Product Requirements Document

TL;DR

A telemedicine platform to make virtual doctor's visits effective and efficient by enhancing patient-doctor communication.

About the Team

Team Name: Minimum Viable Team
Project Name: Apollo
Company: WELL Health
Lead: Ekta Shahani
Scribe: Terrell Marshall
Members:

Chris Lianides (chrislianides@gmail.com)
Michelle Nguyen (michellehnguyen@gmail.com)
Terrell Marshall (tbmarshall97@gmail.com)
Aditya Nadkarni (nadkarniaditya@gmail.com)
Ekta Shahani (shahani.ekta@gmail.com)

Background

Problem

Doctor visits are inconvenient. Patients must worry about the commute and then actual waiting time despite getting there early for your appointment - and that's if you even made an appointment. Health care is a fundamental right yet it is so difficult to access.

Commuting, wait times, and scheduling are significant barriers to accessing healthcare. Telemedicine seeks to address these problems; however, virtual appointments today do not optimize the quality of communication between patients and doctors.

As it exists today, telemedicine platforms are built around video calls between doctors and patients, and may be integrated with patient information systems. The actual experience of the call remains identical to a video call, and does not offer a way to make up for the lack of an in-person communication where it is simpler to conduct in-depth examinations and clarify points.

Motivation

Expanding digital access to healthcare will increase patient satisfaction, promote patients to access healthcare, and help grow medical organizations.

- 84% of healthcare executives felt that the development of telemedicine services is important to their organizations.
- 74% of patients are comfortable with communicating with their doctors using technology instead of seeing them in person.
- 67% of patients say that using telemedicine would increase their satisfaction with medical care.

Existing solutions

- PatientAccess Mobile App
    - Connect patients to healthcare services (book GP appts (remote or in person), order prescriptions, explore pharmacy services, symptom information, view medical record (immunizations, test results, allergies, etc))
- Teladoc, DoctorOnDemand
    - Patients enter symptoms before video appointment and video conference with doctors affiliated with the platform.
- SutterHealth Patient Portal
    - Centralizes messages, health records, appointments, and billing for patients.
    - Live chat support
    - Example of technology behind large healthcare providers

Strengths of existing solutions

- Reporting symptoms is simple and can be done online by the patient.
- For larger providers, information like health records and past prescriptions is easily accessible in a central location.
- Virtual visits save patients time overall.

Gaps in existing solutions

- The actual virtual visit experience does not provide value beyond video conferencing.
    - 41% of millennials trust physicians as the best source of health information.
    - Lack of in-person communication due to virtual visits could negatively influence this already low number.

    - Solutions do not harness technologies that make online communication easier than face-to-face communication. The ability to communicate with someone who speaks a different language is a key example.
- Doctors cannot record patient vitals before visit.
- Types of visits that can be conducted virtually are limited to common conditions that can be easily described and recognized (e.g. fever, allergies, flu) and addressed with a prescription.
- The post-visit experience is largely dependent on the information put forth by healthcare providers.
    - Less than 25% of millennials agree that doctors and pharmacists give them the information they need to make decisions

Note: Our target user group consists of people trying to save time through virtual visits. This group is comfortable with technology and trusts to engage with a telemedicine platform. Thus, millenials are a key target demographic.

Core Technical Advance

One of the project's ambitions is to extend the types of ailments that can be treated virtually, by using computer vision to guide patients through physical therapy. From the patient's view, they will be prompted with different illustrations of physical therapy poses to follow. The program will be automated to notify the patient when they do the exercises correctly. This will visually enhance the telemedicine experience for physical therapy treatments.

Language barriers diminish the quality of healthcare services to the patient. To address this, Apollo will provide patients with real-time multilingual speech-to-text transcription. We will use Google's Cloud Translation API to translate the doctor's English audio into text and then translating it to the patient's language. The text will be displayed as a caption for the patient to read. The patient's audio data will be processed similarly except the API will transcribe their foreign audio data into the text of their native language and then translating that text into English for the doctor to read.

Another issue with virtual doctor visits is that doctors are unable to retrieve their patient's vitals. Without the vitals, doctors will not have a baseline to judge their patient's condition. To solve this problem, we plan to use Fitbit smartwatches to send live heart rate data directly from the patient to our application, for the doctor to analyze. Heart rate also fluctuates in conjunction with a person's pain reception. Real-time heart rate readings will inform the doctor if the patient is experiencing new pain during the video call. This will be helpful specifically for telemedicine physical therapists to make sure their patients are not in any unnecessary extra pain while performing exercises.

