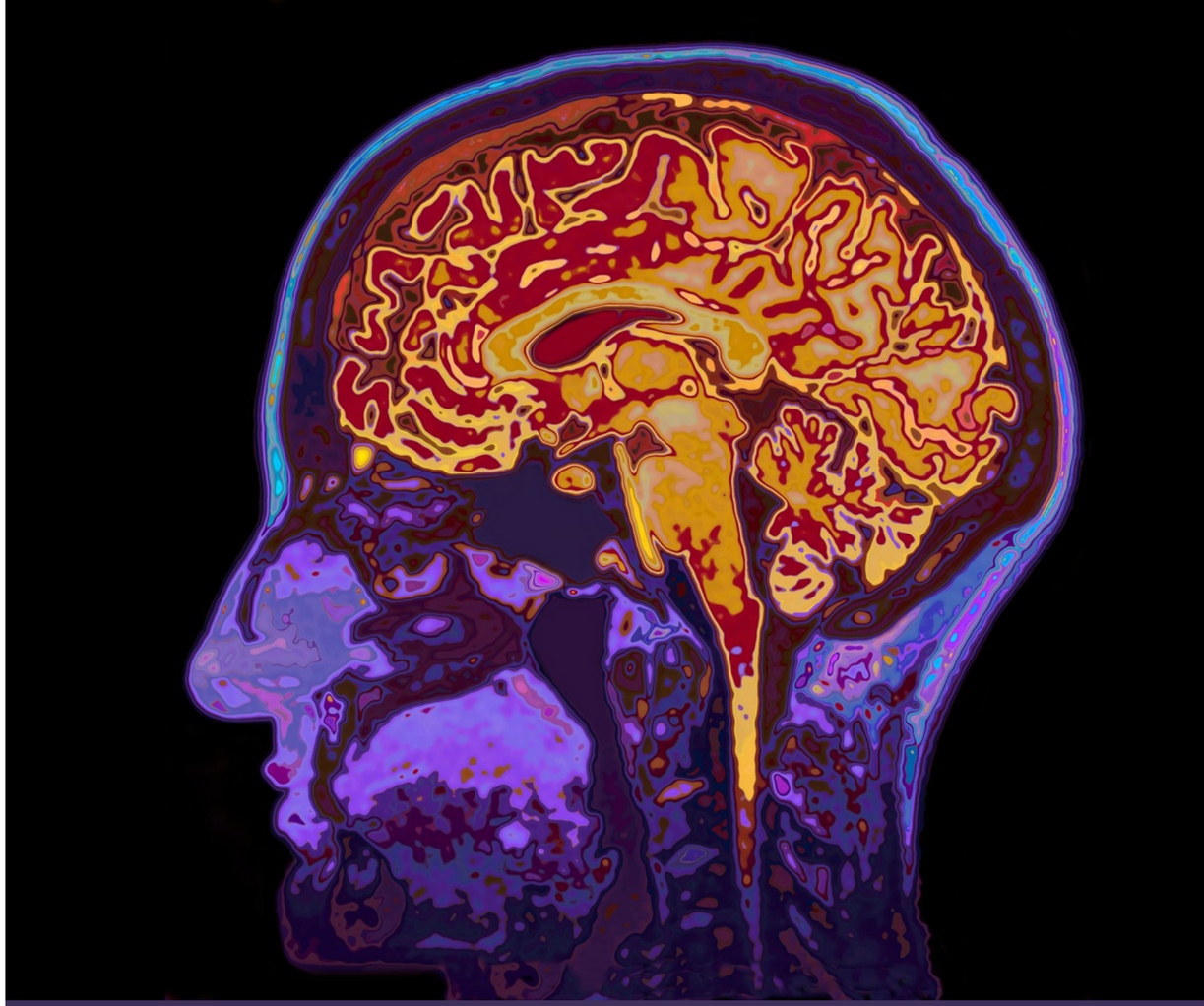
ESILV
ENGINEERING SCHOOL
DE VINCI PARIS

Innovation Project Year 5 ESILV

MRI Stroke Segmentation



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JAN 26, 2023

01

INTRODUCTION

02

PREPARING THE DATA

03

TRAINING & TESTING OUR MODELS

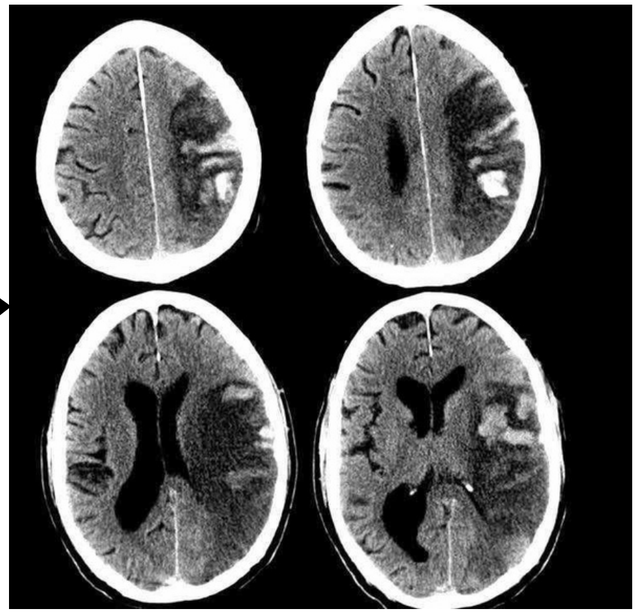
04

CONCLUSION

Stroke

Scan

MRI



Why Deep Learning ?

