UBC Social Ecological Economic Development Studies (SEEDS) Sustainability Program

Student Research Report

Exploring the Potential of Wi-Fi Occupancy Data

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University of British Columbia

PLAN 528A

Themes: Buildings, Community, Energy

March 15, 2018

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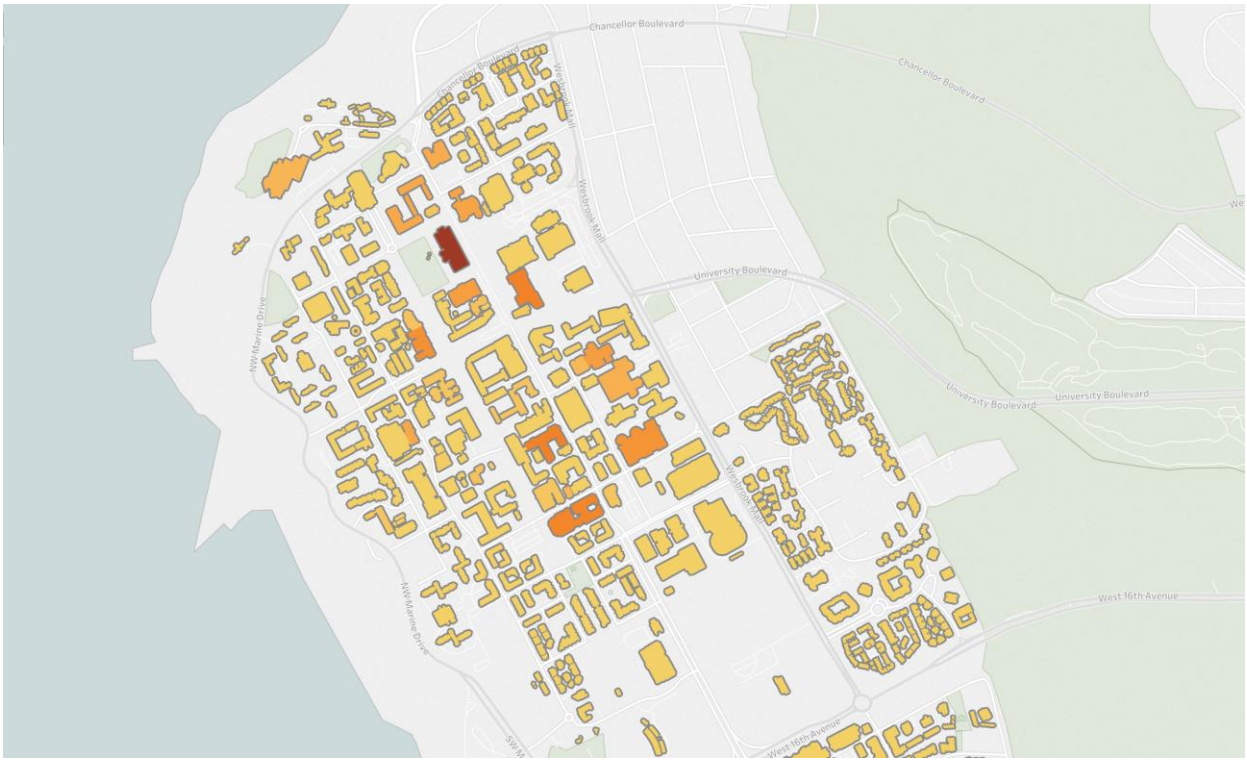


Faculty of Applied Science
THE UNIVERSITY OF BRITISH COLUMBIA

MEL | Master of Engineering Leadership

Executive Summary

This project used occupancy data derived from Wi-Fi connected devices in UBC buildings to better understand the usage of spaces across campus. Additionally, various sustainability related ideas were discovered in the process. Some of the ideas include:

- Supporting the design decision-making process for a bike sharing initiative
- Creating universal building benchmarks for water, energy, and waste
- Determining a strategy to better utilize unused spaces on campus

The technical process involved working with a software called Bridge built by Sensible Building Science. A postgreSQL server contained the anonymized occupancy data which was extracted and formatted to be used with Tableau, a data visualization software. Interviews were conducted with various stakeholders on campus to explore the potential of the data with the visualizations, some of which are described above. Please see Section 3 for visuals.

One key observation that was uncovered during the project was the immense difficulty for students to launch interdisciplinary data-based projects on their own. Easy access to data would support students being able to collaborate with staff and also break down the barrier of collaboration across UBC's siloed departments.

In conclusion, potential future projects were highlighted

- Building Benchmarking - Use the data with water, energy, and waste data to create building performance benchmarks; can be used to create reduction strategies.
- Create Benchmark Repository - Build database with interactive interface allowing for users to see historical benchmark information; can be used to verify reduction strategies.
- Shared Spaces - Use data to determine which rooms are being underutilized and can be opened for shared booking.
- Optimize waste collection services
- Sharing Initiatives - Use data to help determine strategies for various sharing programs:
    - Bike Sharing
    - Coffee Cup Sharing

1 - Introduction

1.1 Purpose

The primary purpose of this project is to determine how Wi-Fi occupancy Data collected from the UBC Cisco backbone can help us understand and plan usage of spaces across campus.

The report will explore and discuss potential uses of the data in regards to innovative sustainability strategies. These results will help a variety of departments in planning and operations; some of the main beneficiaries are:

- Infrastructure Development
- Sustainability and Engineering
- Energy and Water
- Campus and Community Planning
- Building Operations

The project will contribute to creating a campus that uses space more efficiently and effectively. Additionally, the project explores a variety of ideas around data-based decision-making in different departments; this leads to reduced waste, energy consumption, water consumption and climate emissions. This project helps support and progress the Climate Action Plan, Water Action Plan, and “Sort It Out” recycling program. The need for an open-data platform at UBC is also discussed at the end of the report.

1.2 Background

UBC is currently piloting a new technology to reduce building energy consumption, which uses data from the Cisco Wi-Fi network to estimate the number of occupants in different parts of the building, based on the number of Wi-Fi enabled devices. This device data has been stripped of any unique identifiers and provides immense opportunity for innovation if made available to the campus community. There are thousands of ways this data can be used, this report only explores a small portion of what is possible and is meant to be a starting point to inspire more SEEDS projects from across campus; staff or student led.

1.3 Method

Raw server data was acquired from UBC Information Technology and converted to a manageable format for Tableau, a data visualization software. A first round of visualizations were created for proof of concept; these were then used in stakeholder interviews to inspire thought and discussion. Stakeholder interviews were continually conducted, all discussion and ideas were collected and documented. Please see Section 2.1 for technical process.

1.4 Scope

This report includes main 5 sections. Section 2 includes the technical workings, process, and challenges related to working with the data and creating visualizations. Section 3 includes some of the visualizations that were created and used for interview discussion. Section 4 overviews each of the stakeholders and their interview. The last section covers open data potential at UBC and project recommendations, including potential future projects.

2 - Technical Work

This section has been laid out for easy replication of the process.

2.1 Process to Extract Data (Linux/macOS)

1. PostgreSQL dump files are acquired from UBC Information Technology.
2. PostgreSQL was downloaded and installed locally. Detailed instructions for install can be found in Appendix-1. Alternatively, postgreSQL can be downloaded in via an application package via https://postgresapp.com/ (ensure to also install the command line tools at https://postgresapp.com/documentation/cli-tools.html)
3. Launch postgreSQL app and open a command line interface (See Appendix-1)
4. Install server dev package
    - Command: sudo apt-get install postgresql-9.3 postgresql-server-dev-9.3
5. Restart postgres services (or restart computer)
6. Create superuser and database
    - Command: sudo su -postgres
    - Command: createuser -sP sensible
    - Enter password 'a' when prompted
    - Command: createdb -T template0 middlewaredb
7. Restore database via pg_restore or psql
    - Command: pg_restore -d middlewaredb /var/backup/[NAME OF FILE]
    - OR Command: psql middlewaredb < /var/backup/[NAME OF FILE].sql
8. Test database
    - Command: psql
    - Command: \c middlewaredb
    - Command: \d
    - This should display all the tables, you know it's now restored correctly.
9. As the data is now running on your postgreSQL server, you can export data or connect any applications that accept postgreSQL as a data source.

2.2 Challenges

2.2.1 Data Quality

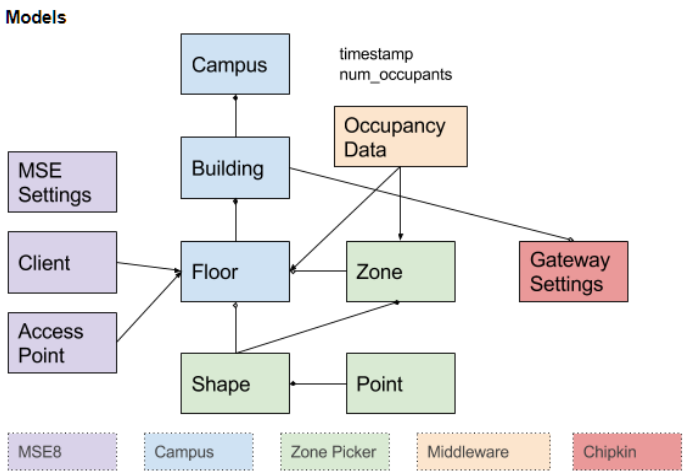
Two issues have been identified in terms of data quality. The first issue stems from the database being in development during the duration of the project. As ideas are developed and tested, the architecture of the database changes. This creates inconsistencies in the dataset, missing data is quite prevalent and is caused when database tables are added or removed, or if building data collection was turned on or off at any point in time over the year. It is important to note that gaps in data can create visualizations that do not represent the whole story, possibly creating a skewed analysis.

