ADAPTING THE CIVET PIPELINE TO MACAQUE BRAINS

Yujian “Charles” Tang
Department of Computer Science
Neuro Image Research and Analysis Lab

Hello, My name is Charles and I’ll be presenting my research on adapting the civet pipeline to macaque brains that I’ve done at the Neuro Image Research and Analysis Lab here at UNC

Outline

- Background
- Setup
- Methods
- Progress
- Discussion
- Acknowledgements

For my presentation I will first be going over the background and setup explaining the motivation behind this research as well as some set up that must be done prior to beginning surface creation
Then I'll be going over methods and progress showing different experimental paths in surface generation as well as their problems and then problems I either solved
Then I will give a short discussion of what the next steps in this surface generation with the CIVET pipeline research are

Background

- Why study the Rhesus Macaque?
- Challenges in surface generation
- Why CIVET?

Why study the Rhesus Macaque?
- Easier access than humans
- Equals more data than humans
- Very similar brains

Challenges in surface generation for macaque brains:
- Surface generation tools we currently have are mapped for human brains
- They don't allow a lot of options/adaptability

Why CIVET?
- Pipeline allows for pausing and many additional options
- Done completely in shell
- Allows replacement of files
- New version has marching cube algorithm which allows for a higher quality surface creation
- Allows for images with different resolutions – very important for us

Setting Up

- Convert file formats
- Converting dimensions
- Resampling images

Convert file formats
- Files come in different formats
- CIVET works with a different format than the

Converting dimensions
- Given imageset in a different space with different step sizes that much be changed to match the template

Resampling images
- Finally all images have to be resampled into the MNI-152 space
- The T1 image, label file, subcortical file, and parcellations file

