Evolutionary model selection in a wavelet-based support vector machine for automated seizure detection

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ABSTRACT

Support vector machines (SVM) have in recent years been gainfully used in various pattern recognition applications. Based on statistical learning theory, this paradigm promises strong robustness to noise and generalization to unseen data. As in any classification technique, appropriate choice of the kernels and input features play an important role in SVM performance. In this study, an evolutionary scheme searches for optimal kernel types and parameters for automated seizure detection. We consider the Lyapunov exponent, fractal dimension and wavelet entropy for possible feature extraction. The classification accuracy of this approach is examined by applying the MIT (Massachusetts Institute of Technology) dataset and comparing results with the SVM. The MIT-BIH dataset has the electrocardiographic (ECG) changes in patients with partial epilepsy which two types ECG beats (partial epilepsy and normal). A comparison of results shows that performance of the evolutionary scheme outweighs that of support vector machine. In the best condition, the accuracy rate of the proposed approaches reaches 100% for specificity and 96.29% for sensitivity.

1. Introduction

Support vector machines are machine learning method based on statistical learning theory, so strong robustness to noise and generalization to unseen data are expected from SVM and this subject is the most important drawback of ANNs. The idea of SVM was first proposed by Vapnik in mid-1970’s, but it is widely used only articles after 1995. SVM is now considered a powerful tool on processing and classification fields, and more development is ongoing. An SVM uses kernels to map the data from input space to a high-dimensional feature space in which the problem becomes linearly separable. The resulting decision function is related to the admissible kernels, number of support vectors (SV) and their weights. There are many kinds of kernels that can be used, such as the radial basis functions (RBF), polynomial kernels, wavelets. Wavelets, a powerful tool for non-stationary signal processing, has been more recently applied to kernel functions in SVM classification and regression. Here, wavelet functions are first used to construct the admitted kernels for SVM according to Mercer theory (Burges, 1998; Widodo & Yang, 2007).

In this study, a wavelet-based support vector machine (WSVM) is applied to detection of epilepsy instances from ECG signals. The approach aims to benefit from robust wavelet-based kernels and evolutionary selection of SVM parameters such its kernel types and parameters to minimize detection error with fewer data items (higher sparsity).

As can be seen, Kernels perform an important role in SVM, but SVMs cannot choose optimal kernel types, kernel parameters and feature subsets. We can use an evolutionary scheme searches to solve this problem. In some of the recent studies, the genetic algorithms have been used for selecting the optimum features for SVM classifier, but many of these studies do not perform the SVM parameter optimization. On the other hand, optimal kernel type and kernel parameters, feature subset and the C parameter of SVM are assessed simultaneously in this paper. Experiments show the feasibility and validity of GA_WSVM in classification.

Electrocardiogram signal is applied for the recording of the bioelectrical and biomechanical activities of the cardiac system. It provides useful information about the functional aspects of cardiovascular system. Mainly, epileptic seizures are associated with several changes in autonomic nervous system, which may cause cardiovascular, gastrointestinal, respiratory, cutaneous and urinary

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