COMPUTATIONAL METHODS FOR NEUROIMAGING ANALYSIS

Aim and scope

There is an increasing need for the application of machine learning (ML) techniques which can perform image processing operations such as segmentation, coregistration, classification and dimensionality reduction in the field of neuroimaging. Although the manual approach often remains the golden standard in some tasks (like segmentation), ML can be utilised to automate and facilitate the work of researchers and clinicians. Frequently used techniques include support vector machines (SVMs) for classification problems, graph-based methods for brain network analysis and recently artificial neural networks (ANNs).

Deep ANNs, i.e. deep learning, have proved to be very successful in computer vision tasks owing to the ability to automatically extract hierarchical descriptive features from input images. It has also been used in the medical and neuroimaging domains for automatic disease diagnosis, tissue segmentation and even synthetic image generation. The issue, however, is the relative sample paucity in typical neuroimaging datasets which leads to poor generalisation considering the high number of parameters employed in typical deep neural networks. Consequently, parameter- efficient design paradigms ought to be created.

Another approach to investigate degeneration is the study and mapping of the neural connections in the brain known as the connectome. The connectome can be seen as a matrix representing all possible pairwise connections between different neural areas. Researchers study both the structural and functional connectivity in order to understand important brain patterns, such as how the connectome impacts the dynamics of disease spreading, ageing and learning.

Topics of interest includes but are not limited to:

- Machine learning techniques for segmentation, coregistration, classification or dimensionality reduction of neuroimages
- Deep learning for neuroimaging analysis
- Brain network analysis
- Applications of graph theory to MRI and fMRI data
- Applications of machine learning methodologies for neurodegenerative disease studies
- Computational modelling and analysis of neuroimaging
- Methods of analysis for structural or functional connectivity
- Development of new neuroimaging tools

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