NeuroGen

Final Report

Team Members:

QianXing Ou, YiYang Wu, Mohfujul Mohammed

City College of New York

Abstract:

According to WHO, there are approximately 55 million cases of Dementia worldwide and this number is growing every year [2]. According to the CDC, the number of cases of dementia related diseases such as Alzheimer's is slated only to increase as time goes on. In the United States, it is expected to increase to over 14 million active cases by the year 2060 [4]. Our mobile application, ***NeuroGen***, is designed to tackle this problem by providing a number of different useful tools to seniors with early stage Alzheimer's disease, designed to help them cope with the disease and manage their symptoms, while also employing very user-friendly interfaces and a framework where patients have to do very little setup to enjoy all the features of the application.

Background:

According to the CDC, over 5.8 million people in the United States were living with Alzheimer's disease as of 2020. Of this group, 72% are aged 75 or older, and 1 in 9 people in the U.S. over the age of 65 suffers from Alzheimer's [4]. The neurodegenerative disease is the leading type of dementia worldwide, and is characterized by symptoms ranging from memory loss, cognitive impairment, confusion, difficulty thinking and understanding, the gradual loss of bodily functions, and ultimately, death. Dementia as a whole is currently the 6th leading cause of disease related deaths [4]. Unfortunately, its cause is not well understood, and there is no known cure, nor are there any treatments that can reverse or even stop its progression.

As one would expect, Alzheimer's disease is extremely disabling to patients with the disease, and places a great burden on their caregivers, who are typically spouses or other close relatives. Those affected by Alzheimer's have their daily lives disrupted, as they begin to misplace things, forget how to or have difficulty in completing once familiar tasks, and in some cases even wander and get lost even in familiar places. As the disease progresses, patients become increasingly reliant on their caregivers, and require constant and intensive care [1]. It is believed that Alzheimer's economic and social costs are on par with that of both cancer and heart disease. Alzheimer's is typically treated through the use of medications, cognitive therapy, diet, and physical and mental exercise programs, all of which are aimed at helping patients manage the symptoms of their disease, and in the hopes of slowing the rate of progression of the disease. However, no treatment available as of now is able to stop, reverse, or prevent the effects of Alzheimer's disease.

Statement of the Problem:

Technology plays a critical role in assisting individuals with various health problems/disabilities, and these patients with Alzheimer's disease deserve to benefit from technological features as well, especially considering that the disease has no known cure. ` Patients with Alzheimer's need tools to assist them in day-to-day life, help them manage their symptoms, and provide a source of cognitive/stimulation and memory training. Existing tools and technologies that could offer tools like daily scheduling, location services, reminders, photo albums, etc. are scattered - they require the use of many different applications to utilize all these features, some of which can be very costly. Moreover, these applications are targeted at users

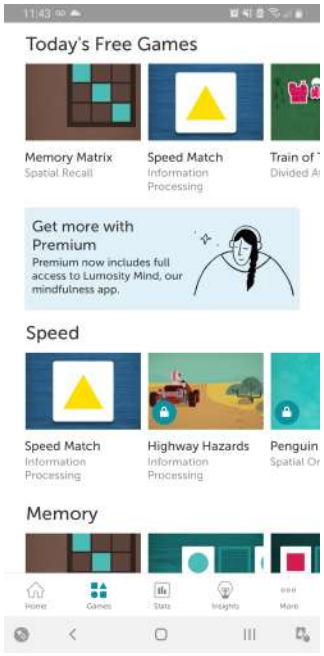
who are familiar with technology, which patients with Alzheimer's generally are not due to their old age. Additionally, patients need an application that can provide tools to assist them in the care of their patient as well. ***NeuroGen*** is an all-in-one mobile app that is designed specifically for use by older individuals unfamiliar with technology, providing both memory games for patients as well as assistive tools for both patients and caregivers to help them manage their day-to-day lives.

Rationale:

We have designed our application to provide features to help patients with their specific conditions, symptoms, and help improve their quality of life as they deal with Alzheimer's disease. Tools like Schedule/Reminders provide a way for patients to maintain daily routines and help them cope with memory issues. With Google Maps integration, caregivers are able to track the location of patients, should they ever become lost, wander off, are in a state of confusion, or simply to keep an eye on the patient. The memory games also provide patients with a source of cognitive stimulation. Certain preliminary studies have shown that mental exercises can benefit patients with early stage Alzheimer's disease [3]. These exercises are intended to keep patients' brains active and help them remember details about their lives and loved ones.

