Diffusion MRI
BrainVISA Diffusion & Tracking Toolbox
Brain white matter

- **Axons**

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

Le Bihan, 2003
Diffusion Imaging

Local modeling

Hypothesis

Diffusion tensor

parallel diffusion
fibers
perpendicular diffusion

$\vec{e}_1$
$\vec{e}_2$
$\vec{e}_3$
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

\[ b_1 + a \quad b = \quad a \quad b \]

\[ \text{background.a} \quad \text{background.b} \quad a.b \quad a.a \quad b.b \]
Bundles analysis

Diffusion & Tracking toolbox
BrainVISA pipelines

- Diffusion model pipeline
  - Echoplanar distortions 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.)