

AN IMPROVED APPROACH FOR AUTOMATIC DIAGNOSIS OF ADHD USING FMRRIS

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History of ADHD

- Condition that leads to behavioral changes in children.
- ADHD was first considered a mental disorder in the 1960s.
- The traditional ways to diagnose ADHD is outdated, making it underdiagnosed in many patients.
- Subjective testing for kids leads to underdiagnosing.
- Neuroimaging research in psychiatric disorders is a new field that is starting to gain popularity.
- The ENIGMA organization's mission is to bring together research in neurology and psychiatry to better understand the brain and how it functions.

ADHD-200

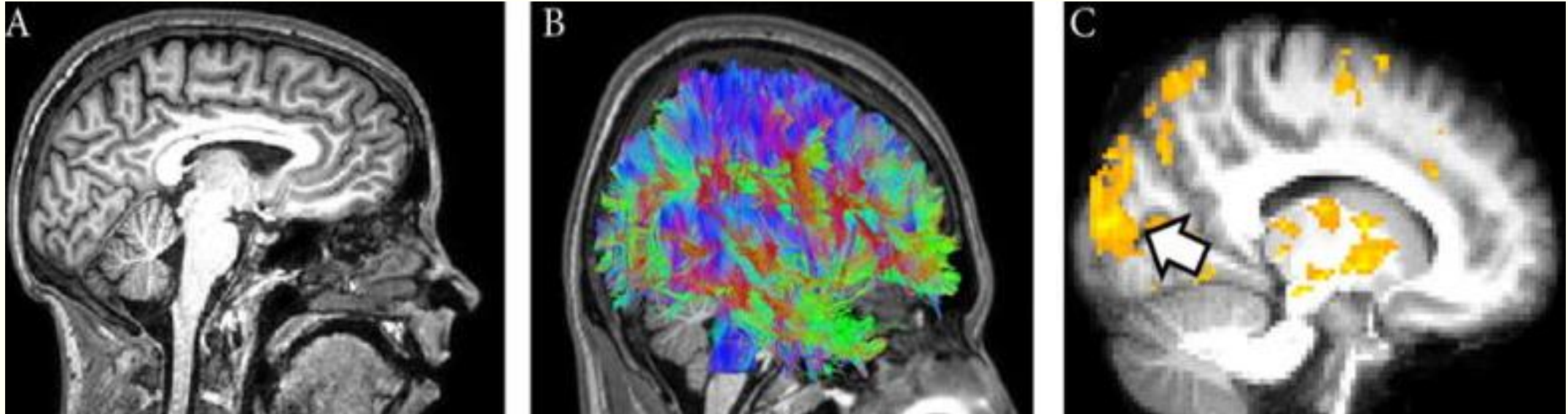
ADHD-200 Dataset

- The dataset consists of approximately 800 subjects MRIs provided from 8 research institutions.
- The MRI scans are preprocessed using different methods.
- The most famous and recent one is the Athena pipeline.

ADHD-200 Competition

- The ADHD-200 global competition started in 2011.
- Single and group entries are both allowed.
- Different methods are applied in aim to reach the best accuracy to better diagnose the subjects.

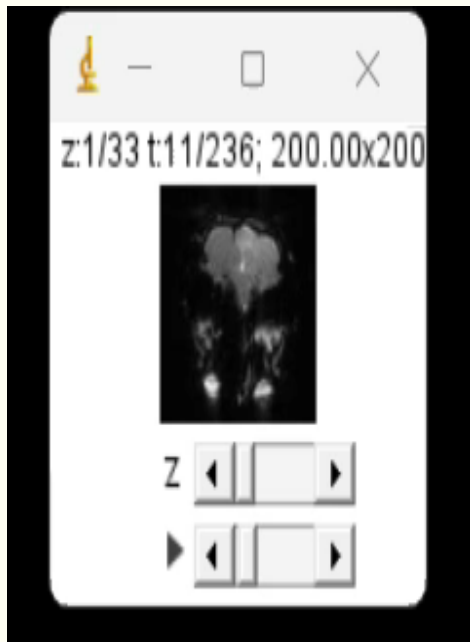
Difference between functional and structural MRI



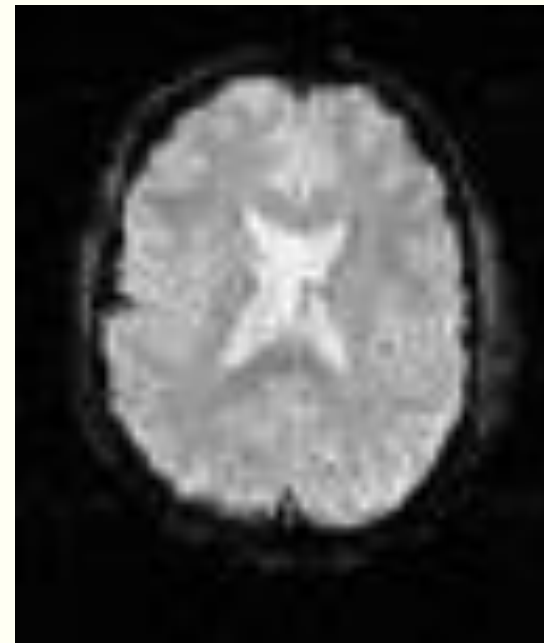
- Functional MRI shows the areas of the brain that are active when a patient is asked to perform a certain task. (C)
- Structural MRI has the gross anatomical view of the brain with high detail. (A)

