Freesurfer-based brain image analysis

Csaba Anderlik

UiB

Bergen Center for Computational Science

PARA//AB

Who are we?

- HPC center at the Univ. of Bergen
- Research areas: computational science, bioinformatics, computational physics, computational mathematics, geophysics
- Grid projects: ENACTS, Eurogrid, NDGF, Norgrid, HPC-Europa, EMBRACE, EGEE, WUN-Grid
- EGEE II: partner in NA3, NA4 and JRA1

FreeSurfer and other brain image analysis tools

Applications

(cognitive aging)

The University of Bergen

http://www.uib.no/ibmp/phenotyping

Neuropsychological phenotyping group

About the group

The main research interest is to characterize behaviour associated with normal function and neuropsychiatric disorders across the life span. The group comprises clinical psychologists and physicians, assessing different aspects of neuropsychological function (sensori-motor, cognitive, emotional and social function). The group collaborates with external experts, making it possible to relat our findings to measures of endophenotypes (Event Related Potentials, MRI) as well as genetic markers.

Methods development

Quantitative brain imaging in health and disease

BBG
Bergen BildebehandlingsGruppe

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Image Processing Group in Bergen

The research area of our group is image processing, using partial differential equations and optimization methods. The processed images are typically minimizers of certain energy functionals. Finding the minimum of such functionals can often be done by solving (nonlinear) partial differential equations (Calculus of Variations). Image processing has huge application areas, and we are especially interested in applications in medical imaging.

http://www.mi.uib.no/BBG

UoB : Faculty of Medicine : Department of Biomedicine : Research

Neuroinformatics and Image Analysis Group

University of Bergen
Department of Biomedicine
Section of Physiology

Telephone: +47 5558 6353 / +47 91561824 (mob)
Telefax: +47 5558 6410
E-mail: arvid.lundervold@biomed.uib.no
WWW: http://www.uib.no/med/biomed/research/lundervold/

Cont.

FreeSurfer and other brain image analysis tools

Applications

(Alzheimer's disease, vascular dementia, mild cognitive impairment)

