Prediction of Malaria using Artificial Neural Network

Rahila Parveen†, Akhtar Hussain Jalbani†, Mohsin Shaikh†, Kashif Hussain Memon††, Saima Siraj†, Mairaj Nabi††† and Shamshad Lakho†

† Quaid-e-Awam University of Engineering, Science & Technology, Nawabshah, Pakistan
††University College of Engineering & Technology, the Islamia University of Bahawalpur, Pakistan
†††Shaheed Benazir Bhutto University, Shaheed Benazirabad, Pakistan

Summary
In current era disease are very common but among all Malaria is one of the major one causes of death, whereas every year, malaria is the cause of about three million deaths including one-third of children.
Several approaches have been proposed and implemented in which Malaria can only be detected by taking a blood sample of patients in the laboratory. These techniques cause a delay in the start of treatment. Due to which, Death ratio is considerably higher for Malaria disease in the world. The aim of this research is to speed up the process of Malaria diagnosis. An Artificial Neural Network with MPL (Multi Layer Perceptron) is used along with back propagation, back propagation with momentum and resilient propagation rule for the prediction of Malaria. Among all three learning rules, Back propagation gives the more efficient results approximately 85%.
In the proposed approach, history and symptoms of patients are considered as an input, system analyses that data and predict the result for the victim as positive or negative for Malaria. This application is useful for those areas where there is no any laboratory facility or where there is no Doctor; in such condition the person who able to operate the application by giving only verbal history and physical appearance of the patient.

Keywords:
Malaria detection; Artificial Neural Network; Multi-Layer Perceptron; Efficiency

1. Introduction

Nowadays disease attack is very common but among all Malaria is one of the major one causes of death. Malaria is also a vector-borne disease, which never transmits by it but a third party that called as a vector. The main cause of malaria is Plasmodium sporozoites which are the blood parasite.
After malaria transmission cycle patient might have complained of some symptoms whom he is affected by the complaint of a headache which is one of the major cause of malaria, and from systemic patient, might has fever also a major cause of malaria [45].
By skin point of view might have complained of chills and sweating while from the respiratory system may affect by a dry cough. It's also happened patient has a complaint about nausea and vomiting from stomach system while the possibility of the occurrence of spleen enlargement.
With the rise of image processing technologies in recent years, it has been decided to use the recently popular convolution neural network in approaching the problem of Malaria diagnosis.
Convolution neural networks have shown a high percentage of success in image classification [38], and such as, the theory was that if a human can be trained to recognize the Malaria parasite, so a convolutional neural network could also. If successful, transferable piece of software, or even a website, could give an immediate result of whether or not a blood slide is infected with Malaria, replacing the cumbersome and costly process that exists in which a blood sample must either be sent to the closest microscopist, analyzed, and the result returned, or through the use of a Rapid Diagnostic Test, known for giving false results [39]. Back propagation is used to diagnose the sleeping disorder at very early [5]. Images classification has been done for the improvement of dark images using Artificial Neural Network(ANN)[4]. Neural Network has deeply trained for image processing using multi-prediction deep Boltzmann machine.
This diagnosis is carried out using neural networks by which cognitive task and brain simulation. Multi layer feed forward network with back propagation learning algorithm is used. The efficiency of the proposed system is compared with other similar systems. Results show that proposed system is robust than all other related systems.

2. Related Work

2.1 Introduction

Millions of people suffered from malaria and face the severity if not a diagnosis at the initial stage. Many applications have been introduced for the diagnosis as well as the treatment to solve this issue but still not recovered fully.

Manuscript received December 5, 2017
Manuscript revised December 20, 2017

2.2 Emergence of Malaria

Malaria is a well-known disease which causes the death a million people. It has been estimated that
Plasmodium is responsible for malaria which causes the millions of people approximately 247 million cases only in 2006 alone. It was observed in 2008 by WHO that two species of Plasmodium were involved one they named as Plasmodium vivax second Plasmodium falciparum [48]. The weather factors directly impact on Malaria incidence due to biological needs for the vector and parasitic agent.
By many experiments done in laboratory and mathematical models, it has been identified basic thresholds of temperature and humidity on mosquito and parasite development [33]
The favorable condition of climate can also result in the more reproduction of vector which increases the risk of malaria [29].

2.3 Malaria as a Vector Born Disease

Malaria is mainly caused by the bite of female mosquito named as Anopheles that spread the Plasmodium sporozoite into Human's red blood cells. Malaria is a vector born disease because it never transmitted by itself but by a vector that is female Anopheles mosquito which is abundantly found in dirty areas, peri-urban side, river side and forestall side [29][49].
By the estimation of people, it has been observed that 300-500 million cases are found every New Year, out of 1.5 to 2.7 million deaths occur in all over the world [40].

