# A Review of Detection of Heart Failure Using Deep Learning Techniques

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***Abstract-*** *One of the major reasons for deaths, not only in India but all over the world is Cardiovascular diseases. Every year, almost a million people die due to these heart diseases. In this study, we will be focusing on heart failure (or congestive heart failure), which is a form of heart disease. In order to reduce the number of deaths due to these heart diseases, there needs to be a quick and efficient detection technique. Though the accurate diagnosis of heart failure in patients is quite important, it is quite difficult due to our insufficient understanding of the characteristics of heart failure. Knowledge of each factor that contributes in a heart disease is crucial for prevention. The healthcare industry generates a huge amount of data on these diseases on daily basis. This paper provides a brief review of the various deep learning techniques used to detect heart failure.*

***Keywords***- Deep Learning, Congestive Heart Failure, Neural Network, Convolutional Neural Network

## I. INTRODUCTION

Heart failure due to its severity has emerged as a syndrome rather than a disease.

Heart failure, also known as Congestive Heart failure, occurs when the heart muscle does not pump blood as well as it should. There are certain conditions that impair the performance of heart such as high blood pressure, narrowed arteries. These make the heart stiff to fill and pump efficiently. Though treatments can improve the heart health but heart failure prevention, which is the main concern, is still to be achieved. Heart failure occurs when the heart is unable to either pump enough blood or fill enough blood in its ventricle. This leads to two types of congestive heart failures – Systolic heart failure and Diastolic heart failure.

Systolic failure occurs when the ventricle fails to contract normally; the reduced force makes it difficult to pump the blood into circulation.

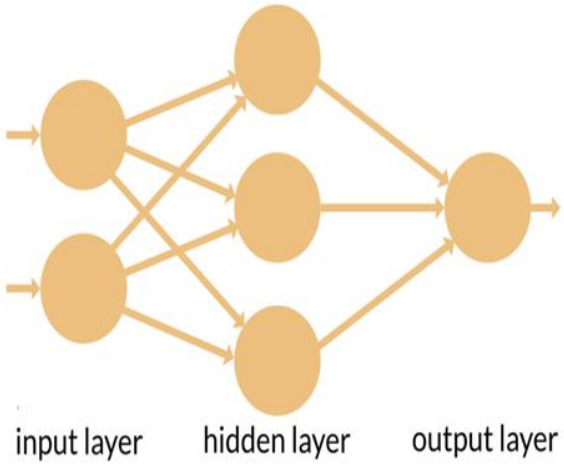
Diastolic failure is when the muscles of the ventricle become stiff which hinders the filling of blood between the beats.

Diagnosis of CHF includes methods making use of HRV and non-HRV measures. Machine learning techniques have been studied and implemented quite successfully towards HF detection. There exist systems that implement data mining techniques to gain knowledge from the available information.

## II. NEURAL NETWORKS

A neural network or a feedforward neural network is a mathematical or computational model for information processing which is based on a connectionist approach to computation. It consists of a collection of nodes connected in some pattern. Each processing node has incoming weights to receive signals from the nodes of the previous layer and outgoing weights to transmit signals to network nodes on the next layer.

A neural network can of the types such as Feedfoward Neural Network as given below in the digram or Feedback Neural Network which consist of backpropogation mechanisms.



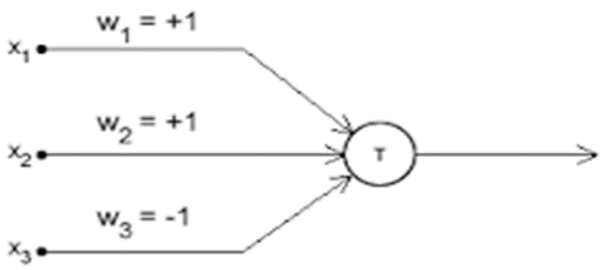



Figure1. Neural Network

Recurrent Neural Network (RNN):

RNN has two inputs, the present and recent past. The network uses backpropogation mechanisms. A random unit is chosen. If any of its neighbours are active, the unit computes the sum of the weights on the connections to those active neighbours. If the sum is positive, the unit becomes active otherwise it remains inactive.

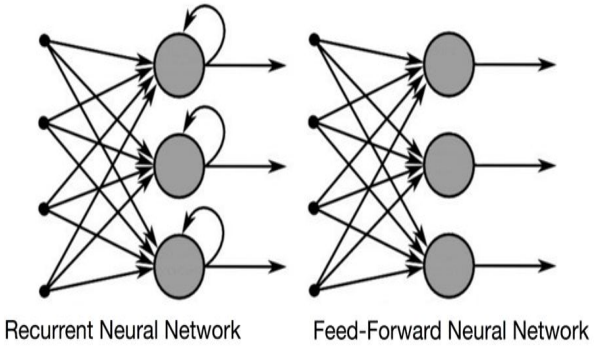



Figure 2. Recuurent Neural Network

Concurrent neural networks:

A CNN is mainly used for image classification or image recognition. A CNN image classifier takes the input image and classifies it under some category. The computer sees the image as an array of pixels which depend on the resolution. Each input layer will pass through a series of convolutional layers and classify objects with probabilistic values between 0 and 1.

