# Graph-Based Tractography Algorithms Applied to Diffusion Tensor Images to Establish White Matter Tracts Between Brain Regions

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## Opportunity

DTI is a brain imaging modality that allows us to view connections within the brain. While we have well established white matter tracts, more data validation is required for gray matter.

## Challenge

Current research concludes that simple white matter fiber tracts can be identified reproducibly. However, regions with complex fiber orientations still lead to errors in the estimated connections due to lack of high resolution data

## Action

Using three standard graph-based algorithms (minimum spanning trees, Dijkstra's algorithm, and Viterbi's algorithm), we developed computational tools for estimating pathways between pairs of brain regions.

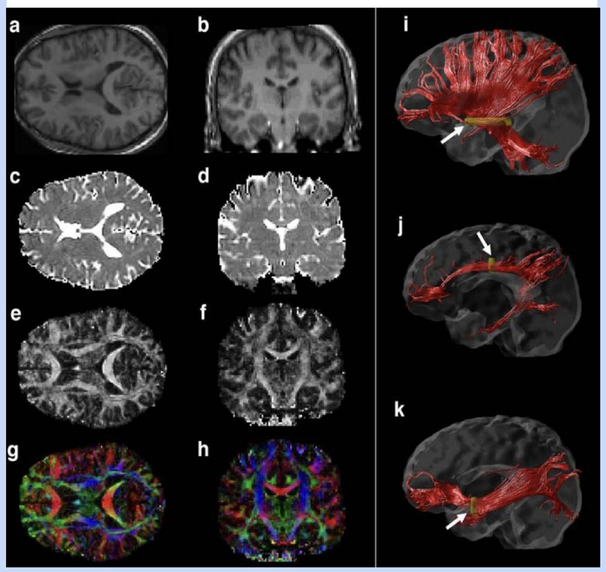
## Resolution

Reconstructions of fiber tracts using MSTs on two samples: a whole brain at low resolution, and a post mortem amygdala at high resolution, are shown. In the future we plan to apply other graph based algorithms and validate estimated connectivity through myelin stained histology.

## Introduction

Diffusion Tensor Imaging (DTI) is a technique that detects how water travels along white matter tracts in the brain

DTI has been used to study the white matter architecture and integrity of the normal and diseased brains (stroke, aging, dementia, schizophrenia, etc.)

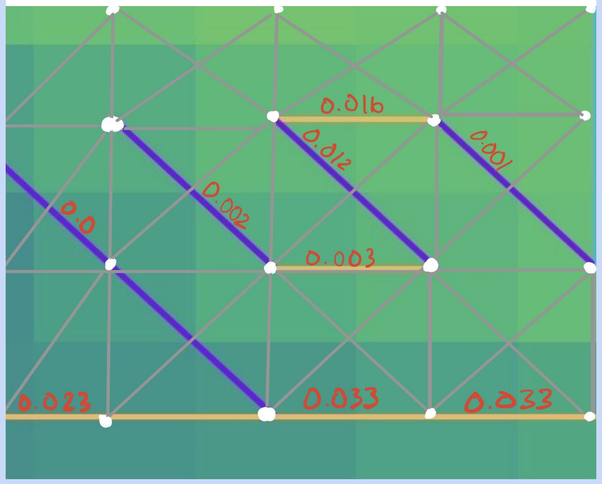



## Methodology

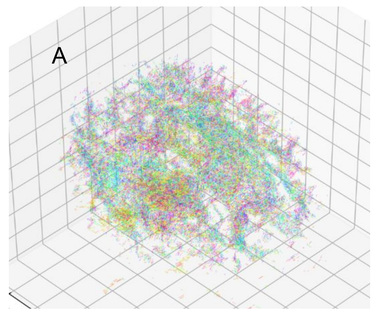
Weighted graph: a graph that has a set of connected nodes with a positive number associated with each connection.