We understand that it is hard for many senior citizens to interface with many modern technology systems, as it's something they didn't grow up with and generally have little experience with. We have experience working with our own family members as well as doing volunteer work for tech-literacy programs for senior citizens, helping familiarize them with

computers, phones, emails, and apps. We've learned that older people do not find technology to be nearly as intuitive as we often think it is. Most applications are developed with younger users in mind, sticking to certain conventions in design and user interfaces that may not be obvious to senior citizens. Issues like hard to read text, an excess of menus, and small buttons are examples of design aspects that serve as barriers for older people using modern technology. Existing technologies that could be helpful to patients with Alzheimer's disease suffer from these issues with UI, and do not offer all the assistive tools we do in one application. Moreover, apps like Lumosity and Eidetic that provide cognitive games are also costly, costing upwards of $12 a month in subscription fees. Not only does our app have assistive tools as well as memory games to help patients as well as their caregivers, but its UI is designed to be accessible to our target users.



UI of the Lumosity app on Android

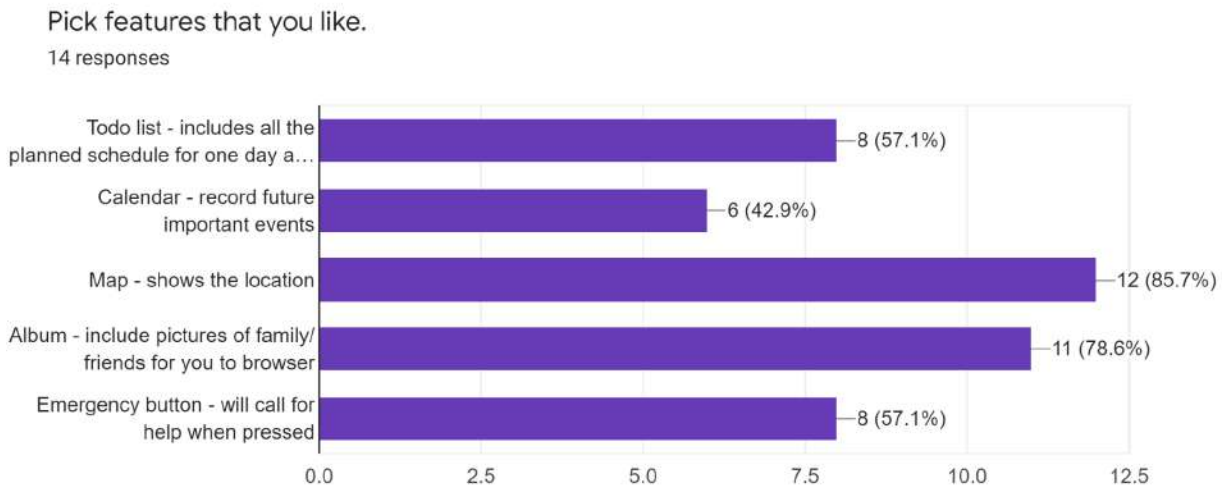
Design and Development of Systems:

NeuroGen is a mobile application, and thus is easily accessible and readily available for all our users. The app emphasizes user friendliness, designed around our target users who are older individuals with early stage Alzheimer's disease. Minimal menus, large text, large buttons, and calming colors are all meant to make our app welcoming to older patients. The app was created in React Native, an open source framework for app development. Using this framework allowed us to develop an app for both iOS and Android devices simultaneously, using one singular codebase.

With the Google Cloud Platform, we are able to utilize Google Maps and Directions APIs to integrate location services and Google navigation into our application. This is used in the Maps feature, which enables patients to navigate to their saved address at the press of a button, and allows the broadcast of their location to the caregiver's app. The caregiver can observe the location of the patient at all times, and navigate to them at any time.

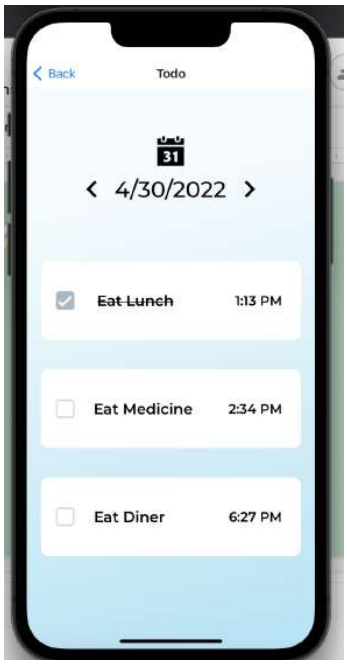
We use Google Firebase to support our backend and database functionality, and is the primary driver for allowing the connectivity between the patients and caregivers' accounts when using the application. It also enables authentication functionality, so that each patient/caregiver is able to have their own user-specific information linked to one another.

