

*The Waisman Laboratory
for Brain Imaging and Behavior*



University of Wisconsin
**SCHOOL OF MEDICINE
AND PUBLIC HEALTH**

Abnormal white matter fiber tract shapes in autism

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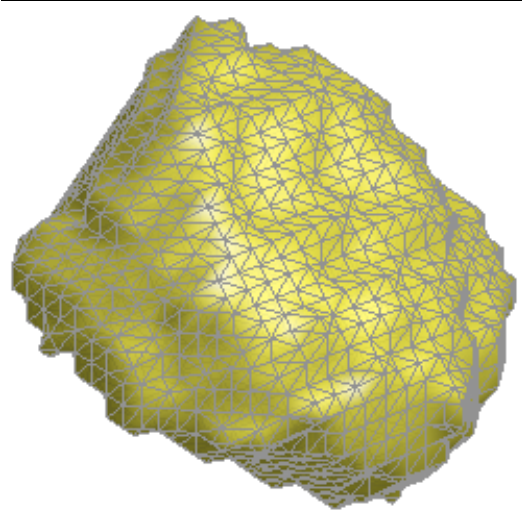
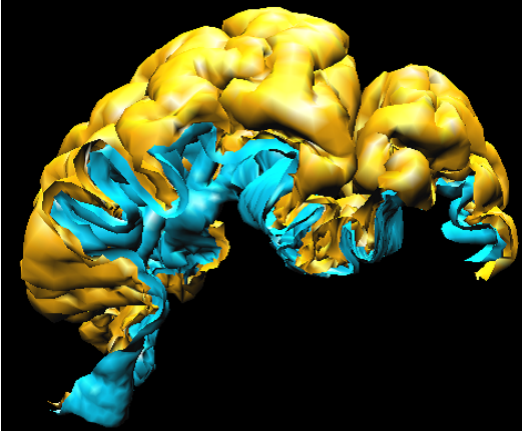
www.stat.wisc.edu/~mchung

Brain Food April 22, 2009

Whole brain structurally constrained functional network model

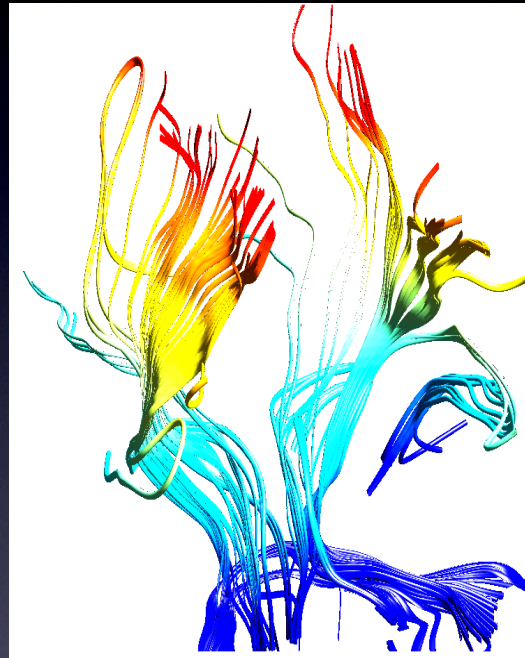
– next 3 years based on Kim Dalton/Seth Pollak + Utah + SNU dataset

Functional connectivity network model via hierarchical clustering
–Daniel J. Kelley



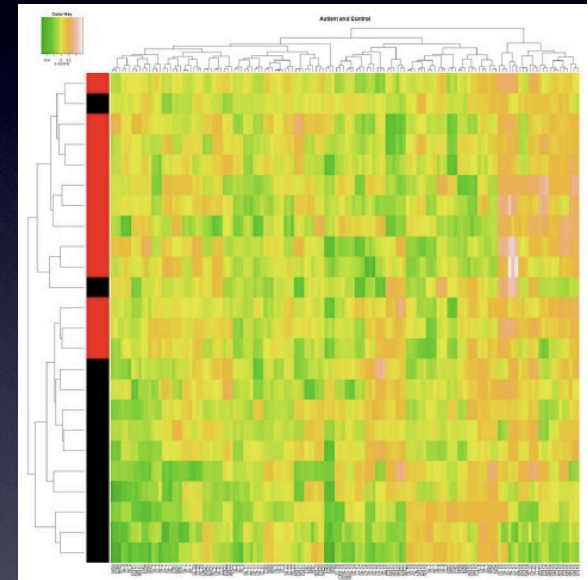
FreeSurfer based
Structural boundaries
→ vertices of graph

