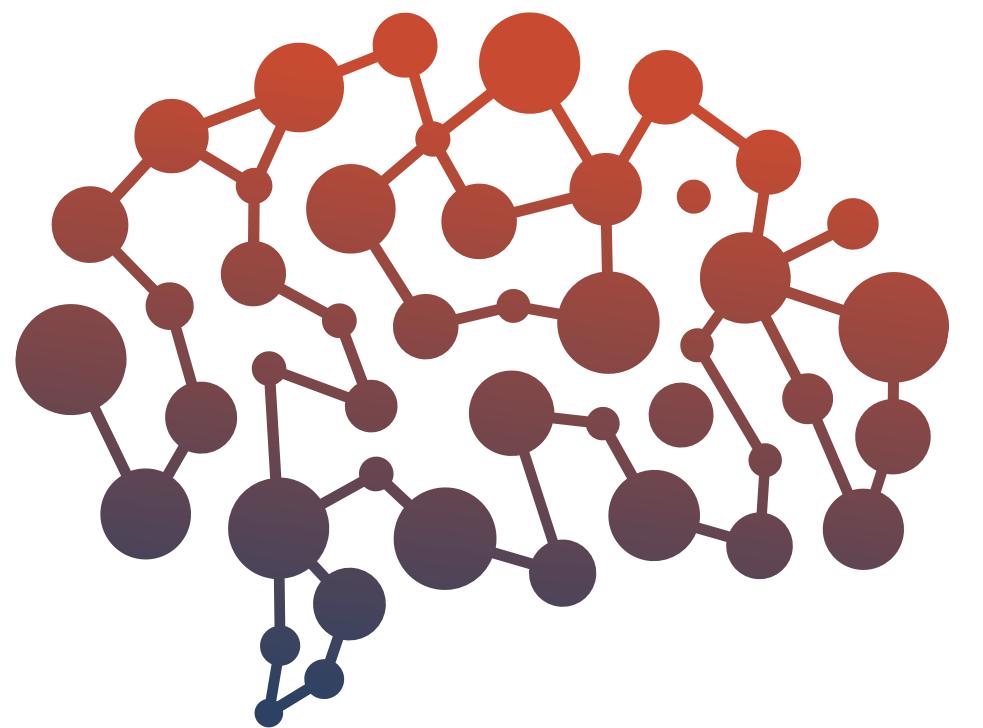


# Schizophrenic or not?



CAPSTONE PROJECT

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- **Schizophrenia:** a spectrum under psychotic disorders that is characterized by disturbances in **thinking** (cognition), **emotional responsiveness**, and **behavior**

DSM-5 Criterion (2+ features for at least 1 month)

- delusions
- hallucinations
- disorganized speech
- grossly disorganized or catatonic behavior
- negative symptoms

Diagnosis of Schizophrenia is not easy, especially on the onset; no single test

## Literature Overview

Exact causes are unknown

**Correlates:** Abnormal anatomical structures and neurological pathways, as well as underlying genetic & environmental factors

"Neuroimaging studies have shown substantive evidence of brain structural, functional and neurochemical alterations in schizophrenia, consistent with the neurodevelopmental and neurodegenerative models of this illness."<sup>2</sup>

**Known:** Decreased brain volume

"whole brain volume tends to positively correlate with a range of cognitive domains in healthy volunteers and female patients"<sup>1</sup>



## Literature Overview (cont.)

Neuroimaging & ML (CNNs) is trending; not widely used

"Despite the promises, and often over-promises, made by various publications, reliable application of machine learning methods in neuroscience is still in its infancy" <sup>3</sup>

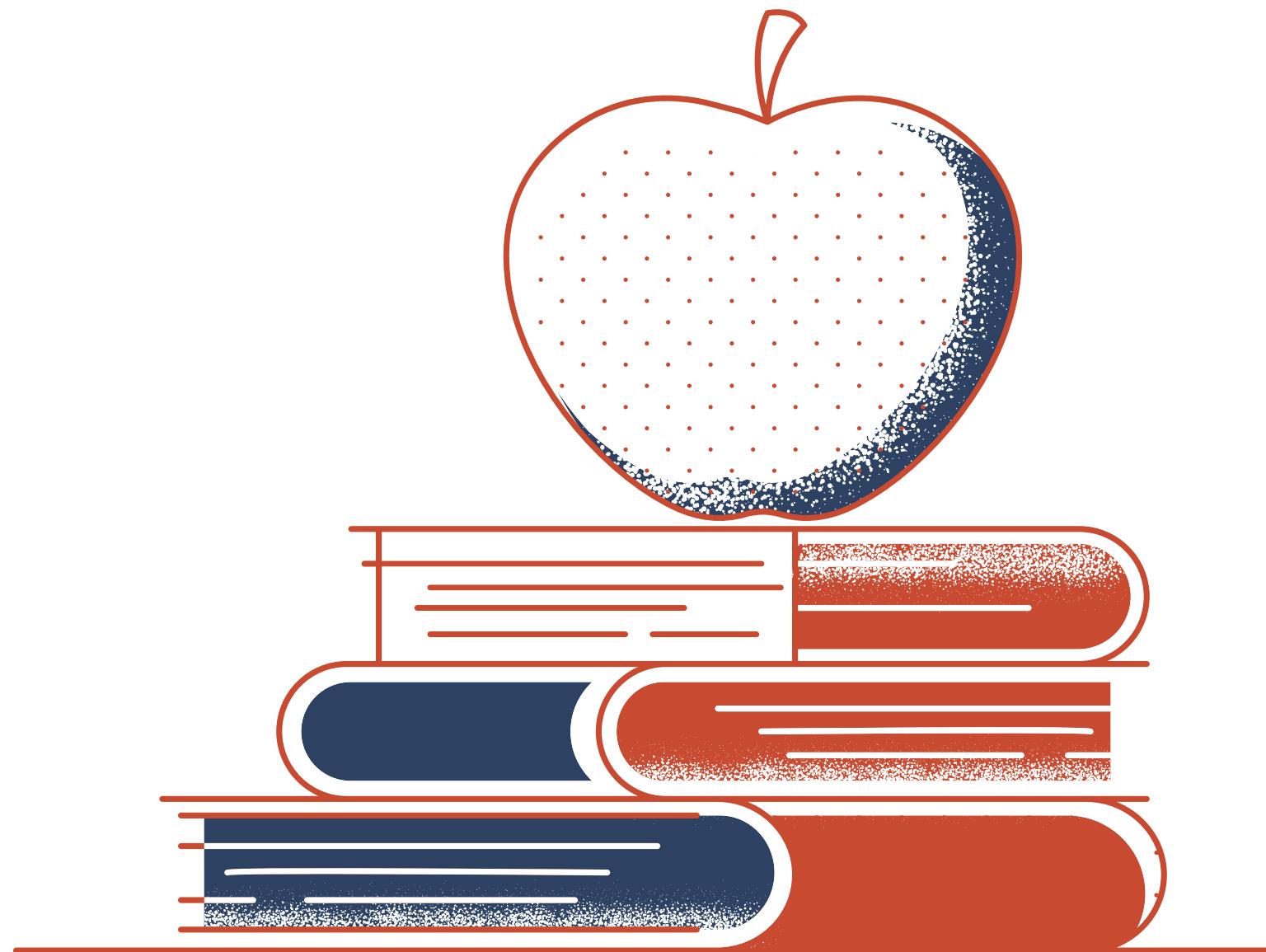
"[For] machine learning classification to have translational utility for individual-level predictions...classification [must be] clinically informative, independent of confounding variables, and appropriately assessed for both performance and generalizability" <sup>4</sup>

