

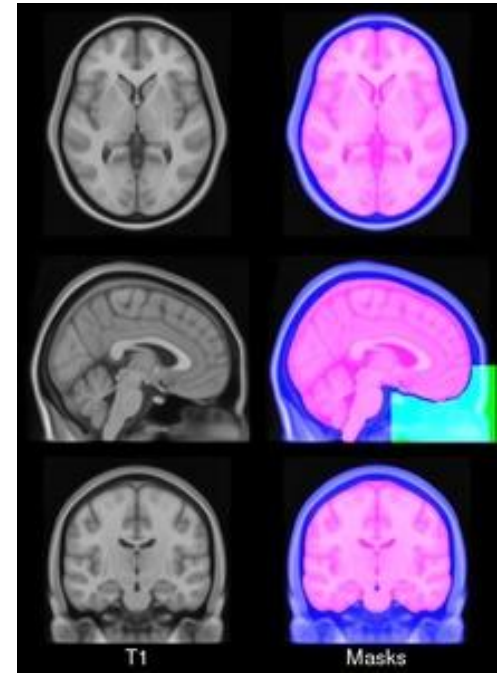
Register Brain CT scans to MRI Template

Po-Yu Kao

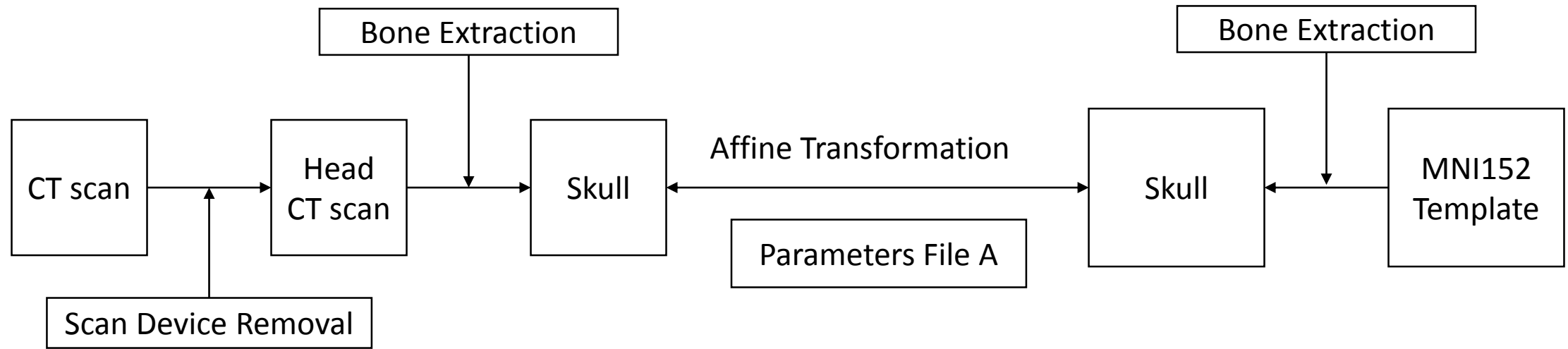
Advisor : Professor Banjunath

Motivation

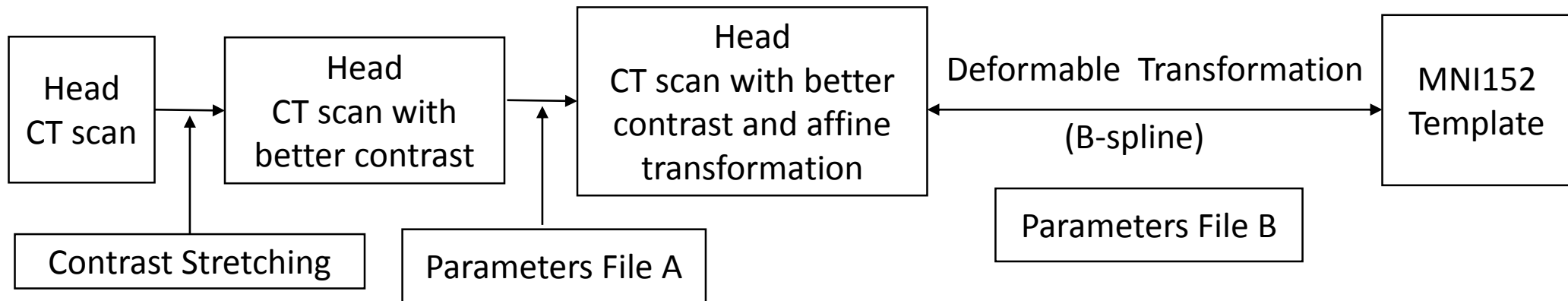
- Map hematomas on CT scan to a MRI template
- Voxel-based lesion-symptom mapping
- CT image → T1-weighted image → MNI152 template
- CT image → MNI152 template (more complicate due to difference in modality and shape of the head)
- Template:
 - [MNI ICBM152 non-linear 6th generation symmetric Average Brain Stereotaxic Registration Model](#)



