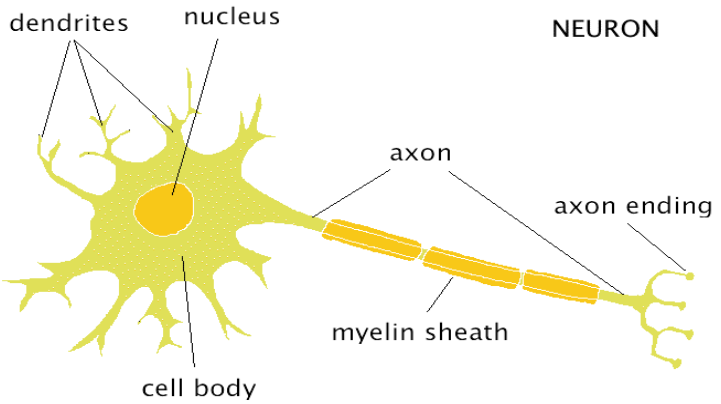
Diffusion MRI
BrainVISA Diffusion & Tracking Toolbox

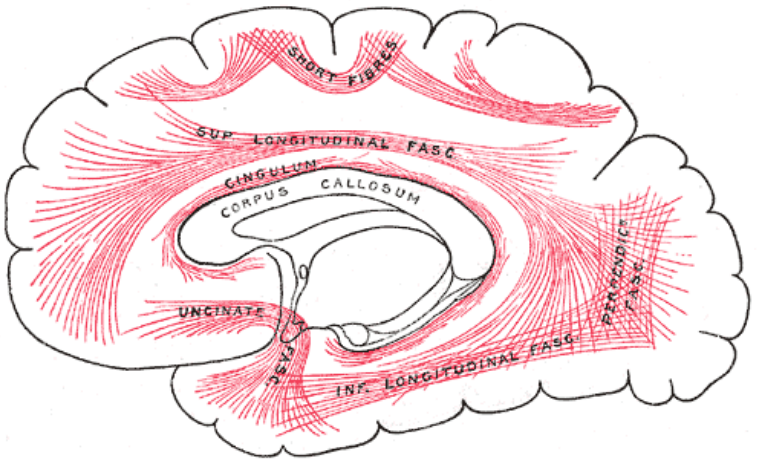
Brain white matter

- Axons

  Nerve fibers that conduct electrical impulses away from the neuron's cell body.

