



Computer Science & IT Research Journal
P-ISSN: 2709-0043, E-ISSN: 2709-0051
Volume 2, Issue 1, P.1-15, November 2021
DOI: 10.51594/csitrj.v2i1.274
Fair East Publishers
Journal Homepage: www.fepbl.com/index.php/csitrj



EXPERT SYSTEM FOR DIAGNOSIS OF MALARIA AND TYPHOID

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Article Received: 07-10-21

Accepted: 30-10-21

Published: 30-11-21

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ABSTRACT

An expert system is a computer program designed to solve problems in a domain that has human expertise. The knowledge built into the system is usually obtained from experts in the field. Based on this knowledge, an expert system can replicate the thinking process of the human experts and make logical deductions accordingly. Malaria and Typhoid are major health challenge in our society today (Nigeria), its symptoms can lead to other illness which include prolonged fever, fatigue, headaches, nausea, abdominal pain and constipation or diarrhea. People in endemic areas are at risk of contracting both infections concurrently. According to the world malaria report 2011, there were about 216 million cases of malaria and typhoid and estimated 655,000 deaths in 2010. (WHO report, 2011). The main challenging issue confronting the healthcare is lack of quality of service at minimal cost implying from diagnosing to predicting patients correctly. This issue can sometimes lead to an unfortunate clinical decision that can result in devastating consequences that are unacceptable. Although many studies were carried

out by different researchers in the medical domain using various data techniques. In this research work, an efficient expert system that diagnoses patients with malaria and typhoid was developed. A secondary data was collected from university of Maiduguri teaching hospital for the period of four years which ranges from 2017 to 2020. The work explored the potential benefits of proposing a new model for prediction and diagnosis of malaria and typhoid using symptoms. The model adopted the Naive bayes and was implemented using the python. The system diagnoses a patient in real time (within 30 minutes) without necessarily visiting the laboratory for a test. Three algorithms were used these are, Support vector machine, Artificial neural network and Naïve bayes. From our finding, it is observed that Naïve bayes and support vector machine give the best result which is 100% in terms of accuracy of diagnosis.

Keywords: Diagnosis, Prediction, Expert System, Typhoid, Malaria

INTRODUCTION

Medical knowledge is expanding rapidly, making computer aided diagnostic system desirable. Such system can give a clinician a second opinion. Recent advances in Artificial intelligence (AI) offer methods and techniques with potential of solving tasks previously difficult to solve with computer-based systems in medical domains. Research worldwide is focusing on the new applications in the medical field and particularly in diagnosis (Shahina, 2009).

An expert system is a computer program designed to solve problems in a domain in which there is human expertise. The knowledge built into the system is usually obtained from experts in the field. Based on this knowledge, an expert system can replicate the thinking process of the human experts and make logical deductions accordingly. (IRMA, 2017).

Expert system belongs to a branch of Artificial Intelligence that engages the usage of human knowledge to solve complex issues that requires the human expert to naturally probe and diagnose using clinical aids. It is an intelligent computer program that helps to systematize, store and obtain appropriate medical knowledge needed by the practitioner/doctors in dealing with each complicated case and suggesting suitable diagnosis for decision-making procedure (Djam *et. al*, 2011).

There are many reasons for building an expert system to solve health related problems. Human experts may not always be available or may even be absent from a location. Also, by pooling knowledge of many experts, an expert system may be better than one human expert in its overall performance. An expert system does not get tired and are expected to be more consistent. It can also be used for training and passing on the knowledge derived from the human experts.

The two most common form of fever in Nigeria are malaria and typhoid. According to Malaria report (WHO, 2010), malaria causes significant morbidity and mortality worldwide. In developing nations, scarce resources lead to inadequate diagnostic procedures. Malaria can result in anemia (a decreased number of red blood cells). The remains of the destroyed red blood cells clump together and cause blockages in the blood vessels. This can result in brain damage or kidney damage, which is potentially fatal. A particularly serious, potentially life threatening, form of malaria parasite is called Plasmodium falciparum. Malaria infection can be either

uncomplicated or severe. It is said to be severe when plasmodium falciparum is the cause of the infection. The life cycle of the parasite (pathogenesis) is so complicated because of the tendency of the merozoite (daughter cell of the parasite) to produce different antigen that are sensitive to different antibody. This has made the production of the vaccine against it difficult and also making it possible for it to hide from the immune system.

There are four plasmodium species that causes human malaria. These are plasmodium vivax that causes vivax malaria, falciparum malaria is caused by plasmodium falciparum malaria caused by plasmodium malarial and the fourth type oval malaria, caused by plasmodium ovale.