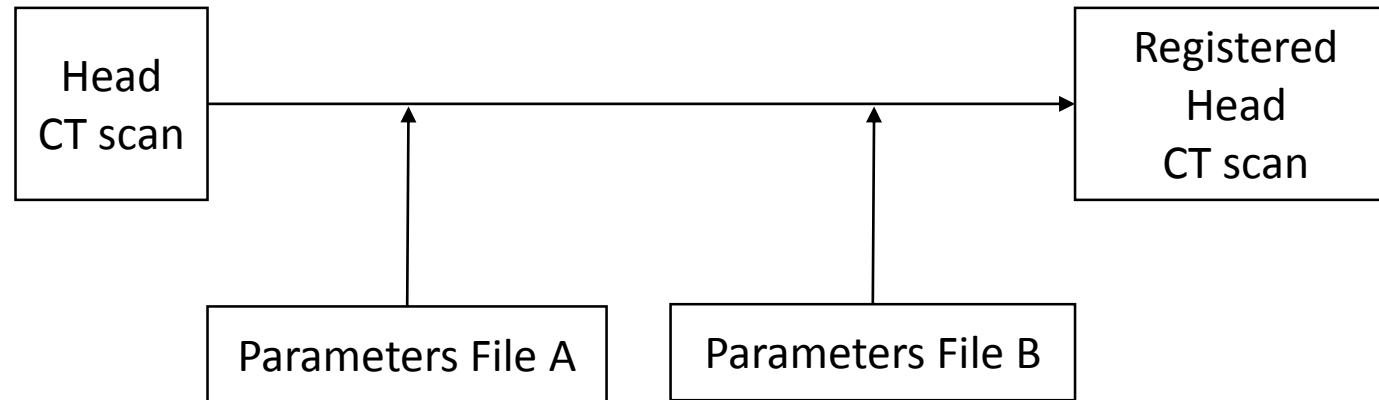
Workflow



Workflow



Workflow



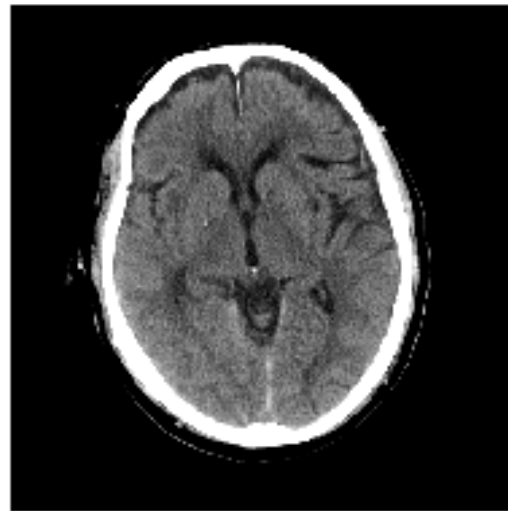
CT Scan Device Removal

- Keep the pixel whose intensity value is larger than 250
- Region Comparison: Keep the largest region among this scan



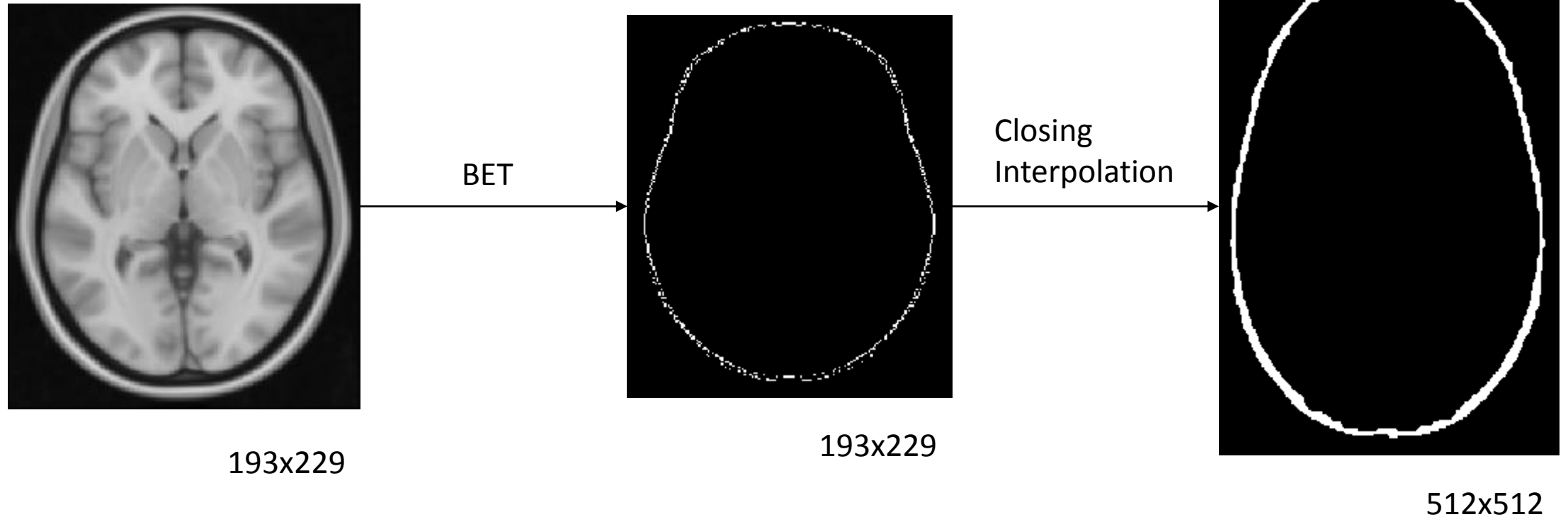
Skull Extraction of CT scans

- [illegible]



Skull Extraction of MRI template

- BET(Brain Extraction Tool) deletes non-brain tissue from an image of the whole head.



Ref: S.M. Smith. Fast robust automated brain extraction. *Human Brain Mapping*, 17(3):143-155, November 2002

Ref: M. Jenkinson, M. Pechaud, and S. Smith. BET2: MR-based estimation of brain, skull and scalp surfaces. In *Eleventh Annual Meeting of the Organization for Human Brain Mapping*, 2005.

Affine Transformation between CT and MRI(1/3)

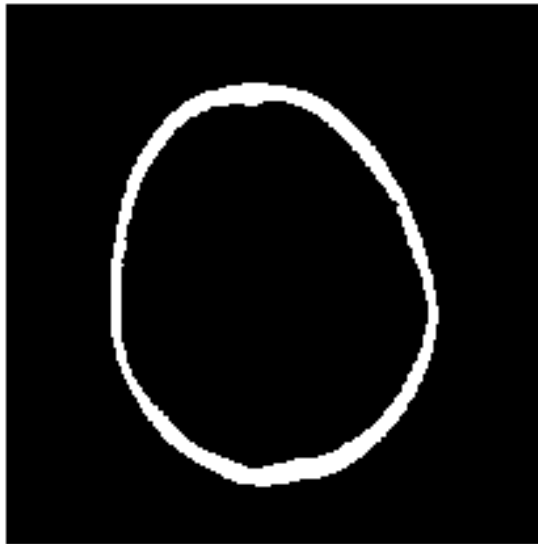
- elastix
- Fixed Image: MRI skull template
- Moving Image: CT skull scans
- Settings of elastix: a multi-resolution approach with four resolutions, the Advanced Mattes Mutual Information metric, and the Adaptive Stochastic Gradient Descent optimizer.



