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Medical Expert ChatBot

Group 9

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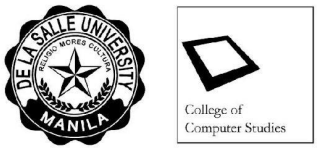

I. Introduction

The group designed and programmed an intelligent medical expert diagnostic system in the form of a chatbot. In order to achieve this result, a question-and-answer sequence consisting of simple yes-or-no questions was implemented to be used by this bot. This sequence of questions may be divided into two distinct sets, with the first set of questions inquiring about the classification of the disease potentially contracted by the patient (i.e., whether the disease in question falls under Infectious, Waterborne, or Respiratory), and the second set of questions asking about the symptoms of the diseases that the patient may have contracted (e.g., coughing, fever, confusion, chest pain, etc.), with the list of said symptoms already stored in the program's database.

The bot designed by the group requires a certain expertise in both technical and non-technical skills. This may include the act of obtaining medical information through proper research and its subsequent implementation when writing the program within PROLOG, a logic-based programming language that is fit for solving this very problem.

In light of this, the ten (10) diseases ultimately chosen for the program’s knowledge base were selected for their prevalence in poor or rural communities in the Philippines, increasing the practicality of using such a program. To be more specific, the diseases of Tuberculosis, Diarrhea, Dengue Fever, Malaria, Pneumonia, Cholera, Typhoid Fever, Hepatitis A, Measles, and Schistosomiasis were chosen among the many diseases to be incorporated into the knowledge base of this chatbot. The program aims to educate users by assisting them in recognizing a disease from its symptoms. Patients, health care providers, students, and many more people may be able to utilize the chatbot to accurately determine a disease and to be able to seek proper medical attention thereafter.

II. Knowledge Base and Chatbot

The group used a variety of reliable sources—including clinic websites found on the web—to search for ten (10) common diseases that were prevalent in poor or rural communities in the Philippines. Information on these diseases was then extracted from said sources, including their specific classification and potential symptoms. The three categories of Infectious, Waterborne, and Respiratory diseases were then used to classify the diseases to be implemented into the knowledge base. To prevent unnecessary data, the diseases' symptoms were examined carefully and organized. These procedures were necessary to efficiently and accurately implement the program into PROLOG.

Correctly translating each disease and its symptoms were one of the problems faced during the creation of this chatbot. As PROLOG was an initially unfamiliar language, there were multiple ways of translating the information into facts within the knowledge base. Ultimately, our group settled on the current system of listing each potential symptom for each disease, while also listing each possible disease for each classification.

Five functions were made to translate the information into facts for the knowledge base, two of which are for the questions the chatbot will ask. The three remaining functions are `has()`, `disease_requires()`, `classification()`. The `has()` function takes in two parameters, the former one being the symptom and the latter one being the status of the symptom (either true or false). Essentially, this acts as a boolean variable for each symptom's status so far. The `disease_requires()` function also takes in two parameters, the disease and the list of symptoms for that disease. This is specifically from where the chatbot gets the symptoms of each disease. Lastly, the `classification()` function—just like the `disease_requires()` function—takes in the classification of disease and the list of diseases associated with that very classification.

In the way the program was designed and created, it will first ask questions to determine the classification of the disease that the patient might have. Once it has found the classification, it would then ask the patient whether they have felt or experienced any symptoms from a list of symptoms. Notably, these symptoms would be taken from all the diseases listed under the classification previously determined. In the case that the program could not determine the disease the patient has, it would promptly indicate that their disease is not currently in the knowledge base and to instead consult a medical professional.

III. Results and Analysis

```
?- run.
Select the classification of the disease you think you might have:
Have you recently been exposed to someone with an infectious disease? (yes/no):no.
Have you recently drank or been in contact with contaminated water? (yes/no): |yes.
"Have you experienced or felt any of the following recently?"
fatigue (yes/no): |: yes.
nausea (yes/no): |: yes.
abdominal pain (yes/no): |: yes.
gray colored stool (yes/no): |: yes.
fever (yes/no): |: yes.
dark urine (yes/no): |: yes.
joint pain (yes/no): |: yes.
jaundice (yes/no): |: yes.
intense itching (yes/no): |: yes.
You have been diagnosed with: hepatitis_a.
```

In this example above, the program is asking regarding the symptoms of the first disease classified as Waterborne, namely, the disease Hepatitis A. It shows intelligence by instantly diagnosing the disease once all symptoms under Hepatitis A have been met.

```
?- run.
Select the classification of the disease you think you might have:
Have you recently been exposed to someone with an infectious disease? (yes/no):no.
Have you recently drank or been in contact with contaminated water? (yes/no): |yes.
"Have you experienced or felt any of the following recently?"
fatigue (yes/no): |: no.
nausea (yes/no): |: yes.
abdominal pain (yes/no): |: yes.
gray colored stool (yes/no): |: no.
fever (yes/no): |: yes.
dark urine (yes/no): |: no.
joint pain (yes/no): |: no.
jaundice (yes/no): |: no.
intense itching (yes/no): |: no.
abdominal cramps (yes/no): |: yes.
bloating (yes/no): |: yes.
vomiting (yes/no): |: yes.
bloody stool (yes/no): |: yes.
mucus in the stool (yes/no): |: yes.
urgent need to have a bowel movement (yes/no): |: yes.
dehydration (yes/no): |: yes.
rectal pain (yes/no): |: yes.
You have been diagnosed with: diarrhea.
```

In this example, the program is inquiring the user about the symptoms of Hepatitis A and Diarrhea as they are the first diseases listed as Waterborne diseases. Furthermore, one may observe that there are overlapping symptoms between the two diseases: nausea, abdominal pain, and fever. Despite this overlap, however, the program is designed and built to be smart enough not to repeat the same questions for said diseases twice over. Once again, the program is able to show intelligence by storing into its knowledge base the answers to the symptoms for previous diseases. This makes it able to avoid re-asking questions for overlapping symptoms when moving onto other potential diseases.

