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Original Article

An Expert System for Screening and Prognosis of Diseases: An Instance of Healthcare Management

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Abstract:

The background of this study is that a Medical Expert System made in Visual Prolog is proposed. This expert system makes a differential diagnosis among heart, lung, kidney, skin, and brain diseases. This system is designed to give help to a medical expert in making the appropriate diagnosis of a patient. Based on a patient's symptoms and medical background, SWI Prolog offers the diagnosis through the declarative knowledge representation methodologies. On the basis of the diagnosis and current medical regulations, it might also offer other treatment options. Medical data analysis using SWI Prolog is used to spot trends or patterns in patient outcomes or disease development. Making better-educated choices concerning patient care and treatment could be made easier by healthcare providers as a result. An SWI Prolog-based medical expert system's output will be influenced by the quality of the data and code used to generate it, as well as by the medical specialists that worked on its design and implementation. The creation of more sophisticated expert systems can be particularly beneficial for early disease detection, helping to reduce the burden of diseases by detecting them more accurately and efficiently.

Keywords: *Disease Classification; Clinical Decision Support; Prognosis; Artificial Intelligence; Expert System, Programming in Logic*

Introduction

Nowadays, medical applications, especially the diagnosis of some heart diseases, have rapidly increased because of their importance and effectiveness in detecting disease and classifying patients (Bhowmik, 2021). The proposed system is requesting symptoms from the patient to help the system make a correct diagnosis, and it has knowledge of seven heart diseases. The same thing happens for lung, kidney, skin, and brain diseases. Lung and kidney diseases share many symptoms, and some of them are very similar. This creates many difficulties for the doctor in making the right decision. This expert system can solve these problems because it is familiar with nine lung diseases and eight kidney diseases. Now, skin diseases have various dangerous effects on the skin and keep spreading over time. Skin disease can be treated and recovered if detected and treated early. For that, this expert system requests the symptoms and makes the right diagnosis of a skin disease, and it has knowledge of fifteen skin diseases. Brain disease is a group of conditions that affect the structure or function of the brain, resulting in a variety of symptoms and potential complications. These conditions can have a significant impact on a person's life,

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as they may cause cognitive impairment, mobility issues, and other physical and psychological symptoms. They can also be difficult to diagnose and treat, as the brain is a complex and delicate organ. It is important to seek medical attention if you experience symptoms of a brain disease, as early diagnosis and treatment can help to slow or manage the progression of the condition. This Expert The system is aware of fifteen brain diseases and can diagnose them based on their symptoms. This expert system is implemented in SWI-Prolog.

Review of Literature

Skin diseases are common and last a long time all over the world. In some cases, they can turn into cancer. They are treatable if caught early and treated properly. An automated image-based detection system with four major modules—image enhancement, region of interest segmentation, feature extraction, and detection—can aid in the early diagnosis of various diseases. To identify various forms of skin diseases, various image-based systems, including machine learning techniques, are being developed (Malviya *et al.,* 2021). This post will go over the tools and strategies used to diagnose 28 common skin illnesses. It has also covered the existing image databases as well as the assessment metrics for the performance analysis of various diagnosis systems. This is critical for determining the implementation framework as well as the effectiveness of the diagnostic procedures for the novice. The most advanced method for diagnosing a specific disease is determined based on performance accuracy. It also emphasizes issues and suggests future study directions (Jeddi *et al*., 2016).

Physicians and radiologists commonly use the ABCD rule of dermoscopy to distinguish between malignant and benign skin lesions. Estimating the dermoscopic score solely through visual inspection may result in an early and accurate diagnosis of the condition. In this study, the ABCD features were improved and quantified in a dermatological expert system (Germany) for distinguishing between malignant and benign lesions. Germany has developed a rule-based expert system by combining dermatological knowledge with the correct measurement of dermoscopic data. DermESy was used to classify dermoscopic images as malignant, benign, or suspicious based on the estimated total dermoscopic score (TDS), which was consistent with expert findings (Chatterjee *et al*., 2021).

