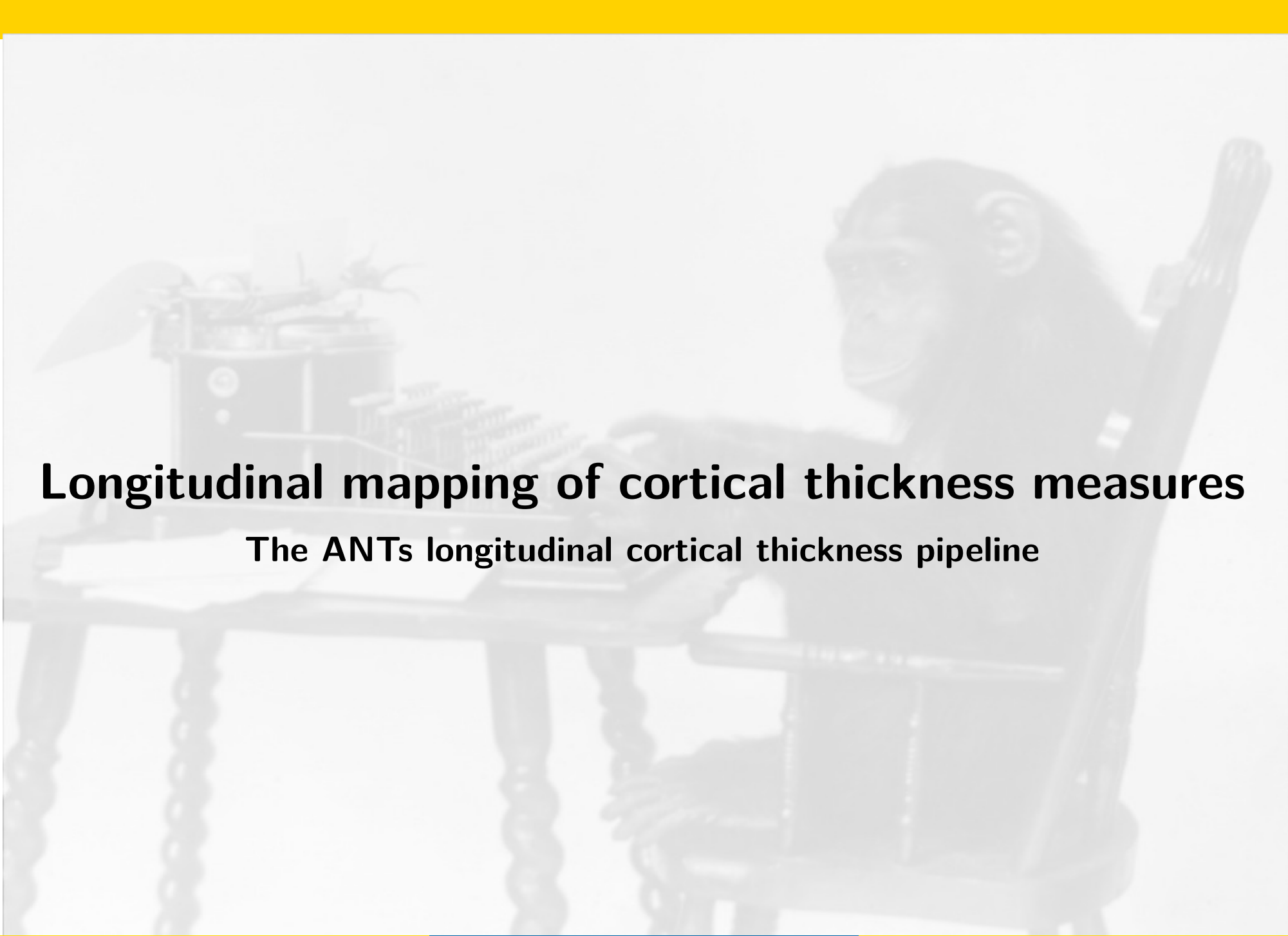
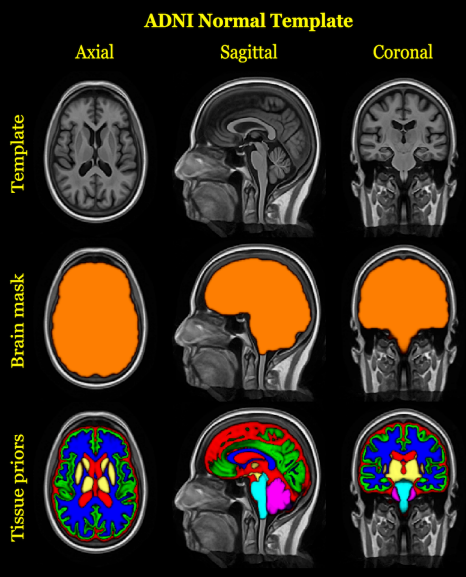
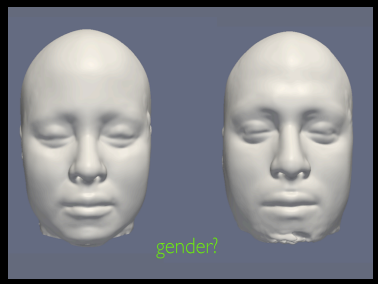


