Expert System for Medical Diagnosis of Hypertension and Anaemia

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Abstract

These days medical application especially diagnosis of some diseases has been rapidly increased because its importance and effectiveness to detect diseases and classify patients. In this paper, we present the design of an expert system that aims at providing diagnosis of hypertension and anaemia. The anticipated methodology is the Bayesian Network Technology which is an efficient technique in modelling real life problems and reasoning under uncertainties. The system uses the computer with an interactive interface to simulate a medical doctor skill in diagnosis of ailments and prescription of treatments and is able to give appropriate diagnosis and prescription treatment for some hypertension and anaemia patients. This can be used to provide the same service in the absence of the medical experts.

KEYWORDS: Expert System, Hypertension, Bayesian Network, Anaemia,

I. INTRODUCTION

Hypertension and Anaemia are some of the most chronic ailments in the world. It has been observed that in rural communities, getting adequate treatment and attention without delay has always been challenging [1]. In these rural areas, the appropriate facilities needed to perform accurate diagnosis are not present or deteriorated. No patient wants to be a specimen for an inefficient medical practitioner. Most times, patients cannot get to see the doctor at the appropriate time and there are some patients that find it difficult communicating their health issues and in other cases, the doctor in turn has no time to keep asking the probable questions. The long wait for a doctor, smell of drug, unwelcoming hospital attendants has kept some people away from visiting a hospital [2]. It becomes disheartening as the death rate in most rural communities increases even due to minor ailments such as Anaemia and Hypertension that could have been managed. Over the years, there have been improvements in technology resulting in increase of efficiency, effectiveness and in turn productivity. Automating some of the processes involved in attending to patients so as to reach a wide number of them at the same time from different locations would be of immense benefit [3]. An example of such tool is the Bayesian Network that can be used to model the causes and symptoms of illnesses.

II. Materials and Methods

A. Artificial Intelligence and Bayesian Network Architecture

Alan Turing defined intelligent behaviour as the ability to achieve human-level performance in all cognitive tasks. Artificial Intelligence (AI) depicted in Fig. 1 is the display of intelligence by machines, and its main goal as a field is to make machines do things that would require intelligence if done by humans. In developing practical applications, AI has been successfully applied in different areas such as logistics, data mining, medical diagnosis, pattern recognition [4] and so on. The success of AI in building applications that can perform reasoning is based on tools such as the Bayesian network [5]. Bayesian networks (BNs), also known as belief networks (or Bayes nets for short) represented in Fig. 2, belong to the family of probabilistic graphical models (GMs). These graphical structures are used to represent knowledge about an uncertain domain. In particular, each node in the graph represents a random variable, while the edges between the nodes represent probabilistic dependencies among the corresponding random variables. These conditional dependencies in the graph are often estimated by using known statistical and computational methods. Hence, BNs combine principles from graph theory, probability theory, computer science, and statistics [6]. Using BN, we can perform diagnostic reasoning i.e. reasoning from symptoms to cause or predictive reasoning, reasoning from cause to symptoms. In this work, we have built a system for the diagnosis of Hypertension and Anaemia complications using the diagnostic reasoning flow.
Hypertension also known as high blood pressure (HBP) is a chronic medical condition in which the blood pressures in the arteries are persistently elevated. Hypertension is having a blood pressure higher than 140mmHg systolic and over 90mmHg diastolic for adults. The value varies for children. Systolic is the pressure at which the heart pumps blood around the body and diastolic is the pressure as the heart relaxes and refills with blood [7]. Hypertension usually does not cause symptoms initially but sustained hypertension over time is a major risk factor for hypertensive heart disease, artery disease, stroke and chronic kidney disease [8]. If measures are not taken to curb the increase of hypertensive patients, HBP is predicted to be 1.56 billion worldwide by the year 2025 by World Health Organization (WHO). An Increasing prevalence of the condition is blamed on lifestyle factors such as physical inactivity, a salt rich diet created by processed and fatty foods, alcohol and tobacco use. Hypertension is rarely accompanied by any symptoms and its identification is usually through screening. However, some with high blood pressure report headaches, altered vision and fatigue.

Thiazide-diuretics, angiotensin drugs and lifestyles measures are used to treat high blood pressure including salt restriction, moderation of alcohol and other diet changes [9].
Anaemia is defined as a decrease in the amount of red blood cells or Haemoglobin in the blood. The symptoms of Anaemia are often vague and may include fatigue, increased thirst, confusion, and loss of consciousness, paleness, shortness of breath on exertion (Dyspnea), and heart failure. Broadly, causes of Anaemia may be classified as impaired red blood cell (RBC) production, increased RBC destruction and blood loss. Some of these may interplay to cause Anaemia. Impaired RBC productions are often caused by Iron deficiency. Iron deficiency is due to insufficient dietary intake or absorption of iron to meet the user need. Infants and pregnant women have higher need for iron rich foods. Anaemia is typically diagnosed on a complete blood count and measurement of the haemoglobin level. The counter also measures the size of the red blood cells. Treatment for Anaemia depends on the cause and severity. Vitamin supplements are usually given to replace specific deficiencies. Blood transfusion is not recommended until the haemoglobin level is very low. However, there are other medications that can replace blood transfusion [10].

C. System Design

The system design of the medical diagnostic expert system serves as the blueprint for a robust implementation[11, 12, 13, 14, 15]. The design is divided into stages:

- **Logical design**: This is an implementation-independent design which lays out the components of the system and their relationships to one another as they will appear to the users. It describes input/output procedures, processing functions to be performed, business procedures, data models and controls. The system is comprised of logical modules such as registration, login, diagnosis and prescription.