Medical diagnostics is based on different methods of research and diseases determination, and their severity with the purpose to aid select and apply necessary treatment, and prevent the development of complications and recurring diseases. Diagnostic procedures involve interaction between the patient and the medical personnel in the form of “question and answer”, good candidate for computerization. (Guardian, 2012).

Similarly, bacteria called Salmonella typhi (S. typhi) is responsible for typhoid. S. typhi may be spread by consuming contaminated water, beverages and food, after which the bacteria enter the intestines and then the bloodstream, where they may spread to other body parts. Initial typhoid symptoms include malaise, headache, diarrhea (or constipation), sore throat, fever as high as 1040F, as well as a rash. Diagnosis is made by any blood, bone marrow or stool cultures and with the Widal test. In epidemics and less wealthy countries, after excluding malaria, dysentery or pneumonia, a therapeutic trial time with chloramphenicol is generally undertaken while awaiting the results of Widal test and -cultures of the blood and stool (Ryan & Ray, 2004). However, Rapid and accurate diagnosis of malaria and typhoid is integral to the appropriate treatment of affected individuals and in preventing further spread of infection in the community.

Diagnosis is the identification of abnormal condition that afflicts a specific patient, based on manifested clinical data or lesions. If the final diagnosis agrees with a disease that afflicts a patient, the diagnostic process is correct; otherwise, a misdiagnosis occurred. (Oguntimilehin, Adetunmbi & Abiola, 2013). Medical diagnosis is a categorization task that allows physicians to make prediction about features of clinical situations and to determine appropriate course of action it involves a complex decision process that involves a lot of vagueness and uncertainty management, especially when the disease has multiple symptoms. (Uzoka, Obat& Barker, 2009). This research is to build an expert system that diagnosis malaria and typhoid infection and assist with appropriate medication and advice. The research will combine both the infection together and build single system to detect the infection.

Aim and Objective of the Research

The aim of the research work is to develop an efficient expert system to diagnose patients with malaria and typhoid.

The objectives are to:

- i. Developed a model with SQL database and Naive Bayes algorithms to enhance the accuracy of the diagnose.
- ii. Carry out a comparative analysis on Naïve Bayes, Support vector classifier, and Artificial neural network in order to ascertain the suitability of using the Naïve Bayes.

- iii. Construct an expert system that will make use of python as tool to diagnose patient with malarial and typhoid within 30 minutes of time.

Significance of the Study

The significant of expert system in diagnose of malaria and typhoid are numerous to mention, but few are:

- i. Consistent solution: Computers do not suffer some of the weaknesses of humans, such as getting tired or ill and they readily accessible than human experts.
- ii. Expert system plays an emphasizing role in assisting the paramedical personnel's in acting like qualified medical doctors.
- iii. It can also be useful where there is no expertise on malaria and typhoid treatment.

RELATED WORKS OF THE LITERATURE

Alaba & Isaac, (2016) developed a Mobile-Based Fuzzy Expert System (MFES) for Diagnosing Malaria that could assist in diagnosing malaria. The fuzzification of crisp inputs by the system was carried out using an inter-valued and triangular membership functions while the defuzzification of the inference engine outputs was performed by weighted average method. Root sum square method of drawing inferences has been employed while the whole development has been achieved with the help of Java 2 Micro Edition of Java. This expert system executes on the readily available mobile devices of the patients.

Tunmibi *et al.*, (2013) developed a rule based expert system for diagnosing fever. The web based expert system used Visual Basic Dot Net (VB.Net) as the language of its implementation while the rules within the knowledge base were Boolean rules and not fuzzy rules hence; drawing of inference as performed by this system could not have a high degree of human like way of reasoning.

Adetunbi *et al.*,(2012) developed a web-based diagnosis and therapy system that used a machine learning technique was developed. A machine learning technique rough set was used on labeled sets of malaria fever symptoms collected to generate explainable rules for each level of severity. The developed system labeled database, was divided into five cases of malaria and the classification accuracy on training dataset was described to be 100% while that of testing data set was 94%. Even though the study claimed to have developed a web-based diagnosis and therapy system that could be accessed anywhere and anytime, it should not escape the minds of individuals that not all the intended users of the system have access to reliable network and internet facilities in their various locations.

Decision Support System for Malaria and Dengue Disease Diagnosis developed by Priynka *et al.*, (2013) Malaria and dengue remain to be the most vital cause of morbidity and mortality in India and in many other tropical countries with complete 2 to 3 million new cases arising every year, Malaria is a major health problem in the world, oldest chronic and most widespread fatal disease, unavailability of pathological and imaging based medical diagnosis tool in remote areas. Methods: The system was developed using the MATLAB. The overall classification was done using fuzzy logic toolbox. The system has three modules; GUI interface showing the symptoms, Knowledge Base where fuzzification takes place, and Inference Engine where the fuzzified value

is defuzzified in the decision support system model. More than 200 fuzzy rules were generated by the system for diagnosis.

