Diffusion MRI Clustering

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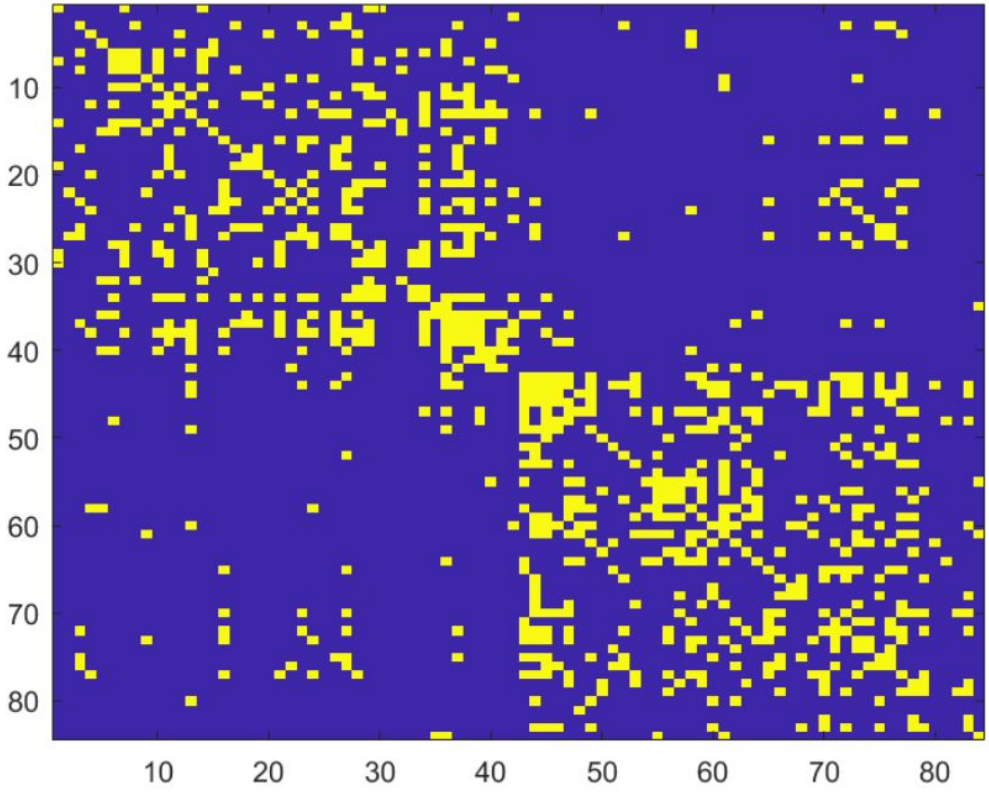
Problem Statement

90% of the fiber trajectories estimated from diffusion-weighted MRI (or estimated by tractography algorithm) do not connect any pair of brain (gray-matter) regions and are discarded in brain connectivity analysis



Brain Analysis Connectivity

My work

Previous Algorithms : Quickbundle
Earlier algorithms took more than 24 hrs while My algorithm for brain data takes 920 seconds

1)Devised a novel algorithm for clustering white-matter fiber tracts of diffusion-weighted MRI
2)This algorithm outperformed previous state of the art method and is computationally cheaper
3)Improved the gray-matter region connectivity of the fiber trajectories, which were initially disconnected when estimated from tractography and were discarded in brain connectivity analysis

