ONE-YEAR SURVIVAL MYOCARDIAL INFRACTION PREDICTION BASED BPNN

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DECLARATION

We hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. We also declare that, as required by these rules and conduct, We have fully cited and referenced all material and results that are not original to this work.

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ABSTRACT

Myocardial infarction is one the causes mortality and morbidity .also involves a high cost of care. Early prediction is helpful witch preventing the development of the myocardial infarction with appropriate diagnosis and treatment. Artificial neural networks have opened new horizons in learning about the natural history of diseases and predicting cardiac disease.

This work aims to use the backpropagation neural network for the prodictin of 1-year survival of patients who have myocardial infarction. A total of 131 cardiac patients with myocardial infarction were used. These data has 12 parameters that have abnormal range of values since they are related to patients who had infarction. Some of these parameters are medical one while others show are historical data and show if the patients have survived or not at 1-year amd the duration of survival. Thus training the network of such data provides it with the capability of predicting if the 1-year survival or death of patients with myocardial infarction. Experimentally, the backpropagation network was trained o 67 patients who had myocardial infarction where the output was considered as the death or alive at 1-year. The data were obtained from a public database available on the internet. The developed system was tested on new unseen data to evaluate its capability of predicting the 1-year survival of patients who had myocardial infarction. The system was capable of reaching 96.8% accuracy, which shows a great effectiveness in prediction this survival or death of myocardial infarction patients.

Keywords: Myocardial infarction, Prediction, Backpropagation, Neural network, 1-year survival.

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CHAPTER ONE

INTRODUCTION

1.1 Introduction

Atherosclerosis is one of diseases that takes the life in the whole world. Furthermore, it is the major cause of coronary artery disease (CAD), a gradual disease that causes atherosclerotic variation in coronary artery walls.Usually we can see the effects after40 years in patient. Acute myocardial infarction, include tumor necrosis factor of heart muscle secondary to long time ischemia, it is the most fatal presentation of CAD. Infarction usually arises from imponderables between oxygen supply and demand, which is the most often caused by plaque rupture and thrombus formation in a coronary vessel, causes a hard reduction to the blood supply of the portion in the myocardium (Hansson, 2005)

Myocardial infarction make systolic or diastolic failure and that may increase capability of the arrhythmias and other Symptoms like ischemic, mechanical, embolic and inflammatory disturbances (Davì, 2005). Myocardial infarction care is expensive, effective treatments and drugs. So the prevention of myocardial infarction is a desirable goal. That lead us to predict the probability of myocardial infarction and there are a lot of factors have been used, such as data of laboratory, history and physical checkup result. A lot of results ware promising. Nevertheless, no one of previous studies was successful .it is failed in accurate predicting that use probability of artificial neural networks (ANN). Artificial neural networks (ANN) have been widely used in different area such as function approximation, modeling, prediction, and classification, and they have the potential to open new likelihood in managing cardiac problems like a diseases prediction, diagnosis and classing a disease with similar signs and symptoms. It should be note that ANN have repeatedly used in different medical fields (Mullasari et al, 2011).

In the area of cardiology, ANN is used in diagnosis and treatment of CAD and myocardial infarction and it was successful, arrhythmias and especially in the analysis of ECG images ware detection by electrocardiogram (ECG) interpretation. Many studies have discovered and reported a positive results that detected myocardial infarction from a 12-lead ECG (with better accuracy than an expert cardiologist), early diagnosis myocardial infarction, and the prediction of infarct situation in patients have chest pain (Karlson et al, 1991).

The most importance is preventing myocardial infarction and because of there is no studies designed to test methods to prediction, this study aimed to compare the ability of two ANN based approaches to expect the myocardial infarction in two weeks for patients have a chest pain.

All the patients had suffered heart attacks at past. Some of them are still alive and some of them are dead. The survival and still-alive variables, when taken parameters, mark whether or no patients survived for at least one year following the heart attack (Mocan et al, 2008).

The problem studded by past researchers was to predict from the other variables whether or not the patient will survive at least one year. The most difficult part of this problem is correctly predicting that the patient will NOT survive.

Therefore, this work is to develop an intelligent system based backpropagation neural network that will be trained by using a database of many patients that had infarction. The database consists of 11 parameters as inputs such as survival period after infarction, a measure of contractility around the heart, etc. The database is obtained from a public online database called UCI learning machine.

The network will be trained by using historical data for patients who had a myocardial infarction. These data consist parameters that show if patients have survived for one year will live or not. These input parameters are correspondent to the other medical variables, which help the network to find differences in the two classes. The network was tested and the network showed a good capability in predicting the 1-year survival of myocardial infarction when tested on unseen data.

1.2 literatures Review

Many studies had done that ware forcing to prediction of medical diseases using intelligent computer systems. Neural networks was applying as categorized to prediction the myocardial infarction. In (Javad et al, 2016), a system for the prediction of myocardial infarction. 935 cardiac patients have chest pain and non-diagnostic electrocardiogram (ECG) were followed for two weeks divided in two groups based on there myocardial infarction situation. And there are two kinds of data were used for all patients: nominal and quantitative. kinds ware two different artificial neural networks – 1Radial basis function (RBF) and2 Multi-layer perceptron (MLP) –used to classification the two groups. Results: The main function of neural network had an accuracy by 83% with electrocardiogram (ECG) findings and an accuracy by 78% with clinical features. A clinical data had used in neural network trained at a genetic algorithm, electrocardiogram (ECG) results lead to a distribution accuracy by 96% and clinical data had an accuracy of 84.5%

In another researches (Rgensen et al, 1996) the writers investigated several sides of using neural networks as a diagnostic system. The nominated clinical problem chosen for explanation was the diagnosis of acute myocardial infarction, given only the electrocardiogram (ECG) and the concentricity of potassium in serum at the time of approval. They found that, in contrast to usual practice, the termination of the training process should be founded on the generalization performance and not on the training performance. Experimentally, they found that a major component analysis can use to remove redundant variables, thereby reducing the data space. The neural network diagnostic performance we used was 78%.

1.3 Aims of Project

The aim of the proposed system is to investigate the use of backpropagation neural network in learning the different parameters related to patients who had myocardial infarction and use them to generalize or predict their 1-year survival or death of those patients. Moreover, the evaluation of this network using different input data that the network was not trained on them before aims to evaluate the capability of the backpropagation neural network in predicting the patient s1-year survival and compare the obtained results with those in the literature review.

CHAPTER 2

MYOCARDIAL INFARCTION: MEDICAL REVIEW

2.1 Background

The heart is the severest and it is important organ that work in the whole human body .furthermore it is acts as a pump of that carry the enriched blood oxygen and nutrients to the network of veins and arteries to be deliver to all tissues in whole body. This perform process is tiring , the heart muscle itself needs a high rich supply of oxygen-rich blood, providing the coronary arteries by a network of vessels. These arteries carry and deliver the blood oxygenated to the myocardium walls ..

A heart attack (myocardial infarction)happent when the flow of blood to the muscles tissues of the heart are closed and there is no deliver to heart tissue .that leads to tissue death because loss of oxygen, this leads to make damage in the heart or flow the blood (Karlson et al, 1996).

