EXTYFD: Implementation of Expert System as A Diagnosis and Suggestion for Management of Tifoid Fever Using Borland Delphi to Improve Work Effectiveness

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Abstract. In the Medical field, expert systems can be used to diagnose diseases. EXTYFD is a program used to diagnose Typhoid fever. This program is intended to assist new doctors (health workers) in determining the type of disease, as well as helping us as the general public to find out the type of illness and suggestions for handling it, based on the symptoms or complaints felt by the patient. EXTYFD traces the rules using the Backward Chaining method and makes the program using Borland Delphi software. Broadly speaking, the EXTYFD program has been running well, among others, being able to diagnose typhoid fever and its comparative diagnoses and presenting suggestions for its treatment. The program also provides facilities to add to the knowledge database with a more user-friendly interface. Both adding patient data, as well as adding data for typhoid fever itself, such as symptoms, rules and suggestions for treatment. This EXTYFD program can display user identification, is also equipped with a password to maintain the security of data stored in the knowledge base, as well as a help menu to assist users in using the program. This program is expected to be a contribution to the advancement of the medical world. This expert system program can increase the effectiveness of the operational work of health services such as hospitals or clinics. Because it can provide time efficiency where patients do not have to wait long to get health services, energy efficiency: does not require a lot of energy to operate this system. Cost efficiency: no expensive hardware or server investment required, just install on existing PC.

Keywords: EXTYFD, software, Database

1 Introduction

In the era of the information revolution, computers are no longer used to help human work, but even today to replace human work that does not require thinking and is routine. Further developments, experts try to imitate the working system of the human brain, so it is hoped that someday it may be possible to create a computer that can weigh and make its own decisions, just like humans. Because the work of this computer system must be recognized as being faster, more thorough and accurate than humans, this is what prompted the birth of Artificial intelligence technology.

One part of Artificial intelligence (AI) is the Expert System. An expert system is a computer program that imitates the thought process and expert knowledge to solve a specific problem. The implementation of expert systems is widely used for commercial purposes because expert systems are seen as a way of storing knowledge in certain fields into computer programs so that

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they can make decisions and reason intelligently. One implementation that can be applied is the field of medicine. In the field of medicine, expert systems are used to diagnose a disease. The diagnosis of this disease uses knowledge and inference procedures from doctors who in this case act as experts. The knowledge possessed by a doctor is stored in a computer program which later is expected to work from this computer program to work or run like the reasoning done by a doctor when diagnosing a disease.

Because of the limitations of medical personnel, especially doctors, cases often occur where when a patient comes to health care facilities (hospitals) there is no doctor who is in place and can immediately diagnose the patient's illness. Meanwhile, patients need help and prompt treatment that must be given, so that the patient's illness does not get worse. For this reason, it is hoped that this expert system program is a program for temporary diagnosis to replace the role of doctors in diagnosing diseases in patients so that preventive measures and assistance can be taken as early as possible so as not to worsen the patient's condition.

This can be done by the medical team who was on the spot at that time. This expert system program can increase the effectiveness of the operational work of health services such as hospitals or clinics. Because it can provide time efficiency: where patients do not have to wait long to get health services, energy efficiency: does not require a lot of energy to operate this system. Cost efficiency: no expensive hardware or server investment required, just install on existing PC.

Typhoid fever is a type of digestive tract infection that is often encountered. This type of disease does not only attack children, but can attack adults. There will be complications of various diseases that accompany this disease, or can cause death if not treated quickly. For this reason, it is necessary to make a computer program that has intelligence to diagnose this disease.

Artificial Intelligence

Artificial Intelligence is one of the fields of computer science that utilizes computers so that they can behave intelligently like humans. Computer science uses software and hardware to imitate human activities. Human activities are imitated such as reasoning, vision, learning, problem solving, understanding natural language and so on. In accordance with this definition, artificial intelligence technology is studied in fields such as Robotics, Computer Vision, Natural Language Processing, Pattern Recognition, Artificial Neural System , Speech Recognition and Expert System.

