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Developing Expert System for Diagnosis and Treatment of Monkey Pox Outbreak

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***Abstract*: The goal of an expert system is to transfer human knowledge to the computer so that it can tackle problems that are typically handled by experts. The goal of a medical expert system is to assist doctors in making diagnoses. To provide a diagnosis, it takes into account both facts and symptoms. This suggests that a medical expert system makes a diagnosis based on information about the patient and knowledge of the diseases. The purpose of this study is to develop a forward chaining expert system prototype for diagnosing diseases associated with MonkeyPox outbreaks. The system is developed using SWI Prolog, represented using decision tree and offer guidance to patients and experts.**

Keywords: Expert system, MonkeyPox, Prolog

1. INTRODUCTION

MonkeyPox cases were recorded in endemic and non-endemic nations since early May 2022. Most confirmed cases with travel histories mentioned visits to Europe and North America rather than West or Central Africa, where the MonkeyPox virus is widespread. This is the first time that several MonkeyPox cases and clusters have been reported concurrently in endemic and non-endemic country in very regions around the globe(World Health Organization, 2022). A new viral zoonotic disease called MonkeyPox has symptoms that are comparable to smallpox but less severe. MonkeyPox has become the most significant orthopoxvirus in humans since the worldwide elimination of smallpox in 1980. The MonkeyPox virus, an orthopoxvirus, is still present in some central and western African nations. The West African clade and the Congo Basin clade, sometimes known as the central African clade, are two different clades that have been identified (World Health Organization, 2017). MonkeyPox is a zoonotic disease, or illness that spreads from animals to people. Cases are frequently discovered close to tropical rainforests where the virus is carried by animals. Squirrels, Gambian poached rats, dormice, many types of monkeys, and other animals have all shown signs of infection with the

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MonkeyPox virus. According to (Update, 2022), 6027 laboratory-confirmed cases of MonkeyPox and three fatalities have been reported to WHO from 1 January to 4 July 2022 from 59 nations, territories, and areas in five WHO Regions (African Region, Region of the Americas, Eastern Mediterranean Region, European Region, and Western Pacific Region) (Table 1).

WHO Region	Confirmed cases	Deaths
African Region	173	3
Region of the Americas	902	0
Eastern Mediterranean Region	15	0
European Region	4920	0
Western Pacific Region	17	0
Cumulative	6027	3

Table I: area-specific confirmed cases and fatalities

Most of the cases in the current outbreak in non-endemic countries have been found in males between the ages of 18 and 50. (Assessment, 2022). The MonkeyPox virus spreads via large respiratory droplets, close contact with lesions, direct touch, and perhaps contaminated foam. (Palich et al., 2022). Knowledge of the MonkeyPox virus, the causes of the illness and the best ways to prevent and cut down transmission are essential.

Related Works

There are several expert systems created to identify human diseases. A system run by professionals that aids in the diagnosis of human organ problems and provides necessary guidance.

In order to inform patients about Covid19 protection and detect whether they are contaminated or not, the author suggested utilizing an expert system. The author developed the expert system using SL5.

To help patients who are showing signs of influenza verify if they are infected with COVID-19, the author has developed a sophisticated knowledge base system. Additionally, the author alerted medical authorities using the Internet of Things (IOT) to assist the patients. The implemented system features a graphical user interface that was created using the Python programming language.

They suggested an expert approach to help physicians diagnose and detect COVID-19 instances by recognizing symptoms. The proposed expert system was implemented using CLIPS and Delphi.

The article's goal is to develop an expert system based on Mamdani fuzzy inference to diagnose chronic renal disease and assess the system's level of accuracy. Matlab R2009a is used to implement the expert system. The outcome demonstrated that the bisector method produces the

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greatest level of precision (98.86%). [7] The purpose of this article is to design an expert system for pre-diagnosis of hypertension, diabetes mellitus type 2 and metabolic syndrome. The system is built using PHP, Apache, and MySQL with the CLIPS tool. 72 patients and 3 genuine doctors validated the method. The results throughout the entire sample of 72 patients are as follows: low risk 16.6%, moderate risk 30.5%, moderate high risk 13.8%, high risk 23.6%, and extremely high risk 15.2%. The [8] proposed an expert system to diagnose thyroid disease and used the rule method to represent the knowledge of domain experts. The graphical user interface is designed by C #.