Automated image analysis

Improved image quality

Quantification

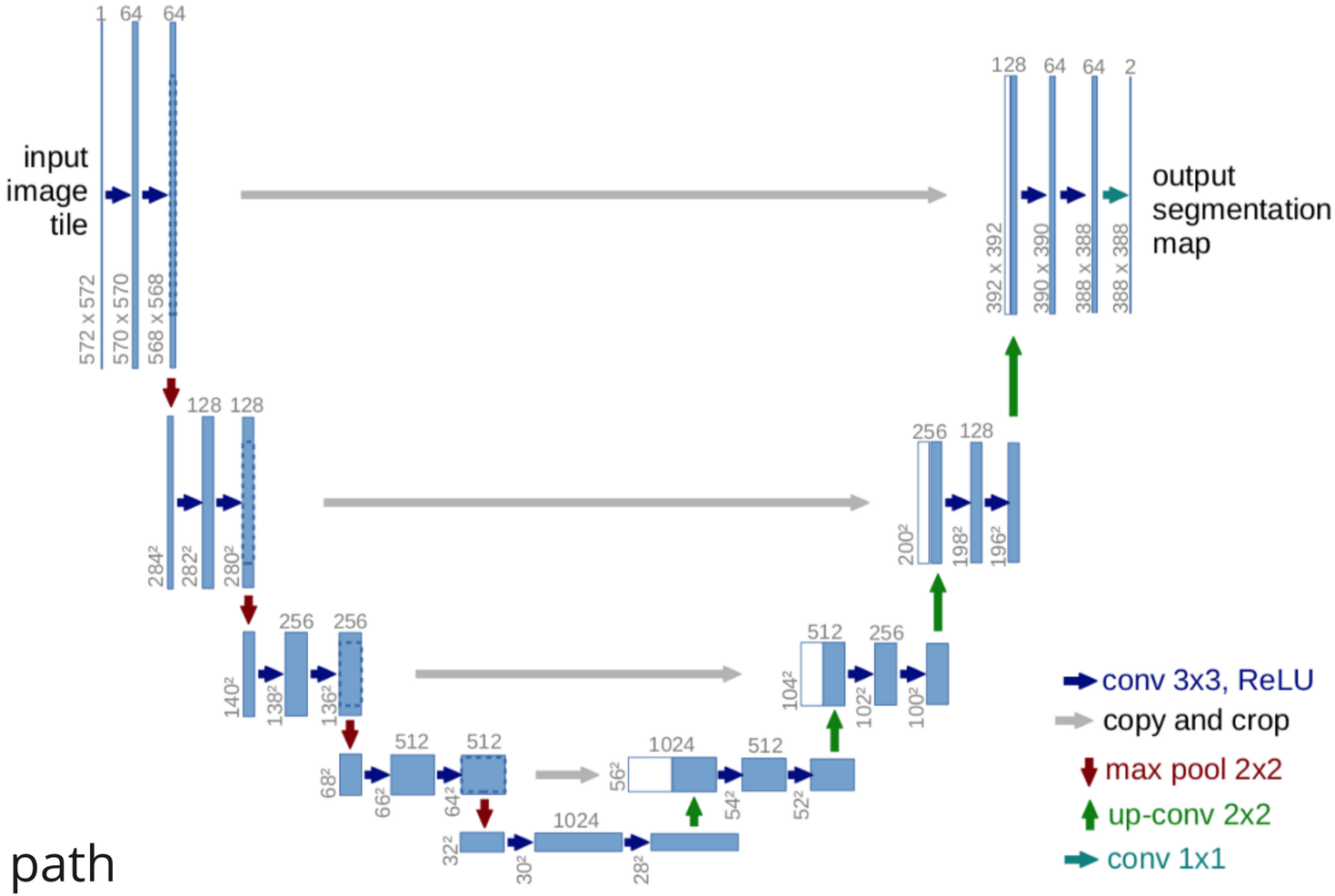
Reduced scan time and radiation dose

Detection of subtle changes

- Deep learning models

- Convolutional neural network (CNN)

- U-Net
  contracting path & expanding path



U-Net architecture

U-Net application in medical field

- Image segmentation
- Medical image synthesis
- Cell Segmentation
- 3D medical imaging
- Medical data augmentation

02

PREPARING THE DATA

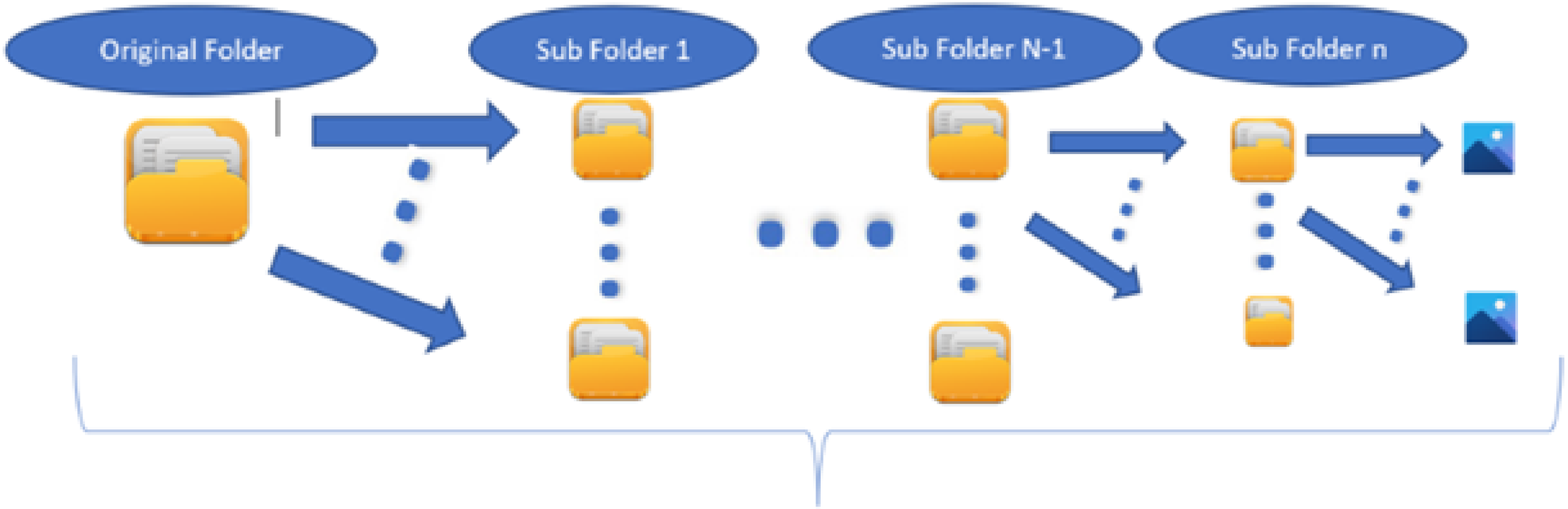
Data Collection & Pre-processing

USC Stevens Neuroimaging and Informatics Institute

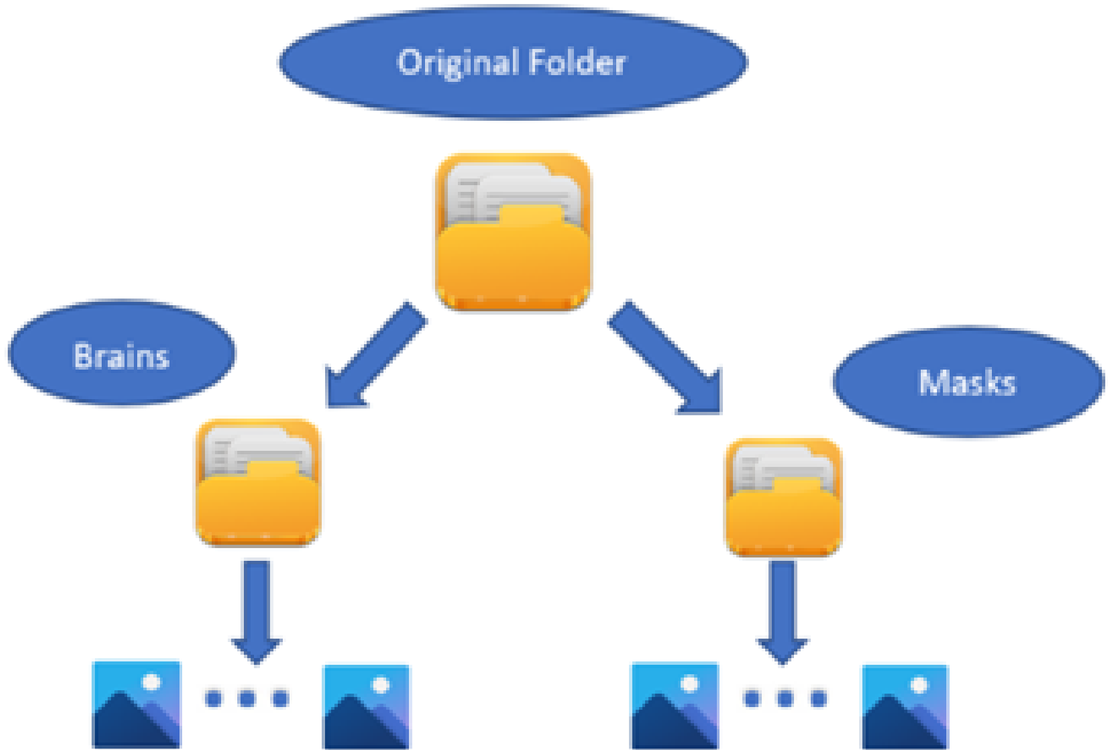
The data contained 955 samples :

- Training dataset (n=655 T1w MRIs with manually segmented lesion masks)
- Testing dataset (n=300 T1w MRIs only)

Each sample of the data was sliced and converted from a nii format to 2d image using a python script (NiBabel library)
It took us around 1.5H to slice the training and testing datasets



Data formating



Problems and solutions:

- **No samples of healthy brains in the dataset**

We created 2d slices from the 3d images, this allowed us to do more data augmentation and introduce healthy images in your training set.