The second issue stems from software functionality. The software product, Bridge, is developed by a company called Sensible Building Science, started by a previous UBC PhD Student. Bridge uses a combination of Wi-Fi device connections and algorithms to determine how many people are in a particular area. The problem is, users often have multiple devices connected to the network and algorithms are required to estimate the occupancy count. In areas with low device counts, the software can't accurately determine how many people are in the area; it does a more accurate job when dealing with larger sample sizes. It was noted by interviewees that without better margins of error, business cases are hard prove at the zone and floor level.

2.2.2 Data Complexity

The SQL tables provided in the dump file came with no documentation. A model was given to explain the high-level connections between tables but this still did not provide enough context of the dataset. By better understanding the dataset, we would have a higher potential to create meaningful visuals and an increased ability to justify and validate our findings.

Fig 1 Internal model showing table relationships



3 - Visualizations with Tableau

This section contains a collection of visualizations used during the project. Visualizations are a powerful way to communicate information very quickly. Visualizations are powerful for idea discover because each person who views the picture will interpret and create their own assumptions. By sharing and critiquing these ideas with various subject matter experts, ideas can be validated and developed into tools and strategies that can make immense impacts.

To learn more about data visualization and why it is so powerful, please visit: https://www.tableau.com/about/blog/2015/11/why-time-tested-science-data-visualization-so-powerful-45705

Please note that some visuals may be displayed in Eastern time and not Pacific time.

Fig 2 Cumulative Line Graph

IK Barber, March 2-8 - showing average occupancy every hour

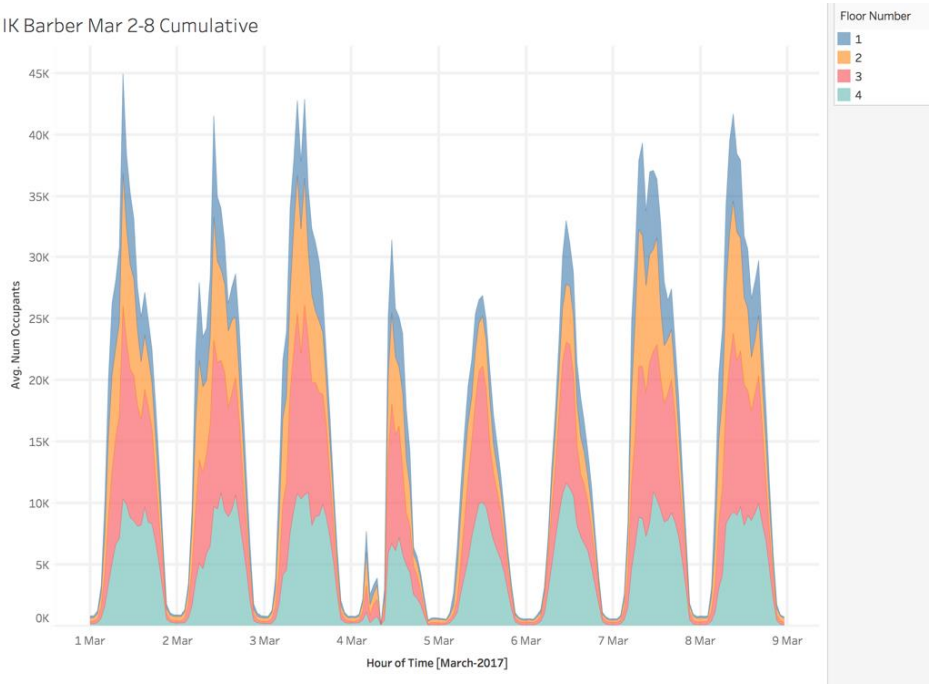


Fig 3 Line Graph (day, school term)

IK Barber, March 2 – showing average occupancy every hour

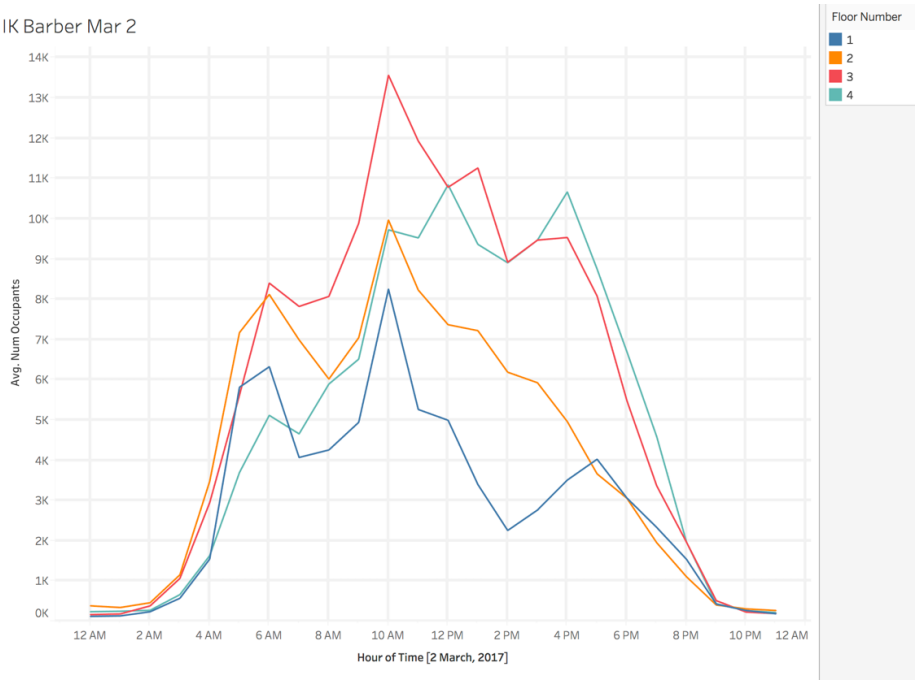


Fig 4 Line Graph (week, school term)

IK Barber, March 1-8 – showing average occupancy every hour

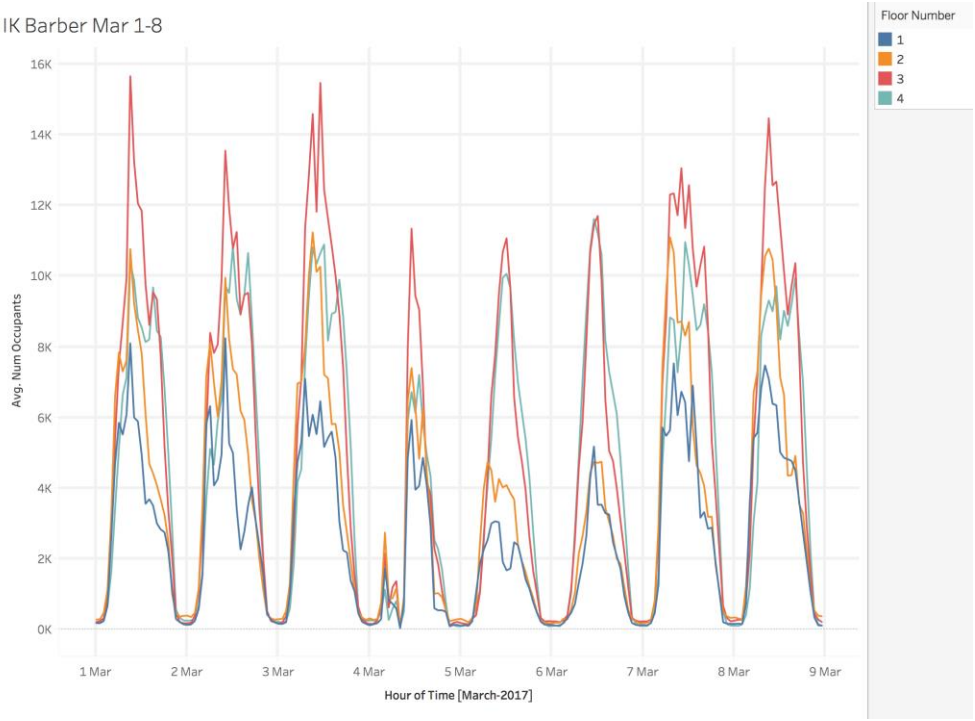


Fig 5 Line Graph (month, school term)

