

Pipeline Platform for DTI Registration and Evaluation

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Background

- Water molecules in biology tissue tend to diffuse faster along, relative to across, obstacle structures such as fibers or membranes.
- Diffusion tensor imaging (DTI) measures this anisotropy, providing information about neural fibers.
- **DTI registration is more complicated than intensity image registration**, because tensor must be re-orientated during transformation.
- **Evaluation of DTI registration is also complicated**, involving eigen-analysis, matrix logarithm, tractography.

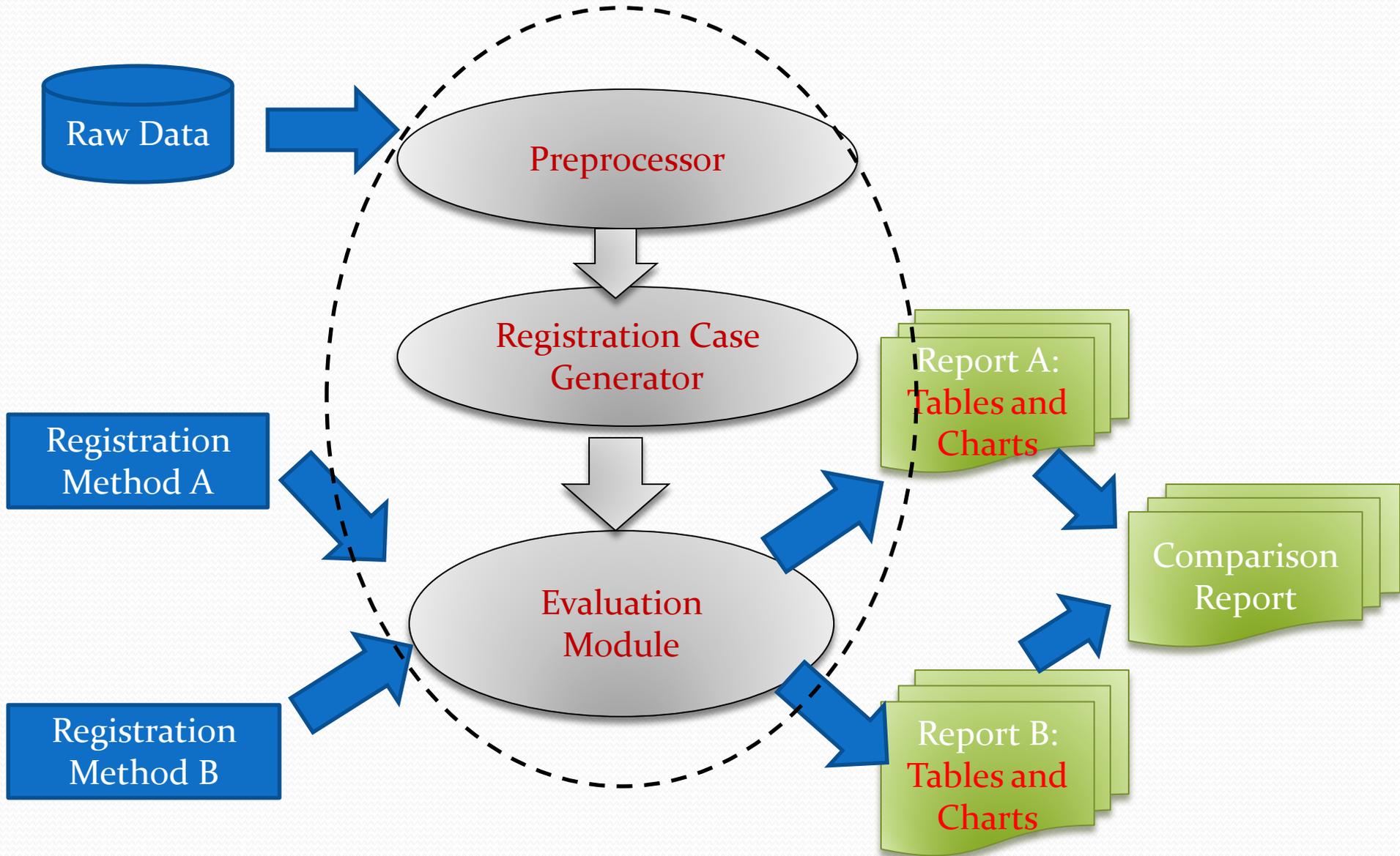
Motivations

- For developers of registration methods:
 - “**How good** is my new method in **comparison** with other methods?”
 - “Can I work **focus on the development of registration method, not distracted** by building the evaluation environment by myself?”
 - “How can I **keep my files well organized** so that I still can understand them some time later?”
- For users of registration methods:
 - “**Can I trust the registration results** I got and forward to group analysis in the template space?”
 - “**Is there some outliers** in my data that I should screen out?”