- **The images in the dataset are preprocessed, meaning we cannot add more images from other sources because of the eventual biases that can occur.**

We added data augmentation layers in the entry of our U-net model to simulate new and diverse samples with each epoch.

- **Some images and especially the masks had some noise that was messing up the predictions (black pixel values not 0)**

We used thresholding on the masks in order to force the values of the pixels to zero.

- **The white representing the brains had different intensities (pixel values).**

First Approach

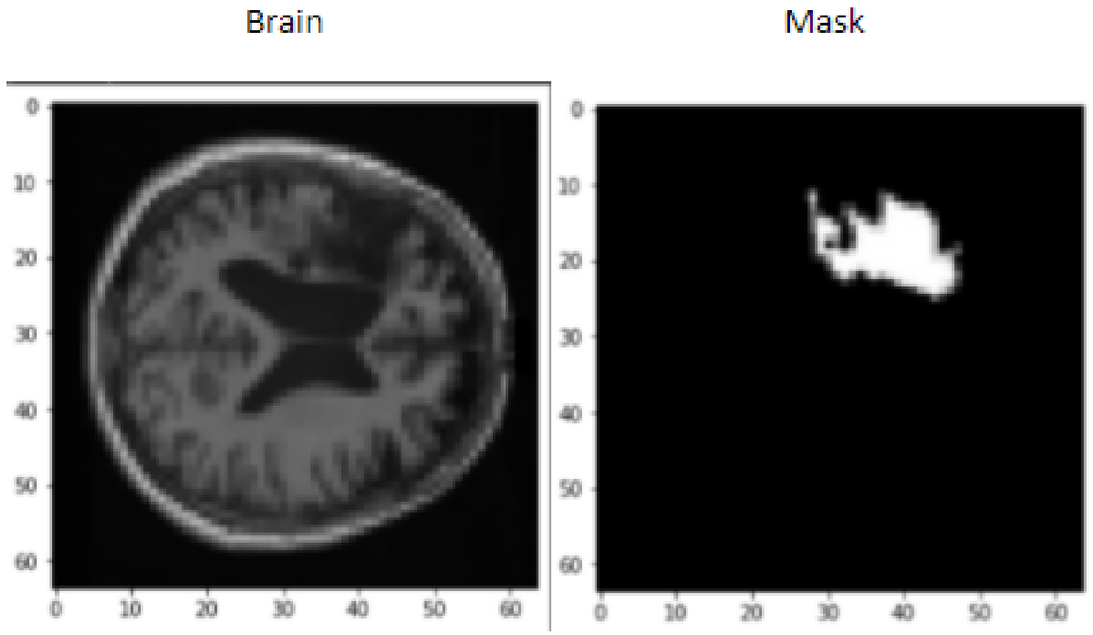
Using all images (200k)

Resolution (64x64) because of RAM issues

Basic Application

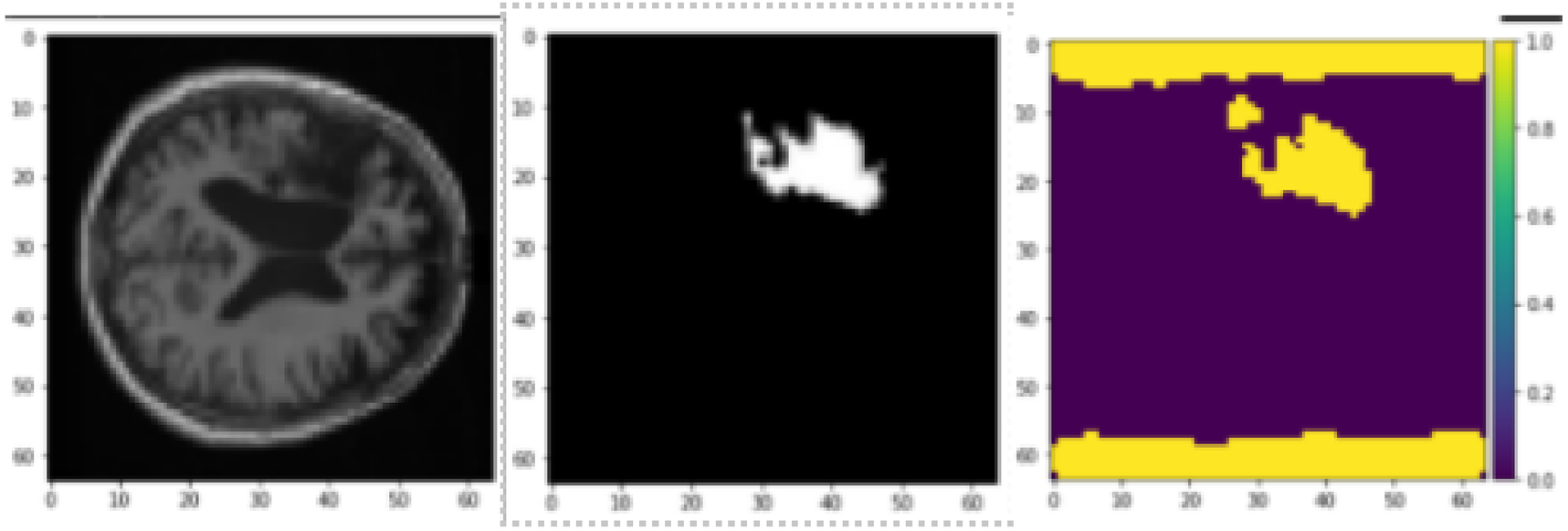
7 epochs

1h22min training



This is the brain and its correspondent mask.

