JOURNAL OF DATA SCIENCE | Vol.2024:65
eISSN:2805-5160

Data-Driven Expert System for Tuberculosis (TB) Diagnosis Using the Forward Chaining Method

Budi Usmanto[1], Rinawati[2], Novita Andriyani[3]

[1-4]Fakultas Teknologi dan Ilmu Komputer Program Studi Sistem Informasi IBN Lampung

[*]**Email:** budiusmanto@gmail.com

Abstract

Tuberculosis (TBC) is a disease caused by Mycobacterium tuberculosis, one of the oldest known diseases affecting humans. While it primarily affects the lungs, about one-third of cases involve other organs, underscoring the importance of early detection and accurate diagnosis. To address this, a data-driven expert system has been developed to assist in diagnosing tuberculosis and providing relevant information to users. An expert system is a form of intelligent software that leverages data and expert knowledge to solve complex problems. In this study, the Forward Chaining method is applied, utilizing a rule-based approach to process data and conclusions from known facts. This method iteratively matches facts to rules, deriving new insights until a conclusion is reached or no further matches are found. If the premise satisfies the conditions (evaluated as TRUE), the system generates a decision. The system is designed to simplify the recognition of tuberculosis symptoms by analyzing user-provided data to produce accurate diagnostic results and actionable solutions. Findings indicate that the data-driven approach enhances the system's ability to provide precise diagnoses and recommendations, ensuring reliability and effectiveness. This work demonstrates the value of integrating data-driven methodologies in expert systems to improve healthcare delivery, particularly in the early detection and management of tuberculosis.

Keywords:

Expert System, Tuberculosis (TB), Forward chaining, Visual Basic.

Introduction

Health is a very important need for every human life, namely physical, mental, and social well-being that allows each individual to live a productive life in social and economic aspects. Meanwhile, various diseases often easily attack when someone does not take care of their health. Infectious diseases are diseases that are dangerous for anyone, both those who have strong immune systems, especially those who are weak because they can spread quickly through the air, touch, or other intermediaries.(Ministry of Health of the Republic of Indonesia, 2022).

Submission: 25 October 2024; **Acceptance:** 21 December 2024

One of the infectious diseases that is currently still a world concern is Tuberculosis or TBC. Tuberculosis (TBC) is an infectious disease caused by Mycobacterium tuberculosis. This disease generally attacks the lungs but can also affect other parts of the body.(Idi Jang Cik & Maikel Jeksen, 2016)

Based on data from the World Health Organization (WHO) in 2015, there were still 10 million cases of TBC worldwide, up from the previous 6.9 million people. The country with the most TBC findings is India with 2.8 million cases, followed by Indonesia with 1.02 million cases and China with 918 thousand cases. Indonesia is the country with the second largest number of TBC sufferers in the world. This number consists of 56% men, 35% women, and 10% children. In 2016, TBC became an infectious disease that caused many deaths, with a figure of 274 deaths every day. Currently, an estimated 1,020,000 people are infected with this infectious disease. However, the Ministry of Health (Kemenkes) noted that the newly reported cases were around 420 thousand. (Cik & Jeksen, 2016)(Amrun et al., 2023)

Previous research conducted by Rizal et al. stated that TBC is an infectious disease that causes major health problems, becoming the second most significant in the world after HIV. The bacteria that cause TB are spread through coughing and sneezing from infected people. An expert system application is needed that can provide information on examinations and prevention methods to overcome potential causes and provide information on diagnostic results. This study aims to develop an expert system that can provide information on TBC and its treatment. The method applied in this study is the ahead chaining method. The results of the study utilizing PHP and MySQL are the creation of an Expert System for Diagnosing Tuberculosis. This system has been successful in diagnosing Tuberculosis. At the testing stage, data on symptoms of the disease caused by Tuberculosis Virus infection was entered, resulting in a diagnosis of between 80% -90%. (Rijal et al., 2021)