In rural villages and flood-affected areas, skin problems are frequent. Skin disease should ideally be addressed as soon as possible by a dermatologist. Yet, due to a lack of competence in rural areas, this is currently impossible. Because an expert system can provide rapid and accurate diagnosis, developing one is a possible issue. In this study, a fuzzy expert system design is provided for the detection of skin (erythematosquamous) illnesses. A fuzzy logic-based architecture is chosen due to the ambiguity and imprecision of the symptoms in the diagnosis process. In a medical expert system, fuzzy logic helps deal with the imprecise bounds of input symptoms. As a result, the dependability of system outcomes will improve. The MATLAB fuzzy logic toolbox is used to create the system (Ali Raza, Liaqat & Shoaib, 2019).

The practical rise in interest in intelligent technologies has resulted in the rapid growth of all activities using sensors and automatic mechanisms for smart operations. The implementations focus on technology that avoids needless user actions while analyzing health issues (Abdullah &Nusari, 2019). One of the most significant features is the continual inspection of skin health owing to potential diseases such as melanomas that can develop when exposed to too much sunlight. A range of motion sensors and cameras can be installed in smart homes to detect and diagnose the potential development of illness. In this paper, a smart home system that uses in-built sensors and proposed artificial intelligence approaches to analyze the skin health of the house's tenants is offered. Because of its potential for use in practice, the proposed solution has been tested and discussed (Połap *et al*., 2018). The finding of the review is that a Medical Expert System using Artificial Intelligence (AI) (Bokolo, 2021; Das *et al*., 2015; Das & Sanyal,

2019) could play a significant role in healthcare management as well as medical diagnosis (Das *et al*., 2018a; Das, Sanyal & Datta, 2020a, 2020b; Das *et al*., 2018b; Das & Sanyal, 2020).

Methodology

Querying and expanding the knowledge base through a command-line interface using a format that is focused on natural language is supported by a Prolog expert system (APES), with the goal of being maintainable by the domain expert (i.e., without requiring talents in programming). The input format is fully specified and extensible because it is a Definite Clause Grammar (DCG), a grammar description language included with Prolog. Definite Clause Grammar (DCG), a generalization of Context Free Grammar, is the most used method of parsing in Prolog (CFG). One of the key uses of Prolog and Logic Programming is parsing. In order to create a domain-specific language that is close to the input format and is maintainable by the domain expert without the need for Prolog or general programming abilities, the information is encoded in text files that contain Prolog predicates with defined operators. This leads to the central concept and objective: an expert system whose knowledge base can be created and maintained without the need for programming expertise, making it a non-domain-specific expert system that could be used to create expert systems for any domain by subject-matter experts rather than programmers.

1. Description of the Work

An expert system can use medical professionals' expertise and criteria to identify diseases. To make a diagnosis, it can examine patient information like age, gender, symptoms, medical history, and test findings. One in fourteen people, or around 550 million people worldwide, are estimated to have cardiovascular problems. Over the past three decades, the number of deaths from chronic lung disorders has increased by 18%. Chronic renal disease affects nearly 10% of the global population (National Kidney Foundation), and brain and skin conditions are also on the rise. This expert system works using the "check and verify" method.

The following figure 1 shows the architecture of this work.

The actions listed below can be conducted to identify disease using an expert system:

- Gathering symptoms: Information on the patient is gathered by the expert system, including the patient's age, gender, and medical background.
- Symptom Analysis: The expert system examines the information gathered to determine potential reasons for the patient's disease.
- Rule-based reasoning: Based on the patient's symptoms, the expert system applies a set of rules to make a diagnosis.
- Diagnose: Based on the evaluation of the patient's data, the expert system makes a diagnosis.