Oladipo, (2016) presented a Mobile Compactable Expert System for the treatment of typhoid fever in developing countries. The motivations for this work include: Typhoid fever is rampant in developing nations with over 21.6 million cases and at least 250,000 deaths occurring annually, expert system development today is either web based or stand-alone application. The methodology involved the use of object-oriented programming approach. The application framework has three parts. User interface, Application login (written in PHP programming language) and Database component using MYSQL server. No evidence of consultation with medical experts, data collection and usage. The prior knowledge and the basis for the diagnosis were not discussed. No computational methodology was deployed.

A Machine Learning Based Clinical Decision Support System for Diagnosis and Treatment of typhoid fever was developed by (Oguntimilehin & Falaki, 2012). Motivating factors include: medical personnel and facilities are adequate for effective tackling of tropical diseases, earlier estimates of global burden of typhoid fever indicate that at least 16millions new cases every year with 600,000 deaths. Two sets of data on typhoid fever cases were collected at different periods. Implementation was done using Visual Basic.NET as front end and MYSQL as backend.

MATERIALS AND METHOD

Location of the Study Area

The study was conducted on the data supplied from the University of Maiduguri Teaching Hospital (UMTH) located in Maiduguri (Borno State). The reason for the choice of sites includes: Proximity (nearness in space, time and relationship) and was happen to be renowned Hospital in Nigeria having enough medical manpower that handles complicated diseases.

Data Collection

In collating and collecting necessary data and information needed for the implementation, the primary source was collected from the patient's folder, direct interview with patient, departments and Parasitology.

In-depth interview was conducted with staff from Parasitology, Virology, and Medical Records Departments for the study. This approach was taken to incorporate the experiences of the respondents.

Population Size and Sampling Technique

The study population size was composed of 738 patients diagnosed with malaria and typhoid for the past four years in UMTH. Purposive and convenience sampling techniques were used to select UMTH Maiduguri as study center. All the patients from 2017 to 2020 was constituted the sample population size of the data from the hospital.

Algorithms Used in the Research Work

In this study, Expert system for diagnosing malaria and typhoid were implemented and Naive Bayes algorithm was proposed as algorithm used. The researched was introduced into three forces which are medical practitioner force, classifier force and the database force, where each force perform an own task under the coordination of the medical practitioner force;

- i. The medical practitioner force enables the user to input his or her symptoms risk factors in order for the classifier force to classify the diseases.
- ii. The classifier force is responsible for classifying the symptoms presented by the medical practitioner force into Complicated or Uncomplicated using the algorithm techniques.

The database force stores and retrieves the information presented to it by the medical practitioner force.

Python Agent Development Environment Platform

Python Agent Development Environment Platform (P.A.D.E) was a framework for development, execution and management of Expert systems environments of distributed computation. P.A.D.E was 100% written in Python language and uses the twisted libraries for implementing and communication.

The implementation phase was based on the python platform. Python is a middle-ware (written entirely in the python language, which simplifies the implementation of expert systems by providing a set of graphical tools that support the debugging and deployment phases. The application platform has been distributed across multiple machines, regardless of the underlying operating system, and the configuration controlled via a remote graphical user interface (GUI).

Malaria and Typhoid Detection Using the Naive Bayes Algorithm

To diagnose malaria and typhoid, the doctor uses his experience and analyze the details provided by:

- i. Patients' medical history
- ii. Physical examination signs

Naive Bayes is a simple, yet effective and commonly-used, machine learning classifier. It is a probabilistic classifier that makes classifications using the Maximum Posteriori decision rule in a Bayesian setting. It can also be represented using a very simple Bayesian network. Naive Bayes classifiers have been especially popular for text classification, and are a traditional solution for problems such as spam detection (Poolsawad & Kambhampati 2014).

Justification for Using the Naive Bayes Algorithm

- It is easy and fast to predict class of test data set. It also performs well in multi class prediction
- When assumption of independence holds, a Naive Bayes classifier performs better compare to other models like logistic regression and you need less training data.