The development of TBC disease is so fast, while many people do not understand the symptoms of this disease, efforts to suppress the evolution of TBC disease have been made by the government, but the results are not in accordance with the goals that have been determined. With this condition, an expert system was created to replace an expert person to diagnose TBC disease using visible fundamentals so that it can be used by anyone. Basically, this system is taken from the knowledge of a human being who is an expert in the area and tries to imitate its methodology and performance. (Nurdianto, 2021; Trenggono & Bachtiar, 2023)

Using an expert system based on Visual Basic, it becomes easier to diagnose if a person is experiencing symptoms of TBC. To make the results of the expert system more accurate, this expert system was built using forward chaining technique. It inputs the variables of symptoms experienced by a person and develops an appropriate treatment solution. This expert system can help reduce the number of people diagnosed with more severe TBC disease and curb the onset of TBC disease.(Kusnadi, 2013) (Kusnadi, 2013; Pratiwi et al., 2023; Zatihulwani et al., 2019)

Methodology

Forward Chaining

Forward chaining is a reasoning method in artificial intelligence, especially in rule-based systems, that works by starting from known facts and using logical rules to draw new conclusions until a certain goal is achieved. This method is also called "data-driven reasoning" because the process starts with existing data. (Aziz, 2023; Marcos & Kusumastuti, 2016; Rahmatullah et al., 2018; Robby Rizky, Sukisno, Mohammad Ridwan, 2020).

How Forward Chaining Works:

1. Fact Initialization; The system starts with the initial known facts.
2. Rule Matching; The system checks each rule in the knowledge base to determine if it can be applied based on the existing facts. A rule usually takes the form: IF Condition THEN Conclusion
3. Rule Application; If a rule matches (its condition is met by the existing facts), the conclusion of the rule is added to the fact set.
4. Iteration; This process is repeated with new facts until: No more rules can be applied, or The desired goal has been achieved.
5. Termination; The system stops after reaching a conclusion or no more rules can be applied.

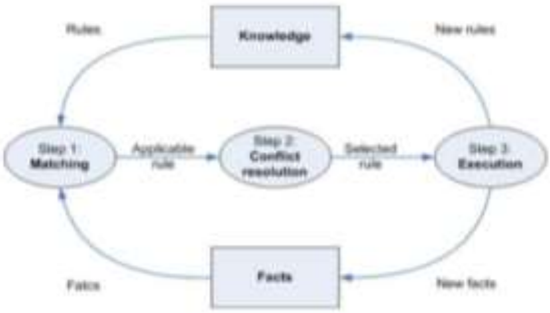


Figure 1. Forward Chaining Method

The function of each stage for the image above is explained as follows:

1. Matching; is each phase where knowledge is compared with known facts to identify which parts are met (the term 'met' refers to a situation, premise, or antecedent that is true).
2. Conflict Resolution. In the first step, conditions may arise where several Conflict Resolution stages function to determine which part has the highest priority that can be executed.
3. Execution. This process produces two possibilities, namely new facts that are derived and new facts and stages that are generated are added to knowledge.

Data Collection Methods

In conducting this research, several data collection methods were carried out as an initial step in collecting information in system development, namely:

1. Literature study, which is a method carried out by reading books, journal articles or previous research that has been carried out by researchers that can support the process of completing the work.
2. The interview method is a discussion between researchers and informants. Researchers here want to obtain information, while informants are individuals who are believed to have important knowledge about TB disease.
3. The observation method is a research method in which researchers observe all activities in the form of phenomena in the field, to support the results of the interview with the aim of providing solutions through the information system that will be created so that it can be more useful.

Data Needs Analysis

A system designed to be able to process problems requires analysis to find out the process of the system running. To find out the problems and needs in system design, it is necessary to analyze the information that has been done in the previous information collection. (Aziz, 2023; Fita Yeny Saraswati et al., 2023; Hartini & Setiatin, 2022). The following is the data needed to create the system:

1. Disease Data, contains information about the type of TB disease.
2. Symptom Data, Information data about the symptoms of TBC disease diagnosed by the system.
3. Solution Data, information about the type of disease solution that explains the solution or treatment suggestions.