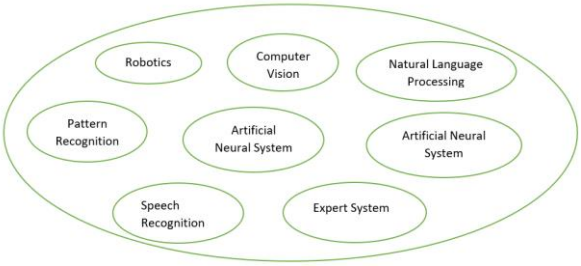

Figure 1. Some areas of Artificial intelligence

Expert System

Artificial intelligence (AI) solves problems by utilizing computers to solve complex problems by following the human reasoning process. One of the artificial intelligence techniques that imitate the human reasoning process is an expert system. Feigberbaum, an AI leader, stated: “An Expert System is an intelligent computer program that uses knowledge and inference procedures to solve problems that are difficult enough to require significant human

expertise for their solution". An expert system (expert system) is a computer system designed to help humans solve complex problems in certain fields that generally require an "expert". The expertise of an "expert" is generally obtained from years of experience and specialized knowledge of the problems at hand.

Expert System Components :

A program that functions to imitate a human expert must be able to do things that an expert can do. To build a system like this, the basic components that must be owned at least are as follows:

a. User Interface
b. Knowledge Base
c. Interface Machine

Meanwhile, the expert system can be provided with the following features to make it more like an interacting expert:

a. Explanation Facility
b. Knowledge Acquisition Facility
c. Self-Training

The architecture of expert system based on knowledge is shown in Figure 1.2 [MAR88]

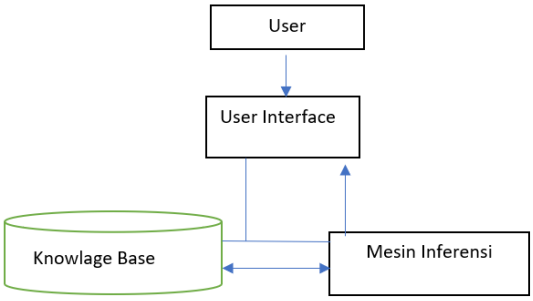

Figure 2. The basic architecture of expert systems

User Interface

Because an expert system replaces an expertise in certain situation, it provides the supporting system which needs by users who are unfamiliar with technical issues. Expert system also provides communication between the system and its user, which we call the interface. An effective and user-friendly interface is important for non-specialist user in the disciplines applied to expert systems.

Knowledge Base

A knowledge base is a collection of expert-level knowledge in a specific topic organized in a specific format. This knowledge is gathered from an accumulation of experts of knowledge and various sources, such as books, magazines, scientific journals, and so on.

Inference Machine

Inference Machine is software that performs the logical inference of expert system, usually referred as a thinking machine. Basically, this inference engine will find solution to a problem. The concept used for inference engines is top-down commonly, which is a logical process that starts from the desired goal. In addition, user can use bottom-up, which is a logical process that starts from known conditions towards the desired goal.

Knowledge Acquisition Facility

Knowledge acquisition is the process of collecting knowledge, transferring and changing the form of problem-solving specialist from experts or sources of knowledge documents that are input into computer programs for the creation or development of a knowledge base [TUR98]. Potential sources used as sources of knowledge include: an expert such as doctor, books, multimedia documents, knowledge bases, research reports, special ones and information that can be obtained from the internet. Knowledge acquisition method can be done by interview, tracing, and observation. Knowledge in expert systems can be added whenever new knowledge is obtained or when existing knowledge is no longer valid. Users will be able using an expert system completely and appropriate as developments once its done. Carrying out the addition process, the expert system is equipped with knowledge acquisition facilities.

With the facility in the system, an expert will easily add new facts or rules to the expert system. Through this facility, the expert system will get new rules based on knowledge or new facts based on domain.

