Research Article

Cardiovascular Diseases Prediction Using Machine Learning Algorithms

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ABSTRACT: A broad variety of health conditions are involved in heart disease. Several illnesses and disorders come under the heart disease umbrella. Heart disease forms include: In arrhythmia, abnormality of the heart rhythm. Arteriosclerosis, Hardening of the arteries is atherosclerosis. Via cardiomyopathy, this disorder causes muscles in the heart to harden or grow weak. Defects of the congenital heart, heart abnormalities that are present at birth are congenital heart defects. Disease of the coronary arteries (CAD), the accumulation of plaque in the heart's arteries triggers CAD. It's called ischemic heart disease occasionally. Infections of the heart, bacteria, viruses, or parasites may trigger heart infections. Heart diseases namely arrhythmias, coronary heart disease, heart attacks, cardiomyopathy will be detect using the proposed algorithm in this paper. Here I compared three algorithms namely Restricted Boltzmann Machines, Deep Belief Networks and Convolutional Neural Networks for electrocardiogram (ECG) classification for heart disease.

1. INTRODUCTION

Heart disease refers to any heart-affecting illness. There are a number of ways, some of which are avoidable. Heart disease affects only the heart, unlike cardiovascular disease, which causes issues with the whole circulatory system. The most common form of cardiovascular problems is coronary artery disease, also known as coronary heart disease. It forms as plaque clogs the arteries that provide blood to the guts . This causes them to narrow and to harden. Cholesterol and other compounds are found in plaque. As a result, the blood flow decreases, and fewer oxygen and fewer nutrients are obtained by the guts . The heart muscle weakens with time, and there is a chance of heart failure and arrhythmia. An arrhythmia is a heartbeat rate or rhythm problem. The heart can beat too quickly, too slowly, or with an irregular rhythm during arrhythmia. The disorder is called tachycardia if the heart beats too rapidly. The disorder is called bradycardia if the heart beats too slowly. Doctors use electrocardiogram (ECG) to detect such heart diseases. [5] Electrocardiography is a procedure that is often non-invasive. It is used for the diagnosis of different heart disorders. The electrocardiogram (ECG) indeed indicates the electrical activity of the heart. [14] ECG signals represent all the heart's electrical activities. Consequently, it plays a vital role in the diagnosis of heart disease and the identification of arrhythmia. Computer-aided diagnosis has become an accepted approach to classifying the heartbeats of various types of arrhythmia based on minor variations in the amplitude, length and morphology of the ECG. The Restricted Boltzmann Machines, Deep Belief Networks and Convolutional Neural Networks will be the subject of this research paper.

1.1 Restricted Boltzmann Machines

Restricted Boltzmann Machines (RBMs) with generative capabilities are a two-layered artificial neural network. They have the ability to learn the distribution of probability over their input set. RBMs are developed by Geoffrey Hinton and can be used for reduction of dimensionality, classification, regression, collective filtering, feature learning, and modelling of topics.

RBM is a generative model and you essentially use it to model the unknown distribution of such data (like images, text, etc.).

1.2 Deep Belief Networks

Deep Belief Networks are a graphical representation that is basically generative in nature, i.e. all possible values that can be generated for the case at hand are generated. It is an amalgamation of probability and statistics with neural networks and machine learning. Deep Belief Networks consist of several layers with values, in which the layers have a relationship, but not the values.

A cyclic graph called belief networks was guided to help solve issues related to inference and learning problems. Deep Belief Networks, which helped establish unbiased values to be stored in leaf nodes, followed this.

1.3 Convolutional Neural Networks

Convolutional Neural Networks have an architecture that is distinct from standard neural networks. By placing it through a series of hidden layers, Standard Neural Networks transform an input. Each layer consists of a series of neurons, where each layer is entirely linked to all the neurons in the previous layer. Finally, there is the last completely connected layer that reflects the projections, the output layer.

A little different are the Convolutional Neural Networks. First of all, the three dimensions of the layers are organized: width, height and depth. In addition, in the next layer, the neurons in one layer do not bind to all the neurons, but only to a specific region of them. Finally, the final output will be reduced, arranged along the depth axis, to a single vector of likelihood scores.

