



NA-MIC

National Alliance for Medical Image Computing

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Slicer3 Tutorial

Nonrigid Atlas Registration

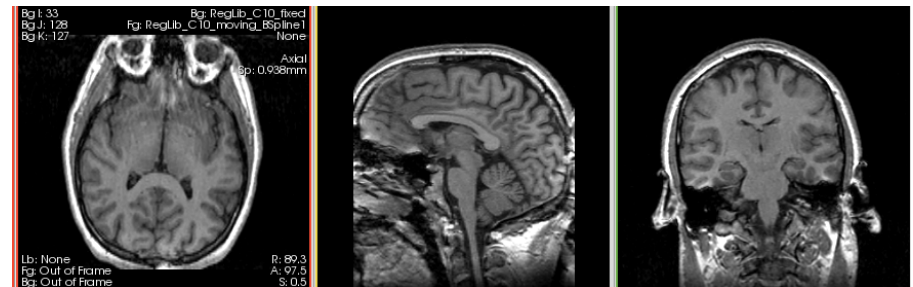
Dominik Meier, Ron Kikinis

February 2010, revised Oct. 2010

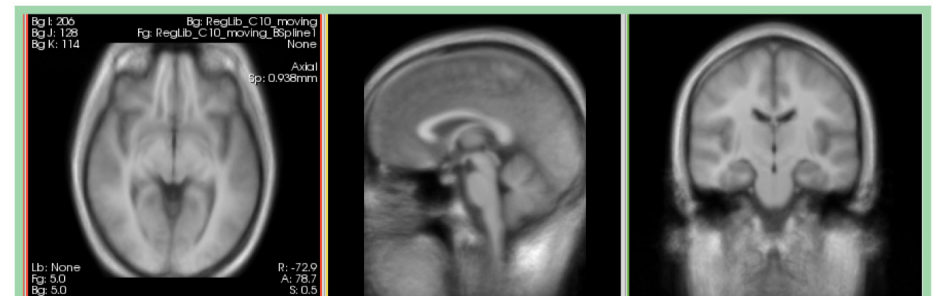


Introduction / Scenario

- This example case contains a **probabilistic atlas image** that defines likelihood of tissue classes. Goal is to use this atlas in a segmentation (e.g. EM) of the target MRI.
- The “probabilistic atlas” here is represented only by a single channel. Additional channels would be registered analogously
- Registration occurs in 2 stages: 1) initial alignment using an automated affine registration, 2) nonrigid alignment using the automated B-spline module
- Because of the strong differences in image contrast and content (different subjects), a rough masking is applied for the initial alignment



fixed target image



moving atlas image



Modules Used

- To accomplish this task we will use the following modules:
 - Fast Marching Segmentation
 - Register Images
 - B-spline nonrigid registration








Prerequisites

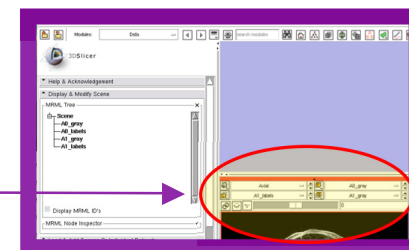
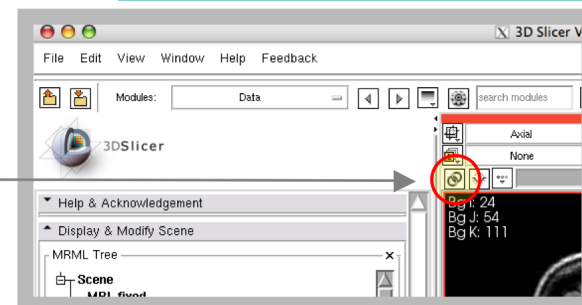
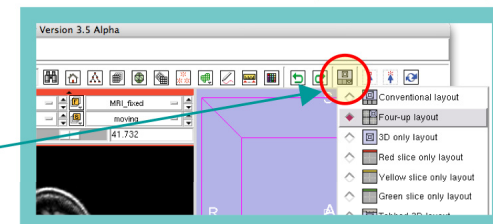
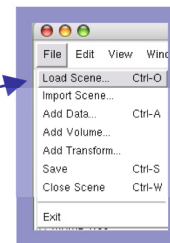
- Slicer version 3.5 or later
- **Example Dataset:** download and extract the dataset for this tutorial: RegLib_C10_MRI_AtlasSegmentation.zip
- **Tutorials to complete first** (helpful but not required):
 - Slicer3Minute Tutorial
 - Loading and Viewing Data
 - <http://www.slicer.org/slicerWiki/index.php/Slicer3.4:Training>