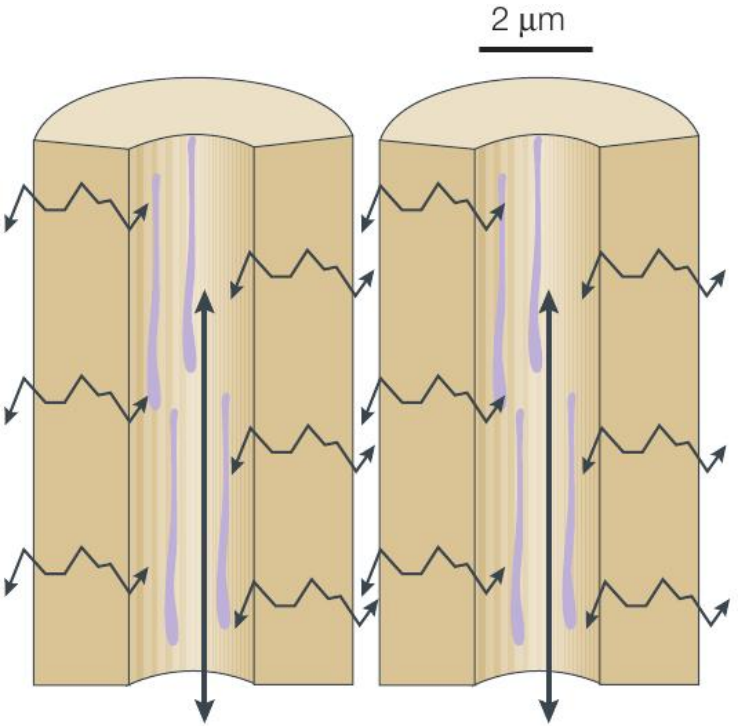


Dissection



Bundles organization

Diffusion Imaging

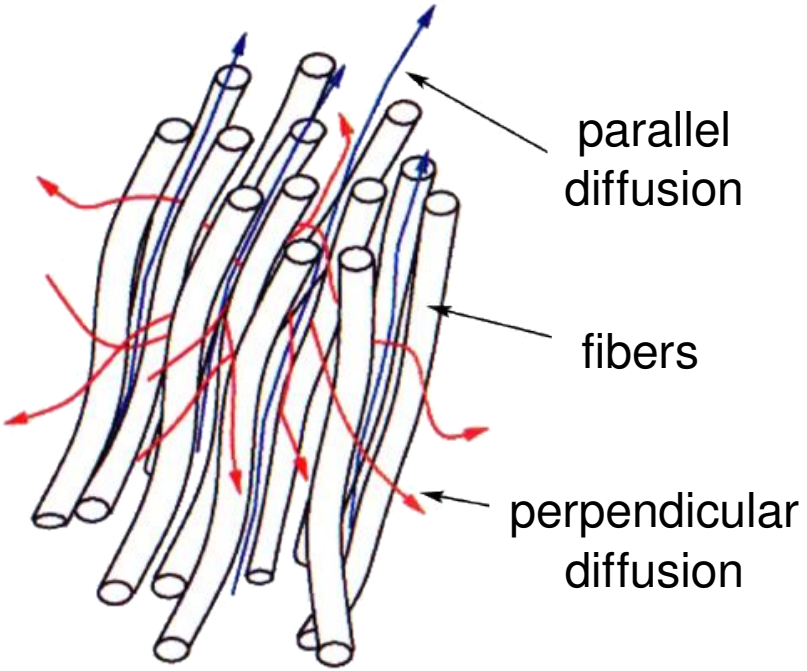


Le Bihan, 2003

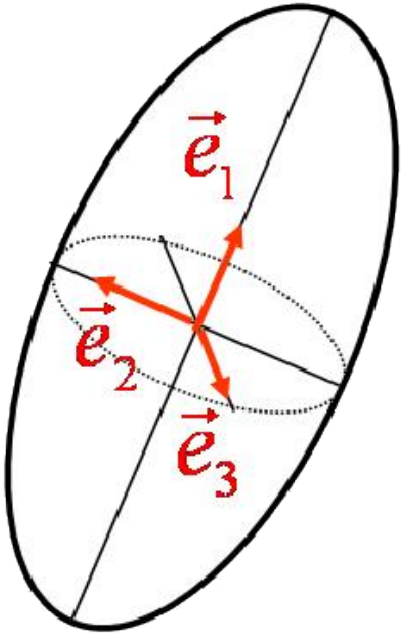
Diffusion Imaging

Local modeling

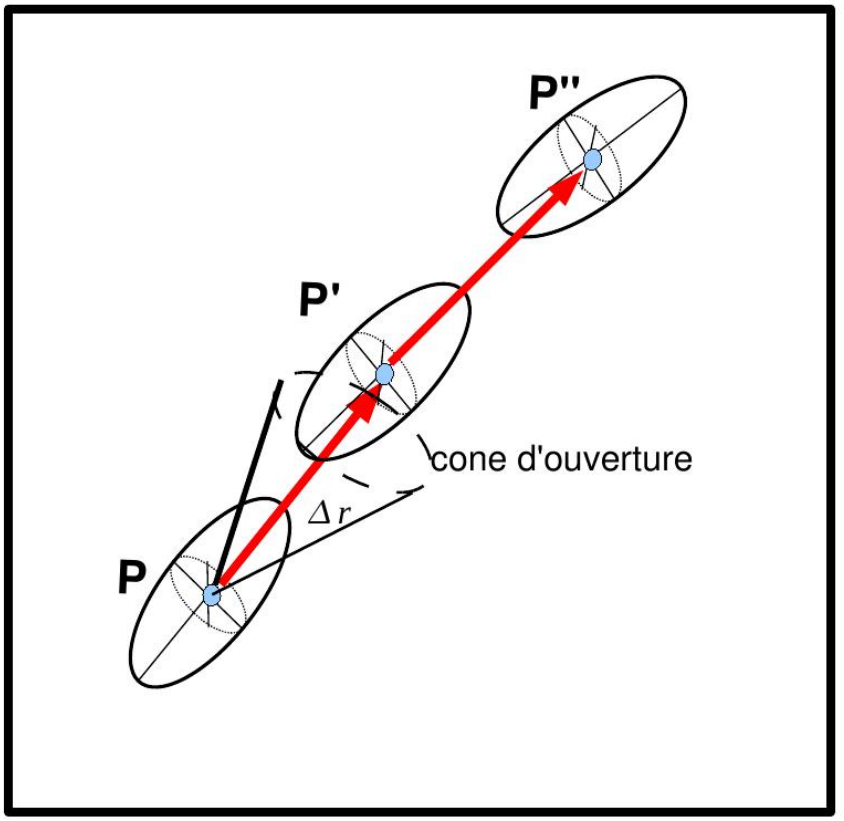
Hypothesis



Diffusion tensor



Tractography



Poupon, 1999

Diffusion Imaging

Powerful tool

- **In- vivo**
- **non invasive**
- **Access to the entire connectome**

With limitations

- Artefacts
- Spatial resolution