IK Barber, March 2017 – showing average occupancy every hour

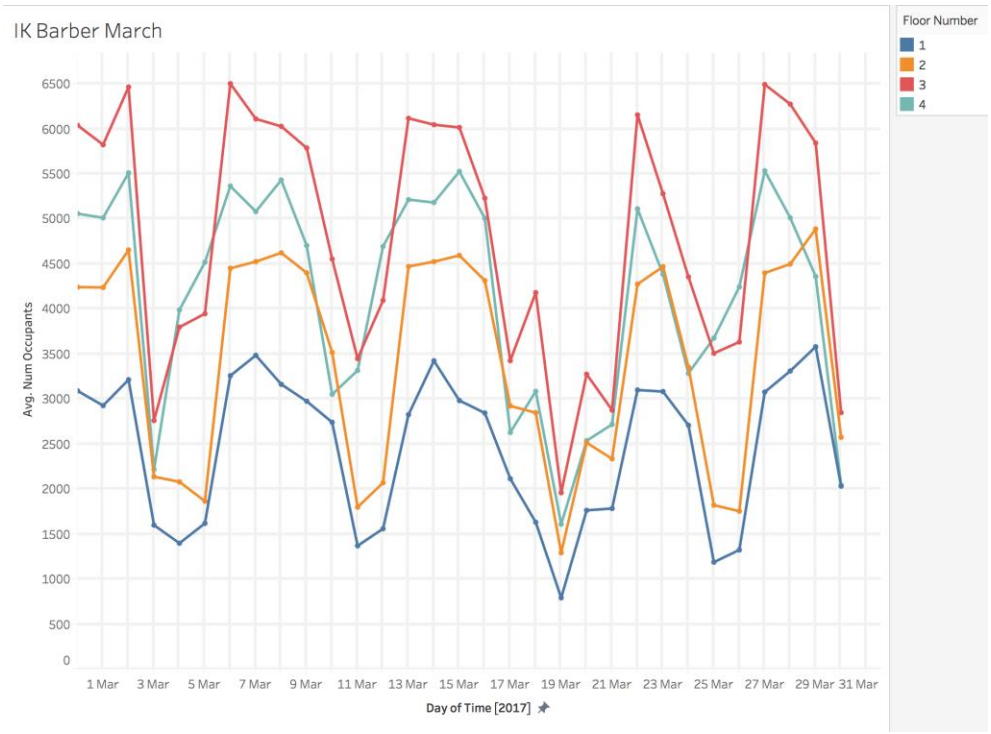


Fig 6 Line Graph (day, summer term)

IK Barber, May 6 – showing average occupancy every hour

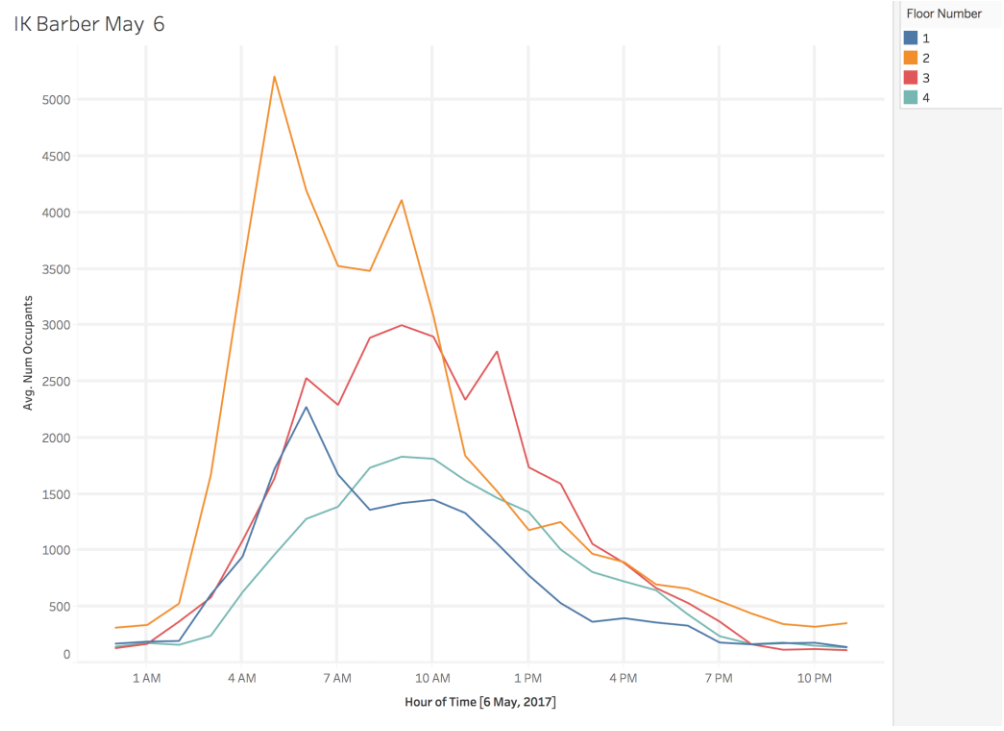


Fig 7 Line Graph (week, summer term)

IK Barber, May 1-8 – showing average occupancy every hour

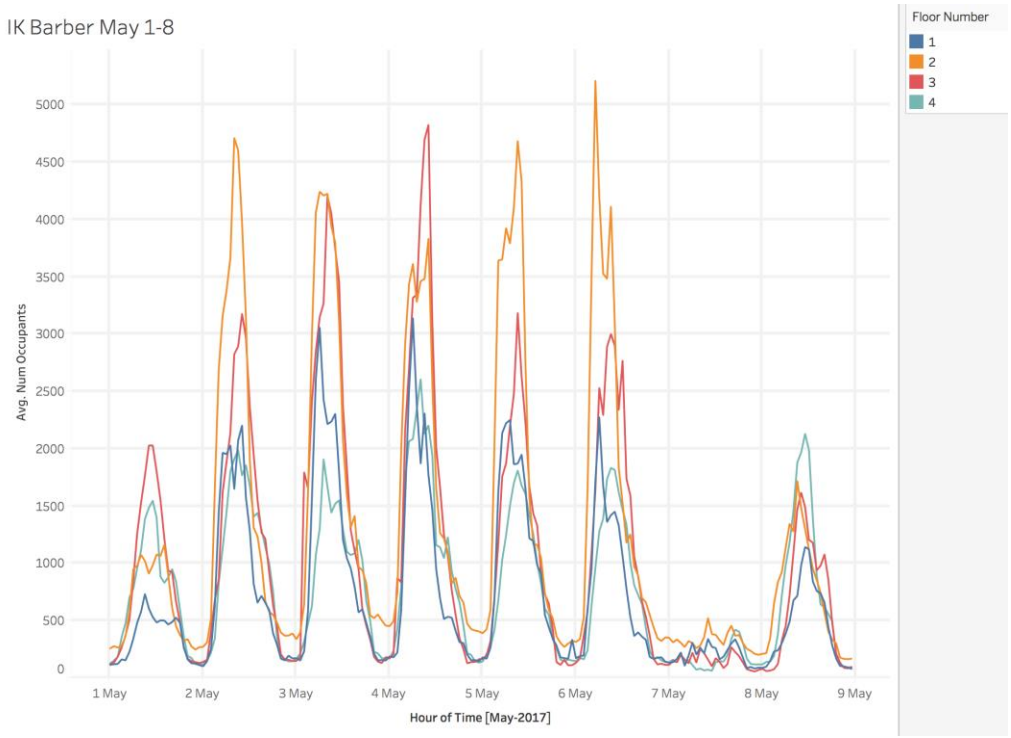


Fig 8 Line Graph (month, summer term)