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2. Research Methodology

2.1 Restricted Boltzmann Machines

The Restricted Boltzmann Machine Algorithm plays a crucial role within the reduction of dimensionality, classification, regression and lots of other features and extraction of features.

Restricted Boltzmann Machines are shallow, two-layer neural networks that constitute the deep-belief network building blocks. The visible or input layer is considered the first layer of the RBM, and the hidden layer is the second. A neuron-like unit called a node represents each circle. Nodes are linked through layers to each other, but no two nodes of the same layer are connected.

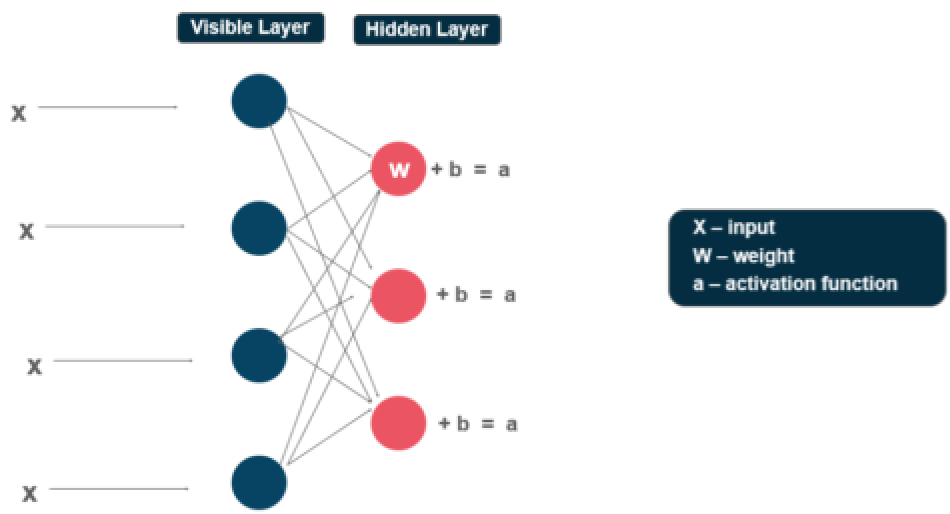

Fig. Restricted Boltzmann Machine Working

2.2 Deep Belief Network

Deep belief networks are algorithms that generate outputs using probabilities and unsupervised learning. They are composed of binary latent variables and both undirected and guided layers are contained.

Unlike other models, the whole input is learned by each layer in deep belief networks.The first layers only filter inputs for basic features, such as edges, in convolutional neural networks, and the later layers recombine all the simple patterns found by the previous layers. On the other hand, deep belief networks operate globally and control each layer in order.

To pre-train deep belief networks, greedy learning algorithms are used. This is a problem-solving technique that requires making the optimal option in the series at each layer, ultimately finding a global optimum.

From the bottom layer, greedy learning algorithms begin and move up, fine-tuning the generative weights. Therefore, each layer also receives a special version of the info, and every layer uses the output from the previous layer as their input.

Greedy learning algorithms are wont to train deep belief networks because they're quick and efficient. Moreover, they assist to optimize the weights at each layer.