- Lack of validation

➢ Tract : numerical approximation

➢ Bundles scale

Diffusion MRI processing

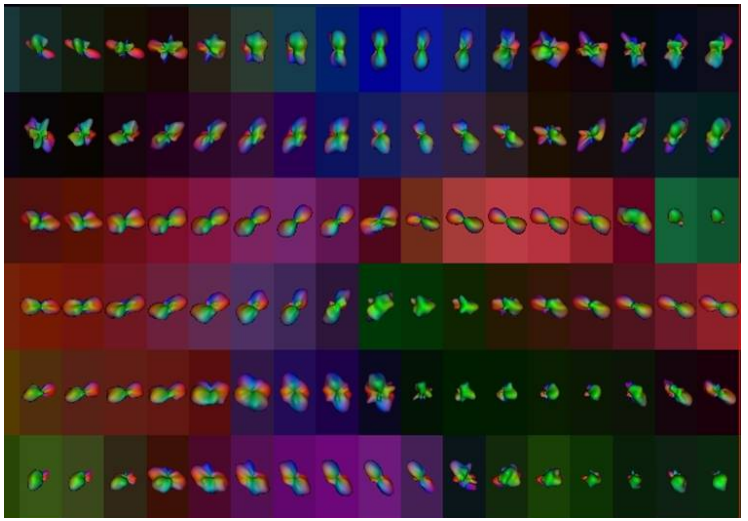
DTI

Interpolated DTI

QBall

Interpolated Qball

Continuous diffusion field



Likelihood

Best choice

Probabilistic

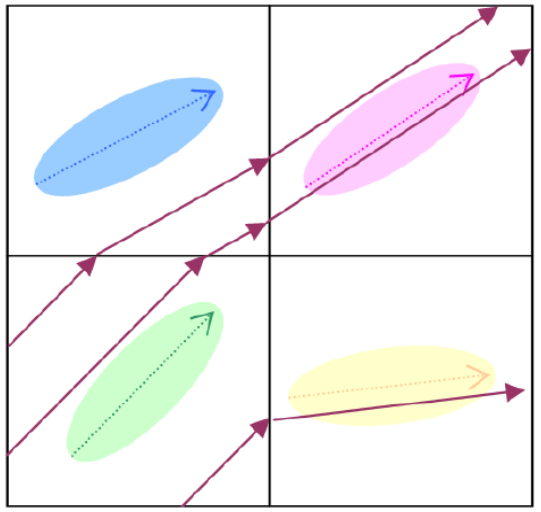
Geodesic

Diffusion model

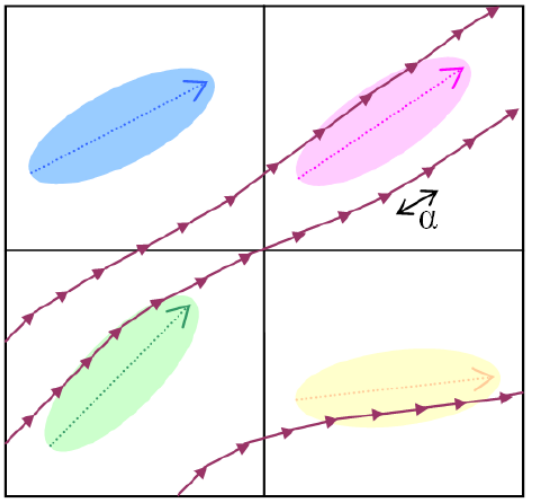
Fibers tracking

Tracking algorithms

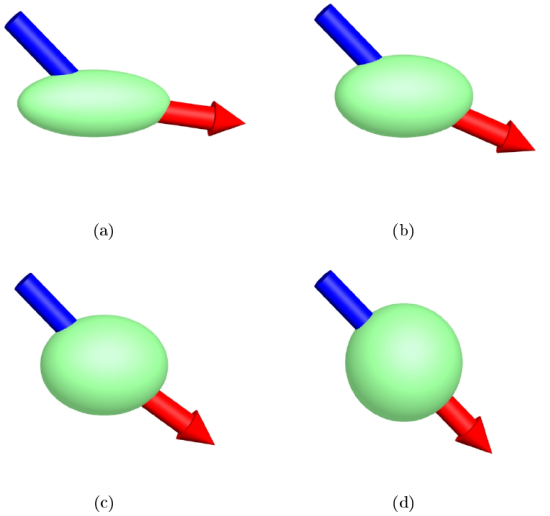
