Bi-Weekly Report (3/1/22~3/15/22)

Accomplishments

- Attempts at transfer learning to improve CNN accuracy.
    - Current best performance is utilizing Dense Net 169 with 5million trainable parameters out of the total 12 million performing with a 94% testing accuracy. [6]
    - Mobile Net v2 Was also attempted with the best performing validation fold of 89% accuracy
- Attempts at recreating CNN structure located in paper [1] who performed with a 100% accuracy on a 233 sized dataset however resulted in a 75%~80% accuracy performance
- Researching the current achievements in MRI classification performed an accuracy of 90% with a variance of 5% however refer to **Issue & Barriers** bullet 2, 3 and 4.
- Attempted with the SVM by applying the PCA first then scaling and achieved the highest accuracy of 74% with 80% variance on the PCA.
- Applied LBP, with different combinations of different numbers of neighborhood P and radius of circle R: (8,1), (16,2) and (24,3). These different combinations of P and R are coming from paper [4] where the authors compare the different methods of LBP. This process is divided into three processes:
    - Applying LBP by converting the images into grayscale, then trying a combination of different P and R values. At the same time, we return the normalized histogram.
    - Then PCA is applied as a feature selection method.
    - Lastly, feature scaling is applied before training the SVM model.

  After k-fold cross validation and gridsearch, the best hyperparameter is C = 2.0, gamma = 0.003597122, kernel = rbf with (8,1) for LBP's P and R on 100% variance (279 number of components) for PCA. With such hyperparameters, it achieves 88.4% accuracy.

- For the existing SVM models for Tumor classification, most of the papers utilized image augmentation techniques such as rotation, horizontal flipping, and cropping in order to improve the accuracy of the model as the authors suggest in the paper [5]. This is something that we could take a look into or add that into our project. However, the main takeaway of paper [5] is the comparative studies of 13 different pre-trained deep learning models (e.g., DenseNet-169, VGG-16, etc) as feature selection methods. The paper utilized a similar dataset (in terms of scale) for the SVM (rbf kernel) to achieve an average of 89.29% accuracy.

Upcoming Goal

- Finalizing classification model details to then proceed to MINST Fashion Dataset as well as FER-2013.

Issue & Barriers

- For the SVM model, after switching around the experiment step (PCA first then scaling), the model boosts around 20% in terms of accuracy. However, one major issue with that is the model is overfitting badly. Therefore, all models in this experiment are deprecated.

- We had some difficulties when searching for some papers (pre-trained models) to compare our models because a few papers that NYIT does not have the access to. Neither the sci-hub site. Fortunately, we got help from one of the librarians, Jeffrey, to loan/request those papers for us but it would take around 2 days (estimate).

- In addition there are no papers utilizing the exact dataset we have, there are papers utilizing MRI Tumor Classification datasets of either a smaller size (253 images)[2] or datasets that are much larger (2475 images)[3]. Also the types of classification being done differs from either binary classification such as ours, or multiclass classification with the types of tumors being classified.

- When researching, the utilization of image augmentation is performed which is not done in our experiments. The reason for this is highlighting the impact of balancing data and we fear that augmentation can dilute that observation.

Relevant Resources/Images

[1] Hassan Ali Khan, Wu Jue, Muhammad Mushtaq, Muhammad Umer Mushtaq. Brain tumor classification in MRI image using convolutional neural network[J]. *Mathematical Biosciences and Engineering,* 2020, 17(5): 6203-6216. doi: 10.3934/mbe.2020328 https://www.aimspress.com/article/id/5701

[2] J. Kang, Z. Ullah, and J. Gwak, "MRI-Based Brain Tumor Classification Using Ensemble of Deep Features and Machine Learning Classifiers," *Sensors*, vol. 21, no. 6, p. 2222, Mar. 2021, doi: 10.3390/s21062222. https://www.mdpi.com/1424-8220/21/6/2222/htm#