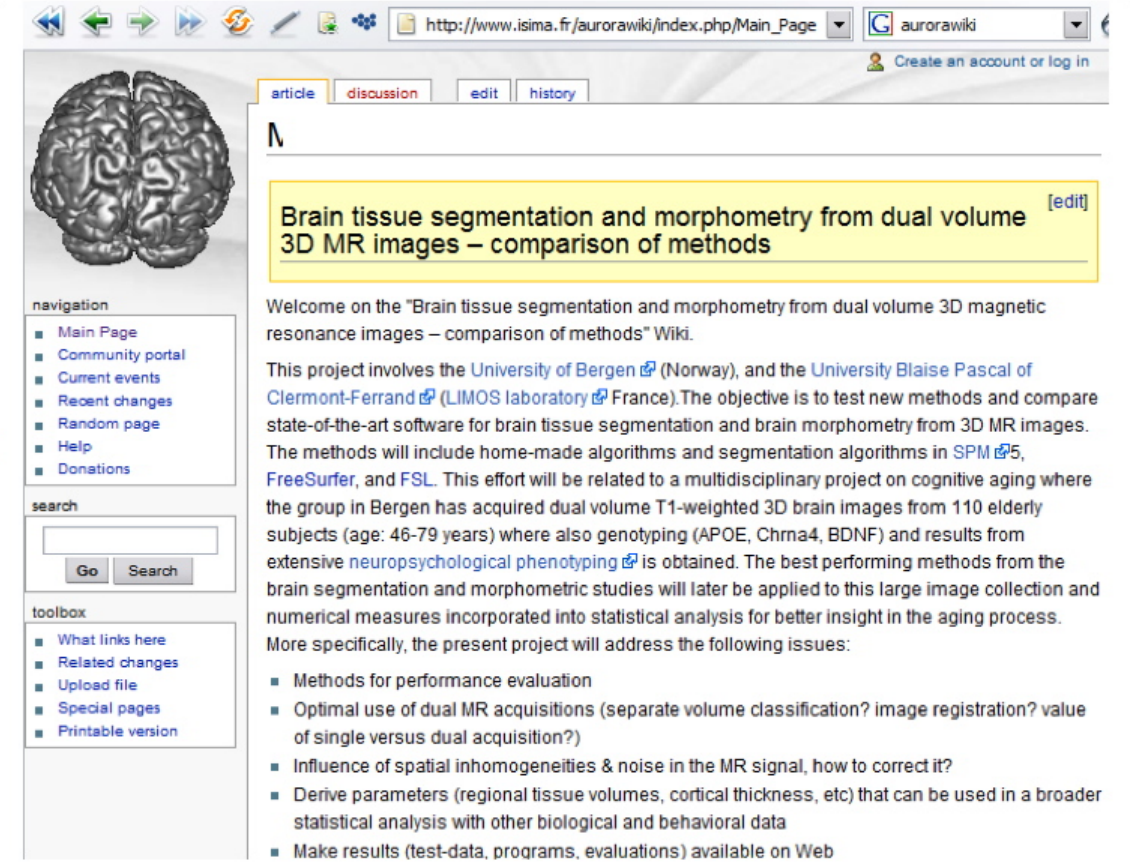
Kavli Center for Dementia Research

Haraldsplass DIAKONALE SYKEHUS Bergen Diakonissehjem

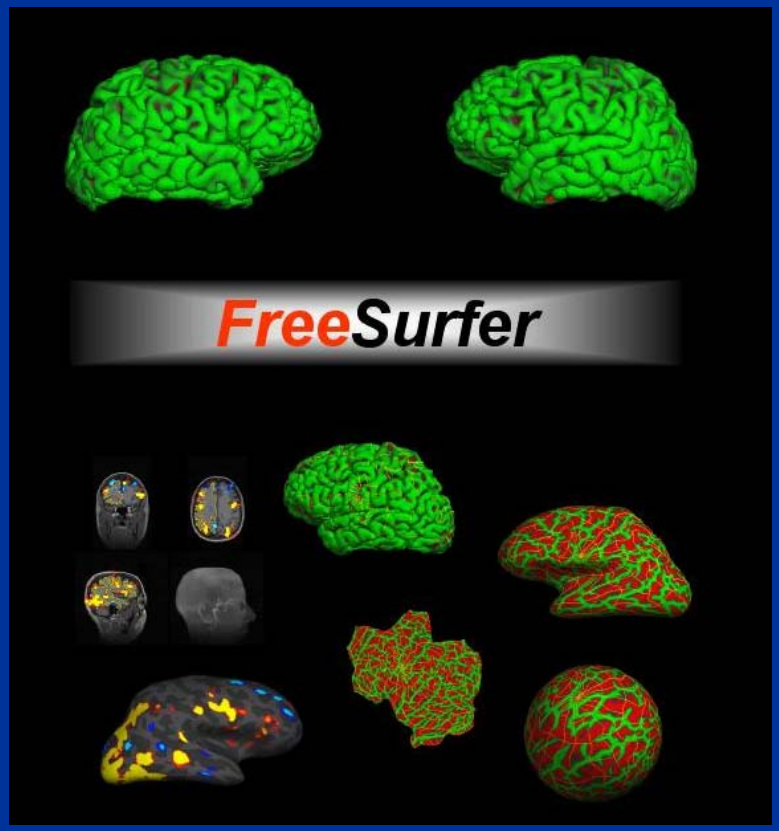
Haraldsplass Deaconess University Hospital

Methods development

- University of Bergen
- University Blaise Pascal Clermont-Ferrand, FR



What is FreeSurfer?



FreeSurfer is a set of automated tools for reconstruction of the brain's cortical surface from structural MRI data, and overlay of functional MRI data onto the reconstructed surface. It is a freely available software package developed by investigators at the Athinoula A. Martinos Center for Biomedical Imaging.

FreeSurfer is used for a number of procedures including:

- Creation of computerized models of the brain from magnetic resonance imaging (MRI) data
- Processing of functional magnetic resonance imaging (fMRI) data
- Measuring a number of morphometric properties of the brain including cortical thickness and regional volumes
- Intersubject averaging of structural and functional data using a procedure that aligns individuals based on their cortical folding patterns for optimal alignment of homologous neural regions

Requirements

Operating system: Linux or OS X

Hardware: ex. 2.5GHz dual processor AMD 64 bit Opteron w/ 4 to 8GB of DDR SDRAM, and 250GB of disk space

Acquisition:

- good quality T1 weighted MRI data, e.g Siemens MPRAGE or GE SPGR sequence
- approx. $1mm^3$ resolution (although a variety of datasets can be processed with manual intervention)
- FreeSurfer is most efficient when working with scans having excellent gray/white matter contrast

Individual Stages

Volumetric Processing Stages (subjid/mri):

1. Motion Correct and Average (orig.mgz)
2. Talairach transform computation
3. Non-uniform inorm (nu.mgz)
4. Intensity Normalization 1 (T1.mgz)
5. Skull Strip (brain.mgz)
6. EM Register (linear volumetric registration)
7. CA Intensity Normalization
8. CA Non-linear Volumetric Registration
9. CA Label (Volumetric Labeling) (aseg.mgz)
10. Intensity Normalization 2 (T1.mgz)
11. White matter segmentation (wm.mgz)
12. Edit WM With ASeg
13. Fill and cut (filled.mgz)

Green = Manual Intervention?

Surface Processing Stages (subjid/surf):

14. Tessellate (?h.orig)
15. Smooth1 (?h.smoothwm)
16. Inflate1 (?h.inflated)
17. QSphere (?h.qsqhere)
18. Automatic Topology Fixer (?h.orig)
19. Euler Number
20. Smooth2
21. Inflate2
22. Final Surfs (?h.white,?h.pial)
23. Cortical Ribbon Mask
24. Spherical Morph
25. Spherical Registration
26. Spherical Registration
27. Map average curvature to subject
28. Cortical Parcellation (Labeling)
29. Cortical Parcellation Statistics
30. Cortical Parcellation mapped to ASeg

recon-all -help

Note: ?h.orig means lh.orig or rh.orig

Plans

- create a simple interface: to easily submit freesurfer jobs (including file staging)
- implement a solution such that user can inspect and modify data produced between the different processing stages
- create suitable metadata to describe the results of the processing (AMGA?)
- provide an interface to retrieve data based on metadata search