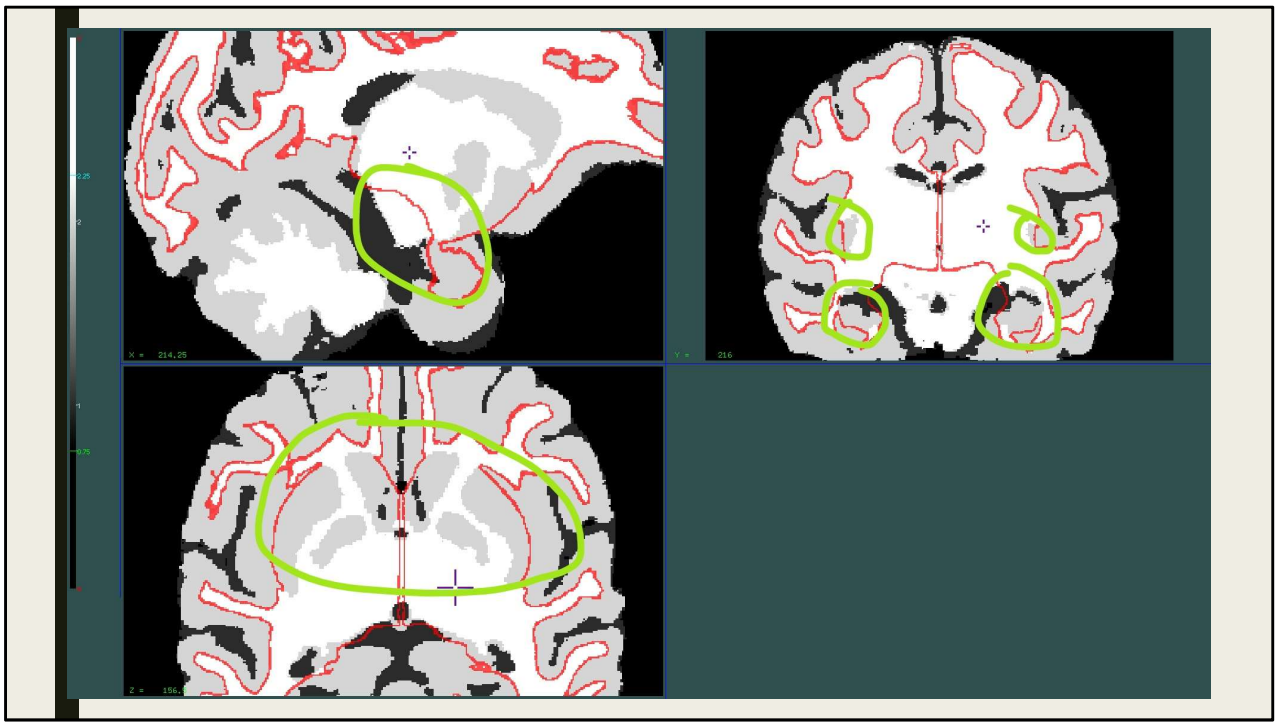
Outline

- Background
- Setup
- Methods
- Progress
- Discussion
- Acknowledgements

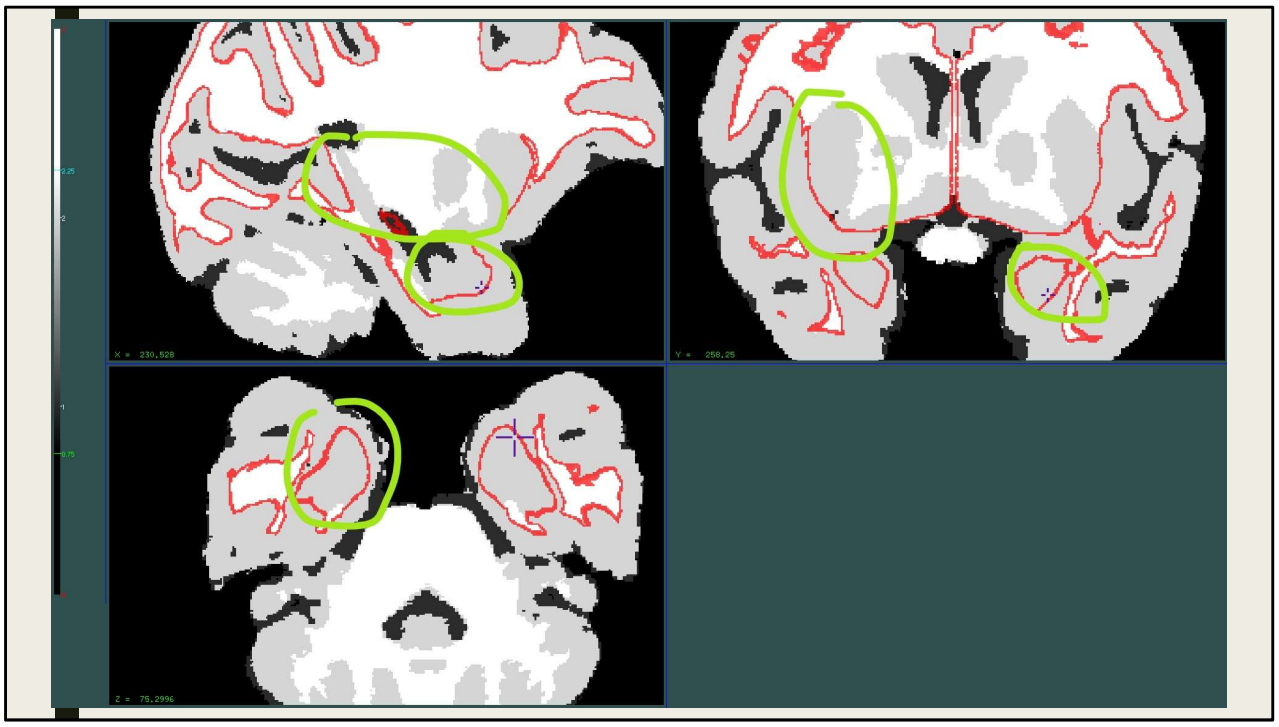
the focus of this presentation is going to be on white matter first and then we'll take a short look at the grey matter surface as well
We run the CIVET pipeline and pause it at certain steps in order to replace some files:
The partial volume effects (pve)
The skull mask
The subcortical structures

