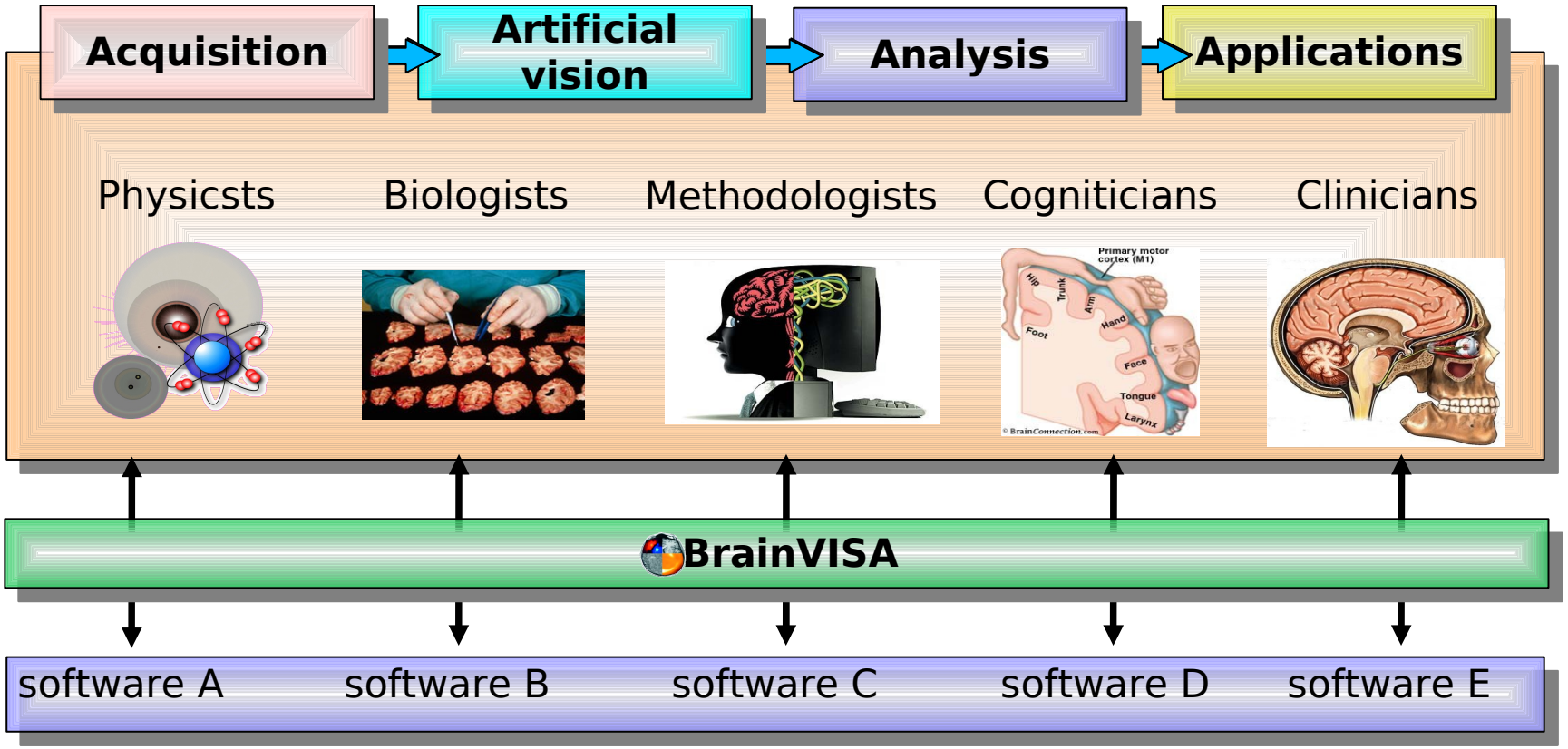
BrainVISA advanced Training Introduction

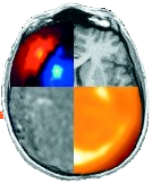
What is BrainVISA ?

- Modular and customizable software platform built to host heterogeneous tools dedicated to neuroimaging research
- **Aim : help sharing neuroimaging data and processing tools.**
- Free and open-source software -> extensible

Image processing pipeline



Outline

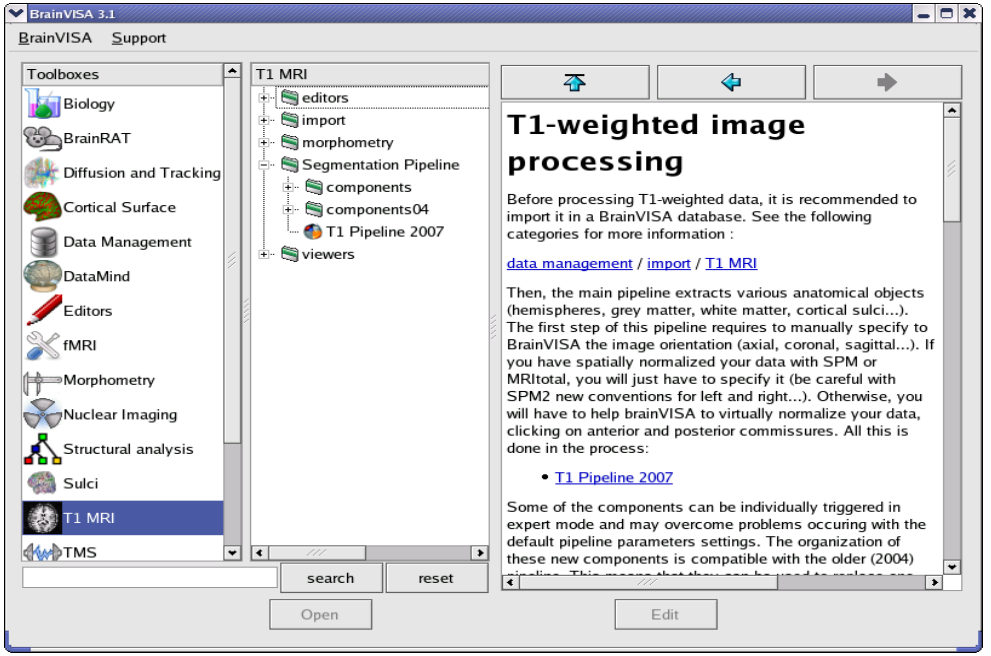


- Overview of BrainVISA package
  - Anatomist
  - BrainVISA
  - Command lines
- BrainVISA toolboxes
- Starting with BrainVISA
- Documentation & Help
- Installation
- Exercises

