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Developed an expert system for analysis of Covid-19 affected

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ABSTRACT

The expert system solves problems within a specific area of the knowledge base. Prolog is a logical programming language which works on its knowledge base and effectively can be used to develop an expert system. Covid 19 is a pandemic deices and an expert system can be developed to diagnose this disease with the help of its symptoms that can be used as a knowledge base in Prolog. This expert system can make a fast diagnosis process for the covid 19 which is important to prevent the spread of the virus. Here we developed an expert system using prolog for the diagnosis purpose. Like humans, these systems can get better with time as they gain more experience. Expert systems combine their experiences and expertise into a knowledge base that is then used by an inference or rules engine, a set of rules that the software employs, to apply to certain scenarios. Prolog is ideal for use with intelligent systems for a few reasons. Prolog can be viewed as a straightforward theorem prover or inference engine that derives from predefined rules. With the help of Prolog's built-in search and backtracking techniques, simple expert systems can be created.

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1. INTRODUCTION

Artificial Intelligence or artificial intelligence is a computer system that can perform activities that normally require human intelligence [1]. A type of computer program is called an expert system that mimics the judgments and actions of an individual or group with expertise and experience in a particular field using artificial intelligence (AI) techniques. Expert systems are often made to complement human specialists rather than to take their place. Modern expert knowledge systems take advantage of machine learning and artificial intelligence to replicate the decisions and behaviours of subject matter experts. These systems can improve over time as they gather more experience, just like humans can. Expert systems compile their knowledge and experience into a knowledge base, which is then applied to specific situations by an inference or rules engine, a collection of rules that the software utilizes [2].

A particular virus that affects people and causes respiratory conditions is called Covid-19. Its surface, which is covered in spikes that resemble crowns, is referred to as the corona. The Covid-19 pandemic has reached all regions of the world [3]. SARS (severe acute respiratory syndrome), MERS (Middle East Respiratory Syndrome), and other illnesses are examples of this illness that affects people. China announced

the COVID-19 novel strain of this virus in 2019. Since that time, the virus has spread to every continent on the planet except Antarctica. Everyone is interested in learning more about the coronavirus and its signs and symptoms. The CDC states that you may have a coronavirus infection if you experience symptoms including a fever, cough, chills, or body aches. having trouble breathing.

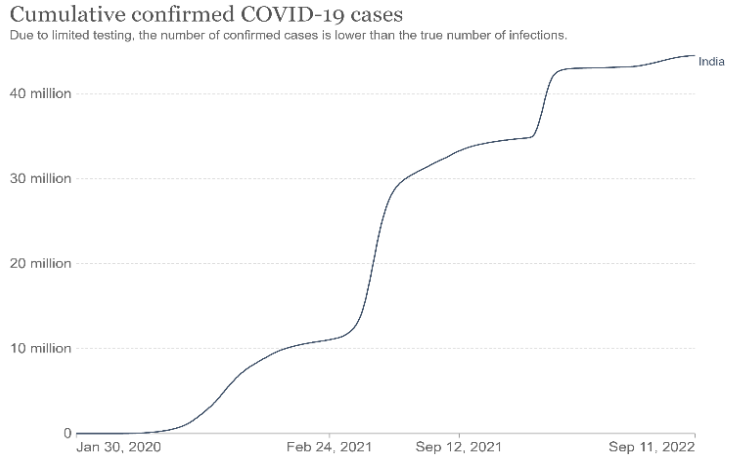

Figure 1. Shows the spread of covid 19 in India [4]

The ability to make decisions of a human expert is simulated by an expert system. There are several reasons why Prolog is perfect for use with expert systems. It is possible to think of Prolog as a simple theorem prover or inference engine that derives from pre-established rules. Simple expert systems can be developed using Prolog's built-in search and backtracking methods. Using Prolog data structures, we may quickly and adaptably construct rule-based systems that need additional capacity, such as probabilistic reasoning [5]. We can easily design meta-interpreters in Prolog to produce distinctive evaluation algorithms for rules.
Here are some simple clauses-
likes (mary, food).
likes (mary, wine).
likes (john, wine).
likes (john, mary).
The following queries yield the specified answers.
|? – likes (mary, food).
yes.
|? – likes (john, wine).