Samples From the Dataset

fMRI Scan



Frame extracted from scan



Related Work Models

Model Name	Accuracy	Year	Method
Multiclass Classification for the Differential Diagnosis on the ADHD Subtypes Using Recursive Feature Elimination and Hierarchical Extreme Learning Machine: Structural MRI Study	60.78%	2016	H-ELM, ELM, and SVM
A general prediction model for the detection of ADHD and Autism using structural and functional MRI	67.30%	2018	3D CNNS using fMRI and sMRI
Classification of ADHD children through multimodal magnetic resonance imaging	71.30%	2019	4D CNN and LSTM



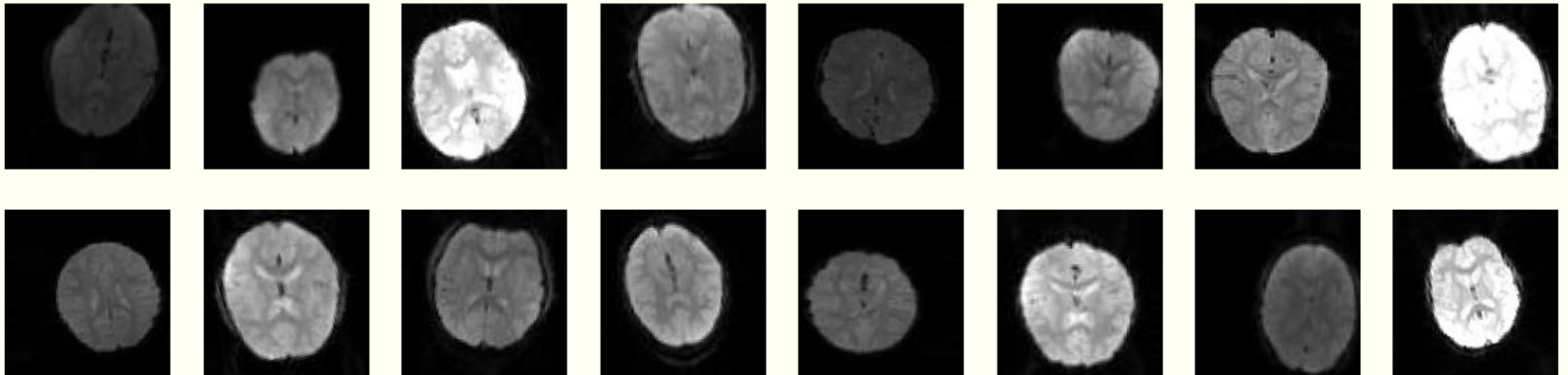
PROPOSED METHODOLOGY

Pt. 1 (fMRI Scans Frames)

Dataset Pre-processing (MRI Scans)

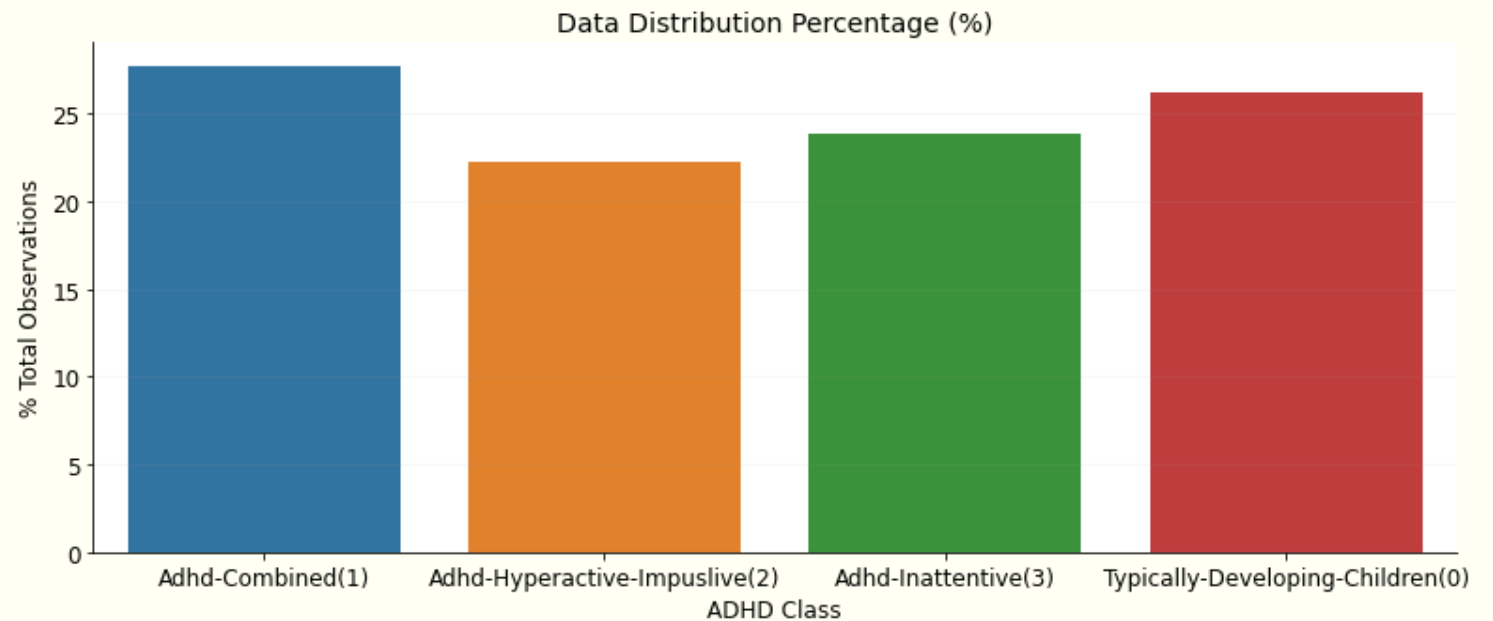
- MRI scans are in gif format.
- Steps to convert gif files into pngs:
 1. Store all gifs in a list according to their class.
 2. According to their class number, convert the gif file then store it in its assigned class number folder.
- Number of provided samples were not enough.
- Increased samples number from 776 to 40522

Samples from the dataset after applying data augmentation.