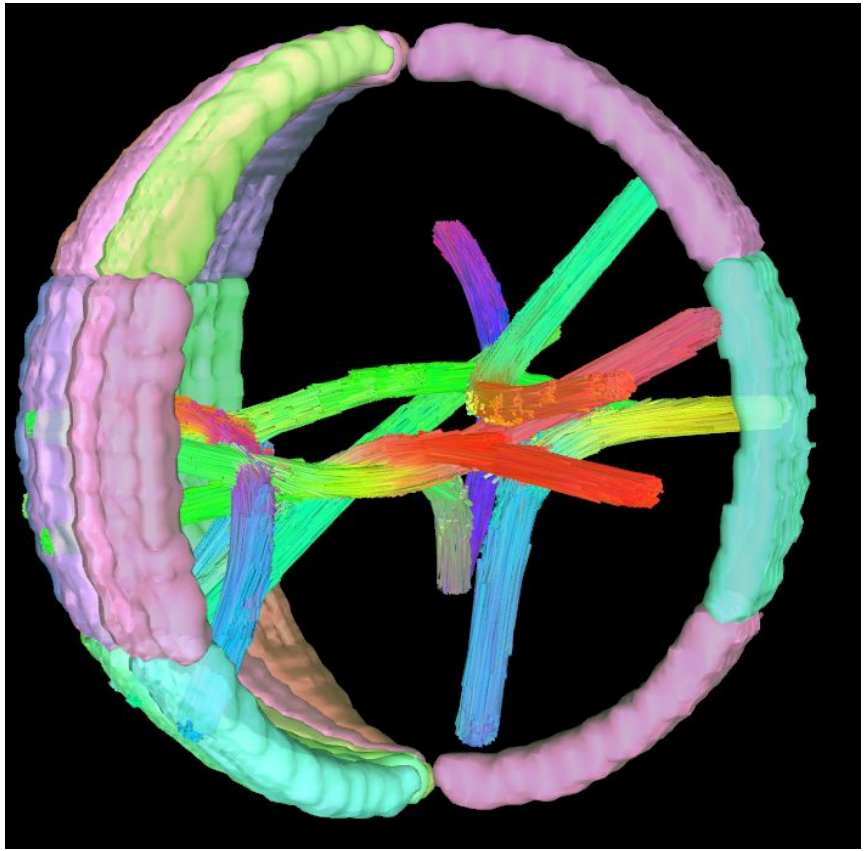
Comparison

Previous Algorithms : Quickbundle

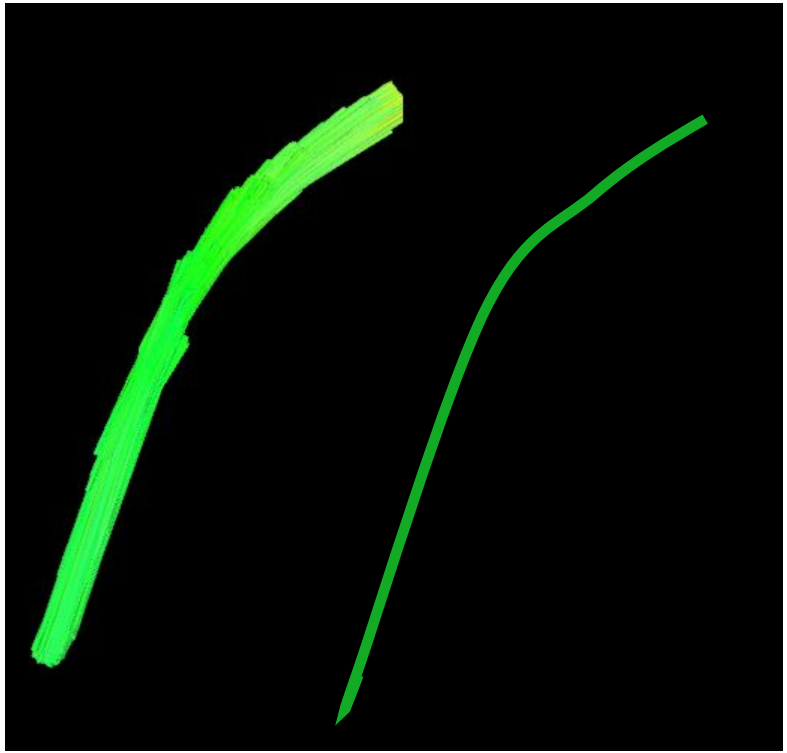
Earlier algorithms took more than 24 hrs.
My algorithm for brain data takes 920 seconds

Algorithm

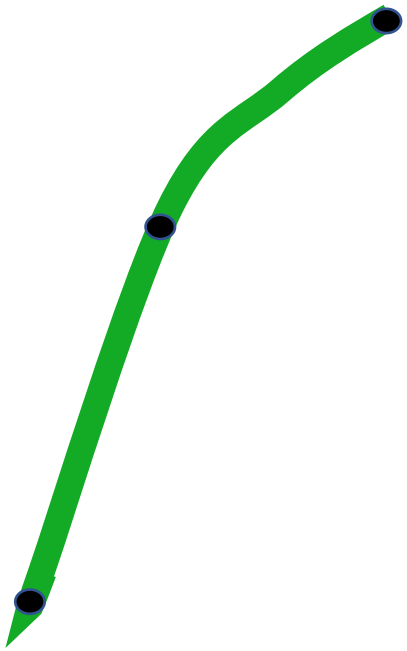
- First we generate a tractogram and extract streamlines connecting pairs of regions
- Streamlines that does not connect any pair of regions are used for partitioning (discarded streamlines)



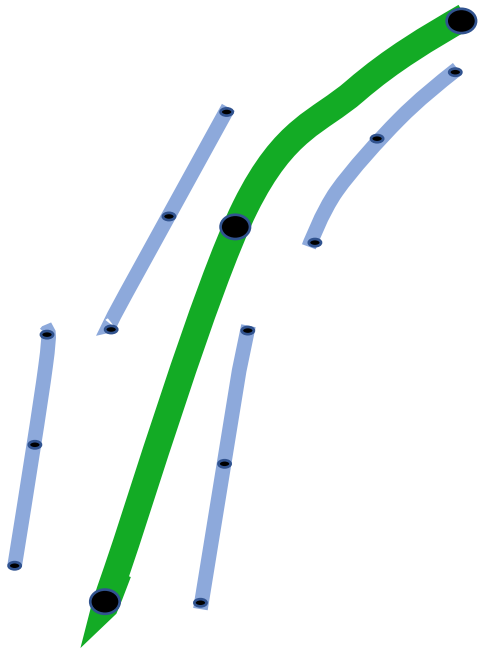
- Streamlines connecting a pair of region are then averaged to obtain a central streamline



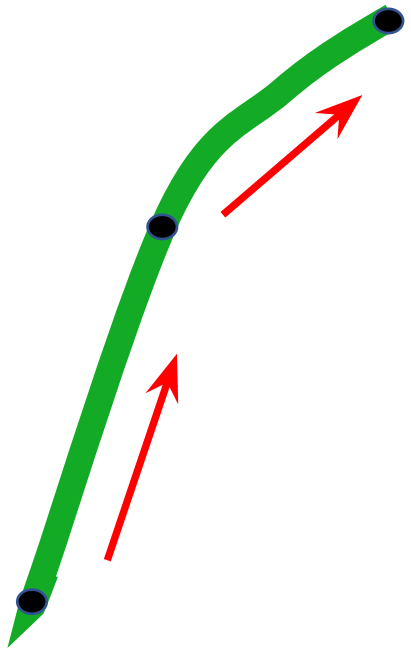
- The central streamline is divided into ‘n-1’ segments using ‘n’ points.
- This is further used to compare the distance of discarded streamlines from central streamline



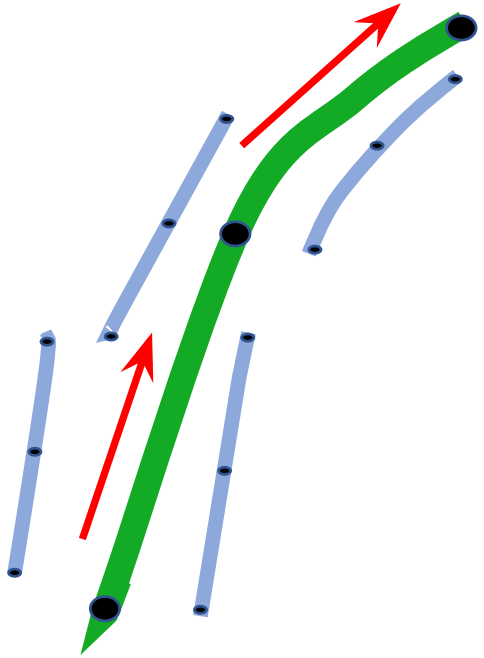
- The discarded streamlines are also divided into ‘n-1’ segments using ‘n’ points.
- The streamlines are interpolated for the sake of calculating Euclidean distance
- If the calculated Euclidean distance for each segment satisfies a given distance threshold, it is selected for the partitioning



