INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact factor: 4.295
(Volume 4, Issue 3)
Available online at: www.ijariit.com

Cardiovascular health pre-diagnosis system based on bp profile using backpropagation algorithm

Rahul Kumar Borah
rahulkumarborah@gmail.com
School of Engineering and Technology Jain University (SET JU), Bengaluru, Karnataka

Kratee Jain
jkratee@gmail.com
School of Engineering and Technology Jain University (SET JU), Bengaluru, Karnataka

Manjunath C R
manjucr123@gmail.com
School of Engineering and Technology Jain University (SET JU), Bengaluru, Karnataka

ABSTRACT

Blood pressure profiling during exercise has been found to predict a future diagnosis of heart-related diseases such as hypertension, hypotension, and coronary heart disease. Non-invasive methods have made it easier to measure blood pressure. Devices like stethoscope and sphygmomanometer are most commonly used in clinics and hospitals to measure blood pressure but these devices provide us with single measurement or partial information about a person's cardiovascular health. Blood pressure does not remain constant; it changes with every instant considering various parameters such as age and gender. So, there is a need to measure BP through a more improved method such as exercise stress testing.

This study describes the implementation of Artificial Neural Network to develop an algorithm to perform cardiovascular health pre-diagnosis of a patient. The decision-making is done through a blood pressure (BP) profile generated by conducting exercise stress testing. The parameters considered for profiling were age, gender, height, weight, blood pressure measurement with the risk factors and BMI. The data generated is imparted as training and testing sets to develop an algorithm, which will be able to accurately pre-diagnose cardiovascular health status of a person. Later an expert system can be developed which will assist medical doctors and practitioners to diagnose a patient with heart-related issues with more accuracy and will be able to spread more awareness in people regarding their cardiovascular health status.

Keywords: *Artificial neural network, Blood pressure, Cardiovascular health pre-diagnosis, Exercise stress test, Hypertension, Hypotension.*

1. INTRODUCTION

Heart-related diseases or cardiovascular diseases are now one of the world's leading cause of death, claiming 17.3 million lives each year. A global study has shown that India leads in deaths from heart failure with 23 percent heart patients not surviving a study, whereas, only 7 percent of Chinese patients succumbed to heart ailments.

A standout amongst the most usually estimated physiological parameter is a circulatory strain (BP). It is an imperative marker of the condition of cardiovascular wellbeing. The estimation of the blood vessel circulatory strain is of extraordinary centrality for the location of heart-related sicknesses, which influences around 33% of the grown-up populace on the planet.

Diverse BP observing strategies can give a solitary estimation of BP. In any case, BP changes with each and every moment and these techniques just give incomplete data on a patient's cardiovascular wellbeing. Along these lines, there was a climb in the need to screen blood pressure, headways that guide the estimation of BP ended up open as a difference in the conventional use of sphygmomanometer. Since the sphygmomanometer is free in many clinics, the encoding of the records of estimation of an observed BP in PCs is done physically. There is an expanded probability of mistakes as human watchfulness and intercession are associated with this procedure.

The customary non-obtrusive approach for evaluating subjects with conceivable or built up hypertension and cardio blood vessel infection utilized by therapeutic experts is Stress Testing. The stress-incited circulatory strain is observed as the subject is provoked to work out. For an aggregate game plan of records of a BP in a single continue running of the Stress Test, the circulatory strain is assessed beforehand, in the midst of and after exercise. Exercise circulatory strain has most extreme

significance in connection to the identification of cardiovascular sicknesses since BP reactions and constricted BP recuperation was observed to be related with the prognostic cardiovascular hazard. The unusual blood reaction that was characterized as an expansion of more noteworthy than 20mmHg in the Systolic BP amid exercise or increment of more prominent than 10mmHg in Diastolic BP is known as a hypertensive reaction. A decline, nonetheless, of around 20mmHg in the Systolic BP amid practice or more noteworthy than 10mmHg in Diastolic BP is known as a hypotensive reaction.

1.1 BLOOD PRESSURE

Blood vessel circulatory strain is the power applied by the blood on the mass of the vein as the heart pumps and unwinds. Two numbers are used to represent it: Systolic pressure (force exerted by blood when the heart contracts and pushes it out) and diastolic pressure (force exerted by blood when the heart relaxes or between the beats).

Blood circulation gives transportation of oxygen and different supplements to tissues. It removes the metabolic waste from the cells. The human blood circulatory framework, which is a "pressurized vessel framework" comprising of the conduits, veins, arterioles, vacuoles, and vessels do the dissemination.

