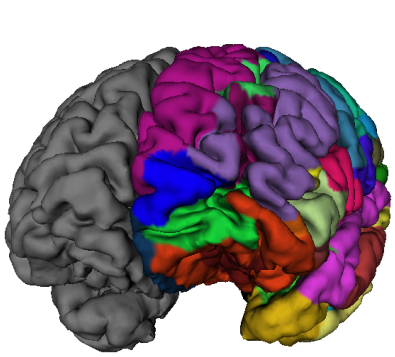
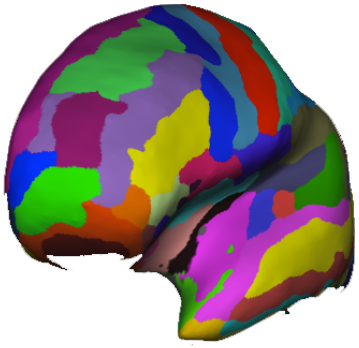
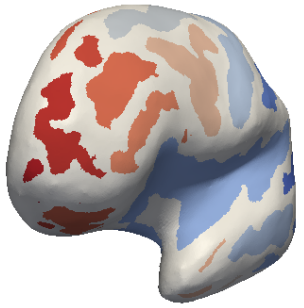
A Structural Shape Descriptor Database for Clinical Biomarkers

Nolan Nichols

CSE-577 Course Project

December 12, 2011



Background and Context

- Our goal is to classify patients into those who respond well to treatment or not based on brain shape analysis measures.
- Apply automated feature extraction and shape analysis algorithms to brains of major depressive disorder (MDD) patients.
- Classify remitters and non-remitters.
- Remitters are depressed subjects who have post-SSRI treatment Hamilton depression scores less than or equal to seven.

The Dataset

	Non-remitter (n=10)	Remitter (n=8)	p-value
Age	31.15 ± 11.28	34.30 ± 14.60	0.61[+]
# Females (%)	7 (70.00%)	4 (50.00%)	0.63[*]
# Not Recently Medicated (%)	7 (70.00%)	7 (87.50%)	0.59[*]
# Suicide Attempters	4 (40.00%)	1 (14.29%)	0.31[*]
Hamilton Depression Rating Scale	24.40 ± 4.40	25.50 ± 7.09	0.69[+]
Beck Depression Rating Scale	26.90 ± 8.50	23.75 ± 11.62	0.52[+]
Genotype			
CC	1 (10.00%)	3 (28.57%)	0.53[*]
CG	6 (60.00%)	4 (57.14%)	
GG	2 (20.00%)	1 (14.29%)	

*p-value from fisher's exact test

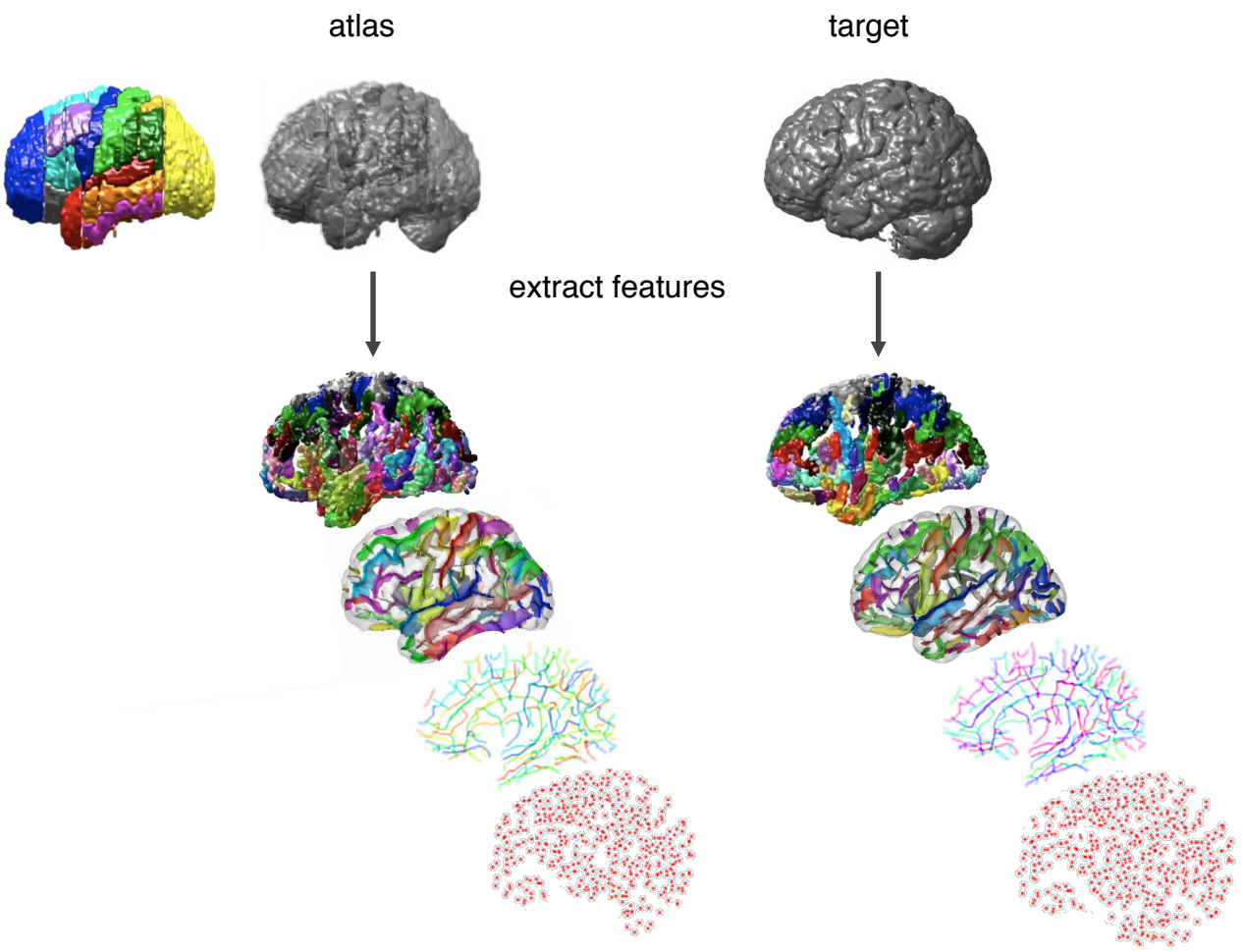
[+]p-value from 2 tailed Student's t-test