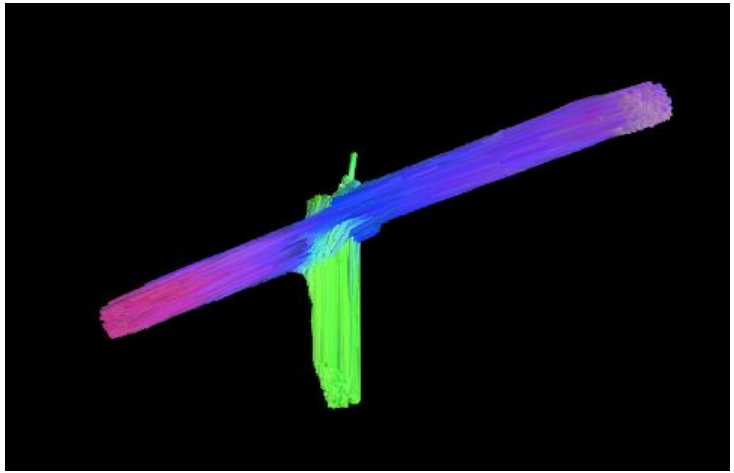
- Similarly, the central streamline is divided into ‘v-1’ vectors using ‘v’ points.
- This is further used to compare with the trajectories of discarded streamlines with the central streamline



- The discarded streamlines (selected for the partition) are also divided into ‘v-1’ segments using ‘v’ points.
- The vectors are compared segment-wise to track the trajectory
- If the angle between the central and discarded segments satisfies a given angle threshold, it is selected for the partioning

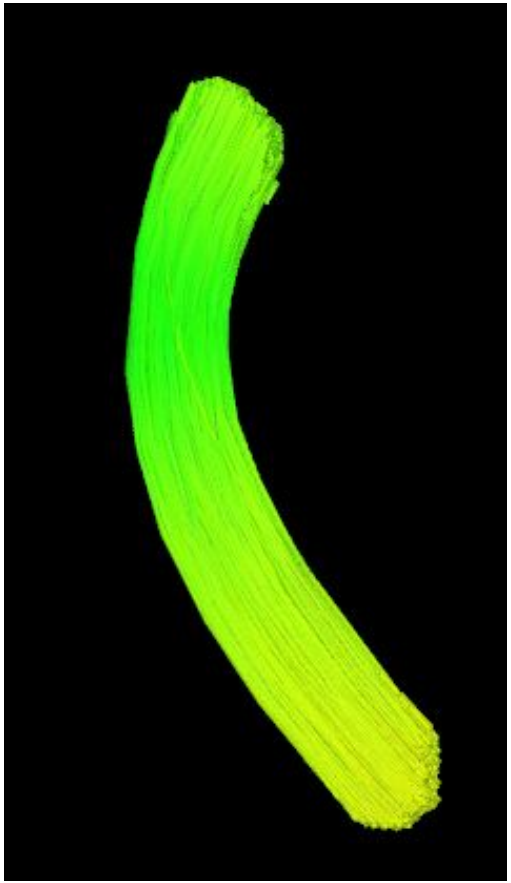


- A lenient threshold result in inconsistent streamlines, whereas a strict threshold results in rejecting the streamlines

