CEN 4010: Principles of Software Engineering

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Table of Contents

Vision Statement

One of the major challenges senior citizens face today is managing their health. Our goal at ReMedFul is create a system that gives patients of primarily older ages the ability to maintain and track their pills in a simple and easy way. As many seniors have a difficult time balancing their health on their own, this project gave us the motivation connect patients to doctors and creates a simple and intuitive way to track their pill usage. This system would track the pills taken, notify doctors, and patients know when the next refill date is. The idea for ReMedFul was built from a personal experience of one of our members. While watching her father go through cancer treatment, heart attack recovery, and managing his diabetes, she saw him take numerous pills each morning and another set in the evening. After observing firsthand how many pills the average patient of chronic illness takes, she envisioned a system that would be easy for her father and others to use. ReMedFul would make seniors' lives easier by giving them more time to enjoy life and time with those they love instead of worrying about refill dates and when to take their pills.

In 2006, a Boston University survey in found that, "In a given week, an average of 82% of adults in the U.S. are taking at least one medication [...]; 29% are taking five or more. Men and women aged 65 years or older continue to be the biggest consumers of medications: 17-19% in this age group take at least ten in a given week".[1] Due to the abundance of pills the average senior takes, it is apparent that this particular age group needs assistance with managing medical history and pills. As well, many of these medications and treatments must be taken when

[1] Boston University "PATTERNS OF MEDICATION USE IN THE UNITED STATES." (2006): http://www.bu.edu/slone/files/2012/11/SloneSurveyReport2006.pdf

prescribed. If delayed, their effects weaken and make the patient more susceptible to major health issues. For example, a patient on Warfarin to treat blood clots must take it as prescribed. If they keep sporadically missing days and lying to their doctor about their usage, it weakens the strength and may lead to a heart attack. This is a prime example why patients, especially those who are older, need a way to track their medications that is simple and intuitive to use with the ability to send their records to their primary care physician.

We also implemented a way for patients to having a running count on their pills and remind them when a refill is needed. If a patient has a standard pill bottle of 30 pills that they must take twice a day, that would mean in 15 days they need a refill. The patients would see a reminder for them around day 10-13 to let them know they need a refill soon. ReMedFul is the answer to the longing patients have for an easy-to-use product to manage and track their medications and share their usage with their doctors.

Project Proposal

As the presence of technology increases in our lives, new solutions arise. ReMedFul answers the call by providing an easy-to-use pill tracker designed for seniors who may have a hard time using other methods. Our system is different than other pill trackers as it allows doctors to input patients' prescriptions into the system and view the history of when the patient takes it. With our main focus on seniors, we wanted to make it as simple as we could for patients. By removing the most complicated aspects of most pill reminder softwares by having the doctor populate the prescription field, all the patient has to worry about is logging in and reviewing their information. There is no type of data entry other than entering the initial data that is collected during the signup process and selecting the pill from a dropdown list of their prescriptions, and it will populate the information on that medication. Once the patient takes the pill, they select the "Take Pill" button. They can select this button multiple times if they need to take two pills of the same prescription.

In order to ensure that everyone can use ReMedFul, we created a website that could be used on a computer, smartphone, or tablet. This way any doctor can update their patients' profiles no matter what their practice uses. As well, this gives older patients who do not use smartphones the ability to use ReMedFul on their computers. We have two different view depending on if the user is a patient or a doctor. For simplicity, the patient sees is their information and a dropdown list of their prescriptions. Once selected, they will see the prescription information and remaining pills. The patient can then select the "Take Pill" button. This will be tracked and the remaining pill count will be decremented. On the doctor side, they

will be able to see a list of all their patients. Selecting a patient will bring up the patient profile with their information and current prescriptions. The doctor can then add and remove prescriptions from the patient's profile. While adding a prescription, the doctor will input the name, refill date, number of pills, and instructions matching with what they will send to the pharmacy. Once a prescription is entered and the patient is taking their pills, the doctor can view the remaining pills on their profile to ensure that the patient is properly taking their prescription.

We paired the webpage with JavaScript for functionality of the webpage and Google Firebase for storage and account management. Firebase links to the JavaScript and uses JSON trees to organize data. So for each entry, there is a JSON[2] tree that encapsulates all their information. For example, if we had John Doe as a patient, we would have his entry in a tree of users. Then his branch would include his relevant information such as name and date of birth. Under him, he would also have a branch of prescriptions with information such as prescription name, refill date, and pill count. As well, Firebase takes the challenge of managing emails and passwords and provides a simple and secure solution. Firebase stores the information and then uses a hash algorithm to ensure security.

As with most software, there is always room to grow. ReMedFul's expansion and evolution plans include becoming and registering for HIPAA[3] compliance. Due to software and cost limitations, this current rendition of ReMedFul is not HIPAA compliant. In the future, we would update our software and security to be HIPAA compliant. As well, in real world application, we would implement a strict verification processes for the doctor profiles, making sure that only current prescribing doctors can access patients' information. We also want to

[2] **JSON**-JavaScript Object Notation
[3] **HIPAA**- Health Insurance Portability and Accountability Act of 1996 that provides guidelines for data privacy and medical information safety

expanding our system to an easy-to-use app and having notification alerts to remind patients to take their pills or to refill their medication. Another possible future addition would be the integration of pharmacies. This would remove the need for paper prescription and patient interaction. The pharmacy would be able to communicate directly with the doctor, as the patient would simply pick up their prescription. Refills for medications could be automatically done through the software, based on the patients pill count. This would in turn allow doctors and pharmacies to monitor pill intake and send notifications to the patient when there is an issue or misuse of medication.