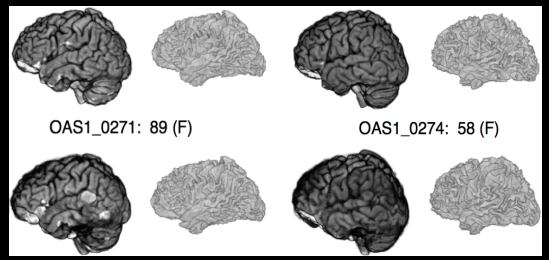
Longitudinal mapping of cortical thickness measures

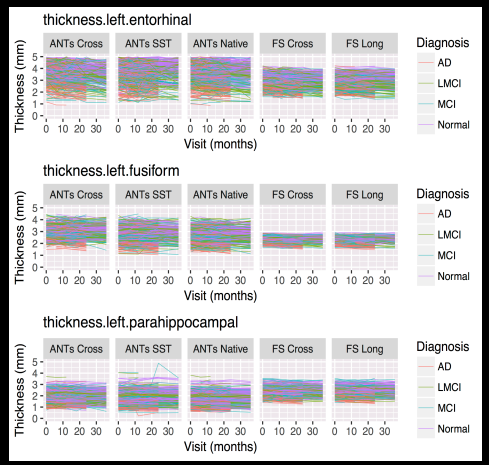
The ANTs longitudinal cortical thickness pipeline

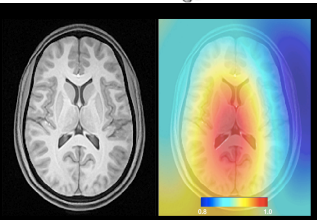
ANTs for large-scale neuroimage quantitative analysis