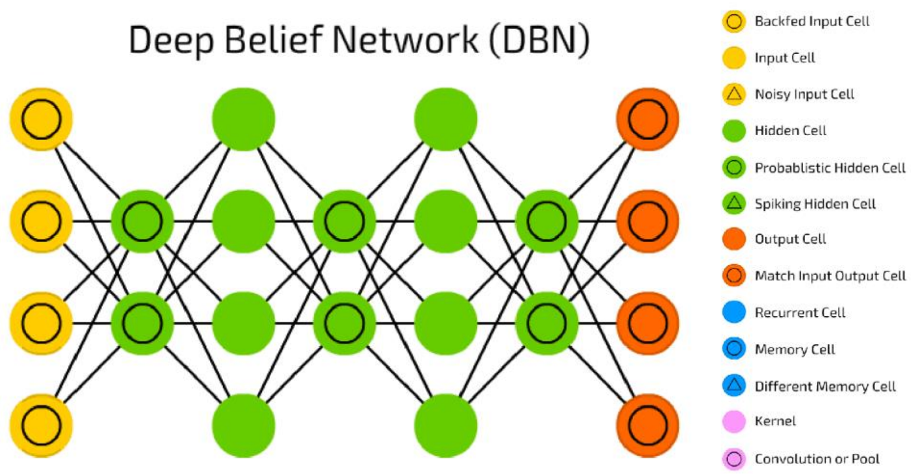

Fig. Deep Belief Network Working

2.3 Convolutional Neural Network

A Convolutional Neural Network is a class of neural networks that focuses on the processing of data with a grid-like topology, like an image, also known as ConvNet or CNN. A binary representation of visual data is a digital image. It involves a set of pixels arranged in a grid-like manner that contains pixel values to show how bright each pixel should be and what color.

There are typically three layers in a CNN: a convolutional layer, a pooling layer, and a fully connected layer.

Convolution Layer

The CNN central building block is the convolution layer. The main portion of the computational load of the network is borne by it.

Adding a Fully-Connected layer is a (usually) inexpensive way of learning high-level characteristic non-linear combinations as represented by the convolutional layer output. In that space, the Fully-Connected layer is learning a potentially non-linear function.

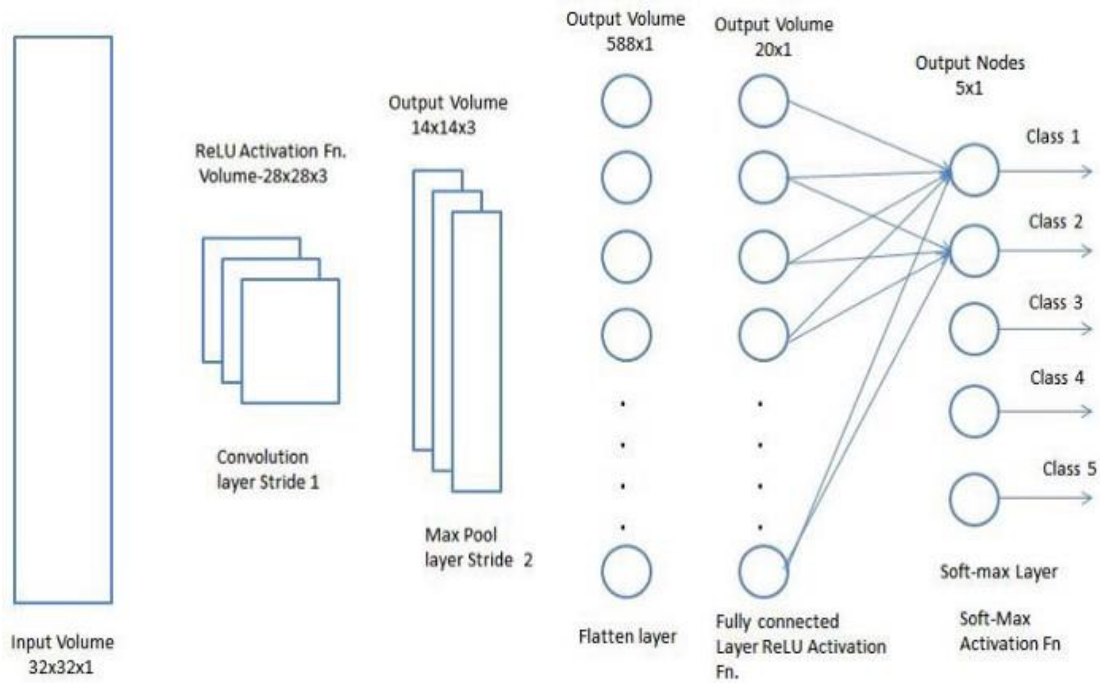

Fig. Convolutional Neural Network Working

3. DATA COLLECTION

The random data gathered from the heart disease online UCI repository dataset will be analyzed using proposed techniques.

4. LITERATURE REVIEW

According to researchers in (2019) et al. [2] In their research, they designed a model using supervised machine learning that can find anomalies analyzing it. Six supervised machine learning algorithms were implemented to differentiate between normal and abnormal ECGs. And, they used them to predict the chances of a patient suffering from heart disease and divided the data set into two parts. 75% data in one group for training the model and the rest 25% data in another group for testing.

