

# Occupancy Monitoring Application for University Library, Seeat

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## ABSTRACT

Seeat is a monitoring system of library seat availability which allows students to spot an empty seat to study with simple display using a web application interface. As the need to provide an efficient and personalized way that can help students find available study space in libraries increases, our application features displaying live availability update as well as providing optimal recommendation to study based on user preference.

## KEYWORD

availability tracking; university library; web application; recommendation system.

## INTRODUCTION

Despite the fact that university libraries have adequate quantity of seats available for its students, we find that this resource has an imbalanced usage both interlibrary and intralibrary. Cases are that students head to one library after another just hoping to find one seat. This could be worse during midterms and finals. Also, some students prefer a quiet place with few people in it while others prefer to study with many people surrounded. Library resources could be utilized better. Moreover, we recently learned a conversation about the study place in colab

on a conversation about the study place in colab on the current MIMS community Slack channel where a MIMSier detected a problem with the availability of the study spots (i.e., some seats and tables are saved by leaving their belongings.). Under the thread of that post, several other MIMSiers came up with their strategies to address the problem. Nonetheless, with regard to those solutions, they can be designed in a more intelligent and unobtrusive manner which will effectively mitigate the existing study place saved for non-use problem.

## ELIGIBILITY AND SCOPE

Our initial pilot stakeholders are students in UC Berkeley and library administrators, both of whom will benefit from the solution. The project is considered a capstone for its comprehensive design and implementation as well as its mission to enhance study experience for students and facilitate library administration. We will implement an end-to-end application which includes a front-end web interface for students to quickly check seat availability, a back-end system to implement business logics, including a database to store user data for further analysis. We will explore the possibility to use biosensors to detect real-time physical data in libraries for powering our system to

display space availability and apply machine learning techniques to tailor a recommendation of study space based on student's personal preference. As an added value, school officials can utilize the system to monitor seats that have been unreasonably occupied and hence administrate study space without manually check in person. Overall, this project assembles members with diverse skill sets to develop an interactive application which we hope to address the pain points of the stakeholders and ultimately promote a harmonious study space across campus.

## **IMPACT ANALYSIS**

Our project fits an intersection of Sustaining Democracy and Building Community. Specifically, there are several key scenarios that our system addresses:

### **Scenario 1: Exam Preparation Week (busy time periods)**

Berkeley is famous for its crowdedness at libraries, or any public study space, during final week. That's the time everybody pull all nighters, stay focused and try to absorb as much knowledge as they can. Many times, students have to spend tons of time and energy hopping from one library to another, asking multiple friends until they settle to study. They always complain about how much time they wasted and blame that partially for not getting a great score.

This is a scenario where our system can typically help. Before heading to campus or on the way there, one can easily check the app for different libraries and browse its current occupancy and capacity, and make a decision about which room in library to head to.

If, very unlikely, by the time one gets there and it's all full, he/she can quickly locate vacancies in other rooms in the same library, or in other libraries. Once one settles down, the spot he/she occupies should appear occupied right after in our app so future students would have to choose other places. Our project stands with students together to save time and effort for looking a spot and share their burden.

### **Scenario 2: Normal time**

Our project will also bring convenience and efficiency to university students and people in the community during normal/non-busy times. We understand that different individuals have different preferences about their study and work environment. For instance, some people like to work at quiet places with few people surrounded, while others enjoy studying at a relatively crowded place with some decent noise. Our application will not only provide users with seats information in different libraries, but also some other indicators (e.g. noise level) of the library. In this way, students and people in the community can find a good place to study and work at, enjoying an increase in their work efficiency.

## **DESIRED OUTCOME**

Finding available seats in public space has been a consistent need for university students, especially during peak period. The purpose of this project is to create a system that helps students find available seats in the library with better accuracy and efficiency. In order to build a harmonious environment for students, our system introduces several features which include request seat and communication tool to help students utilize study space with fairness. The system is designed to be low cost and low maintenance with an interface should be a clear

display of occupied or unoccupied seats that can be easily read and students can get access to the information easily. The impact of our product includes all organizations with public space such as library, meeting room or even dining area.