Now we will be talking about the features we have. We have a list of features that we want to have before we start coding. And we ask our users about it.

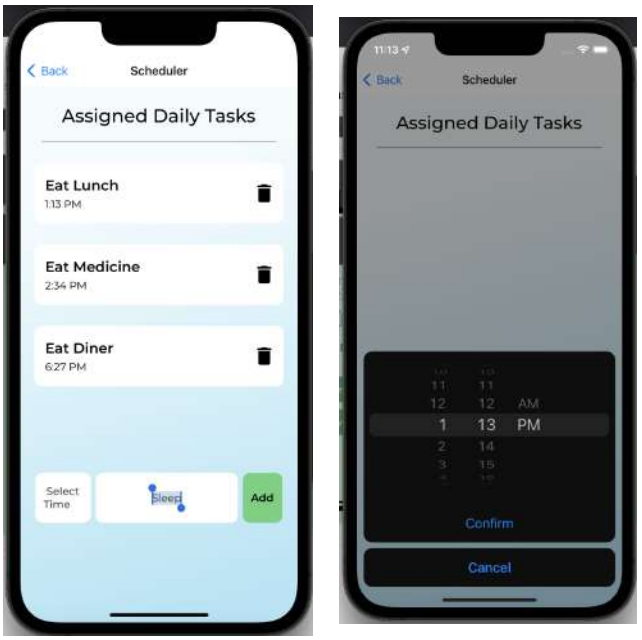


After the survey, we decided to remove the calendar and emergency button. For the calendar, some users said that although they love the idea of having a calendar, they prefer a real physical calendar instead of using our app. Therefore, it is unlikely for them to use it. For the emergency button, users said that it might look like a good idea, but during a real emergency, they will call the police instead of using our app.

Todo:



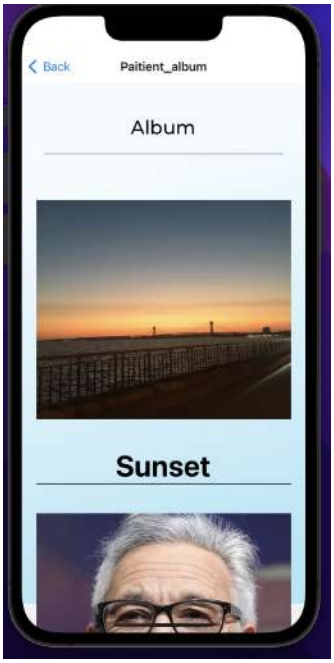
Patient

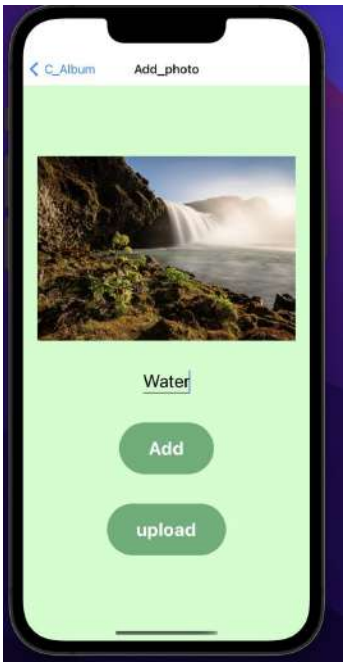


Caregiver

We have two versions, the one on the left side is the patient's version. All they need to do is to check their daily schedules. The one on the right side is the Caregiver's version. They can add/delete/modify daily schedules for patients. This was implemented using Google Firebase to support the backend functionality. Caregivers are able to add new items to the daily schedule, which is sent to a database table that the corresponding patient pulls from. On the patient side, their application will pull and display all the items from their database, as shown above.

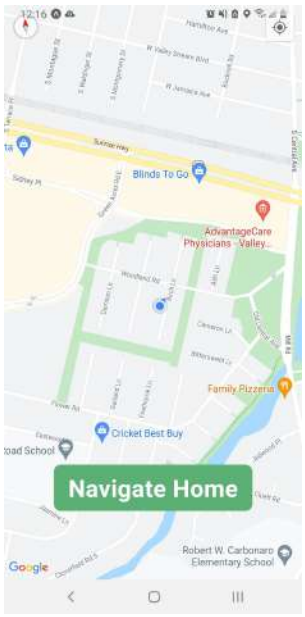
Album:

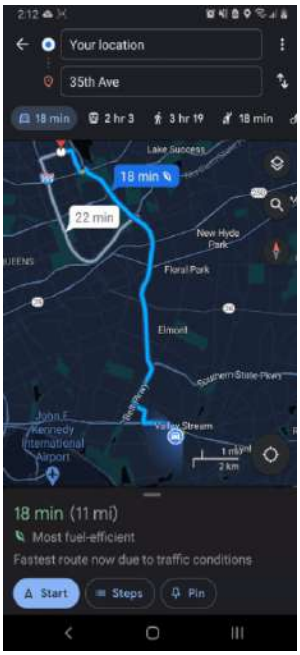


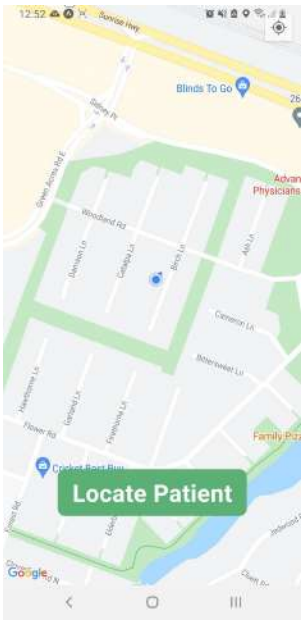


The one on the left side is the patient's version. They can view responses and images that are posted by caregivers. The goal is to help them remember their daily lives and their loved ones. The one on the right side is the caregiver's version. They can post responses and images for the patient. Google Firebase is once again the driving component of the backend, allowing us to upload and remove images directly from the online database, and link the two accounts of the patient and caregiver together so the patient can see what the caregiver has uploaded for them.

Map:

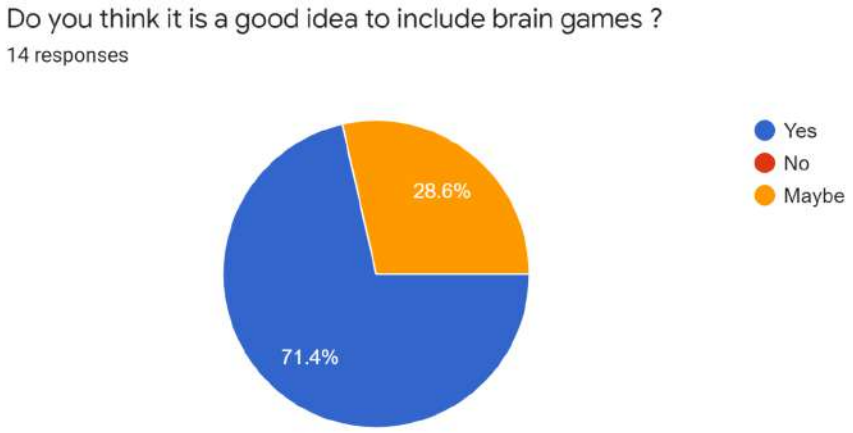


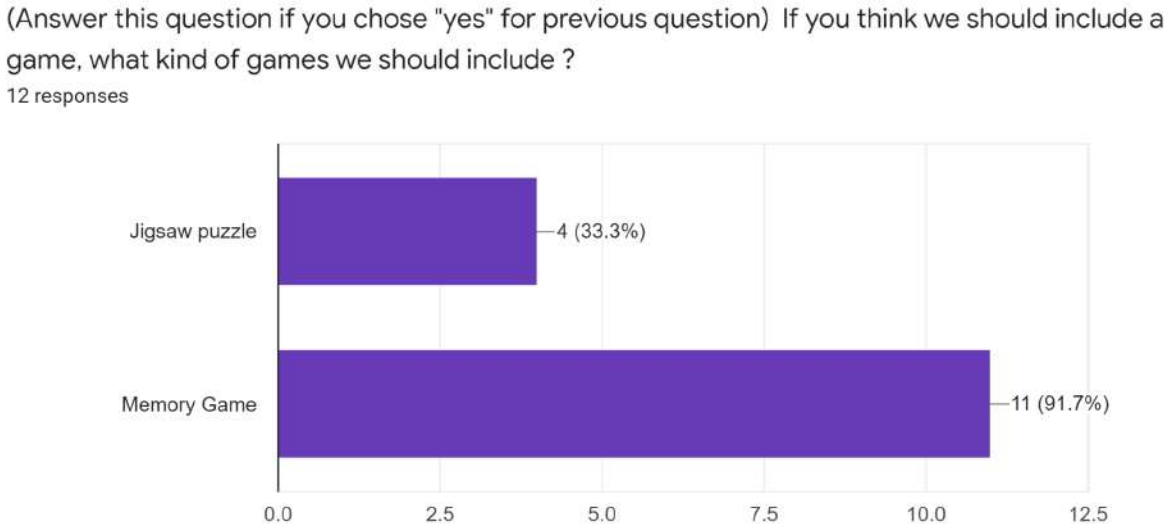




The one on the left side is the patient's version. The patient can click “Navigate Home” to find their way home. The one on the right side is the caregiver's version. The caregiver can check the current location of the patient by clicking on “Locate Patient”. Moreover, the caregiver can also click on the patient’s location and begin navigating to them directly in the event of an emergency. This feature was implemented using Google’s Maps and Directions APIs, which enable the integration of Google Maps directly into our application. It enables us to use existing systems that people already are familiar with seamlessly, rather than reinventing the wheel. Using our phones’ built in GPS systems and location services, we are able to broadcast the patient’s to the caregiver in real time, so that they are always able to see where the patient is at any given time.

Other than these features, we also implement a memory based game, which is voted by users.





Memory Game:

The patients get to answer some of the basic questions about themselves or family members. The purpose of this game is to help patients' to remember about their daily lives and family members.

<u>This is a link to our app prototype:</u>

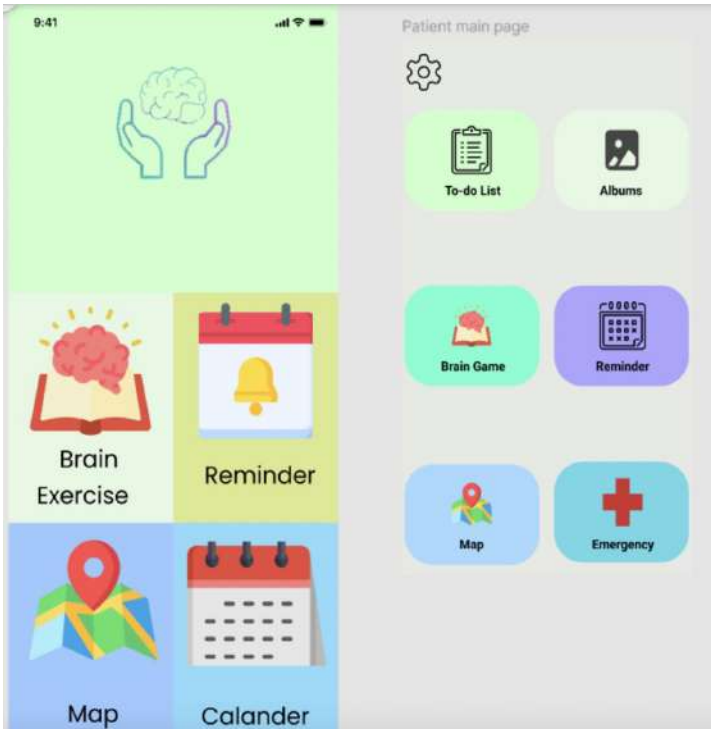
https://www.youtube.com/watch?v=QF4AAnbWt-M

Evaluations:

Throughout the development process, we tried to work with our target users throughout the development process. Knowing that our users have specific challenges due to their old age and the symptoms of their disease, we wanted to use their feedback to guide the development of

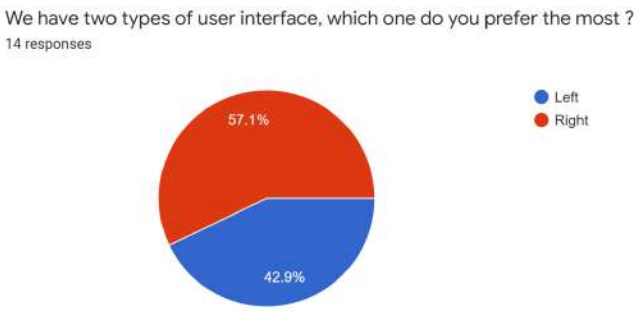
our application to make sure they would actually be able to use NeuroGen. Our test users were seniors in our own families as well as people that our group mate YiYang's mother (who is a nurse) works with, giving us a sample of feedback from older patients with Alzheimer's as well as seniors who are generally healthy.

Our UI designs and many redesigns were entirely guided by user feedback. We had many drafts regarding the UI for this reason:



First draft of interface(two version)

The above is our first draft. The one on the left hand side has a bigger text/button, while the one on the right hand side looks much prettier and cleaner. We were not able to make a decision between these two. Therefore, we conducted a survey.