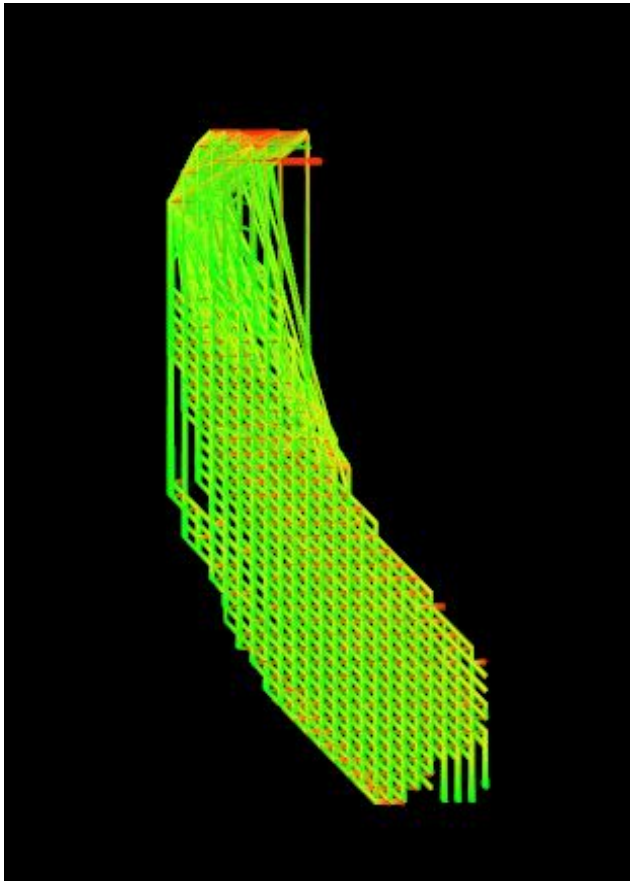


Results on clustered

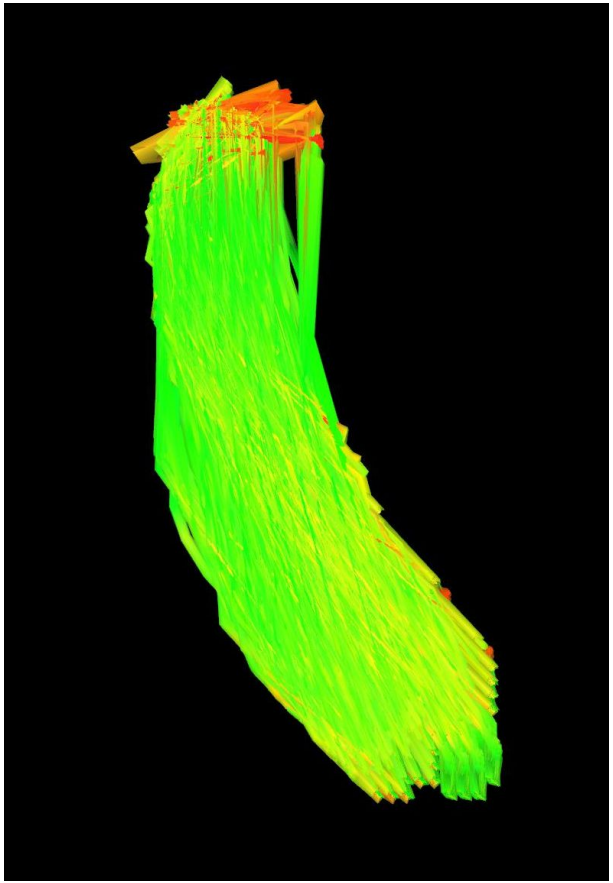
Streamlines



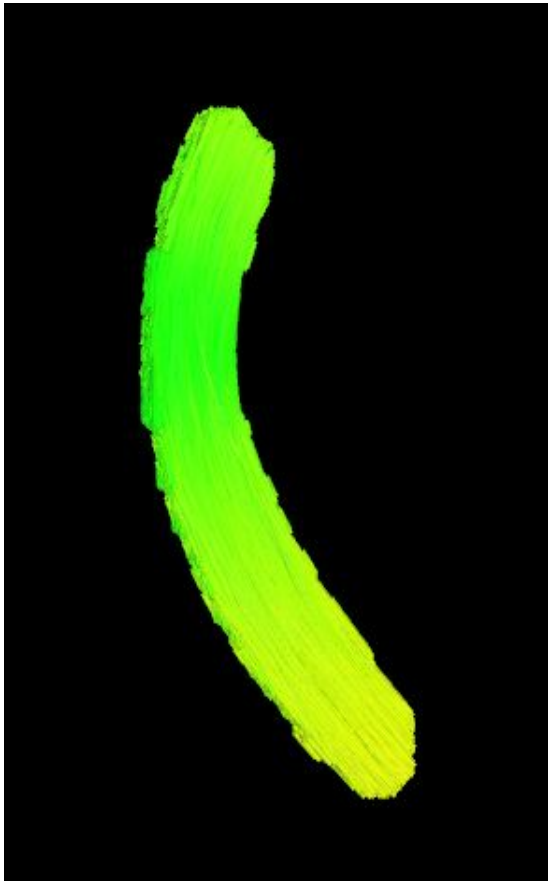
Raw block-chain



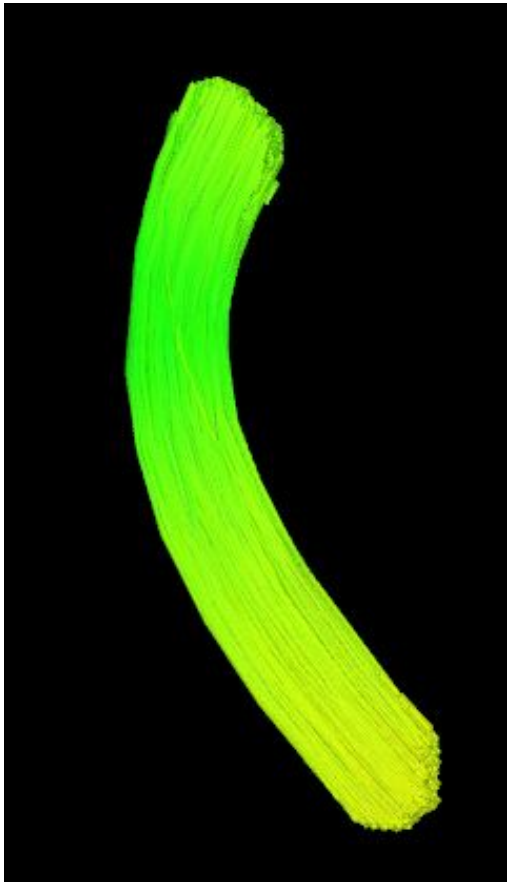
Interpolated



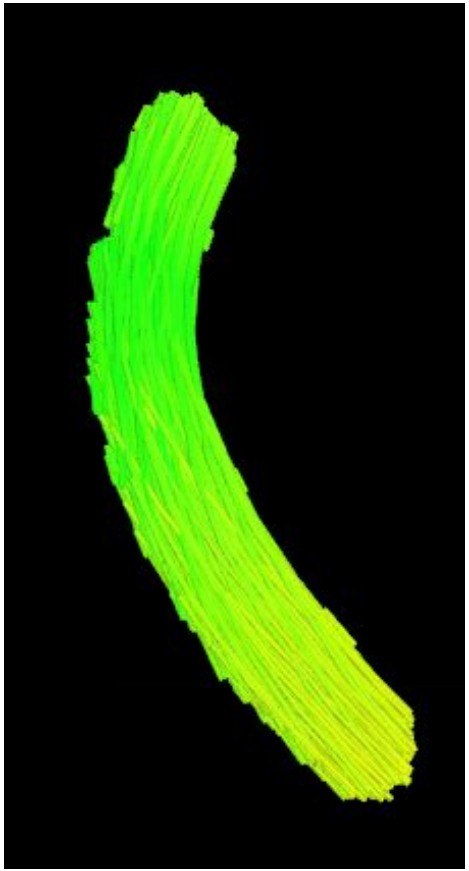
Original



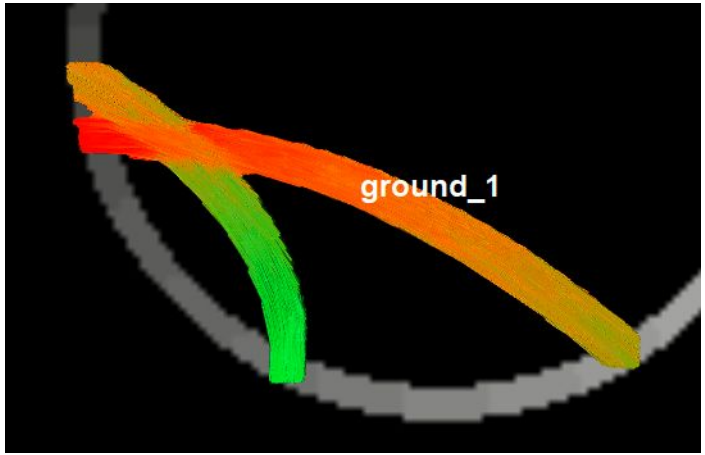
Connected

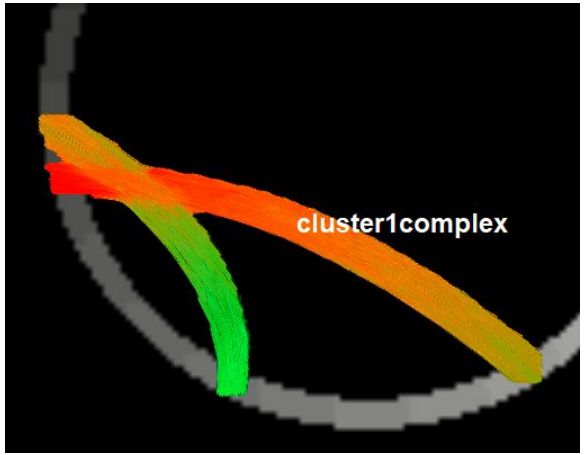


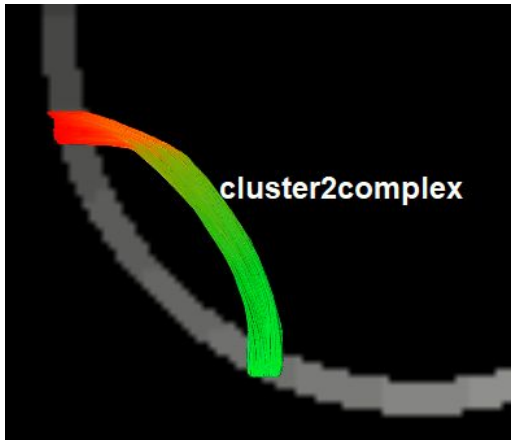