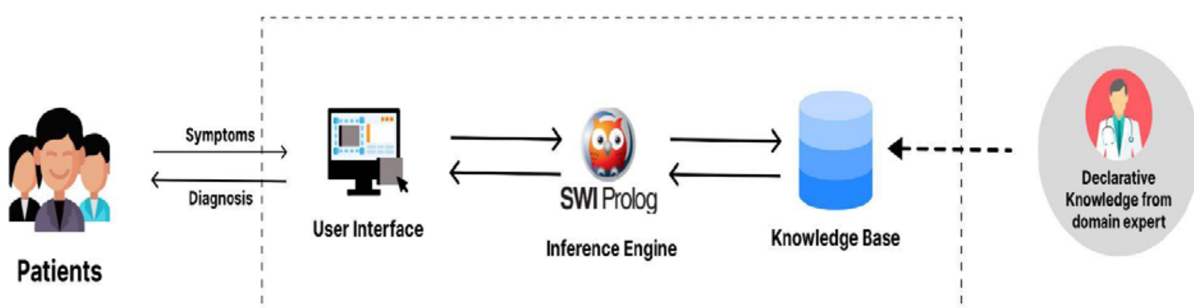

Figure1: Architecture of the proposed expert system

2. Implementation of AI Tool

Hypothesis rules are applying for making this expert system. While creating an expert system in Prolog, which is a computer program made to decide and offer suggestions or advice depending on input from the user or other data sources, hypothesis rules are utilized.

Hypothesis rules are employed in the context of an expert system to produce new hypotheses or predictions based on current facts or knowledge. These laws often take the shape of a conditional statement, requiring the fulfillment of one or more conditions before the rule is enforced(Das *etal*., 2023).

A Prolog hypothesis rule, for instance, might resemble this:

Hypothesis(X, Y):- condition1(X), condition2(Y).

This rule's name is "hypothesis," and the variables "X" and "Y" stand in for the incoming data or information. The ":-" sign denotes that the rule is a conditional statement and that it will only be implemented if both "condition1(X)" and "condition2(Y)" are true.

Following application, the rule may produce a new hypothesis or prediction based on the incoming data. This new hypothesis can then be utilized to produce more forecasts or suggestions, as well as to improve the system's accuracy over time by enhancing the data already available.

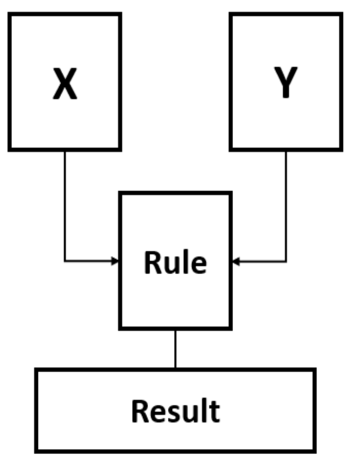

Figure 2: Prolog hypothesis rules

The input variables "X" and "Y" in this diagram stand for the data or information utilized to produce a new hypothesis or prediction. The "Rule" block represents the Prolog hypothesis rule, which uses a collection of conditions and the input variables as arguments to produce a new outcome or prediction. The output produced by the rule is represented in the "Result" block.

The graphic demonstrates how the rule receives the input variables "X" and "Y" and then applies a set of constraints to produce a new prediction or outcome. The expert system can then make more complicated predictions or suggestions based on the basic data by using this result as input for additional rules or procedures. Here is one example of the prolog code for lung cancer:

```
do:- hypothesis(Disease),
            write('AI_Dr: I think you are suffering from : '),
            write(Disease),
        nl,
            undo.
%Hypothesis that should be tested
hypothesis(lung_cancer):- lung_cancer, !.
 /* no diagnosis*/

%Hypothesis Identification Rules
lung_cancer :-
       verify(chest_pain),
       verify(wheezing),
       verify(coughing_up_blood),
       verify(weight_loss).
/* how to ask questions */
ask(Question) :-
    write('AIDr: Does the patient have the following symptoms: '),
    write(Question),
    write('? '),
    read(Response),
    nl,
    ( (Response == yes ; Response == y)
      ->
       assert(yes(Question)) ;
       assert(no(Question)), fail).
:- dynamic yes/1,no/1.
/* How to verify something */
verify(S) :- (yes(S) -> true ;
               (no(S)  -> fail ;
               ask(S))).
/* undo all yes/no assertions */
undo :- retract(yes(_)),fail.
undo :- retract(no(_)),fail.
undo.
```

