

MCO2: Medical Chatbot Report

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I. Introduction

The focus of the proposed medical chatbot is to help individuals in rural areas—especially those with limited access to healthcare—identify their ailments. The diseases covered in this chatbot are based on the National Health Plan of the Department of Health which aims to address the needs of local communities in the Philippines (Japan International Cooperation Agency, 1997). This document details the mortality rate of infectious and non-communicable diseases of Filipinos in rural areas.

Ten of the most common diseases were selected after analyzing the report and consulting a medical practitioner. All the diseases selected have distinct symptoms and do not require additional laboratory tests for diagnosis. This is to ensure the accuracy of the chatbot and to avoid complications with overlapping symptoms across infectious diseases. The final list of diseases along with pertinent information is located in the appendix.

Since the chatbot aims to diagnose potent and potentially life-threatening diseases, information stored in the knowledge base must come from reliable sources such as people with medical expertise. One misdiagnosis could lead to an individual taking a treatment regimen unsuitable for his or her ailment. Additionally, this delays proper treatment, especially when a patient is misdiagnosed with a minor disease despite truly having something severe. This could derail a patient's condition, hinder their recovery, or even cause their death. Hence, this chatbot must be used with caution. Diagnoses from this chatbot still require verification from a health professional. It is also important to note that stages and severity of the illness is not within the scope of the proposed medical chatbot.

Nonetheless, this system empowers individuals with limited access to healthcare facilities by helping them become more aware of their health conditions. With the use of the chatbot, these people may seek or be provided with proper treatment sooner. The chatbot also reduces transportation costs incurred by visiting medical facilities, as it provides a simple, accessible method of a preliminary examination. Having a patient consult a medical professional virtually would also supplement this process, as any data that had been acquired from the chatbot may be used to streamline the diagnosis process and enhance the patient's treatment regimen.

General Instructions for Using the Proposed Medical Chatbot

1. Run the executable file of the Prolog source code, **app.exe**.
2. Type **go.** to start the program.
3. The program will then ask for your personal information. Please be reminded however that your name must be enclosed with quotation marks. All inputs must end with a **period .** to denote the end of an input. For instance, to answer yes to a question prompt, simply type **yes.** to the terminal.
4. After a series of prompts, the program identifies the disease attributed to the user's symptoms.
5. If the user wants to perform another diagnosis, a question prompt will appear to confirm this. Simply type **yes.** to proceed or **no.** to exit the program.

II. Knowledge Base and Chatbot

The knowledge base comprises ten diseases, with their major and minor symptoms acting as the chatbot's basis to identify the user's disease. Other information stored in the knowledge base includes their description, additional tests for diagnosis, treatments, and preventive measures. The final list of diseases along with pertinent information is located in the appendix.

Diagnosing a disease depends solely on a given set of major and minor symptoms. Major symptoms are often specific to a disease, while minor diseases are initial manifestations of a disease. Minor symptoms are less reliable predictors of a specific disease (Ben-Shabat et al., 2022). Translating each disease's symptoms and storing them in the knowledge base involved classifying every symptom into one of two categories: non-negotiable or optional. Non-negotiable symptoms refer to major symptoms that characterize an ailment while optional symptoms refer to minor symptoms that patients may or may not exhibit in an ailment. Figure 1.1 is a visual representation illustrating how symptoms in each disease are classified in major and minor groups, denoted by red and orange respectively. It is also important to note that similar symptoms worded differently in various references are identified as the same in the knowledge base.

	Dengue Fever	Amoebiasis	Acute Gastroenteritis	Filariasis	Chicken Pox	GERD	Tuberculosis	Rabies	Tetanus	Asthma
fever										
bleeding from nose and gums										
nausea										
vomiting										
rash										
eye, muscle and bone pain										
abdominal pain										
diarrhea										
bloody stools										
fatigue										
pain and swelling of the genitalia (breast, vagina or scrotum)										
pain and swelling of the legs and arms										
coughing										
shortness of breath										
wheezing										
fluid-filled blisters										
loss of appetite										
headache										
burning sensation or heartburn										
backwash of sour liquid										
trouble swallowing										
throat lumps										
chest pain										
coughing up of blood										
anxiety										
delirium										
hydrophobia and insomnia										
itching										
involuntary stomach spasms										
muscle stiffness										
seizures (jerking or staring)										
sweating										
changes in blood pressure and heart rate										

Figure 1.1 Visual Representation of Minor and Major Symptoms

Grouping these symptoms into either category involves two logical operators, namely conjunctive (,) and disjunctive (;) operators. Symptoms that are considered non-negotiable are separated by a conjunctive operator. For instance, let us consider chicken pox with two major symptoms: rashes and fluid-filled blisters. This will be written in our knowledge base like the following:

symptom('rashes'), symptom('fluid – filled blisters')

Optional symptoms are grouped by a parenthesis and connected using a disjunctive operator. Chickenpox may also manifest one or more minor symptoms such as fever and headache. This will be then written like the following:

(symptom('fever'); symptom('headache'))

The combination of both major and minor symptoms for one disease, when inputted in the database, will be written as

*symptom('rashes'),
symptom('fluid – filled blisters'),
(symptom('fever'); symptom('headache'))*

After placing the symptoms for each disease in the knowledge base, the rest of the knowledge base is formulated based on Prolog's backward chaining logic. This allows the program to identify a disease based on a subsequent yes or no query to the user. These questions involve asking whether the user has the specified symptom. For instance, the program may ask "Do you have cough?". If the user answers no, $\neg cough$ will be added to the knowledge base. On the contrary, if the user answers yes, *cough* \equiv *True or cough* will be added to the knowledge base.

Found below is the step-by-step process as to how the chatbot adds knowledge to the knowledge base and thereafter identifies a disease after enough information has been obtained.