Clustered



Logic 2

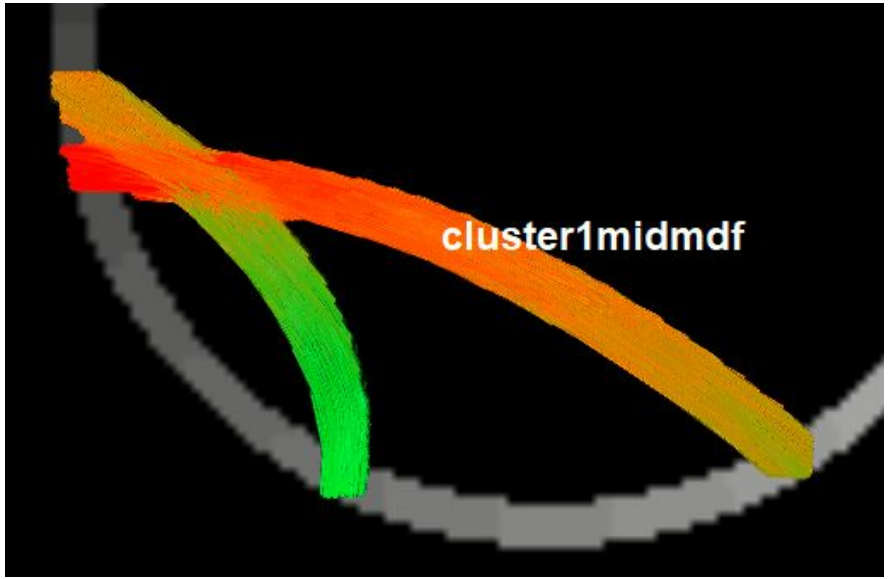




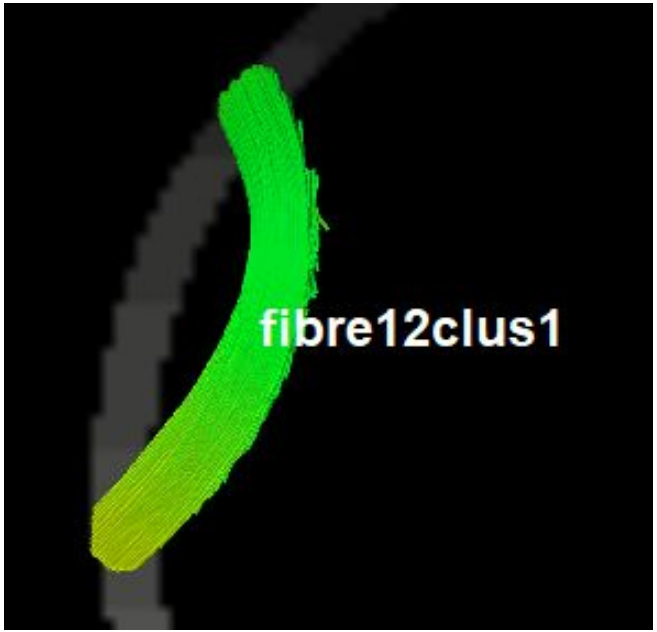


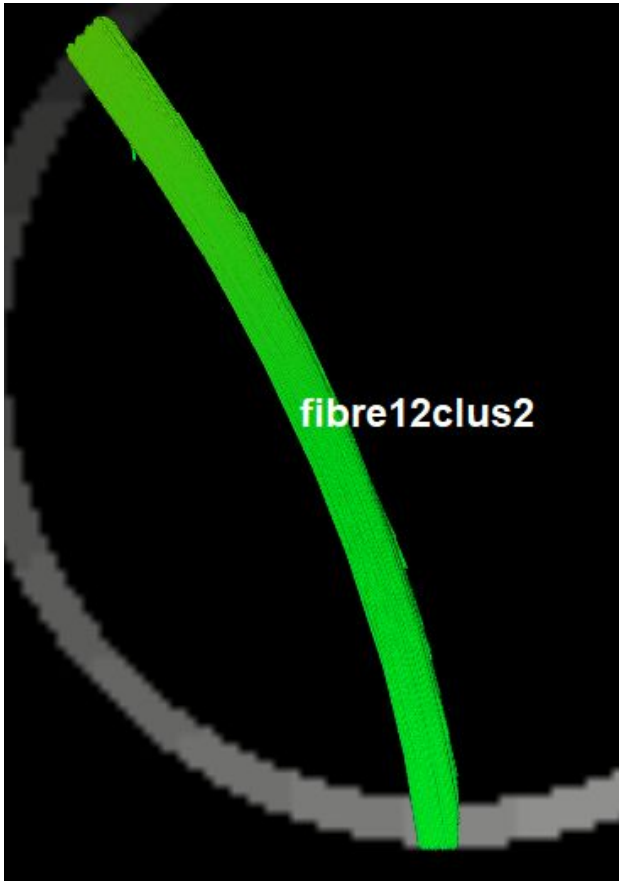
Logic 3

Logic 5

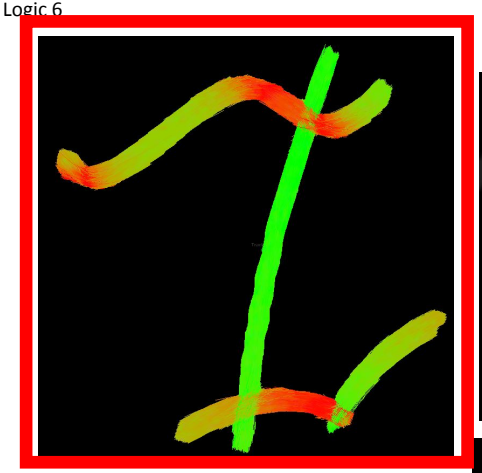


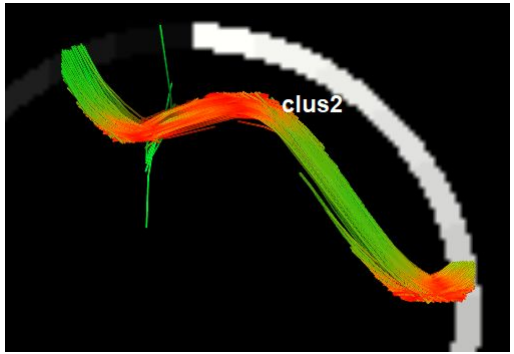
Logic 6

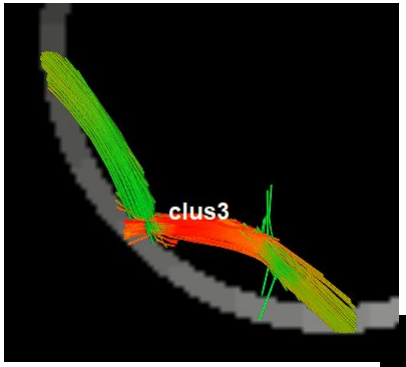




Logic 6




clus2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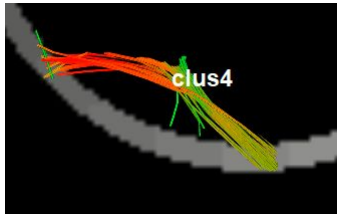