- The basis of a CNN is the convolutional layer. This is the first layer that receives the input signal. Convolution is the process where the network tries to label the input signal by referring to what it has learned in the past, and the resulting output is then passed to the next layer.
- Inputs from the convolution layer can be smoothened to reduce the sensitivity of the filters to noise and variations. This smoothing process is called subsampling or pooling, and can be achieved by taking averages or taking the maximum over a sample of the signal.
- And lastly, the layers in the network are fully connected to the subsequent layers. This ensures high level reasoning where all possible pathways from input to output are considered.

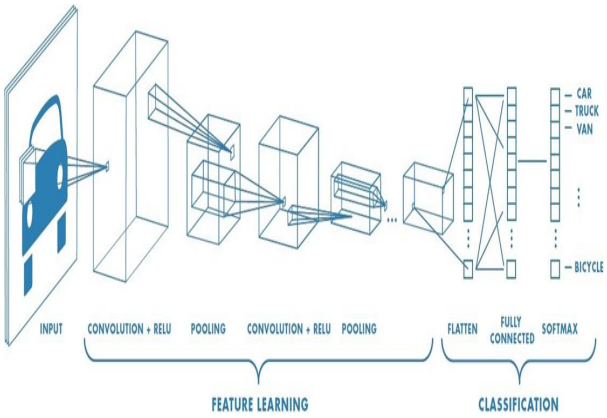



Figure 3. Convolutional Neural Network

## III. EXISTING SYSTEM

Traditional Machine Learning Techniques have been previously applied to predict Heart Failure.

However, these methods have limitations in their ability to process raw natural data. Deep learning is a method with multiple levels of representation, obtained by composing non-linear modules into a higher representation of an abstract level.

SVM:

Yang et al. [2] proposed a scoring-based model based on SVM. SVM is a non-probabilistic binary linear classifier. A scoring model based on SVM was proposed and samples were classified into two groups HF-prone and HF-group. The model gives a 74.4% accuracy. However, the speed of SVM is a bit slow.

DECISION TREES:

Son et al. [3] designed a decision-making model by making use of a model that uses rough sets (RSs) and decision trees. They compared the discriminatory power of decision-making model that make use of RS and linear regression decision models. This model gives an accuracy of 97.2%.

But Decision tree is prone to noise during learning.

RANDOM FORESTS:

Masetic et al. [4] used Random forests to classify normal and congestive heart failure (CHF) on the long-term ECG time series. In the classification phase various classifiers such as Decision trees, k-nearest neighbour, SVM, neural networks and random forest classifier were compared and their performance in terms of sensitivity, specificity, accuracy were recorded. This model gives a 100% accuracy on the classification. However random forest fail when there are rare outcomes or rare predictors.

PROPOSED SYSTEM:

Deep learning is a subset of Machine learning which achieves great power and flexibility by learning to represent the world as nested hierarchy of concepts, with each concept defined in relation to similar concepts. Deepmind's Alpha go, a artifical game playing system playing the game of Go has been a landmark achievement in human history. The move 29 is considered the best by some. It is trained using deep learning which uses GANs and reinforcement learning for training the model. Such models can also be created in the medical field which will impact the health industry and also assist doctors in early diagnosis.

A deep-learning classifier identifies patients with clinical heart failure using whole-slide images of H&E tissue

Deep convolutional neural networks (CNN) have been applied successfully to various diseases in medical imaging. The authors et al. [5] have developed a CNN to detect HF from H&E strained whole-slide images. The CNN was able to identify patients with HF with a 99% sensitivity and 94% specificity on the test set.

## IV. DEEP NEURAL NETWORKS FOR DETECTING HEART DISEASES

The authors et al. [6] developed a five-layer DNN architecture named Heart Evaluation for Algorithmic Risk-reduction and Optimization Five (HEARO-5). They used k-way cross validation and Matthews correlation coefficient to tune the architectures. The model yielded 95% accuracy.

HEART ATTACK PREDICION USING DEEP LEARNING:

The authors et al. [7] proposed a heart attack prediction system using Deep learning techniques, specifically Recurrent Neural Networks to predict the possibilities of heart related diseases. RNN is a neural network which has an extra hidden layer wherein the hidden layer influences the output of the network.

REPRESENTATION LEARNING FROM ELECTRONIC HEALTH RECORDS:

The authors et al. [8] built an efficient method for patient and medical concept representation learning. They transformed clinical data from electronic health records into meaningful constructed features. Their model improves the predictive modelling performance for onset of heart failure up to 23%.

RECCURENT NEURAL NETWORKS TO PREDICT HEART FAILURE:

The authors et al. [9] explored whether use of deep learning to model temporal relations among events in Electronic Health Records could improve the model performance in predicting early diagnosis of heart failure. DL models adapted to leverage temporal relations. Deep learning models showed improvement in the performance of models with a window period of 12-18 months.

A CHF BASED DL METHOD USING RR INTERVALS:

The intervals between the heartbeats in the ECG or electrocardiogram is called as R-R interval.

The authors et al. [10] checked for robustness of CHF detection based on heart rate variability. They applied a sparse auto-encoder based deep learning algorithm in CHF detection with RR intervals. Their model achieved an accuracy of 72.41%. However, R-R intervals don't have the potential to detect CHF and can't reflect dynamic change in 24-hr.

## V. CONCLUSIONS

Various Deep Learning models to detect heart failure have been studied. Although the training window period may be larger than traditional machine learning algorithms, Deep learning models are more robust and can extract features more precisely as compared to Traditional Machine Learning Algorithms.

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