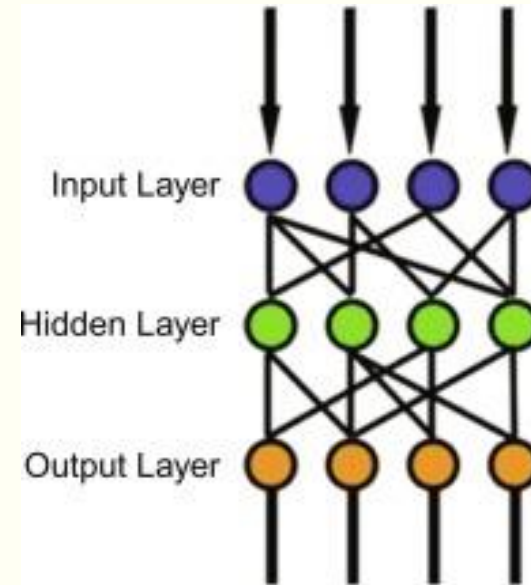
Dataset Distribution Percentage

- Total number of ADHD-Combined increased to 11,232.
- Total number of ADHD-Hyperactive-Impulsive increased to 9,016.
- Total number of ADHD-Inattentive increased to 9,649.
- Total number of TDC increased to 10,625.



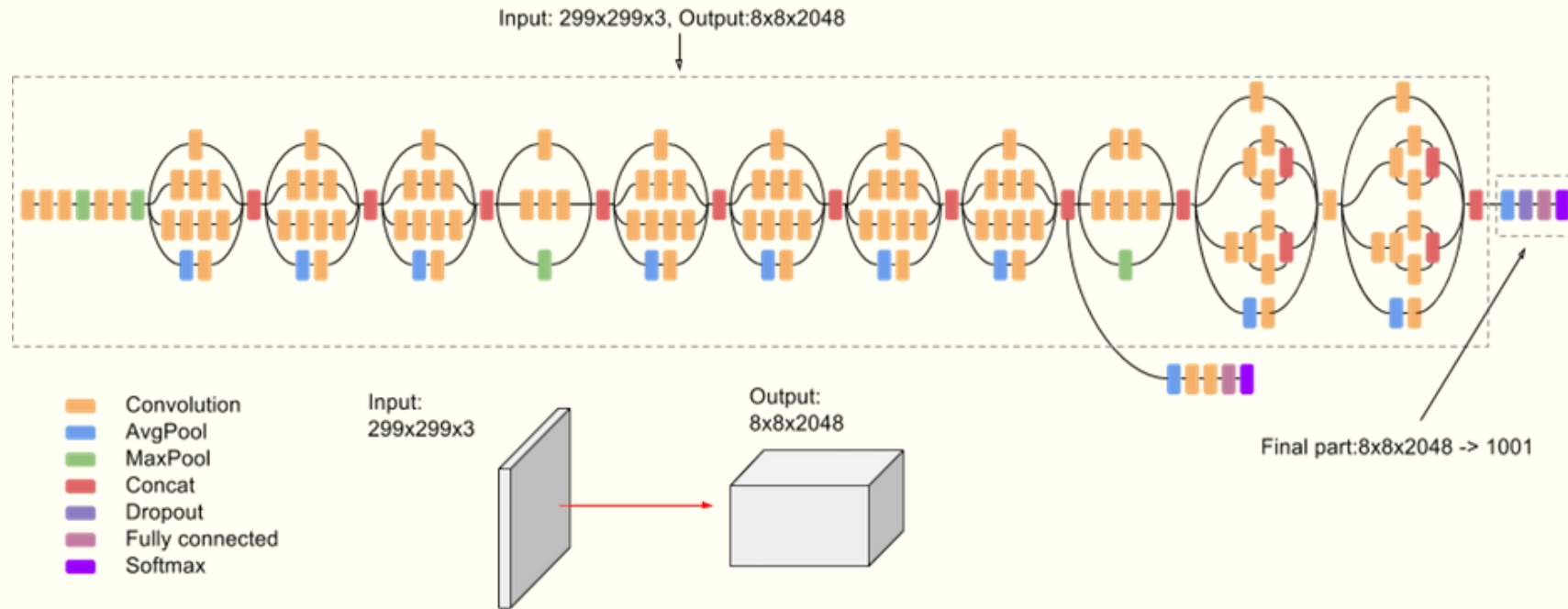
Multi-Layer Perceptron Architecture

- The input to the MLP is a 1-D vector representation of the image.
- The total number of hidden layers, batch normalization layers, and dropout layers is 3.
- Total number of neurons in the output layer is 4, representing the 4 different classification classes using a softmax function.



