



# A Predictive Analysis of Heart Diseases and Diabetes Using Adaptive Modified Backpropagation

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## Abstract

An Artificial Neural Network (ANN) is a data preparing method that is motivated by the way organic sensory systems, for example, the mind, process data. ANN learns (i.e. logically enhance execution on) errands by thinking about illustrations, for the most part without assignment particular programming. Backpropagation is a method utilized as a part of neural networks to figure a value that is required in the computation of the weights to be utilized as a part of the system. In this project, neural network Backpropagation with adaptive learning rate is used to predict heart and diabetes diseases to the patients by the given parameters. The algorithm modifies the learning rate at each step based on the data and gives faster results when compared to the traditional algorithm. This is chosen to implement on Hear Diseases and Diabetic Disease dataset and results are compared. The model is trained with a set of training data and then that trained model is used to predict the testing data of patient disease. These predictions will give an idea of the type of disease and can be used to diagnose the patient.

**Keywords:** Artificial neural networks, feed forward neural networks, backpropagation, adaptive learning rate, heart disease and diabetic disease datasets.

## 1. Introduction

The examinations began about human mind since a large number of years. With the electronic gadgets, it completely was exclusively normal to do to saddle this reasoning technique. The essential advance toward neural systems came in 1943 once Warren McCulloch, a neurophysiologist, and a youthful researcher, conductor Pitts, published a paper on how neurons would conceivably function. They displayed a direct neural system with electrical circuits. Neural systems, with their extraordinary capacity to get that implies from troublesome or erroneous data, is acclimated remove examples and discover patterns that are too confounded to be in any way saw by either people or diverse pc procedures. A prepared neural system is thought of as partner degree "master" inside the class of information it's been given to break down. With progression inside the field of physical science and connected science, it totally was the suspicion that we will utilize these regular methods for this reasoning technique for a mind to style some AI framework.

Neural systems adopt an uncommon strategy to disadvantage assurance than that of customary Personal Computer (PC). Conventional PCs utilize algorithmic approach i.e. the pic takes after a gathering of bearings in order to determine an issue. Except if the specific advances that the pc needs to take after are outstanding the pc can't explain the issue. That limits the issue assurance ability of conventional PCs to issues that we tend to as of now see and keenness to determine. Anyway PCs would be

such a considerable measure of supportive on the off chance that they may do things that we don't exactly discernment to attempt to.

Neural systems technique information in a fundamentally the same as approach the human cerebrum will. The system comprises of an outsized scope of to a great degree interconnected process segments (neurons) working in parallel to determine a specific task [1]. Neural systems learn by illustration. They can't be customized to play out a specific undertaking. The illustrations ought to be choose demandingly generally accommodating time is squandered or possibly more regrettable the system might work erroneously. The inconvenience is that because of the system discovers an approach to illuminate the issue without anyone else's input, its activity are frequently unusual.

On the contrary hand, customary PCs utilize a subjective way to deal with downside unraveling; the approach the issue is to determine ought to be prominent and communicated in little unambiguous ways. These bearings are then changed over to an abnormal state dialect program thus into machine dialect that the pc will see. These machines are completely unsurprising; if something turns out badly is a direct result of a program or hardware [2]. Neural systems and standard recursive PCs aren't in rivalry anyway supplement each other. There are errands are a considerable measure of suited to algorithmic approach like number-crunching activities and undertakings that are a great deal of suited to neural systems. Significantly more, an outsized scope of assignments, require frameworks that utilization a blend of the two (2) approaches (ordinarily a customary workstation is utilized to oversee the neural system) in order to perform at generally strength [5].

## Artificial Neural Networks

Artificial Neural Networks square measure nearly unrefined electronic models upheld the anatomical structure of the mind. The cerebrum basically gains from aptitude. It's characteristic evidence that a few issues that square measure on the far side the extent of current PCs square measure so resolvable by little vitality proficient bundles. This mind displaying moreover ensures a less specialized approach to create machine arrangements. This new way to deal with registering also gives a great deal of smooth debasement all through framework over-burden than it's a considerable measure of ordinary partners. These organically inspired techniques of processing are believed to be resulting significant headway inside the registering business. Indeed, even clear creature brains are fit for capacities that by and by impractical for customary PCs.