1. The knowledge base already contains the rules to determine what combination of symptoms has to be true in order to make a disease true. The program's goal is to make at least one hypothesis to be true or to make all hypotheses false.

```
(hypothesis(Disease)
->
    % IF a hypothesis is true
    % Some code that prints details of diagnosis if found %
    diagnose_again % Ask if they want to diagnose again
    ;
    % ELSE (all hypotheses are false)
    write('\nSorry, the system is unable to identify the
disease'),
    nl,
```

```
diagnose_again).
```

Figure 1.2.1 Partial Prolog Code for the “if-then” Directive of hypothesis(Disease)

2. To check the truthness of a hypothesis – whether the disease is true – it checks the symptoms that must be true as defined in the “if-then” rule of a hypothesis.

```
hypothesis('chicken pox') :-  
    symptom('fluid-filled blisters'),  
    symptom('rash'),  
    (symptom('fever');  
    symptom('fatigue');  
    symptom('loss of appetite');  
    symptom('headache');  
    symptom('itching')),  
    nl,  
    % Code that outputs details of the disease %  
    nl, !.
```

Figure 1.2.2 Partial Code for the “if-then” Rule Attributed to hypothesis(‘chicken pox’)

3. The program first checks if the symptom has a true or fail value attributed to it – that is if ‘yes(S)’ or ‘no(S)’ already exists in the knowledge base
 - a. If there is no value attributed to the symptom, it proceeds to ask whether the user is experiencing the symptom, then adds the corresponding value to the symptom depending on the user’s response. This is because ‘symptom(S)’ and ‘ask(Question)’ are defined as follows

```
ask(Question) :-  
    write('Is the patient suffering from '),  
    write(Question),  
    write('? '),  
    prompt(_, ''),  
    read(Response),  
    ((Response == yes ; Response == y) ->  
        assert(yes(Question)) ;  
        assert(no(Question)), fail).  
  
symptom(S) :-  
    (yes(S) ->true;  
    (no(S) ->fail;  
    ask(S))).
```

Figure 1.2.3 Prolog Code Defining “if-then” rule for ask(Question) and symptom(S)

- b. Otherwise, if the symptom identifies to be true, the program proceeds to check the next symptom in the same disease, unless the symptom is a minor symptom (connected by the ‘;’ operator), in which case the hypothesis is labeled as true.
 - c. However, if the symptom is classified as major and is identified to be fail, the program proceeds to check the next hypothesis.

4. The program repeats steps 2 to 3 until there is a disease in which all needed symptoms are identified as true or when there is no symptom left to check.
5. If the program can identify such disease, the program creates a diagnosis. Otherwise, the program prompts the user that it is unable to make a diagnosis.

After the chatbot diagnoses the user, it provides additional information about the diagnosed disease. The chatbot does not need this information to determine the disease. Rather, it helps the user confirm their diagnosis; thus, improving the chatbot's reliability and credibility.

The following is a complete Prolog code for one disease in the knowledge base that details how the symptoms and supplementary information are inputted:

```
hypothesis('chicken pox') :-
    symptom('fluid-filled blisters'),
    symptom('rash'),
    (symptom('fever');
    symptom('fatigue');
    symptom('loss of appetite');
    symptom('headache');
    symptom('itching')),
    nl,
    nl,
    write('Description:'),
    nl,
    write('Chickenpox is a highly contagious disease
caused by the varicella-zoster virus (VZV). It can cause an
itchy, blister-like rash among other symptoms.'),
    nl,
    write('To confirm this diagnosis, the following test
is recommended:'),
    nl,
    write('Use of polymerase chain reaction (PCR) to detect VZV
in skin lesions'),
    nl,
    nl,
    write('Suggested Treatment:'),
    nl,
    write('1: Calamine lotion'),
    nl,
    write('For Future Prevention:'),
    nl,
    write('Chickenpox Vaccine (Two doses)'),
    nl, !.
```

Figure 1.2.4 Full Prolog Code for Chickenpox

Process of Finalizing the Chatbot

Initially, the symptoms were not differentiated into major vs minor symptoms. As such, associating the symptoms to each disease was simple – the symptoms were just conjunctively joined together as seen below.

```
hypothesis('chicken pox') :-  
    symptom('rash'),  
    symptom('fluid-filled blisters'),  
    symptom('fever'),  
    symptom('tiredness'),  
    symptom('loss of appetite'),  
    symptom('headache'),  
    nl,  
    ...
```

Figure 1.3.1 1st Version of the Prolog Code for Chickenpox

The symptoms were simply ordered based on how they appeared in the researched information on the disease. To improve this, the symptoms that appeared in the most number of diseases were prioritized. The symptoms that were given the most priority were ‘fever’ (appeared in 8/10 diseases), ‘abdominal pain’ (appeared in 4/10 diseases), ‘headache’ (appeared in 3/10 diseases). The symptoms associated with each disease were then ordered based on the number of diseases they appeared in, as seen in *Figure 1.3.2*.

```
hypothesis('chicken pox') :-  
    symptom('fever'),  
    symptom('headache'),  
    symptom('rash'),  
    symptom('fluid-filled blisters'),  
    symptom('tiredness'),  
    symptom('loss of appetite'),  
    nl,  
    ...
```

Figure 1.3.2 2nd Version of the Prolog Code for Chickenpox

However, this version of the code still rarely diagnoses diseases as it would require all symptoms to be present in order to diagnose a certain disease – which is not always the case since a person may have a certain disease without exhibiting all the symptoms associated with that disease. The chatbot was improved in order to take this into account. With this, each symptom was classified either as a major or minor symptom, with minor symptoms given priority as they appeared more often among diseases.

```
hypothesis('chicken pox') :-
```

```

        (symptom('fever');
        symptom('tiredness');
        symptom('loss of appetite');
        symptom('headache')),
        symptom('fluid-filled blisters'),
        symptom('rash'),
        nl,
    ...

```

Figure 1.3.3 3rd Version of the Prolog Code for Chickenpox

After testing, this version of the code turns out to be inefficient. If all minor symptoms and major symptoms for a certain disease are true, the chatbot would have to go through all the minor symptoms before exiting the hypothesis. Compared to if the major symptoms are placed ahead if the first major symptom fails, the program exits the hypothesis already. As such, the code was further modified so that the major symptoms are placed ahead of the minor symptoms since the former has a bigger bearing.

```

hypothesis('chicken pox') :-
    symptom('fluid-filled blisters'),
    symptom('rash'),
    (symptom('fever');
    symptom('tiredness');
    symptom('loss of appetite');
    symptom('headache')),
    nl,
...