We know a lot and not enough about the brain <sup>5</sup>



24 million people or 1 in 300 people (0.32%) worldwide;  
1 in 222 people (0.45%) among adults

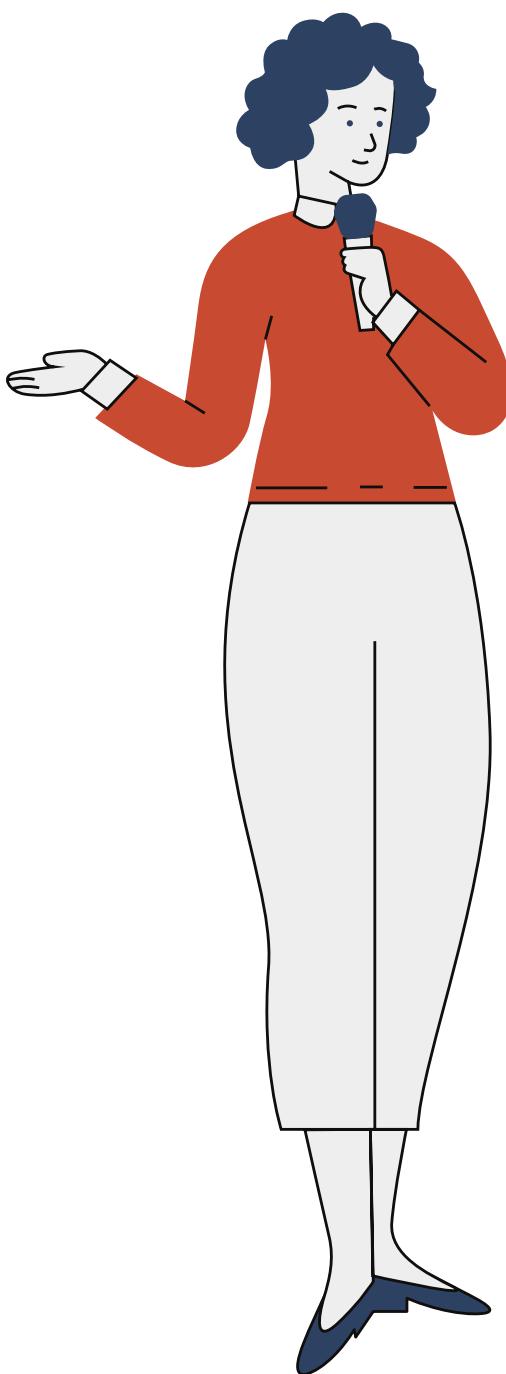
- ~50% of people in mental hospitals have a schizophrenia diagnosis
- 31.3% of people with psychosis receive specialist mental health care<sup>6</sup>
- Often co-occurs with other illnesses; therefore remain "poorly understood, and clinically challenging"<sup>7</sup>
- Successful outcome for treatments (17%)<sup>8</sup>



- Can I classify patients diagnosed with schizophrenia with at least 85% accuracy for specific sMRIs?
- How much difference do models trained on similar data but on different slices make?



## Data



Cobre Study from COINS

Control group (N=94)

Schizophrenic group (N=83)

Structural MRIs

- T2-Weighted Scans
- Use long TE (time to echo) & TR (repetition time) times; information about disease burden/lesion load
- Mprage Scans
- T1-Weighted gradient echo pulse sequence; uses short TE & TR times; determined by T1 tissue properties

Differences: T2 – disease burden & lesion load; T1 – active areas of inflammation/current disease activity<sup>9</sup>



## T2 Scans



Sample of T2 Scan on the  
axial/transverse plane ([120 Slices](#))

## Mprage Scans



Sample of Mprage on the sagittal  
plane ([192 Slices](#))