IK Barber, May 2017 – showing average occupancy every hour

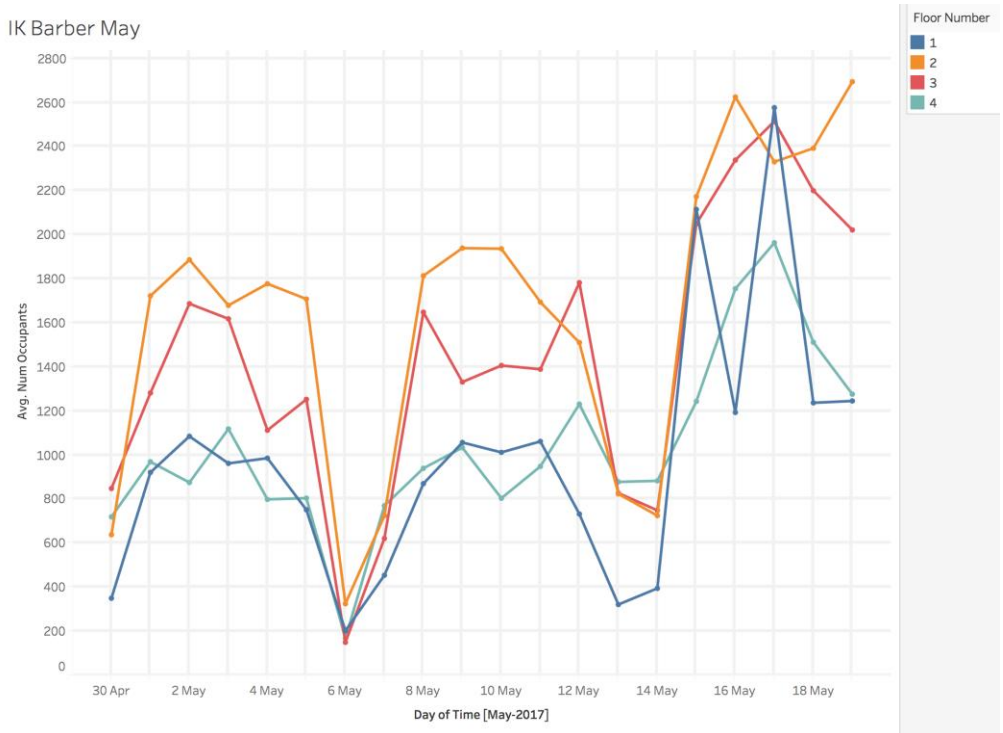


Fig 9 Multi-building Line Graph

Jan 2-9 – showing average occupancy every hour

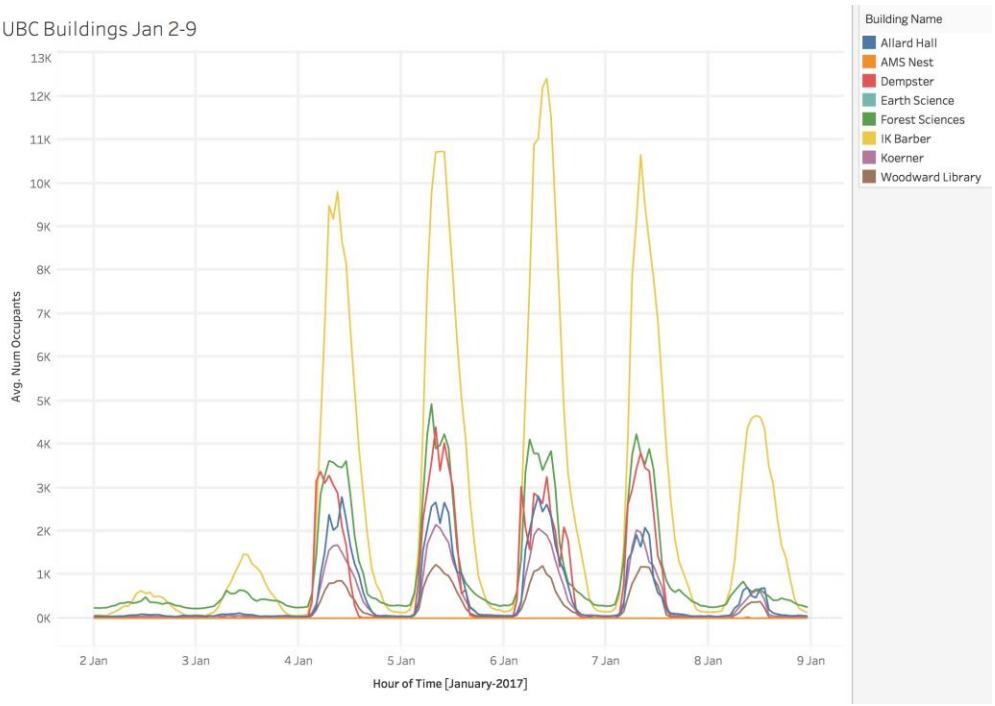


Fig 10 Multi-building Line Graph

Feb 20-26 – showing average occupancy every hour

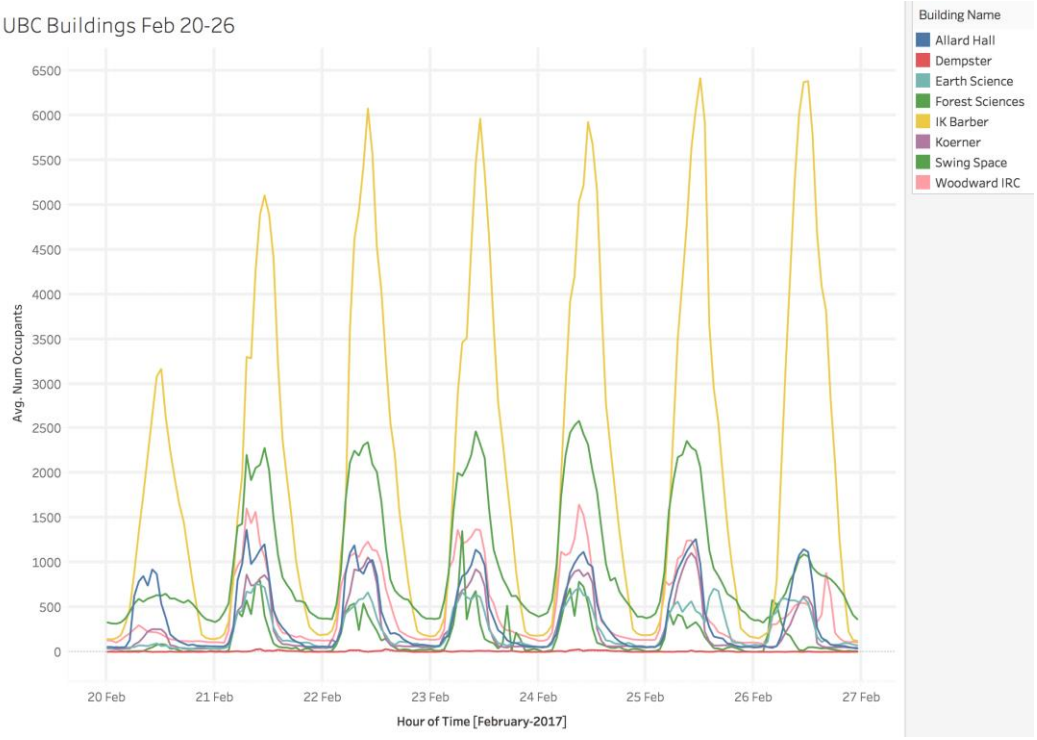


Fig 11 Multi-building Line Graph

March 25-31 – showing average occupancy every hour

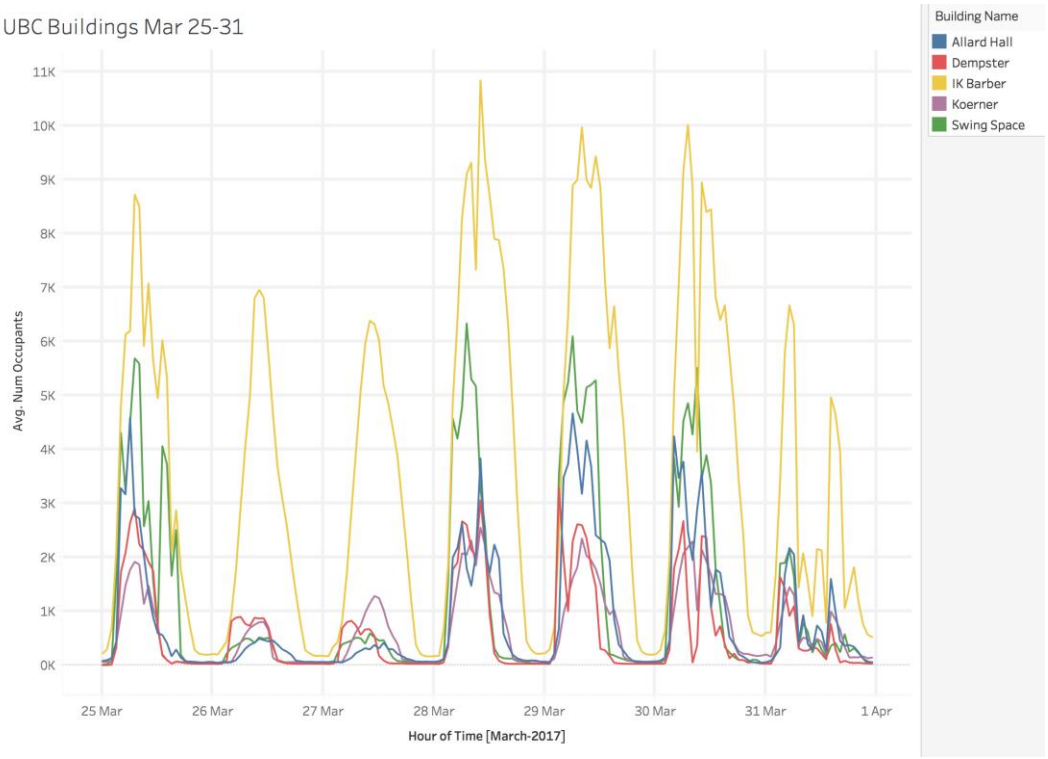


Fig 12 Multi-building Line Graph