White Matter Surfaces

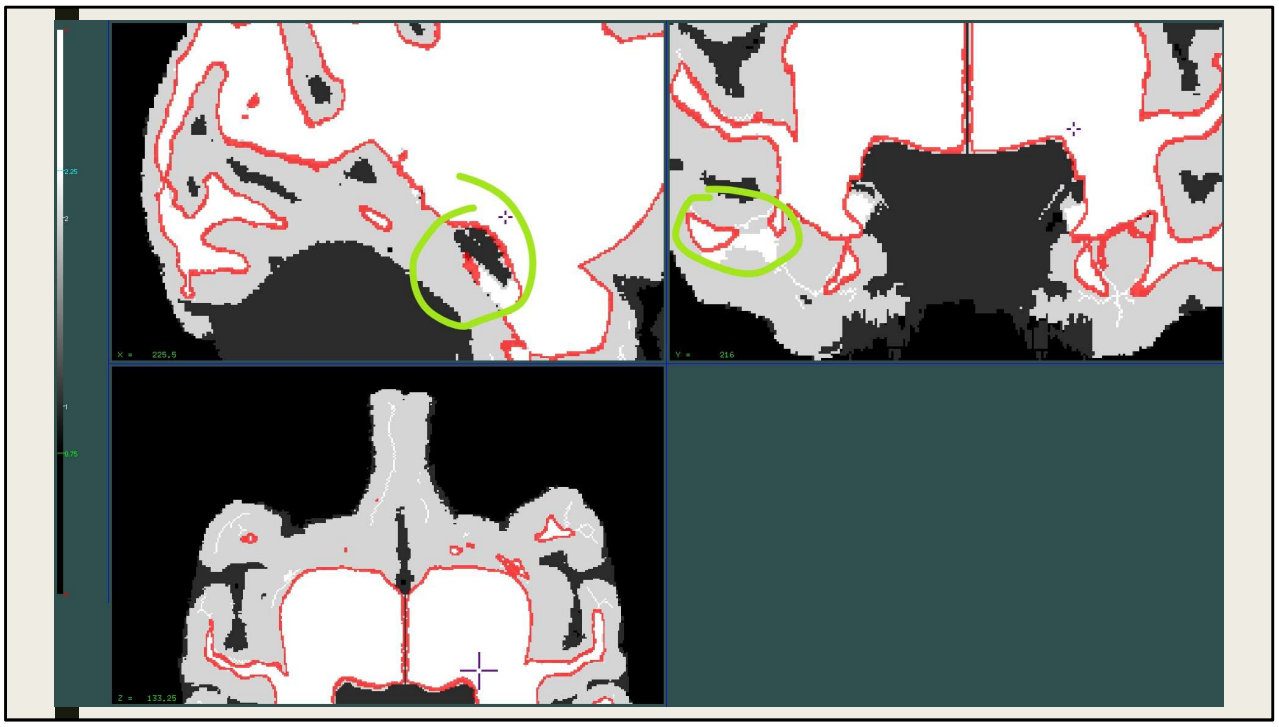
First we'll look at the white matter surfaces



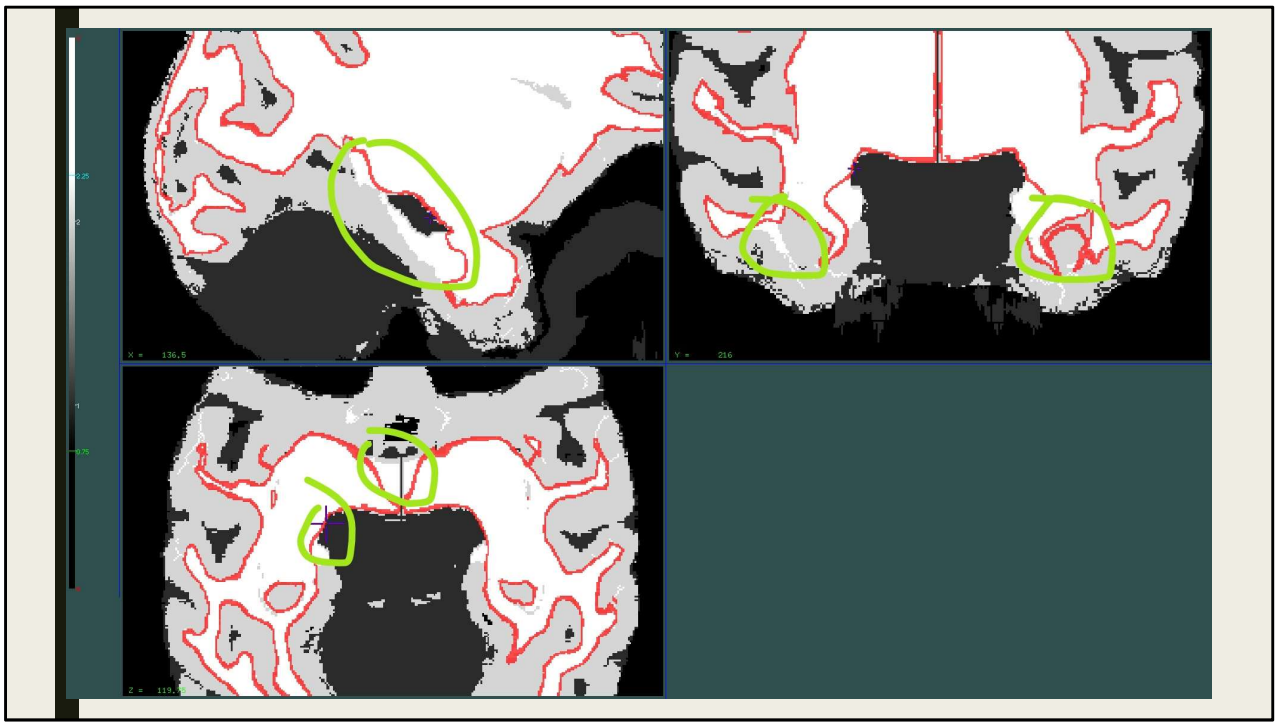
For the next few slides I'll be talking through early stage testing
This first run was run with the options to not calibrate white matter
We see some overestimation in the inferior regions of the brain and some underestimation right above that (1)(2)
There's also some wrong surface area near the ventricles (3)