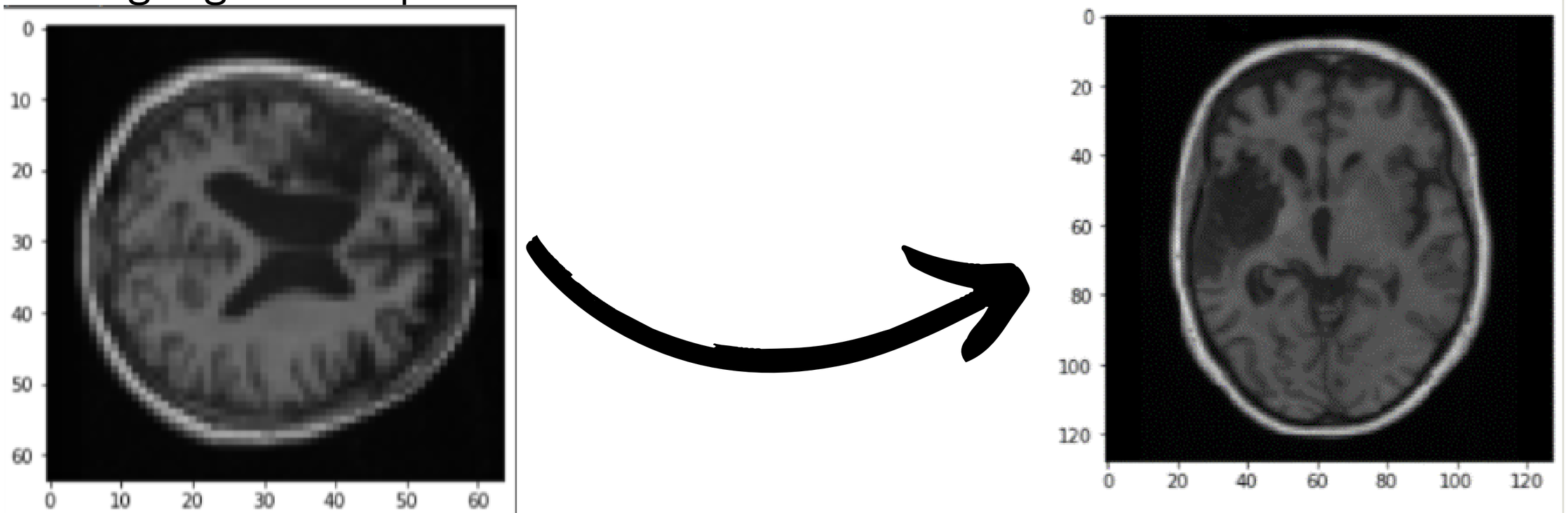
Result of the first model:



Improving the models

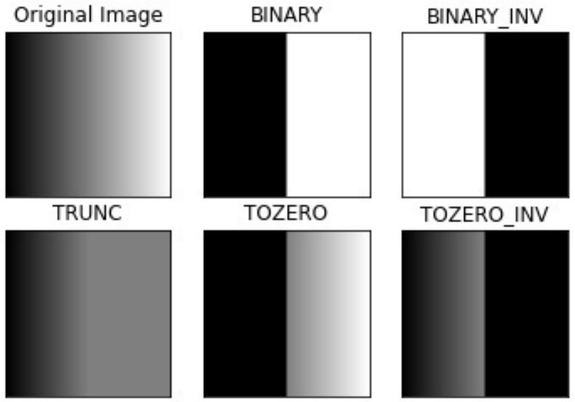
Moving forward we decided to overcome this challenge by taking several steps:

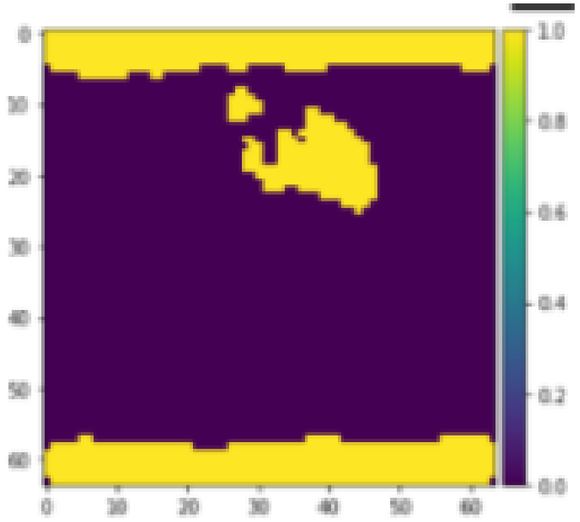
- Reducing the number of images per brain from 0 -> 189 to 50 -> 150
- Having a higher quality image from 64px to 128px
- Adding padding to the original brain on the sides to have a square dimension so we do not lose any information while downsizing.
- Use of google colab pro