## Models

2 CNNs

1 T2 Model (1)

1 Mprage Model (2)

## Specifications

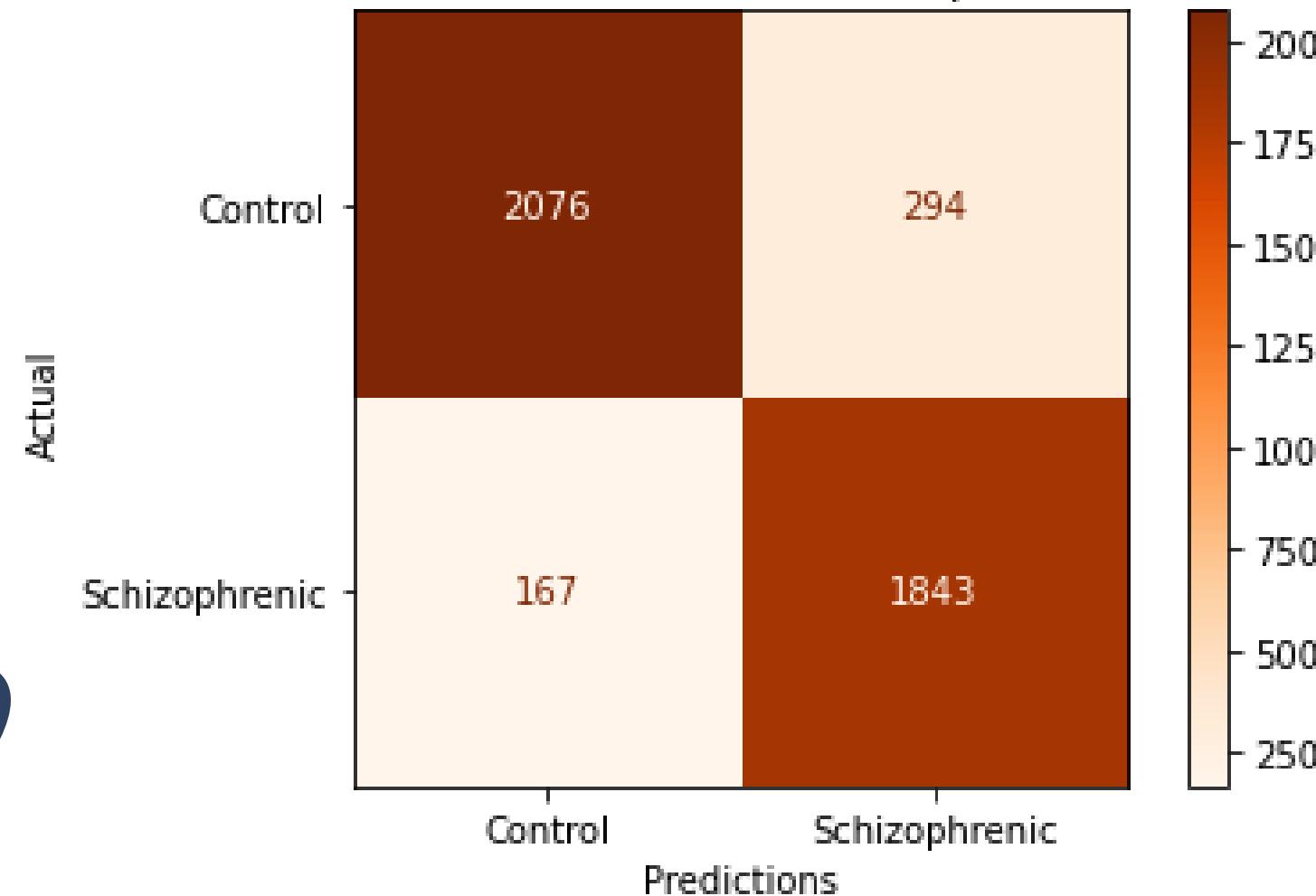
(1) 9480 Control & 8040 Sz  
images

Baseline = 0.4589

(2) 22848 Control & 22656 Sz  
images

Baseline = 0.4979

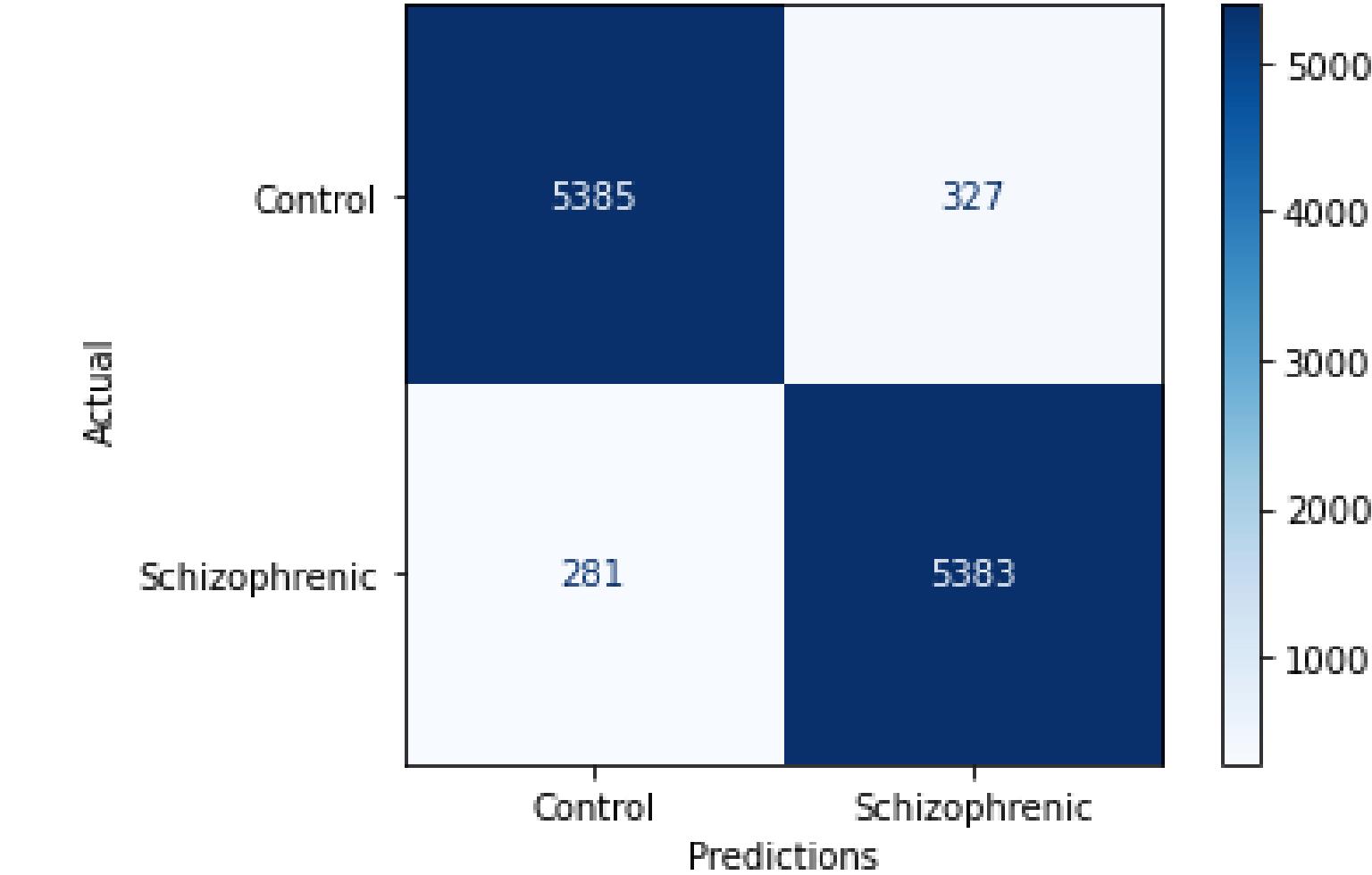
Confusion Matrix for Control vs Schizophrenic (T2 Scans)



