THE UNIVERSITY OF SYDNEY

School of Information Technologies
Faculty of Engineering & IT

ASSIGNMENT/PROJECT COVERSHEET - INDIVIDUAL ASSESSMENT

Unit of Study: COMP 5424 - Information Technology in Biomedicine

Assignment name: Assignment 2 - MIC Module Development

Tutorial time: 5:00 pm Monday

Tutor name: Crane Yu

DECLARATION

I declare that I have read and understood the *University of Sydney Academic Dishonesty and Plagiarism in Coursework Policy*, and except where specifically acknowledged, the work contained in this assignment/project is my own work, and has not been copied from other sources or been previously submitted for award or assessment.

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I realise that I may be asked to identify those portions of the work contributed by me and required to demonstrate my knowledge of the relevant material by answering oral questions or by undertaking supplementary work, either written or in the laboratory, in order to arrive at the final assessment mark.

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Task A: Medical Image Enhancement (MIE)

As required, three different filters were applied on the brain image, including smoothing, sharpening, and edge detection.

The Original image is shown below:

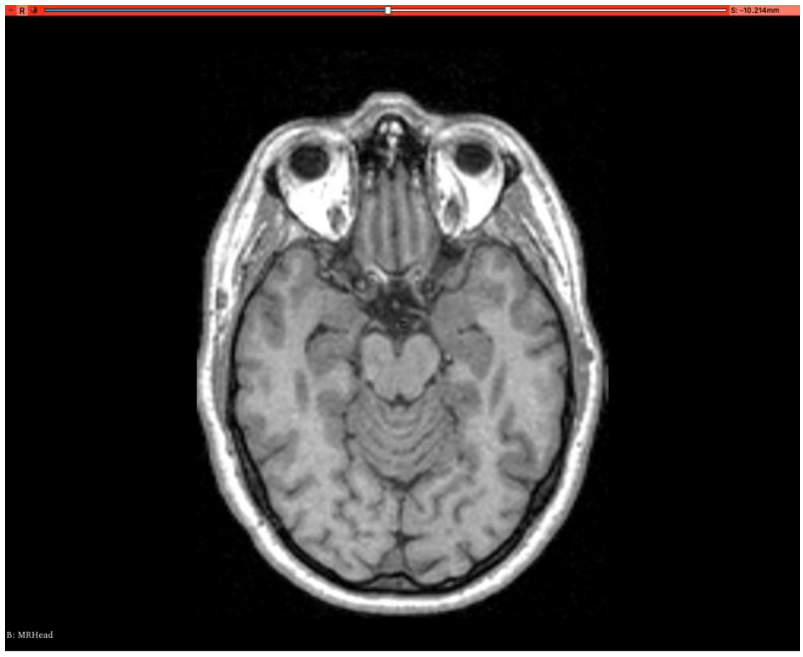

Figure 1: Original Brain Image

Smoothing

The filter provided by tutor is Box filter, it can blur the image like shown in below:

We can see from Figure 2, the image overlayed with 50% original image has more clear edges than the one without overlaying.

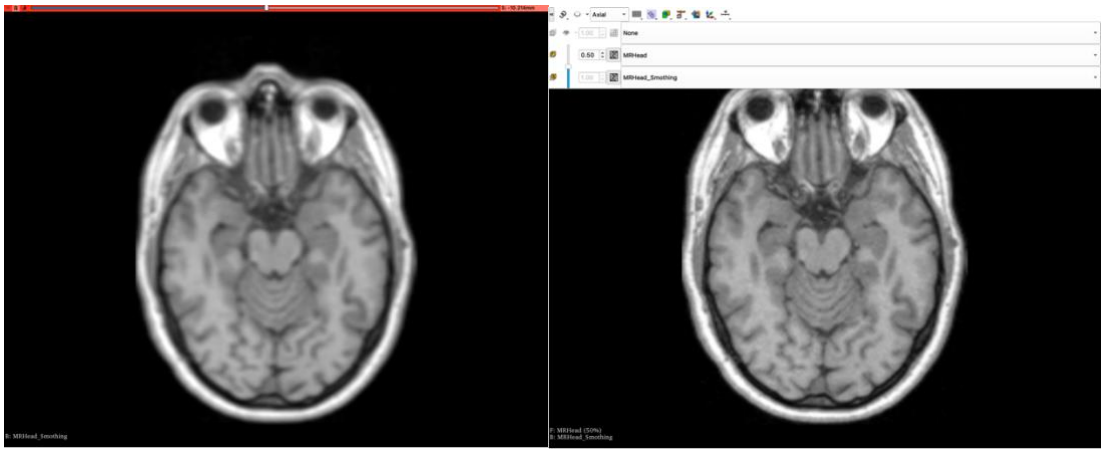

Figure 2: Brain Image with Smoothing Filter –

(a) without overlaying of original one; (b) with 50% overlaying of original one

Sharpening

The sharpening filter emphasises the differences in adjacent pixel value and will make the image looks more vivid and sharpen become more vivid. The following figures shows four different sharpening filters I've tried in this section.