The researcher Elif Izci in (2019) et al. [3] Arrhythmia is irregular changes of normal heart rhythm and effective manual identification of them requires a lot of time and depends on the experience of clinicians. Their paper proposes a deep learning-based novel 2-D convolutional neural network (CNN) approach for accurate classification of five different arrhythmia types. ECG signals were segmented into heartbeats and each heartbeat was converted as input data for CNN structure data into 2-D grayscale images.The accuracy of the proposed architecture was found as 97.42% on the training results revealed that the proposed 2-D CNN architecture with transformed 2-D ECG accuracy with none preprocessing and have extraction and have selection stages for ECG signals

According to researchers in (2018) et al. [4] In the paper proposed by them, a novel computationally intelligent-based electrocardiogram (ECG) signal classification methodology using deep learning (DL) machine is developed. Their focus was on patient screening and the identification of paroxysmal atrial fibrillation (PAF) patients, which is a life-threatening cardiac arrhythmia. The suggested approach operates as inputs to deep convolutionary neural networks with an outsized volume of raw ECG time series data (CNN).It autonomously learns to use the PAF's representative and key features through a classification module. The learned features can effectively replace the hand-crafted features of the traditional ad hoc and time-consuming user.

By researchers Hsin Chen and Alan Murray in (2002) et al. [8] This paper proposed endless stochastic generative model that gives an improved with an easy and reliable learning algorithm. The architecture forms endless Restricted Boltzmann Machine, with a completely unique learning a model have been demonstrated with both artificial and real data.

Researchers Sina Dami and Mahtab Yahaghizadeh in (2021) et al. [9] In this paper, over afewweeks/months before the event, a deep learning approach was used to predict arterial events using a 5-min electrocardiogram (ECG) to record and extract time frequencycharacteristics of ECG signals by considering the possibility of learning long-term dependencies to identify and prevent these events as quickly as possible.The Long Short-Term Memory (LSTM) neural network was used.The approach is briefly called LSTM-DBN.

According to researchers in (2019) et al. [10]The DBN performance was compared with other methods of feature selection and representation such as PCA and AutoEncoder. Experimental results showed that, in comparison with all other deep learning approaches and traditional classifications, the proposed LSTM-DBN(88.42 % mean accuracy) had significantlybetter performance.

5. RESEARCH DESIGN ARCHITECTURE

As seen in the research design architecture, the proposed structure comprises two hidden layers, two probabilistic max pooling layers and one fully connected layer. There is one Convolutional Restricted Boltzmann Machine (CRBM) in the first stage that consists of a convolution and probabilistic max pooling layer.CRBM is composed of the second level, but it has the output from stage one's probabilistic max pooling sheet. The Fully Connected layer joins the last output of the probabilistic max pooling layer. And the Fully Connected layer provides a targeted label for output.The final layer will be the Completely Connected Layer that takes the probabilistic max pooling layer output as input and returns the targeted mark. Here, the comparison of RBM, DBN and CNN produces an algorithm.