- **Likelihood algorithm**: tracks fibers forward and backward in max_eigenvector direction from point p.
- **Best choice algorithm**: tracks fibers forward and backward in more probable direction and with inertia.



FACT
[Mori 99]



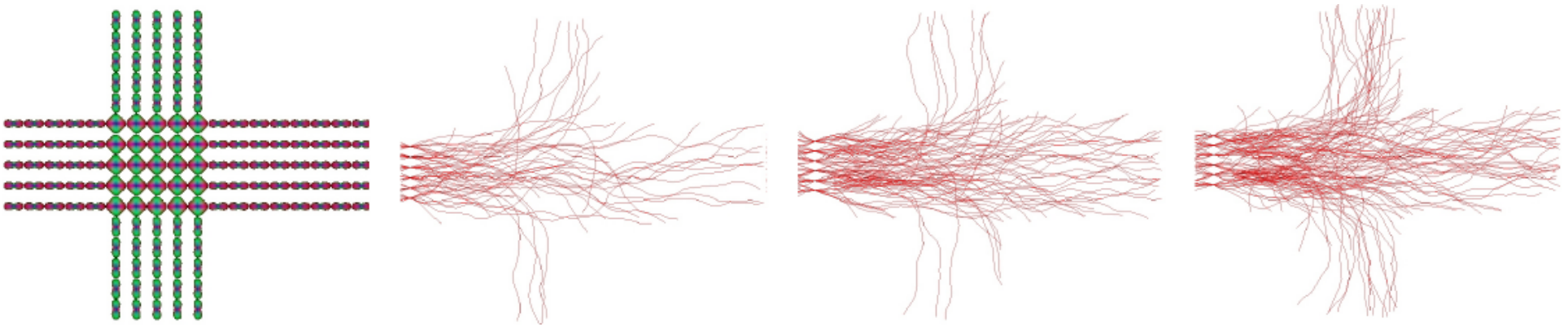
Interpolé
[Conturo 99]



Régularisée
[Weinstein 99]

Tracking algorithms

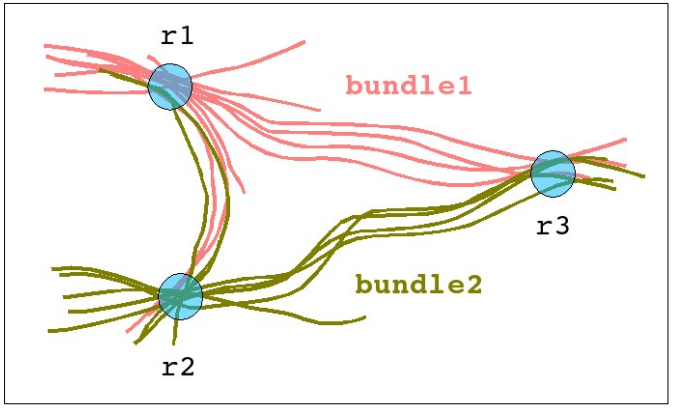
- **Probabilistic algorithm**: tracks fibers forward and backward in random walk weighted by probabilities distribution and with inertia.