Workflow

- Extract features
- Quantify feature shapes
- Identify features
- Label brains
- Database features with labels

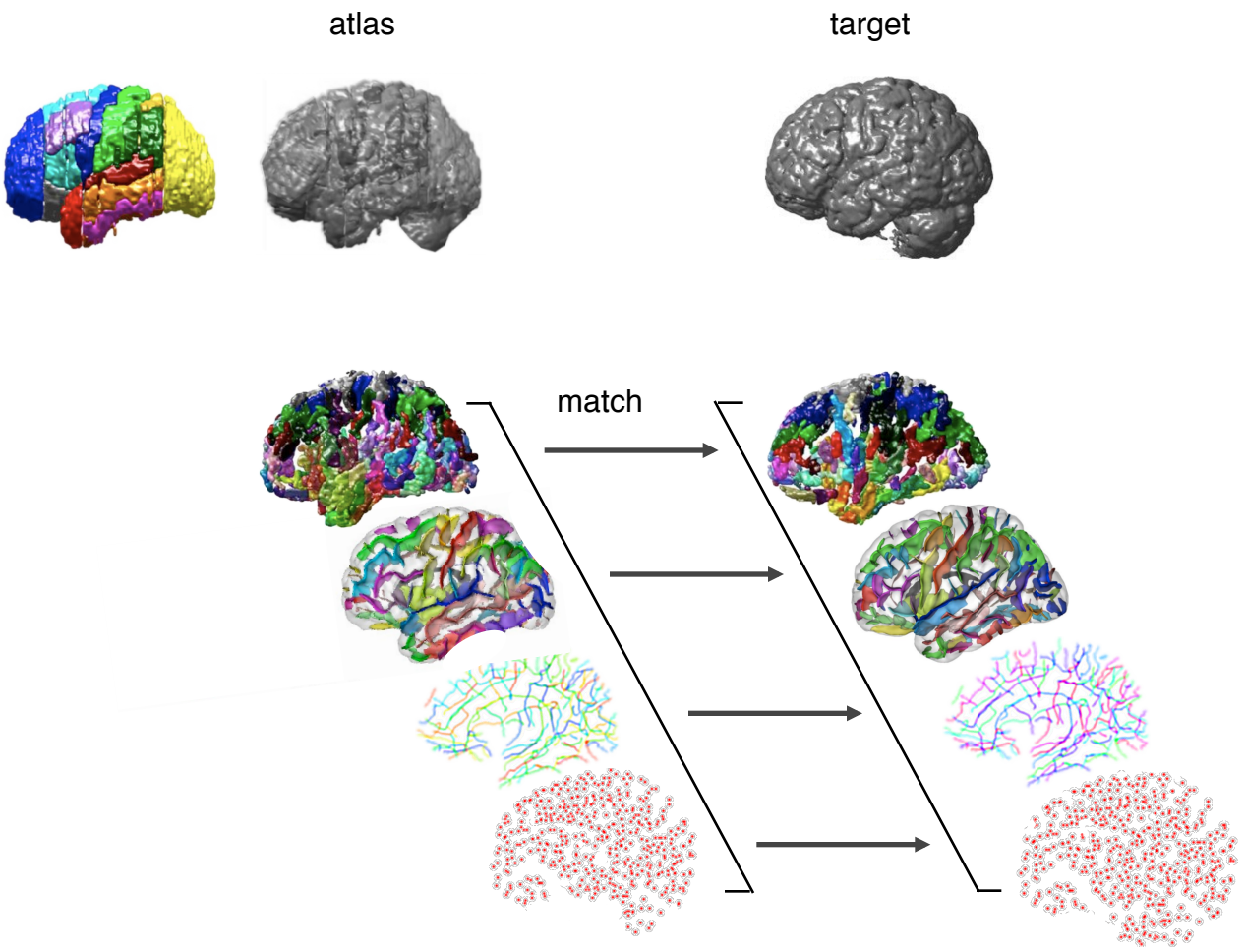
Feature-based labeling

Step 1: extract features



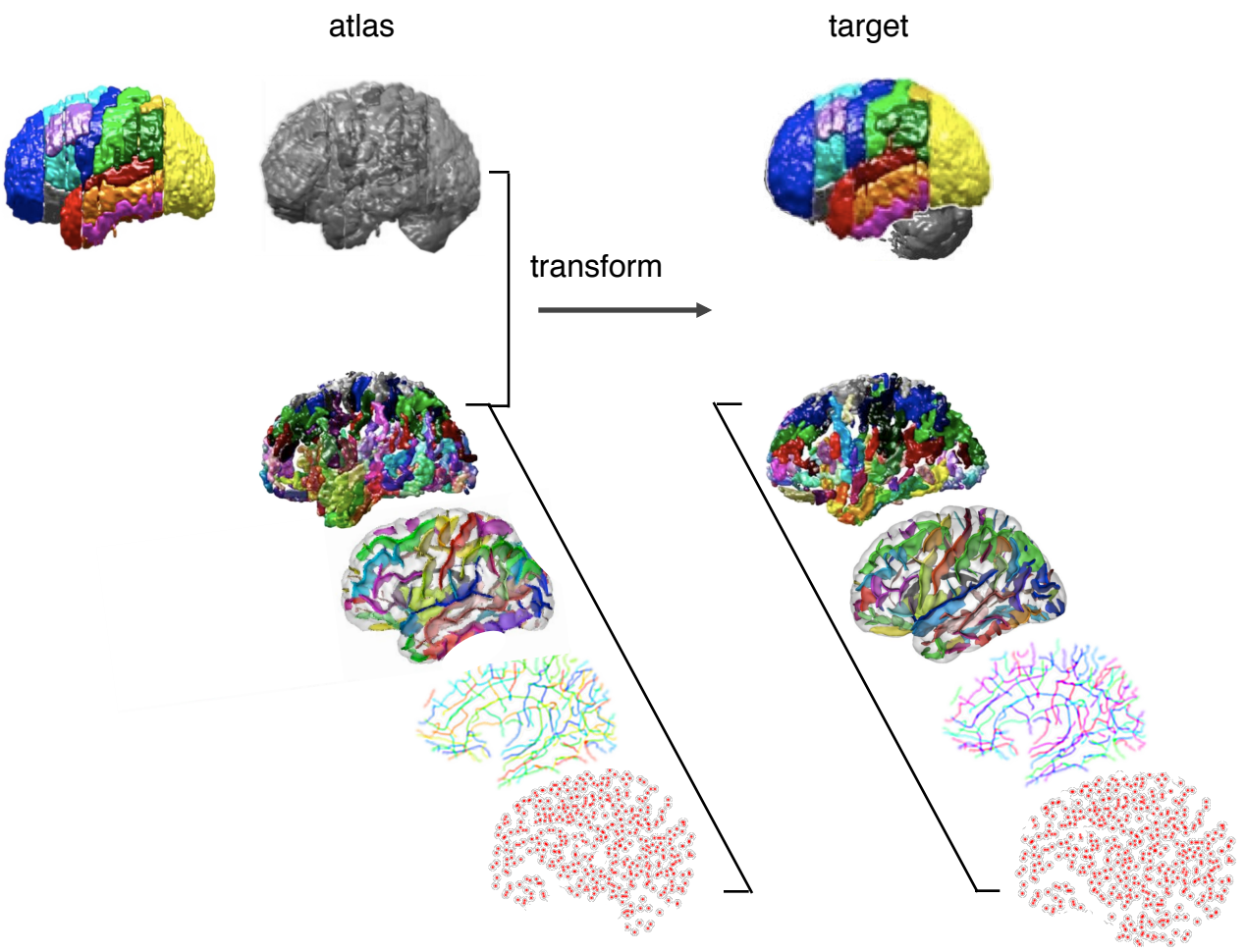