1.1.1 MEASUREMENT OF BLOOD PRESSURE

Circulatory strain estimation at human services facilities and doctor's facilities are for the most part done utilizing a stethoscope or a manual sphygmomanometer.

Two numbers constantly represent circulatory strain:

1) Systolic Pressure (during the point of heart muscles contraction to pump blood)

2) Diastolic Pressure (between two heartbeats)

Estimations are given one over the other with systolic weight being the primary number. For e.g. 110/70

Low Blood Pressure Range

Low BP is called as Hypotension.

Table 1.1 Low BP Range Table

Systolic Pressure (mm Hg)	Diastolic Pressure (mm Hg)	Indication
90	60	Marginal Low BP
60	40	Too Low BP
50	33	Hazardously Low BP

Normal Blood Pressure Range

Table 1.2. Normal BP Range

Systolic Pressure (mm Hg)	Diastolic Pressure (mm Hg)	Indication
130	85	High Normal BP
120	80	Normal BP
110	75	Low Normal BP

High Blood Pressure Range

High BP is called as Hypertension.

Table 1.3. High BP Range Table

Systolic Pressure (mm Hg)	Diastolic Pressure (mm Hg)	The stage for High BP
210	120	4
180	110	3
160	100	2
140	90	1

The finding requires just a single estimation, either systolic or diastolic, or both to be outside the sound range to choose whether a man has high or low circulatory strain. Numerous individuals don't have the foggiest idea about the main driver of why their pulse being higher than a typical circulatory strain. The variables that may add to hypertension are:

1) Aging
2) Stress
3) Smoking
4) The absence of physical activity
5) Being overweight
6) Genetics
7) High liquor consumption
8) The family history of high BP

A few symptoms of a headache, unsteadiness, beating in ears and a wicked nose don't happen until high BP has come to a progressed and even dangerous stage.

1.2 HYPERTENSION

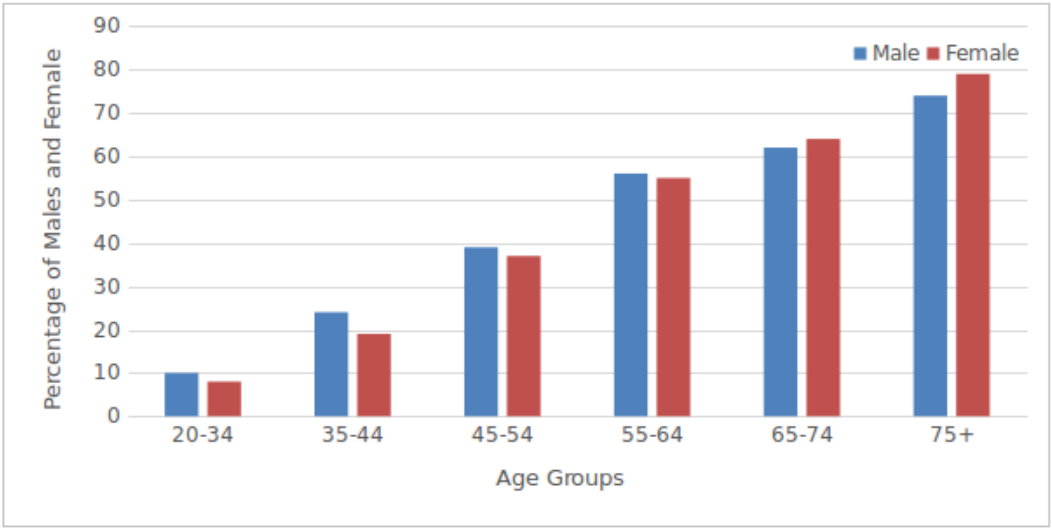

Fig 1.1 Hypertension Grouped by Age in Males and Females

Hypertension or High Blood Pressure (HBP) is said to be a noiseless executioner as it has no indications and can cause genuine inconvenience if left untreated for quite a while. Hypertension assumes a noteworthy part in instances of heart-related diseases and can be additionally a reason for kidney diseases.

It has been found in the most recent overview that dominant part of individuals is experiencing hypertension. 95% of patients with hypertension are characterized as having essential hypertension, where no particular reason can be given. Factors, for example, an inactive way of life, overweight, liquor consumption, smoking, stretch, rest apnea have been viewed as contributing to causing hypertension.

A precise and legitimate pre-demonstrative master framework is fundamental for better treatment of hypertension patients. This diminishes the heart attacks, heart failures and different maladies which may put one's life in peril.