Figure 3: Sample code of lung disease

A hypothesis rule in Prolog is a collection of guidelines that a computer algorithm uses to anticipate or suggest anything based on the supplied data or information. The rule acts as a recipe, instructing the computer how to process input data in order to provide a response. The rule develops a new hypothesis or prediction based on the supplied data if all of its requirements are satisfied. This forecast may be used to produce additional forecasts or suggestions, to improve the accuracy of the system over time, or to modify the data already available. The program is designed by using 53 diseases, a bit examples are depicted in table 1.

Table 1: Hypothesis and Symptoms

Skin Disease					
SL. NO.	**Hypothesis**	**Verifiable/ Symptoms**	**SL. NO.**	**Hypothesis**	**Verifiable/ Symptoms**
1.	Acne(Mayo Clinic, 2023a)	✓ whiteheads ✓ blackheads	2.	Alopecia areata(“Alopecia Areata,”	✓ thinning of hair ✓ patchy bald spots

		✓ red bumps		2023)	✓ brittle nails
3.	Eczema(Mayo Clinic, 2023b)	✓ dry skin ✓ itchiness ✓ oozing and thrusting	4.	Psoriasis(Web MD Editorial Contributors, 2023)	✓ patchy rash ✓ scaling spots ✓ cracked skin

Results &Discussion

It should be mentioned that under the SWI-prolog environment, the relevant files where the program is written are examined after the prologue program has been designed. Afterwards, several queries are entered to produce the required results. Reportedly, a number of ailments can be detected by typing different searches.

Based on its knowledge in previous literatures (Das *et al*., 2018a; Das, Sanyal & Datta, 2020a, 2020b;), this expert system is requesting some data from the patients about their physical condition. After taking all information from patients, this expert system diagnoses and gives the result when all conditions (symptoms) are satisfied for a specific disease.