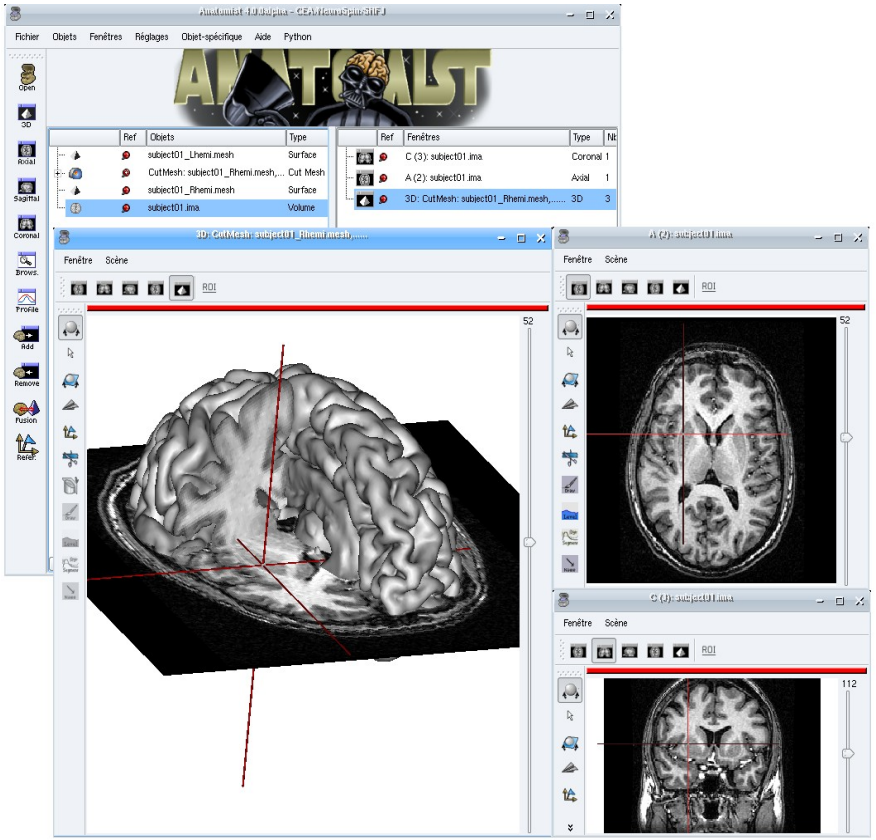
Overview of BrainVISA package

Available for free download on http://brainvisa.info

Linux, Windows XP, and MacOS versions



BrainVISA



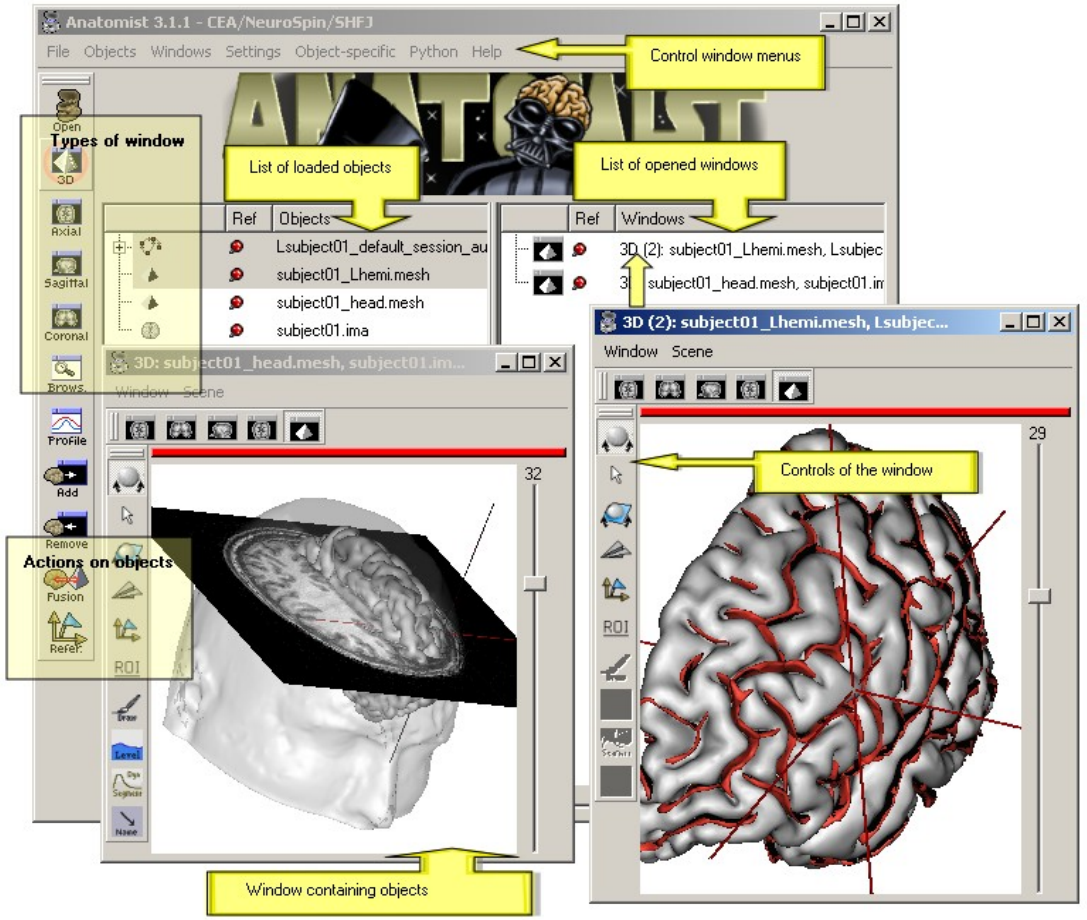
Anatomist

Aims Commands

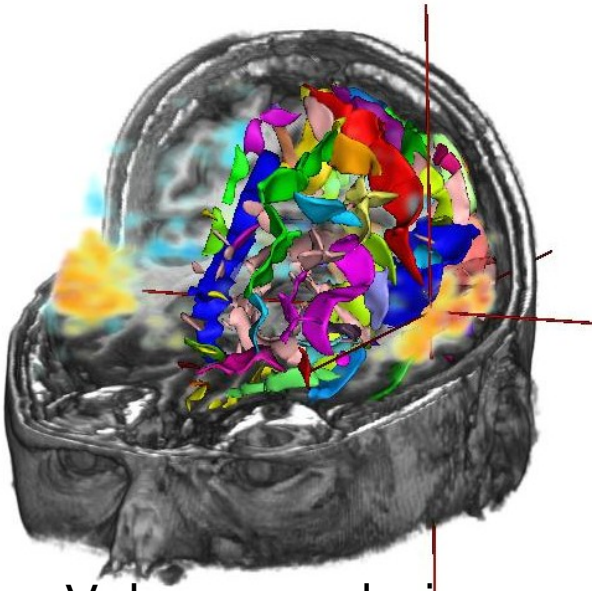
```
$AimsSubVolume -i diff_data.ima -o t2.ima -t 0 -T 0
$AimsThreshold -i voronoi_lesson1.ima -o hemi_only.ima -m lt -t 3
$AimsGraphConvert -i label_image.ima -o label_graphe.arg –bucket ...
```

Anatomist

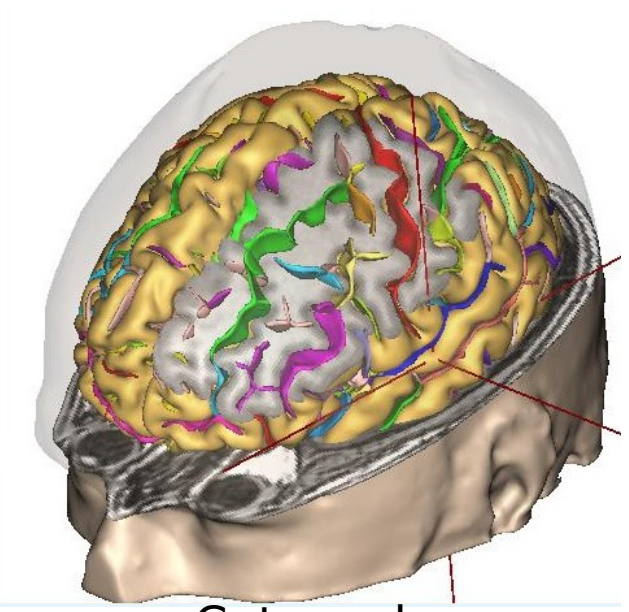
- Visualization of several types of objects : image, volume (3D, 4D), mesh, graph (sulci, ROI)
- Management of coordinate systems and transformations
- Possibility of building complex 3D scenes with several objects (merging, superimposing...).
- A lot of tools : color palettes, region of interest module, manual registration



