



De La Salle University - Manila

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In partial fulfillment

of the course

INTRODUCTION TO INTELLIGENT SYSTEMS

MC02: ChatBot

CSINTSY - S12

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I. Introduction

The Philippines faces challenges in providing proper access healthcare to those in poor and rural areas. According to the Department of Health (2020), only 50% of Filipinos have access to rural health centers within 30 minutes. As reported by Chanco (2019), the 2nd Philippine Wellness Index shows that nearly half of Filipinos do not have the confidence to pay for hospitalizations in case of sickness. Additionally, the country also has a shortage of medical professionals. (Chanco, 2022)

This domain aims to provide a diagnosis—specifically the possible diseases they may be suffering from. The patient will be asked if they have a specific symptom which comes from a predetermined set of disease and symptoms. The diseases included are the following: Tuberculosis, Dengue Fever, Measles, Diabetes, Stroke, Asthma, Diarrhea, Pneumonia, Leptospirosis, and Rabies. Whenever the patient answers, the set of symptoms asked to them may be narrowed down depending on their answer. Consequently, it would then present the patient with possible disease they might have based on their answers/symptoms.

Incorporating an expert system for disease diagnosis would ultimately benefit, not only those in rural communities, but every user of the domain. According to the Overview of the National eHealth Program (n.d.), *“...the health sector through the leadership of the Department of Health (DOH) has recognized the necessity of using information and communication technologies (ICT) for health or eHealth as one of the enabling strategic instruments not only to address these current disparities in service care delivery, and timely access to information for better decision making and intervention...”* The expert system would then provide accurate and timely diagnosis to the users by narrowing down the diseases they may have by taking note of their symptoms. Additionally, it can assist medical professionals in providing faster and more efficient diagnosis.

As the domain mainly focuses on assisting those in rural areas, the diseases are based on those commonly found there. The domain would benefit those who do not have access to hospitals or do not have healthcare centers near them. Furthermore, given proper budgeting and planning, it could effectively reduce expenses on both health sectors and patients. It would lessen transportation costs, manpower resources, and other medical costs.

II. Knowledge Base

The knowledge base of this expert system consists of the 10 diseases that were researched on, along with the symptoms that are primarily found in each disease (sources for the diseases are placed in the references part of the report). These symptoms were then translated into atoms, which were placed under a predicate called “*verify()*”. The *verify()* predicate was created with the logic of using it to check whether a certain patient had the minimum symptoms to be diagnosed with a certain disease. As such, each disease is defined as a rule with all the predicates and the symptoms as atoms defined as conditions for the disease rule. After this, based on the research conducted, we were able to identify the symptoms in diseases that were most common, and the symptoms in diseases that are simply a possibility to be present in a person. This led to the implementation which requires the most common symptoms to be identified before the chatbot is able to identify a disease. (More on this will be discussed later in the Chatbot section)

below.) For example, in the figure below, in order for the chatbot to identify that the patient has diabetes, the patient should first be able to inform it that the most common symptoms of diabetes such as darkened skin, frequent urination, increased thirst, and fatigue, are present. After that, the other symptoms that can be found in a patient with diabetes such as numbness, blurred vision, and increased hunger, are *grouped* together in *or* statements so that if just one of those symptoms is true, the chatbot is certain that the patient has diabetes. The last *verify(_)* predicate is simply there in order to make sure that if the patient says no to all of the optional symptoms, the chatbot can still identify that the patient had diabetes. Finally, once it identifies the disease, it also prints out the advices and suggestions for medicating the patient.

```
44  diabetes :-
45      verify(darkened_skin),
46      verify(frequent_urination),
47      verify(increased_thirst),
48      verify(fatigue),
49      (verify(numbness);
50      verify(blurred_vision);
51      verify(increased_hunger);
52      verify(_)),
53      write('Advices and Suggestions:'),
54      nl,
55      write('1: Healthy eating, regular exercise, weight loss,
56      nl.
```

Sample code which displays the knowledge base translation,
and the easiest and most difficult parts.