The tracking process

The tracking process applied in this system follows a forward chaining pattern. In recognizing TB disease, the forward chaining process begins by asking about the symptoms experienced by the patient, then from the symptoms given, a diagnosis will be obtained regarding the type of TB disease faced and how to treat it.

Knowledge Representation

In this study, the knowledge base is represented using **IF-THEN**. Example: if long cough and **shortness of breath** and **night sweats** N then diagnosis: **pulmonary tuberculosis** (type of disease), followed by information on solutions and how to overcome it. The knowledge base of the type of tuberculosis disease that will be detected by the system consists of the code and name of the disease. The following is data on the type of tuberculosis disease used in making the system.

Table 1. Types of TBC disease

Number	**Code**	**Description**
1.	P1	Pulmonary TBC
2.	P2	Glandular TBC
3.	P3	Bone TBC
4.	P4	Miliary TBC

Table 2. Symptoms of TBC disease

Number	**Symptom code**	**Description**
1.	G1	Coughing up phlegm
2.	G2	Coughing up blood.
2.	G3	Long-term/persistent cough
`4.	G4	Shortness of breath/asthma
5.	G5	Body gradually becomes weak
6.	G6	Decreased appetite.
7.	G7	Weight loss
8.	G8	Night sweats
9.	G9	Prolonged fever
10.	G10	Chest pain
11.	G11	Feeling unwell (malaise).
12.	G12	Decreased consciousness
13.	G13	Mild cough
14.	G14	Enlarged spleen
15.	G15	Lumps appear in the neck.
16.	G16	Lumps appear in the armpit
17	G17	Lumps appear between the thighs
18	G18	Body aches accompanied by fatigue in the afternoon
19	G19	Pain in the joints of the bones
20.	G20	Swollen bones
21.	G21	Limited movement

22.	G22	Appears on the skin with a bluish red color
23.	G23	Skin feels hot and/or cold around the infected area

Table 3. Table of symptoms and types of TBC

Symptom code	**Disease Code**			
	P1	P2	P3	P4
G1	■			
G2	■			
G3	■		■	
G4	■			
G5	■			
G6	■	■	■	■
G7	■	■	■	■
G8	■	■		■
G9	■	■	■	■
G10	■			
G11	■		■	
G12		■		
G13		■		
G14		■		
G15			■	
G16			■	
G17			■	
G18				■
G19				■
G20				■
G21				■
G22				■
G23				■

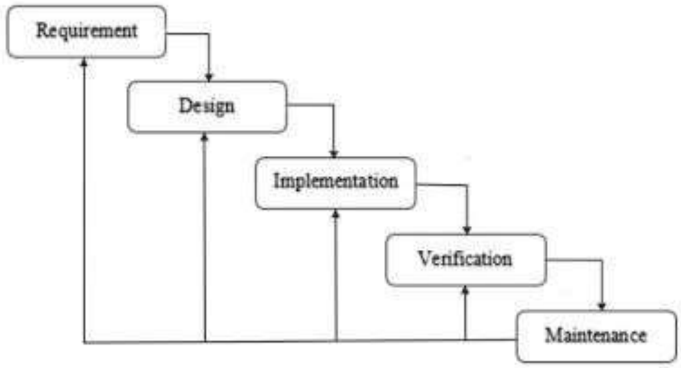
Decision on TBC disease determination Information on TBC disease control includes data on solutions or recommendations related to TBC, consisting of solution codes, disease codes, and solutions. The following are several types of data on TBC disease and solutions needed to start creating a system.