The ReMedFul Team

(Left to Right: Carlos Pinto, Danailys Lorenzo, Jenna Voutsinas, Taylor Sullivan, Isaack Morales, Megan Ogron)

Danailys Lorenzo-Junior Database Manager[4], Scrum Master[5]

Danailys is a senior, majoring in Computer Science at Florida Atlantic University. She is a quick learner and loves to problem solve. Experienced in many languages such as C/C++, HTML, and JavaScript as well as her knowledge of databases made her a perfect fit for the back-end team. Dedication is something that she does not take lightly and with that hopes to gain all the knowledge she can to further her career.

Isaack Morales - Front-End Web Developer[6]

Isaack Morales is a junior, who is majoring in Computer Science at Florida Atlantic University. He has a solid understanding of HTML and CSS. Main interest in programming projects are web pages primarily. Getting introduced to the programming language Swift to create iOS mobile applications to spread knowledge of programming on various platforms.

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[4] **Database Manager**- Our back-end team. Broken up into Senior and Junior roles. These members worked with Google Firebase and JSON to create a functional library to connect to the front-end.
[5] **Scrum Maste**r- The ScrumMaster is responsible for ensuring that the Scrum process is followed and guides the team in the effective use of Scrum. He or she is responsible for interfacing with the rest of the company and for ensuring that the Scrum team is not diverted by outside interference (Sommerville).
[6] **Front-End Developer**- Our front-end team. Members worked on design and functionality of the webpages.

Megan Ogron - Front-End Web Developer

Megan Ogron is a junior at Florida Atlantic University, who is majoring in Computer Science. She is a quick learner when it comes to learning HTML and CSS. She can get websites done fast and up to perfection. Web designing is Megan's passion and wants to go as far as she can with it in her life.

Carlos Pinto - Front-End Web Developer

Carlos Pinto is a senior at Florida Atlantic University majoring in Computer Science. While he has an interest in cybersecurity, he has focused on developing his computer science fundamentals and basics including learning how to use HTML and CSS over the past year.

Taylor Sullivan - Senior Database Manager

Taylor is a senior Computer Engineering student at Florida Atlantic University. He excels in embedded system architecture and microcontroller programming. Web design is a new self-taught skill acquired this year.

Jenna Voutsinas - Junior Database Manager, Project Leader

Jenna Voutsinas is a rising senior studying Computer Engineering at Florida Atlantic University. Her main focus is in embedded systems, but also enjoys learning new programming languages and solving problems. Having her hand in both the front and back end as a project leader, she learned more about website design and JSON.

Stakeholder Definition

A Stakeholder is a person, group, or organization that is actively involved in a project, is affected by its outcome, or can influence its outcome (Sommerville). Some Stakeholders of ReMedFul are:

Caretakers

A caretaker can use ReMedFul to organize patient's prescriptions and treatment. As a caretaker may have multiple patients, it creates a unified system to manage each patient.

Developers

The developers role is to make sure the system is up-to-date and secure. This will prevent any unnecessary loss of data or security breaches.

Doctors

The doctor will be able to add or remove medications from a patient's account. While adding a prescription, they will list the refill date, the number of pills, and instructions with the medication.

Ethics Manager

This role is meant to oversee the program to ensure that patient information is being used and stored properly. This position also will make sure the system is HIPAA compliant.

Nurses

The nurses will consult with the doctor and administer treatment and may run examination on the patient.

Patients

The patient will log in and be able to select a medication. Once the medication is selected, they can confirm that they took it. The patient can do this multiple times for medications that need to be taken multiple times a day, as we added a debuff on the button. They will also be able to see the refill date and notifications for when a refill is needed.

Pharmacist

The pharmacist will provide the prescriptions sent over by the doctor to the patient. A future iteration of ReMedFul is to integrate pharmacists so doctors can update the system and send the prescription over at the same time.

Statement on Developmental Model

Due to the nature of development, we did not have any clients to show the product to during development. As the idea of ReMedFul evolved, we found more requirements that needed to be covered through development. Because of this we created ReMedFul using an Agile Methods[7] approach. Through the Agile Methods process, we divided into two teams (front-end and back-end) and ran extreme programing[8] tactics such as scrum and running sprint cycles[9] that would include incremental planning, test-first development, and continuous integration with the whole system.

We implemented these extreme programming tactics in a few different ways. Incremental planning is where "Requirements are recorded on "story cards," and the stories to be included in a release are determined by the time available and their relative priority and] break these stories into development 'tasks'" (Sommerville). We broke down our project into patient and doctor scenarios and worked out scenarios for each. We then organized priority tasks such as creating a login page and figuring out how to store prescription information. From these priority tasks, we used test-first development. We got into the mindset of the user and imagined what functionality we would needed for each task. Through this, we created test cases throughout the process. As we programmed and saw that each test was passed, we moved into integrating the code with the

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[7] **Agile Methods**- Methods of software development that are geared to rapid software delivery. The software is developed and delivered in increments, and process documentation and bureaucracy are minimized. The focus of development is on the code itself, rather than supporting documents (Sommerville).