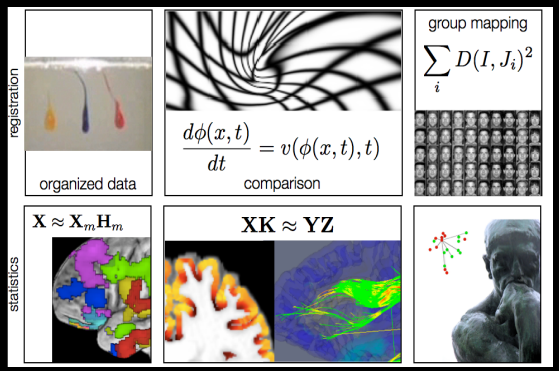


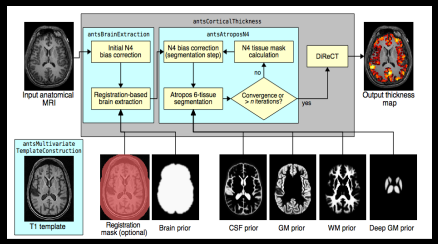


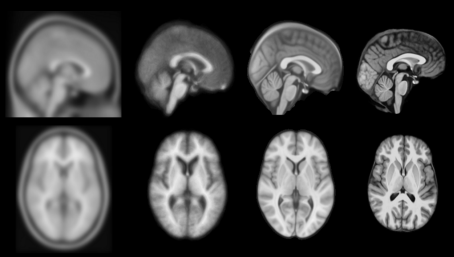


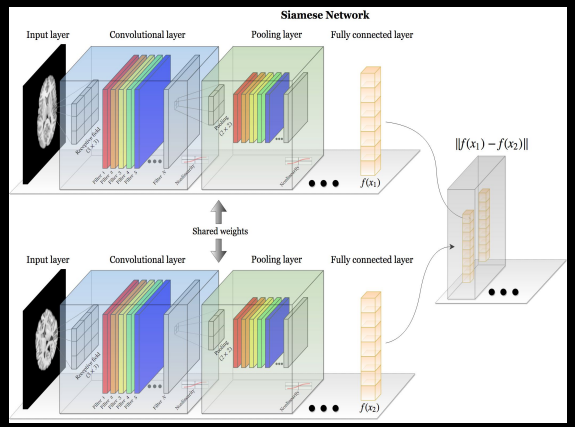


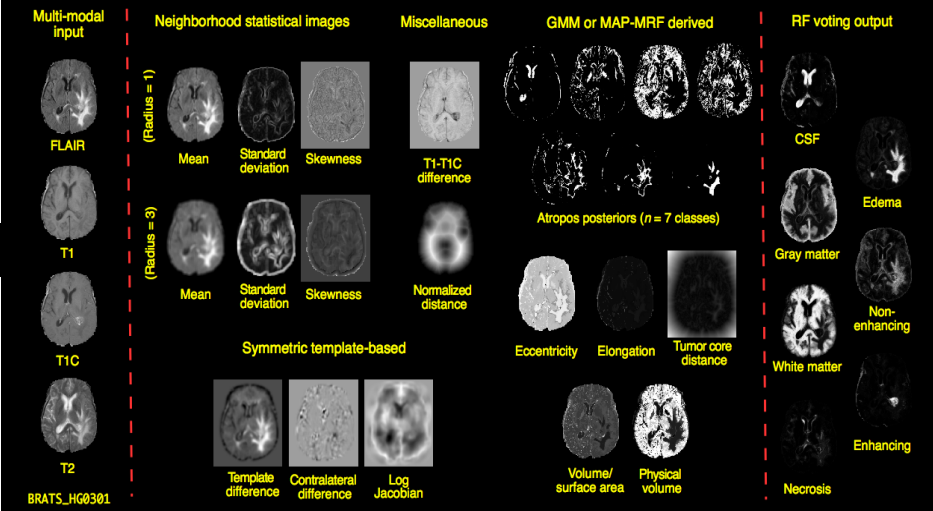


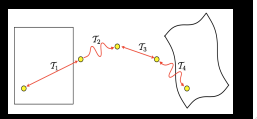


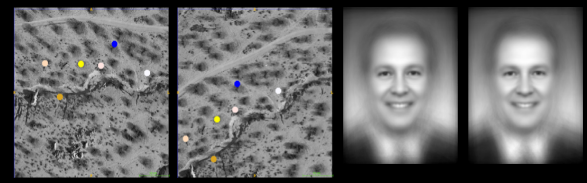






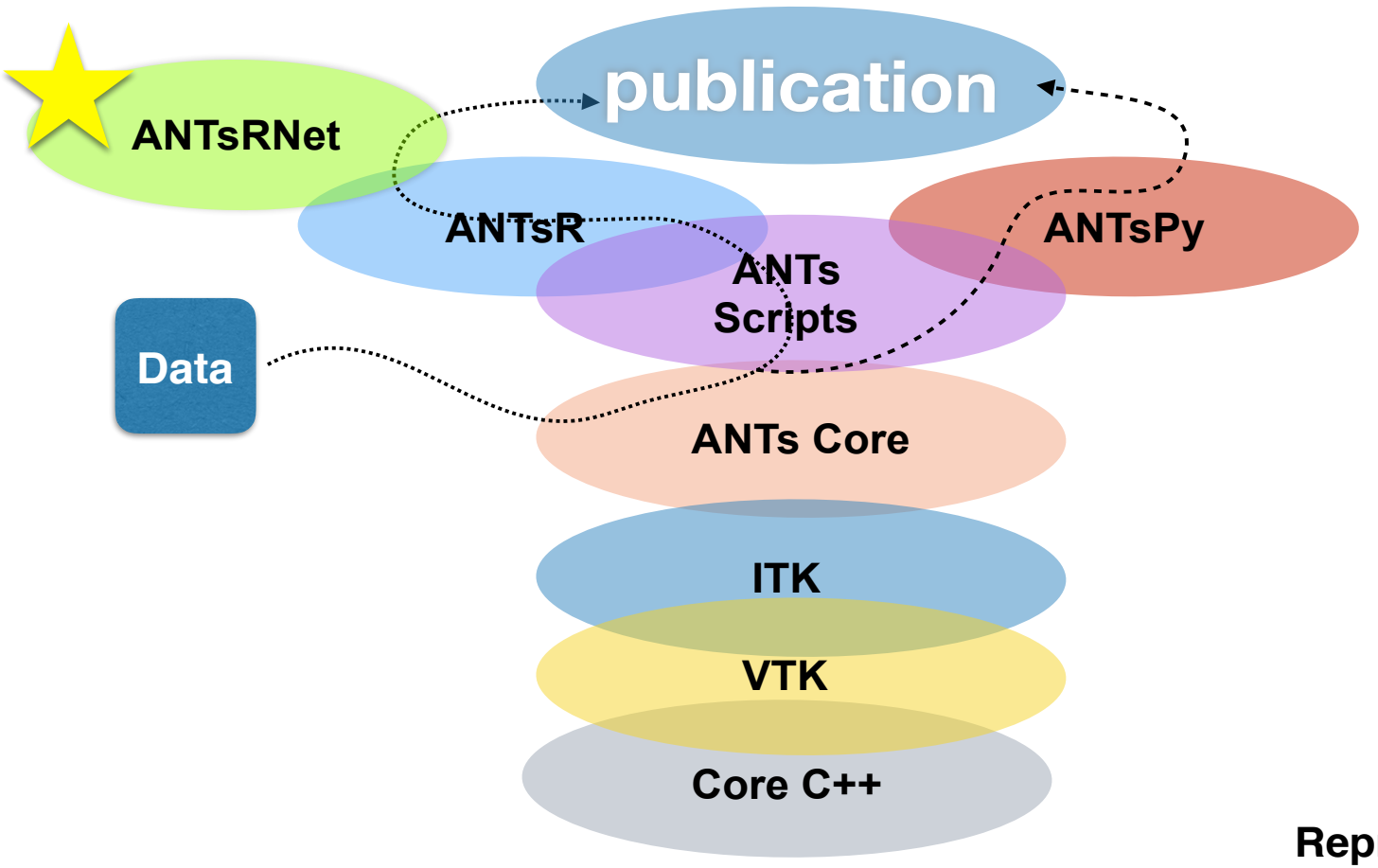






ANTs open-source ecosystem

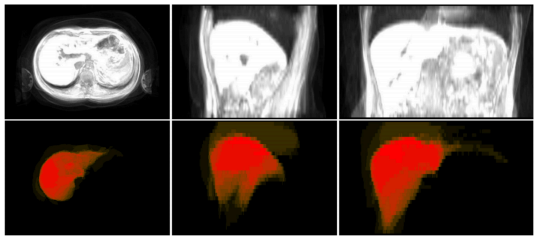
ANTsR & ANTsPy

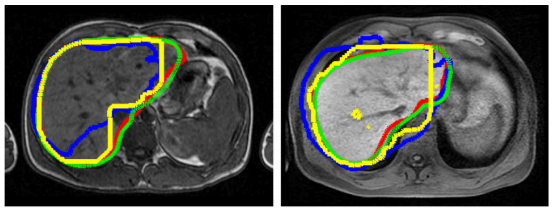


Reproducible science stack

General purpose core

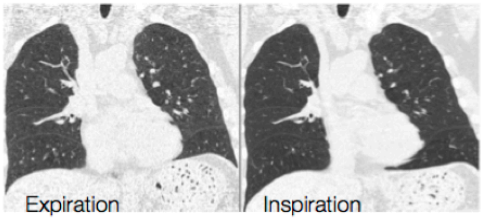
Liver registration/segmentation*



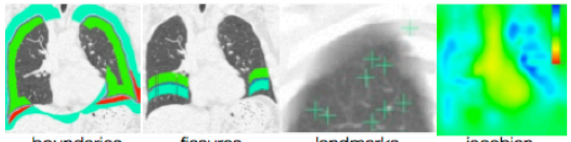


(a) Subject 1 (b) Subject 2

Lung: EMPIRE 10 Challenge

