Characterisation of VBM Algorithms for Processing of Medical MRI Images

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Background:

Voxel-Based Morphometry (VBM) is the process of measuring volumetric changes in structural imagery. We propose to characterise different algorithms that measure the accuracy at the scale of gross morphological structures. For images to be studied, the brains have to be labelled first. Before registrations, images are usually skull-stripped, leaving only the brain in the image. Images are then linearly registered using FSL software. Rigid registration is usually using a standard MNI152 template.

(Klein et al. 2009) used volume and surface overlap, volume similarity, and distance measures to evaluate how well individual anatomical regions, as well as total brain volumes, register to one another. Metrics for measuring differences in algorithm performance can be average brain volume, grey matter overlap, white matter overlap, correlation of a measure of curvature, local measures of distance and shape between corresponding principal sulci. In conclusion, (Klein et al. 2009) mentioned that the results of comparisons were better or comparable with skull-stripped images.

MR and functional MR image analysis can be a significant portion of the diagnoses of psychological related diseases. One such disease is Autism. When the most significant regions regarding specific condition are identified, appropriate machine learning algorithms can be applied for its analysis.

Motivation:

Structural magnetic resonance images of brains can differ among subjects in many ways. A useful measure of structural difference among populations is derived from a comparison of the local composition of different brain tissue types (e.g., grey matter, white matter, etc). VBM has been designed to be sensitive to these differences while discounting positional and other large-scale volumetric differences in gross anatomy (Ashburner et al. 2001). Depending on this, the outputs of the co-registration or findings, which represents a characterisation of algorithms is useful for algorithm optimisation for use with machine learning techniques.

Proposed Research:

As for many research topics, the information must be disseminated appropriately with careful consideration of the potential impact of the research.

Prior to public release, research and findings will be shared with fellow researchers and hospital professionals so that they can investigate the characteristic of the proposed methods.

It may also be pertinent to present the findings to research forums and at industry-specific conferences whereby industry professionals can evaluate and critically discuss the implications of

the work, and how best to translate these findings into actionable methods of diagnosing patients or studying other phenomena related to VBM process.

Having undertaken these stages a final report will be created for wider public dissemination via traditional methods including Journals, Conferences, websites and specialist press releases.

Potential Impact:

VBM is a useful way to obtain information from MRI images which is a non-invasive method to study the human brain. VBM helps in diagnosis of multiple severe psychological related diseases such as schizophrenia or multiple sclerosis among others, such diagnosis can be made with increased ease and precision. It also investigates what can be a measurable aspect which could cause a difference in brain structure between healthy and psychologically ill subjects.

What if there are no differences? There is nothing random about the VBM analyses done around the world to date. Which makes for a strong incentive to perform the study regardless. What if there is a difference? It has an implication about work which has previously been published. Such work would be acceptable for publication in NeuroImage especially if it is in a region as important as the Hippocampus which would ultimately contribute to an existing pool of knowledge.

References:

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Klein, Arno et al. (2009). “Evaluation of 14 nonlinear deformation algorithms applied to human brain MRI registration”. In: *NeuroImage* 46.3, pp. 786–802. ISSN: 1053-8119. DOI: **https://doi.org/10.1016/j.neuroimage.2008.12.037**. URL: **http://www.sciencedirect.com/science/article/pii/S1053811908012974**.