The use of expert systems is currently used in the field ofhealth, such as the problem in making a diagnosis of diseases [6]. According to [2], this research thought that a zoonotic virus was to blame for the disease. According to the genome sequencing of SARSCoV-2, it shares 50% similarity with MERS-CoV and shares 96.2% identity with the bat coronavirus (Zhou et al. 2020; Ai et al. 2020). As of September 14, 2020, there were more than 6.7 million documented instances of the diseases in the United States, with 198,520 fatalities. India and Brazil were next, with more than 450,000 cases apiece. Utilizing the CRISPR-Cas gene editing method, which can work wonders in the field of detection, is another aspect that needs to be examined for detecting COVID-19 (Chekani-Azar et al. 2020). There have been reports of the use of CRISPR-Cas in healthcare and diagnostics.

In [5] The outcomes of the research stages based on the research framework are contained in this stage. The steps of the study involve gathering information from the UCI Machine Learning Repository. The following step involves preprocessing the data using the Forward Feature Selection technique, followed by classification using the Backpropagation ANN technique. The final step is performance assessment based on the precision of the technique used using the Confusion Matrix.

There are 794,000 fewer cases of breast cancer in women in industrialised countries than there are in developing ones (833,000 cases compared to 794,000). Most people in developing nations are affected by cancer, and the 5-year survival rate is only 40.5%. Breast tissue can develop into cancer in cases of breast

cancer. This cancer develops when breast tissue cells proliferate uncontrolled and invade neighbouring, healthy breast tissue. The molecular subgroups and kinds that make up this heterogeneous disease are determined. The oestrogen and progesterone receptors have been shown to significantly increase the likelihood of developing BC due to hormones.

In [7] The Nidovirales order and family of Coronaviridae contain the coronavirus. These are the four coronavirus genera: CoV-, CoV-, CoV-, and CoV-. CoVs can only be acquired by mammals, yet they mainly affect birds. Among the human coronaviruses are the Middle East respiratory syndrome-related coronavirus (MERS-CoV), SARS-CoV, CoVs (229E and NL63), CoVs (OC43 and HKU1), and CoVs (229E and NL63) (5). The genomic and phylogenic investigations revealed that the COVID-19-causing CoV is a separate clade of the same subgenus as the SARS virus. According to the China National Health Commission, COVID-19 disease is diagnosed using one of the following methods: high-throughput genome sequencing, serological analysis of anti-viral immunoglobulin M (IgM) and G (IgG) antibodies, as well as real-time reverse transcriptase-polymerase chain reaction (RT-PCR).

[8] A broad family of viruses called coronaviruses can infect both humans and animals and cause sickness. Infectious disease is brought on by the SARS syndrome and the most recent coronavirus (COVID-19). Epidemiology - On six continents, more than 1,998,.111 confirmed cases, 126.604 fatalities, and the presence of COVID-19 have been reported as of 15 April 2020 by 210 countries and territories worldwide. Hypoxia is more likely since the infection targets the lungs. The patient should be given oxygen and a nasal catheter immediately. The patient should have either minimally invasive or invasive mechanical ventilation in an emergency.

[9] The severe acute respiratory syndrome coronavirus 2, also known as the 2019 novel coronavirus (2019-nCoV), has its origins in Wuhan City, Hubei Province, China (SARS-CoV-2), is currently spreading swiftly throughout the world. The spread of COVID-19 to healthcare professionals poses the biggest risk. Healthcare professionals made up 21% of those infected by the SARS pandemic in 2002. To date, nearly1500 healthcare professionals in China have contracted 6 deaths. A virus warning was first provided by a doctor, who has now died away. In the published series, 25–30% of the affected patients required admission for critical care. Injuries to the acute lung included complications., ARDS, shock, and acute kidney injury. In the second or third week, recovery started. Those who recovered spent an average of 10 days in the hospital. Older adults and those with underlying co-morbidities are more likely to experience negative outcomes and death (50–75% of fatal cases).