```

Figure 1.3.4 Semi-Final Version of the Prolog Code for Chickenpox

The bot was then further improved by renaming the symptoms as some of them were associated with many diseases but were just under different similar names. For example, ‘tiredness’ was changed to ‘fatigue.’ This change can be seen in the final version of the Prolog code for chicken pox as seen in *Figure 1.2.4*.

Furthermore, the diseases were arranged such that the diseases with the most overlap with other diseases – the diseases whose symptoms are most common – are given higher priority. This is because if some symptoms in the first diseases are already true, they no longer have to be asked when checking the other diseases. As such, prioritizing diseases with the most common symptoms will lessen the total number of questions to be asked on average.

Overall, the easiest part to finalize in the knowledge base was associating symptoms to their respective diseases as this was a simple translation from real-world information to code. The

more difficult part to finalize was the order in which the symptoms and diseases appeared. In addition, the conceptualization of the need to classify between major and minor symptoms was also difficult to finalize.

At some point, the idea of putting numerical weights on each symptom was discussed but was difficult to implement. As such, it was settled that differentiating between major and minor symptoms was enough to make the chatbot intelligent in terms of efficiency and accuracy. It's efficient in that it lessens the number of questions needed to be asked and it's accurate in that it will rarely misdiagnose as it would prefer not to diagnose a disease than to diagnose incorrectly. This is further discussed in Section III.

III. Results and Analysis

The program can correctly identify each disease listed in the appendix if the user exhibits all the major symptoms and at least one of the minor symptoms of a certain disease. If the program cannot identify the user's disease based on the knowledge base, it will prompt the user that it is unable to find a diagnosis.

There are instances in which the program can identify a disease quickly. This occurs when the user's symptoms match all the major symptoms and at least one of the minor symptoms as seen in Figure 2.1.

---BASIC INFORMATION---

Please input the following basic information for recording purposes.

Kindly enclose the answer in quotations ("")

Name: "DAPHNE GO".

Age: 19.

---INTERVIEW QUESTIONS---

Please answer the following questions as part of the interview process to ascertain the disease.

Kindly type "yes" or "y" (without the quotations) for yes and "no" or "n" (without the quotations) for no

Is the patient suffering from fever? yes.

Is the patient suffering from bleeding from nose or gums? yes.

Is the patient suffering from nausea? yes.

---DISEASE INFORMATION---

Description:

Dengue viruses are spread to people through the bite of an infected Aedes species (Ae.aegypti or Ae. albopictus) mosquito. These mosquitoes also spread Zika, chikungunya, and other viruses. Dengue viruses are spread to people through the bite of an

infected Aedes species (Ae. aegypti or Ae albopictus) mosquito. These mosquitoes also spread Zika, chikungunya, and other viruses.

Symptoms:

- 1: Fever
- 2: Nausea or vomiting
- 3: Rash
- 4: Eye, muscle and bone pain
- 5: Belly pain
- 6: Bleeding from nose or gums

To confirm this diagnosis, the following test is recommended:
A blood test is the only way to confirm the diagnosis.

Suggested Treatment:

- 1: Rest as much as possible
- 2: Give paracetamol to control fever and relieve pain. Always follow product label instructions. Do not give ibuprofen, aspirin, or aspirin-containing drugs.
- 3: Cool the person's skin with cold cloth to reduce fever.
- 4: Prevent dehydration " Dehydration occurs when a person loses too much body fluid from fever, vomiting, or not drinking enough liquids.
- 5: Severe Case: Requires immediate hospitalization

For Future Prevention:

- 1: Remove standing water where mosquitoes could lay eggs
- 2: Kill mosquitoes outside your home

---DIAGNOSIS---

Name: DAPHNE GO

Age: 19

Based on the description and symptoms above, it is suggested that the patient is suffering from dengue fever

Do you want to perform another diagnosis? (yes or no)

no.

Thank you for using the diagnosis system.

true.

Figure 2.1 Impressive conversation where the disease is immediately identified

Even with a mix of yes and no answers to the program's queries, there are diseases that are still identifiable by the program after just a few questions. This is shown in Figure 2.2.

---BASIC INFORMATION---

Please input the following basic information for recording purposes.

Kindly enclose the answer in quotations ("")

Name: "KRIZCHELLE WONG".

Age: 19.

---INTERVIEW QUESTIONS---

Please answer the following questions as part of the interview process to ascertain the disease.

Kindly type "yes" or "y" (without the quotations) for yes and "no" or "n" (without the quotations) for no

Is the patient suffering from fever? y.

Is the patient suffering from bleeding from nose or gums? no.

Is the patient suffering from diarrhea? y.

Is the patient suffering from bloody stools? n.

Is the patient suffering from abdominal pain? y.

---DISEASE INFORMATION---

Description:

Acute gastroenteritis, known colloquially as a stomach bug, is an intestinal inflammation following an infection that affects the mucous membranes present in the stomach and intestine. This condition is due, in the vast majority of cases, to a virus or, more rarely, a bacterium.

Symptoms:

1: Fever

2: Fatigue

3: Nausea or Vomiting

4: Diarrhea

5: Abdominal pain

To confirm this diagnosis, the following test is recommended:

In case of an episode lasting beyond one week or where symptoms are poorly tolerated, a doctor will order a blood and stool exam so as to search for a possible bacterial infection.

Suggested Treatment:

1: Recommended Bed Rest

2: No medication needed

3: Anti-diarrheal or Emetic Drugs (for severe cases)

For Future Prevention

1: Practice simple things like washing your hands routinely with soap and water, after using the toilet, or after contact with an infected person

2: Wash fruits and vegetables before eating them.

