Team 10

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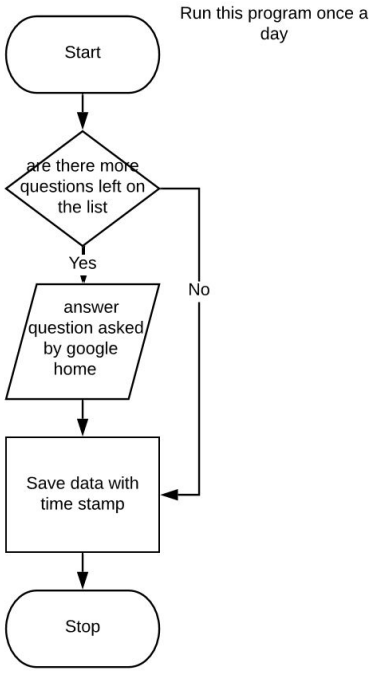
Prototype Design Brief

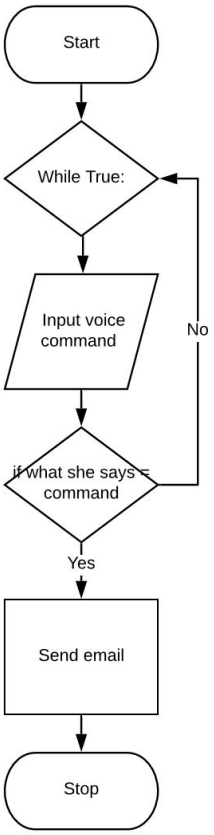
First Prototype

The initial prototype idea was to design a computer program to be paired with either a Google Home or an Amazon Alexa. This program would make use of the voice prompts behind either one of these devices and assist Ms. Liu to collect data regarding her condition in-between doctor visits. By solely using voice prompts and voice-recognition software, data would be collected without any physical interaction, specifically fine motor movements, that may harm Ms. Liu. Additionally, this program would specifically be designed in such a manner that a single daily reminder would inform Ms. Liu to input her daily data. Once Ms. Liu replies to the prompt of inputting her daily data, she would begin to answer a series of questions. These questions include, but are not limited to, asking Ms. Liu to rate her pain from 1 to 5, a location of the pain (only a series of specific words are recognized, such as hands, arms, knees, etc.), and what type of activities she participated in (again, only a series of specific words are recognized, such as walking, dancing, typing, etc.). Additionally, the questions can easily be reprogrammed to be more doctor specific. For example, a specific question regarding sodium consumption could be asked if that is what her doctors are currently investigating.

Collected data would then be saved with a specific time stamp, indicating the day and time at which Ms. Liu inputted data. Then, a day or so before her scheduled doctor appointment, Ms. Liu would order the Google Home to send an email to her group of doctors, containing a summary of her collected data, amongst a series of relevant graphs and other visualistic graphics. An example of a statement found within this email would be “In the first week of the past month, Ms. Liu reported an average pain level of 3.67 in her hands”.

To illustrate this in our first design review, we developed two flowcharts which showcase the structure of each major function in our program. These two flowcharts can be found to the right.





External Feedback

We received many pieces of helpful feedback from faculty members during our design review. First, the faculty mentors brought to light that the Google Home would be stationary and would only assess pain at home. It would not be able to monitor her activity during the day, which could decrease the functionality of the prototype. They recommended that the Google Assistant should ask how she felt during very specific points of the day, instead of looking at the day as a whole. They identified that we need to think about her activities and the timing with that in order to uncover a possibly cyclical occurrence.

In addition, the mentors suggested that we should figure out if Ms. Liu owns a Google Assistant or Amazon Alexa already, as we could code and design the actions around the previously owned device. This could be beneficial to her as she would already know how to work the device.

Another important topic that was discussed during the design review was pain. The mentors mentioned that pain is very hard to understand as it is subjective. They told our group important questions to ask Ms Liu in order to pinpoint the pain, such as where the pain specifically was on her body, what she was doing when she had the pain, how long the pain lasted for, and what made the pain go away. They also recommended that we assess specific symptoms individually.

Lastly, the faculty mentors questioned us on how we would transfer Ms. Liu's voice responses into data points, in order that the recorded statistics could be sent to doctors. They suggested voice recognition software in order for the best results. They also brought to light that it could be problematic if Ms. Liu does not give one of the voice recognized responses, and that we would need to code for exceptions in order to avoid that.

Overall Outcome from Design Review: Minor Revisions Recommended

Internal Feedback

Through building and discussing the initial prototype, we made the following analysis: a Google Home would be a better option than an Amazon Alexa, which was initially considered as well, because there were many more online tools to use for creating the program on a Google Home, and the Google Actions Console could also be used on smartphones. However, the Google Home system did not support email or direct memory, so a message would have to be sent from the Google Home using a messenger service, such as Twilio, and then received by a server, saved to a file, and then computed and outputted in a useful form. The original flow charts for the input of information from the user to the Google Home were all found to be possible, using the web-tools of Dialogflow and the Google Actions Console to create the code. Our idea for an app as output was discussed, and we decided that it would be the best way to display the output data. Overall, the first prototype solidified our idea, and showed that the idea met the needs of the patient in a very efficient and effective way.