2.4 Types of Plasmodium

Malaria is mainly caused by four different species of genus malarial parasite which includes Plasmodium. Plasmodium has four different types which are P.falciparum, P.vivax, ovaleand, and P.malariae. Plasmodium is a single-cell, small blood protozoan which originated by mosquito species [50]. Malaria can be detected by thin blood smears which detect the species f malaria among all four types, as well as thick blood smears find the density of Plasmodium per micro liter of RBC's [41].
It has been diagnosed species of Plasmodium [54] by thin blood cell cover while the density of Plasmodium diagnosed by thick blood coats in per microliter of RBC's.

2.5 Brief Introduction of an Artificial Neural Network with Its Working

M Today's computers are highly effective to use for solution of algorithms and mathematical problems but still, it is hard to define algorithm fully by computers. Some of the features like facial recognition, voice recognition, and processing of a language cannot be solved easily by using computer's algorithm, however, these tasks are very common to humans. Artificial Neural Networks process information in a similar way like our brain do by using brain neurons [41].
2.5.1 How do they work?
Biological neuron looks like that a neuron is the basic unit of the brain. Our brain has millions of interconnected neurons which send the messages from body to brain for decision.
2.5.2 How do they work?
Artificial neurons also work like biological neuron named as 'perceptron'.
Artificial neurons models work like biological neurons functions.
2.5.3 Implementation of Artificial Neural Networks
Here we will see how neurons work together, how their weight is being calculated to provide desired output.
Fig 1: feed forward network is shown where three layers are there Input, hidden and an output layer which is interconnected to each other. Arrows direction shows the network is sending information in a single direction which is forward because of that network is called as feed forward network because input fed to hidden neuron then to output neurons. Hidden neuron might be one may be more than one in MPL network.

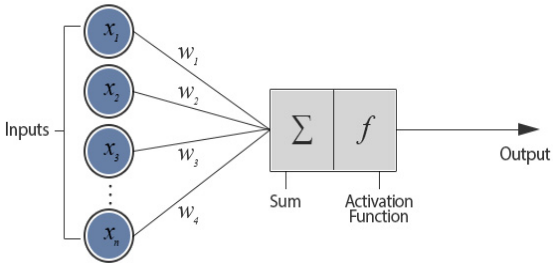


Fig. 1 Feed Forward Network.

3. Proposed System

This model constructed to shed light on five steps which involve predicting the affected patients.

3.1 Patients Symptoms

It has been observed that malarial symptoms begin 8-25 days following infection; however, it is also might possible late occurrence of symptoms in those patients who have taken antimalarial medication for prevention. One of the major symptoms from the skin are shivering followed by fever and sweating, occur every two days in p.vivax P.ovale infections, and every three days for P.malariae, P.falciparum infection can cause continuing fever every 36–48 hours. Along with a fever headache and

Fig. 2 Research Model.

fatigues also are the major symptoms of malaria. According to doctors if two major symptoms appear at the same time then the patient is affected by malaria.
Along with those 4 major symptoms, there are four other minor symptoms included vomiting spleen enlargement, dry cough and back pain. P.falciparum usually caused by severe malaria, its symptoms appear 9-30 days after patient get infected. It is also caused for one of the major symptoms which is a headache. [45]
Here we collect the symptoms verbally and visually. Also, we consider the history of the patient by which symptoms patient is being suffered.

3.2 Store Patient's Symptoms

After collection of symptoms, we store all the symptoms in our database which are already collected by the brief history of the patient.

3.3 Database

Initially, data base is created which is implemented on neural network classification for processing. As mention in Table No.1.Here is table 0 indicates that patient is not affected by particular symptom and 1 indicates that patient affected by it.

3.4 Neural Network Classifier

A neural network classifier consists of units (neurons), arranged in layers, which convert an input vector into some output. Each unit takes an input, applies an (often nonlinear) function to it and then passes the output on to the next layer. Generally, the networks are defined to be feed-forward: a unit feeds its output to all the units on the next layer, but there is no feedback to the previous layer. Weightings are applied to the signals passing from one unit to another, and it is these weightings which are tuned in the training phase to adapt a neural network to the particular problem at hand. This is the learning phase. Neural networks have found application in a wide variety of problems. These range from function representation to pattern recognition, which is what we consider here. [54]
An Artificial Neural Network is designed and implemented which predict malaria by getting verbal input from the patient.

Table 1: Database

*Fever	*shivering	Vomiting	spleen Enlargement	Dry cough	*fatigu esness	back pain	*Head ache	Result
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	1	0
1	1	1	1	1	1	1	1	1
0	0	0	0	0	0	1	1	0
0	0	0	0	0	1	0	0	0
0	0	0	0	0	1	0	1	1
0	0	0	0	0	1	1	0	0
0	0	0	0	0	1	1	1	1
0	0	0	0	1	0	0	0	0
0	0	0	0	1	0	0	1	0

4. Results and Discussions

This study focused on to prediction of malaria using the Artificial Neural network with the method of Multi Layer Perceptron using its three rules which include Back propagation, Back propagation with momentum and Resilient propagation by considering the verbal history and physical appearance of the patient.

