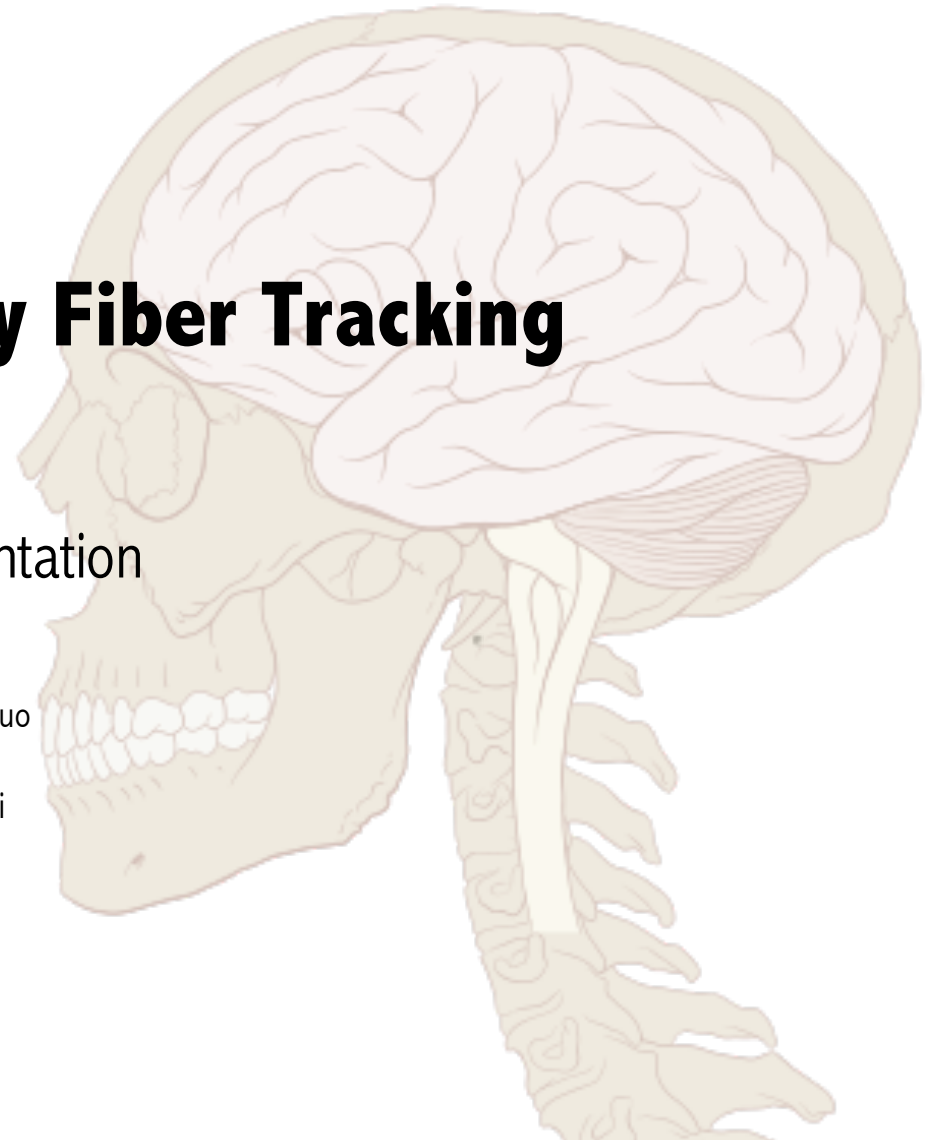


DTI Visualization by Fiber Tracking

Final Presentation

Dongliang Luo
Qing Ye
Zheng Wei



Introduction—Data Outline

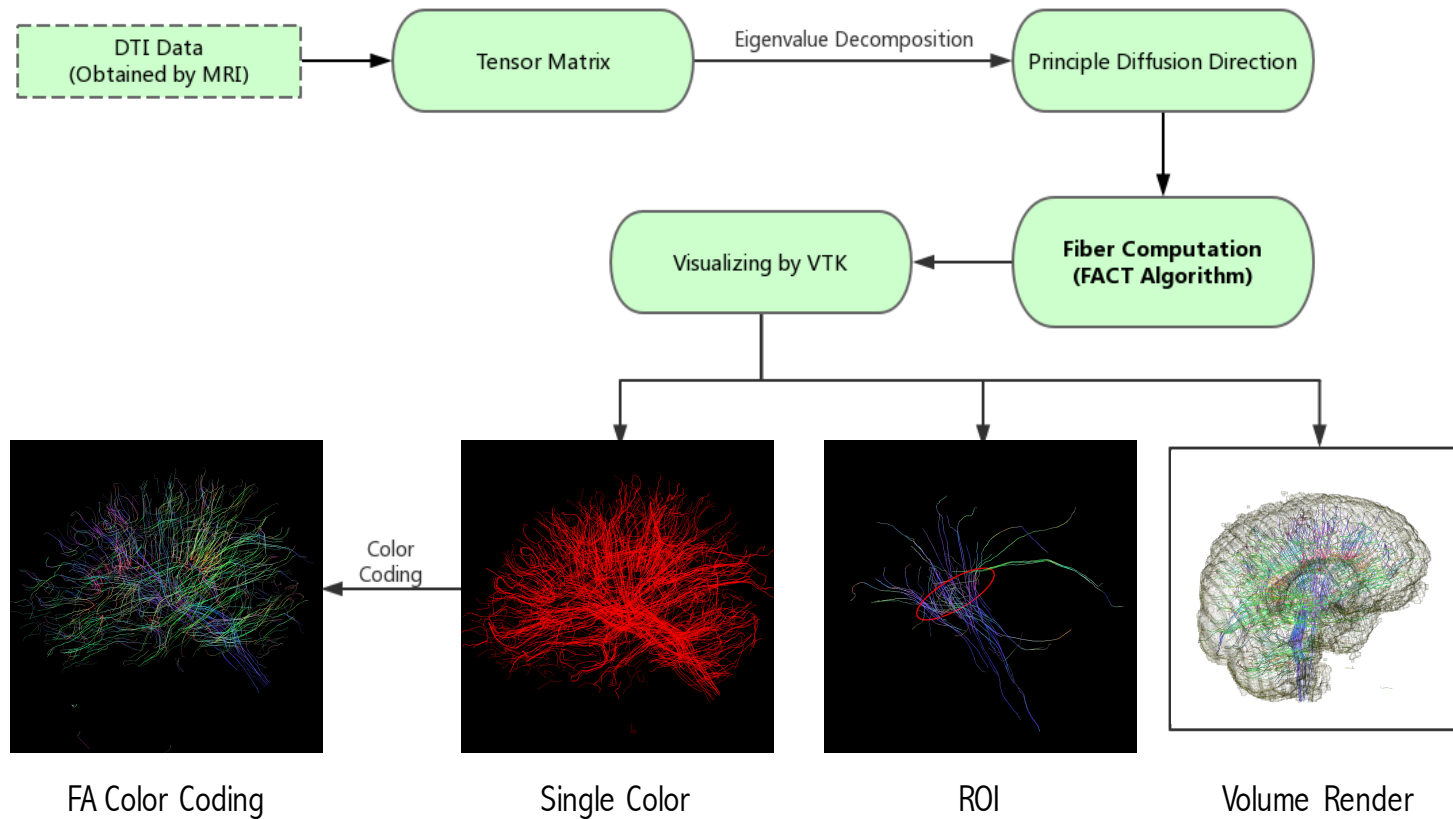
- 数据获取：通过对MRI数据计算得到
- 数据格式：NIfTI
- 数据维度：7 x 148 x 190 x 160
- 张量数据：空间上每个点都有7维的张量数据，分别对应为

$D_{xx}, D_{yy}, D_{zz}, D_{xy}, D_{xz}, D_{yz}$ 和 confidence

Introduction—Problem

- 均匀介质中水分子随机运动，在各个方向运动几率相同，具有各向同性 (isotropy)
- 在人体组织中，水分子运动受到组织结构影响，在各个方向弥散程度不同，具有各向异性 (anisotropy)
- 本次使用的DTI数据包含张量数据，刻画一个体素中水分子扩散的各向异性

