



Machine Learning for Diagnosis of Malaria in Tropical Africa

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ABSTRACT

Although significant progress towards elimination of malaria, it still remains a major health challenges in several tropical regions where it thrives in nations with a weak healthcare system. Significant increases in investment have resulted in the creating of new tools to combat this parasitic disease. Some of the newest tools require expensive and complex technologies that are not available to national malaria programmes. However, malaria control or reduction of mortality and morbidity to be possible infected person must be identified early of the illness. This goal can be achieved when people that leave in malaria affected environment have quick, good medication and reliable diagnostics. In this study, an Artificial Neural Network classifier algorithm was developed for the early diagnosis of malaria. The program was developed with Anaconda Spyder 3.7. Test run shows that the program can effectively predict malaria as part of the said early diagnosis.

INTRODUCTION

Artificial intelligence can be described as the ability to create non-natural intelligence that can mimic human nature as it respond to its environment through computer programming. Machine learning is an intelligent approach use in artificial intelligence for classification and prediction (Mohammed, 2018). Machine learning uses algorithm for prediction and classification. Machine learning is a process which permits computer input to learn directly from data by using machine

learning algorithm to generate output and with continuous improvement without notable programming. There are three categories of machine learning as listed below, Supervised Learning, Unsupervised Learning and Reinforcement Learning.

This study adopted supervised learning to classify and predict malaria. Malaria is a very deadly disease that can kill anybody irrespective of the color, gender, economic background and not even a specific age group. It can affect anyone, at any time if they put themselves in a situation where they could be at risk. In assessment of the current World malaria report, made available in December, 2019, around 228,000,000 issues of malaria in 2018 were recorded. The World Health Organization (WHO) malaria report shows that 219,000,000 malaria issues and 435,000 deaths were stated in the world record, 80% were from sub-Saharan Africa and India (WHO, 2019). Malaria has become a war in Sub-Saharan Africa with 25% of malaria cases and 24% mortality rate of the world in Nigeria (WHO, 2019). Half of all malaria issues in the nations were accounted by six nations of the nation. In the same, the overall money spent on malaria control and eradication was about US\$ 2.7 billion but yet the war on malaria remains. There are outstanding achievement in artificial intelligence especially machine learning such as fraud detection, market prediction, gaming etc.

In medical diagnosis, practitioners make variations of decisions due to their approaches in dealing with vagueness, imprecision and uncertainties in clinical data. Their intuition and expertise aids in diagnostic decisions. As the volume of information available to these clinicians from new medical technologies increases, the process experience of classifying different sets of symptoms under a single name and determining the appropriate therapeutic actions become increasingly difficult (Jaiswal and Sarode, 2015).

The use of artificial neural network, a subset of machine learning for the prediction of this life threatening disease malaria is important. This system is designed to calculate early malaria patient to avoid death and other consequence. Anaconda Python programming language was used to developed machine learning application for prediction and data were stored in Microsoft excel.

In this research, practical aspect of a developed machine learning application System for early diagnosis that is hoped to form part of clinical infrastructure to enhance diagnostic processes and reduce the morbidity and mortality connected with malaria available.

Problems of study

According to malaria World malaria outcome 2019, malaria has affected countless number of people and yearly a great amount of money is spent on malaria control and eradication to about

US\$ 2.7 billion. Huge capital is invested by different countries to curtail the spread of this disease. Despite the capital invested, malaria challenges are still rampant. It has turned out to be more difficult and cumbersome when diagnosing patients due to these physicians are only able to diagnose very minimal number of patients as compared to the number of sick people who attend hospital daily. Also the physicians spend more time on a patient in trying to diagnosis them.

Again patients delay for a very long time before his/her turn may be up. This sometimes deteriorated the conditions of patients where it became almost impossible to bear. Another problem observed was inaccuracy in the doctor's decision. This occurred frequently in the physician's diagnosis and thus patients had to be re-diagnosed. This is the focus of our work to solve the stated challenges.

The main research question here is: Machine learning application capable of predicting malaria is not available in many parts of Africa.

Secondly, Diagnosis is centered on patient's subjective description of symptoms and the clinical skills and opinions of clinicians.

Objectives of study

This research work is to develop a Machine Learning Application for the Diagnosis of Malaria with the following objectives.