(103.3M Parameters)

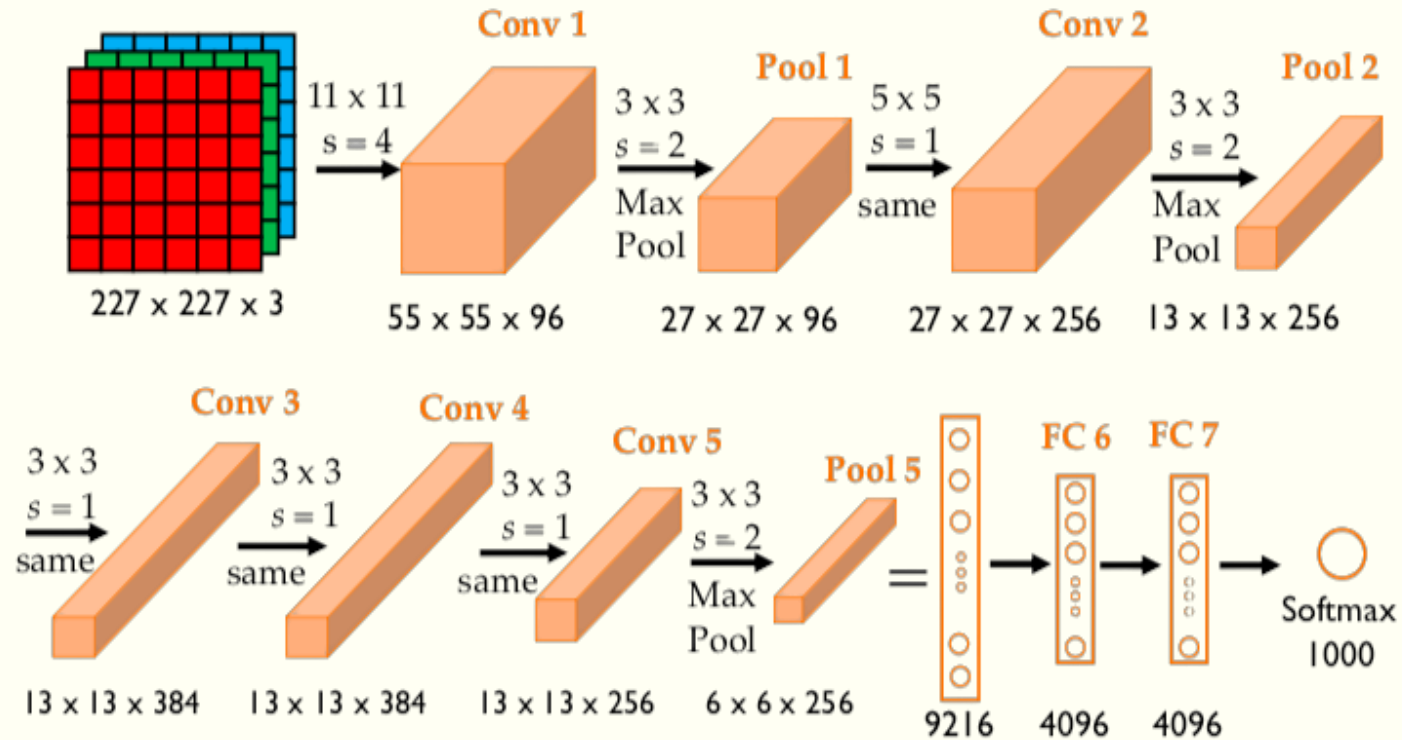
Inception V3 Architecture



- It is a widely-used image recognition model that has been shown to attain great results.
- It combines convolution as well as pooling operations to allow the network to decide which of these parallel operations is the best for each layer.

(24M Parameters)

AlexNet Architecture



- The input to the AlexNet will be a 1-D vector representation of the image.
- The variant of the AlexNet used consists of 5 convolutional layers, 2 dense layers, and 4 neurons in the final output layer.

(3.8M Parameters)

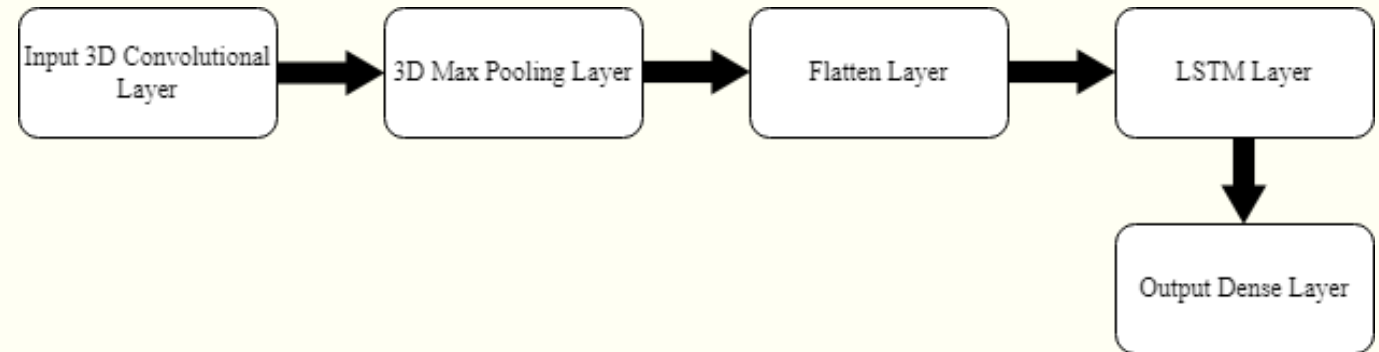


PROPOSED METHODOLOGY

Pt. 2 (fMRI Scans)