- **Physical design**: At this stage, the abstract logical model is translated into the specific technical design for the system. It produces the specification for the hardware, software, physical storage, input/output media. The architecture and module diagram of the system is shown in fig. 3 and fig. 4 below.

![Fig. 3: Medical Expert System Architecture](image1)

Expert system for the medical diagnosis of Hypertension and Anaemia

![Fig. 4: Block diagram of system modules](image2)
TABLE 12. BAYESIAN NODES AND STATE

<table>
<thead>
<tr>
<th>NODE NAME</th>
<th>TYPE</th>
<th>VALUES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obese</td>
<td>Boolean</td>
<td>{True, False}</td>
</tr>
<tr>
<td>Smoker</td>
<td>Boolean</td>
<td>{True, False}</td>
</tr>
<tr>
<td>Heart Disease</td>
<td>Boolean</td>
<td>{True, False}</td>
</tr>
<tr>
<td>Salt Intake</td>
<td>Binary</td>
<td>{Low, High}</td>
</tr>
<tr>
<td>Other Infections</td>
<td>Boolean</td>
<td>{True, False}</td>
</tr>
<tr>
<td>Hypertension</td>
<td>Boolean</td>
<td>{True, False}</td>
</tr>
<tr>
<td>Blood Pressure</td>
<td>Binary</td>
<td>{Low, High}</td>
</tr>
<tr>
<td>Heart Problems</td>
<td>Boolean</td>
<td>{True, False}</td>
</tr>
<tr>
<td>Dyspnoea</td>
<td>Binary</td>
<td>{Positive, Negative}</td>
</tr>
<tr>
<td>Fatigue</td>
<td>Boolean</td>
<td>{True, False}</td>
</tr>
</tbody>
</table>

D. A Bayesian Network (BN) for Hypertension and Anaemia Problem

STRUCTURE

Fig. 5: The Bayesian network model

E. Algorithm for the Medical Diagnosis System

Step 1: start

Step 2: implement the Bayesian network model shown in fig.4

Step 3: design the database schema shown in Table 3.1 and Table 3.2
Step 4: login interface
   If user is not registered then
       Register
   Else
       Login with userID and password

Step 5: perform diagnosis
   User answers the probable question
   If there are more questions
       Ask next question
   Else
       Match answers to Bayesian network model

Step 6: return the probabilistic values for the hypertension and anaemia nodes.

Step 7: if values<0 then
   Patient has neither hypertension nor anaemia. Move to step 9
Else if values>0 then
   If hypertension value > anaemia value then
       Return probabilistic of patient having hypertension
   Else
       Return probabilistic of patient having anaemia

Step 8: offer prescription based on result of step 7

Step 9: Stop

F. JavaBayes Library

JavaBayes is a system that handles Bayesian networks: it calculates marginal probabilities and expectations, produces explanations, performs robustness analysis, and allows the user to import, create, modify and export networks.

JavaBayes is the first full implementation of Bayesian networks in Java. A Java implementation has several advantages. A capability of JavaBayes, which sets it apart from other inference engines, is the ability to conduct robustness analysis on top of inferences. Bayesian robustness analysis is an on-going research topic, where sets of distributions are associated to variables: the size of these sets indicates the "uncertainty" in the modeling process. JavaBayes can use models with sets of distributions to calculate intervals of posterior distributions or intervals of expectations. The larger these intervals, the less robust are the inferences with respect to the model.
III. RESULTS AND DISCUSSION

The Expert System has been designed to be user friendly and it is easy to navigate. The various modules used have been integrated from a single web interface. The user can easily access the whole application from the home page where there is menu bar from which the user can perform the desired functions. Hypertension is one of the most chronic ailments that plague millions of people worldwide, but patients do not often get appropriate medical attention. This Expert System can provide instant access to help users better manage these ailments. The main problem with managing Hypertension is often Lifestyle changes. These could include taking in food with low salt, stooping excessive use of drugs or alcohol or taking in food rich in Iron. Thus, the Medical Expert system will be of a great benefit for people with Hypertension since it can help track of the severity of the ailment. The System implemented as a standalone desktop application can reduce the amount of maintenance required and increase reusability and flexibility of the application.

A. Diagnosis Module

The diagnosis interface has questions that users are expected to answer. The diagnosis is performed in three different steps (interfaces).

The figure below shows one of the steps (interface)

![Diagram of Diagnosis Interface](image)

Figure 6: Diagnosis Interface

B. Diagnosis Result Module

The result module returns the probabilistic values for the diagnosis of hypertension and anaemia. Depending on the symptoms felt, the expert system performs inferencing (or belief updating) and returns the probabilistic values.
IV. CONCLUSION

The medical diagnostic expert system for the various complications of Hypertension and Anaemia has been designed to help patients and assist doctors not to replace them. There are times that some symptoms that an individual has might be taken for granted, that is, they might just be overlooked and the individual will not see a need to visit the hospital. This means that instead of a patient consulting the doctor for mild cases of Hypertension and Anaemia, the patient can receive treatment even from the house through the Medical Diagnostic Expert system. This will help to solve the problem of too many patients seeking daily medical attention. The system uses the computer with an interactive interface to simulate a medical doctor skill in diagnosis of ailments and prescription of treatments and is able to give appropriate diagnosis and prescription treatment for some hypertension and anaemia patients. Work is in progress to enhance this expert system by implementing the system with the hybrid of expert system and artificial neural networks (ANN). If the proposed system is deployed for use, it will prove to be a valuable asset to both naïve users and medical practitioners.
V. REFERENCES