The problem with this chatbot's approach that the group has noticed is that it needs all symptoms under a disease to be met for it to diagnose that disease. With this approach, even if only one symptom from a disease is answered with a *"no"*, it would fail to diagnose that disease. Here is an example of such a case:

```
?- run.
Select the classification of the disease you think you might have:
Have you recently been exposed to someone with an infectious disease? (yes/no):no.
Have you recently drank or been in contact with contaminated water? (yes/no): |no.
Have you noticed differences in your breathing? (yes/no): |: yes.
Have you experienced or felt any of the following recently?

chest pains (yes/no): |: no.
confusion (yes/no): |: yes.
phlegm (yes/no): |: yes.
fatigue (yes/no): |: yes.
fever (yes/no): |: yes.
profuse sweating (yes/no): |: yes.
shaking chills (yes/no): |: yes.
lower than normal body temperature (yes/no): |: yes.
nausea (yes/no): |: yes.
vomiting (yes/no): |: yes.
shortness of breath (yes/no): |: yes.
fast breathing (yes/no): |: yes.
fast heartbeat (yes/no): |: yes.
body pain (yes/no): |: yes.
loss of appetite (yes/no): |: yes.
coughing blood (yes/no): |: yes.
coughing (yes/no): |: no.
unintended weight loss (yes/no): |: yes.
joint damage (yes/no): |: yes.
lung damage (yes/no): |: yes.
infection or damage of your bones, spinal cord, brain, or lymph nodes (yes/no):yes.
liver problems (yes/no): |: yes.
kidney problems (yes/no): |: yes.
inflammation of the tissues around heart (yes/no): |: yes.
poor reflexes (yes/no): |: yes.
We could not determine your disease. Please consult a doctor.
```

In this scenario, pneumonia and tuberculosis are the only diseases under the respiratory classification. Under the current implementation, the chatbot asks for all symptoms of diseases under a classification until either a diagnosis is found or all relevant symptoms have been asked. Due to this, it asks for all symptoms of pneumonia and tuberculosis before declaring that it could not determine the disease. In this case, the patient responded *"no"* to chest pains and coughing but *"yes"* to everything else. However, due to that singular *"no"* answer, the chatbot was unable to diagnose a disease, even if the patient most likely has contracted pneumonia.

To summarize, being able to diagnose diseases given exact symptoms accurately is the chatbot's core strength, however, it is also the bot's main weakness. Being too accurate, the program asks the patient an abundant number of questions instead of simply just asking the relevant ones that get the diagnosis faster.

IV. Recommendations

A few recommendations could be made in order to improve this chatbot on both the efficiency front and reliability front. The first recommendation is to use weights instead of checking whether all symptoms have been met. This could be used to help lessen the number of symptoms being asked. Certain symptoms could have higher weights for a particular disease, while diseases themselves have thresholds that—once met—would be diagnosed as the disease for that patient. The order of symptom asking could also be changed in a way that favors asking the symptoms of diseases that are currently near their threshold so that diseases could be diagnosed quicker, effectively improving efficiency by a large margin.

Another recommendation that could be made to make this chatbot better is to have better classifications within the knowledge base. Currently, there are only three broad classifications in the knowledge base (Infectious, Waterborne, and Respiratory). Due to this relatively low number of classifications, the number of symptoms that need to be identified is also relatively high. In light of this, if future iterations of this chatbot are able to incorporate more specific and detailed classifications, then it would be able to diagnose the patient faster and more accurately overall.

Last but not least, improving the user experience when using this program may be considered an avenue for potential improvement. Although usability is not part of the current project specifications, the program as it stands currently may be considered fairly difficult to use, due to the fact that those with low technological knowledge may find it hard to properly handle and run an executable file. Furthermore, as this program is targeted for use in poor and rural communities, the usability and accessibility aspect of such a program is a priority when placed into practice.

In this light, developing a simple graphical user interface (GUI) may prove to aid massively in this regard, as it greatly simplifies the learning curve in using the program. As such, making sure that the user experience is as easy and intuitive as it can be may prove to be a point of further improvement for future versions of this chatbot.

V. References

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VI. Contributions of Each Group Member

Name	Contributions
Aspecto, Don Laude Andres	Was assigned the task of researching the information needed in the database and assisting the implementation of the program to PROLOG.
Lim, Lanz Kendall Yong	Was assigned the task of creating the documentation and assisting in the evaluation of the bot's capabilities.
Martinez, Jose Raphael Espeleta	Was assigned the task of researching the information needed in the database and implementing the program onto PROLOG.
Tan, Tyler Justin Hernandez	Was assigned the task of creating the documentation and assisting in the evaluation of the bot's capabilities.