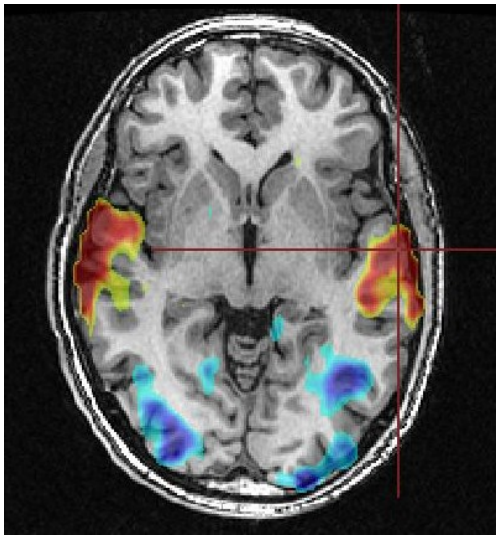
Anatomist features



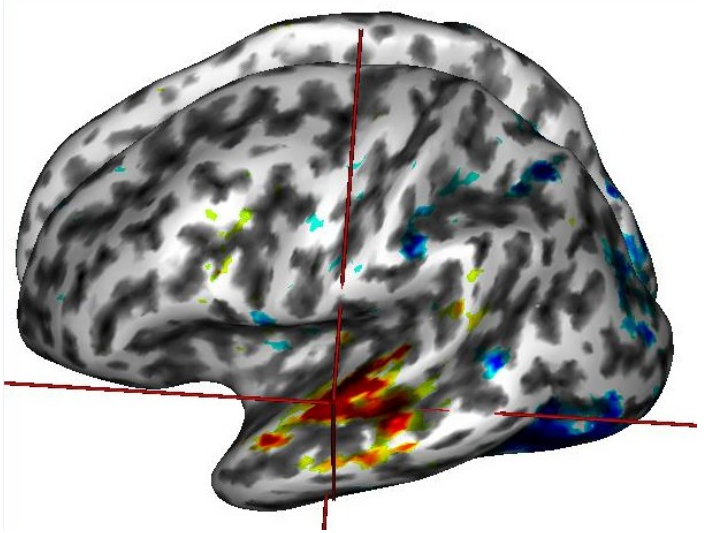
Volume rendering



Cut mesh



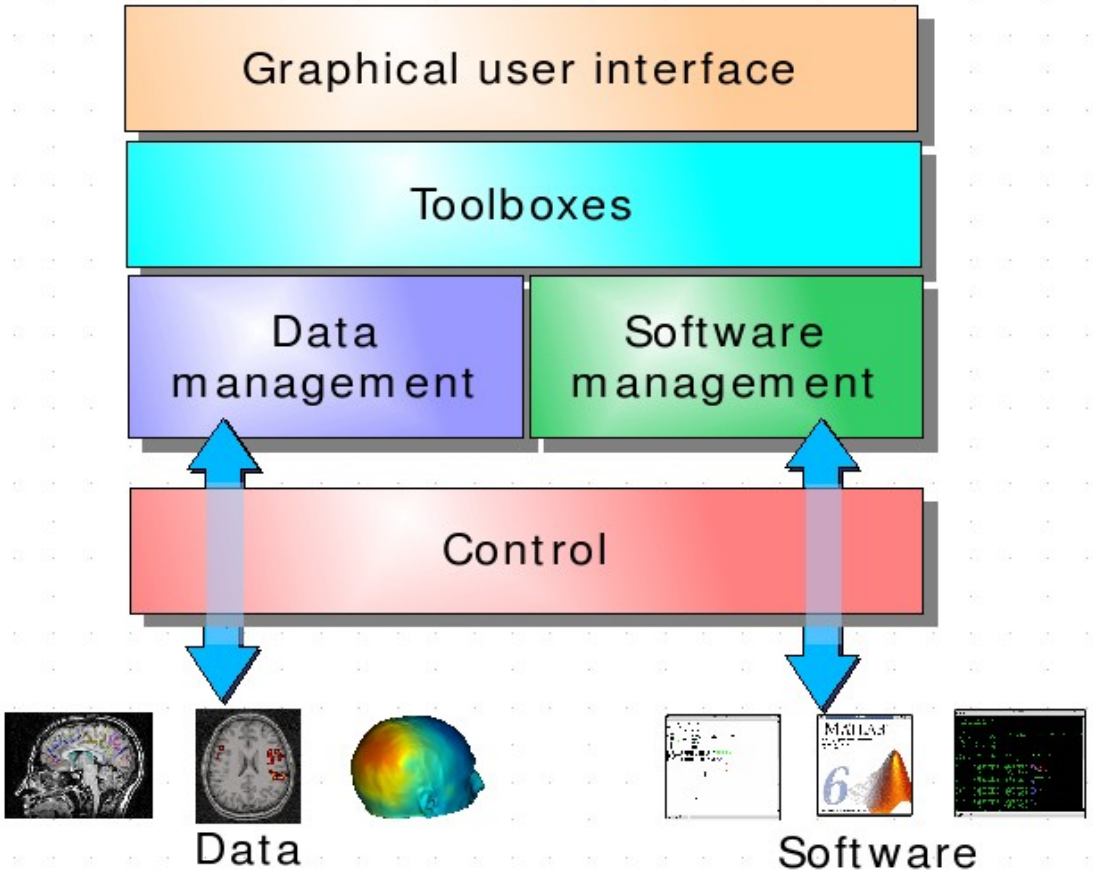
2D fusion



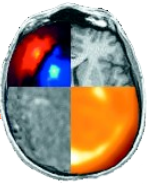
3D fusion

BrainVISA features

- Data management system allows database sharing
- Harmonization of communcations between different software
- Interactive visualization of multimodal data
- Automatic generation of graphical user interface
- Workflow monitoring : processes, pipelines, iterations



Aims Commands



Commands for many purposes

- File information and conversion: *AimsFileInfo, AimsFileConvert, AimsGraphConvert, AimsSetMinf, AimsAttributedViewer*
- Cut / cat / merge and other simple operations: *AimsTCat, AimsSubVolume, AimsOverVolume, AimsFlip, AimsMerge2RGB, AimsSplitRGB, AimsGraphMerge, AimsMergeLabel*
- Simple, basic processing: *AimsThreshold, AimsAverage, AimsMassCenter, AimsMeshArea*
- Coordinates transformations: *AimsComposeTransformation, AimsInvertTransformation, AimsGraphExtractTransformation*
- Labels selection (ROI): *AimsLabelSelector, AimsSelectLabel*
- *Mathematical morphology: AimsErosion, AimsDilation, AimsOpening, AimsClosing, AimsVoronoi, AimsChamferDistanceMap, etc.*
- *Statistics on ROI and images: AimsRoiFeatures, AimsVoiStat.*
- Mesh operation: *AimsMeshGenerate, AimsMeshCut*

