Integrative Biology-2013
OMICS Group Conferences
Accelerating Scientific Discovery
International Conference on
Integrative Biology Summit
August 5-7, 2013 Embassy Suites Las Vegas, USA

A new novelty detector for finding abnormal beats in ECG recordings

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Abstract

Electrocardiogram (ECG) recordings of two persons with the same type of abnormality can differ significantly from one another due to differences in age, gender, physical condition, emotional state, genetics, family history and the underlying cause of a cardiac abnormality. This variability is one of the major causes of inaccurate predictions from an automated detector of abnormal beats as most of these detectors do not take this variability into account. Additionally, most existing approaches require both normal and abnormal beats as examples during training of their machine learning method. The annotation of abnormal beats is a difficult task as, usually, only a small fraction of cardiac beats in a Holter ECG recording is abnormal.

This paper presents a novel machine learning method (called Quadratic Programming Dissimilarity based Data Descriptor or QPDDD). QPDDD is a one-class classifier (or novelty detector) that requires a small number of only normal beats for training. These beats can either be presented to the system through annotation by a medical expert or they can be selected randomly from the recording when the number of abnormal beats is expected to be very small in comparison to the number of normal beats. Once trained, QPDDD can accurately and efficiently predict whether any input beat from that individual is normal or abnormal. This paper compares the performance of QPDDD with other one-class classifiers using the MIT-BIH Arrhythmia database. An equal error rate (EER) of 90-95% (depending upon the amount of training data) was observed for QPDDD. This clearly indicates the efficacy of the proposed scheme and the potential of its application to related problems in biology and medicine.

Biography

Fayyaz ul Amir Afsar Minhas is currently a Ph.D. student at Colorado State University. He is a recipient of the William J. Fulbright doctoral scholarship. He has worked on the detection of cardiac abnormalities through the analysis of electrocardiogram (ECG) recordings for about 3 years. He has published more than 25 papers in reputed journals and conferences in areas related to applications of machine learning techniques. He is currently using kernel methods for the prediction of interactions between protein molecules.