Visualizing the CSXL's Impact on UNC's CS Community

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ABSTRACT

In 2023, the UNC Computer Science Department added a new collaborative space, the Computer Science Experience Lab (CSXL), to Sitterson Hall. This space greatly expanded the amount of collaborative productivity space for students in the department and, in turn, has seen a large influx of users. In this project, we aimed to quantify and visually represent the impact the CSXL has had on student productivity by comparing its utilization with that of its predecessor, the App Lab. From reservation and check-in data of each respective space, we discerned the most popular reservation types and times. We also analyzed the top users of both the CSXL and App Lab and compared the overall number of people who have used each space. Analyzing these visualizations, we found that the CSXL has quadrupled the number of students utilizing these workspaces, as well as the number of reservations day-to-day. From these findings, professors and administration heading the development of the space can truly see the impact it has had on the community of the CS department and use that knowledge to guide further development of spaces such as the CSXL.

1 INTRODUCTION

Computer Science at UNC has long been a department focused on collaboration and community. Having a community at a university can be an essential part of a student's college experience, and can help individuals form friendships and connections. Additionally, software and technology as an industry itself is heavily reliant on collaboration, cooperation, and teamwork, and developing these skills can be crucial for one's career. Thus, the CS department has worked to provide spaces to foster this type of environment for its students, most recently with the development of the CSXL.

The Computer Science Experience Lab, or CSXL, was first founded by the CS Department in 2023 with the intent of being a collaborative, student-oriented space. This is represented by its tagline: "Gain Experience, Grow Community & Go Places". Now including reservable pair programming rooms, group meeting rooms, as well as the collaborative XL space itself, students have a designated place to work with other students in their major and foster deeper relationships within the community. With this recent uptick in collaborative space usage, there stands the question of how the reservation system is being utilized, especially in comparison to previous, smaller-scaled study places the department previously offered. By studying the usage of the XL, both over time and compared to its predecessors, we can gain a better understanding of its impact on the community and provide an outlook for future CSXL development.

One pressing question relating to the usage of the CSXL relates to its space utilization. In its original iteration, the CSXL's reservation system was non-specific. Reservations could be made for the space, and any seat available was fair use. In the past academic year, however, this has been overhauled to include desk-specific reservations, allowing users to choose between communal seats, standing desks with monitors, and normal desks with monitors. Observing these organizational changes in the XL reservation system could give insight on the effectiveness of reserving by seat type. Similarly, the most frequently used seating types could be analyzed by comparing the number of each reservation type. This could guide future space development by giving an idea of which reservations are in highest demand by students. These research questions cater specifically to ideas concerning reservation systems and their implementations.

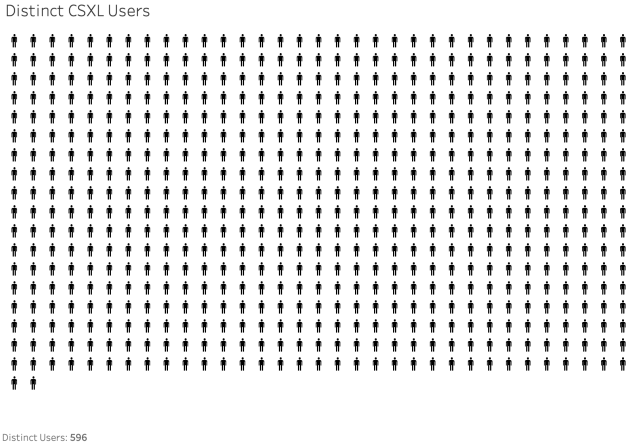

Figure 1: A visual display of the number of distinct users that have checked-in to the CSXL.

Another area of interest is how the CSXL is being utilized in relation to time. More specifically, we can analyze which times are most popular for students to be checking into the CSXL, as well as trends in the lengths of reservations. This could prove interesting for seeing if certain days experience a greater influx of reservation traffic, as well as if certain times of the day are busier than others. Adjacent to this thought, we can look at the specific usage of each user to get a sense of average reservation frequency. This could also help analyze how many students are frequent users of the XL versus how many only check in on occasion.

Lastly, we can observe how the CSXL has compared to prior collaborative spaces, namely the App Lab – which was previously a part of the department. The App Lab was a small space that was hard for people to find. Conversely, the CSXL has been widely advertised to the department and offers dozens of seats for students to utilize. With both a larger occupancy and bigger presence in the department, comparing the number of reservations (as well as the number of users) could highlight the impact the CSXL has had on collaboration within the CS department.