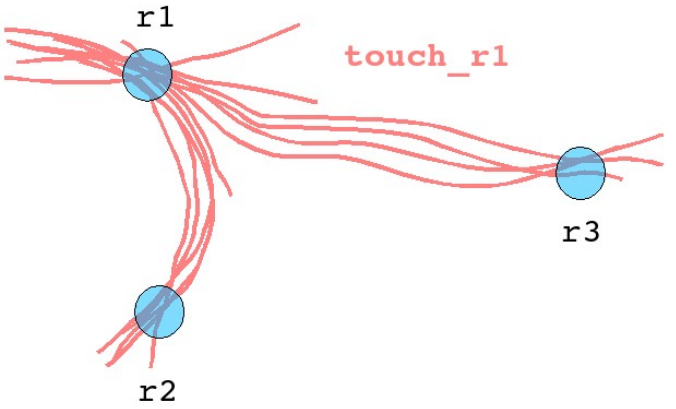


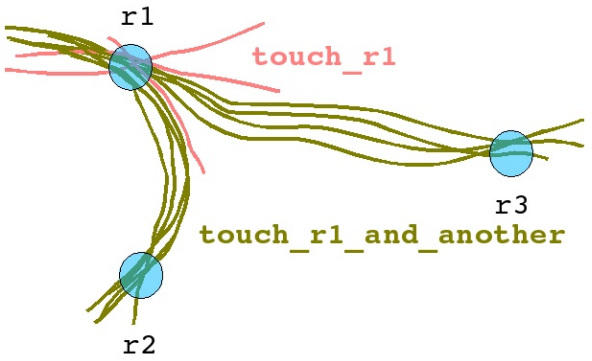
[Perrin 06]

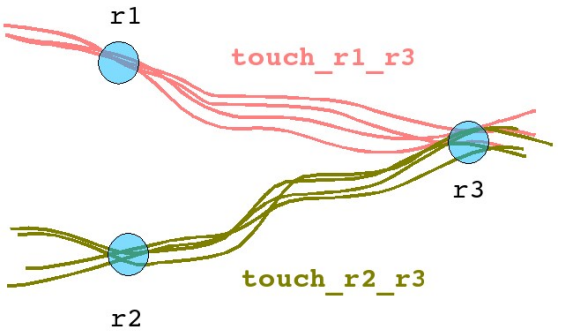
What do we do with these bundles ?