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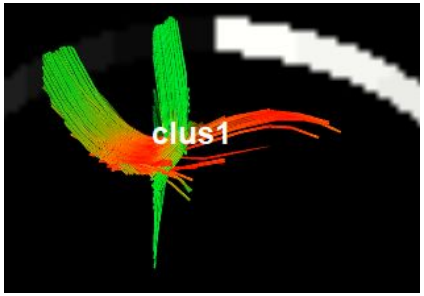
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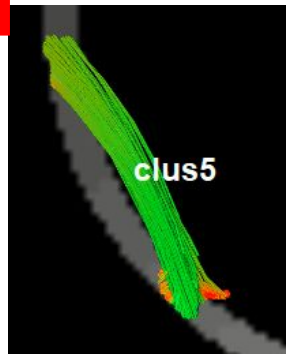
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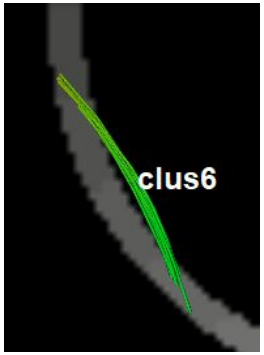
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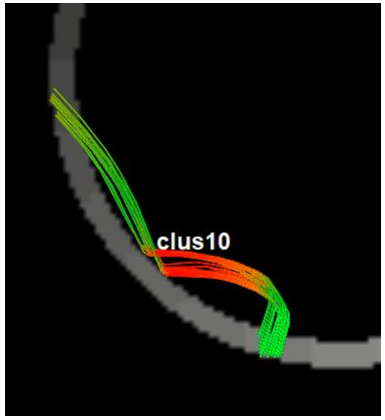