Sept 10-18 – showing average occupancy every hour

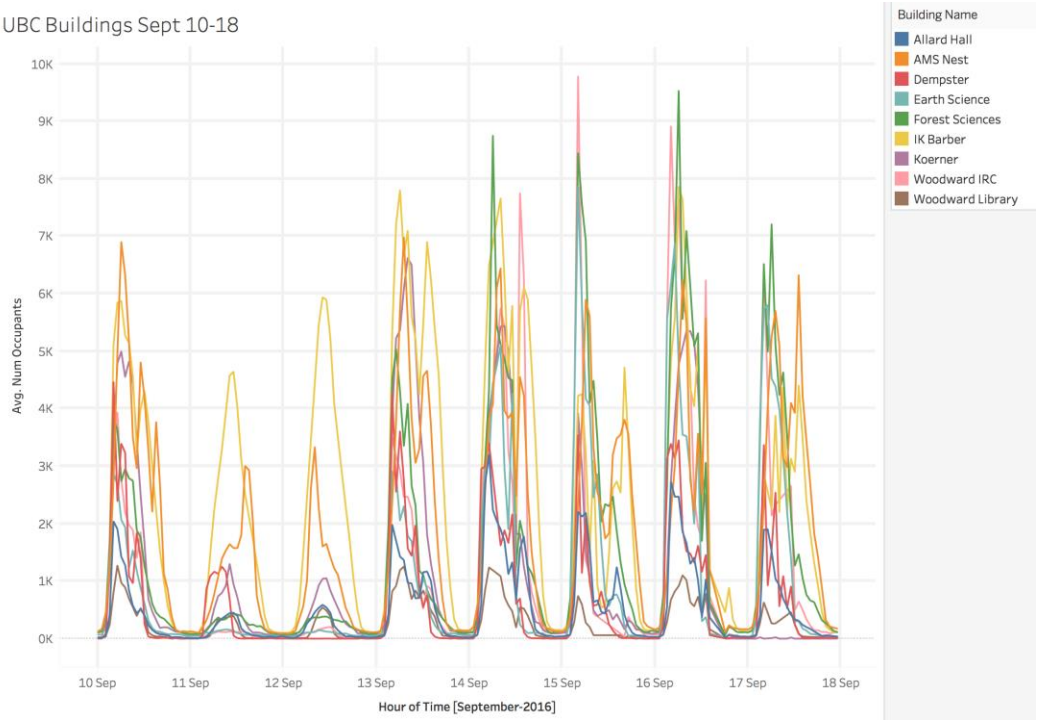


Fig 13 Multi-building Line Graph

Dec 1-8 – showing average occupancy every hour

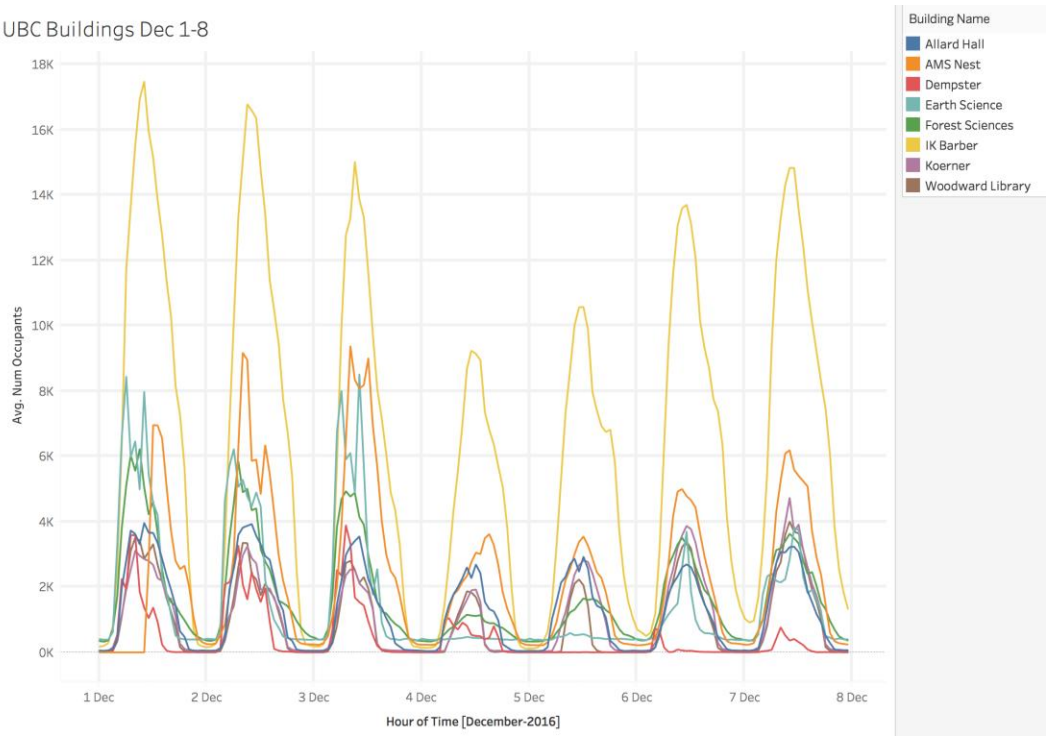


Fig 14 Multi-building Map

Fig 15 Multi-building Bar Graph

Average occupancy every day for the selected buildings, divided into time periods.

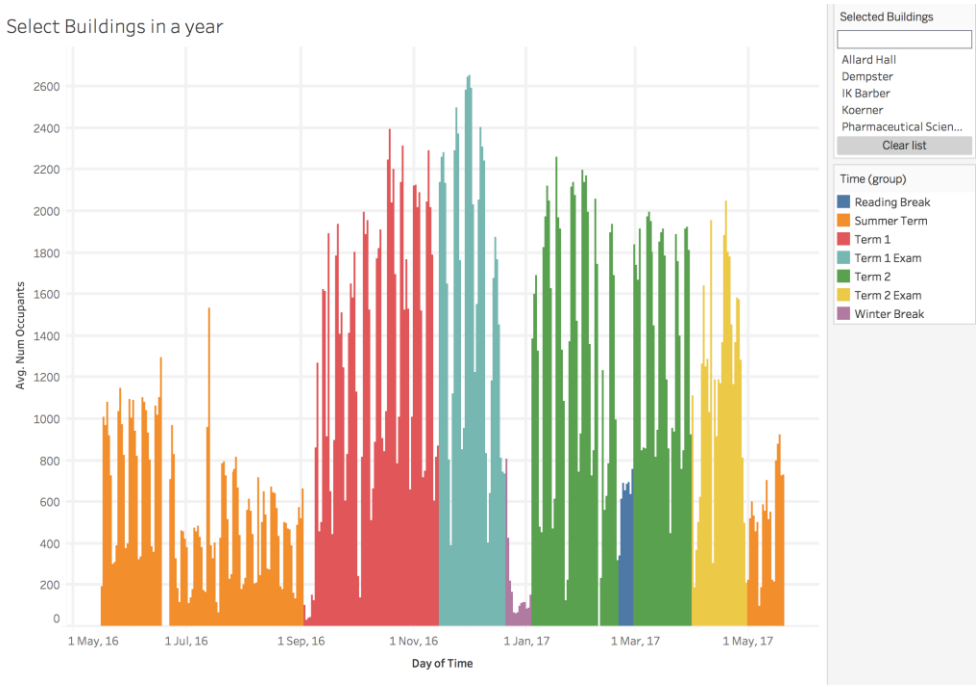


Fig 16 Multi-building Bar Graph

Total occupancy with all data available (note: large missing gaps of data from source). Divided into time periods.