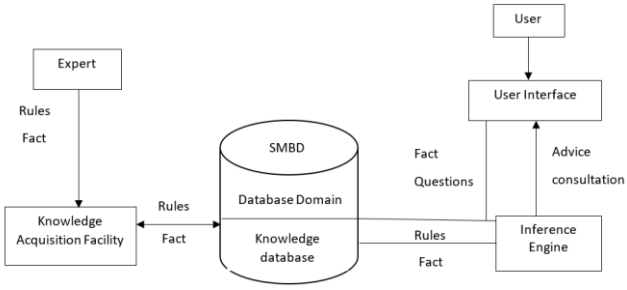

Figure 3. Complete Architecture of Knowledge-Based Expert System

Knowledge Representation

After determining the area of expertise that will be applied to the expert system, then knowledge is collected in accordance with the domain of expertise. The knowledge collected cannot be simply applied in the system. Knowledge must be presented in a certain format and compiled in a knowledge base. Knowledge representation is a method used for coding existing knowledge in the knowledge base of an expert system [DUR94]. There are many methods for presenting knowledge in artificial intelligence software. Designers can choose between predicate calculus, lists, frames, semantic network scripts or production rules. This choice depends on the problem, level of knowledge and also the type of knowledge to be presented. Through years of experience, it can be determined that a good knowledge representation method for expert systems is the production rule method.

The production rule was chosen to represent knowledge because it has the following advantages:

a. Production rules are modular so they have flexibility that allows each rule to be modified easily.
b. Production rules are a type of knowledge representation that is easy to interpret.
c. Production rules imitate human thinking to solve problems.
d. Production rules are very useful for representing declarative knowledge.

The steps taken to create a knowledge representation in the form of rules for this expert system knowledge base are as follows:

Knowledge Representation

After identifying of expertise area that will be applied to the expert system, knowledge is collected afterward base on the domain of expertise. The collected knowledge cannot be applied in the system simply. Knowledge must be presented in a certain format and compiled in a knowledge base. Knowledge representation is a method used for coding existing knowledge in the knowledge base of an expert system [DUR94]. There are many methods to present knowledge in artificial intelligence software. Designers can choose between predicate calculus, lists, frames, semantic network scripts or production rules. This choice depends on the problem, level of knowledge and also the type of knowledge to be presented. Through years of experience, it can be determined that a good knowledge representation method for expert systems is the production rule method.

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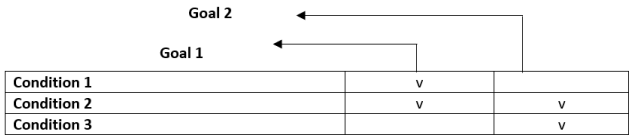
c. Production rules reflects human thinking to solve problems.
d. Production rules are very useful for representing declarative knowledge.

The steps taken to create a knowledge representation in the form of rules for this expert system based on knowledge are as follows:

1) Making a decision table
   Decision table is a method for documenting knowledge. The decision table describes knowledge, the decision table is a matrix of conditions considered in the description of the rule. The decision table can be seen in table 3.1 below:



2) Conversion of decision tables into production rules
   Knowledge representation, production rules, formed from changing the decision table. Making a Rule is done in several stages. As an example, consider the following Rule 1 creation. First, look at Goal 1 which is the conclusion of rule 1. This conclusion can be reached if the conditions that support it are met. Second, a check mark in the column under Goal 1 indicates which conditions relate to that conclusion. On goal 1, it can be seen that the check marks are in Condition 1 and Condition 2. Third, making rule 1 using the goals and conditions that have been obtained from steps 1 and 2, as follows:

   Rule 1: Goal 1 IF
   Condition 1
   And Condition 2
   Rule 2 can be obtained in the same way.

   Rule 2: Goal 2 IF
   Condition 2
   And Condition 3

The following is the process of acquisition and representation of knowledge of typhoid fever:

Thypoid Fever

Typhoid is an acute infectious disease of the small intestine which is characterized by acute fever due to infection with salmonella sp. (more than 500 species). Species that are often found in the clinic are Salmonella typhi, Salmonella parathyphi A, Salmonella parathyphi B, Salmonella parathyphi C.

