

Freesurfer-based brain image analysis

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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)

Methods
development



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 relate our findings to measures of endophenotypes (Event Related Potentials, MRI) as well as genetic markers.

Quantitative brain imaging in health and disease

BBG
Bergen BildebehandlingsGruppe

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Bergen BildebehandlingsGruppe

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



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Cont.

FreeSurfer
and other
brain image
analysis
tools

Applications

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



Kavli Center
for Dementia
Research



Haraldsplass Deaconess University Hospital

Methods
development

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

http://www.isima.fr/aurorawiki/index.php/Main_Page

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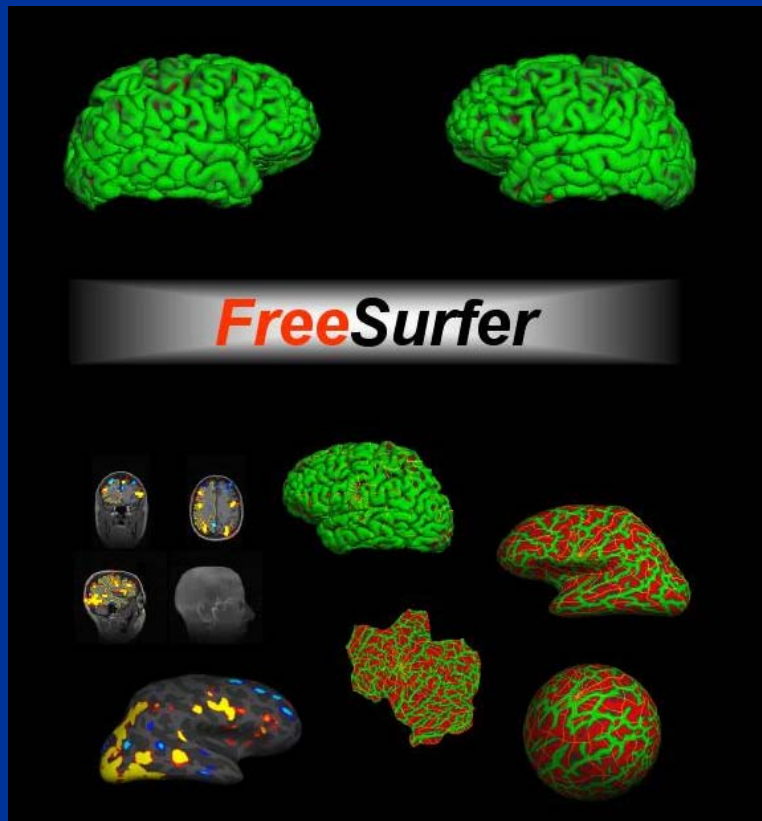
Brain tissue segmentation and morphometry from dual volume 3D MR images – comparison of methods [edit]

Welcome on the "Brain tissue segmentation and morphometry from dual volume 3D magnetic resonance images – comparison of methods" Wiki.

This project involves the [University of Bergen](#) (Norway), and the [University Blaise Pascal of Clermont-Ferrand](#) (LIMOS laboratory France). The objective is to test new methods and compare state-of-the-art software for brain tissue segmentation and brain morphometry from 3D MR images. The methods will include home-made algorithms and segmentation algorithms in [SPM5](#), [FreeSurfer](#), and [FSL](#). This effort will be related to a multidisciplinary project on cognitive aging where the group in Bergen has acquired dual volume T1-weighted 3D brain images from 110 elderly subjects (age: 46-79 years) where also genotyping (APOE, Chra4, BDNF) and results from extensive [neuropsychological phenotyping](#) is obtained. The best performing methods from the brain segmentation and morphometric studies will later be applied to this large image collection and numerical measures incorporated into statistical analysis for better insight in the aging process. More specifically, the present project will address the following issues:

- Methods for performance evaluation
- Optimal use of dual MR acquisitions (separate volume classification? image registration? value of single versus dual acquisition?)
- Influence of spatial inhomogeneities & noise in the MR signal, how to correct it?
- Derive parameters (regional tissue volumes, cortical thickness, etc) that can be used in a broader statistical analysis with other biological and behavioral data
- Make results (test-data, programs, evaluations) available on Web

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.qsphere](#))
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