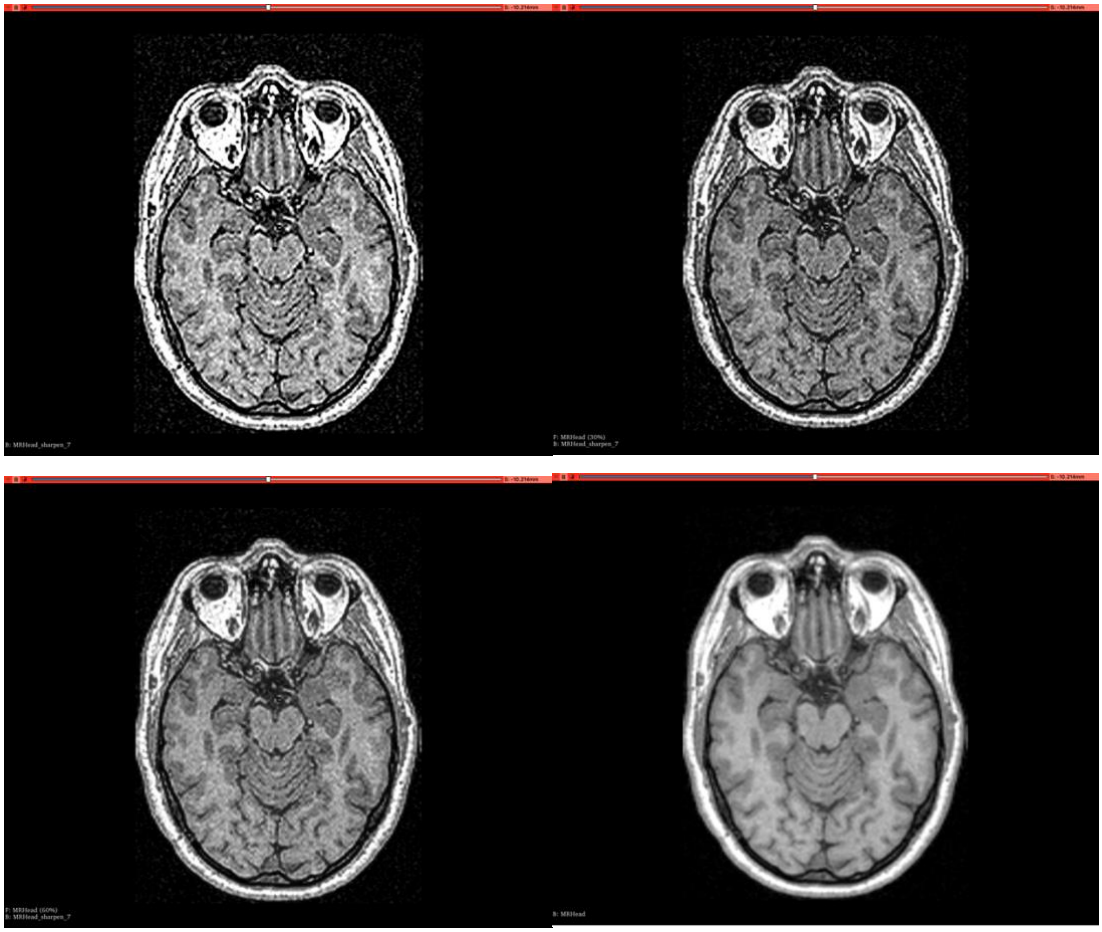

Figure 3: Sharpened Brain Images (order: up to down, left to right)

The matrix I've used for this sharpen filter is shown below:

```
[[[0, 0, 0], [0, -1, 0], [0, 0, 0]],
[[0, -1, 0], [-1, 7, -1], [0, -1, 0]],
[[0, 0, 0], 0, -1, 0], [0, 0, 0]]]
```

As required by the sharpen filter, the sum of all weights inside the matrix should be 1. So I made some changes based on the Wikipediae 2D version matrix, to make sure the filter can work efficiently on 3D version. Figure 3 show the different percentage of original overlaying on the sharpened images (0%, 30%, 60%, 100%). We can see that the images become more blur as the percentage of overlaying increasing.

Edge Detection

Edge detection is similar with sharpening, they all emphasise the edges of the image. We can view the sharpening matrix as the sum of edge detection matrix and identity matrix. I've also made a little change based on the Wikipediae 2D version matrix and the filtered images as shown below:

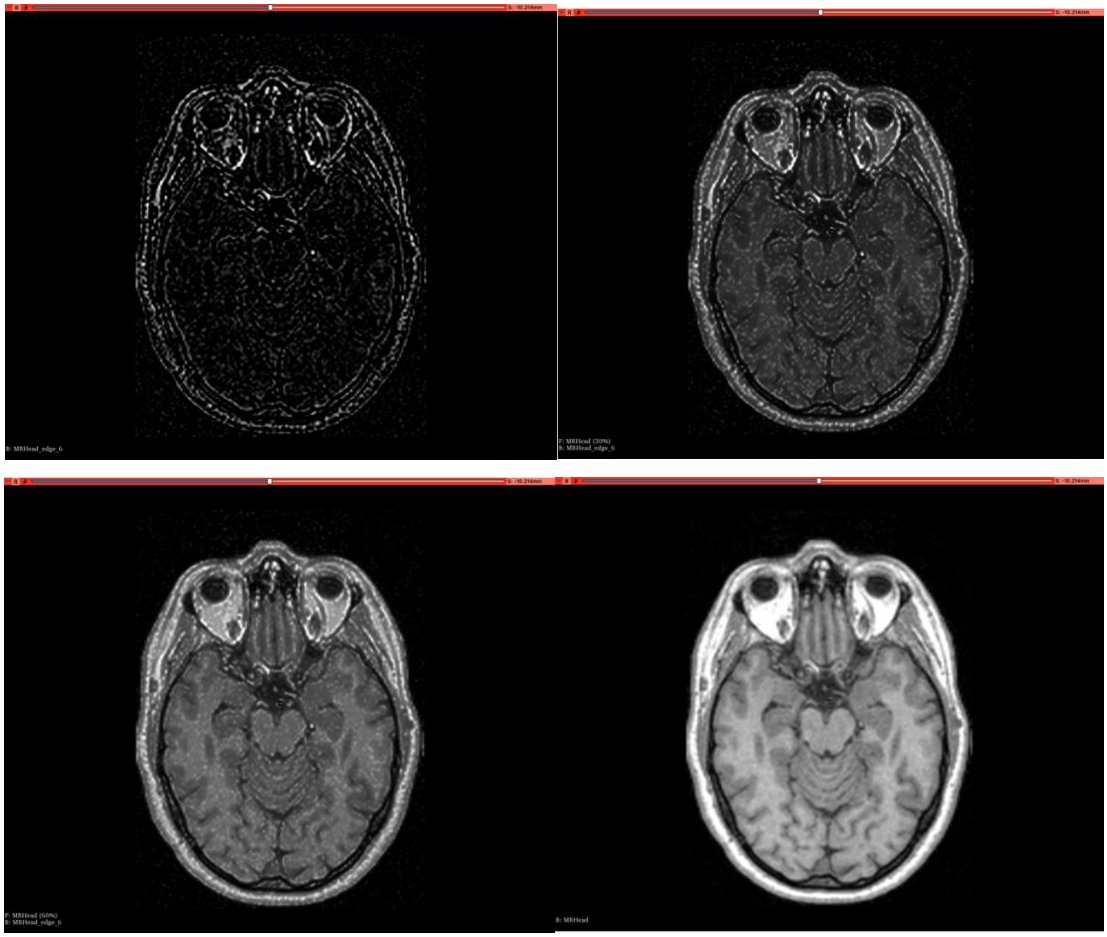

Figure 4: Brain Images with Edge Detection Filter (order: up to down, left to right)

The matrix I used in this matrix is:

```
[[[0, 0, 0], [0, -1, 0], [0, 0, 0]],
[[0, -1, 0], [-1, 6, -1], [0, -1, 0]],
[[0, 0, 0], 0, -1, 0], [0, 0, 0]]]
```

The sum of all weights inside the edge matrix should be 0, so the filtered image is darker than before. In fact, only the detected edges are bright. Figure 5 show the different percentage of original overlaying on the edged images (0%, 30%, 60%, 100%). It is clear to see that the brightness of images become higher, and the edges of the images become more blur.

Task B: Medical Image Segmentation (MIE)

After loading the brain tumour image, choose yellow slice in which tumour has a clear boundary. And adjust the R value to around -5mm to have a clearer boundary of tumour, as shown in Figure 5.

Figure 5: Brain Tumour with Seed Area (Green dot)

After modifying and reloading the MIE module, try to apply the module by default (20, 20), and the images shown as below.