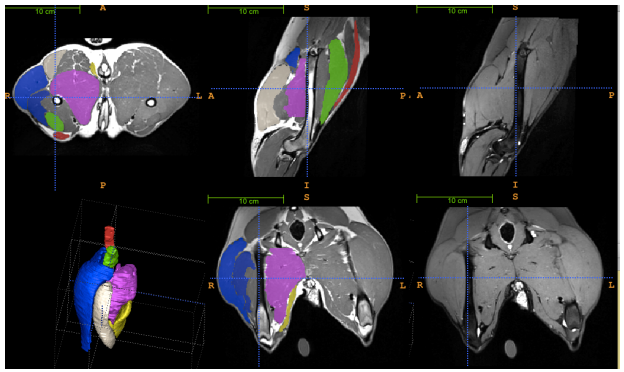


- Register pairs of thoracic CT volumes
- Part of MICCAI 2010 Grand Challenges: http://empire10.isi.uu.nl
- First round offline competition finished on June 21, 2010
- **ANTS** by *picsl gsyn* : 1st place among 34 teams

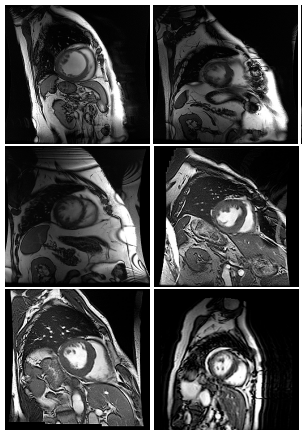


	Lung Boundaries		Fissures		Landmarks		Folding		Overall			
Team Name	Avg Score	Avg Rank	Avg Score	Avg Rank	Avg Score	Avg Rank	Avg Score	Avg Rank	Avg Rank	Placed	Last Update	Method Type
picsl gsyn	0.12	8.00	0.03	9.52	0.75	3.65	0.00	13.77	8.73	1	25 Jun 2010	Fully Auto
Nifty Reggers	0.00	7.57	0.27	12.30	0.75	7.25	0.00	12.50	9.90	2	26 Jun 2010	Fully Auto
Iowa sstvd											26 Jun	Fully

