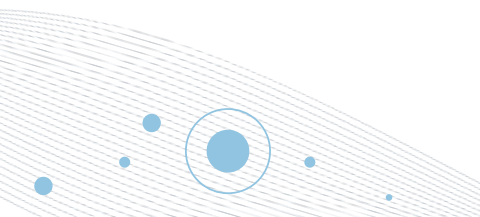# Assignment Report

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Study Design

Two Class Classification

- Evaluate the DenseNet and ResNet in:

- AD and Normal

- ASD and Normal

Bonus

Three Classes Classification

- AD, ASD, Normal
- AD, Mild Cognitive Impairment (MCI), Normal

Three classes classification of AD, ASD, and Normal brain image

- **Research background**: Brain functional abnormalities and structural changes in autism spectrum disorder (ASD) and Alzheimer's disease (AD).
- **Purpose of the study**: Analyzing fMRI data of ASD and AD using 3D CNN models.

Data Preprocessing

- Merge AD_Data and ASD_Data into a new Data - Merged_Data

- Standardization and Normalization

- Image training and testing parameters:

- Image size: 96x96x96

- Training test set ratio: 80:20

- Batch Size: 15

- Epochs: 50

- Learning Rate: 0.01

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Model Structure

- Selected model: **3D DenseNet121**

- Spatial Dimension: 3D

- Input channels: 1

- Output channels: 2 (ASD and AD classification)

- Model training parameters:

- Loss function: **BCEWithLogitsLoss**

- Optimizer: **Adam**, Learning Rate: 0.01

- Visualization tools:

- GradCAM (GradCAM-like Neural Network Interpretability).

- Occlusion Sensitivity.

Performance Of The Model - Accuracy

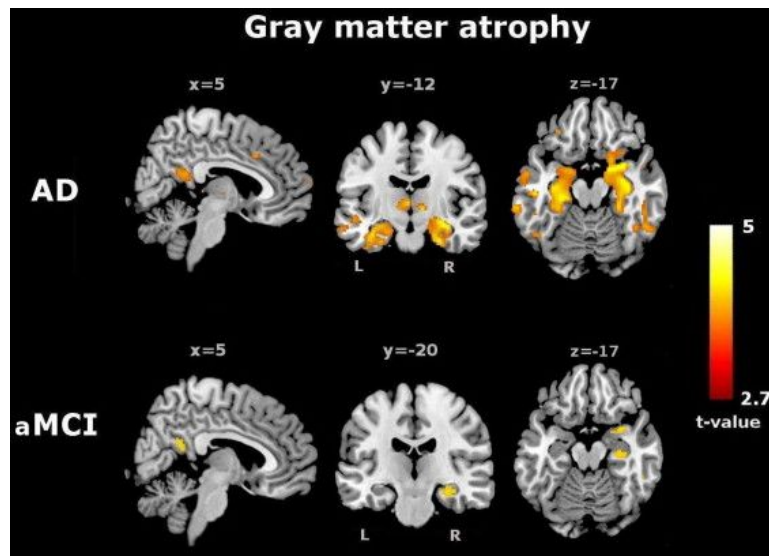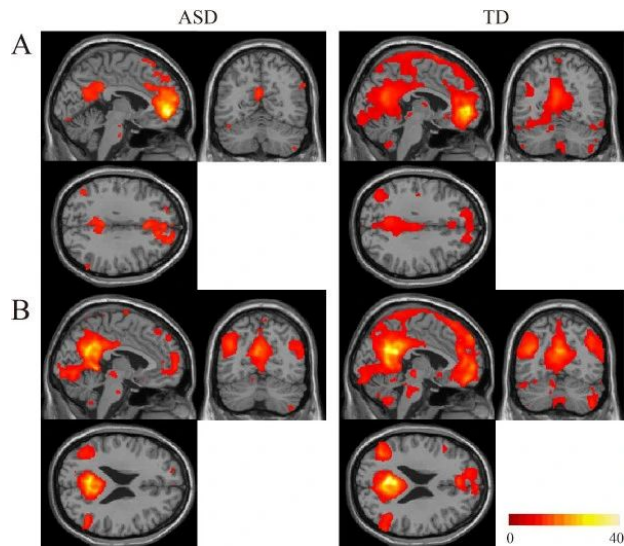|	precision	recall	f1-score	support
Normal	0.57	0.54	0.55	52
ASD	0.42	0.43	0.43	37
AD	0.83	1.00	0.91	10
accuracy			0.55	99
macro avg	0.61	0.66	0.63	99
weighted avg	0.54	0.55	0.54	99
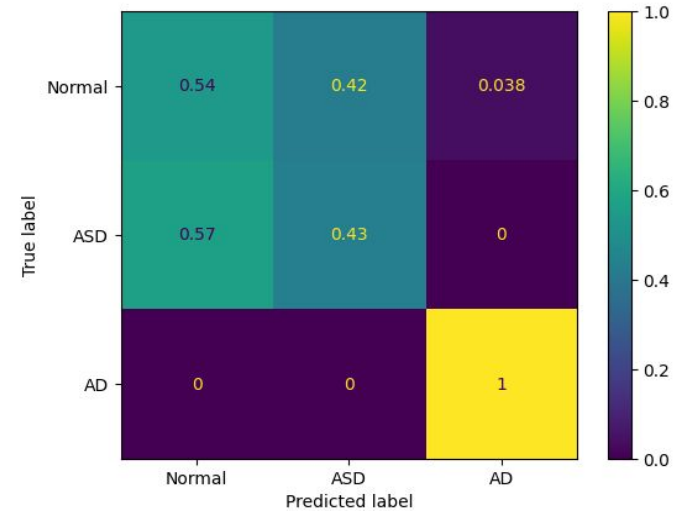
Performance Of The Model - Loss
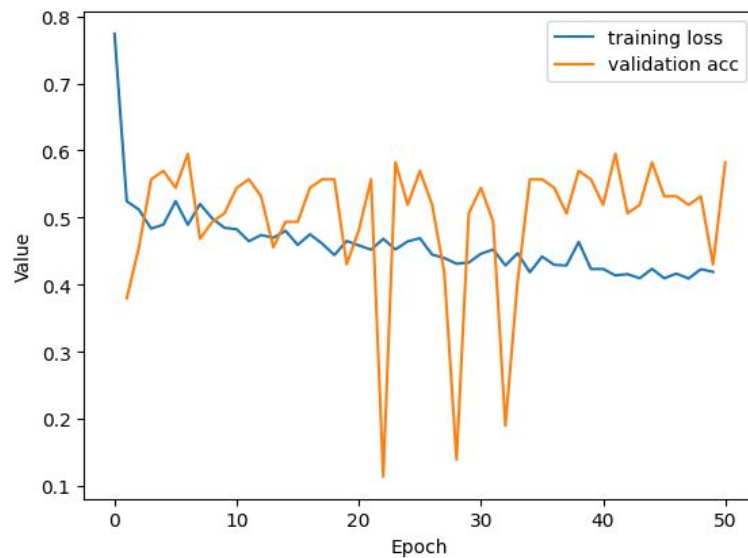
Brain Regions Affected in AD

