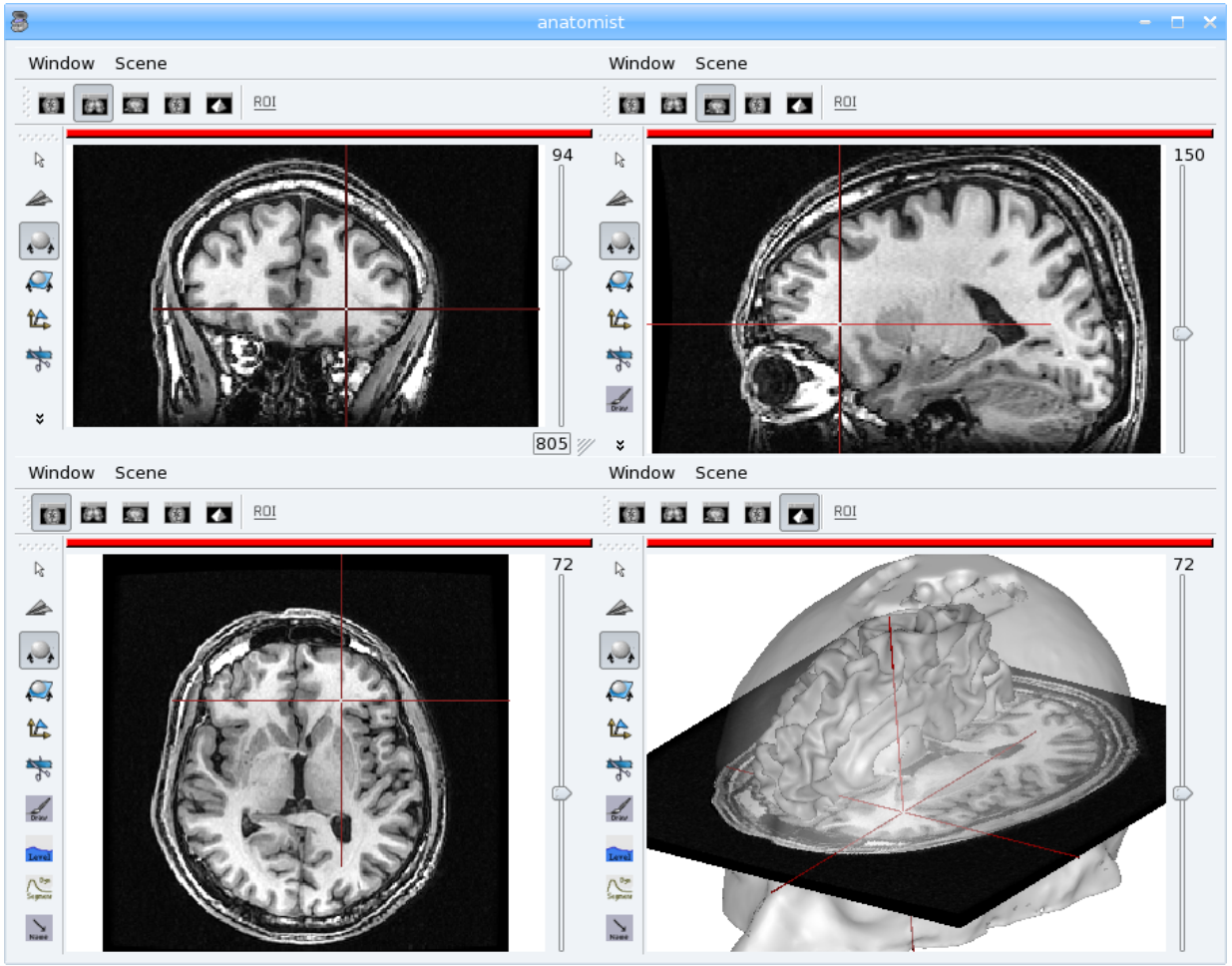
Morphologist Pipeline
BrainVISA T1 MRI Toolbox

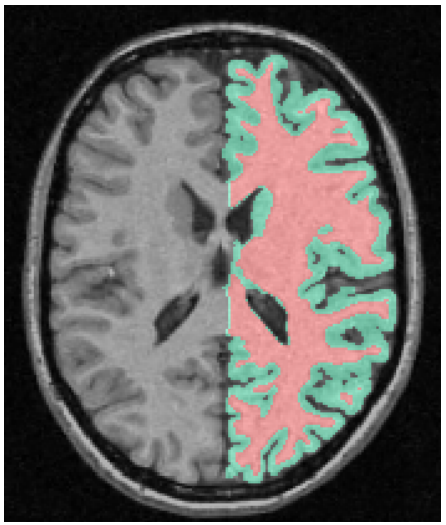
Human brain T1 MRI image

- T1 weighted image
- Anatomical image
- Contrast enables to distinguish tissues: values in white matter > gray matter > CSF