Goals

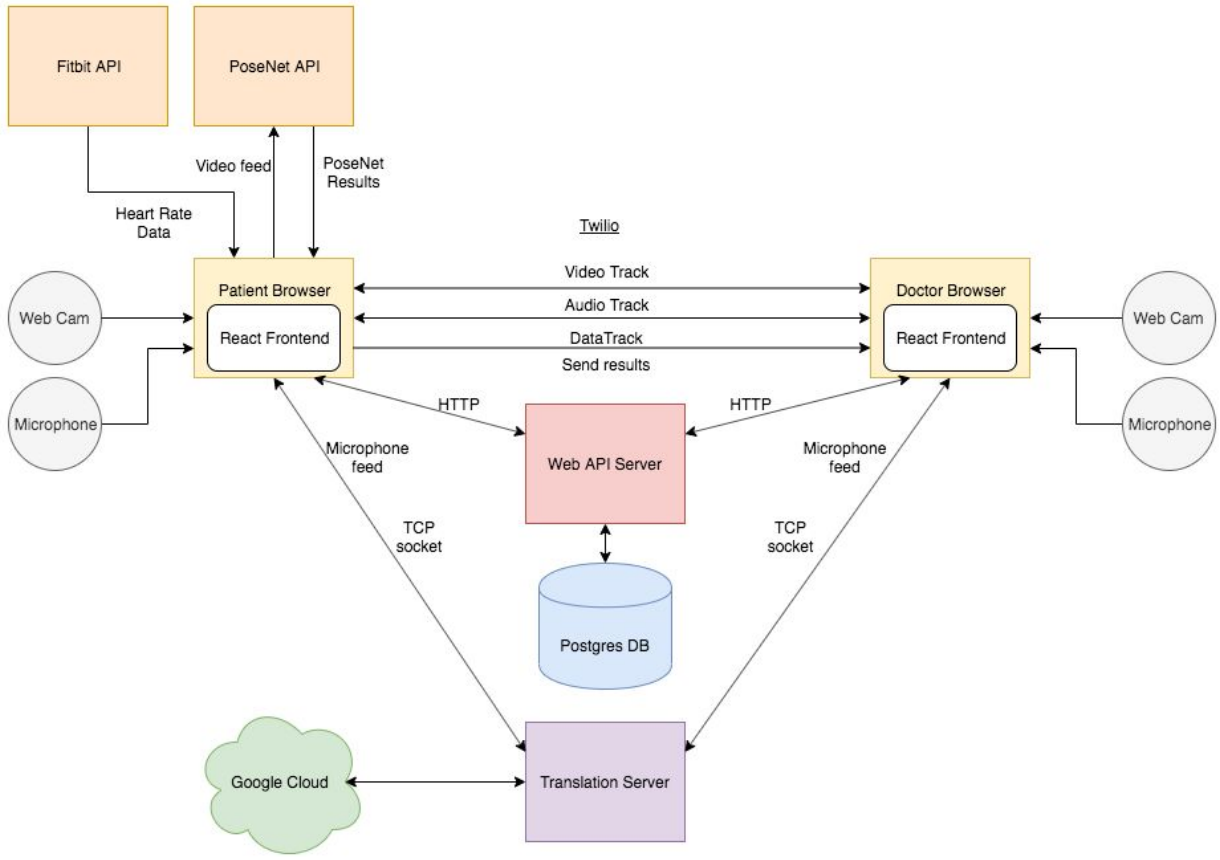
Existing telemedicine solutions utilize video conferencing to connect patients and doctors. Our goal is to augment the patient experience of virtual doctor's appointments and make virtual visits as effective as in-person visits by:

1. Improving virtual patient-doctor communication by allowing patients to communicate with any doctor in the language of their choice without a translator
2. Collecting patient data from wearables to better inform doctors about patient's current state during virtual visits.
3. Target a new use case for virtual visits by allowing doctors to demonstrate physical therapy exercises and have patients follow along with a virtual guide.

Assumptions

1. Doctors and patients using this platform are associated with a particular clinic.
2. Clinics using this platform already have access to detailed patient information and medical records.
3. A sizable number of patients have Fitbit devices.

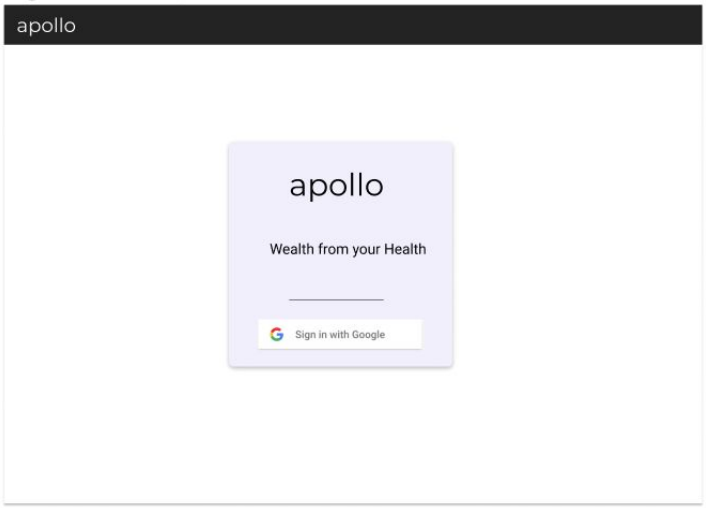
Architecture Diagram



Primary UI Mockup

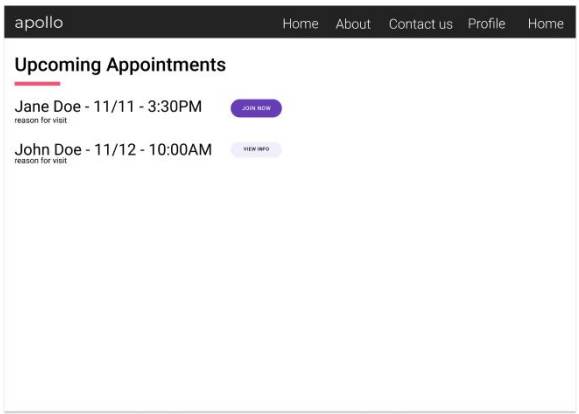
1) When app is launched for the first time