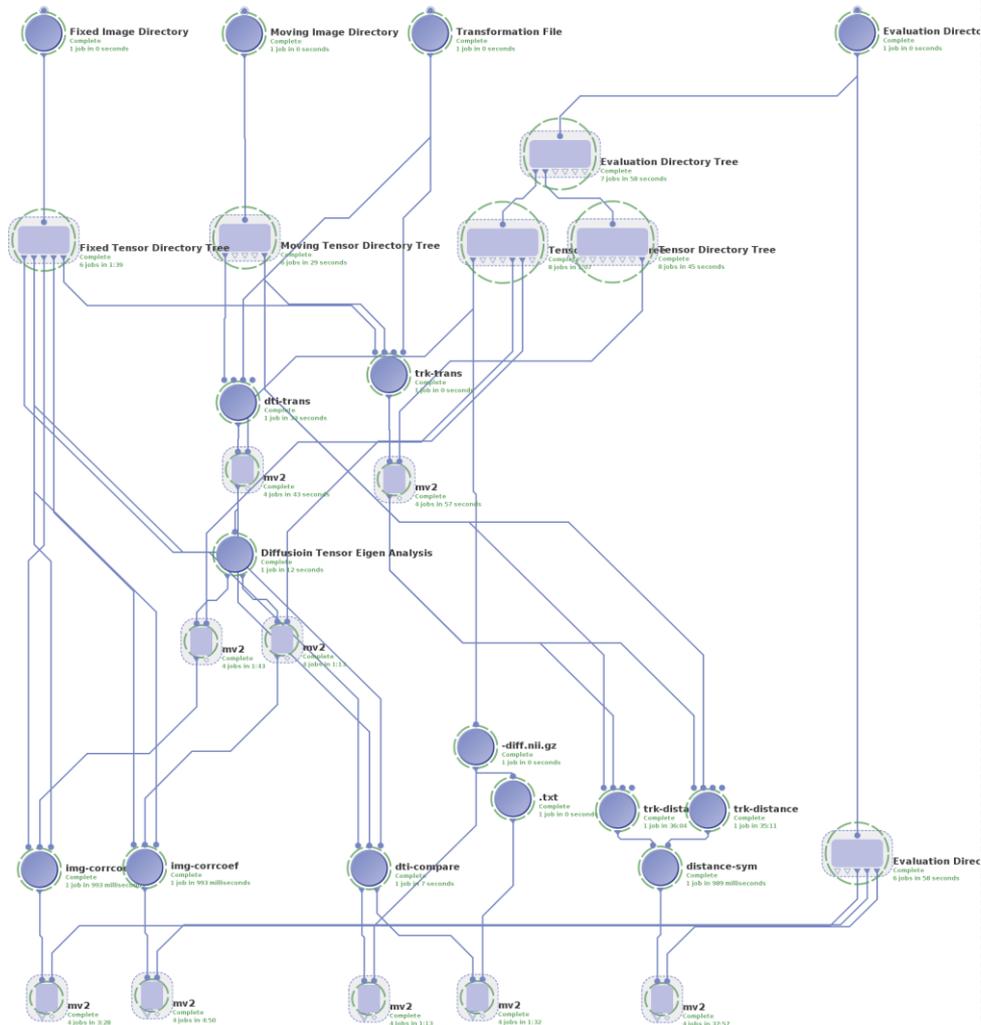
Software Environment for DTI Registration and Evaluation is Complicated

- **A complicated workflow:**
 - Format conversion
 - Tensor reconstruction
 - Tractography
 - Image Registration
 - Warping of images and tracks
 - Goodness evaluation
 - Report of evaluation summaries statistics
- **Many software packages** using **different data formats or coordinate systems** involved:
 - DTI-TK, TTK, DTK, Carmino, FSL, ...

