

## Abstract

A number of procedures have been developed for brain morphometry, many of which are essential in functional imaging applications. The theme developed in the thesis is computational neuroanatomy, which relies upon a series of image registration methods, image segmentation and statistical methods for characterising brain structure.

The simplest registration is for rigid bodies, and is normally applied within subject. Methods are described for rigid registration of both inter- and intra-modality images. More complex models are required for registering images of different subjects into the same stereotactic space. A coarse, but fast method is described, which begins with a 12-parameter affine registration, followed by nonlinear warps modelled by a linear combination of spatial basis functions. The registration proceeds within a Bayesian framework, which is used for penalising unlikely shape changes. A high-dimensional warping method follows for refining the initial registration. In order to estimate more accurate warps, this method emphasises consistency of the deformations, by considering that warping brain A to brain B should not be different, probabilistically, from warping B to A. A Bayesian framework is used again, whereby a prior probability distribution for the warps is assumed that embodies this symmetry.

A new scheme for segmenting grey and white matter from MR images has been developed, which is based on Mixture Model cluster analysis. Registered prior probability maps of different tissue classes are used to make the classification more robust, and MRI intensity nonuniformity correction is also incorporated into this model.

Finally, a taxonomy of morphometric methods is described, which characterise the regional distribution of different tissue types, or shape differences inherent in the deformations computed by the warping methods.