1.3 HYPOTENSION

Low circulatory blood strain is named as Hypotension. Incessant low circulatory blood strain without any indications is never genuine however a sudden drop in the pulse may deny the human mind of a satisfactory blood supply. Basic side effects are tipsiness, dazedness, diminishing or obscuring of vision, weakness, queasiness and fair skin and so on. This sudden drop in the circulatory strain might be perilous.

In the event that somebody's circulatory blood strain gets seriously low, there is a huge threat that the body won't get enough oxygen to do typical activities. This can cause impeded working of heart and cerebrum, trouble with breathing and there is a likelihood that a man may lose awareness or go into shock.

Like hypertension, lucidity on the reason for hypotension isn't there generally. It might be caused because of pregnancy, hormonal issues, heart arrhythmias, liver sickness or warmth stroke and so forth.

2. PROPOSED SYSTEM

This study aims to develop a system that is prepared for arriving at a pre-diagnosis of hypertension through looking at a profile of circulatory blood strain estimations. Studies have demonstrated that circulatory BP profile can be utilized to give precise pre-determination of heart-related ailments. The framework comprises four noteworthy components – data acquisition, BP profiling utilizing pressure test, building up an algorithm for pre-diagnosis.

The fundamental working of the pre-analysis framework will be a result of its readiness through a progression of conclusions on BP profile taken in the midst of an Exercise Stress Test. This helps a physicist or a medicinal specialist in the pre-determination of heart-related illnesses. The objective is to spread mindfulness in individuals about their cardiovascular wellbeing status.

2.1 Delimitation

Blood pressure (BP) measurement is not the only parameter considered for pre-diagnosis. There are few additional factors that help the system to make decisions accurately, which are:

- Age
- Gender

- BMI
- Heart rate

Both hypertension and hypotension are triggered by almost the same factors such as inactive lifestyle, obesity, high average alcohol consumption, genetics, and heredity. Thus, other parameters such as fasting lipoprotein profile are discarded. Discarding such factors may provide slightly inaccurate pre-diagnosis of heart-related diseases.

2.2 Exercise Stress Test

Exercise pressure test or stress test gathers data about the working of the heart amid a physical movement. Since practice influences the heart to pump harder and quicker than common, it can uncover heart-related issues that may go unnoticed something else.

It, for the most part, includes strolling on a treadmill or riding a stationary bicycle while the individual's heartbeat, circulatory strain, and breathing are being checked.
A specialist may suggest an activity stress test on the off chance that he or she presumes a man has coronary vein infection or a sporadic heartbeat (arrhythmia). The test may likewise be utilized to manage your treatment in the event that you have just been determined to have a heart condition.

2.2.1 Risks of an exercise test

Exercise pressure test is, for the most part, sheltered and intricacies are uncommon. The potential complexities are:

Low pulse: Sudden drop in circulatory strain making the patient feel bleary-eyed or swoon. The weight ought to standardize in the wake of working out.
Heart arrhythmias: Abnormal heart rhythms ought to leave not long after a man quits working out.
Heart attack: Very uncommon possibility yet it is conceivable that an activity test may incite a heart attack.

2.2.2 How Exercise Stress Test is conducted

At the point when a man touches base for a test, the specialist asks him/her about their medical history and how regularly they generally work out. This causes them decide the measure of activity that is suitable for a man amid the test.

In the middle of a test

An attendant or professional spots sticky patches (anodes) — which are associated by wires to an electrocardiogram (ECG or EKG) machine — on patient's chest, legs and arms to record their heart's electrical signs. A sleeve on the patient's arm checks your circulatory strain amid the test. The patient might be requested to inhale into a tube amid the test to decide how well he/she inhale amid work out.

The patient at that point starts strolling on the treadmill or accelerating the stationary bicycle gradually. As the test advances, the speed and slope of the treadmill increments. On a stationary bicycle, the protection increments as the test advance, making it harder to pedal.

A patient may keep practicing until his/her heart rate has achieved a set target or until he/she create side effects that do not enable them to proceed. The signs and side effects may include:

• Severe chest pain
• Breathlessness
• Abnormal pulse
• Irregular heartbeat
• Dizziness
• Certain changes in your ECG

A patient may stop the test whenever if excessively awkward, making it impossible to keep working out.

After a test:

After the patient quit working out, he/she might be approached to stop for a few seconds and afterward rests for around five minutes with the screens set up so medical caretaker can keep taking estimations as your heart rate and breathing come back to typical.
At the point when the test is finished, the patient can come back to their ordinary routine activities for the rest of the day.