4.1 Data Description

The results provided by NN classifier are verified by using confusion matrix which will be discussed in next chapter also the efficiency will be measured by this method.
Result analysis involved into two steps which are verification and validation.
The huge study data collected by the laboratory, in which 256 patients were trained in our application, out of which we have tested 120, male were 20, females was 40 and infant were 60 as mention in Table 2.

Table 2: Data Description of Patients

Total Data	376
Trained Data	256
Tested Data	120
Male	20
Female	40
Infant	60

4.2 Application for the Prediction of Malaria

This study predicts malaria using the artificial neural network with three different learning rules. In our study Neural network is used along with Back propagation, Back propagation with momentum and Resilient Rule.

4.3 Results

Neural Network has trained on different patient's data which is collected by laboratory and Doctors than after it was tested as well.

Fig. 3 shows the environment of neural network after training and testing.

Multi Layer Perceptron has been used along with back propagation, back propagation with momentum and resilient propagation. Fig 3 also shows 3 layers, layer 1, layer 2 and layer 3.

The network is using 8 different neurons on layer 1, along with biased neuron. The first neuron indicated Fever, second Shivering, third vomiting, forth spleen enlargement, fifth dray cough, sixth fatigueness, seventh back pain and eighth headache. Whereas Fever, shivering, fatiguesness, and headache are the major symptoms of malaria. According to doctors if any two of them appear same time then the patient must be affected by malaria.

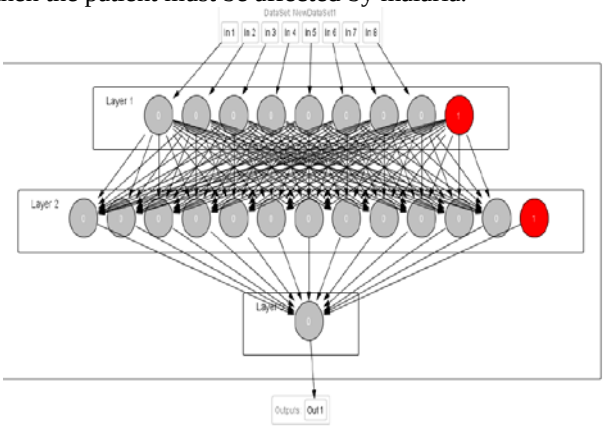


Fig. 3 Model for Prediction of Malaria.

Patient 1

Patient must input the symptoms in the dialogue box to get know the result for malaria prediction. Fig 4 shows the dialogue box, where patient 1 data is given as input.

The data which will be given by any patient it will calculate the result according to rules which have been trained to the network.

Fig 5 shows that patient 1 is not suffering from fever, shivering, vomiting, spleen enlargement and dry

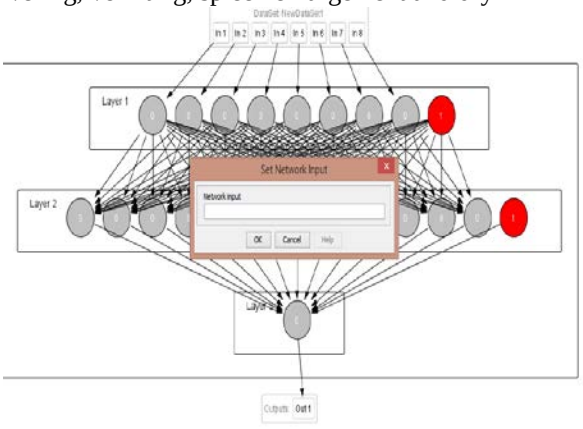


Fig. 4 Network Input Dialogue Box.

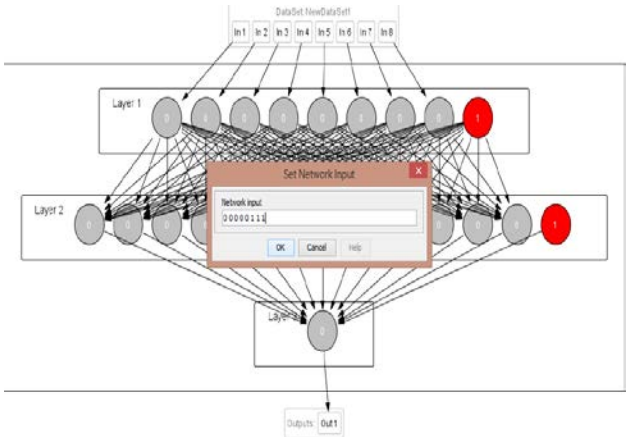


Fig. 1 Patient 1 Input Data according to symptoms a cough although it has complained of fatigueness, back pain and headache.