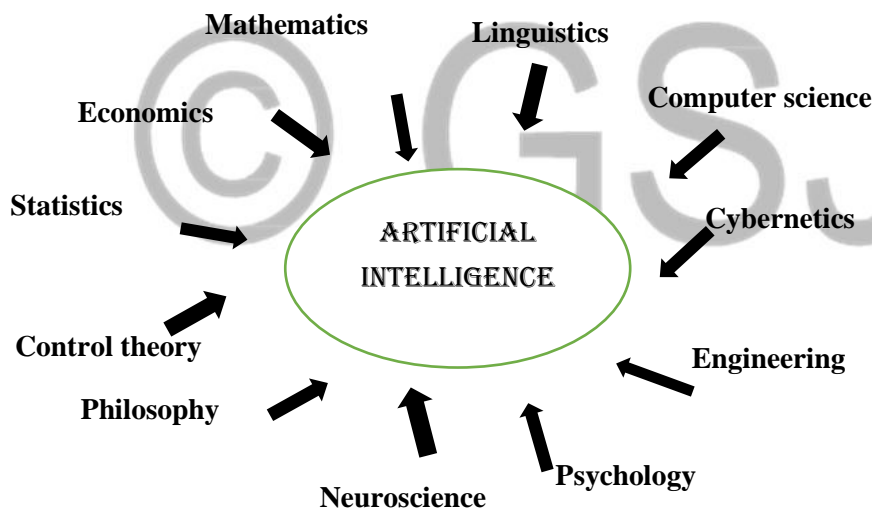
- i. To design a machine learning application for early diagnosis of malaria.
 - ii. To implement the artificial neural network algorithms for early diagnosis of malaria.
 - iii. To test the artificial neural network classifier application for the early or pre-diagnosis malaria following software development standard. A healthy and prosperous world is all our interest, and the avoidance of terminal diseases is one of the best actions to embark. This will encourage the routine of information technology in the day to day activities of Nigerian especially in early diagnosis as less effort is required in its operation.
- i. This would permit consistent uncovering of malaria infections particularly in remote areas.
 - ii. It would provide novice healthcare workers mostly in rural areas as a double method of affirming their diagnosis.

RELATED LITERATURE

Artificial Intelligence: This study adopts the definition by the founding father of AI, John McCarthy who defined AI as intelligent systems that can solve real-world problems as well as perform complex activities.

According to Mohammed (2018) Artificial Intelligence is the capability to meditate and comprehend instead of doing things by instinct or automatically. This is not the activity of using your brain to consider a problem or an idea. AI has been widely perceived as the technological innovation that will continue to shape the transformation of modern society into the next century. It has gained much popularity as a result of its industrial and commercial applications (Neha et al., 2019). According to Naik (2016) the targets of AI is to invent an expert systems that exhibit intelligent conduct, acquire, establish, explain, and instruct its users and to implement human intelligence in machines.

Artificial Intelligence is a broad interdisciplinary field which has roots in all aspect of life and intersects with many domains, as captured in figure 1



Tom Mitchell states that computer program that learn from practice (P) through certain tasks (T) and some Practice measure (P), when its output on (T), is restrained by (P), enlarges output (O) then the program is called a machine learning program (Kajaree and Narayan, 2017).

The machine learning is capable to arrange data and fix it into model that can be agreed and used by people. The program improved against itself. As time goes on, the checkers learned the right positions on the board and equally the wrong moved on the board. This is as a result of playing the game in contradiction of itself. Machine Learning is the capability of the computer to master a pattern and use it to initiate solution to other related problem. Jollie (2018), stated that Machine Learning has made modern business and research easy by applying algorithms of neural network

model to improve computer systems performance.

Machine Learning algorithms develop a mathematical model (training data) through a sample data “to establish an action such that it is independent of its decisions. In engineering, there are larger and larger dataset that are being understood using learning algorithms. Machine learning focused on two related questions:

Is there any way we can develop a computer systems that improve through itself or past data? Secondly, what is the vital statistical computational-information or theoretic laws which control learning systems, human, computer and organization? They have produced exceedingly practical software across many applications or discipline. Artificial intelligence, a subset of Machine Learning has emerged as the method of excellent for practical software development such as computer vision, speech recognition, natural language processing, robot control, etc

Many AI developers know that it is easier to train a system through illustrations of desired response for possible data inputs. The outcome of machine learning can be felt across all discipline such as industries data issues, services, the diagnosis of faults, and govern logistics chains (Domingos and Pazzani, 2018).

Although, Machine Learning differs from conventional computational approaches as conventional computing algorithms are sets of instructions pass to the computer be processed into information solve problem, while machine learning gets solution through existing data or program.

Machine learning techniques are usually classified in three main groups according to the feedback signal available to the learning system (Balcan et al., 2018). Machine learning permits computers to find unseen insights using algorithms that iteratively learn from data. The iterative aspect of it is that it adapt independently.

They learn from previous computations to produce reliable, repeatable decisions and result. There are three main categories of machine learning algorithms are unsupervised learning, supervised learning and reinforcement learning machine learning is important because as models are exposed to new data, they are able (Sultan et al., 2018).

