International Journal of Advanced Technology in Engineering and Science
Vol. No. 11, Issue No. 04, April 2023
www.ijates.com
ijates
ISSN 2348 - 7550

Heart Disease Prediction Using Neural Networks

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ABSTRACT

Heart disease is a fatal condition that affects a great number of people worldwide. It becomes clear how crucial early identification of heart disease is when death rates and the sheer volume of heart disease patients are taken into account. The conventional method of diagnosis is insufficient for this condition. The development of a machine learning-based medical diagnosis system for heart disease prediction offers a more precise diagnosis than current methods do. It is suggested to employ artificial neural network back propagation techniques to forecast cardiac disease. The neural network was trained with a back propagation approach to predict absence or presence using 13 clinical characteristics as input.

INTRODUCTION

According to figures from the World Health Organization (WHO), heart disease is the leading cause of death. Heart disease causes millions of deaths every year and affects a significant portion of the population. Early cardiac disease prediction is essential for effective treatment. Many patient fatalities could be avoided and a more precise and effective form of therapy could be offered if cardiac disease could be predicted in advance. Such a medical diagnosis method is becoming more and more necessary. Cost savings and improved efficiency are the systems' primary strengths in terms of medical diagnosis. The development of a machine learning-based medical diagnosis system for heart disease prediction results in a more accurate diagnosis than current methods and lowers costs.

Deep Learning

Deep learning is an AI function that mimics how the human brain processes data and builds patterns to be used in decisionmaking. Artificial intelligence's deep learning is a subset of machine learning that enables networks to learn unsupervised from unlabeled or unstructured data. also referred to as a deep neural network or deep learning. Artificial neural networks, a class of algorithms inspired by the structure and operation of the brain, are the focus of the machine learning discipline known as deep learning.

Deep Learning Methods

Artificial neural networks are used in deep learning to process enormous volumes of data in complex ways. It is a form of artificial intelligence that is based on the composition and operation of the human brain. Deep learning techniques teach computers by using examples to learn. Deep learning is frequently used in the healthcare, e-commerce, media, and entertainment industries. The choice of a model is crucial because there are numerous models accessible in deep learning. LSTM, RNN, CNN, and ANN are a few examples. Over the past five years, deep learning has developed, and deep learning algorithms have gained enormous popularity across numerous industries. Deeplearning techniques teach computers by using examples to learn. Deep learning is frequently

employed in the healthcare, eCommerce, entertainment, and advertising sectors. Despite the fact that deep learning algorithms have self-learning representations, they rely on ANNs

Defining Neural Networks

A neural network is structured like the human brain and consists of artificial neurons,also known as nodes. Three layers of these nodes are arranged next to one another:

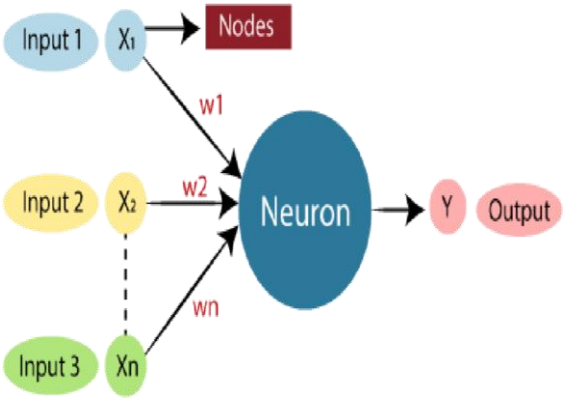
The hidden layer or layers, the input layer, and the output layer Each node receives information from data in the form of inputs. The node calculates the inputs, multiplies them using random weights, and then adds a bias. To choose which neuron to fire, nonlinear functions, sometimes referred to as activation functions, are used.

ANN

Artificial neural networks are a branch of artificial intelligence inspired by biology and fashioned after the brain. A computational network based on biological neural networks, which create the structure of the human brain, is typically referred to as an artificial neural network. Artificial neural networks also feature neurons that are linked to each other in different layers of the networks, just as neurons in a real brain. Nodes are the name for these neurons. The lesson for artificial neural networks covers every facet of these networks. ANNs, Adaptive Resonance Theory, Kohonen Self-Organizing Map, Building Blocks, Unsupervised Learning, Genetic Algorithm, etc. will all be covered in this lesson.

What is Artificial Neural Network?

The biological neural networks that shape the structure of the human brain are where the term "artificial neural network" originates. Artificial neural networks also have neurons that are interconnected to one another in different layers of the networks, much like the human brain, which has neurons that are interconnected to one another. Nodes are the name for these neurons.