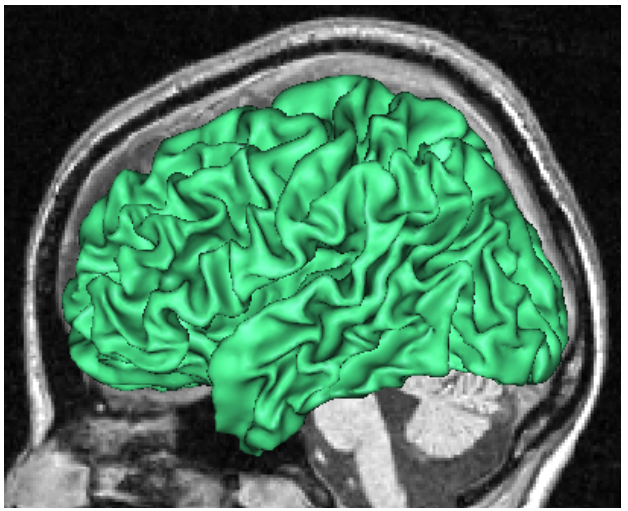


T1 MRI processing

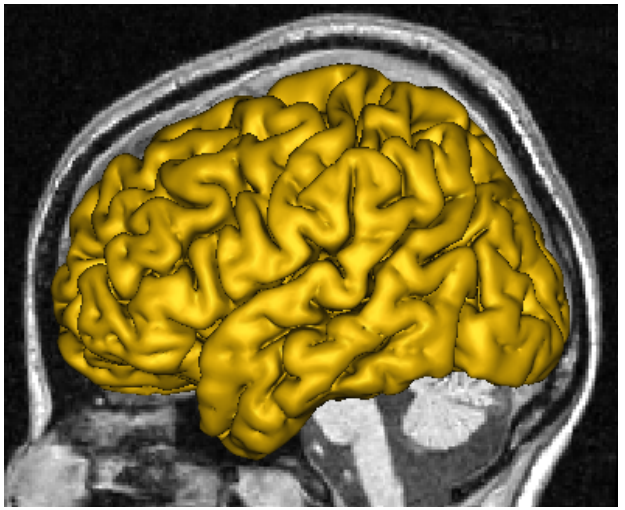
- BrainVISA T1 pipeline



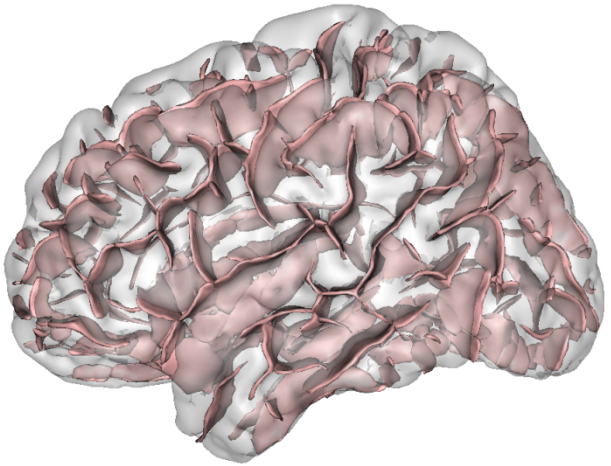
Grey white matter segmentation



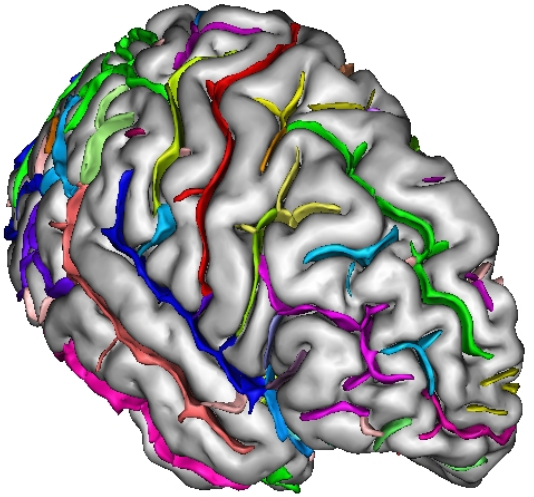
White matter mesh



Grey matter mesh



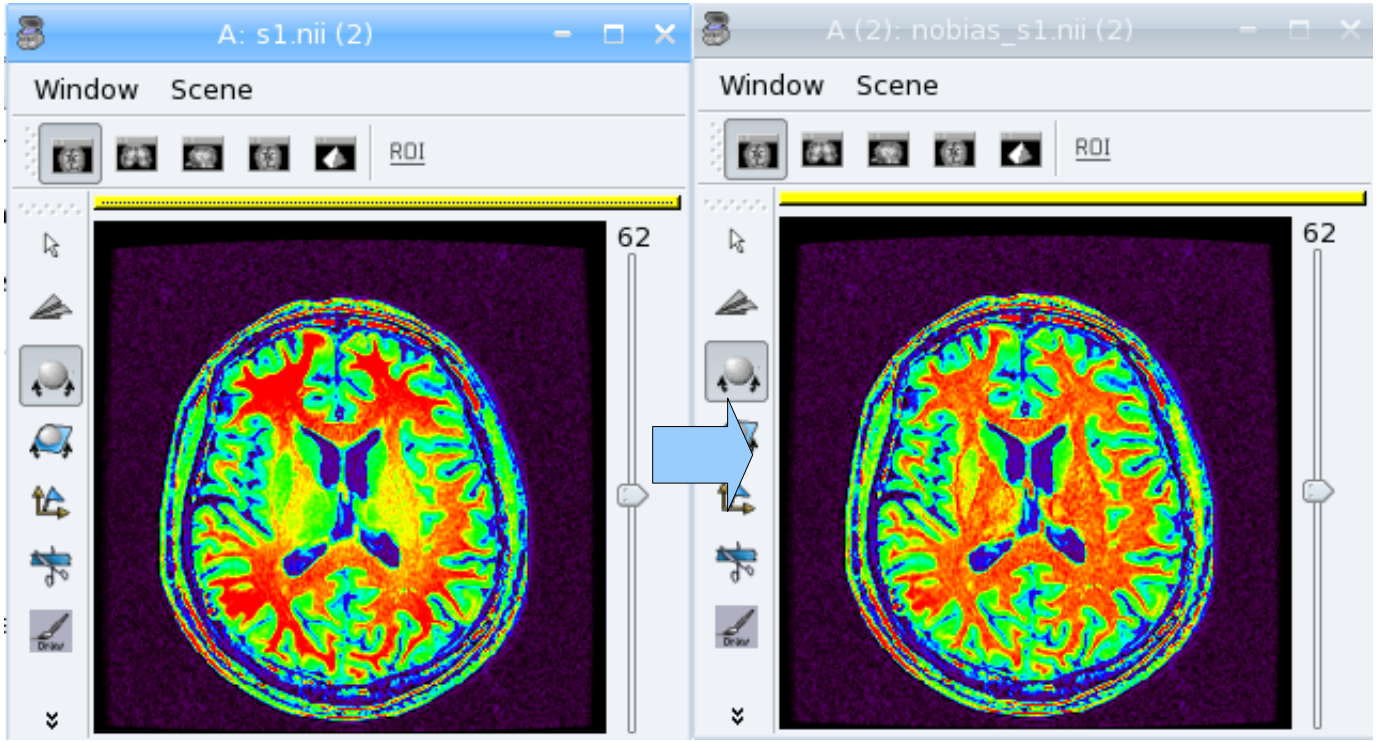
Cortical folds graph



Automatically identified sulci

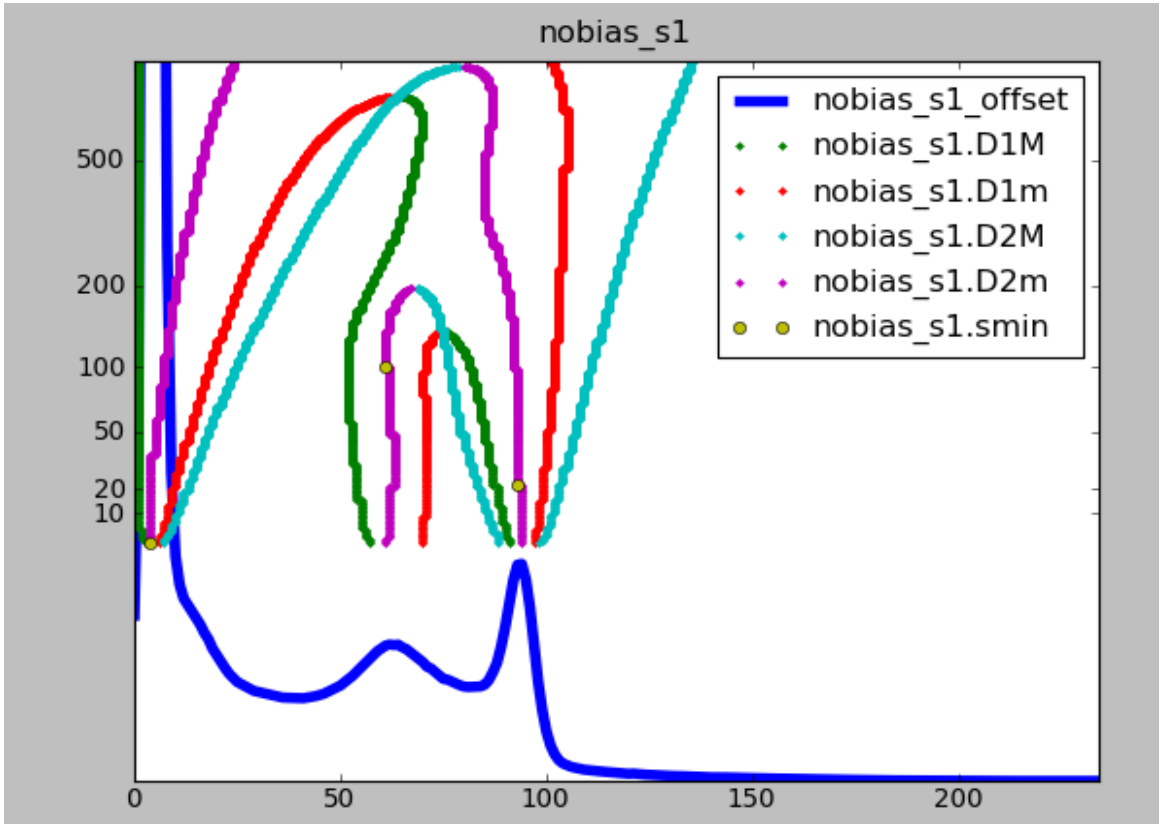
Bias correction

- Spatial bias correction in usual MR images
- Values in raw image not only depend on the tissue but also on the localization in the field of view => need to be corrected before segmentation
