Rule Based Expert System for Viral Infection Diagnosis

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Abstract— One of the key components of life is health care. Nowadays, people are enormously concerned about their health and use various health services. With the current inventions made in technology, major focus is made on usage of technology to benefit the people in over all wellbeing. A rule based expert system; provide consultation along with reasoning is more beneficial when used through web based applications. In this paper, we have proposed a web based expert system for diagnosing viral infections. Medications to these infections can be deduced through the system; which are not only faster in time but accurate as well since many medical practitioners' knowledge has been utilized to develop the knowledge base.

Keywords— Artificial Intelligence, Expert System, Rule based Expert System, Viral Infection Diagnosis, Web based application

I. INTRODUCTION

Artificial Intelligence (AI) has become a very well-known topic of research and many systems have been developed in various domains to assist human for different kind of problems. Expert system (ES) is one such part of AI, which is widely used as a problem solution provider. ES emerged during early 1970s, has become one of the most important innovations of AI because they have been shown to be successful commercial products as well as interesting research tools (1). Disease diagnosis has also become a key domain where these tools are very useful. One such very common disease is viral infection; caused due to viruses. The virus uses the host cells to reproduce and thereby disturb the immune system of the host. There are various symptoms and medications available for the disease. For common symptoms, medications can be prescribed using such expert systems. In this paper, we have tried to focus major symptoms falling under this disease group name and make available their medications.

II. RULE BASED EXPERT SYSTEM

Generally the knowledge representation used in the expert system is done using the if-then rules (2). The systems which use a set of if-then statements to declare the rules are also called rule based systems or specifically rule based expert systems. A conventional rule-based expert system consists of four major components (3). The Fig. 1 describes the components of a simple expert system.
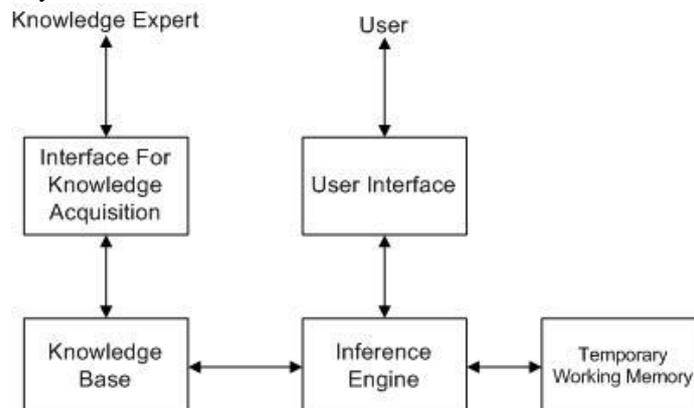

Fig. 1 Components of Rule-Based Expert System

The knowledge base is a collection of rules, so we call it rule base. The experts' knowledge is taken using the Interface for Knowledge Acquisition component and transferred to the knowledge base. The construction of the knowledge base is very important process in developing an expert system and hence generally requires a lot of care and many aspects are to

be considered. The data is collected from the experts; this data is processed and converted into the patterns to define rules. A rule is nothing but an expression having a set of conditions on the left hand side, which when evaluated to TRUE can derived to an action on the right hand side. These set of rules completes the knowledge base creation. The third component of the rule based expert system is the inference engine. It infers the information or takes the action based on the input and the rule base. The inference engine works in two phases – looking for a rule–match and performing action. This component is tightly coupled with other two components – User Interface and Temporary Working Memory. The input to act upon is taken by the User Interface, which may be any web application or a mobile application client. The User Interface acts as a communication medium between the outside world and the expert system. The rule collection from knowledge base, rule matching as per the inputs and deriving the action as a conclusion is performed in the Temporary Working Memory. Thus the result is passed on to the user using the User Interface.