Results (T2)

accuracy	recall	precision	specificity	f1 score	misclassification
0.8947	0.9169	0.8624	0.8759	0.8888	0.1053

Confusion Matrix for Control vs Schizophrenic (Mprage Scans)

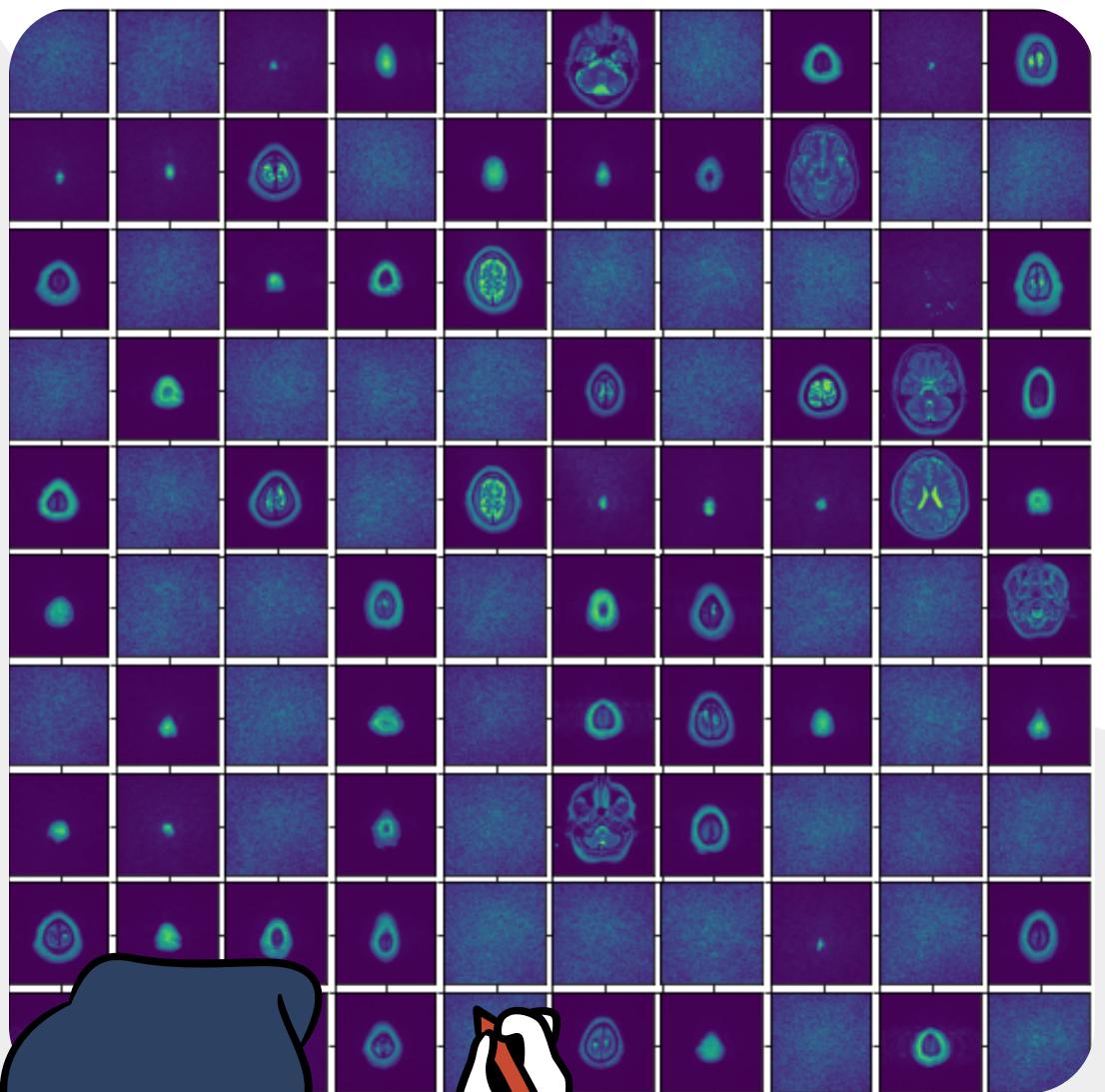


Results (Mprage)