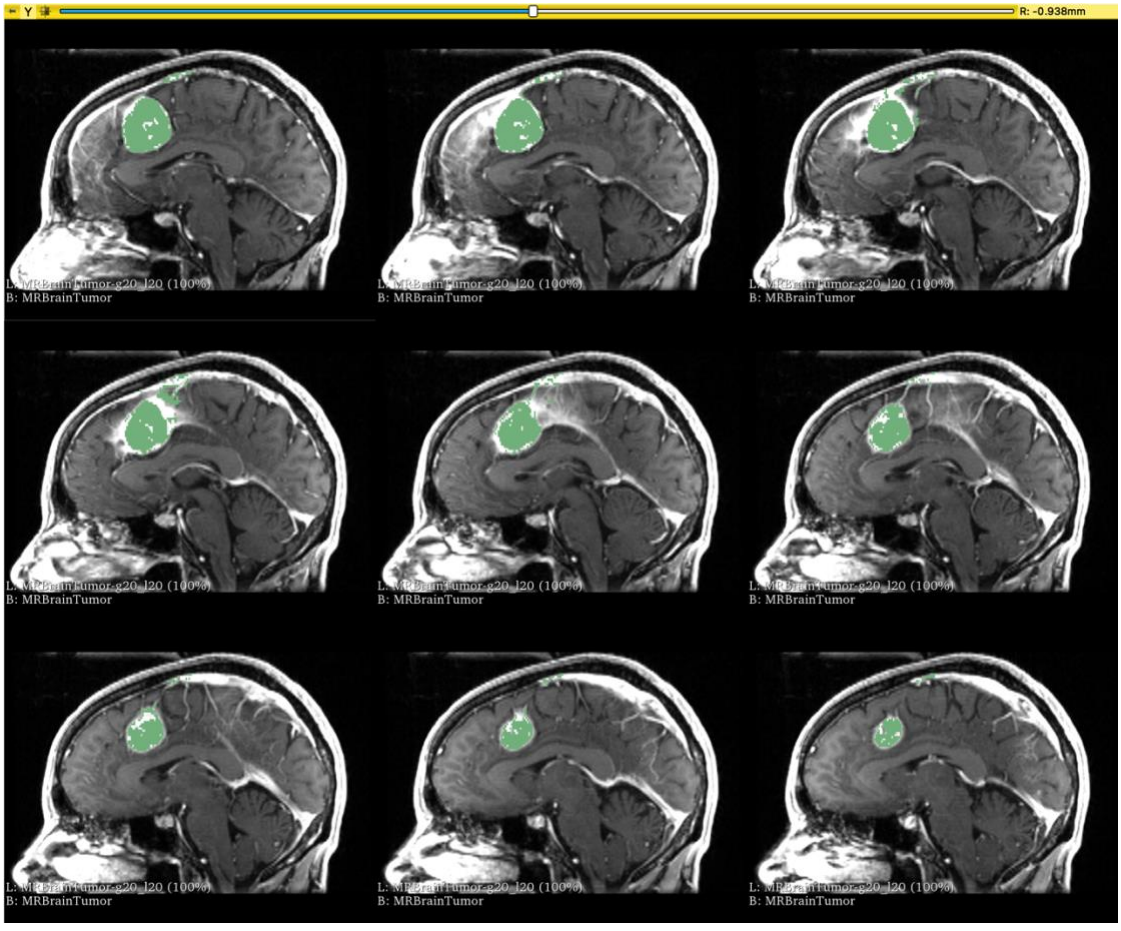

Figure 6: 3x3 views of (Global, Local) – (20, 20)

Parameter Tuning

We can see from Figure 6 that the performance of default value is not very good. To be specific, the false positive is too high, which means the algorithm label the negative to positive. So, I tried to decline the parameters to narrow down the checking range.