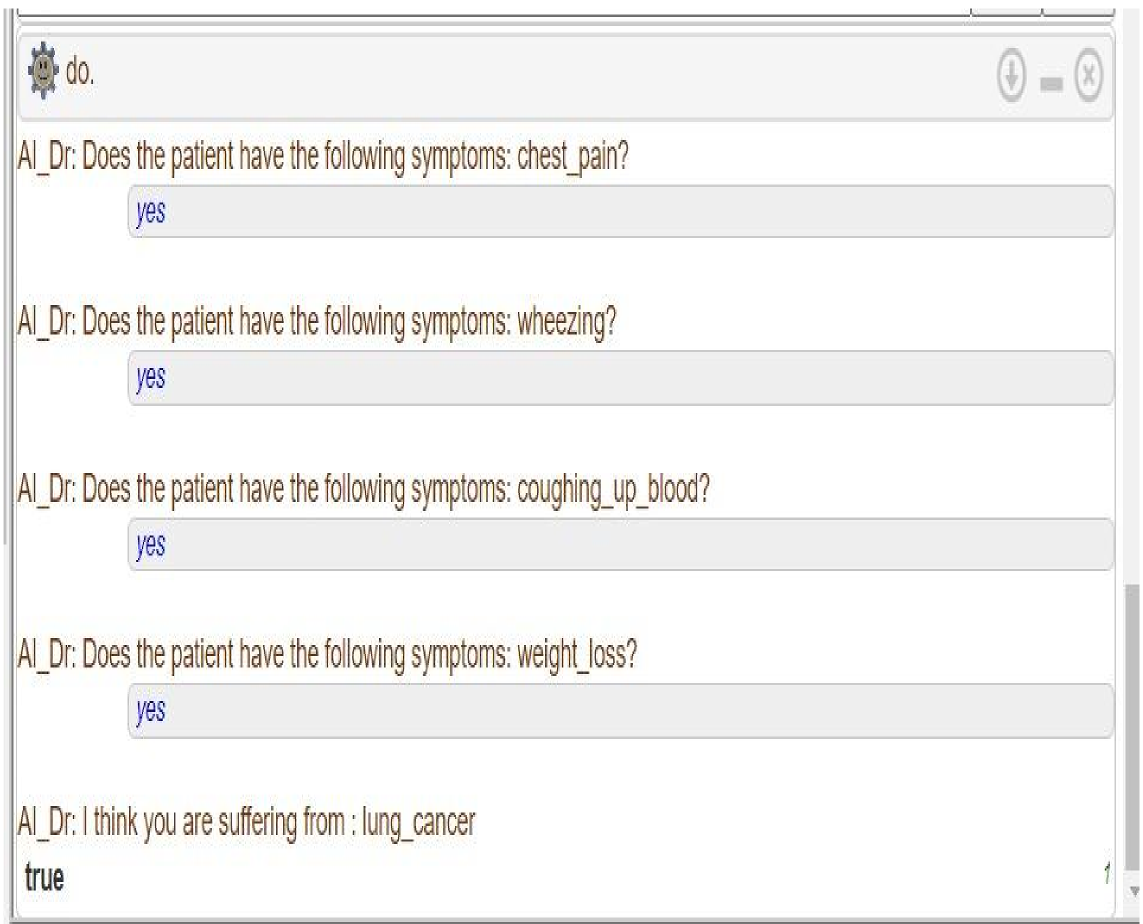

Figure 4: Lung cancer diagnosis

1. Here are some other results for the different disease of Lung Disease:

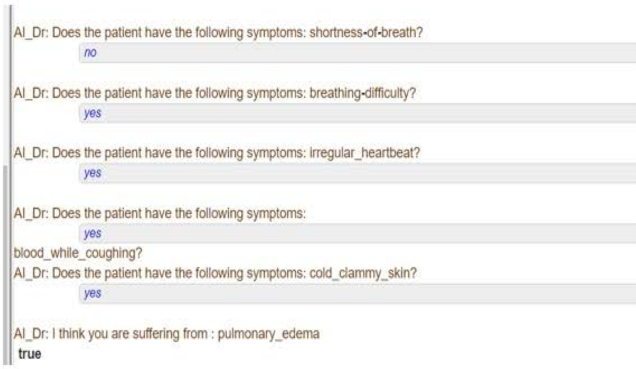

Figure 5: Diagnosis: Pulmonary edema

Figure 6: Diagnosis: Bronchitis

Figure 7: Diagnosis: pneumothorax

Figure 8: Diagnosis: copd

2. Here are some other results for the different diseases of Heart Disease:

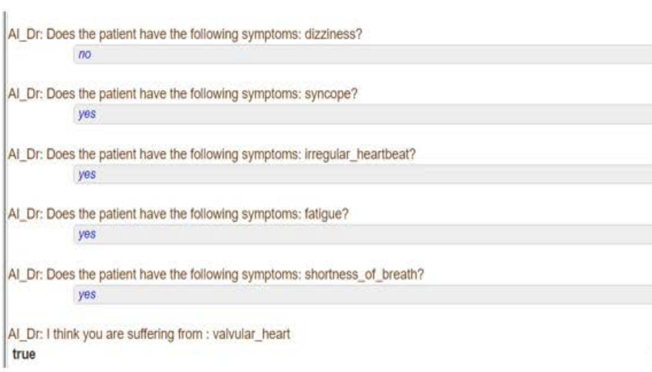

Figure 9: Diagnosis: valvular heart

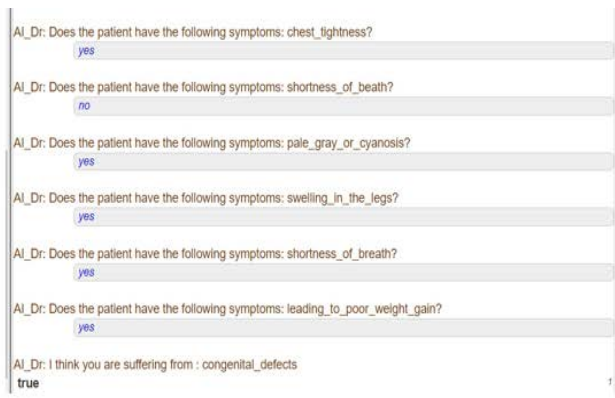

Figure 10: Diagnosis: congenital defect

Figure 11: Diagnosis: angina

Figure 12: Diagnosis: cardiomyopathy

3. Here some other result for different disease of Kidney Disease:

Figure 13: Diagnosis: glomerulonephritis

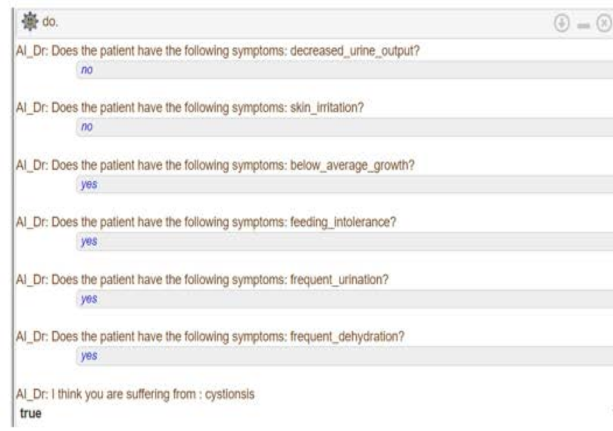

Figure 14: Diagnosis: cystinosis

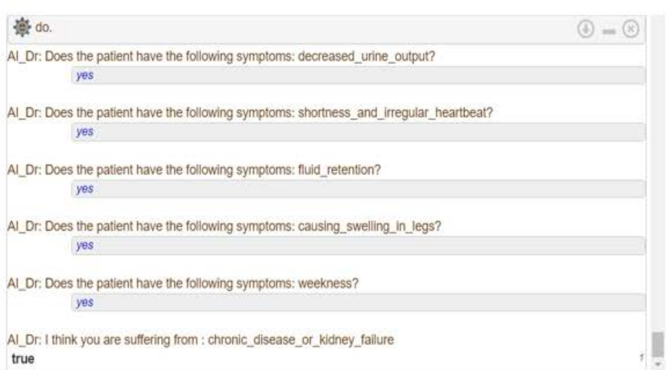

Figure 15: Diagnosis: chronic

Figure 16: Diagnosis: polycystic

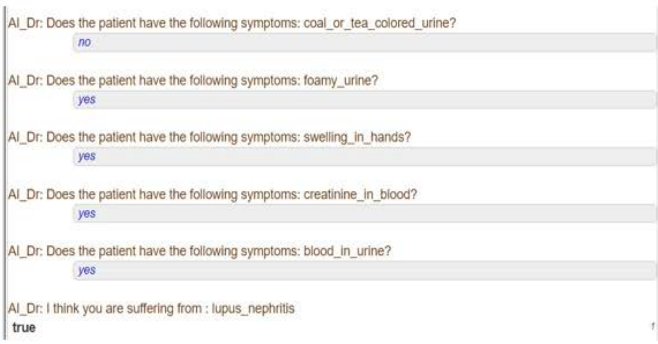