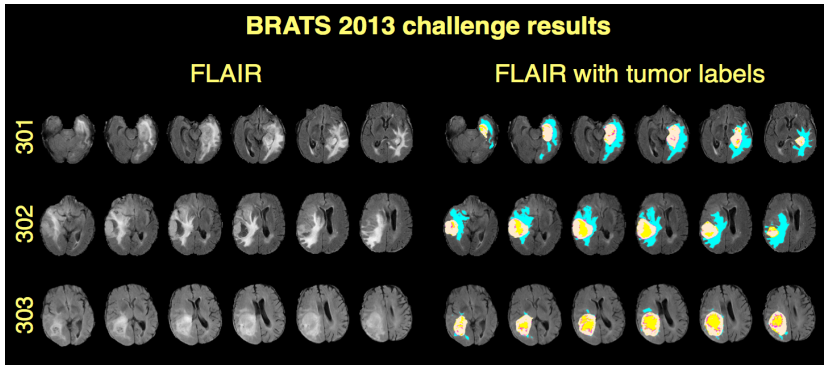
7,000+ *multivariate* registrations



Heart: 13,000+ 4D registrations



Brain tumor segmentation

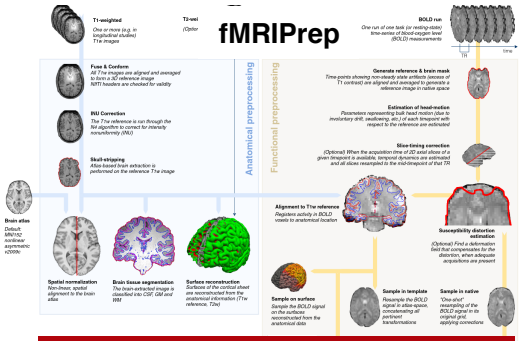


Patient

Position	User	Dice			Positive Predictive Value			Sensitivity			Kappa	Complete tumor Rank	Tumor core Rank	Enhancing tumor Rank
		complete	core	enhancing	complete	core	enhancing	complete	core	enhancing				
1	Nick Tustison	0.87 (1)	0.78 (1)	0.74 (1)	0.85 (2)	0.74 (4)	0.69 (4)	0.89 (2)	0.88 (1)	0.83 (1)	0.99 (1)	1.67	2.00	1.89
2	Raphael Meier	0.82 (5)	0.73 (2)	0.69 (3)	0.76 (6)	0.78 (2)	0.71 (1)	0.92 (1)	0.72 (4)	0.73 (3)	0.99 (4)	4.00	2.67	3.00
3	Syed Reza	0.83 (4)	0.72 (3)	0.72 (2)	0.82 (3)	0.81 (1)	0.70 (3)	0.86 (5)	0.69 (6)	0.76 (2)	0.99 (3)	4.00	3.33	3.22
4	Liang Zhao	0.84 (3)	0.70 (4)	0.65 (5)	0.80 (4)	0.67 (5)	0.65 (6)	0.89 (3)	0.79 (3)	0.70 (4)	0.99 (5)	3.33	4.00	4.11
5	Nicolas Cordier	0.84 (2)	0.68 (5)	0.65 (6)	0.88 (1)	0.63 (6)	0.68 (5)	0.81 (6)	0.82 (2)	0.66 (6)	0.99 (2)	3.00	4.33	4.33
6	Joana Festa	0.72 (6)	0.66 (6)	0.67 (4)	0.77 (5)	0.77 (3)	0.70 (2)	0.72 (7)	0.60 (7)	0.70 (5)	0.98 (6)	6.00	5.33	5.00
7	Senan Doyle	0.71 (7)	0.46 (7)	0.52 (7)	0.66 (7)	0.38 (7)	0.58 (7)	0.87 (4)	0.70 (5)	0.55 (7)	0.98 (7)	6.00	6.33	6.44

Multiple modality canine MRI: segmentation

User base (industry and academia)