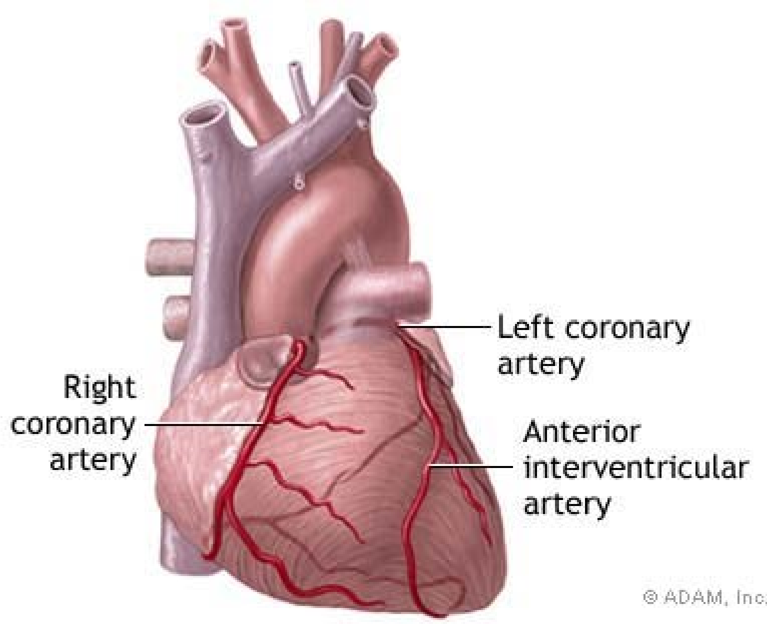


Figure 1: Heart anatomy

2.2 Coronary Artery Disease.

Coronary artery disease is main problem that lead to heart attacks or heart diseases. Coronary artery disease is the end situation the rare process and it is because a lot amount of cholesterol within heart walls called atherosclerosis (commonly called "hardening of the arteries"). This common of disease causes objection for arteries (ischemia) and prevents blood have a rich amount oxygen for arriving the heart (Hansson et al, 2015).

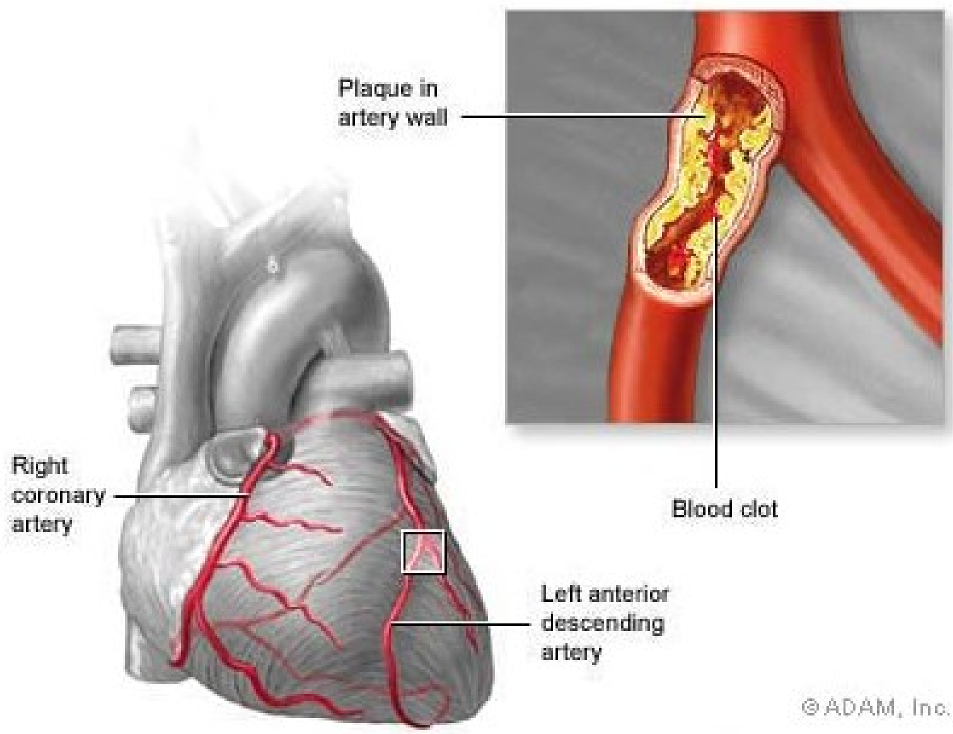


Figure 2: Atherosclerosis

2.3 Heart Attack

Heart attack is most dangerous that resulting from a lot of atherosclerosis and permanent damage to the heart wall muscle . It can occur as a result of one of two effects of the atherosclerosis.

The function of the platelets helps heal of the fracture or wounds when occur in body tissue. When the function of the patient does not occur, there is a heart problem that does not deliver the blood to tissue, oxygen and food in blood to the heart , then to electrical signals change and affect when examined by ECG. (Al-shayea, 2011).

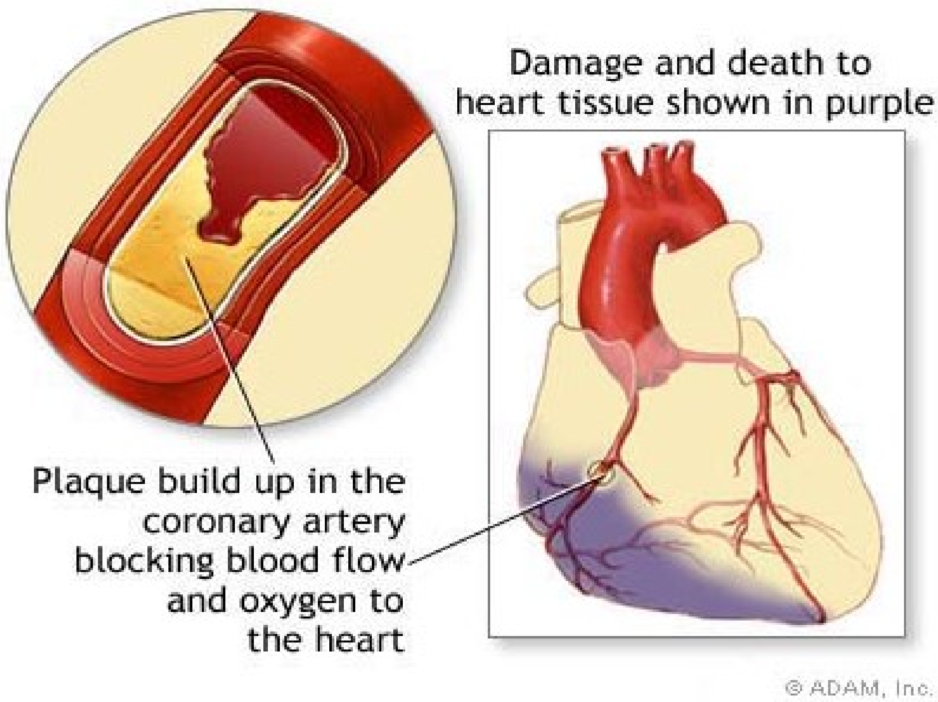


Figure 3: Plaques build up in the coronary artery

2.4 Angina

Angina, the first symptom of CAD, is usually testing as chest pain. There are two types of angina:

Stable Angina. This is predictable chest pain that can commonly be enabling with lifestyle changes and the drugs, such as low-dose aspirin.