Figure 17: Diagnosis: lupus nephritis

Figure 18: Diagnosis: kidney stone

4. Here some other result for different disease of Brain Disease:

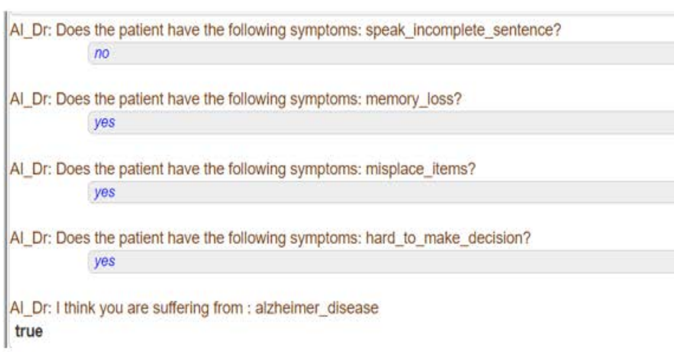

Figure 19: Diagnosis: alzheimer

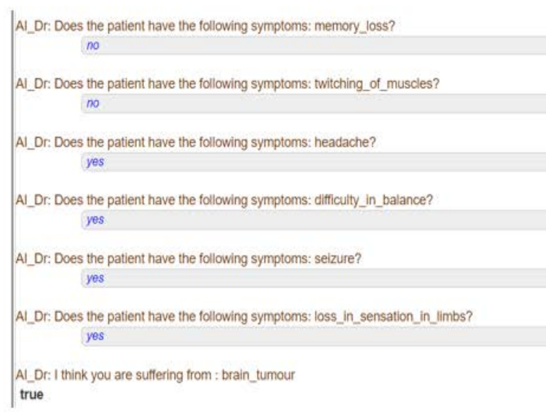

Figure 20: Diagnosis: brain tumor

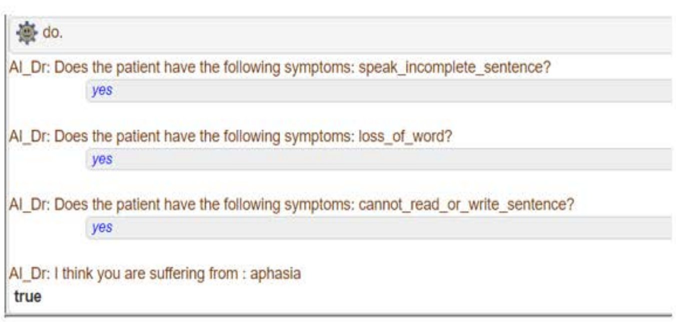

Figure 21: Diagnosis: aphasia

Figure 22: Diagnosis: ais and neuromuscular

Figure 23: Diagnosis: cerebral palsy

Figure 24: Diagnosis: ataxia

5 Here some other result for different disease of Skin Disease:

Figure 25: Diagnosis: alopecia areata

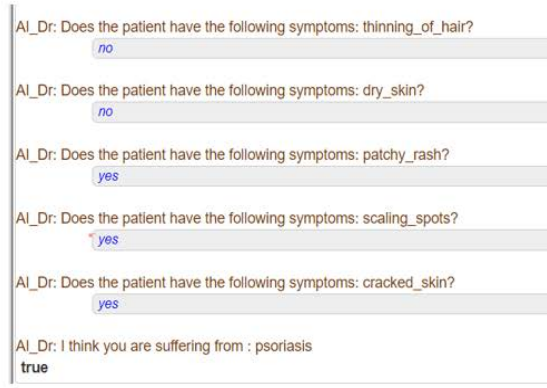

Figure 26: Diagnosis: psoriasis

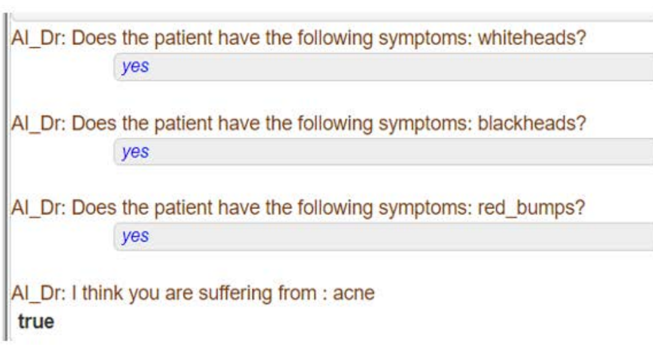

Figure 27: Diagnosis: acne

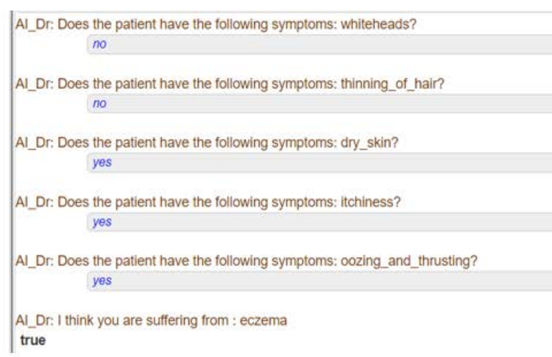

Figure 28: Diagnosis: eczema

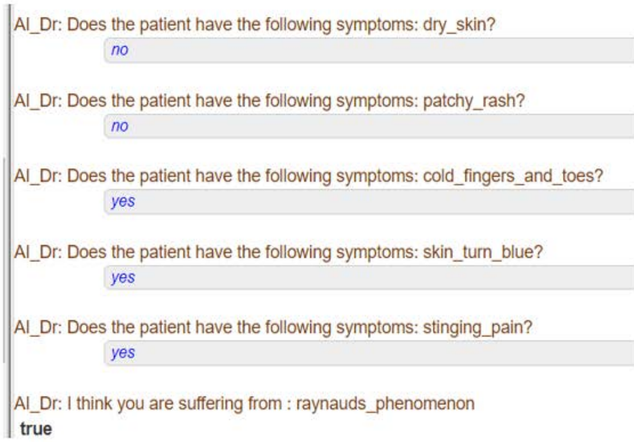

Figure 29: Diagnosis: raynaud's phenomenon

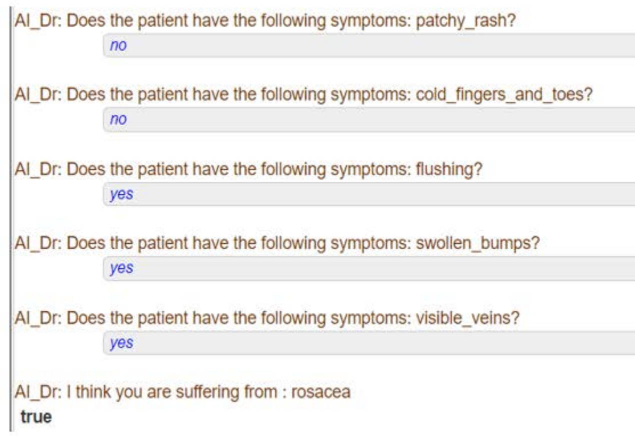

Figure 30: Diagnosis: rosacea