## USER RESEARCH

### Phase 1: Summative Research

#### Method

We used online short survey and paper-based questionnaire to obtain qualitative and quantitative data from students. (See Appendix A for short survey questions)

#### Goal

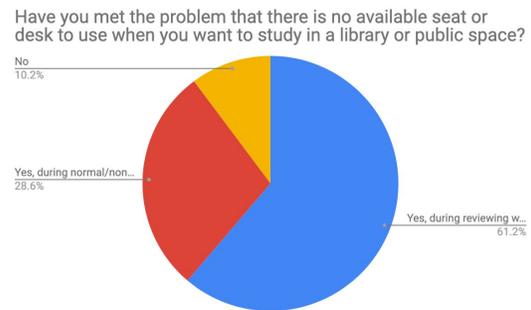
We hope to utilize preliminary survey result to confirm our assumption and identify general study pattern and ways to find study space for university students.

#### Recruitment

We obtained over 50 online survey results and 30 in person questionnaire distribution at Moffitt library.

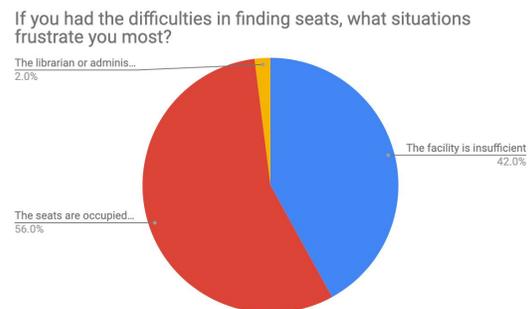
#### Key finding

- Students find during exam period is the most difficult time to find seat to study (61.2%). Overall, only 10.2% of our respondents identify no issue in seat finding, while the majority of students did face the situation when the seats are not sufficient and they have to check every library physically.



**Figure 1. Short survey result: students respond to find seat availability timing**

- Regarding the issue of find seat availability, nearly all (98%) of the respondents mention either insufficient facility or seats occupancy by others' personal belongings



**Figure 2. Short survey result: students respond to find seat difficulty**

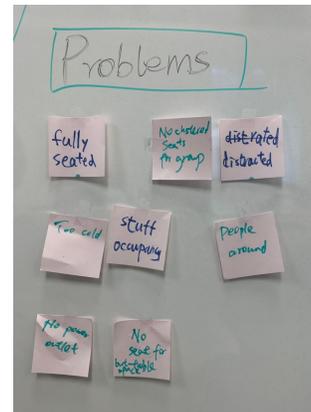
- Students also show high interest in trying a new technology solution which helps them in seat finding to save time and focus on study.



seats such as personal cubic ones or public clustered ones affect students choosing seats in libraries.

### *Problems*

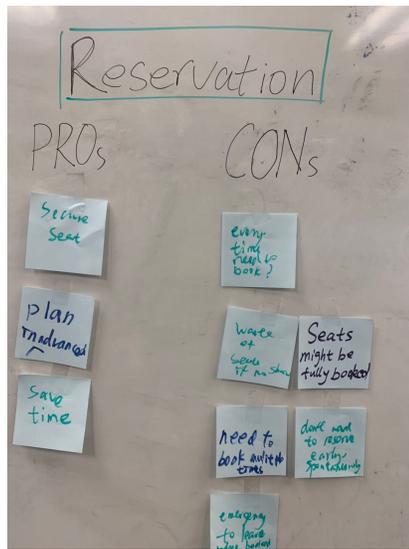
- The Moffitt library is a popular option for students to either study individually or have group project discussion/meetings.
- In addition to the problem that all seats are taken (either by people or personal stuff), the lack of power outlet, environmental temperature, distracted level, and the type of seat make students not take those available seats.
- It is time consuming to look or wait for available seats in libraries.
- The reservation feature might cause the facility waste, since students might not show up with reservations.
- Also, all seats might be occupied with the reservation feature, which causes the imbalanced use or unavailability of more seats.
- The booking step before getting an available seats might annoy the students.
- students doubt the availability would last until they actually get those available seats.
- The existing reservation of the group study rooms is hard to get a schedule of certain points of time.