[10]On December 12th, Seven of the 27 cases of viral pneumonia that the Wuhan Municipal Health Commission (WMHC) reported were seriously unwell. At the Huanan Seafood Wholesale Market in Wuhan, China, where chickens, snakes, bats, and other farm animals were also sold, most patients had recently been exposed to wild animals. Bats have been identified as the cause of the most recent coronavirus infection. Zhou and colleagues discovered that 2019-nCoV is 96% identical to a bat coronavirus at the whole-genome level using full-length genome sequencing. According to WHO guidelines, both moderate and severe cases should get oxygen and intravenous fluid therapy. Target SpO2 levels for non-pregnant adults and children are 90% while for pregnant patients are 92-95 per cent.

In [11] this COVID-19 pandemic, which is caused by the SARS-CoV-2 coronavirus, continues to pose a major and immediate threat to global health. The outbreak that began in the Hubei region of the People's Republic of China at the beginning of December 2019 has grown globally. As of October 2020, there have been more than 39,500,000 confirmed cases of the ailment worldwide, while the actual number of people affected is probably far greater. More than 1,110,000 people died because of COVID-19.

The model's area under the receiver operating characteristic curve (auROC) prediction for the prospective test set was 0.90, with a 95% confidence interval (CI) of 0.892-0.905. The possible working points utilising test set predictions are either 87.30% sensitivity and 71.98% specificity or 85.76% sensitivity and 79.18% specificity.

In [12]Artificial intelligence helps with efficient text processing and information extraction related to patient and mortality cases during and after the pandemic that can help with epidemic prevention. COVID-19. Social media connects users to the outside world, which has a big impact on daily life. Social media can be used to gather information on public opinion on a range of contentious issues, including COVID-19. The COVID-19 outbreak is quickly becoming one of the major issues or trends that the public is following on social media. One of the social media platforms with sentiments that can be swiftly and easily accessed is Twitter.

The steps involved in data processing include converting data into numerical form, sharing data between training and test sets, and grouping data to identify the variables that will be used. Researchers collected a total of 1,000 data points for the categorization process during the data processing step, with 500 positive and 500 negative attitudes represented in the data. Determine the percentage ratio between the training data and the testing data before executing the classification. In this study, it was found that the random state was equal to 0.2, which means that 20% of the test dataset and 80% of the training data were used in the comparison.

The testing and evaluation process is now conducted to ascertain how well each algorithm performs. The testing strategy used in this study is 10-fold cross-validation. A statistical technique called cross-validation (CV) can be used to assess a model's or algorithm's performance after splitting the data into two subsets: learning process data and validation/evaluation data. The learning subset trains the model or algorithm, and the validation subset verifies it. The size of the dataset can also be taken into consideration while choosing the type of CV. Because it can shorten computation times while retaining estimate accuracy, the CV k-fold test is employed. A confusion matrix for count score accuracy was created after testing performance measurements.

In [13] The JIProlog interpreter and Java were used to develop this medical expert system. These languages both have interactive user interfaces that let users ask and answer questions, as well as visualisation modules that the inference engine may utilise to generate visual decision trees. Expert systems are a class of artificial intelligence-based computer software (AI). By enabling the creation of computer programmes that display intelligent behaviour, AI aims to improve research. It incorporates ideas and techniques for symbolic inference, sometimes known as computer-generated reasoning, and a process inside the machine that uses data to conclude. The two essential components of an expert system are an inference engine and a knowledge base. To operate an expert system, the inference engine employs the knowledge base to reason as a human would. To communicate with users, the system employs a dialogue interface. The system may communicate with users using a "conversational" interface.

In [14] This study offers a COVID-19 diagnosis expert system model to prevent the spread of COVID-19 throughout Indonesia. The model development process involves several processes, including data gathering, analysis, model design, implementation, and testing. An expert system is needed to diagnose the Covid-19 sickness. It should support the doctor in offering a workable solution to resolve the problem. This expert system was made using the following technique: The method is based on the initial circumstances where, following the Bayes Classifier Theorem, Then, the highest truth value is utilised to determine conclusions and treatments for the phenomenon in question. Initial conditions of existing phenomena are then guided by predetermined laws.

This study has suggested a Nave Bayes Classifier-based model expert system for the diagnosis of Covid-19. It is helpful and can aid the community in identifying the Covid-19 sickness, particularly the Indonesian government.