Fig 6 shows the result of patient 1 using the Back propagation rule.

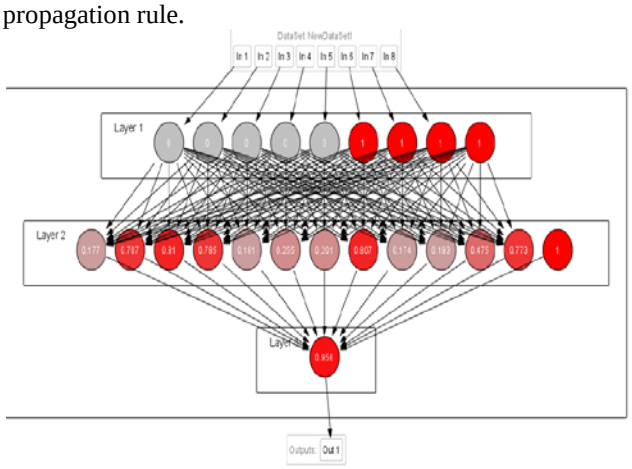


Fig. 6 the result of patient 1 using the Back propagation rule.

The network has predicted patient 1 as affected for malaria by given percent 0.956.

On layer 2 hidden neurons are calculated different weight mentioned in Fig, then layer 3 output neuron provides the result of an affected person after prediction.

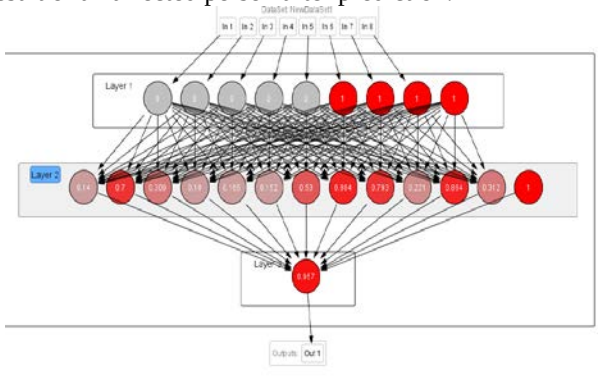


Fig. 7 Result of Patient 1 using Back propagation with momentum Rule

Patient 1 after checking into another rule of Multi Layer perceptron that is resilient propagation which provided the result as affected by malaria with percent 0.94 on layer 3 on output neuron as shown in Fig 4.6 along with the weight of 12 hidden neurons on layer 2.

Patient 2

Data of patient 2 given as input to input dialog box to network as mentioned in Fig 9, affected by two

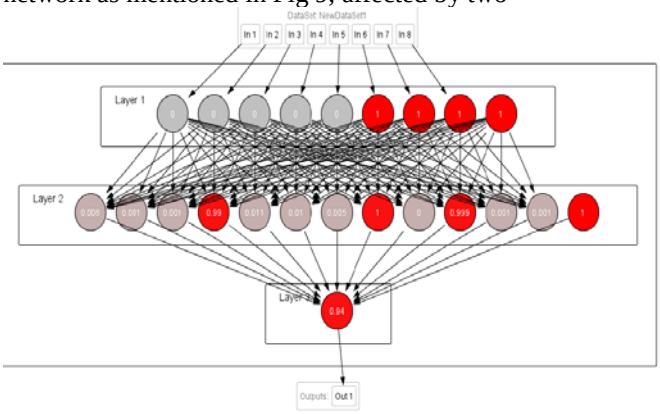


Fig. 8 Result of Patient 1 using Resilient propagation Rule

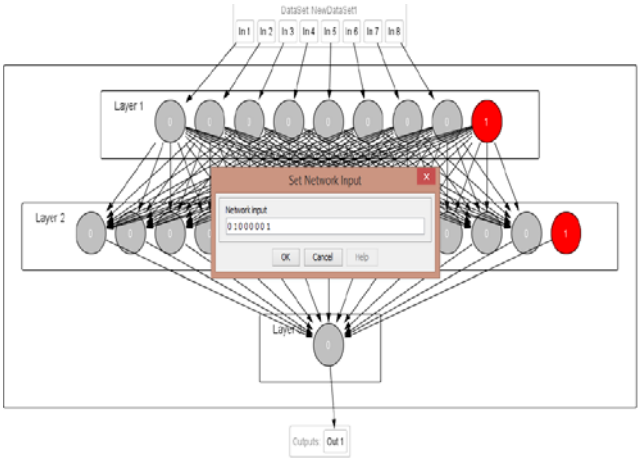


Fig. 9 Patient 2: Input data according to symptoms

symptoms shivering and headache out of eight symptoms of malaria which has been trained to network, but among those, these two are also major symptoms which must cause for malaria if appear same time. In the input box, it is clearly shown that patient is not suffering from fever, vomiting, spleen enlargement, dry cough, fatigueness and back pain by representing by input 0.