Architecture of Hybrid 3D CNN-LSTM Model

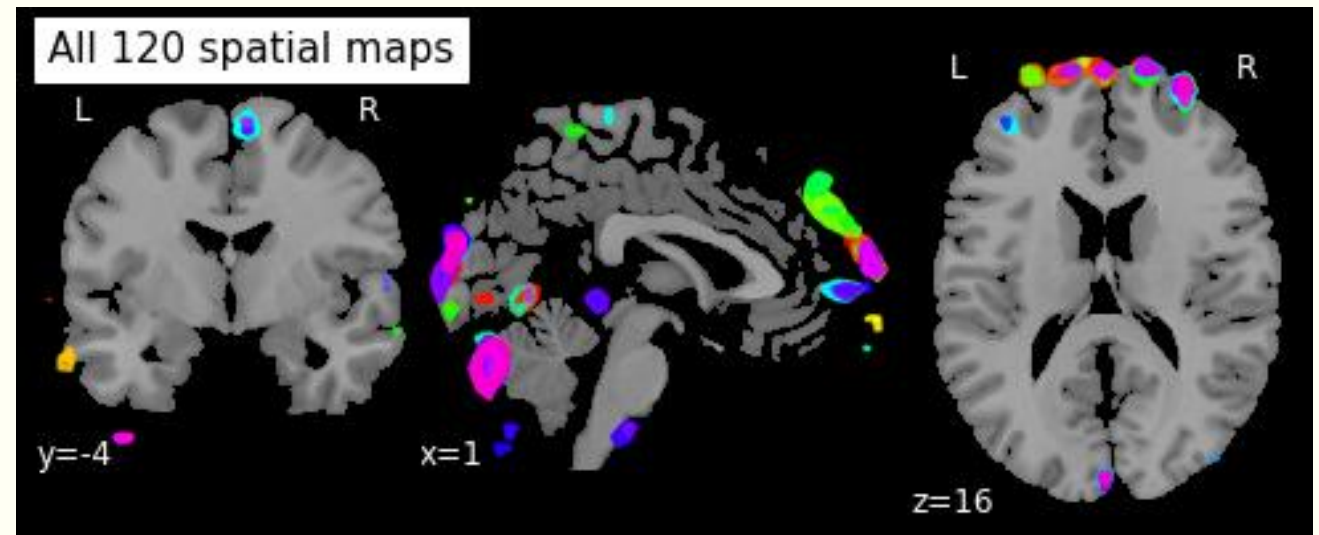
- CNNs retrieve spatial features of the data and extract all details of active areas in the brain.
- LSTMs retrieve the temporal features of the data and models the flow of blood.

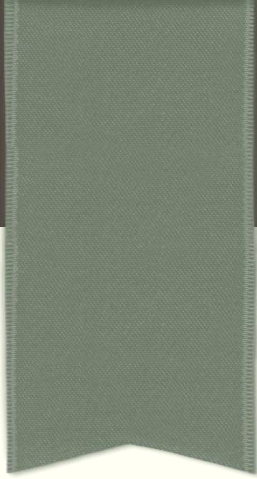


(845K Parameters)