+

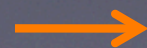


White matter fibers
→ edges of graph

+



fMRI / PET signal
→ Measurements on graph



Massive 3D graph with 800000 nodes

DTI tract shape modeling in autism using Utah dataset

Acknowledgments

This is based on Utah dataset:

Nagesh Adluru, Jee Eun Lee, Mariana Lazar,
Janet E. Lainhart, Andrew L. Alexander

Waisman Laboratory for Brain Imaging and Behavior
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Department of Psychiatry
University of Utah, Salt Lake City

Background

Very limited research on parametric model of white fiber tracts

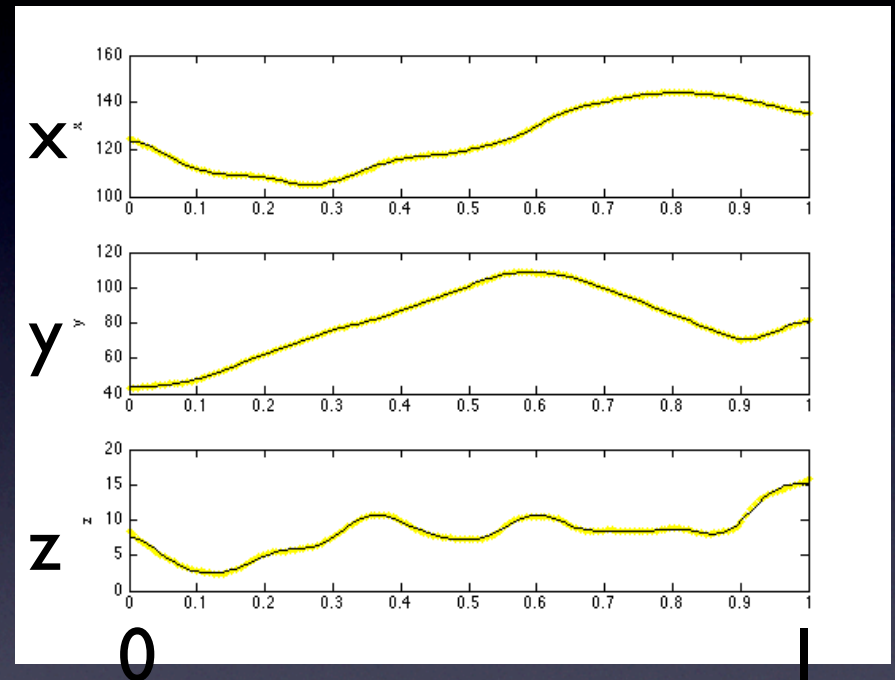
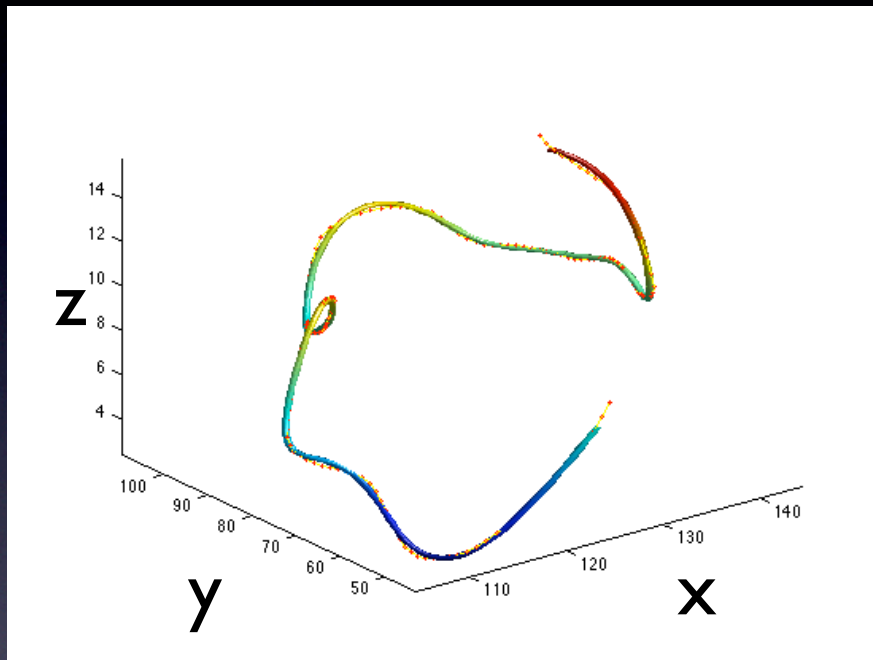
Clayden et al. TMI 2007

Cubic B-spline is used to model and match tracts.

