An Application of Expert System for Diagnosing Fever Caused by Viral Infection

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Abstract—A fever, also known as a high temperature, is not caused by an illness. It’s usually a symptom of an underlying condition, most often an infection. In children with fever, accompanying symptoms such as lethargy, fussiness, poor appetite, sore throat, ear pain, vomiting and diarrhea. Some parents think they should not go to the hospital when children get fever, because they will be ridiculed. As a first-aid solution, An Application of expert system (AExS) can help parents to identify fever caused by viral infection. It implements forward chaining as the technique of searching through rule-base system. Some programming code were also written in PHP for making deduction of new fact from rules in the knowledge base. The web based expert system enables user to diagnose the children’s disease anytime and anywhere, just by accessing the internet. It is very interesting and has created considerable importance system to diagnose fever caused by viral infection.

Index Terms—fever, symptom, expert system, forward chaining, rule-base system, knowledge base

I. INTRODUCTION

Fever is usually associated with physical discomfort. Many experts believe that fever is a natural bodily defense against infection. There are also many non-infectious causes of fever. As fevers range to 104 F (40°C) and above, however, there can be unwanted consequence, particularly for children. These can include delirium and convulsions. Although a fever is easy to measure, determining its cause can be hard. Besides a physical exam, the doctor will ask about symptoms, conditions and medications.

The part of the brain called the hypothalamus controls body temperature. The hypothalamus increases the body’s temperature as a way to fight the infection. However, many conditions other than infectious may cause a fever. Cause of fever include bacterial infections, viral infections, medications, illicit drugs, illness related to heat exposure and allergies.

Computer-based methods are increasingly used to improve the quality of medical services. Artificial Intelligence (AI) is the area of computer science and it is applied for decision making, diagnosis, pattern recognition, and analysis of evidence. Furthermore, an application of the scientific study of AI, expert systems area able to use human knowledge through an interference engine to solve problem that require a human expertise [1]. This system (AExS) allows the user (parents) to find out symptoms by providing questions related to conditions that appeared similar to the symptoms. Then, it diagnoses fever caused by viral infection based on its artificial knowledge. The data which is used by AExS came from books and a few electronic website.

II. METHODS

Factual knowledge relevant to the problems is realized as data or as a database or bases. The skills needed to use the knowledge are available to solve problems, and as a guide to acquire new facts and to learn new skills, are realized as rules. Rule-based systems require that the expert’s knowledge and thinking patterns should be explicitly specified [2]. Hence, obtaining this knowledge and writing proper rules is called the knowledge acquisition phase. The writer is going to represent a knowledge base of skills as a set of rules.

An expert system rule may be formulated as

\[ \text{if } A \text{ then } B \] (1)

where A is a set of conditions on data and B is a set of instructions to be carried out if the rule is fired. In forward chaining (Fig. 1), that sequence is followed.

![Figure 1. Knowledge base of forward chaining](image-url)

The rules are examined to see which rules are made fireable by the data, that is, A is satisfied, and a rule or
rules selected for firing. When the rule is fired, the set of instructions B is executed. This is the way most rule-based expert systems work, including AExS. Forward chaining is reasoning from facts (symptoms) to the conclusion (fever) resulting from those facts.

The most popular type of expert system today is the rule-based system [3]. A rule-based system consist of IF-THEN rules, facts, and an interpreter that control which rules is invoked depending on the facts in working memory. It is appropriate methodology for all medical domains and tasks for the following reasons: cognitive adequateness, explicit experience and subjective knowledge, automatic acquisition of subjective knowledge, and system integration [4]. Rule based system presents an essential technology of building intelligent Clinical Support System for medical diagnoses that can aid significantly in improving the decision making of the physicians.

Computer assisted application for patient’s diagnosis and treatment seems to be more recent area of interest. Diagnosis is the identification of the nature and cause of a certain phenomenon. Diagnosis is used in many different disciplines with variations in the use of logic, analytics, and experience to determine “cause and effect”. The expert diagnosis (or diagnosis by expert system) is based on experience with the system. In addition, by using this experience, a mapping is built that associates the observations to the corresponding diagnoses effectively and efficiently. The experience can be provided by human operators who translate human knowledge into a computer language.