[15] To stem the spread of this deadly infection by recommending quarantine, it’s critical to identify Coronavirus Disease 2019 (COVID-19) early. This is especially true in cases when a specific vaccine is not available or is only partially provided. Another ensemble learning technique built on boosting, XGBoost incrementally transforms poor learners into strong learners. Trees have been used as the typical foundation learners in XGBoost ensembles. In this work, we used a grid search with the Python-based programme xgboost 0.7 to optimize XGBoost in terms of the learning rate, maximum depth, number of boosting rounds, booster, and subsample ratio. In this work, we created a system called COVIDC for the preliminary diagnosis and severity prediction of COVID-19 infection using chest CT scans. Our proposed approach can be utilised successfully to not only detect COVID-19 infection but also to forecast its severity, as shown by the detailed performance evaluation utilising a 10-fold CV, on an external validation dataset, and in a real-world application.

[16] The proposed expert system can diagnose the coronavirus (COVID-19) symptoms that may appear in people who are suspected of having the disease by questioning the patient and then evaluating the patient's condition. The SL5 Object language was used to create the suggested expert system, which is meant to help patients determine whether they are infected or not and what suggestions to take. One of the typical viruses that cause throat infections, sinus infections, and upper respiratory tract infections is the coronavirus.

The language used by the chosen expert system, Simpler Level 5 Object Expert System Language, was developed by Professor Sami Abu Nasser. A rule-based declarative language called SL5 Object is used to specify expert systems and can be used to run production systems. Our expert system is compatible with the SL5 Object rule-based expert system language. This paper created and presented a novel knowledge-based strategy for supporting patients in the diagnosis of symptoms of the COVID-19 coronavirus, such as fever, cough, shortness of breath, or difficulty breathing. drowsiness, discomfort, runny nose, and painful throat.

The Saudi MOH [17] states that suspected COVID-19 patients are either confirmed cases (asymptomatic and symptomatic) or negative examples (see Supplementary Materials S1 for a COVID-19 case definition).To make the diagnosis, one must consider the existence of clinical symptoms, epidemiological considerations Chest imaging tests based on clinical imaging, laboratory findings (nucleic acid amplification tests), and contact during incubation. The clinical classification encompasses cases involving expectant moms,

elderly people, children, and newborns, as well as mild, moderate, severe, and critical cases (see Supplementary Materials S2 for clinical classification of confirmed cases). A slight illness affects about 80% of COVID-19 patients, and symptoms typically go gone in two weeks. However, the other cases may recur and require hospitalisation in addition to other treatments. Research suggests a prototype for the diagnosis and treatment of COVID-19 in Saudi Arabia. By monitoring COVID-19 patients, this approach can ease the stress on doctors and lower healthcare expenses. To develop an expert system, clinical guidelines might be employed as expert knowledge.

[18] This article explores the contributions made by several researchers while discussing a variety of expert systems used in medical diagnosis. Starting with the experts, researchers have assessed several aspects of their medical expert systems in hospitals. Sensitivity and precision are a couple of them. One of the most common uses of artificial intelligence is the expert system. It is a collection of computer programmes designed to manipulate knowledge to address issues unique to a given field and requiring human skill. The two main objectives of any medical expert system are to diagnose and treat diseases. An important part of expert systems is the medical domain. A medical expert system is made up of computerised programmes and a database of medical information.

For their medical expert systems in hospitals, researchers have assessed a variety of factors, beginning with the experts. These factors include accuracy and sensitivity. These characteristics have been used to calculate the expert systems' performance. The accuracy and other traits of the expert system depend on the knowledge base's knowledge base, which has pertinent knowledge.

[19] In this study, research constructs and construct a symptom-based diagnosis system based on medical knowledge and indicators using features for searching qualities including symptoms, medicines, and hierarchical groupings of specific diseases. Instructions on how to create an expert system using Java and prolog have been provided by our system. This system can be incorporated with any rule-based expert system for disease diagnosis because it is all-inclusive and knowledge-based. An expert system solves problems that frequently require human skill by using human knowledge that has been recorded in a computer. It is computer software that uses algorithmic knowledge to address specific types of problems. For instance, diagnostic processes for both people and machinery use expert [18], [19] systems.

