Prediction of Mild Cognitive Impairment Progression using Longitudinal MRI Scans

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Introduction

Alzheimer's Disease (AD) is the most common form of dementia among elderly people. AD is a neurodegenerative disorder that is clinically characterized by gradual loss of cognitive functions, such as episodic memory. Mild cognitive impairment (MCI) is an intermediate condition between normal aging and dementia, that involves noticeable decline in cognitive abilities, such as memory and thinking skills. MCI often represents a prodromal form of dementia, conferring a significantly higher risk of converting to AD.

Magnetic resonance imaging (MRI) is a tomographic imaging technique, that produces virtual images from inside of the body. Brain MRIs provide comprehensive data on brain structures. Advance image processing algorithms and machine learning methods provide opportunities to analyze and find inherent patterns in this complex data. By doing so, it is possible to separate groups, determine which factors cause the separation and make predictive models of disease.

MRI has been widely studied in clinical trials for early detection of AD and MCI, mostly using cross-sectional MRI data. Longitudinal studies track the same individuals for several years and therefore provide an opportunity to investigate the disease's progression and the changes of patterns overtime, in addition to cross-sectional patterns.

Aims

The aim of this project is to evaluate the performance of longitudinal MRI-derived patterns of disease (regional and global structural changes), for prediction of progression from MCI to AD. We hypothesize that, using longitudinal MRI data, longitudinal image processing stream and appropriate time-series classification methods will improve the performance of diagnostic index.

Material & Method

Subjects

Data from the Alzheimer's Disease Neuroimaging Initiative (ADNI - `www.adni-info.org`) cohort including more than 600 AD, MCI and cognitively normal (NC) subjects and with up-to 36 months of follow-up MRI scans will be used.

Data collection and image analysis

1.5T sagittal 3D T1-weighted MPRAGE MRI scans have already been collected. The FreeSurfer pipeline (`http://surfer.nmr.mgh.harvard.edu/`) is used for processing of MRI images. The longitudinal stream of FreeSurfer is used to extract reliable volume and thickness estimates. Compared with cross-sectional studies, the longitudinal stream can significantly reduce the confounding effect of inter-individual morphological variability by using each subject as his/her own control. A total of 55 MRI-derived regional measures, including 34 cortical thickness and 21 subcortical volumes, are extracted from each MRI scan.

Classification and prediction

Data should be analyzed by means of appropriate time-series classification methods, such as Hidden Markov Models. A preliminary literature review can be conducted, so that the relevant methods can be evaluated and the most appropriate method/methods can be used in the practical part of the project.

In the first step the classifier will be trained using longitudinal AD and NC subjects. Subsequently, the resulted classification model will be used to predict MCI subjects as AD-like or NC-like.

Practical Details

The project's supervisors will be:

- Farshad Asramai Falahati (`farshad.falahati@ki.se`) - Division of Clinical geriatrics - Karolinska Institutet

Personal Background

My background includes a number of completed course both as a master student at KTH and as an undergraduate student at the Aristotle University of Thessaloniki (AUTH), that makes this an appropriate project:

- Image Based Recognition and Classification (DD2427) - KTH
- Pattern Recognition (EQ2340) - KTH & AUTH
- Computational Photography (DD2429) - KTH
- Machine Learning (DD2431) & Machine Learning, Advanced Course (DD2434) - KTH
- Biomedical Engineering - AUTH
- Computer Graphics - AUTH
- Digital Image Processing - AUTH

I assure that I have completed all courses for the bachelors' degree and at least 60hp on advanced level and that the 60hp include the course "Introduction to the Philosophy of Science and Research Methodology" (DA2205) and all mandatory courses relevant for the thesis.

I have one course left for the completion of my program: SF2568 Parallel Computations For Large Scale Problems. This course is currently running and is going to finish at the end of this spring semester. At this point, only the final project is left for the course's completion.