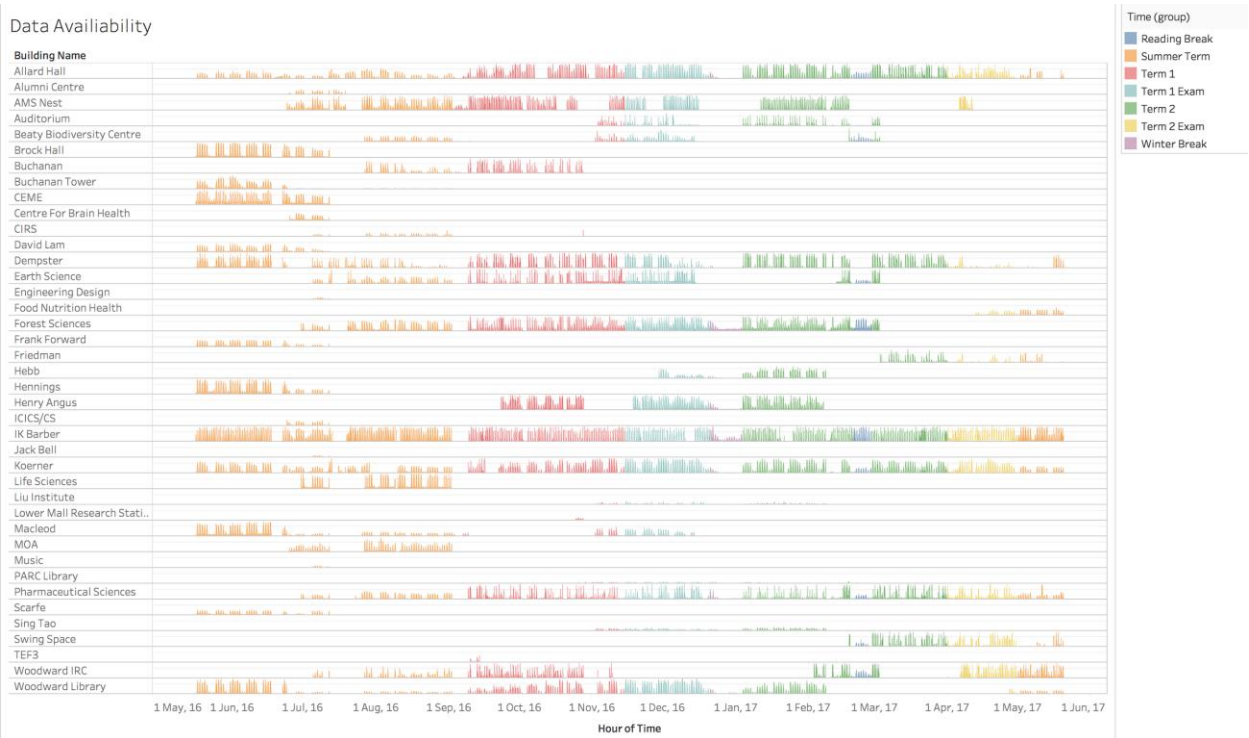


Fig 17 Multi-building Sankey Diagram

Shows distribution of people among selected buildings during certain time frames.

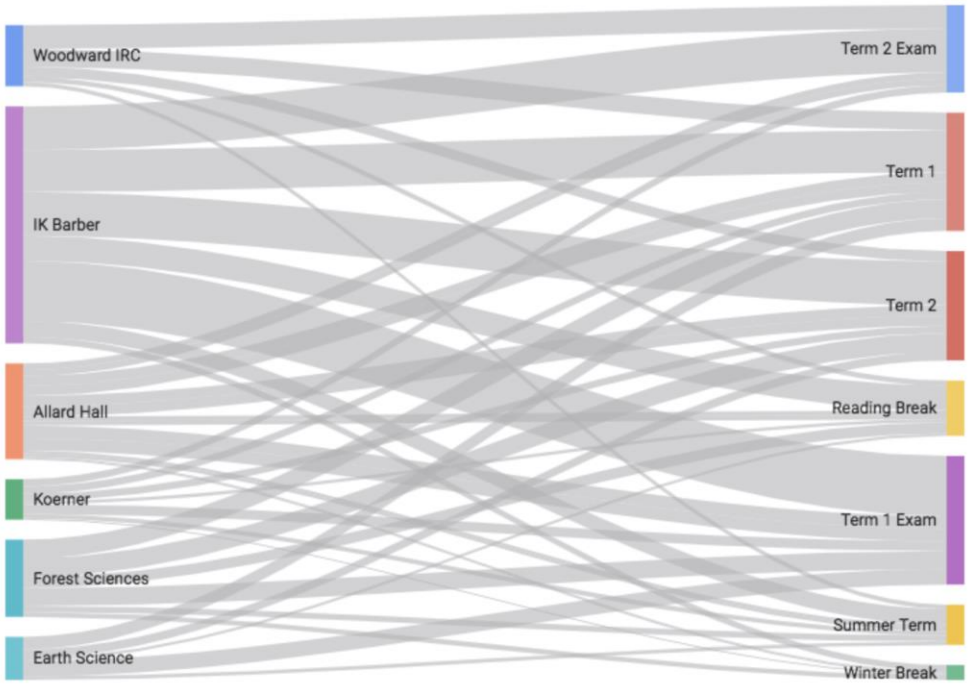


Fig 18 Single building Sankey Diagram

Shows distribution of people among floors during certain time frames.

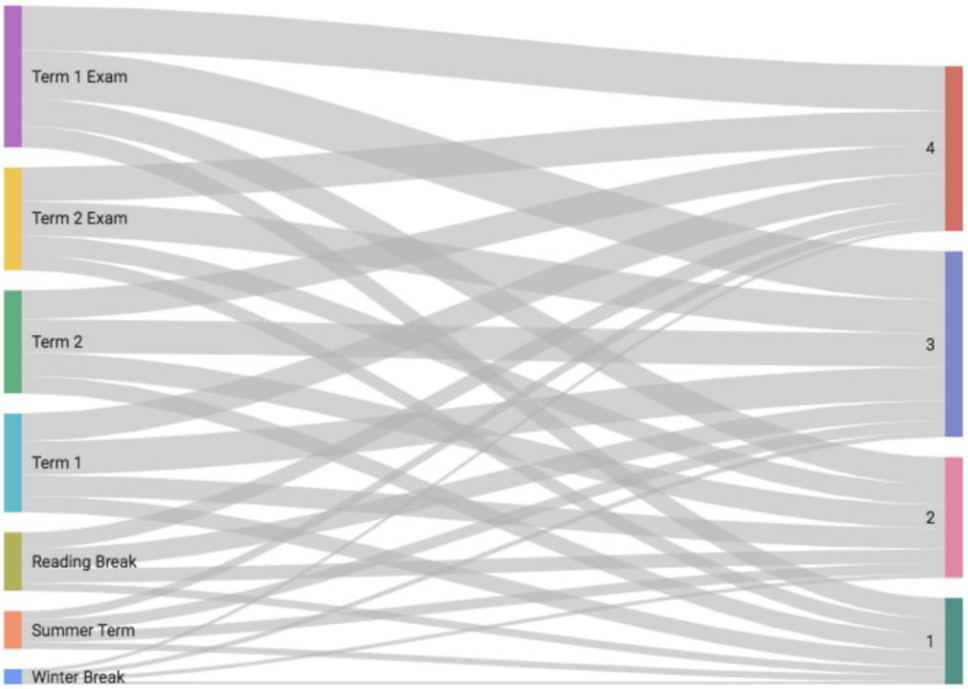
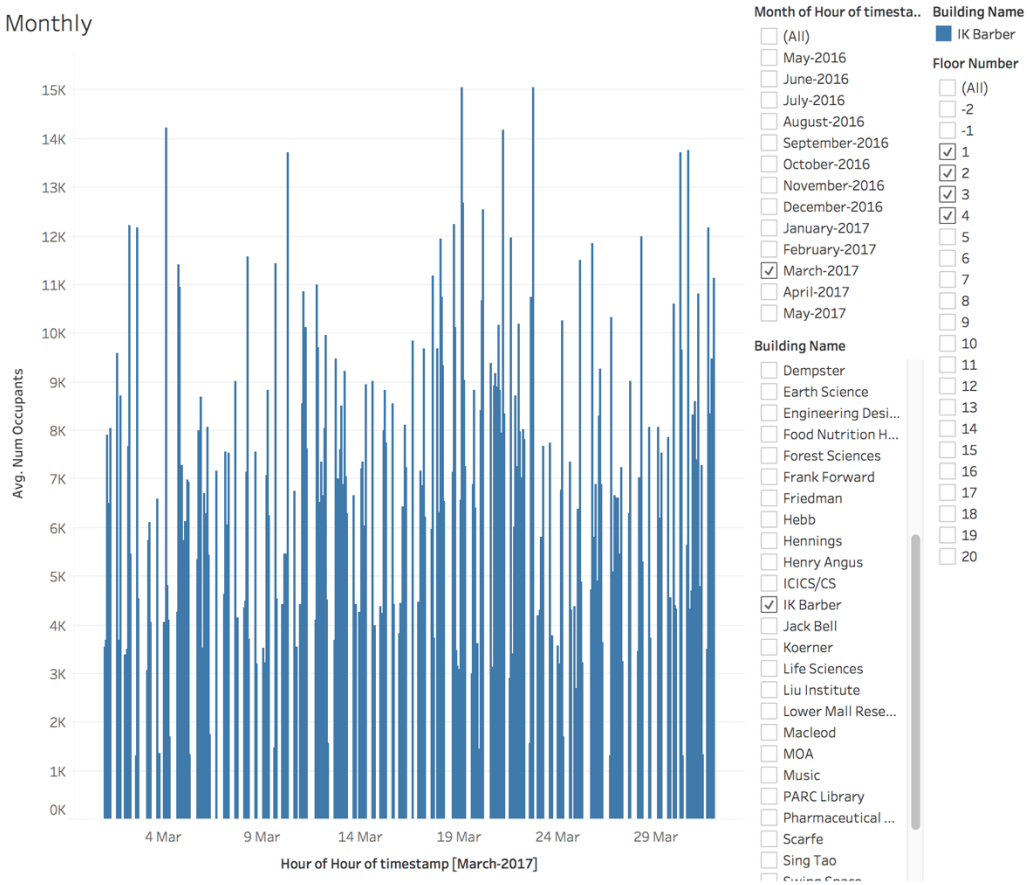


Fig 19 Occupancy Dashboard

Interactive dashboard in Tableau that allows the user to select a specific time period, building, and floor.