1. Loading Example Dataset

To get the Example Dataset loaded into Slicer:

-  **File** Menu: File: Load Scene...
 - Select the Slicer Scene file that comes with the downloaded example dataset, called: RegLib_C10_SlicerScene.mrml
 - This will load all the necessary images, ransforms and presets
-  **Select Layout:** From the icon bar, click on the **Layout** menu and select “Conventional Layout”.
-  **Link Views:** Click on the Ring Icon in any of the slice views to link all the views together. This will save you the work of making selections for each slice window separately.
-  **Choose Background:** RegLib_C10_fixed
-  **Choose Foreground:** RegLib_C10_moving



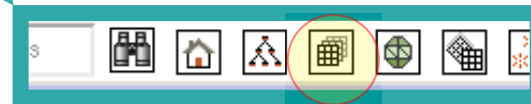


Adjust Slice Views

If necessary adjust the window & level controls for the two images, until they appear approx. as shown on the right:



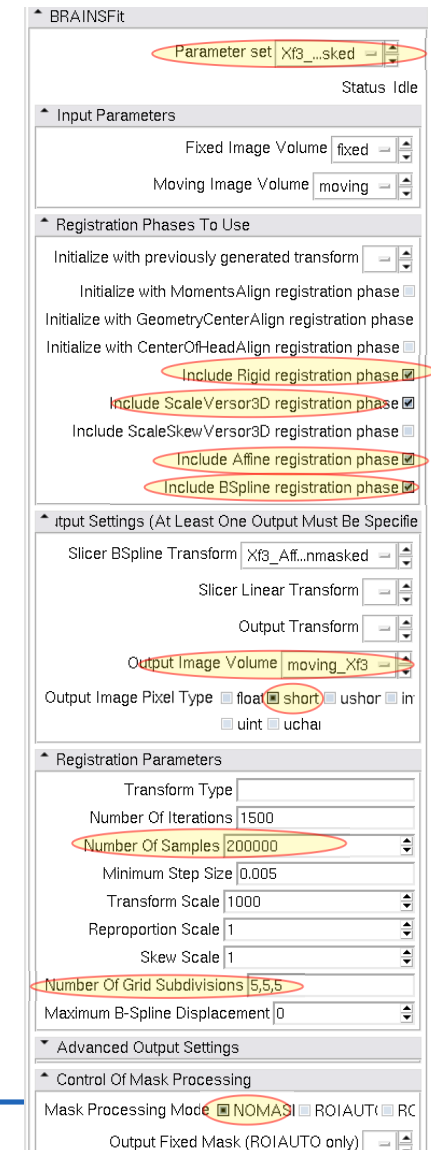
1. Go to the “Volumes” module & click on the “Display” tab
2. From the pulldown menu, select each image in turn, then adjust the contrast via the slider bars. Remember to switch both the **active volume menu** and the **display tab** to switch from adjusting one volume to the other.





