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Research Article

Design and Implementation of A Knowledge-Based Typhoid Fever Diagnosis Expert Advisor Using Forward Chaining Inference Mechanism

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Abstract: The medical field is experiencing setbacks, medical cases almost always seems to outnumber the number of medical experts required to attend to them. This in part is due to lack of qualified doctors to handle specialize cases. Inefficient medical expert to diagnose and properly treat typhoid fever has significantly increased mortality and morbidity rate in both infant and adult resulting from the ailment. The objective of this project therefore is to Design a Rule-Based Expert System that will offer proper diagnosis and prescribe appropriate medication for patients. The shell of the Expert System developed in this project uses the Forward Chaining Inference Algorithm (Mechanism), a technique that has been neglected by many expert system developers in the medical field. Oral and written interview was adopted to acquire knowledge from experts in the domain and get insight into the required information needed for the development of the system. Java programming language and its related technology were used in the development of the system based on its functionality of platform independence. We employed Derby's database engine for our database design. Derby's database engine is a full-functioned relational embedded database-engine which supports JDBC and SQL as programming APIs. The System was tested and also evaluated by users of the System and was considered satisfactory. The researcher recommends that user training and technical support team should be in place.
Keywords: typhoid fever, Algorithm, Java programming language, qualified doctors.

INTRODUCTION

Artificial Intelligence (Al) is the area of computer science concerned with the emulation of human thought processes. Efforts in the application of Artificial intelligence (AI) methods to intelligent problem solving led to the development of *expert systems, a* systems which perform tasks that require a great deal of specialized knowledge that experts in a particular field acquire from long experience with such tasks [1]. An Expert System is a computer program that is designed to imitate the decision-making ability of a decision maker in a particular narrow domain of expert knowledge or skill [2]. The expert system has become the largest area of applications of AI.

Today, Expert Systems have become fashionable techniques for representing large bodies of knowledge for a specified field of expertise. The explicit task of an Expert System is to be an alternative source of decision-making ability for organizations to use instead of relying on the expert knowledge or skill of few people or just one person. Expert's knowledge is in short supply. Therefore, the focal point in the development of expert system is to acquire and represent the knowledge and experience of a person(s) who have been identified as possessing the special skill or mastery in the given field of expertise [3].

An expert system often consists of three parts, namely: a knowledge base editor which helps the expert or knowledge engineer to easily update and check the knowledge base; an inference engine which is used for reasoning with both the *expert knowledge* extracted from expert and data specific to the particular problem being solved. The expert knowledge will typically be in the form of a set of IF-THEN rules; and a user interface which may use menus, natural language or any other style of interaction [4].

Notwithstanding the numerous improvements in medical science and medical research, there are a number of impede in the medical fields, and that is partly due to the number of medical research experts and inadequate funding of medical outfits. Consequently, the number of medical cases have almost always seems to outnumber the number of medical

experts needed to attend to them. Most of these cases that are simple enough to be diagnosed properly if the right information is given and the required tools are available. Typhoid fever is a tropical disease that is widespread to both adult and children. Insufficient medical expert to diagnose and properly treat typhoid fever, either due to inadequate staffing of medical Doctors or incessant Doctors striking as is the case in Nigeria, has dramatically increased mortality and morbidity rate in both infant and adult resulting from the ailment. The objective of this research work, therefore, is to Design a Knowledge-Based Expert Advisor that will offer proper diagnosis and prescribe appropriate medication for patients with typhoid case in the absence of a Doctor, using the Forward Chaining inference techniques.