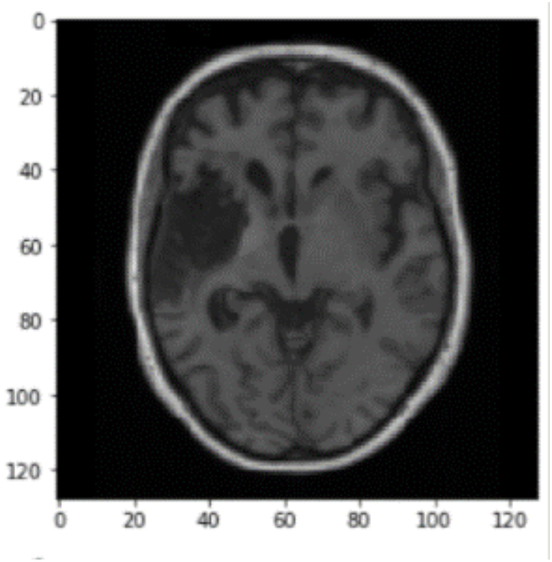
Second Approach

.Using thresholding on masks to have only black and weight colors

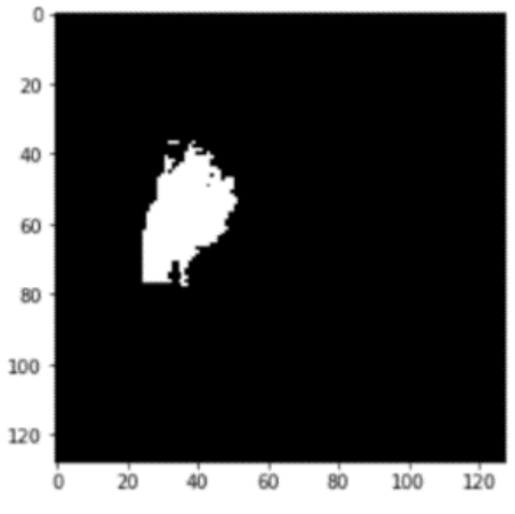




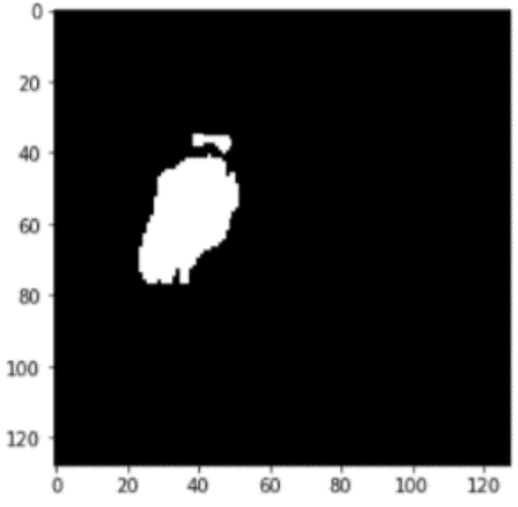
brain



mask

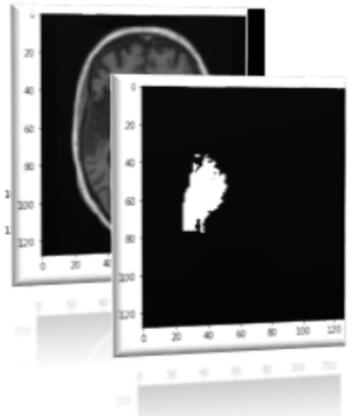


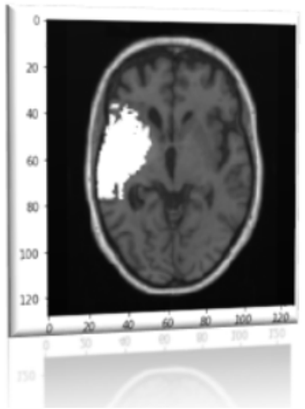
Prediction

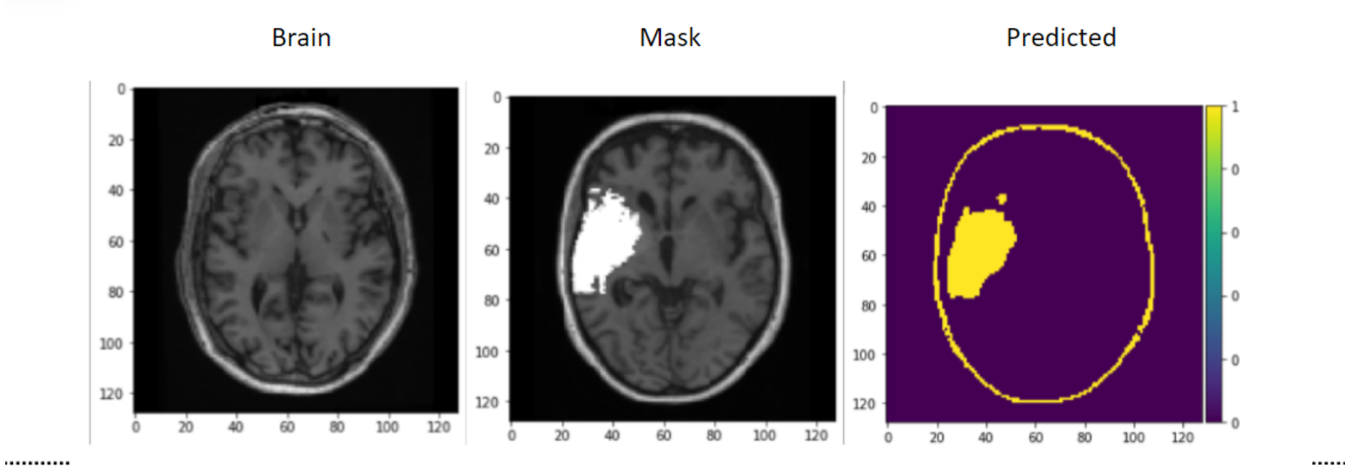


Third approach

For this approach working with data was a bit different since the masks have more size than the brains for the third approach we decided to see what would happen if the output layer was actually 2 layers on top of one another.





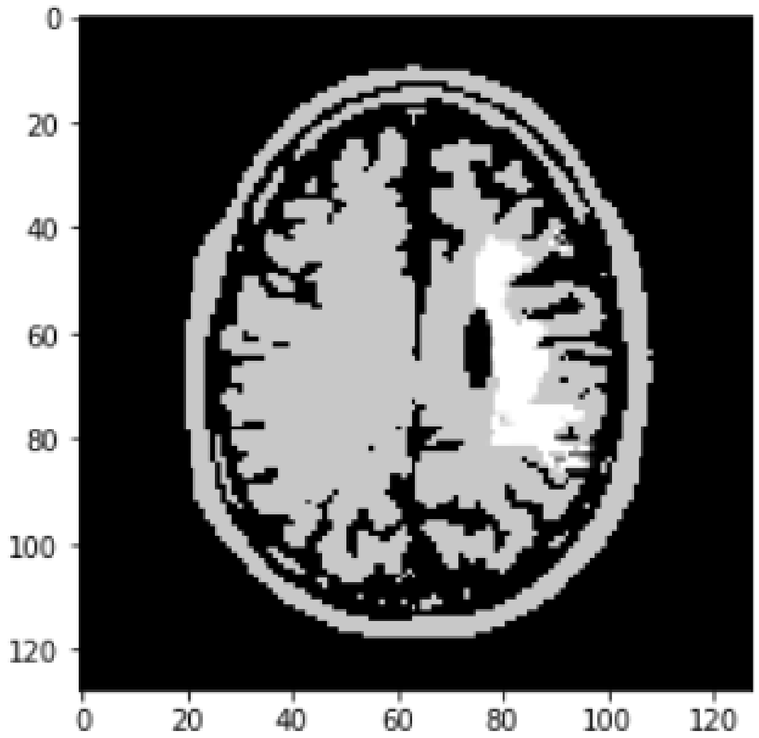


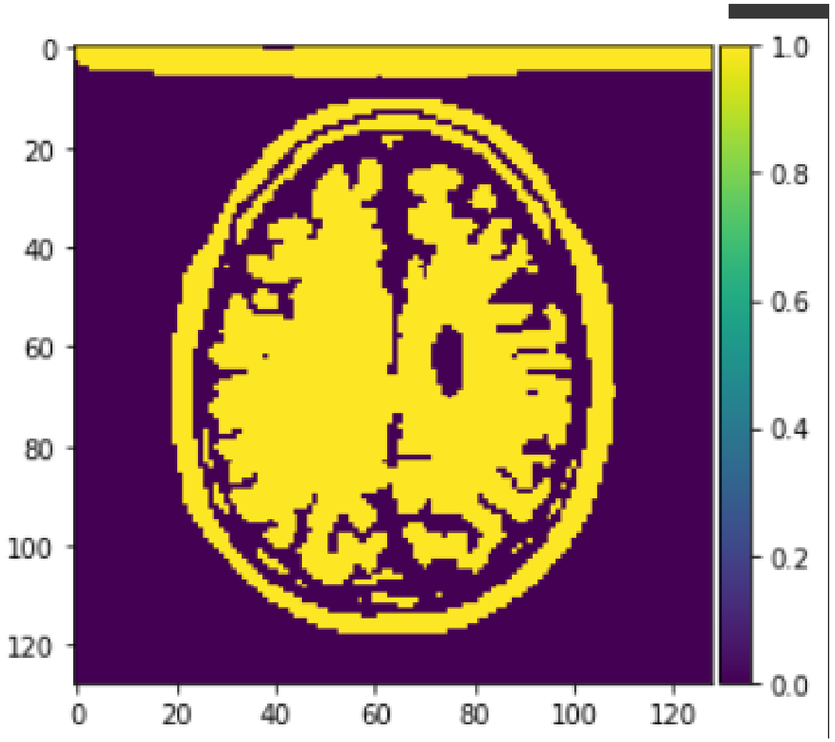
how do the 2 models behave?