It performs well in case of categorical input variables compared to numerical variable(s). For numerical variable, normal distribution is assumed (bell curve, which is a strong assumption)

DESIGN

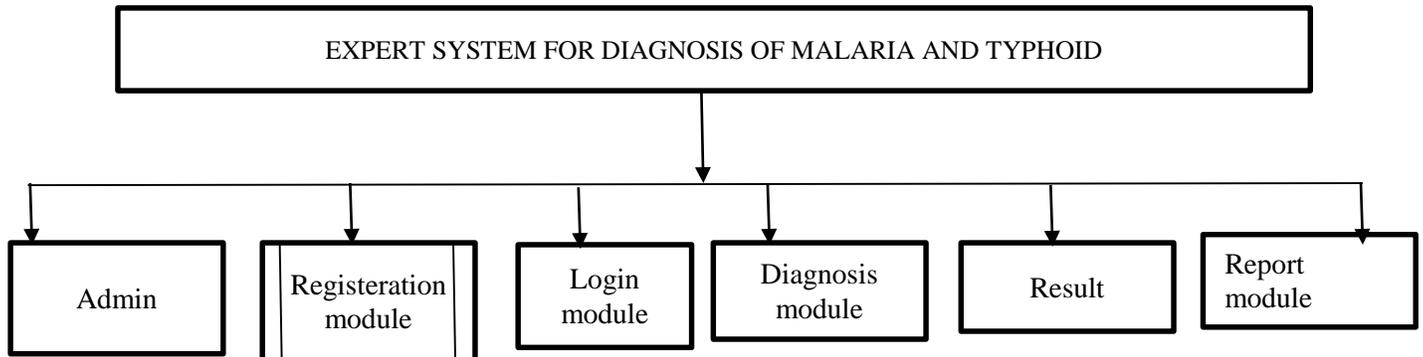
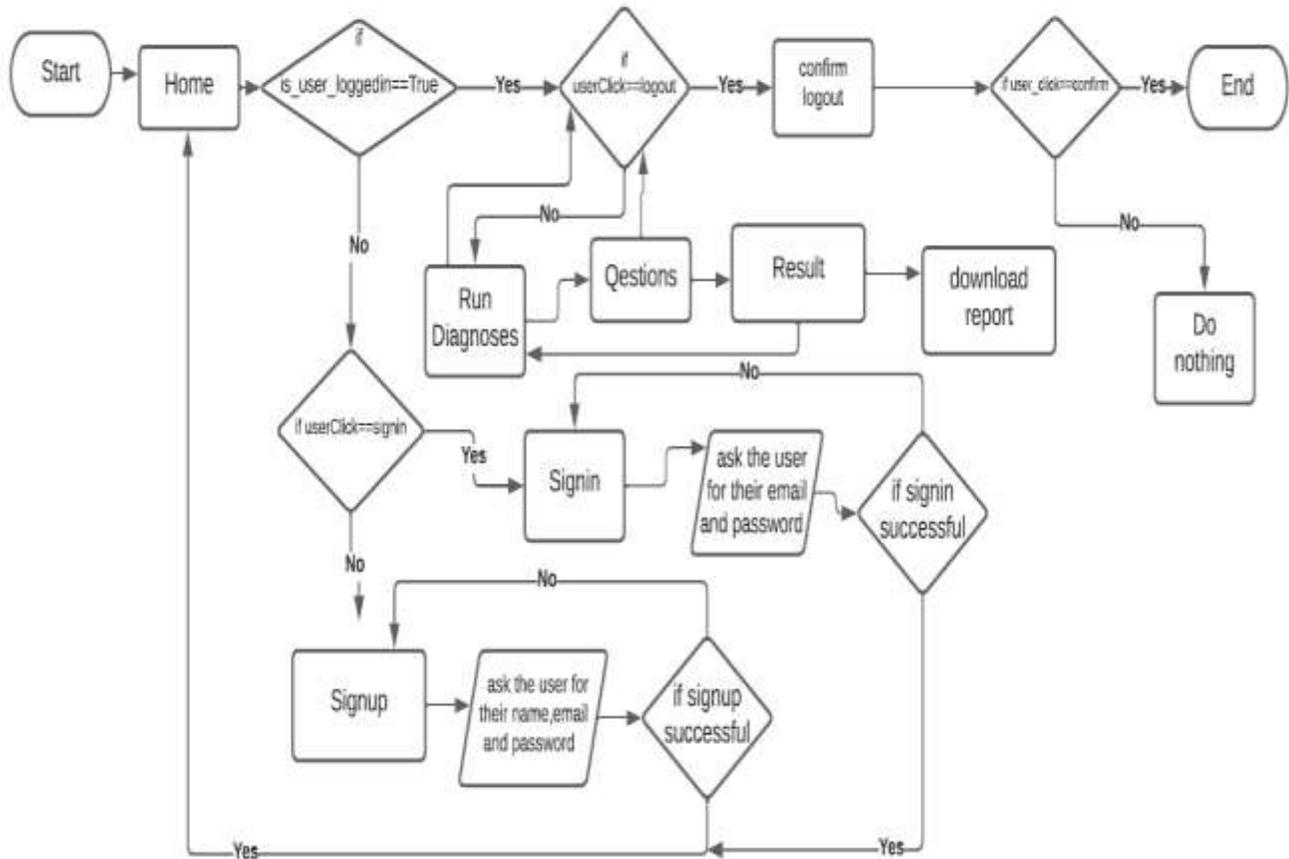