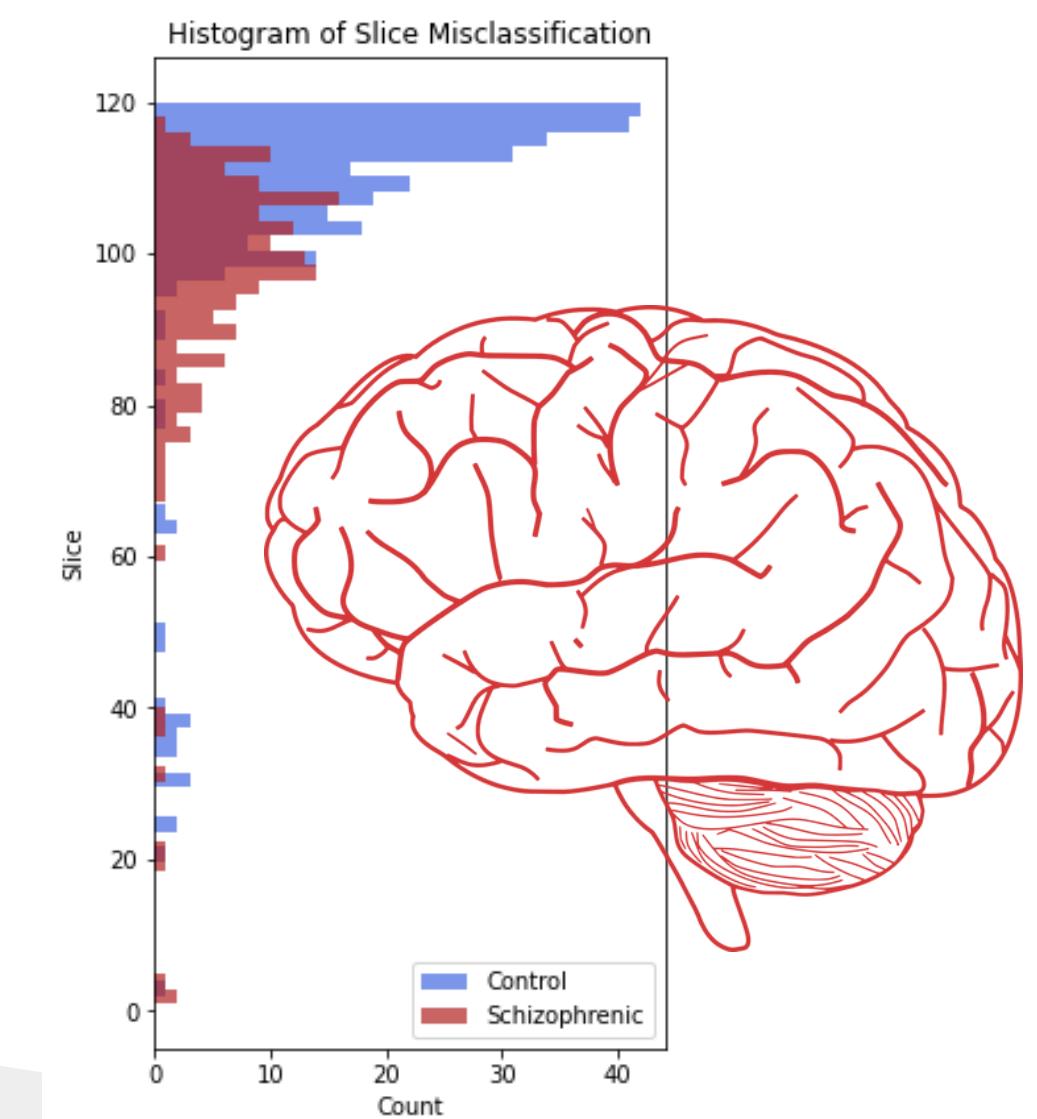
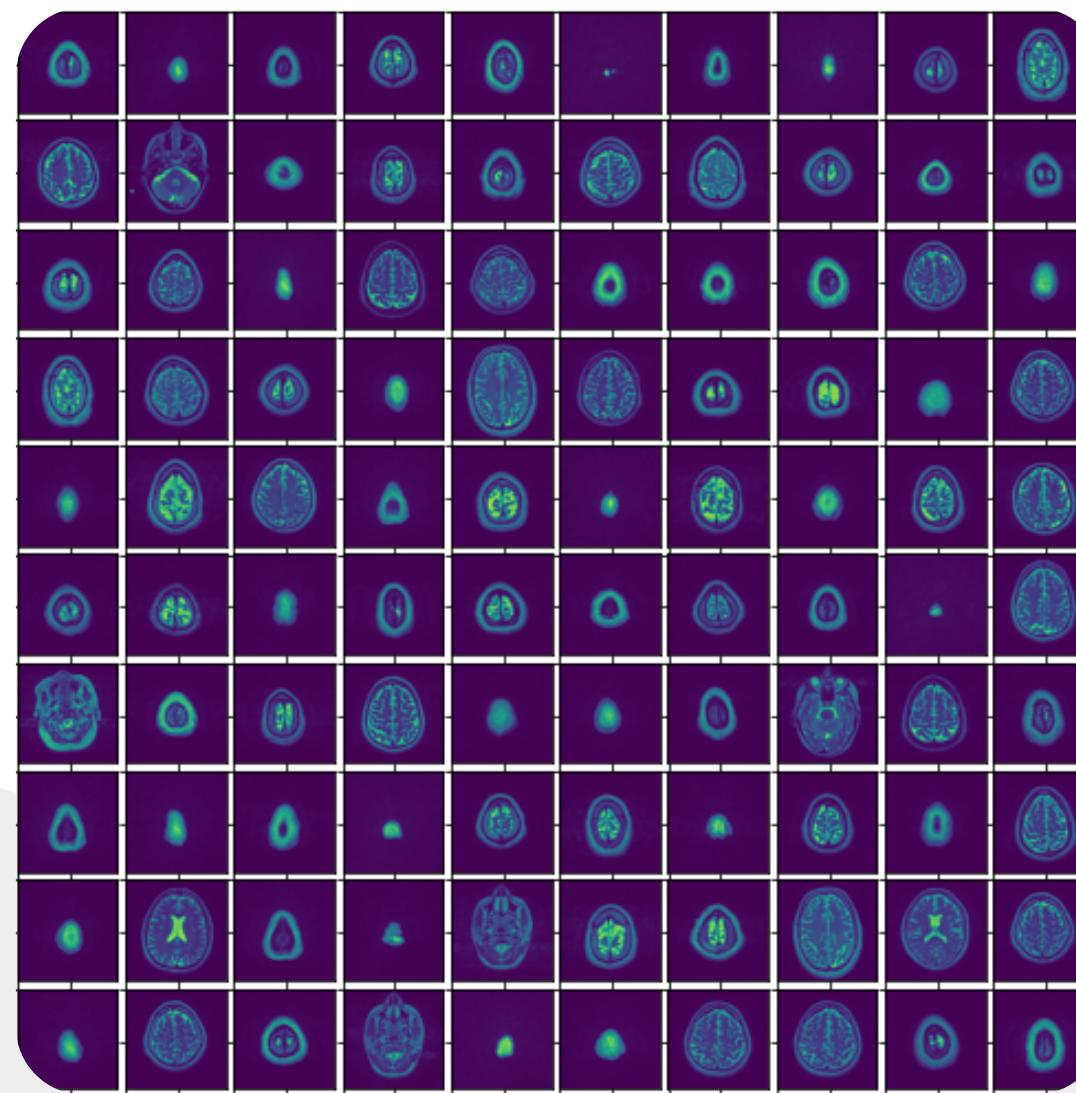
accuracy	recall	precision	specificity	f1 score	misclassification
0.9466	0.9504	0.9427	0.9428	0.9465	0.0534