2.3. PROFILING AND PRE-DIAGNOSIS

2.3.1 Data Acquisition

Information can be obtained from healing centers or facility research facilities where as of now stress tests are being directed. As BP reacts in a short way to the physical exercises done by the body, EST will have the capacity to give better data to profiling BP.

2.3.2 Profiling and Pre-Diagnosis

In the investigative examination completed by the University of Santo Tomas, the product used in information profiling was Microsoft Excel. After the information was gathered, it was arranged by the discoveries of the medicinal specialist. 80% of the information was utilized as preparing information and the other 20% was utilized as the testing information.

The succeeding portions in the Excel record were balanced by the data beginning with the volunteer's basic information including Age, Gender, and Height and Weight, which were used to process the BMI. The accompanying portions that in that took after were the pre-practice circulatory blood strain readings, both when sitting and staying, in the midst of and post-hone beat readings. The BP readings of each stage were trailed by their looking at heart rates.

Besides, the last portions included the assurance of cardiorespiratory health, metabolic partners and foreseen heart rate. To make a fitting profile, the typical of the impressive number of parameters, besides sexual orientation, for the underlying two EST runs was gotten. This took the technique done in the examination drove by the Philippine Heart Association-Council on Hypertension where two estimations were accomplished, and their ordinary was recorded. The profile intends to use the authentic scenery of the patient, which is addressed by the underlying two EST runs, to give a conclusion of the current condition, the third EST run.

3. TECHNOLOGY USED

Neural Network

In Data mining Neural Networks is an imperative instrument. It is utilized for grouping and clustering. It is an endeavor to construct a machine that will emulate mind exercises and have the capacity to learn. Neural Network, for the most part, learns by illustration. Work of neural system is to perform characterization and need to find new examples of information. It has three layers, information, yield and concealed layer. In this layer, all layers can have various hubs. Info layer's hubs are associated with the hubs of the shrouded layer. Shrouded layer's hubs are associated with the hubs from yield layer. Weights between hubs are spoken to by its associations. New utilization of BP computation is creating and there are two or three parameters that could be changed to upgrade the execution of BP.

Characterization is gathering of comparative things. Cases of orders are discovered all over the place, general stores set up comparable things together, there is a rack for meat, journal items, cleaning items. In information mining, numerous order methods are utilized with the neural system being one of them. In light of learning strategy, there are two kinds of neural system. , they can be overseen where yield regards are known as of now (backpropagation calculation) and unsupervised where yield regards are not known (grouping).

Neural framework building, number of center points to pick how to set the weights between the centers, setting up the framework and surveying the results are secured. Initiated work gets said together with learning rate, vitality, and pruning. Backpropagation calculation, apparently the most acclaimed Neural framework count is delineated. From the latest couple of years, Neural frameworks have seen an impact of interest and are in actuality viably associated over a remarkable extent of issue spaces, in zones as varying as back, drug, outlining, geography and material science.

There are two standard purposes behind NN examination, first undertaking to get a cognizance on how human personality limit and second is need to collect machines that are skillful for dealing with complex issues that sequentially working PCs were not capable settle.

Contingent on the issue neural system works, if issue structure is broke down appropriately, PC could, in any case, beat neural system however in the event that circumstance is the place issue has not been investigated profound, the neural system can be utilized to learn set of the case. The neural system can use to deal with blunders superior to anything the conventional PCs programs.

3.1 Architecture

Engineering of a straightforward Neural Network spoke to in figure. It is made up of an information, output and at least one hidden layers. In this layer, all layers can have a number of hubs. Information layer's center points are related to the center points of the hidden layer. Hidden layer's center points are related to the centers from output layer. Weights between centers are addressed by its affiliations. Information layer addresses an unrefined information that is energized by the framework. This bit of the framework is never hinting at changing its characteristics. Every last commitment to the framework is replicated and send down to the centers in the hidden layer. Hidden Layer recognizes information from the information layer. It uses input regards and changes them using some weight regard, this new regard is then sent to the output layer anyway it will in like manner be balanced by some weight from the relationship among hidden and an output layer. Output layer process information got from the hidden layer and conveys an output. This output is then arranged by an activation function.