Table 4. Solution Table

Num.	**Solution Code (S)**	**Disease Code(P)**	**Description**
1.	S1	P1	Solutions for pulmonary tuberculosis
2.	S2	P2	Solutions for glandular tuberculosis

3.	S3	P3	Solutions for bone tuberculosis
4.	S4	P4	Solutions for miliary tuberculosis

System Development
SDLC (System development life cycle) method used in the system development process, with a waterfall approach. (Indra & Harahap, 2022; Lestyaningrum & Anardani, 2017)



The waterfall method has several sequential stages, namely:

1. Requirement (Requirement analysis); at the stage of the development system, communication is carried out to understand the software desired by the user along with its limitations. This information is generally obtained through interviews, discussions, or direct surveys. The data required by the user is obtained through analysis of this information.
2. Design; At this stage, the requirements specifications from the previous stage will be reviewed and the system design will be prepared. The supporting system design determines the hardware and system requirements, and helps describe the overall system stages.
3. Implementation; At this stage, the system is first created in the form of a small program called a unit, which is then integrated in the next stage. Each unit that is built and tested for its functions is known as unit testing.
4. Verification (Integration & Testing); All units created in the implementation phase are combined into the system after testing of each unit is complete. After the integration process, the entire system is tested to detect potential failures and errors.
5. Mantance (Operation & Maintenance); This is the last stage of the waterfall model. The software that has been developed is run and maintained. Maintenance includes fixing errors that were not detected in the previous step, repairing system units that have been implemented, and improving system services according to new needs.

Context Diagram

A context diagram is a picture that includes the main inputs, the overall system, and the results. A diagram that consists of a process and shows the boundaries of a system. A context diagram is also the highest level of DFD that shows all inputs into the system or the results of the system that provide an overview of the system as a whole.

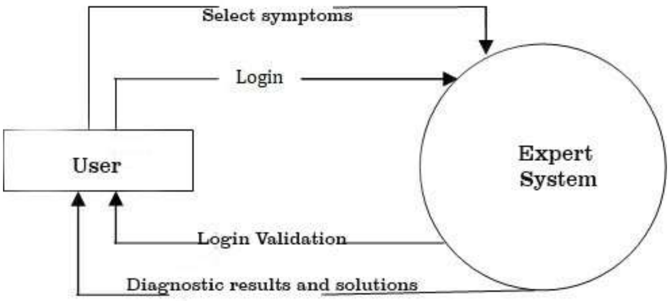


Figure 3. Context Diagram

Results and Discussion

Implementation

The system design aims to design the system during research, test, and record the program steps required by the approved system design document. This expert system program for diagnosing TBC disease uses Visual Basic. Below is the interface of the expert system program that has been developed.

Login Form Display

The login form functions to carry out the process of entering the system. The login form display can be seen in Figure 4.

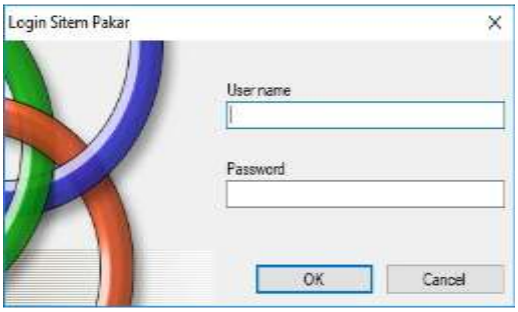


Figure 4. Login form

Expert System Program

The main form display of this expert system program is filled by the user by selecting the symptoms experienced. The user selects more than one symptom available in the program. Then the user selects the diagnosis button to see the diagnosis results.

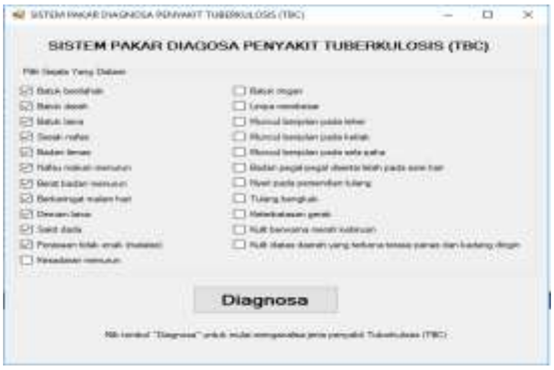


Figure 5. Expert System Program Display.