Surprisingly, the poll results were very close. People voted for the left UI because they think the UI has big text/buttons which makes their lives easier as a lot of them actually wear glasses. People voted for the right UI because it is much cleaner, and they preferred its aesthetic look. As a result, we decided to combine both versions. And we have the below UI:

We designed this UI as a combination of the previous two designs, keeping the overall theme of our second iteration but incorporating the positives of the first iteration - namely bigger buttons and bigger text. We chose to make some more tweaks by adjusting some of the colors,

fonts, and look of the buttons to create an overall more modern look, as shown below in our final version:

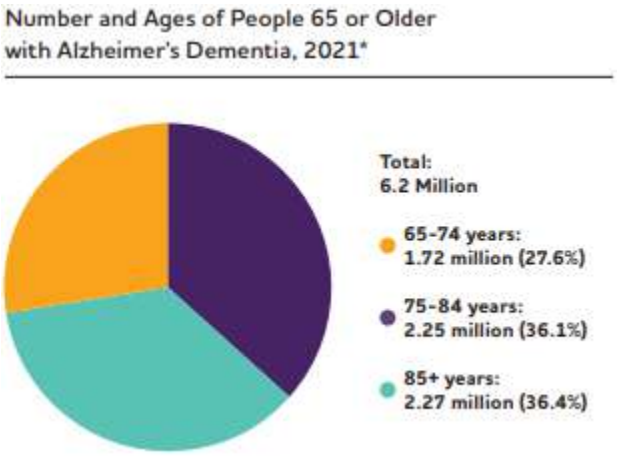
In general, our driving principle was that we wanted to keep the UI as simple as possible and the text/buttons as big as possible, to ensure that our application would be readily usable by individuals with patients with Alzheimer's disease. User feedback on this final iteration of the UI was that it was "very nice, and very big and readable."

When designing the other features, as mentioned in the Design section, we surveyed our users to see what types of tools they would like to see in a mobile application they would use everyday. We removed initially proposed features such as Emergency Button and Calendar based on user feedback, as users reported they would rather call the police in the event of an emergency and would prefer a physical calendar if they were to use one. Features like Maps, Memory Games, Albums, and Schedule were implemented based on user preference. For instance, in feedback we learned that users preferred having photos arrange from top to bottom instead of from left to right, and as a result we changed the Album feature accordingly. Users

also reported Memory Games as being “alright”, meaning that in the future we must continue to add more variety and improve this feature, but it is a good start. Other features like push notifications, while implemented, users reported that they “never look at notifications”. Regardless, the feature is there in the event that some users will use it even if most do not.

Potential Market:

Currently, there are as many as 6 million Americans over the age of 65 living with Alzheimer’s disease. And this number is expected to increase to around 13 million by 2050. 11 million family members provided an estimated 16 billion hours of care in 2021 alone [1]. In addition, around 200,000 Americans under the age of 65 have early onset Alzheimer’s disease [5]. Therefore, the market for our application is pretty huge.



From Alzheimer’s Disease 2021 Facts and Figures, published by the Alzheimer’s Association

Our application is targeting older patients who have early stages of Alzheimer's disease who might have vision trouble and are likely unfamiliar with technology. In addition, we also allow caregivers/family members to access the app. They will manage the application such as adding/modifying daily schedules for the patients. In essence, our market for our application is not only the growing number of patients with Alzheimer's disease in the U.S. and internationally, but also the even faster growing number of caregivers providing home care to patients as well.

Cost Structure and Revenue:

- Cost of platform
    - Google Play Store (One time fee of $25)
    - Apple Store (annual fee of $99)
- Google Cloud Platform and Firebase cost
    - Free initially, but has cost that scales with usage
- Hardware : Computer, Iphone and Android Phone
- Salary for the developers

Below is the summary that we have for the cost structure.

Platform Cost	**Firebase**	**Google Cloud Platform**	**Total**
Apple Store: $99 **Google Play Store:** $25	**$0.108** per additional storage in GB(Firestore)	Static Maps SDK: $4 per 2000 requests	**Google Play Store** Onetime: $25 Annual: $4 per

	$0.026 per addition storage in GB (cloud storage)		2000 requests + $0.108 for each additional GB + $ 0.026 for each additional GB **Apple Store:** Annual: $99

Regarding the revenue, we plan to have a trial for approximately 3 months. And after that the caregivers will pay for an $8 one time fee. In addition, we can always ask for fundings as it is a very popular topic in the medical field. Lastly, we can also have advertisement sponsorship.