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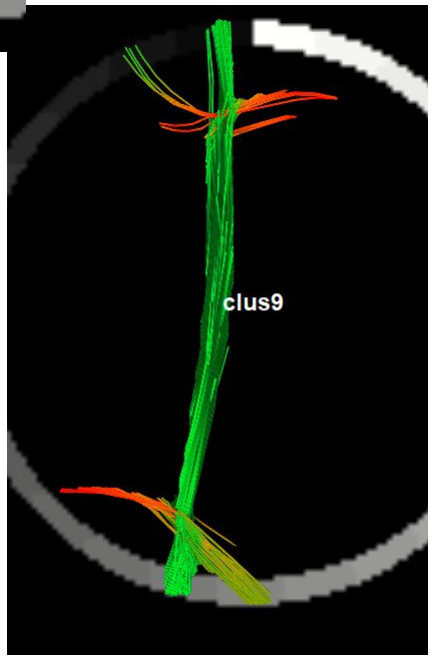
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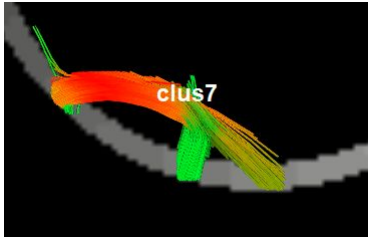
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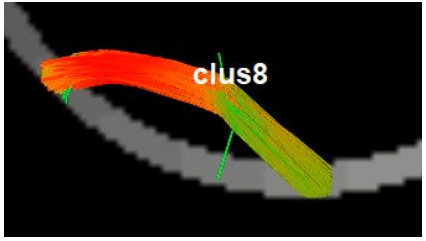
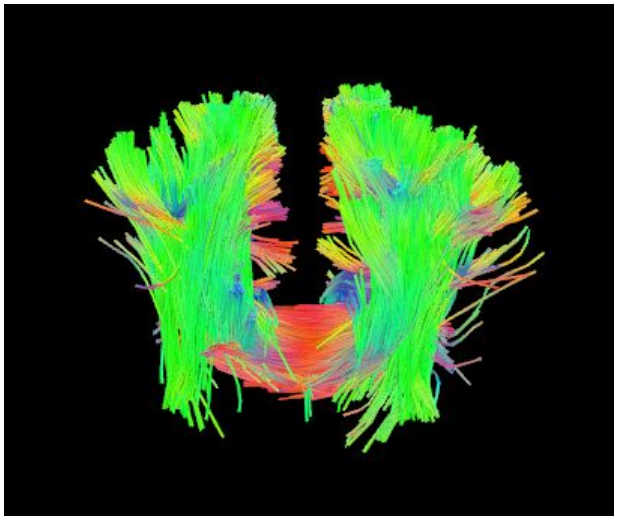
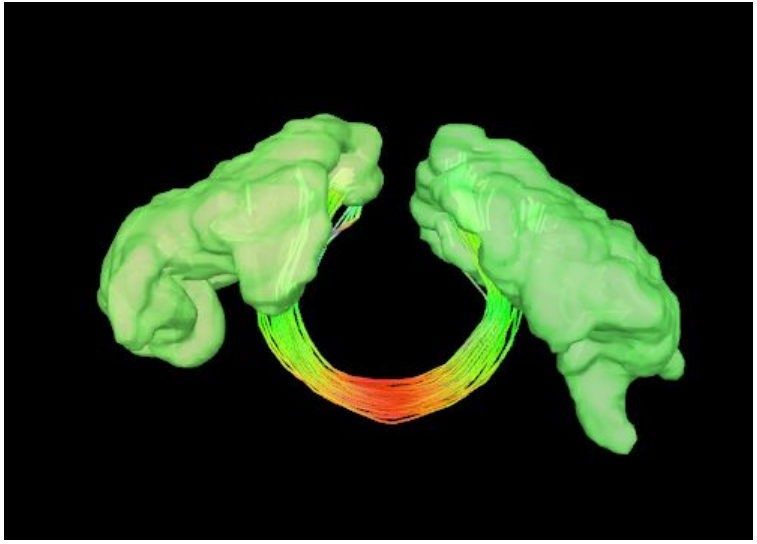

clus8

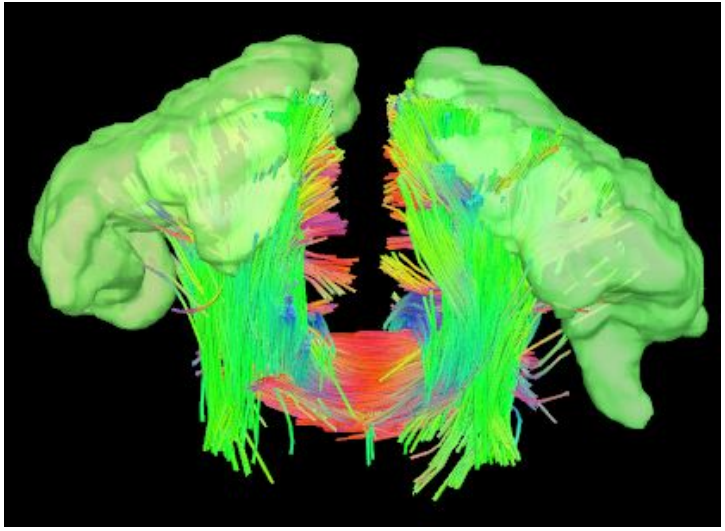
Results (Partitions)