Architecture of the Knowledge-Based Expert Advisor

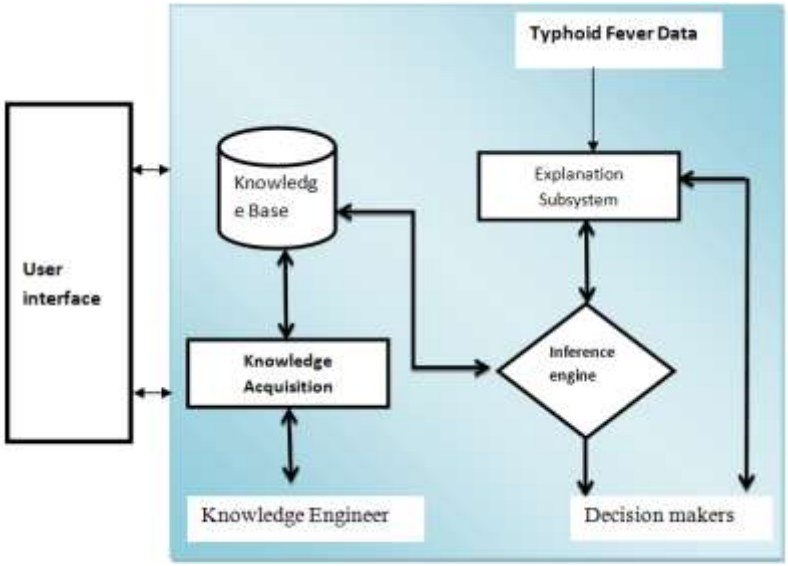
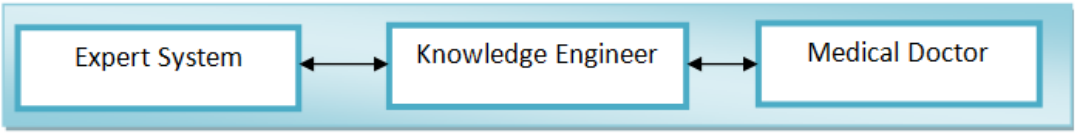


Fig-1: Architecture of the Knowledge-Based Expert Advisor

Knowledge Acquisition

The system must liaise with people in order to gain knowledge and the people must be specialized in the appropriate area of activity.

The acquisition of knowledge in this paper was conducted through interviews with medical doctors on Typhoid fever symptoms and possible cause. The main objective of this work is to develop an Expert System that will act as an advisor and diagnose typhoid fever by providing a systematic and step-wise analysis of possible symptom (s) and recommend medications. Knowledge was also acquired through books, web materials and journals.



Consultative System

Users interacts with the system by entering data in English and the system responds by using its inference engine to perform the reasoning to deriving an answer to the questions asked by the user. The task of the inference engine is to search for facts that match the condition part of the productions that match the action part of the question. We made use of the forward chaining inference mechanism in representing our knowledge. An Inference engine using forward chaining searches the inference rules until it finds one where the **IF** clause is known to be true. When found, it concludes or infers the **THEN** clause, resulting in the addition of new data to its dataset.

System: What is your Name?
Patients: Blessing
System: What is your age?
Patient: 23 years
System: do you feel fever?
Patient: Yes
System: do you feel aches and pains?
Patient: Yes
.
.
System: You test positive for confirmatory test.

Fig-1.2: Sample data in our consultative system

Methodology

In this work, we adopted the user centre approach as our methodology where we engaged in personal interviews with medical doctors with specialty in typhoid diagnosis and treatment. The model adopted in this work for our design is the object-oriented analysis and design (OOAD) with Unified Modeling Language (UML). An attractive feature of the UML is its flexibility. UML modelers are free to use various processes in designing systems. The UML is a complex, feature-rich graphical language [5]. The UML specifies diagram for documenting the system behaviour. The system was developed using Java and the user interface designed in Java Netbeans. The database for this work was design using the Derby's database engine. Derby's database engine is a full-functioned relational embedded database-engine which supports JDBC and SQL as programming APIs.

System Design

Use Case Diagram

Here we present the different way the Typhoid Advisor can be used by the user's .use Case corresponds to the high-level functional requirements. The use case model for the Typhoid Advisor is shown in figure 2. This system has 4 use cases, **Register Patient**, **View Patient**, **View Diagnosis** and **View Symptoms**.