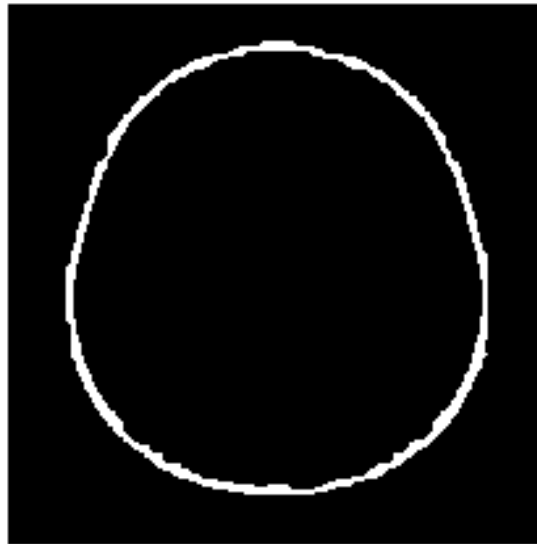
Affine Transformation between CT and MRI(2/3)

- Parameter Files: 12 parameters for 3-D affine transformation
- Running Time: 21 seconds for 28 slices

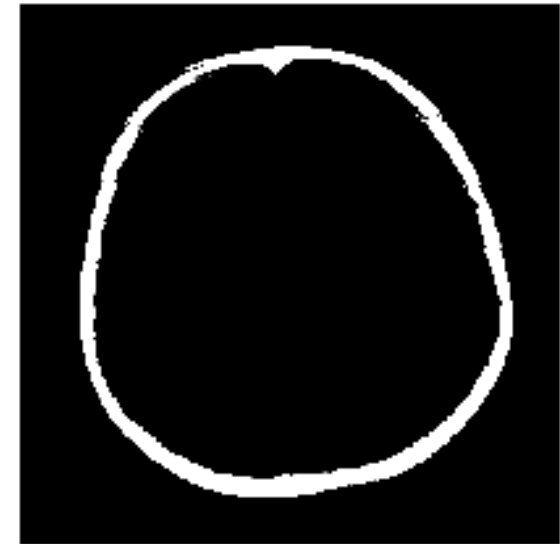
Moving Image



Fixed Image



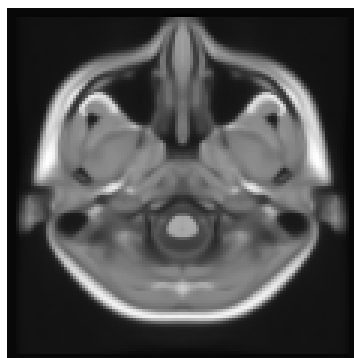
Result Image



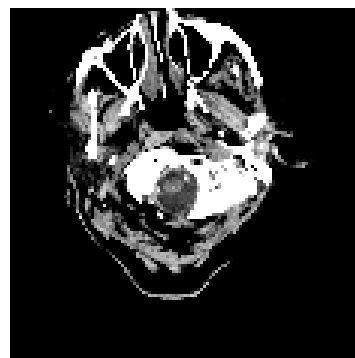
Affine Transformation between CT and MRI(3/3)

- Implement Affine Transformation on Head CT Scan
- `transformix -in patient_brain.nii -out C:\elastix\result_affinetransform -tp TransformParameters.0.txt`
- Running Time: 2 seconds for 28 images

