Automatic Design of Neuromarkers for OCD Characterization

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Abstract. This paper proposes a new paradigm to discover biomarkers capable of characterizing obsessive-compulsive disorder (OCD). These biomarkers, named neuromarkers, will be obtained through the analysis of sets of magnetic resonance images (MRI) of OCD patients and control subjects.

The design of the neuromarkers stems from a method for the automatic discovery of clusters of voxels relevant to OCD recently published by the authors. With these clusters as starting point, we will define the neuromarkers as a set of measurements describing features of these individual regions. The principal goal of the project is to come up with a set of about 50 neuromarkers for OCD characterization that are easy to interpret and handle by the psychiatric community.

1 Introduction

In some areas of medicine it is quite common to find punctuation systems that allow for state evaluation and patient diagnosis. For instance APACHE II (Acute Physiology and Chronic Health Evaluation) [17] is one of the most widely used score systems to quantify the seriousness of critical patient’s state by means of 12 factors or routine physiological measures (blood pressure, body temperature, heart rate, etc.). Among these punctuation systems we can also find the Ranson criterion, which predicts the severity of acute pancreatitis [26], the Glasgow scale [15], used to measure a person’s conscience level, or the SAPS II index (Simplified Acute Physiology Score) [19] which, as the APACHE II index, estimates the severity of a patient’s state. It has been shown that the adequate use of these scores provides a better characterization of the illness and helps researchers analyse the success of new therapies and compare their effectiveness in different hospitals.

However, psychiatry lacks direct and objective indicators of a subject’s physiological state for the diagnosis of a certain pathology or its evolution analysis.
To this end, psychiatrists usually use the Diagnostic and Statistical Manual of Mental Disorders, which provides a classification of mental illnesses along with descriptions of the diagnostic categories based on the patient’s medical history and the disorders they may show. Over the past few years, neuroanatomical and neurofunctional analysis have become common practice in the evaluation of certain mental conditions by means of Magnetic Resonance Imaging (MRI), either structural (sMRI) or functional (fMRI), aimed at the study of pathologies and the detection of the structural brain anomalies that cause them [4] [31]. For this purpose, different techniques have been proposed in the literature, such as voxel based morphometry” (VBM) [2], enabling the analysis of structural abnormalities in the brain; or the “General Linear Model” [1], which establishes a mathematical model to either analyse sMRI data or obtain the functional response of the brain in fMRI studies. These research lines have laid the basis for the re-evaluation of previous neuroanatomical hypotheses that were considered to be associated with certain disorders, and the proposal of new models with a sound biological foundation, although in some occasions these results have not been correctly translated to the clinical practice [23]. As a result, there has been a growing interest in the application of other analysis strategies, such as machine learning (ML) methods, since they are able to describe differences between patient and control groups and to obtain mathematical models that allow discerning between them [20].

ML techniques have positioned themselves as some of the most promising options to extract relevant information from the neuroimaging data through statistical learning methods. These approaches have the main characteristic of being able to automatically learn a model of data from a collection of examples, which in many occasions can enable the detection of information that would otherwise be hidden from the eyes of an expert. For this reason, ML methods are being successfully used in data based diagnosis in many fields of medicine. For instance, they are being used in the classification of tissue-cells, the segmentation of retinopathy, the detection breast-cancer or auricular arrhythmia, just to name a few.

Furthermore, the multivariate nature of these techniques, as well as their ability to extract the greatest amount of available information possible when the number of data is limited (a very common situation with MRI data) has favoured the widespread use of ML tools in neuroimaging analysis [25] and the diagnosis from this type of data [16]. So far, scientific production in relation to neuroimaging and ML methods has followed a path in which the psychiatric community provides MRI data from an experiment designed to study the brain, and the ML community directly applies standard techniques. Because of this, we can find many examples of the application of ML approaches to magnetic resonance experiments, such as brain mapping from fMRI data sequences [37], temporal fMRI series analysis [18] or brain state decoding [14] [21]. Clinical applications can also be found, in which the goal is to detect a particular mental illness, such as Alzheimer’s disease [34], schizophrenia [5] or obsessive compulsive disorder (OCD) [20] [24].