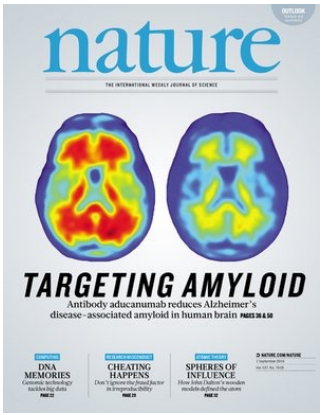


Stanford University

NeuroDebian

KONICA MINOLTA

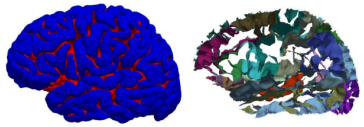
USC Laboratory of Neuro Imaging



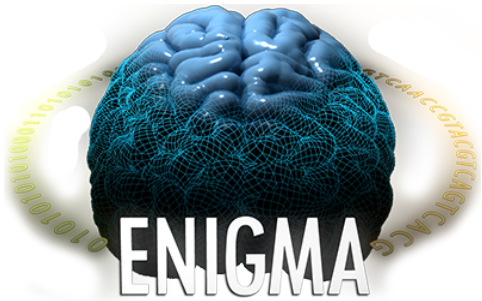
hhmi Howard Hughes Medical Institute

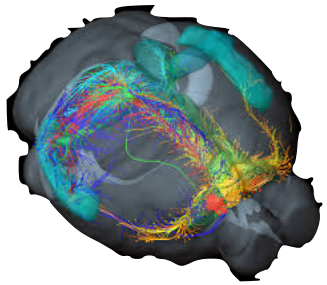
LEAD DBS

ADNI Alzheimer's Disease Neuroimaging Initiative


MINDBOGGLE

Princeton Neuroscience Institute





SCT Spinal Cord Toolbox

Google

ALLEN INSTITUTE for BRAIN SCIENCE

CHILD MIND® INSTITUTE big data analytics

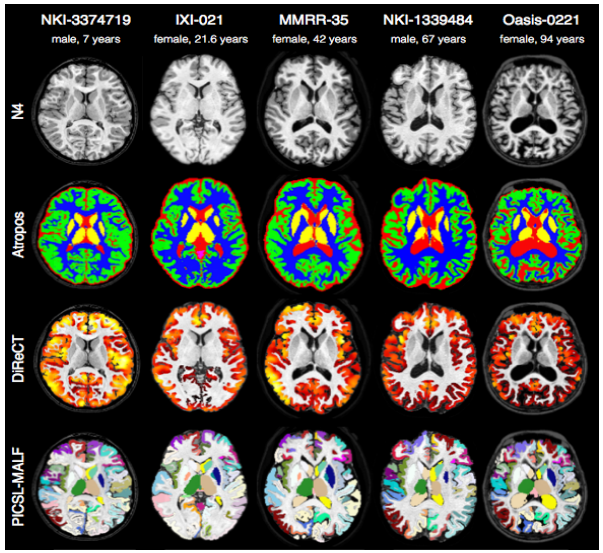
C-PAC

ITK

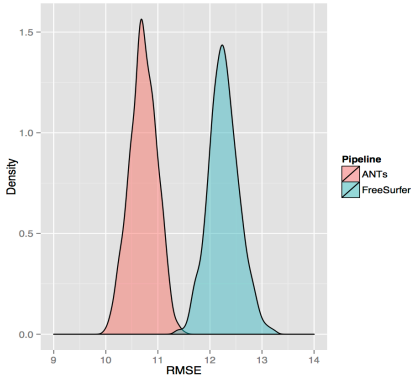
DiReCT: cortical thickness

DiReCT
cortical thickness

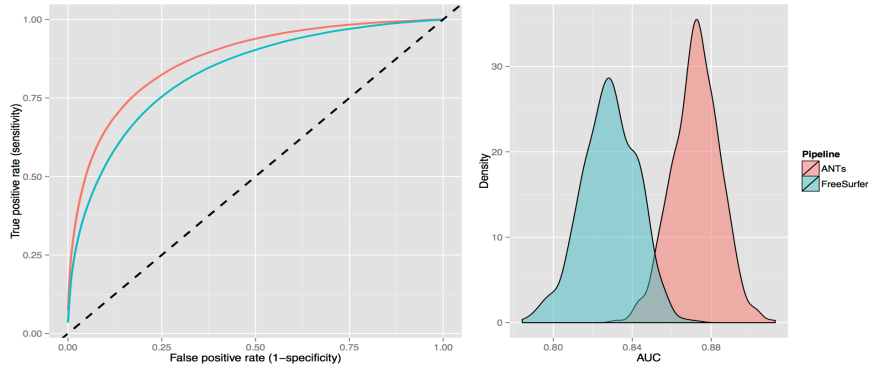
Column1	Column2
Tetris-playing ability	chronic pancreatitis
Huntington's disease	obsessive-compulsive disorder
schizophrenia	ADHD
bipolar disorder	obesity
Alzheimer's disease	heritable depression
frontotemporal dementia	elderly depression
Parkinson's disease	age
Williams syndrome	gender
multiple sclerosis	handedness
autism	intelligence
migraines	athletic ability
chronic smoking	meditative practices
alcoholism	musical ability
cocaine addiction	tendency toward criminality
Tourette syndrome in children	childhood sexual abuse in female adolescents
scoliosis in female adolescents	traumatic brain injury
early-onset blindness	untreated male-to-female transsexuality



How do we evaluate?