Artificial neural networks are used in artificial intelligence to simulate the network of neurons that make up the human brain, giving computers the ability to comprehend information and make decisions in a manner similar to

that of a person. Computers are programmed to function exactly like a network of interconnected brain cells to create an artificial neural network. The human brain contains about 1000 billion neurons. Between 1,000 to 100,000 association points are present in each neuron. Data is distributedly stored in the human brain, allowing us to simultaneously access many pieces of information from memory as needed. We can infer that the human brain has exceedingly small.

The architecture of an artificial neural network

Understanding the components of a neural network is necessary to comprehend the idea of the architecture of an artificial neural network. A vast number of artificial neurons, also known as units, are placed in a hierarchy of layers to form what is known as a neural network. Let's examine the many kinds of layers that can be found in an artificial neural network.

Generally speaking, an artificial neural network has three layers:

As its name implies, the input layer accepts inputs from the programmer in a variety of different formats.

The hidden layer is displayed between the input and output layers. It makes all the computations necessary to uncover patterns and buried features.

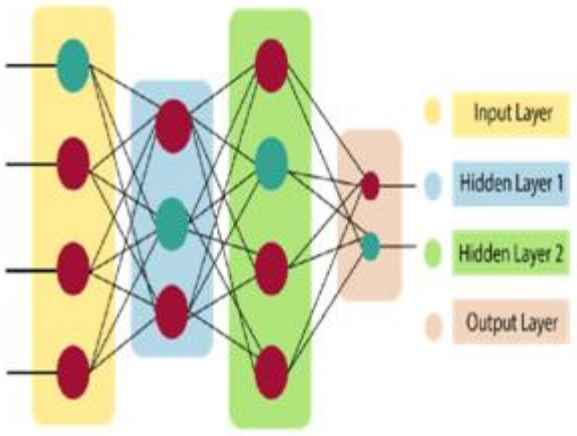
Output Layer: Using the hidden layer, the input is transformed in a succession of ways before being sent to the output layer.

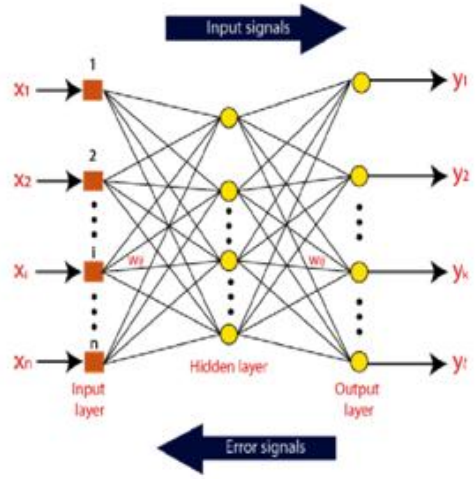
$$\sum_{i=1}^{n} wi * xi + b$$

In order to produce the output, it passes the weighted total as an input to an activation function. A node's activation functions determine whether or not it should fire. The output layer is only accessible to individuals who are fired. Depending on the type of task we are completing, there are many activation functions that can be used.

How do synthetic neural networks function?

The ideal way to visualise an artificial neural network is as a weighted directed graph, where the nodes are the artificial neurons. The directed edges with weights represent the relationship between the neuron inputs and outputs. The input signal for the artificial neural network comes from an external source as a pattern and an image as a vector. Then, for each nth input, these inputs are mathematically





Each input is then multiplied by the corresponding weights (these weights are the details utilised by the artificial neural networks to solve a specific problem). In the artificial neural network, these weights often indicate how well neurons are connected to one another. Inside the computer unit, a summary of each weighted input is created.

The output is made non-zero by adding bias if the weighted total is equal to zero, or else something else is added to scale up the output to the system's reaction. The input for bias is the same, and the weight is 1. The sum of the weighted inputs in this case can range from 0 to positive infinity. Here, a specific maximum value is used to keep the response inside the intended value's bounds.

Let us take a look at each of them in details:

Binary: The output of a binary activation function is either a one or a zero. Here, a threshold value has been established in order to achieve this. The final output of the activation function is returned as one or 0 depending on whether the net weighted input of neurons is greater than 1.

Sigmoidal Hyperbolic: Often, a "S"shaped curve is used to represent the Sigmoidal Hyperbola function. Here, the output from the actual net input is approximated using the tan hyperbolic function.

The definition of the function isF(x) = (1/1 + exp(-????x))

Where ????is considered the Steepness parameter.

Types of Artificial Neural Network

Artificial neural networks (ANN) come in a variety of forms, and they all carry out tasks in a way that is comparable to how human brain neuron and network functions. Most artificial neural networks will share certain characteristics with a biological counterpart that is more complicated, and they are quite good at what they are meant to do. segmentation or categorization, as examples.