[20] Robots are now the preferred intelligent agent model in healthcare due to the growing use of artificial intelligence and robots in numerous services. Robotic evolution generates the best possible robotic innovation in morphology, kinematics, and control of the robotic system or its subsystems. The robotic manipulator's control is programmed with an intelligent algorithm.

Robots were developed to mimic human actions in an effort to make tasks simpler and more effective. Robots are built and programmed to have the desirable and necessary traits or actions. Robotic evolution is the process of modifying a robot's design such that it can gauge its capacity to adapt to its surroundings without being programmed with certain actions.

2. METHOD

2.1 Proposed Methodology

For the analysis and classification of a disease it is important to know about the symptoms of that disease. Here the expert model collects the symptoms of all the diseases which it must distinguish in the form of If-Then rules. For the working of the model user must reply for the questions asked by system in the form of yes or no. Based on these answers Expert system get able to classify different diseases.

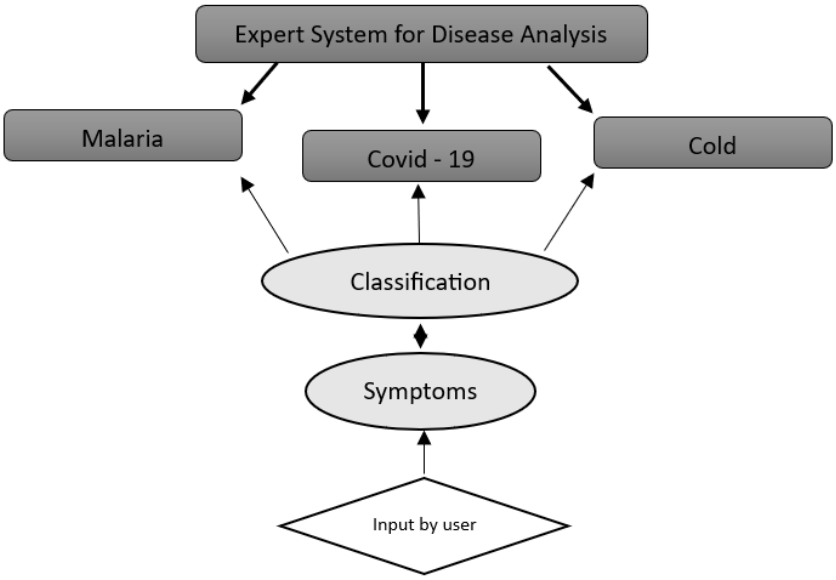

Figure 2. Working of expert system

2.2 Proposed COVID-19 Diagnosis Expert System

- Defining the knowledge base

The covid 19 expert system is mainly based on different symptoms present in the human body related to disease or other medical complications. These symptoms can act as the knowledge base for the expert system based on the prolog in this research work [11]. Based on the facts extracted from the knowledge base covid 19 diseases can be classified and summarized by the system.

- IF-THEN rules creation

Developing the prolog-based expert system is the first step to creating the if-then rules for the disease classification problem. The IF-THEN statement is used in the Prolog language and therefore the knowledge base based on the symptoms must be organized into the IF-THEN structure [12], [17]. Some of the knowledge base data is—

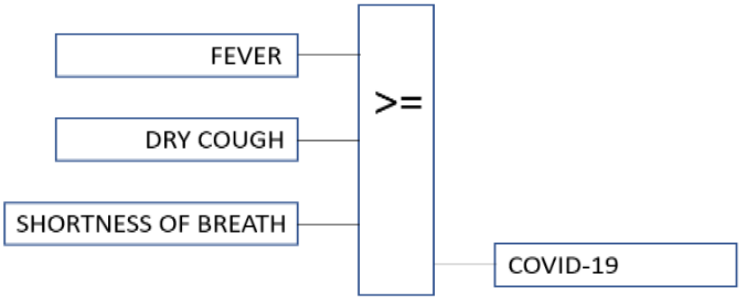

Figure 3. Defines the symptoms of covid 19 which must be organized in the IF-THEN statement

```
covid :-
verify(fever),
verify(dry_cough),
verify(shortness_of_breath),
write('Advices and suggestions:'),
```

