2

The second model that was tested consisted of three hidden convolutional layers with 32, 64, and 128 units respectively. No image preprocessing was performed. Categorical cross entropy was used as the loss function and classification accuracy was used as the performance metric. Each hidden layer used kernel regularization to try and simplify the model. This can sometimes lead to a reduction in overfitting. The model was run for 20 epochs because the initial test showed that model performance did not increase past 20 epochs.



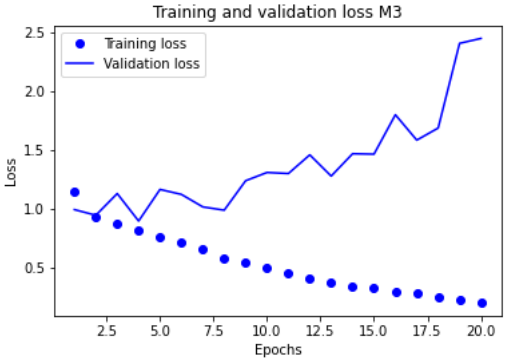


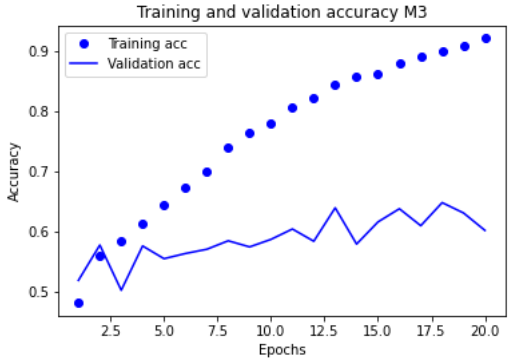


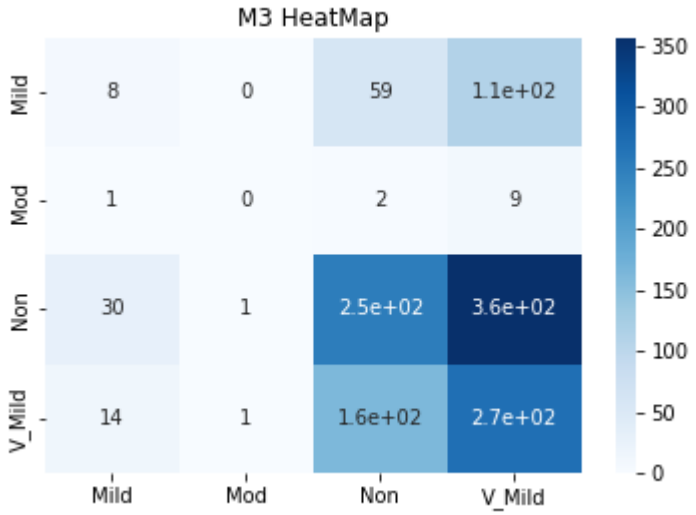
The second model also shows indications of overfitting based on the loss and accuracy graph. The loss is reduced compared to the first model though. The heat map for this model shows that there is still a bias towards classifications of Non Dementia and Very Mild Dementia. This model outperformed the first model in classifying Mild cases, however. This could be due to this model's overall tendency to classify more cases as mild.

5. Model 3

The final model that was tested consisted of three hidden convolutional layers with 32, 64, and 128 units respectively. Image preprocessing was used to changed different features of the images such as zoom or rotation. This preprocessing causes the model to generalize the patterns it is looking for and can sometimes lead to a reduction in overfitting. Categorical cross entropy was used as the loss function and classification accuracy was used as the performance metric. Each hidden layer used kernel regularization to try and simplify the model. This can sometimes lead to a reduction in overfitting. The model was run for 20 epochs because the initial test showed that model performance did not increase past 20 epochs.







Based on the loss and accuracy graphs, overfitting is still a major issue with the final model. The overall accuracy of the final model was 0.5862. The heatmap shows that model heavily favors Non Demented and Very Mild Demented classifications. Compared to the first model, the final model performed marginally better at classifying Very Mild and Mild cases, while performing worse at classifying Non Demented cases.

4. Conclusion

Based on the performance of the three models, it would not be effective to use these methods as a sole classifier for determining stages of dementia. Perhaps by changing the problem to binary classification and only providing doctors a notification if any sort of dementia is occurring model performance could be improved. Model performance could also be improved by providing more training samples. Regardless of the performance of these models, the possibility of accurately classifying brain scans for a variety of diseases is a fascinating topic that will continue to improve in the future.