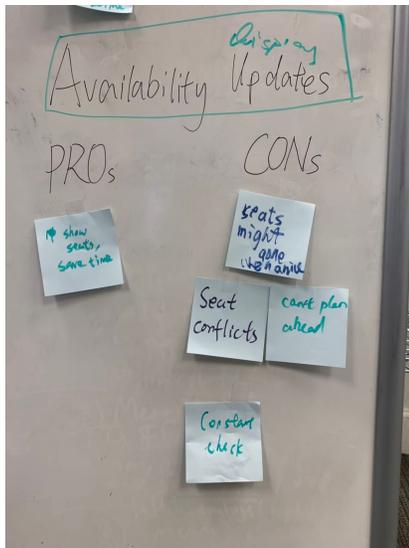
**Figure 5. Identify problem space**

### *Idea and solutions*

- The existing reservation of the group study rooms is hard to get a schedule of certain points of time.
- To find available seats, students usually go to libraries and walk around in different floors.
- Going to libraries in very early time (8 AM) or time gaps right before the classes, or choosing unpopular libraries make students find available seats.
- Students sometimes check with classmates/friends who are in the libraries about the available seats.
- For the reservation feature, it might be helpful in reducing the time spent on looking for a seat. Also, it might enable students to secure seats if they have a clear schedule of studying in libraries.
- While receiving a live seat availability update saves the time spent on going to and walking around the libraries.



**Figure 6. Analyze pros and cons of reservation system**



**Figure 7. Analyze pros and cons of showing availability update**

## IDEATION AND DESIGN

### Phase 1: Industry Insights

#### Current market

In phase 1 we explore different solutions in current market, trying to find the positioning

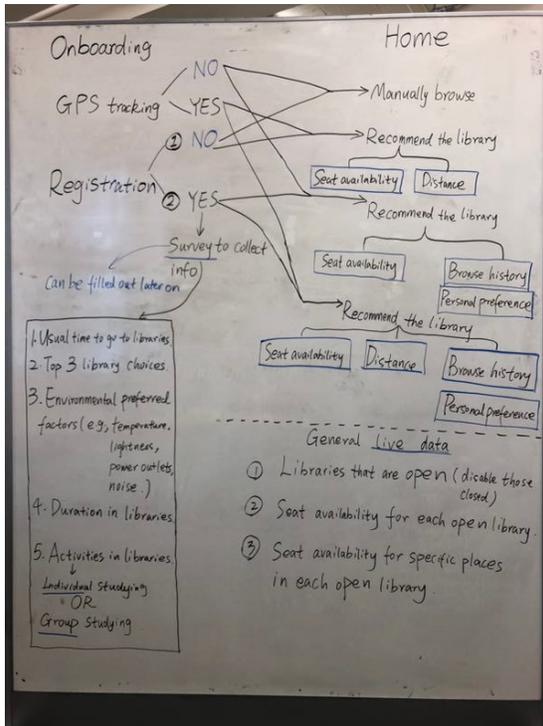
of our product against its core competencies. Our research result shows that there are some existing reservation system for university libraries, such as Wuhan University and National Library of Public Information. [3][4] Under those system, users have to create an account with credential and can make reservation up to 14 days ahead, same day or the next day. On the other hand, at UCL library, the school provides a public available web page displaying current occupancy at each library. [2] Users can view current status of each library based on the format of x free out of y.

#### White space identification

The advantage of a reservation system is to secure a spot in advance, therefore users of public space can plan ahead of time. However, the system is restricted to certain users like university students and lack of flexibility, we identify that this feature does not fit into our design. On the other hand, from the example of UCL library, the display only shows the number of available seat without showing the actual in-door map, therefore we then decide to incorporate a dynamic map which shows the availability of each seat to help users minimize the time spent on walking around. As a result, we identify those unique strengths we could leverage into new areas.