Fixed Image



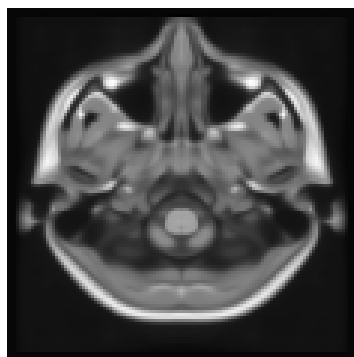
Moving Image



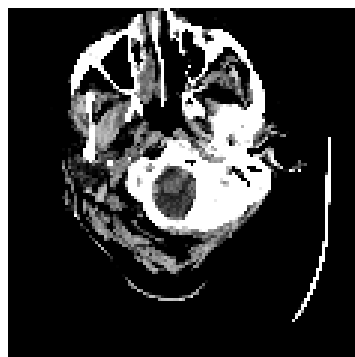
Result Image



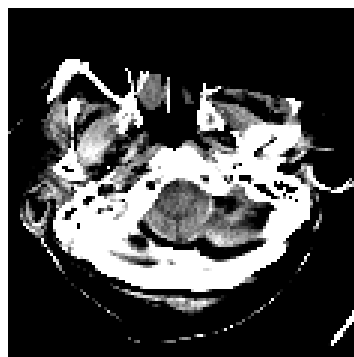
Fixed Image



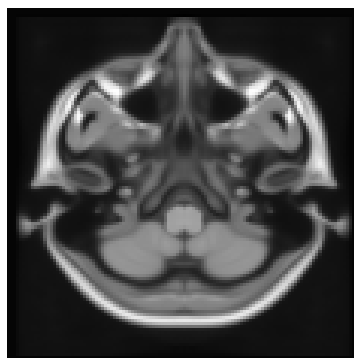
Moving Image



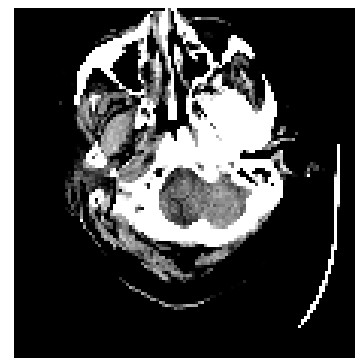
Result Image



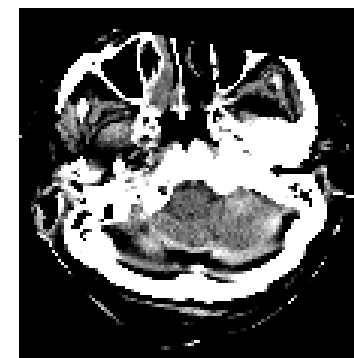
Fixed Image



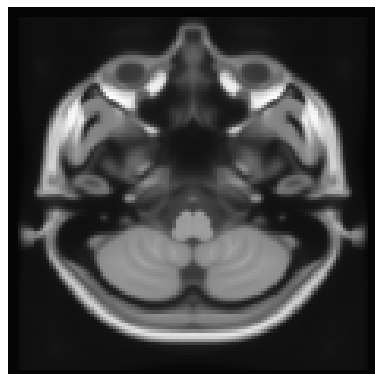
Moving Image



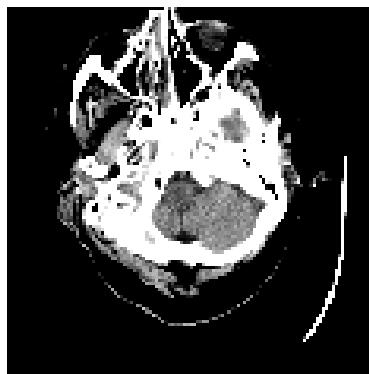
Result Image



Fixed Image



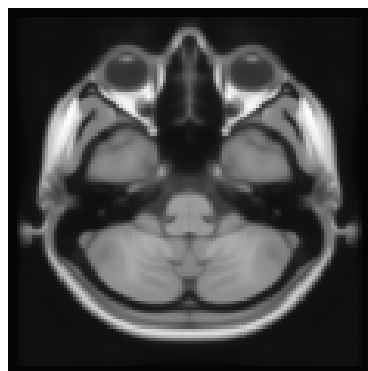
Moving Image



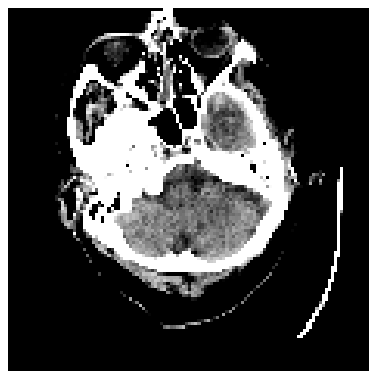
Result Image



Fixed Image



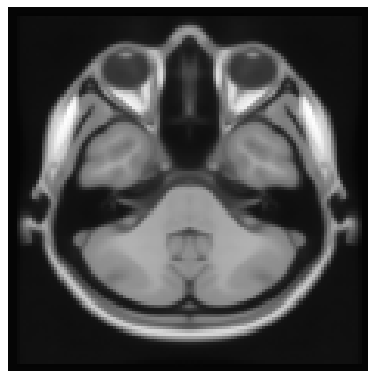
Moving Image



Result Image



Fixed Image



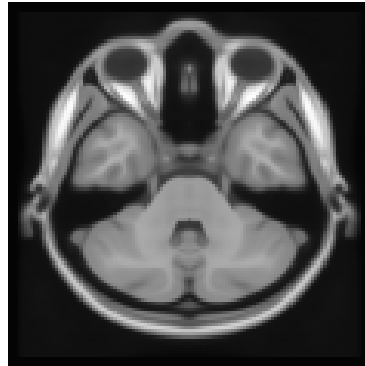
Moving Image



Result Image



Fixed Image



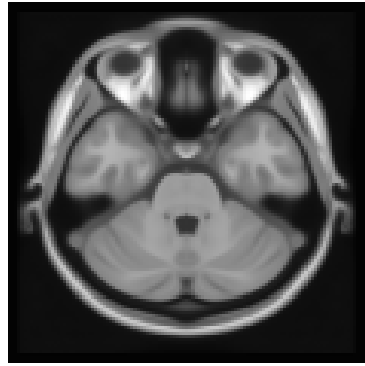
Moving Image



Result Image



