CIS 400 Senior Project
Spring 2018 Final Report

1 Student Information

List the names and Penn email addresses of all members of the team. Also, please indicate your team or project name.

Mindful - Group 21

- Daniel Moreno

- Anvita Achar

- Francisco Selame

- Karinna Loo

2 Advisor Information

List the name and Penn email address of your CIS faculty advisor. Also, please document all the meetings you have had with your advisor this semester.

- CIS Advisor: Chris Callison-Burch

Faculty Advisor Meetings

- 1/26/18: Discuss goals for the rest of the semester.

- 2/1/18: Progress update on development; working with user accounts.

- 2/9/18: General updates on progress; quick meeting.

- 2/16/18: Replacing face expressions with out of box version; general testing of product.

- 2/23/18: Added a settings page, minor bug fixes

- Spring Break: No meetings

- 3/16/18: Final polishes on the app UI

- 3/23/18: Spoke about adding streaks and gamifying the app

- 3/30/18: Talked though MTurk funding opportunities and how to gather the data correctly.

- 4/6/18: Final thoughts, advice, gave CCB a thank you card

3 Summary

Describe your project in one sentence.
We built a mental health journaling iPhone application that uses real-time facial expression recognition, natural language processing and sentiment analysis on our users voices to help them track their mental wellbeing.

4 Overview of Problem and Approach

Briefly describe the problem you set out to solve and how you approached solving it.

4.1 Background

The growth in demand for counseling services in college campuses outstrips supply. 76% of undergraduate students reported dealing with depression or anxiety in the last year, but only 13% reported getting treated for said depression or anxiety. Mentally healthy students are more likely to perform better academically, as well as to contribute to the community of the university. Universities have the responsibility to keep their students safe physically, emotionally and mentally. This aligns to our experience at Penn with services such as CAPS and beyond.

4.2 Requirements

We decided to build a tool for college students to better keep track of their mental health. Our requirements for the solution were that it should be a lightweight application that offers as little as friction to our users as possible. Our users should be able to pull out their phones and track their mental health with ease. It would have to keep this information secure, and be compelling enough to encourage regular tracking.

5 Implementation

Describe what you built/implemented in your project, including the system architecture, implementation details for each component, and how components communicate.

5.1 Proposed Solution

We gained inspiration from personalized physical health indicators such as apps that track the number of steps taken, calories consumed and hours of sleep in order to implement similar mental health indicators in an iOS application. We also referred to research that establish the psychological benefits of journaling with regards to reducing stressors and anxiety. We built an augmented journaling iOS application that understands you. Our users open the application, begin recording audio and video guided by our prompts, and then store their entries when they are done. In the background, we analyze the users facial expressions in real-time, as well as process the input text for sentiment. We also take into account the user's context (time of day, weather and location) during each entry and present that information to the user.

Figure 1: Mindful recording and journal interfaces

5.2   System Architecture

Our iOS client authenticates each user with information stored on our Firebase. In the recording screen, the camera tracks facial expression in real-time in the background by analyzing facial landmarks from the video frames. When the user taps the record button, we start transcribing the audio of the entry and running it through our sentiment analysis model using the CoreML framework. We also make API calls to the weather and location APIs provided by Apple. We then combine the facial expression and natural language processing measurements into a score. We store this back in Firebase and add it to the journal entries, displayed on the left view of the application. The right screen displays a user's streak, or how many days they have journaled in a row.
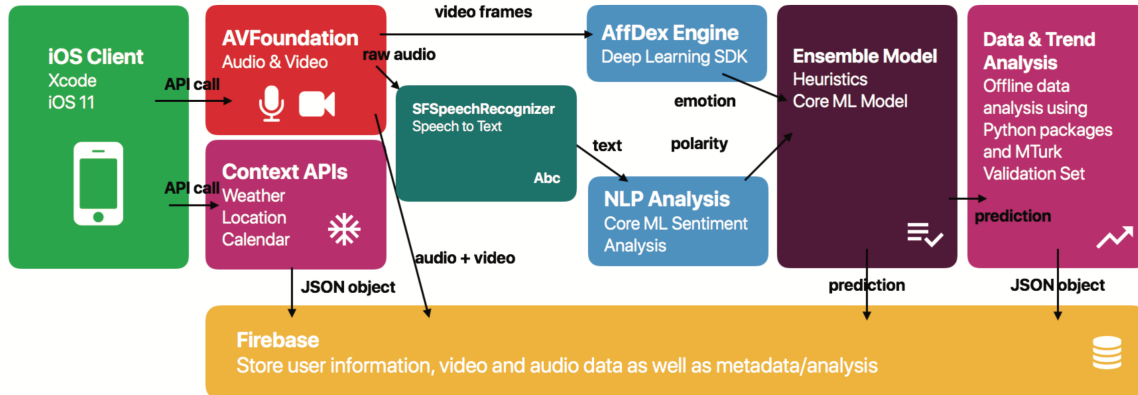

Figure 2: Mindful system architecture

6   Evaluation

Describe how you determined that your solution solved the problem that you have identified. We used different evaluation methods to test different components of our application, relying on both qualitative and quantitative measures.