## T2 Misclassification

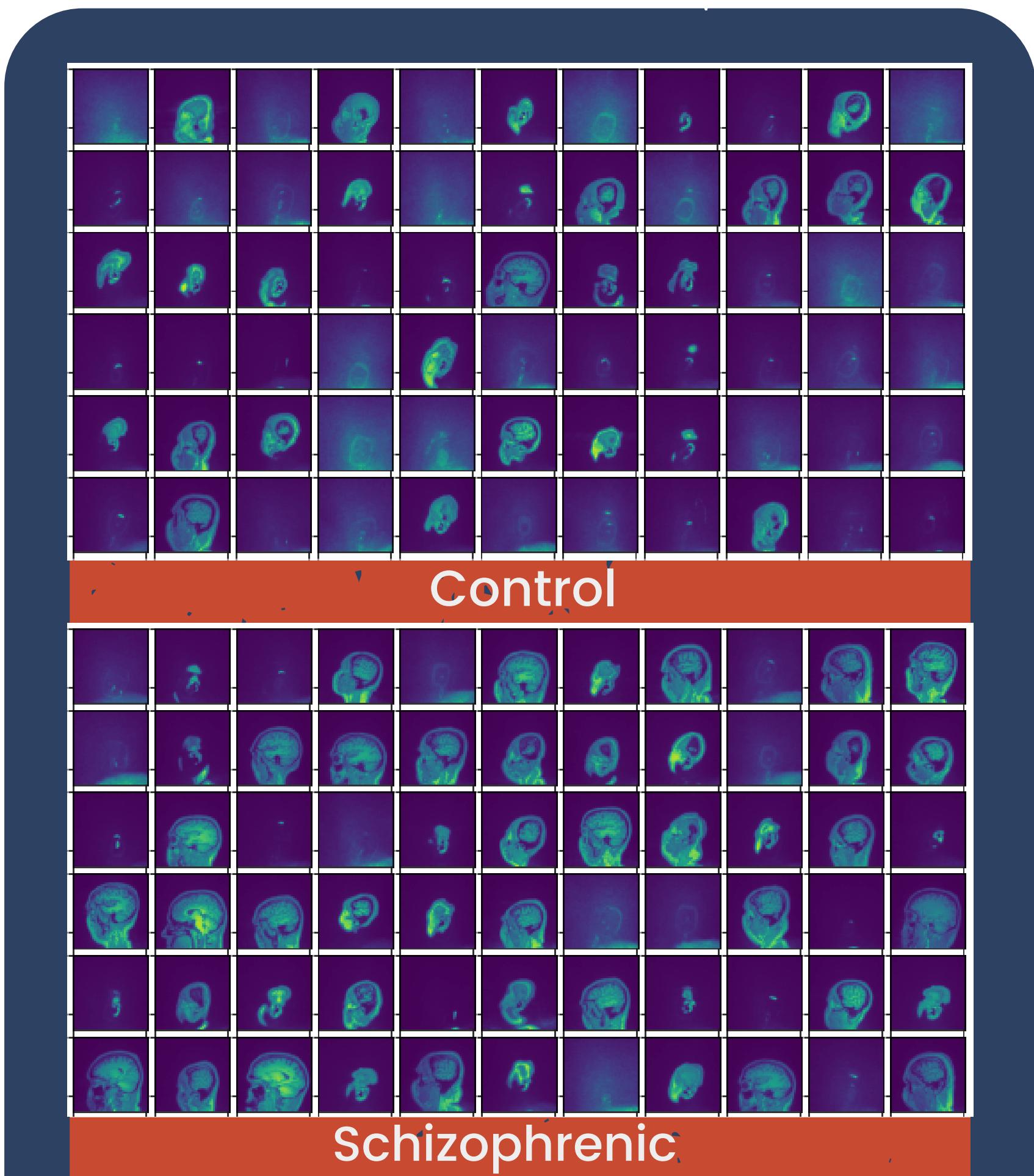
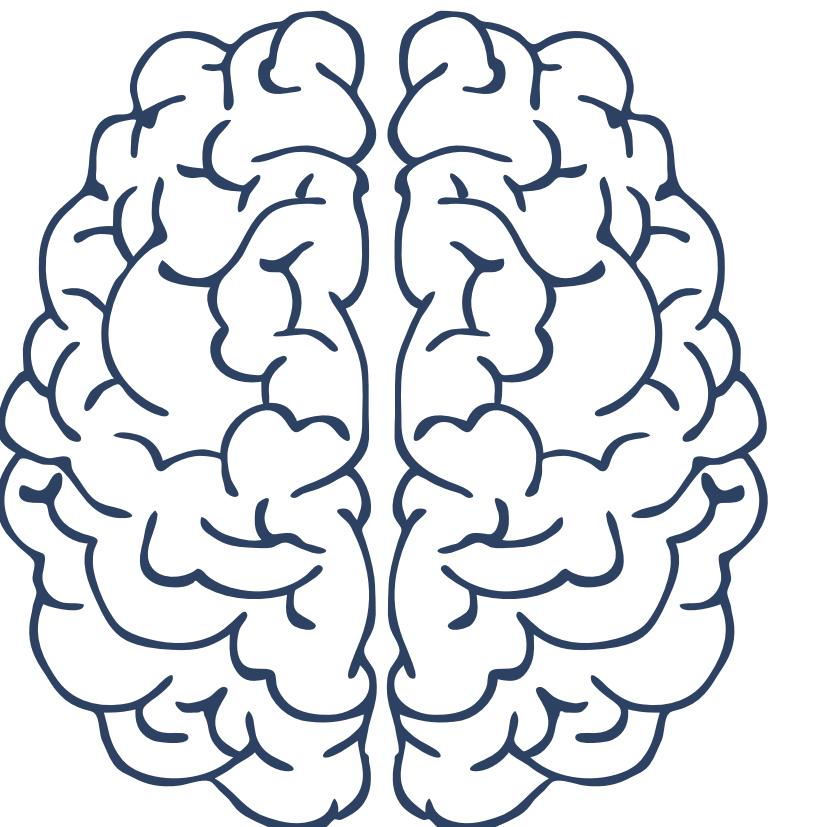
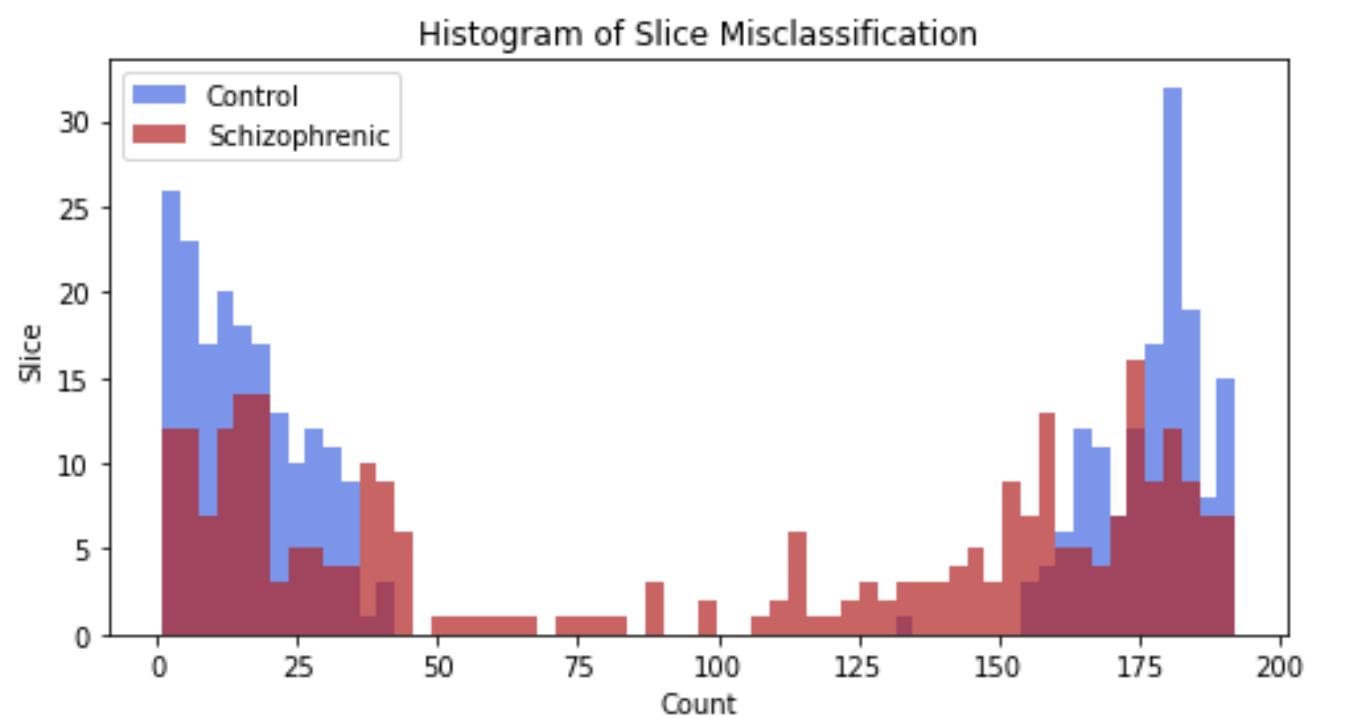
Control