Future Work:

For our future work, we hope to expand the current features in our application. We would like to incorporate an educational section to make available to both patients and caregivers, and present them with the latest research. We believe that an important part of patient care in dealing with Alzheimer's is education for both the patient and the caregiver, and to help them understand how the disease works but also to understand the latest in research surrounding it as we learn more about how Alzheimer's works and new cutting edge trials and treatments for combatting it. We would like to expand the number and quality of the memory games that are available to patients, and provide them with an even better source of mental and cognitive stimulation, which is a promising area of research into treatment for patients with Alzheimer's.

We would also like to use our application as a framework for Alzheimer's studies. With the right additional features, could see NeuroGen be used to help collect data about patients in scientific studies conducted by researchers, for willing participants. The score feature can be expanded, and a new user type could even be added for researchers to be able to track a patient's performance and results over time in long form studies/experiments to help better understand the intricacies of Alzheimer's disease.

Branding:

Below is the logo that we use for our application :

We choose to have this color because we think it gives a feeling of calmness. The logo also gives a similar feeling with addition of support. The design that we have which is a hand

holding a brain conveys a message of support and improving quality of life. Lastly, we choose to use Neue Einstellung as our font because we think it is sleek, simple, and aesthetically pleasing.

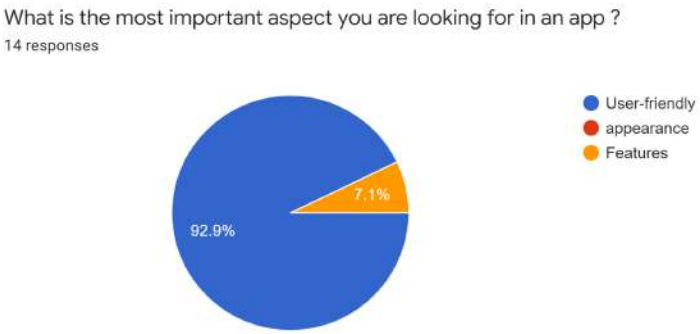
The main message that we want to convey through our band is that although Alzheimer's' cannot be cured with our current medical knowledge, we should give these people enough support to help them to overcome any challenges they might have.

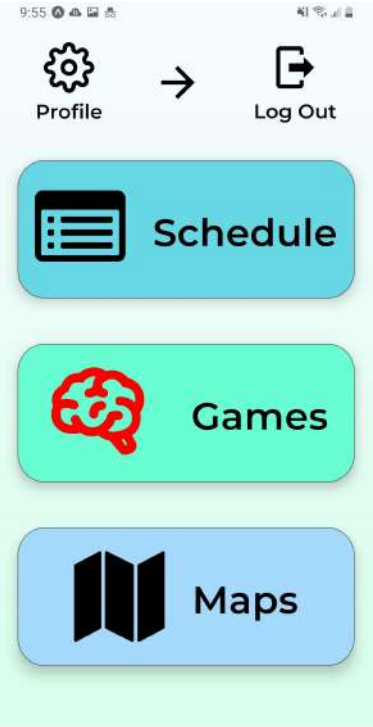
With this in mind, we came out with the following slogan:

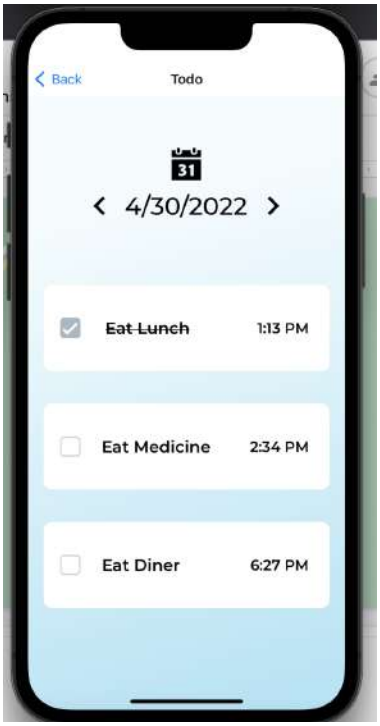
"An aide for those who need it most."

We want to provide help and support to those who experience Alzheimer's' and we want to let them know that we are always on their side no matter what happens.

Regarding our user interface and the appearance of our features, we don't have a pretty or complicated design because we want to make it clean, user friendly, and big. Based on our survey results which we attached below, our users do not care about how our app looks. They only care about user friendliness and of course the size of the text because many of them might have vision problems.







Acknowledgements:

The work in this project is our own. Any outside sources have been properly cited.

The project is supported by the CCNY CEN Course Innovation Grant.

We would like to thank Professor Zhu for all his support and feedback throughout the semester, Goodwill NY/NJ for helping us gain incredible insight into communities and groups that could benefit from assistive technologies as well as for their feedback on our class's project updates, as well as a big thanks to Katherine Olives, Kesia Hudson, Steven Monzon, Gerardo A. Blumenkrantz, Nancy R. Tag, and Marlene Leo for their insights into the branding, business, and entrepreneurship side of our projects, and of course to all the evaluators for their great feedback and advice throughout these last 2 semesters.