Operation procedure – Overview



Tensor matrix

$$\mathbf{D} = \begin{bmatrix} D_{xx} & D_{xy} & D_{xz} \\ D_{yx} & D_{yy} & D_{yz} \\ D_{zx} & D_{zy} & D_{zz} \end{bmatrix}$$

$$\bar{\mathbf{D}} = [D_{xx}, D_{yy}, D_{zz}, D_{xy}, D_{xz}, D_{yz}]^T$$

Principal direction

- Eigenvalue decomposition

$$\mathbf{D}\mathbf{v} = \lambda\mathbf{v}$$
$$\Rightarrow \mathbf{D} \begin{bmatrix} \vec{v}_1^T \\ \vec{v}_2^T \\ \vec{v}_3^T \end{bmatrix} = \begin{bmatrix} \lambda_1 & & \\ & \lambda_2 & \\ & & \lambda_3 \end{bmatrix} \begin{bmatrix} \vec{v}_1^T \\ \vec{v}_2^T \\ \vec{v}_3^T \end{bmatrix}$$

Principal direction

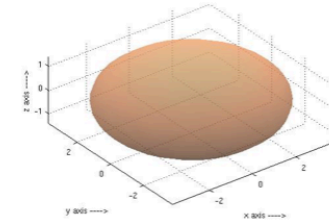
- Principal direction

$$\mathbf{D}v_{principal} = \lambda_{max}v_{principal}$$

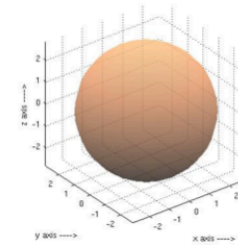
- Fractional anisotropy (FA) calculation

$$FA = \frac{\sqrt{3}}{\sqrt{2}} \frac{\sqrt{(\lambda_1 - \lambda)^2 + (\lambda_2 - \lambda)^2 + (\lambda_3 - \lambda)^2}}{\sqrt{\lambda_1^2 + \lambda_2^2 + \lambda_3^2}}$$

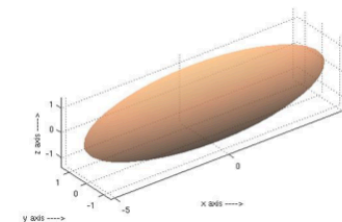
$$\lambda = \frac{\lambda_1 + \lambda_2 + \lambda_3}{3}$$



FA = 0.603



FA = 0



FA = 0.902

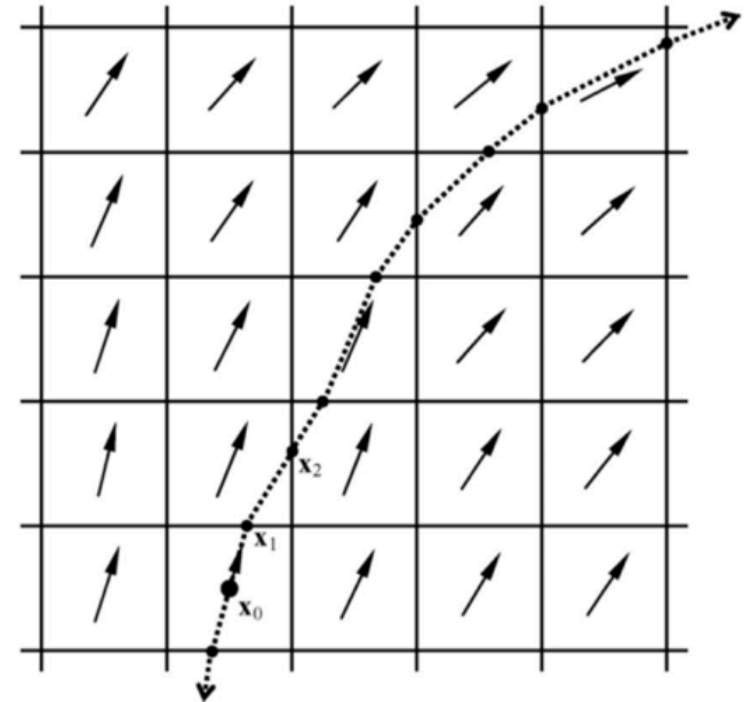
Fiber computation

- Tracking Algorithm

Fiber Assignment by Continuous Tracking (FACT)

- Stop tracking when:

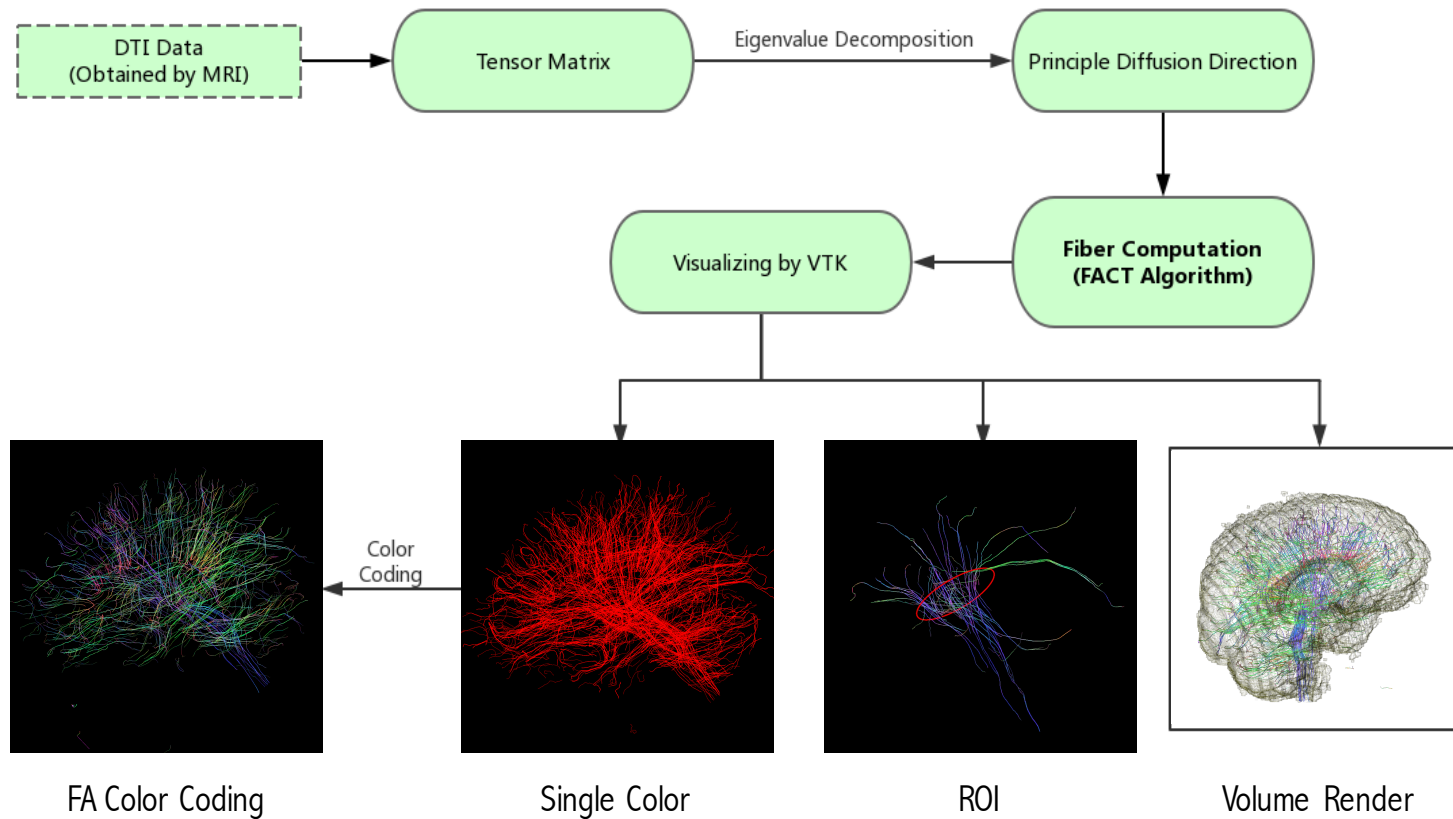
1. FA 值低于阈值，说明该点趋于各向同性
2. 当进入新体素运动角度发生的偏折角度大于阈值
3. 纤维扩展到了边界体素



Visualize by VTK

- Region of interest(ROI)
 - User defined
- Diffusion anisotropy visualization
 - (R, G, B) represents diffusion anisotropy in each direction
 $(R, G, B) = FA * (v_x, v_y, v_z)$
- Volume Rendering
 - Brain tissue structure information

Operation procedure



Reference

1. Jiang H, van Zijl P C, Kim J, et al. DtiStudio: resource program for diffusion tensor computation and fiber bundle tracking.[J]. Computer Methods & Programs in Biomedicine, 2006, 81(2):106-116.

Thank you for listening!!!

Dongliang Luo
Qing Ye
Zheng Wei