1. UI/UX: We beta tested our application on a sample of college students at Penn. They provided qualitative feedback on the design and usability of our application. We synthesized their recommendations and iterated on the design based on their feedback. We saw the net promoter score steadily increase

2. Text Emotion Classifier: We trained an LSTM to classify text samples according to the dominant emotion they expressed. We trained our models on the ISEAR dataset, which was built by psychologists across the globe over a period of several years. We used cross validation to evaluate our models during parameter tuning, and then did our final testing on a hold-out set.

3. We first built our own landmark tracker to estimate facial expressions on a frame by frame basis. Due to the difficulty of obtaining training data for our facial classifier, we moved towards using an SDK as a fallback for this component of the project. We evaluated several different options based on cost, ease of integration, and reported accuracies before settling on our final solution. We get accurate results with very low latency using this solution.

4. Ensemble testing: In order to test our ensemble classifier, we built a validation dataset using Amazon Mechanical Turk. We had our Turkers submit short 2 minute videos responding to sample prompts in our application. They also labeled their videos according to the predominant emotion they displayed during the clips. We tested our ensemble model on this data.

7   Individual Contributions

Describe each team members primary contributions to the project.
Daniel Moreno and Karinna Loo worked primarily on the front end aspects of the application. Dan took lead on utilizing a new face classifier for emotions that made our app smoother by not evaluating data by each frame. He also added in contextual information about the user, like their location, and the weather on the day that they submitted their journal entry. Thirdly, he added a new view which allowed users to see an overview of their past journal entries. Karinna worked on other UI aspects of the application, such as creating a settings page for the user, in which they could log out of their sessions, and where they could view a live count of how many consecutive days that they have journaled. She also worked on fixing several necessary bugs in the application, like layout errors that blocked entries in the overview page, disabling edit boxes that were blocking user functions, and preventing the app from crashing statically.

Anvita and Francisco worked primarily in the backend of the application. Anvita created user accounts which enabled our team to expand functions to our users like saving journal

entries and logging data from sessions. She also added a graph display in the overview page, which allowed users to quickly view their mental health rating over time. Francisco worked on setting up and running our tasks on Mechanical Turk, which allowed us to gather valuable user entries for analysis. He also built a new NLP text sentiment system for our application, training an LSTM to classify emotions by dominating emotion, rather than simply overall text.

8   Business Plan

8.1   Need

Our product seeks to make strides in personalized digital mental healthcare in the same way that weve seen companies like Fitbit, Apple, Strava and others do for physical healthcare. These companies and their products allow users to track their steps, caloric intakes, exercise routines and miles in order to let them assess their own wellbeing and leverage their data to achieve health goals. We see that there is currently an untapped need for similar empowering products in the mental health space.

Depression amongst college students has been on the rise in the past ten years. Unfortunately, colleges have not proportionately increased the number of mental healthcare providers in response to the growing demand. Without an increase in funding, university counseling centers will be unable to provide adequate care for their students.
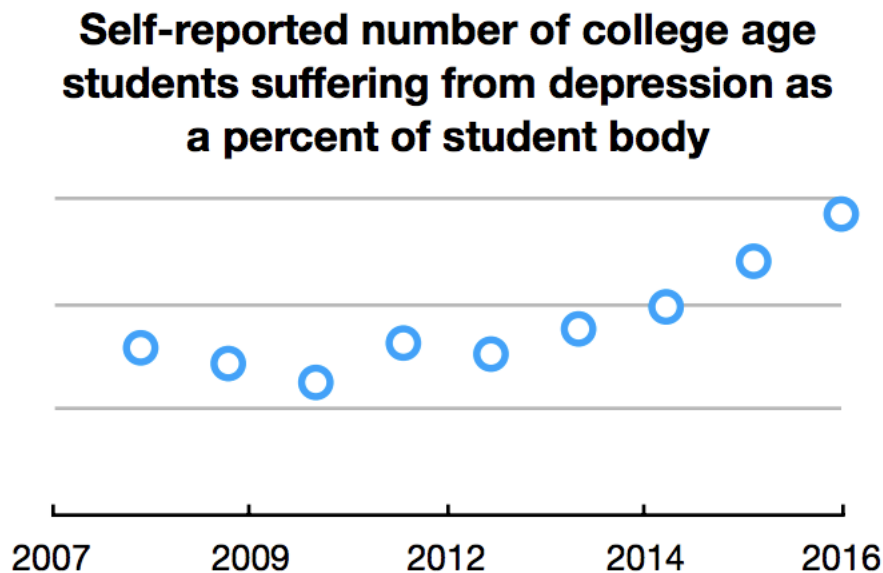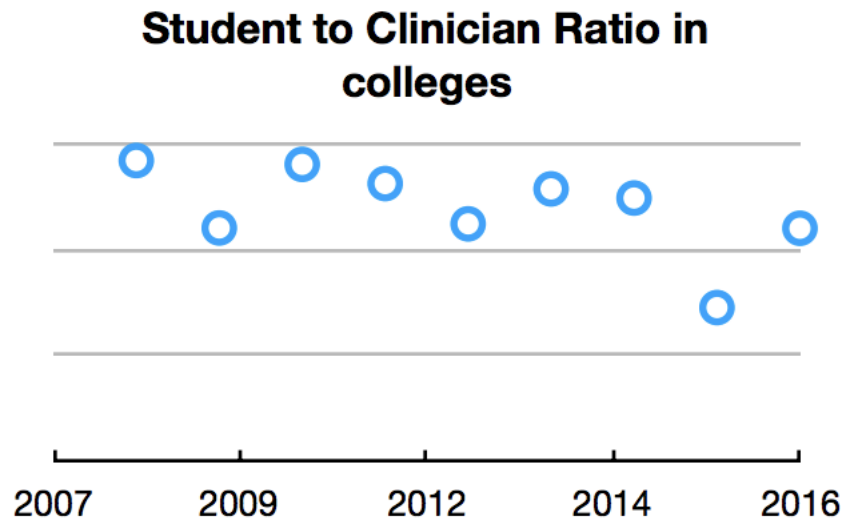
8.2 Our Solution

