Analysis of Human Brain Connectivity from Multi-Modal Imaging

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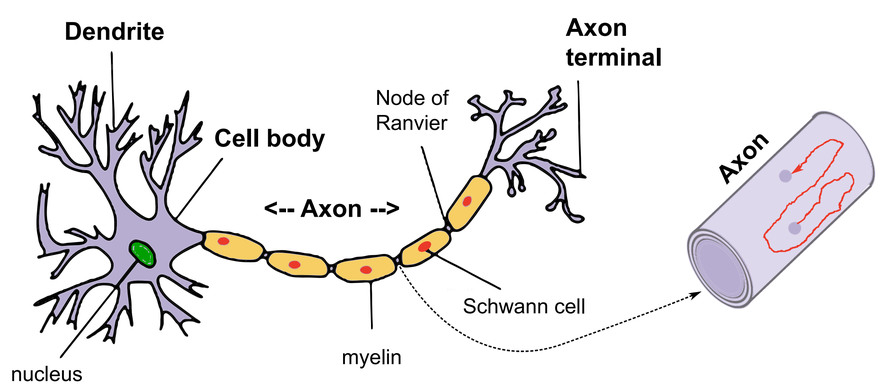
Introduction

- Human brain is arguably the most complex system in the universe.
- Finding the connections between various regions of the cortex helps to
  - understand the property of the brain under cognitive tasks such as memory and language.
  - understand the biological basis of psychiatric disorders such as Autism and Attention Deficit Hyperactivity Disorder (ADHD).
  - We use two imaging techniques to measure the brain connectivity: Diffusion Tensor Imaging (DTI) and functional MRI (fMRI) .

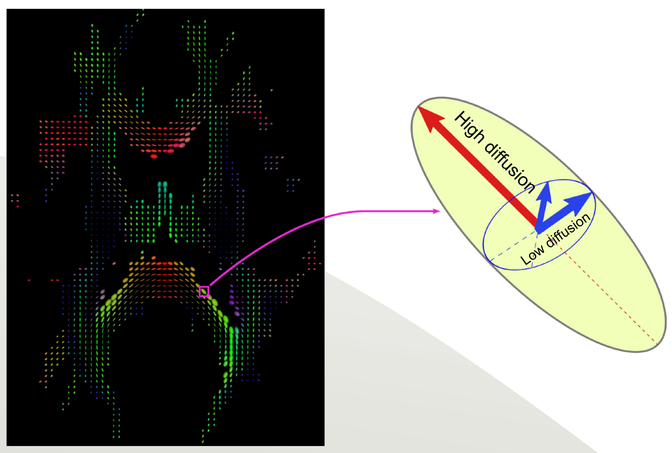
Diffusion Tensor Imaging

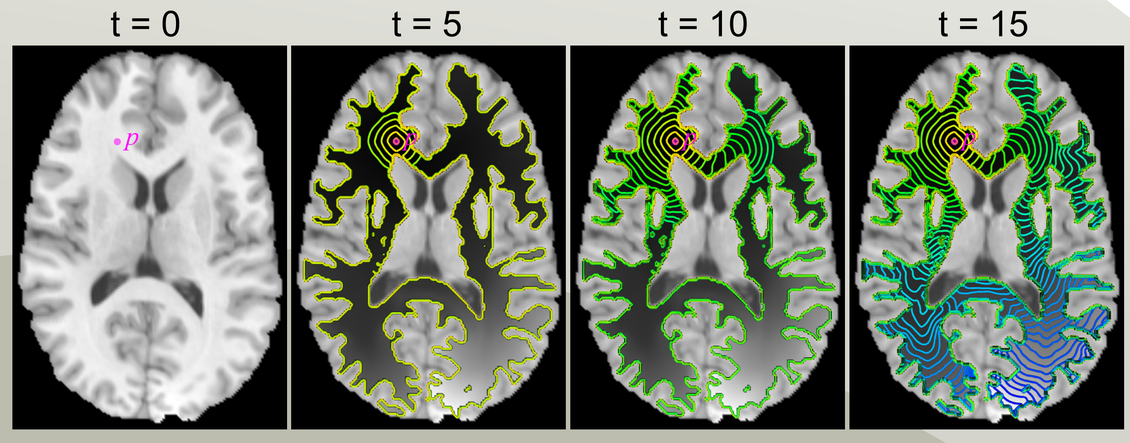


Neuros are connected by axons in white matter.

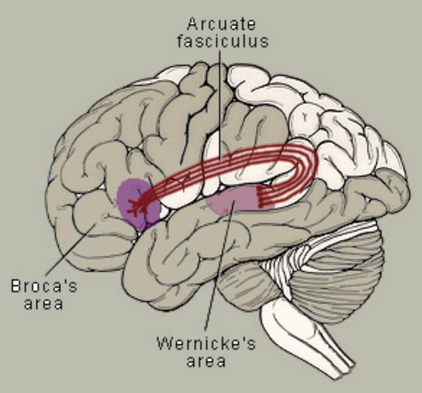
DTI is contructed by measuring the water diffusion inside axons.

Each voxel of DTI is visualized by an ellipsoid.