Input data is checked into the network along with back propagation rule as shown in Fig 10 with accuracy 0.972 for patient 2 who have complained of shivering and headache.

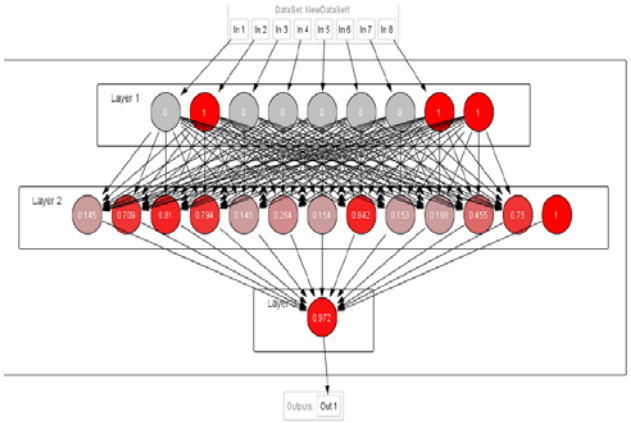


Fig. 10: Result of Patient 2 using Back propagation Rule

Layer 1 shows the input neurons according to symptoms given by patient which is directly connected to a data set of the network where rules have been described.

On layer 2 hidden neurons weight is calculating along with biased neuron.

Input data of patient 2 is given to network by using back propagation with momentum rule. The system is predicted patient 2 as affected for malaria with an accuracy of 0.972 as shown in Fig 10, where the patient has complained of shivering and headache which are major symptoms of malaria. This rule also predicted patient 2 as affected by malaria.

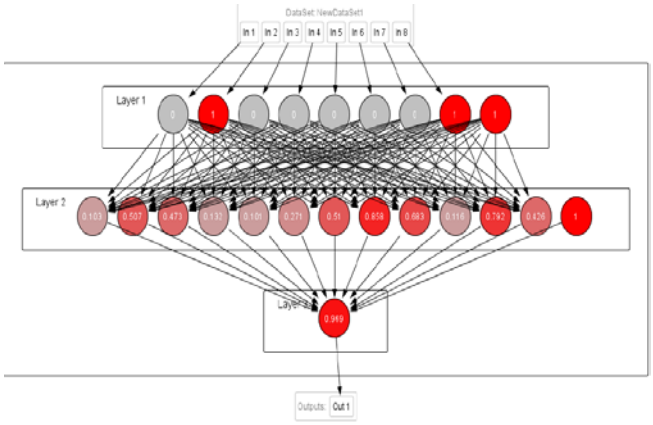


Fig. 11: Result of Patient 2 using Back propagation with momentum Rule

The network here shows in Fig 12 that patient 2 is predicted by using Resilient Propagation which provided the result as affected by malaria accuracy of 0.955.

On layer 1 neuron two represent shivering and neuron eight represent a headache while neuron nine is a biased neuron. Fig shows three layers of multi layer perceptron,

Layer 1 shows the input nodes for neurons, layer 2 shows the hidden nodes for neurons and layer 3 shows the output neuron after calculating the result for input data provided by the patient.