PCs do remembrance things well, such as keeping records or acting propelled science. Anyway PCs have try perceiving even direct examples a considerable measure of less summing up those examples of the past into activities of the long run. Presently, propels in logical research guarantee relate degree starting comprehension of the characteristic reasoning system. This investigation demonstrates that brains store information as examples. some of these examples which has capacity to perceive to recognize singular appearances from numerous different points. This technique for putting away information as examples, using those examples, thus discovering issues envelops a fresh out of the box new field in figuring. This field, as said previously, doesn't use old programming anyway includes the production of greatly parallel systems and furthermore the training of these systems to determine particular issues [2].

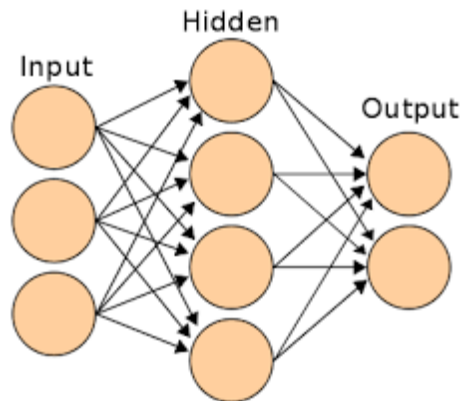


Figure 1.1: A simple artificial neural network

ANN was acclimated allude as system door of organic neurons, be that as it may, in vogue utilization of the term as a rule alludes to ANN. ANN is a numerical model or machine show, relate degree logical teach worldview i.e. inspired by the approach natural framework apprehensive, similar to mind information framework. ANN is framed of interconnecting fake neurons that square measure modified wish to copy the properties of n organic neurons. These neurons working as one to determine particular issues. ANN is sorted out for discovering software engineering issues while not making a model of the genuine natural framework. ANN is utilized for discourse acknowledgment, picture investigation, and adjustment administration and so on. These applications square measure done through a learning technique, such as learning in a natural framework that includes the modification between neurons through conjunction affiliation. Same occur inside the ANN [6].

## Background

The examination of the focal arrangement of the human mind was the motivation of neural systems. In an exceptionally incredible

Neural Network, clear counterfeit hubs, named as "neurons", "handling components" or units", unit associated on to make a system that is named an organic neural system. There is no single formal meaning of an unbelievable neural system. Be that as it may, a class of connected science or scientific or machine models would perhaps commonly be named as "Neural Networks" on the off chance that they have the following qualities: one. Grasp sets of versatile weights, i.e. numerical parameters that unit tuned by a learning calculation, and equipped for approximating non-straight elements of their inputs[ 3]. The versatile weights unit reasonably connection qualities between neurons, that unit enacted all through work and expectation. Neural systems unit indistinguishable to organic neural systems in performing capacities along and in parallel by the units, as opposed to there being a reasonable depiction of subtasks thereto different units unit named. The expression "neural system" for the most part alludes to models used in insights, logical teach and processing. Neural system models that copy the focal framework unit an area of hypothetical neuroscience and computational neuroscience [9].

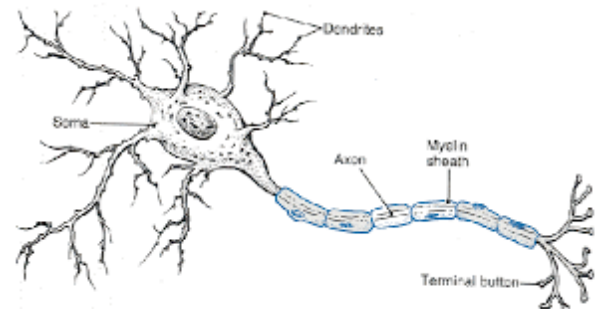


Figure 1.2: A simple neuron

The traditional strategy for preparing feedforward neural system (FNN) is the backpropagation calculation (BP) which depends on the steepest descent optimization method. Preparing is typically done by iterative refreshing of weights in light of the mistake flag. Backpropagation is a plunge calculation which endeavors to limit the mistake at every cycle. The weights of the system are balanced by the calculation with the end goal that the mistake is diminished along with a plummet heading. Customarily two parameters called learning rate and force factor are utilized for controlling the weight modification along the plunge bearing. Discovering introductory learning rate and settled learning rate must be finished with extraordinary care. On the off chance that the learning rate is extensive, at that point the learning may wind up precarious. On the off chance that it is little, at that point regularly it is moderate for down to earth applications which prompts finding of quick learning calculations.