Batchelor et al. MRM 2006

Sine and cosine Fourier descriptors are used to extract global shape features for classification

DTI Tract parameterization




x, y, z coordinates are mapped onto a unit interval and represented using the cosine basis.

Cosine series representation

88.1799	56.6336	5.7367
-12.4775	-11.2552	-2.0791
2.4336	-15.4428	-0.4021
4.3956	2.2733	-0.9354
-0.0106	-0.0674	0.6999
2.1773	-2.4194	-0.1176
0.5808	0.8390	1.2942
0.0615	-0.1893	0.1188
-0.2629	0.7524	0.1089
0.7909	-0.7276	-0.1901
0.5458	0.6236	0.6939
0.4295	-0.4337	0.2185
0.2150	0.4157	0.0254
0.1584	-0.1973	0.0762
-0.1557	0.2466	-0.1086
0.0632	-0.0978	-0.0208
0.0389	-0.0143	-0.0284
-0.0014	-0.1193	0.1970
0.0004	0.0129	-0.0198
0.1342	0.0002	0.0260
x	y	z

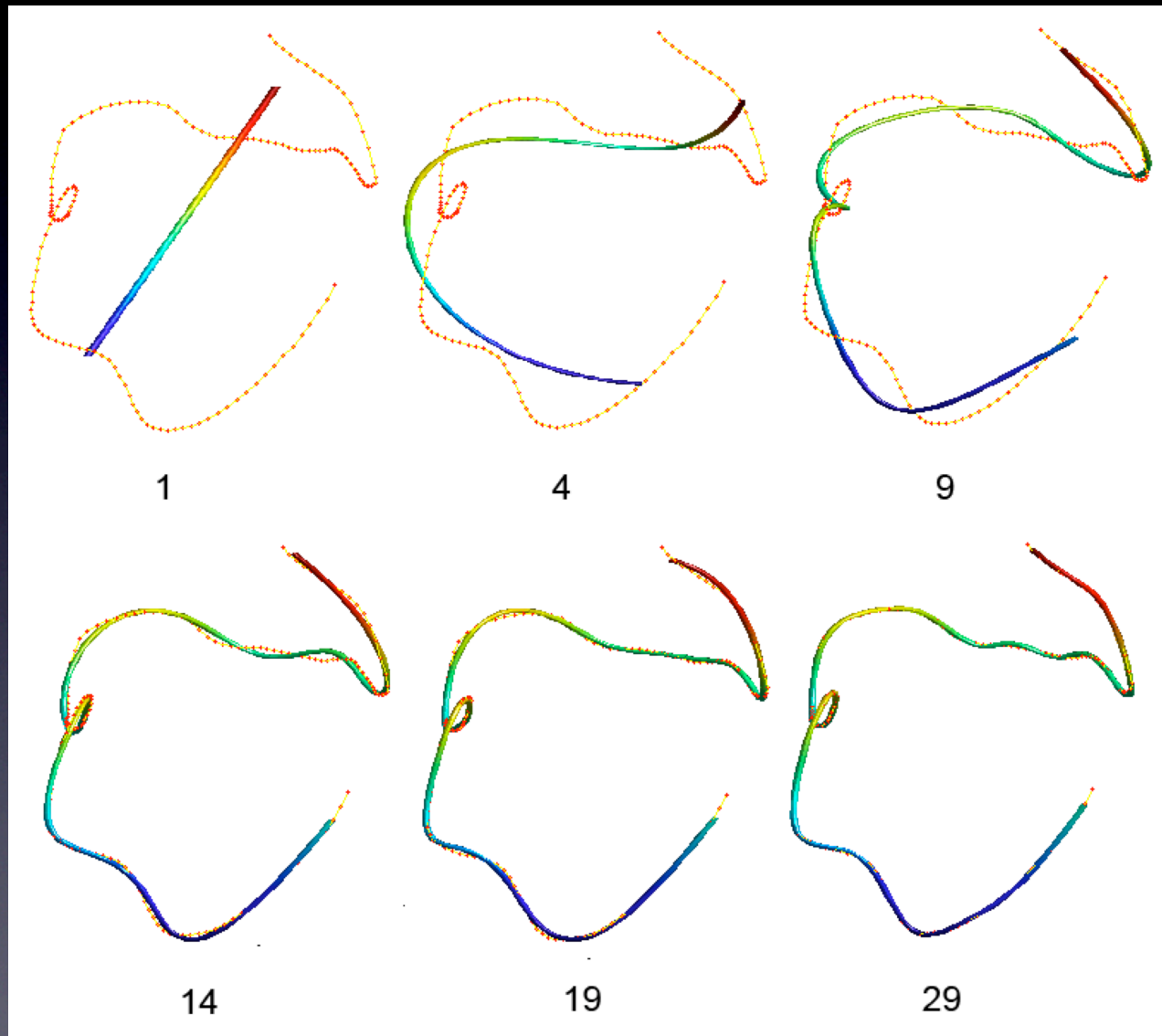
Coefficients of Cosine series expansion of coordinates