The easiest part of the knowledge base to translate was converting the symptoms into conditions for the disease rule to become true. Because all it took was to convert the symptoms into predicates, that was a simpler task to accomplish. On the other hand, the hardest part in creating the knowledge base is figuring out how to solve the issue of the chatbot being able to only identify a disease if all the symptoms are present. At first we thought we were done because the chatbot was able to identify the disease without asking all of the symptoms in the knowledge base, however, when we learned that the chatbot should be able to identify the disease even if all the symptoms of that disease are not present, it really stumped us and we took a long time to figure that out. Eventually it was decided that the more uncommon symptoms would be grouped up while the more common symptoms would be required to identify the disease.

III. Chatbot

The chatbot is accessed by initializing the knowledge base in `swipl` and by calling on the `go` predicate to begin the diagnostics. A series of questions will then be asked to the user regarding the symptoms that they may be experiencing. After the user answers yes or no, it would output the hypothesized disease identified by the knowledge base.


The logic for the chatbot to infer the user's disease is rather straightforward and is largely based on the research done by the students. The system first hypothesizes a disease in the knowledge base with the use of the `hypothesis` predicate. From that hypothesis, a set of questions would be asked by calling on the `verify` predicate. These sets of questions are separated into asking common symptoms and uncommon symptoms. The system first asks the common symptoms; following that, the uncommon symptoms would be asked. If at least one of the common symptoms is rejected by the user, the system immediately moves onto the next hypothesized disease and its set of verification of symptoms. But if the user answered yes to all of the common symptoms, the user is diagnosed with the hypothesized disease after answering yes to an uncommon symptoms or even if all the uncommon symptoms are rejected. Symptoms are never asked repeatedly, since the system will store in the `verify()` predicate whether or not the symptom has been answered before. If it was answered beforehand, then the system keeps searching for the next symptom that hasn't been answered yet.

After answering the list of questions, a user may receive a proper disease diagnostic or an unknown disease diagnostic. A proper diagnostic is resulted by satisfying the aforementioned condition of a hypothesized disease's common symptoms all being affirmed by the user. This shows the diagnosed disease's name, and the system would also provide the user an advise for it. An unknown disease diagnostic is the result of not satisfying all of the common symptoms for all the diseases; this would mean that the user has too few symptoms or that they have a set of symptoms that knowledge base does not recognize as a disease.

IV. Results and Analysis

Impressive Sample Conversations

First Example:

 SWI-Prolog (AMD64, Multi-threaded, version 9.0.4)

File Edit Settings Run Debug Help

Welcome to SWI-Prolog (threaded, 64 bits, version 9.0.4)
SWI-Prolog comes with ABSOLUTELY NO WARRANTY. This is free software.
Please run `?- license.` for legal details.

For online help and background, visit <https://www.swi-prolog.org>
For built-in help, use `?- help(Topic).` or `?- apropos(Word).`

`?-`
`% c:/Users/user/Documents/Prolog/Disease Identification.pl compiled 0.00 sec, 27 clauses`
`?- go.`
Answer y/yes when you have a certain symptom, otherwise answer n/no
Does the patient have following symptom:fever? y.

Does the patient have following symptom:headache? |: y.

Does the patient have following symptom:weakness/discomfort? |: n.

Does the patient have following symptom:darkened_skin? |: n.

Does the patient have following symptom:wheezing? |: y.

Does the patient have following symptom:breathlessness? |: y.

Does the patient have following symptom:tight_chest? |: y.

Does the patient have following symptom:pain_behind_eyes? |: y.

Advices and Suggestions:
1: Use a reliever inhaler to treat your symptoms when they occur.
I believe that the patient has asthma
TAKE CARE
true.