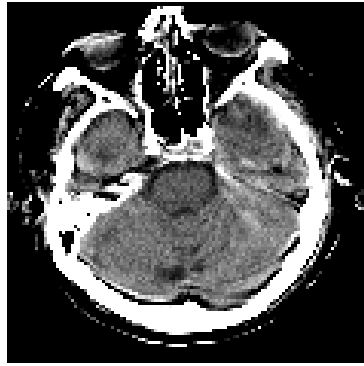
Fixed Image



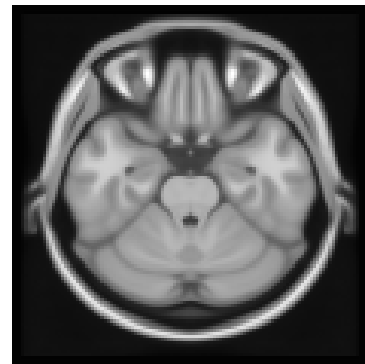
Moving Image



Result Image



Fixed Image



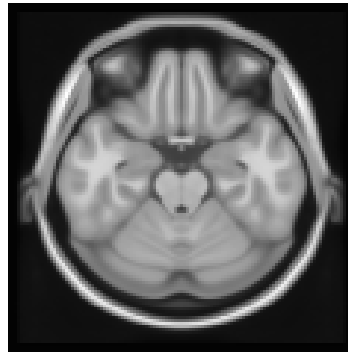
Moving Image



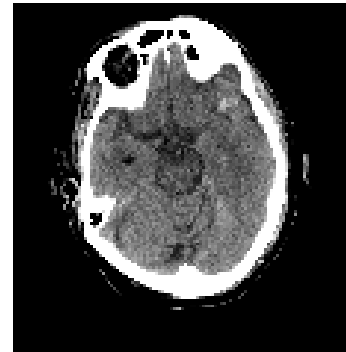
Result Image



Fixed Image



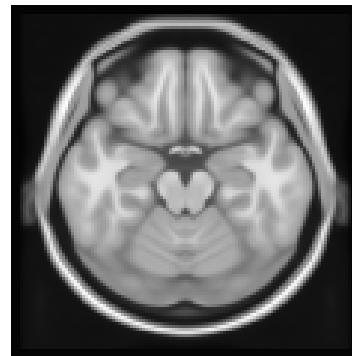
Moving Image



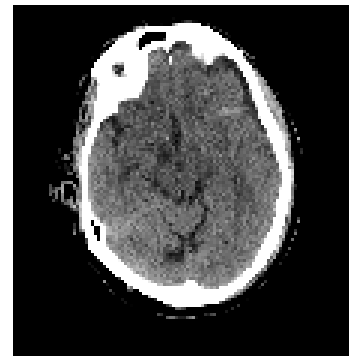
Result Image



Fixed Image



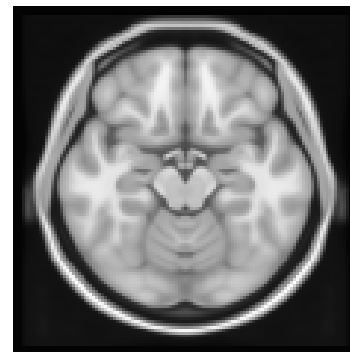
Moving Image



Result Image



Fixed Image



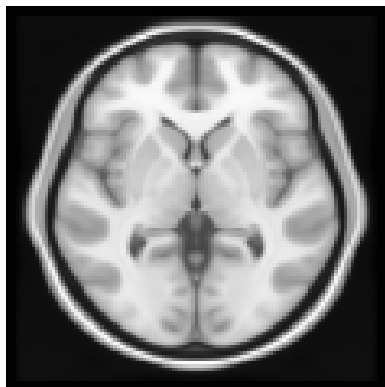
Moving Image



Result Image



Fixed Image



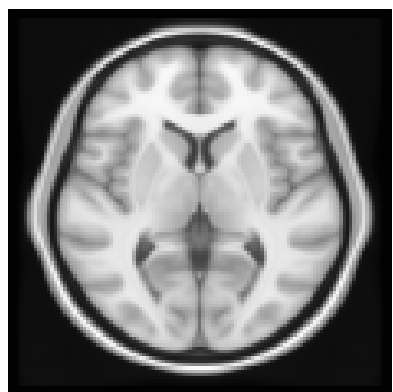
Moving Image



Result Image



Fixed Image



Moving Image



Result Image



Fixed Image



Moving Image



Result Image



Fixed Image



Moving Image



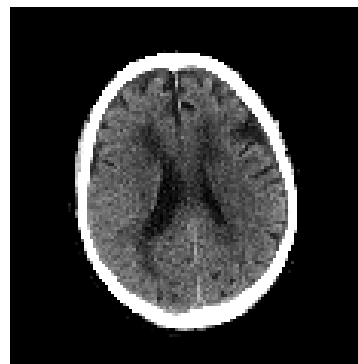
Result Image



Fixed Image



