UBC SEEDS Project

Exploring the Potential of Wi-Fi based Occupancy Data

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January 4, 2018

MEL | Master of Engineering Leadership

THE UNIVERSITY OF BRITISH COLUMBIA

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Agenda

1 Introduction

2 Stakeholder Interviews

3 Challenges and Recommendations

3 The Data

4 The Future

1 Introduction

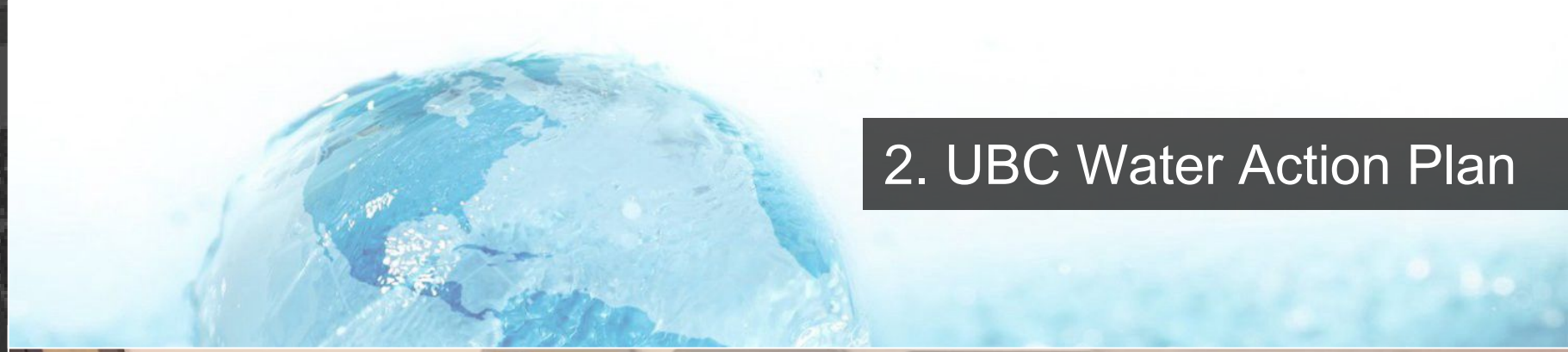
Purpose

Purpose - Determine how Wi-Fi occupancy data can be used to help understand and plan the usage across campus

Supports

3 UBC Action Plans

1. UBC Climate Action Plan



2. UBC Water Action Plan

3. UBC “Sort It Out”

Purpose

Explore Potential Applications in:

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

Background

New Wi-Fi Technology - UBC piloting new technology (Bridge) to reduce building energy consumption.

Occupancy Counts - Bridge takes Wi-Fi connection data from the UBC Cisco Network and converts it to anonymous occupancy counts by building, by floor, by zone.

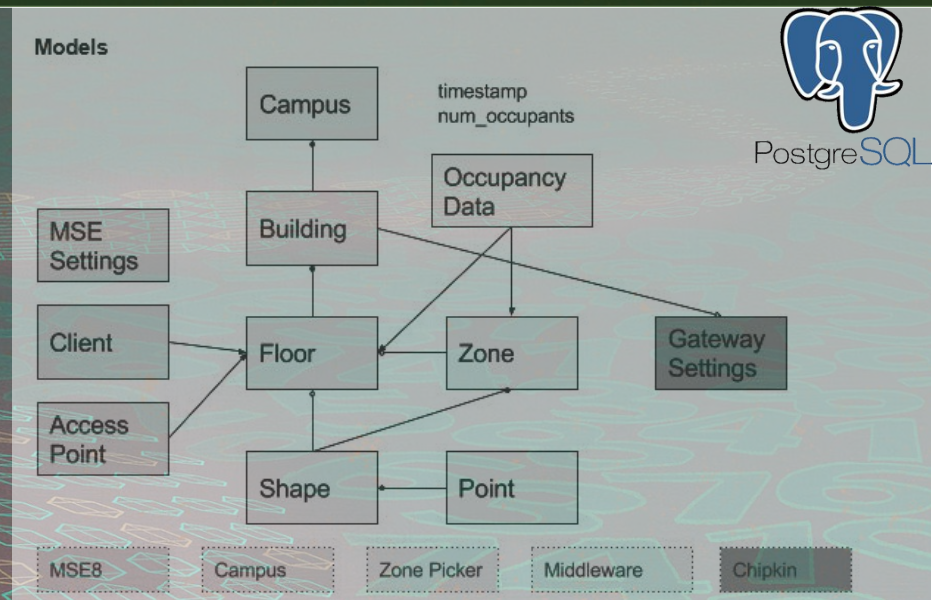
New Uses - This project uses the same occupancy data but explores other applications