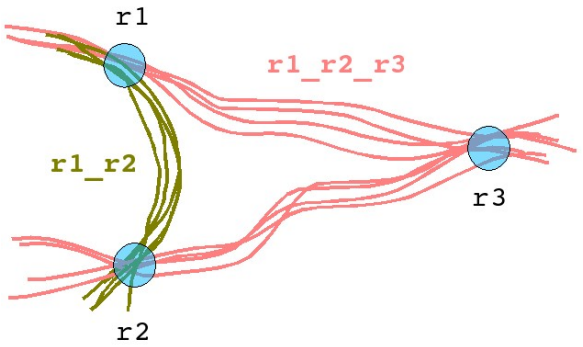
Bundles selection according ROIs

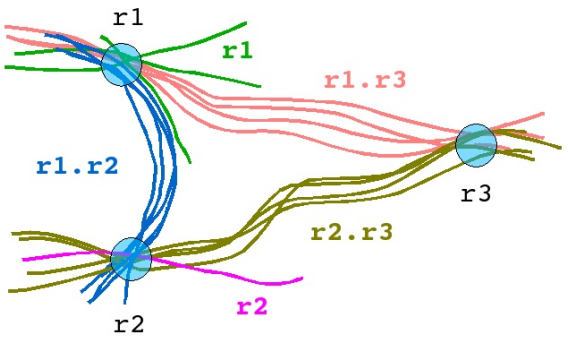




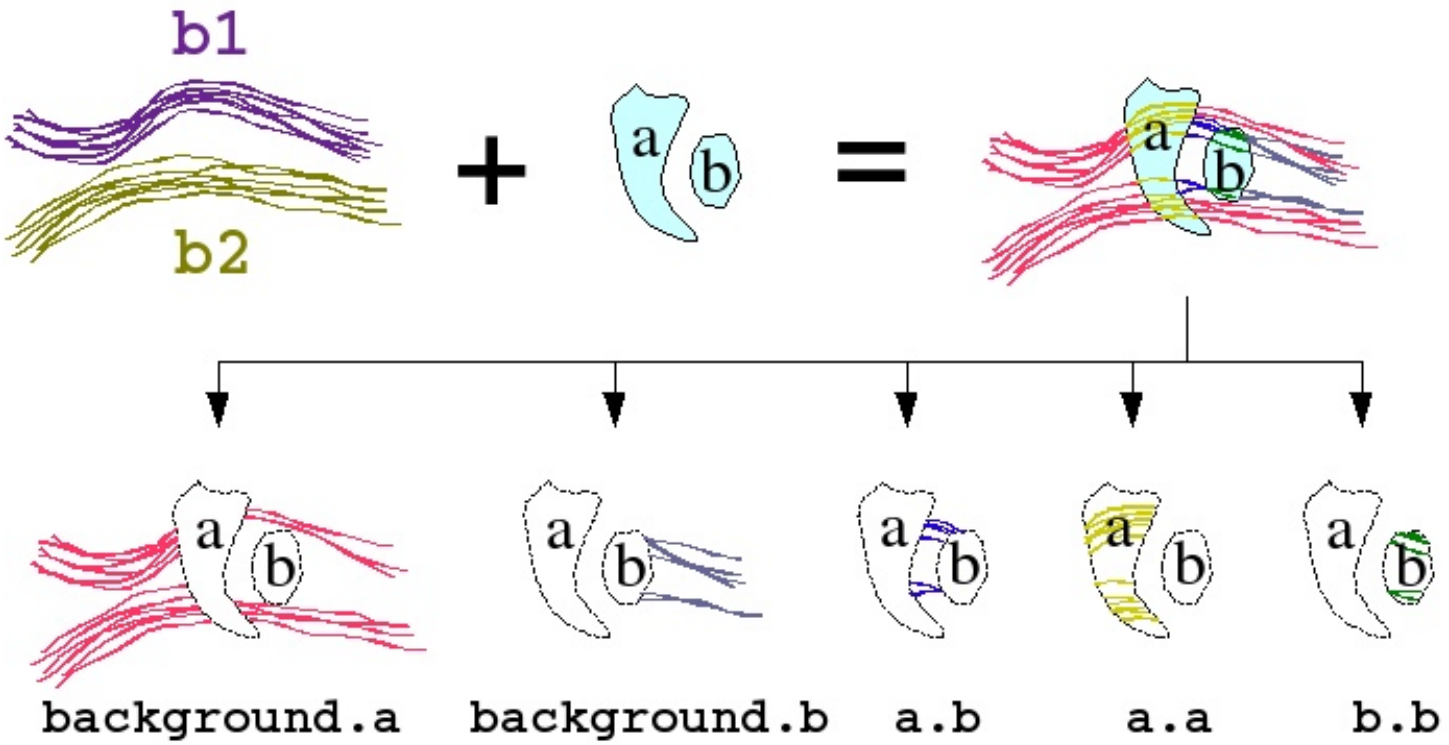




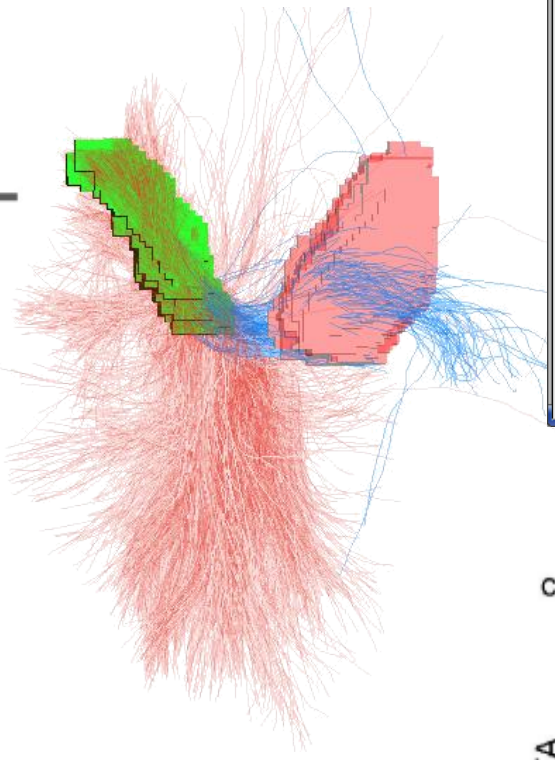


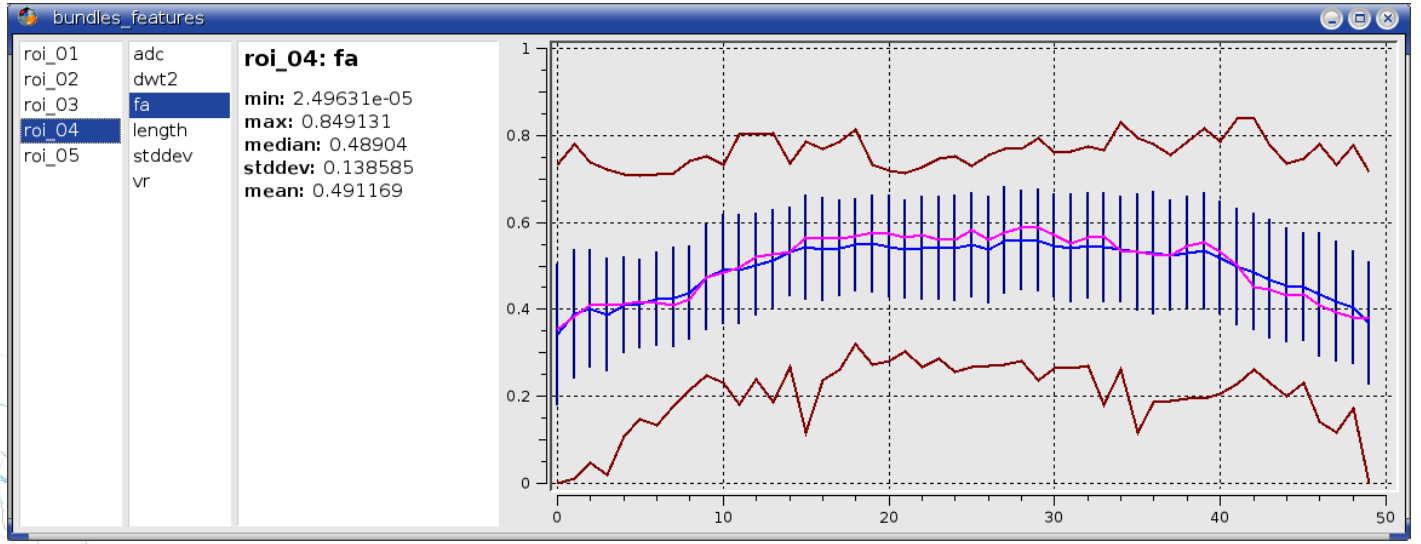