---DIAGNOSIS---

Name: KRIZCHELLE WONG

Age: 19

Based on the description and symptoms above, it is suggested that the patient is suffering from acute gastroenteritis

```
Do you want to perform another diagnosis? (yes or no)
n.
Thank you for using the diagnosis system.
true.
```

Figure 2.2 Impressive conversation where the disease is immediately identified even with a mix of yes and no answers

Though sometimes the program has to ask several questions before eventually identifying the disease. In Figure 2.3, the program asks twenty-one questions before finally diagnosing the user. This is manageable for a small knowledge base of ten diseases, but if the knowledge base contained hundreds or thousands of diseases, determining a disease may take an unreasonable amount of time.

```
---BASIC INFORMATION---

Please input the following basic information for recording
purposes.
Kindly enclose the answer in quotations (")

Name: "KYLIE CARLA".
Age: 45.

---INTERVIEW QUESTIONS---

Please answer the following questions as part of the interview
process to ascertain the disease.
Kindly type "yes" or "y" (without the quotations) for yes and
"no" or "n" (without the quotations) for no

Is the patient suffering from fever? y.
Is the patient suffering from bleeding from nose or gums? n.
Is the patient suffering from diarrhea? n.
Is the patient suffering from abdominal pain? y.
Is the patient suffering from pain and swelling of the genitalia
(breast, vagina or scrotum)? y.
Is the patient suffering from pain and swelling of the legs and
arms? n.
Is the patient suffering from fluid-filled blisters? y.
Is the patient suffering from rash? n.
Is the patient suffering from burning sensation or heartburn? y.
Is the patient suffering from backwash of sour liquid? n.
Is the patient suffering from chest pain? y.
Is the patient suffering from coughing up of blood? n.
Is the patient suffering from anxiety, confusion and agitation? y.
Is the patient suffering from delirium and hallucinations? n.
Is the patient suffering from sudden, involuntary muscle spasms -
often in the stomach?
y.
Is the patient suffering from painful muscle stiffness all over
```

the body? y.
 Is the patient suffering from trouble swallowing? y.
 Is the patient suffering from seizures (jerking or staring)? n.
 Is the patient suffering from trouble breathing? y.
 Is the patient suffering from wheezing? y.
 Is the patient suffering from coughing? y.

---DISEASE INFORMATION---

Description:
 Asthma is a disease that affects your lungs. It is one of the most common long-term diseases of children, but adults can have asthma, too. The asthma attack happens in your body's airways, which are the paths that carry air to your lungs. As the air moves through your lungs, the airways become smaller, like the branches of a tree are smaller than the tree trunk. Less air gets in and out of your lungs, and mucous that your body makes clogs up the airways.. If you have asthma, you have it all the time, but you will have asthma attacks only when something bothers your lungs.

Symptoms:
 1: Coughing
 2: Chest tightness
 3: Wheezing
 4: Trouble breathing

To confirm this diagnosis, the following test is recommended:
 Spirometry: A breathing test to find out how well your lungs are working by testing how much air you can breathe out after taking a very deep breath before and after you use asthma medicine.

Suggested Treatment:
 1: Quick Relief Medicines can help control the symptoms of an asthma attack.
 1.1: Asthma Inhalers are one form of quick-relief medicines and should be prescribed by your doctor
 2: Long-term Control Medicines help you have fewer and milder attacks, but they don't help you while you are having an asthma attack.

For Future Prevention
 1: Asthma as a disease itself cannot be prevented but one can avoid common triggers to lessen asthma attacks

---DIAGNOSIS---

Name: KYLIE CARLA
 Age: 45
 Based on the description and symptoms above, it is suggested that the patient is suffering from asthma

Figure 2.3 Poor conversation where the program asked many questions to determine a disease

However if the user's symptoms do not meet all the major symptoms necessary to diagnose the user for a certain disease, then it will not be diagnosed, as seen in Figure 2.4. This is to avoid misdiagnosis; however, it is still a major limitation as the user may still have a disease despite not meeting all the major symptoms. Thus, an appointment with an expert physician may still be necessary despite the program being unable to give a diagnosis.

As shown in Figure 2.4, the two symptoms may be enough to infer that the disease is asthma. However, the program tends to be more cautious, in that it requires all major symptoms and at least 1 minor symptom to be present to account for accuracy.

```
---BASIC INFORMATION---

Please input the following basic information for recording
purposes.
Kindly enclose the answer in quotations (")

Name: "JUAN DELA CRUZ".
Age: 20.

---INTERVIEW QUESTIONS---

Please answer the following questions as part of the interview
process to ascertain the disease.
Kindly type "yes" or "y" (without the quotations) for yes and
"no" or "n" (without the quotations) for no

Is the patient suffering from fever? n.
Is the patient suffering from diarrhea? n.
Is the patient suffering from abdominal pain? n.
Is the patient suffering from pain and swelling of the genitalia
(breast, vagina or scrotum)? n.
Is the patient suffering from fluid-filled blisters? n.
Is the patient suffering from burning sensation or heartburn? n.
Is the patient suffering from chest pain? n.
Is the patient suffering from anxiety, confusion and agitation? n.
Is the patient suffering from sudden, involuntary muscle spasms -
often in the stomach? n.
Is the patient suffering from trouble breathing? y.
Is the patient suffering from wheezing? y.
Is the patient suffering from coughing? n.
Is the patient suffering from chest tightness? n.

Sorry, the system is unable to identify the disease

Do you want to perform another diagnosis? (yes or no)
no.
Thank you for using the diagnosis system.
true.
```

Figure 2.4 Poor conversation where the disease is not identified due to lack of minor symptoms

The range of diseases it can detect is also limited. Even if the user exhibits several major and minor symptoms across different diseases, if they do not exhibit **all** the major symptoms for any one disease, then they will not be diagnosed since the program will decide that the information is insufficient.

---BASIC INFORMATION---

Please input the following basic information for recording purposes.

Kindly enclose the answer in quotations ("")

Name: "RENATO JUNIOR SR.".

Age: 82.

---INTERVIEW QUESTIONS---

Please answer the following questions as part of the interview process to ascertain the disease.

Kindly type "yes" or "y" (without the quotations) for yes and "no" or "n" (without the quotations) for no

Is the patient suffering from fever? y.