Revisions

Through this feedback, we decided to modify our prototype in various ways to ensure that the device is easy for Ms. Liu to record her symptoms, and to ensure that the symptoms recorded are an accurate representation of her pain throughout the day. Additionally, we wanted to make it easier for the doctors to understand her data.

First, we originally were just asking Ms. Liu to rate her pain at the end of the day. However, by the end of the day, she may have forgotten how she felt in the morning and a whole day of information may be too much to input. Therefore, we decided to ask Ms. Lui to record her data once when she wakes up, and once before she goes to bed. As a result, we will be able to see how her pain changed throughout the day and ensure that she does not forget any details from the morning. Adding morning data in relation to the evening data could also allow her doctors to possibly detect a pattern regarding her changing symptoms through the day. For example, if her pain consistently decreases throughout the day, or if the pain in her fingers increases throughout the day but the pain in her hips decreases. A pattern like this would further help in her diagnosis and so recording her symptoms twice a day will be beneficial for Ms. Liu.

Secondly, we originally were asking about her general, overall pain, however we have now modified our end product to ask for her pain levels in regards to specific body parts. This will help the doctors understand where her pain is coming from and how severe this pain is in specific locations. We also decided to change the pain rating scale to a scale of one to five. This provides us with a more conventional rating that the doctors are familiar with. As a result of this, the doctors will have more insight into activities that cause pain in specific regions, and this will further help with identifying a pattern in regards to her symptoms.

Lastly, we also decided to add an app to our prototype, which will be used instead of the emails. An app will provide the end-users with an accessible space that can display all symptom data in one place. Here, the doctors could have access to the summarized data and the raw data, which would provide better insight into her condition. An app will also provide a platform where the device can send her notifications to remind her to log her symptoms. Additionally, the way the data is displayed could be modified easily, dependent on what the doctors find the most helpful, which allows for more flexibility that cannot be found by sending her emails. There were going to be weekly or daily updates sent via email depending on what she wants, however, with an app, a summary of the past week can be provided any day, and this will help her doctors get the most updated information at any of her appointments. Lastly, the app will also be beneficial if she is not at home when she wants to record her symptoms. The app will be able to input data the same way that the Google Home would, but instead of voice commands, it would be through typing her answers on a phone or computer.

Final Prototype Description

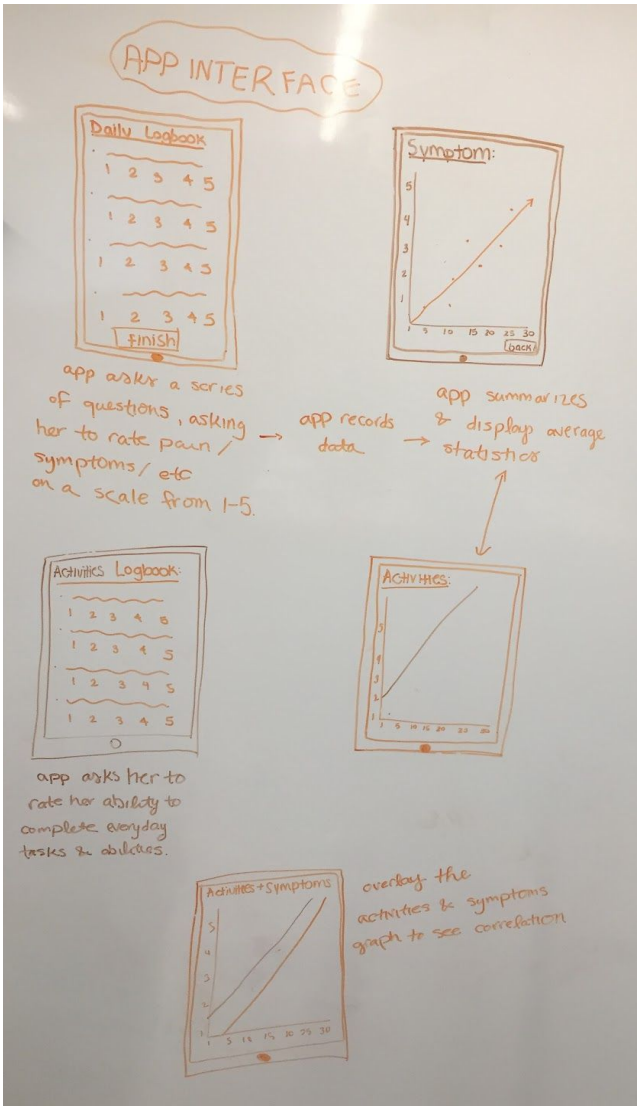
The final prototype would be made of two main components, the Google Home data-collection computer program and a compatible app accessible by phone or PC.