This specific conversation from the chatbot expert system was taken since it exhibits a form of machine learning, where if a specific symptom was answered as no, it leads to a new set of questions that the expert system (chatbot) would ask. Moreover, this behavior of the chatbot implies that it will not be redundant in the set of questions (and no longer asks questions once it has been asked before) it asks and thus removing the chances of having inconsistencies in the answer of the user/patient.

Second Example:

```
SWI-Prolog (AMD64, Multi-threaded, version 9.0.4)
File Edit Settings Run Debug Help
Welcome to SWI-Prolog (threaded, 64 bits, version 9.0.4)
SWI-Prolog comes with ABSOLUTELY NO WARRANTY. This is free software.
Please run ?- license. for legal details.

For online help and background, visit https://www.swi-prolog.org
For built-in help, use ?- help(Topic). or ?- apropos(Word).

?-
% c:/Users/user/Documents/Prolog/Disease Identification.pl compiled 0.00 sec, 27 clauses
?- go.
Answer y/yes when you have a certain symptom, otherwise answer n/no
Does the patient have following symptom:fever? y.

Does the patient have following symptom:headache? |: y.

Does the patient have following symptom:weakness/discomfort? |: y.

Does the patient have following symptom:hydrophobia? |: n.

Does the patient have following symptom:hallucinations? |: n.

Does the patient have following symptom:abnormal_behavior? |: y.

Advices and Suggestions:
1: Rapid and accurate laboratory diagnosis of rabies in humans and other animals is essential for timely administration of postexposure prophylaxis.
I believe that the patient has rabies
TAKE CARE
true.
```

This conversation was also taken since this exhibits a feature of the chatbot where it doesn't need all symptoms of a certain disease to be true in order for it to be diagnosed as such. For most diseases, you don't need all symptoms to be true to be conclusive that they're that certain disease, thus this feature was implemented to have more leeway for those diseases that don't need all symptoms to be true. In the case of the chatbot as well, the common symptoms of specific diseases were given more weight than the uncommon symptoms since the common ones were more indicative of the diseases and for most of the disease in the knowledge base, the common symptoms suggests that if most/all were true then it's very likely they're the diseases.

Poor Performance

First Example:

```
SWI-Prolog (AMD64, Multi-threaded, version 9.0.4)
File Edit Settings Run Debug Help
Welcome to SWI-Prolog (threaded, 64 bits, version 9.0.4)
SWI-Prolog comes with ABSOLUTELY NO WARRANTY. This is free software.
Please run ?- license. for legal details.

For online help and background, visit https://www.swi-prolog.org
For built-in help, use ?- help(Topic). or ?- apropos(Word).

?-
% c:/Users/user/Documents/Prolog/Disease Identification.pl compiled 0.02 sec, 27 clauses
?- go.
Answer y/yes when you have a certain symptom, otherwise answer n/no
Does the patient have following symptom:fever? y.

Does the patient have following symptom:headache? |: y.

Does the patient have following symptom:weakness/discomfort? |: n.

Does the patient have following symptom:darkened_skin? |: ■
```

In the chatbot, the symptoms of the diseases were split into two categories, either common or uncommon. In the chatbot, it requires all common symptoms to be true, but this is partially incorrect since that doesn't exhibit a very good accuracy in some cases where a particular set of symptoms were enough to diagnose the disease as such. For example, in the above conversation, the questions it's asking are symptoms deriving from rabies, but for rabies, fever, headache, and weakness/discomfort are all common diseases and are the first to show when you have that disease. But not all patients may be having those symptoms so this will cause an inaccuracy in the diagnosis since the chatbot only diagnoses a disease when all its common symptoms are true. It somehow tries to guarantee that disease is true but it's not very accurate in the case mentioned earlier (patient not needing to have all of them).