Sign in - Doctor/Patient

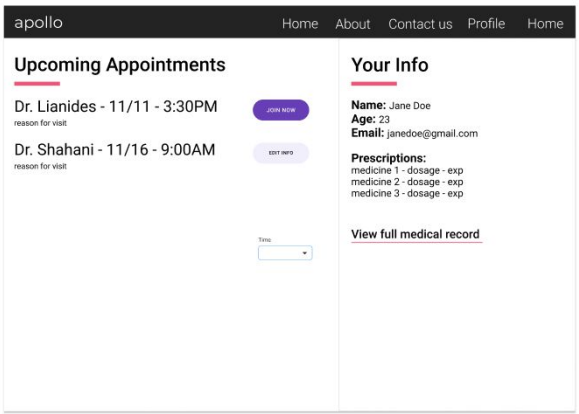


2) User signs up/in as a patient or doctor and is directed to profile page

Profile - Doctor

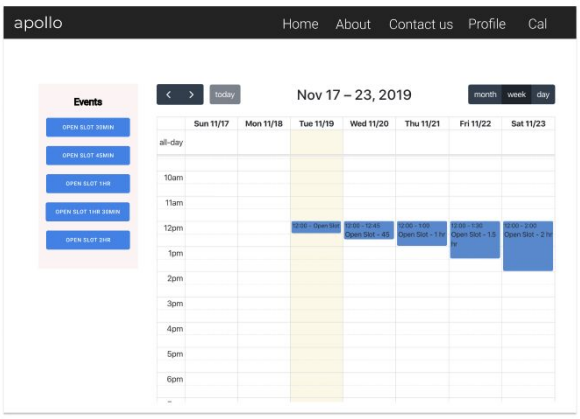


Profile - Patient

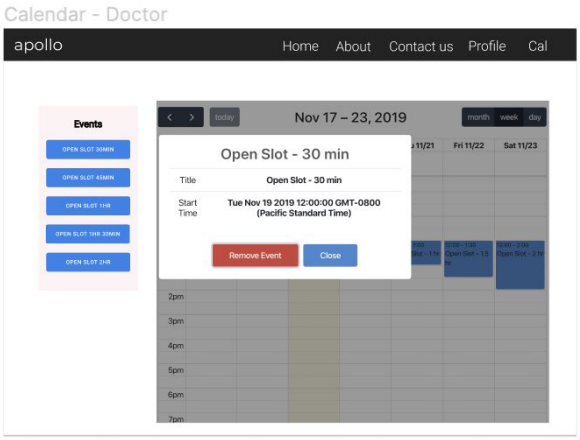


3) Doctor will input available time slots for appointments

Calendar - Doctor

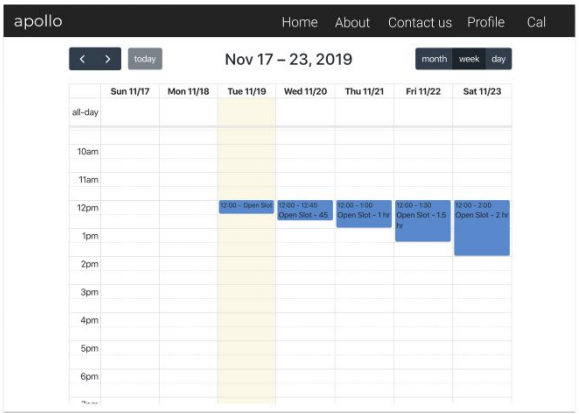


Calendar - Doctor

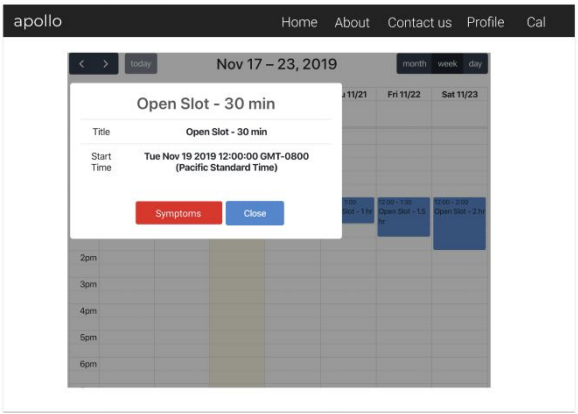


4) Patient will select available time slot of their choice

Calendar - Patient

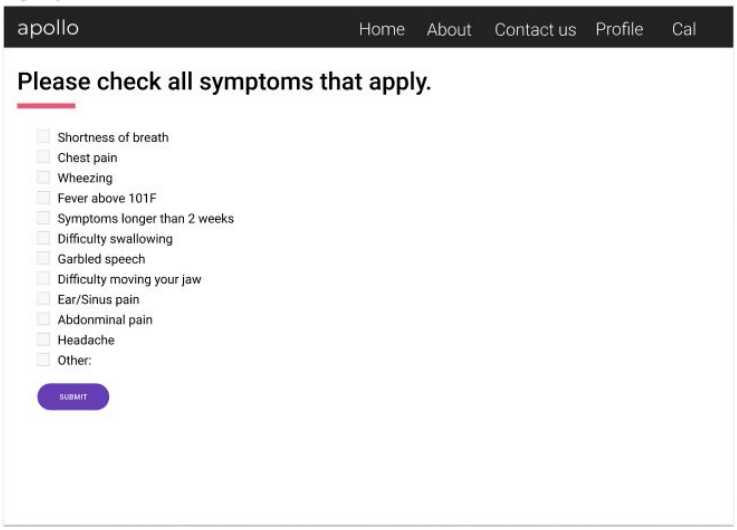


Calendar - Patient



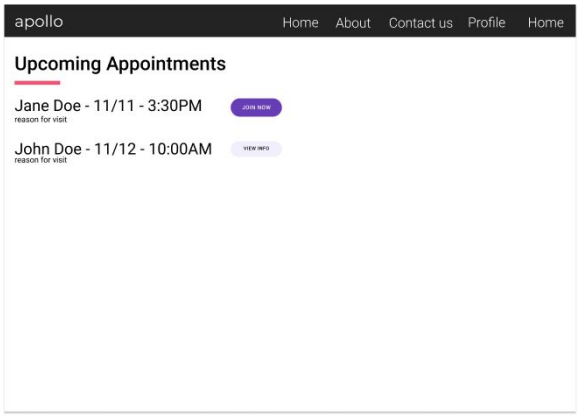
5) After the patients clicks on “Symptoms”, they will be directed to the symptoms page where they will checkbox any symptoms they are experiencing

Symptoms - Patient

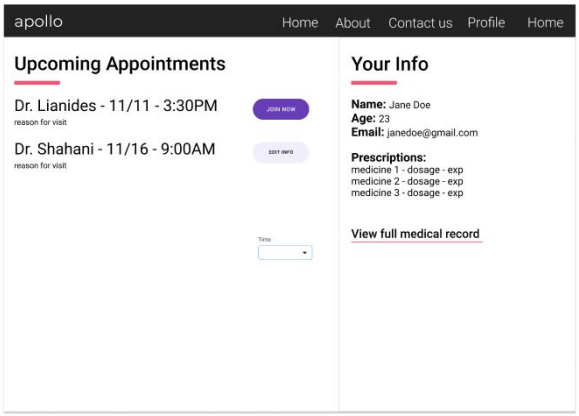


6) To enter the video chat when the appointment is about to start, user will select “join now” to the specific appointment

