The ANTs Cortical Thickness Pipeline

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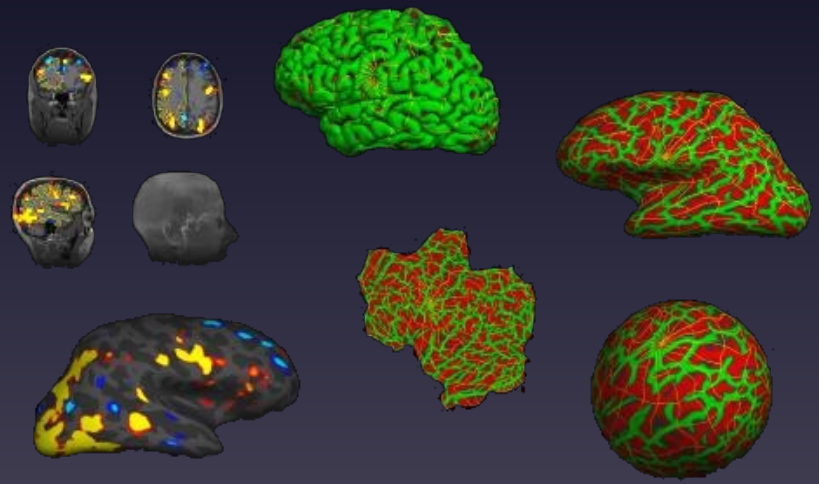
Cortical thickness studies

- Huntington's disease
- schizophrenia
- bipolar disorder
- Alzheimer's disease
- Fronto-temporal dementia
- Parkinson's disease
- Williams syndrome
- multiple sclerosis
- autism
- migraines
- chronic smoking
- alcholism
- cocaine addiction
- Tourette syndrome in children
- scoliosis in female adolescents
- obsessive compulsive disorder
- attention deficit hyperactivity disorder
- obesity
- heritable depression
- elderly depression

Cortical thickness studies (cont.)

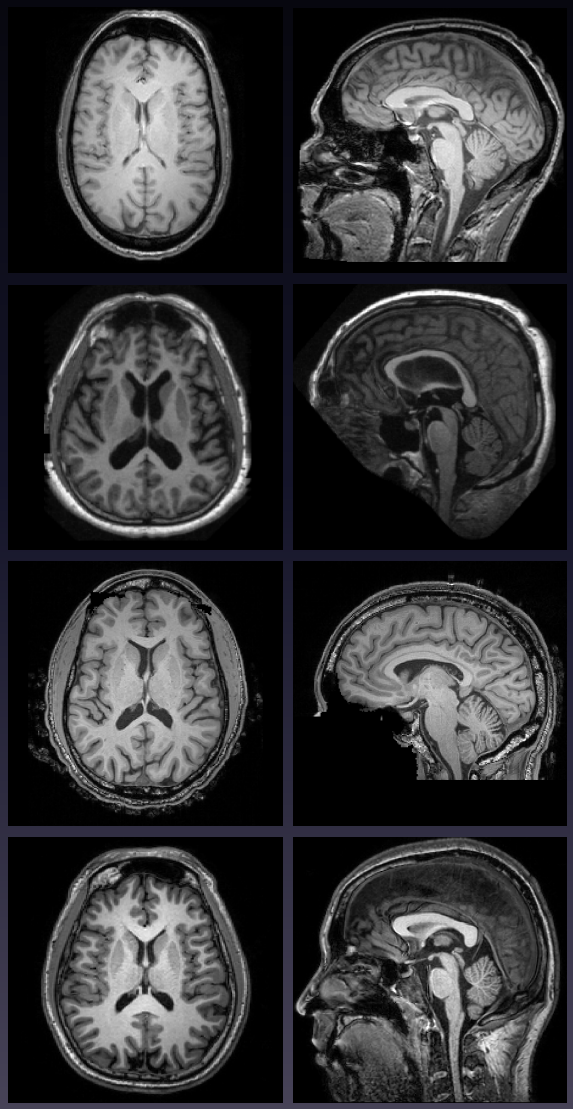
- Correlated with:
  - age
  - gender
  - untreated transsexuality
  - handedness
  - intelligence
  - athletic ability
  - musical ability
  - tendency towards criminality
  - Tetris-playing ability in female adolescents
- functional connectivity relationships

FREESURFER



Data

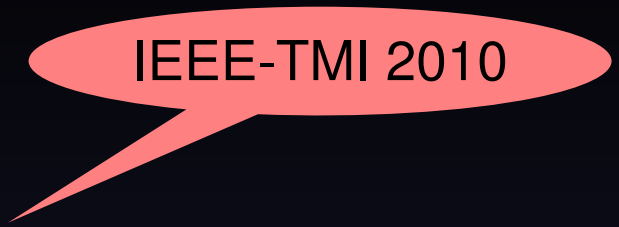
- IXI (Imperial College)
  - 581 subjects
  - T1, T2, PD, DWI
  - 3 sites, 1.5 & 3 T
- Oasis (WUSTL)
  - 416 subjects
  - 100 mild AD
  - defaced
- NKI/Rockland
  - 188 subjects
  - T1, T2, R-fMRI, DTI
  - defaced
- Kirby (VU)
  - 41 subjects
  - T1, T2, DTI,. . .