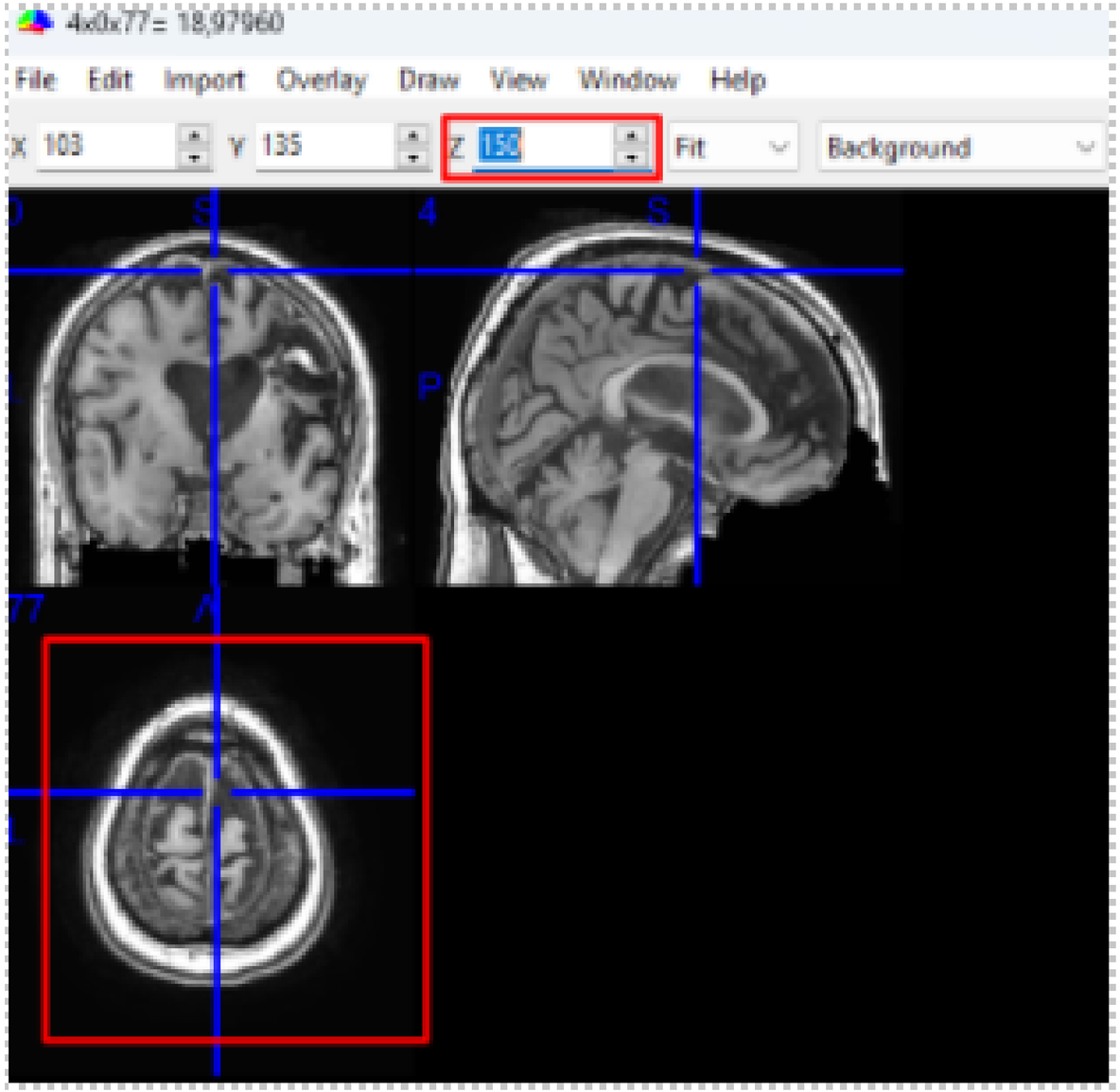
More approaches

Some approaches we took that ended up failing:

- Using 256px images instead of 128px
- using thresholding on model 3



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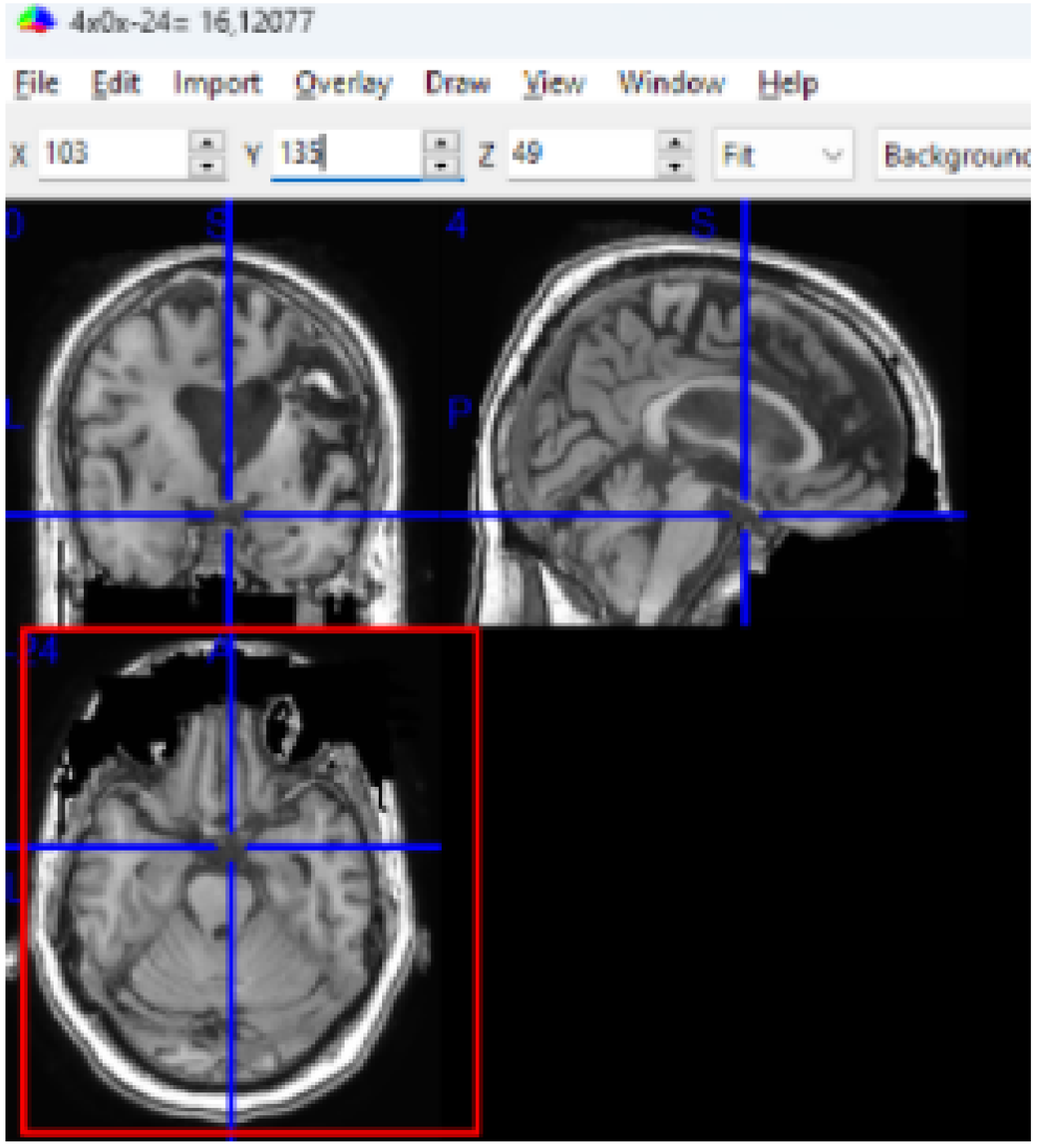
File Edit Import Overlay Draw View Window Help
X 103
Y 135
Z 150
Fit
Background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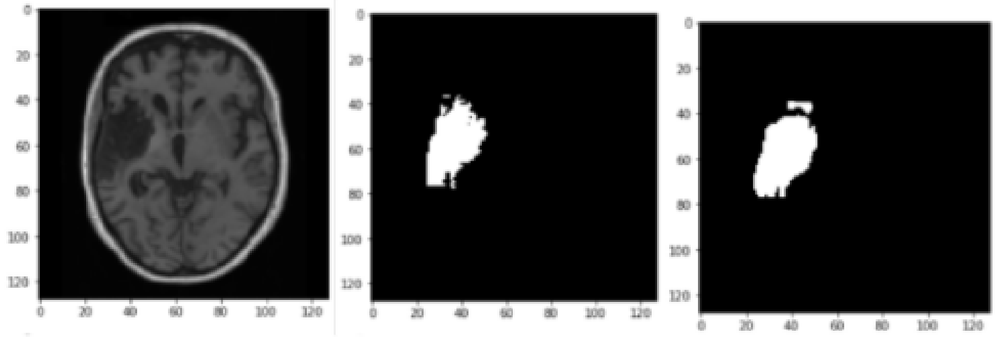
X 103
Y 135
Z 49
Fit
Backgroun