The purpose of this study is to develop an application for an expert system that uses the forward chaining approach to diagnose eye conditions. Usability testing has been used to determine whether users will accept this application. The work's scope is expanded to include 16 different types of eye disorders and their associated 41 symptoms, which are arranged according to 16 rules. PHP has been used as a programming language, and MySQL was used as the Relational Database Management System (RDBMS).

In this study, they created an expert system based on a hybrid inference method and extensive integrated information to help professionals diagnose spinal illnesses quickly and accurately. In order to achieve good performance, a novel hybrid inference algorithm that incorporates backward chaining inference and the Theory of Uncertainty was developed. The current research suggests a knowledge-based expert system for diagnosing common spinal illnesses and making treatment suggestions based on movement therapy. [11].

Several problems with the conventional approach to disease diagnosis are discussed in this article. A rule-based expert system was created for the diagnosis of breast cancer, typhoid fever, malaria, cholera, and tuberculosis. The proposed Medical Expert System (MES) contains 46 rules to accurately diagnose illnesses.

The goal of this study is to develop an expert system to diagnose dental illness using the certainty factor method. An expert system app made by the author runs on the Android operating system. Additionally, 19 instances matched and 1 case did not in the measurement accuracy of the system test carried out by 20 patients. Because of system testing with 20 patients, a 95 percent accuracy rate was obtained.

In this research, an expert system is shown that can diagnose a patient's illness fast and offer a workable fix. The SL5 Object language was used to create and implement this expert system. This expert system was evaluated by a team of doctors, who found it to be a helpful tool for treating individuals with hearing impairments.
However, there is no expert method that can diagnose and treat MonkeyPox epidemic symptoms.

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2. METHODOLOGY

In this research, many techniques are used to develop the proposed knowledge-based system. This would include knowledge acquisition, knowledge modelling, knowledge representation, Rule-based Expert system creation for diagnosing MonkeyPox disease.
The primary information required for this study is obtained from the WHO Health Emergency Dashboard, NIH, and documented sources of information from various sources, including journals, publications, internet sources, and symptoms of the MonkeyPox disease, protection guidelines, and meeting manuals are analysed.
Using decision trees, the obtained knowledge is modelled. Decision trees may handle complex issues in a concise manner and visually depict the relationships in the problem [15]. Decision trees can simply be translated to rules, and knowledge diagramming is frequently more intuitive to specialists than formal representation techniques. Drawing a decision tree using flow chart symbols makes it simpler for many people to read and comprehend. The ability to add new situations and identify the approach most likely to achieve a goal is helpful.
Following constructing a decision tree to model the newly learned knowledge, it is presented in a manner that can be used by computers and understood by people. The most common type of knowledge representation is rule-based, which is simple to comprehend and reasonably effective at identifying issues. Knowledge is expressed as condition-action pairs: IF this state (or premise or antecedent) happens, THEN any action (or result, conclusion, or consequence will (or should) occur.

Development of Models
MonkeyPox diagnosis is based on strategies for rule-based inference. The approach, as seen in (*Figure 1)* illustrates that the knowledge was collected from WHO Health Emergency Dashboard and reliable knowledge sources such as, books, journal articles, electronic sources, and material on the internet are examples of potential knowledge sources. The knowledge engineer then properly codes the acquired knowledge into the knowledge base. The knowledge base includes the rule base from which the inference engine makes conclusions for the system. The inference engine takes user queries via the user interface and, if the target is achieved, prompts the user to take some action in a way that is understandable to them. As an inference mechanism, a backward chaining technique is used to find and extract the rules for a particular type of MonkeyPox disease.