Feedback ANN

In this kind of ANN, the output loops back into the network to achieve the best internally evolved results. based on the Center for Atmospheric Research at the University of Massachusetts, Lowell. The feedback networks are excellent for addressing optimization problems because they feed information back into themselves. Using feedback ANNs, the internal system error repairs.

Feed-Forward ANN

A feed-forward network is a type of neural network that consists of at least one layer of neurons as well as input and output layers. The network's intensity can be observed based on the collective behaviour of the connected neurons, and the output is chosen by evaluating the network's output in the context of its input. The main benefit of this network is that it learns to assess and identify input patterns.

Backpropagation

Back propagation is a popular approach in deep learning for training feed-forward neural networks. Backpropagation can be generalised to various artificial neural networks (ANNs), as well as to functions in general. Backpropagation is a collective term used to refer to all of these groups of algorithms. Contrary to a naive direct computation of the gradient with regard to each weight individually, backpropagation efficiently calculates the gradient of the loss function with respect to the network weights for a single input-output example while training a neural network. Due to this effectiveness, it is possible to train multilayer networks using gradient methods, updating weights to reduce loss. Gradient descent or its derivatives, such as stochastic gradient descent, are frequently employed. The gradient of the loss is computed to operate the backpropagation method.

Autoencoders

The input and output of autoencoders, a particular kind of feed-forward neural network, are the same. Autoencoders were created by Geoffrey Hinton in the 1980s to address issues with unsupervised learning. The data from the input layer to the output layer is replicated by these trained neural networks. Image processing, popularity forecasting, and drug development are just a few applications for autoencoders.

How Do Auto encoders Work?

The encoder, the code, and the decoder are the three essential parts of an autoencoder.

- The design of autoencoders allows them to take an input and change it into a different representation. Thereafter, they make an effort to accurately recreate the original input.
- When a digit's picture is not clearly visible, an autoencoder neural network receives the information.
- Autoencoders compress the input into a smaller form after first encoding the image. In order to create the reconstructed image, the autoencoder finally decodes the original image.

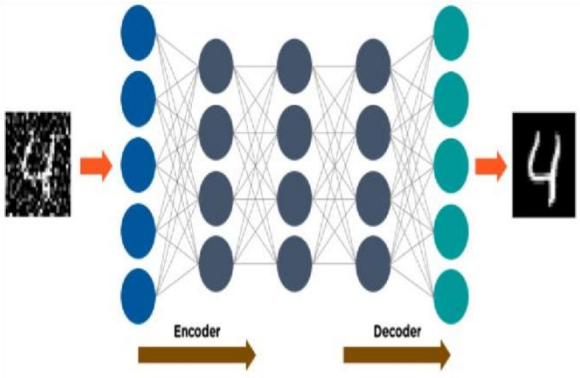


Fig:Autoencoders

Restricted Boltzmann Machines (RBMs)

RBMs are stochastic neural networks that have the ability to train based on a probability distribution over a collection of inputs.

RBMs are made up of two layers:

- Visible unit
- Hidden unit

All hidden units are linked to all visible units. RBMs have no output nodes and a bias unit that is coupled to all of the visible and hidden units.

How Do RBMs Work?

Forward pass and backward pass are the two phases of RBMs.

The inputs are translated into a collection of numbers by RBMs, which then encode the inputs for the forward pass.

- RBMs integrate all inputs with a single overall bias and individual weights. The output of the algorithm is passed to the hidden layer.
- RBMs use this set of numbers as inputs during the backward pass to create new inputs.
- Each activation is combined with an individual weight and an overall bias by RBMs, which then send the output to the visible layer for reconstruction.
- To assess the quality of the outcome at the visible layer, the RBM compares the reconstruction with the original input.

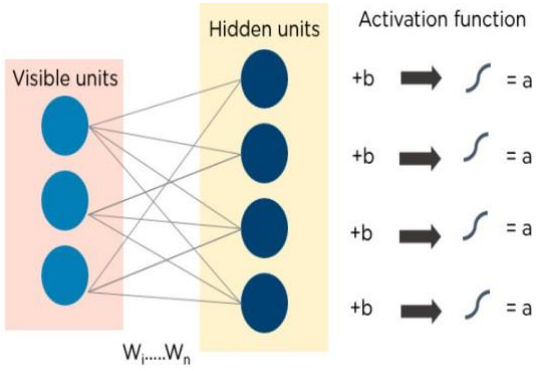


Fig: RBM

Recurrent Neural Networks (RNNs)

The outputs from the LSTM can be sent as inputs to the current phase thanks to RNNs' connections that form directed cycles. Due to its internal memory, the LSTM's output can remember prior inputs and is used as an input in the current phase. Natural language processing, time series analysis, handwriting recognition, and machine translation are all common applications for RNNs.