$$(x, y, z)' = \sum_{l=0}^{19} \beta_l \cos(l\pi t)$$


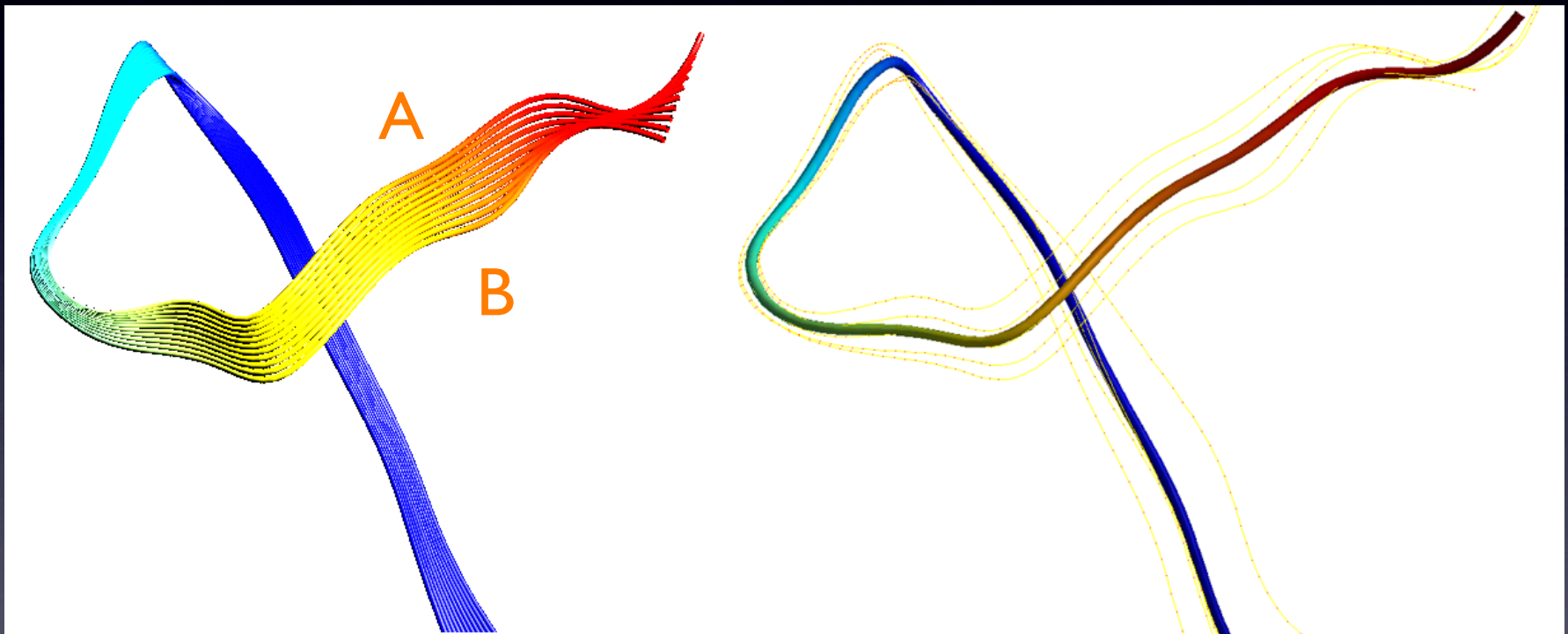
Advantage 1 regardless of shape and length, any tract is always represented by 60 parameters.