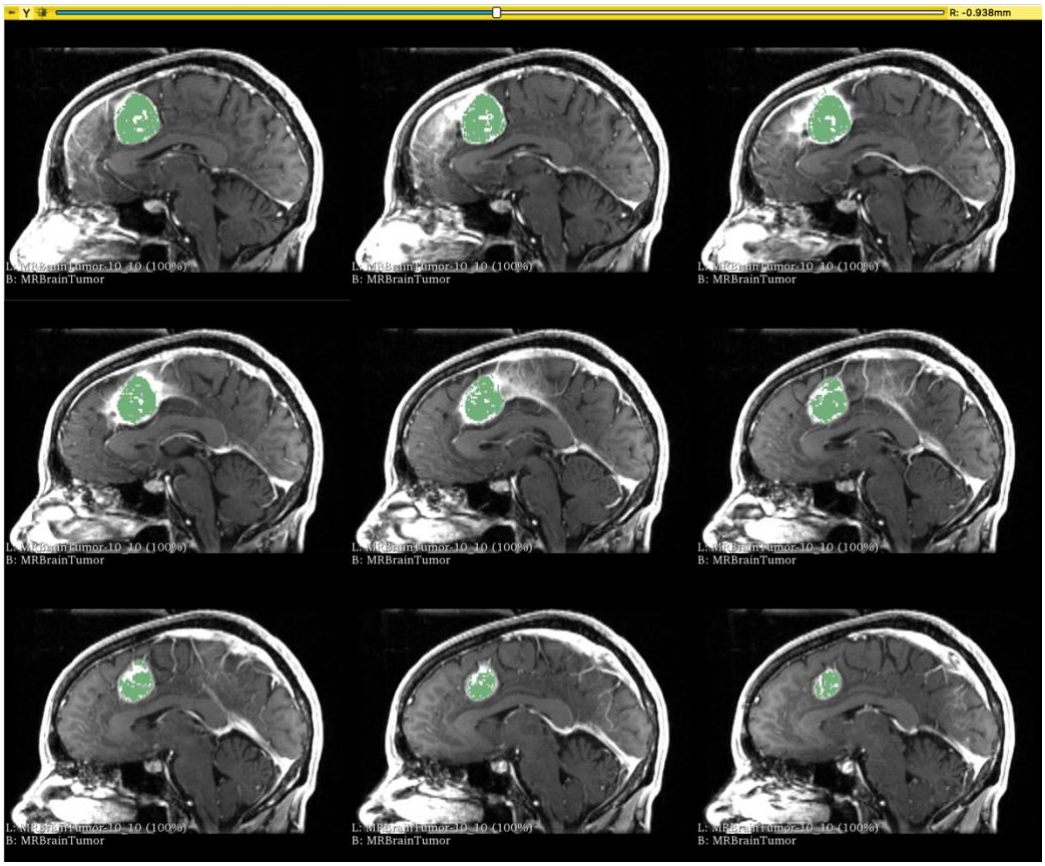

Figure 7: 3x3 views of (Global, Local) – (10, 10)

Result of (10, 10): the false positive declines, but the false negative part increased. So tried to apply another two value sets: (8, 8) and (12, 12). For (8, 8), although the false positive almost disappear, the false negative part increase. In the contrary, the (12, 12) has higher false negative but lower false positive. It seems like, if we want to have a better performance, different parameter sets need to be set and the values should be in range [8, 12].

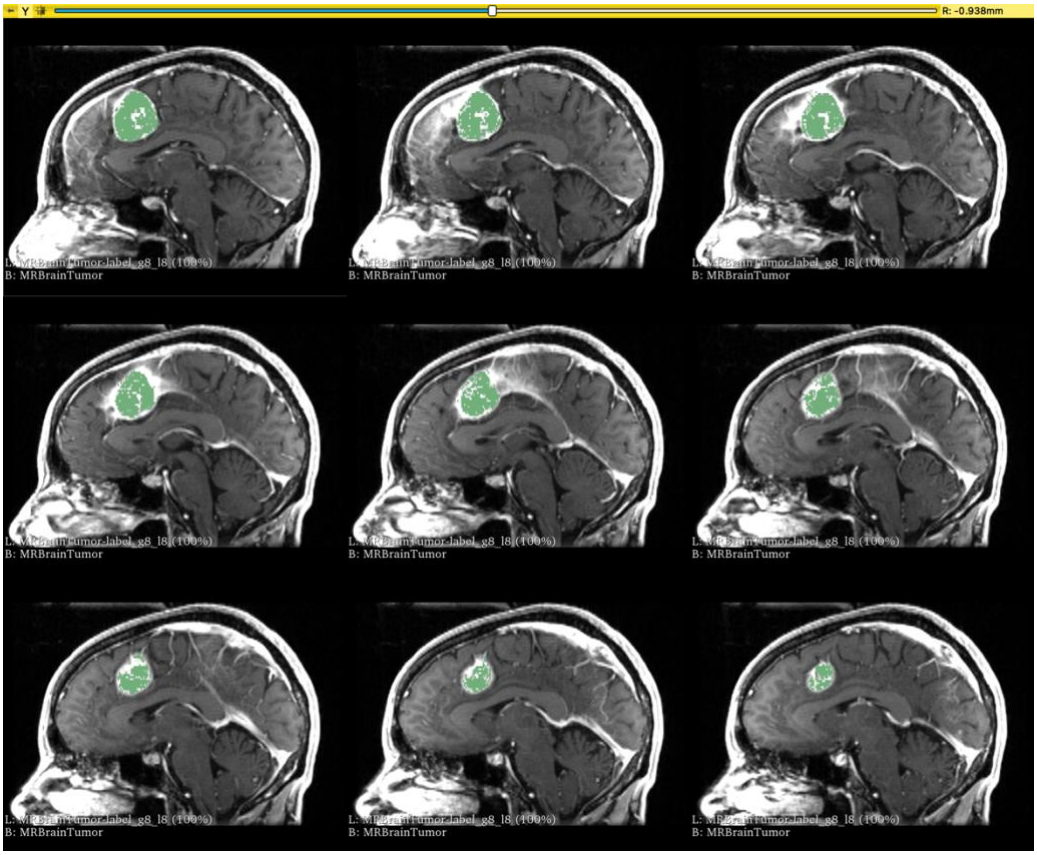

Figure 8: 3x3 views of (Global, Local) – (8, 8)