In answering these questions, our project aims to highlight how the CSXL has shaped the community and collaborative environment within the Computer Science Department at UNC. The visualizations we develop to answer these questions can be applied to both current and future data and show trends in reservation and space impact, giving administration a better idea of the benefits of this space. In doing this, we hope to provide data to professors and students alike to better the CSXL experience as the space continues to evolve in the coming years.

2 RELATED WORKS

2.1 Space Utilization in Educational Institutions

Several studies have been performed at other universities on how spaces are utilized on their campuses, which relates directly to the

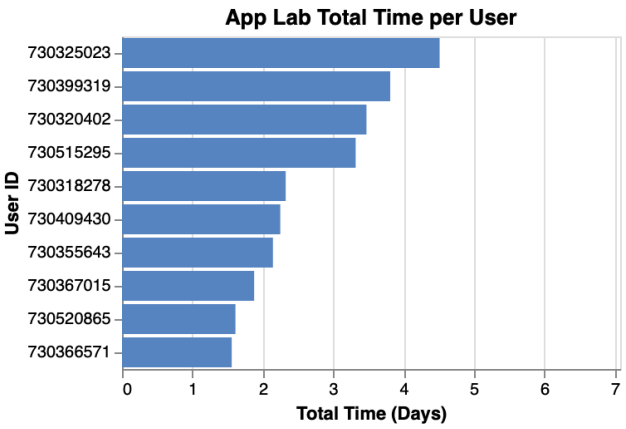

Figure 2: A visualization of the time that the top 10 users from the App Lab spent on the lab over the course of the 2021-2022 academic year.

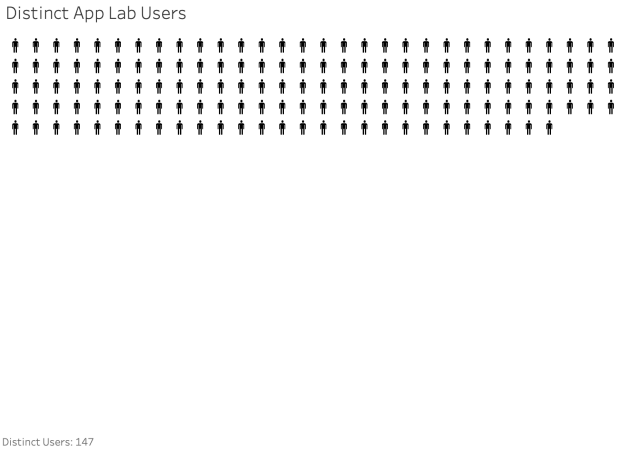

Figure 3: A visual display of the number of distinct users that have checked-in to the App Lab.

questions we are asking here at UNC Chapel Hill. This includes how classrooms and academic spaces are being used as a whole, as well as reservable spaces like study rooms.

One such study, performed at Western Carolina University, looked at how academic buildings were being used by the university and what needed to be adjusted to accommodate space needs [1]. This research incorporated visualizations demonstrating the distribution of building usage, as well as percent occupancy being utilized in comparison to target efficiencies. In doing this, the study was able to identify how their current classroom capacity would be able to support their projected enrollment rates, as well as identify buildings that may need to be repurposed, restructured, or constructed.

A similar, less extensive study was also completed at Wake Forest University to make recommendations for campus infrastructure projects [9]. Through their analysis of assignable square footage usage, the study was able to determine underutilized buildings as well as frequented areas that lack spatial capacity.

Studies have also been conducted to determine usage of study rooms specifically. One such study from NC State University was performed over a two-year span to determine the most common study rooms booked, as well as usage patterns [8]. Their research was able to discern that 2 hour reservations were most common, as were study rooms near the ground floors.

Reservation systems can make space utilization much more streamlined and organized. Rather than having users of that space drop by in an unregulated manner, reservation systems ensure that users have fair access to a space and keeps track of who uses it. This can help managers of such a space understand the demand for that space, both in quantity of people and time spans.

A study done at Fordham University on the implementation of a Google Calendar reservation system helped to quantify demand for such spaces. This study also identified a need for reservation limits so that all users could access the spaces fairly [3]. These ideas can be translated to our research in that we can implement a similar need identification and space effectiveness process for the CSXL. Analyzing the current capacity compared to utilization, we can discern if the current seating capacity is enough, guide future study space development, and show the impact and value that the CSXL has had thus far.