Figure 1: Block Diagram of the system model



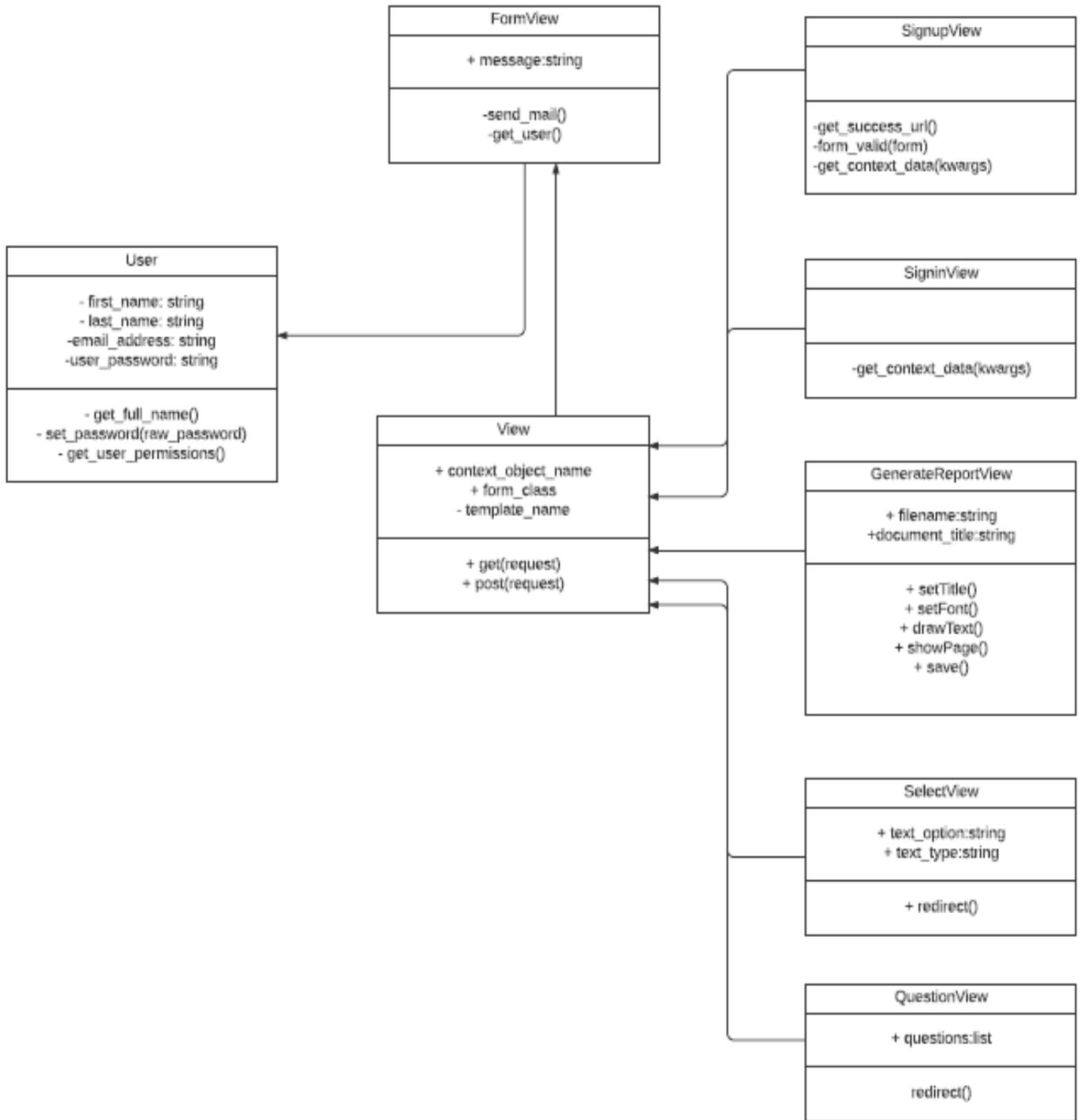


Figure 2: Class Diagram for Expert system to Diagnosis Malaria and Typhoid

RESULTS

The result of this work was presented into two phases. These are:

- i. Result from model interface

ii. Result from the algorithms.