Novaliendry [5] designed Expert System to diagnose vitamin deficiency in humans in the form of desktop-based application. This application uses forward chaining method and technique of depth first search engines. Santosh [6] introduced a Diagnosis Expert System (DExS) with forward reasoning. DExS helps to diagnose diseases based on user’s answers to specific questions which are asked by the system. Computer Assisted Diagnoses for Red Eye (CADRE) is a rule-base Expert System that assists in red eye diagnosis and treatment. It was introduced by Asghar [7]. CADRE evaluates the risk factors of 20 eye diseases and works just like an ophthalmologist.

A comprehensive study of medical expert systems for diagnosing of various diseases was presented by Jimmy [8]. It provides a brief overview of medical diagnostic expert systems and presents an analysis of already existing studies. In the Fig. 2 the simulation of medical expert systems is presented. Si and D1 denote the first symptom and first disease respectively. In general Si Dj denotes the “i” symptom of “j” disease.

The logic of AExS like this: if it has a positive answer to the symptom, it goes on with the symptoms from that disease. If only one symptom from the disease is negative, it moves to the first symptom from the next disease.

### III. ANALYSIS AND SYSTEM DESIGN

Distinct diagnosis tools have been used as a approach before designing the Application of Expert System (AExS). In [8] explained that the performance of expert system depends on these factors: (1) The accuracy and other parameters of expert system depend on the knowledge base. (2) The knowledge base should have relevant knowledge. (3) There should be stress on knowledge acquisition, a stage in which knowledge is gathered.

The knowledge in expert systems may be either expertise, or knowledge that is generally available from books, magazine, and knowledgeable persons [3]. So, symptom information for conditions involving a fever caused by viral infection has been gathered from various sources [9]-[11]. It may vary on each child and only the doctor can give sufficient diagnosis.

Rule-based experts system has been used to construct the AExS. It is better-suited representations for explanation as their inferences can provide transparency because of the explicit way in which the knowledge is represented [12]. Fig. 3 shows the most important modules that make up a rule-based expert system.

![Figure 3. Structure of AExS](image)

An end user (parent and doctor) would communicate with the system via a user interface and explanation facility that would interact with an expert system inference engine. Parents only choose symptoms which are asked by the system, while doctors can add and edit the disease and the rule.

One of the most popular approaches to knowledge presentation is to use production rules, sometimes called IF-Then rules (Table 1). Some of benefits of IF-THEN rules are that they are modular, each defining a relatively small and, at least in principle, independent piece of knowledge. New rules may be added and old ones deleted usually independently of other rules.
TABLE I. PRODUCTION RULE

<table>
<thead>
<tr>
<th>Rule 1:</th>
<th>Rule 5:</th>
</tr>
</thead>
<tbody>
<tr>
<td>If fever and anorexia (eating disorder) and headache and vomiting and muscle pain and painful swelling of one or both parotid glands and sore ears</td>
<td>If fever and anorexia (eating disorder) and severe headache and vomiting and malaise (uneasiness) and cough and nausea and sudden high fever and low blood pressure and bleeding gums and fingers and tip of nose feel cold and lethargy (tiredness) and feel agitated and mouth cyanosis and acting fussy / fussiness</td>
</tr>
<tr>
<td>Then Epidemic parotitis (Mumps)</td>
<td>Then Dengue Fever</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rule 2:</th>
<th>Rule 5:</th>
</tr>
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<tbody>
<tr>
<td>If fever and malaise (uneasiness) and coryza (head cold, sneezing) and conjunctivitis (red eyes) and cough and red flat rash (macular rash) and papular rash</td>
<td>If fever and loss / poor appetite and headache and vomiting and body aches and nausea and abdominal pain and lethargy (tiredness) and dark urine and fatty liver / enlargement of liver and stools are pale or clay-colored</td>
</tr>
<tr>
<td>Then Morbili (Measles)</td>
<td>Then Hepatitis B</td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th>Rule 3:</th>
<th>Rule 7:</th>
</tr>
</thead>
<tbody>
<tr>
<td>If fever and anorexia (eating disorder) and headache and malaise (feeling tired) and cough and aching muscles and the small red dots on the face, scalp, torso, upper arms and legs, small bumps, blisters and pustules</td>
<td>If fever and weakness and swollen lymph nodes (lymphadenopathy/lymphadenitis) and weight loss and high fever and sweets (particularly at night) and chronic diarrhea and opportunistic infections</td>
</tr>
<tr>
<td>Then Varicella (Chickenpox)</td>
<td>Then AIDS</td>
</tr>
</tbody>
</table>