Figure 4. Defines the rules need to verify for covid

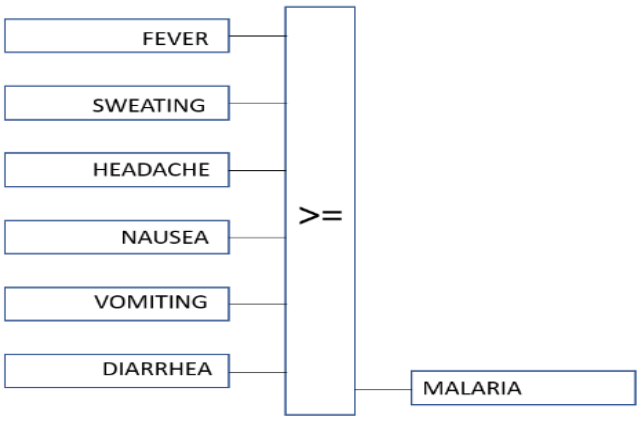

Figure 5. Defines the symptoms of malaria which must be organized in the IF-THEN statement

```
malaria :-
verify(fever),
verify(sweating),
verify(headache),
verify(nausea),
verify(vomiting),
verify(diarrhea),
write('Advice and Sugestions:'),
```

Figure 6. Defines the rules need to verify for malaria

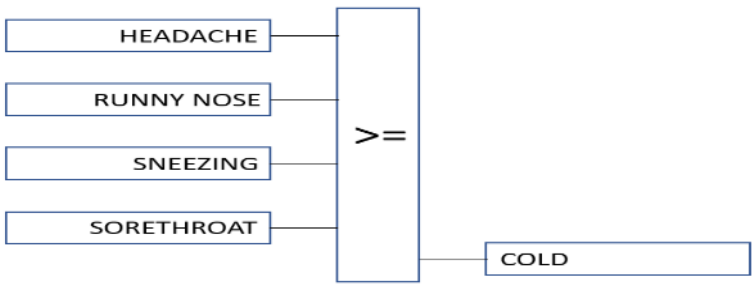

Figure 7. Defines the symptoms of other cold disease which must be organized in the IF-THEN statement

```
cold :-
verify(headache),
verify(runny_nose),
verify(sneezing),
verify(sore_throat),
write('Advice and Sugestions:'),
```

Figure 8. Defines the rules need to verify for cold

2.3 Methodology/Tools Used

Prolog is an abbreviation for logic programming. At the University of Marseille, a prolog was created in the first half of the 1970s. Prolog is a declarative language. The Prolog language includes an intelligent system for finding, correlating, and locating results. Prolog states what the program should do after describing the problem in terms of Facts and Rules [7], [21]. It addresses the issue of how knowledge bases should be represented as Facts and Rules by using the knowledge base as a source of data [8], [20].

- Define Facts and Rules in Prolog

Facts serve as the foundation of logical programming. The Facts are made up of a specific thing or a relationship between two entities. A fact is an explicit relationship between two or more things and any potential features those items may have [4]. Facts are therefore inherently valid. So, these are some facts, that are unconditionally valid or True. These are factual claims that we must accept as true [9].

- Define Queries in Prolog

Prolog is one of the most important candidates to build expert systems and AI-related programs and has potential applications in embedded systems[22]. In the prolog, queries work with pattern-matching techniques. The query pattern is defined as “Goal”. Within the system, if there is a fact that matches the goal then the listener responds with “yes” and the query gets to succeed [10], [23]. If there is no fact available in the system which matches the goal, then the listener will respond as “no”, and the query get failed.

3. RESULTS AND DISCUSSIONS

Here some diseases are tested as per their symptoms on the expert system developed with the help of prolog which provides good accuracy with the help of facts stored as a knowledge base in the system. The developed system can extract the correct diagnosis of different diseases as per the input given to the system which further uses its knowledge base for the diagnosis. As the system is developed mainly for covid 19 diagnosis ad it stores the knowledge base of covid 19 symptoms so developed system provides the expert diagnosis system of covid 19.