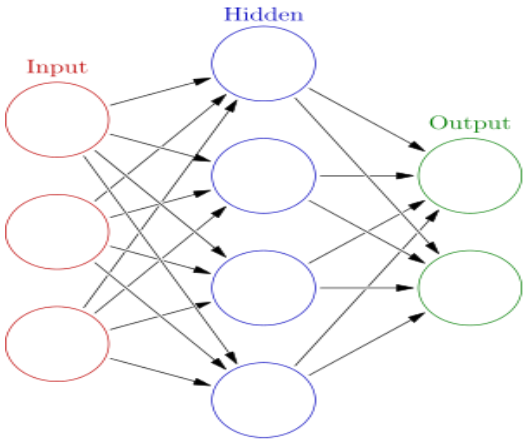

Fig. 3. 1. Artificial Neural Network

3.2 Number of Nodes and Layers

Picking number of center focuses on each layer will rely on issue NN is trying to clear up, sorts of information orchestrate are administering, nature of information and some exceptional parameters. Various data and yield center focus depends in the wake of arranging set close by. Picking number of center focuses in disguised layer could be attempting a try. On the off chance that there is excessively different center focuses on a covered layer, the quantity of conceivable checks that calculation needs to regulate increments. Picking only a few centers focuses in the concealed layer can keep the estimation of its learning limit. Right, the change should be picked. It is crucial to screen the advance of NN amidst its arranging. On the off chance that happens are not redesigning, at that point, some change to the model may be required.

3.3 Setting Weights

The ideal approach to manage control Neuron Network is by setting and changing weights between focuses. Starting weights are all things considered set at some unpredictable numbers and afterward they are balanced amidst Neuron Network arranging. The spotlight ought not to be on transforming one weight at the time, changing every single one of the weights ought to be attempted meanwhile. Some Neuron Network is supervising thousands, even a far-reaching number of focuses so changing conceivably a couple at any given moment would not help in adjusting Neuron Network to get required outcomes, fortunately. Strategy for the thinking behind weight empowers is to a great degree clear. Amidst the Neuron Network, arranging weights are restored after cycles. If results of Neuron Network after weights fortify are superior to anything past course of action of weights, the new estimations of weights are kept and the cycle goes on. Finding a mix of weights that will engage us to confine bungle ought to be the basic minute that setting weights. This will progress toward getting the opportunity to be a piece all the more clear once the learning rate; imperative and arranging set is explained.

3.4 Running and Training NN

When we run the network it comprises two passes, forward pass, and backward pass. The forward pass figures the yield and contrasted it and the coveted one. Blunders are ascertained from wanted and genuine yield. These blunders are utilized to change the weights in networks, to decrease the span of the mistake in backward pass. The emphasis on the forward and backward pass proceeds till the mistake is sufficiently low.

Preparing NN is an expansive theme however we have clarified it in a nutshell as per this paper reason. In preparing NN we encourage the network with an arrangement of cases which incorporates wanted information and yields. Suppose on the off chance that we have 1000 examples then we utilize just 100 to prepare the network and the rest is utilized to test our model. We can pick our own learning rate and force that will help us in weight modification.

1) It is a troublesome errand set the correct learning rate, in the event that it is too little it will require any longer investment to merge. Furthermore, on the off chance that we set the learning rate vast, the calculation could veer. Some of the time in NN, each and every weight has its own particular learning rate. While preparing NN the prominent decision of learning rate is 0.35. In this paper, we will utilize 0.45 yet this esteem is utilized due to the basic NN engineering utilized as a part of illustrations.

2) According to Larose[2005], force term speaks to latency. Because of the vast estimations of force term, the modification in the present weight impacted to move an indistinguishable way from past one.

3.5 Back Propagation (BP) Algorithm

A champion among the most surely understood NN computations is backpropagation algorithm. Blood Pressure count could be isolated to four essential advances. In the wake of picking the weights of the system subjectively, the backpropagation algorithm is used to figure the fundamental changes. The algorithm is composed of four stages:
i) Feed-forward computation
ii) Back propagation to the output layer
iii) Back propagation to the hidden layer

iv) Weight updates

The algorithm is stopped when the estimation of the blunder work has ended up being pretty much nothing. This is a cruel and principal condition for BP calculation. There are a couple of assortments proposed by another analyst however definition is in every way exceptionally correct and easy to take after. The last propel, weight invigorates are going on all through the algorithm.

3.5.1 Worked Example

In figure 3.2, NN has two nodes N(0,0) and (N0,1) in the input layer, two nodes N(1,0) and N(1,1) in the hidden layer and one in the output layer N(2,0).