- Hippocampus: memory formation and storage.

- Entorhinal Cortex: Spatial Navigation and Memory.

- Parietal Cortex: Spatial cognition and perception functions.

Agosta, F., Pievani, M., Geroldi, C., Copetti, M., Frisoni, G. B., & Filippi, M. (2012). Resting state fMRI in Alzheimer's disease: beyond the default mode network. Neurobiology of aging, 33(8), 1564-1578.
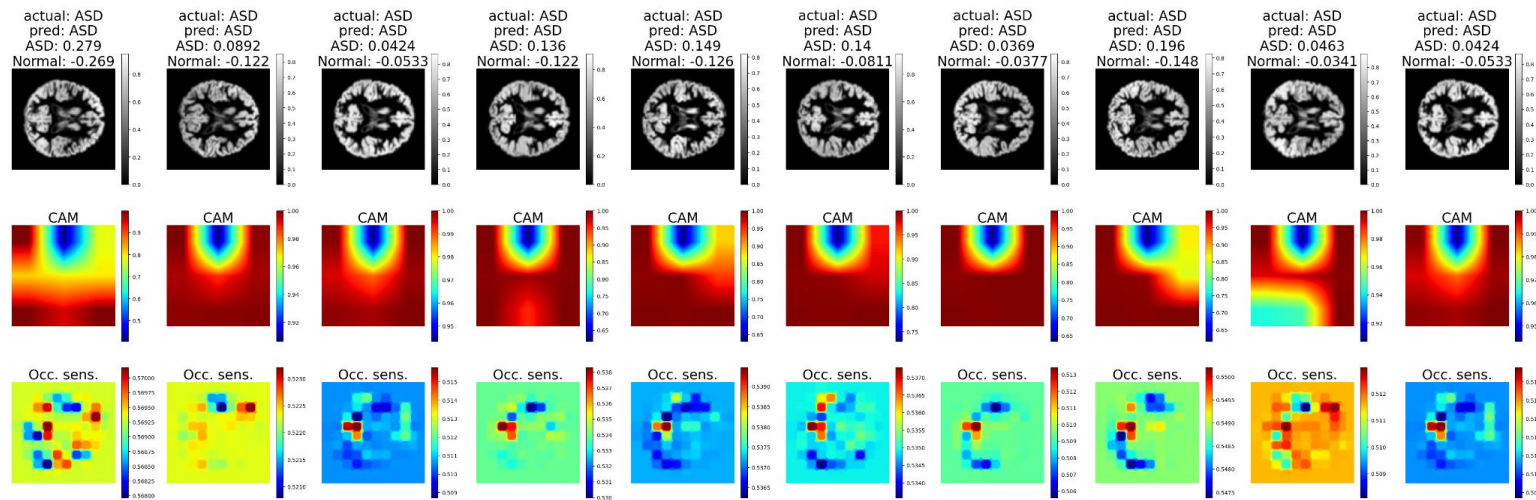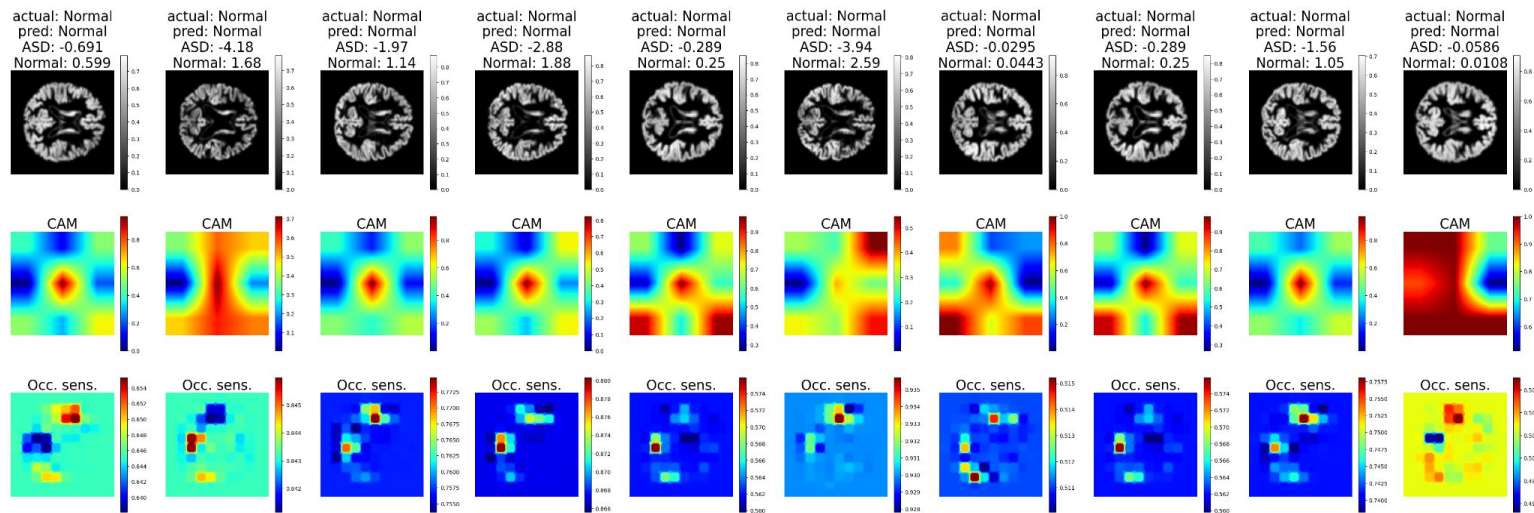
Brain Regions Affected in ASD

- Amygdala: emotion regulation and social behavior

- Prefrontal cortex: cognitive function, planning and decision-making

- Cerebellum: motor control and language processing.

Uddin, L. Q. (2015). *Salience Network Dysfunction in Autism Spectrum Disorder*. Trends in Cognitive Sciences.
Jack, C. R., et al. (2013). *Tracking Pathological Changes in Alzheimer's Disease via MRI*. Neurobiology of Aging.

Brain imaging and model interpretation results of ASD patients

Brain imaging and model interpretation results of Normal people

Conclusion

- Deep learning did not effectively identifies abnormal brain regions between AD, ASD and Normal.

Discussion

- Issues in classification for ASD and AD:

- Unadjusted questions for labeling in ASD datasets, affecting model training and data reliability

- TD label should modify into Normal

- Lack of brain imaging model interpretation of AD patients brain imaging model interpretation

- Problems in the normal samples combination of AD and ASD

- Mixing normal samples from ASD (young) and AD (old) creates confounding effects

  → Add Age as a covariate

Thank you for your advice