Algorithms

- `N4BiasFieldCorrection.cxx`
- `antsRegistration.cxx`
- `antsAffineInitializer.cxx`
- `Atropos.cxx`
- `KellyKapowski.cxx`
- `ImageMath.cxx`
- `abp.sh`

Algorithms



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Algorithms

MIA 2008, IEEE-TIP 2009

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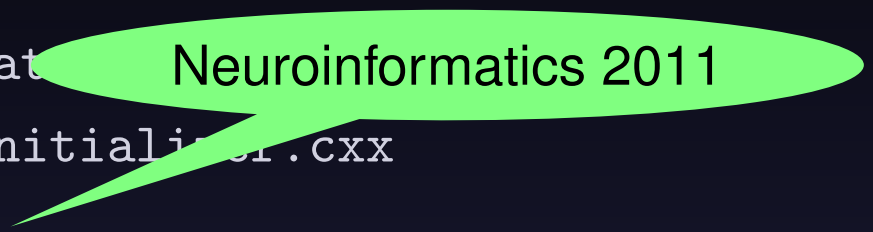

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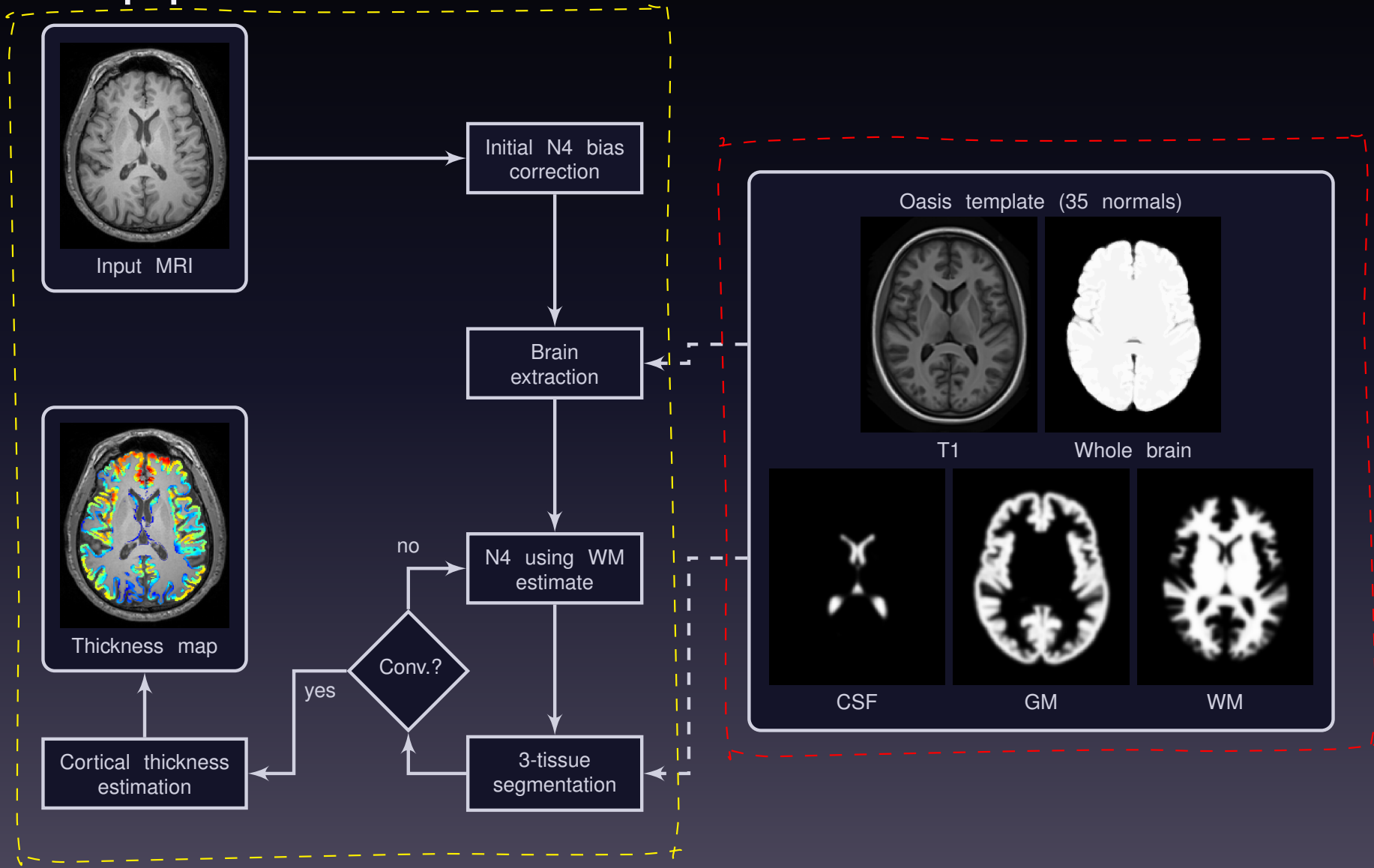
Neuroimage 2009