Moving Image



Result Image



Fixed Image



Moving Image



Result Image



Fixed Image



Moving Image



Result Image



Fixed Image



Moving Image



Result Image



Fixed Image



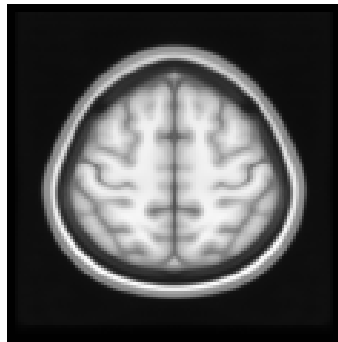
Moving Image



Result Image



Fixed Image



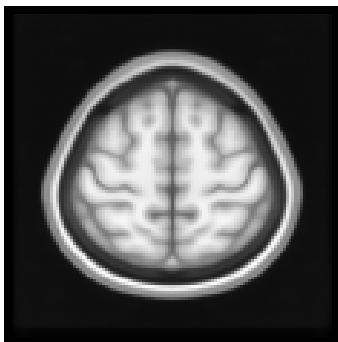
Moving Image



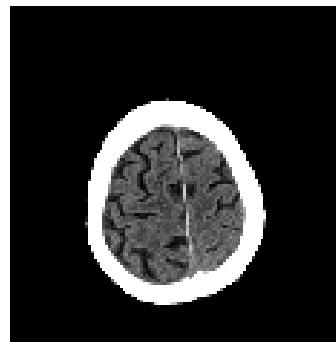
Result Image



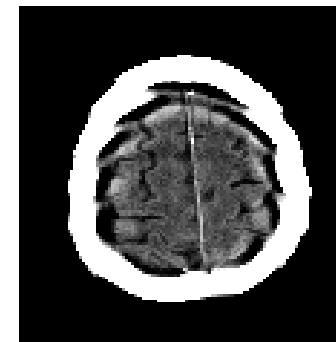
Fixed Image



Moving Image



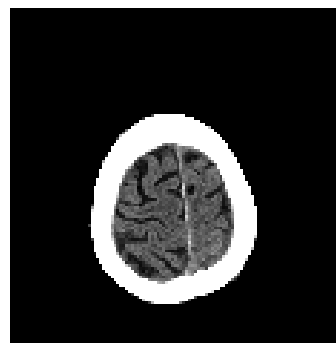
Result Image



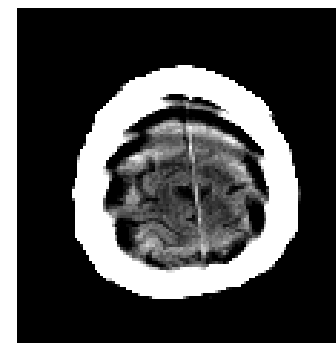
Fixed Image



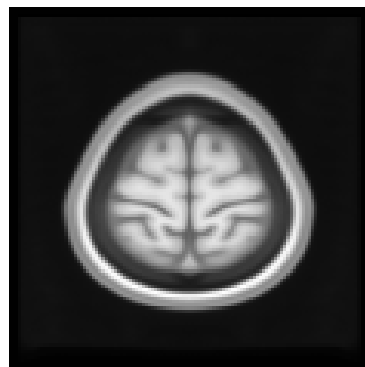
Moving Image



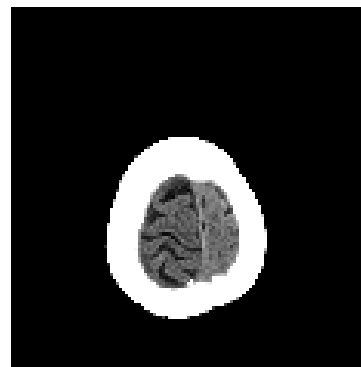
Result Image



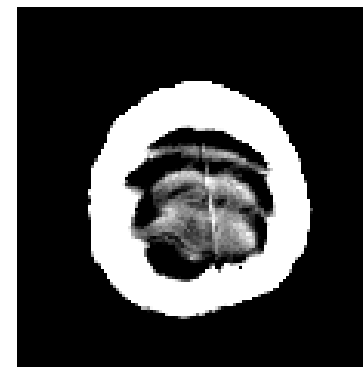
Fixed Image



Moving Image



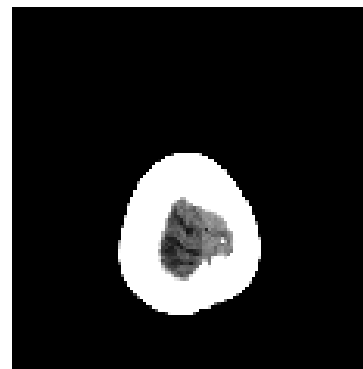
Result Image



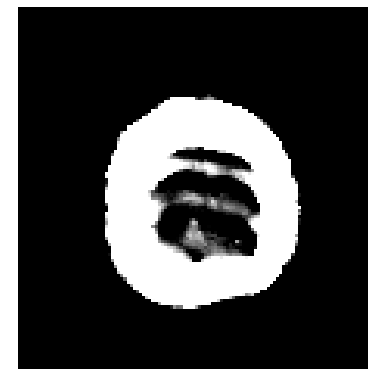
