NCBC Collaboration
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3D Shape Analysis for Computational Anatomy

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Computational Functional Anatomy is the study of structure and function of populations in anatomical coordinates.

One thing that is hard is that anatomical coordinates are curved.
We compute statistics using Gaussian random fields on the response variables and complete orthonormal bases indexed over the anatomical coordinates.
Caudate Template Injected into Targets

Shape Encoded on Template Surface Structures via Random Field Models

\[ F = \sum_{k} F_k \]

structure-function
response-variables

Laplace-Beltrami or PCA Basis
Laplace-Beltrami Operator
Orthonormal Base
Computational Anatomy Analysis Toolkit

CIS Contribution to ITK

Years 1&2
• Laplace Beltrami
• PCA
CA Analysis Example cont.: Laplace-Beltrami Operator

- Implement as `itk::QuadEdgeMeshToQuadEdgeMeshFilter`
- Eventually add to `itk::` under `BasicFilters`
- Use existing `itk` and `vnl` functions (i.e., no new dependencies such as ARPACK)
- Add capability for closed and open surfaces
- Add capability for PCA base
The CFA Program: Calculate Bijections Between Anatomical Coordinate Systems
Surface Harmonics

Amygdala

Hippocampus

LB Basis 1  LB Basis 2  LB Basis 3
Left and right templates of the basal ganglia in the medial view. The caudate (C), putamen (P), and globus pallidus (G) are respectively represented in blue, yellow, and green.

Diagnostic effects within boys

Subcortical Shape Analysis in Dementia

<table>
<thead>
<tr>
<th>Groups</th>
<th>N</th>
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<th>age (mean±SD)</th>
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</tr>
</tbody>
</table>

Reconstructions in statistically significant p<.05
The ROI Statistical Paradigm

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\[ \phi_{k} \]

structure-function response-variables

Laplace-Beltrami or PCA Basis