Version 1: fast registration w/o masking

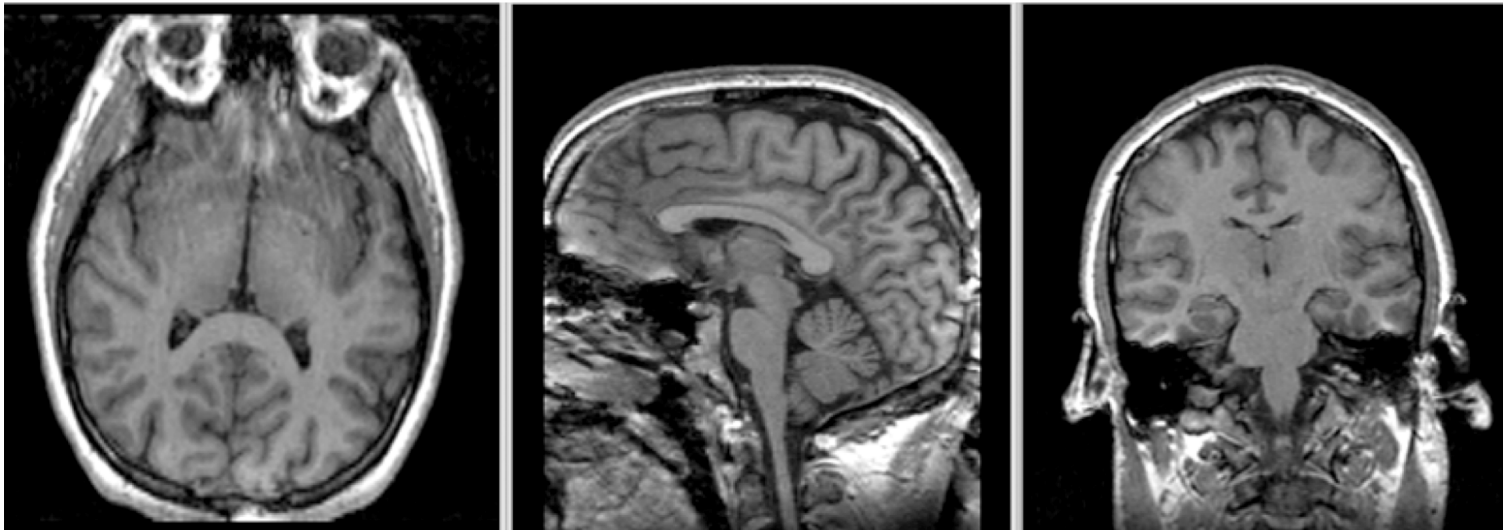
1. The fast route is via the BRAINSfit module, where we perform all steps in one go:
2. Select “fixed” and “moving” as input volumes and all parameters as shown on the right
3. Set the Bspline Grid to 5,5,5
4. don’t forget to specify an output volume and output transform
5. increase # of samples to 200,000
6. Hit “Apply”





Version 1: results

animated GIFs: view in Presentation Mode





Version 2: Affine + BSpline with Masking

1. This 2nd and more labor-intensive version uses the Expert Automated and the Fast Bspline modules and also builds a mask via the Skull Stripping Module. The masking and the two-step registration provide more control about what happens at each step. You may opt for this version if results of BRAINSfit for your dataset are insufficient. The pipeline is as follows:
 2. Create mask for fixed reference volume
 3. Perform Affine Registration (unmasked)
 4. Perform nonrigid B-Spline registration

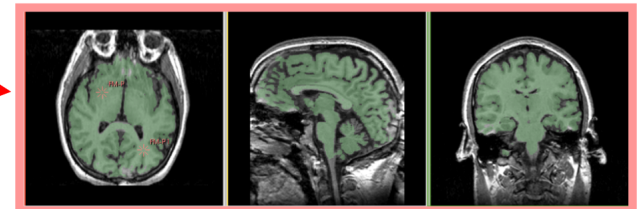
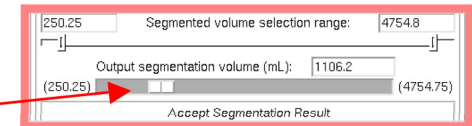
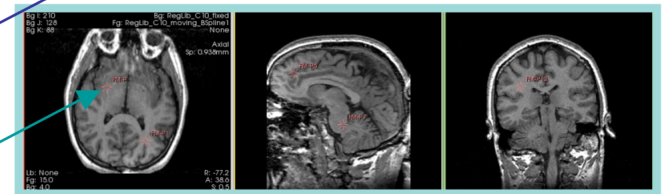
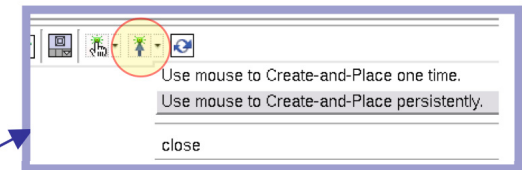


Build Mask

Modules: FastMarchingSegmentation

FastMarchingSegmentation
Modules:

1. For the initial registration we need a rough mask of the target/fixed brain. We use the “Fast Marching Segmentation” module for this:
2. For input volume, select the fixed image
Under “Input Seeds”, select “Create New Fiducial List”
3. Switch to BG view to display fixed image. From the top toolbar switch the mouse function to the “Fiducial Selection”.
4. Place several (>4) fiducial markers at different positions throughout the brain. Try to include both GM and WM.
5. enter 5000 as the expected volume. Click on “Run Segmentation”
6. Under “Result Adjustment” tab, move the “Output segmentation volume” slider bar until the segmented volume looks approx. as shown.
7. Click on “Accept Segmentation Result”