Feature-based labeling

Step 2: match atlas and target features



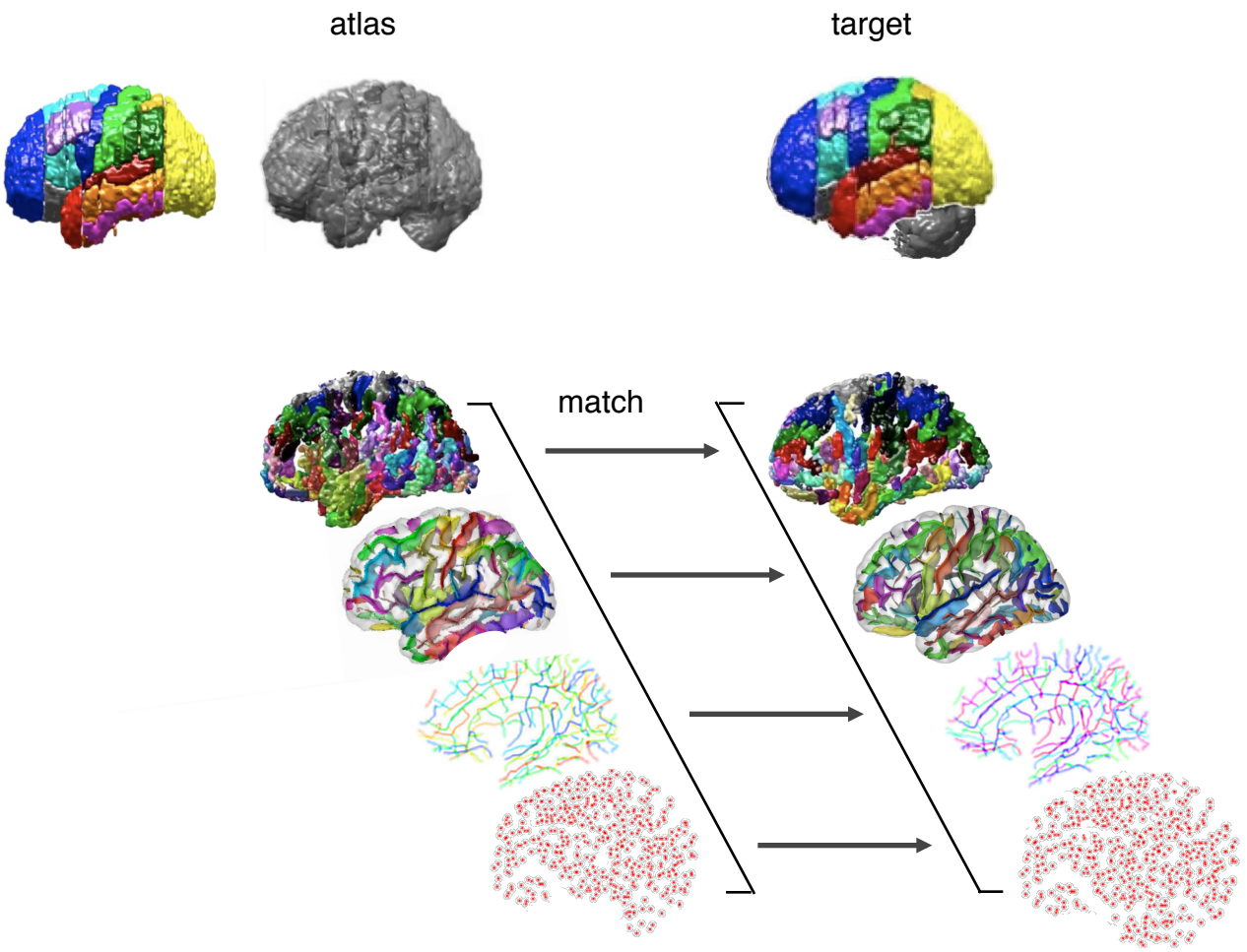
Feature-based labeling

Step 3: compute image + landmark-based registration transform from atlas to target