Unstable Angina. This conjuncture is much more dangerous than stable angina, and is often an intermediate stage between myocardial infraction and stable angina. Unstable angina is called *acute coronary syndrome (snow et al, 1996)*.

2.5 Acute Coronary Syndrome

Acute coronary syndrome (ACS) is a heart condition that is critical, dangerous and unexpected, although it is needing an attacker has not developed to a fully heart attack. Acute coronary complex syndrome involving: -

Unstable Angina*:* Unstable angina is very critical and frequently chest pain, but blood tests do not show markers for heart attack.

NSTEMI (Non ST-segment Elevation Myocardial Infarction): This cause, also called non Q-wave myocardial infarction, is diagnosed when in the hospital making a test for blood and some vital sings.

Patients diagnosed with acute coronary syndrome (ACS) may be at risk for a heart attack. In this cause of disease the doctor must be know the medical history of the patient .can give him many information about this disease and how to be deal with this problem .

2.6 Myocardial Infarction

Heart attack, or (MI), is permanent damage to the heart muscle. "Myo" means muscle, "cardial" means heart, and "infarction" means damage of tissue because lack of blood give it (Hansson et al, 2015).

Your heart muscle needs to take a supply of oxygenic blood in every moment to function. heart muscle gets the blood it needs to do its job from the coronary arteries.

2.6.1What is coronary artery disease ?

Coronary artery get more narrower and that caused by some problemes . This disease is the result from narrowing of the arteries or the presence of fat deposits in arteries walls.resulting from the of long body fat becuase of bad health care and not to stay away from the causes of disease such as fat and soft drinks and others

Without enough blood, the heart becomes famished of oxygen and the vital nutrients it needs oxygen to work rightly .And feeling a pain in chest called angina. When the network of coronary arteries are completely damege and closed ,then the disease will be appear.

2.6.2What happens during a heart attack?

A coronary arteries it is like a network of blood vessels surrounding the heart muscle and give . The heart muscle needs this oxygen to give this function.

A heart attack happens when a coronary artery becomes suddenly closed and does not deliver oxygen, the flow of the blood to the heart muscle and appear the problem . All or part of the heart muscle becomes have no oxygen supply.

CHAPTER 3

NEURAL NETWORKS

3.1 Artificial Neural Networks

Artificial Neural Networks (ANN) is system that process information pattern , working in way like the biological nervous, such the human brain,when the info processing.

The Basic elemet of this model is the building information of system proceses. It is working orderly to solve problems because it consist of a lot of linked elements (neurons) for processing the information .ANNs, like the human brain for processing , learn by using examples to be able processing information . An ANN is designed for a special information processing applications, that use to pattern confession or data categorizion, in the learning process.The learning step in biological systems is consist modifications of data to able synaptic existing connections that is between the neurons (Abdi et al, 2005).

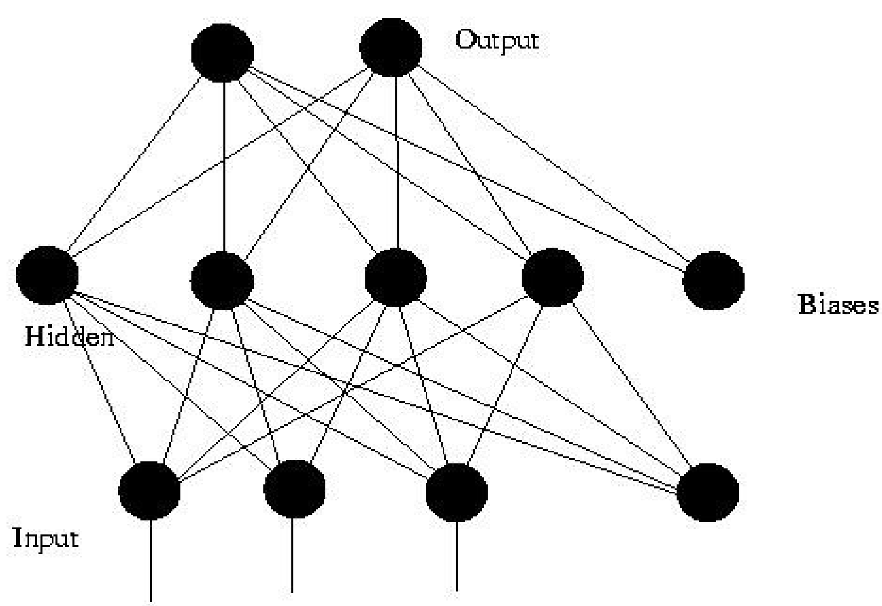


Figure 4: A neural network general architecture

3.2 Historical Background

When we focus situation of neural network simulation evolution seem to be a modern. any way, this type of working was decided before computers invention, and this fialed was vulnerable to extinction but it is survived (Abdi et al,. 2005).

The advanced technology have been support this field by use inexpensive computers emulations. Also this field has strongly faced many difficulties and challenges to become one of the best field that interest if classification of information. few researchers proved support of funding and professional support when it was limited, to make great refinement were made by comparatively. These majors were able to improveconvincing technology which skip the determination specified by Papert and Minsky ,now the neural network field has return back due to a lot of supports and funding. The first success was for neurophysiologist Warren McCulloch and the logician Walter Pits created the artificial neoruon in 1943 (zurada.2002).

3.3 Advantages of neural networks

Computer techniques can use neural networks, because it has ability to get meaning from difficult data that human con not understand it, to fined patterns trends that are very complex to notices by human brain.

A trained neural network is experienced because it is designed to do specific job to the class the information that given to resolve it. In addition, trained neural network used to foresee that help us to detect the correct projections.

The most pros is an adaptive learning: this type of learning ability to know how to do all of tasks based on data that given to train or first test (Zurada, 2002).

Also. there are an ANN self-Organization system and an ANN Opration of real time. ANN self-Organization can organize itself by modifying the received information in duration of learning or training times. ANN opration of real time: it is use a special design and invent devices hardware to step up the work rate of calculations that loaded out in parallel to be fast in processing information.

3.4 Biological versus artificial neural network

It's a system that contains a large set of interrelated signaling elements called nerve cells where the principle of its function is that it depends on the processing of information as a reaction to the external provinces .Artificial neurons represent a simulation of the entire signal by biological neurons and mimic the behavior of mathematical equations. We also notice that through communication that finds information flowing between two neurons connected to the artificial cells with each other .The catalyst can restricted and also we can transfer it from one treatment element to another by means of nerve points or links.