Numerous strategies have been proposed to expand the union speed. Abid et al. depicted modified Backpropagation algorithm (MBP) in light of total of straight and nonstraight mistakes of yield neurons to enhance the meeting in the least cycles. The calculation focalizes speedier than the standard BP calculation. A few scientists concentrated on the determination of better vitality capacity and choice of reasonable learning rate and energy. Learning rate alteration by sign changes will modify the movement assess by having an alternate learning rate for each affiliation. An issue with these systems is their meeting to nearby minima. To take care of this issue, worldwide hunt calculation like hereditary calculation must be connected. Yet, scanning for the worldwide least might be caught at nearby minima amid angle plummet. Likewise, if the system is prepared with unsettling influences in the information, at that point worldwide least point can't be found. So quick joining and solid power may not be ensured. To tackle these issues versatile learning calculations have been produced as of late [3].

## 2. Literature Survey

This book focuses on motivation and history of neural networks, how they originated. Then it comes to the biological neural networks like peripheral and central nervous system, neurons, etc[1]. Then the author has explained about components of neural networks, its topologies, representing neurons, orders of activation. In the next chapter he told about learning and training samples, in this he mentioned unsupervised, reinforced and supervised learning.

As neural networks come under supervised learning he mainly focused on it. Then in the next chapter, he focused on backpropagation algorithm and its variants. He also mentioned about a number of neurons, hidden layers, selecting an activation function. Then he focused on deep learning like recurrent neural networks. Jordan networks and Elman networks are given in a deeper way. Hopfield networks have a chapter separately. Unsupervised learning network paradigms are mentioned deeply in this book.

The main motto of this book is to focus on basic neural network technics and going deeply into its methods and algorithms. The author has divided this book into two parts as one part focuses on supervised learning algorithms and another part of unsupervised learning algorithms. Various methods and algorithms are explained deeply in this book.

In this paper, they have introduced the fundamental investigation of the counterfeit neural system, its qualities, and its applications. This paper says that counterfeit neural systems are regularly alluded as the neural systems of data or flag handling numerical model which depend on the natural neuron. A neural system is a structure which comprises of a gathering of associated neurons which gives a[2] great procedures to troublesome issues and other application which assumes a vital part in the present software engineering field. This is the motivation behind why analysts from the diverse spaces outlining the ANN's to tackle the issues like example acknowledgment, expectation, improvement, cooperative memory, and control. In this paper, they have displayed the essential investigation of the fake neural system, its qualities, and its applications.

How the system capacities, the qualities of the system, the structure of the system are said in this paper. There are likewise a few points which tell about the capacity of parallel handling, conveyed memory, adaptation to non-critical failure capacity, aggregate arrangement. The points of interest, impediments, and uses of the fake neural systems are said in this paper.

The creators of this paper began with the presentation of the human mind and after that gradually went into the fake neurons which are rising in a quick. At that point they related the natural neuron to the counterfeit neuron. Diverse layers of the neurons have been clarified profoundly. This paper additionally said the historical backdrop of the neural systems, who as first began it and how they have actualized in the before days. Begun from a basic neural system and went ahead till numerous neurons by utilizing backpropagation calculation.

They have actualized another proficient altered back-propagation calculation with versatile learning rate, which builds the merging velocity and furthermore it limits the blunder. This strategy stops at first settling of learning rate and supplanted by an versatile learning rate. In each emphasis, a versatile learning rate for yield and shrouded layers are ascertained by figuring direct and nonlinear mistakes of yield layer and concealed layer independently. In this method, each layer has distinctive learning rate in each emphasis. The execution of this proposed calculation has been confirmed by the recreation comes about.

