Morphologist Pipeline
BrainVISA Morphologist 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 Morphologist 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
Histogram analysis

- Analyses a T1-weighted histogram to estimate grey/white statistics
- The histogram shape is variable: 3-5 peaks (background, grey, white, CSF, fat)
Brain mask segmentation

- Computes a binary mask of the brain from a bias corrected T1-weighted image

- Mathematical morphology: thresholding – erosion - dilation

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
  - Statistical Probabilistic Anatomy Map (SPAM) recognition
Sulci recognition methods

- **ANN**: Artificial neural networks trained on a base of manually labelled sulci graphs. Recognition based on sulci descriptors.
- **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 - Talairach
- Recalage global
- Markov
- Recalage local
SPAM and normalization

\[ \Theta_a^{(n+1)} = \arg \max_{\Theta_a} P \left( \Theta_a \mid D_a L_a, M = m^{(n)} \right) \]

\[ m^{(n)} = SPAM \left( \left\{ D_a L_a \Theta_a^{(n)} \right\}_{a \in A} \right) \]
SPAM models

Talairach

recalage global

recalage local

Morphologist pipeline
SPAM models and variability

Posterior cingulate sulcus

Central sulcus

Morphologist pipeline