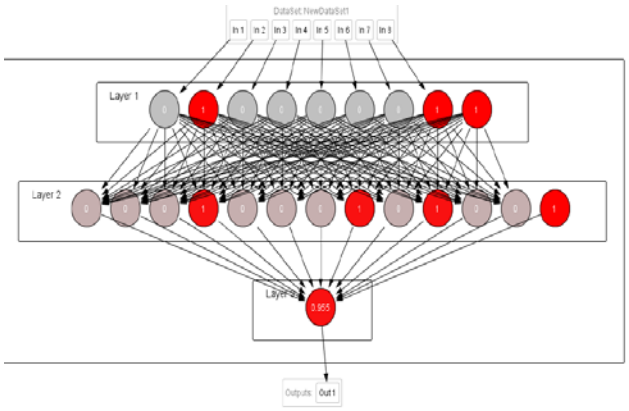


Fig. 12. Predication of Patient 2 by using Resilient Propagation

4.4 Over All Monthly Result of Visited Patients

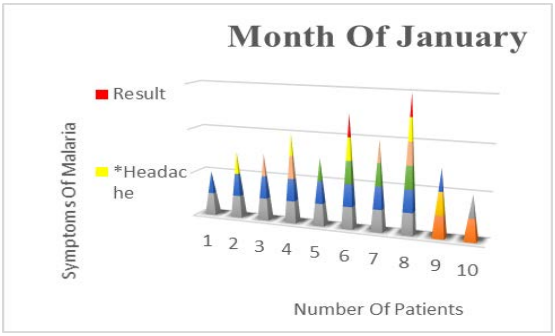


Fig. 13 Patient predicted in January

In the month of January 10 patient has predicted by network out of which two were affected for malaria including patient 6 who have complained of a headache, fatigueness, dry cough and vomiting while patient 8 was also affected by malaria due to same reasons along with back pain as shown in Fig 23. Rest of eight patient also complained about some of the symptoms of malaria but they were not affected by malaria which was patient number 1, 2, 3, 4, 5, 7, 9 and 10.network has trained on different patient's data which is collected by laboratory and Doctors than after it was tested as well.

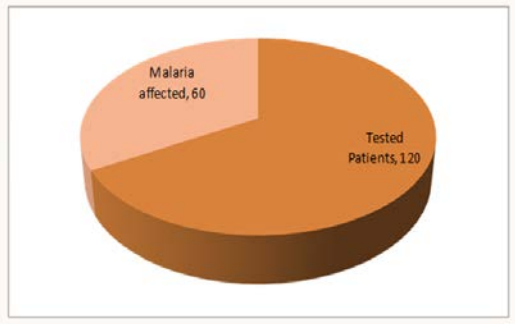


Fig. 14 over all affected patients

4.5 Recognition Rate With Respect To Ground Truth Value

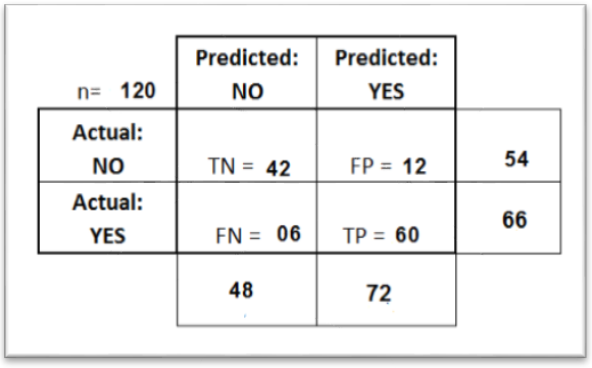
Table 3 Recognition rate with respect to ground truth value

S.NO	Input Data	Back Propagation	Back Propagation with Momentum	Resilient Propagation	Ground Truth Value
1	Patient 1	0.956	0.957	0.94	1
2	Patient 2	0.958	0.954	0.941	1
3	Patient 3	0.961	0.942	0.942	1
4	Patient 4	0	0	0	0
5	Patient 5	0.922	0.935	0.927	1

4.6 Recognition Rate by Using Confusion Matrix

The confusion matrix is an error checking matrix, in machine learning it's also knows as Contingency table. It is a specific table layout by which performance of an algorithm can be measured visually, typically a supervised learning while in unsupervised learning it's commonly called as matching matrix. Each column of the matrix represents the instances in a predicted class while each row represents the instances in an actual class (or vice-versa).The name stems from the fact that it makes it easy to see if the system is confusing two classes (i.e. commonly mislabeling one as another) [55].

Accuracy: Overall, how often is the classifier correct?
(TP+TN)/total = (60+42)/120 = 0.85
Misclassification Rate: Overall, how often is it wrong?
(FP+FN)/total = (12+6)/120 = 0.15
True Positive Rate: When it's actually yes, how often does it predict yes?
TP/actual yes = 60/66 = 0.90
Also known as "Sensitivity" or "Recall"
False Positive Rate: When it's actually no, how often does it predict yes?
FP/actual no = 12/54 = 0.22
Specificity: When it's actually no, how often does it predict no?
TN/actual no = 42/54 = 0.77
Precision: When it predicts yes, how often is it correct?
TP/predicted yes = 60/72 = 0.83
Prevalence: How often does the yes condition actually occur in our sample?
Actual yes/total = 66/120 = 0.55



n= 120	Predicted: NO	Predicted: YES	
Actual: NO	TN = 42	FP = 12	54
Actual: YES	FN = 06	TP = 60	66
	48	72	

Fig. 15 Recognition rate by using Confusion Matrix.

4. Conclusions and Future Work

In this study, malaria is predicted by verbal and visual features.

In our proposed approach, history and symptoms of patients are considered as an input, system analyses that data and predict the result for the victim as positive or negative for Malaria by using the Neural network with Multi-Layer Perceptron along with its three different learning rules (Back probation, Back propagation with momentum, resilient propagation).

Among all three learning rules, Back propagation gives the more efficient results approximately 85%.

By this study malaria can be predicted by all rural areas, small clinics, medical camps, a training system for new doctors, hospitals also anywhere it needed without the need for experts.

