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Diagnosis and Classification of Cardiac Arrhythmia

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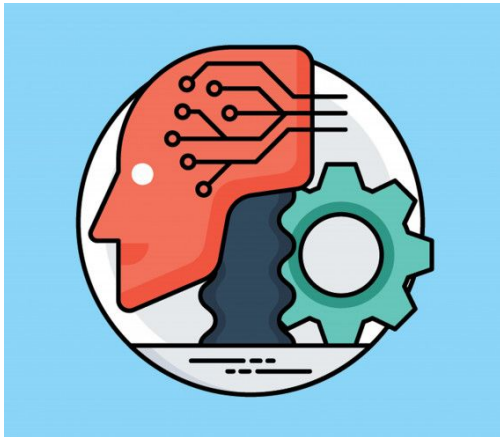
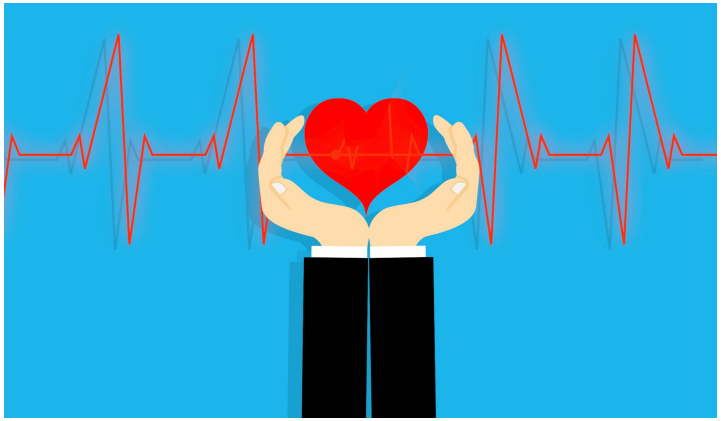
Problem Statement

To predict the diagnosis of Cardiac Arrhythmia as well as classify it into different categories by comparing the different machine learning algorithms on the data provided by a patient's ECG waveform and selecting the one with the highest accuracy.



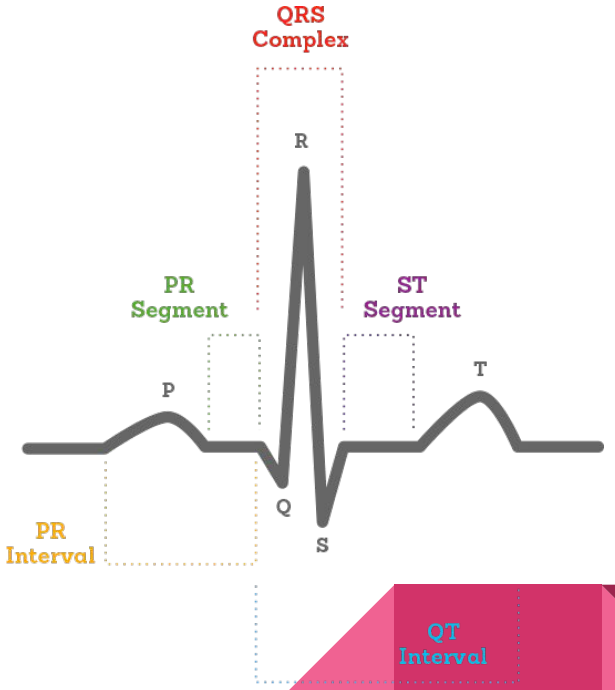
Motivation



- According to World Health Organization, about 17 million people in the world die every year due to cardiovascular diseases.
- Cardiac Arrhythmia is a group of conditions in which the electrical activity of the heart is irregular or is faster or slower than normal. This is a critical problem and can even cause death and hence it is crucial to accurately detect the presence of arrhythmia as well as classify it.

Introduction

- An ECG(Electrocardiogram) measures heart activity and helps in the analysis of cardiac condition of patients.
- Different parameter values can be extracted from the ECG waveforms and can be used along with other information about the patient like age, medical history, etc to detect arrhythmia and classify its type.
- However,sometimes it may be difficult for a doctor to look at these long duration ECG recordings and find minute irregularities. This calls for using machine learning for automating arrhythmia diagnosis.