The Evaluation Environment

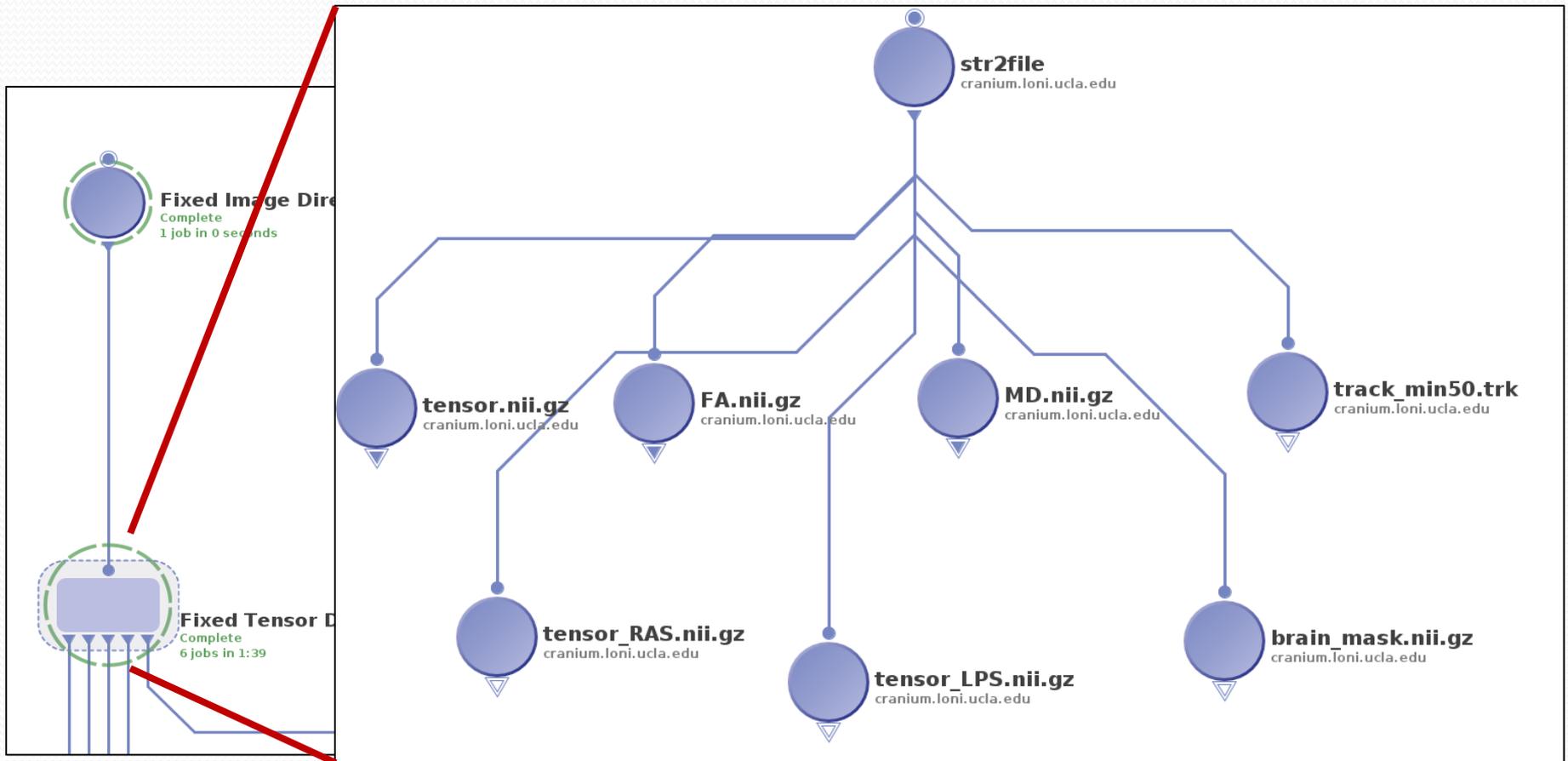


Evaluate DTI Nonlinear Registration

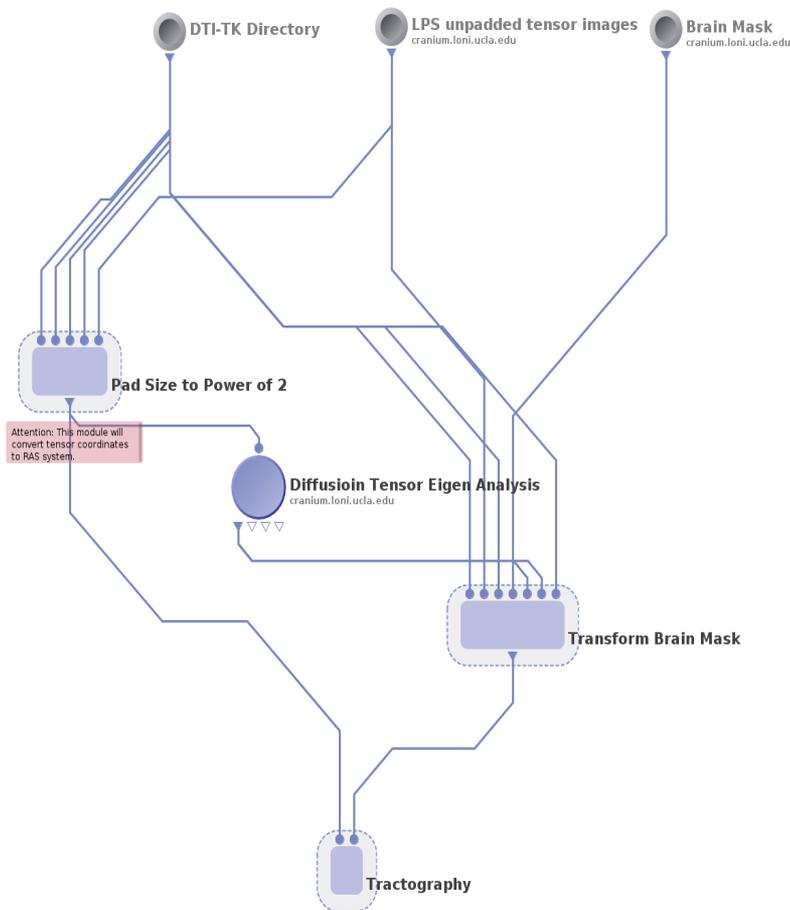


- **Functionality:**
 - Calculate transform. Smoothness: **curvature, diffusion, affinity.**
- Warp tensor images and compare **FA, MD, RA, Euclidian difference, logarithm difference.**
- Warp tracks and **track distances.**