Fixed Image



Moving Image



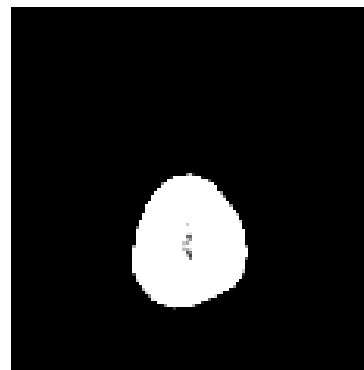
Result Image



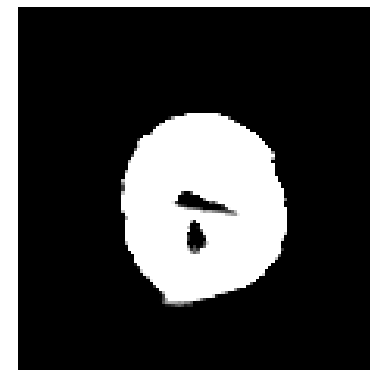
Fixed Image



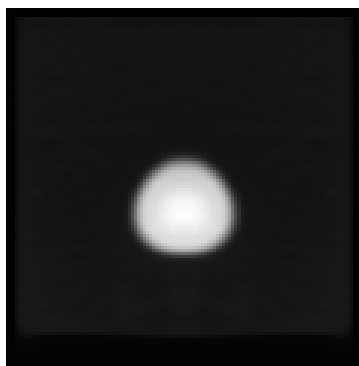
Moving Image



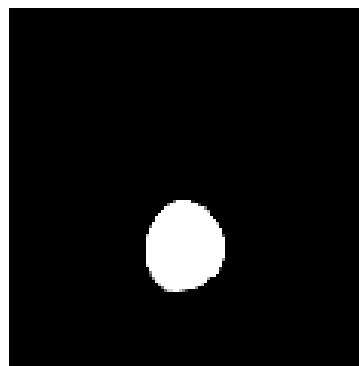
Result Image



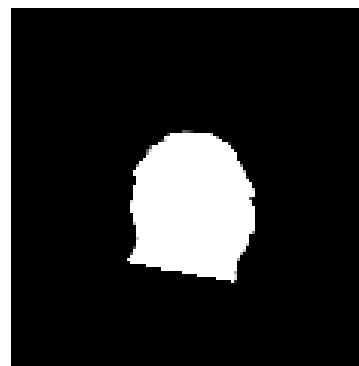
Fixed Image



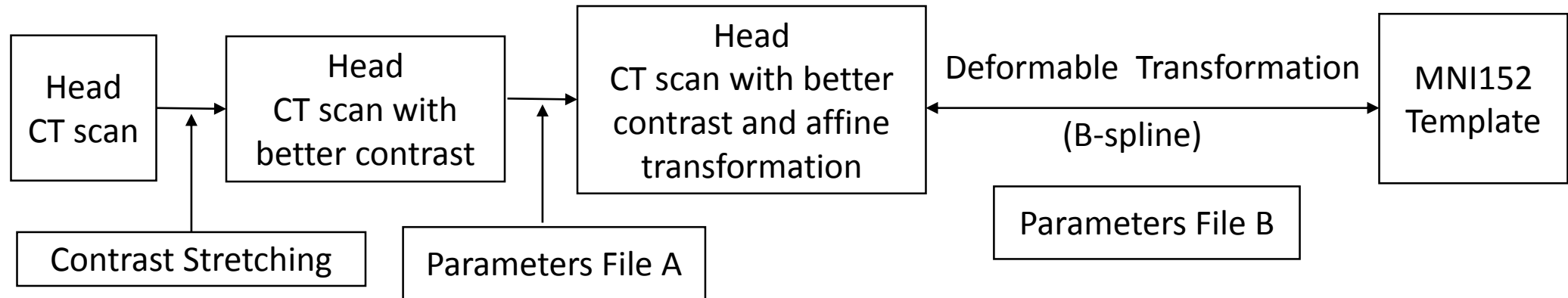
Moving Image



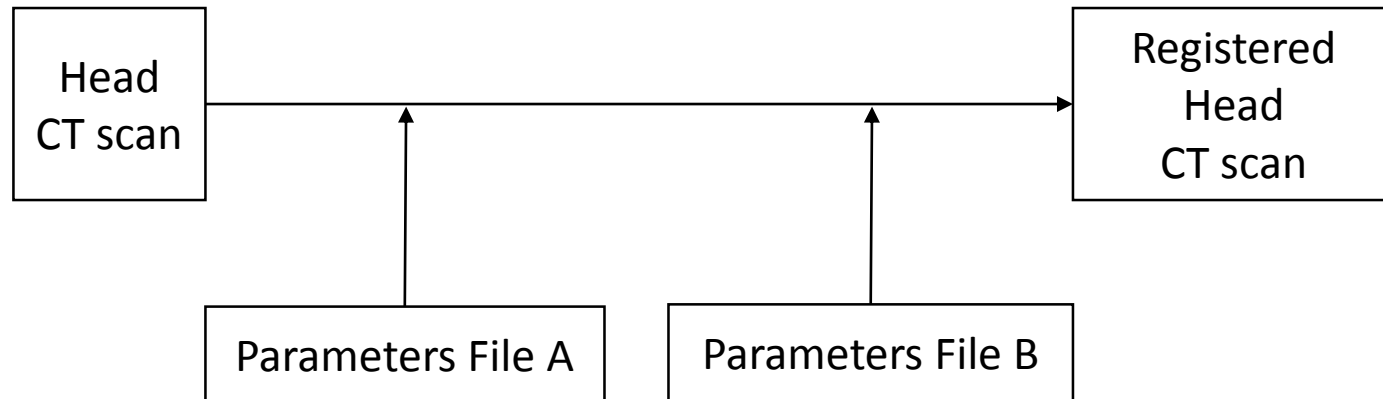
Result Image



Workflow



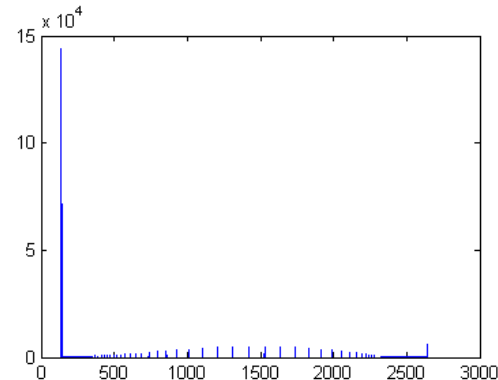
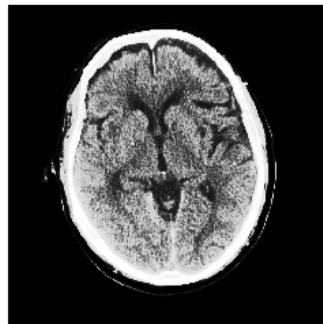
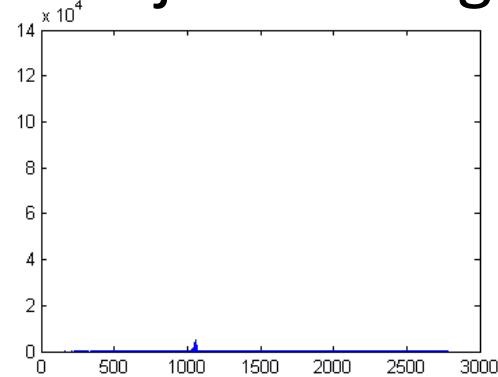
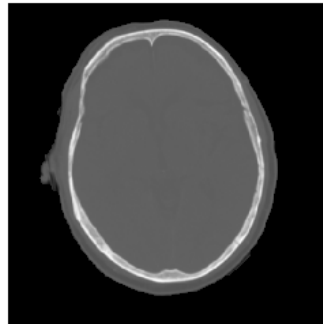
Running Time : 51 seconds



Running Time : 2 seconds

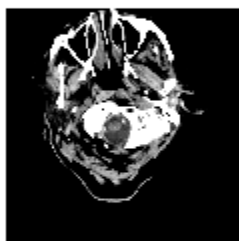
Contrast Stretching

- Motivation: To increase the number of bins of the gray matter, white matter and cerebrospinal fluid in the joint histogram (over 15 bins)



