

Kernel methods for supervised classification of structural brain networks

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Abstract

The human brain anatomical organization can be modeled as a complex network, called a connectome. This representation enables the use of powerful mathematical tools to detect individual differences in brain structure. In this work, we introduce three kernel methods based on Support Vector Machines, to classify connectomes according to a given label. The presented methods take advantage of the perfect nodes correspondence property exhibited by connectomes. We demonstrate the efficiency of our methods compared to existing approaches through experiments on our dataset built from publicly available MRI data, and for the classification between male and female brains. We further show the ability of one of our methods to interpret the classification outcome in terms of one particular wiring feature, namely the inter-hemispheric ratio.

In recent years, impressive progress made in neuroimaging techniques have allowed us to explore the human brain as never before. In particular, a discipline called "connectomics" has attracted much interest. A connectome is a mathematical modeling of the structural or functional connections between brain regions as a complex network. This representation of brain connectivity takes advantage of the powerful tools of modern network theory to analyse and understand brain structure and function.

In this work, we are interested in detecting individual differences in brain structure. These differences can be related to pathological conditions or behavioral habits for example. We begin by explaining how to build structural connectomes (Figure 1), starting from MRI data. Afterwards, we propose three novel kernel methods based on Support Vector Machines for the classification of structural connectomes, with respect to given classes. These methods rely on the fact that, by construction, the connectomes under consideration have the perfect node correspondence property. This implies that all connectomes have the same number of vertices, and that a particular vertex corresponds to the same anatomical location in every

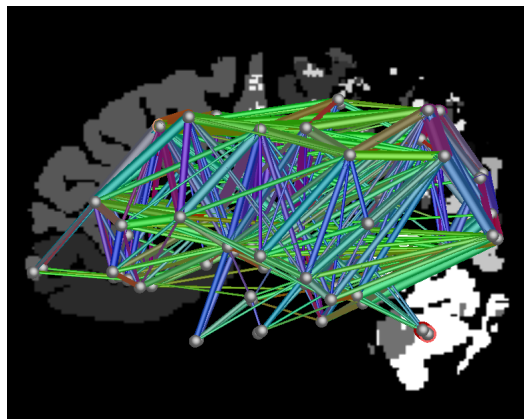


Figure 1: *Structural connectome: abstract representation of brain anatomical structure as a complex network.*

connectome. As a case of study, we present the results of the classification between male and female brains and show that our methods outperform existing approaches.

Eventually, we demonstrate the ability of one of our methods to highlight the origin of the classification outcome. Indeed, we show that on average women have stronger anatomical connections between hemispheres than men.

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