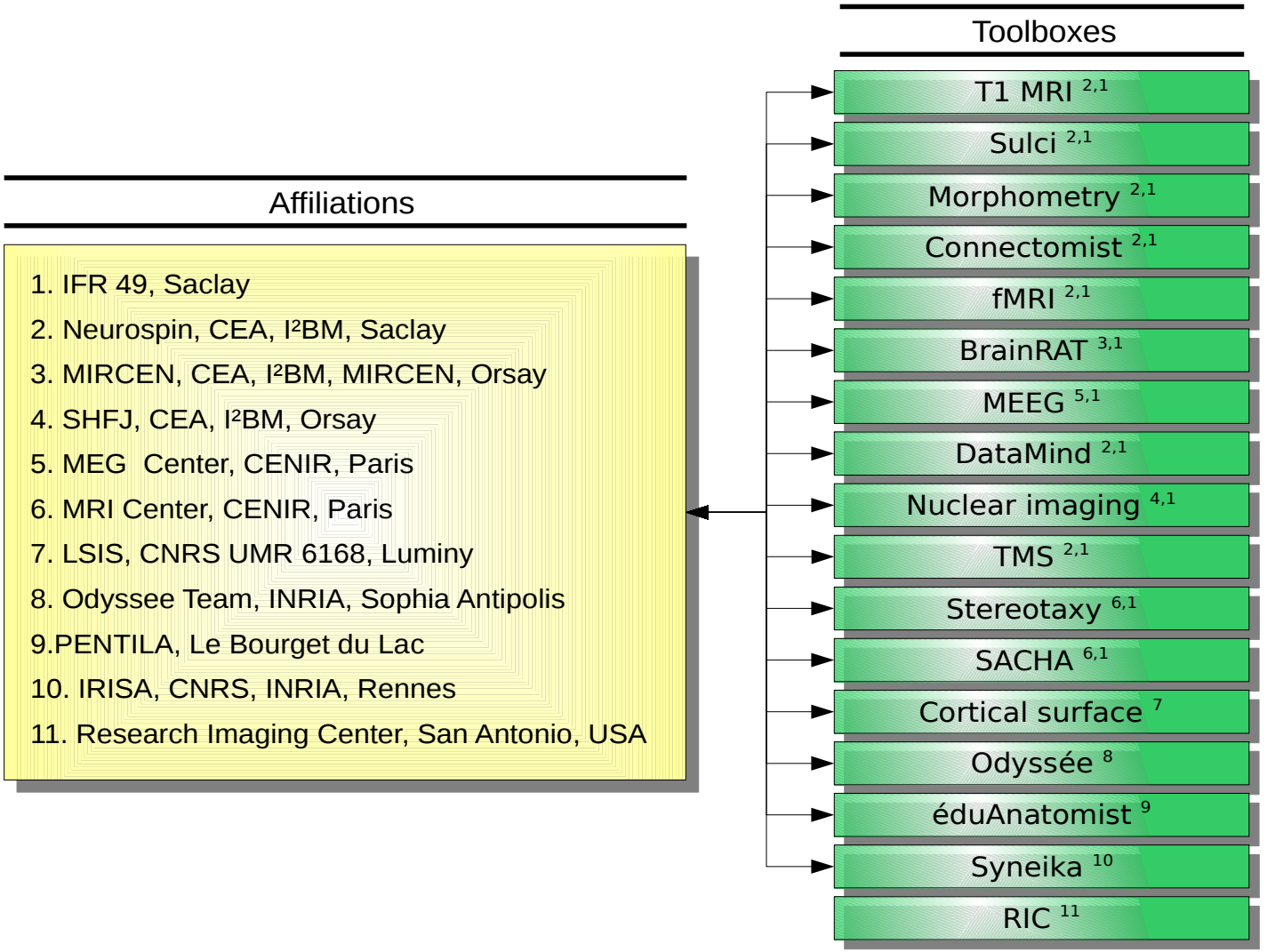
Inline help with --*help* option

List of all commands on brainvisa website
http://brainvisa.info/doc/documents-3.1/shfjcommands/commands.html

Python API enables to write scripts to handle data (volume, mesh, texture, graph...)

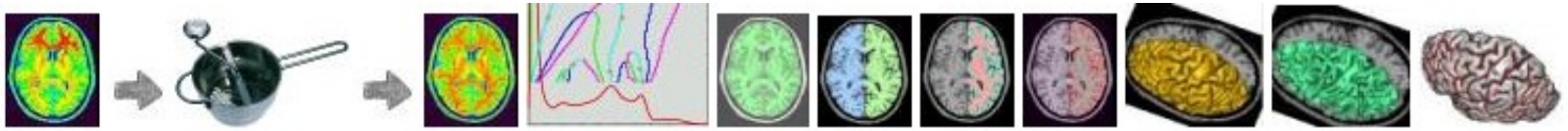
BrainVISA toolboxes

- Currently, there are 17 application toolboxes among which 12 are developped by IFR49 teams.



T1 MRI, Sulci and Morphometry

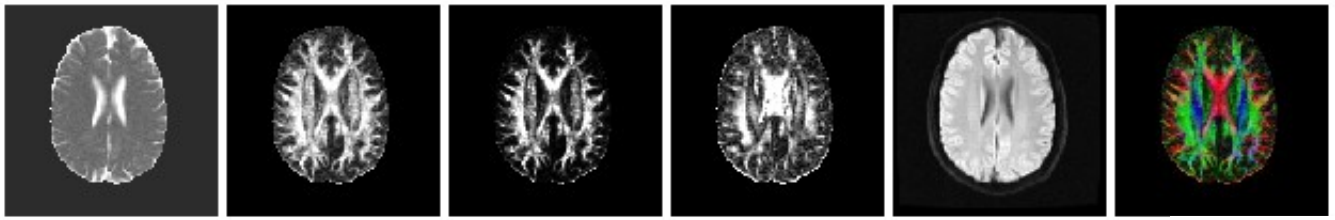
- First tools developped in BrainVISA
- Anatomical T1 MRI processing
  *T1MRI -> Segmentation Pipeline -> **T1 Pipeline 2007***
  - Cortex and white matter segmentation
  - hemispheres and cerebellum separation
  - meshes building
  - cortical sulci segmentation
  - automatic identification of cortical sulci



- **Sulci** toolbox : sulci recognition processes, recognition models creation tools (to learn a model from a database of manually identified brains)