III. RELATED WORK

The key advantages of Rule Base Systems are homogeneity, simplicity, independence and separation of knowledge from its use and control (2). This has resulted into developing application in various domains for solving problems in the real world. The development of rule based expert system for GIS has been described in (4). The author has developed an application of AI in GIS using Visual Basic. The application takes inputs by a question-answering mechanism and then provides the solution using the rule-base developed using the experts' knowledge. In paper (5), the authors have developed an expert system using C programming language. Forward chaining mechanism is used for inference engine implementation. The paper represents how universal and special purpose VLSI chips can be constructed through silicon compilation to implement rule-based expert systems. The use of rule based expert system in mineral identification has been described in (6). The physical characteristics of forty minerals were studied as a knowledge domain. Microsoft Access was used to develop the knowledge base. The inference engine and user interface was developed using Visual Basic. Forward chaining mechanism was used in the interference engine. The user interface takes the values of the attributes and based on the change in the attribute values, the rules were checked for condition. It is only when all the conditions are satisfied, the rule would be fired and thereby the action is executed. The author also describes this application to be useful for educational purpose as it also serves as a mode of expertise distribution. The author in (7) has very well described the various other domains where rule based expert systems are useful. A variety of financial applications have been developed using expert system widely used in banks, insurance companies and financial houses. Even industrial applications are developed for fault diagnosis, software design, planning of instrumentation design and complex administrative procedures, quality assurance. The expert systems have also been beneficial in the learning process. In (8), the authors have presented an expert system which assists the students to improve their web based problem solving skills. The knowledge base is developed by analysing the online problem solving behaviours of the teachers. It is difficult to record each student's online problem solving ability and hence the system will be useful for each individual student for sharpening their skills on the Internet.

Many rule based expert system applications have been developed in the medical domain. In (9), an expert system implementation has been demonstrated for a heart failure mobile phone-based tele-monitoring system. Depending on the user input like patient's weight, blood pressure, heart rate and symptoms; the expert system generated alerts and instructions.

IV. EXPERIMENT

The proposed system is a rule based expert system application for viral infection diagnosis. In this section, system implementation and its results are described.
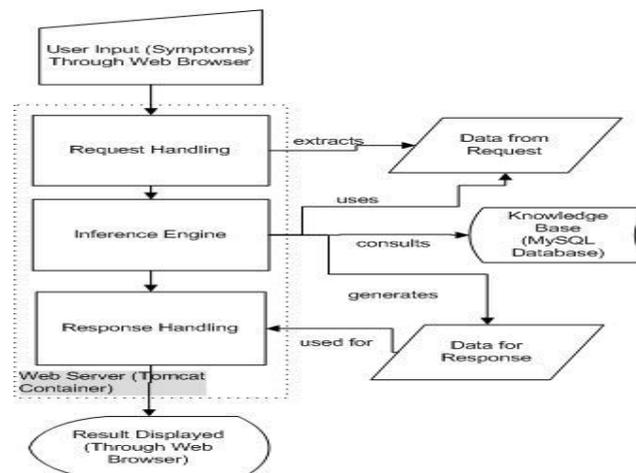

Fig. 2 System Flow Diagram

A. System Implementation

The system architecture is similar to the conventional rule based expert system as shown in Fig. 1. Two interfaces have been designed – one for the Knowledge Engineer and one for the Normal User. A knowledge engineer collects the expert knowledge in the form of data and processes it to generate the pattern-action rules and they are stored in the knowledge base using the developer interface. A normal user is one who uses the system. The system flow is described in Fig. 2.

The expert system is deployed on the web server. The web-sever is a dual server comprising of a Tomcat container; used for request-response cycle processing and a database – MySQL that acts as a knowledge base. Both, knowledge engineer and normal user use the system through web-browser.

The knowledge engineer enters the processed data and stored in the knowledge base in the form of rules. The knowledge engineer manages symptoms, diseases, medicines and binding medicines to the diseases through the system. This acts as the knowledge base; which will be later used by the normal user. The normal user may be a medical officer or a skilled person having domain knowledge. Few screen shots of the system are presented here. Fig. 3 shows the list of symptoms added to the system. Using this view, the user can edit or delete the symptom as well. Symptom creation feature is also available to add a new symptom.

Fig. 3 Symptom List

The Fig. 4 depicts the disease creation; the symptoms are chosen from the symptom list. Generally, a disease can show up one or more symptoms. To grab the possible combinations, logical 'AND' and 'OR' are used along with the symptom selection. This selected symptom list is characterized by disease.

Fig. 4 Create Disease

Fig. 5 shows the disease list, with its symptoms. In the knowledge base the symptoms act as the patterns and the medicines act as the actions.

Fig. 5 Disease List

Let us consider one rule for the system. According to the definition,

IF *symptom* THEN *medicine*

We shall explain this rule as, if the symptoms entered by user match the rule's left hand side, then we can deduce that patient is suffering from disease say d and hence medicines on the right hand side of the rule shall be prescribed to the patient. For instance, if the patient is suffering from fever with shivering AND is feeling Fatigue (or weakness in other

words) AND Joint Aches, the expert system figures out that patient is suffering from disease Viral Syndrome and hence medicines will be prescribed accordingly.