Epidemiology

Typhoid is an endemic disease in Indonesia. This disease includes infectious diseases listed in law number 6 1962 about epidemic of a disease. This group of infectious diseases are diseases that are easily contagious and can attack many people, so they can cause outbreaks.

a. High fever more than 7 days
b. Increase in temperature > 380 C (reaches 40 – 410 C)
c. Headache
d. Dizzy
e. Muscle and Joint Pain
f. Malaise
g. Nausea or vomiting / stomach discomfort
h. Enlarged liver and spleen and tenderness
i. Constipation, digestive disorders or diarrhea
j. Fever curve rises slowly
k. Tongue dirty in the middle, red edges and tips, shaking (tremor).

Laboratory Examination Results:

a. Usually Leukopenia (3000-4000/mmk)
b. Blood culture (+) in the first week, if (-) bone marrow culture is a lot (+)
c. Blood culture after 3 weeks 50%
d. Feces culture (+) 75% at 3 weeks of fever
e. Urine culture (+) at 3 weeks of fever
f. Widal titer O 1/320, widal titer H 1/640, the increase can reach 2-4 times

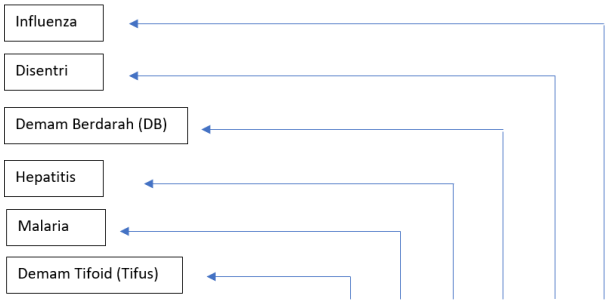
Differential Diagnosis:

There are several diseases whose symptoms are similar to typhoid fever. Disease Differential diagnosis of typhoid fever, among others:

a. Influenza
b. Malaria
c. Hepatitis
d. Dengue Hemorrhagic Fever (DB)
e. Dysentery

2 Hypothesis

For Typhoid Fever and differential diagnosis diseases whose symptoms resemble those of Typhoid Fever, a decision table can be made as follows:



No	Disease Symptoms						
1	Fever	√	√	√	√	√	√
2	Headache	√	√	√	√	√	√
3	Dizzy	√	√	√	√	√	√
4	Muscle and Joint Pain	√	√	√	√	√	√
5	Not feeling well (malaise)	√	√	√	√	√	√
6	Body Temperature > 38^0 C	√	√	√	√	√	√
7	Nausea and Vomiting	√	√	√	√	√	
8	Enlarged heart and tenderness	√	√	√	√		
9	fever > 7 days	√	√	√			
10	High fever with chills	√	√				
11	Enlarged and tender spleen	√	√				
12	Fever curve rises slowly	√					
13	Indigestion (diarrhea/constipation)	√				√	
14	Dirty white tongue in the middle, red tips and edges, and vibrates	√					
15	Leukopenia 3000-4000/mmk	√			√		
16	SGPT/SGOT positive	√		√			
17	Widal Titer O > 1 :320	√					
18	Widal Titer H > 1:640	√					
19	Fever curve up and down		√				
20	Anemia		√				
21	Positive malaria blood preparation		√				
22	Yellow skin and Yellow eyelids (sclera)			√			
23	Urine colored like strong tea			√			
24	Bleeding spots on the skin				√		
25	Decreased platelets (≤ 100,000/mm3)				√		
26	Feces/stool contains mucus and blood					√	
27	Cough and cold						√
28	Sore throat						√

3 Method Expert System EXTYFD

The method used in the EXTYFD system is Backward Chaining, which starts from a collection of facts about a symptom felt by the patient as input to the system and then tracking until the final goal is reached in the form of a clinical diagnosis of the disease and suggestions

for overcoming it. Knowledge acquisition method can be done by interviewing with experts (Expert), tracing, and observation.