Supervised Learning: This is a subdivision of machine learning. Every machine learning developer take off with supervised learning algorithms which is provided with sample inputs as well as its corresponding outputs (Wilson, 2019). The algorithm learns with trained input and output to generate subsequent or corresponding outputs in case there is error, amend the model accordingly. Supervised learning therefore forecasts label data values to generate unlabeled data (Tagliaferri, 2017). The training of a supervised learning algorithm consists of inputs matched

with the accurate outputs. Thereafter, a supervised learning algorithm take the unseen inputs and determine which label the inputs will be classified based on the previous training. (Wilson, 2019). Supervised learning mostly uses historical data to forecast events of future. It can use historical information of any given organization to anticipate upcoming event or activity, or distinguish some action or outcome. Some popular use cases of supervise learning are Spam detection, Loan approval system, Image classification, recommender System, Medical diagnostic system, Stock price prediction, Handwriting or Speech recognition, Weather Forecast System etc. supervised learning can further be sub divided into regression analysis and classification analysis.

Unsupervised Learning: This uses unlabeled data such that the learning algorithm searches for entity common amidst the input data. Unlabeled data are often more than labeled data to facilitate unsupervised learning.

The purpose of unsupervised learning is to discover unseen patterns among dataset as well as a goal of feature learning, which permits the computer to spontaneously notice the depictions that will be relevance to categorize facts or data. Unsupervised learning procedures can examine complex data that are large and relatively uncommon to organize it in potentially meaningful ways. Unsupervised learning can be used for fake credit card purchases anomaly detection, also acclaim products to buy. In unsupervised learning, unidentified pictures of goats are usually used as input data for the algorithm to discover similarities and classify them together (Tagliaferri, 2017). The ability to forecasts based on previous record creates economical advantage. For example, if an institute has the capacity to envisages the sales quantities of a product. It will be in a more favorable position to optimize inventory levels. This could result in an improved liquidity of the establishments' cash reserves, decrease of working capital and improved customer satisfaction by reducing the backlog of orders (Maklin, 2019).

Reinforcement Learning (RL)

Reinforcement learning, as indicated by Sutton and Barto (2012) is an active branch of Machine learning that describes learning that makes decision based on past or immediate action to bring outcome that is better. This situation can affect the action of the learner and subsequent action. Here, the machine learning only uses the available data to make subsequent decision continuously without considering if the decision is good or bad as long the initial programme is active or executing. Reinforcement learning is machine learning algorithm interacts with a dynamical environment while performing actions toward fulfillment of the goal without a teacher's

evaluation if the performed actions are good or bad. A typical example for reinforcement learning is the self-driving car. Reinforcement learning solely depends on two criteria: trial and error search and delayed outcome. Reinforcement learning deals with how an agent takes action in an environment to maximize a reward. Reinforcement learning has saw huge success in the last few years especially in the context of game theory. Reinforcement Learning (RL) is very closely related to the theory of classical optimal control, as well as dynamic programming, stochastic programming, simulation, optimization, stochastic search, and optimal stopping (Carbonnelle, 2020). Reinforcement Learning is now finding popular uses across industrial areas like Manufacturing, Aerospace, Finance, Advertisement, Robotics and Automation.

Machine Learning Algorithms

There are three main categories of machine learning algorithms for example unsupervised learning, supervised learning and reinforcement learning. There are massive numbers of algorithms used in machine learning to erect models of machine learning and implemented in it (Kajaree and Narayan, 2017). All algorithms can be grouped by their learning methodology, as follows:

Regression Algorithms

In Regression algorithms predictions are made by the model with modeling the relationship between variables using a measure of error (Ayodele, 2010). Continuously varying value is predicted by the Regression technique. The variable can be a price, a temperature. The favoured regression algorithms are Linear Regression algorithm, Ordinary Least Squares Regression, Multivariate Adaptive Regression Splines, Logistic Regression, Locally Estimated Scatter Plot Smoothing are Stepwise Regression. For example, what is the number of people that attend church in Owa-Alero every Sunday? How many age 7 children fetches water from a particular location? When you have a trained data set & outputs and your algorithm forecasts the output based on a fitting function.

Algorithms using Decision Tree

This is a flowchart like structure, in which the internal (root) node represents an assessment on an attribute, the branch or leaf represents an outcome of the test or root, and each leaf node (terminal node) holds a class label. Algorithms using Decision trees are used mainly in classification problem. They split attributes in two or more groups by sorting them using their values. Each tree has nodes and branches (Kajaree and Narayan, 2017). Attributes of the groups are represented by

each node and each value represented by branch. It can be used to solve a variety of problems. Here are a few reasons why you may use Decision Tree:

1. It is easy to understand the tree structure
2. It can be used for classification and regression problems.
3. It is different from most Machine Learning Algorithms because it can work excellently non-linear data.
4. Decision Tree is very easy construct since it uses only one feature per node to split the data.

An example of a decision tree is when asking a question that response yes or no. Have you eaten? If No, will you eat Eba? If No, will you eat rice? When the answer is yes the node will be terminated. In this process the first node is the root while the following nodes are internal nodes. This process will continue or traverse back to first step until the input data is processed.