The first component would be developed completely via the Google Actions Console and the Dialogflow API. This would allow the development of an action which can be installed onto any Google Home or other compatible Google devices and applications. Once this is installed, the program would begin to prompt data collection from Ms. Liu twice a day. In the morning, the Google Home would execute a voice command after Ms. Liu's wake-up alarm, prompting her to input data via voice regarding her immediate state. Then, in the evening, Ms. Liu will have the option to choose a reminder time at which the Google Home will once again prompt her to input data by speaking with her. This reminder time can be changed whenever Ms. Liu pleases, and can be varying on different days of the week. Regardless, it should typically be roughly before she goes to sleep, as no more activities will be done and a very general summary of the day can be constructed. As for the structure of the data input itself, the final prototype would first ask Ms. Liu to state where exactly her pain is, and then depending on her answer, a series of appropriate questions would be asked. Obviously, it is possible for Ms. Liu to experience pain in more than one place at any given time. Thus, the program would naturally loop to ask Ms. Liu if she is experiencing pain in any other part of her body, and if so, a series of appropriate follow-up questions as well, until she expresses that all areas of pain have been covered. Also, if Ms. Liu states an area of pain unlisted in the API's entity list, the artificial intelligence behind Dialogflow should be able to match it to the closest area of pain and continue as normal. Moving forward, examples of follow-up questions will always include a rating of pain from 1-5, and will sometimes include a rating of redness or swelling from 1-5 as well, where a rating of 1 would indicate very mild and a rating of 5 would indicate severe. These types of questions will be asked in both the morning and evening data-input sessions. However, only in the evening data-input session, Ms. Liu would be prompted to list any physically demanding activities or potentially painful activities she participated in that day. Once again, for each activity she mentions, a follow-up question asking her how long she participated in this activity is asked. Then, a loop identical to what was previously explained would be executed and would only terminate when Ms. Liu clarifies that all activities have been discussed. It is also important to note that these questions could be altered to the specific needs of the doctors, for either data-collection session. This inputted data would then be sent to a server using the messaging service Twilio, and all of this collected data is then saved onto a cloud-storage based platform where it can be sent to the compatible app via a wifi connection.

The second main component of this prototype would be the compatible, mobile app designed through Python. Theoretically, the data-collection process can be completely carried out through the first part of this prototype alone. However, data collection can be carried out through the app as well. In fact, if Ms. Liu found herself away from home and needed to input either her morning or evening data, she could easily do it through a section of the app dedicated to the patient. Additionally, the app would act as an additional reminder to input data. For example, if for some reason Ms. Liu did not hear the voice prompt by Google Home, the app would send a notification 10 minutes after the usual data-input time to remind her of the most recently missed session. Overall though, these would be additional features to this app's main purpose; the display of data and its ease of analysis. The transmitted data to

the app would then be analyzed in a multitude of ways, including a calculation of pain, redness, and swelling averages, as well as amount of occurrences for common areas of pain and painful activities. Additionally, this data would also be displayed in various graphs in an attempt to more easily illustrate a pattern. To showcase potential correlations between symptoms and activities, graphs spanning a specified period of time can be combined and displayed. Typically though, the goal is that this analysis of data would occur once every meeting between Ms. Liu and her doctors, and the specified period of time for all graphs and collected data would be since their last meeting together up until the day before their current meeting. Lastly, the app would also be able to display all of the raw, unprocessed data for further inspection or analysis by doctors.

To further showcase this prototype, we have included a sketch below which resembles our app's graphical user interface. In addition, we have also shared with the prof1p10@mcmaster.ca email our Google Actions Console where we were developing our data-collection program thus far. To showcase how to use this console and demonstrate what we have achieved, we have also created a video demo which can be found at this link: https://youtu.be/y9Vw7FR79TI. Finally, submitted with this document will be a preliminary python code resembling how we will be using Twilio to save data on a cloud-based server. Please note that for this code to function, you need to download and use ngrok (https://ngrok.com/download) as well as link a Twilio account to your computer.



Testing the Prototype

There would be different levels of testing for the prototype. Firstly, the input software would be tested in the Google Actions Console, where the program was created, in order to ensure the input, questions, and replies are all working correctly. Secondly, the system in which that data is transferred from the Google Home to a server would be tested. This could be done easily by sending a text from a Twilio account to another which is linked to a set of Python code on a computer, to ensure the contents of the message were recorded to a text file properly. Thirdly, the app portion would be tested. This could be done by simply using the app with the test data from the second step, and ensuring that the interface was functioning properly with the correct data. Finally, the Google Action could be downloaded to a Google Home, and the entire prototype, (input, data transfer, and output), could be tested together by simply running the program and seeing if the output on the app was correct.

After performing these initial tests to ensure the program functions properly, the prototype could be brought to the end user, (in this case, Ms. Liu and her doctors), to see if any edits should be made, (for example, to the question process or app interface), since they will be the people using it. After this, these edits could be made and the cycle would repeat until the users were satisfied and the program was ready for use.