Advantage 2 Tract registration is done by matching these parameters

Cosine series representation at various degrees

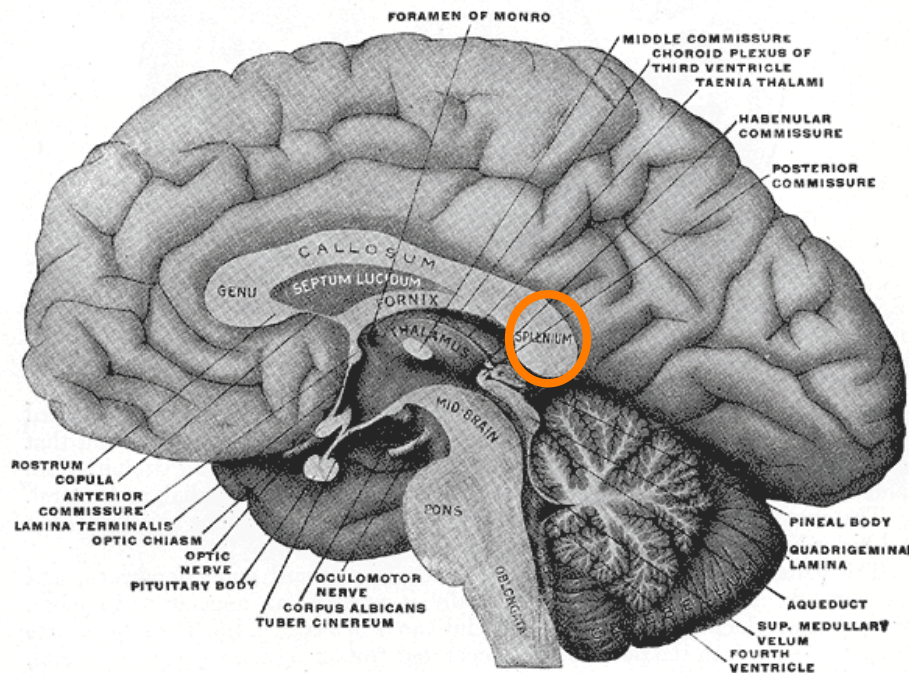


Registering tracts



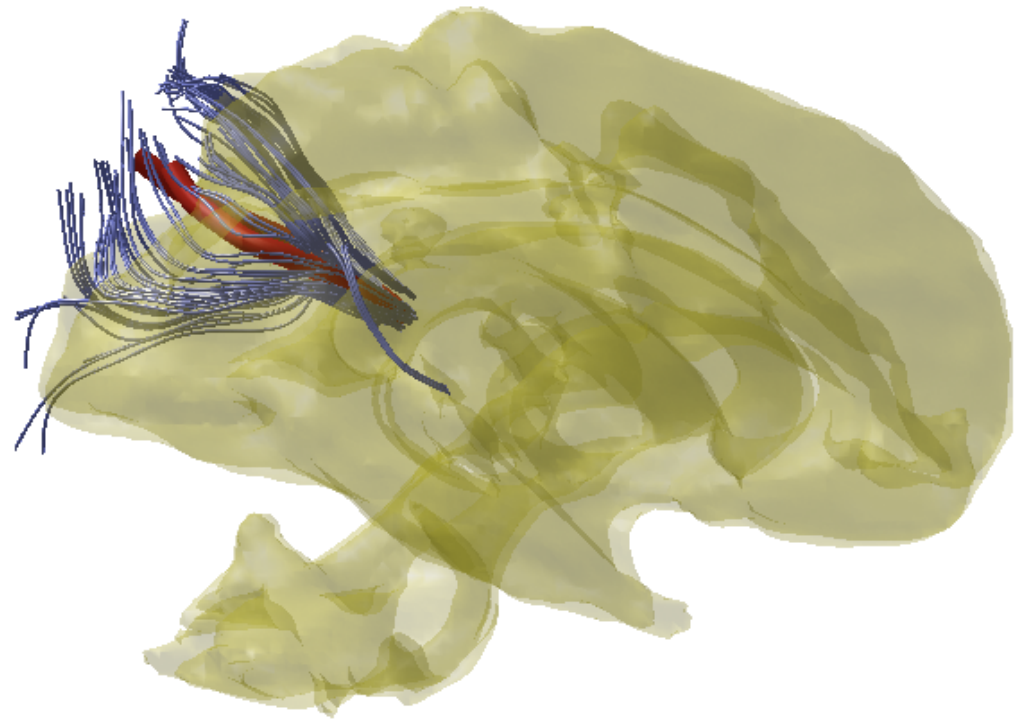