Bayesian Algorithms

Machine Learning is a field of Computer Science that deals with any system that is programmable and uses computer to store information. Bayesian algorithms use probability theory and Bayes' Theorem to manage and quantify uncertainty. The most famous Bayesian algorithms are Bayesian Belief Network (BBN), Multinomial Naive Bayes Bayesian Network (BN), Averaged One Dependence Estimators (AODE), Gaussian Naive Bayes, and Naive Bayes. Naïve Bayes algorithm is a probabilistic machine learning that depends on the Bayes Theorem, and it uses different classification method on task. Naïve Bayes algorithm has all important ideas such that there is better understanding. Bayes' Theorem can be used for solving conditional probabilities. This is a measure of the probability of an activity occurring when another event has occurred through assumption, presumption, assertion, or evidence. (Chatterjee, 2019)

Types of Naïve Bayes Classifier:

Multinomial Naïve Bayes: Feature vectors represent the frequencies with which certain events have been generated by a multinomial distribution. This is the event model typically used for document classification.

Bernoulli Naïve Bayes: In the multivariate Bernoulli event model, features are independent binary variables explaining inputs. Like the multinomial model, this model is popular for document classification tasks, where binary term occurrence (i.e. a word occurs in a document or not) features are used rather than term frequencies (i.e. frequency of a word in the document).

Gaussian Naïve Bayes: In Gaussian Naïve Bayes, continuous values associated with each feature are assumed to be distributed according to a Gaussian distribution (Normal distribution). When plotted, it gives a bell-shaped curve which is symmetric about the mean of the feature values.

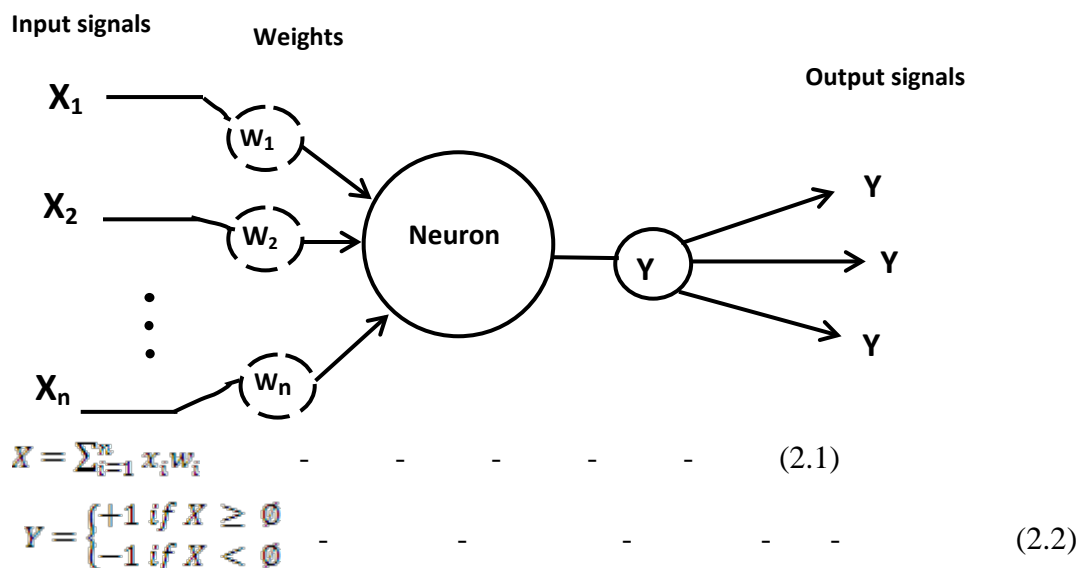
Data Clustering Algorithms

This algorithm split items into different types of batches. It groups the item set into clusters in which each subset shares some similarity. It is unsupervised learning method and its methods are categorized as hierarchical or network clustering and partitioned clustering. We treat a cluster of data objects as one group. While doing cluster analysis, we first partition the set of data into groups. That based on data similarity and then assigns the labels to the groups. The main advantage of over-classification is that it is adaptable to changes. And helps single out useful features that distinguish different groups. The examples of algorithms for clustering are K Means, Expectation Maximization (EM), K Medians, and Hierarchical Clustering (Garbade, 2018).

Algorithms using Artificial Neural Network

Over the decades, ANNs have proved to be powerful computational models for solving complex estimation and classification problems (Viharos and Kis, 2015), as they are robust and are capable of high level generalization. Neural network (NN) comprises of an interconnected group of neurons (Obi and Imianvan, 2011), inspired in the natural neurons. Natural neuron receives signals through synapses located on the dendrites or membrane of the neuron. When signals received are strong enough, the neuron is activated and emits a signal through the axon. This signal might be sent to another synapse, and might activate other neurons. ANN basically consist of inputs (like synapses), which are multiplied by weights (strength of the respective signals), and then computed by a mathematical function which determines the activation of the neuron, then the output (Ghosh, 2018)

Figure 2 is a simple neuron, with input signals X, weights W and Output signals Y:



Where

X is the net weighted input to the neuron,

x_i is the value of input i,

w_i is the weight of input i,

n is the number of neuron inputs, and

Y is the output of the neuron.