- Entropy minimization for automatic correction of intensity non uniformity, J.-F. Mangin, MMBIA (Math. Methods in Biomed. Image Analysis), Hilton Head Island, South Carolina, IEEE Press 162-169, 2000



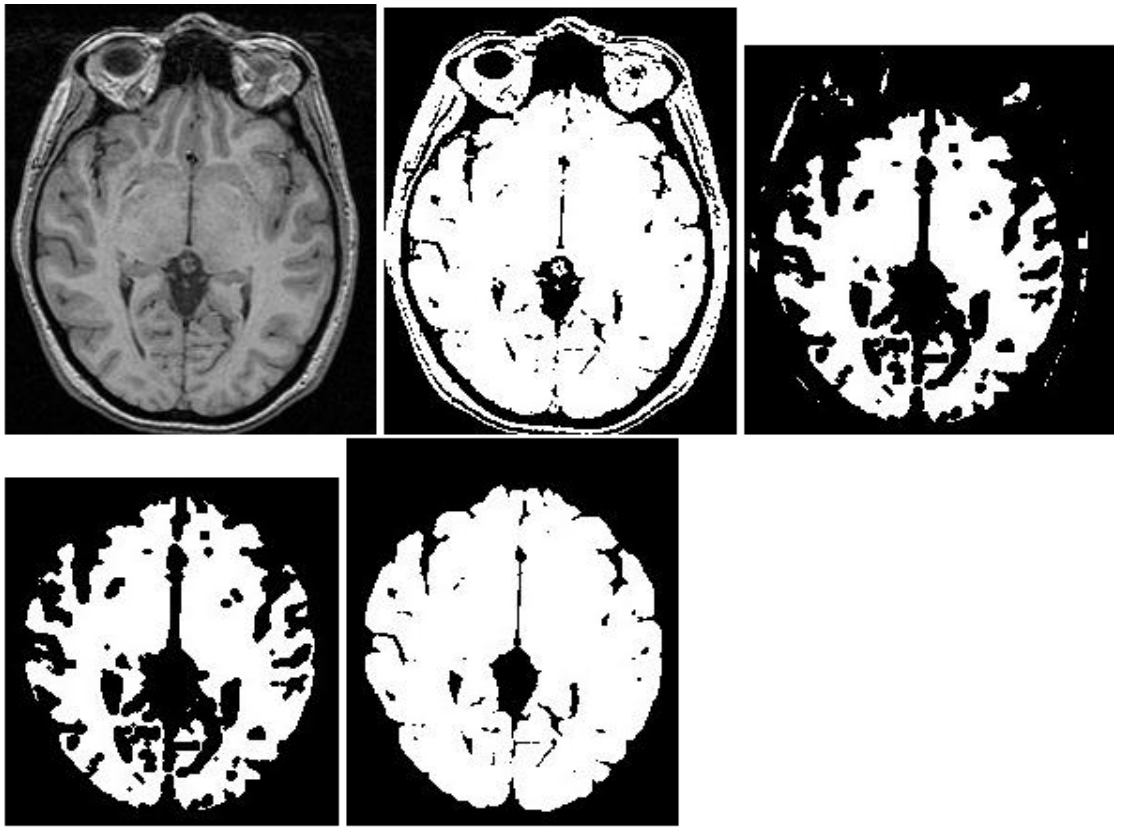
Histogram analysis

- Analyse a T1-weighted histogram to estimate grey/white statistics
- The histogram shape is variable : 3-5 peaks (background, grey, white, CSF, fat)
- Robust brain segmentation using histogram scale-space analysis and mathematical morphology, J.-F. Mangin, O. Coulon, and V. Frouin MICCAI, MIT, LNCS-1496, Springer Verlag 1230-1241, 1998



