Prediction and Categorization of Heart Arhythymia

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***Abstract*— Heart arrhythmia is a state of the heart in which the heartbeat is unbalanced, either too fast, too slow or unstable. Electrocardiography (ECG) is used for the recognition of Heart arrhythmia. It registers the electrical activities of the heart of a patient for a period through electrodes attached to the skin. Due to the ECG signals that reflect the physiological conditions of the heart, medical specialists tend to utilize ECG signals to detect and analyze heart arrhythmia. The most important skill of medical doctors is being able to identify the dangerous types of heart arrhythmia from ECG signals. In spite of this, interpretation of the ECG waveforms performed by a professional medical doctor manually is proven to be monotonous and time consuming. As a result, the development of automatic systems for identifying abnormal conditions from diurnal recorded ECG data is of primary importance. Suitable and timely medical treatment measures can be effectively applied when such irregular heart conditions are identified instantly using health monitoring equipment and tools utilizing machine learning algorithms. Therefore, an important investigation in this regard would be machine learning approaches.**

***Index Terms*— Cardiac autonomic nervous system, Cardiac arrhythmias, Atrial fibrillation, Ventricular tachyarrhythmia, Denervation, Nerve stimulation, Neuromodulator**

I. INTRODUCTION

Effective treatment and management now exists for many arrhythmias. Devices and high-level catheters, along with computerised-plotting systems that permit for ablation treatment and therapy, have produced some notable and incredible clinical electrophysiology into one of the most rapidly multiplying cardiology subspecialties.

Pacemakers are the acknowledged standard model of supervision for those with bradycardia, and if facilities are available, patients with Wolff-Parkinson-White syndrome or similar arrhythmias should be looked up for ablation.

However, knowledge of the underlying biology has not kept up with technical improvements, and queries about clinical management remain. Foremost, although we know some of the common factors that incline and prompt arrhythmias, the evaluation precision is not always sufficient to justify prophylaxis or intervention. Secondly, if we want to suppress arrhythmia not responsive to ablation, we have few options. In the past thirty years, the range of available drugs has scarcely expanded, and available drug treatments have pro-arrhythmic risk, other toxic effects, low tolerability, and variable efficacy. However, recent developments suggest that most of the arrhythmia biology is tractable. Improvements in the relevant genetics and genomics, and the availability of data and new model systems, are reassuring. The promising picture is one of many molecular perturbations that come together and interact in individuals to generate arrhythmia-prone hearts, expressed through the phenotypic variability familiar to clinicians.

II. BACKGROUND

A. *Machine Learning*

Artificial Intelligence (AI) is a rapidly advancing technology, that can learn, reason, plan, perceive or process natural language. From evaluations made by many scientists, the term “machine learning” is interchangeably used along with the term “artificial intelligence”, given that the possibility of learning is the main characteristic of intelligent agents. The most significant purpose of machine learning is the formation and building of computer program code that can learn, test and improvise and adapt accordingly, using past experience and data.

B. *Supervised Learning*

This assessment is determined on the study of a system based on distinct methods of supervised learning. In supervised learning, the system must “learn”, including using target function. This target function is an abstract of a model which describes the data. In order to conclude the best target result, the learning system, given a training set, must take appropriate hypothesis for the function and be represented by h.

In supervised learning, there are two kinds of learning tasks: classification and regression. Classification models envisage distinct classes using its trained data, such as e.g. blood groups, while regression models forecast numerical values. Some of the most common procedures are Support Vector Machines (SVM), Decision Trees (DT), Genetic Algorithms (GA), Artificial Neural Networks (ANN) and Instance Based Learning (IBL), such as k- Nearest Neighbors (k-NN).

III. METHODOLOGY

Analysis of the heart state or normal ECG waves is not considered an easy task. As a point of fact, the ECG signal is nonstationary and thus, symptoms of a disease, if any, may not occur regularly. Thus, medical specialists need to document the records and closely observe the heartbeat for a long time to categorize the rhythm into regular or irregular type. For ECG signal analysis, the size of the generated data can be huge, which requires a lot of time and effort, therefore there is a need for an automatic classification system.

A. Dataset

For the current study, publicly available Physio Net, MIT–BIH arrhythmia database sampled at 360 Hz is used. Then, the heartbeats from the complete dataset collected are categorized into five arrhythmia classes as suggested by the ANSI/AAMI EC57:1998 standard. The MIT-BIH database comprises of 48 registered records. Each recorded note has a period of 30 minutes with sampling frequency of 360 Hz. Table 1 shows the heartbeat distribution.