Monthly
Avg. Num Occupants
15K
14K
13K
12K
11K
10K
9K
8K
7K
6K
5K
4K
3K
2K
1K
0K
4 Mar
9 Mar
14 Mar
19 Mar
24 Mar
29 Mar
Hour of Hour of timestamp [March-2017]
Month of Hour of timesta..
(All)
May-2016
June-2016
July-2016
August-2016
September-2016
October-2016
November-2016
December-2016
January-2017
February-2017
March-2017
April-2017
May-2017
Building Name
Dempster
Earth Science
Engineering Desi...
Food Nutrition H...
Forest Sciences
Frank Forward
Friedman
Hebb
Hennings
Henry Angus
ICICS/CS
IK Barber
Jack Bell
Koerner
Life Sciences
Liu Institute
Lower Mall Rese...
Macleod
MOA
Music
PARC Library
Pharmaceutical ...
Scarfe
Sing Tao
Building Name
IK Barber
Floor Number
(All)
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-1
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4 - Stakeholder Interviews

4.1 Bud Fraser

Introduction

Bud Fraser is the Senior Planning and Sustainability Engineer with the Sustainability and Engineering Department at UBC.

Fraser facilitates development and implementation of programs that support sustainability initiatives on campus. Some of the initiatives include the Zero Waste Plan, Climate Action Plan, and Water Action Plan.

https://planning.ubc.ca/vancouver/news-events/newsletter/2013-07-26/qa-bud-fraser

One program Fraser is currently supporting involves the upgrade of all recycling infrastructure on campus. It may seem simple, but it's actually a major coordination effort involving multiple parties. For example, upgrading the outdoor bins involves working with designers, suppliers, and UBC Building Operations to ensure that the garbage bins fit into the waste operations ecosystem and can survive the weather. Fraser's team supports these program by helping solve questions like: How many bins should there be? Where should they be placed?

Discussion

Below you will find a summary of each of the topics that were discussed in the interview.

Benchmarking Building Operations

Fraser describes one of the areas he sees will directly benefit from Wi-Fi occupancy data. Building Operations are deploying a new data collection system that allows them to see how much and what type of waste they are collecting in their trucks. By knowing the overall waste distribution of buildings and layering with Wi-Fi occupancy data, they can create campus-wide per capita benchmarks for each type of waste. This allows them to rate buildings against each other to identify the outliers so they can pinpoint their waste reduction efforts. Investigating why these buildings are generating so much of a certain type of waste can provide insight for campus-wide waste reduction strategies. It is important to note that this concept can be applied to energy and water usage as well; by combining energy or water usage data with Wi-Fi occupancy data, we can create benchmarks, compare buildings, and identify outliers.

Strategy Verification

Looking at it from the long-term perspective, Fraser knows that the Wi-Fi occupancy data has another role: post-implementation reviews. Once benchmarking information is created and historically tracked, the baseline can be used to validate the performance of new solid-waste, water, or energy strategies. A strategy Fraser would like to test this out on is happening this

upcoming holiday shutdown. Departments across campus are asked if there will be people in their buildings between certain dates over the winter holiday. If there won't be, it's an opportunity to save some energy by lowering the heat, turning off the lights and computers. The Wi-Fi occupancy data can be used to verify if anyone occupied the building during the break...and if not, it shows an opportunity for next shutdown!

4.2 Catherine Alkenbrack & Steven Lee

Introduction

Catherine Alkenbrack is the Director of Facilities Planning in the Infrastructure Development Department at UBC. Alkenbrack's role involves high-level planning and coordination between the diverse facility needs across campus, whether they be for academics, administration, research, or other.

Steven Lee is a Facilities Planner, also in the Infrastructure Development Department. Lee works with multiple groups on campus to ensure learning spaces are meeting academic need. Because of his role, Lee has an interest in how efficient UBC is using spaces and how effective they are for staff and students.

You can learn more about the Infrastructure Development team at http://infrastructuredevelopment.ubc.ca/meet-the-team/

Discussion

Below you will find a summary of each of the topics that were discussed in the interview.

Maximizing Usage of Space

As Lee's role is to understand and plan spaces across campus, he had much to say about how Wi-Fi occupancy data could support better space usage.

Lee first mentioned how different types of spaces could be shared across user groups. The Wi-Fi occupancy data can be used to determine which meeting rooms are being utilized the most and least. This opens up the opportunity for staff to book meetings in rooms nearby if their departments are booked up; or for students to find quiet areas to study in meeting rooms not being utilized at all. An interesting discussion point was the culture around students being in staffs' space; some departments are open to the idea of sharing and some are definitely not.

Next, we discussed classroom and lecture hall spaces. With classrooms, especially in service courses with high registration, a fraction of the students attend. For example, a classroom for 80 students will be booked but maybe only 20-30 students attend for majority of the year. With the Wi-Fi occupancy data, they could determine which classes have this issue because long-term, filling classes 25% full is not sustainable. Another way to use the data could be to determine when too many students show up to a lecture section they aren't enrolled in. For example, a

popular class may have three sections at 8am, 11am, and 2pm; students enroll in the 8am section but attend the 11am or 2pm section. Another student project has explored these issues using registrar's aggregated classroom schedule data but this data does not show the true story, it only shows what is expected.

The Wi-Fi occupancy data is very useful for exploring study and social spaces on campus. Planners could analyze which spaces are most busy, what times during the day, and start to dig deeper into understanding why students are clustering there. Are there amenities there? Is it quiet or maybe has good lighting? What makes this spot unique? This type of information would support decisions on where the greatest need for new spaces is and what to provide in the space.

Long Walking Distances on Campus

Much like discussed in the “Space Utilization” section, the Wi-Fi occupancy data and registrar data could be used to determine how many students have to walk farther than 10 minutes between classes. Alkenbrack stated that another study on campus showed that approximately 2,000 students are affected by this. This information would help determine where to schedule courses to reduce people’s travel time and for facilities planning, where to put new classrooms so that the issue doesn’t escalate further.

Seismic Upgrades

Perhaps the most immediate use for the Wi-Fi occupancy data is for seismic upgrade planning. Alkenbrack and Lee both explain how important it is for them to be able to compare the occupant loads they gathered from other sources with the Wi-Fi occupancy data. It is a method to verify the methodology and findings of their department. The importance comes from using the verified data to inform seismic upgrade plans on campus; for example, scheduling highest occupant buildings first.

Post Occupancy Reviews

Alkenbrack shared some ideas that leverage the Wi-Fi occupancy data for post occupancy activities. She is interesting in how this type of data collection can evolve into post-occupancy reviews, as manual ones are time and cost intensive.

She inspires thought around how the data can be used to find which buildings, floors, and rooms have the highest user satisfaction. She views this whole project has an evolving process; we are starting to use the data to optimize time and space but eventually it will be about enhancing the user experience. How well are facilities meeting the academic, research, administrative, and student need? Ultimately, she would like to see a post-occupancy review from every person who enters the building; how can we achieve this with minimal user input? It is important to note that by using the Wi-Fi occupancy data to determine user satisfaction, we can now use the user satisfaction data to accomplish different goals in other topics such as psychology. Interesting research is currently being conducted by Dr. Jiaying Zhao, Assistant Professor in the Department of Psychology at UBC. The research involves looking at whether

there are any relationships between the condition of physical study space and cognitive performance. http://zhaolab.psych.ubc.ca/research.html

4.3 Martino Tran

Introduction

Martino Tran is the Director of the Urban Predictive Analytics Lab (UPAL), Co-Director of the Master of Engineering Leadership in Urban Systems, and Assistant Professor in the School of Community and Regional Planning at UBC. He is also a Visiting Research Associate at the Environmental Change Institute and a former Oxford Martin Fellow in Complexity, Resilience and Risk at the University of Oxford.

https://www.urbanpredictiveanalytics.com/ // https://scarp.ubc.ca/people/martino-tran

Tran is an expert in predictive modelling and simulation of urban environments. The Urban Predictive Analytics Lab helps inform decision makers around the world on policy and investment strategies that have positive sustainability outcomes. One of the high-level challenges that Tran and his research team experience on a constant basis is a lack of high-quality, easy to find data. Even if the data exists, it is extremely hard to acquire due to privacy concerns, intellectual property issues, or high cost of licensing. This challenge is not only faced by Tran and UPAL but every person at UBC leveraging data in their work. This is further discussed in Section 5.

Discussion

After showing the data and some preliminary visuals, Tran spoke from a systems perspective and provided some amazing insights on how the data could be used.

Congestion Zones

Tran's first ideas during the interview were around facilities planning, specifically, optimizing mobility and occupancy density around UBC. With the current data, it's possible to determine where congested buildings exist. By adding mobility data (much like Adam Hyslop would use), Tran states we could estimate the location and size of congestion zones on campus. Sankey diagrams (Fig 17/18) were a visualization suggestion from Tran; it would provide planners with a quick reference to see approximate occupancy flows.

Building Profiles

Next, Tran discussed ideas around correlating occupancy with utilities in buildings. This idea is identical to Frasers in Section 4.1. By bringing occupancy trends together with utility usage trends (energy consumption, water consumption, waste generation, etc.), we can create universal building indicators for the campus. These indicators can be used to generate a profile of a building, allowing comparison of utilities and occupancy across all UBC buildings. An

immediate use of this system could be determining the outlier building profiles and evaluating their indicators to find areas of improvement.

