Classification of heart rate data using artificial neural network and fuzzy equivalence relation

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Abstract

The electrocardiogram is a representative signal containing information about the condition of the heart. The shape and size of the P-QRS-T wave, the time intervals between its various peaks, etc. may contain useful information about the nature of disease afflicting the heart. However, these subtle details cannot be directly monitored by the human observer. Besides, since bio-signals are highly subjective, the symptoms may appear at random in the time scale. Therefore, the signal parameters, extracted and analysed using computers, are highly useful in diagnostics. This paper deals with the classification of certain diseases using artificial neural network (ANN) and fuzzy equivalence relations. The heart rate variability is used as the base signal from which certain parameters are extracted and presented to the ANN for classification. The same data is also used for fuzzy equivalence classifier. The feedforward architecture ANN classifier is seen to be correct in about 85% of the test cases, and the fuzzy classifier yields correct classification in over 90% of the cases. © 2002 Pattern Recognition Society. Published by Elsevier Science Ltd. All rights reserved.

Keywords: Heart rate; Pattern recognition; ECG; Neural network; Fuzzy equivalence; Disease classification

1. Introduction

Electrocardiography deals with the electrical activity of the heart. Monitored by placing sensors at the limb extremities of the subject, electrocardiogram (ECG) is a record of the origin and propagation of the electric potential through cardiac muscles. It is considered a representative signal of cardiac physiology, useful in diagnosing cardiac disorders.

The state of cardiac health is generally reflected in the shape of ECG waveform and heart rate. It may contain important pointers to the nature of diseases afflicting the heart. However, bio-signals being non-stationary signals, this reflection may occur at random in the time scale. (That is,

the disease symptoms may not show up all the time, but would manifest at certain irregular intervals during the day.) Therefore, for effective diagnostics, the study of ECG pattern and heart rate variability signal (instantaneous heart rate against time axis) may have to be carried out over several hours. Thus, the volume of the data being enormous, the study is tedious and time consuming. Naturally, the possibility of the analyst missing (or misreading) vital information is high. Therefore, computer-based analysis and classification of diseases can be very helpful in diagnostics.

The present paper makes use of heart rate variability (HRV) as the base signal for analysis and classification of diseases. The heart rate is evaluated by measuring the time interval between the successive R-peaks (R–R interval) of the ECG waveform. It is known that almost all the useful frequency components in ECG signal falls below 40 Hz [1], and therefore sampled at the rate of 200 samples/s. The heart rate, plotted against the time scale provides the HRV signal

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Machine Learning in Bio-Signal Analysis and Diagnostic Imaging Nilanjan Dey,Surekha Borra,Amira S. Ashour,Fuqian Shi,2018-11-30 Machine Learning in Bio Signal Analysis and Diagnostic Imaging presents original research on the advanced analysis and classification techniques of biomedical signals and images that cover both supervised and unsupervised machine learning models standards algorithms and their applications along with the difficulties and challenges faced by healthcare professionals in analyzing biomedical signals and diagnostic images These intelligent recommender systems are designed based on machine learning soft computing computer vision artificial intelligence and data mining techniques Classification and clustering techniques such as PCA SVM techniques Naive Bayes Neural Network Decision trees and Association Rule Mining are among the approaches presented The design of high accuracy decision support systems assists and eases the job of healthcare practitioners and suits a variety of applications Integrating Machine Learning ML technology with human visual psychometrics helps to meet the demands of radiologists in improving the efficiency and quality of diagnosis in dealing with unique and complex diseases in real time by reducing human errors and allowing fast and rigorous analysis The book s target audience includes professors and students in biomedical engineering and medical schools researchers and engineers Examines a variety of machine learning techniques applied to bio signal analysis and diagnostic imaging Discusses various methods of using intelligent systems based on machine learning soft computing computer vision artificial intelligence and data mining Covers the most recent research on machine learning in imaging analysis and includes applications to a number of domains **Biomedical Sensors and Smart Sensing** Ayan Kumar Panja,Amartya Mukherjee,Nilanjan Dey,2022-06-02 Biomedical Sensors and Smart Sensing A Beginner s Guide a book in the 10 volume Primers in Biomedical Imaging Devices and Systems series covers a wide range of interdisciplinary applications in imaging modalities nuclear medicine computed tomographic systems x ray systems magnetic resonance imaging ultrasound and virtual reality The series explores the essential fundamental techniques required to analyze and process signals and images for diagnosis scientific discovery and medical applications Volumes in this series cover a wide range of interdisciplinary areas combining foundational content with practical case studies to demonstrate the applications of these technologies in real world situations In addition the 10 volume series considers various medical devices electronics circuits sensors and algorithms Several applications ranging from basic biological science to clinical practice are included to facilitate ongoing research Covers a variety of sensing and signal processing techniques Introduces different approaches relating to communication and intelligent data processing for early detection and prediction of diseases Includes practical case studies

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