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Selection of Optimal Reduced Feature Sets of Brain Signal Analysis Using Heuristically Optimized Deep Autoencoder

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Abstract : In brainwaves research using electroencephalogram (EEG) signals, finding the most relevant and effective feature set for identification of activities in the human brain is a big challenge till today because of the random nature of the signals. The feature extraction method is a key issue to solve this problem. Finding those features that prove to give distinctive pictures for different activities and similar for the same activities is very difficult, especially for the number of activities. The performance of a classifier accuracy depends on this quality of feature set. Further, more number of features result in high computational complexity and less number of features compromise with the lower performance. In this paper, a novel idea of the selection of optimal feature set using a heuristically optimized deep autoencoder is presented. Using various feature extraction methods, a vast number of features are extracted from the EEG signals and fed to the autoencoder deep neural network. The autoencoder encodes the input features into a small set of codes. To avoid the gradient vanish problem and normalization of the dataset, a meta-heuristic search algorithm is used to minimize the mean square error (MSE) between encoder input and decoder output. To reduce the feature set into a smaller one, 4 hidden layers are considered in the autoencoder network; hence it is called Heuristically Optimized Deep Autoencoder (HO-DAE). In this method, no features are rejected; all the features are combined into the response of responses of the hidden layer. The results reveal that higher accuracy can be achieved using optimal reduced features. The proposed HO-DAE is also compared with the regular autoencoder to test the performance of both. The performance of the proposed method is validated and compared with the other two methods recently reported in the literature, which reveals that the proposed method is far better than the other two methods in terms of classification accuracy.

Keywords : autoencoder, brainwave signal analysis, electroencephalogram, feature extraction, feature selection, optimization
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