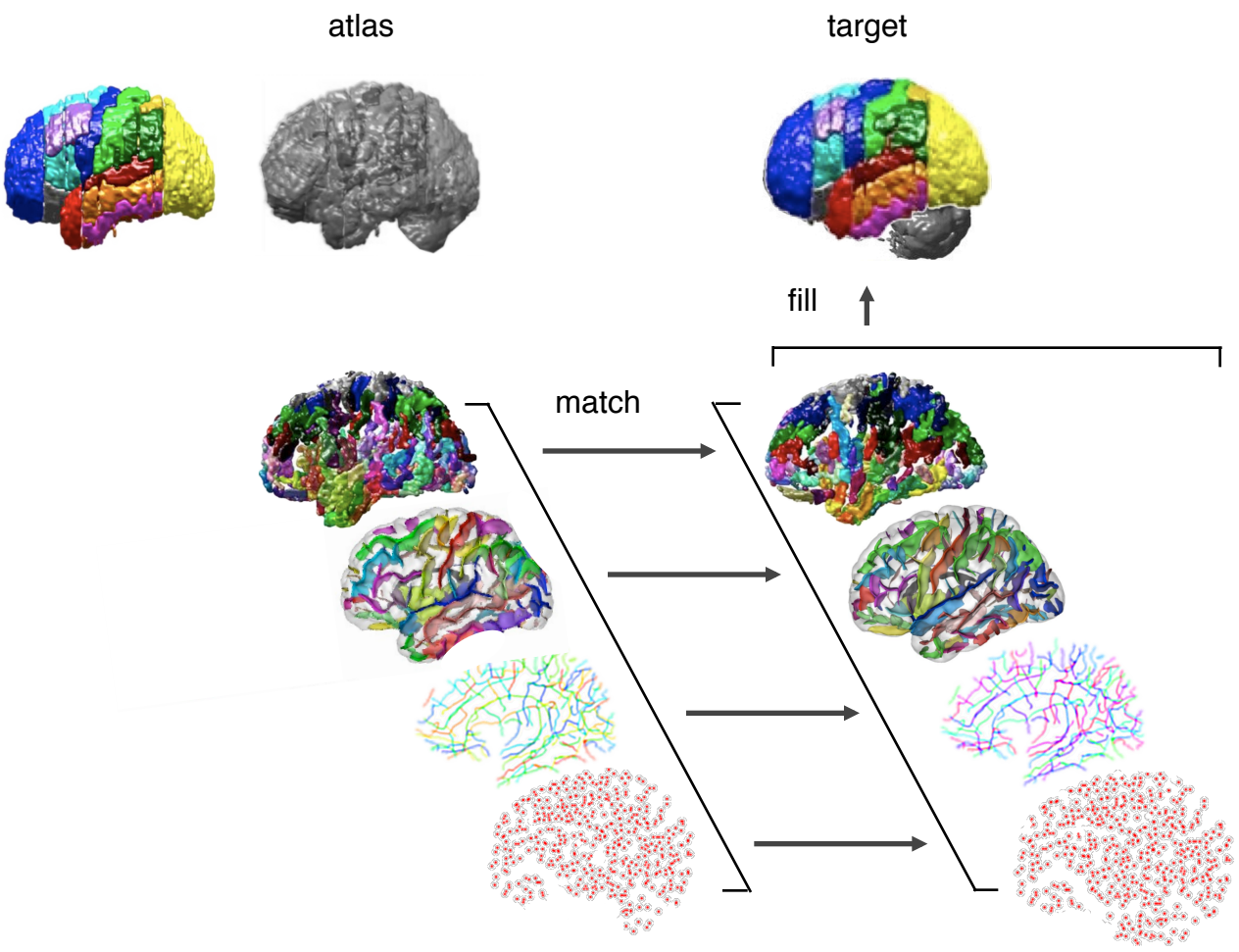
Feature-based labeling

Step 2: or match...



Feature-based labeling

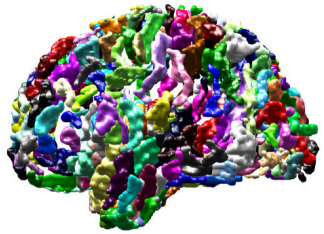
Step 3: then propagate labels within inferred label boundaries?