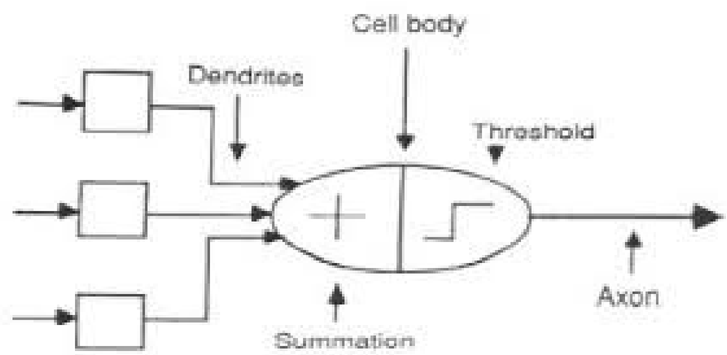
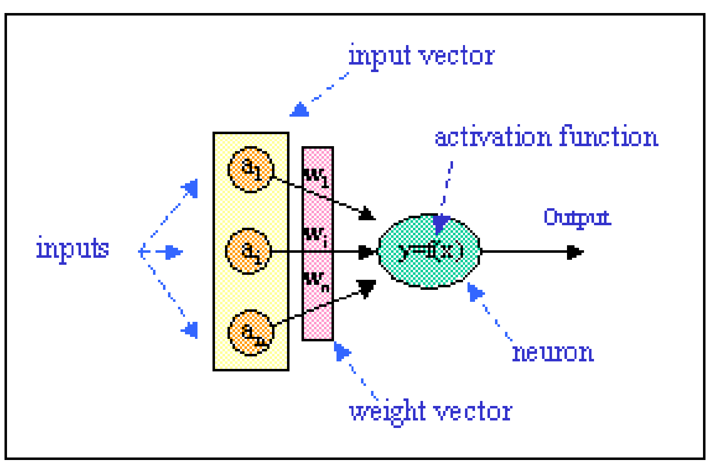


Figure 5: From human brain to artificial neural network

If that entry ANN into the neurous is exciting, such that such neurous will transmit exciting signal to other neurons related to it .In terms of that the restrain input will be like diffusing restraint.

Figure 6: Basic neural network



Inputs are received by a processing single element (depicted in Figure 1) can be presented such an input vector A= (a1, a2,… an), where ai is the signal from the ith input. A weight is linked with tow connected pair of neurons. So weights are connected to the jth neuron that can be represent such a weight vector from the Wj= (w1j, w2j, …, wnj), where wij appear weight linked to the connection between two processing element ai,. A neuron contains a threshold value that regulates its action potential. While action potential of a neuron is figure out by weights linked with an input of neuron (Eq. 1), a so the θ intone the neuron responding for a particular stimulus fixation such as responding to a pre-defined range of values. Equation 2 defines the output y of a neuron as an activation function f of the deliberated sum of n+1 inputs. These n+1 correspond to the n incoming signals. So it is incorporated into the equation as [biological neuron 14]

the extra input –θ, and is called *bias*.

$$SUM = \sum_{i=1}^{n} x_i w_i \tag{1}$$

$$y = f\left(\sum_{i=0}^{n} x_i w_i\right) \tag{2}$$

Lock activation functions for the output of neurons to a pre-defined range. The most common setoff functions is used ,they are:

Step function. The responding of activation function is only for sign of the input weighted sum defined by Eq. 1.

$$f(x) = \begin{cases} 1 \; if \; \sum_{i=1}^{n} x_i w_i > 0 \\ 0 \; if \; \sum_{i=1}^{n} x_i w_i \le 0 \end{cases} \tag{3}$$

3.5 Types of learning

The industrial network is triggered by two different processes first: education, A group of models is introduced into the network in the first training process. prediction: the output network for each model. Second: training, at this stage the network is editing internally until the stable level is achieved. The result of conditioning is related to the neural cells that are interconnected to be the best response possible., neural networks have two ways: unsupervised or supervised.

3.5.1 Supervised learning a network that is trained using a set of input and output of the objectives of online training of distinguish inputs with production are coveted. For each example of a set of exercises the network receives input and produced an effective output..

3.5.2 Unsupervised learning training is done through input signal only this because internal network monitoring is done by producing output that are agreed with the aid. Inputs store a range of input space. Each of these groups represent a real part with some similar characteristics.

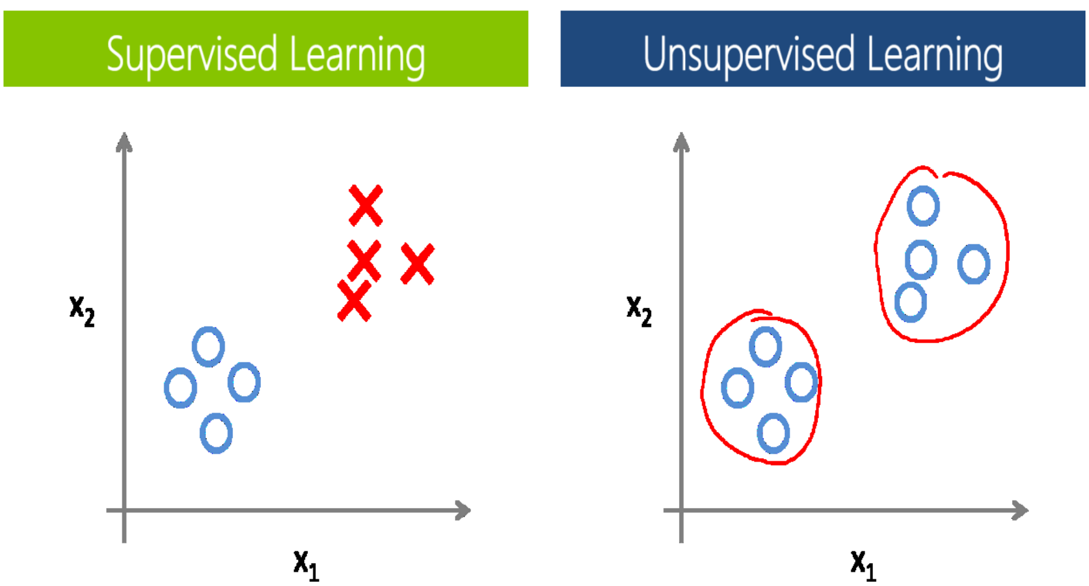


Figure 7: Supervised and unsupervised learning (Rojas, 2013)

In both cases once the network has reached the desired performance, the learning stage is over and the associated weights are *frozen*. The final state of the network is preserved and it can be used to classify new, previously unseen inputs. At the testing stage, the network receives an input signal and processes it to produce an output. If the network had correct learned.(moraga, et al, 2007).

3.6 Back propagation neural network (BPNN)

Neural networks the most popular layers are the Vidor network, which teaches how to acquire instruction by means of a property a logarithm for supervision. These successive errors are transmitted in the output section back to the grid to modify the weight and have use of the delta rule described and differences between them and the algorithm has a wide spread of multilayered networks. (moraga et al, 2007).

The back Propagation neural networks depends on the reference value of the error to compare the cumulative errors at the output of the network to update the correlation weight between the layers of the network. Note that there is no reverse calculation for calculating these cases only when the training is performed. All lines go towards the front direction of the simulation. The algorithm is based on the optimal ratio method.

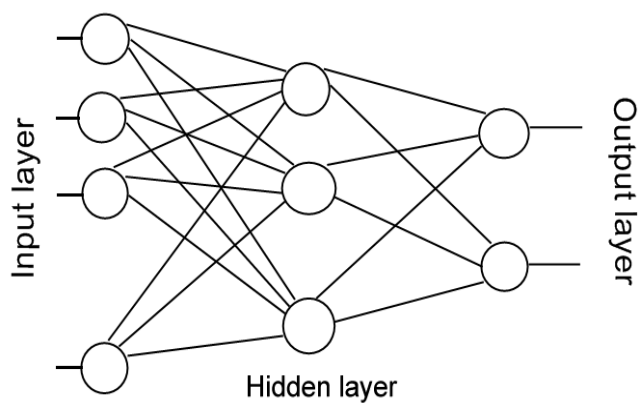


Figure 8: Back propagation neural network

The pseudocode algorithm for BPNN is given below:-

- Chosen of initial weights is done Randomly
- While the error percentage is too high

-For each training pattern (presented in random order)

  - enter inputs to networks
  - Outputs calculated for all neurons that entered in input layers, Within hidden layers structure, to the outer layers.
  - At output ,errors is calculate
  - outputs errors used to counting the error signal for pre-output of layers
  - Computing the weight adjustments is done by using error signals
  - the weight adjustments is Applied from computing

-Periodically evaluate the network performance

- Apply the value of each input parameter to each input node
- Input nodes compute only the identity function

To calculate outputs for every neuron in network based on the network pattern, the equations that use is below.