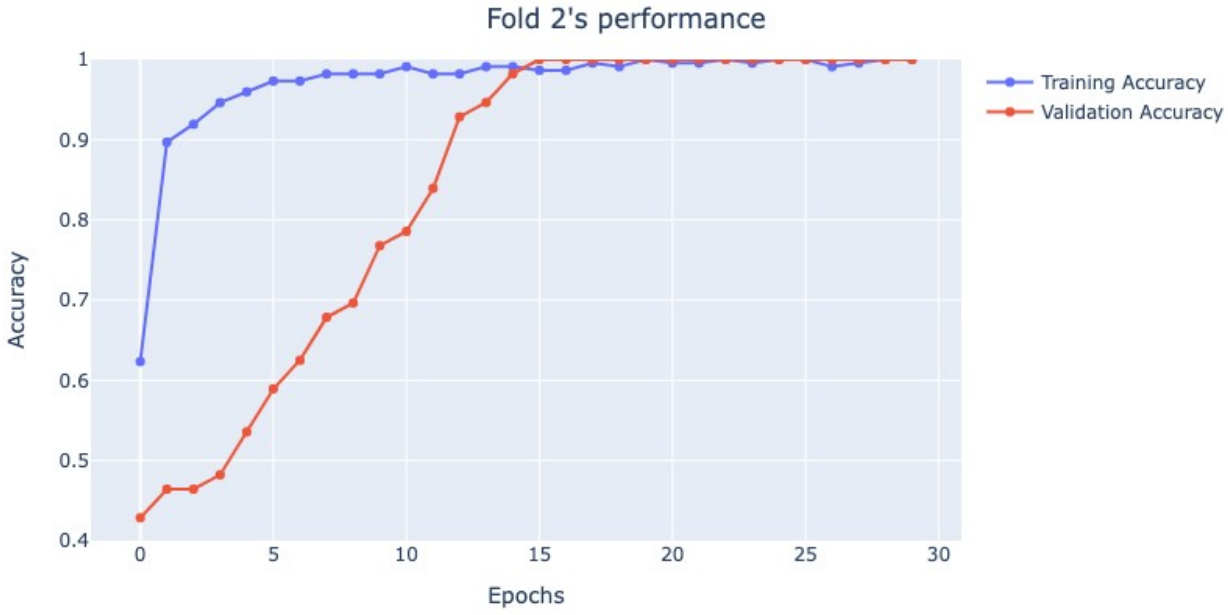
[3] Irmak, E. Multi-Classification of Brain Tumor MRI Images Using Deep Convolutional Neural Network with Fully Optimized Framework. *Iran J Sci Technol Trans Electr Eng* 45, 1015–1036 (2021). https://doi.org/10.1007/s40998-021-00426-9

[4] Liu, L., Zhao, L., Long, Y., Kuang, G. and Fieguth, P., 2012. Extended local binary patterns for texture classification. Image and Vision Computing, [online] 30(2), pp.86-99. https://www.sciencedirect.com/science/article/abs/pii/S0262885612000066

[5] Kang, J., Ullah, Z., & Gwak, J. (2021). MRI-Based Brain Tumor Classification Using Ensemble of Deep Features and Machine Learning Classifiers. Sensors (Basel, Switzerland), 21(6), 2222. https://doi.org/10.3390/s21062222