Age

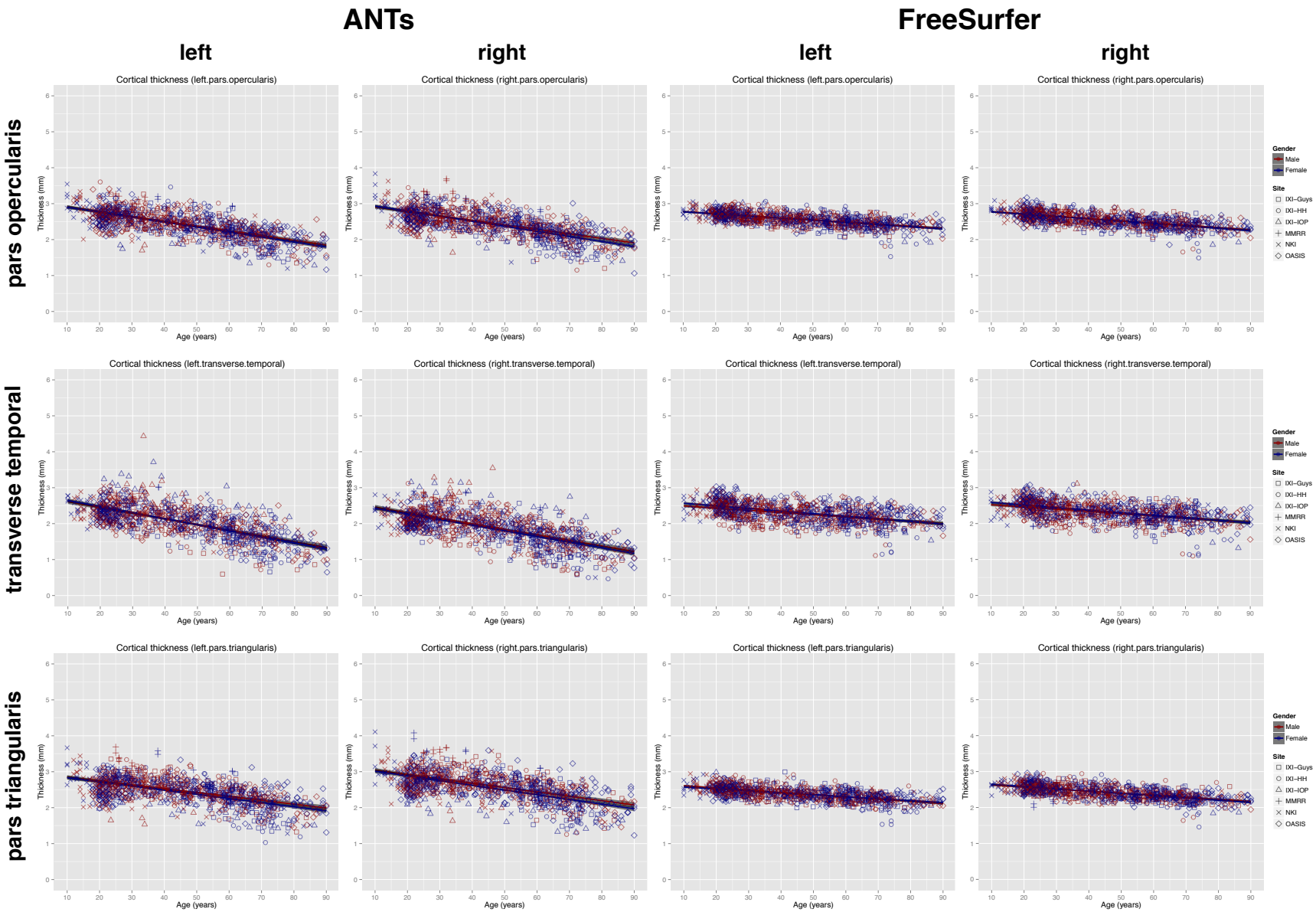


Gender

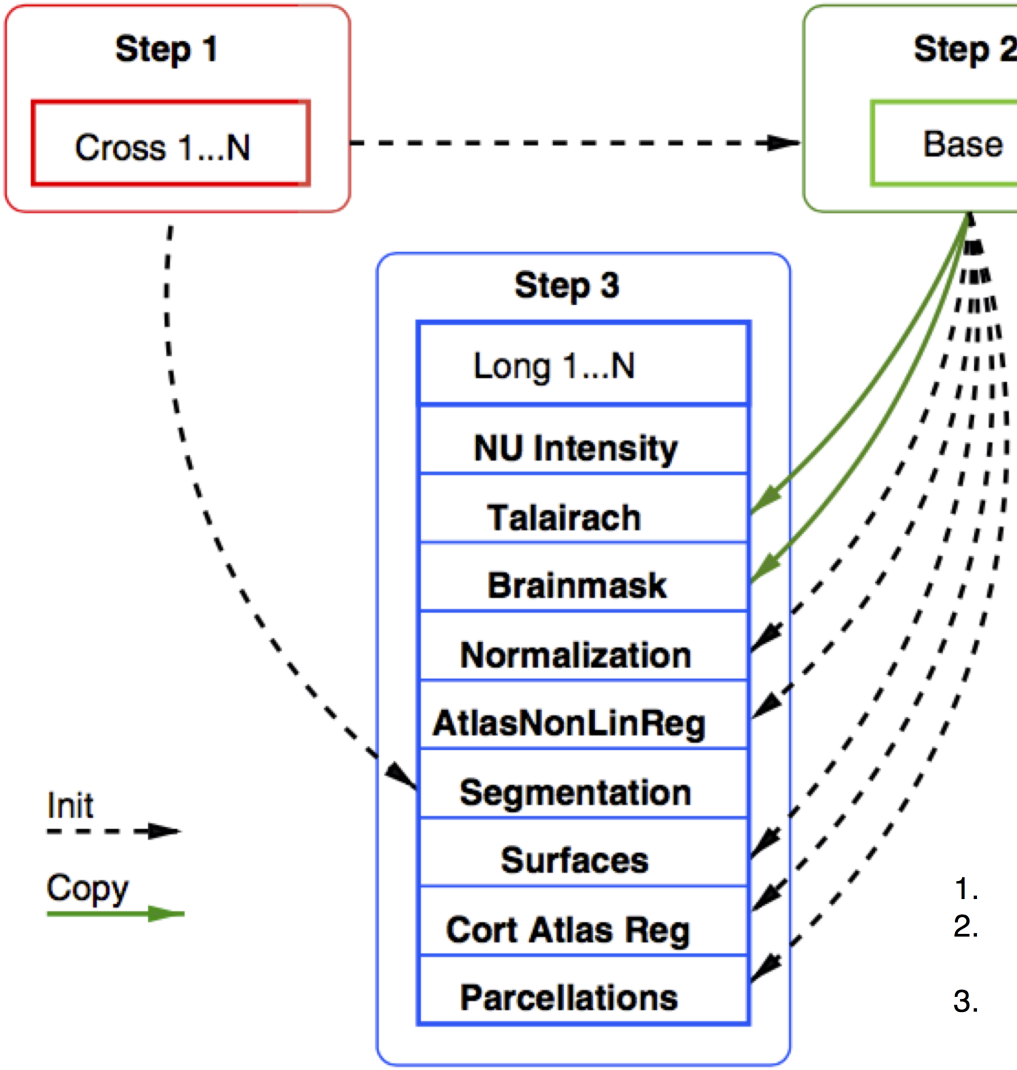
Repeatability:
$ICC_{FS} = 0.97$, $ICC_{ANTs} = 0.98$

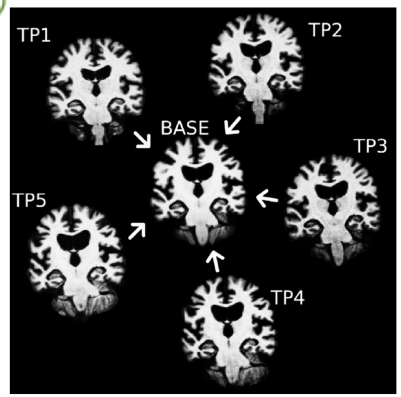
Large-Scale Evaluation of ANTs and FreeSurfer Cortical Thickness Measurements. NeuroImage, 2014.