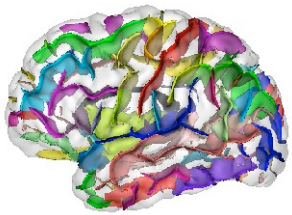


Feature-based labeling

3-D:
labeled sulcal
sulcal sulcal

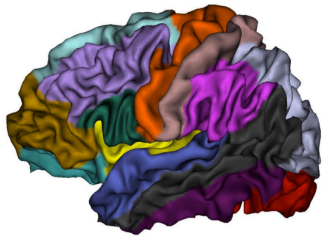
regions (manual)
basins
skeletons

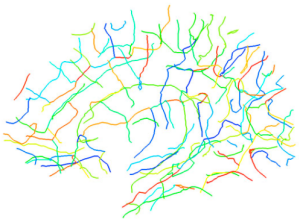




2-D:
sulcal gyral

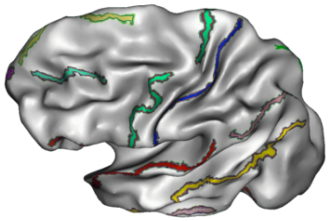
ribbons
surfaces

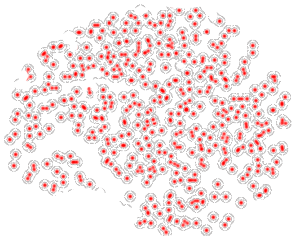




1-D:
sulcal & gyral

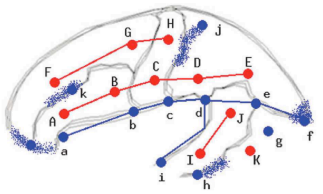
curves





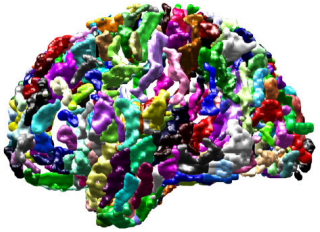
0-D:
SIFT sulcal

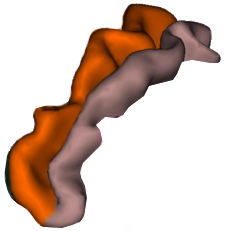
points
pits



Candidate shape measures

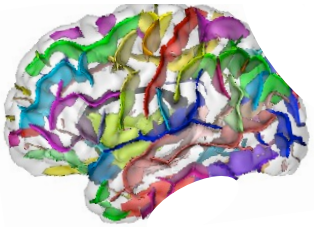
3-D

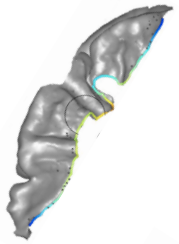




volume
surface area
lengths (thickness)
?

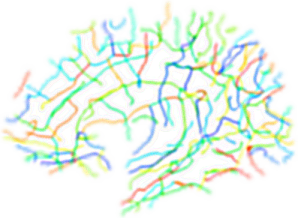
2-D





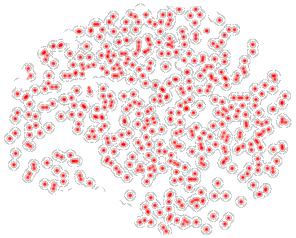
area
curvature
convexity
?