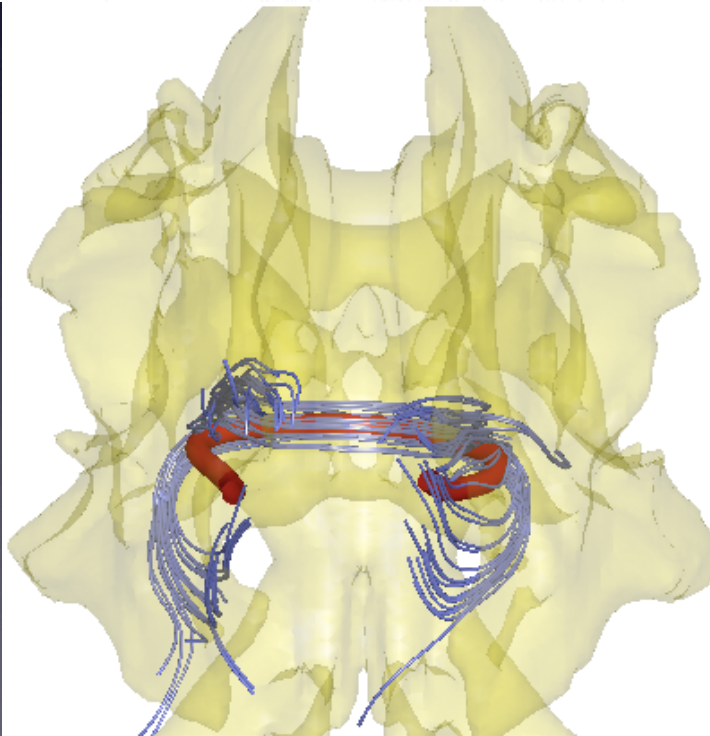
Tract **A** is registered to tract **B**

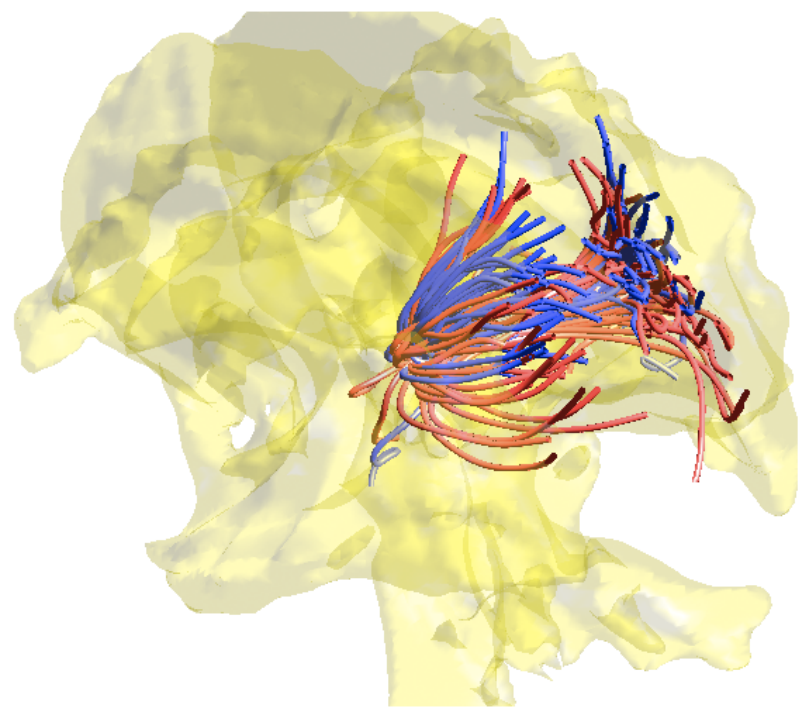
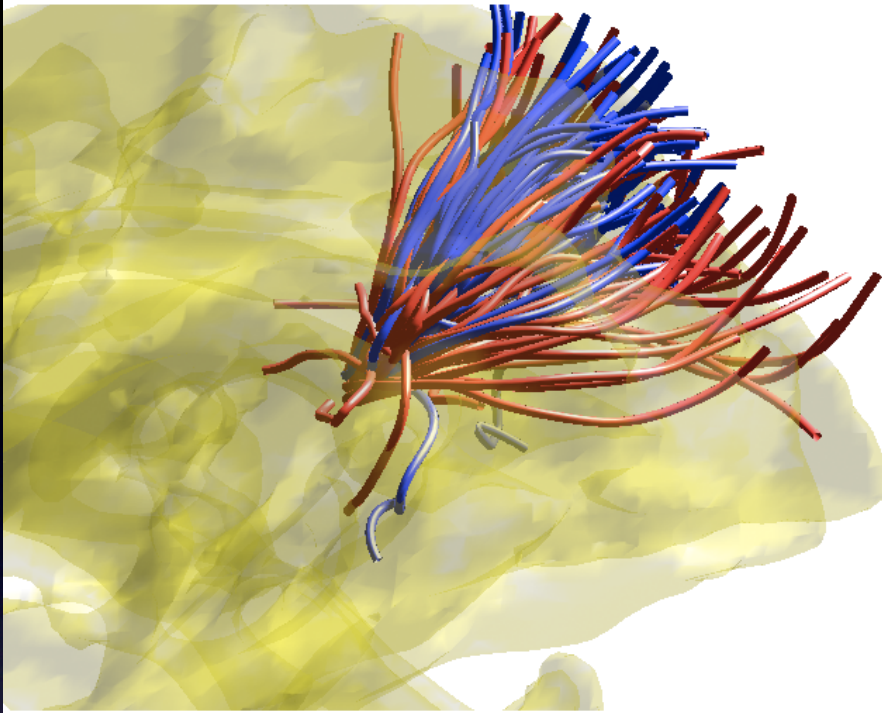
Average of 5 tracts