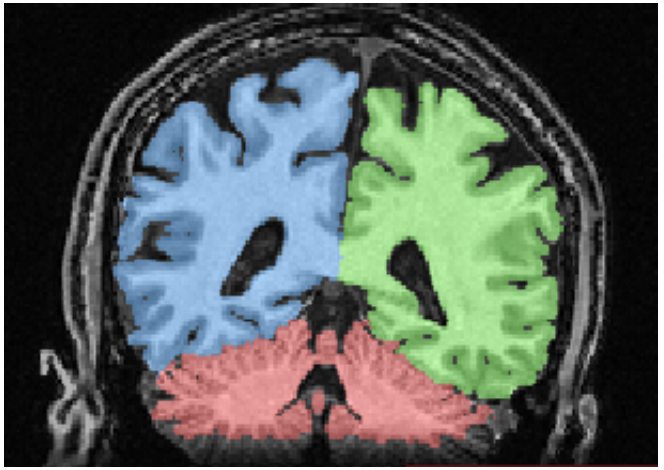
Brain mask segmentation

- Computes a binary mask of the brain from a bias corrected T1-weighted image
- thresholding – erosion - dilation
- Robust brain segmentation using histogram scale-space analysis and mathematical morphology, J.-F. Mangin, O. Coulon, and V. Frouin MICCAI, MIT, LNCS-1496, Springer Verlag 1230-1241, 1998

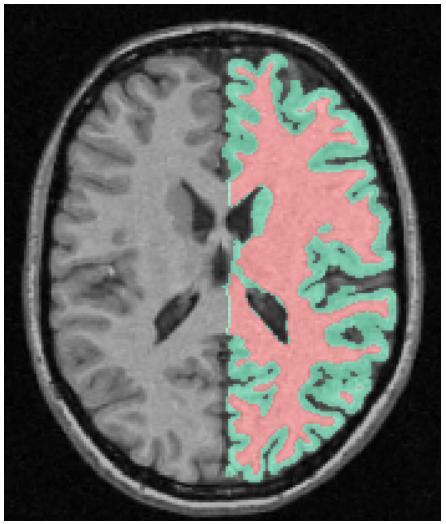


Segmentation

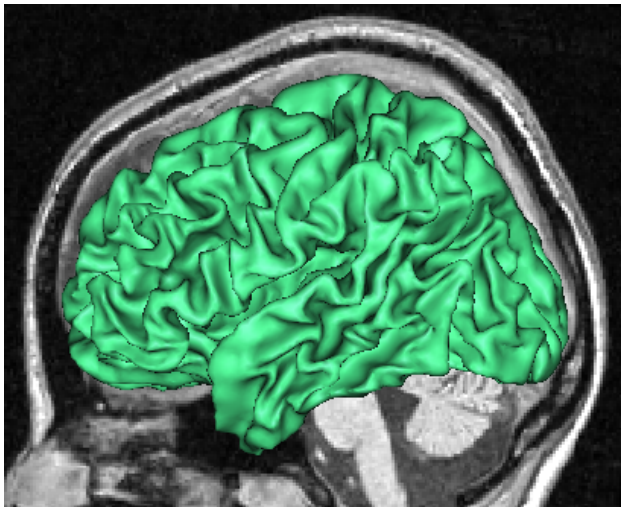
- Split Brain Mask: three parts: hemispheres + cerebellum/stem



- Grey / White interface



Grey white matter segmentation



White matter mesh

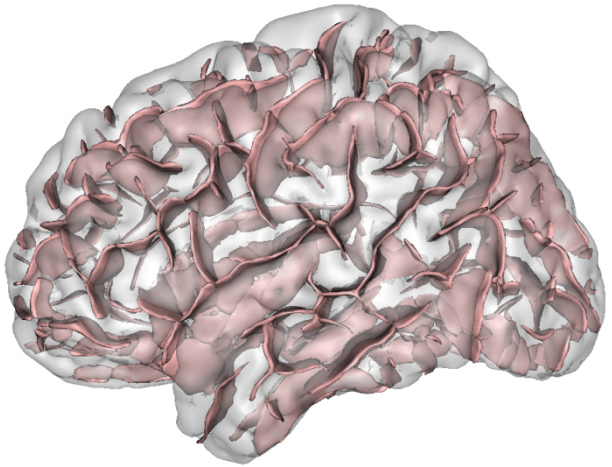
Cortical folds

- Structural representation of the sulci folds: surfaces going inside the folds and neighbouring information.
- Automatic recognition of sulci. Several methods exist:
  - Artificial Neural Network (ANN) recognition

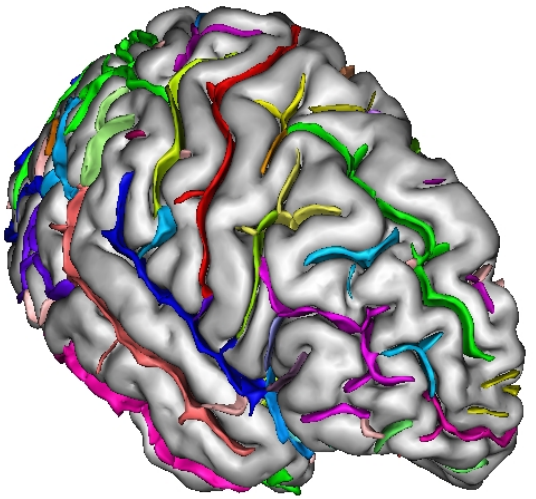
D. Rivière, J.-F. Mangin, D. Papadopoulos-Orfanos, J.-M. Martinez, V. Frouin, and J. Régis. Automatic recognition of cortical sulci of the Human Brain using a congregation of neural networks. Medical Image Analysis, 6(2):77-92, 2002.

  - Statistical Probabilistic Anatomy Map (SPAM) recognition

M. Perrot, D. Rivière, and J.-F. Mangin. Cortical sulci recognition and spatial normalization. Medical Image Analysis, 15(4):529-550, 2011.