The output from neuron j for pattern p is O_{pj} where

$$O_{pj}(net_j) = \frac{1}{1+e^{-\lambda net_j}} \tag{4}$$

and

$$net_j = b_j + \sum_k O_{pk} W_{kj} \tag{5}$$

k ranges over the input indices and W_{jk} is the weight on the connection from input k to neuron j, b_j is the bias weight to output neuron j.

To calculate the error signal for each output neuron, the equations that use is below.

The output neuron error signal d_{pj} is given by

$$d_{pj} = (T_{pj} - O_{pj})\, O_{pj}\, (1 - O_{pj}) \tag{6}$$

Where, T_{pj} is the target value of output neuron j for pattern p and O_{pj} is the actual output value of output neuron j for pattern p.

error signal for each hidden neuron is calculated,by equations below can be used.

The hidden neuron error signal d_{pj} is given by

$$\delta_{pj} = O_{pj}(1 - O_{pj}) \sum_{k} \delta_{pk} W_{kj} \tag{7}$$

When the d_{pk} is the error signal of a post-synaptic neuron k and W_{kj} is the weight of the connection from hidden neuron j to the post-synaptic neuron k.

To calculate and apply weight adjustments, the equations below can be used.

- Compute weight adjustments ΔWji at time t by

  $$\Delta W_{ji}(t) = \eta \delta_{pj}\, O_{pi} \tag{8}$$

- weight adjustments Applied for according to
- $$W_{ji}(t+1) = W_{ji}(t) + \Delta W_{ji}(t) \tag{9}$$
- Some add a momentum term

  $$\beta \Delta W_{ji}(t - 1) \tag{10}$$

CHAPTER 4

MATERIALS AND METHODS

4.1 The Proposed Methodology

Artificial neural networks have opened new research area in learning about the natural history of diseases and predicting heart disease. In this work, we propose the use of artificial neural network to predict the 1-year survival of patients who have suffered myocardial infarction.

Artificial Neural Networks revolutionized the world of medicine and surgery. This step has been important in helping surgeons, especially in cardiac operations, which have given great efficiency or predict survival of the patient living for one or more years. These networks have given a new opportunity for patients to help them live

. The problem that doctors are faced with is the precise knowledge of whether the patient will survive for a year or more or will not live for a year and what variables help to know that

Therefore, this work is to give more push forward an intelligent system based backpropagation neural network that will be using a database and training the data on a many patients that had disease. The database consists of 11 parameters as inputs such as survival period after infarction, a measure of contractility around the heart, etc,..

We can check the network and train it according to the data, symptoms and variables with us. There is usually historical data for the patient to see if there is a myocardial infarction or not. These input parameters or vital signs are correspondent to the other medical variables which help the network to find differences in the two classes.

For outputs we will have one parameter which represents if the patient has survived for one year or not. Upon training the system will be capable of predicting whether the patient is going to survive for one year or will die before.

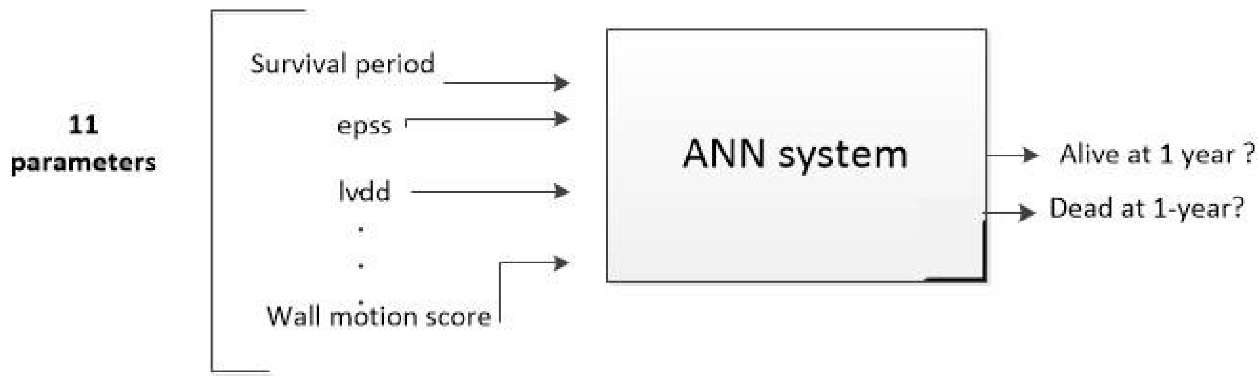


Figure 9: The Proposed prediction system

4.2 Database Description

The database consists of (survival period ……….wall motion score) that indicate the patient's conditions after having myocardial infarction. Those parameters will be in table 1 below. As seen in the table 1, some parameters are different medical such as the occurrence of myocardial infarction pericardial-effusion which represents the fluid found around the myocardium. The wall represents medical information such as motion showing the left ventricle movement

Some information such as surviving for his or her age cannot be helped by the patient's historical medical information These two parameters in addition with the other medical parameters can be enough for the prediction of the 1-year survival of myocardial infarction patients.

The database consists of 131 cases of different patients obtained for the public online database: UCI Learning Machine [Lichman2013..]. The database has 13 different parameters: 11 are considered as inputs and one as output which is the variable that shows if the patient has survived or not at 1 –year.

Table 1 Database description

Attribute	Attribute Description
Survival	Refer to the number of months that patient survived (has survived, if patient is still alive). Because patients have heart attacks at different times.
Still-alive	A binary variable. 0=dead at end of survival period, 1 means still alive
Age-at-heart-attack	Age in years when heart attack occurred
Pericardial effusion	Binary. Pericardial effusion is fluid around the heart. 0=no fluid, 1=fluid
Fractional-shortening	A measure of contractility around the heart lower numbers are increasingly abnormal
Epss	E-point septal separation, another measure of contractility. Larger numbers are increasingly abnormal.
lvdd	Left ventricular end-diastolic dimension. This is a measure of the size of the heart at end-diastole. Large hearts tend to be sick hearts.
wall-motion-score	A measure of how the segments of the left ventricle are moving
wall-motion-index	Equals wall-motion-score divided by number of segments seen. Usually 12-13 segments are seen in an echocardiogram.
mult	a derivate var which can be ignored
name	The name of the patient (I have replaced them with "name")
Group	Meaningless, ignore it
alive-at-1	Boolean-valued. Derived from the first two attributes. 0 means patient was either dead after 1 year or had been followed for less than 1 year. 1 means patient was alive at 1 year.