**Result from Interface is Display Below
The Login/ singn up interface**

This shows the login interface. It secures and allows access to the use of the system by an authorized user. It encompasses with sign up as new user and login as register patient.

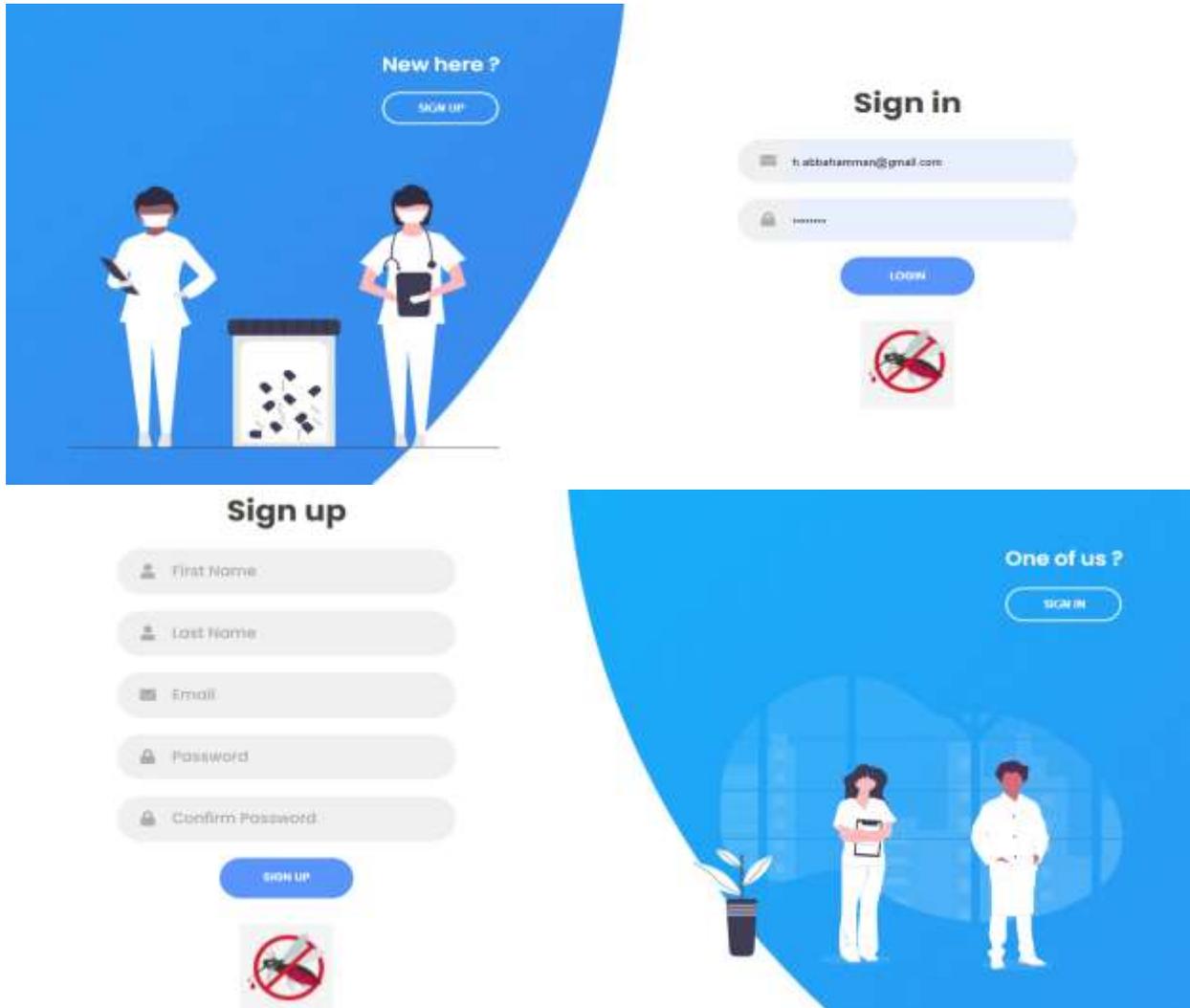


Figure 3: Login/Signup interface

DIAGNOSIS INTERFACE

The screenshot displays the LabAi diagnosis interface. At the top, there is a navigation bar with 'Home', 'Log out', and 'Run Diagnosis' buttons. The main header area includes the LabAi logo, a welcome message for 'Abba Hamman', and a description of the service: 'LabAi offers a Malaria and Typhoid diagnoses. Based on the entered symptoms it tells the patient if he/she have malaria or typhoid'. A 'Run Diagnosis' button is located below the description. The central part of the interface is a questionnaire with the following questions and status:

- Are you feeling feverish ?
- Have you vomitted lately ?
- Do you feel tired ?
- Are you having headache ?
- Are you experiencing constipation ?
- Are you experiencing abdominal pains ?
- Are you having watery stool ?
- Do you have skin rash ?