## Phase 2: IDEATION

### Raw design



**Figure 8. Sketch of user flow**

We drew a user flow sketch of our product. The onboarding process starts with user registration, along with a short survey for future recommendation. After this phase, the user will be directed to the main page where the system can detect the current GPS location of the user and display of occupancy summary and static information (open hour, allow food/drink etc) of each library. User can pick any library for further seating information to better decide which library to go.

### Categorization of ideas

Mainly there are 6 categories of our application and each category contains sub options:

- Onboarding
  - Anonymous user: no user

profile/ setting and recommendation

- Registered user: register with view recommended library after filling out survey.

- GPS tracking
  - Allow: be able to know the distance to the library and current position on the map.
  - Not allow: can only view from the default location.
- Main page browse
  - Summary of each library: a school map with pins of each library.
  - Label: different coloring indicates status of each library.
- Individual library browse
  - Summary of each level: a bar chart showing current percentage of occupancy.
  - Detailed display: an indoor mapping showing whether the seat is occupied or not.
- Live data monitoring
  - Update duration: default update duration is 5 minute.
- Recommendation system
  - Short survey: consists of 5 questions regarding personal preference, such as environmental factors ( temperature, noise level, lightness, power outlet), general duration at library and main task at library.

## Phase 3: High Fidelity Prototype

### Logo



### Theme Color



**Founder's Rock**

**Hex** 3B7EA1

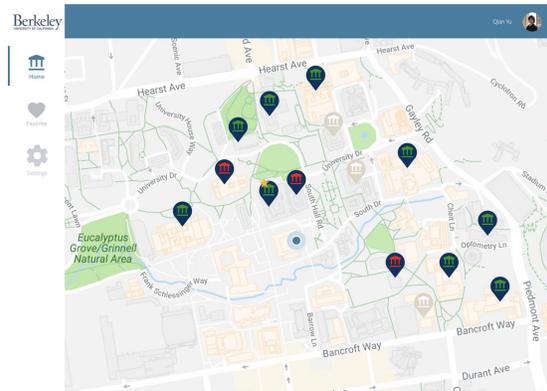
**CMYK** 76|34|21|0

**Pantone** 7697

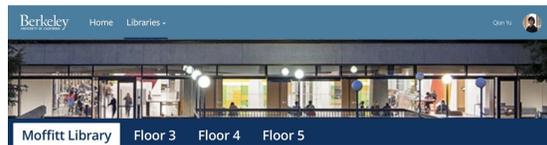
Our application is developed for university library, therefore the theme color of our product should follow the guidelines of university. According to Berkeley Brand Guidelines, we chose Founder's Rock (Hex 3B7EA1) to be the theme color. [7]