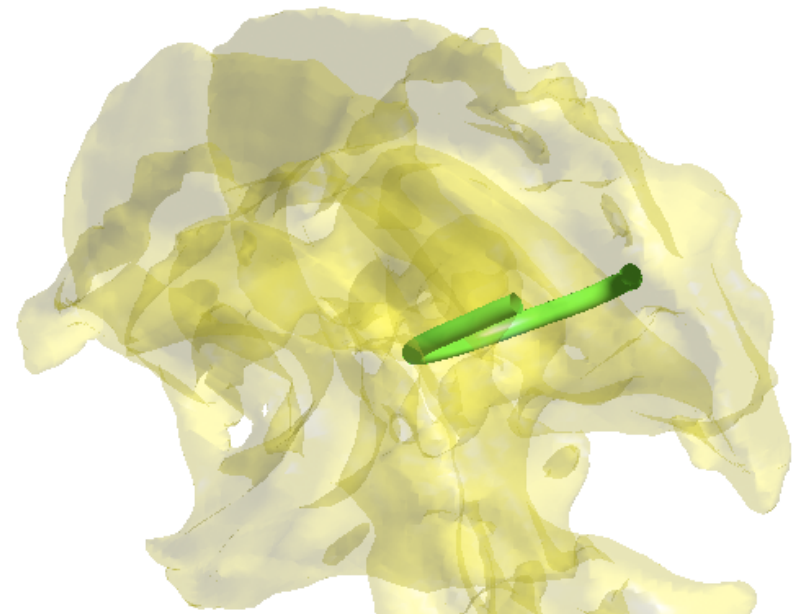
Averaging tract passing through the splenium of the corpus callosum