2.2 Space Quality and User Productivity

In addition to the usage of spaces, many researchers have attempted to explore the correlation between the quality of a workspace and the productivity of its users. A study published in the Journal of Business, Economics and Finance surveyed a random sample of students from a local university in Turkey and found that 58% agree that the quality of the environment and space has a very strong influence on the productivity of students [7]. The study also showed that the quality of the furniture was the physical factor that brought the most impact when it came to the students' ability to use the space. The higher the quality of the furniture in the space, the more productive the students felt. Participants also reported that "downtime" was one of the biggest factors that impede productivity. Downtime was defined as the amount of time that students had to spend configuring their space before making it usable, such as configuring chairs and moving things around.

These factors can be one of the explanations as to why the usage of the CSXL has increased so much with the new furniture and features provided to the students. They are able to reserve spaces in the website, and have a guarantee that they will have a seat/room reserved for them, greatly decreasing the downtime. This was not the case with the previous version of the CSXL and the App Lab before it. Students were not able to reserve spaces and they would have to walk-in to determine whether they would have a space available for them. This contrast can be one of the reasons why there was such a discrepancy between the two spaces.

2.3 Visualization of Occupancy Data

Studies have shown how visualizing data in multiple dimensions can be quite tricky [4] [6]. In this case, our goal was to show visualizations of the occupancy of the space over time. However, that proves quite difficult since displaying both of these factors leads to complicated visualizations. This is made even more complicated by the fact that the CSXL is a rather small space, which was listed as a limitation on one of the studies that attempted to visualize occupancy over time on a space with a small scale. Due to these limitations, several institutions have explored alternatives. One of them attempted to create a VR model that can be used to create a physicalization of the space and show the changes in occupation over time based on that [5]. The platform, OViz, is still in active development and has not been tested in industry settings yet.

However, it has shown great progress in actually immersing the user in a particular space, showing parallel changes and bringing issues that would otherwise be overlooked into focus. One of the limitations discussed in this study was the fact that it is not at displaying patterns in variables, since the user is immersed in the space and is seeing things as they are, they might not have an idea of the trends

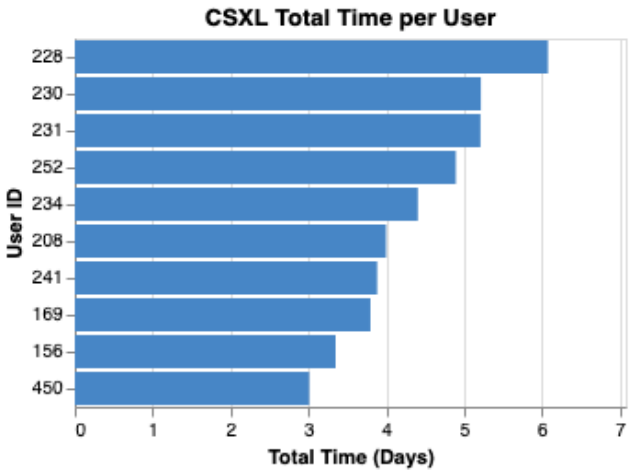

Figure 4: A visualization of the time that the top 10 users from the CSXL spent on the lab over the course of the 2023-2024 academic year.

within it. It's easy to be misled by the immersive environment and to disregard the overall pattern of the variables that were displayed through a physical medium.

3 Discussion of Visualization Decisions

3.1 Ignoring Erroneous Data Points

During the process of writing the visualizations for the project, we had to make several decisions in order to polish the data and to create honest visualizations from it. When it came to creating graphs about the usage of the spaces, we relied on the data collected through the check-in systems maintained by the CSXL and the App Lab. This left us exposed to possible issues in their reservation bookkeeping. For example, if a student forgets to check-out of the space. How does each system handle this case? They could either cap the reservation at a certain number of hours, or just have someone periodically go through the reservations and manually check users out when needed. After speaking to maintainers of both spaces, we managed to get an understanding of how they each handled this particular case.

The App Lab system closed all reservations at midnight of the day that the reservation started if the user didn't checkout, which means that reservation durations are capped at a maximum of 24 hours. Since the CSXL has staff members checking members in and out of the space at all times, they have a different policy. The staff members are always scanning the space to determine whether a user is still checked-in or not. If a user forgot to check-out, the staff member can end their reservation manually. This means that the reservations are rather short, but they are also non-deterministic. It is hard to know whether a reservation ended because a user checked-out, or because a staff-member ended their reservation. This doesn't happen in the App Lab, where we know that reservations ending at 11:59PM were closed by the system.

This makes for an interesting dilemma when creating the visualizations. Since we don't know which reservations accurately reflected the user's visit, we have to make some arbitrary cut-offs to ensure that we are not counting data points for users that forgot to check out for metrics such as duration. The maximum duration that we decided on was 8 hours, since we think it is unlikely that someone would actually remain in the space for longer than that. Any reservation with a duration over that threshold were ignored.