\emptyset is empty set

This type of activation function is called a sign function. Thus the actual output of the neuron with a sign activation function can be represented as:

$$Y = \text{sign} \left\{ \sum_{i=1}^n x_i w_i - \emptyset \right\} \quad (2.3)$$

\emptyset = theta

Each neuron in a layer of the ANN is connected with each neuron in the next layer through a weighted connection (Amato *et al.*, 2013). The value of the weight w_{ij} indicates the strength of the connection between the i th neuron in a layer and the j th neuron in the next one. NN model is a structure that can be adjusted to produce a mapping from a given set of data to features of relationships among the data. The model is adjusted, or trained, using a collection of data from a given source as input, typically referred to as the training set. After successful

Type of Malaria Plasmodium

There are four types of malaria that are known to infect man. These are as follow.

- i. Plasmodium Vivax (P.V.):** This is widespread in world that is common seen in India. It can kill and still can cause additional problems or disease. The common symptoms are stated as fatigue, diarrhea, fever and chills e.t.c.
- ii. Plasmodium Ovale (P.O):** It is uncommon varieties malaria located in Ghana, Liberia, Nigeria and West African. Plasmodium ovale can stay long and resurface in the body after many years. These parasites can likely invade RBCs and make the patient sick again.
- iii. Plasmodium Malariae (P.M):** This is not deadly disease. Disease is characterized by high fever and chills.
- iv. Plasmodium Falciparum (P.F):** It is known to be most harmful organism that causes malaria infections and deaths. This category is generally found in Africa, South America, and South

East Asia. The symptoms are fatigue, dizziness, abdominal pain, aching muscles, sore back, joint pain, vomiting, nausea, fever, headache, anemia and some neurological symptoms.

Methodology

The research uses machine learning to improve prediction of malaria. This is a classification problem that follows systematic sequence of events to achieve the objectives. This section unveils the methods or procedures that will be used to achieve the objectives of the research being carried out. Normally, this will answer questions concerning the objectives. It follows a procedure in solving problems as stated below. Firstly, the existing system for solving same problem was studied. Data of previously diagnosed patients with appropriate features is extracted from report from the hospital visited and lastly the expert system will be developed.

Data Gathering

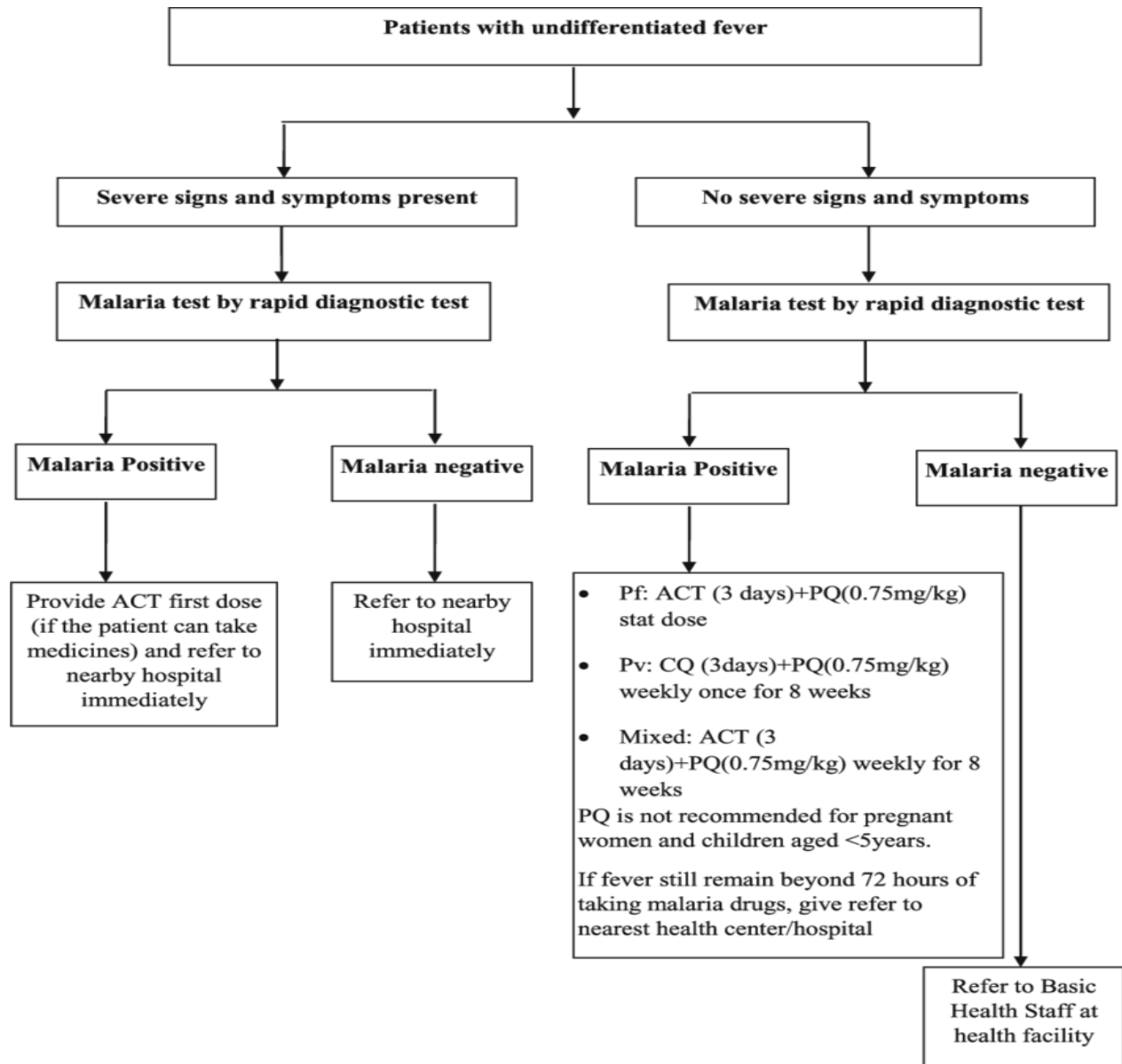
An adequate system methodology would ensure a very detailed research work and ensure that a higher degree of accuracy and efficiency is achieved. With the research permission granted by the institution, we visited Delta State Polytechnic Health Centre, Ozoro that offered records of 1,321 diagnosed patients on malaria. The diagnosed malaria cases were extracted and entered into Microsoft excel package. The records contained information such as, malaria present or not malaria. This was used to build the model of this research. See below the sample data.