- **Morphometry** toolbox : measurements on identified sulci or named ROIs (size, length, depth, barycenter position, orientation...)

Diffusion and Tracking

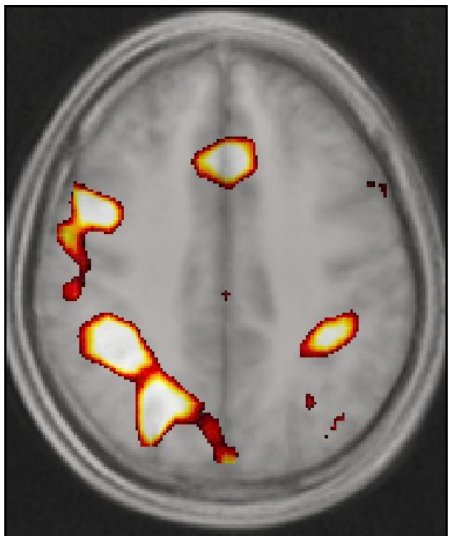
- DWI data processing :
  - Echoplanar distorsions correction
  - Diffusion model creation (DTI or Q-Ball)
  - Diffusion maps (ADC, FA, VR...)
  - Fibers tracking and reconstruction
  - Analysis of white matter fibers
- 2 main pipelines :
  - Diffusion model pipeline

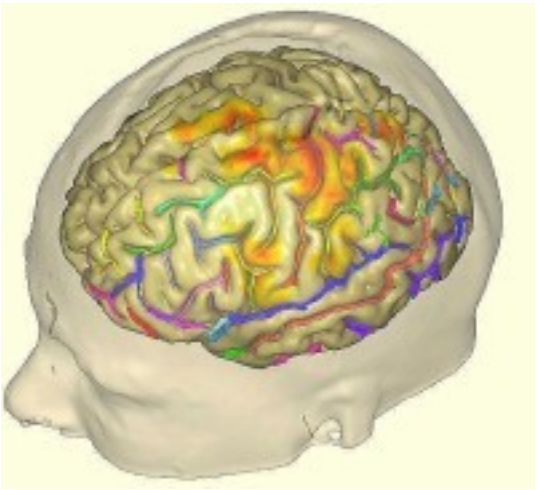


  - Fascicles Tracking Pipeline

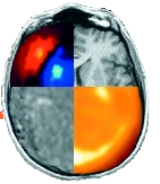
fMRI

- Aim : to ease neuroimaging studies involving both structural and functional modalities and/or large cohorts, for which automated database management is critical.
- Original algorithms developed at Neurospin/LNAO, INRIA Saclay/Parietal and partners to do univariate analyses a la SPM and less conventional multivariate analyses.
- Features
  - Pre-prossessings using SPM or FSL
  - First level analysis (intra-subject)
  - Group analysis (inter-subject)
  - Advanced visualization tools using Anatomist