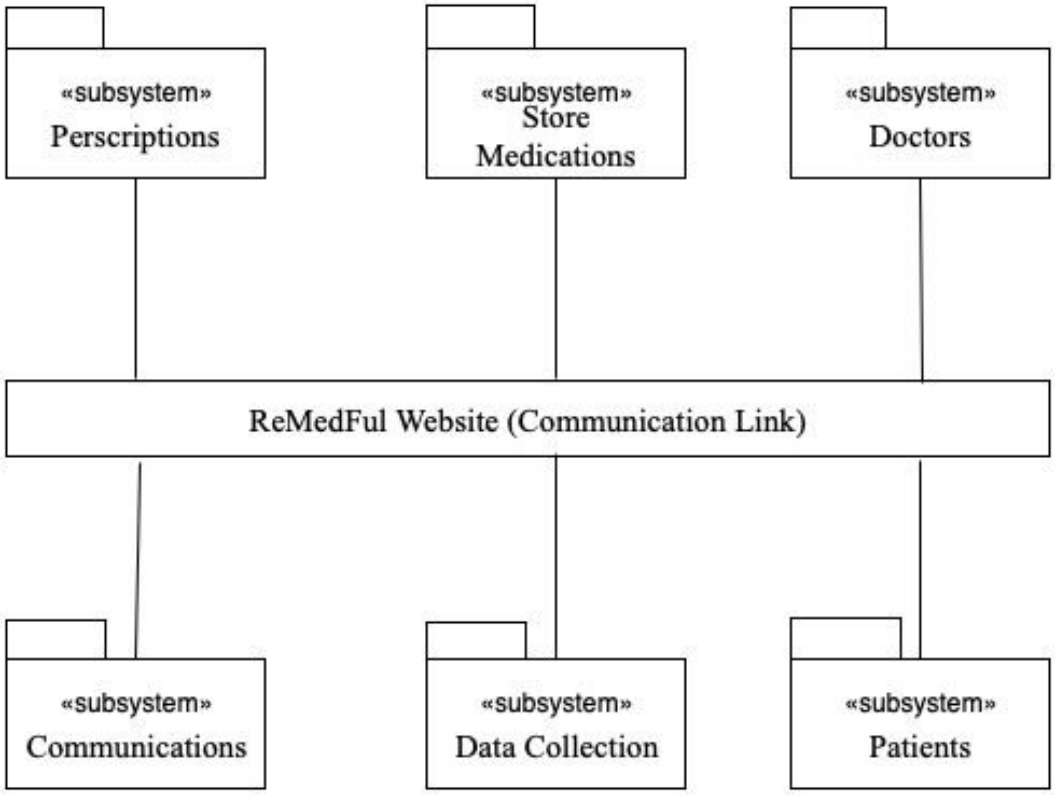
[8] **Extreme Programming**- A widely-used agile method of software development that includes practices such as scenario-based requirements, test-first development and pair programming (Sommerville).

[9] **Sprint cycles**- fixed length, normal 2-4 weeks. They correspond to the development of a release of the system in the extreme programming (Sommerville).

rest of the system. This process is called continuous integration, “as soon as the work on a task is complete, it is integrated into the whole system. After any such integration, all the unit tests in the system must pass” (Sommerville). We tested the whole system again as we added each page and functionality to make sure that there were unintended interactions and failures in the system.

To complete this we used the Scrum method, “an agile method of development, which is based on sprints – short development cycles” (Sommerville). As our group was small enough, we became one scrum group and would focus only on smaller tasks and combining them with the whole project as we progressed. Our scrum ran in sprint cycles in 2-4 week cycles. In those, the Scrum Master, the leader of the scrum, would hold a meeting and discuss what specifications and functionality needed to be developed in this particular task. Through breaking down development into chunks as agile allows you to do, we found that it gave our team the perfect setup to develop ReMedFul, but also the option to scale up to a mobile app or add more features in the future.

System Architecture Model



User Requirements with Corresponding System Requirements

User Requirement 1:

The ReMedFul system shall track what medication each user is prescribed.

System Requirements 1:

1.1 The system shall be linked to a database to store what medications each user is prescribed and what the daily dose is for each prescription.

1.2 The system shall only allow doctors to add and delete prescriptions for each of their respective patients.

1.3 The system shall display a patient's currently prescribed medication and daily dosage for each medication from the database.

User Requirement 2:

The ReMedFul system shall have a function that allows patients to track how much of their daily dosage of each medication they have taken on the current day.

System Requirements 2:

2.1 The system shall be linked to a database to store what medications each user is prescribed and what the daily dose is for each prescription.

2.2 The system shall display a patient's currently prescribed medication and daily dosage for each medication.

2.3 The system shall provide a button that users can click to once for each pill/dosage taken.

User Requirement 3:

The ReMedFul System shall provide doctors with the ability to add or remove prescribed medications to their respective patients accounts.

