Towards whole-brain validation of diffusion MRI fiber orientation distributions with x-ray microcomputed tomography

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Diffusion MRI (dMRI) is a powerful, non-invasive tool for characterizing three-dimensional (3D) tissue microstructure on a macroscopic scale, and is widely used in both research and clinical settings. New methods of reconstructing 3D fiber orientation distributions (FODs) from dMRI data are rapidly being developed, each based on the assumption that dMRI provides an accurate model of the underlying anatomical fiber structure. Previous efforts to validate this assumption have relied on ground truth histological data with non-isotropic resolution over a small field of view. In this study, we develop a pipeline for the use of natively isotropic, synchrotron-based x-ray microcomputed tomography (μCT) data to validate dMRI FODs over a whole mouse brain.

A post-mortem brain was scanned with dMRI (*waiting on MRI specs from Sean*) at 150 μm^3 resolution. The specimen was then stained (*what are the stains? Anything else on uCT preparation?*) and imaged at the Advanced Photon Source at Argonne National Lab using a mosaic sinogram stitching method, yielding an image volume over the whole brain with isotropic 1.2 μm^3 resolution. N (*actual number TBD*) sample ROI were identified for validation based on prior anatomical knowledge. Structure tensor analysis was performed on the x-ray data to compute a ground truth FOD for each ROI. The corresponding FODs from the dMRI data were evaluated based on overall agreement in FOD shape, correct assessment of the number of fiber populations, and angular accuracy in orientation (*criteria taken verbatim from Schilling*).

(*Expecting comparable results to Schilling, actual results TBD*)

This study has led to the development of a pipeline for performing quantitative 3D validation of dMRI FODs over a whole mouse brain with isotropic resolution. Ground truth FODs across the whole brain will allow for further validation studies in dMRI and tractography.