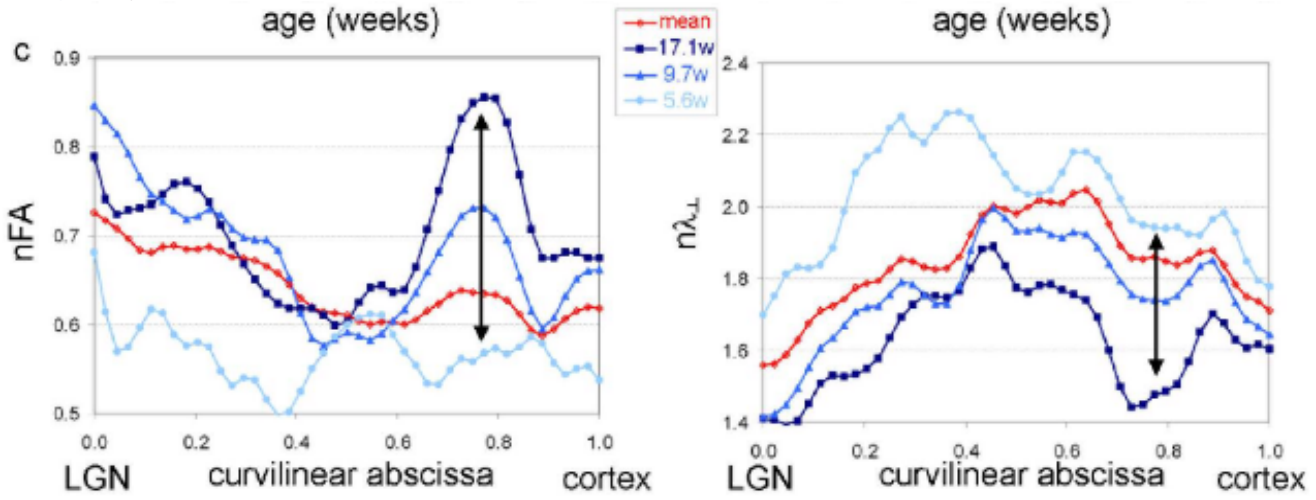
Bundles split according ROIs



Bundles analysis

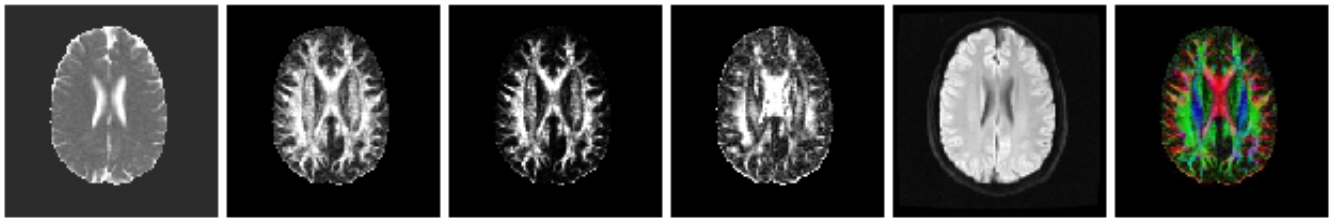






BrainVISA pipelines

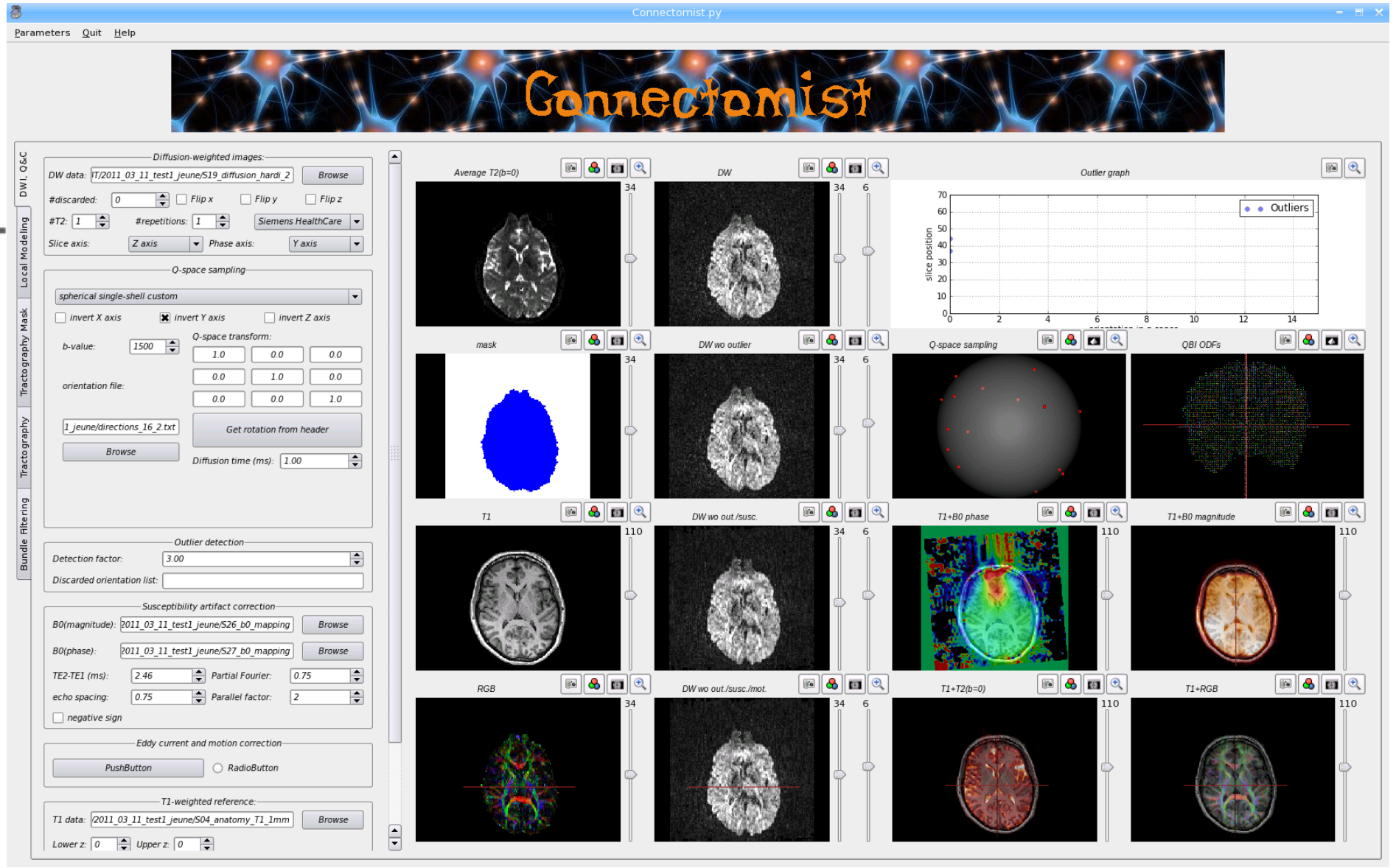
- Diffusion model pipeline
  - Echoplanar distorsions correction
  - Diffusion model creation (DTI or Q-Ball)
  - Diffusion maps (ADC, FA, VR...)



- Fascicles Tracking pipeline
  - Fibres tracking and reconstruction
  - Bundles transformation
  - Bundles analysis

Next Connectomist toolbox

- *Not available yet*



(image: courtesy of C. Poupon et al.)