Result

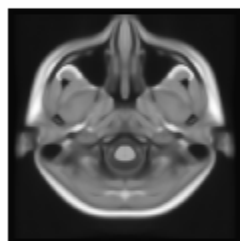
Moving Image



Result Image

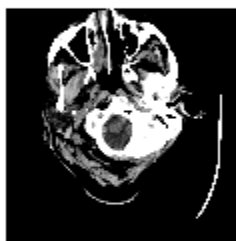


Fixed Image

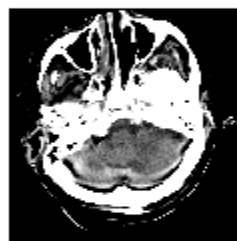


Result

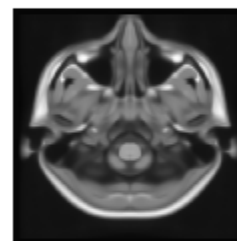
Moving Image



Result Image



Fixed Image



Result

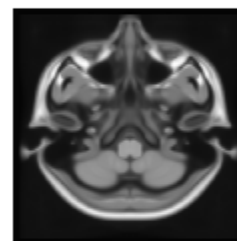
Moving Image



Result Image



Fixed Image



Result

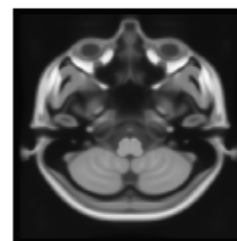
Moving Image



Result Image



Fixed Image



Result

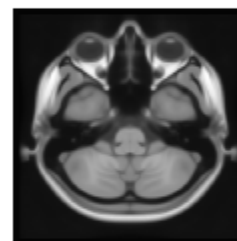
Moving Image



Result Image



Fixed Image



Result

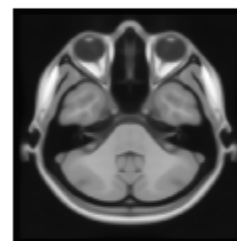
Moving Image



Result Image

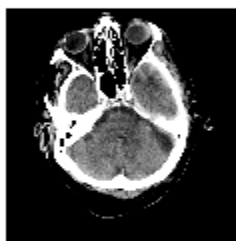


Fixed Image



Result

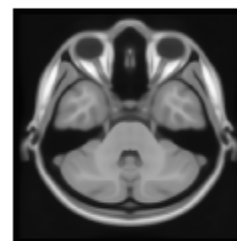
Moving Image



Result Image



Fixed Image



Result

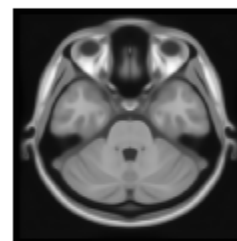
Moving Image



Result Image

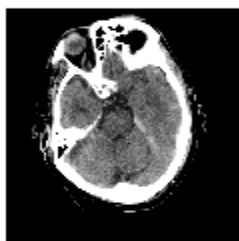


Fixed Image



Result

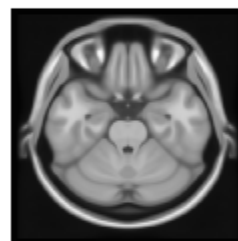
Moving Image



Result Image

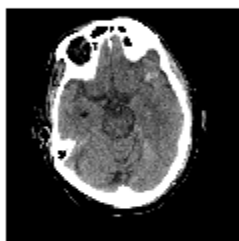


Fixed Image



Result

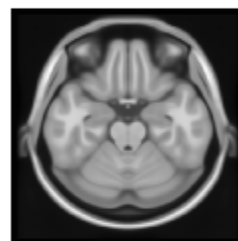
Moving Image



Result Image

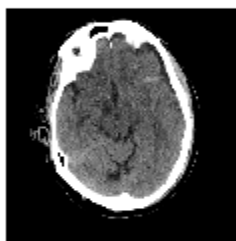


Fixed Image



Result

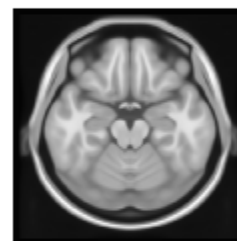
Moving Image



Result Image



Fixed Image



Result

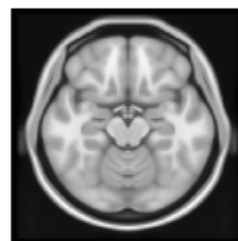
Moving Image



Result Image



Fixed Image



Result

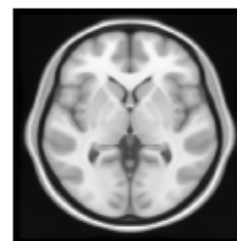
Moving Image



Result Image



Fixed Image



Result

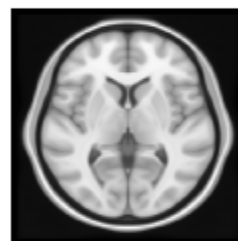
Moving Image



Result Image



Fixed Image



Result

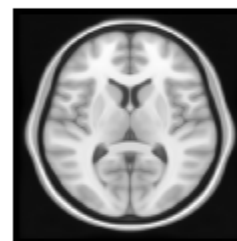
Moving Image



Result Image



Fixed Image

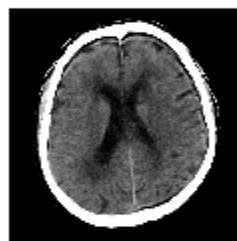


Result

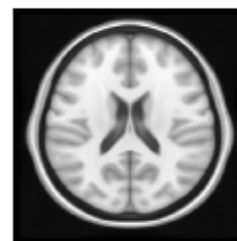
Moving Image



Result Image

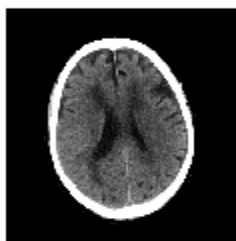


Fixed Image

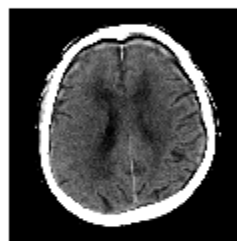


Result

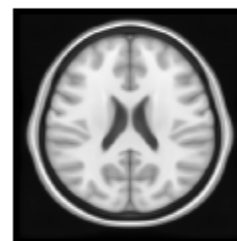
Moving Image



Result Image

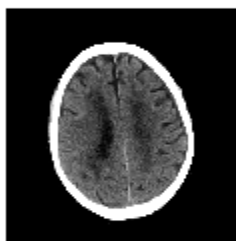


Fixed Image

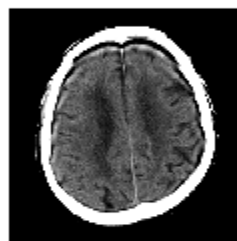


Result

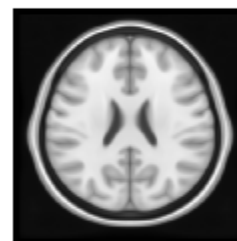
Moving Image



Result Image



Fixed Image

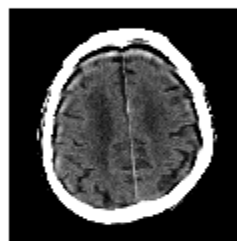


Result

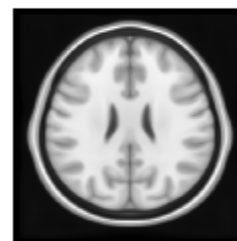
Moving Image



Result Image

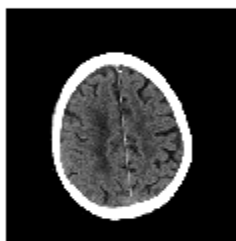


Fixed Image

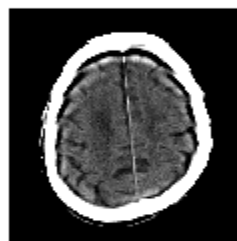


Result

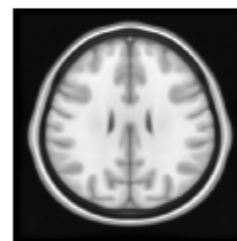
Moving Image



Result Image



Fixed Image



Result

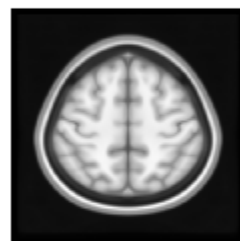
Moving Image



Result Image



Fixed Image

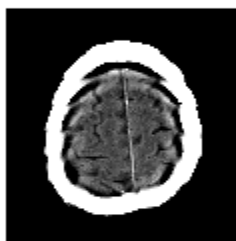


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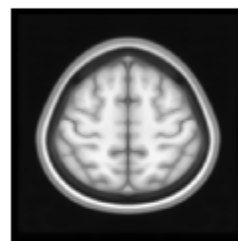
Moving Image



Result Image



Fixed Image

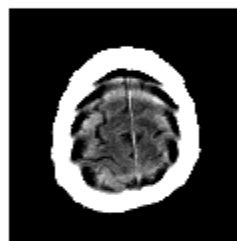


Result

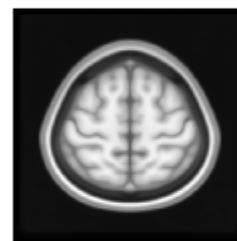
Moving Image



Result Image



Fixed Image



Result

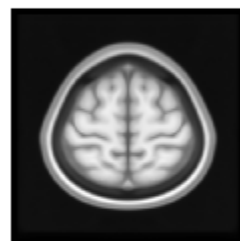
Moving Image



Result Image



Fixed Image



Result

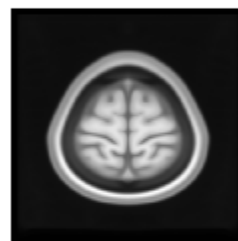
Moving Image



Result Image



Fixed Image



Result

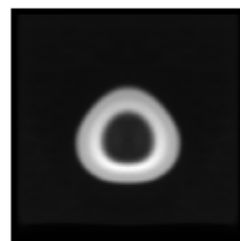
Moving Image



Result Image

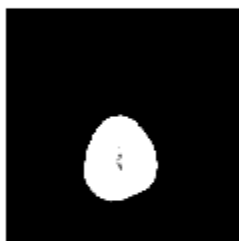


Fixed Image



Result

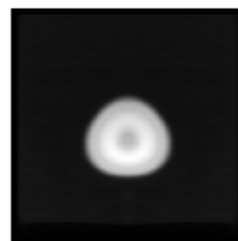
Moving Image



Result Image



Fixed Image



Result

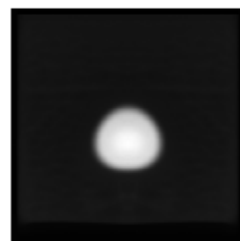
Moving Image



Result Image



Fixed Image



Future Work

- Exclude the beginning and end scans
- Slice-by-slice registration
- Automatically find the corresponding slices