The query criteria can be generated using the form shown in Fig. 6. The result for these symptoms is shown in Fig. 7; if the symptom list matches the diseases' symptom list in the knowledge base, then prescribed medicine list will be fetched and displayed. If the list does not match, a message will be displayed accordingly.

Fig. 6 Query for Medicine

Figure 7. Prescribed Medicine

The layout for the knowledge engineer and system user are different but procedure to query the system remains the same.

B. Experiment Result

The system has not been deployed on the internet, since it is still in testing phase. The system was deployed on a computer having Pentium IV processor, 1 GB RAM and Windows XP operating system. A set of 12 diseases along with its symptoms were added to the knowledge base. The experiment was carried out by taking 50 patient data from two clinical centres. The details were then used as input to the system, hosted on the intranet and thereby the result was deduced. For the same 50 patients, doctoral diagnosis reports have also been collected. The results are compared and shown in the Fig. 8 below. The system has achieved around 90% accuracy.
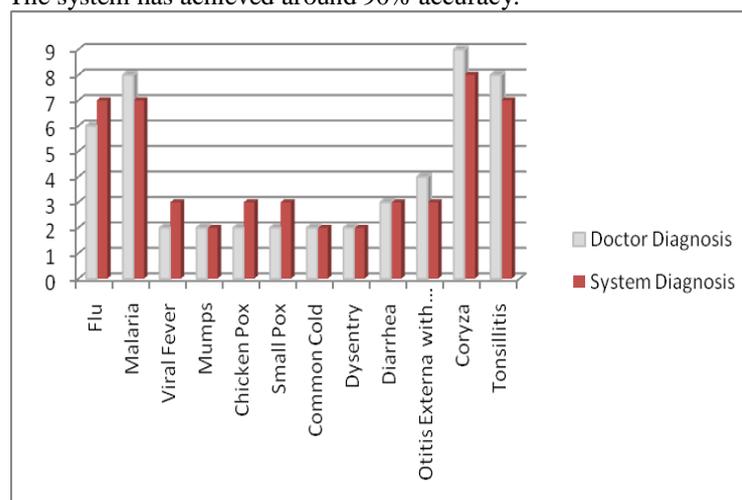

Fig. 8 Doctor and System Diagnosis Result Comparison

Since, the code optimization has not been performed at all places in the system; the accuracy is not 100%. But the next version of the system will be deployed with all the checks to input data before processing and with proper code optimization hence the accuracy can be increased.

V. CONCLUSIONS

The rule based expert system presented in this paper can be beneficial to the medicine practitioners for not so serious viral infection diagnosis. The rule-based system has been developed by having number of meetings with the domain
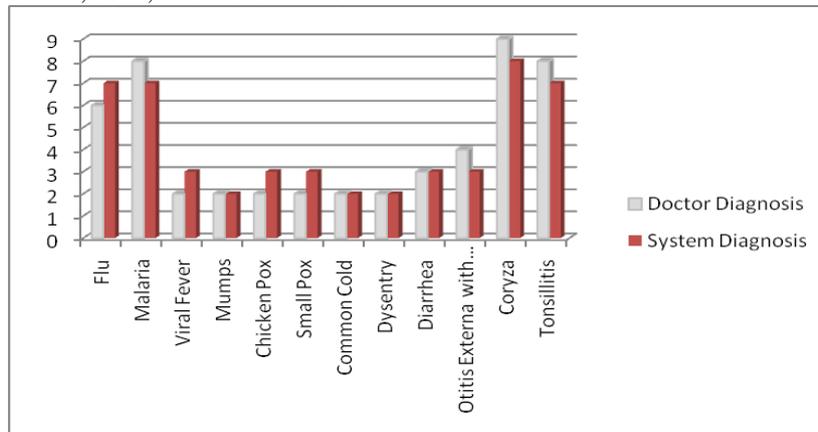
experts and the knowledge engineer has converted the expertise into pattern-action format. The knowledge base itself has been verified by the domain experts using the Querying facility developed in the admin module of the expert system. Although the system has been in the testing phase, the accuracy of the system is 90%; achieved without code optimization.

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