Temp	TempStatus	headc	HeadStatus	weakness	WeakStatus	nausea	NausStatus	Remark
1	High Temp	1	Severe	1	Severe	1	Severe	Malaria present
1	High Temp	1	Severe	1	Severe	2	Not Severe	Malaria present
1	High Temp	2	Not Severe	1	Severe	2	Not Severe	Malaria present
1	High Temp	1	Severe	1	Severe	1	Severe	Malaria present
1	High Temp	1	Severe	1	Severe	1	Severe	Malaria present
1	High Temp	1	Severe	1	Severe	1	Severe	Malaria present
1	Not High Temp							Malaria not present
2	Temp	2	Not Severe	1	Severe	2	Not Severe	Malaria not present
2	Temp	1	Severe	1	Severe	2	Not Severe	Malaria not present
2	Temp	2	Not Severe	1	Severe	2	Not Severe	Malaria not present
2	Temp	2	Not Severe	1	Severe	1	Severe	Malaria not present
1	High Temp	2	Not Severe	1	Severe	2	Not Severe	Malaria present
1	High Temp	1	Severe	1	Severe	1	Severe	Malaria present
1	High Temp	1	Severe	1	Severe	1	Severe	Malaria present
1	High Temp	1	Severe	1	Severe	1	Severe	Malaria present

Figure 3.1 shows how the doctor relates with patient in a manual system.

System Analysis of the Present System

Analysis refers to breaking down system into its parts with the intent of understanding the nature, function, and interrelationships. According to Alan *et al.*, (2018), during this phase, the project team investigates any current system, identifies improvement opportunities, and develops a concept for the new system. This can also be referred to as the process of gathering and interpreting facts, diagnosing problems, and using the information to recommend improvements to the system. The major objective of system analysis is to find answers for each process: What is being done? How is it done? Who is doing it? When is he doing it? Why is it being done and How can it be improved? It is more of a thinking process and involves the creative skills of the System Analyst. The present model of the structure a patient goes through at the hospital in order to receive treatment. First and foremost the patient goes to the outpatient department (OPD) for the necessary data to be taken including the temperature and weight. Afterwards the patient queues to meet the doctor in the consulting room. The doctor symptoms gives prescription or decision on what the patient is diagnosis. The patient goes to the laboratory if necessary for investigation, which in turn goes to the pharmacy for collection of drugs prescribed by the doctor. The problem with the present model is that malaria is not diagnosis on time and diagnosis is based on patient's subjective description of symptoms and the clinical skills and opinions of clinicians. Under this model, the absolute decision of the doctor is totally dependent on his/her frame of mind. If the soundness of mind was affected in anyway, the decision or diagnosis would be definitely affected. Figure 3.1 shows how the doctor relates with patient in a manual system.