In summary, Prolog hypothesis rules function similarly to recipes in that they instruct a computer program on how to make predictions or recommendations based on input data. The rules use conditions to determine whether certain things are true or false and then use that information to generate new hypotheses or predictions. The finding of the study is that a Medical Expert System using Artificial Intelligence(AI)(Bokolo, 2021; Das *et al*., 2015; Das & Sanyal, 2019) is being playing a momentous responsibility in healthcare disease analysis and medical diagnosis(Das *et al*., 2018a; Das, Sanyal & Datta, 2020a, 2020b; Das *et al*., 2018b; Das & Sanyal, 2020) to assist the doctor as well as nurses as an AI crisis manager.

Conclusion

In conclusion, using expert systems to identify diseases has proven to be a successful and efficient method of assisting patients and medical professionals in identifying and treating illnesses. Expert systems can evaluate enormous volumes of data, offer recommendations that are fast and accurate, and serve as a decision-support tool. By enabling early diagnosis, lowering diagnostic mistakes, improving treatment outcomes, and raising patient happiness, this technology has the potential to change the healthcare sector. The development of more advanced expert systems can be very useful to detect diseases with better accuracy and effectiveness, ultimately helping with the early detection of diseases and minimizing their impact.

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Conflict of Interest:

Author Dr. Sumit Das, Monali Sanyal, Rghab Rano and Rik Choudhury declare that they have no conflict of interest. This article does not contain any studies with human participants or animals performed by any of the authors. Informed consent was obtained from all individual participants included in the study.

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