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Prediction of ADHD from a Small Dataset Using an Adaptive EEG Theta/Beta Ratio and PCA Feature Extraction

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Abstract. EEG Theta/beta ratio (TBR) is conventionally used as a biomarker in childhood Attention-Deficit/Hyperactivity Disorder (ADHD) prediction and treatment. Due to the heterogeneity of ADHD symptoms, several studies have applied machine learning algorithms for enhancing the recognition of ADHD. These methods, however, have limited performance in a small dataset. In this paper, we propose an adaptive EEG feature extraction approach using TBR and PCA. Repeated TBR-PCA feature extraction, SVM classification and statistical testing were applied on a small EEG sample with ADHD/typically developing (TD) labels. The steps were repeated with an update of the feature extraction technique until a high accuracy is achieved, allowing the small samples to be correctly identified ($r = 0.833$, one-sided, Bonferroni-corrected $p < 0.0166$). Within subjects EEG samples analyses performed better compared to between subject analyses, with accuracy getting worse with the increase of EEG segments. The contribution of this work is two-fold: the practical application allows for a reliable adoption of machine learning in non-invasive EEG screening of small ADHD dataset, while the theoretical contribution extends beyond the eyes closed resting state condition considered in this study and provides a methodological approach when working with limited samples.

Keywords: Learning disability · Principal components · Small data · Adaptive learning

1 Introduction

Attention-deficit/hyperactivity disorder (ADHD) is one of the most prevalent neuro-developmental disorders across countries, regions, and ethnic groups. ADHD is typically characterized by impaired levels of inattention, disorganization and/or hyperactivity-impulsivity. The identification of ADHD is a lengthy process. ADHD assessment requires obtaining background information from parents and/or teachers, followed by a formal ADHD diagnosis (termed as the gold standard) performed by health professionals based on DSM-V [1] or hyperkinetic disorders from ICD-10 [2]. A typical checklist for assessing ADHD might require an informant to recall a child's abnormalities during the

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