This application makes they delay in treatment because malaria is predicted at an initial level so treatment will be started soon that can avoid the risk of severity of patient.

- This research can be extended by more dataset
- Malaria can be predicted by its type(*P. falciparum, P. vivax , P. ovale, P. malariae, P. knowlesi)*
- In future, medicine will also be suggested by the Doctor automatically after knowing the type of malaria
- Furthermore, it can be tested in another model of Neural Network with different learning rules rather than MPL

References

[1] Wu, Tony Hao, Enid Wai-Yung Kwong, and Grantham Kwok-Hung Pang. "Bio-medical Application on Predicting Systolic Blood Pressure Using Neural Networks." Big Data Computing Service and Applications (BigDataService), 2015 IEEE First International Conference on. IEEE, 2015.

[2] Sawada, Yoshihide, and Kazuki Kozuka. "Transfer learning method using multi-prediction deep Boltzmann machines for a small scale dataset." Machine Vision Applications (MVA), 2015 14th IAPR International Conference on. IEEE, 2015.

[3] Hussain, Abir Jaafar, Dhiya Al-Jumeily, and Haya Al-Askar. "The application of dynamic self-organised multilayer network inspired by the Immune Algorithm for weather signals forecast." Technological Advances in Electrical, Electronics and Computer Engineering (TAEECE), 2015 Third International Conference on. IEEE, 2015.

[4] Periyasamy, N., P. Thamilselvan, and J. G. R. Sathiaseelan. "A comparative study of ANN, k-means and AdaBoost algorithms for image classification."Innovations in Information, Embedded and Communication Systems (ICIIECS), 2015 International Conference on. IEEE, 2015.

[5] Garg, Vijay Kumar, and R. K. Bansal. "Comparison of neural network back propagation algorithms for early detection of sleep disorders." Computer Engineering and Applications (ICACEA), 2015 International Conference on Advances in. IEEE, 2015.

[6] Wang, X., Kuzmicheva, O., Spranger, M., & Graser, A. (2015, May). Gait feature analysis of polyneuropathy patients. In Medical Measurements and Applications (MeMeA), 2015 IEEE International Symposium on (pp. 58-63). IEEE.

[7] Ozdemir, Merve Erkinay, Esen Yildirim, and Serdar Yildirim. "Classification of emotional valence dimension using artificial neural networks." Signal Processing and Communications Applications Conference (SIU), 2015 23th. IEEE, 2015.

[8] Hajimani, Elmira, M. G. Ruano, and A. E. Ruano. "MOGA design for neural networks based system for automatic diagnosis of Cerebral Vascular Accidents." Intelligent Signal Processing (WISP), 2015 IEEE 9th International Symposium on. IEEE, 2015.

[9] Mao, Yunxiang, Zhaozheng Yin, and Joseph M. Schober. "Iteratively training classifiers for circulating tumor cell detection." Biomedical Imaging (ISBI), 2015 IEEE 12th International Symposium on. IEEE, 2015.

[10] Barcelos, Allan, Sandro J. Rigo, and Jorge LV Barbosa. "Ubiquitous System for Stroke Monitoring and Alert." Computer-Based Medical Systems (CBMS), 2015 IEEE 28th International Symposium on. IEEE, 2015.

[11] Ercelik, Emec, Rahmi Elibol, and Neslihan Serap Sengor. "A model on building and modifying the stimulus action association in the brain." Signal Processing and Communications Applications Conference (SIU), 2015 23th. IEEE, 2015.

[12] Kawoos, U., Meng, X., Tofighi, M. R., & Rosen, A. (2015). Too Much Pressure: Wireless Intracranial Pressure Monitoring and Its Application in Traumatic Brain Injuries. Microwave Magazine, IEEE, 16(2), 39-53.

[13] Frize, M., Gilchrist, J., Martirosyan, H., & Bariciak, E. (2015, May). Integration of outcome estimations with a clinical decision support system: Application in the neonatal intensive care unit (NICU). In Medical Measurements and Applications (MeMeA), 2015 IEEE International Symposium on (pp. 175-179). IEEE.