This paper totally focuses on how to decrease the time of modeling the neural networks and how to converge it fast. So to do that they have proposed an adaptive learning algorithm which has an adaptive learning rate. Traditionally, the backpropagation algorithm of neural networks uses a standard and constant learning rate which will be near to 0. But by fixing into a constant value the time taken to the algorithm to converge and model is increased. So the author proposed a new algorithm called as an adaptive learning rate algorithm. In this algorithm, the learning rate will not be constant. It changes on every iteration. The change of the learning rate depends upon the data which it is passing through it. The change of learning rate is done on both output layer and hidden layer. The changes are done based the values of the output layer and hidden layer. The authors of this paper have developed an algorithm to explain how to use the adaptive learning rate in backpropagation algorithm. By using this algorithm they have stimulated the results and done a comparison. This algorithm shows a faster convergence and the model is being trained faster than the traditional backpropagation algorithm with a traditional constant learning rate.

Starting with the introduction of the human brain and then slowly went into the artificial neurons which are emerging at a rapid fast. Then they related the biological neuron to the artificial neuron. Different layers of the neurons have been explained deeply. This paper also mentioned the history of the neural networks, which as first started it and how they have implemented in the earlier days. Started from a simple neural network and went on till multiple neurons by using backpropagation algorithm.

The focus of this paper is on working of artificial neural networks and the given many block diagrams for the artificial neural networks architecture. In this paper, the creator says that counterfeit neural systems are regularly alluded as the neural systems of data or flag preparing scientific model which depend on the natural neuron. A neural system is a structure which comprises of a gathering of associated neurons which gives great methods to troublesome issues and other application which assumes an imperative part in the present software engineering field. This is the motivation behind why analysts from the distinctive spaces outlining the ANN's to take care of the issues like example acknowledgment, expectation, enhancement, cooperative memory, and control. In this paper, they have displayed the fundamental investigation of the counterfeit neural system, its qualities, and its applications. The system capacities, the attributes of the system, the structure of the system are said in this paper. There are also some topics which tell about the ability of parallel processing, distributed memory, fault tolerance ability, collective solution. The advantages, limitations, and applications of the artificial neural networks are mentioned in this paper. Unsupervised learning, supervised learning and reinforcement learning are also discussed in this paper in a deeper way.

MirzaCilimkovic, Neural Networks, and Back Propagation Algorithm, This paper depicts a standout amongst the most prominent NN calculations, Back Propagation (BP) Algorithm. The point is to demonstrate the rationale behind this calculation. The thought behind BP calculation is very basic, the yield of NN is assessed against wanted yield. In the event that outcomes are not agreeable, association (weights) between layers are altered and a procedure is reshaped and again until the point when the blunder is sufficiently little. This paper portrays the prevalent ANN calculation got back to as Propagation (BP) Algorithm. [5] The creator primary aphorism is to demonstrate the rationale behind this calculation. The creator says that the thought behind backpropagation calculation is extremely straightforward, the yield of ANN is computed in light of the coveted yield. On the off chance that the outcomes are not attractive, at that point the weights between the layers are changed and a similar procedure is reshaped until the point when the mistake is little and forecasts are

up to the check. A simple backpropagation example is taken in this paper with ANN architecture. The implementation of backpropagation algorithms are increasing and there are few parameters which will change to improve the performance of backpropagation algorithm.

In this paper, the author focused on basics of neurons and architecture of artificial neural networks. This paper gave a detailed description of choosing the number of hidden layers and nodes. Actually, the number of layers and nodes are to be changes based on the data we are using. But here the author gave clarity on how to choose the number of hidden layers for our problem so that the model will be perfect. Setting the value of the weights is also a difficult problem in artificial neural networks. This is also given an initial idea of setting the weights. Choosing the best activation function also matters the accuracy of the algorithm. The author mentioned all these parameters and how to use them efficiently with the backpropagation algorithm.

Then the author mentioned about training and running the neural network. The algorithm has been given in this paper for following and implementing the backpropagation neural network. A deep explanation is given about the change of weights of output layers and hidden layers and how they are changed.

NicolusKibetRotich Nicholas, Forecasting Of Wind Speeds And Directions With ANN, Lappeenranta University Of Technology, This is a master's thesis, here the breeze paces and headings were demonstrated reasonable for hourly, every day, week by week and month to month forecasting's. He as executed ANN's in MATLAB programming which he used to play out the forecasts[6]. There are three primary sorts of the counterfeit neural system were assembled, to be specific: Feedforward neural systems, Jordan Elman neural systems and Cascade forward neural systems. and furthermore there are four sub-models of every one of these neural systems additionally fabricated.