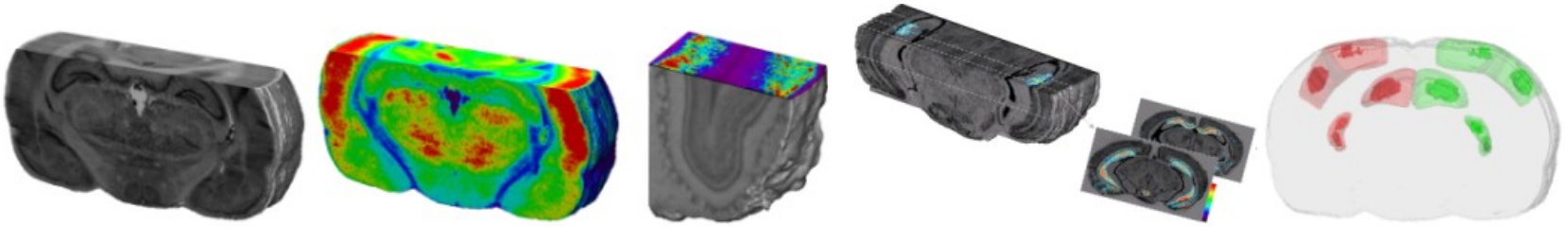




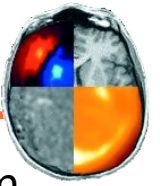
BrainRAT



- Aim : Process histological and autoradiographic sections (rodents and monkeys) using 3D information.
- BrainRAT results from collaborative work of image processing methodologists and biologists of MIRCen.
- Features :
  - optimized digitization
  - 3D reconstruction of volume based on a reliable registration method
  - analysis

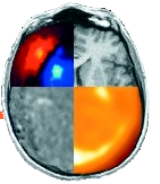


BrainVISA toolboxes



- **Cortical surface**: processing surface-based data. Developed by researchers from the LSIS lab (Marseille).
  - build a coordinate system constrained by sulci on a cortical surface
  - tools for morphometric study of cortical sulci surfaces
  - Surface-based functional data processing
- **Datamind**: analysing features over multidimensional arrays. Classification, data mining...
- **Nuclear Imaging**: processing of Positron Emission Tomography images. Developped in the SHFJ.
- **TMS**: Transcranial magnetic stimulation toolbox provides tools helping positioning a stimulation target in a subject specific referential.
- **Tools**: internal toolbox containing common image processing tools like threshloding, resampling, linear combination, conversion...

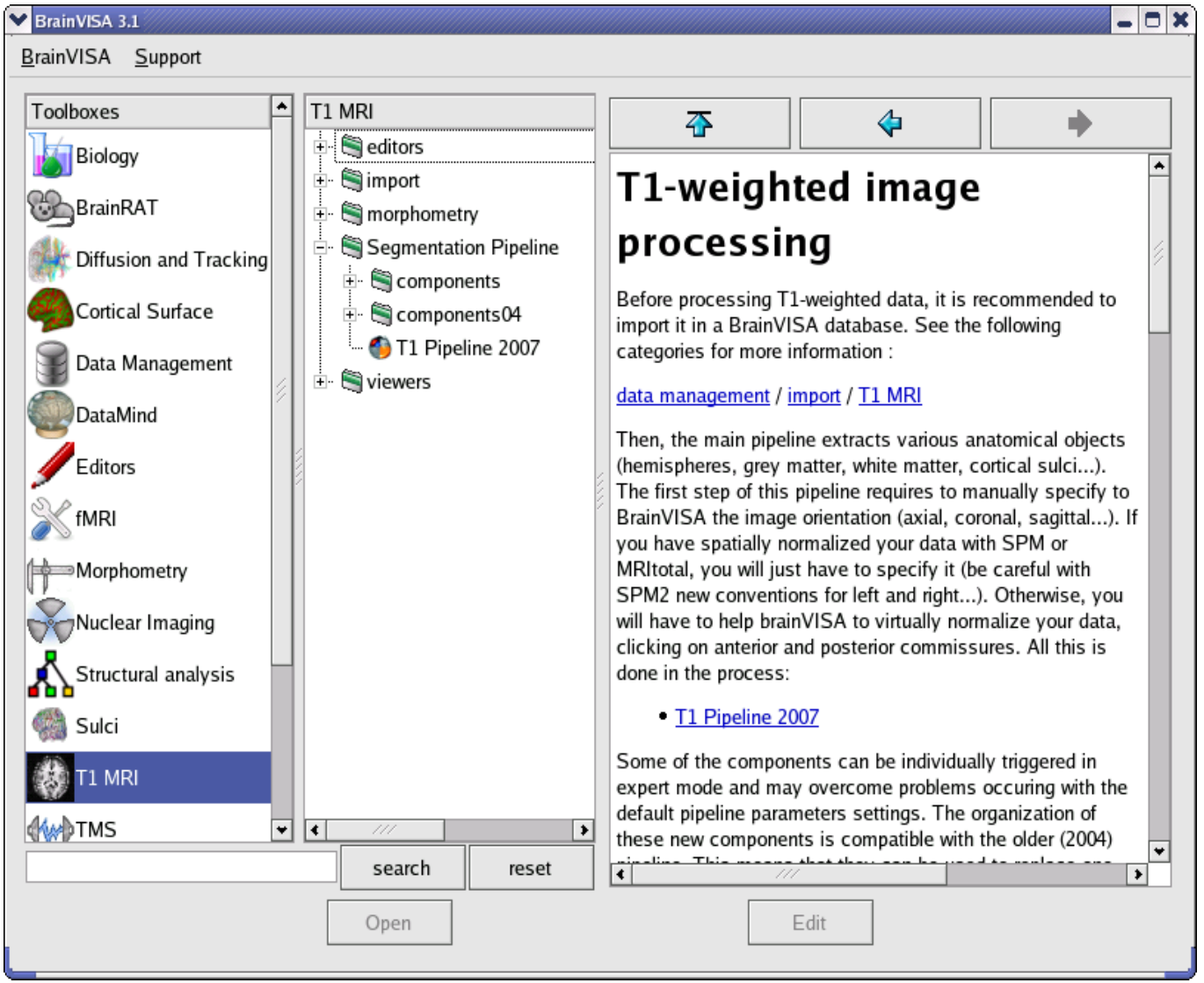
External toolboxes



- **MEEG**: MEG / EEG signals processing. Developed on the MEG/EEG Salpêtrière platform, by the LENA lab. Source localization, visualization and statistical analysis. http://cogimage.dsi.cnrs.fr/logiciels/index.htm
- **Stereotaxy**: help electrode implantation surgery planning by computing stereotaxic coordinates for a target in the brain. Developed in the Pitié-Salpêtrière hospital.
- **SACHA**: automatic segmentation of the hippocampus and the amygdala from clinical MRI scans.
- **Odyssée**: visualization and analysis of diffusion MRI data. Developed at INRIA Sophia Antipolis.
- **RIC**: processes to compute cortical thickness maps, gyrification index, sulcal length and depth, and also NIFTI and NEMA formats converters. Developed by P. Kochunov (Health Science Center at University of Texas). http://ric.uthscsa.edu/personalpages/petr/genetics.html