Using tractography

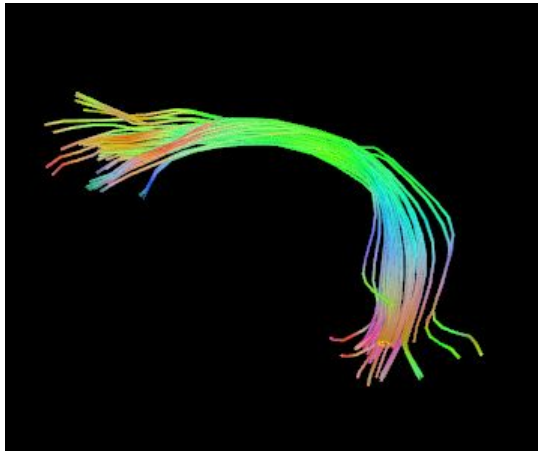


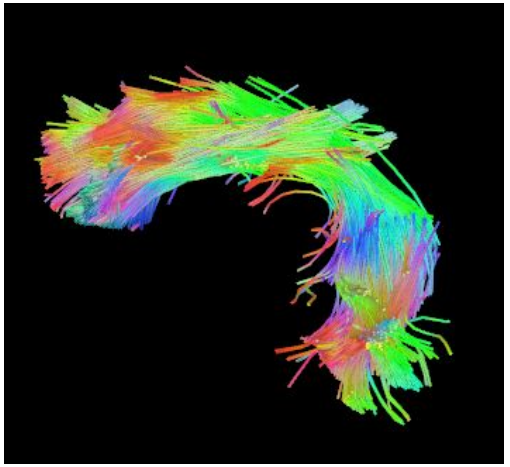
Using BDS



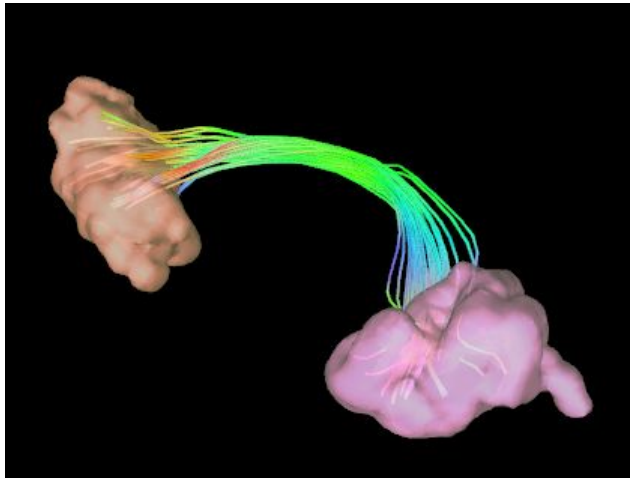


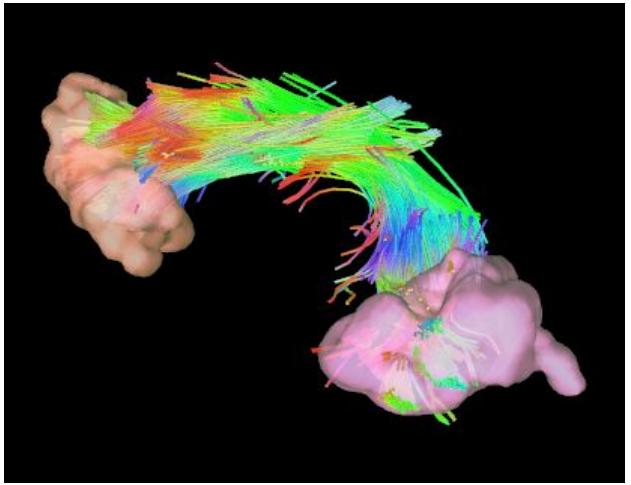
Using tractography

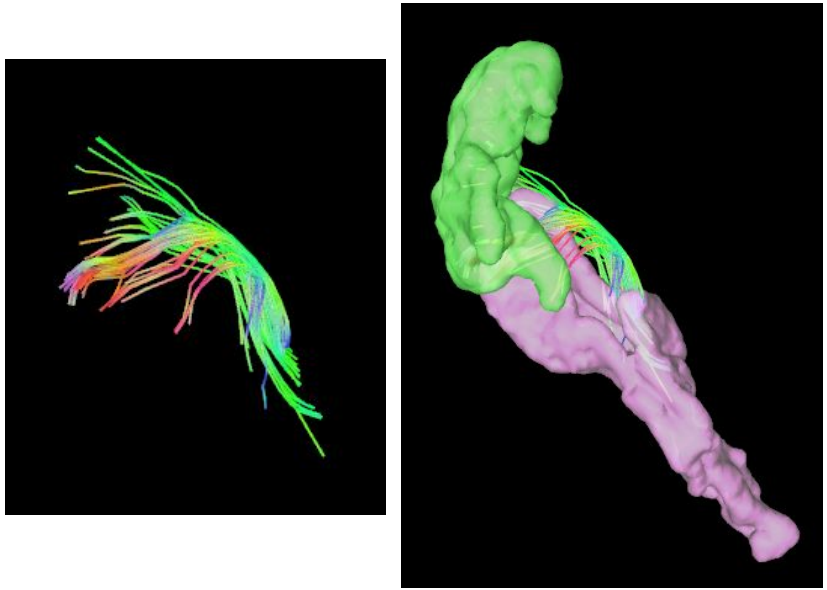




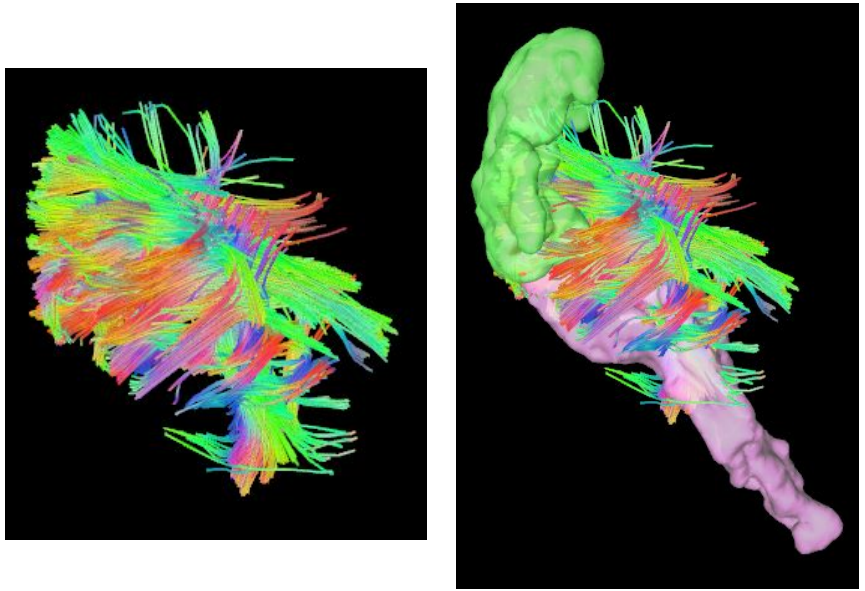
Using BDS







Using
tractography



Using BDS