Data Set

- The data set of project is from UC Irvine Machine Learning Repository. https://archive.ics.uci.edu/ml/machine-learning-databases/arrhythmia/arrhythmia.data
- The data set consists of 452 records, each of them having 280 attributes.
- The attributes can be split into 5 categories
  - features concerning biological characterstics like age,sex,height,weight etc.
  - features concerning average wave durations of each interval
  - features concerning vector angles of each wave
  - features concerning widths of each wave
  - features concerning amplitudes of each wave

Literature Review

Paper Title	Year	Abstract
Enhanced tele ECG system using Hadoop framework to deal with big data processing	2016	In this research, the tele-ecg system was enhanced using Hadoop framework, in order to deal with big data processing. The system classified the ecg data using decision tree and random forest.
Cardiac arrhythmia detection using deep learning	24-25 Aug 2017	Transferred deep convolutional neural network previously trained on a general image data set is used as a feature extractor and the extracted features are fed into a simple back propagation neural network to carry out the final classification.The steps include, signal pre-processing, QRS detection, ECG feature extraction using transferred deep learning and ECG signal classification using a conventional Artificial Neural Network (ANN).
Automated detection of cardiac arrhythmia using deep learning technique	May 2018	Indicates abnormalities in the ECG signals to analyse the risk associated with any type of arrhythmia. Each trail of experiment was run till 500 epochs. It is observed that most of the deep learning architectures learn the normal category patterns of input data within 250 epochs.

Literature Review

Paper Title	Year	Abstract
A Fast Machine Learning Model for ECG-Based Heartbeat Classification and Arrhythmia Detection	2019	In this work, an ensemble of Echo State Networks (ESNs) as the classifier method is proposed, using the raw ECG waveforms and time intervals between the heartbeats as the input features. A particular advantage of the ESNs is that they have recurrent connections, being able to take into account time dependencies between neighboring heartbeats.
Electrocardiogram Monitoring and Interpretation: From Traditional Machine Learning to Deep Learning, and their Combination	2018	The challenges and differences between machine learning techniques for ECG monitoring and interpretation are reviewed.ECG is the most widely available and most frequently performed cardiac diagnostic test. It has been estimated that 300 million ECGs are recorded every year. Promising results achieved by combining traditional machine learning with novel deep learning approaches and improvement in interpretability of these combined models may increase the popularity to these techniques
Comparing different supervised machine learning algorithms for disease prediction	2019	Extensive research was made to identify those studies that applied more than one supervised machine learning algorithm on single disease prediction using Scopus and PubMed databases.Support Vector Machine (SVM) algorithm is applied most frequently (in 29 studies) followed by the Naïve Bayes algorithm (in 23 studies). However, the Random Forest (RF) algorithm showed superior accuracy comparatively

Literature Review

Paper Title	Year	Abstract
Analysis and classification of heart diseases using heartbeat features and machine learning algorithms	31 August 2019	Implemented using ML-libs and Scala language on Apache Spark framework. Classification algorithms like Decision Tree, Random Forests, Gradient-Boosted Trees were applied on a dataset with 205,146 records to evaluate the performance of the approaches.
Classification of Arrhythmia by Using Deep Learning with 2-D ECG Spectral Image Representation	25 May 2020	Proposed a 2D CNN model for the classification of ECG signals.The 1D ECG time series signals are transformed into 2D spectrograms through short-time Fourier transform. The 2D CNN model consisting of four convolutional layers and four pooling layers for extracting robust features from the input spectrograms.
Genetic algorithm for the optimization of features and neural networks in ECG signals classification	31 January 2017	A method based on genetic algorithm-back propagation neural network (GA-BPNN) for classifying ECG signals with feature extraction using wavelet packet decomposition (WPD) was proposed. WPD combined with the statistical method is utilized to extract the effective features of ECG signals.GA is employed to decrease the dimensions of the feature sets and to optimize the weights and biases of the back propagation neural network (BPNN).

Applications

- Learning how to interpret the subtle differences in characteristic changes that can arise is a specialized skill that can take years to learn. Hence, this will assist the doctors to diagnose a patient both accurately and quickly. A classification model to identify the condition at its early stage could effectively reduce the mortality rate by providing a timely treatment
- It can prove to be very helpful in big hospitals that handle a large number of patients.
- The results can be used for medical research purposes e.g identifying which class of patients may be more susceptible to this disease in the future and accordingly creating awareness amongst them.

Thank You