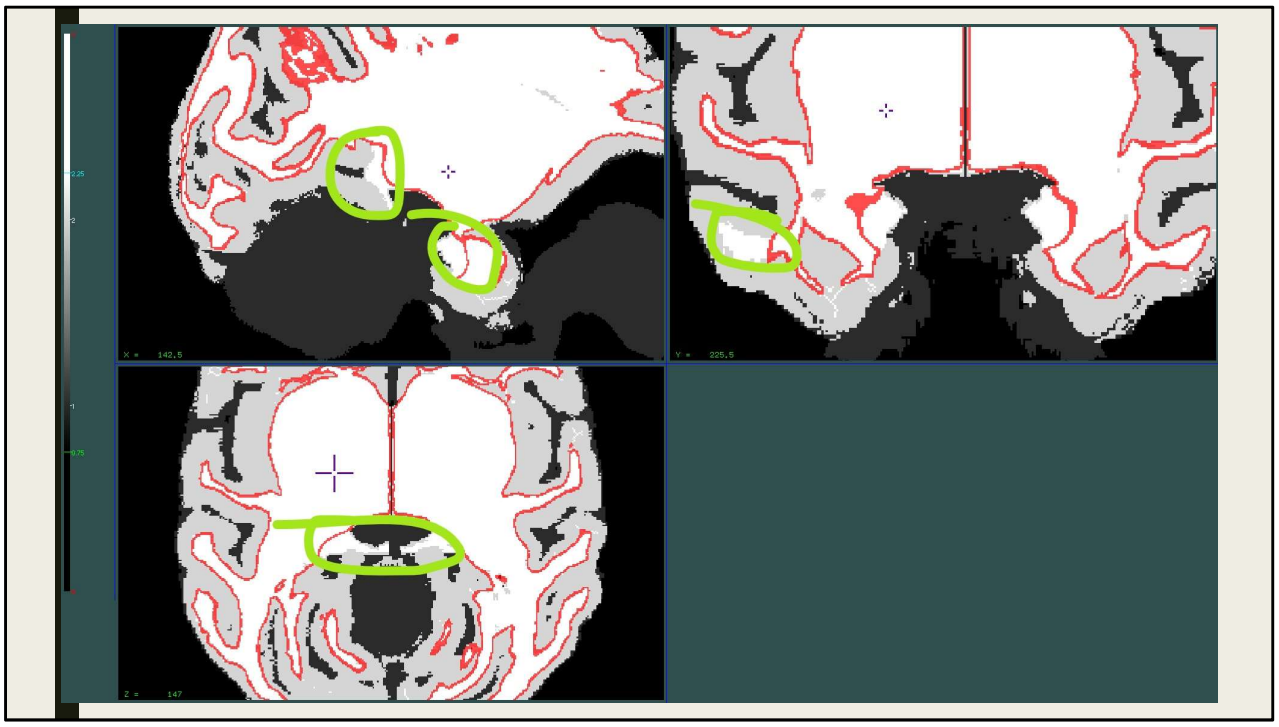
This run is with the option to correct the pve set
There’s similar problems in the inferior lobe and the ventricle areas