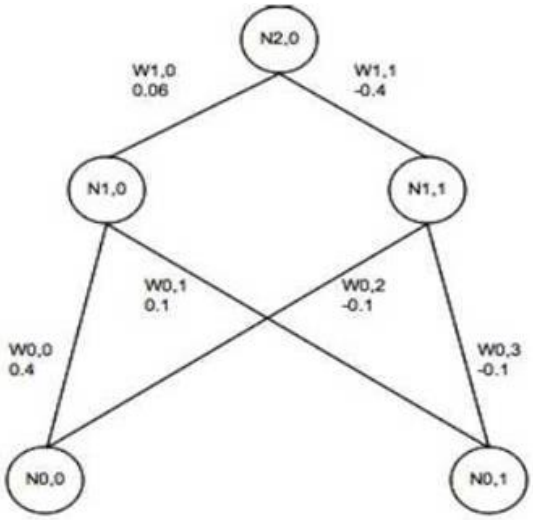

Fig 3.2.

Information Layers and Hidden layer Nodes are related to each other with the help of weights W(0,1)- W(0,4). Output layers and Hidden layers are related with weights W(1,0)- W(1,1). The characteristics doled out to weights are discretionarily picked and can be changed in the midst of the methodology of BP Iterations. It moreover have a formula called sigmoid capacity f(x)=1.0/(1.0+exp(- x)). The estimations for this direct framework have shown up. In NN Training method of the reasoning behind tallies of all outline, the set is same.

3.5.2 Feed-Forward Computation

It is a two-step process. In the initial step we get the estimations of hidden layer node and in the second one, we figure the estimations of output layer with the assistance of qualities we accumulate from hidden layer. Nodes in the hidden layer N(1,0) and N(1,1) have taken their input esteems from nodes N(0,0) and N(0,1). These qualities are increased by weights of interfacing nodes and by applying this we figure the estimation of hidden layer nodes.

N(0,0)	N(0,1)	N(2,0) output
1	1	1
1	0	0
0	1	0
0	0	0

Fig 4.3 Pattern Data for AND

β = Learning rate = 0.45
α = Momentum = 0.9
f(x) = 1.0/(1.0 + exp(-x))

For the calculations, sigmoid function is used *f(x) = 1.0/(1.0 + exp(-x))* .

*N(1,0) = f(x1) = f (w(0,0) * n(0,0) + w(0,1) * n(0,1)) = f(0.4 + 0.1) = f(0.5) = 0.62245*
*N(1,0) = f(x1) = f (w(0,2) * n(0,0) + w(0,3) * n(0,1)) = f(-0.4 - 0.1) = f(-0.2) = 0.45016*

After calculating hidden layer values. Network propagates forward. It passes values from hidden layer to an output layer node N(2,0). This is the second step of feed forward computation.
*N(2,0) = f(x3) = f (w(1,0) * n(1,0) + w(1,1) * n(1,1)) = f(0.06 * 0.622459 + (-0.4) * 0.45016) = f(-0.14271) = 0.46438*

A forward pass is completed after calculating N(2,0).

3.5.3 Back Propagation to the output layer

Presently our subsequent stage is to ascertain the error in N(2,0). The output ought to be 1 as per the table of figure 4.3. The anticipated esteem N(2,0) in the case is 0.464381. The count of error is done in an accompanying way:-

*N(2,0) error = n(2,0) * (1-n(2,0)) * (N(2,0) desired - N(2,0)) = 0.464381(1 - 0.464381) * (1 - 0.464381) = 0.133225*

The error is utilized as a part of in backpropagation and weights modification after it is known. Right off the bat, the error is transmitted to hidden layer from output layer. This is where learning rate and energy are taking back to the condition. So measures W(1,0) and W(1,1) are refreshed first. Before refreshing the weights the rate of progress must be found by increasing learning rate, mistake esteem and node N(1,0).

*ΔW(1,0) = β * N(2,0) error * n(1,0) = 0.45 * 0.133225 * 0.622459 = 0.037317*

Now new weight can be calculated with the help of W(1,0).
The estimation of Δ(t-1) is past delta change of weight. We do not have any past delta change so it generally stays zero. In the event that next cycle was to be computed then this will contain some esteem.

3.5.4 Back Propagation to the Hidden Layer

Presently error will begin to proliferate to input layer from hidden layer. This procedure is somewhat troublesome than the past case. In the past case, N(2,0) output was known previously and output of N(1,0) and N(1,1) was obscure. Presently we begin by finding the error in N(1,0) first. The error will be computed by duplicating new weights W(1,0) with the error for the node N(2,0). In a similar way error for N(1,1).
*N(1,0)error = N(2,0)error * W(1,0)new = 0.13322 * 0.09731 = 0.01296*
*N(1,1)error = N(2,0)error * W(1,1)new = 0.13322 * (-0.37301) = -0.04970*