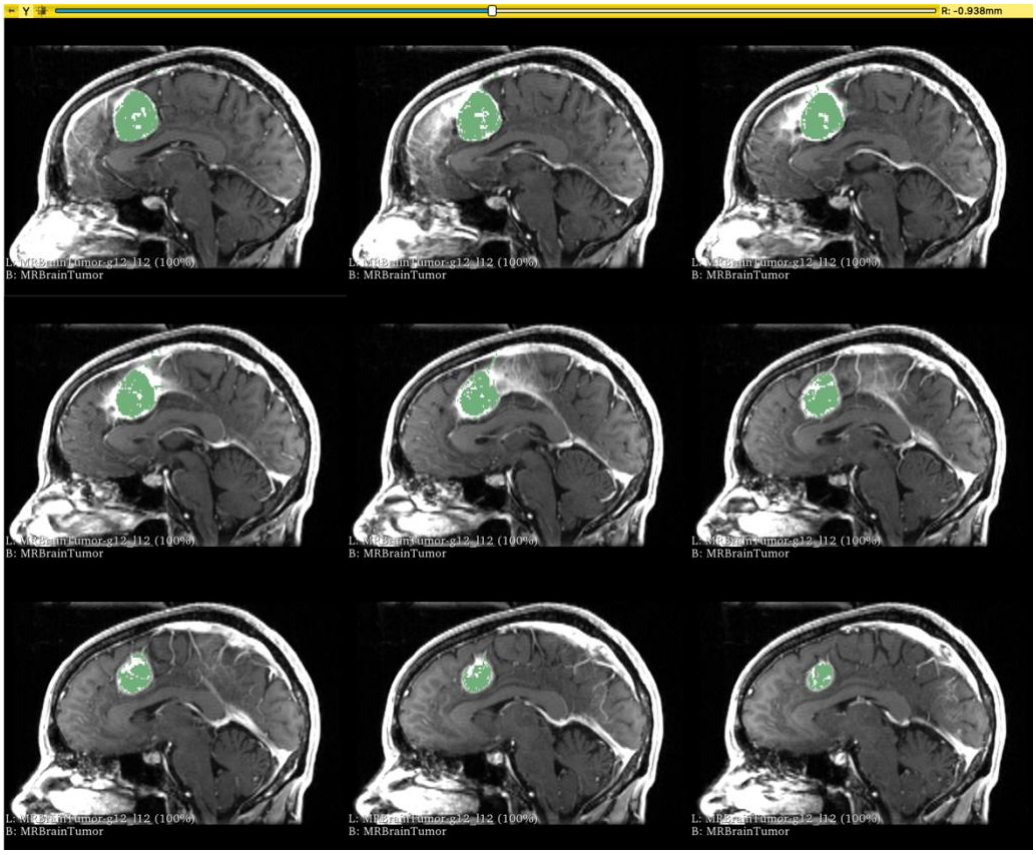

Figure 9: 3x3 views of (Global, Local) – (12, 12)

After trying several possible sets, I think the value set (11, 9) has the best performance

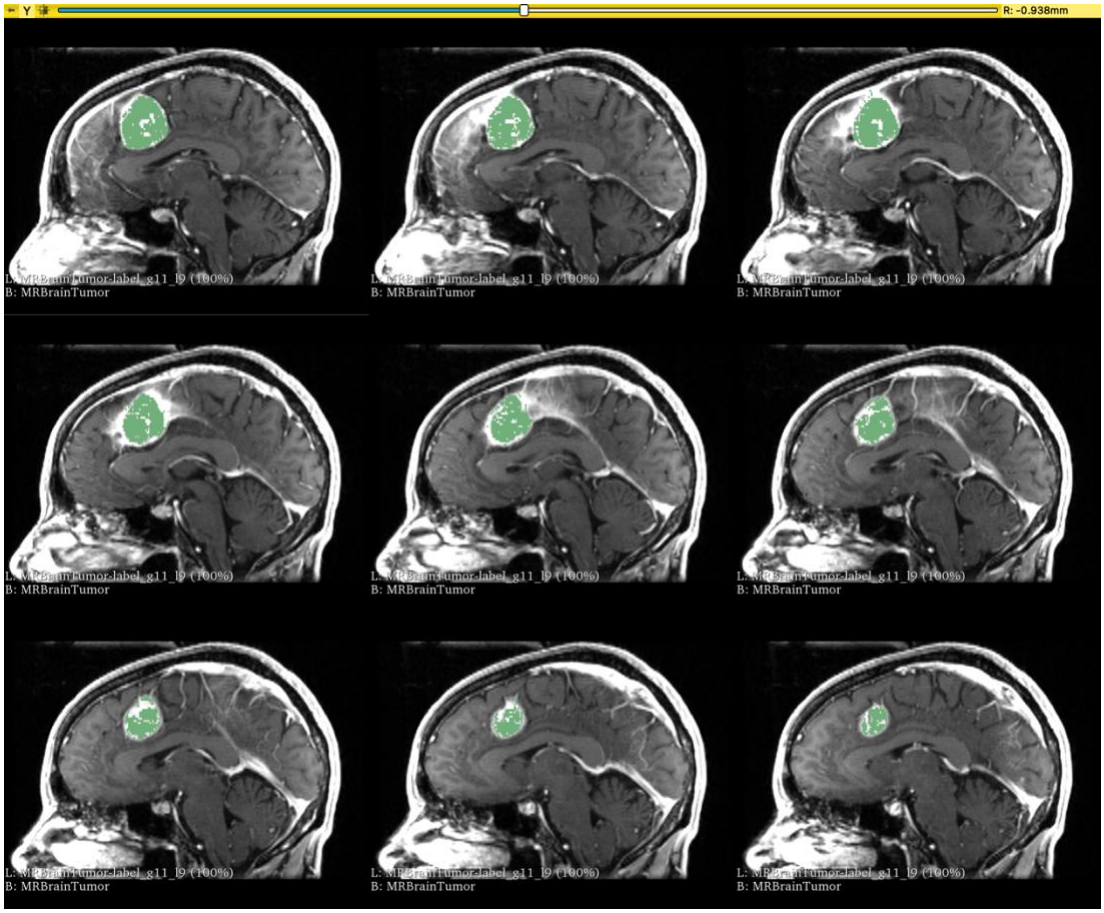

Figure 10: Best Parameter Set: 3x3 views of (Global, Local) – (11, 9)