Is the patient suffering from bleeding from nose or gums? n.

Is the patient suffering from diarrhea? n.

Is the patient suffering from abdominal pain? y.

Is the patient suffering from pain and swelling of the genitalia (breast, vagina or scrotum)? y.

Is the patient suffering from pain and swelling of the legs and arms? n.

Is the patient suffering from fluid-filled blisters? y.

Is the patient suffering from rash? n.

Is the patient suffering from burning sensation or heartburn? y.

Is the patient suffering from backwash of sour liquid? n.

Is the patient suffering from chest pain? y.

Is the patient suffering from coughing up of blood? n.

Is the patient suffering from anxiety, confusion and agitation? y.

Is the patient suffering from delirium and hallucinations? n.

Is the patient suffering from sudden, involuntary muscle spasms - often in the stomach?

y.

Is the patient suffering from painful muscle stiffness all over the body? y.

Is the patient suffering from trouble swallowing? y.

Is the patient suffering from seizures (jerking or staring)? n.

Is the patient suffering from trouble breathing? y.

Is the patient suffering from wheezing? n.

Sorry, the system is unable to identify the disease

Do you want to perform another diagnosis? (yes or no)

no.

```
Thank you for using the diagnosis system.  
true.
```

Figure 2.5 Poor conversation where the disease is not identified due to lack of major symptoms

Additionally, because of the knowledge base's structure and the program's underlying logic, some symptoms may be missed during a diagnosis process. Even if the user exhibits minor symptoms found in the knowledge base, the program may never ask about it. This is because the program only asks about minor symptoms **if all major symptoms** for that disease are exhibited.

For example, the Dengue Fever disease has two major symptoms, “fever” and “bleeding from nose or gums,” and several minor symptoms as seen in Figure 2.6. If the user is suffering from a fever, nausea, vomiting, rashes, and abdominal pains but they are *not* suffering from a bleeding nose or gums, the program will never ask the user about the minor symptoms.

```
% Disease 1: Dengue Fever  
hypothesis('dengue fever') :-  
    symptom('fever'),  
    symptom('bleeding from nose or gums'),  
    (symptom('nausea');  
    symptom('vomiting');  
    symptom('rash');  
    symptom('eye, muscle and bone pain');  
    symptom('abdominal pain')),  
  
% Program Run  
---BASIC INFORMATION---  
  
Please input the following basic information for recording  
purposes.  
Kindly enclose the answer in quotations ("")  
  
Name: Enrique.  
Age: 20.  
  
---INTERVIEW QUESTIONS---  
  
Please answer the following questions as part of the interview  
process to ascertain the disease.  
Kindly type "yes" or "y" (without the quotations) for yes and  
"no" or "n" (without the quotations) for no  
  
Is the patient suffering from fever? y.  
Is the patient suffering from bleeding from nose or gums? n.  
Is the patient suffering from diarrhea? n.  
Is the patient suffering from abdominal pain? n.  
Is the patient suffering from pain and swelling of the genitalia  
(breast, vagina or scrotum)? n.  
Is the patient suffering from fluid-filled blisters? n.
```



```
Is the patient suffering from burning sensation or heartburn? n.
Is the patient suffering from chest pain? n.
Is the patient suffering from anxiety, confusion and agitation? n.
Is the patient suffering from sudden, involuntary muscle spasms -
often in the stomach? n.
Is the patient suffering from trouble breathing? n.

Sorry, the system is unable to identify the disease

Do you want to perform another diagnosis? (yes or no)
n.
Thank you for using the diagnosis system.
```

Figure 2.6 *Poor conversation where the program overlooks minor symptoms due to the lack of sufficient major symptoms*

Figure 2.6 shows that the program will overlook all the minor symptoms of a particular disease if the user doesn't exhibit all the major symptoms already. The program will not diagnose the user even though it is likely they have dengue fever.

Nonetheless, it is important to note that refusing to provide a diagnosis due to uncertainty is still better than misdiagnosis in the medical industry. The restrictions of the program are imposed to avoid misdiagnosing a patient, to avoid inducing potentially unnecessary panic or confusion, or to avoid poor treatments. Given there are also no weights imposed on the symptoms in the program, it cannot determine the likelihood the user has a certain disease, and it is only able to identify if they do or do not have it.

IV. Recommendations

After developing the program and running several tests, the group has devised the following recommendations that would enhance the program's performance.

First, diseases can be diagnosed in less rigid ways by improving how symptoms are represented. Instead of conjunctions and disjunctions denoting major and minor symptoms, each symptom per disease can be assigned a *weight*. A symptom's *weight* refers to how much its presence increases the likelihood of having a certain disease. The closer a symptom's weight is to 1, the more likely the user exhibiting that symptom is suffering from the predicted disease. Then for each disease, the sum of all the weights of the exhibited symptoms is calculated. If this sum exceeds a pre-defined threshold for any disease, then the program diagnoses the user with that disease.

Figure 3.1 showcases an example of this system for Filariasis. If the user exhibits symptoms with a combined weight of 0.35 or greater, then the bot diagnoses them with Filariasis. With this new implementation, symptoms that were occasionally overlooked by the program because they were considered *minor* symptoms can still contribute to a diagnosis. This implementation is based on the threshold model by Altkorn (2020).

```

% Define the weight of each symptom for Filariasis
weight('pain and swelling of the genitalia (breast,
vagina or scrotum)', 0.7).
weight('pain and swelling of the legs and arms', 0.5).
weight('fever', 0.4).
weight('coughing', 0.3).
weight('shortness of breath', 0.6).
weight('wheezing', 0.5).

% Define the threshold for diagnosis
threshold(0.35).

```

Figure 3.1 Example of improved symptom weight system.

Second, the program should be capable of diagnosing diseases with more overlapping symptoms or diseases that are more specific versions of overarching diseases. Because of the program's current implementation, only diseases that do not share major symptoms can be diagnosed. Every disease in the knowledge base has a distinct set of major symptoms to avoid misdiagnosis. But in reality, many diseases share several symptoms with only a few niche conditions that set them apart. Influenza and pneumonia share most of the same symptoms and are often only distinguished by a dry or mucolytic cough. The weight symptom explained above could facilitate this as well. Having the two diseases share the same symptoms but with different weights and thresholds could distinguish the two enough for the chatbot to accurately diagnose the user.

