Development and Evaluation of White Matter Resources of the IIT Human Brain Atlas

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www.nitrc.org/projects/iit
Comprehensive, multi-channel atlas of the young adult brain.

The IIT Diffusion Tensor template outperforms other standardized templates and study-specific template\textsuperscript{1,2}.

2. Zhang S. & Arfanakis K. Neuroimage 2018
Resources & Data

• **Resources of the IIT Human Brain Atlas used to build the WM connectome**
  – Tissue probability maps
  – Probabilistic GM labels (Desikan)
  – HARDI template

• **Data used to evaluate the WM connectome**
  – 20 unrelated subjects from the Human Connectome Project (HCP)
  – 10 female, 28.8 ± 4.22 years of age, 22-36 years age range
  – $b=1000$ s/mm$^2$, approximately 90 diffusion weighting directions

2. Glasser MF. et al. Neuroimage 2013
Tractography

- **Tractography using MRtrix3**
  - Tracking algorithm: Second-order Integration over Fiber Orientation Distributions\(^1\) (iFOD2)
  - Anatomically-constrained tractography\(^2\) (ACT)
  - Spherical-deconvolution informed filtering of tractograms\(^3\) (SIFT)

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1. Tournier JD, et al. ISMRM 2010
Evaluation

• Small edges of the IIT connectome were filtered out.
Evaluation

- 20 HCP connectomes were constructed using the same tractography methods.
- Edge by edge comparison between the IIT connectome and 20 HCP connectomes.
IIT Connectome:

- Edges are spatially matched well to the HCP subjects.
- Track density images have higher correlation with those of individual HCP subjects than individual HCP subjects to the others.
Evaluation

• Parcellations using the connectivity information

- Corpus callosum
  - FRONTAL
  - PARIETAL
  - MOTOR
  - TEMPORAL
  - OCCIPITAL
  - SENSORY

- Thalamus
  - Frontal Lobe
  - Parietal Lobe
  - Sensory cortex
  - Motor cortex
  - Temporal Lobe
  - Occipital Lobe

• Edge information

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Each GM label connects to multiple GM labels

4 seed regions of interest were added to the Desikan-Killiany regions for completeness of the resulting connectivity information:

- Axial section through medulla
- Fornix body
- Left optic tract
- Right optic tract
The Multi-layer WM Labels of the IIT Human Brain Atlas:

- Each voxel is assigned a list of labels representing the most probable connections.
- The corresponding multi-layer probability map contains the probability of each connectivity label is provided.
Multi-layer WM Labels

- Find rapidly the connectivity of a selected region of interest using the \textit{regionconnect}^{tm} app (by MRIIT)
- Available at www.iit.edu/~mri
74 WM Bundles were extracted using RecoBundles\textsuperscript{1} and can be used as regions of interest in ROI-based analyses.
Conclusion

WM Resources of the IIT Human Brain Atlas:

- Facilitate structural connectivity studies
- Facilitate WM regions of interest analyses
- Support multi-channel studies
- Allow integration of findings across studies
- Released with IIT Human Brain Atlas version 5.0
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