Construction of the atlas

- Needed softwares: *FreeSurfer, FSL, Matlab, SPM and ANTS*

1. Thalamic mask

1.1. Subcortical parcellation

- Performed with the FreeSurfer function recon-all

  e.g. *recon-all -subjid SUBJID –all*

- Use the output *aseg* where the left thalamus has the label 10, while the right one 49

  e.g. *mri_extract_label aseg.mgz 10 49 thalami.nii.gz*

1.2. Refinement of the thalamic mask

- Apply Segment from SPM toolbox on T1w for determining the probability maps for the 3 brain tissue classes: grey matter, white matter and cerebrospinal fluid (CSF)

- Perform tensor fitting on the DWI data with b~1000s/mm2 for calculating the FA map (FSL function: dtifit)

  e.g. *dtifit -k DWI_b1000 -o output_basename -m mask -r bvecs -b bvals*

- Registeration to DWI space

  e.g. *antsRegistrationSyN.sh -d 3 -f <DWI> -m <T1_NativeSpace> -t r -o <T1_2_Diffusion>*

- Transform the CSF probability map and the thalamic masks into DWI space

  e.g. *antsApplyTransforms -d 3 -i <CSF> -o <CSF_DiffusionSpace> -r <DWI> -t <T1_2_Diffusion> -n Linear*

  antsApplyTransforms -d 3 -i <thalami> -o <thalami_DiffusionSpace> -r <DWI> -t <T1_2_Diffusion> -n NearestNeighbor

- Exclude voxels form the FreeSurfer thalamic mask that have CSF probability greater than 5% and FA value higher than 0.55

2. Thalamic parcellation

- Compute the ODF coefficient in SH basis of order 6 (FSL function qboot)

  e.g. *qboot -k DWI -m mask -r bvecs -b bvals --lmax=6 --savemeancoeff*

- Use the Matlab code from the related “Software Robust thalamic nuclei segmentation method based on local diffusion magnetic resonance properties” available at Zenodo with DOI: 10.5281/zenodo.1253021 for each thalamus

3. Template construction

- Used ANTS command:
  antsMultivariateTemplateConstruction2.sh -d 3 -i 3 -k 2 -f 4x2x1 -s 2x1x0vox -q 30x20x4 -t SyN -m CC -c 2 -j 6 -o multiT1T2_template T1_T2_corr_templateBuilding_test.csv[*]

- For each subject we estimate as well the transform to bring the T1w from native to the custom-template space

  e.g. *antsRegistrationSyN.sh -d 3 -f <multiT1T2_template> -m <T1_NativeSpace> -t a -o <native_2_custom>*

- Affine registration of the custom multimodal template to MNI space

  e.g. *antsRegistrationSyN.sh -d 3 -f <MNI152_template> -m <multiT1T2_template> -t a -o <custom_2_mni>*

- For each subject we transform the thalamic nuclei segmentation from the individual DWI space to the MNI space

  e.g. *antsApplyTransforms -d 3 -i <thalamic_nuclei> -o <thalamic_nuclei_multiT1T2_template> -r <MNI152_template> -t <[T1_2_Diffusion,useInverse]> <native_2_custom> <custom_2_mni> -n NearestNeighbor*

- By averaging across the subjects we computed the probability maps of the 14 thalamic subparts (seven per hemisphere). Additionally, the maximum likelihood labelling was determined by identifying, at each voxel, the label with the greatest value in the nuclei probability maps.

[*] The T1_T2_corr_templateBuilding_test.csv could be found among the provided documents