Starting with BrainVISA

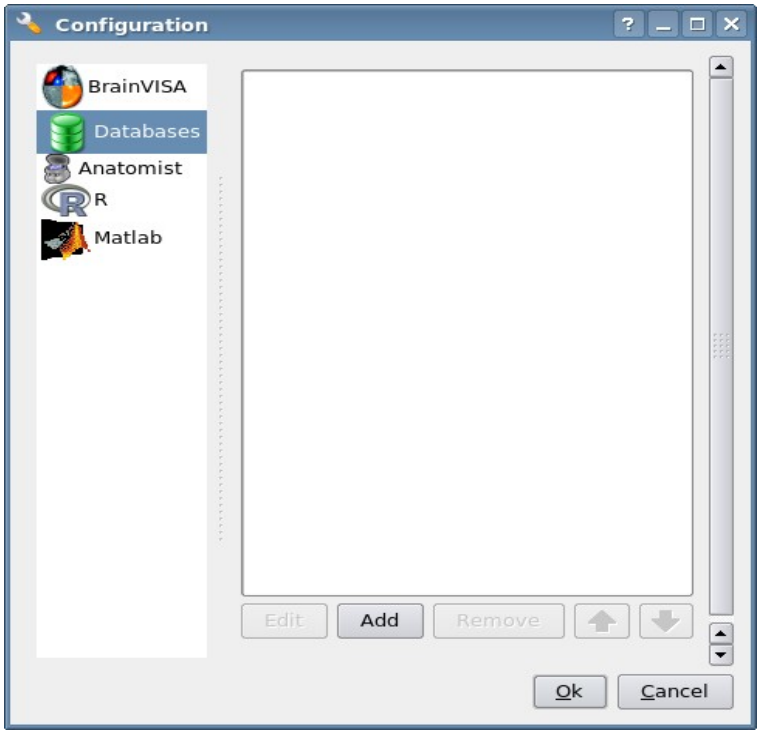
- Run the program by tiping *brainvisa* in a terminal
- Processes organized by toolbox



Graphical user interface

First step : define a database

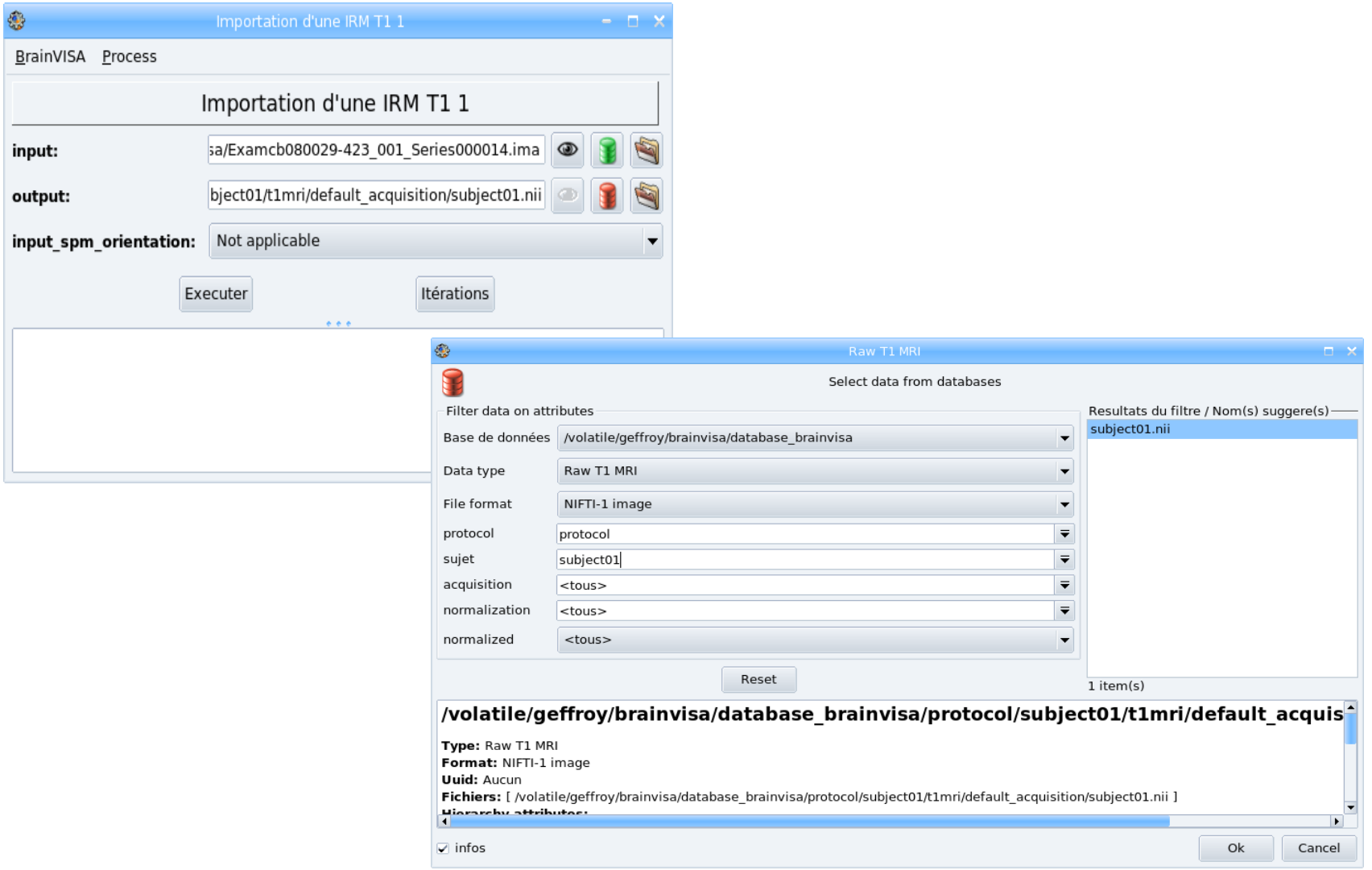
- A directory where all data written by BrainVISA will be stored.
- BrainVISA database is organized to store information in addition to the data files : protocol, subject, modality, acquisition, analysis...
- Data management toolbox : visualization, update, conversion, importation