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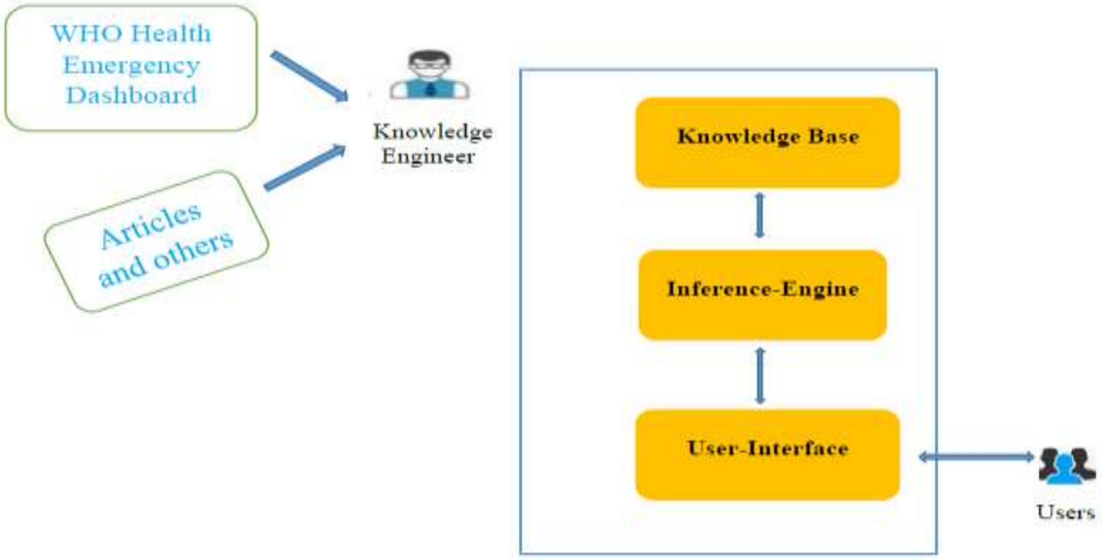

Fig 1: proposed architecture of rule based expert system to diagnosis monkeypox

Implementation tools

The Prolog programming language is being used to create a rule-based, knowledge-based system for diagnosing and treating MonkeyPox disease. Prolog is a declarative language that can describe the physical world. Prolog is an important tool for natural language processing programs because of its declarative semantics, built-in search, and pattern matching.

Rule based MonkeyPox disease diagnosis and treatment

R1: IF (High fever)
R2: (extreme headache)
R3: (chills)
R4: (swelling of the lymph nodes)
R5: (back pain)
R6: (myalgia or muscle aches)
R7: (intense asthenia (lack of energy)
R8: IF (A few days later, a blister-like rash appears on face and in the genital or anal areas) THEN Monkey Pox.

3. RESULTS AND DISCUSSION

The MonkeyPox user interface is represented by the SWI Prolog window. The system has a MonkeyPox file saved on it (monkeypox.clp). The knowledge base is contained in the file, which is a collection of questions that a medical expert is required to ask a patient suspected of having MonkeyPox. The system uses symptoms and treatment outcomes to populate the knowledge base. Following the user's responses to the system's combination of inquiries, the

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system employs a diagnostic pattern. When the user boots the machine, he clicks the SWI Prolog icon, which opens the Prolog window. He then loads or consults the file that contains the combination of MonkeyPox disease inquiries. The following command is entered: (start.). The system's final diagnostic will be determined by the user's responses of y (Yes) or n (No). Figures 2-3 show the results of the MonkeyPox diagnostic procedure. The method offers both diagnostic and treatment recommendations for MonkeyPox outbreak.