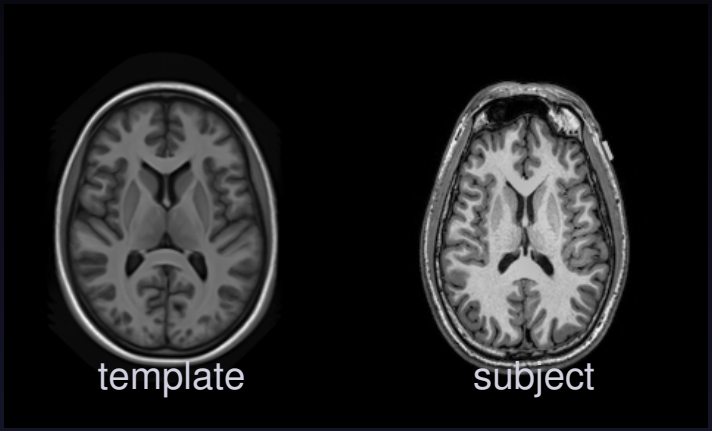
abp.sh

```
$ sh ~/Pkg/Utilities/scripts/abp.sh

This script, apb.sh, performs T1 anatomical brain processing where the following
steps are currently applied:

  1. Brain extraction
  2. Brain 3-tissue segmentation
  3. Cortical thickness
  4. (Optional) registration to a template

Usage:

abp.sh -d imageDimension
       -a anatomicalImage.nii.gz
       -e brainExtractionTemplate
       -m brainExtractionProbabilityMask
       -l brainSegmentationTemplate
       -p brainSegmentationPriors
       <OPTARGS>
       -o outputPrefix

Example:

  bash /Users/ntustison/Pkg/Utilities/scripts/abp.sh -d 3 -i t1.nii.gz -e brainWithSkullTemplate.nii.gz
  -m brainPrior.nii.gz -l segmentationTemplate.nii.gz -p segmentationPriors%d.nii.gz -o output

Required arguments:
   ...

Optional arguments:
   ...
```

ANTs pipeline for cortical thickness estimation



Brain extraction



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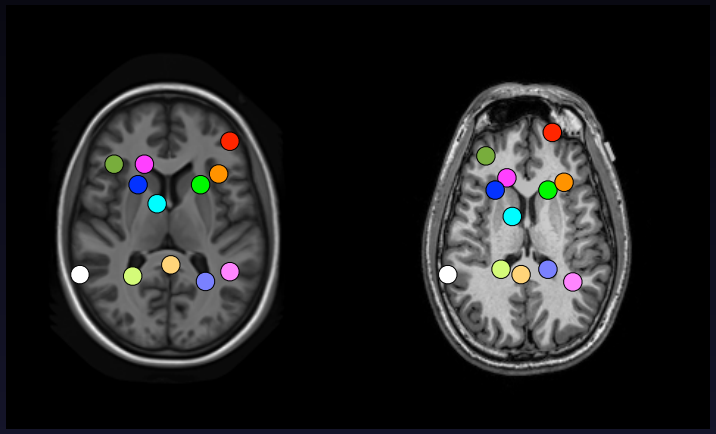
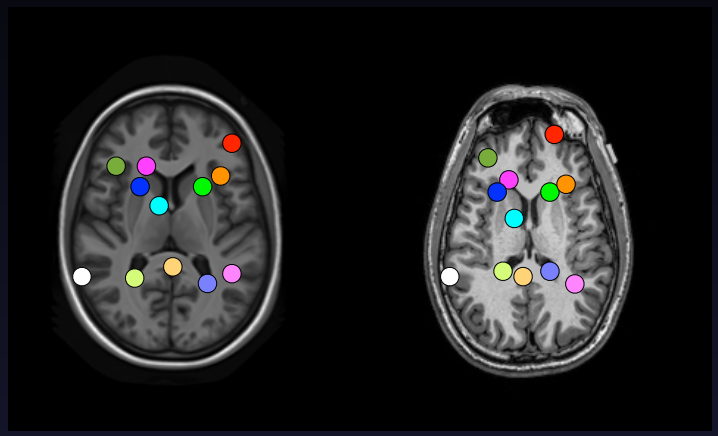
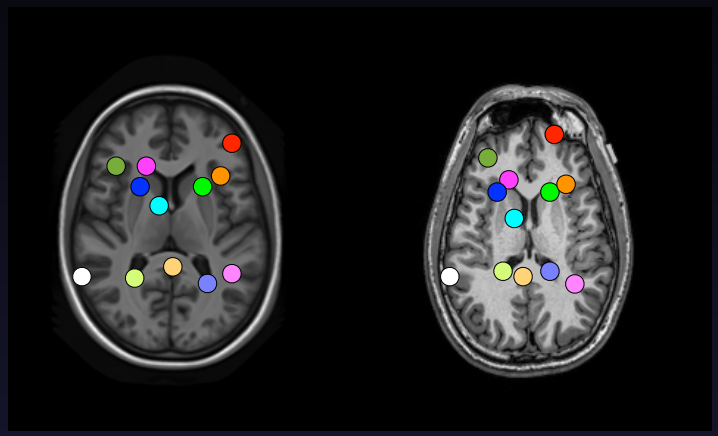


