# Cortical Differences Analysis with Multivariate Tensor-Based Morphometry in 829 ADNI subjects

Xing An[1,2], Jie Shi[1], Yalin Wang[1] , the Alzheimer's Disease Neuroimaging Initiative
1. Arizona State University, Tempe, USA 2. Beijing Institute of Technology, Beijing, China

## Introduction

- As the widely used way to find candidate biomarkers of disease progression, computational anatomy methods are usually applied to map the profile of disease effects on the brain and model the localized changes in Alzheimer's disease (AD).
- We propose a new framework of cortical surface morphometry analysis based on FreeSurfer and multivariate tensor-based morphometry (MTBM) associated with 829 subjects from the Alzheimer's Disease Neuroimaging Initiative (ADNI).
- With the effective segmentation accuracy of FreeSurfer's and strong statistics ability of MTBM, the proposed framework shows a powerful performance on detecting localized anatomical differences on cortical surface in ADNI database.

## Materials and Methods

- Data: Baseline T1-weighted MRI scans from the ADNI (http://www.loni.ucla.edu/ADNI) . 196 AD, 406 mild cognitive impairment (MCI), 227 controls.

- Cortical surface was extracted with FreeSurfer tools following the step of creating surface mesh models for each cortical.
- Cortical meshes were registered and transformed to a standard space according to the result of FreeSurfer.
- Using the sphere coordinate of each cortical, we sampled these meshes on a regular sphere grid and computed the surface Jacobian for MTBM [1-2] statics.
- Differences in the full surface deformation tensor were computed with MTBM by using standard Euclidean formulae by extending the idea of log-Euclidean metrics.

## Results

- Fig. 1 shows regions with significant shape differences in AD versus controls (CTL).
- Fig. 2 shows regions with significant shape differences in AD versus MCI.
- Fig. 3 shows regions with significant shape differences in CTL versus MCI.
- All these statistics show consistent morphometric differences in cortical analysis, especially AD-CTL.
- In addition, FDR p-value comparison is list in Table. 1. The results show that our method can get effective result for cortical surface analysis.

Table 1. FDR corrected p-value comparison on 196 AD, 406 MCI, 227 control subjects from ADNI baseline dataset.

| | Left Cortex | Right Cortex |
|---|---|---|
| **AD-CTL** | 0.0045 | 0.0037 |
| **AD-MCI** | 0.0003 | 0.0001 |
| **CTL-MCI** | 0.0002 | 0.0007 |

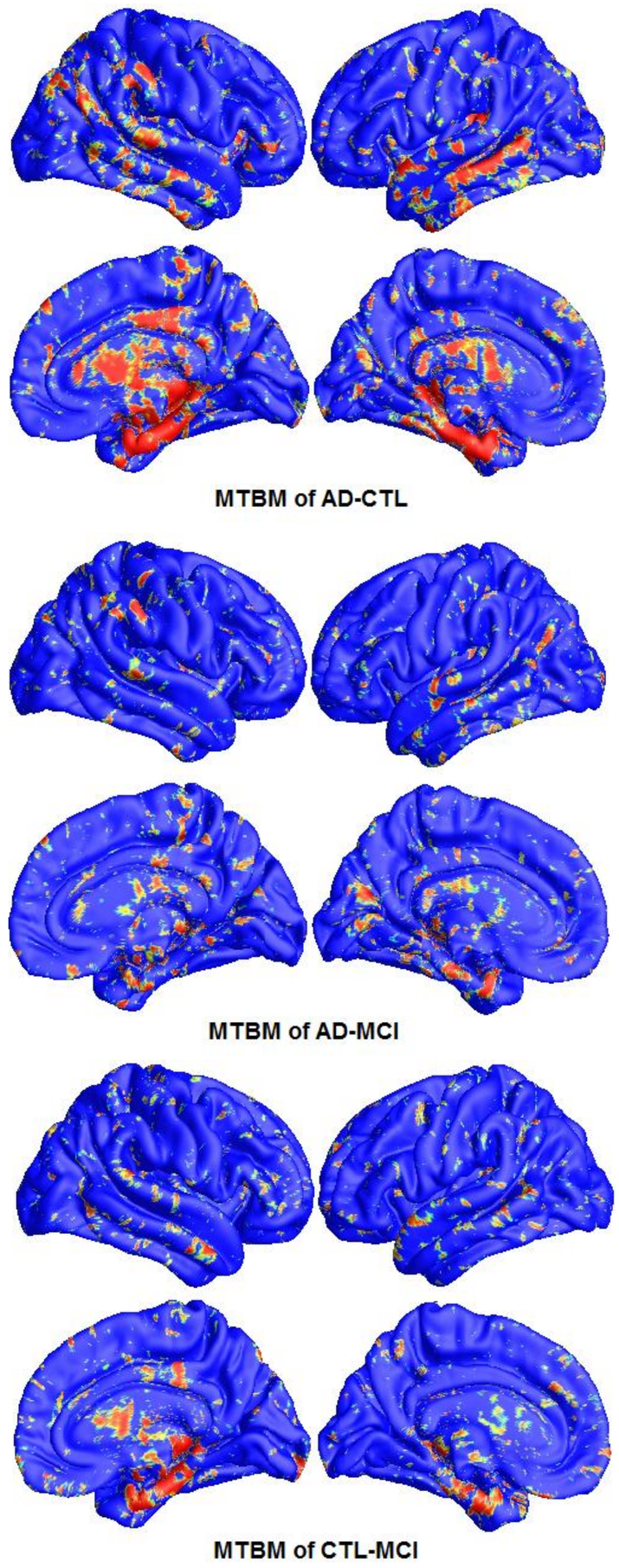


Figure 1. Results of group difference based on MTBM in 196 AD, 227 CTL subjects from ADNI baseline dataset.

Figure 2. Results of group difference based on MTBM in 196 AD, 406 MCI subjects from ADNI baseline dataset.

Figure 3. Results of group difference based on MTBM in 227 CTL, 406 MCI subjects from ADNI baseline dataset.

## Conclusions

- This framework consists of automated surface extraction, registration, conformal mapping and tensor statics.
- This framework required minimal manual intervention, and it can be used for the analysis for large data.
- In this large cortical morphometry study, effective results were obtained by using our method.
- Future work will use multivariate surface statistics for map-based disease classification and prognosis, such as Ricci flow method.

## References

[1]. Wang, Y.L., et al. (2010), 'Multivariate tensor-based morphometry on surfaces: Application to mapping ventricular abnormalities in HIV/AIDS', NeuroImage, vol.49, no.3, pp. 2141-2157.
[2]. Wang, Y.L., et al. (2010), 'Hippocampal and Ventricular Differences in 804 ADNI subjects mapped with Multivariate Tensor-Based Morphometry', in The 16th Annual Meeting of the Organization for Human Brain Mapping. Barcelona, Spain.