A blue 'Submit' button is positioned below the questionnaire. The bottom section of the interface shows a 'Negative!!' result notification with a green checkmark icon. The message reads: 'Congratulation you tested Negative for Typhoid Kindly note that you still need to visit a doctor to confirm the best result. Download report here'. A 'Dismiss' button is located at the bottom of the notification box. The footer of the interface includes the LabAi logo and 'Home' and 'Log out' buttons.

Figure 4 Diagnosis interface

RESULTS PRESENTATION

The diagnosis framework has been implemented using Python programming language built on version 3.9.6 (Software code is attached as Appendix). Naïve Bayes algorithm, Support vector machine and artificial neural network were used in training of data. Training set1 and Training Set2 respectively was used. A total sample record of 738 was taken from the hospital and used in the training. The designed system is user-friendly in which users can supply their parameters, and then the system would automatically diagnose and predict the result of their malaria and typhoid. Their complication if necessary. Figure4.1 to figure 4.6 above shows the main windows.

Table 1: Data analysis

s/n	itching	skin_rash	head_ache	continuous_vomiting	shivering	chills	joint_pain	stomach_pain	nuasea	uncer_on_tongue	bla
0	0	0	1	1	0	1	0	0	0	0	...
1	0	0	1	1	0	1	0	0	0	0	...
2	0	0	0	0	0	1	0	0	0	0	...
3	0	0	0	0	0	0	0	0	0	0	...
4	0	0	0	0	0	1	0	0	0	0	...

5 rows × 133 columns

CONFUSION MATRIX

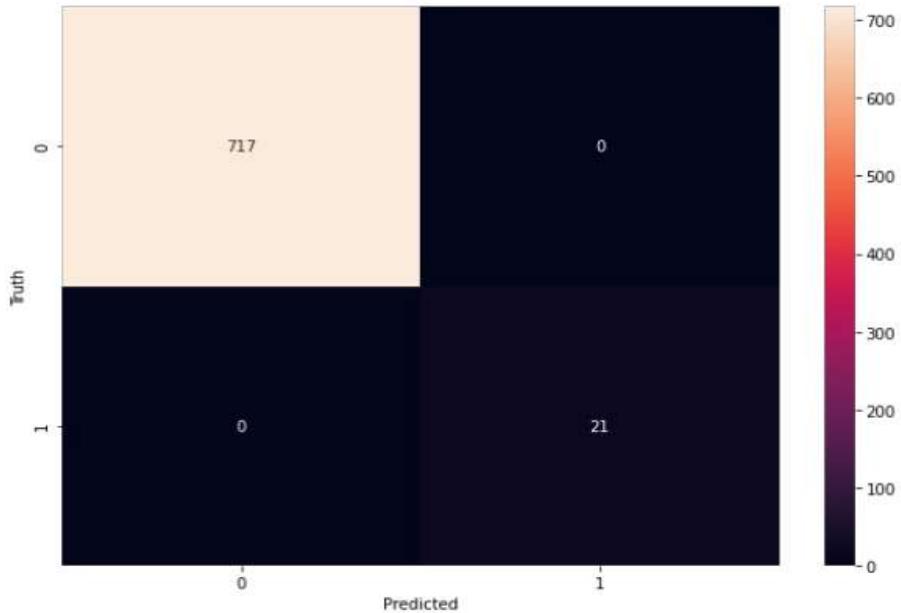


Figure 5: Confusion Matrix for Malaria data set.

```
TP = 21
TN = 717
FN = 0
FP = 0
print('Accuracy=(TP + TN)/n')
print(f'\t={round((TP+TN)/738*100,2)}%\n')
print('Sensitivity=(TPR)=TP/(FN + TP)')
print(f'\t={round(TP/(FN+TP)*100,2)}%\n')
print('Specificity=(TNR)=TN/(TN + FP)')
print(f'\t={round(TN/(TN+FP)*100,2)}%\n')
print('False positive rate(FPR)=FP/(TN + TP)')
print(f'\t={round(FP/(TN+TP)*100,2)}%\n')
print('False negative rate(FNR)=FN/(FN + TP)')
print(f'\t={round(FN/(FN+TP)*100,2)}%\n')
print('Precision=TP/(TP+FP)')
print(f'\t={round(TP/(TP+FP)*100,2)}%\n')
Accuracy=(TP + TN)/n
=100.0%
Sensitivity=(TPR)=TP/(FN + TP)
=100.0%
Specificity=(TNR)=TN/(TN + FP)
=100.0%
False positive rate(FPR)=FP/(TN + TP)
=0.0%
False negative rate(FNR)=FN/(FN + TP)
=0.0%
Precision=TP/(TP+FP)
=100.0%
```