Brain extraction



Affine init.

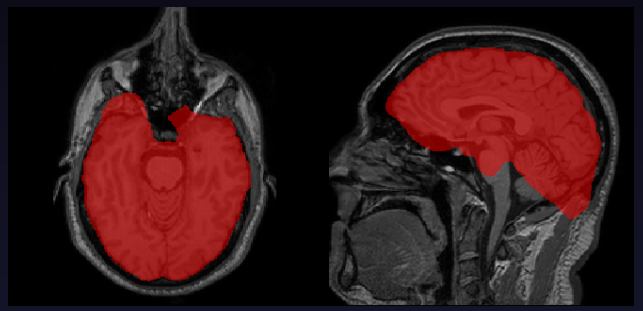
Brain extraction



Affine init.

Extraction failures

IXI_191



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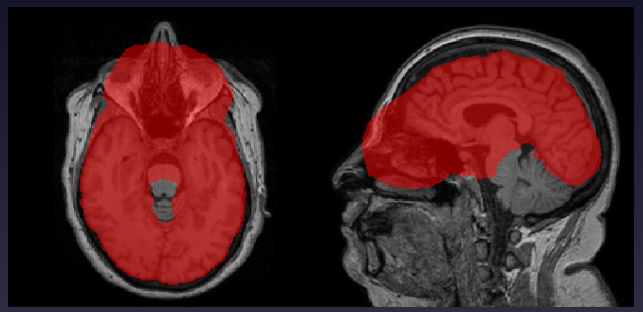
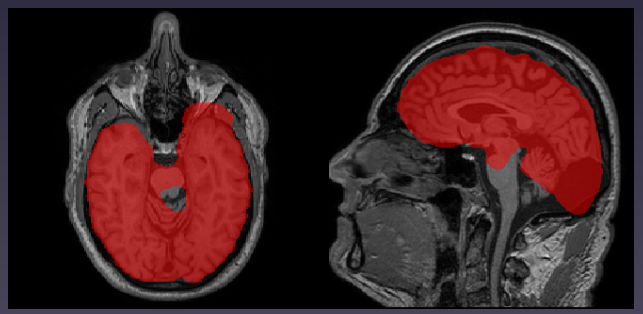
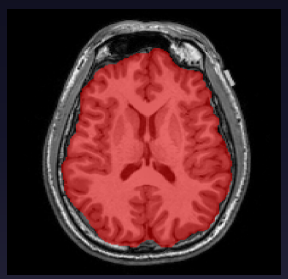