Team Contribution:

QianXing Ou:

- **Worked on the final report**
    - **Background, Abstract, Design, Market**
- Setting up the project including things like Github and Firebase.
    - Set up everything related to firebase such as secret keys, so that the team can use firebase without any trouble.
- Worked on the authentication system of the app.
    - Users can register for their accounts.
    - Databases have no trouble saving user information.
- Worked on the Album.
    - Set up the database for the album.
    - Users can save their photos to the database.
- Worked on the Game.
    - App is able to display different questions based on which screen they are on.
    - Able to detect whether the answer is correct or not.
    - Able to display the scores that the patient gets.
- Worked on the todo
    - Patients can view the schedules that are posted by caregivers.
    - Caregivers are able to delete, add and modify the schedule.
- Helped to conduct survey data.
    - Collected 10% of the data.
    - Prepared survey questions.
- Implemented many quality of life changes, such as checkbox ,hide password ,score system , feedback system , address for the patient.
- Helped with the figma design
- Wrote all the weekly logs.

YiYang Wu:

- **Worked on the final report and slides such as adding images.**
    - **Cost Structure and Revenue, Acknowledgements, images for report**
- Worked on the design in the beginning to middle of the semester.
    - Login page.

    - Homepage for caregiver and patient
    - All the design for features.
    - Change designs multiple times based on user and class feedback.
- Worked on figma design
    - Have many versions of designs
    - Constantly changing the design based on the feedback we got.
- Worked on the Album
    - Users can now see all the images/responses that are in the database.
    - Fixed some issues related to the album.
- Helped us to conduct most of the survey data.
    - Collected 90% of the data.
    - Helped us a lot by asking his grandma a lot of app related questions
- Worked on the final modification for the app
    - Final UI update and bug fix to make it look good on the app demo
- Worked on the final video
- Upload all the proposals, slide , report and video to the wiki page.

Mohfujul Mohammed:

- **Work on the final report**
    - **Problem, Rationale, Design, Future Work**
    - Checked and edited all grammar and wording for the report.
- Worked on the authentication system of the app.
    - Users can perform log in and log out.
- Take over the UI design part later in the semester.
    - Tweaking the designs based on what our users want.
    - Added custom fonts, colors, modernized the app's look
    - Fixed some design bugs.
    - Come out with many design ideas.
- Removed most of the warnings we have on our app.
- Google Firebase
    - Set up realtime connection to database for use in our different features so patients/caregivers' shared information is always synced up
- Worked on todo.
    - Make it prettier.
    - Added many quality of life changes including making it more user friendly.
    - Bug fixes
- Added Location Services to the application for use in the Maps feature
    - Patients location is broadcasted to the caregiver at all times (if enabled by user)
- Helped to conduct surveys

    - Prepared survey questions
- Worked on the Maps feature.
    - Setting up Google Cloud Platform to work with the application
    - Set up patient's map, added button to navigate the patient home
    - Caregivers can locate the patient.

Everyone works hard for this project !

Reference:

1. “Alzheimer’s Facts and Figures Report | Alzheimer’s Association.” *Alzheimer’s Disease and Dementia*, https://www.alz.org/alzheimers-dementia/facts-figures#:~:text=An%20estimated%206.2%20million%20Americans,Americans%20with%20Alzheimer’s%20are%20women.
2. “Dementia.” *WHO | World Health Organization*, https://www.who.int/news-room/fact-sheets/detail/dementia
3. “Mental Stimulation Slows Alzheimer’s Progression | Fisher Center for Alzheimer’s Research Foundation.” *Fisher Center for Alzheimer’s Research Foundation*, 21 Aug. 2012, https://www.alzinfo.org/articles/mental-stimulation-slows-alzheimers-progression/
4. “What Is Alzheimer's Disease?” *Centers for Disease Control and Prevention*, Centers for Disease Control and Prevention, 26 Oct. 2020, https://www.cdc.gov/aging/aginginfo/alzheimers.htm
5. “Minorities and Women Are at Greater Risk for Alzheimer's Disease” *Centers for Disease Control and Prevention*, Centers for Disease Control and Prevention, 20 Aug, 2019, https://www.cdc.gov/aging/publications/features/Alz-Greater-Risk.html#:~:text=Current%20estimates%20are%20that%20about,65%20with%20younger%2Donset%20Alzheimer%27s