### Webpage layout

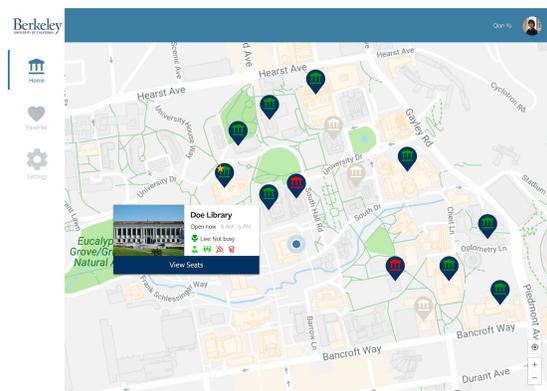
#### *Home page*



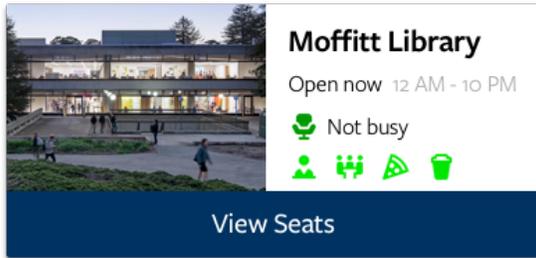
#### *Individual library page*



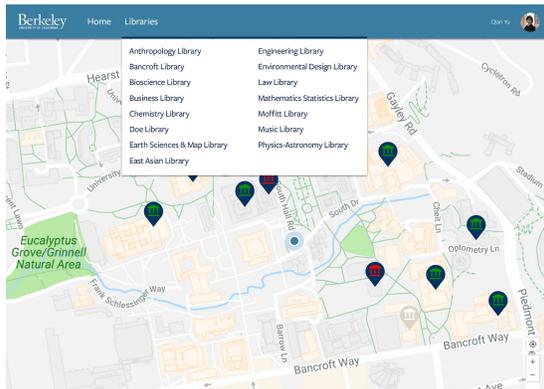
#### *Specific information display*



### Hover card design



### Menu dropdown



## DEVELOPMENT

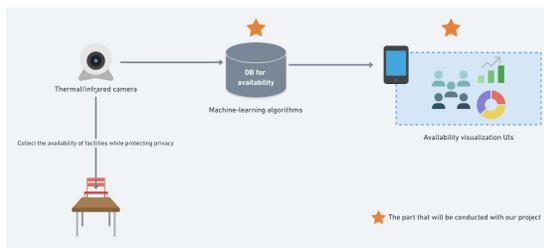


Figure 9. System architecture

### Tech Stack

#### Backend framework: Python Django

We chose Django, a full-stack Python web framework on our backend. Django is developed based on batteries included approach. This approach makes it easier to accomplish common web development tasks

like user authentication, URL routing and database schema migration. Also, Django accelerates custom web application development by providing built-in template engine, ORM (Object Relational Mapping) system, and bootstrapping tool. Compared with another common framework Flask, although Flask is considered a lightweight, and minimalist web framework, it lacks some of the built-in features provided by Django. Overall, the features provided by Django help us to build large, scalable and complex web applications.

### Database

#### Database choice: SQLite

Django framework allows us to take advantage of a robust ORM system and instead of directly working on the database table via SQL, Django enables developers to manipulate the corresponding Python object. We chose SQLite for its noticeable features: self-contained, serverless, zero-configuration, transactional. SQLite is also a lightweight relational database management system in terms of setup, database administration, and required resource.

### Database design

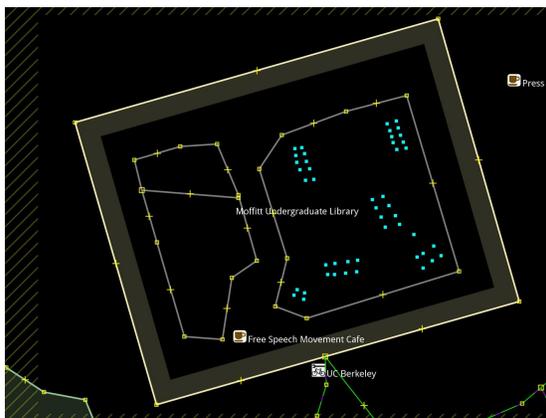
The schema of library, floor and seat class is listed below:

- class Library(models.Model):
  - name: String
  - longitude: Decimal
  - latitude: Decimal
  - geojson: Text
  - floorCount: Integer
  - Img: Image

- class Floor(models.Model):
  - libraryId: Integer
  - Index: Integer
  - geojson: Text
  - seatCount: Text
  
- class Seat(models.Model):
  - floorId: Text
  - longitude: Decimal
  - latitude: Decimal
  - Occupied: Boolean

### Open source: JOSM

In order to represent indoor layout of each library, we leverage an open source tool named JOSM, an extensible editor for OpenStreetMap to obtain GeoJSON format data which required in our data model. [8] First of all, we locate the longitude and latitude of each library at Berkeley, and exporting data to GeoJSON format. Finally, importing GeoJSON to Google Maps.



**Figure 10. JOSM mapping of moffitt library**

### **NEXT STEPS**

Our project focuses on proof of concept,

in-depth user research to prototype development. Due to device and budget constraint, we did not incorporate sensor technology in our data collection. For next steps, we would like to utilize devices with technology such as infra-red to detect human presence and can be placed on each chair or underneath desk. Moreover, we hope design the device will not collect any personal data and can not identify an individual. We also would like to transform our solution to be a standalone API service that can be adopted by any university or public library.