Subsequent to knowing the error for hidden layer nodes, the weights of hidden layer and input can be refreshed effectively. Most importantly, we need to figure the rate of progress for each weight.
*Δw(0,0) = β * N(1,0)error * N(0,0) = 0.45 * 0.01296 = 0.05834*
*Δw(0,1) = β * N(1,0)error * N(0,1) = 0.45 * 0.01296 = 0.05834*
Δw(0,2) = β N(1,1)error * N(0,0) = 0.45 * -0.0497 * 1 = -0.022365*
*Δw(0,3) = β * N(1,1)error * N(0,1) = 0.45 * -0.0497 * 1 = -0.022365*

Then we calculate the new weights between the input and the hidden layer.
*Δw(0,0) new = Δw(0,0) old + Δw(0,0) + (α * Δ(t-1)) = 0.4 + 0.05834 + 0 = 0.45834*
*Δw(0,1) new = Δw(0,1) old + Δw(0,1) + (α * Δ(t-1)) = 0.1 + 0.05834 + 0 = 0.10583*
*Δw(0,2) new = Δw(0,2) old + Δw(0,2) + (α * Δ(t-1)) = -0.1 - 0.02236 + 0 = -0.12236*
*Δw(0,3) new = Δw(0,3) old + Δw(0,3) + (α * Δ(t-1)) = -0.1 - 0.02236 + 0 = -0.12236*

3.5.5 Weights Updates

Until the point when all errors are not computed, we don't refresh the weights. We effectively overlook this and because of this while computing errors on the off chance that we utilize new weights then the outcome isn't substantial. We have a speedy strategy to check whether the error is diminished utilizing new weights or not.
*N(1,0) = f(x1) = f(w(0,0) * n(0,0) + w(0,1) * n(0,1)) = f(0.406 + 0.1) = f(0.506) = 0.623868*
*N(1,1) = f(x2) = f(w(0,2) * n(0,0) + w(0,3) * n(0,1)) = f(-0.122 - 0.122) = f(0.506) = 0.623868*
*N(2,0) = f(x3) = f(w(1,0) * n(1,0) + w(1,1) * n(1,1)) = f(0.097 * 0.623868 + (-0.373) * 0.04393) = f(-0.103343) = 0.474186*

In the wake of computing N(2,0) forward pass is finished. Next, we calculate the error for N(2,0) node. As indicated by the table in figure 4 the output ought to be one. The anticipated an incentive for N(2,0) in our illustration is 0.464381. the count of error is done in an accompanying way:-
*N(2,0)error = n(2,0) * (1 - n(2,0)) * (N(2,0)desired - N(2,0)) = 0.474186 * (1 - 0.474186) * (1 - 0.474186) = 0.131103*

So after the redundancy process, an error that was calculated was 0.13321 and recently the error (calculated) was 0.131103. The calculation has enhanced, not much but rather it will give us a smart thought of how BP calculation functions. One might say that calculation learned through emphasis. The number of emphases in NN would be ten to ten thousand as indicated by dspguide.com [2010]. The main illustration set pass will be rehashed until the point when the error is sufficiently little.

4. MODEL CONSTRUCTION

The accompanying tables show the pattern of the parameters that were found in the investigation utilized as a part of building up the Artificial Neural Network both in around 400 men and in 400 ladies.

Table - 4.1 Different Parameters in Men

Age	BMI	Heart Rate	Systolic Blood pressure
20-29	27.25	80	120
30-39	28.01	84	120
40-49	27.42	75	120
50-59	28.90	76	120
60-70	26.01	75	120

Table - 4.2 Different Parameters in Women

Age	BMI	Heart Rate	Systolic Blood pressure
20-29	24.97	81	110
30-39	27.14	82	110
40-49	27.25	80	120
50-59	27.52	76	120
60-70	25.18	74	120

Each column is perceived as a parameter of the info. This sections and columns are set to be the preparation information of the Artificial Neural Network. The yield or target esteems are likewise inputted in the framework and are organized per segment.

The remembrance of examples and the resulting reaction of the network is the learning procedure followed by the network. This sort of learning is dictated by the way in which the parameter changes occur. One can prepare a neural network to play out a specific capacity by altering the estimations of the associations (weights) between components.
The proposed algorithm appears to be a more precise pre-diagnosing instrument for hypertension than that of specific fuzzy master framework design. Restorative Diagnosis utilizing ANN is right now an extremely dynamic research zone in solution and is as of now utilized as a part of various examinations including hypertension diagnosis. The yield layer comprises three neurons, which speak to hypertension, hypotension and ordinary conditions.