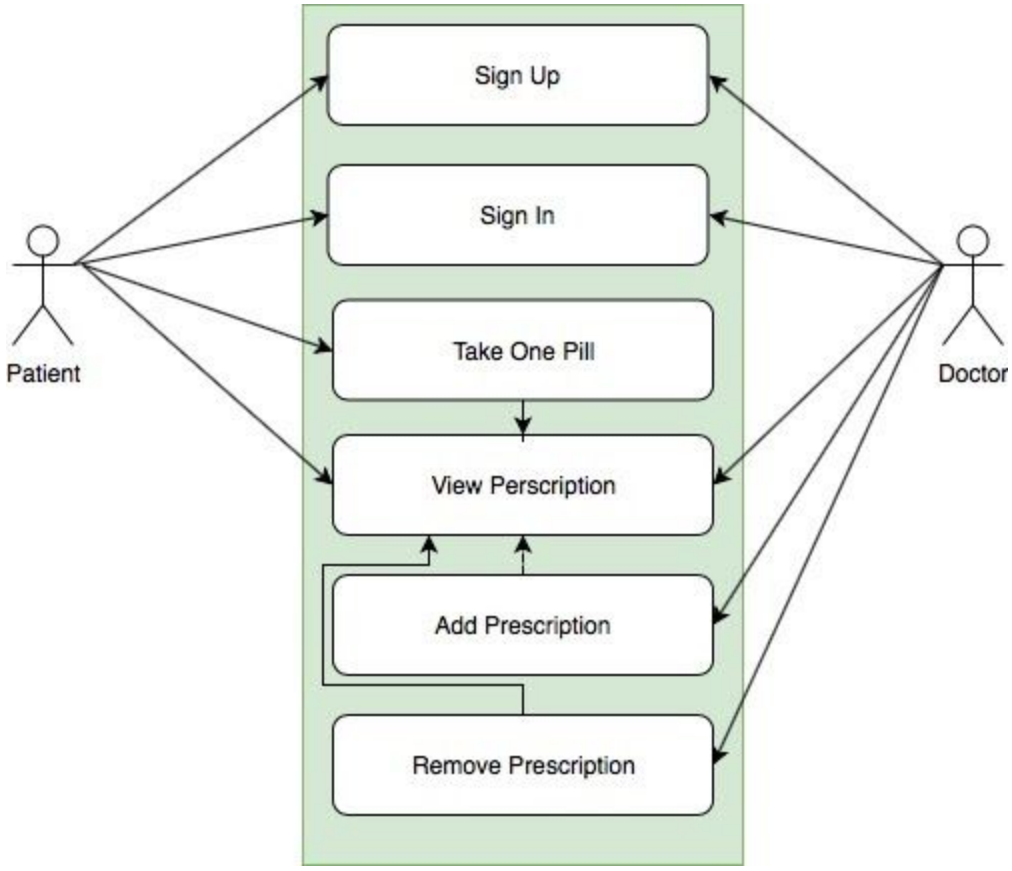
System Requirements 3:

3.1 The system shall be linked to a database to store what medications each user is prescribed and what the daily dose is for each prescription.

3.2 The system shall only provide doctors with the exclusive rights to add or delete prescribed medication from their patient's accounts.

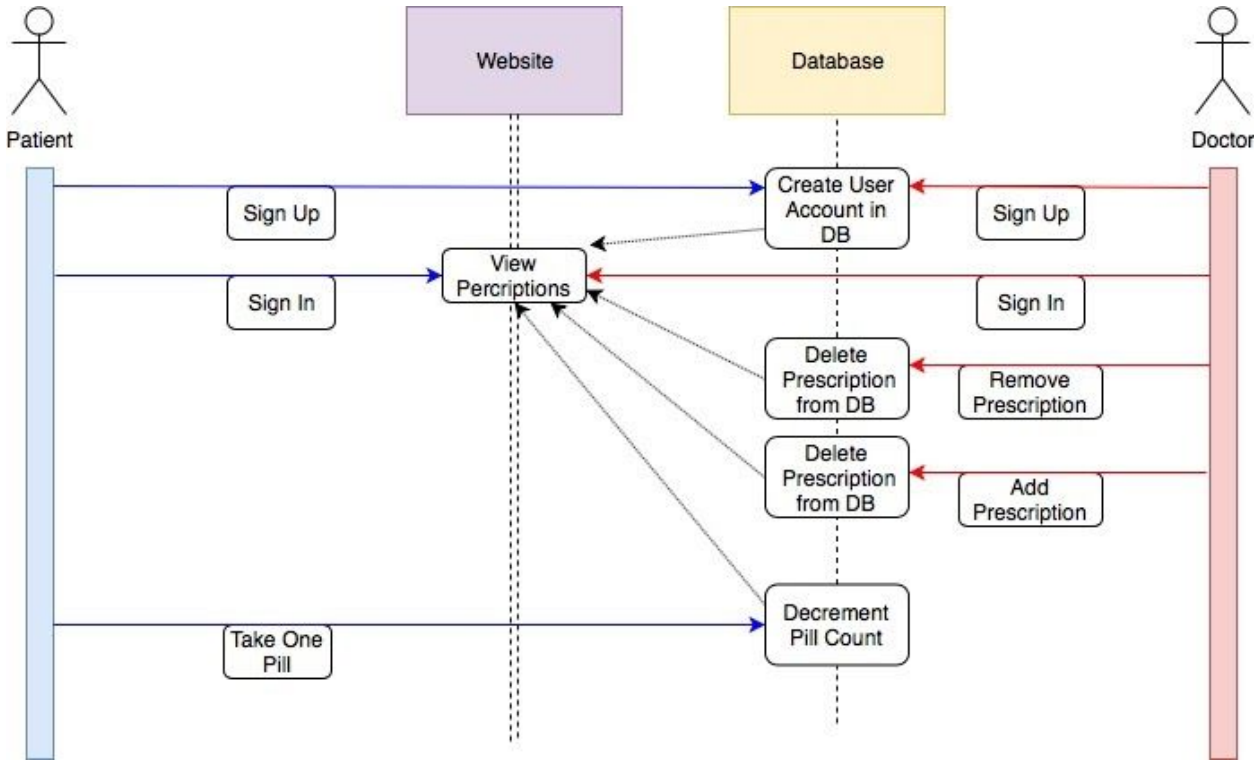
3.3 The system shall provide a field for doctors to fill out the information for the prescriptions.