IXI_594



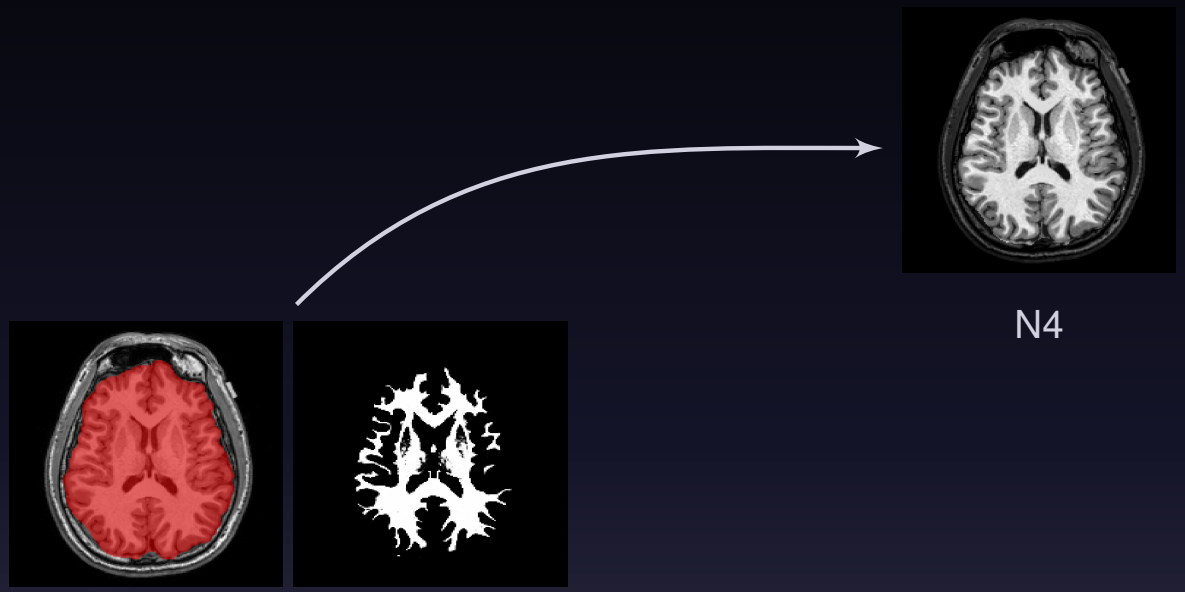
N4 $\leftrightarrow$ Atropos



brain mask

weight mask

N4 $\leftrightarrow$ Atropos



N4

brain mask

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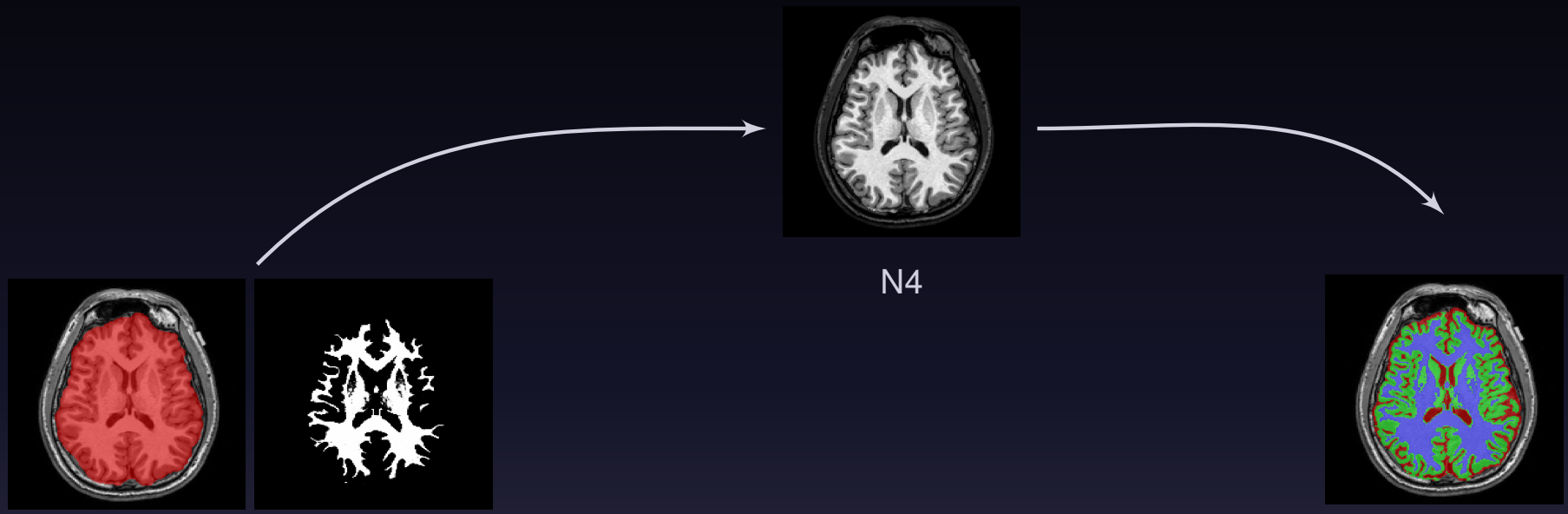

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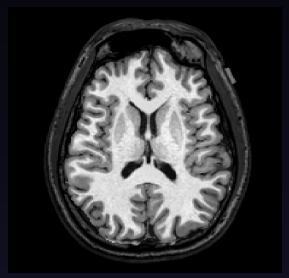
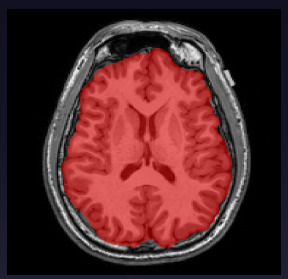