4.3 The Proposed Network Topology

The developed system is about a neural network to be trained on some parameters of 131 instances of patients who have had myocardial infarction. The number of parameters used in the database is 11 therefore the number of inputs neurons in the input layer is 11 where each one represents a different parameter. The number of neurons in the input layer is 2 since the proposed system is to classify two classes: death at 1 year, or alive at 1-year. The number of hidden neurons was taken as 100 by experience.

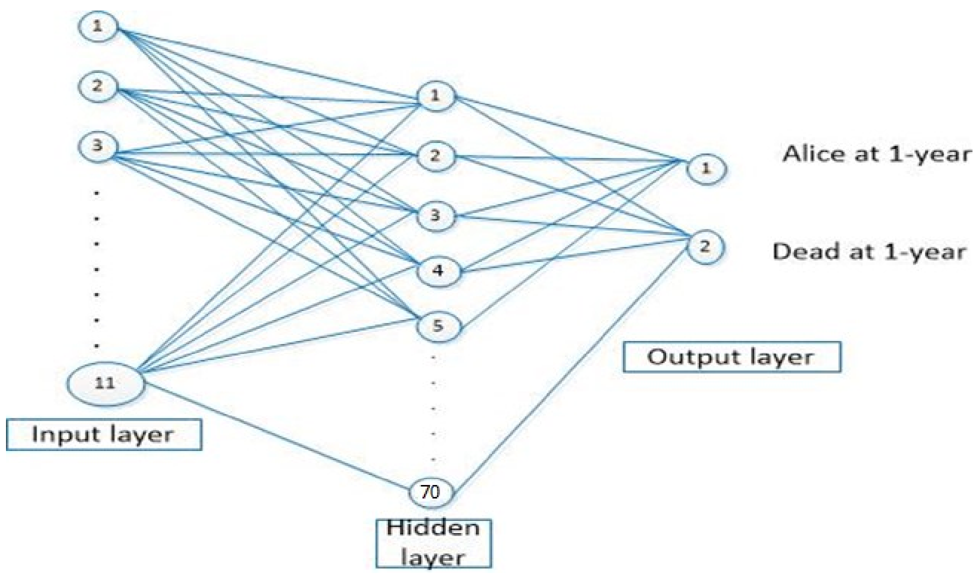


Figure 10: The proposed BPNN architecture

The output coding

Table 2 Output coding and classes

Output classes	Coding
Dead at 1-year	[0 1]
Alive at 1-year	[1 0]

4.4 Training the Network

The Network was trained on 67 instances obtained from UCI learning machine [Lichman.2013]. The table 3 represents the training set of images which consists of two types of data's: dead and alive at 1-year. In the training and examination phase, a number of records of the contents of the data and its base are shown. The training is carried out by the learning algorithm. It is necessary to make sure that the error is at the minimum and then start feeding the neural networks with inputs and data as follows.

Table 3 Training and testing data

Data	Dead	Alive	Total
Training	45	22	67
Testing	44	20	64
Total	89	42	131

Data normalization is done by analyzing and examining the data and information entering the program and representing 0-1 which is represented by achieving the goal in a row

Figure 11 represents a flowchart that illustrates our proposed system for the prediction of 1-year survival myocardial infarction. Table 4 shows the network parameters setting used during the training phase.

Table 4 Input network parameters

Network data	Values
Number of training images	67
Number of hidden neurons	70
Activation function	Sigmoid
Learning rate (η)	0.1
Momentum rate (α)	0.8
Epochs	1000

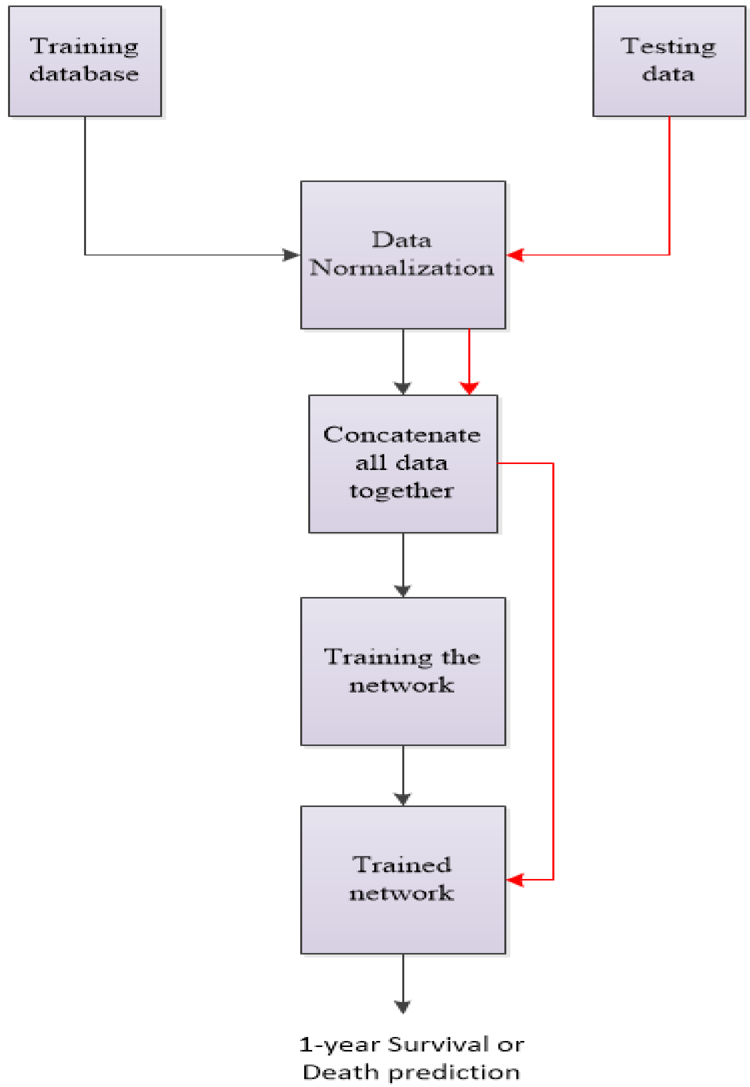


Figure 11: Flowchart of the developed network system

The figure below shows the flowchart of the developed system. As seen in the figure the whole obtained data is divided into two sets: training and testing sets The inputs are divided into two parts, namely 0-1, which is similar to the input to the network. The information is represented within the program and is trained to allow the network to predict the correct result and help it with learning and development.