Schizophrenic

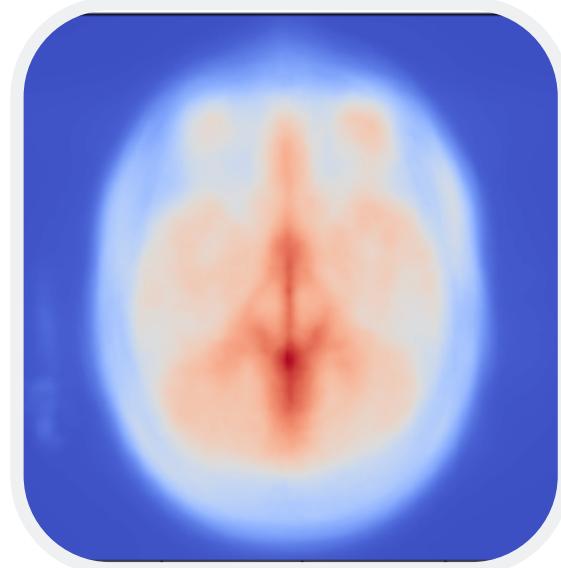


## Mprage Scans

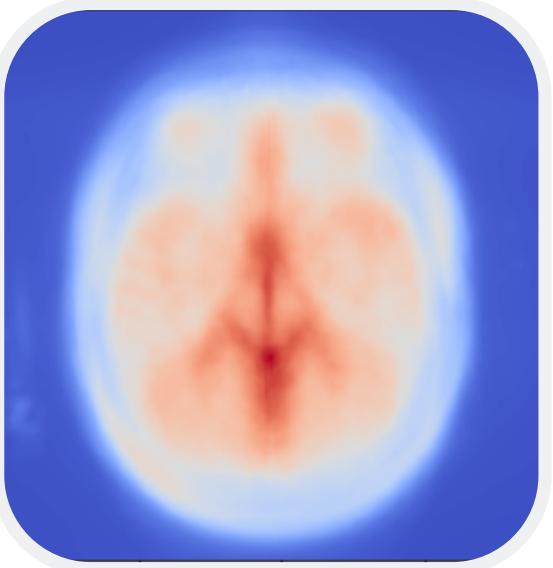


## Mean Images

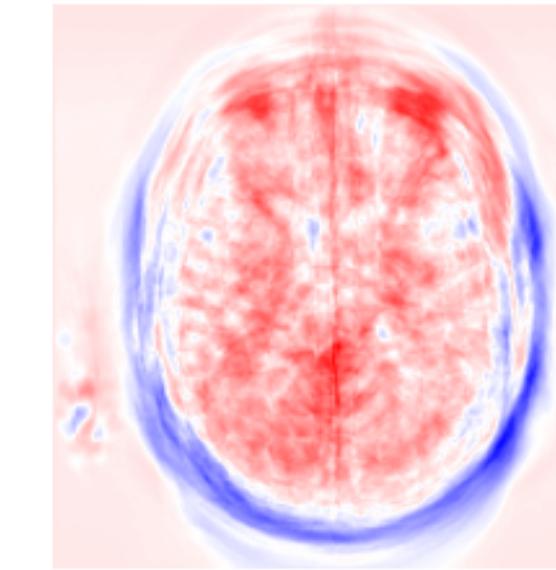
Control



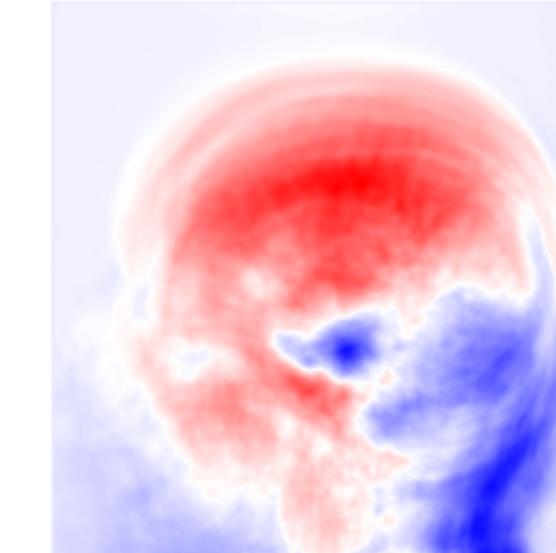
Schizophrenic



Difference between Control & Schiz Average



Difference between Control & Schiz Average



## Inferences

- Despite slice misclassifications, mean images reveal minute differences the model may be learning
- In practice, models can be run separately or individually and can be done on entire volume of scans **per patient**.
- The mean score of slices could be used to aid diagnosis & investigation

**Patient A00014898: 12 Misclassified slices – mean score of .1235**

## Project Recommendations



## 3D Modeling & Data Augmentation

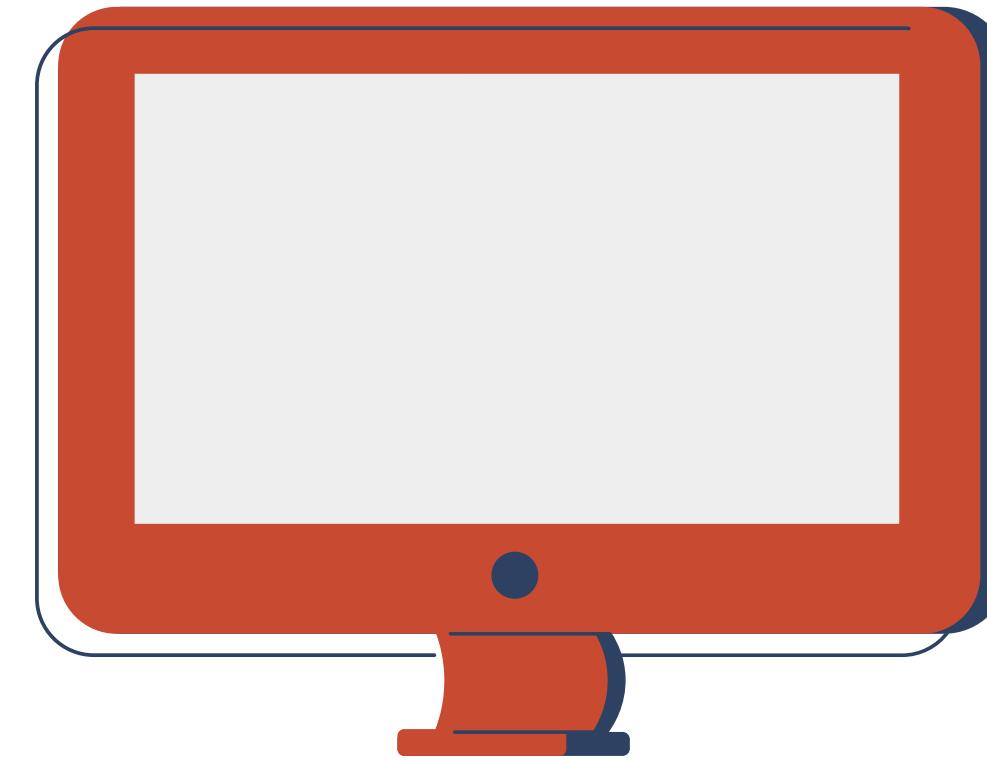
Use Conv3D layers, PCA & Eigen Images or Autoencoding (non-linear, +2D) to reduce dimensionality. Rotate and shift the images, introduce GANs

## Obtain more data & optimize

Use more T1 or T2 scans or more varied scans. Optimize more thoroughly; highly recommend utilizing ATS or transfer learning

## Streamlit & Gradient Ascent

Use streamlit to sample how the models could be used with different modalities. Use gradient ascent to better shed light on what's being learned



## Project Limitations

- Limited patient sample size; no meta data used
- Data Intensive
- Machine/scan type/ plane/ head shape