Menu BrainVISA -> Preferences -> Databases -> Add

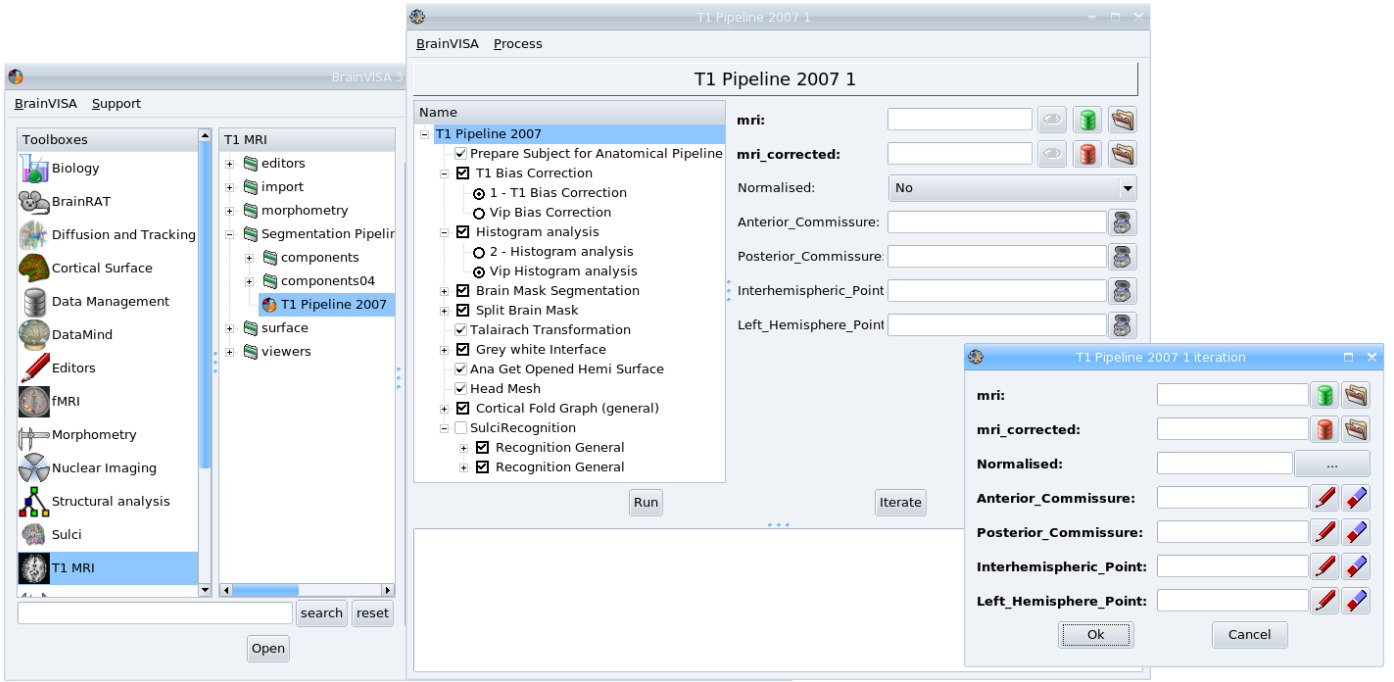
Second step : Import data

- Import data to process in your BrainVISA database : you enter information about data with BrainVISA copy it in the database.
- Different **importation processes** exist according the type of data (T1 MRI, Diffusion MRI, fMRI…)

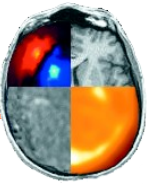


Process data

- Select a process and open it (double click or open button)
- Enter input parameters by selecting them in the database using the button
- BrainVISA automatically complete as many parameters as possible. Output data will be written in the database.
- Data visualization with
- Iteration of a process on several data.
- Execution log : Menu BrainVISA -> Show log
- Pipeline : set of processes (serie, choices)



Documentation & Help

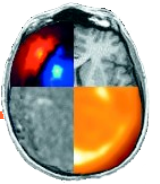


- Manuals and tutorials available on BrainVISA website : http://brainvisa.info/documentation.html
- Document of the JIRFNI 2008 training course about Anatomist and BrainVISA with associated data.

http://brainvisa.info/doc/jirfni_bv-2008/jirfni_bv_training/fr/html/index.html
http://brainvisa.info/downloadpage.html#data

- Inline BrainVISA documentation about toolboxes and processes in the right panel of BrainVISA main window
- Forum to ask questions : http://brainvisa.info/forum/

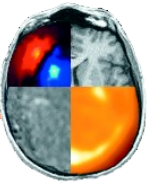
Installation



- Steps to install:
  - Download an archive according to the system on: http://brainvisa.info/downloadpage.html
  - Uncompress the file
  - Go into the created directory
  - Execute the setup file
  - Run the executable « BrainVISA »
- Installation instructions available in a README file
- Visualization problems can occur on some computers because of the 3D graphical card. Solutions can be found on the forum.

http://brainvisa.info/forum/viewtopic.php?f=6&t=1131&p=3880

Exercise



- Run BrainVISA

/tsi/medikit/tp-data/brainvisa/BrainVISA

- Create a new empty database in

/scratch/<login>/<databaseName>

- Import a Raw T1 MRI

/tsi/medikit/tp-data/brainvisa/data_unprocessed/sujet01/anatomy/sujet01.ima

- Browse the database with the DatabaseBrowser process.
- Visualize data.

- Anatomist tutorial : http://brainvisa.info/doc/anatomist-3.2/ana_training/en/html/index.html