Research has shown that journaling cognition and emotions related to stressful events can improve mental and physical health. We think that mindful, can be that tool that helps young people journal, frictionlessly and effectively.

In a traditional journal, one either writes, types, or speaks into a microphone that simply records thoughts without interacting with the user in any way. Our journal, on the other hand, interacts with the user during the journaling process, through real-time emotion detection. It concurrently records your thoughts, while also recording an analysis of your emotional state. Our product is designed for wellness-oriented individuals with high-end smartphones that can run our computer vision and natural language processing models in real-time. We want to create a journaling experience that encourages daily use. As with other personalized healthcare applications, the system is better at uncovering patterns and assessing behavior the more its used by our users. We see users of other mindfulness or meditation applications such as Headspace or SimpleHabit as our target audience.

As all you need to journal on mindful is your smartphone and you can record short sessions guided by our prompts, we see it as a product with low barrier to entry and high stickiness. Were planning on monetizing the application in the future by limiting our free version of the application to a limited number of journal entries, with a subscription model similar to Headspaces for a premium version of the application. When a user opens mindful, they record an entry with their microphone and camera. Our application automatically transcribes the text that is spoken as well as classifies the users facial expression through the camera feed. Our application also analyzes content of their journal entry for emotional valence. We store the entry in the users journal along with the weather conditions, geographic location, and summary of the emotions detected during the session.

8.3 Competitive Landscape

	Description	Cost	Friction	Adherence	Tracking Progress
University counseling centers	University sponsored mental health programs that are free to college students.	LOW: universities provide these services for free	HIGH: Colleges only provide counseling services for a semester before referring a student elsewhere. Further, understaffed centers often only provide emergency therapy services.	LOW: Students dont have long term access to these services anyway.	LOW: No access to analysis
Private psychiatrist		HIGH: It is not mandatory for insurance providers to cover mental health treatment.	HIGH: They are often unavailable outside appointments.	LOW: There are high dropout rates among young people with cheap insurance policies.	LOW: Same as above.
Meditation apps (eg. Headspace)	These mobile apps guide the user through various forms of behavior change therapy on a daily basis.	LOW: These apps cost around $4.99 for a monthly subscription	LOW: These apps are on phones, and can be accessed at any time,	LOW: Despite having around 400,000 paying subscribers, we think that most of the apps in the space rely on generic psychological therapy on all users.	HIGH: You can track progress over time in the app.

8.4   Revenue Model

For Universities we plan on licensing our application so that they can offer the service to students for free. The university can either pay per student license or per average student usage.

Specifically target large universities where the lack of mental health services are most prevalent. Pricing would be $19.99 per student license.

For Individuals: Three potential models to pick from:

- completely unlimited journaling until max number of sessions hit, then user must subscribe

- free journaling through type and sentiment analysis, but dictation, facial expression analysis and long-term tracking features only unlocked with premium

- unlimited journaling access, but only last week of data is saved, so no long-term trend analysis available unless you pay

Subscription pricing: $12.99/month for monthly subscription, $7.99/month for a yearly subscription or a one-time $399.99 payment for lifetime access