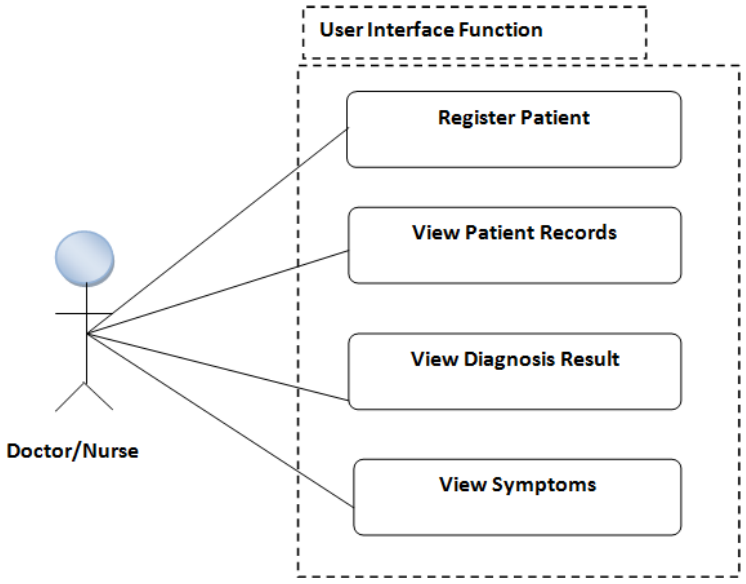


Fig-2: Use Case Diagram for the Typhoid Advisor System

Activity Diagram

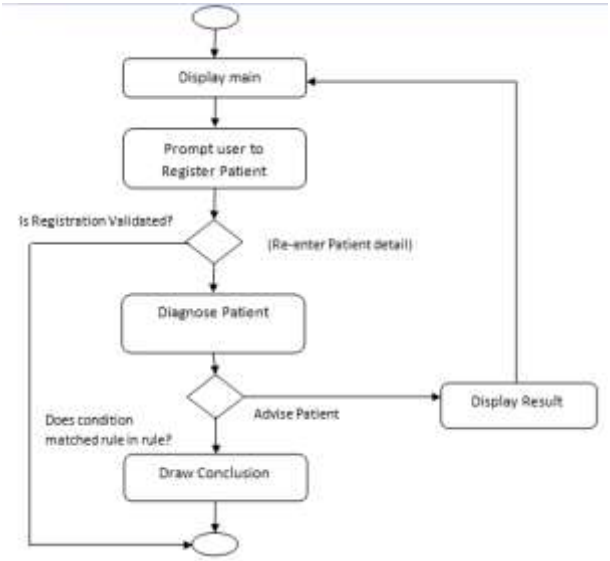


Fig-3: Activity Diagram of the Expert Advisor

Database Design

The Typhoid Expert Advisor makes use of three database tables namely viz: PATIENTS_RECORDS, RESULTS_RECORDS, PATIENT_REGISTRATION and SYMPTOM_RECORDS. The PATIENTS_RECORDS table stores the records of each patient that is diagnosed by the application; the PATIENT_REGISTRATION table stores the patient's details before he/she is diagnosed; the RESULTS_RECORDS stores data concerning diagnosis results of a patient. The RESULTS_RECORDS is related to the PATIENTS_RECORDS using a foreign key. The SYMPTOM_RECORDS table forms the core of the knowledge base of the application.

Table-1: Patient Records Table

S/NO	FIELD NAME	DATA TYPE	WIGTH	NULL	FOREIGN KEY	REFERENCE
1	PATIENT_ID (p.k)	INT	10	NO	NO	PATIENT
2	AGE	INT	5	NO	NO	-
3	GENDER	VARCHAR	25	NO	NO	NO
4	PAT_ADRESS	VARCHAR	255	N0	N0	N0
5	STATE_OF_ORIGIN	VARCHAR	100	NO	NO	NO
6	DIAGNOSIS_DATE	VARCHAR	13	NO	NO	NO
7	DIAGNOSIS_TYPE	VARCHAR	100	NO	NO	NO
8	HOSPITAL_NAME	VARCHAR	255	NO	NO	NO

Table-2: Symptom Table

S/NO	FIELD NAME	DATA TYPE	WIGTH	NULL	FOREIGN KEY	REFERENCE
1	PATIENT_ID (p.k)	INT	10	NO	NO	PATIENT
2	SYMPTOM_ID	INT	5	NO	NO	SYMPTOM
3	GENDER	VARCHAR	25	NO	NO	NO
4	PAT_ADRESS	VARCHAR	255	N0	N0	N0
5	DIAGNOSIS_DATE	VARCHAR	13	NO	NO	NO
6	DIAGNOSIS_TYPE	VARCHAR	100	NO	NO	NO
7	SYMPTOM	VARCHAR	255	NO	NO	NO
8	SYPTOM_TYPE	VARCHAR	255	NO	NO	NO