N4



brain mask

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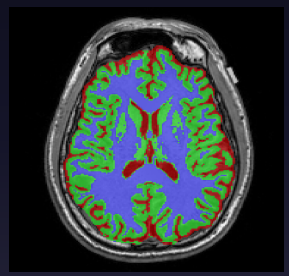
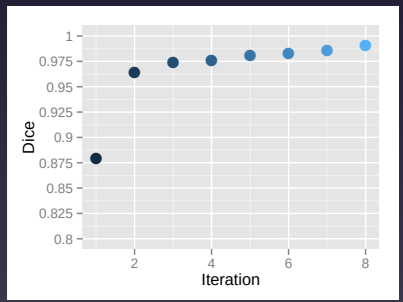
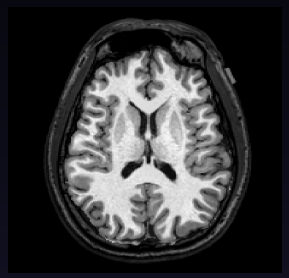


Atropos

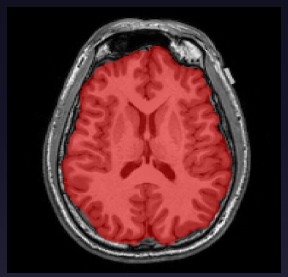


Convergence?