After the user has made a diagnosis, the results of the disease suffered and the solutions suggested by the system to the user will appear. The results and solutions display can be seen in the following image:

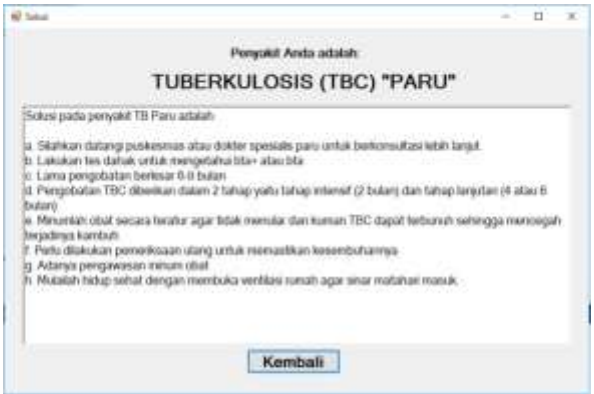


Figure 6. Display of results and solutions

Conclusion

From the explanation of the expert system in diagnosing TBC disease using the forward chaining method developed with Visual Basic, it can be concluded that this system offers a valuable tool for general users to detect TBC symptoms quickly, easily, and at any time. By leveraging the forward chaining method, the system ensures logical and systematic identification of symptoms, providing accurate diagnostic results based on the data entered by users. Moreover, the expert system enhances accessibility to preliminary health assessments, especially in areas where access to medical professionals may be limited. By providing suggestions for handling the symptoms, the system not only assists users in understanding their condition but also guides them toward seeking appropriate medical attention when needed. This development highlights the potential of expert systems in improving healthcare delivery by offering timely and user-friendly solutions. Future enhancements could include integrating more advanced algorithms, expanding the knowledge base for greater diagnostic accuracy, and incorporating multilingual support to reach a wider audience. Additionally, the inclusion of real-time data updates and a mobile application version could further improve the usability and effectiveness of the system in combating TB disease globally.

References

Amrun, J., Khairiah, K., & Sarifandi, S. (2023). The Spread Of Disease Outbreak In Southeast Asia In The Early 20th Century. *Nusantara; Journal for Southeast Asian Islamic Studies*, *19*(1). https://doi.org/10.24014/nusantara.v19i1.24513

Aziz, M. R. (2023). Gastric Disease Diagnosis Expert System Using Forward Chaining Method. *Jurnal Riset Dan Aplikasi Mahasiswa Informatika (JRAMI)*, *4*(03). https://doi.org/10.30998/jrami.v4i03.8590

Cik, I., & Jeksen, M. (2016). Expert System for Diagnosing Tuberculosis (TBC) at the Besemah Pagaralam Regional General Hospital (Rsud). *Jurnal Ilmiah Matrik*. 18(3) DOI:10.33557/jurnalmatrik.v18i3.413

Fita Yeny Saraswati, Nurberta Dyah Kurniawati, Sri Hidayati, Dwi Indah Purnama Sari, Nur Lailiyah, Shillvyarifianti, & Toni Budiarto. (2023). Hypervolemia Management To Achieve Adequacy of Hemodialysis in CKD Patients with Nephrolithiasis at Dr. Wahidin Sudiro Husodo Hospital. Ezra Science Bulletin, *1*(2A). https://doi.org/10.58526/ez-sci-bin.v1i2a.45

Hartini, F. S., & Setiatin, S. (2022). Security and Confidentiality of Covid-19 Patient Medical Records at Lembang Regional Hospital. *Jurnal Delima Harapan*, *9*(1). https://doi.org/10.31935/delima.v9i1.145

