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Brain Fiber Segmentation

Anand K. Parmar(B12021), Mani Kumar(B12012)
Mentor
Dr. Aditya Nigam

School of Computing and Electrical Engineering
Indian Institute of Technology, Mandi

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Problem Statement and Long Term Goal

Anand K. Parmar(B12021), Mani Kumar(B12012)
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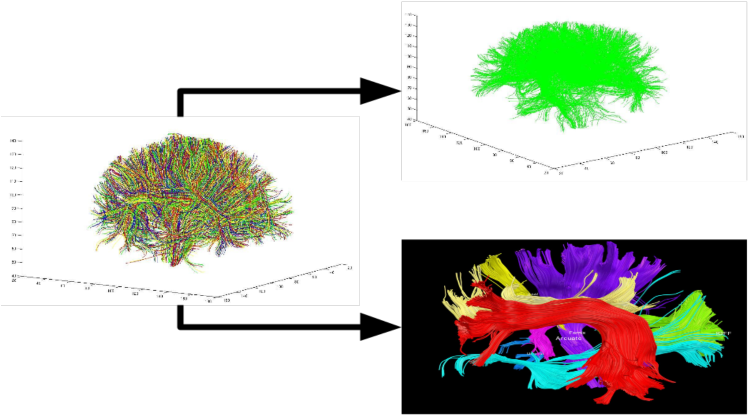
Problem Statement

Given the tractography data of a human brain, Segment it automatically into tracts having **"similar"** fibers which are anatomically meaningful.

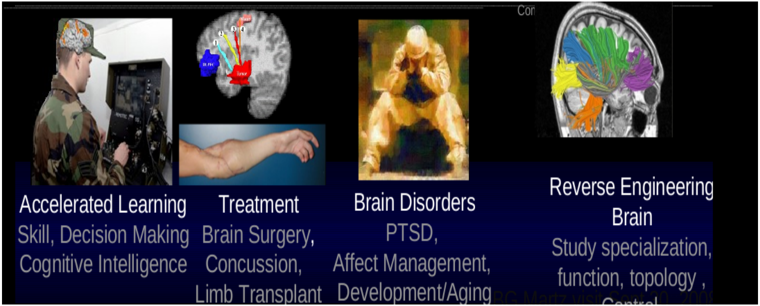
Goal

Make a software, which will take tractography data of brain as input and gives "similar" fiber 3D model of brain and some useful information according to given application(like, for brain tumor operation, it will give us shortest path for cutting fibers to remove tumor.)

Problem Statement and Long Term Goal



Motivation



- To Study about the localization of specific tracks of fibers.
- Surgery planning with minimum damage to the fibers.

Background and Related Work

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Introduction

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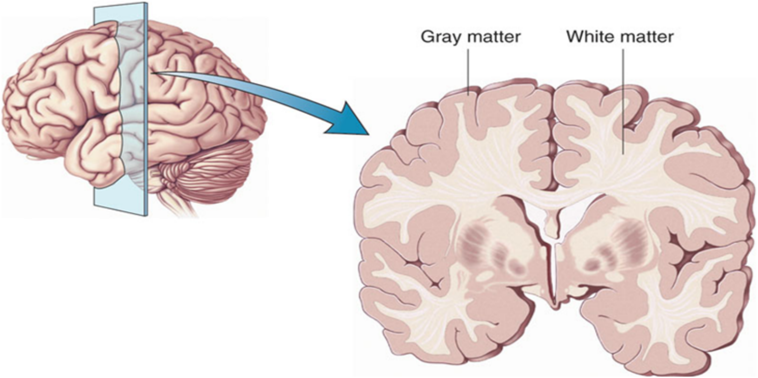
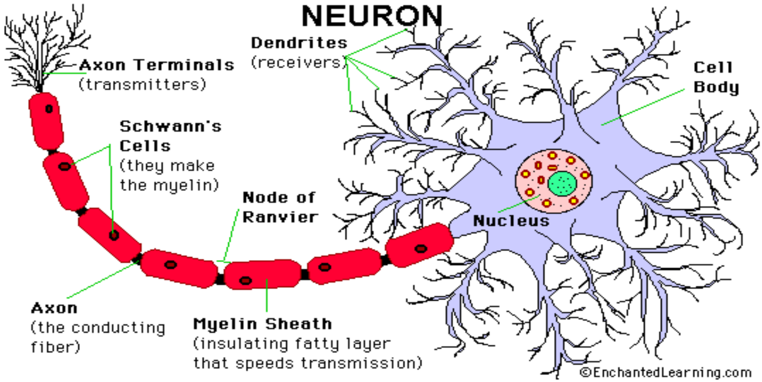
- The brain contains more than 100 billion neurons that communicate with each other via axons for the formation of complex neural networks.
- In Brain, two kinds of tissue are there:
  - Grey matter,
  - White matter.

Introduction: Brain

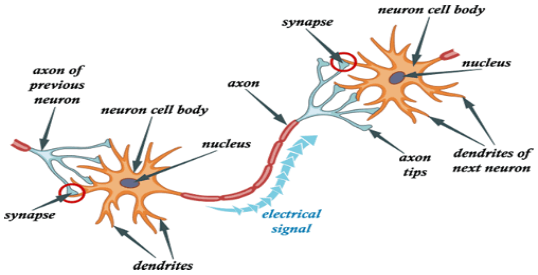


- Grey matter, which has a pinkish-grey color in the living brain, contains the cell bodies, dendrites and axon terminals of neurons, so it is where all synapses are.
- White matter is made of axons connecting different parts of grey matter to each other.