While closely looking at the data, we found that there were 47 CSXL reservations that each, supposedly, lasted longer than 24 hours, with the longest lasting over a month. These dramatically skewed the visualizations that we created, so the 8 hour cutoff was a necessary and helpful technique.

3.2 User Friendly Interface

Another issue that we faced was with the conversion to more user-friendly dates. Most software systems use military time for their time libraries. This is because it is easier to encode hours in a 24-hour period rather than a 12-hour period with an "AM/PM" modifier.

Since the majority of the world deals in military time, this is not a problem for most countries. However, given that our users are located in the United States and the most common way to represent time in this country is non-military time, we decided to change the time scale to accommodate this.

3.3 Anonymizing Data Points

One of the most important tasks that we had to do when working with these datasets was to make sure that we were using anonymous data. Although attendance to the space is not classified as a sensitive piece of information, privacy has gotten increased attention in recent years [2].

Although our data was collected in the United States, there are several regions where data privacy laws were passed to ensure privacy of user information, such as the General Data Protection Regulation (GDPR) passed in Europe to protect the personal pieces of information provided by users to software companies. We attempted to follow those regulations as much as possible. We removed all the identifying pieces of information and created an anonymous id, so that information about users could be tracked but users of the data could never identify who other individuals' ids are referring to.

3.4 Ease of Use

After speaking to the key stakeholder, we received feedback that the most important aspect of these visualizations would be to have them dynamically update based on new data. Given the newfound popularity of the space, its data becomes stale very quickly. As a result, the visualizations quickly become outdated, too. In order to ensure that we can seamlessly transition from one dataset to the other, we have used the current CSXL database schema. This way, if there is ever more data generated, as long as the schema stays the same, a staff member can simply dump the database into a CSV, bring it into the repository, and rerun the Jupyter Notebook to regenerate the visualizations.

This also creates great flexibility if these visualizations are ever added to the CSXL website. Since the visualizations are already based on the database schema, if the source file is changed from a CSV to a live database, the logic for rendering the visualizations should not have to change.

We also created a public website to display this Jupyter Notebook so that the visualizations can be seen live on the web. In the future, these graphs could be embedded onto the CSXL website's dashboard to ensure that the most recent data is up.

3.5 Choice of Visualizations

After discussing with the current manager of the space, they requested that we create visualizations that highlight the discrepancies between the old space and the new one. They are currently in the process of requesting more funding for the space, and getting a better idea of the impact of the already allocated funding would help them in their pitch. Therefore, we have decided to create the visualizations outlined below.

3.5.1 Distinct Users

The first visualization that we worked on was getting an idea of how many distinct users visited the spaces. This is so we can get an idea of the reach within the student body. If a space has reached more distinct users, then that means that there are more people who are

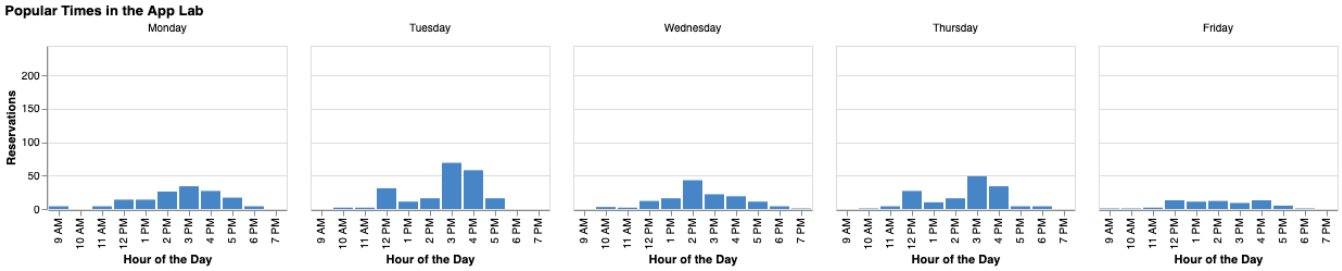

Figure 5: A visualization of the occupancy of the App Lab per time and day of the week.