Breakdown the Silo'd Departments

The last insight Tran provided was a question around integration of departments; how can we improve the silo work environment with occupancy data? This inspired some critical thinking and discussion. I believe we can mitigate the departmental barriers by sharing information. The Wi-Fi occupancy data is universal, it can be understood and used by any department because it reflects human behaviour. Creating visualizations allow a person to see the data from multiple perspectives more easily; they can make more informed decisions and are able to communicate with external parties more effectively through these perspectives. Using the universal data as a conversational starting point, each party is able to further engage, listen, and really understand the other party. Occupancy data could be a very good start towards integrated discussion and learning across silos.

Predictive Analysis

Tran concluded our interview with an overview of how he approaches projects from the predictive analysis perspective. In brief, he states the data must be understood so that interdependencies and interrelationships can be determined and proven. Once these are mapped out, the analyst can start defining the flow of the network and key indicators. With this information, forecasts and predictions can be created, allowing for better system-level planning.

4.4 Adam Hyslop

Introduction

Adam Hyslop is a Transportation Planner with the Campus & Community Planning Department at UBC.
https://www.linkedin.com/in/ahyslop/ // https://scarp.ubc.ca/people/adam-hyslop

Currently, Hyslop is working on the feasibility, strategy, and implementation of a campus-wide bike sharing program. Some of the work to accomplish this includes determining what type of bike share program would be more successful (dockless vs dock bike system), usage and adoption rates, and rebalancing bikes between hotspots to optimize between supply and demand patterns.

Discussion

One of Hyslop's biggest hurdles is fully understanding people's movements on campus; which buildings are people travelling between and what are the paths they choose. To successfully and accurately implement Hyslop's vision, he needs a method to collect aggregate travel path information.

Bike Sharing at UBC

Hyslop has been working with an old dataset from 2011 to develop the initiative. He is able to draw assumptions from this data but it's still not accurate enough to successfully implement the strategy he is developing.

In 2014, a Social Ecological Economic Development Studies (SEEDS) report by David Stonham was released which included 10 people's bike usage. In the report called, "Enhancing Campus Transportation Monitoring", it describes how Stonham used GPS technology to accurately track on-campus transportation patterns of the participants. Stonham concludes that this raw data can support planning strategies on campus, which we directly see with Hyslops current project. Hyslop found the data and report extremely useful, but still requires a much larger sample size.

Ideally, Hyslop acquires large sample sizes of aggregate GPS travel paths. This would make planning easier and more accurate for the bike sharing initiative, but also with general walking and bike path planning. Due to the immense privacy concern and cost for collecting GPS information from individuals, heat maps are a good start to support his work. Heat maps can be created with the Wi-Fi occupancy data and would inform where people are, at what times. By overlaying with bike location heat maps, he could determine a bike relocation strategy, for example.

Another, less accurate way Hyslop could use the Wi-Fi occupancy data is by having start and end locations of a specific participant. For example, if a student leaves Building A and goes into Building B, we would be able to know the general flow of where the student is moving. But without GPS data, we cannot accurately say the path they took, if they made a stop, and how long or fast they were walking, running, biking...it is easy to see how much more useful GPS data can be. It is important to note that we continue to have privacy concerns even with just tracking a person's start and stop location.

5 - Open Data

During this project, a theme around open data was identified. This section gives an overview of some of the discussions around data at UBC.

5.1 The Challenges

Acquiring Data at UBC

David Gill, Program and Policy Planner with the SEEDS Sustainability Program in Campus and Community, has managed this SEEDS Wi-Fi occupancy data project from the start. Gill shared his view of data issues from the perspective of managing many SEEDS projects across campus.

He states that Social Ecological Economic Development Studies (SEEDS) program has great project ideas from campus stakeholders, but students undertaking projects often can't find the data they require to complete the project in such a short timeframe, typically 4 or 8 months. Data is required from numerous departments, often taking days of emailing just to find the right person. While most of this is done in project planning stage before students are involved, students often need to find additional data along the way, and weeks are consumed because students are being bounced around and within departments in search of the data. Even if a student locates the information they need, they might require department approvals, leaving them with half the semester gone and midterm exams around the corner. If students had access to the type of data they need right away and easily throughout their projects, they could better prioritize their project workload over the semester resulting in higher quality projects from students with less stress and greater operational relevance.

Data Privacy

By far, one of the most controversial topics around this project was privacy. Collecting and releasing information that allows a user to pinpoint densely populated areas worries stakeholders. From another perspective, they know that without analysis of this data, we would not be able to innovate across sectors and push sustainability agendas forward. It is suggested that the data should be made available to anyone who requests it, as long as there is a checks and balances system to ensure the user is causing no harm.

6 - Conclusion

While this project uncovered some amazing and innovative ideas in sustainability, it also highlighted a major barrier to innovation at UBC. Acquiring data for student and staff projects is taxing and time consuming, there needs to be a better system for sharing information. Faster access to information means more time to develop projects over the semester.

Open access to data also means increased ability to bring people together and innovate across sectors. Proof of this is this SEEDS project itself; the occupancy data opened up doors to many different subject matter experts, students and staff, all locally on our beautiful campus. People who have ideas and specialized skills but no data. People who's goals align but can't find who to talk to. People who can innovate together but are locked in their silo departments. Access to data is not only a powerful way to innovate across sectors, it's a powerful way to bring minds together, unifying stakeholders over a single vision.

6.1 Recommendations

An open-data platform at UBC would organically develop interdisciplinary projects by breaking down the "barrier to collaboration;" not just between siloed departments, but also between students and staff. It is recommended that UBC work on its open data platform to include more datasets and to make it easier use for students at all levels; it should be a key tool for the learning experience. The data exists, it just needs to be found, cleaned, and stored properly for everyone to share.
https://open.library.ubc.ca/collections/abacusopen

Another recommendation is to find other ways to combine the Wi-Fi occupancy data with other datasets. It was found that when combined with complementary data related to a specific field, more innovation could occur. The Wi-Fi occupancy data can provide preliminary insights but the real benefit comes if you are able to relate the date to another dataset. This is evident in all the interviews, whether the data is combined with GPS tracking for the bike sharing initiative, compared against class registrations to optimize space usage, or combined with waste/energy/water data to determine outliers and create reduction strategies.

6.2 Potential Projects

- Building Benchmarking - Use the data with water, energy, and waste data to create building performance benchmarks; can be used to create reduction strategies.
- Create Benchmark Repository - Build database with interactive interface allowing for users to see historical benchmark information; can be used to verify reduction strategies.
- Shared Spaces - Use data to determine which rooms are being underutilized and can be opened for shared booking.
    - Development of an app for students to find open study spaces on campus.
- Sharing Initiatives - Use data to help determine strategies for various sharing programs:
    - Bike Sharing
    - Coffee Cup Sharing

Appendix - 1

Instructions for PostgreSQL dump file restore (TXT file)

Note: for compatibility, PostgreSQL 9.3 is recommended
General info:
	-Database name: middlewaredb
	-User name: sensible
	-User password: a
Detailed installation guides:
	 - https://wiki.postgresql.org/wiki/Detailed_installation_guides
Restoring the dump using PostgreSQL dump file:
	$ pg_restore -d middlewaredb /path/to/file/database_backup_2017_05_19_1630
Restoring the dump using SQL dump file:
	$ psql middlewaredb < /path/to/file/database_backup_2017_05_19_1655.sql
Additional links:
	- https://www.postgresql.org/docs/9.4/static/backup-dump.html
	- https://www.postgresql.org/docs/9.4/static/app-pgrestore.html

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Step-by-step installation and dump restore (Linux - Ubuntu/Debian)
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Install and start PostgreSQL 9.3
	$ sudo apt-get update
	$ sudo apt-get install postgresql-9.3 postgresql-server-dev-9.3
	$ sudo service postgresql start
Create DB superuser and DB
	$ sudo su - postgres
	$ createdb -T template0 middlewaredb
	$ createuser -sP sensible # enter password 'a' when prompt'd
#restore DB via pg_restore or psql
	$ pg_restore -d middlewaredb /var/backup/database_backup_2017_05_19_1630
OR
	$ psql middlewaredb < /var/backup/database_backup_2017_05_19_1655.sql

#Test the db:
	$ psql
	$ \c middlewaredb
	$ \d
will display DB tables

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MacOS
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MacOS install and setup is very similar to the Linux one, the following tutorial go over its details:

- https://www.codementor.io/devops/tutorial/getting-started-postgresql-server-mac-osx

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Windows

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Windows installation (use the One Click installer package maintained by EnterpriseDB)
Suggested tutorial:

- http://www.postgresqltutorial.com/install-postgresql/

http://www.thegeekstuff.com/2009/01/how-to-backup-and-restore-postgres-database-using-pg_dump-and-psql/

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Reference - Sensible Building Science - Filipe Deo

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