Introduction: Neuronal cell Structure



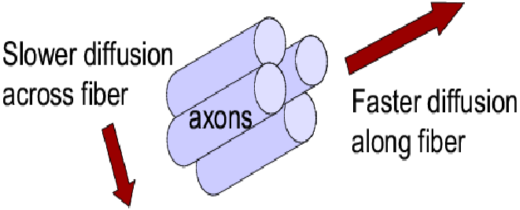
Introduction: Communication in Neurons



Here, Dendrites receives signals from other neurons, the cell body, which processes those signals and the axon, a long cable that reaches out and interacts with other neuron's dendrites. When different parts of the brain communicate and coordinate with each other, they send nerve impulses, which are electrical charges that travel down the axon of a neuron, eventually reaching the next neuron in the chain.

Diffusion Tensor Imaging(DTI)

- It is important when a tissue, such as the neural axons of white matter in the brain has an internal anisotropy fibrous structure.
- Water will then diffuse more rapidly in the direction aligned with the internal structure, and more slowly as it moves perpendicular to the preferred direction.
- Tensors are used to model diffusion. Major eigen vectors of the tensor(Principle Directions) gives the fiber tract direction.



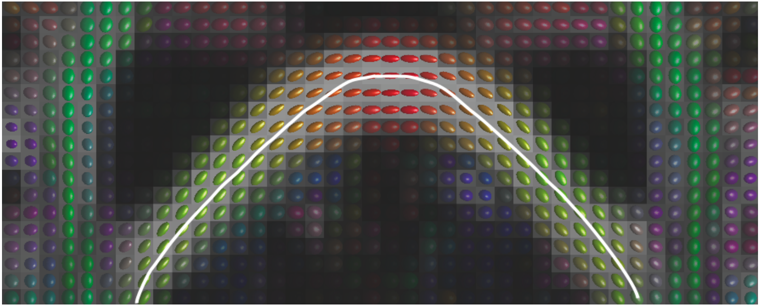
Tractography

wikipedia.org

In neuroscience, tractography is a 3D modeling technique used to visually represent neural tracts using data collected by diffusion tensor imaging (DTI).

- Streamline Tractography estimates white matter tract trajectories following the most likely tract direction. It locally chooses the most likely fiber trajectory.
- **DTI with Tractography gives us the white matter fiber orientation.**

Tractography



Preferred diffusion directions are shown as the long axes of diffusion ellipsoids.Here, red denotes left-right, green denotes back-front and blue up-down direction(out of the image plane). The white line shows the streamline obtained by connecting up a set of pixels based on their preferred directions and is an example of tractography.

Data Format

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Parameter-1.1

Class no.	Start-points Mean
Class1	(41.75930000,132.90225000,97.68317000)
Class2	(78.09513500,136.08315000,103.33668500)
Class3	(90.27637500,91.59677500,42.43649000)
Class4	(79.32306000,42.33381500,80.40204000)
Class5	(89.58828500,113.84820000,64.95563500)
Class6	(74.16783000,143.52725000,70.49763500)
Class7	(49.87368500,127.74495000,118.32490000)
Class8	(113.37985000,132.37805000,51.36863000)

Parameter-1.2

Class no.	Start-points Standard deviation
Class1	(3.59007200,1.65377037,2.55151559)
Class2	(4.80101352,6.46182409,2.89388383)
Class3	(0.18937435,0.47351493,0.22717374)
Class4	(5.34165247,3.08654294,2.31996886)
Class5	(2.22060831,1.51108827,1.66560462)
Class6	(3.34551431,7.42975410,14.83555032)
Class7	(0.39485908,0.52277337,0.41652010)
Class8	(4.39531984,4.82689752,10.91509012)

Parameter-2.1

Class no.	End-points Mean
Class1	(40.06050500,70.78955500,67.03863500)
Class2	(80.37367000,74.72157500,97.63405500)
Class3	(113.63880000,93.41260500,131.96160000)
Class4	(94.92560000,43.25754500,85.80602500)
Class5	(99.47859000,89.79473000,87.79484500)
Class6	(71.82542500,46.68512000,71.95375500)
Class7	(55.48636000,61.11233000,112.44245000)
Class8	(110.58140000,127.81460000,61.19712000)

Parameter-2.2

Class no.	End-points Standard deviation
Class1	(2.92963392,3.72654027,1.47660720)
Class2	(2.84154346,2.92655120,6.99558243)
Class3	(1.25299823,1.39776723,0.56241572)
Class4	(5.78067766,3.68521876,8.15535096)
Class5	(7.50444281,6.03372304,2.54777244)
Class6	(3.05448935,4.78675452,5.94266455)
Class7	(2.08037457,1.94918669,1.98636540)
Class8	(3.92595123,3.12721375,8.44942414)

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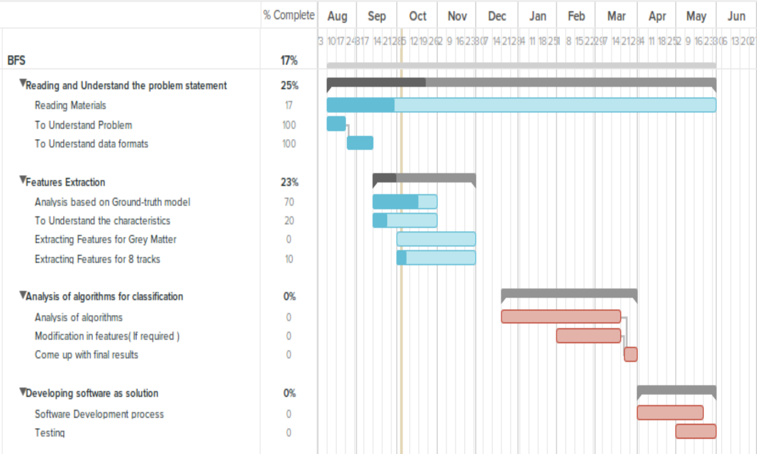

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Thank You