CONFUSION MATRIX

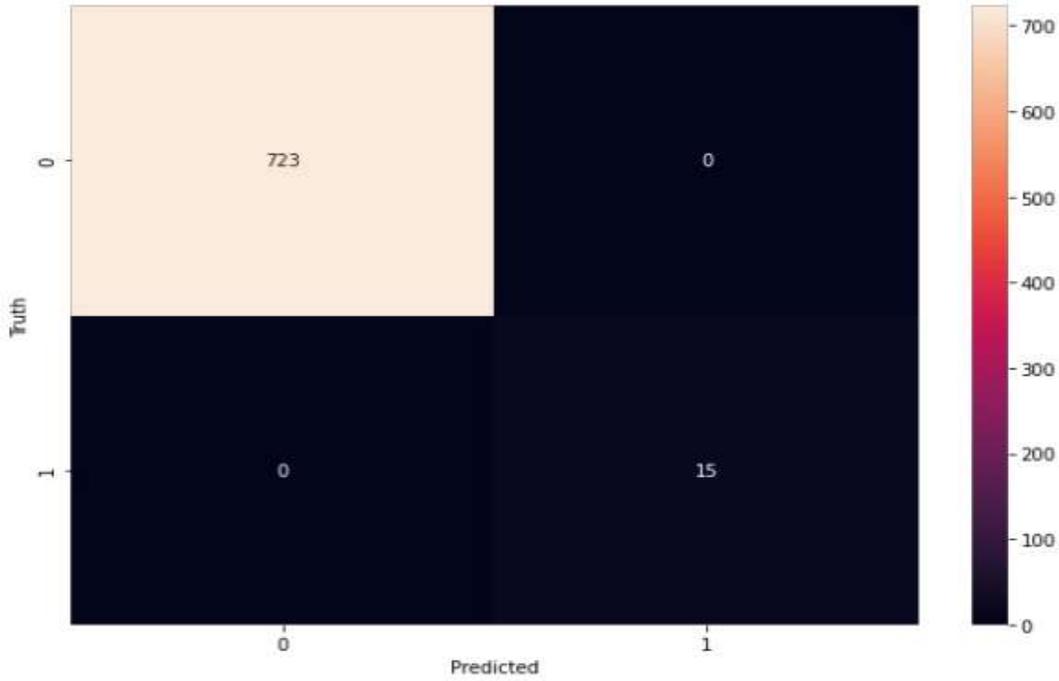


Figure 6: Confusion Matrix for typhoid data set.

Table 2: Summary of performance

Classifier	Correctly Classified Accuracy (In %)		Incorrectly Classified (In %)	Incorrectly Classified (In %)	Mean Absolute Error (In %)	Root Mean Sq. Error (In %)	Coefficient Of Determination (In %)	Number Instance
Support Vector Machine		100	0	0	3	16	-3	738
Artificial Neural Network		99	1	95	0	5	90	738
Naïve Bayes		100	0	0	3	16	-3	738

CONCLUSION AND RECOMMENDATION

The proposed system (Expert system for diagnosis of malaria and typhoid) discussed in this research was successfully implemented using PYTHON platform, MYSQL, and the Naïve bayes algorithm. Similarly, comparative analysis on the naïve bayes, support vector machine and artificial neural network were carried out to ascertain the Florence of Naïve bayes. The model captures symptoms to diagnose a patient in real time (within 30 minutes) without necessarily visiting a laboratory for a test. This led the researcher to believe that the findings of this research will be useful for the next generation Hospitals, Clinics and intending researchers in this field of study.

The following are the research's recommendations.

- i. This proposed system (Expert system for diagnosis of malaria and typhoid) is recommended to be used in medical or in general, tele-medicine particularly the Hospitals and Clinics where medical practitioners can utilize it efficiently and with enough confidence.
- ii. The outcome of the impressive comparative results recommends the need of employing the Naïve bayes classifier on other medical conditions in which prediction conditions are difficult to diagnose.
- iii. It is also recommended that researchers should further expand the research to cover areas that are not included or covered in this study i.e other kind of fevers.

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