EXAMPLE OF THE DATA GENERATION PROCESS

HCP dataset → Global tractography

Final tractogram of the 25 fiber bundles → Manual segmentation and processing of 25 fiber bundles

Simulated diffusion-weighted and T1 image
IN A NUTSHELL

1. Manually segmented white matter bundles.
   - These serve as ground truth streamline fibers.

2. Clinical-like diffusion MRI dataset generated using Fiberfox¹:
   - 2mm isotropic, artefacts (motion, distortions, noise, etc.),
   - 32 directions, b-value 1000 s/mm², 2 b=0 images

3. Tractometer² for the evaluation of fiber tracking results
   - Sensitivity & specificity with ground truth

MANUAL TRACT SEGMENTATION

- Fiber tracking algorithm ran on high-resolution 1.25mm isotropic HCP data
- Bundle segmentation manually done by expert radiologist using anatomically placed regions of interest
- 26 bundles extracted covering association, projection and commissural fibers across the whole brain
26 MANUALLY SEGMENTED WHITE MATTER BUNDLES

• These 26 bundles serve as ground truth models. They are used as artificial fibers to generate the raw diffusion MRI dataset.

• This is just another way to generate a phantom dataset based on realistic looking streamline fibers.
DIFFUSION MRI SIMULATION

• MOTIVATION: **Clinical-like dataset**
  
  • 2 mm isotropic, 2 b=0 images
  
  • 32 directions, b-value 1000 s/mm²
  
  • Noise added
  
  • Many types of artefacts

Example of simulated b=1000 s/mm² of typical clinical imaging protocol
DATA FOR PARTICIPANTS

1. Diffusion MRI dataset:
   Diffusion.nii.gz, Diffusion.bvals, Diffusion.bvecs
   (1st image b=0 and then 32 dwi)

2. Diffusion with reverse-phase encoded b=0 image
   Diffusion_WITH_REVERSEPHASE.nii.gz

3. B0 FieldMap for this dataset:
   fmap_RadPerSec.nii.gz,
   fmap_Hz.nii.gz

4. T1-like image:
   T1.nii.gz
DIFFUSION - DWI #3
REVERSE PHASE

i. $b=0$ blipup

ii. $b=0$ blipdown
The same field map is applied to all image volumes, regardless of head motion.

Field map available in rad/sec or Hz.
DIFFUSION MRI

Basic DTI reconstruction (no correction)
EXPECTED SUBMISSION

• A single whole brain tractogram (max 2Gb). Accepted format:
  • .trk (TractVis)
  • .tck (MRtrix)
  • .vtk

• Challenge website will gives further indications for fileFormat conversion
EVALUATION WITH THE TRACTOMETER

- Valid connections
- Invalid connections
- No connections (stopping in white matter or ventricles)
- Overlap with ground truth streamline fibers

Tractometer. [Coté et al Descoteaux. MEDIA 2013]
VALID CONNECTION

Connects 2 connected regions

Illustration with the *FiberCup* dataset

INVALID CONNECTION

Connects 2 valid regions through a wrong path
INVALID CONNECTION
Connects 2 regions that should not be connected
INVALID CONNECTIONS

Connects 2 regions that should not be connected
NO CONNECTION

Does not connect 2 regions
(stops prematurely in white matter or ventricles)
OVERLAP

Ground truth streamlines
Estimated streamlines
(Example on the CST)

Overlapping voxels
Non-overlapping voxels
LOCAL ANGULAR ERROR

Voxel-wise tractogram directions compared to ground truth directions.
QUESTIONS?