Diffusion Analysis - Absolute Beginner's Guide to Neuroimaging Methods

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Target Audience

This talk is designed for clinicians, scientists and engineers who wish to gain a broad overview of different methods that can be applied to analyse diffusion-weighted MRI data.

Overview

Diffusion-weighted MRI exploits the interaction of diffusing water molecules and tissue microstructure to obtain macroscopic information about tissue properties. This talk will discuss various techniques for exacting meaningful information from diffusion-weighted images at both a per-subject and group level.

Following diffusion-weighted image acquisition and pre-processing, a model is fit to the data within each image voxel, from which meaningful information can be derived. The previous presentation will introduce the most commonly used model: the diffusion tensor. This talk will begin with a discussion on some limitations of the diffusion tensor; focusing on issues with its interpretation in voxels that contain multiple-overlapping fibre bundles (also known as crossing fibres). I will then give a brief overview of some recent alternatives to the tensor model, which aim to better represent the underlying data in regions with crossing fibres.

Diffusion MRI models can provide two different types of information:

1. Orientation of the fibres within the voxel
2. Quantitative measures of the tissue, eg. density, diameter etc.

The remainder of the talk will be split into two sections, with each covering analysis methods that utilise the two different types of information (Fig. 1). The first section will discuss how orientation information can be used to estimate the trajectory of fibre pathways (fibre tractography). A brief overview of typical fibre tractography applications will be given (connectivity analysis, parcellation and region of interest delineation). The second section will discuss various quantitative measures and methods for their analysis (from global histogram-based analysis to localising voxel-based analysis).

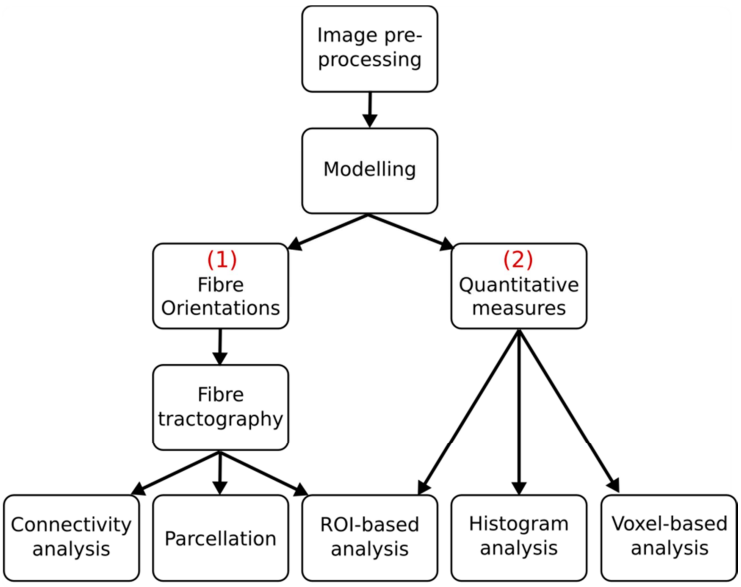

Figure 1.