Table-3: Result Record Table

S/NO	FIELD NAME	DATA TYPE	WIGTH	NULL	FOREIGN KEY	REFERENCE
1	PATIENT_ID (p.k)	INT	10	NO	NO	PATIENT
2	AGE	INT	5	NO	NO	-
3	GENDER	VARCHAR	25	NO	NO	NO
4	PAT_ADRESS	VARCHAR	255	N0	N0	N0
5	STATE_OF_ORIGIN	VARCHAR	100	NO	NO	NO
6	DIAGNOSIS_DATE	VARCHAR	13	NO	NO	NO
7	DIAGNOSIS_TYPE	VARCHAR	100	NO	NO	NO
8	REPORTED_SYMPTOM	VARCHAR	255	NO	NO	NO
9	CONCLUSION	VARCHAR	255	NO	NO	NO

System Implementation

The System was developed and implemented using Netbeans IDE because of its maximum support for development of Java desktop applications. After coding and testing of the entire application in the NetBeans™ IDE, the application was packaged it into an installer. An installer is a software component and application programming interface (API) used for the installation, maintenance, and removal of software. The user interacts with the system by answering questions prompted by the system, the inference engine proceed to draw conclusion based on the user response to the system.

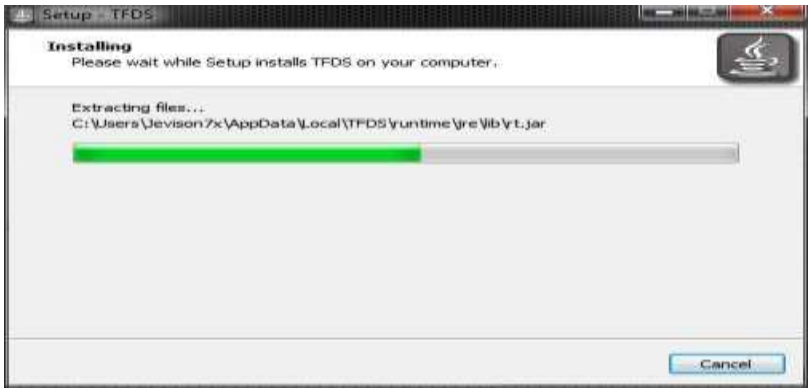


Fig-4: Installation Process of the Expert Advisor

Fig-5: Main window of the Typhoid Expert Advisor

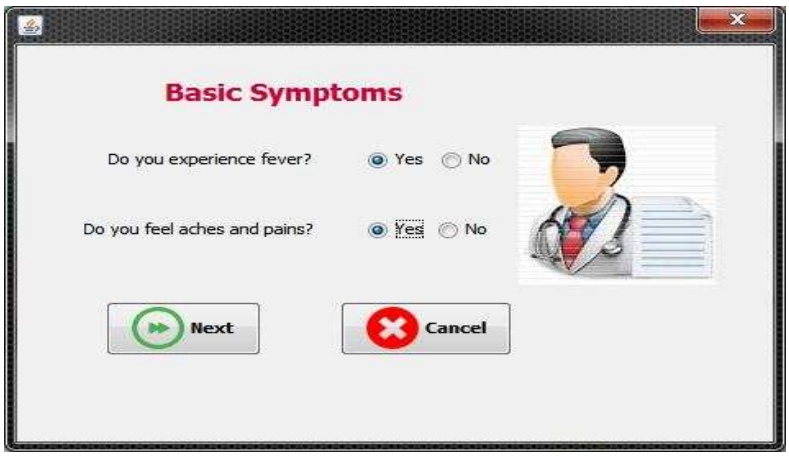


Fig-6: Screen Showing Expert Advisor Diagnosis Process (User Interaction Process)

Fig-7: Expert Advisor Diagnosis Process (User Interaction Process) continue

Fig-8: Screen showing patient Confirmatory Symptoms

Fig-9: Screen showing Result and Drug Prescription

CONCLUSION

An Expert System to diagnose typhoid fever has been developed in this work. The results achieved have clearly established that an Expert System Application is critical for medical diagnosis. The work has also shown that Expert System has the potential to make tremendous impact not only in the medical field, but in all spheres of life. The system has been tested, and the operation proved to be very consistent and accurate. The system is open for improvement and full implementation.

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