Use-Case Diagrams and Descriptions

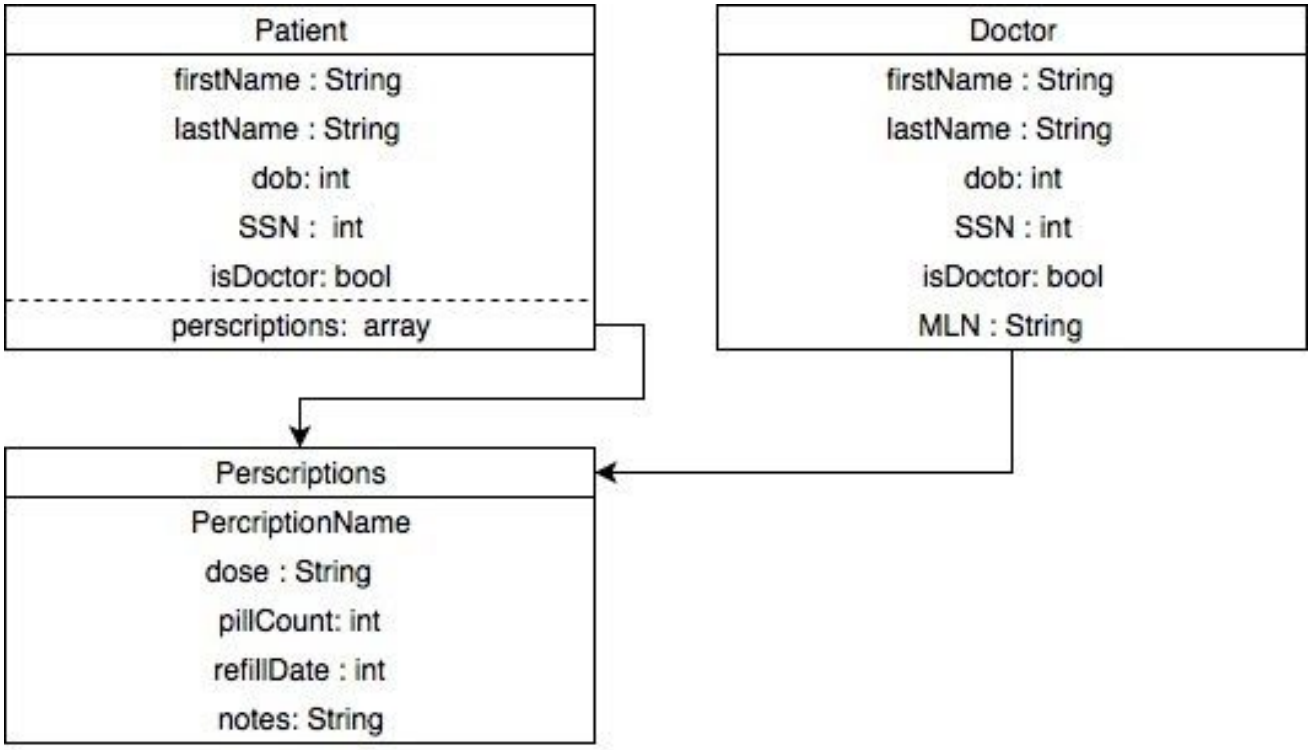


Both the patient and doctor can sign up and sign into the system. Once signed in, they can view the patient's prescription. The patient can confirm that they took a pill. The doctor has control to add or remove a prescription from the patient's profile. Once that change happens, both can view the updated prescriptions.