Third, the program can make more accurate diagnoses by storing more information about the patient in the knowledge base. At the moment, the program only asks about and stores the user's present symptoms. But chronic medical conditions and past diseases can also influence a patient's current predicament. Thus, the program can ask about the user's medical history and store the information in the knowledge base. Past diseases and medical conditions can be included as factors and can be given weights for a disease similar to current symptoms are implemented. This improvement would lead to enhanced diagnosis accuracy because more pertinent data is being used.

V. References

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VI. Contributions of Each Member

Go, Daphne Janelyn L.	Research Coding and Testing of the Program Paper – Introduction Paper – Knowledge Base and Chatbot Paper – Recommendations Paper – References Paper – Appendix
Lejano, Enrique Rafael A.	Paper – Results and Analysis Paper – Recommendations Paper - Revising and Proofreading
Manlises, Maria Monica	Coding and Testing of the Program Paper – Knowledge Base and Chatbot Paper – References Paper – Recommendations
Wong, Krizchelle Danielle A.	Paper – Results and Analysis Paper – References

VII. Appendix

Data Gathering

All information on the diseases is quoted from the Center for Disease Control and Prevention (CDC) and National Library of Medicine database. There are little to no changes in the quoted text with the objective of keeping the accuracy of the descriptions.

1. Filariasis

- a. **Description:** Lymphatic filariasis is a parasitic disease brought on by tiny, thread-like worms that is classified as a neglected tropical disease (NTD) worldwide. Adult worms can only survive in the lymphatic system of humans. The lymph system prevents infections and keeps the body's fluid equilibrium. Mosquitoes transmit lymphatic filariasis from one person to another.
- b. **Symptoms:**
 - i. **Pain and swelling of the breast, vagina, scrotum, legs and arms:** Fluid collection because of improper functioning of the lymph system
 - ii. **Fever, Cough, shortness of breath, and wheezing:** Filarial infection can also cause tropical pulmonary eosinophilia syndrome, although this syndrome is typically found in persons living with the disease in Asia. Eosinophilia is the presence of higher than normal disease-fighting white blood cells in the body.
- c. **Diagnosis:**
 - i. **Microscopic Examination:** Identification of microfilariae in a blood smear
- d. **Treatment:**

- i. **DEC (Diethylcarbamazine Citrate) and Albendazole-** Selective treatment with DEC (Diethylcarbamazine Citrate) is given to people with clinical manifestations of the disease. Mass treatment of the people living in established endemic areas. Medicines (DEC and albendazole) are given once a year for 5 years.
- e. **Prevention:**
 - i. Wear a long sleeve shirt and long pants when working in farms or areas endemic to filariasis.
 - ii. Sleep under a mosquito net.

Quoted from *CDC - Lymphatic Filariasis - Treatment. (2019). Center of Disease Control and Prevention. <https://www.cdc.gov/parasites/lymphaticfilariasis/treatment.html>*

2. Chicken Pox

a. Description:

- i. Chickenpox is a highly contagious disease caused by the varicella-zoster virus (VZV). Among other symptoms, HPV can also create an itchy, blister-like rash. The chest, back, and face are where the rash first develops before spreading over the entire body. Chickenpox can be dangerous, especially for pregnant women, children, teenagers, adults, and those with compromised immune systems (lowered ability to fight germs and sickness).

b. Symptoms:

- i. **Rashes and Fluid-filled blisters:** Rash turns into itchy, fluid-filled blisters that eventually turn into scabs. The rash may first show up on the chest, back, and face, and then spread over the entire body, including inside the mouth, eyelids, or genital area.
- ii. Fever
- iii. Tiredness
- iv. Loss of appetite
- v. Headache
- vi. *Symptoms from B to E appear 1 to 2 days before rashes appear.*

c. Diagnosis:

- i. Use of **polymerase chain reaction (PCR)** to detect VZV in skin lesions (vesicles, scabs, maculopapular lesions). **Vesicular lesions or scabs**, if present, are the best for sampling.

d. Treatment:

- i. Calamine lotion and a cool bath with added baking soda, uncooked oatmeal, or colloidal oatmeal may help relieve some of the itching.
- ii. Use non-aspirin medications, such as acetaminophen, to relieve fever from chickenpox.
- iii. Antiviral medications are recommended for people with chickenpox that are more likely to develop serious illness, including:
 - 1. Otherwise healthy people older than 12 years of age
 - 2. People with chronic skin or lung disease

3. People receiving long-term salicylate therapy or steroid therapy
4. People who are pregnant
5. People with a weakened immune system

e. Prevention

- i. **Chickenpox Vaccine (Two doses):** If a vaccinated person does get chickenpox, the symptoms are usually milder with fewer or no blisters (they may have just red spots) and low or no fever.

Quoted From CDC. (2019). Chickenpox. Center of Disease Control and Prevention. <https://www.cdc.gov/chickenpox/hcp/index.html>

3. Dengue Fever

a. Description:

- i. With the bite of an infected Aedes species mosquito (Ae. aegypti or Ae. albopictus), dengue viruses are transmitted to people. These mosquitoes can transmit other viruses including Zika and chikungunya. With the bite of an infected Aedes species mosquito (Ae. aegypti or Ae. albopictus), dengue viruses are transmitted to people. These mosquitoes can transmit other viruses including Zika and chikungunya.
- ii. One in every four dengue infections results in illness. Within a few hours, severe dengue can be fatal, necessitating frequent hospital care.

b. Symptoms:

- i. **Mild Case**
 1. Fever
 2. Nausea, vomiting
 3. Rash
 4. Aches and pains (eye pain, typically behind the eyes, muscle, joint, or bone pain)
 5. Symptoms of dengue typically last 2–7 days. Most people will recover after about a week.
- ii. **Severe Case**
 1. Belly pain, tenderness
 2. Vomiting (at least 3 times in 24 hours)
 3. Bleeding from the nose or gums
 4. Vomiting blood, or blood in the stool
 5. Feeling tired, restless, or irritable

c. Diagnosis

- i. A **blood test** is the only way to confirm the diagnosis.