Every one of these models are prepared with genuine information of wind velocities and bearings which are gathered over a time of two years in the city area of Puumala in Finland. The creator has taken just 70% of the information which he utilized for preparing, approval, and testing of the models, and after that the second last 15% of the information was given to a prepared model for checking the outcomes. At that point these yields are then contrasted and the last 15% of the first information. At that point the count power and see between them are finished. In light of the yields and contrasting the yields, the FFN's has restored the most minimal speculation blunders for hourly, week after week and month to month gauges. The Jordan Elman organize has restored the most minimal mistakes when it is utilized for guaging every day wind speeds. Course forward systems exhibited the most minimal mistakes when computed for day by day, week after week and month to month. Jordan Elman systems gave best outcomes when utilized hourly. Clearly, the mistakes are less while preparing the models, however has expanded a bit with new information inputs. With this blend of hyperbolic digression exchange capacities for the two layers has given a superior yield when contrasted and different mixes of exchange capacities. For the most part, wind speeds are unsurprising as when contrasted with wind headings. This is the aggregate review of his paper for estimating wind paces and bearings utilizing backpropagation neural systems.

### 3. Methodology

Artificial Neural Networks Backpropagation algorithm is being used for many classification techniques and in predictions. Traditionally, in backpropagation algorithm, a standard constant learning rate (<1) is used. If the learning rate is very large, then

the learning may become unstable. If it is small, then often it is very slow for getting stable. So there should be a learning rate which can modify itself based on the data.

The proposed system is giving a solution to the learning rate. The algorithm modifies the learning rate at each step based on the data and gives faster results when compared to the traditional algorithm. This learning rate has been called as Adaptive Learning rate. This is chosen to implement on Hear Diseases and Diabetic Disease dataset and results are compared.

### Adaptive Learning Rate

The proposed new learning rate calculation is to accelerate the learning procedure of the neural network. In the proposed calculation isolate versatile learning rate is utilized as a part of both shrouded and output layers. In this, immediate and nonlinear oversights for each neuron in the yielding layer are duplicated with a subordinate of the relating neuron's institution work, included and thereafter separated to get the flexible learning rate for the yielding layer. The immediate and nonlinear oversight of each shrouded neuron is expanded with its contrasting yield layer weights freely and a while later included. The nth regard is isolated by various covered neurons. The division of the sigmoidal limit of this regard is used as a learning rate for the covered layer [3].

### 4. Modified Backpropagation Algorithm

For each info design the direct and nonlinear yields of the jth neuron in yield layer s of the system are computed individually as takes after:

$$u_j^s = \sum_{i=1}^{n(s-1)} w_{ji}^s y_i^{s-1} \quad (1)$$

$$f(u_j^s) = \frac{1}{(1 + e^{-u_j^s})} = d_j^s \quad (2)$$

where n(s-1) represents a number of neurons in the layer. The MBP approach limits changed type of paradigm Ep utilized as a part of standard BP calculation. The criteria Ep is the total of the direct and nonlinear quadratic blunders of the yield neuron for the present example p.

where the nonlinear error signal is

$$e_{1j}^s = (y_j^s - d_j^s) \quad (3)$$

and the linear error signal is

$$e_{2j}^s = (ly_j^s - u_j^s) \quad (4)$$

### Adaptive Learning Rate

In the proposed method first straight and nonlinear blunders of jth neuron in the yield layer s are ascertained utilizing (1) and (2). At that point all the direct and nonlinear mistakes of the neurons are duplicated with the subsidiary of the comparing neuron's action work and included independently as demonstrated as follows:

$$\delta_{o1} = \sum_{j=1}^{n_s} e_{1j}^s f'(u_j^s) \quad (5)$$

$$\delta_{o2} = \sum_{j=1}^{n_s} e_{2j}^s f'(u_j^s) \quad (6)$$

Then  $\delta_{o1}$  and  $\delta_{o2}$  are added to get the total error

$$\delta_o = \delta_{o1} + \delta_{o2} \quad (7)$$

Presently the aggregate mistake is isolated by the aggregate number of yield neurons