After the network learns, it is tested by the testing set and the network here doesn't iterate; it goes only for one forward pass and it simulates the testing input data and shows the actual predicted outputs

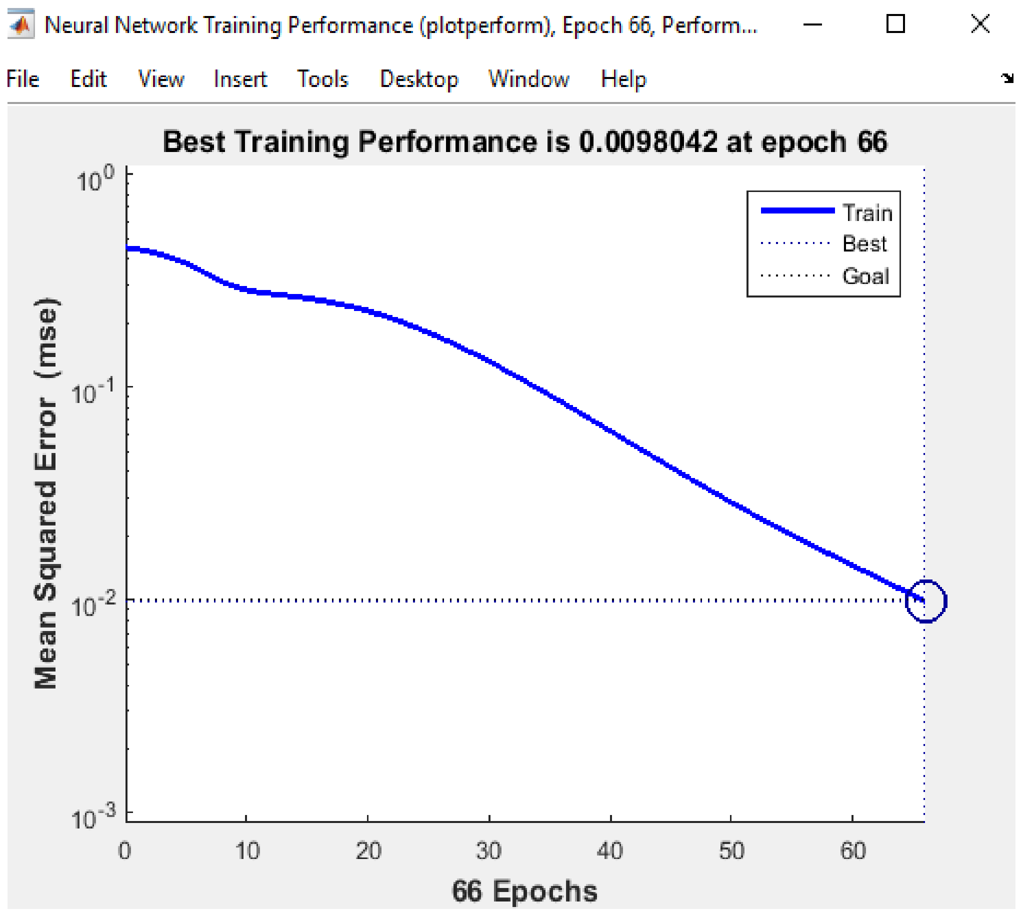


Figure 12: Error variation with the iteration number

Figure 12 shows the learning curve of the trained network. It can be seen that the network learned well since the error is decreasing after each epoch or iteration. The network has reached an error of 0.009 at epoch 66 which is good enough for this phase.

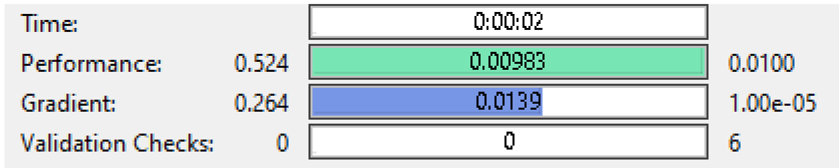


Figure 13: Training time and error achieved

Figure 13 shows that the time taken for the network to learn and achieve the minimum square error. As seen, the network was able to learn in 2 seconds and achieved a minimum square error of 0.009.

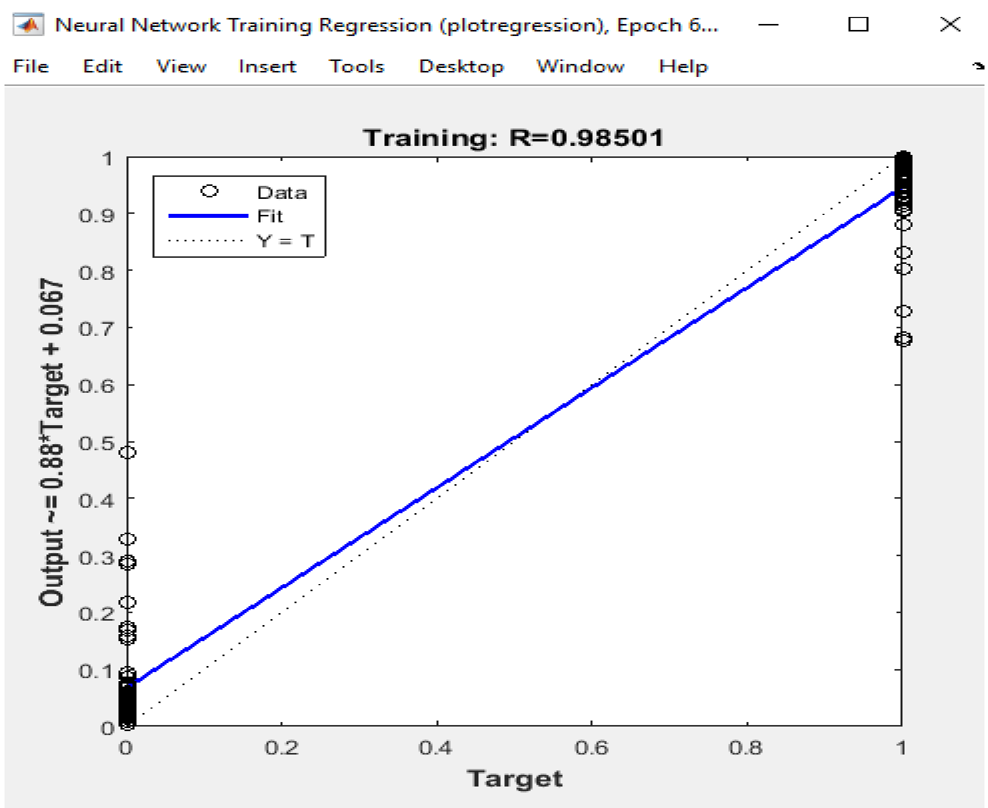


Figure 14: Training classification rate

The figure 14 shows the regression plot of the trained network. This graph shows the difference between the actual outputs and the targets. The dotted lines represents the targets however, the blue one shows the actual output obtained after training the network. As seen in the figure the two lines are very close to each other which means that the network learned well and the error is very low. The graph shows the training recognition rate achieved which is 98.5%.

4.5 Network Performance

The network was simulated and trained on Mat lab software and tools. It was implemented using 2.7 GHz PC with 4 GB of RAM, Windows 7 OS and Mat lab 2013a program tools. Math Lab is a mathematical equations program developed by scientists for many uses in medicine, software, information simulation and its use in software and manufacturing.

The network was tested on a dataset of 64 records or patients; 44 for dead at1-year, and 20 for alive at 1-year. Table 5 represents the total prediction rate of the designed 1-year survival myocardial infarction prediction system. The ranking and testing rate is in the table and shows for each category of data used in the smart system .This table below represents the number of These cases and steps that have been filtered, examined and categorized by the smart grid in the training, testing and testing phase . It also shows the percentage of images that were not correctly classified by the network during the testing phase. The data were obtained from the public database UCI leaning machine. They were processed and then normalized for the purpose to values between 0 and 1 for easy computing and faster processing during the learning phase of network.

Table 5 Total recognition rate

	Total number of data (patients)	Number of correctly classified cases	Prediction rate
Training	67	66	66/67 98.5%
Testing	64	61	95.3%
Total	131	127	96.9%

The MACD cases were categorized correctly on a number of training cases and this process was called predictive rate. It shows the efficiency and strength of neural networks in the examination and prediction of survival for one year. The experimental results of the developed 1-year survival myocardial infarction prediction system were as follows: 98.5% using the training data set (67), and 95.3% using the testing data set (64). The overall prediction rate was eventually calculated and the result is approximately 96.9% correct recognition rate.