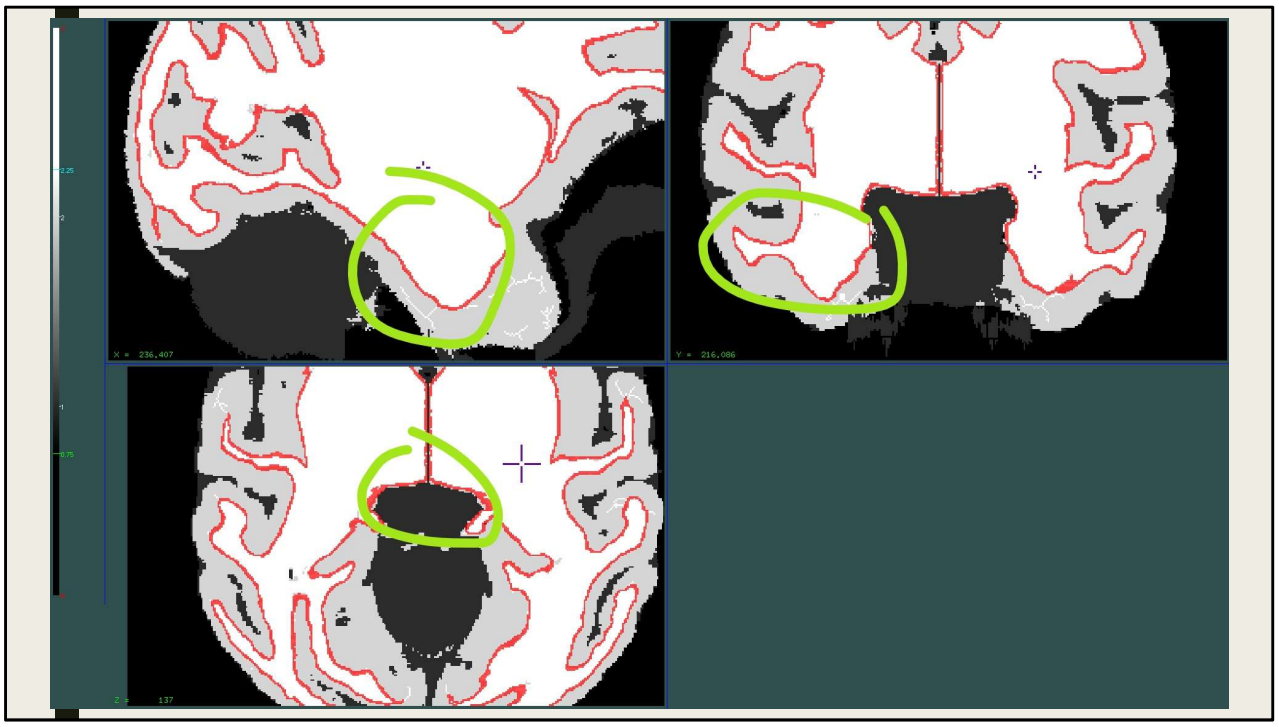
The next few slides are more goal oriented towards certain problems that I'll point out. This run was done after getting a new T1 image that was NU-corrected, this and all following test cases have both the option to not calibrate the white matter and to correct the pve as well as a different method of creating the pve images that we replace.
The white matter surface looks much better in the problematic regions before but it comes with it's own problems as you can see the white matter still doesn't cover some of the areas in the inferior region and near the temporal lobe very well



We decided to add in a csf and wm skeleton
We also masked the interior csf in the third ventricle as white matter
As you can see the white matter surface still has problems fulling extending in the hippocampus region and near the temporal lobe
Some new problems arose near the inferior region of the frontal lobe



