

# Expert system on diagnosing children's illness using Bayesian Method

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**Abstract.** Expert system is a computer program that replicates the process of thinking and expert knowledge in solving a particular problem. The expert system can be implemented in wide range of areas, including in the medical field. Children are very susceptible to germs and parents often fear of not being able to detect symptoms of illness usually suffered by children. This expert application system for paediatric diagnosis is an expert system application designed to assist parents to sign in as users and enable them to diagnose the type of illness suffered by children according to the perceived symptoms based on a dynamic knowledge. This knowledge is obtained from various sources including scientific journals, the results of interviews and intensive discussions with medical experts. The knowledge base is structured systematically into a database with several tables including disease tables, symptom tables, and tables on basic rules to support system performance in drawing conclusions. The conclusion in this expert system is drawn using Bayesian Method. The assessment on 30 cases shows that the accuracy of system output is 76.3 percent and the system evaluation on users is 85 percent.

## 1. Introduction

Expert systems are knowledge-based programs that replicate the problem solving of human experts in a special domain by capturing and representing expert quality knowledge [1]. This expert system is a method implemented on computer programs that can mimic the thinking process and expert knowledge in solving a particular problem. Problem solving can resemble human abilities in the form of heuristics. The expert system can be applied in all fields, including in the medical sector. The knowledge methods used are interviews, analysis of past records, and observations of experts involved in a certain activity [1].

Health is considered as the most prominent aspect for human life, considering the fact that every person is very susceptible to health problems, especially children who are very vulnerable to germs. Hence, parents often experience excessive worry of not being able to detect symptoms of children's illness. It is not uncommon for parents to directly rush their sick children to see doctor without prior consideration of whether the sickness is severe or not. However, paediatricians usually have limited working hours; consequently, patients must spend a considerable amount of time to queue. Based on this current situation, parents need an expert system tool that can aid the diagnosis process faster so they can take early precautions. Several methods of disease diagnosis are used in expert systems such as



certainty factors, Bayesian networks, Dempster-Shafer belief functions, fuzzy, and others. The researcher [2] employed Forward Chaining Method and Certainty Factor for the diagnosis of children's digestive tract diseases. The expert system method used is the forward chaining method for identifying children's severe malnutrition by researcher [3]. A study in [4] built an expert system using the certainty factor method for early diagnosis of meningitis. Other research such as in [5] diagnosed early dementia symptoms using clinical data with mechanical learning techniques while Naïve Bayes classification was used in [6] by involving the rules of repeated temporal associations in the diagnosis of coronary heart disease. researchers use the Bayesian inference method to find out dangerous devices in the health care environment [7]. The researches [8] combined the Particle Swarm Optimization (PSO) algorithm and the Bayesian Method to improve the efficiency of the APM system and evaluate the fitness of selected candidates. Application of an expert system made by [9] for the diagnosis of teeth and oral diseases in children using the forward chaining method and the Bayes method, the results are quite accurate used to diagnose oral diseases in children.

The previous researches on expert system have different capabilities in diagnosis as they combined two methods in which one was used to draw conclusions and the other facilitated the process of calculating conclusions. Based on the method used in the diagnosis, this present study proposes an expert system for diagnosing paediatric disease using Bayesian Method. The next section elaborates methodology in the development of expert systems, followed by the results and discussion of the expert system and conclusion.

## 2. Methodology

### 2.1. Expert system

Expert system is defined as a system that seeks to emulate human knowledge to computers which is designed to have the ability to solve problems like an expert. Knowledge acquisition is the process of taking knowledge from experts or other sources of knowledge into computer systems to build a knowledge base. An expert system can run because of its interconnected components [7]. The components of the expert system are Knowledge Base, Inference Engine, and Best-First Search Technique.

The research technique employed in this study is Best-First Search technique. Best-First Search technique is a search technique that uses knowledge of a problem to guide searches to the nodes where the solution is located. The approach is taken to seek for the best solution based on the knowledge being possessed so that the starting point of where to begin the search and how to use the best process to find a solution can be determined [10]. The advantage of using this type of search is reducing the computational burden because it only tests the most possible solutions and the process will end once it finds the best alternative. This is a model that resembles the way humans take solutions into consideration so it will result in an absolute correct solution.