Directory Tree Modules: Keep Files Organized and Names Consistent

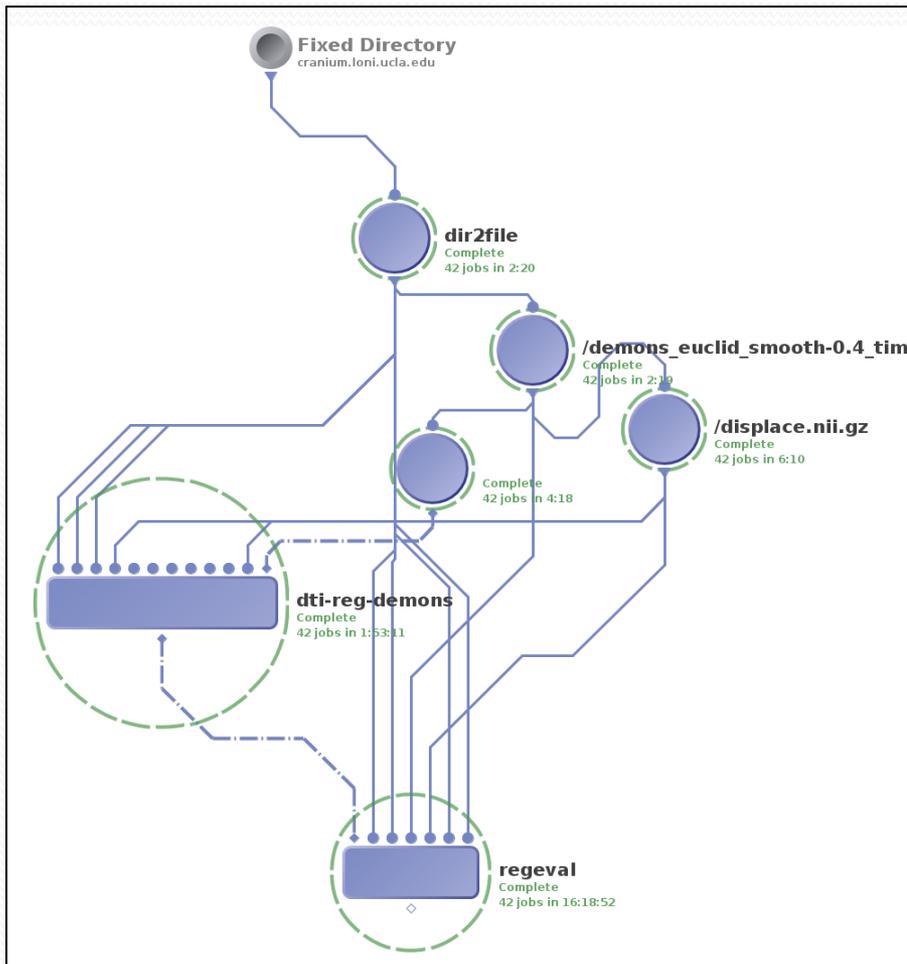


Format Conversion Modules



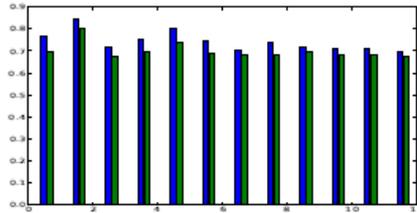
- **Functionality:**
- **Automatically convert tensor images to a different space and different coordinate systems.**
- **Automatically convert related files, such as brain masks and tracks.**

Example Workflow

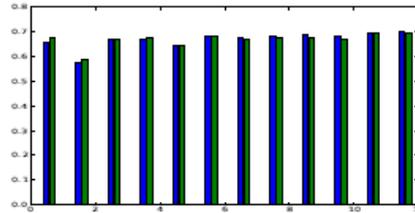


- **Comments:**
 - **Programming effort for evaluation is minimized.**
 - **Develop just need to input fixed and moving images and tracks and transformation file into the evaluation module, a comprehensive evaluation result will be reported.**
 - **Batch job is automatically distributed** to computation clusters.

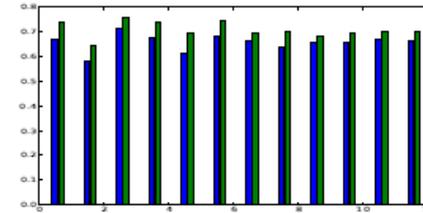
Example of Comparison Reports



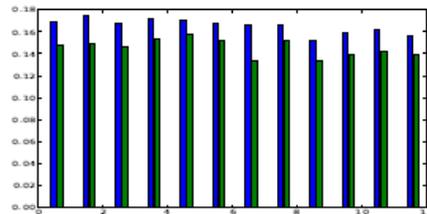
Tensor R.M.S. Difference



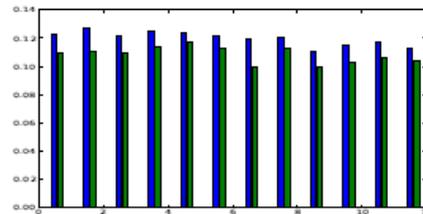
FA Corr. Coef.



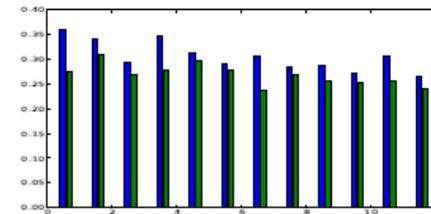
MD Corr. Coef.



