Background

Anatomic Variability: expected amount and type of structural variation between individuals

In human brain:
• Functional imaging
• Characterize disease-specific variations
• Assist feature recognition algorithms

Generated by deformable registration methods

Visualized by glyphs previously used in diffusion tensor visualization
Tensor computation

1) Affine transform to ICBM coordinates

2) Meshing

3) Cortical surface extraction, definition of sulcal landmarks

4) Deformable registration, tensor calculation

Per mesh node: \( T = \sum v_i v_i^T \)

Glyph Representation

\[
T = R A R^{-1}
\]

\[
= \begin{bmatrix} v_1 & v_2 & v_3 \\ \lambda_1 & 0 & 0 \\ 0 & \lambda_2 & 0 \\ 0 & 0 & \lambda_3 \end{bmatrix}
\]

Visualization of Anatomic Covariance Tensor Fields
Results with Ellipsoids

Thompson et al., 2001

Visualization of Anatomic Covariance Tensor Fields

Ellipsoid problem: visual ambiguity

one viewpoint:

another viewpoint:

Visualization of Anatomic Covariance Tensor Fields
Solution: superquadrics

Barr, 1981
For computer vision:
Pentland, 1986
For visualization:
Shaw + Ebert,
Diffusion Tensors:
Kindlmann, 2004

Superquadric Glyph Method
Superquadric Glyph Method, cont.

- Edges emphasize shape differences
- Shape respects eigensystem symmetry

Kindlmann, 2004

Covariance tensor visualization method

Contour map of tensor attribute: magnitude

Glyphs over mesh surface

Color map of tensor attribute: linear vs. planar
Results

Visualization of Anatomic Covariance Tensor Fields

Contours: FA, Colors: linear vs. planar

Results

Visualization of Anatomic Covariance Tensor Fields

Contours: size, Colors: FA
Comparison

Visualization of Anatomic Covariance Tensor Fields

ellipsoids

superquadrics

slide 12/14

Comparison

Visualization of Anatomic Covariance Tensor Fields

ellipsoids

superquadrics

slide 13/14
Discussion

Relationship to:
• brain function (language areas, sensory, motor)
• developmental stages
• evolutionary stages

Future work:
• Quantify relationship to underlying diffusion tensors
• Other visualization methods (streamlines)

All software open-source:
http://software.sci.utah.edu

Thanks:
NIH NCRR: P41 RR12553, P2 HL68566,
P41 RR13642, R21 RR19771
NIBIB: EB 001561
NIMH/NIDA: P20 MH/DA52176
Questions?