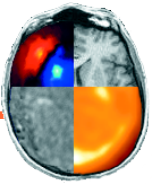


Cortical folds graph



Automatically identified sulci

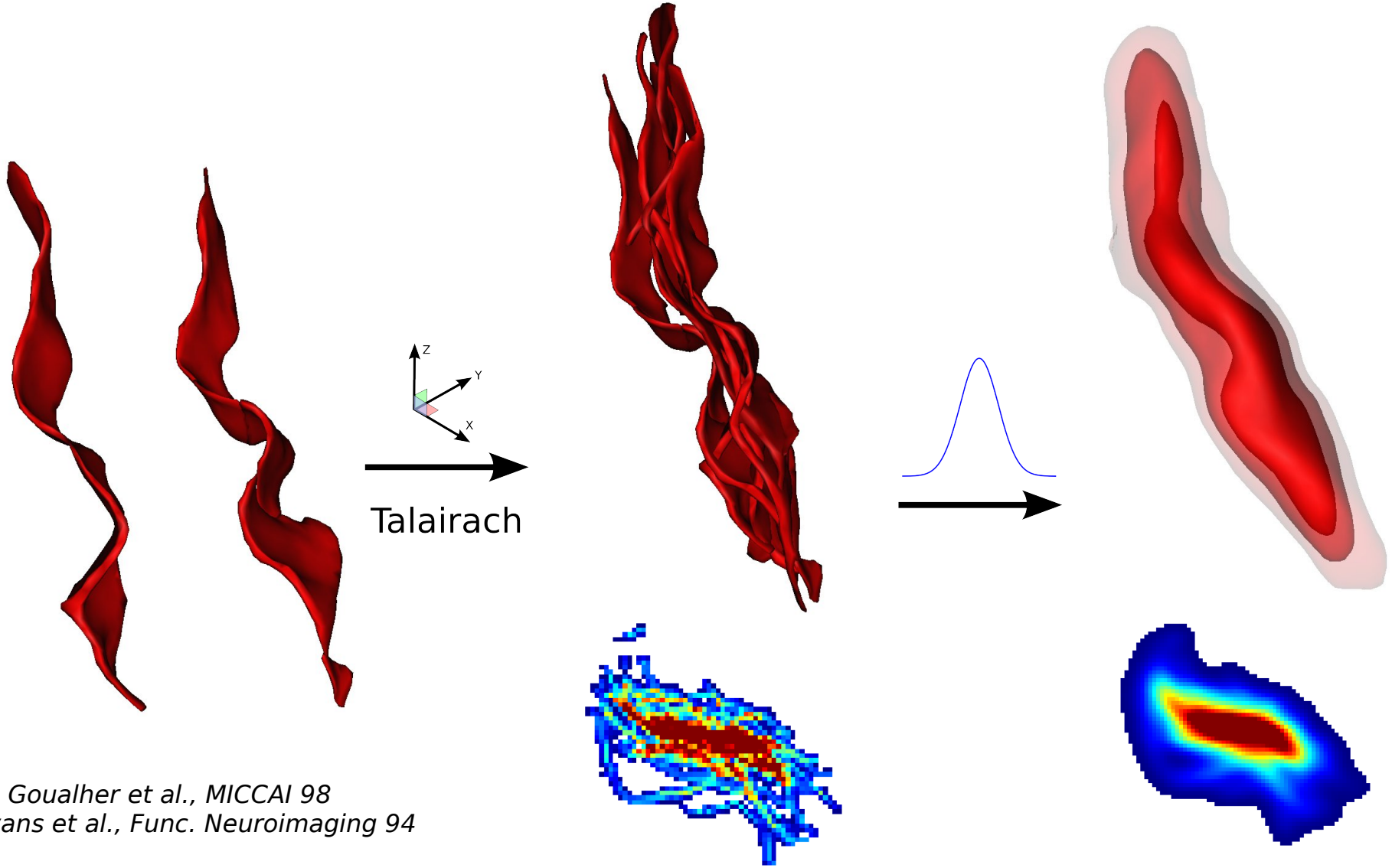
Sulci recognition methods



- **ANN**: Artificial neural networks trained on a base of manually labelled sulci graphs.
- **SPAM**: Recognition based on statistical maps of sulci presence probabilities
  - **Talairach**: no registration, spam and subject in talairach space
  - **Global** registration
  - **Global + Local** registration
  - **Global registration + Markovian model**: use the relations between sulci.