Idi Jang Cik, & Maikel Jeksen. (2016). Expert System for Diagnosing Tuberculosis (TBC) at the Besemah Pagaralam Regional General Hospital (Rsud). *Jurnal Ilmiah Matrik*, *18/3*. DOI:10.33557/jurnalmatrik.v18i3.413

Indra, Z., & Harahap, M. R. P. (2022). Development of Expert System for Diagnosing Tuberculosis Disease During Pandemic Using Forward Chaining Method in Medan Johor Health Center. Charismatics*: Kumpulan Artikel Ilmiah, Informatika, Statistik, Matematika Dan Aplikasi*, *8*(3). DOI : 10.24114/jmk.v8i3.40989

Kementerian Kesehatan Republik Indonesia. (2022). *TBC a World Health Problem. Accessed December 31, 2017*. https://kemkes.go.id/id/rilis-kesehatan/tbc-masalah-kesehatan-dunia

Kusnadi, A. (2013). Design of Expert System Applications to Diagnose Diseases in Humans. *Jurnal ULTIMATICS*, *5*(1). https://doi.org/10.31937/ti.v5i1.307

Lestyaningrum, A. D., & Anardani, S. (2017). Design and Construction of an Expert System for Diagnosing Tuberculosis (TBC) Disease Using the Forward Chaining Method. *DoubleClick: Journal of Computer and Information Technology*, *1*(1). https://doi.org/10.25273/doubleclick.v1i1.1367

Marcos, H., & Kusumastuti, G. (2016). Lung Disease Diagnosis Expert System Using Forward Chaining Method. *Jurnal Teknik Elektro*, *8*(2). https://doi.org/10.15294/jte.v8i2.7436

Nurdianto, A. R. (2021). Corona Virus Disease 2019 (COVID-19) In the principle of Salus Populi Suprema. In *ResearchGate* (Vol. 2019, Issue June 2021). ISBN: 978-623-6975-32-9

Pratiwi, A. C. P., Luturmas, A., Prabowo, D. A., & Pusporini. (2023). Community Empowerment in Efforts to Prevent and Treat Tuberculosis. *Jurnal Pengabdian Komunitas*, *02*(03). https://jurnalpengabdiankomunitas.com/index.php/pengabmas/article/view/52

Rahmatullah, S., Purnia, D. S., & Suryanto, A. (2018). Expert System for Diagnosing Eye Diseases Using Forward Chaining Method. *Jurnal Sentra Penelitian Engineering Dan Edukasi*, *10*(2). DOI: http://dx.doi.org/10.55181/speed.v10i2.279

Rijal, S., Sarjan, M., & Syarli, S. (2021). Expert System for Diagnosing Tuberculosis Disease. *Journal Peqguruang: Conference Series*, *3*(1). https://doi.org/10.35329/jp.v3i1.1232

Robby Rizky, Sukisno, Mohammad Ridwan, Z. H. (2020). Implementation of the Forward Chaining Method for Diagnosing Covid 19 Disease at the Berkah Pandeglang Banten Regional Hospital. *Infokam*, *4*(1). hal 69-72

Trenggono, P. H., & Bachtiar, A. (2023). PERAN ARTIFICIAL INTELLIGENCE DALAM PELAYANAN KESEHATAN : A SYSTEMATIC REVIEW. *Jurnal Ners*, *7*(1). https://doi.org/10.31004/jn.v7i1.13612

Zatihulwani, E. Z., Aryani, H. P., & Soelistyo, A. (2019). Hubungan Tingkat Pengetahuan Keluarga Dengan Sikap Pencegahan Penularan Tuberkulosis Paru. *Jurnal Keperawatan Dan Kebidanan*.11(2). https://e-journal.lppmdianhusada.ac.id/index.php/jkk/article/view/103.