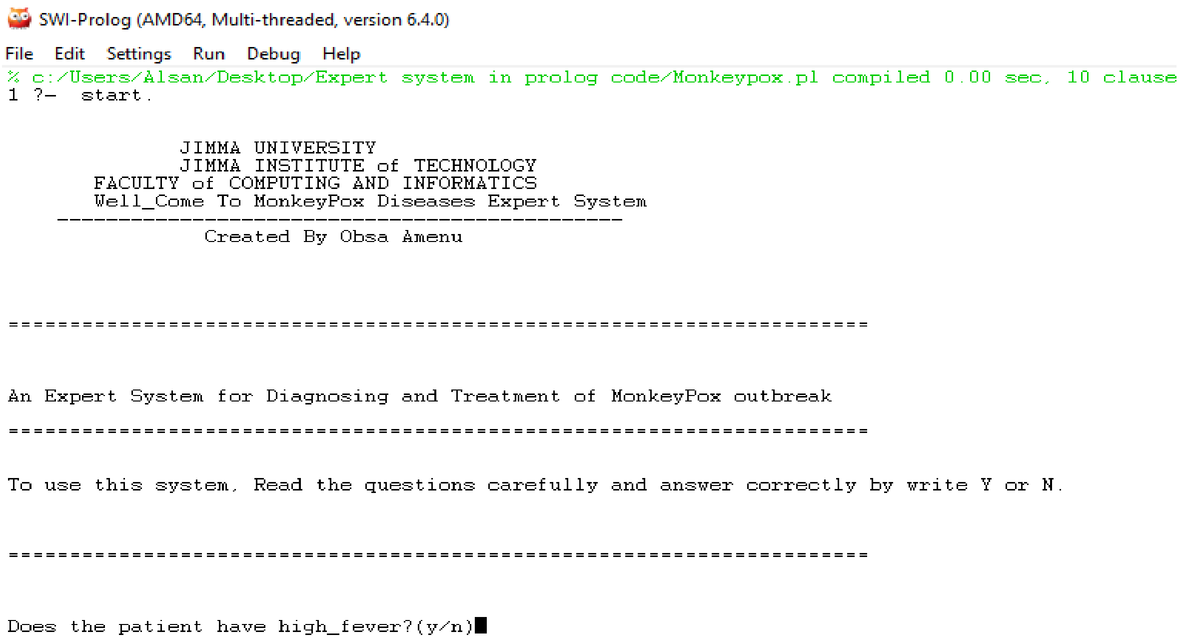

Fig 2. welcome user interface

Below is screenshot of MonkeyPox diagnosis and treatment.

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```
SWI-Prolog (AMD64, Multi-threaded, version 6.4.0)
File  Edit  Settings  Run  Debug  Help

Does the patient have high_fever?(y/n)y.
Does the patient have extrem_headache?(y/n)y.
Does the patient have chills?(y/n)y.
Does the patient have swelling_of_lymph_nodes?(y/n)y.
Does the patient have back_pain?(y/n)y.
Does the patient have intense_energy?(y/n)y.
Does the patient have blister_like_rash_appers__on_face?(y/n)y.
Does the patient have mylgia?(y/n)y.

==========================================================
This patient could  have monkeypox disease

======================================================
Treatment
========================================================
1. Avoid close contact (including intimate physical contact) with others until a healthcare provider examines you.
2. Avoid close contact with pets or other animals until a healthcare provider examines you.
3. Keep your distance from infected people and their clothing, blankets, and other personal items.
4. Hands should be thoroughly washed often.
5. If you are taking care of someone who has monkeypox or has symptoms of the disease, use a mask, gloves, or other protective gear.
6. If your test result is positive, stay isolated until your rash has healed, all scabs have fallen off.

Try again ? (y/n)
```

Fig 3. Conversation between user and monkeypox symptoms expert system

4. CONCLUSION AND FUTURE WORK

Expert systems have been found to be quite beneficial in today's technologically advanced environment. When an expert's knowledge is retrieved and preserved, it can be utilized to replace him or her in the event of death. Medical diagnosis will benefit more from expert systems because there aren't many medical specialties. It is possible to replicate and use this specialist's knowledge in situations of essential necessity. In this study, a rule-based medical expert system for diagnosing MonkeyPox illness is developed and codified using the SWI-Prolog editing tool to provide assistance to experts and patients.

This rule-based system is unable to learn on its own. A learning component should be included to aid users in reasoning and memory when they are requested to offer answers for unfamiliar situations and unknown facts in the future. To enhance the functionality of the prototype expert system, case-based reasoning in conjunction with hybrid strategy techniques should be investigated. The system can learn from prior experiences by incorporating case-based reasoning. In its current state, this system can operate alone. If a Web-based version is developed, making the diagnostic system accessible to anybody with a computer and an Internet connection, it will be more engaging and effective in the future.

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