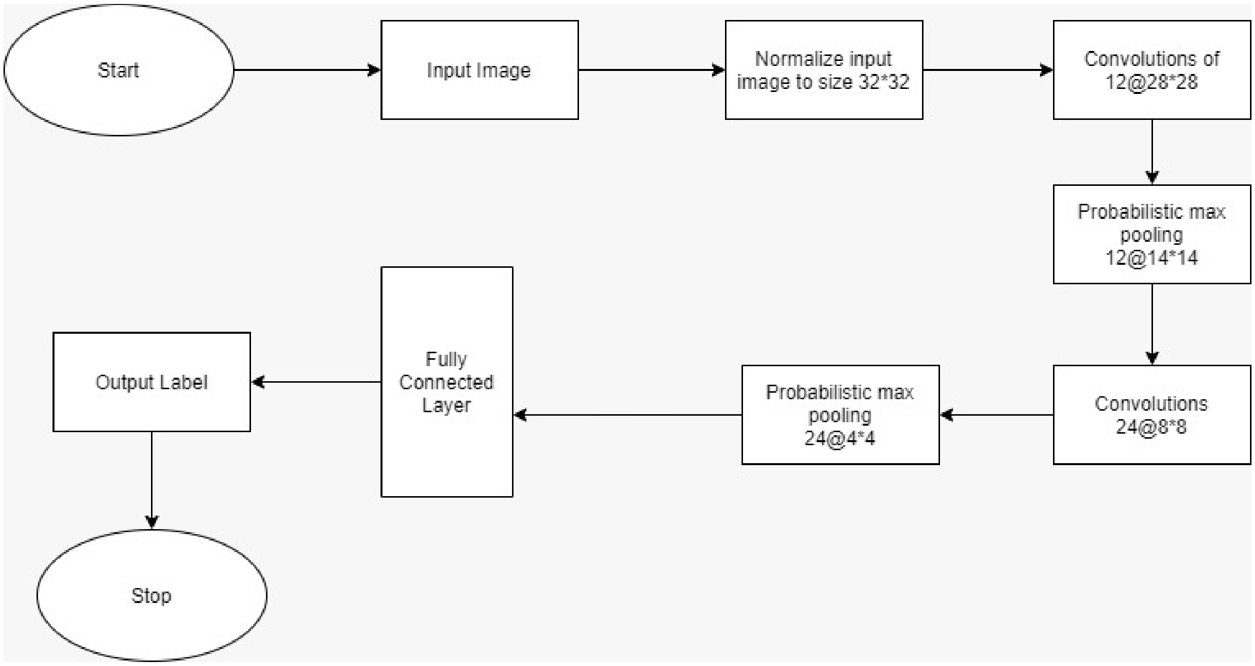

Fig. Research Flowchart

Algorithm:
Input: Data Sample, Image Data of ECG
Output: Type of known disease detected
Step 1: Initialization and Labeling
(1) Enter the dataset to train the model.
(2) In the first frame, obtain manual labels of disease- arrhythmias, coronary heart disease, heart attacks, and cardiomyopathy.Collect the ground-truth set of positive samples s_g^+ and negative samples s_1^-.
(3) Resize to 32 * 32 pixels of each positive/negative image patch.
(4) Use fine-tuning and transfer of the pre-trained model to construct the new appearance model using s_g^+ and s_1^-.
(5) Initialize the particle set $\{x_{1,}^i w_1^i\}_{i=1}^{N1}$1 at time t = 1, where w_1^i = 1/N1, i = 1,..., 1
(6) Setthemaximumbuffersize$T$forlong-termpositive samples s_{It}^+.
Step 2: For t=2 to the End of the Image
(1) Prediction: for i = 1, . . . , N1, generate $x_t^i \sim p(x_t \mid x_{t-1}^i)$.
(2) Likelihood evaluation: for i = 1, . . . , N1, let $w_t^i = w_{t-1}^i p(y_t \mid x_t^i)$.
(3) Determine the optimum object state x_t^*as the maximum weight of the particle.
(4) Resample: Normalize the weights and calculate the normalized weights covariance. If this variance exceeds one threshold, then $\beta_j \sim \{w_t^i\}_{i=1}^{N1}$and replace $\{x_{t,}^i w_t^i\}_{i=1}^{N1}$with $\{x_t^{\beta j}, 1/N1\}_{j=1}^{N1}$.
(5) Update:
(5.1) Set positive short-term samples s_t^+ as the image patches with the 10 highest confidences at time t (estimated by the likelihood evaluation).
(5.2) Select negative samples s_t^- at time t.
(5.3) Update the long-term set of positive samples $s_{It}^+ = s_{It}^+ \cup \{x_t^*\}$.
(5.4) If the size of s_{It}^+ is larger than T, then s_{It}^+ is truncated to keep the last T elements.
(5.5) Update the appearance model based on s_g^+, s_{It}^+, s_t^+ and s_t^-.
End For

6. CONCLUSION:

It has been found that often the causes of heart problems are hereditary. And it is also proven that one copy of each parent would be inherited into the child if either parent has heart disease. In order to reduce the complications, the goal is to find relationships between arrhythmias, coronary heart disease, heart attacks, and cardiomyopathy heart diseases.

7. FUTURE ENCHANCEMENT

Diagnosis of heart disorders such as arrhythmias, coronary heart disease, heart attacks and cardiomyopathy is related to the proposed work. We will focus on how to minimize it after discovering associations between the above heart disorders and the heart beat rate.

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