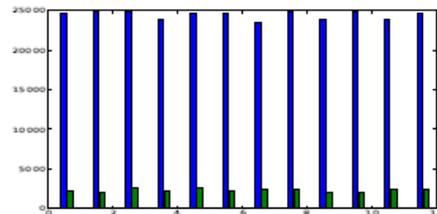
Affineness, Rooted



Curvature, Rooted



Diffusion, Rooted

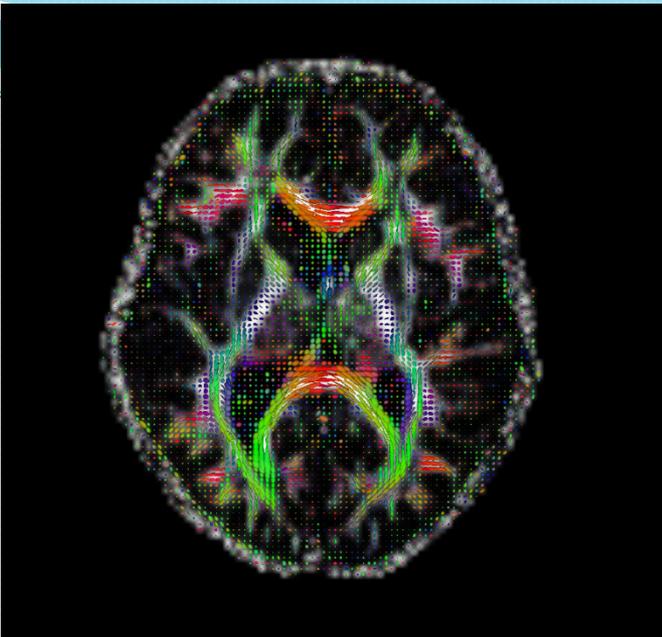


Time (sec.)

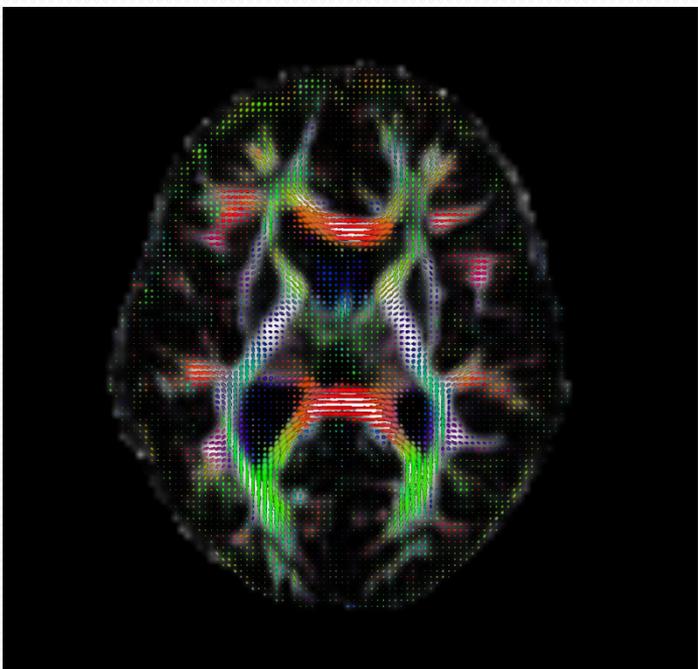


Junning Li, Yonggang Shi, Ivo Dinov, Jiongiong Wang, Toga Arthur, "Fast Diffusion Tensor Registration with Exact Reorientation and Regularization", submitted to MICCAI 2012

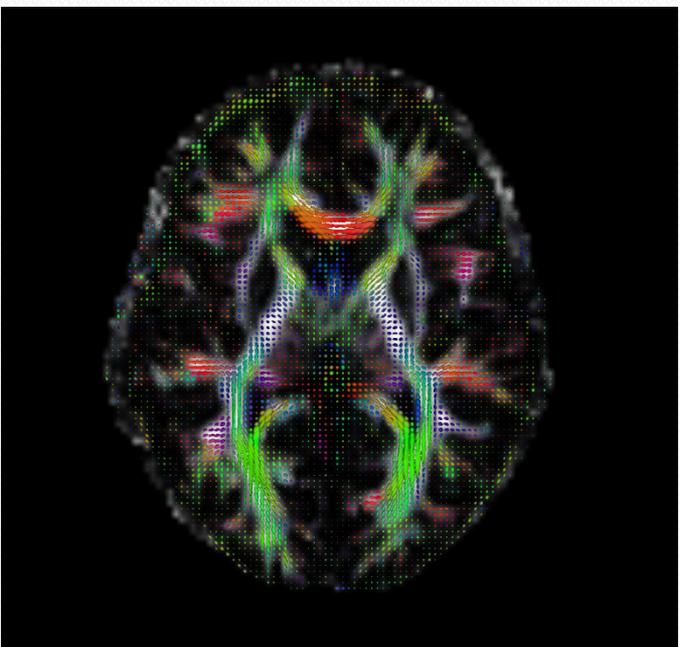
Example Images



Fixed Image



Warped Image



Moving Image