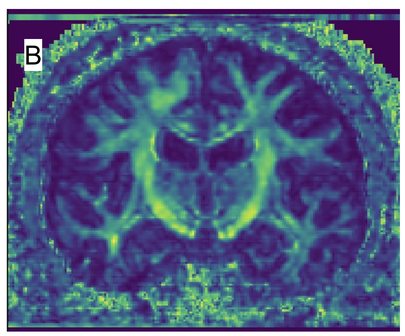
A minimum spanning tree (MST): a spanning tree that has a sum of all the edge weights is as small as possible

Below is an MST diagram highlighting edge weights in red, potential connections in gray, vertices in white, and MST edges in purple and orange

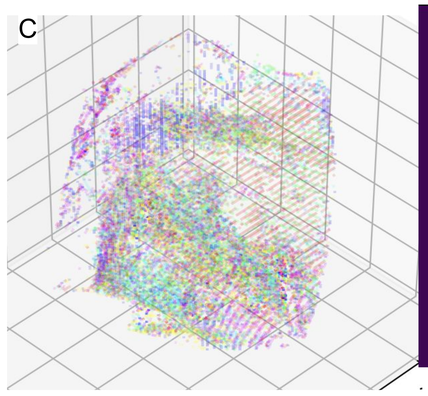


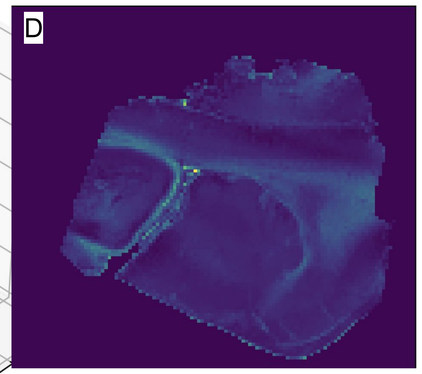

## Results

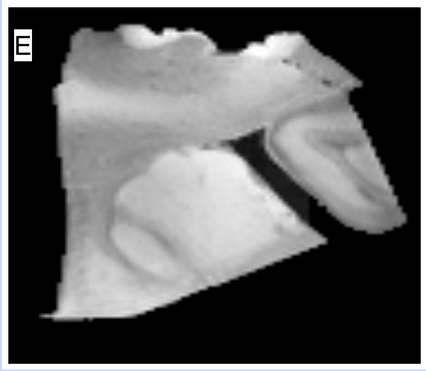


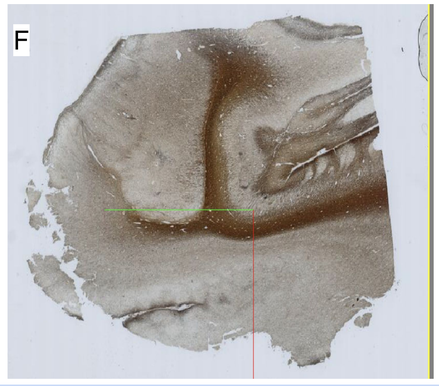



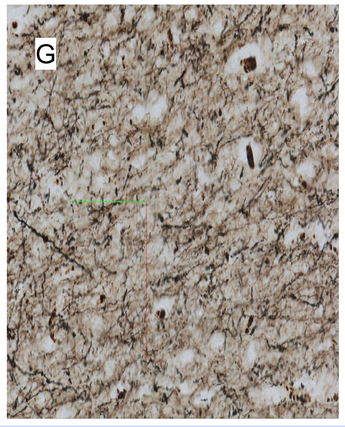

A. 3D rendering of whole brain using a MST
B. FA coronal slice of whole brain
C. 3D amygdala rendering using MST
D. FA image of amygdala
E. amygdala b0 MRI
F. myelin stained microscopy image
G. high resolution amygdala myelin stained image




## References

Assaf, Y., & Pasternak, O. (2007). Diffusion Tensor Imaging (DTI)-based white matter mapping in Brain Research: A Review. *Journal of Molecular Neuroscience*, *34*(1), 51–61. https://doi.org/10.1007/s12031-007-0029-0

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