N4 $\leftrightarrow$ Atropos



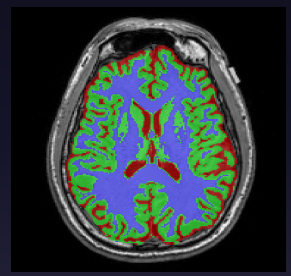
N4



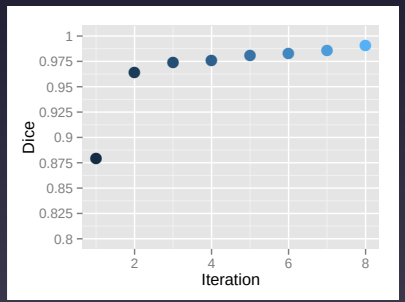
brain mask

weight mask

update weight mask

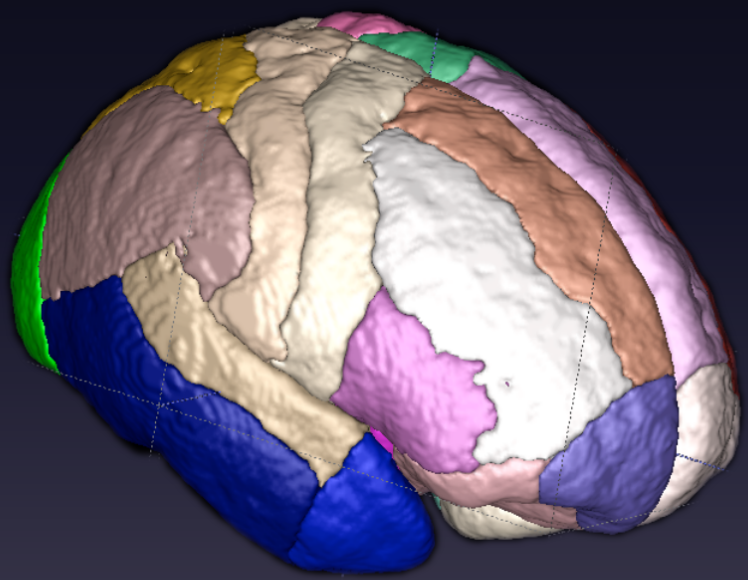


Atropos

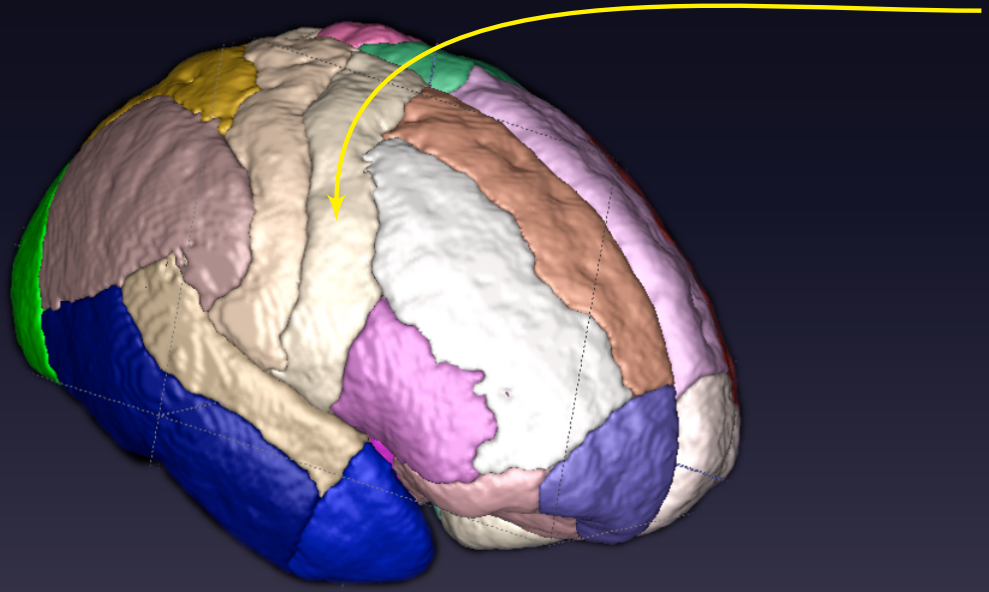


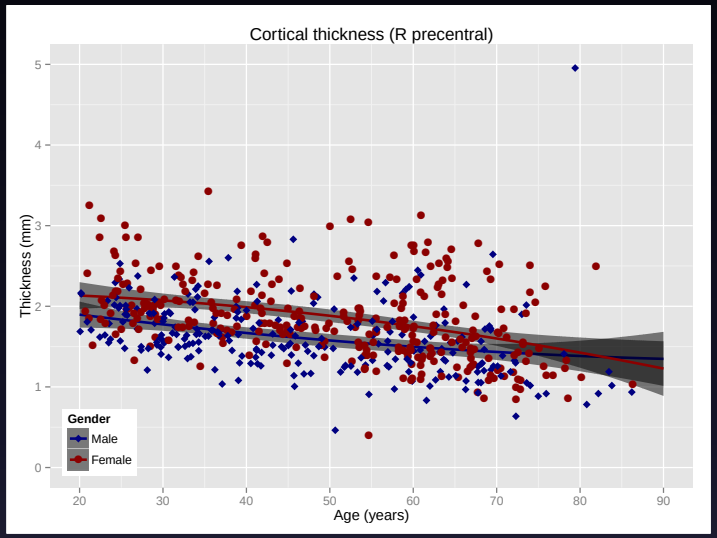
Convergence?

$$\texttt{thickness} \sim 1 + \texttt{age} + \texttt{I(age\^{}2)}$$



thickness $\sim 1 +$ age $+$ I(age^2)





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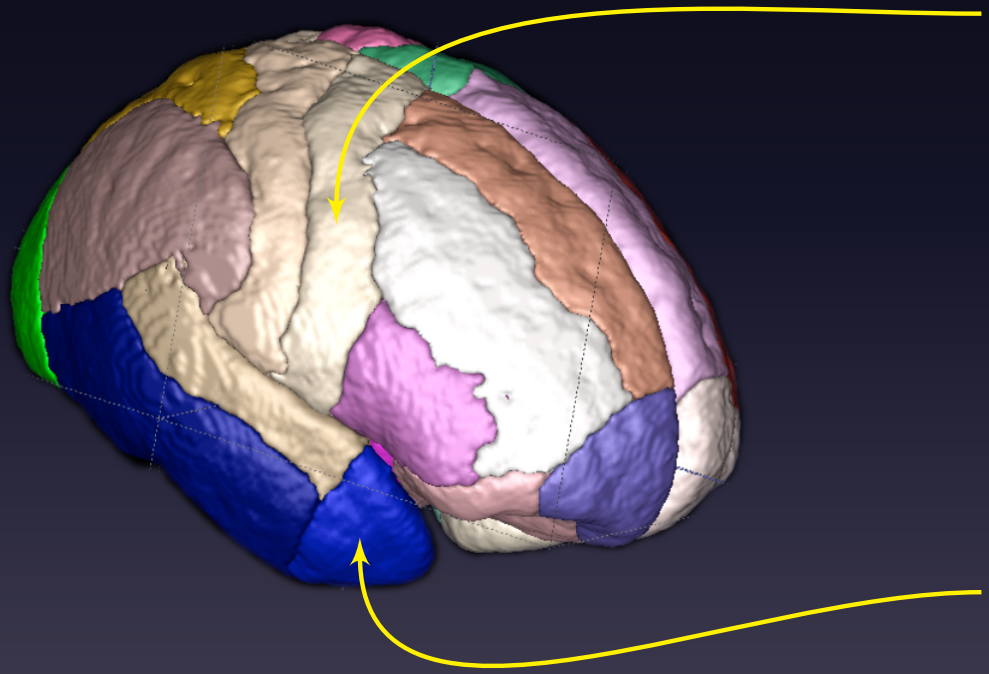