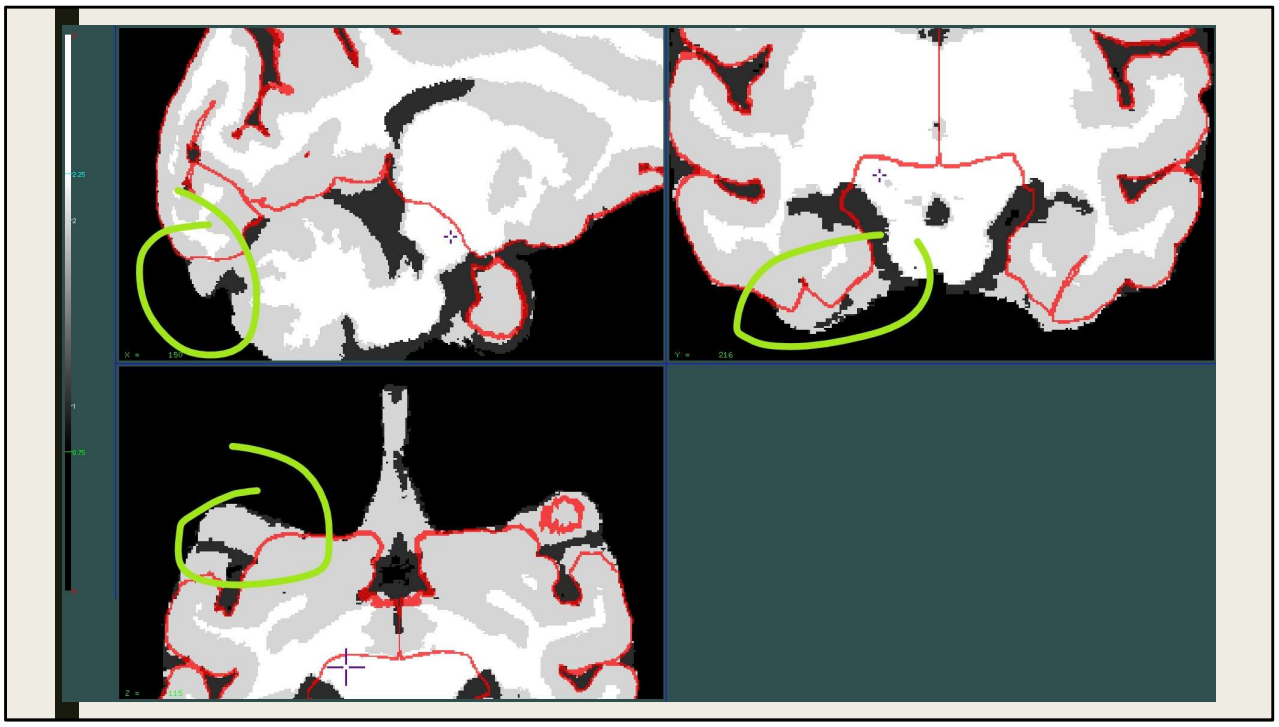
This one was run with all the same options and adaptations as above but with a new subcortical structure file transformed into the talaraich space
It looks slightly better in the back of the hippocampus region as well as the right temporal lobe, but as you can see it still as problems in the left temporal lobe as well as towards the middle of the brain near the back of the third ventricle
As you can see in the previous three slides the hippocampus area is not being included in the calculation of the white matter surface. We found that the way to correct that was to replace the skull mask with a new one that I made as well as changing the hippocampus, currently being represented as grey matter, into white matter



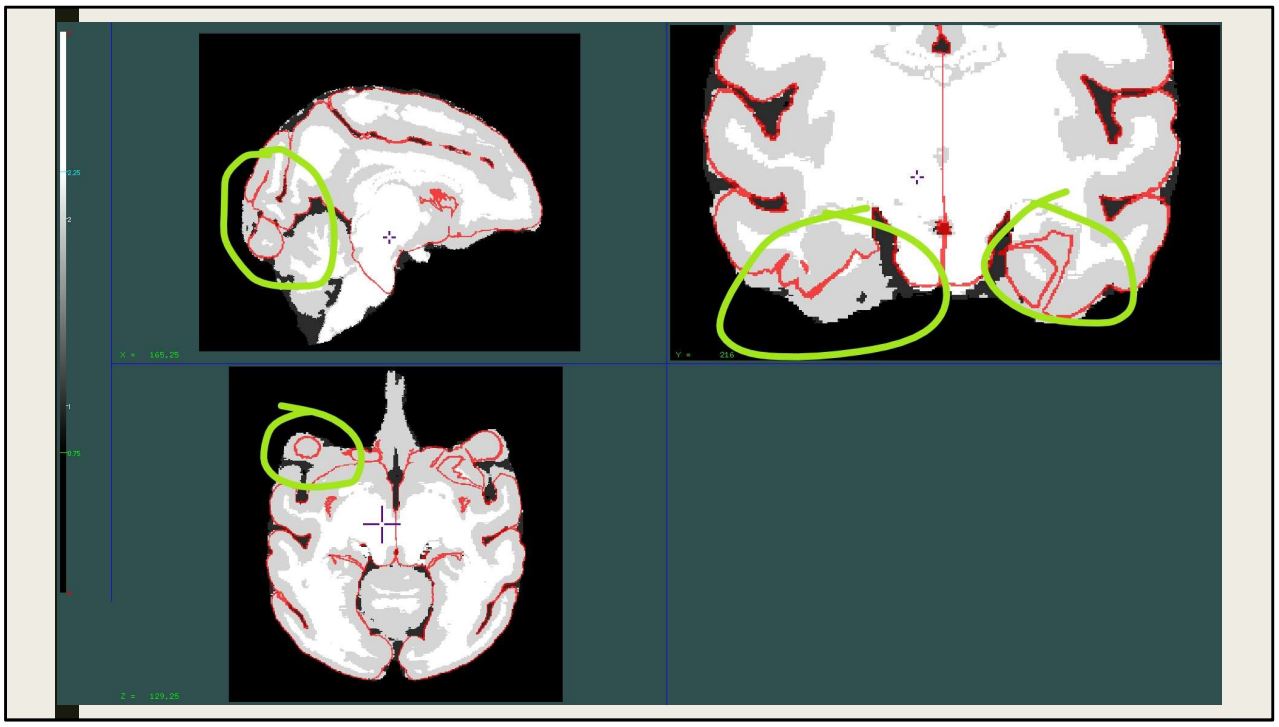
In this run through I added a triply dilated hippocampus into the white matter
As you can see the areas I pointed out before are much better