d. Treatment

- i. **Mild Case**
 1. Rest as much as possible
 2. Control fever

3. Give paracetamol to control fever and relieve pain. Always follow product label instructions. Do not give ibuprofen, aspirin, or aspirin-containing drugs.
 4. Cool the person's skin with cold cloth to reduce fever.
 5. Prevent dehydration – Dehydration occurs when a person loses too much body fluid from fever, vomiting, or not drinking enough liquids.
- ii. **Severe Case**
 1. Requires immediate hospitalization
- e. **Prevention**
- i. **Remove standing water where mosquitoes could lay eggs**
 1. Once a week, empty and scrub, turn over, cover, or throw out any items that hold water. Mosquitoes lay eggs near water.
 2. Tightly cover water storage containers so that mosquitoes cannot get inside to lay eggs.
 - ii. **Kill mosquitoes outside your home**
 1. Use an outdoor insect spray made to kill mosquitoes in areas where they rest.

Quoted from *Dengue CDC*. (2019, August 21). Center of Disease Control and Prevention. <https://www.cdc.gov/dengue/testing/index.html>

4. Amoebiasis

- a. **Description:** Amebiasis or amoebic dysentery is a common parasitic enteral infection. It is caused by any of the amoebas of the *Entamoeba* group. The parasite may enter the bloodstream and enter the liver, where it may spread throughout the body and result in amoebic liver abscesses. Abscesses in the liver can develop without any prior diarrhea. Stool samples are often examined under a microscope to make a diagnosis. It's possible that the WBC count has risen. Blood tests that look for certain antibodies are the most reliable.
- b. **Symptoms:**
 - i. loose feces (poop),
 - ii. stomach pain, and stomach cramping
 - iii. **bloody stools (poop)**
 - iv. fever
- c. **Diagnosis**
 1. **Examination of stools (poop) under a microscope** Because *E. histolytica* is not always found in every stool sample, you may be asked to submit several stool samples from several different days.
- d. **Treatment**
 - i. Metronidazole
 - ii. Tinidazole
 - iii. Nitazoxanide
 - iv. Dehydroemetine

- v. chloroquine

e. Prevention

- i. Practice good sanitation practices
- ii. Drink only safe to drink water

Quoted from Amebiasis CDC. (2021, December 29). Center of Disease Control and Prevention. <https://www.cdc.gov/parasites/amebiasis/general-info>.

5. Gastroesophageal reflux disease (GERD)

- a. **Description: Gastroesophageal reflux disease (GERD)** occurs when stomach acid repeatedly flows back into the tube connecting your mouth and stomach (esophagus). Your esophageal lining may become irritated by this backwash (acid reflux).

b. Symptoms:

- i. **A burning sensation in your chest (heartburn)** (usually after eating, which might be worse at night or while lying down)
- ii. **Backwash (regurgitation)** of food or sour liquid
- iii. Upper abdominal or chest pain
- iv. Trouble swallowing (dysphagia)
- v. Sensation of a lump in your throat

c. Diagnosis

- i. **Upper endoscopy:** Your doctor inserts a thin, flexible tube equipped with a light and camera (endoscope) down your throat. The endoscope helps your provider see inside your esophagus and stomach.
- ii. **Ambulatory acid (pH) probe test:** A monitor is placed in your esophagus to identify when, and for how long, stomach acid regurgitates there.
- iii. **X-ray of the upper digestive system:** X-rays are taken after you drink a chalky liquid that coats and fills the inside lining of your digestive tract. The coating allows your doctor to see a silhouette of your esophagus and stomach
- iv. **Esophageal manometry:** This test measures the rhythmic muscle contractions in your esophagus when you swallow
- v. **Transnasal esophagoscopy:** A thin, flexible tube with a video camera is put through your nose and moved down your throat into the esophagus.

d. Treatment

- i. **Antacids that neutralize stomach acid:** Antacids containing calcium carbonate, may provide quick relief.
- ii. **Medications to reduce acid production:** Histamine (H-2) blockers don't act as quickly as antacids, but they provide longer relief and may decrease acid production from the stomach for up to 12 hours.
- iii. **Medications that block acid production and heal the esophagus:** Proton pump inhibitors are stronger acid blockers than H-2 blockers and allow time for damaged esophageal tissue to heal. Nonprescription proton pump inhibitors include lansoprazole (Prevacid 24 HR), omeprazole (Prilosec OTC) and esomeprazole (Nexium 24 HR).

e. **Prevention**

- i. **Maintain a healthy weight.** Excess pounds put pressure on your abdomen, pushing up your stomach and causing acid to reflux into your esophagus.
- ii. **Stop smoking.** Smoking decreases the lower esophageal sphincter's ability to function properly.

Quoted From Gastroesophageal reflux disease (GERD) - Mayo Clinic. (2020). <https://www.mayoclinic.org/diseases-conditions/gerd/diagnosis-treatment/>

6. **Tuberculosis**

a. **Description**

Tuberculosis (TB) is brought on by microbes that travel from person to person through the air. Although TB often affects the lungs, it can also harm other organs like the brain, kidneys, or spine. If a person with TB does not receive treatment, they risk dying from the disease.

b. **Symptoms**

- i. Coughing
- ii. Chest pain
- iii. Coughing up of blood
- iv. Fever
- v. Night sweats

c. **Diagnosis**

- i. A positive TB skin test or TB blood test only tells that a person has been infected with TB bacteria. It does not tell whether the person has latent TB infection (LTBI) or has progressed to TB disease.
- ii. Other tests, such as a chest x-ray and a sample of sputum, are needed to see whether the person has TB disease.

d. **Treatment**

- i. Isoniazid.
- ii. Rifampin (Rifadin, Rimactane)
- iii. Ethambutol (Myambutol)
- iv. Pyrazinamide.

e. **Prevention**

- i. **Good ventilation:** as TB can remain suspended in the air for several hours with no ventilation.
- ii. **Natural light:** UV light kills off TB bacteria.
- iii. **Good hygiene:** covering the mouth and nose when coughing or sneezing reduces the spread of TB bacteria.