The accompanying figures will demonstrate the examination of two artificial neural networks by breaking down its most extreme insight by utilizing non-profiled or single perusing Exercise Stress Test and by utilizing the profiled Exercise Stress Tests. The confusion matrix consists of the following classes:

- Hypertension: High Blood Pressure
- Normal: Normal Blood Pressure
- Hypotension: Low Blood Pressure

Table - 4.3 Non-Profiled ANN Confusion Matrix

	1	2	3
Predicted Class			
1	27.7%	6.9%	0.3%
2	6.1%	23.9%	1.5%
3	0.7%	1.1%	33.0%

Target Class

Table 4.3 demonstrates the main framework, which just utilized a solitary keep running of EST. It displayed a general precision of 83.5% with the exactness of identifying ordinary, hypotensive and hypertensive reactions of 75%, 95.9% and 82.6% separately.

Table – 4.4 Profiled ANN Confusion Matrix

Predicted Class	1	2	3
1	31.2%	1.8%	0.15%
2	2.6%	32.1%	0.25%
3	0.2%	0.1%	30.0%

Target Class

Table – 4.4 demonstrates the main framework, which just utilized a solitary keep running of EST. It displayed a general precision of 94.2% with the correctness of identifying typical, hypotensive and hypertensive reactions of 93.2%, 98.0% and 91.3% individually. These figures are clearly better than the figures shown by the primary system.

5. CONCLUSION

A system that automatically pre-diagnoses a blood pressure status of a person based on BP readings in an exercise stress test can be designed and implemented using back propagation algorithm. The developed system could give an acceptable pre-diagnosis which may be not too far from the diagnosis from the attending practitioner that facilitates the EST. This system would serve as an additional reference for both the patient and the medical practitioner monitoring the former's blood pressure condition.

However, a better accuracy rating can be achieved if the number of training data for each class is close to one another. Diagnosis of both hypertension and hypotension will be more accurate if the model is fed with a much larger data set. Additional parameters can be added to further improve the performance of the system.

6. REFERENCES

[1] Jackielyn G. Domingo, Sean Harvy S. Geronimo, Gavril Ryan N. Ochoa, Diane Christelle N. Vergara, KannyKrizzy D. Serrano, Edison A. Roxas, Angelo R. dela Cruz, Ph.D., Argel A. Bandala and Ryan Rhay P. Vicerra Ph.D., " Cardiovascular Health Pre-Diagnosis Based on a BP Profile Using Artificial Neural Network, IEEE Paper, 2017

[2] Philippine Heart Association-Council, "Hypertension Report on Survey of Hypertension and Target Organ Damage (PRESYON 2TOD*)A Report on Prevalence of Hypertension, Awareness Treatment Profile, and Control Rate," Philippine Journal of Cardiology, vol. 35, no. 1, 2016.

[3] Beyond Blood Pressure and Heart Rate Monitoring: Towards a Device for Continuous Sensing and Automatic Feature Extraction of Cardiovascular Data Nalini Gayapersad; Sean Rocke; Zhovaan Ramsaroop; Arvind Singh; Craig Ramlal 2016 8th International Conference on Computational Intelligence and Communication Networks (CICN)

[4] A survey on the investigation of vital human parameters from photoplethsmography signal to predict the risk of cardiovascular diseases S. Balambigai; P. Jeevitha 2017 4th International Conference on Advanced Computing and Communication Systems (ICACCS)

[5] Multiparametric prediction with application to early detection of cardiovascular events
Diogo Nunes; Paulo Carvalho; Jorge Henriques; Teresa Rocha 2017 IEEE 3rd International Forum on Research and Technologies for Society and Industry (RTSI)

[6] Padwal RS, Bienek A, McAlister FA, Campbell NR. Epidemiology of Hypertension in Canada: An Update. *The Canadian Journal of Cardiology* 2016

[7] Miller TD, Askew JW, Anavekar NS. Noninvasive Stress Testing for Coronary Artery Disease. *Heart Failure Clinics* 2016;12:65-82

[8] Kjeldsen SE, Mancia G. Unobserved automated offi ce blood pressure measurement in the Systolic Blood Pressure Intervention Trial (SPRINT): systolic blood pressure treatment target remains below 140 mmHg. *European Heart Journal. Cardiovascular Pharmacotherapy* 2016

[9] Hyman DJ, Pavlik V. Medication adherence and resistant hypertension. *Journal of Human Hypertension* 2015

[10] O'Neal WT, Qureshi WT, Blaha MJ, Ehrman JK, Brawner CA, et al. Relation of Risk of Atrial Fibrillation With Systolic Blood Pressure Response During Exercise Stress Testing (from the Henry Ford ExercIse Testing Project). *American Journal of Cardiology*.
2015