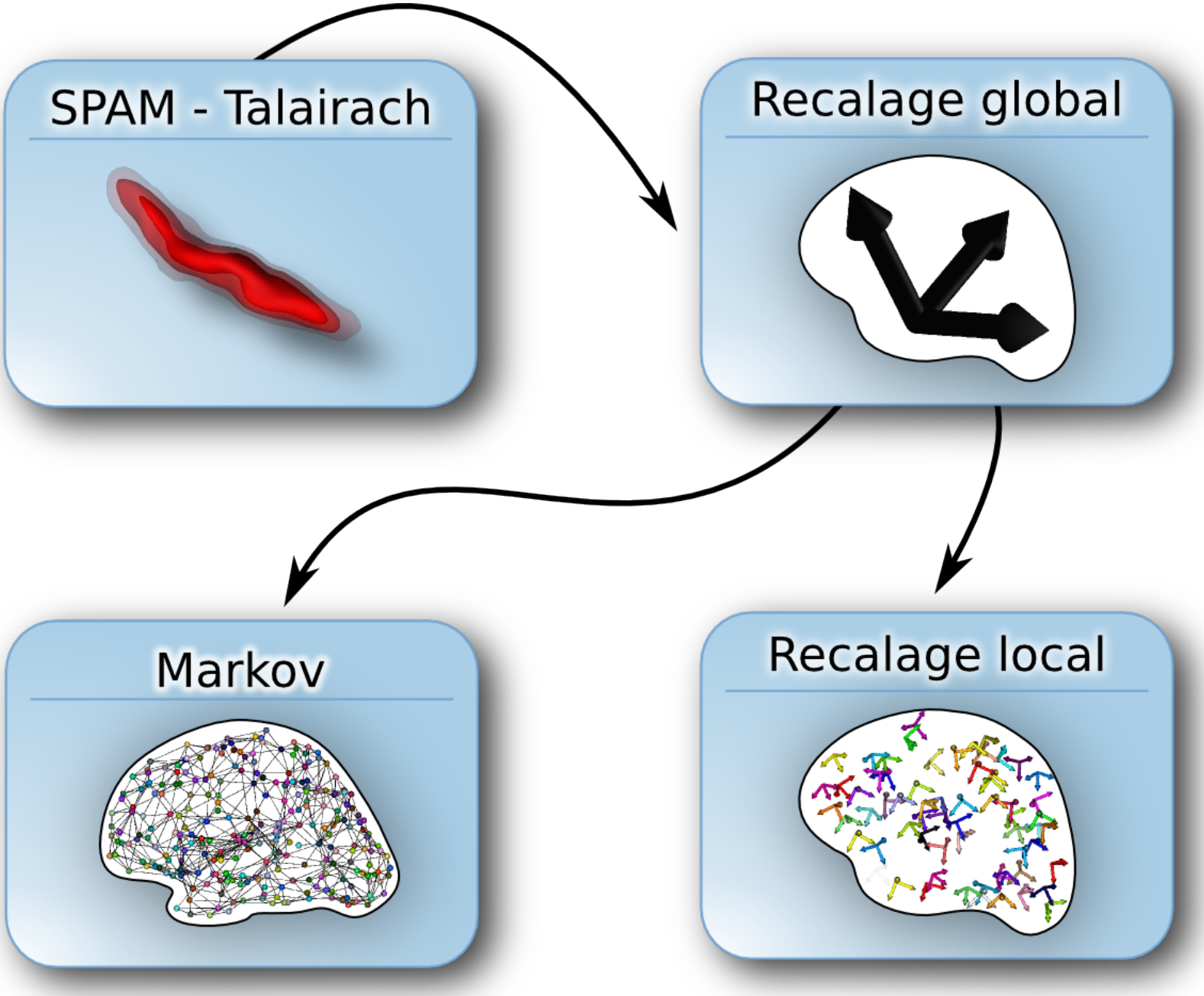
SPAM-based sulci recognition

- SPAM creation on a base of manually labelled graphs

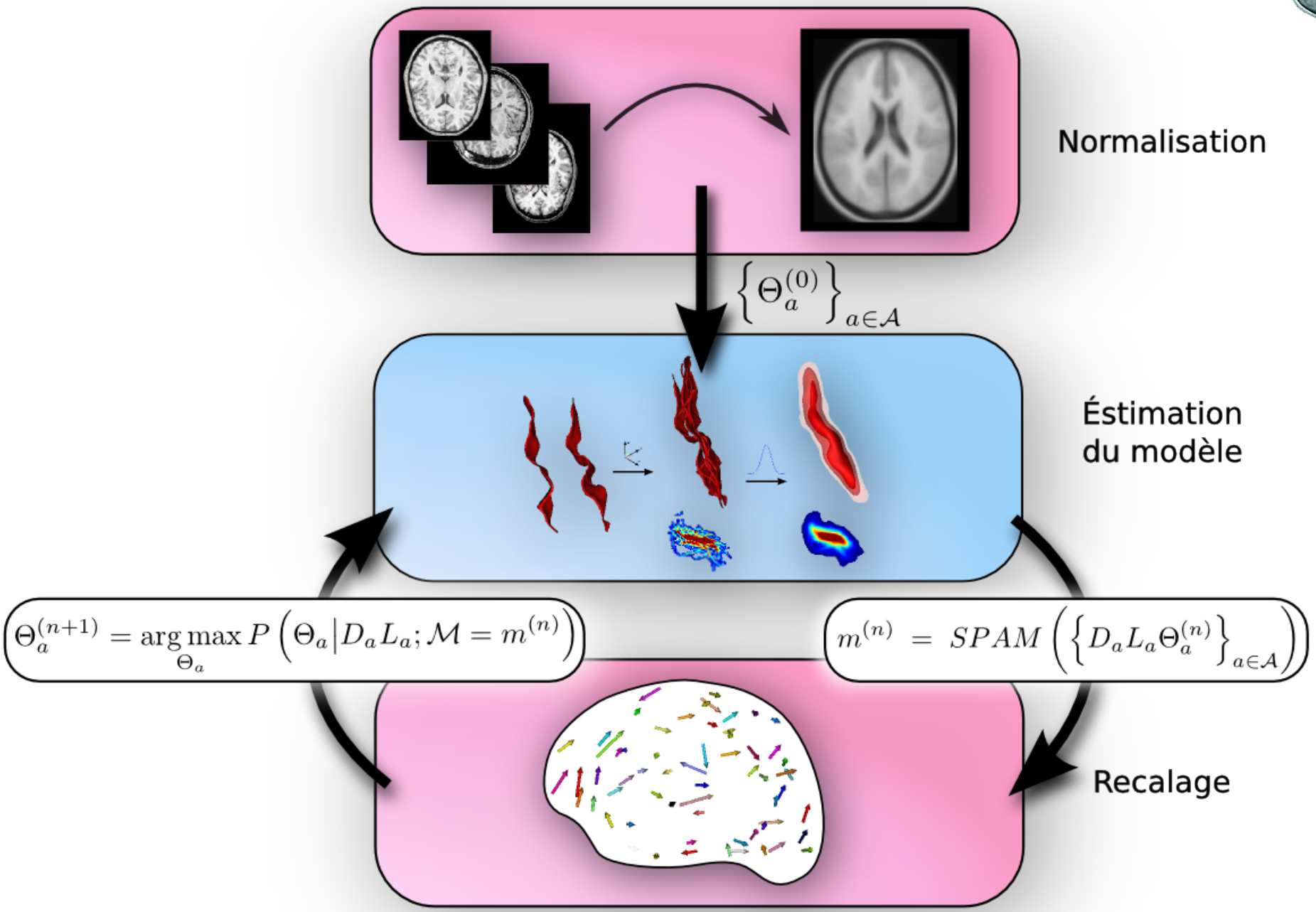


Le Goualher et al., MICCAI 98
Evans et al., Func. Neuroimaging 94