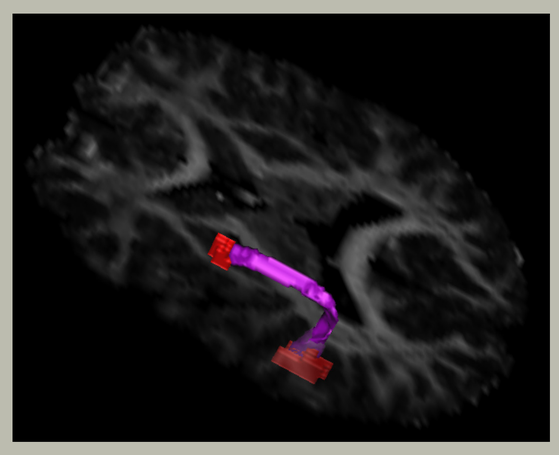


Starting from point p, we compute a timeofarrival function and this function can be used to represent the probability of the brain connectivity.

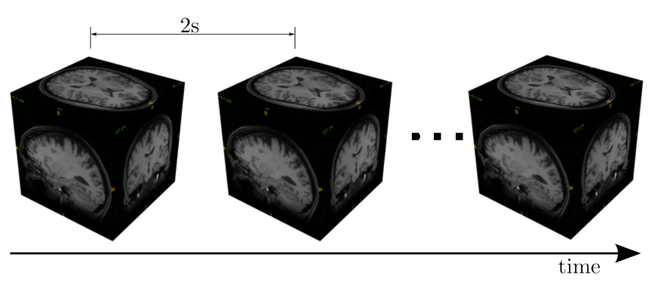


- A key diagnostic feature of autism is impairment in communication
- The arcuate fasciculus is a white matter tract crucial in language

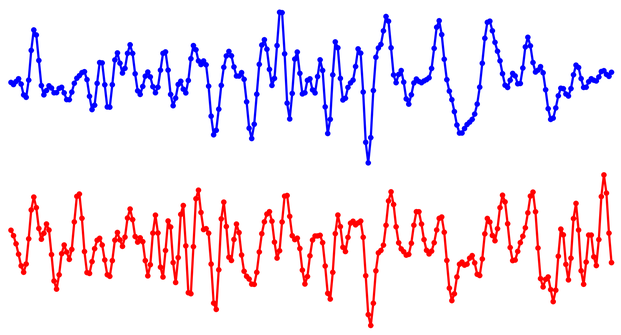
- Is the arcuate fasciculus different in autism?
- Extract arcuate fasciculus automatically. (Joint work with Janet Lainhart from Dept. of Psychiatry).



Functional MRI

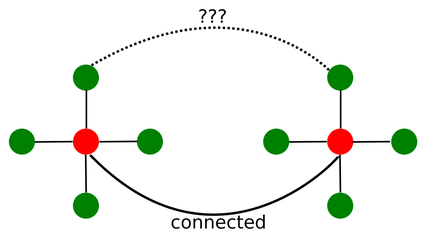


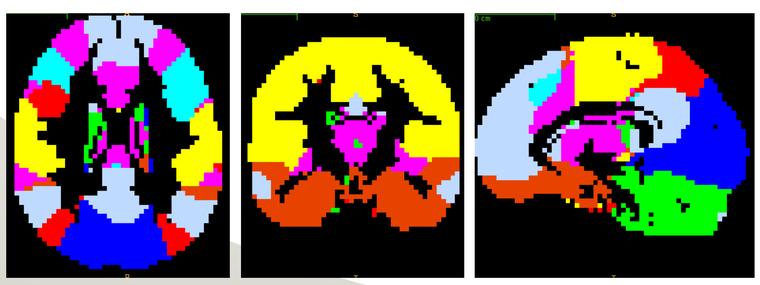
RestingState functional MRI: Subject does not perform any cognitive task while being scanned. Benefits: 1) Noninvasive. 2) Easy for patients with metntal disorder.



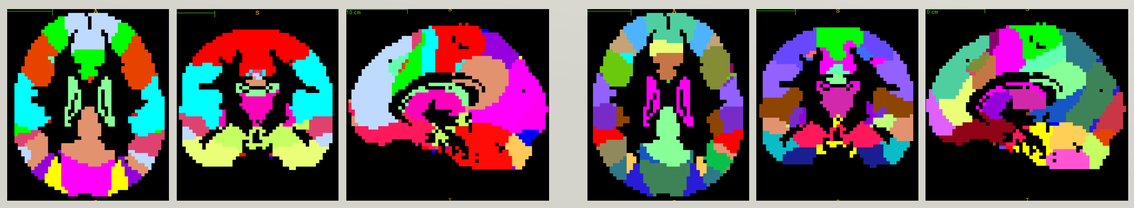
Functional connectivity is measured by linear correction btween two voxel (time series), i.e. how they are synchronized over time.

The connectivity of a region or voxel depends on its spatial neighbors. This is modeled by Markov Random Field (MRF)

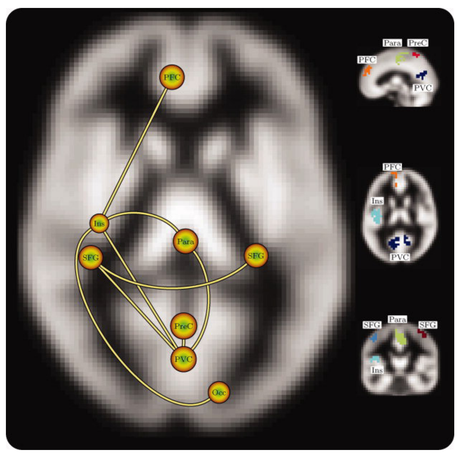




Brain partitions using 16 subjects restingstate fMRI data. Number of networks: 8.



Number of networks: 20 and 50



- Structural connectivity as physical constraints of functional connectivity.
- Integrate multimodality Imaging to get consistent brain connectivity.

Andrew Zalesky (2011, Human Brain Mapping). The abnormal network of schizophrenia

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