Averaging = starting point of any statistical analysis



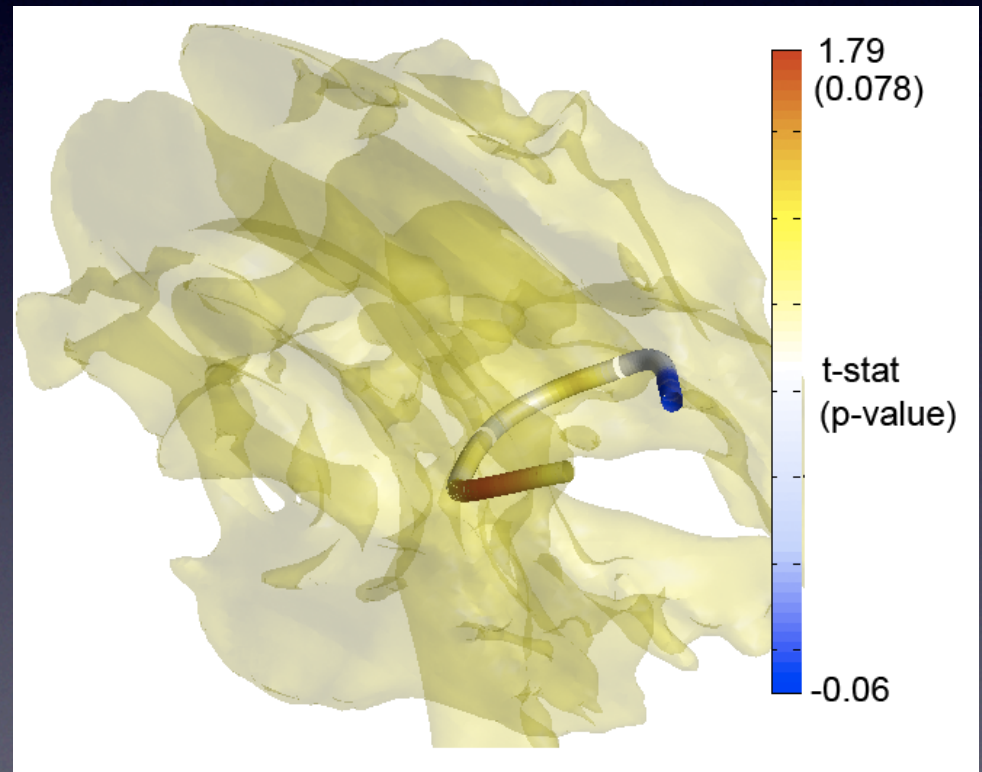
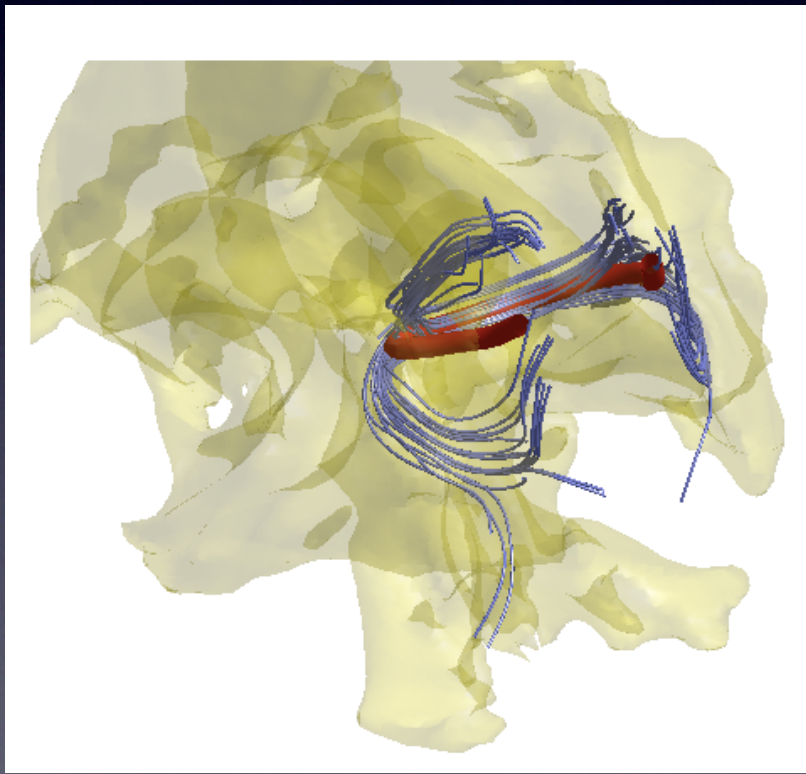


Averaging tracts across
74 subjects
(42 autistic 32 control)



Fiber Concentration for each subject

$$C(\eta^1, \dots, \eta^n) = \sum_{i=1}^n \frac{1}{\rho(\eta^i, \bar{\eta})}$$



control - autism

Discussion

Cause of weak signal

1. Need a better way to remove outlying tracts (currently a manual editing for extreme outliers)
2. Need a better tract alignment method
3. Need a better concentration metric