fMRI Visualization After Pre-processing

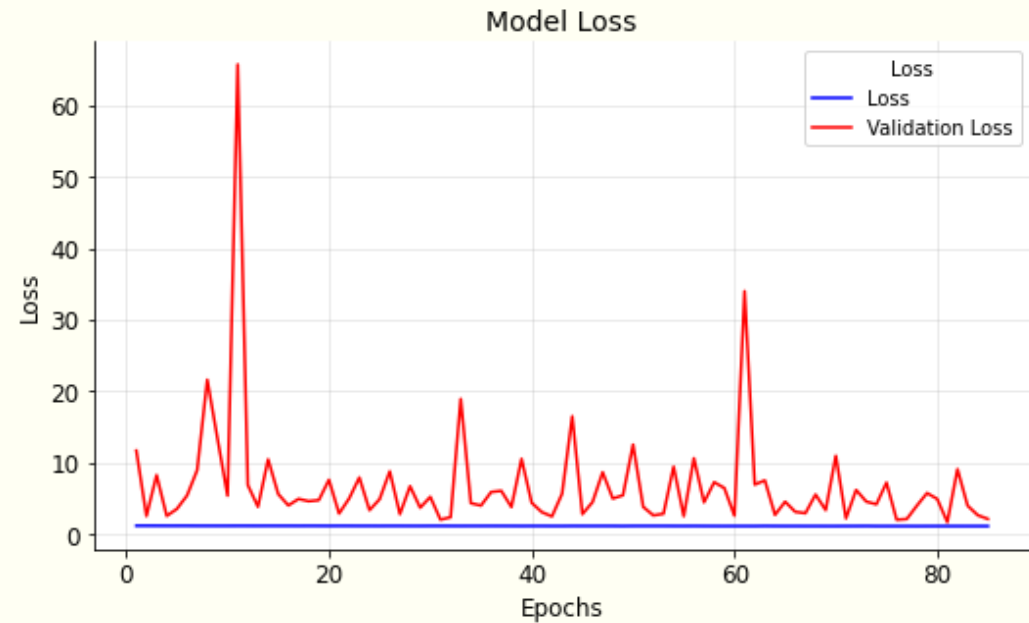
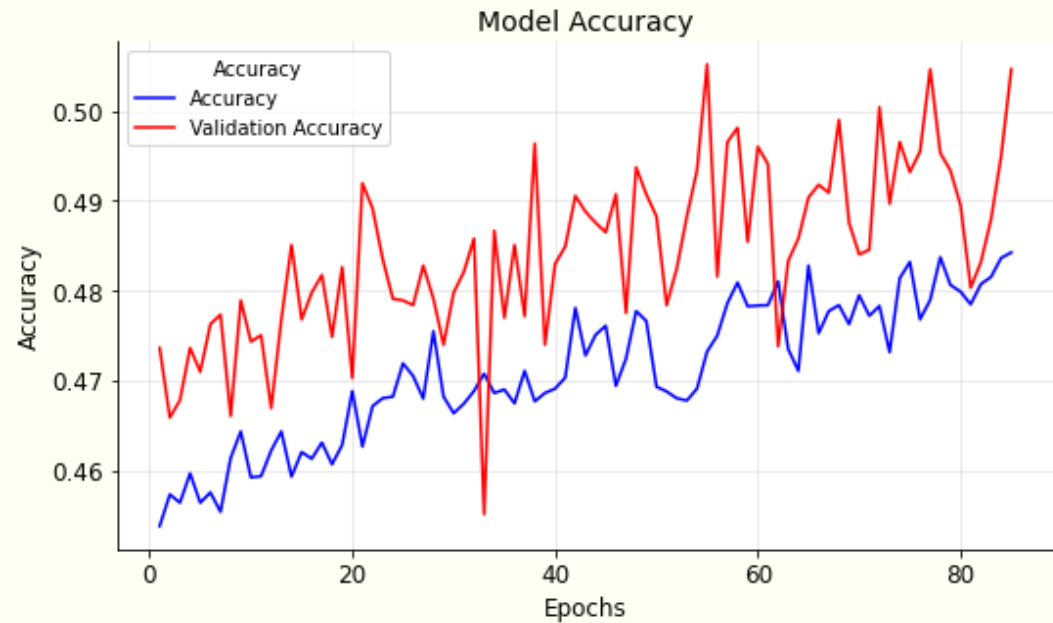
- This figure shows the active areas of the brain during the scan after being pre-processed.
- Spatial maps are snapshots taken from the fMRI scan.
- The brain slices are clearer, sharper, and brighter allowing for better positioning of the active parts in the scan.