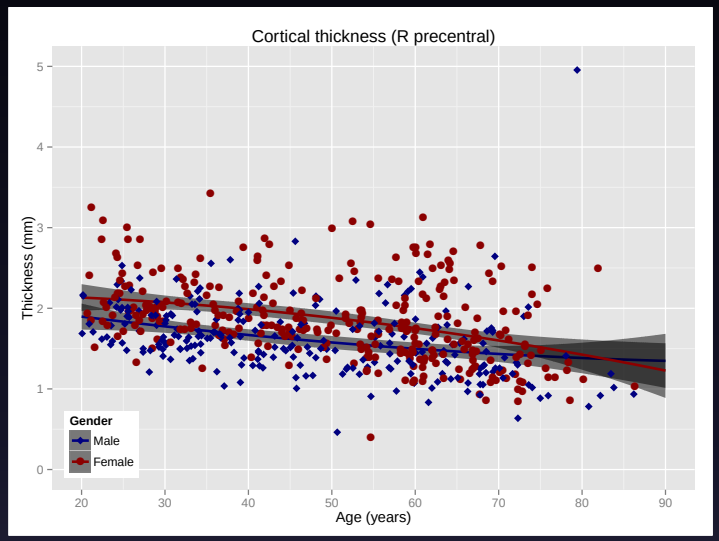

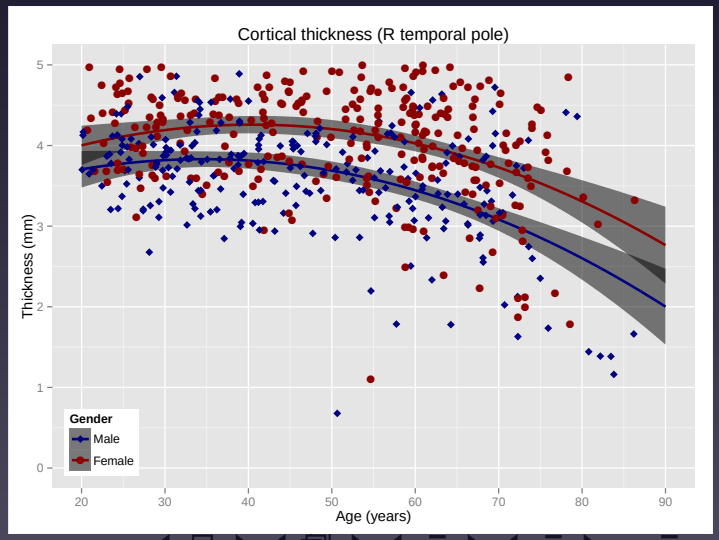

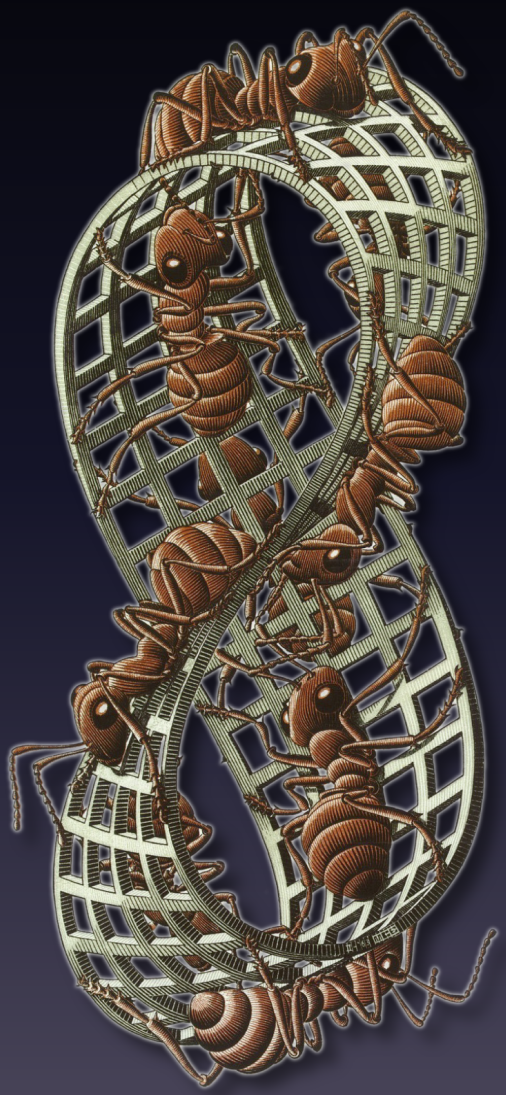

Further information

- http://www.itk.org
- http://www.picsl.upenn.edu/ANTs