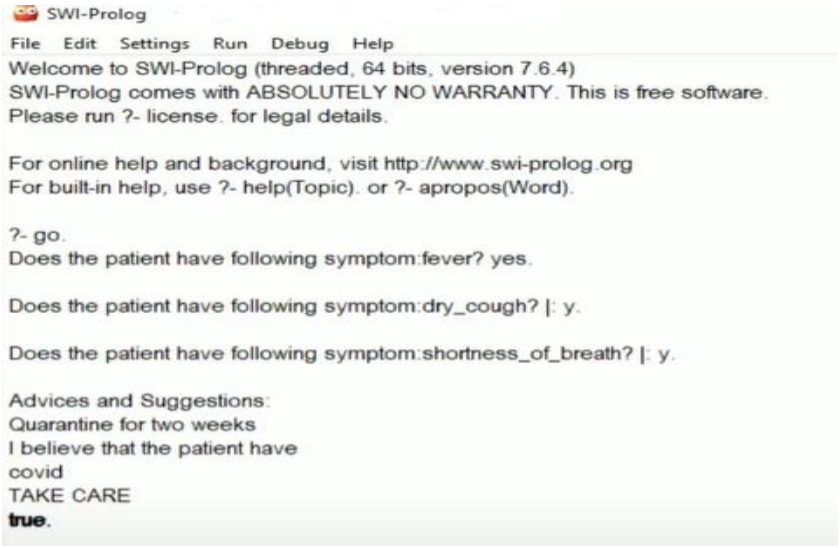

Figure 9. Outcome

4. CONCLUSION

This study has suggested a Prolog-based model expert system for the diagnosis of Covid-19. In this study, a novel knowledge-based system for assisting patients in coronavirus diagnosis was created and presented. Fever, cough, shortness of breath or difficulty breathing, fatigue, aches, runny nose, and sore throat are symptoms of COVID-19. It is beneficial and can aid the population in identifying Covid-19 illness. The use of the expert system in this study gave information about early Covid-19 illness signs in patients that were previously unknown to the general population. It can track the outcomes of the diagnosis, clarify them, and offer better. Patients' tests, as well as the expert system's Covid-19 results for such a disease diagnosis based on facts, are incorporated in the prologue. Tests demonstrate that the built Expert model for the COVID-19 diagnosing system can correctly identify COVID-19 based on the user's entered symptoms. The use of the model developed in this study aids medical professionals in identifying COVID-19.

REFERENCES

[1] A. Dwiantoro, I. Maulana, N. P. Damayanti, and R. N. al Zahra, "Artificial Intelligence (AI) Imaging for Enhancement of Parking Security," *Journal of Student Research Exploration*.

[2] N. Verma, D. Patel, and A. Pandya, "Emerging diagnostic tools for detection of COVID-19 and perspective," *Biomed Microdevices*, vol. 22, no. 4, p. 83, Dec. 2020, doi: 10.1007/s10544-020-00534-z.

[3] J. Jumanto, M. A. Muslim, Y. Dasril, and T. Mustaqim, "Accuracy of Malaysia Public Response to Economic Factors During the Covid-19 Pandemic Using Vader and Random Forest," *Journal of Information System Exploration and Research*, vol. 1, no. 1, pp. 49–70, 2022.

[4] E. Mathieu *et al.*, "Coronavirus Pandemic (COVID-19)," *OurWorldInData.org*, 2020.

[5] J. Jumanto, M. F. Mardiansyah, R. N. Pratama, M. F. al Hakim, and B. Rawat, "Optimization of breast cancer classification using feature selection on neural network," *Journal of Soft Computing Exploration*, vol. 3, no. 2, pp. 105–110, Sep. 2022, doi: 10.52465/joscex.v3i2.78.

[6] E. Y. Rachmawati, B. Prasetiyo, and R. Arifudin, "The Comparison between Bayes and Certainty Factor Method of Expert System in Early Diagnosis of Dengue Infection," *Scientific Journal of Informatics*, vol. 5, no. 2, pp. 159–170, Nov. 2018, doi: 10.15294/sji.v5i2.15740.

[7] Ö. Özdemir, "Coronavirus Disease 2019 (COVID-19): Diagnosis and Management (narrative review)," *Erciyes Medical Journal*, 2020, doi: 10.14744/etd.2020.99836.

[8] A. Hafeez, S. Ahmad, S. A. Siddqui, M. Ahmad, and S. Mishra, "A Review of COVID-19 (Coronavirus Disease-2019) Diagnosis, Treatments and Prevention," *Eurasian J Med Oncol*, 2020, doi: 10.14744/ejmo.2020.90853.