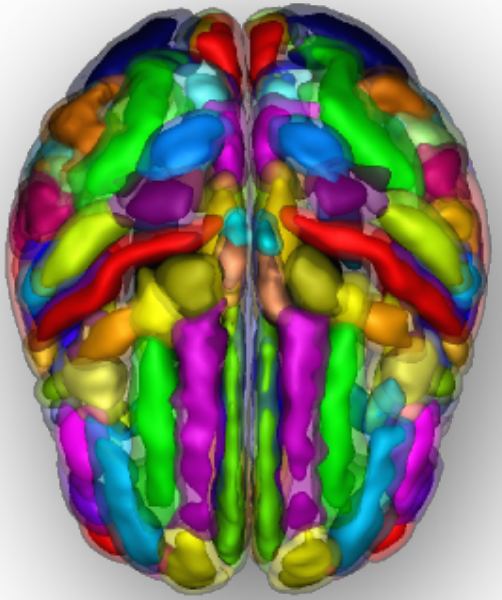
SPAM Methods



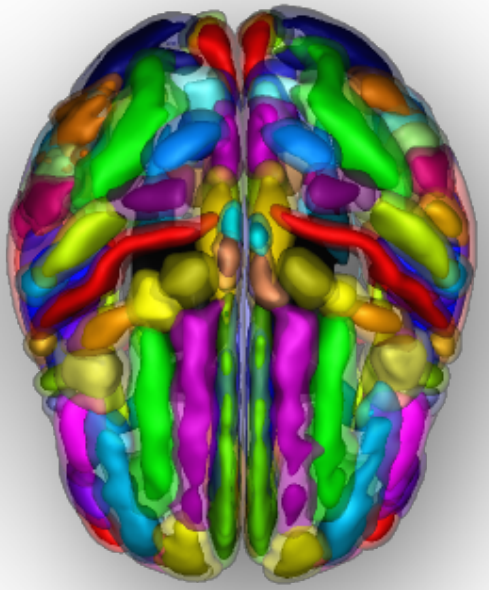
SPAM and normalization



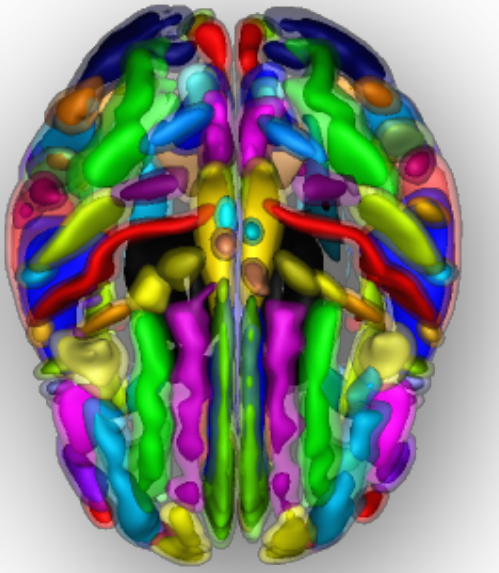
SPAM models



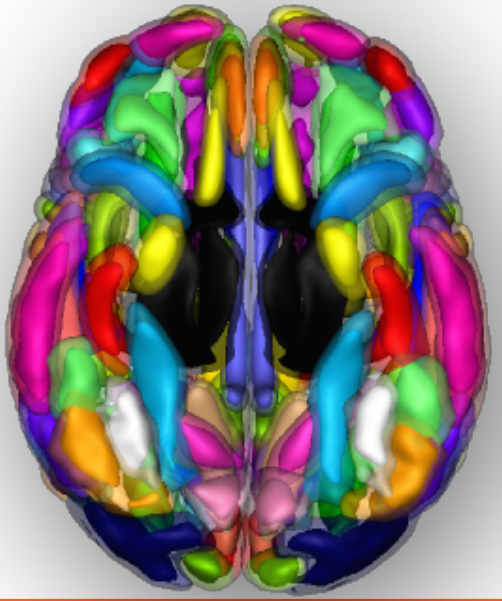
Talairach

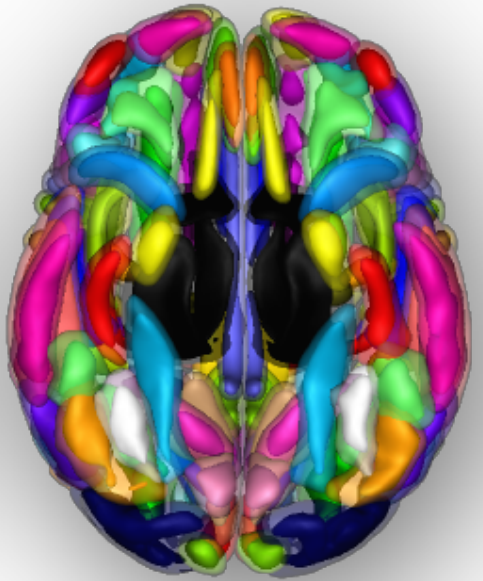