Cross-sectional comparison



FreeSurfer longitudinal pipeline



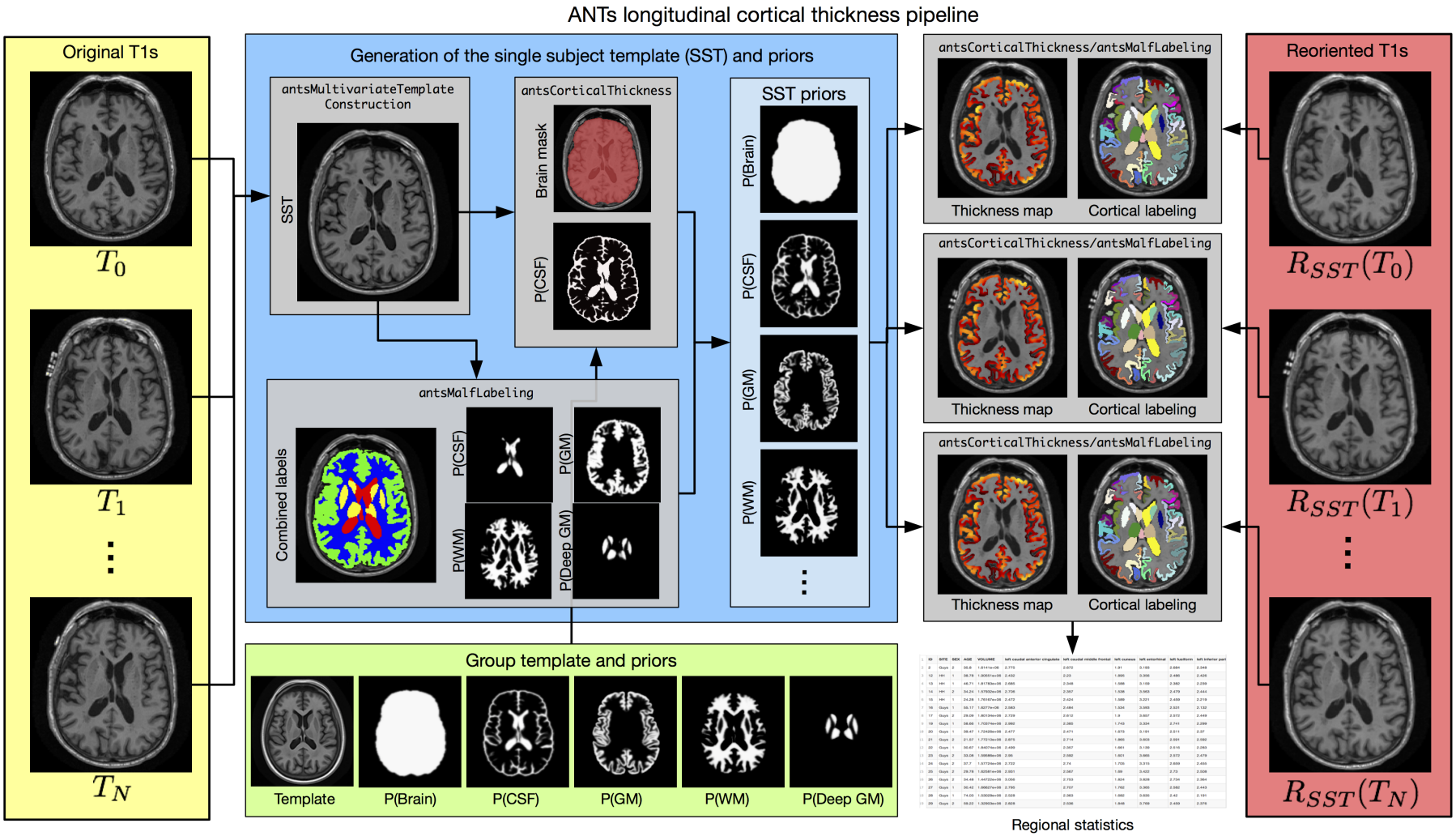


Median template ("Base")

FreeSurfer long. steps

1. FS processing of each time point.
2. Median template construction and FS processing.
3. FS processing of each rotated time point with "Base" initialization.

ANTs longitudinal pipeline



Evaluation?

After all this developmental effort[1]:

- is the extra longitudinal processing worth it? I.e., is it better than just processing data through the cross-sectional pipeline?
- And, if so, do we process in native space or SST space?

Although ANTs processing has certain advantages (just as FreeSurfer has advantages),

- can we determine if the cortical thickness measures are somehow "better" than FreeSurfer's?
- And can we do it in a more general way than has been done previously?

[1] First GitHub commit Aug. 27, 2014. Most recent Feb. 28, 2019.