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Improving EEG signal peak detection using feature weight learning of a neural network with random weights for eye event-related applications

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Abstract. The optimization of peak detection algorithms for electroencephalogram (EEG) signal analysis is an ongoing project; previously existing algorithms have been used with different models to detect EEG peaks in various applications. However, none of the existing techniques perform adequately in eye event-related applications. Therefore, we aimed to develop a general procedure for eye event-related applications based on feature weight learning (FWL), through the use of a neural network with random weights (NNRW) as the classifier. The FWL is performed using a particle swarm optimization algorithm, applied to the well-studied Dumpala, Acir, Liu and Dingle peak detection models, where the associated features are considered as inputs to the NNRW with and without FWL. The combination of all the associated features from the four models is also considered, as a comprehensive model for validation purposes. Real EEG data recorded from two channels of 20 healthy volunteers were used to perform the model simulations. The data set consisted of 40 peaks arising in the frontal eye field in association with a change of horizontal eye gaze direction. It was found that the NNRW in conjunction with FWL has better performance than NNRW alone for all four peak detection models, of which the Dingle model gave the highest performance, with 74% accuracy.

Keywords. Neural network with random weights (NNRW); feature weight learning (FWL); electroencephalogram (EEG); peak detection algorithm; pattern recognition; particle swarm optimization (PSO).