1-D



length
curvature
convexity
depth
thickness

0-D

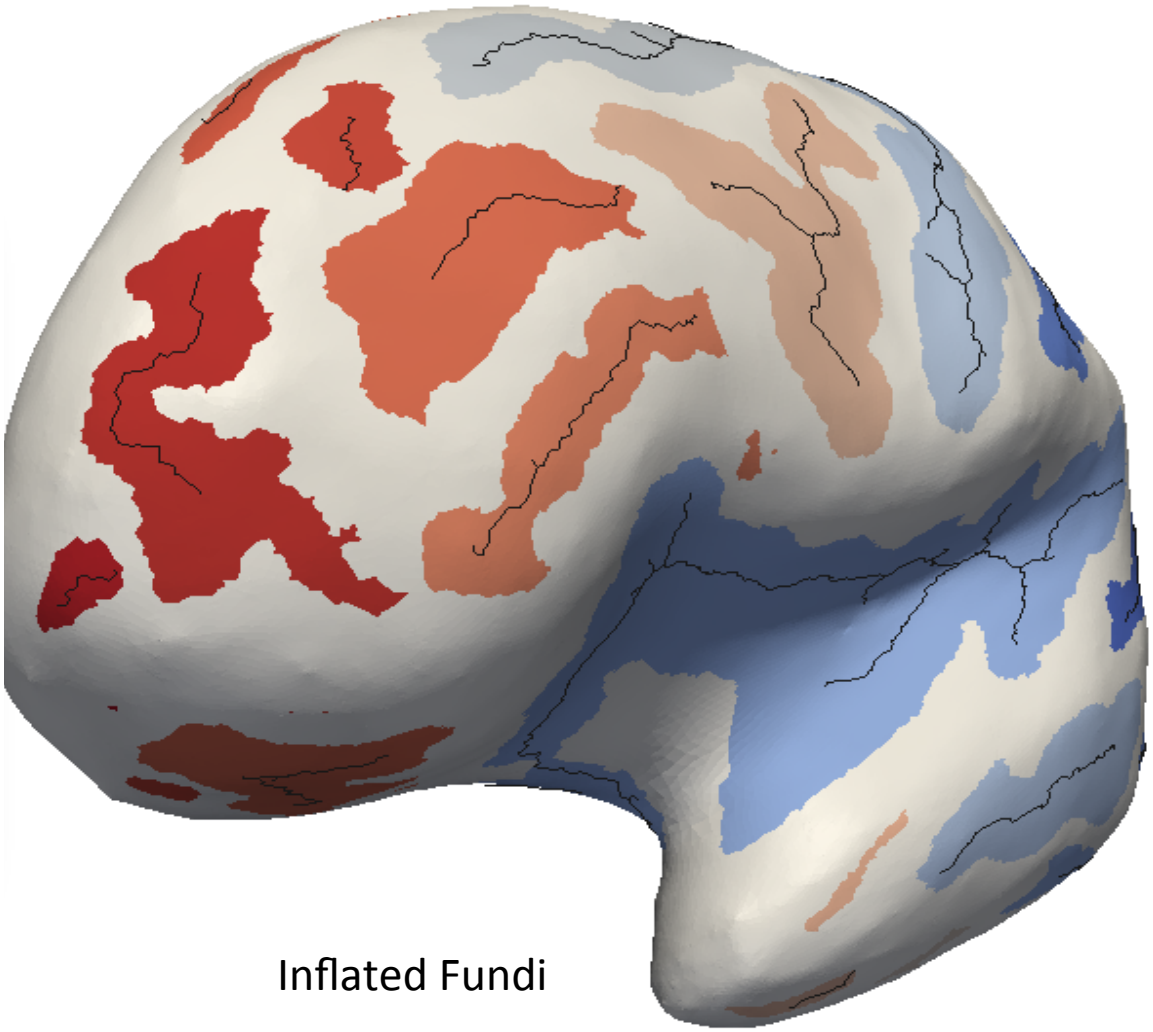


number of points