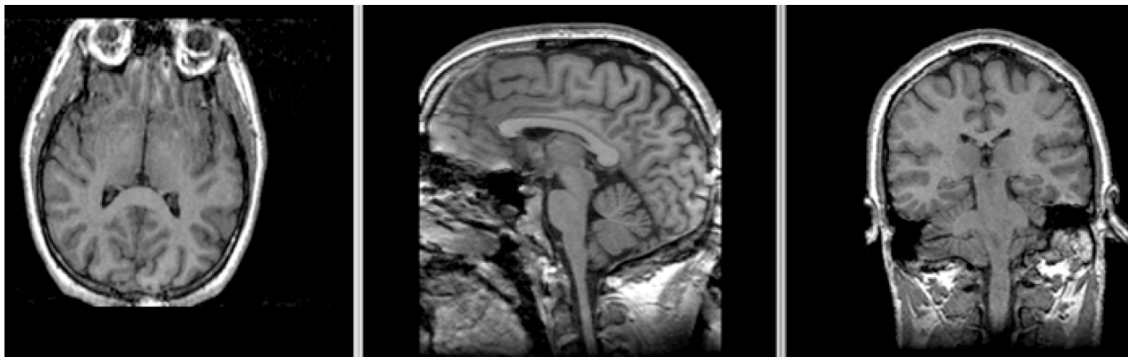


Affine Registration

Register Images
Modules:



1. We now perform an initial alignment via automated affine registration. Go to the “Register Images” module
2. You can load the presets as shown on the right via the “Parameter Set” menu, or select them manually. Also set the mask we just segmented as the “fixed image mask”.
3. Hit “Apply”
4. Go to the “Data” module. Drag the “RegLib_C10_moving” image onto the newly created transform.
5. You should get a registration similar to the one shown below:



animated GIFs: view in Presentation Mode

Parameter set: RegLib_C10_...ets_Affine

Status: Idle

IO

Fixed Image: RegLib_C10_fixed

Moving Image: RegLib_C10_moving

Resample image: None

Registration Parameters

Load transform: None

Save transform: Re...k

Initialization: None Landmark ImageCenter CentersOfMas SecondMoment

Registration: None Initial Rigid Affine BSpline PipelineRigid PipelineAffine PipelineBSpline

Metric: MattesMI NormCorr MeanSqrd

Expected offset magnitude: 10

Expected rotation magnitude: 0.2

Expected scale magnitude: 0.1

Expected skew magnitude: 0.05

Advanced Registration Parameters

Verbosity level: Silent Standard Verbose

Sample from fixed/moving overlap:

Fixed Image Mask: RegLib_C10_fixed_mask

Random number seed (0=none): 0

Number of threads (0=max): 0

Minimize memory:

Interpolation: NearestNeighbor Linear BSpline

Advanced Initial Registration Parameters

Advanced Rigid Registration Parameters

Advanced Affine Registration Parameters

Affine Max Iterations: 80

Affine sampling ratio: 0.05

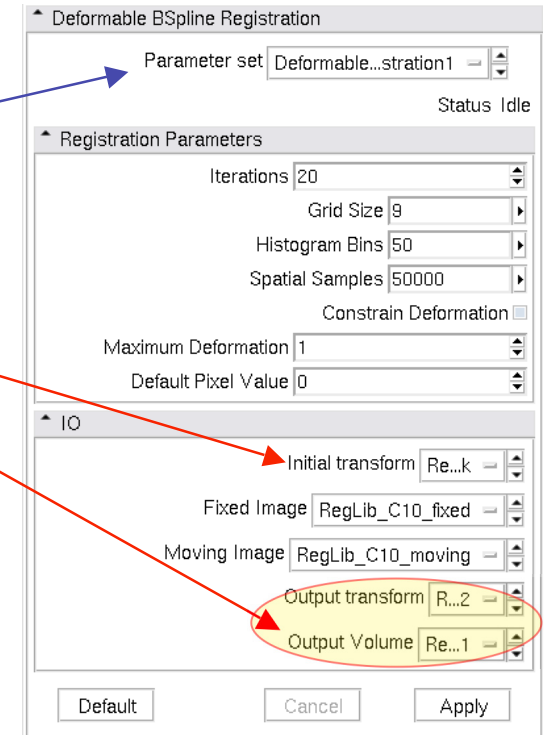
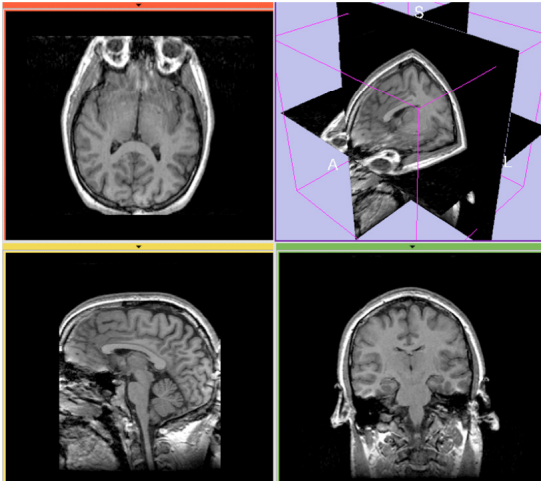
Advanced BSpline Registration Parameters

Default Cancel Apply



Non-rigid Registration

1. Go to the “Fast Nonrigid (Bspline) Registration” module
2. You can load the presets as shown on the right via the “Parameter Set” menu, or select them manually. **Make sure to select the Affine registration result we obtained previously as “Initial Transform”, and specify “output volume” and “output transform”.**
3. Hit “Apply”
4. Upon completion, set the foreground and background image to the Bspline result and fixed image, respectively.
5. You should get a registration similar to the one shown below:



Note: in current (3.5) and older versions the Bspline module will automatically place the input moving image under the result transform node, even though the immediate feedback you get when placing images within rigid or affine transforms is **not** supported for non-rigid transforms. So you will not see an effect from moving a volume under a non-rigid transform.

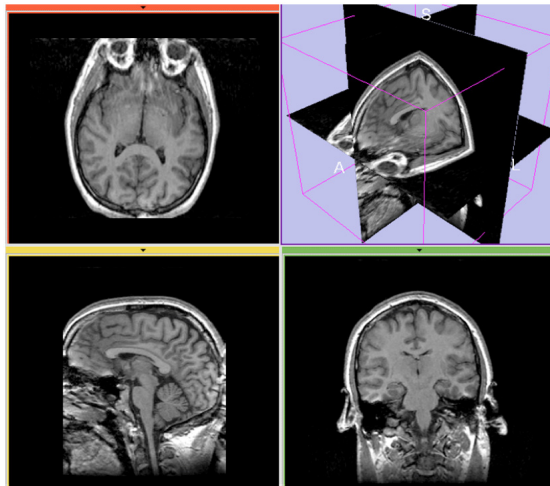
RegLib_C10_XForm_BSpline2
RegLib_C10_moving

This form of visualizing nonrigid transforms via the MRML tree is not supported in current and older slicer versions. You must resample your image to see the effect of the transform.

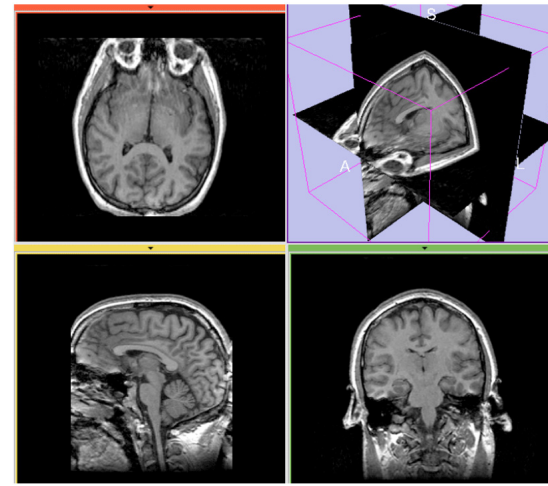


Version 2: Results

animated GIFs: view in Presentation Mode



unregistered




after affine + nonrigid registration



Save

1. Select “Save” from the File Menu.
2. Check all boxes except the original input images
3. Create a new output directory, and select it via the “Change Destination For All Selected” button.
4. click “Save Selected”.

Change Destination for All Selected:  /



Acknowledgements



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