Pf- *Plasmodium falciparum*; Pv- *Plasmodium vivax*; mixed: *Plasmodium falciparum* and *Plasmodium vivax*; ACT- Artemisinin based combination therapy (Artemether+ Lumefantrine); PQ-Primaquine; CQ-Chloroquine; RDT-rapid diagnostic test with dual antigen

Figure 3.1 Model for Treatment of Malaria
Source: Sivakumar (2014)

Analysis of the Proposed System

The proposed machine learning application system encompasses of artificial neural network which is used to provide early diagnosis of malaria. In training of the above symptoms to behave in a particular way, the neural network adjusts its weights in order to minimize the mean square error between the output of the network and the desired output. The weights of the neural network represent the parameters. In this sense, the training of this neural network results in automatically adjusting the parameters finding for their optimal values. This training is carried out using

back-propagation (BP). Back-propagation is one of the most famous training algorithms for multilayer perception (Abraham and Nath, 2001). Basically, BP is a gradient descent technique to minimize the error E for a particular training pattern. The network is adjusted as many as possible so that the output correspond to a desired output. To design our Machine Learning Application for malaria classification, we designed a system which consists of a set of symptoms needed for the diagnosis (here, we are using four parameters). Figure 3.2 shows the model of the development of Machine Learning Application for the early Diagnosis of Malaria, indicating how the input in this case the malaria symptoms must be fed into the neural network so that it can be trained to yield a particular output, the input to the neural network is retrained. Again pressure from external factors such as financial issues, family cares, social problems among others affected the turn out the diagnosis of the doctors.

Benefit of the proposed system

The new system will help in the early diagnosis of malaria. The software will be of immense benefit to the society especially country where malaria is prominent. Some of the benefits of the proposed system include:

- i. It will help in early diagnosis of malaria.
- ii. It will help to give timely and ideal malaria diagnosis.
- iii. Maintainability: The proposed system will continue to be enhanced since the output becomes the next input of dataset.
- iv. Reliability: The proposed system is reliable and unbiased since the Machine Learning Application is trained with data gotten from previous diagnosis.
- v. It improved test and validate the model using real data of staff's records.

Figure 3.2 shows how the proposed system is integrated in to the existing system. This is the proposed system.