3-D convex hull volume
1-D sequence
?

Fundi Measurements

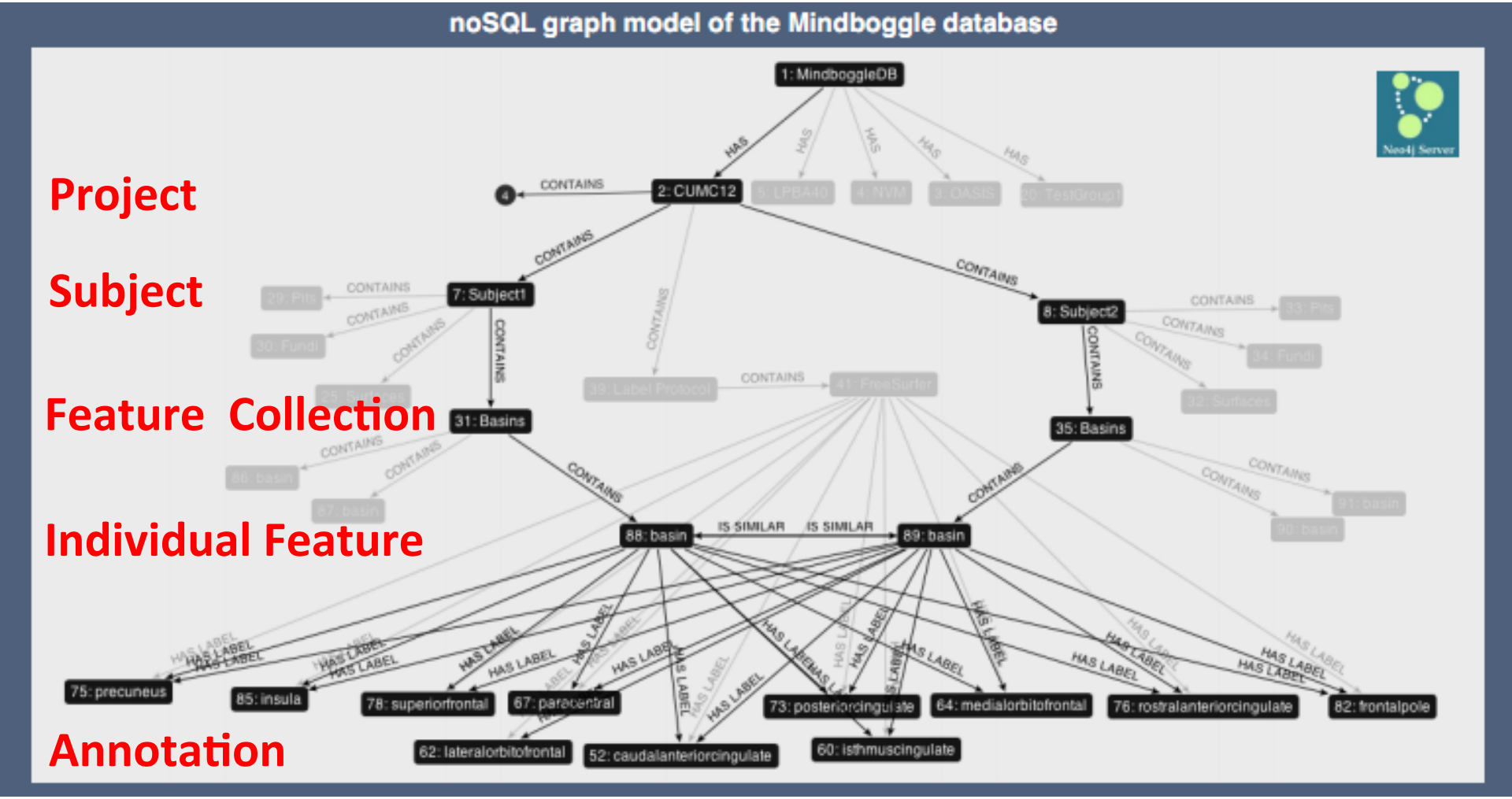
Measures:

- **length**
- **curvature**
- **convexity**
- **depth**
- **thickness**

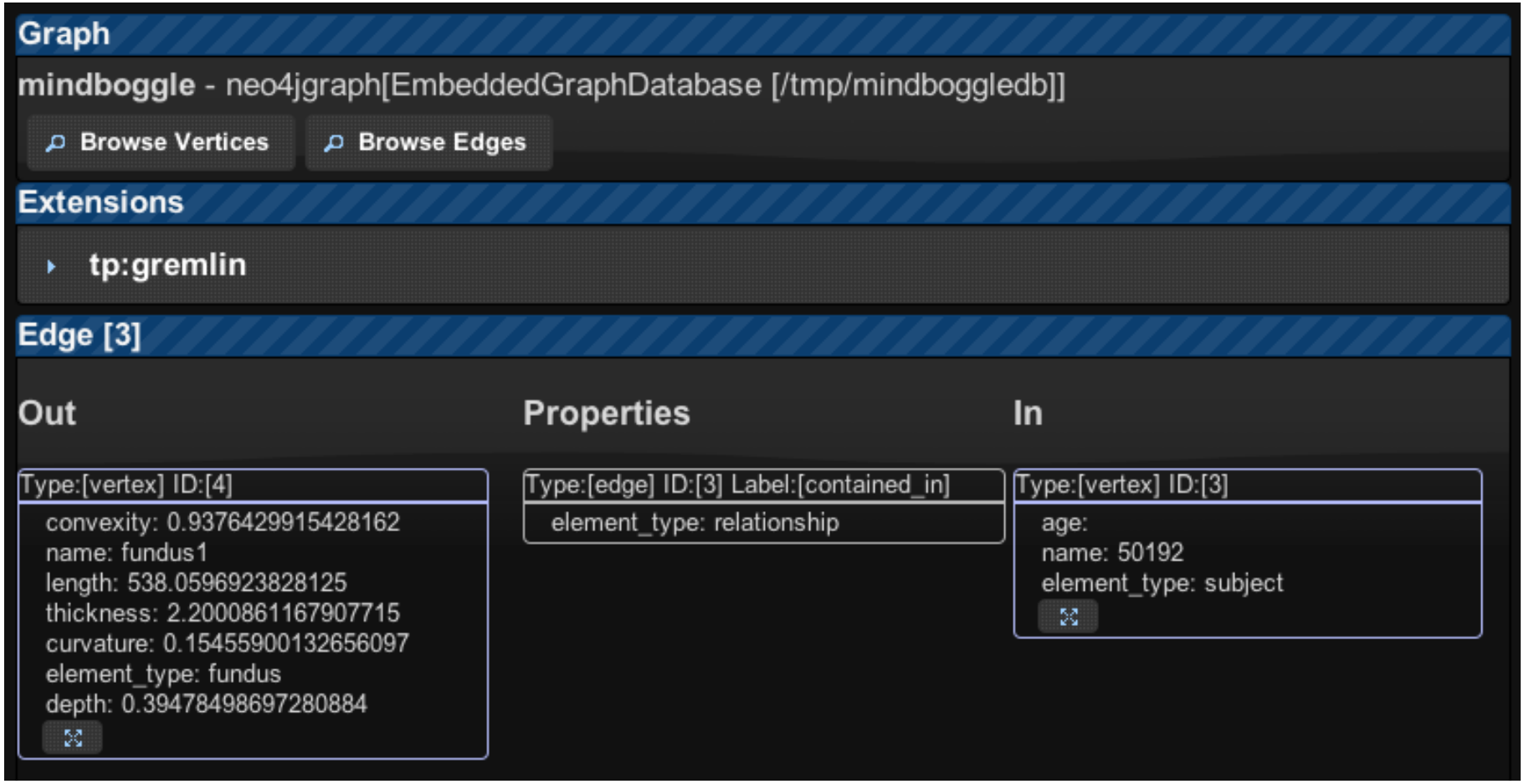


Inflated Fundi

noSQL Graph Data Model



Screenshot


Graph
mindboggle - neo4jgraph[EmbeddedGraphDatabase [/tmp/mindboggledb]]
Browse Vertices
Browse Edges
Extensions
tp:gremlin
Edge [3]
Out
Properties
In
Type:[vertex] ID:[4]
convexity: 0.9376429915428162
name: fundus1
length: 538.0596923828125
thickness: 2.2000861167907715
curvature: 0.15455900132656097
element_type: fundus
depth: 0.39478498697280884
Type:[edge] ID:[3] Label:[contained_in]
element_type: relationship
Type:[vertex] ID:[3]
age:
name: 50192
element_type: subject

Future work

- Extend graph data model to accommodate inter-subject vaiability
- Query library
  - Extract measures needed for classification
  - Sub-graph mapping
- Annotation framework
  - Semantic labels from ontologies