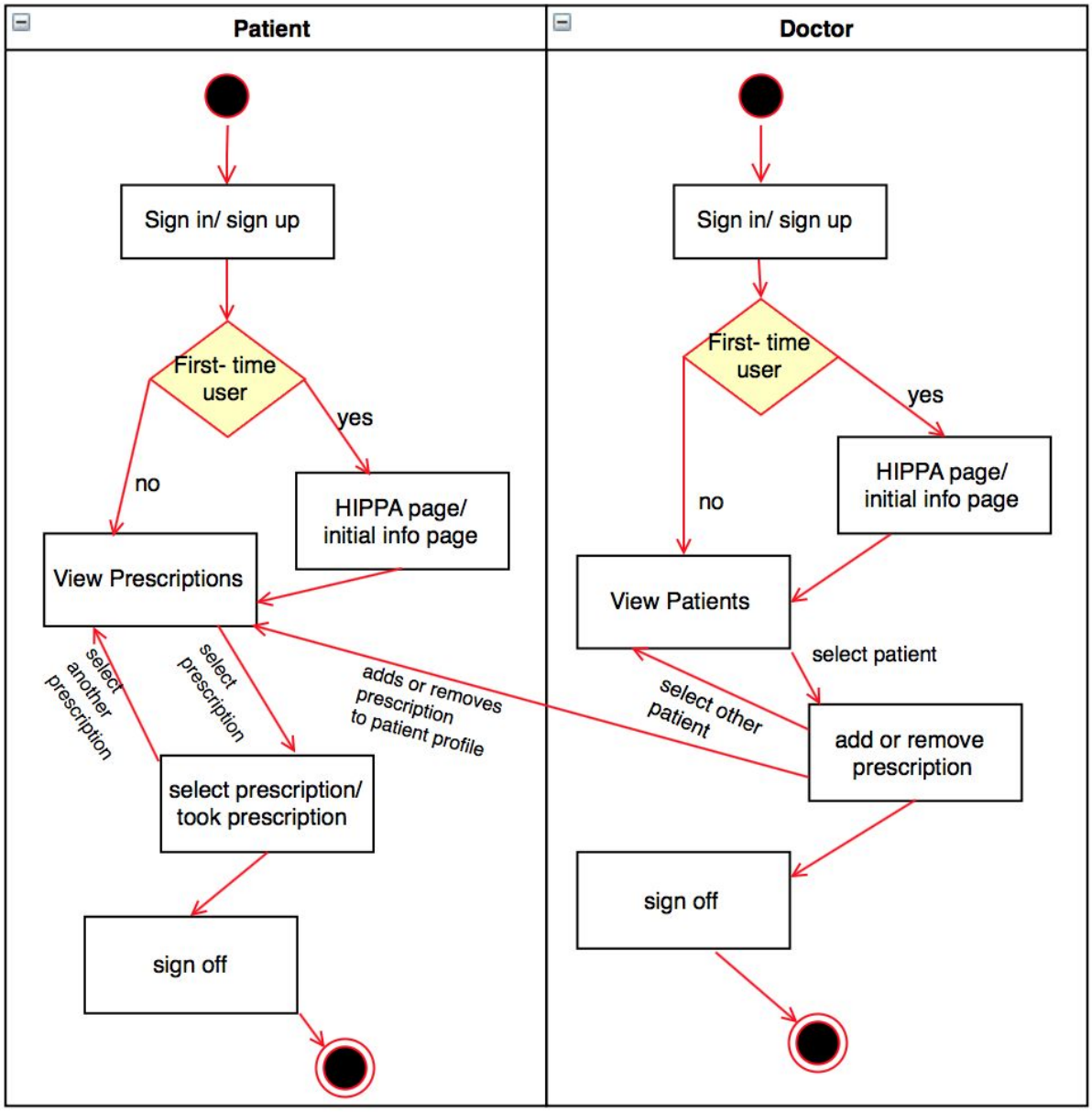
Sequence Diagrams



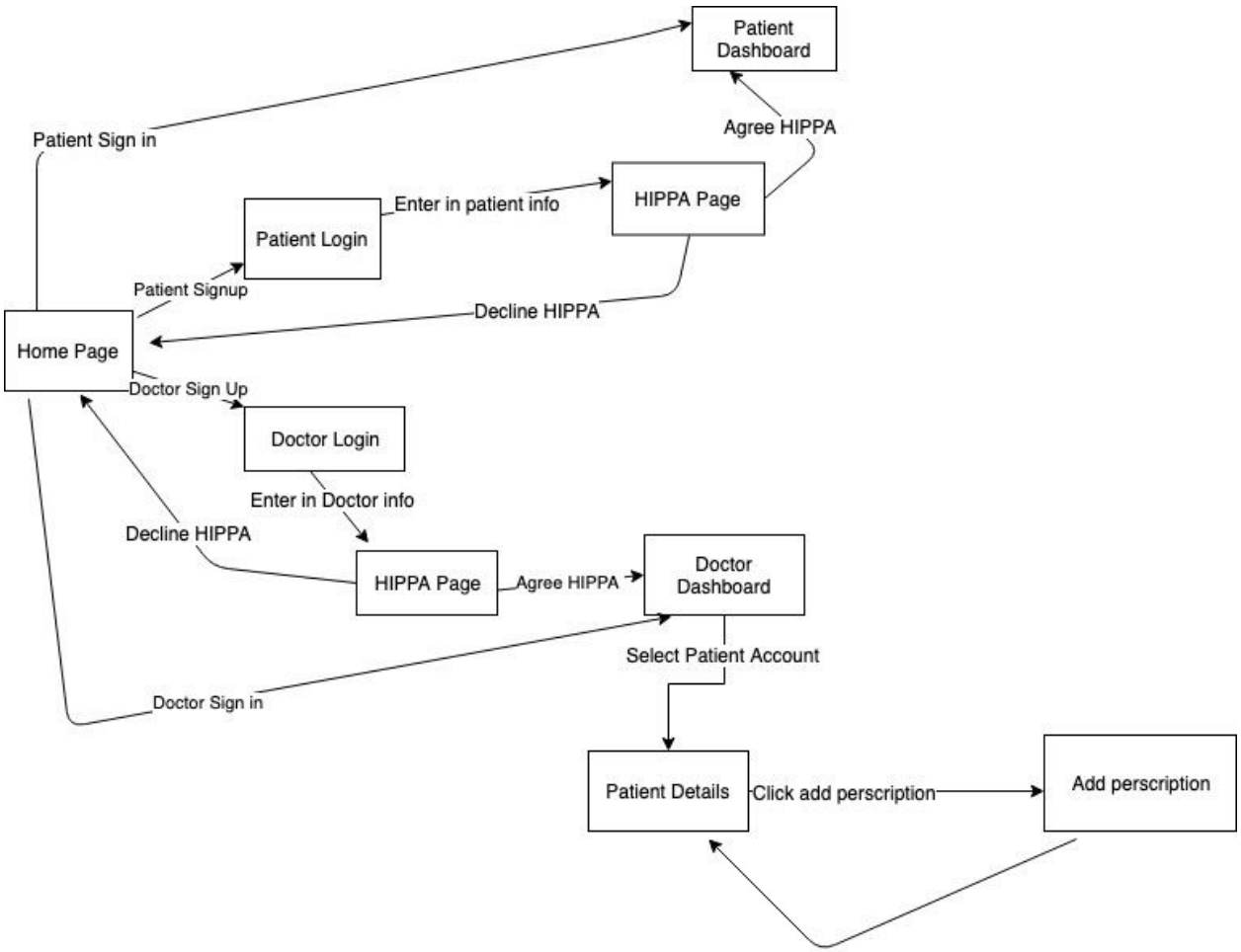
Class Diagrams



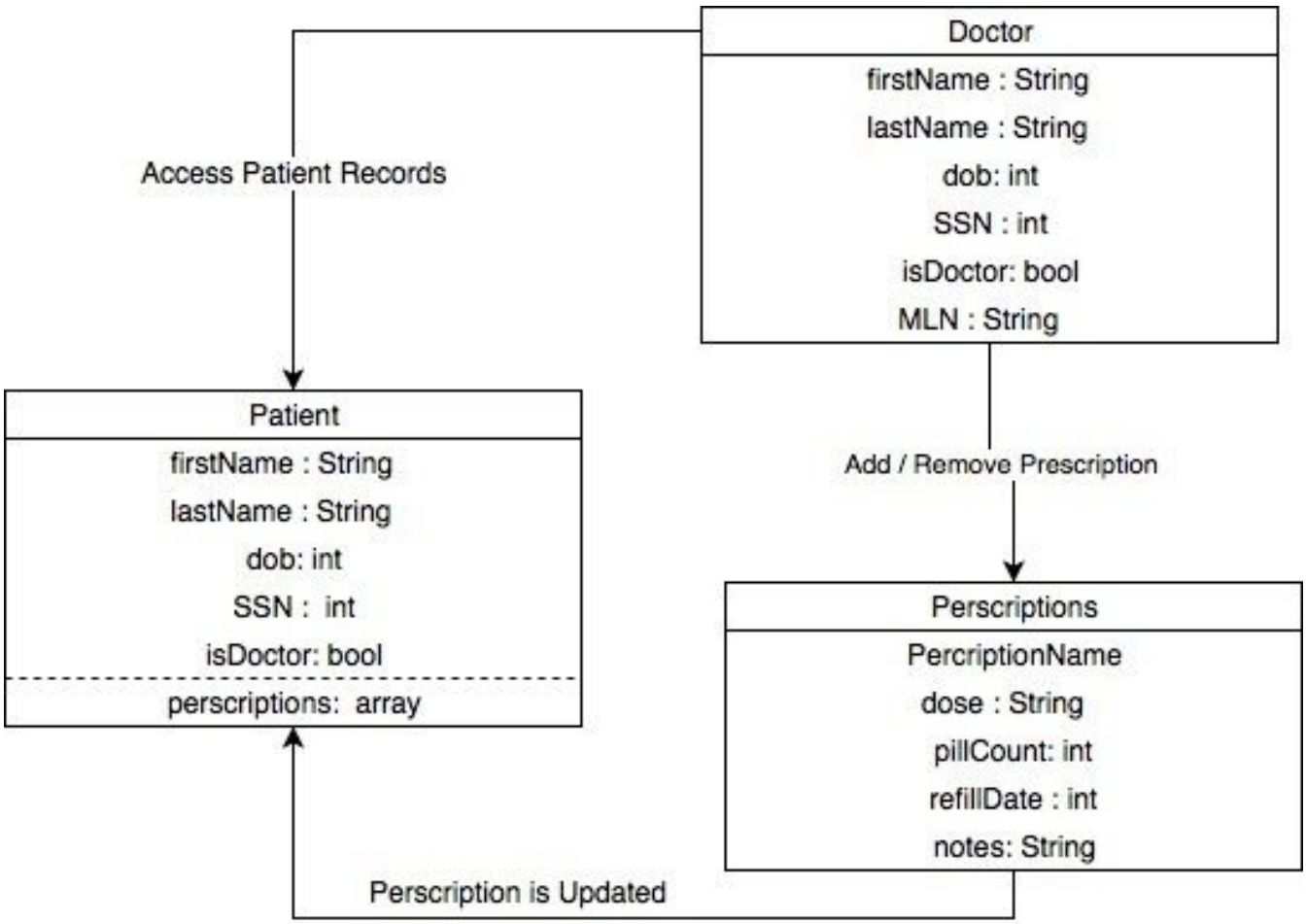
Activity Diagram



User Interface Diagrams



Database Design Diagram



Statement of Dependability

1. **Availability**

   At ReMedFul, the availability of the ReMedFul system is to quickly deliver the services needed when clients request it. When the patient needs to see their medications, ReMedFul is quick and responsive for the patient to open up the web app and look at what he or she has to take today. Patients have an easy responsive interface when looking at their medications so it is simple for them to see what they need for the day and log off as they wish.