Quoted from CDC. (2019). Tuberculosis (TB). Centers for Disease Control and Prevention. <https://www.cdc.gov/tb/default.htm>

7. Rabies

- a. **Description:** Rabies is a preventable viral disease most often transmitted through the bite of a rabid animal. The rabies virus attacks mammals' central nervous systems, which leads to brain illness and eventual death.

- b. **Symptoms**

- i. Flu, including weakness or discomfort, fever, or headache
- ii. Prickling, or Itching sensation at the site of the bite.
- iii. Cerebral dysfunction, Anxiety, Confusion, and Agitation
- iv. Delirium, Abnormal behavior, Hallucinations
- v. Hydrophobia (fear of water), and Insomnia

Acute period of disease typically ends after 2 to 10 days. After which, the disease is nearly always fatal.

- c. **Diagnosis**

- i. Samples of saliva, serum, spinal fluid, and skin biopsies of hair follicles at the nape of the neck may be obtained.
- ii. Saliva from the nape of the neck can be tested by virus isolation or reverse transcription followed by polymerase chain reaction (RT-PCR).
- iii. Serum and spinal fluid are tested for antibodies to rabies virus.
- iv. Skin biopsy specimens are examined for rabies antigen in the cutaneous nerves at the base of hair follicles.

- d. **Treatment**

There is currently no effective treatment for this.

- e. **Prevention**

- i. **Keeping your pets up to date on their rabies vaccination** will prevent them from acquiring the disease from wildlife, and thereby prevent possible transmission to your family or other people.
- ii. If you do come into contact with a rabid animal, rabies in humans is 100% preventable through prompt **rabies vaccination**.

Quoted from CDC. (2019). What is Rabies? Center for Disease Control and prevention. <https://www.cdc.gov/rabies/about.html>

8. Tetanus

- a. **Description:** Tetanus is an infection caused by bacteria called *Clostridium tetani*. These bacteria release a toxin that causes painful muscular contractions when they enter the body. Tetanus is also referred to as "lockjaw." It frequently results in the neck and jaw muscles locking, which makes it challenging to open the mouth or swallow.

- b. **Symptoms:**

- i. Jaw cramping
- ii. Sudden, involuntary muscle spasms — often in the stomach
- iii. Painful muscle stiffness all over the body
- iv. Trouble swallowing
- v. Seizures (jerking or staring)
- vi. Headache
- vii. Fever and sweating

viii. Changes in blood pressure and heart rate

c. Diagnosis

- i. Asking about recent history of cuts, scrapes, punctures, and trauma, and examining someone for certain signs and symptoms
- ii. No hospital lab tests that can confirm tetanus

d. Treatment

- i. Evaluation and care in the hospital
- ii. Immediate treatment with medicine called human tetanus immune globulin (TIG)
- iii. Aggressive wound care
- iv. Drugs to control muscle spasms
- v. Antibiotics
- vi. Tetanus vaccination

e. Prevention

- i. Tetanus Vaccination
- ii. Good wound care:
 1. Apply first aid to even minor, non-infected wounds like blisters, scrapes, or any break in the skin.
 2. Wash hands often with soap and water or use an alcohol-based hand rub if washing is not possible.

Quoted from Tetanus. (2019). Center for Disease Control and Prevention.
<https://www.cdc.gov/tetanus/about/symptoms-complications.html>

9. Asthma

a. Description:

- i. **Asthma is a disease that affects your lungs.** It is one of the most common long-term diseases of children, but adults can have asthma, too. Your body's airways, which are the channels that convey air to your lungs, are where an asthma attack takes place. The airways in your lungs narrow as air passes through them, just as the branches of a tree are narrower than the trunk. Your lungs receive less air, and the mucus your body produces clogs up the airways. If you have asthma, it's something you have constantly, yet attacks only happen when your lungs are bothered.

b. Symptoms:

- i. Coughing
- ii. Chest tightness
- iii. Wheezing
- iv. Trouble breathing.

c. Diagnosis

Breathing test, called **spirometry**, to find out how well your lungs are working by testing how much air you can breathe out after taking a very deep breath before and after you use asthma medicine.

d. Treatment

- i. Use your **asthma inhaler** in case of an asthma attack

- ii. Asthma medicines come in two types—**quick-relief and long-term control**. **Quick-relief** medicines **control the symptoms of an asthma attack**. If you need to use your quick-relief medicines more and more, visit your doctor to see if you need a different medicine. **Long-term control medicines** help you have **fewer and milder attacks**, but they don't help you while you are having an asthma attack.

Quoted from CDC. (2019, October 18). Asthma. Center for Disease Control and Prevention. <https://www.cdc.gov/asthma/>

10. Acute Gastroenteritis

a. Description:

Acute gastroenteritis, known colloquially as a stomach bug, is an **intestinal inflammation** following an infection that affects the mucous membranes present in the stomach and intestine. In the vast majority of cases, a virus or, less frequently, a bacterial infection is the likely cause of the disease.

b. Symptoms

- i. Fever
- ii. Fatigue
- iii. Nausea or vomiting
- iv. **Diarrhea**
- v. **Abdominal pain**

c. Diagnosis

In case of an episode lasting beyond one week or where symptoms are poorly tolerated, a doctor will order a **blood and stool exam** so as to search for a possible bacterial infection.

d. Treatment

Treatment of gastroenteritis usually requires **rest and no medication**. When symptoms are very bothersome, treatments such as **anti-diarrheal or emetic drugs** may be prescribed.

e. Prevention

- i. Practice simple things like washing your hands routinely with soap and water, after using the toilet, or after contact with an infected person
- ii. Wash fruits and vegetables before eating them.

Quoted from Graves, N. S. (2013). Acute Gastroenteritis. Primary Care: Clinics in Office Practice, 40(3), 727–741. <https://doi.org/10.1016/j.pop.2013.05.006>