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<tr>
<th>Rule 4:</th>
<th>Rule 8:</th>
</tr>
</thead>
<tbody>
<tr>
<td>If fever and anorexia (eating disorder) and headache and vomiting and muscle pain and sore throat and nausea and abdominal pain and hyperemic pharyngeal and neck stiffness and pains in the arms and legs and having a convulsion and suffering a neurological disorder</td>
<td>If fever and vomiting and sore throat and feel tired and mouth sore and sores or blisters may appear in or on the mouth and on the hands, feet, and sometimes the buttocks and skin rash and insomnia and sweat out</td>
</tr>
<tr>
<td>Then Poliomyelitis</td>
<td>Then Hands-foot-and-mouth disease</td>
</tr>
</tbody>
</table>

TABLE II. DISEASES DIAGNOSED IN AEXS

<table>
<thead>
<tr>
<th>No</th>
<th>Name of Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Epidemic parotitis (Mumps)</td>
</tr>
<tr>
<td>2</td>
<td>Morbili (Measles)</td>
</tr>
<tr>
<td>3</td>
<td>Varicella (Chickenpox)</td>
</tr>
<tr>
<td>4</td>
<td>Poliomyelitis</td>
</tr>
<tr>
<td>5</td>
<td>Dengue Fever</td>
</tr>
<tr>
<td>6</td>
<td>Hepatitis B</td>
</tr>
<tr>
<td>7</td>
<td>AIDS</td>
</tr>
<tr>
<td>8</td>
<td>Hands-foot-and-mouth disease</td>
</tr>
</tbody>
</table>

A rule based system will contain global rules and facts about knowledge domain covered. During a particular run of the system a database of local knowledge may also established, relating to the particular case in hand.

The application of expert system diagnoses fever caused by viral infection involving 8 kind of diseases usually suffered by the children (Table II). It helps parents to acquire the required solution regarding the unusual disorder attack their children. The expert rules were built up on the symptom of each kind of diseases, and they were offer ed using inference tree and deduced using forward-chaining technique.

The inference tree provides a schematic view of the inference process (similar to a decision tree). Each rule is composed of the symptoms and a disease. In the diagram
below (Fig. 4) each of these is represented by a node. Branches connect the symptoms and diseases.

The Inference tree will make easier to draw up the knowledge base and rules of the diagnosis of fever caused by viral infection. Inference engine directs the search through the knowledge base. It dictates which rule to “fire”. The AExS implements forward chaining as the technique of searching through rule-base system. This method is helpful in recognizing the symptoms which is felt by the children, while parent is given the facility to choose the existing symptoms.

The Entity Relationship (E-R) diagram shows the entities for which information need to be stored and the relationship between those entities. AExS consists of six entities (Fig. 5) such as disease, rule, symptom, user, tmp_analysis and tmp_disease.

IV. RESULT

System tests, such as logic tests, debugging, rule checking were carried out by knowledge engineer to ensure the system would work correctly.

In the expert system, rules are required to implement the desired knowledge. User (doctors) can add and edit the rule. Fig. 6 show the screen of designed rules.

AExS provides diagnostic assistance especially concerned with fever caused by viral infection. User (parents) only choose symptoms which are asked by the system. Fig. 7 shows the interface screen to accept the input values of symptoms.

In a few minutes after choosing the symptoms, the system will determine disease suffered by the children, the detail information, and suggestion of treatment. The Fig. 8 below is the view of the result of the consultation form dialog.

On the form dialog consultation result will be displayed along with the diagnosis and solution form based on input data from the consultations.

V. CONCLUSION

AExS contains knowledge of fever caused by viral infection involving 8 kind of diseases. It accommodates
to input all kind of disease. The inference chain of this system has strong-coupling between rules in the knowledge base. It means “if the firing of one rule is guaranteed to make another rule fire”. Therefore, a strong link in the inference chain that leads from valid symptoms to a valid conclusion (disease).

The explanation component would combine with the inference engine to provide explanation that could follow a consultation and provide postadvice explanation-called feedback. Not only providing feedback, this system should be complete with a feedforward explanation, that provides the user with a means to find out why a questions is being asked during a consultation (i.e., during the symptom input stage). Then, this system should be complete with the experimental result to know the system performance.

The process of constructing AExS is in many ways similar to that of designing and building any large computer program or a suite of programs. It is very interesting and has created considerable importance system to diagnose fever caused by viral infection. It was presented at the 6th ICTC, Jeju Island, Korea, Oct. 28-30, 2015.


REFERENCES