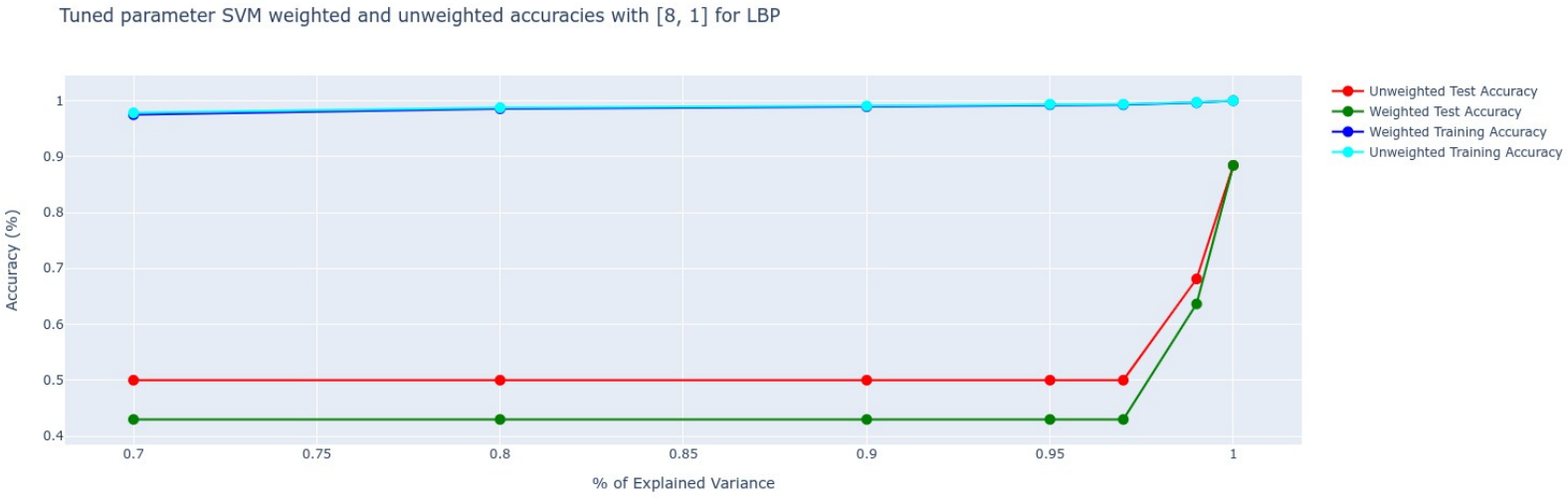
[6] Relevant CNN Model Images:

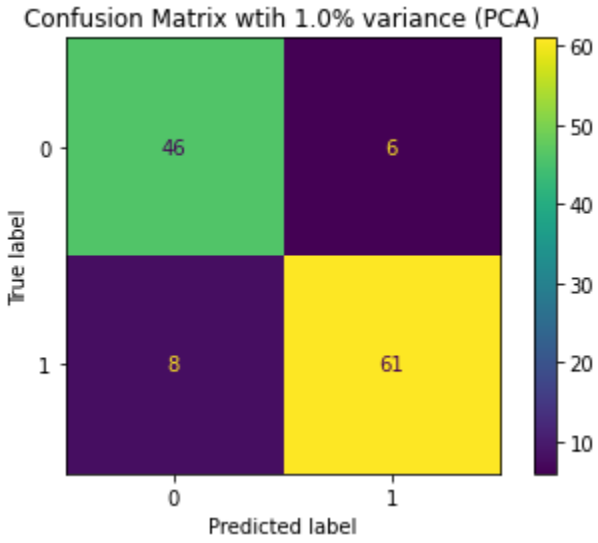
```
Model: "model"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 input_1 (InputLayer)        [(None, 128, 128, 3)]     0

 tf.math.truediv (TFOpLambda  (None, 128, 128, 3)      0
 )

 tf.nn.bias_add (TFOpLambda)  (None, 128, 128, 3)      0

 tf.math.truediv_1 (TFOpLamb  (None, 128, 128, 3)      0
 da)

 densenet169 (Functional)    (None, 4, 4, 1664)        12642880

 global_average_pooling2d (G  (None, 1664)             0
 lobalAveragePooling2D)

 dropout (Dropout)           (None, 1664)              0

 dense (Dense)               (None, 1)                 1665

=================================================================
Total params: 12,644,545
Trainable params: 2,958,017
Non-trainable params: 9,686,528
_________________________________________________________________
```



```
[[45  7]
 [ 0 69]]
Normal accuracy: 0.8653846153846154
Tumor accuracy: 1.0
              precision    recall  f1-score   support

      Normal       1.00      0.87      0.93        52
       Tumor       0.91      1.00      0.95        69

    accuracy                           0.94       121
   macro avg       0.95      0.93      0.94       121
weighted avg       0.95      0.94      0.94       121
```

[7] Relevant SVM model:





SVM accuracy per class and report:

```
The variance: 1.0
Normal accuracy: 88.46153846153845, Tumor accuracy: 88.40579710144928


Classification report for 1.0
              precision    recall  f1-score   support

      Normal       0.85      0.88      0.87        52
       Tumor       0.91      0.88      0.90        69

    accuracy                           0.88       121
   macro avg       0.88      0.88      0.88       121
weighted avg       0.89      0.88      0.88       121
```