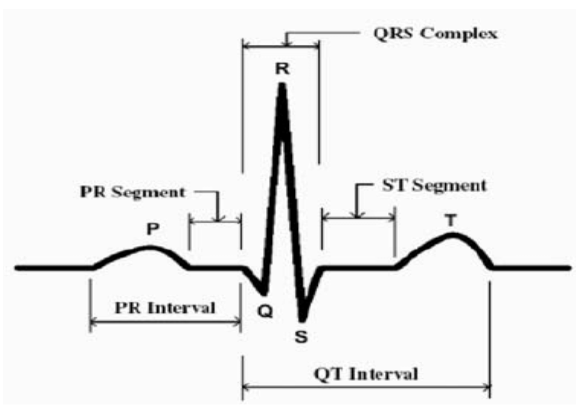
Table 1. Distribution of Heartbeats

Heartbeat	ECG Recording Containing Respective Type
N	100, 101, 105, 112, 115, 000, 000
LBBB	109, 111, 207, 214
RBBB	124, 212, 231, 232
PVC	105, 109, 116, 119, 214, 000, 000

For suitable feature selection, we intend to use Machine Learning Algorithms: K-Nearest Neighbors, Logistic Regression, Naïve Bayes and SVM.

Each standard ECG signal has components that are composed of P-wave, QRS complex, followed by T wave as shown in Figure 1. On inspecting the shape, the correlation between these waves and the duration of each waves is used to analyze the diagnosis and category of the arrhythmia.

Figure 1. Components of ECG Signal.



B. Pre-processing the ECG Signal for the Intended System

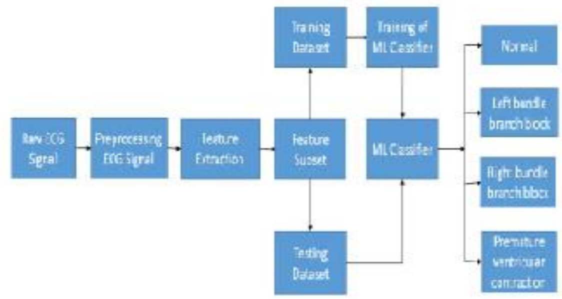
Input to the system will be detailed and rare ECG signals. This detailed signal contains noise. Pre-processing of the ECG signal detaches this noise. Three different DE noising techniques are used: median filter, moving average filter and notch filter. Following this, features are removed from the filter ECG signal. In total 9 characteristics are removed for each beat using discrete wavelet transform, namely R point location, area under QRS complex, duration of QR, RS, RR points, R peak, R normal, area under autocorrelation and SVD of ECG. Various techniques such as FFT, CWT and DWT etc., will be used for the extraction of different features from the expired ECG signal. The resulting feature dataset will then be split into training and testing datasets. Training dataset will be fed to the different Machine Learning classifier. In the suggested system, an SVM classifier and an ANN classifier will be used.

Different hypotheses and weights will be taken into consideration to raise the accuracy of ranking. At the end, the best combination of the pre-processing and classification techniques resulting from the proposed system will be used to more accurately identify the type of heart arrhythmia.

C. System Evaluation Approach

The proposed system architecture is shown in Figure 2.

Figure 2. Proposed System Architecture



For conducting evaluation, we used three standard metrics: sensitivity, specificity, and accuracy. These metrics are used to quantify the performance of the system.

Sensitivity is a measure of the capacity of the positive samples and is denoted by:

$$(Sn) = (TP/ TP + FN) * 100$$

Where TP represents the real positive and FN represents the false negative.

Specificity is measures of the capacity of test the negative samples, defined by:

$$(Sp) = (TN / TN + FP) * 100$$

Where TN represents the true negative and FP represents the false positive.

The precision accuracy is described as the ability of the test to correctly identify a classified type with and without positives. It reflects both sensitivity and specificity.

$$\text{Accuracy } (Ac) = (TP + TN) / (TP + TN + FP + FN) * 100$$

IV. Conclusion

The proposed machine learning system can be used in hospitals or medical diagnostic centres, where a large dataset is available. They can can assist medical specialists in developing more precise analytics decisions and to cut down the number of causalities due to heart diseases in the future. This classification technique is based on the algorithms K-Nearest Neighbors, Logistic Regression, Naïve Bayes and SVM, with an assumption of independence among predictors.

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