CHAPTER 5

RESULTS DISCUSSION AND COMPARISON

5.1 Results Discussion

This work has proposed a new intelligent framework for the prediction of the survival of patients who have myocardial infarction. Therefore, the system can predict the patient will be alive or dead at 1-year. The prediction capability of this system was obtained by training this system using a database that contains different parameters that have abnormal ranges when one has myocardial infarction. The main attributes is that shows if the patients has survived or not at 1-year. This parameter was considered as an output of the system. Thus the network learned the different values of parameters in both classes; when the patient died at 1-year and alive at 1-year. This way of training the network provided it with generalization and predicting ability when simulated with new data.

During training, the network was able to learn and converge in a short time and low minimum square error. Thus, the training recognition rate was satisfying. During testing, the network shows a great generalization capability of predicting the survival of patients that were not seen before. The efficiency of this network is high due to it is the clearance of the clinical data used where the difference between the two classes is obvious. This made it easy for the network to learn and produce a high efficiency and accuracy during testing.

Figure below shows some output results during training the network. These data are for the live for 1-year class where the output is coded as [1 0]. As seen in the figure the neuron that fires is the first one.

0.8646	0.8698	0.9441	0.9629	0.6242	0.8316	0.8379	0.8916	0.9677	0.9126	0.9517	0.9067
0.0468	0.0249	0.0096	0.0020	0.1641	0.0069	0.1153	0.0008	0.0148	0.0155	0.0029	0.0008

Figure 15: training output results sample

5.2 Results Comparison

To esteem the efficiency of the advanced prediction system, the obtained results were compared to the other related works listed in the literature review section. In (Resa et al, 2016), the authors developed a system for the prediction of myocardial infarction. A total of 935 cardiac patients have chest pain and non-diagnostic electrocardiogram (ECG) were following during two weeks divided into two groups based on their myocardial infarction situation. Therefore, two types of data had used for all patients are nominal (clinical data) and quantitative (ECG findings).

Two different artificial neural networks, multi-layer perceptron and radial basis function. were used for classifying two groups. Results: The radial basis function neural network had an accuracy by 83% with electrocardiogram findings and an accuracy by 78% with clinical features. When and clinical data were used in an MLP neural network trained with a genetic algorithm, electrocardiogram results led to a classification precision of 96% and clinical data give an accuracy of 84.5% . In other researches (Jorgan et al, 1996) the authors investigated several aspects of using neural networks as a diagnostic tool. The specific clinical problem chosen for explanation was the diagnosis of acute myocardial infarction, given only the electrocardiogram and the concentricity of potassium in serum at the time of acceptance. They found that, in contrast to usual pursuit, the termination of the training process should be based on the popularization performance and not on the training performance. Experimentally, they found that a principal component analysis could be used to eliminate redundant variables, thereby reducing the data space. The diagnostic performance of the neural network we used was 78%

In table 6 below shows, the results compare of our signing up confession, system with some other systems that used several databases but same classifiers. It can be seen that the advanced system perform well in the popularization phase since its accuracy is either equal or higher than the other proposed researches.

Table 6 Results comparison

Paper Title	Authors	Methods used	Prediction Rate
Prediction of acute myocardial infarction with artificial neural networks in patients with nondiagnostic electrocardiogram	Javad Kojuri et al.	Backpropagtion neural networks and Radial Basis Function Network	83% and 84.5%
Use of neural networks to diagnose acute myocardial infarction. I. Methodology	JORGEN et al.	Backpropagtion neural networks	78%
The proposed prediction system	NEAR EAST STUDENTS	Backpropagation neural network	96.8%

CONCLUSION

A neural network is a modeling of the human biological brain in terms of layers and neurons and memory. Neural networks process information similar of the of way human brain does. The network is including large number of highly interfaces processing elements (neurons) working in parallel to solve a specific problem. Neural networks are learning by examples. So they cannot programmed to do a specific task. The examples must be chosen carefully otherwise useful time is wasted or even worse, the network can be functioning in wrong way. The disadvantage is that because the network finds out how to solve the problem by itself, its operation can be unpredictable.

In this work, an intelligent system for the 1-year survival prediction of the myocardial infarction patients was developed. The system is a neural network of 11 inputs and 2 outputs. The 11 inputs represent the number of parameters of the database used. The 2 outputs neurons represent the 2 classes being predicted which are: dead or survived at 1-year.

One of the challenges that were faced is the training recognition that couldn't be obtained by the first runs. Therefore, the network was training for many runs until the mean square error is obtained and a high recognition rate is achieved. Thus, the network has to be trained for 3 to 63 times before testing it so that the right weights will be obtained and the high recognition rate will be achieved.

Moreover, the network used to learn well during training means that the recognition rate was high. However, whenever this network is tested, it seems that the network is not capable of generalizing or correctly predicting. To improve the network capability when testing is to attempt to stop the training before the network gets into over fitting. This can be done by reducing the number of iterations used to train the network.

It can be stated that a simple signature recognition system was developed in this work. Regardless of the simplicity of the system it is efficient enough to be compared to more complex and advanced related intelligent prediction systems for the same prediction task.

Finally, a recommendation for future work is the use of different classifiers for predicting the myocardial infarction such as support vector machine (SVM) and Radial Basis Network. It is conceived that using SVM can help eliminate the classifier re-training as obtains in the BPNN; since SVM is a maximum margin classifier that always converge to the same local minima. However, it is noteworthy that working with SVM on data with high dimensionality can significantly raise required computational cost and time. Hence, future work should reveal some important trade-offs for using SVM as compared to BPNN.

Moreover, also recommended to use more data for training and testing as well as use of more advanced neural networks for prediction tasks.

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APPENDIX A

Codes

```
close all
clear all
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

train_input=xlsread('input data.xlsx');
t1=ones(2,131);
a=t1(:,1:45);
b=t1(:,90:111);

a(2,:)=0;
b(1,:)=0;

train_target=[a,b];
% CREATING AND INITIATING THE NETWORK
net = newff(minmax(train_input),[70 2],{'logsig','logsig'},'traingdx');


% TRAINING THE NETWORK
net.trainParam.goal = 0.01; % Sum-squared error goal.
net.trainParam.lr = 0.11;  % Learning Rate.
net.trainParam.epochs =1000;% Maximum number of epochs to train.
net.trainParam.mc = 0.8 % Momentum Factor.

[net,tr] = train(net,train_input,train_target);
ActualOutput=sim(net, train_input)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%



%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%testing the network
test_input=xlsread('test data.xlsx',);
ActualOutput=sim(net, test_input)
```

APPENDIX B

INTERVEIW

We had an interview with Dr. Gamal Abdul Hafiz Alomla .we have asked him about One-year Survival Myocardial Infarction Prediction network.

Q1/ What factors must be considered in Myocardial Infarction؟

Age – smoking- - Family medical history-blood pressure – Diabetes- obesity - exposure to stress- Pericardial effusion and fluid around heart.

Q2/ Can be this system helpful for doctors to make decision?

Yes, it can.

Q3/ Does parameters good for this system?

Yes it does .But need more parameters.