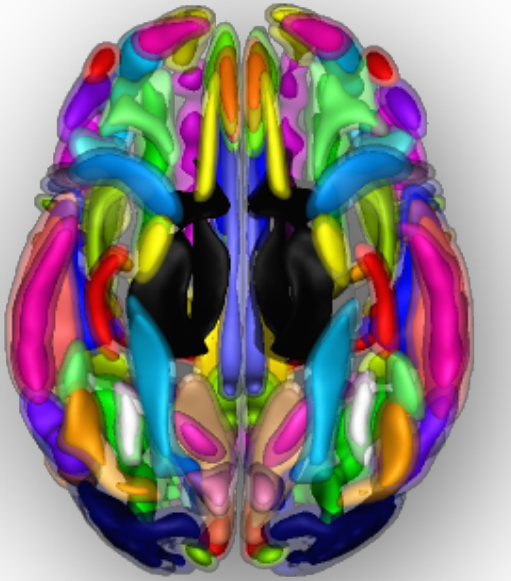
recalage global



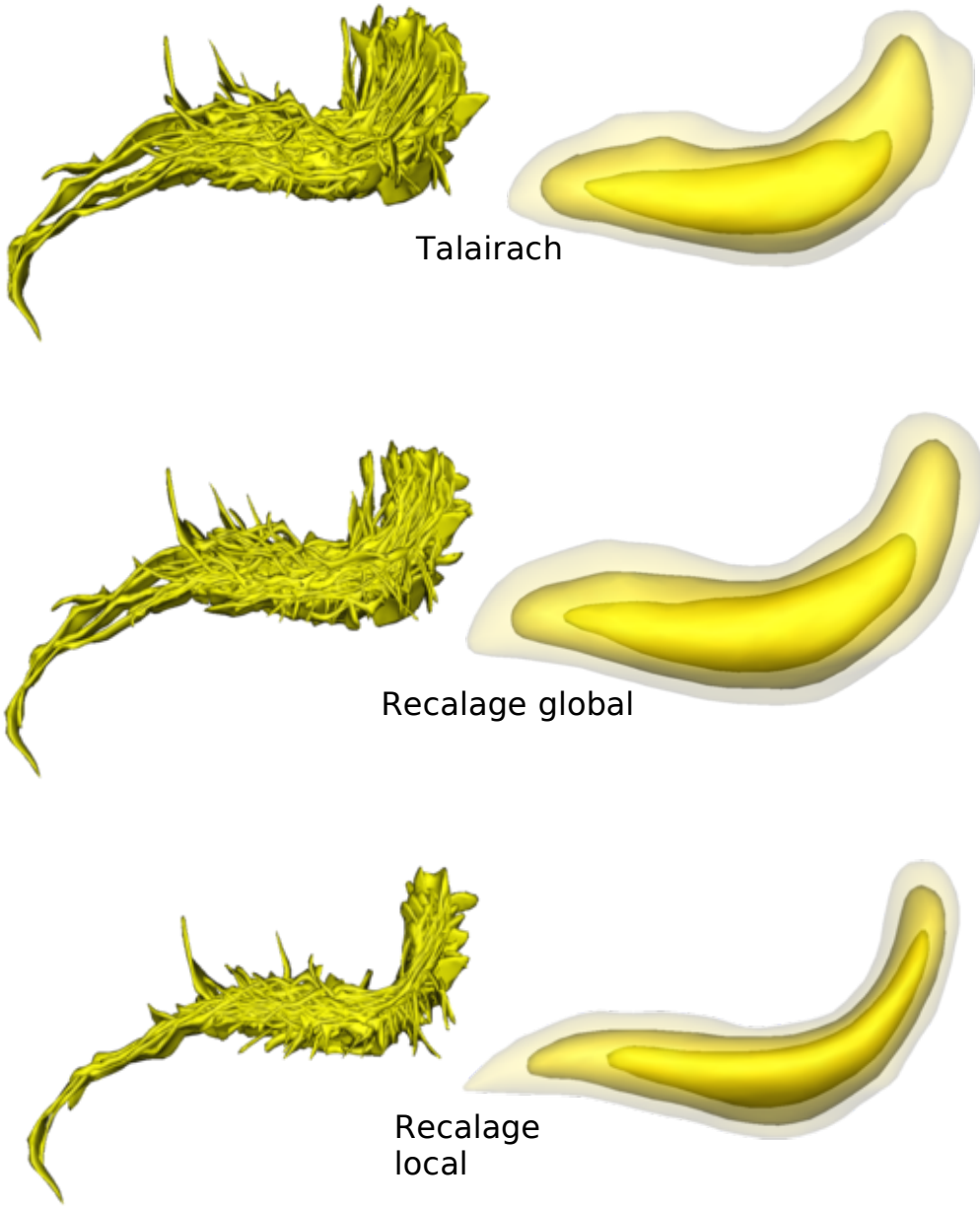
recalage local



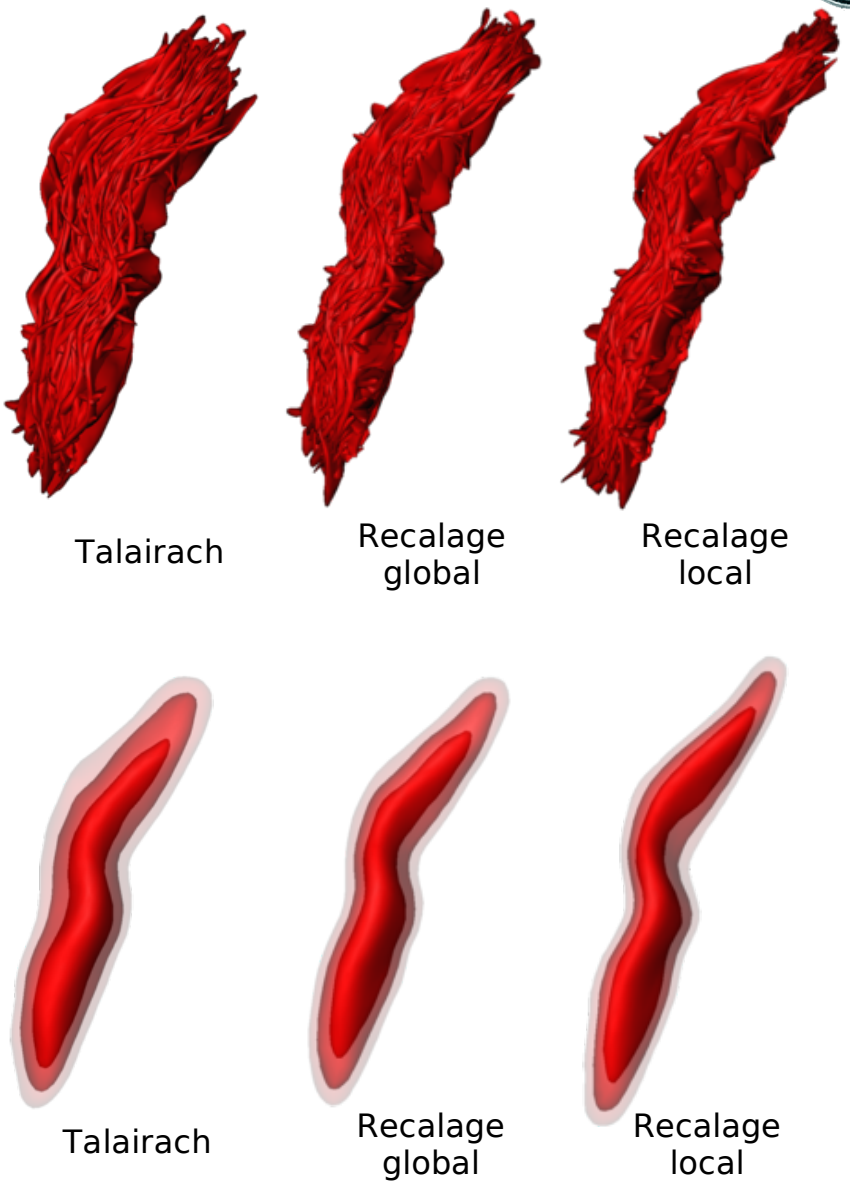




SPAM models and variability



fissure cingulaire postérieure



sillon central