Comparison

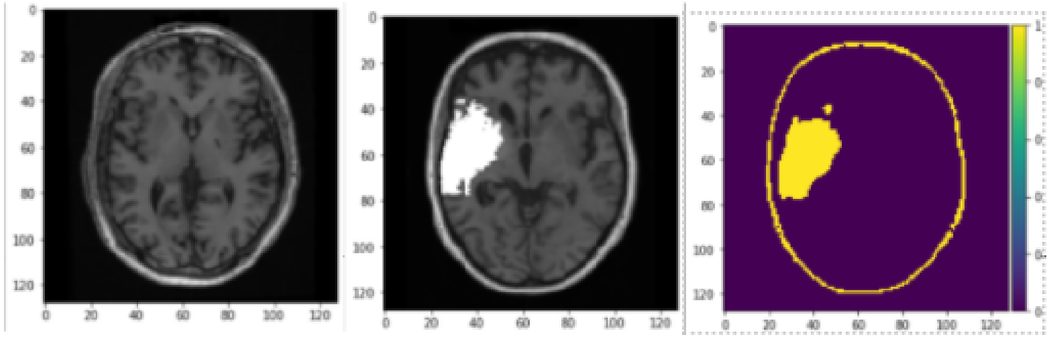
a. Model 2:

brain Mask Predicted



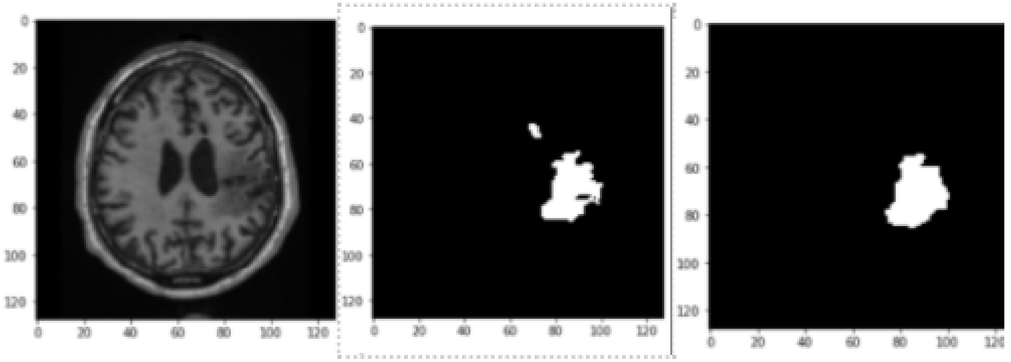
b. Model3:

brain Mask Predicted



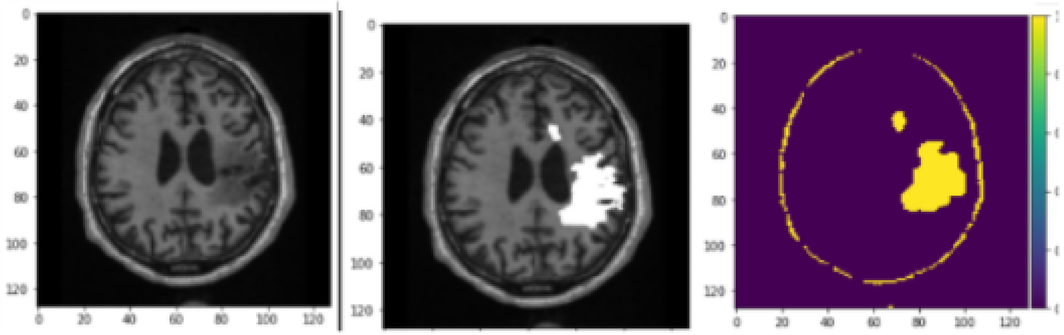
a-Model 2:

brain Mask Predicted



b-Model 3:

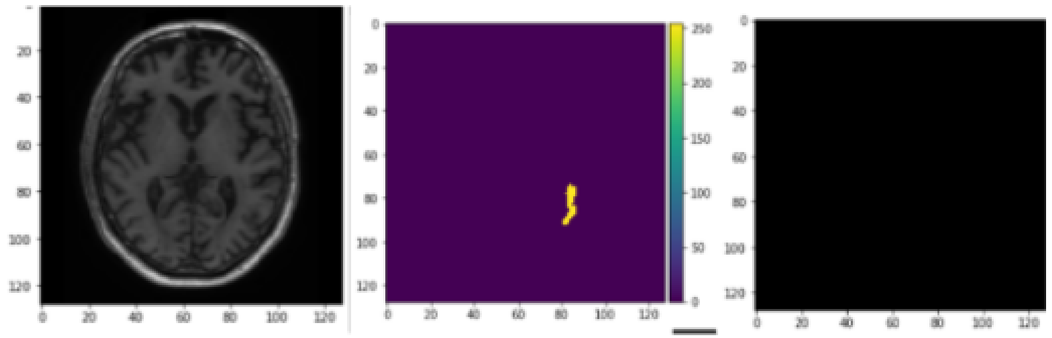
brain Mask Predicted



Comparison

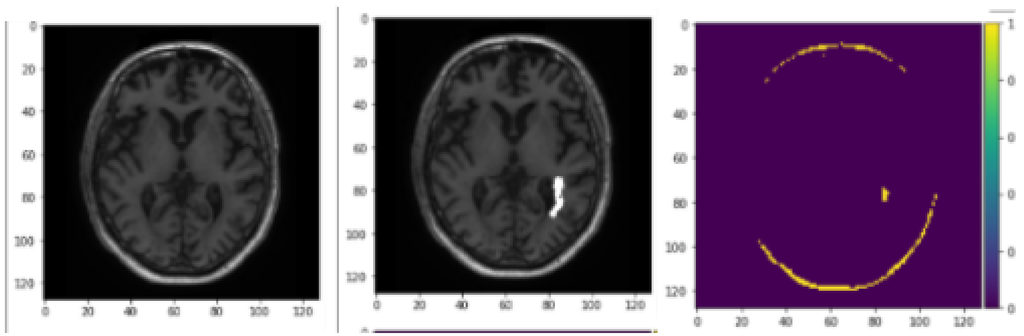
A-Model 2:

brain Mask Predicted



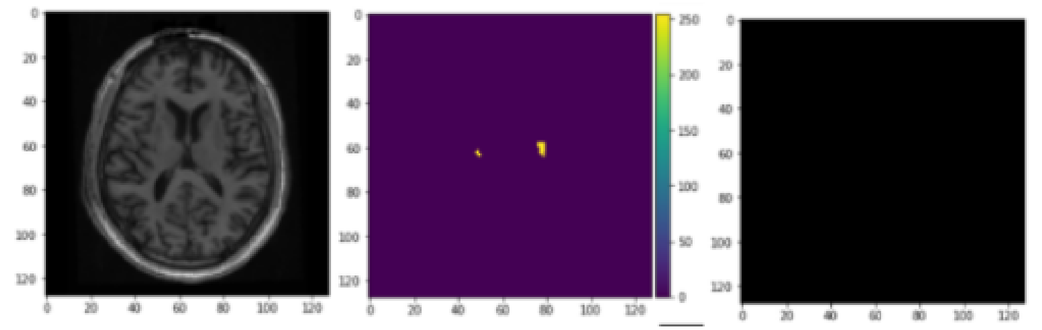
B-Model 3:

brain Mask Predicted



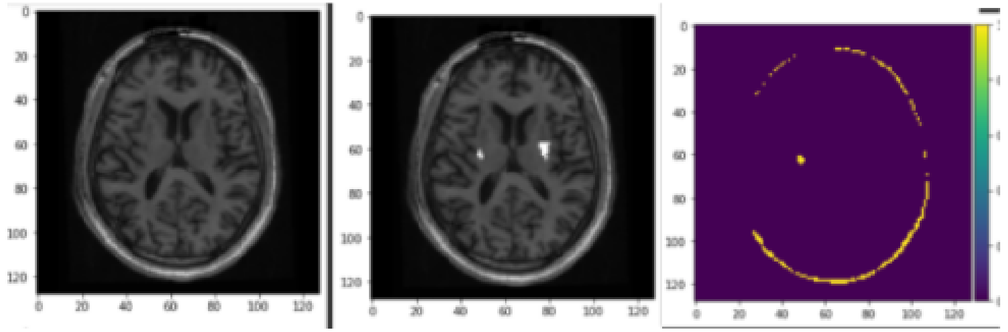
A-Model 2:

brain Mask Predicted



B-Model 3:

brain Mask Predicted



Conclusion

Disscusion

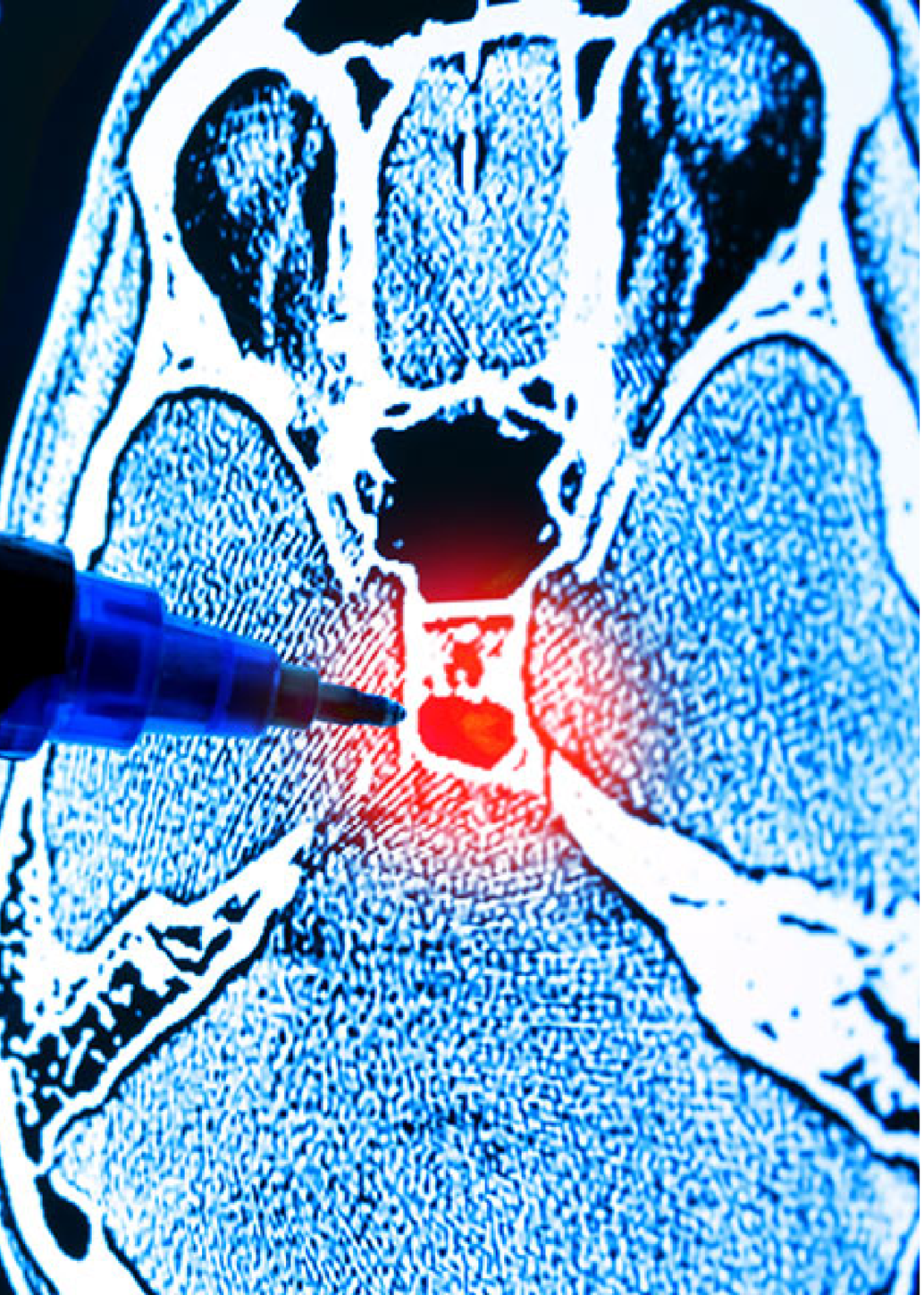
The two models perorme decently well in diffrent ways: the 2nd model dont predict the outline of the brain giving its prediction more accuracy, while the 3rd model is generally more accurate with the strokes and is able to detect smaller strokes more frequently.

Critique

- These approaches are defenitly steps in the right direction but the current model still lack accuracy in order to be considered for deployment.
- These models were not tester on real world example due to the confidenciality of patients date.

Future Work

This work can easely be improves with better thresholding methods applied to the 3rd model to remove the prediction of the brain's skull as well as using better machines with more RAM and GPUs for better fine tuning of the models.



Thank you for your attention !

Any questions ?