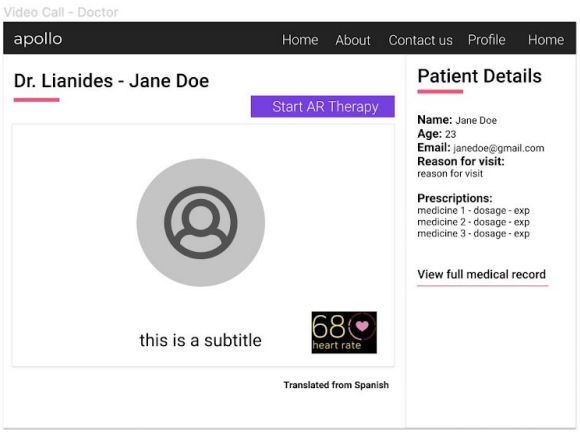
Profile - Doctor

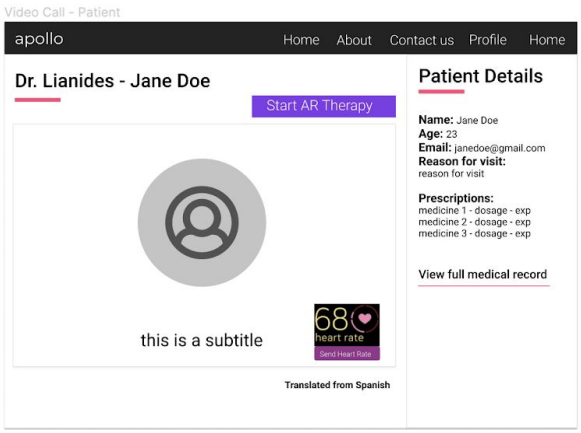


Profile - Patient



7) Once both users have entered the chat, the patient has the option to share their live-heart or start the AR physical therapy exercises by “Send Heart Rate” or “Start AR Therapy”. The Doctor will also have the option to start physical therapy the same way.





User Stories

End-To-End Pipeline

User Story: As a user, I can send a message to the server through a client app, which is added to a database, and retrieve the message afterwards through the client.

Acceptance test: Given the client and server are running, the described behavior accurately updates the frontend and database and the server gets and sends the correct API calls.

Time estimate: 1 week

Github commits:

- Initial skeleton setup
- Client and server communicate
- Client input form
- Docker container set-up + Server->Database Communication

Logging in / Signing Up

User Log In

User Story: As a user, I will be able to log into Apollo through my Google account.

Acceptance test:

On the sign-in page user can select their Google account and submit it for authentication. Upon successful login, user is redirected to the homepage.

Time estimate: 3 days

Github commits:

- Firebase authentication
- Redirecting to home page

User Sign In

User Story: As a user, if I am signing into Apollo for the first time, I can enter my name, email, and select whether I am a patient or doctor.

Acceptance test:

After signing up as a new user, when the user signs in for the second time, their name, email, and whether they are a patient or doctor can be retrieved from the database. They will not have to go through the sign up flow more than once.
Time estimate: 1 week
Github commits:

- Log-in Changes and saving proper info in DB

Scheduling an appointment

Patient scheduling
User Story: As a patient I can view any of my doctor's available time slots so that I can schedule an appointment that works for both of us.
Acceptance Test: Given patient has logged in, when they navigate to the 'Schedule Appointment' page then they can select a doctor, see their doctor's available time slots on a calendar, and schedule an appointment in that time slot. Then the slot is marked as unavailable in the doctor's calendar, and both the patient and doctor can see the appointment set up at that time.
Time estimate: 2 days
Github Commits:

- Patient calendar functional, updated add appt route

Doctor views calendar
User Story: As a doctor/medical staff, I am able to view a calendar of my patient appointments and my existing available time slots, so that I am informed about my work day calendar.
Acceptance Test:
Given the doctor is signed in and has open time slots and appointments scheduled, they can return to the calendar page at any time to view them and click on the events to view more details.
Time estimate: 1 day
Github Commits:

- Display appts & open slots

Doctor edits calendar
User Story: As a doctor/medical staff, I am able to edit a calendar of my patient appointments and my available time slots, so that I can have full control over my work day calendar.
Acceptance Test:
Given the doctor is signed in, they can add open time slots and delete existing time slots and appointments. These changes will be reflected for patients viewing the doctor's available time slots.
Time estimate: 1 day
Github Commits:

- Doctor can add open slots

Display appointments
User Story: As a doctor or patient, I am able to see a list of my upcoming appointments through my profile page.
Acceptance Test:
Given the user is signed in, they can see a list view of any appointments scheduled through the calendar on their profile page. This will include the patient and doctor names, time and date, and an option to join the video call if the appointment has begun.
Time estimate: 2 days
Github Commits:

- Retrieve db entry in Appointments table for specific user with GET request

Medical Information

***Use Case**: Enter/Update Symptoms*
Actors: Patient, Health System, Patient Information Database
Precondition: Patient has logged into the system and entered their profile. They have just scheduled an appointment through the calendar.
Flow of Events:
Basic Path:

1. System retrieves patient account from the database
2. System asks the patient to choose one option from a general list of grouped symptoms.
3. Based on the selection, system asks a followup question with more specific symptoms based on the original question. Patient can select more than one option here.
4. After two rounds of questions, the patient clicks, 'Submit Symptoms' and sees a confirmation dialogue.
5. System updates the database with the new Patient information.

Alternative Paths:

1. In the case that the symptom is not listed, there will be an 'Other' option and the followup question will consist of a free-response section.
2. Patient logs out, clicks cancel, or leaves the page at any point before hitting 'Submit Symptoms'. System redirects to the Patient Portal.

Postcondition: Patient's symptoms data has been updated in the Patient Information Database
Time estimate: 2 days
Github commits:

- Symptoms stub page
- Checkboxes work and state is changed/collected from unchecking/rechecking before submission
- Send POST request with array of symptoms to server

Access patient records and symptoms
User Story: As a doctor, I am able to access my patient's information through their appointment slot, so that I know what to expect before our appointment.
Acceptance Test: Given that the patient has submitted their symptoms, when the doctor opens up the calendar to see their upcoming appointments, the doctor can view the appointment details, which will contain the patients' reported symptoms.

Time estimate: 1 day
Github commits:

- View patient symptoms from clicking on an appt in the calendar

Live Appointments

Video call
Story: As a patient or doctor, I can video conference via the web app for a virtual appointment.
Acceptance Test: Given an appointment is in session, when both the patient and doctor have joined the video call, then they can see and hear each other live.
Time estimate: 4 days
Github commits:

- Video calling integrated into project

Real-time content sharing
Story: As a patient, I can share and annotate pictures, links, and documents with my doctor in real-time during a video call so that I can share specific concerns with my doctor.
Acceptance Test: Given a picture, document, or link on a patients' laptop, when selected by the web app, then the patient and doctor can see the content and draw on the item.
Time estimate: 2 weeks
Github Commits:

- Currently N/A

Real-time system information sharing
Story: As a doctor, I can view or share and annotate a patients' records or notes from previous appointments with my patient in real-time so that I can clearly explain my observations and diagnosis as needed.
Acceptance Test: Given a patient information already contained in the system, when selected by the web app, then the patient and doctor can see the record and draw on it.