Conceptual Design:

Over all of system EXTYFD is made to be able to perform the following tasks:

a. Get data Patient identity
b. Get symptom consultation from patient consultation results
c. Matching these symptoms with the rules that exist in the knowledge base and storing these symptoms into patient data.
d. Describe the patient's condition
e. The description of the patient's condition as the EXTYFD output contains the general condition of the patient, the diagnosis of the disease and suggestions for overcoming or drug therapy that can be given.

Expert System Structure Design

The three main components that must exist in the expert system program are the knowledge base, the inference engine and face-to-face with the user (user interface). Meanwhile, the EXTYFD expert system program consists of several components, including:

a. Knowledge Acquisition
b. Knowledge Base
c. Interface Engine
d. User
e. User Interface
f. Blackboard (working memory)

Using Borland Delphi as a shell creation tool

The inference engine is a central concept for making expert systems. By using Borland Delphi an inference engine is made that can run the rules that have been made in the knowledge base without having to change the program code of the inference engine. The process of tracing these rules uses the method of backtracking reasoning.

4 Implementation

Inference Engine

The inference engine is vital in making this EXTYFD program. The inference engine is designed to perform tracking on the knowledge base without adding or changing the program as well as tracking using the Backward Chaining method. First, initialize the variables that will be executed in the program procedures. This variable is placed in a private procedure.

The following is a program listing:

```
Private
NoKode, JumpQT, NoNext, NoJwb: Integer;
{Private declarations}

Then assign values to the variables, the following is the program listing:
Procedure TForm1.FormShow{Sender: TObject};
Begin
RadioGroup1.ItemIndex := -1;
NoKode := 1;
```

JumQT := 0;
End;

Assigning a value to No Code when the form appears, it means that the inference engine starts from the first record with the code's primary key. While the value of QT = 0 because the system is not running. See table 4.1 which is a table of questions run by the inference engine.

Table 1. Questions

Code	Symptom	Question	IDYES	IDNO	QT
1	Fever	Do you have a fever?	2	-1	1
2	Headache	Do You Have Headaches?	3	-1	2
…	…		…	…	…
18	Widal titer H> 1:640	Is the result of Laboratory Widal titer H Antibody > 1:640	0	-1	18

The list of programs when the user selects the RadioButton "YES" button or selects the RadioButton "NO" button on the RadioGroup is as follows:

Procedure TForm1.BitBtnClick{Sender: TObject};
Begin
Case RadioGroup1.ItemIndex of
0: begin
NoNext := Table1.FieldByName('IDYES').asInteger;
JumQT := JumQT + Table1.FieldByName('QT').asInteger;
NoKode := NoNext;
BitBtn1.Enabled := false;
RadioGroup1.ItemIndext : = -1;
Table1.FindFirst;
End;
1:begin
NoNext := Table1.FieldByName('IDNO').asInteger;
JumQT := JumQT + Table1.FieldByName('QT').asInteger;
NoKode := NoNext;
BitBtn1.Enabled := false;
RadioGroup1.ItemIndext : = -1;
Table1.FindFirst;
End;
The inference engine keeps tracking until it finally stops at code with a value of -1 or a value of 0.
If the value code is = -1 then the machine concludes that no solution has been found, and if the value code is = 0, the machine displays the final conclusion in the form of the name of the disease along with the sum of the values in the QT column. The following is a program listing:

Case NoID of
-1: begin
NoJwb : = 0;
tblJawab.Open;

```
tblJawab.findfirst;
RadioGroup1.Enabled := False;
If tblMemo.FindKey {[NoJwb]} then
Memo2.Text := tblmemo.fieldByName ('memo').AsString;
MessageDlg('Maaf Solusi Anda Belum Ditemukan', mtInformation, [Mbok].0);
Exit;
End;
0:begin
NoJwb : = JumQT;
tblJawab.Open;
tblJawab.findfirst;
RadioGroup1.Enabled := False;
If tblMemo.FindKey {[NoJwb]} then
Memo2.Text := tblmemo.fieldByName ('memo').AsString;
MessageDlg('Solusi Anda Telah Ditemukan', mtInformation, [Mbok].0);
PageControl1.ActivePageIndex : = 1;
End;
```

Knowledge Base

The menu of Question Data Form is a knowledge base that displays data on questions, data on symptoms, and rules, which will be executed by the inference engine. The Question data, symptom data and rules are stored in a knowledge base database.