### 2.2. Bayes theorem

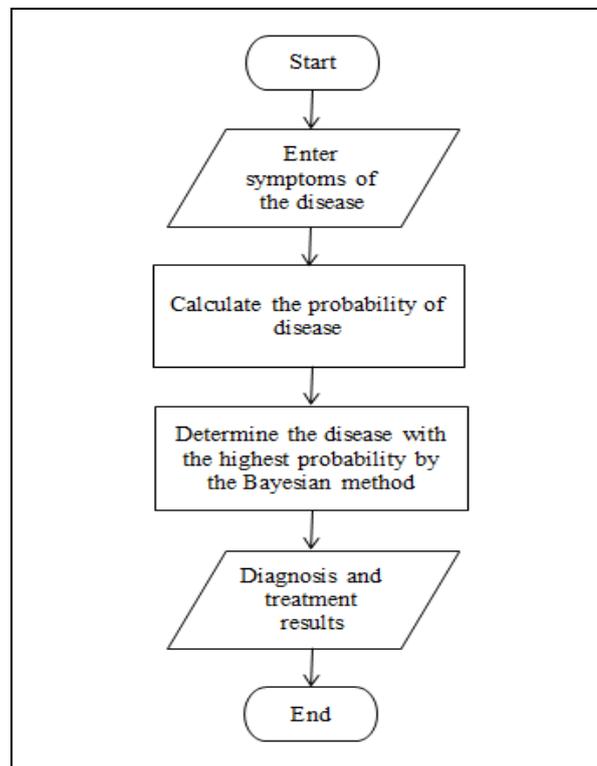
Bayes probability is one of the methods used to overcome data uncertainty by using Bayes formula [11] as follows:

$$P(H_k|E) = \frac{P(E|H_k)P(H_k)}{\sum_{k=1,n} P(E|H_k)P(H_k)} \quad (1)$$

$P(H_k | E)$  is the probability of the hypothesis  $H_k$  is correct if given evidence  $E$ ,  $P(E | H_k)$  is the probability of the emergence of evidence  $E$ , if the hypothesis  $H_k$  is true,  $P(H_k)$  is the probability of hypothesis  $H_k$ , regardless of any evidence, and  $n$  is the number of possible hypotheses.

There are several stages of software development involved in the process of creating the expert system for diagnosing paediatric disease using Bayesian Method as follows:

- Planning, conducting interviews with experts in the hospital in order to gather data on symptoms and diseases, making analysis by creating a table of symptoms and disease relations along with knowledge representation. This activity helps to solve problems in expert knowledge.
- Design, in this stage all results of expert system requirements analysis are defined in the form of flowcharts while system interfaces are modelled with interface design. To understand the system processes that are made can be seen on Figure 1. User opens the application to make a diagnosis. Then, user clicks the Diagnosis Menu and selects the symptoms seen in the children including in the form of physical, skin, and behavioural conditions. The system then calculates the probability of each symptom and formulates it into the Bayesian algorithm to determine what disease is in accordance with the symptoms described by the user. The results of the probability calculation of each symptom based on the related disease will be sorted by the highest probability value.
- Coding, at this stage the application will be created using Ruby by applying Rails Framework which is linked to PostgreSQL as a database server. The system design is not used online.
- Testing, the last stage of this process is the testing phase. This stage is done by testing the results of the existing system design using black box testing and functional testing.



**Figure 1.** Flowchart of expert system on diagnosing children's illness using Bayesian Method.

### 3. Implementation

The process of creating an expert system for diagnosing paediatric diseases using the previously described method has been successfully done in the form of an application. In order to test the system in terms of its usability, the evaluation has been conducted based on the perspective of experts and users.

### 3.1. Evaluation of system output by expert

The accuracy of system analysis results is tested by evaluating the output of the system based on user input, namely whether the output produced is appropriate from the point of view of a medical expert. Table 1 shows a summary of assessment results from 30 cases tested by the examiners.

The data show that the examiners gave a quite good assessment to the system output with the accuracy of 76.2 %.

**Table 1.** Results of system analysis.

Cases	Accuracy (%)	Cases	Accuracy (%)	Cases	Accuracy (%)	
1	72	11	90	21	80	
2	70	12	80	22	80	
3	80	13	85	23	80	
4	75	14	70	24	75	
5	90	15	80	25	70	
6	65	16	70	26	80	
7	70	17	70	27	90	
8	70	18	76	28	70	
9	85	19	70	29	75	
10	80	20	60	30	80	
					Mean	76.2

### 3.2. Evaluation of system output based on users

In addition to system analysis carried out by experts, system testing was also carried out by users. The purpose of this analysis was to determine system performance in general. Users were asked to try using the system and then they were given a questionnaire consisting of 4 questions. The sample used was 40 respondents who were randomly chosen. The results showed that 85 percent users expressed satisfaction while using the application.

## 4. Conclusions

Based on the results of system testing and evaluation, it can be concluded that the knowledge acquisition process carried out by the application is considered effective. This is confirmed by the results of evaluations of system output accuracy based on perspectives of both experts and users. The accuracy of the system output is one indicator signifying the quality of system's knowledge base. Moreover, the system's knowledge base can be built properly if the knowledge acquisition process is done properly. The evaluation results show that the system accuracy rate assessed by experts and users are 76.2 percent and 85 percent respectively. Nevertheless, the acquisition process in reality is not easy to be conducted because there are various kinds of obstacles including time, tacit knowledge of the experts, difficulties experienced by the knowledge engineer in understanding knowledge of the medical field as well as observation methods that cannot be done due to the aspect of medical ethics.

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