Longitudinal MR Imaging of Dementia

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Overview

• Introduction to application
  – Image analysis challenges
• Existing approaches
  – Limitations
• New techniques
• Future plans
What is dementia?

- Neurological disorders causing impaired functioning of the brain
- Alzheimer’s Disease
  - Most common form
  - Memory, learning, communication, judgement, etc.
  - 10% of over-65s
  - Growing problem
Why study dementia with MRI?

• Diagnosis is difficult
  – Proof of AD requires post-mortem
  – MRI is non-invasive and safe
• Structural changes observed before symptoms
  – (familial AD studies)
• MRI measures correlate with clinical and histopath
Why “longitudinal” imaging?

- Major biological variability
  - Confounds diagnosis from single scan
- *Progression* of atrophy
  - Distinguishing diseases
  - Disease modifying drugs
Subtraction
Existing Approaches

• BBSI
  – Global
• Traced ROI
  – Manual
  – Prior hypotheses
• Voxel-based Morphometry
  – Automatic
  – Local change over whole brain
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<tr>
<th>Register/normalise</th>
<th>Segment</th>
<th>Smooth</th>
<th>Voxel-wise stats</th>
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Compare groups A and B with t-test at each voxel

Ignores correlations
Wastes temporal info
Multivariate Methods

- Principal Component Analysis
  - Models spatial and temporal correlations
  - Dimensionality reduction
- Linear Discriminant Analysis
  - Group differentiation
- Other techniques
  - ICA, N-way FA, Kernel methods
Projection on y-axis
\((t = 5.53)\)
Projection on PC2
Projection on LD
(t = 7.93)
Rigid registration difference images
Rigid registration difference images
Fluid registration Jacobian images
Global measure (BBSI) vs LDA on Jacobians

![Values of Brain Boundary Shift Integral](image1)

(t = 2.34)

![LDA Scores for Jacobian images](image2)

(t = 5.58)
Future Plans

- Other multivariate methods
  - Hierarchical/multi-way
- Better voxel-wise correspondence
  - Groupwise registration
- Enabling technologies
  - Reliable non-rigid registration
Acknowledgements & References

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Ashburner, J. & Friston, K.J.  *Voxel-based morphometry--the methods.*  Neuroimage, 2000, 11, 805-821