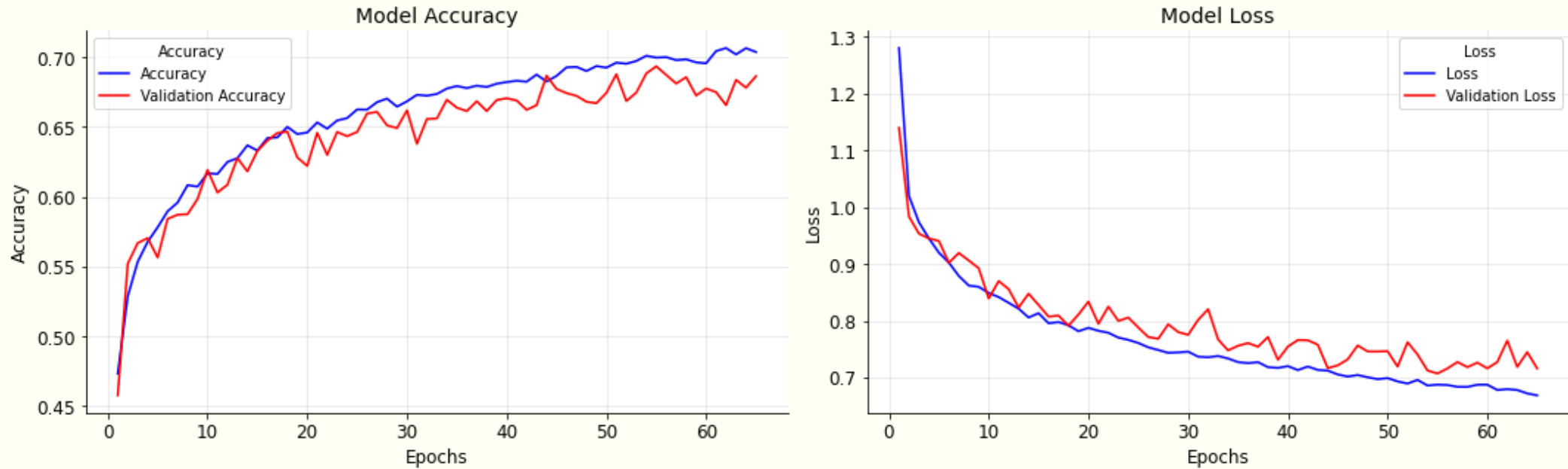
RESULTS AND DISCUSSION

MLP Results



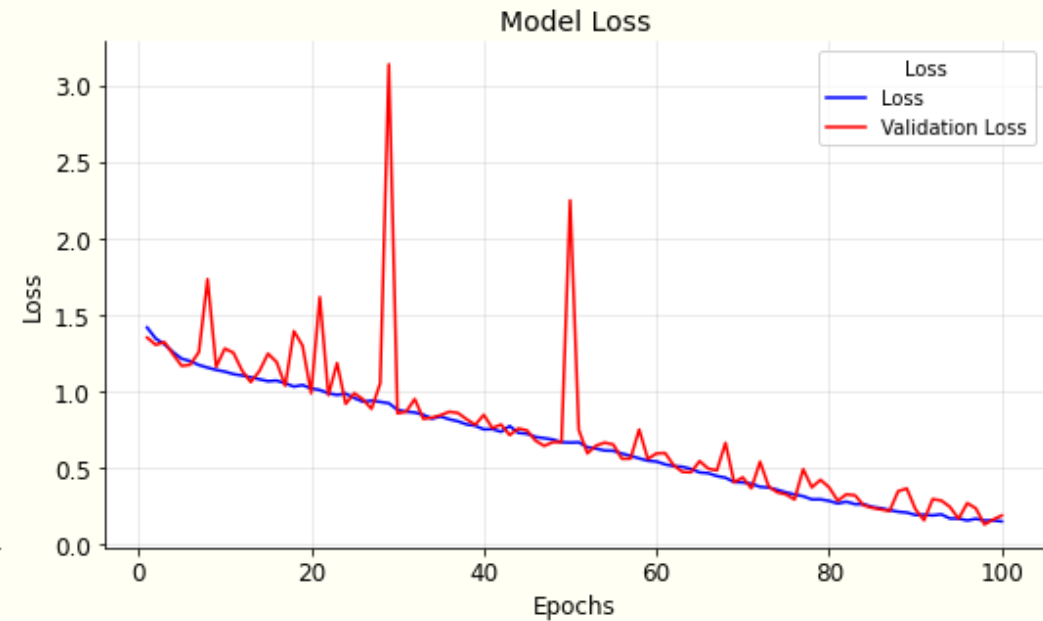
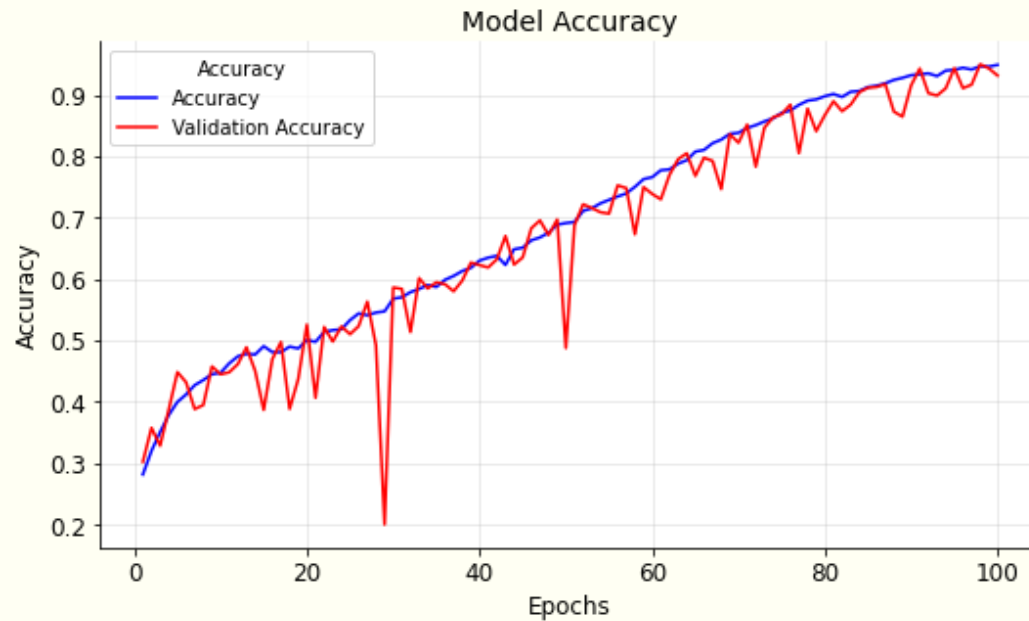
- The MLP model showed the worst results with accuracy reaching 51%.
- It is too complex for the dataset.

