ADNI Alzheimer's Disease Neuroimaging Initiative

Hierarchical Parcellation of MRI using multi-atlas labeling methods

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Summary

Baseline MRI scans of ADNI1 participants (230 cognitively normal (CN) individuals, 200 Alzheimer's (AD) patients, and 410 patients with Mild cognitive impairment (MCI)) were automatically partitioned into 145 regions of interest (ROIs) spanning the entire brain. The segmentation method applies a multi-atlas consensus-based label fusion scheme on template ROIs deformed to subject space. Also 114 derived ROIs were calculated by combining single ROIs within a tree hierarchy, to obtain volumetric measurements from larger structures. Volumes of all 259 ROIs were measured and reported. Individual ROI masks are also available upon request, to be used with other co-registered images (e.g. amyloid and PET FDG). This work was supported by R01AG14961 (PI: Christos Davatzikos, Ph.D.). Please contact Christos Davatzikos (Christos.Davatzikos@uphs.upenn.edu) for details. Pertinent software is available under https://www.cbica.upenn.edu/sbia/software/index.html

Method

Multi-Atlas ROI Segmentation:

Preprocessed T1 scans (GradWarp, B1 Correction, N3, Scaled) were first downloaded from the ADNI website. This was followed by brain extraction*[1]* for further processing. A new multi-atlas registration based label fusion method *[2]* was applied for ROI segmentation. Multi-atlas segmentation has gained increasing interest in recent years and has shown significant improvement in accuracy over single-atlas-based segmentation *[1,2]*. In this framework, multiple atlases with semi-automatically extracted ground-truth ROI labels are first warped individually to the target image using non-linear registration methods *[3,4]*. A spatially adaptive weighted voting strategy is then applied to fuse the ensemble into a final segmentation. In the fusion, a local similarity term is used for ranking and weighting ground truth labels from different atlases, and an image intensity based term is used for modulating the segmentations at the boundaries of the ROIs according to the intensity profile of the subject image. In validation experiments, the multi-atlas approach achieved significantly higher accuracy in comparison to single-atlas based segmentation. Figure 1 shows example segmentation. Figure 2 shows the box plots of volumes of bilateral hippocampus, amygdala and ventricle for AD, CN and MCI subjects. The ROI hierarchy is provided in the Excel spreadsheet along with the ROI volumes.

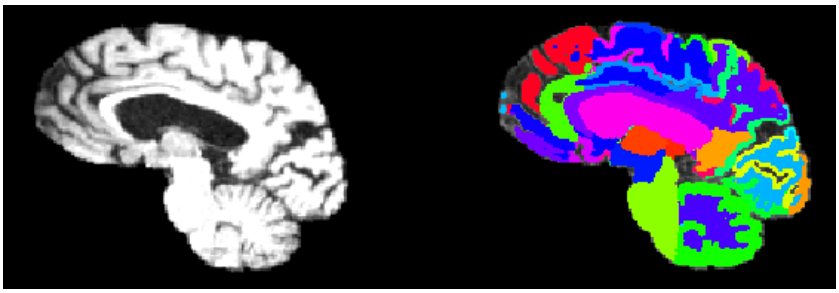

Figure 1. Segmentation into anatomical ROIs.

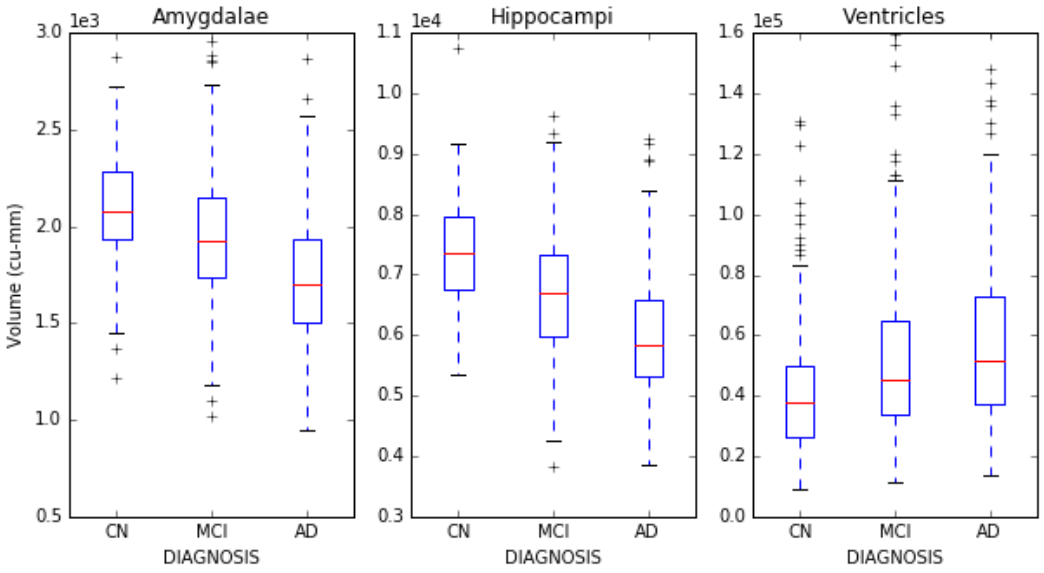

Figure 2. Box plots of volumes of amygdalae, hippocampi and ventricles CN, MCI and AD

Dataset Name	Date Submitted
Multi-atlas ROI UPENN	6 April 2016

References

1. *Doshi, J., et al., Multi-atlas skull-stripping. Academic radiology 20 (12), 1566-1576*
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3. *Ou, Y., et al., DRAMMS: deformable registration via attribute matching and mutual-saliency weighting. Medical Image Analysis, 2011. 15(4): p. 622-639.*
4. *Avants, B., et al., Symmetric diffeomorphic image registration with cross-correlation: evaluating automated labeling of elderly and neurodegenerative brain. Med. Image Anal., 12 (1) (2008), pp. 26–41 (Feb)*

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