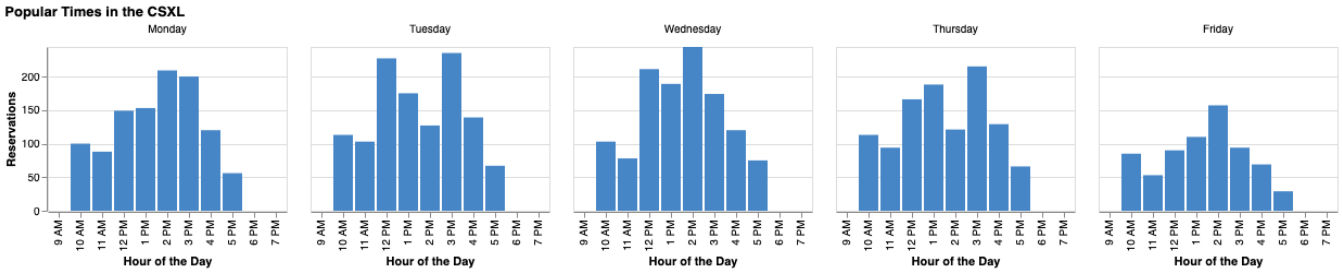

Figure 6: A visualization of the occupancy of the CSXL per time and day of the week, scaled to be compared to the scaled App Lab visualization.

aware of the space and are utilizing it. Fig. 1 visualizes this for the CSXL and Fig. 3 does the same for the App Lab.

3.5.2 All-Time User Statistics

We created two graphs comparing the use top 10 users from each space and the amount of hours that they spent checked-in (similar to leader boards) to get an idea of the overall usage. This is not an accurate metric to get utilization by itself, however, it gives an idea of how much passionate users enjoy spending time in the space, which we consider a proxy for overall usage. Fig. 2 visualizes this for the App Lab and Fig. 4 does the same for the CSXL.

3.5.3 Popular XL Times

For the final visualization, we created a comparison of the count of checked-in users per hour and day of the week. This is the visualization where the utilization of the space is most evident. This is because we are plotting both the spatial and temporal data of the space in the same graph. Fig. 5 visualizes this for the App Lab and Fig. 6 does the same for the CSXL.

3.6 Removing Misleading Aspects - Scale of Visualizations

One of the more severe issues that we ran into was how to remove some of the misleading aspects of the visualizations. Given that the usage of the spaces was vastly different, the magnitudes of the scales were also different. This means that we had to normalize the scales so that users mislead by their labels, as this is one the main sources of confusion for users that are seeing the same visualization for two different datasets.

We solved this problem by setting the scales based on the maximum attribute within the data to-be-displayed. In doing so, both graphs appear on the same scale when visualized. This can be seen in each pair of visualizations that we have created.

4 Discussion of Results

After analyzing these visualizations, it is evident that the re-branding (and re-imagination) of the App Lab space to CSXL has had a significant impact in students' utilization of the space. Prior to its relocation to the larger, more central space and the renovation of the furniture, it had very little usage. Afterwards, we can see a drastic increase in the usage of the space.

It also evident that the CSXL space is utilized more frequently than the App Lab. By comparing Fig. 5 and Fig. 6, we can see that, throughout the entire week, the CSXL consistently sees many, many more visitors than its predecessor.

Additionally, we can see that the CSXL was able to increase the number of reservations while also reaching more people.

By comparing Fig. 1 and Fig. 3., we can see that the CSXL reached a much broader group within the Computer Science community. We can clearly see that the CSXL has had much more attendance than the App Lab. From the CSXL data, we noticed that 596 distinct students visited the space over the course of the year. This is about 50% of the Computer Science student body population. Meanwhile, the App Lab only had 158 distinct users over the same period. This indicates the much broader impact of the CSXL on the overall community.

This is emphasized by Fig. 2 and Fig. 4, which show the total time spent by the top ten users with the most time spent in each space. From these, we're able to see that the top ten users in each space spent roughly the same amount of time in both and that the CSXL's increase in utilization truly came from more people using the space, rather than by a small group disproportionately using the space more.

5 Conclusion

In the end, it's clear that the renovation of the space has given it a new life. The numbers indicate that the attendance has grown significantly over the course of the year, reaching over 50% of the department's student body. It also reached passionate students who can't seem to get enough of the space.

By creating an easy-to-run script, these visualizations can be quickly regenerated when new data is available. We hope to have helped in the cause of acquiring more funding for the lab, so that more amazing things can happen to it.

6 Future Works

With regards to the next steps, the most important piece of work left to do is to add the ability for these scripts to pull from the live database when creating the visualizations. Another possibility is to modify these visualizations to be embedded on the CSXL website. This might prove difficult with the current visualizations using altair, as Angular does not provide native support for graphs with this library. However, Angular does have a D3 extension that might make the process easier. Given the timeline, we did not have enough time to complete this part of the project.

Acknowledgments

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