[9] T. Singhal, "A Review of Coronavirus Disease-2019 (COVID-19).," *Indian J Pediatr*, vol. 87, no. 4, pp. 281–286, Apr. 2020, doi: 10.1007/s12098-020-03263-6.

[10] Z. J. Cheng and J. Shan, "2019 Novel coronavirus: where we are and what we know," *Infection*, vol. 48, no. 2, pp. 155–163, Apr. 2020, doi: 10.1007/s15010-020-01401-y.

[11] Y. Zoabi, S. Deri-Rozov, and N. Shomron, "Machine learning-based prediction of COVID-19 diagnosis based on symptoms," *NPJ Digit Med*, vol. 4, no. 1, p. 3, Jan. 2021, doi: 10.1038/s41746-020-00372-6.

[12] R. Pambudi and F. Madani, "Analysis of public opinion sentiment against COVID-19 in Indonesia on twitter using the k-nearest neighbor algorithm and decision tree," *Journal of Soft Computing Exploration*, vol. 3, no. 2, pp. 117–122, Sep. 2022, doi: 10.52465/joscex.v3i2.88.

[13] X. Huang *et al.*, "A Generic Knowledge Based Medical Diagnosis Expert System," in *The 23rd International Conference on Information Integration and Web Intelligence*, Nov. 2021, pp. 462–466. doi: 10.1145/3487664.3487728.

[14] D. Silahudin, Henderi, and A. Holidin, "Model Expert System for Diagnosis of Covid-19 Using Naïve Bayes Classifier," *IOP Conf Ser Mater Sci Eng*, vol. 1007, no. 1, p. 012067, Dec. 2020, doi: 10.1088/1757-899X/1007/1/012067.

[15] W. A. Abbasi *et al.*, "COVIDC: An expert system to diagnose COVID-19 and predict its severity using chest CT scans: Application in radiology," *Inform Med Unlocked*, vol. 23, p. 100540, 2021, doi: 10.1016/j.imu.2021.100540.

[16] H. R. Almadhoun and S. S. Abu-Naser, "An Expert System for Diagnosing Coronavirus (COVID-19) Using SL5," *International Journal of Academic Engineering Research (IJAER)*, vol. 4, no. 4, pp. 1–9, 2020.

[17] H. R. Banjar, H. Alkhatabi, N. Alganmi, and G. I. Almouhana, "Prototype Development of an Expert System of Computerized Clinical Guidelines for COVID-19 Diagnosis and Management in Saudi Arabia," *Int J Environ Res Public Health*, vol. 17, no. 21, p. 8066, Nov. 2020, doi: 10.3390/ijerph17218066.

[18] R. Nohria, "Medical Expert System- A Comprehensive Review," *Int J Comput Appl*, vol. 130, no. 7, pp. 44–50, Nov. 2015, doi: 10.5120/ijca2015907046.

[19] X. Huang *et al.*, "A Generic Knowledge Based Medical Diagnosis Expert System," *DeepAI*, Oct. 2021.

[20] I. Suwarno, A. Cakan, N. M. Raharja, M. A. Baballe, and M. S. Mahmoud, "Current trend in control of artificial intelligence for health robotic manipulator," *Journal of Soft Computing Exploration*, vol. 4, no. 1, Dec. 2022, doi: 10.52465/joscex.v4i1.96.

[21] G. Nápoles, F. Hoitsma, A. Knoben, A. Jastrzebska, and M. Leon Espinosa, "Prolog-based agnostic explanation module for structured pattern classification," *Inf Sci (N Y)*, vol. 622, pp. 1196–1227, Apr. 2023, doi: 10.1016/j.ins.2022.12.012.

[22] G. Li, Y. Shao, S. Hong, and B. Liu, "An IPC-based Prolog design pattern for integrating backward chaining inference into applications or embedded systems," *Chinese Journal of Aeronautics*, vol. 27, no. 6, pp. 1571–1577, Dec. 2014, doi: 10.1016/j.cja.2014.10.024.

[23] D. Warren, L. Pereira, and N. Fernando, "Prolog the language and its implementation," Apr. 2015.

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