### **CONCLUSION**

Seeat is a useful project in terms of addressing general need of university students and proposing a solution that can be beneficial to all public space users. We discovered insights and direction of our prototype based on 2 phases of user research and carefully compare with current existing solution. While some existing product provides the ability to reserve a seat in the library, we focussed to address the problem of lacking a clear and real-time display of occupancy for libraries. To come up with user-centric design, we conducted over 50 summative research and 5 generative research. From the result of user interview, we realized that a lightweight, easy-access and informative dashboard can be useful and handy to users. We designed both generative and individual pages of university library with clear display that can truly provides users a simpler and easier way to spot a place to study. Our project has made a major contribution by providing a prototype to verify the proof of concept. Our project also sets a stage for further exploration to utilize sensor technology in public space, such as libraries, offices, or restaurant.

## REFERENCE

1. Olin Library Seat Tracker:  
<https://ese.wustl.edu/ContentFiles/Research/UndergraduateResearch/CompletedProjects/WebPages/sp14/BrookeSophie/index.html>
2. UCL Library available study spaces:  
<https://www.ucl.ac.uk/library/libraries-and-study-spaces/available-study-spaces>
3. National Library of Public Information Seats and Rooms Booking:  
<https://www.nlpi.edu.tw/ReaderService/OnlineServicePage/seatbooking.htm>
4. Wuhan University library seat reservation system:  
<https://seat.lib.whu.edu.cn/login?targetUri=%2F>
5. Study Hunt: Library seat availability live monitoring system:  
<https://www.element14.com/community/community/stem-academy/stem-projects/blog/2017/06/08/study-hunt-library-seat-availability-live-monitoring-system>
6. Spaces, an app which predicts how likely you are to find a seat in library:  
<https://thetab.com/uk/leeds/2016/01/13/two-fourth-years-have-created-an-app-to-find-you-a-seat-in-the-library-21374>
7. Berkeley Brand Guidelines:  
<https://brand.berkeley.edu/colors/>
8. JOSM:  
<https://josm.openstreetmap.de/>

## Appendix A: Short survey questions

1. Have you met the problem that there is no available seat or desk to use when you want to study in a library or public space?

- A. Yes, during reviewing weeks before exams
- B. Yes, during normal/non-busy time
- C. No
- D. N/A
- E. Other

2. What methods have you used to find available seats or desks to study in a library or public space?

- A. Go to that library/public space and look for available seats or desks
- B. Check with your classmates or friends who are studying in that library/public space
- C. Anticipate the availability by using the facility information on library's website
- D. Other

3. If you had the difficulties in finding seats, what situations frustrate you most?

- A. The facility is insufficient
- B. The seats are occupied by others' personal belongings
- C. Other

4. If there was an APP that delivers real-time availability of seats or desks in a library or public space, how do you feel like using it?

- A. Definitely will try it
- B. Might try it but worry about its usability/accuracy
- C. Not interested
- D. Other

## **Appendix B: Individual interview questions**

### **Warm-up session**

- How is your day going?
- Did you go to library? Or are you planning to go to library to study?

### **Major session**

- Could you talk about the reasons you choose to study in libraries?
- What factors make you choose seats in libraries? Any preference such as location, temperature, lightness, or whether the environment is noisy or distracted?
- Which library you visit most often in Berkeley? Why?
- Based on your experience of going to libraries, could you describe your route in finding a spot to study?
- Could you share the most recent time you went to library to study? How was that experience?
- Have you met problems in finding available seats in libraries? How were those problems?
- What solutions did you use to address the problem of finding available seats? How do you think about those solutions?
- Have you tried to get help from the library or librarians in finding available seats? How was it?
- How long do you usually study in libraries? Do you usually stay with the same seat? Or you shift to different seats or going to different libraries? Why?

- If there was a system that allows you to reserve a seat in libraries on campus, how do you think about it?
- If there was a system that sends you live updates of the seat availability in libraries with sorting/filtering options, how do you think about it?

### **Wrap up session**

- Except for those questions we talked about, is there anything you'd like to talk about your experience in finding available seats in libraries on campus?