Result

From the results of the questions about the symptoms felt by the patient, the EXTYFD system can display the kinds of diseases suffered by the patient. The following is a table of diseases generated by the system, along with diseases compared to Typhoid Fever:

Table 2. Kinds Of Diseases

QT	Solution
0	No solution
83	Influenza
89	Dysentery
125	Dengue Hemorrhagic fever
138	Malaria
158	Hepatitis
171	Typhoid Fever

In addition to displaying the type of illness suffered by the patient (user), the system also displays solutions for handling or how to treat the illness:

Code	Disease	Medicine
0	No Solution	
83	Influenza	a. Antibiotics - Amoxicillin 30-50 mg/kg/day in 3 divided doses or - Ampicillin 50-70 mg/kg/day in 4 divided doses. b. Heat Reduction

		- Paracetamol 10 mg/kg/time, 3-4 times/day, if necessary. c. Have a cold - Ephedrine 3x 10 mg, children's dose adjusts d. Cough - Dextromethorphan 3x10-15 mg or, - Codeine 3x8 mg, children's dose adjusts
89	Dysentery	…
…	…	…
171	Typhoid fever	a. Antibiotics - Chloramphenicol 50-100 mg/kgBW/day, in 4 divided doses b. Heat reducer - Paracetamol 3-4 times 10 mg/kg/day, if necessary c. Lots of bed rest, if severe symptoms need to be treated d. Eat soft foods (example: porridge) e. Do not eat spicy, sour food.

5 Conclusions and Suggestions

Conclusions

a. The EXTYFD expert system program is used to diagnose typhoid fever based on the symptoms felt by the patient and suggestions for handling them.
b. The stages of making the EXTYFD expert system include: Knowledge Acquisition, Knowledge Base preparation, Knowledge Representation, User Interface Development, and making ES Shell, namely the inference engine.
c. The process of gathering knowledge from an expert is a complex and not easy task that often creates obstacles or obstacles in the manufacture of expert systems.
d. EXTYFD expert system as a tool to assist new doctors in determining the type of disease, as well as helping us as the general public to find out the type of disease suffered and suggestions for handling it, based on the symptoms or complaints felt by the patient.
e. The data inputted by the patient (user) is the patient's identity data and the data from the consultation results.
f. The data inputted by the doctor (Expert) is New knowledge data, Data on diseases and their symptoms.
g. The data inputted by the Administrator (Knowledge Engineer) is new knowledge data, namely question data, disease type data and handling data.
h. The data that has been inputted can be displayed again at any time during data editing by the doctor or administrator.
i. Can be a contribution to the advancement of the world of medicine and the field of information technology (IT).
j. The System Can improve the effectiveness of operational work in health service places such as hospitals or clinics. This system can also provide time, cost and resource efficiency. Because patients do not have to wait long or queue to get health services, cost efficiency: does not require expensive server hardware investment and resource efficiency where the

system does not require a lot of operational personnel to operate this system, this system can be installed on a hospital PC or clinic and In future development, this system can be accessed by patients at home using a web application or android application.

Suggestions

Based on the testing of the EXTYFD expert system program, the program still needs to be developed again so that the program performance is better. This is done by adding and improving facilities, including:

a. Obtained from an expert (doctor) in order to have high data validity in accordance with the development of medical science.
b. Developing this EXTYFD program into an expert system program based on web and android applications, so that it can be widely known by the world community through the internet network.
c. There needs to be better documentation of all aspects so that the documentation can be used as the main source of knowledge.
d. The EXTYFD expert system can be developed with a system that has a certain level of confidence, namely by including the percentage of each value obtained from each disease as well as suggestions for handling it so that users are confident enough to trust the answers given by the system.

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