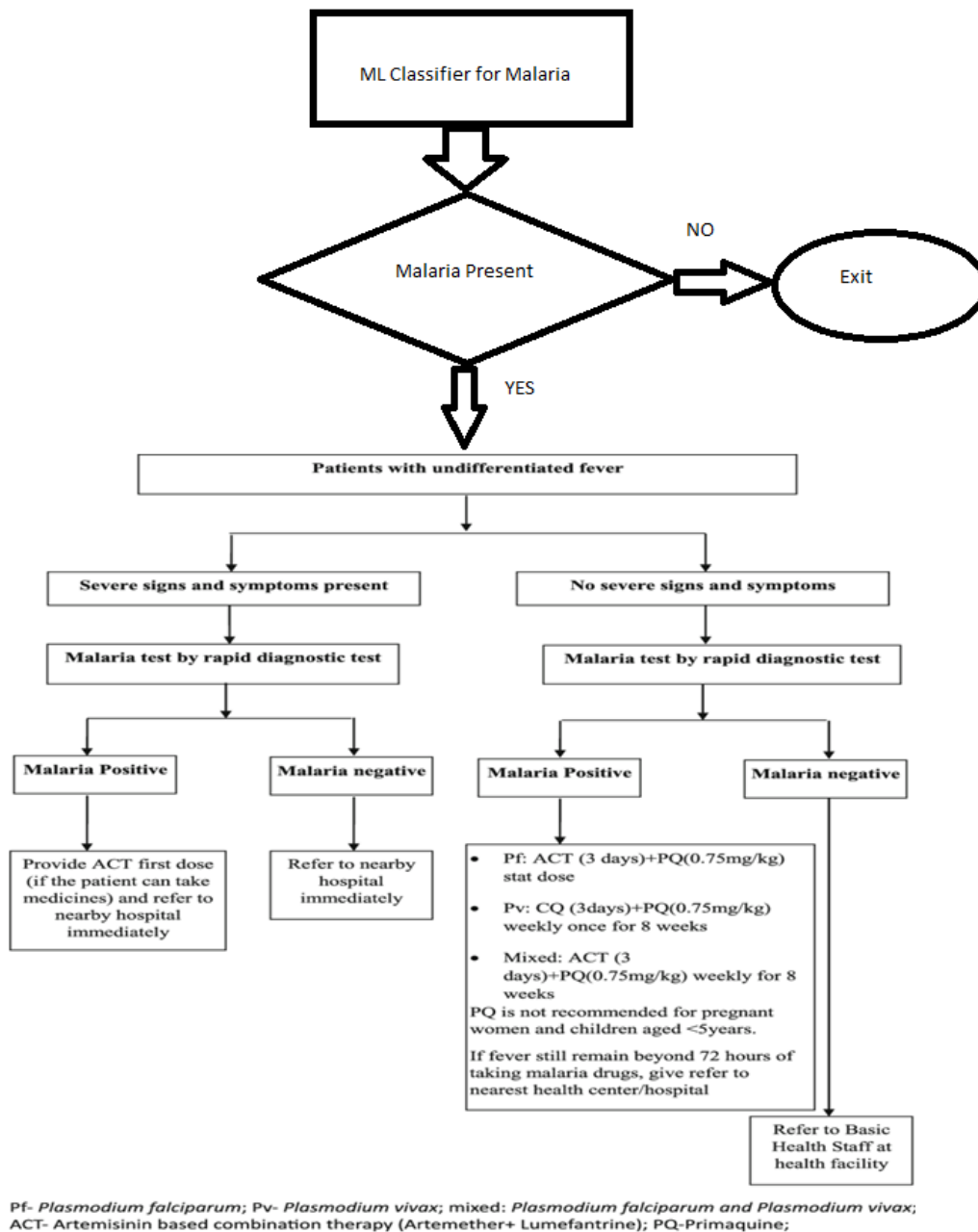


Figure 3.2: The proposed model for Machine learning classifier for malaria

Database Design

A database is a gathering of files that similar. The main function of a database is to offer an enabling environment that will allow convenient and efficient retrieving and storing of database information. Database system is designed to manage large volume of information. The database management system used for the design is Microsoft excel. The database was used to create tables with respect to independent and dependent variables. This database acts as a back end of the system. The new system database is a collection of records of Machine Learning Application for the prediction and classification of malaria plasmodium. Table 3.1 shows the database design structure of the data of malaria.

Structure of Database Table 3.1:

S/N	Field	Database	Width (Bytes)
1	Temperature	Number	2
2.	Weakness	Number	2
3	Nausea	Number	1
4.	Headache	Number	1
5	Remark	Character	4

Input Design

The input indicated that data is collected, validated and stored for use. This design further includes how users can interact with the system and the access level of each user. The input of this design is the patient symptom. The patient is expected to choose the symptoms he/she is experiencing.

Output Design

System analysis and design focuses primarily on the outputs of a system. These are the information the clinician/patient gets as response from the system after the diagnosis. The output design is aim at displaying an accurate result from the input fed into the system.

Results

The reported showed averages which consist of macro average (averaging the unweighted mean per label), weighted average (averaging the support-weighted mean per label), and sample average (only for multilabel classification). Micro average (averaging the total true positives, false negatives and false positives) is only shown for multi-label or multi-class with a subset of classes, because it corresponds to accuracy. Multiple classifiers consist of a set of classifiers whose individual predictions are combined in some ways to classify a new example. Various names such as ensemble methods, committee, classifier fusion, combination is called the process which is intended to improve predictive accuracy. The fi-score of the dataset is 1.00 which corresponds to low false positives and low false negative, that is we are suitably detecting actual threats and you are not disturbed by false alarms.

Table 1 MLPClassifier shows the precision, recall, fi-score and support of classification on Malaria Dataset.

Python	precision	recall	f1-score	support
Malaria not present	1.00	1.00	1.00	150
Malaria present	1.00	1.00	1.00	180
Accuracy			1.00	330
Macroavg	1.00	1.00		330
Weightedavg	1.00	1.00	1.00	330

Summary and Conclusion

This journal examined the challenges with medical diagnosis of malaria. Delta State Polytechnic Health Centre, Ozoro. We had a discussion section with both physicians and patients. From the discussion, it was noted that much of the challenges faced in malaria diagnosis revolves round the non-automated approach of diagnosis. To enhance the quality of malaria result and streamline the diagnostic process, AI-smart workforce was implemented. One of the AI algorithms such as Artificial Neural Network was applied to the management of Malaria. AI tools (Artificial Neural Network) for Machine Learning Application was applied in the clinical diagnosis of malaria. Neural network has the advantages of good learning capacity, generalization capacity, low-level capability and robustness in relation to disturbances. The machine learning application for early diagnosis system for malaria diagnosis was implemented by training of malaria dataset collected from the hospital was done with NN back-propagation and forward-propagation algorithm. The

trained dataset was used as an input of the inference engine for validation and testing. Result from the model, showed that the introduction of machine learning application in medical diagnosis offer the potential of low solution cost and reduce diagnostic time, human expertise and medical error. In this study, an artificial neural network machine learning application was developed for the early diagnosis of malaria. This designed interface can accept symptoms of malaria. Four symptoms were our parameters or variables for the early diagnosis of malaria. The implementation of the machine learning application was done using Anaconda Python (Spyder). This was achieved by using artificial neural network algorithms for the machine learning application. This was tested and it was successful. This is capable of predicting whether malaria is present or not present.

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