And part of the process part can be seen from Figure 11.

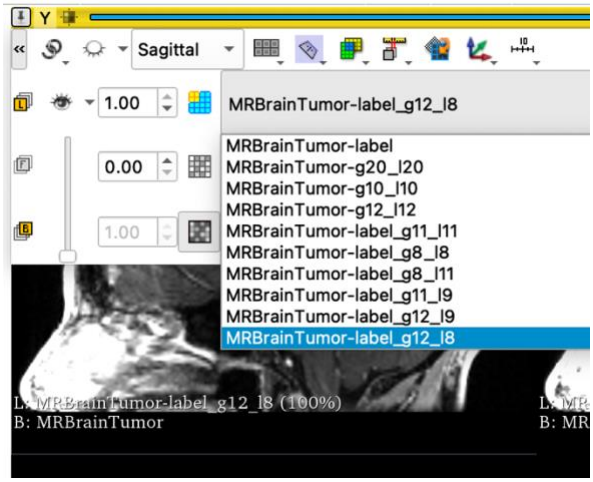

Figure 11: Part of Parameter Sets I've tried

Task C: Medical Image Registration (MIR)

The two paths I've used in this task are displaying below.

Path 1: Applying affine registration from Subject B T2 → Subject B T1, and then applying non-linear registration from above registration → Subject A T1.

Path 2: Applying non-linear registration from Subject B T2 → Subject A T2, and then applying affine registration from above registration → Subject A T1.

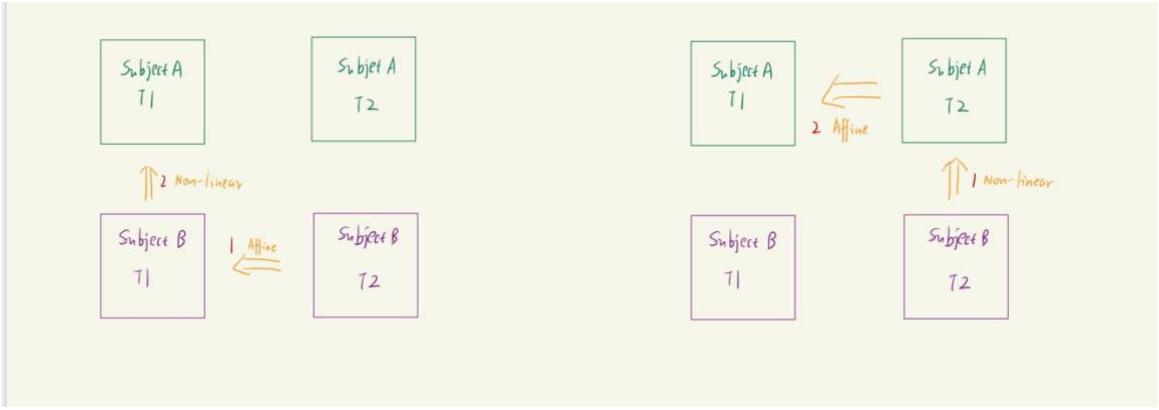

Figure 12: Two Registration Paths

The two registration images and their paths in slicer are shown below:

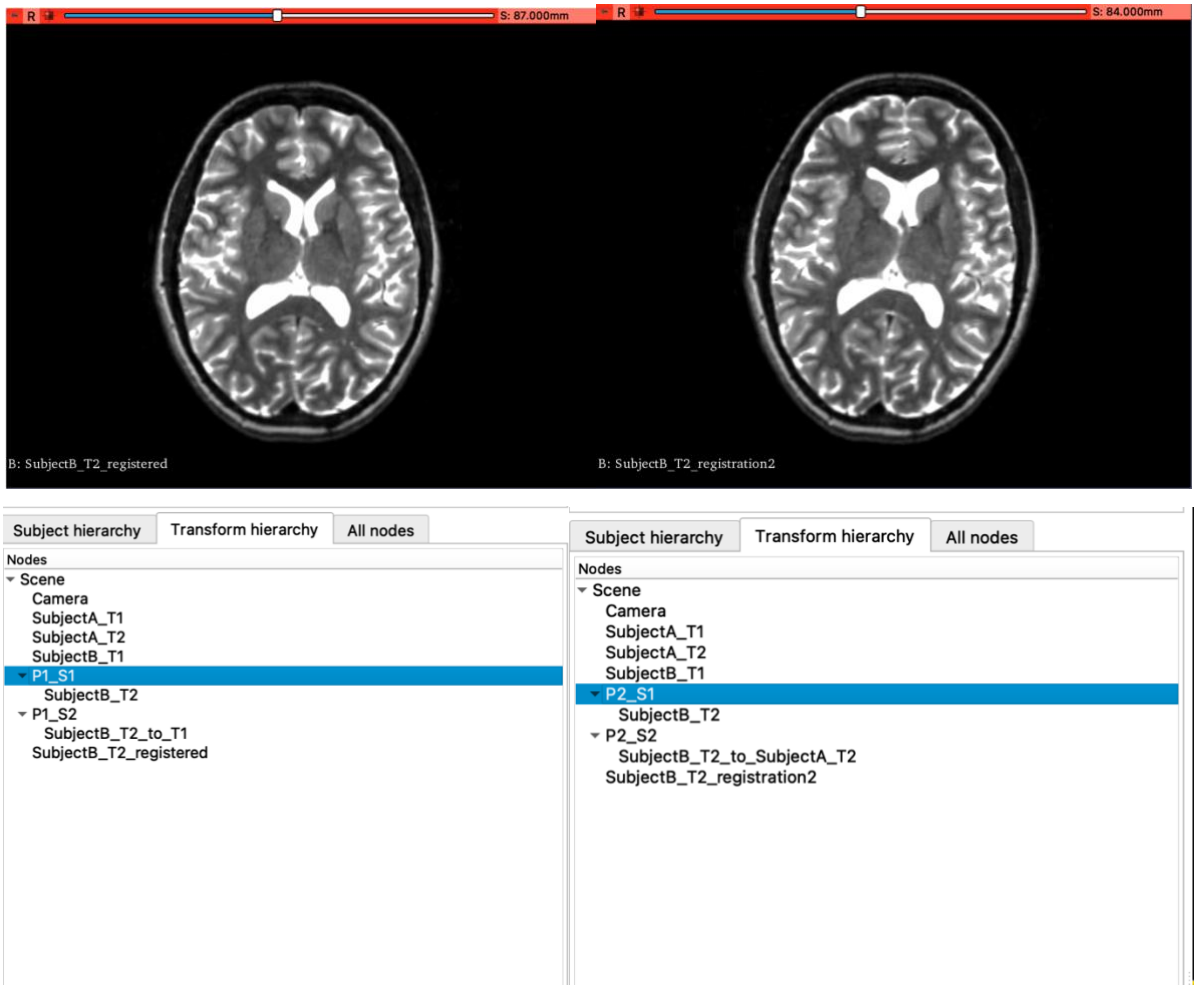

Figure 13: Registration Images using Two Registration Paths

After overlaying the Subject A T1 on the two registrations, I think the registration 1 has the better result, which align the ventricle better in both images.

The best registration path is: Subject B T2 → Subject B T1 → Subject A T1.

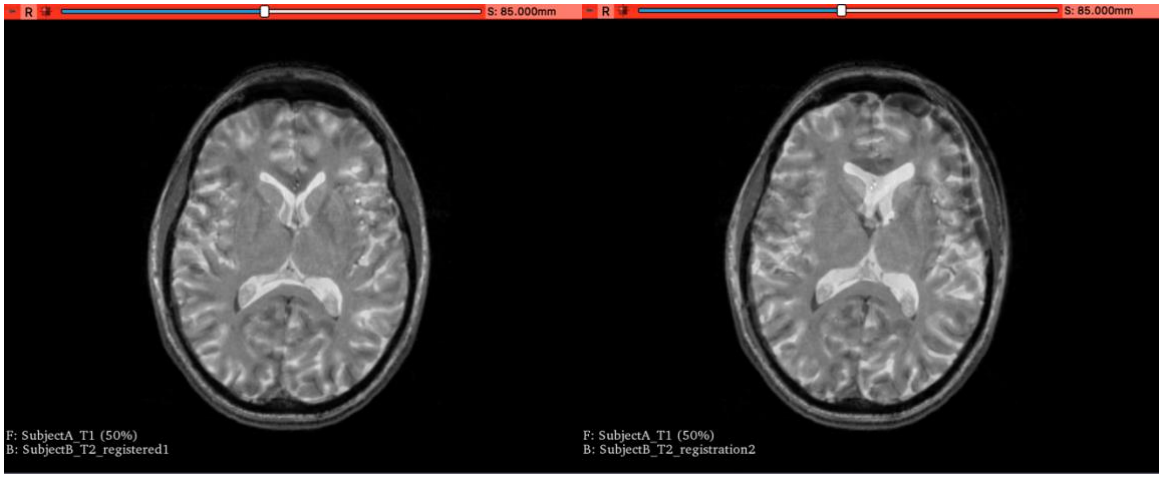

Figure 14: Two Overlaying Registrations