$$\delta^a = \frac{\delta^a}{n_s}$$

and the out  $\mu$  of the output layer  $s$  is computed as follows:

$$\mu_{out} = f'(\delta^a)$$

Where  $f$  is a sigmoidal activation function given by

$$f(\delta^a) = \frac{1}{1 + e^{-\delta^a}}$$

With property

$$f'(\delta^a) = f(\delta^a)(1 - f(\delta^a))$$

Then the change of weights are calculated using

$$\Delta w_{ji}^s = \mu_{out} e_{1j}^s f'(u_j^s) y_i^{s-1} + \mu_{out} \lambda e_{2j}^s y_i^{s-1}$$

$$\delta_{h1} = \sum_{i=1}^{n_{(s-1)}} \sum_{j=1}^{n_s} e_{1j}^{(s-1)} w_{ji}^s \quad (13)$$

$$\delta_{h2} = \sum_{i=1}^{n_{(s-1)}} \sum_{j=1}^{n_s} e_{2j}^{(s-1)} w_{ji}^s \quad (14)$$

and then both  $\delta_{h1}$  and  $\delta_{h2}$  are added to get the total error as below:

$$\delta_h = \delta_{h1} + \delta_{h2} \quad (15)$$

Presently the aggregate blunder is isolated by the aggregate number of shrouded neurons

$$\delta^b = \frac{\delta_h}{n_{(s-1)}} \quad (16)$$

and then  $\mu_{hid}$  is computed as follows:

where  $f$  is a sigmoidal activation function. Then the change of weights are calculated using the following equation:

$$\Delta w_{ji}^{(s-1)} = \mu_{hid} e_{1j}^{(s-1)} f'(u_j^{(s-1)}) y_i^{(s-2)} + \mu_{hid} \lambda e_{2j}^{(s-1)} y_i^{(s-2)} \quad (17)$$

Now the weights of both hidden and output layer are updated using

$$w_{ji}(t-1) = w_{ji}(t) + \Delta w_{ji} \quad (18)$$

## 5. Results

Comparison of the two algorithms

Dataset	Learning Rate	No of Hidden Layers	No of Epochs	Accuracy	Time in MSECs
Heart Disease dataset	fixed- 0.1	6	2000	75.48%	193
Heart Disease dataset	adaptive	6	2000	78.22%	68
Heart Disease dataset	fixed - 0.1	9	2000	81.37%	220
Heart Disease dataset	adaptive	9	2000	85.93%	75
Heart Disease dataset	fixed - 0.1	9	3000	84.96%	302
Heart Disease dataset	adaptive	9	3000	88.24%	85
Diabetes dataset	fixed - 0.1	6	2000	75.39%	150
Diabetes dataset	adaptive	6	2000	79.41%	54
Diabetes dataset	fixed - 0.1	6	3000	78.23%	220
Diabetes dataset	adaptive	6	3000	83.20%	69
Heart Disease dataset	fixed - 0.1	6	2000	75.48%	193
Heart Disease dataset	adaptive	6	2000	78.22%	68

The above table describes how the two algorithms (Traditional backpropagation and backpropagation with adaptive learning rate) varies the results when the two datasets given to the above algorithms.

## 6. Conclusion

This paper mainly focuses on Artificial Neural Networks using Backpropagation algorithm. Traditionally, backpropagation algorithm uses a fixed learning rate. This leads to the very slow modeling of the network. So we have implemented adaptive learning rate algorithm which is very fast when compared to the old one. We have implemented this algorithm to two different datasets (Heart\_Disease\_Data.csv and Diabetes.csv). I have

trained and modeled these datasets on both algorithms (fixed learning rate and adaptive learning rate). The results are more satisfactory by using adaptive learning rate than fixed learning rate. By this doctors can come to a conclusion about that patient disease and they can diagnose based on that prediction. This will decrease the time of diagnosis and also reduce the mistakes done by Humans. This algorithm can also be used for many other datasets where we need to predict the result based on different parameters. We can also use this algorithm for forecasting time series data also. Artificial Neural Networks with Backpropagation algorithm has many applications which can be used in day to day life like Face Recognition System, License Plate Recognition, Leaf Recognition System, etc.

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