- No segmentation of data by age or severity
- MRI costs and diagnosis limit overall samples

## Further Recommendations

- Use fMRIs & clustering to study actual neural network functions
- Run models based on meta data (age, genes, speech)
- Use MRIs on other mental illnesses that are comorbid

## References

- <sup>1</sup> <https://www.tandfonline.com/doi/full/10.1080/09540260701486647?scroll=top&needAccess=true>
- <sup>2</sup> <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7724147/>
- <sup>3</sup> <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6499712/>
- <sup>4</sup> <https://www.sciencedirect.com/science/article/abs/pii/S2451902219303040>
- <sup>5</sup> <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4975723/>
- <sup>6</sup> <https://www.who.int/news-room/fact-sheets/detail/schizophrenia>
- <sup>7</sup> <https://focus.psychiatryonline.org/doi/10.1176/appi.focus.20200026>
- <sup>8</sup> <https://www.psychiatrist.com/jcp/depression/suicide/why-are-outcomes-patients-schizophrenia-poor/>
- <sup>9</sup> [https://www.msaustralia.org.au/glossary/t1-t2-lesions/?fbclid=IwAR2sEn80xqncnwxs9TBR59r98GV6zPE\\_lFrB\\_7XKbKnW9F2wdtMGpHisHMo](https://www.msaustralia.org.au/glossary/t1-t2-lesions/?fbclid=IwAR2sEn80xqncnwxs9TBR59r98GV6zPE_lFrB_7XKbKnW9F2wdtMGpHisHMo)
- <sup>10</sup> <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7008229/>



The End

Thank you  
for listening