2. **Reliability**

   The ReMedFul website delivers services exactly how specified, meaning the ReMedFul web app is easy to use with a clean and simple interface for all patients elderly. ReMedFul made it a goal and a number one priority to make the interface for the users to be friendly, so they do not struggle with inputting their data, this goes for doctors and patients. The specifications were made and delivered accordingly.

3. **Safety**

   Due to ReMedFul using Firebase and HIPAA laws, the ability of the system to operate without catastrophic failure is guaranteed to use without destruction. Firebase and HIPAA protects the system from crashing and burning.

4. **Security**

   In the ReMedFul system, the patients and doctors computers have access into the

Google Firebase. The credentials that they put in the open fields of the dashboards of the patient and doctor assure the ability of the system to protect itself against deliberate or accidental intrusion.

5. **Resilience**

HIPAA and Firebase at ReMedFul also play a role in protecting the system to resist and recover from damaging events. By HIPAA containing the patients and doctors important information, such as SSN's, Medical ID's, and more the recover and resist is protected for all users.

Statement on Distributed Model

1. **Resource sharing**

   The patients' and doctors' fields in information is logged into Google Firebase. Firebase then collects a catalog of the patients' basic information, such as their first and last name, sex, SSN. As well as, the doctors' credentials, similar to patients' info, but requires doctors to enter medical license number, which acts as the primary key in the Google Firebase.

2. **Openness**

   Patient's computer and doctor's computers gain access into the google firebase. From there credentials that they place in the open fields of the respected dashboards of the patient and doctor.

3. **Concurrency**

   The web interface communicates with Google firebase through utilizing JavaScript and JSON into the html code that has been integrated into the webpages.

4. **Scalability**

   The scalablity is more on scaling outwards, this site can be can expanded more on its functionality and processing if more servers were established to handle more traffic on the site. The site can be Used to scale out to more patients and doctors who choose to join the site for their Practices.

5. **Fault Tolerance**

System can tolerate many different inputs from various different patients and doctors. The site can only register the patients and doctors if all proper information is submitted into proper fields on the assigned dashboards of the site. If not, system will request that the user place a valid entry into the fields of the patient and doctor dashboards. Request to login into site will not be granted.

Statement on Security

1. **What are you protecting?**

   We are protecting sensitive patient information. This information includes prescription information such as refill dates, medication names, dosing information, and basic information that is the patient's name, email, and SSN.

2. **Why is this important to #1?**

   This is important information to protect by law due to Hippa regulations. If this information is compromised the patient's medical identity could be stolen. There is a tremendous amount of harm that can be caused by stealing someone's medical information. With such information one can steal actual prescriptions, go to doctors appointments as different people, and even sell valuable information to advertising companies.

3. **How are you protecting #1?**

   We are protecting the patients' information through emails and passwords. Passwords are encrypted on the database side to increase security in case of an attack on the system. A future expansion on the controls of the system can be a dual authentication such as a text, email, or other form of dual authentication. In future expansions there will also be more controls on the doctors account. Doctors accounts should be reviewed after sign up, but before account activation. During this review the doctors information, in specific their license should be review to ensure that only doctors have access to the doctor user interface.

4. **What is your security policy?**

Our security policy goes hand in hand with HIPAA. Through HIPAA, the users of ReMedFul have their important information safe and stored in HIPAA. ReMedFul ensures that all special numbers and prescriptions in relation with the patients are safe and password protected. HIPAA allows ReMedFul to have medical data protection to put the users minds at ease.

Glossary

A:

Agile Methods

Methods of software development that are geared to rapid software delivery. The software is developed and delivered in increments, and process documentation and bureaucracy are minimized. The focus of development is on the code itself, rather than supporting documents (Sommerville).

C:

Continuous Integration

As soon as the work on a task is complete, it is integrated into the whole system. After any such integration, all the unit tests in the system must pass (Sommerville).

D:

Database Manager

Our back-end team. Broken up into Senior and Junior roles. These members worked with Google Firebase and JSON to create a functional library to connect to the front-end.

E:

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A widely-used agile method of software development that includes practices such as scenario-based requirements, test-first development and pair programming (Sommerville).

F:

Front-End Web Developer

Our front-end team. Members worked on design and functionality of the webpages.

H:

HIPAA

Health Insurance Portability and Accountability Act of 1996 that provides guidelines for data privacy and medical information safety.

I:

Incremental Planning

Requirements are recorded on "story cards," and the stories to be included in a release are determined by the time available and their relative priority. The developers break these stories into development "tasks" (Sommerville).

J:

JSON

JavaScript Object Notation

S:

Scrum

An agile method of development, which is based on sprints – short development, cycles. Scrum may be used as a basis for agile project management alongside other agile methods such as extreme programming (Sommerville).

Scrum Master

The ScrumMaster is responsible for ensuring that the Scrum process is followed and guides the team in the effective use of Scrum. He or she is responsible for interfacing with the rest of the company and for ensuring that the Scrum team is not diverted by outside interference (Sommerville).

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