[14] [14] Korkmaz, F., Yilmaz, A., Akdogan, E., Aktan, M. E., & Atlihan, M. (2015, May). Estimation of impedance control parameters with artificial neural networks for variable robotic resistive therapy. In Modeling, Simulation,

and Applied Optimization (ICMSAO), 2015 6th International Conference on (pp. 1-6). IEEE.
[15] Ozdemir, Merve Erkinay, Esen Yildirim, and Serdar Yildirim. "Classification of emotional valence dimension using artificial neural networks." Signal Processing and Communications Applications Conference (SIU), 2015 23th. IEEE, 2015.
[16] Hajimani, Elmira, M. G. Ruano, and A. E. Ruano. "MOGA design for neural networks based system for automatic diagnosis of Cerebral Vascular Accidents." Intelligent Signal Processing (WISP), 2015 IEEE 9th International Symposium on. IEEE, 2015..
[17] Hui, Jonathan, and Richard Kelsey. "Multicast protocol for low power and lossy networks (MPL)." (2015).
[18] Dunn, Eleanor M., and Madeleine M. Lowery. "A model of the cortico-basal ganglia network and local field potential during deep brain stimulation." Neural Engineering (NER), 2015 7th International IEEE/EMBS Conference on. IEEE, 2015.
[19] Jambukia, Shweta H., Vipul K. Dabhi, and Harshadkumar B. Prajapati. "Classification of ECG signals using machine learning techniques: A survey."Computer Engineering and Applications (ICACEA), 2015 International Conference on Advances in. IEEE, 2015.
[20] Gerlach, C., Krumm, D., Illing, M., Lange, J., Kanoun, O., Odenwald, S., & Hubler, A. (2015). Printed MWCNT-PDMS-Composite Pressure Sensor System for Plantar Pressure Monitoring in Ulcer Prevention.
[21] Rao, B. Srinivasa, K. NageswaraRao, and S. P. Setty.(2014)"An approach for heart disease detection by enhancing training phase of neural network using hybrid algorithm." Advance Computing Conference (IACC), 2014 IEEE International.IEEE.
[22] Marciniak, P., Kotas, R., Kaminski, M., &Ciota, Z. (2014, June). Implementation of artificial intelligence methods on example of cardiovascular diseases risk stratification.In Mixed Design of Integrated Circuits & Systems (MIXDES),Proceedings of the 21st International Conference (pp. 503-507).IEEE
[23] Arifianto, Anditya, Ari MoesriamiBarmawi, and Agung Toto Wibowo. "Malaria Incidence Forecasting from Incidence Record and Weather Pattern Using Polynomial Neural Network."International Journal of Future Computer and Communication, Vol. 3, No. 1, February 2014
[24] Filimon, Delia-Maria, and Adriana Albu.(2014) "Skin diseases diagnosis using artificial neural networks." Applied Computational Intelligence and Informatics (SACI), IEEE 9th International Symposium on.IEEE.
[25] Maltas, Ahmet, AhmetAlkan, and Mustafa Karabulut(2014) "Use of artificial neural network algorithm in the immunohistochemical dyeing based diagnosis of thyroid tumor." Signal Processing and Communications Applications Conference (SIU), 22nd.IEEE
[26] Malaria Fact Sheet. World Health Organization, 2014, Available-at http://www.who.int/mediacentre/factsheets/fs094/en/ Accessed 22/01/2014
[27] WHO Millenium Development Goals. World Health Organization, 2014, Available at http://www.who.int/topics/millennium_development_goals/en/. Accessed22/01/2014.
[28] Rismala, Rita, TheHouwLiong, and ArieArdiyanti. "Prediction of malaria incidence in Banggai Regency using Evolving Neural Network." Technology, Informatics, Management, Engineering, and Environment (TIME-E), 2013 International Conference on.IEEE, 2013
[29] Loha Shumbullo, Eskindir. "Variation in Malaria Transmission in Southern Ethiopia. The impact of prevention strategies and a need for targeted intervention." (2013).
[30] Patel, Ankeeta R., and Maulin M. Joshi. "Heart diseases diagnosis using neural network." 2013 Fourth International Conference on Computing, Communications and Networking Technologies (ICCCNT). IEEE, 2013.
[31] Maithili, A., R. Vasantha Kumari, and Mr S. Rajamanickam. "Neural networks cum cloud computing approach in diagnosis of cancer." Int. J. Eng. Res. Applic2 (2012): 428-435.

Mohsin Shaikh received the B.E. degree in software engineering from Mehran University of Engineering & Technology Jamshoro, Hyderabad, Pakistan in 2006. M.S. degree in Computer Science & Engineering from Hanyang University ERICA Campus, South Korea in 2010. Ph.D. degree in Computer Science & Engineering from Chung-Ang University, Seoul, Korea, 2017. His research interests include software engineering.

Kashif Hussain Memon is currently working as Assistant Professor in Computer Systems Engineering Department, University College of Engineering & Technology, The Islamia University of Bahawalpur. He received the B.E. degree in software engineering, M.E. degree in Communication System and Networks from Mehran University of Engineering & Technology Jamshoro, Hyderabad, Pakistan in 2006 and 2008 respectively. He received his Ph.D. degree from Hanyang University ERICA Campus, South Korea. His research interests include pattern recognition, computer vision, application of fuzzy set theory, and clustering techniques with applications to image segmentation and content-based image retrieval.