Second Example:

```

SWI-Prolog (AMD64, Multi-threaded, version 9.0.4)
File Edit Settings Run Debug Help
Welcome to SWI-Prolog (threaded, 64 bits, version 9.0.4)
SWI-Prolog comes with ABSOLUTELY NO WARRANTY. This is free software.
Please run ?- license. for legal details.

For online help and background, visit https://www.swi-prolog.org
For built-in help, use ?- help(Topic). or ?- apropos(Word).

?-
% c:/Users/user/Documents/Prolog/Disease Identification.pl compiled 0.00 sec, 27 clauses
?- go.
Answer y/yes when you have a certain symptom, otherwise answer n/no
Does the patient have following symptom:fever? y.

Does the patient have following symptom:headache? |: y.

Does the patient have following symptom:weakness/discomfort? |: y.

Does the patient have following symptom:hydrophobia? |: n.

Does the patient have following symptom:hallucinations? |: y.

Advice and Suggestions:
1: Rapid and accurate laboratory diagnosis of rabies in humans and other animals is essential for timely administration of postexposure prophylaxis.
I believe that the patient has rabies
TAKE CARE
true.

```

This conversation was taken as the code ends abruptly when a certain disease's common symptoms have all been met. This is a poor performance display by the chatbot since what if a disease that's part of the knowledge base also had similar symptoms and weren't displayed as a possible diagnosis.

Summary of Strengths and Weaknesses

Features of the chatbot exhibit some form of intelligence where it implements rules such as preventing redundancy in the symptoms asked and has a basis on the diagnosis of the diseases, where it is based on the most common symptoms of the disease to get as much accuracy as possible in its diagnosis. Moreover it does not require diseases to have all symptoms to be true, however, the weakness in this part of the chatbot is that it requires all common symptoms to be true, which is not necessary for some diseases. The chatbot also lacks a mathematical way of measuring the likelihood of the diseases and thus fails to be able to display a set of possible diseases for the diagnosis.

V. Recommendations

While that chatbot works generally, it could falter or produce an inaccurate result in some potential real life scenarios. The chatbot only factors in common and uncommon symptoms in which only the former is required to be all true. And when that requirement is

met, the disease will then be true for the patient. This could fail when the patient exhibits symptoms that are similar to multiple diseases. Additionally, the bot also lacks in presenting all possible diseases the patient may have; therefore, decreasing its reliability. Moreover, as the bot only bases on the limited knowledge base, it should present the likelihood of the diseases as there are other factors outside the knowledge base that could affect the patient.

Confidence scores and mathematical computations could be implemented to address the bot's limitations. The bot could also consider other factors such as the duration and severity of the disease instead of the general disease only. This way, the bot could possibly use the presence and absence of symptoms and other factors to compute the confidence scores by an implemented mathematical computation. A higher confidence score would mean that the patient is more likely to have them and a lower confidence score would mean that it is less likely. These confidence scores would then be used to create the list of possible diseases. Consequently, it would no longer present the first disease the patient meets the criteria of.

The bot could also make use of machine learning algorithms. This would then enhance intelligence and accuracy in presenting the results. In addition to this, it is also recommended to consistently update the knowledge base in order to keep up with new findings and diseases which would also increase accuracy and reliability.

VI. CONTRIBUTIONS

DELA CRUZ, Frances Julianne R.	Contributed in obtaining information that will be used as the knowledge base for the expert system. Contributed in formulating the logic, and the code in PROLOG for the expert system. Contribution in the write-up in explaining the chatbot.
GAMBOA, Mikkell Dominic	Contributed in obtaining information that will be used as the knowledge base for the expert system. Contributed in formulating the logic, and the code in PROLOG for the expert system. Contribution in the write-up in explaining the chatbot.
VERANO, Carl Matthew	Leader. Contributed in obtaining information that will be used as the knowledge base for the expert system. Contributed in formulating the logic, and the code in PROLOG for the expert system. Contribution in the write-up in explaining the chatbot.
YU, Hanz Patrick	Contributed in obtaining information that will be used as the knowledge base for the expert system. Contributed in formulating the logic, and the code in PROLOG for the expert system. Contribution in the

	write-up in explaining the chatbot.
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