Grey Matter Surfaces

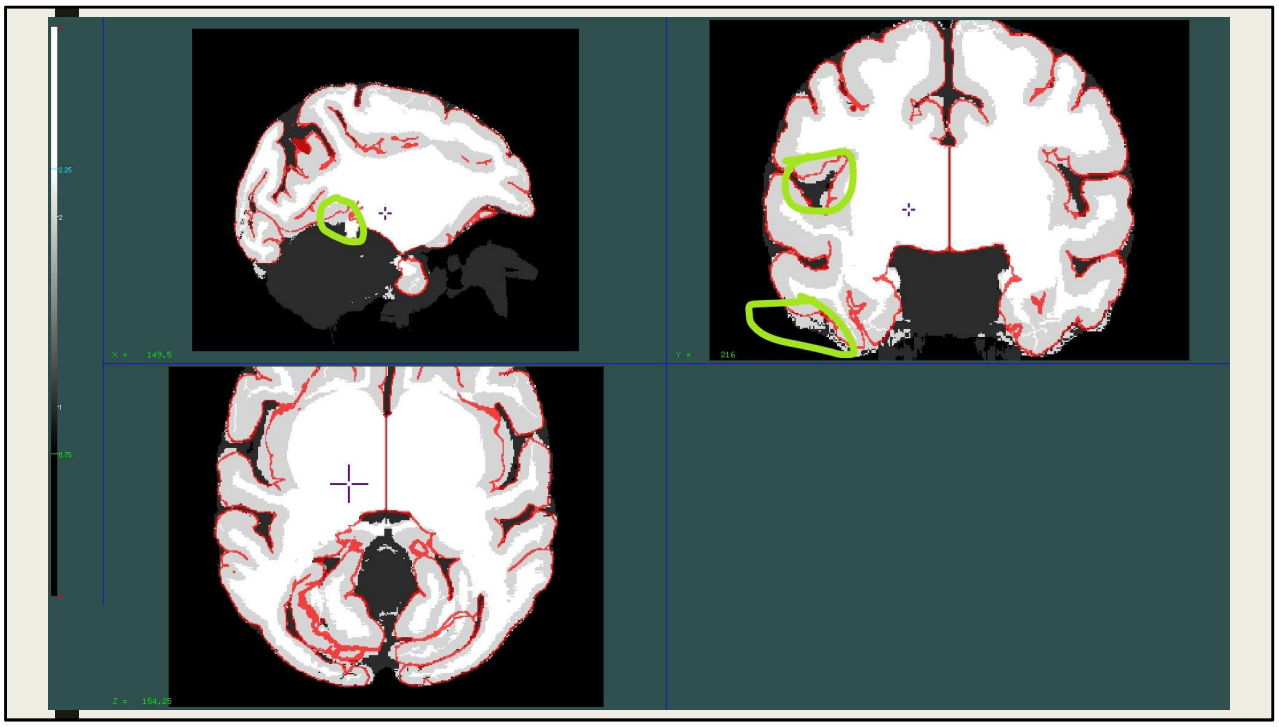
Now it’s time to move on to grey matter



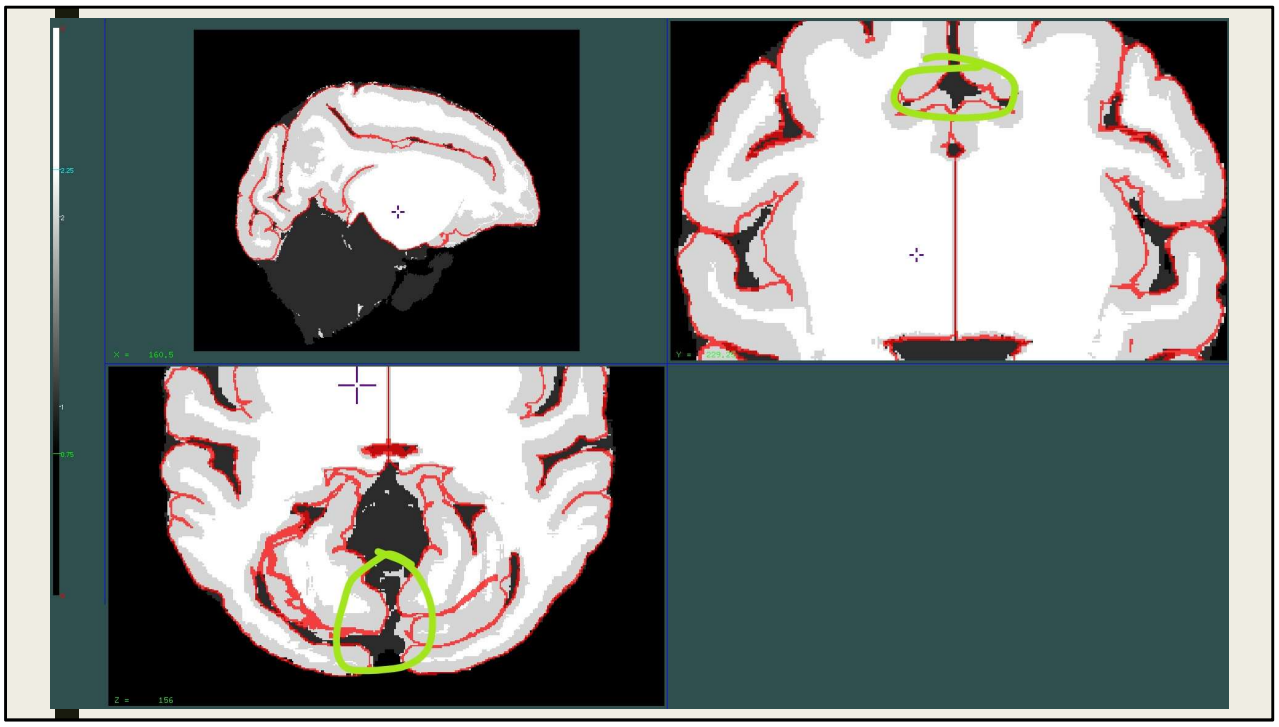
This is one of the image sets from early stage testing, this was run with the option to not calibrate white matter and correct the pve as are all the following runs shown
The grey matter doesn't fully extend the occipital lobe nor in the inferior region of the frontal lobe or hippocampus region



This run was done with the internal csf of the third ventricle masked as white matter The occipital lobe now expands more in the lower region but not so much towards the back, the frontal lobe and hippocampus still have a similar error



Run with the NU-corrected image, the internal csf masked out as wm, wm and csf skeletons added in, subcortical structures masked as white matter, and the cerebellum masked out as csf
There is still not enough extention in the grey matter and it's underestimated in the inferior regions as well as the parietal lobe still



This final run was done with most of the same options as above, this time there was no wm skeleton added and the hippocampus, with a triple dilation, was also masked in as white matter
The errors are similar but the occipital lobe looks better
There's still underestimation in the superior regions and the middle region of the parietal lobe

Outline

- Background
- Setup
- Methods
- Progress
- Discussion
- Acknowledgements

Next Steps

- White Matter
- Grey Matter

We’re satisfied with the current white matter surface generated
With the grey matter moving forward we’re trying to fully extend it by doing a double run and editing the Laplacian vectors
My current direction with the Laplacian is lowering the smoothness vectors which allows for more expansion

Acknowledgements

- Dr. Sun Hyung Kim
- Dr. Martin Styner