- Note: The system will not connect to a real EMR system.

Time estimate: 2 weeks
Github Commits:

- Currently N/A

Use case: *Live translation*
Actors: Patient, Doctor, system
Precondition: Patient and doctor are both in a video call. Doctor is speaking in English. Patient is speaking in a non-English language that is supported by the system.
Flow of Events:
Basic Path:

1. Doctor questions patient in English.
2. Patient sees captions in their language of Doctor's speech in realtime.
3. Patient answers questions and describes problems in their language.
4. Doctor sees captions in English of Patient's speech in realtime.

Alternative Paths:

1. If captions do not appear or are significantly delayed, the patient or doctor can indicate the problem through a chat box.
2. The patient / doctor can communicate through the chat box, which will translate their text appropriately, or reiterate until captioning resumes.

Postcondition: Any post-visit information generated will be available in both languages for both the doctor and patient.
Time estimate: 3 weeks
Github commits:

- Browser to server translation
- Added single-utterance to Speech-To-Text config
- English -> foreign language translation working

AR Physical Therapy (Patient Side)
User Story: As a patient, I am able to show my body on the screen so that the system can recognize my actions and I can follow along.
Acceptance Test: Given the patient's body is visible through the webcam, the patient can listen to the doctor's instructions and move their body according to the virtual lines displayed by their screen. The virtual line with first outline the patient's body in a greyed out line. The correct position of the therapy movement will be shown in yellow and will turn green once the patient has formed the correct position.
Time estimate: 3 weeks
Github Commits:

- PoseNet API works in our web app
- Fix PoseNet warning message

Share Live Heart-rate

Fitbit Heart rate
Story: As a patient, I can open the Apollo Fitbit app on my watch and view my live heart rate on my Fitbit.
Acceptance Test: Given the app is running, when the patient's heart rate changes, then the heart rate displayed on the watch changes.
Time estimate: 1 week
Github Commits:

- Currently N/A

Video call heart rate
Story: As a patient, I can open the Fitbit app on my phone to send my heart rate to the Apollo web app.
Acceptance Test: Given the Fitbit app is running, when the patient is in a live appointment, then both the doctor and patient can view the patient's live heart rate in the Apollo app.
Time estimate: 2 weeks
Github Commits:

- Currently N/A

Get next steps

Access information from completed appointment

User Story: As a patient, I can review my appointment details which contains an automatically generated appointment summary, action items and documents referenced during the appointment via email/webapp, so that I remember exactly what happened during an appointment and I know what to do next to best treat my symptoms.

Acceptance Test: Given the patient has completed a virtual appointment with their doctor and the patient is in the webapp, when the patient interacts with that appointment, then Apollo displays to the patient a pop-up that shows (in this order) an appointment summary, next steps, and documents shared during the appointment (this flow can also be completed similarly in an email that would link the user to the webapp).

Time estimate: 1 week

Github Commits:

- Currently N/A

Get a second opinion

User Story: As a patient, I can request a "second opinion" while viewing an appointment summary, so that I can feel confident that I am receiving the best, peer-reviewed treatment possible

Acceptance Test: Given the patient has completed a virtual appointment with their doctor and the patient is in the webapp, when the patient is viewing their appointment summary and requests a second opinion, then Apollo suggests doctors that specialize in their symptoms for the patient to choose from and proceed to schedule another virtual appointment with that doctor.

Time estimate: 1 week

Github Commits:

- Currently N/A

Follow referral

User Story: As a patient, I can be notified via email/webapp notification when I have been referred by my doctor and be guided to an appointment set-up flow, so that my referral process is as quick and as seamless as possible

Acceptance Test: Given the patient is activated on Apollo, when the patient is referred by their doctor, then Apollo sends a push notification and/or email to the user which will notify them that they have been referred to [Doctor name] and offer an option to the user from the notification to quickly launch an appointment set-up flow. This flow can take one of two forms:

- **Doctor is activated on Apollo -** this will simply trigger the default make appointment flow and notify the doctor within the webapp when the appointment has been created
- **Doctor is not activated on Apollo -** from the patient's side, this looks the same as the previous option, but after finishing the appointment setup flow, this will create a templated email with the patient's preferred times, symptoms, record, etc, and allow the patient to review the email in-app before sending it out

Time estimate: 1 week

Github Commits:

- Currently N/A

Recommend next steps / follow up appointment

Automatically generated "next steps"/appointment summary

User Story: As a doctor/nurse, I can optionally review/modify Apollo's automatically generated "next steps," so that I can quickly ensure my patient is receiving the best treatment possible.

Acceptance Test: Given the doctor is engaged in a virtual appointment with their patient, when the appointment is about to end/has ended, then Apollo displays automatically generated "next steps" on the screen, and the doctor has 4 choices to deal with the pop-up: approve, edit, assign, or dismiss

- **Approval** will send the next steps to the patient through the webapp and potentially via email
- **Edit** will allow the doctor to manually fix any errors in Apollo's auto generated "next steps" and/or attach any relevant documents
- **Assign** will pop-up a list of the doctor's assigned nurses to quickly assign-to so they can review the "next-steps" and the doctor can move on with their day
- **Dismiss** the pop-up which will not send patient "next steps" at all

Time estimate: 3 weeks

Github Commits:

- Currently N/A

Refer the patient to another doctor/specialist

User Story: As a doctor/nurse, I can refer my patient to another doctor directly within Apollo, so that I can quickly refer the patient without having to waste time finding that doctor's contact information through external services and I don't have to waste time reaching out to that doctor myself

Acceptance Test: Given the doctor has had one appointment scheduled with a given patient (could be an appointment in the past or upcoming), When the doctor visits that patients profile and clicks "Refer patient," Then Apollo automatically suggests doctors to refer to the patient depending on the symptoms the patient entered into the appointment details or the doctor can manually search for the doctor And after clicking on a doctor, there are 2 possibilities:

- **Doctor is activated on Apollo -** this will simply notify the "clicked-on" doctor's practice that this given patient has been referred to them from within the webapp. There will be an additional experience on the patient's side as well
- **Doctor is not activated on Apollo -** this will automatically generate a template email based on the symptoms the patient entered on their most recent appointment creation. This experience will be continued on the patient's side

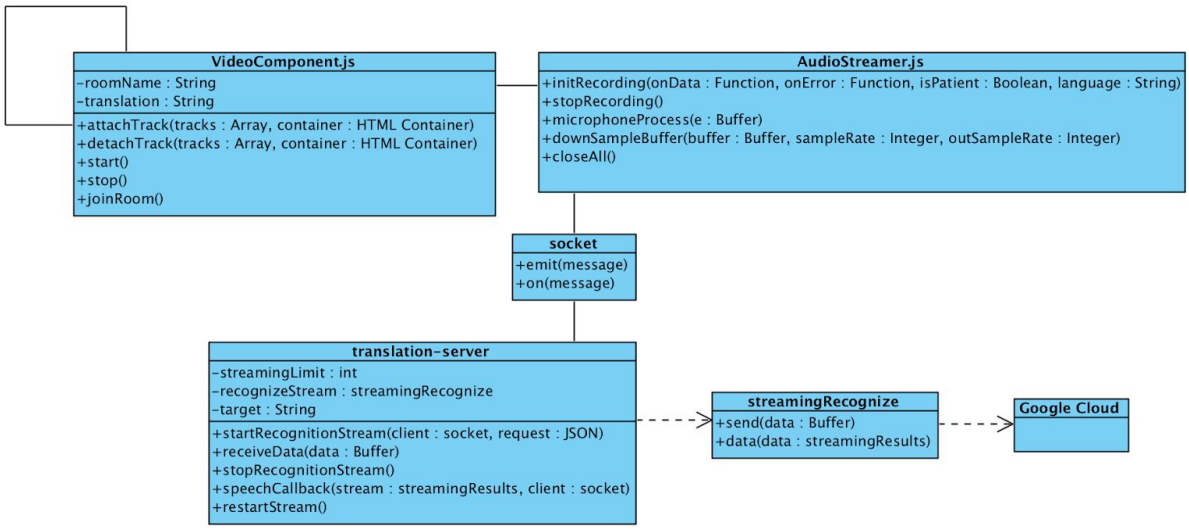
Time estimate: 2 weeks

Github Commits:

- Currently N/A

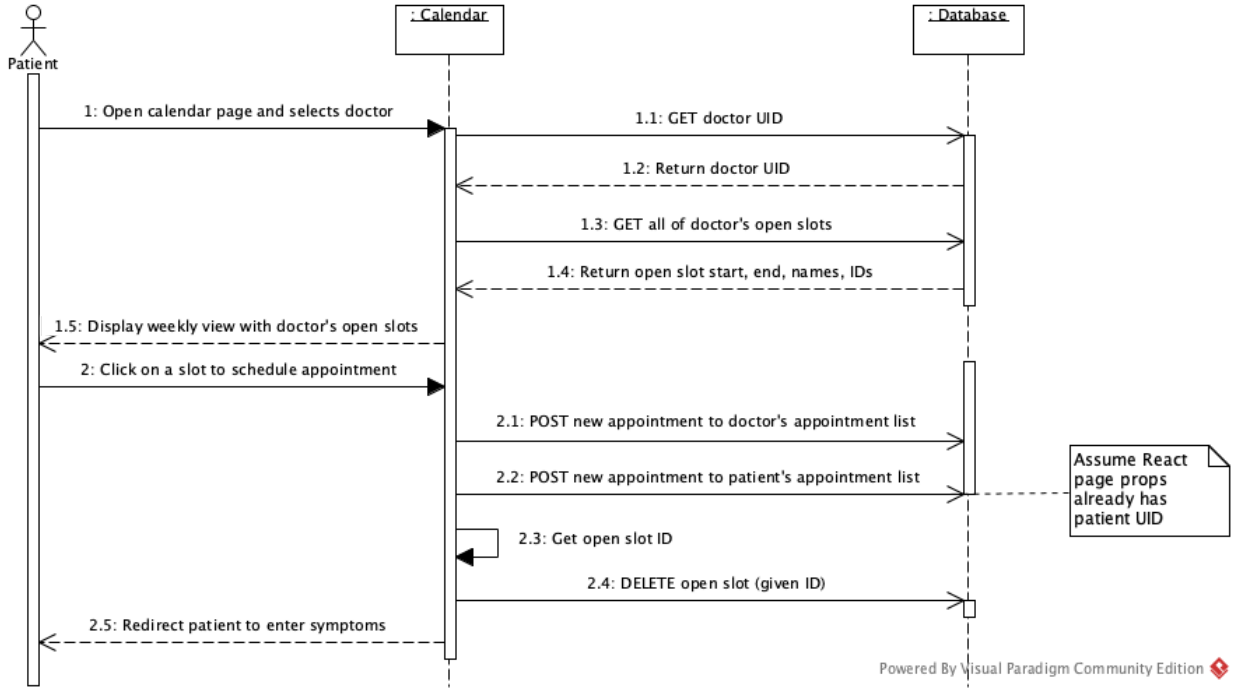
System Models

UML Diagram - Translation

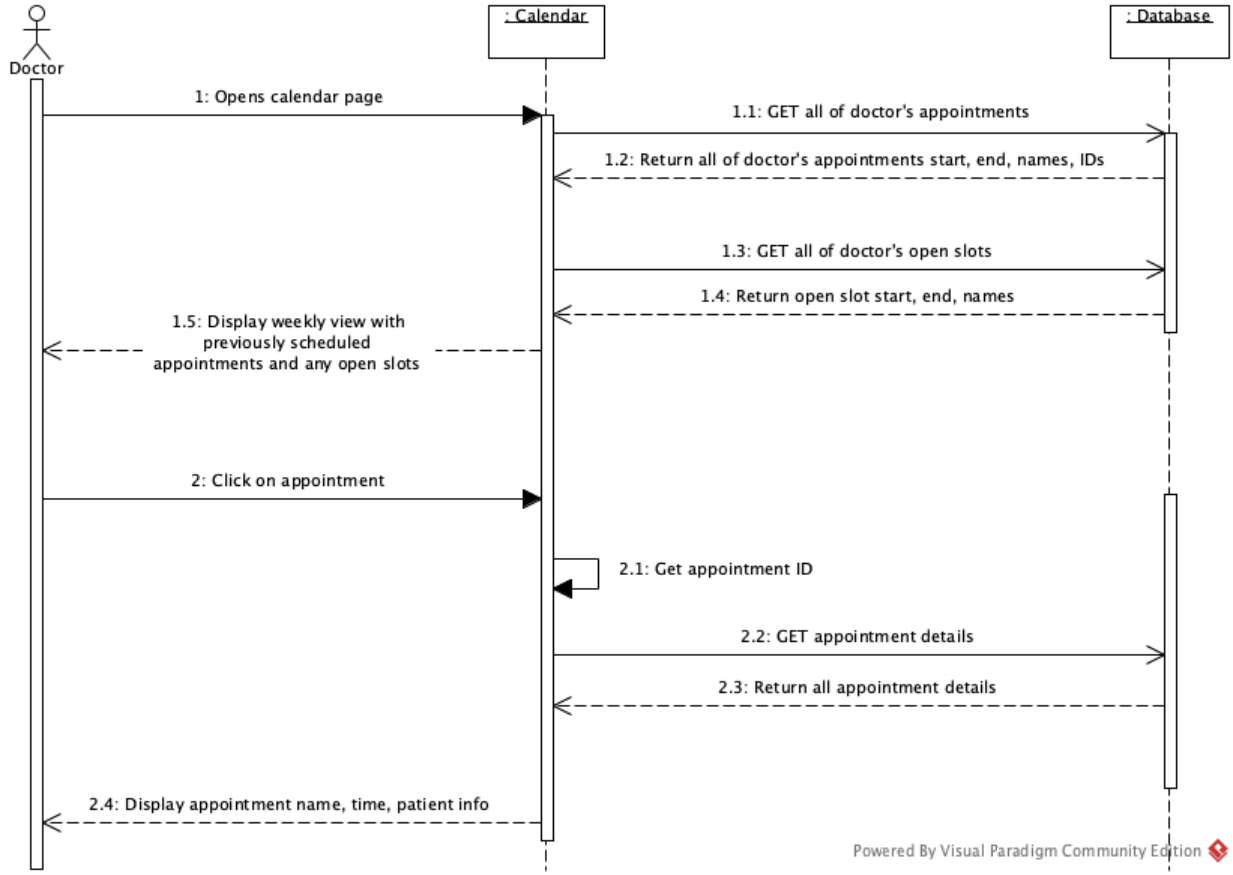


Sequence Diagrams - User Interactions

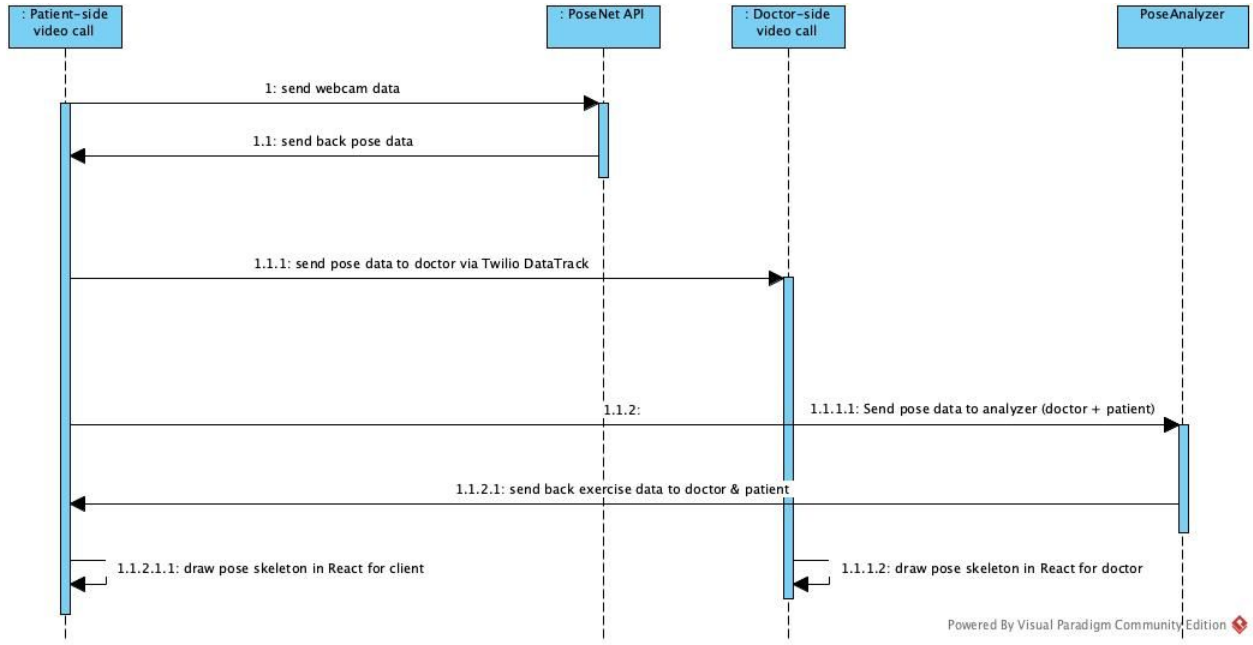
Patient creates appointment



Doctor views appointment details

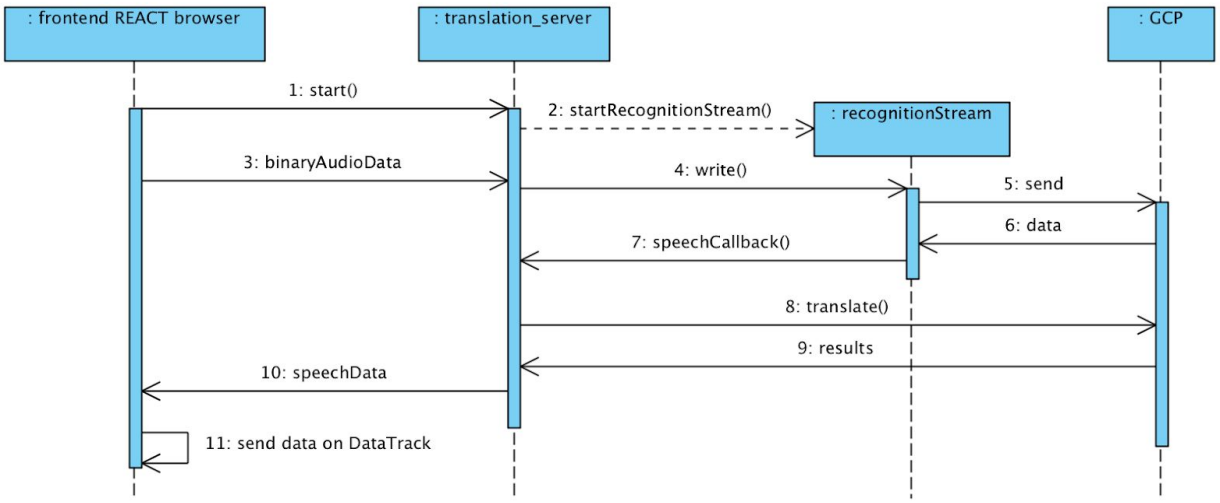


PoseNet Video Call Patient-Doctor Sequence

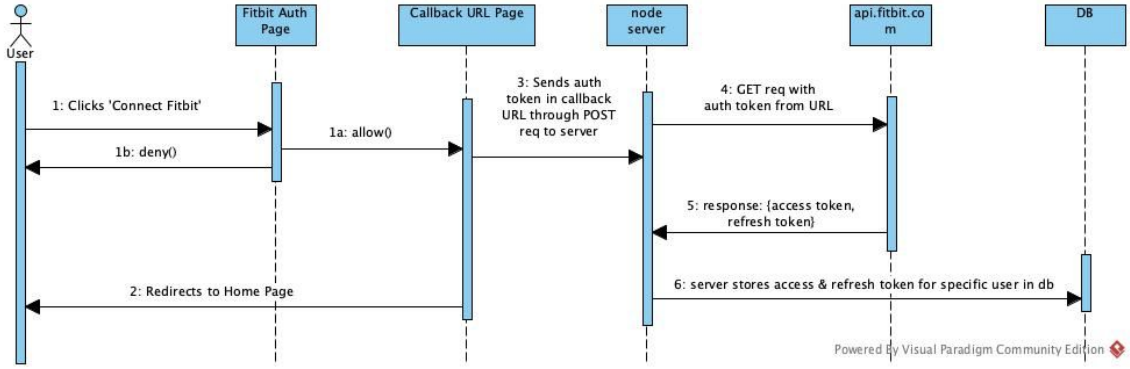


Sequence Diagrams - Class Interactions

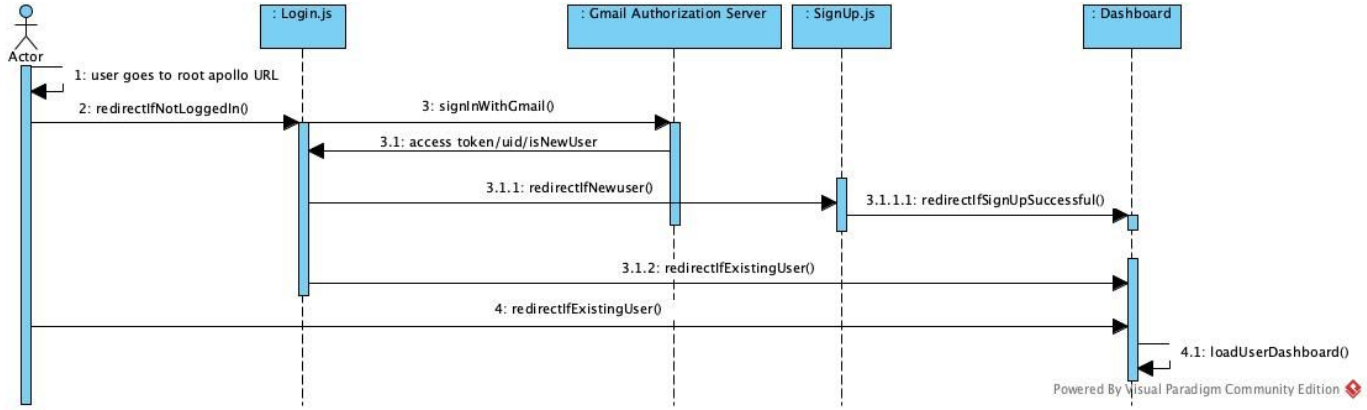
Translation



Fitbit Authorization



User Authentication



Appendix

Technologies

Client-side

- React

        - Used to build UI components and manage state of frontend components.
    - React-bootstrap
        - Used to safely integrate bootstrap components with React frontend.

Server-side

- Node.js
    - Used to build our application servers. This includes a REST API that handles database updates and authentication and a translation server that interfaces with GCP Speech-to-Text.
- Koa
    - Web framework for Node.js used to create routes in our REST API.
- Socket.io
    - Used to manage TCP connection to stream audio and text data between the client and translation server.
- Node-pg
    - Wrapper around the Postgres C++ client library to send queries to a Postgres DB in Node.js

Database

- Postgres
    - Our primary database for this project. Used to manage patient, doctor, appointment, openslot data
- Firebase
    - Used for generating unique UIDs, handling login with gmail, and general user management

API's

- Twilio
    - Used to facilitate the video call between the patient and the doctor. Sends audio, video, and data (translate, poseNet, heart rate) between both parties
- GCP Speech-to-Text
    - Used to convert stream of audio data into text.
- Google Translate
    - Used to translate transcription provided by GCP Speech-to-Text.
- PoseNet
    - Used for AR Physical Therapy for generating keypoint data that will be analyzed in the React front-end
- FullCalendar
    - Used to surface a convenient calendar conditionally populated with Postgres DB information to a patient or doctor
- Fitbit
    - Used to keep track of a patient's heart rate in real time while engaged in a virtual appointment. Can be correlated to a user's current pain level during physical therapy. Also uses a fitbit watch app and fitbit mobile companion app

Resources

https://www.forbes.com/sites/forbestechcouncil/2019/04/09/five-ways-millennials-do-health-care-their-own-way/#66e4003220c5

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