Inception V3 Results



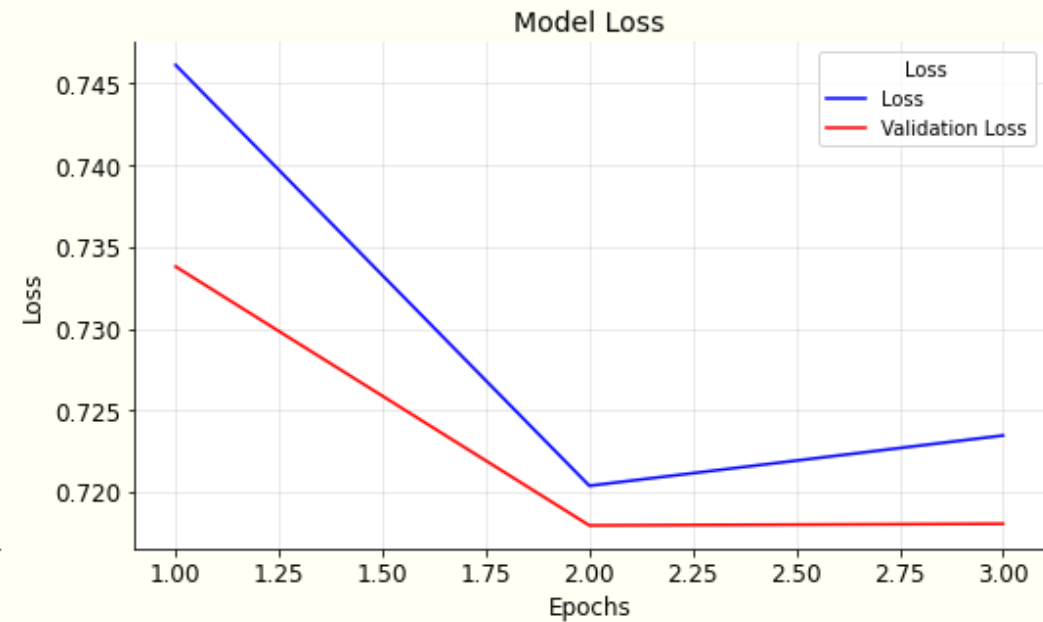
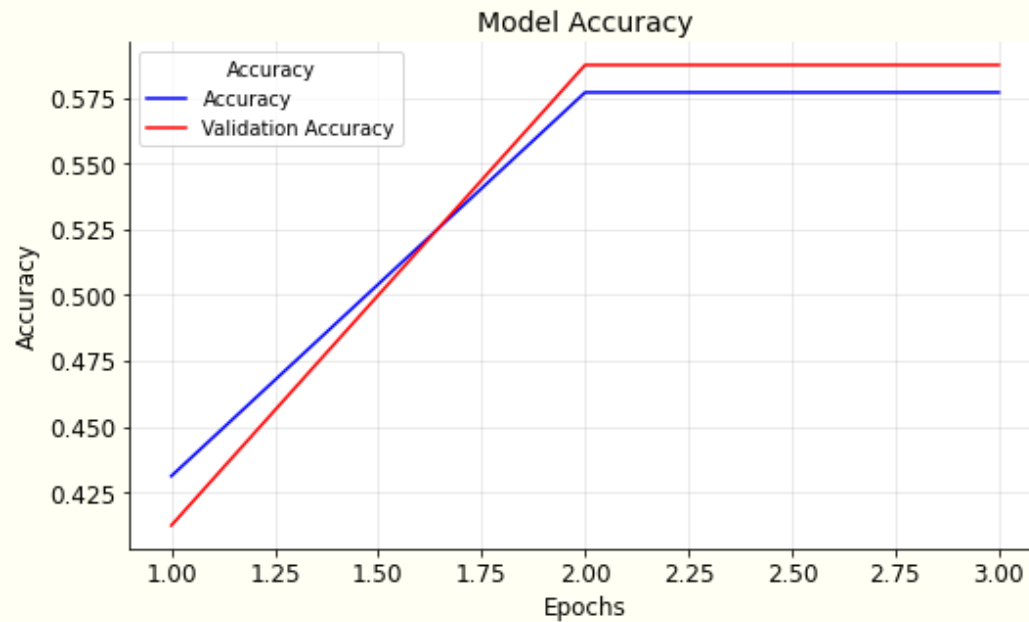
- The Inception V3 had the second-best results with accuracy reaching 68%.
- It shows promising learning curve that can be used on a bigger dataset to have better accuracies.

AlexNet Results



- The AlexNet had the best results.
- It reached a new milestone accuracy of 92%.
- Steps taken to improve accuracy of AlexNet model:
- Used data shuffling to allow switching between training and testing data.
- Changed the optimizer from Adam to SGD.
- Used best weights.

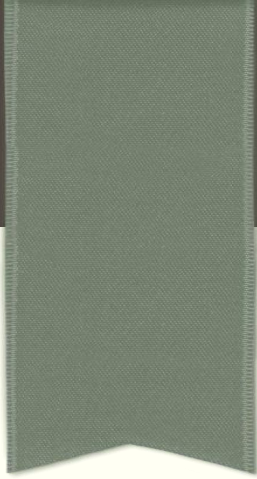
3D CNN-LSTM Results



- The 3D CNN-LSTM model required too much resources to be able to run for more than 3 epochs.
- It reached final accuracy of 58%.

Comparison Between Different Models

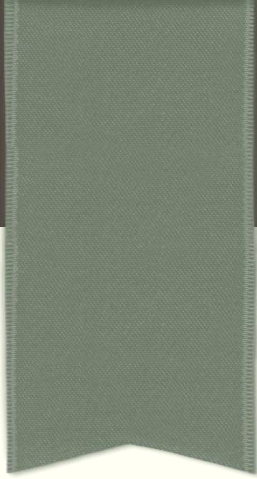
Model Name	AlexNet	Inception V3	3D CNN-LSTM	MLP
Accuracy	92%	68%	58%	51%



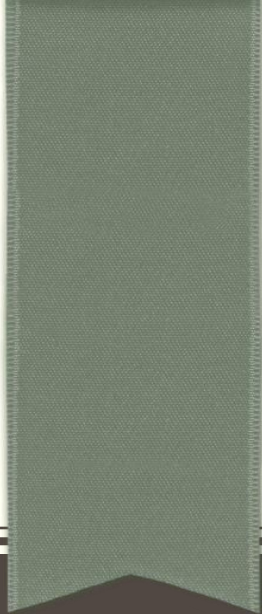
CONCLUSION

Conclusion and Future Work

- The study of machine learning techniques to diagnose mental illnesses still has a long way to go.
- To be able to accurately diagnose a patient with ADHD using fMRIs would require millions of scans.
- The gap between the different results is because of the different techniques and approaches used in each study.
- The ADHD-200 consortium should add more data from different age groups.
- A supercomputer is required to be able to handle all the fMRI scans to find the best results.



QUESTIONS?



THANK YOU