How Do RNNs work?

In the same way that the output at time t feeds into the input at time t+1, so does the output at time t feed into time t+1.

- Any length of input can be handled by RNNs.

- The computation takes into consideration historical data, and the model size is unaffected by the size of the input.

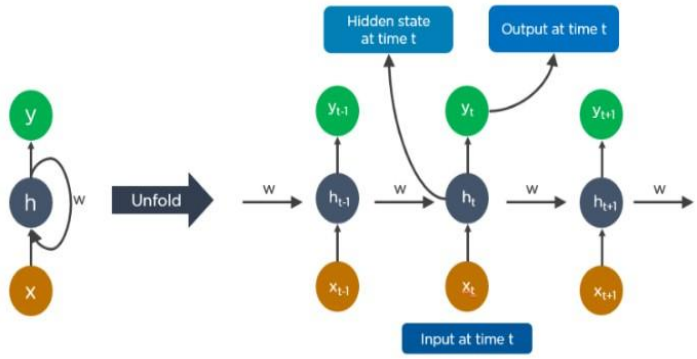


Fig: RNN

CNN

A Convolutional Neural Network(ConvNet/CNN) is a Deep Learning system that can accept an input image, prioritise different aspects and objects within the image, and distinguish between them. CNN's sequential model enables layer-bylayer model building.A convolutional neural network has three different types of layers: convolutional, pooling, and fully connected.

Convolutional layer

The first layer that is utilised to extract the various features from the input images is the convolutional layer. In a procedure known as feature extraction, this layer isolates and identifies the distinct aspects of the image for study. There are many factors employed, including filter, kernel size, activation, padding, and input shape. The Rectified Linear Unit (ReLU) activation function is employed in this layer, and it returns 0 if it gets a zero input, but it returns the value of x for any positive number x**.**

Rectified Linear Unit (ReLU)

ReLU is a layer that CNNs have to manipulate elements. The rectifiedfeature map is the result.

Pooling Layer

- A pooling layer receives the rectified feature map after that. Pooling is a downsampling procedure that shrinks the feature map's dimensions.
- The resultant two-dimensional arrays from the pooledfeature map are then flattened by the pooling layer into a solitary, lengthy continuous linear vector.

Fully Connected Layer

When the flattened matrix from the pooling layer is supplied as an input, a fully linked layer that classifies and labels the images develops.

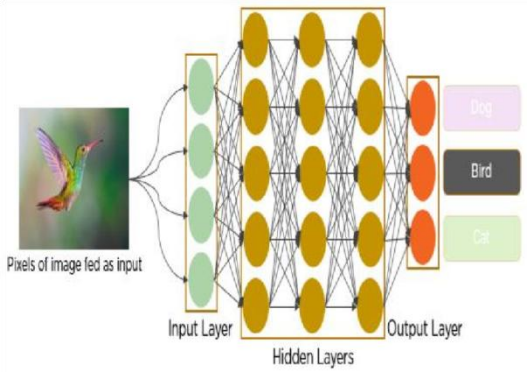


Fig: CNN

Importance of Deep Learning

A subset of artificial intelligence known as "Deep Learning" makes use of data to teach robots how to complete tasks on their own. This technology is already in use and is employed in self-driving cars, virtual assistants, facial recognition systems, and automatic email reply prediction. Innovations in this field of technology are also having an effect on the healthcare industry. We can give health care providers greater information by using these advanced analytics.Deep learning is extremely effective when working with unstructured data because of its capacity to handle vast amounts of features. Yet, because deep learning algorithms need access to a huge amount of data to be effective, they can be overkill for less complicated situations.

FUTURE ENHANCEMENT

In order to get over the restriction of using only a desktop to access the system, this project can also be turned into an Android application.Future software can be designed so that new testing data should join training data after a specified period of time. Currently, the system is taught on old training datasets. This prediction module can be coupled with the automated processing system module**.**

CONCLUSION

The proposed multilayer perceptron neural network-based method for heart disease prediction has been developed. Cleveland dataset was used for the system. Thirteen clinical data points from the Cleveland Dataset were used as input by the neural network in the system. It was trained using a backpropagation algorithm to determine if the patient had heart disease or not. Many research have been done on the possibility of heart disease. The accuracy of these studies' findings varies from close to 100%. According to comparable studies in this subject, the proposed method has a 95% accuracy rate, which is a very good rate. The proposed methodology can be improved as a hybrid model with additional classification algorithms as part of ongoing research to acquire

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