Technical Method

Step 1: Database Query

Raw data acquired in postgreSQL dump file

PostgreSQL Server was hosted and data tables extracted

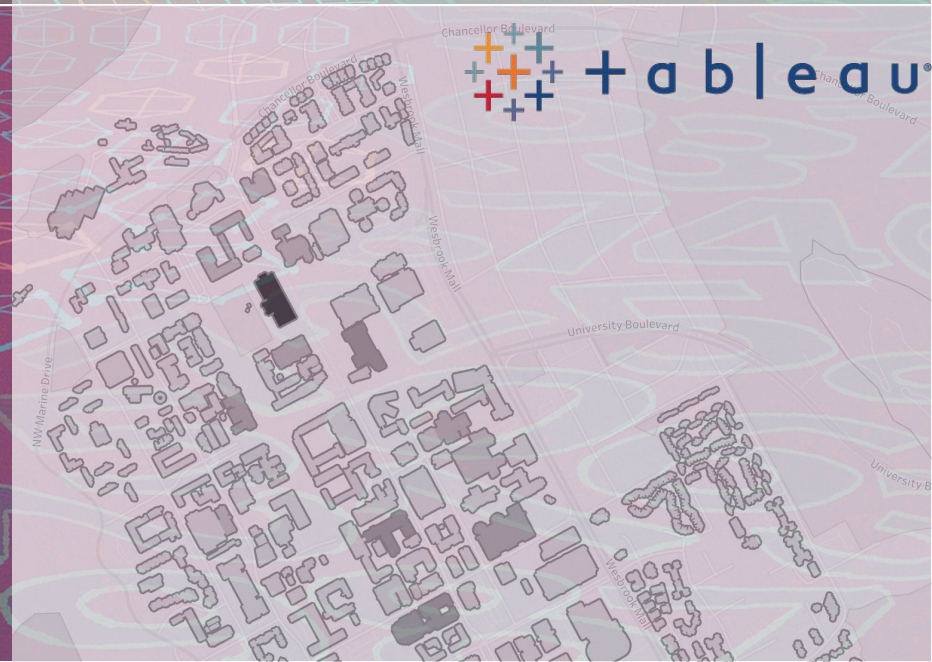


Step 2: Data Visualization

Data was wrangled, cleaned, stitched and joined

Tableau was used to visualize data

Visualizations were used as discussion starters for stakeholder interviews



Data Quality

Development Database:

-Database architecture constantly changing

-Database constantly being turned off and on

Accuracy of Dataset:

-Bridge system counts all devices, does not distinguish individual users. Algorithms used to estimate occupancy counts.

Ex) Bridge register devices of occupants passing through (not staying) or are outside buildings

Ex) Exceptionally high occupancy counts may not accurately represent actual occupancy levels

Ex) Bridge system is inaccurate when occupancy levels are low

2 Stakeholder Engagement

Stakeholder Group

Preliminary visuals were created and shared with:

Adam Hyslop campus + community
Transportation Planner

Bud Fraser UBC sustainability
Senior Planning and Sustainability Engineer

Catherine Alkenbrack INFRASTRUCTURE DEVELOPMENT
Director, Infrastructure Development

Steven Lee INFRASTRUCTURE DEVELOPMENT
Facilities Planner

Dr. Martino Tran UBC Applied Science
Assistant Professor | Co-Director: MEL, Urban Systems

Overview of Ideas from Stakeholders

01 Bike Sharing Program

02 Congestion Zone and Predictive Analytics

03 Benchmarking Building Operations

04 Strategy Verification

05 Maximizing Space Usage

06 Seismic Upgrade Planning

07 Post Occupancy Reviews

01 Bike Sharing Program

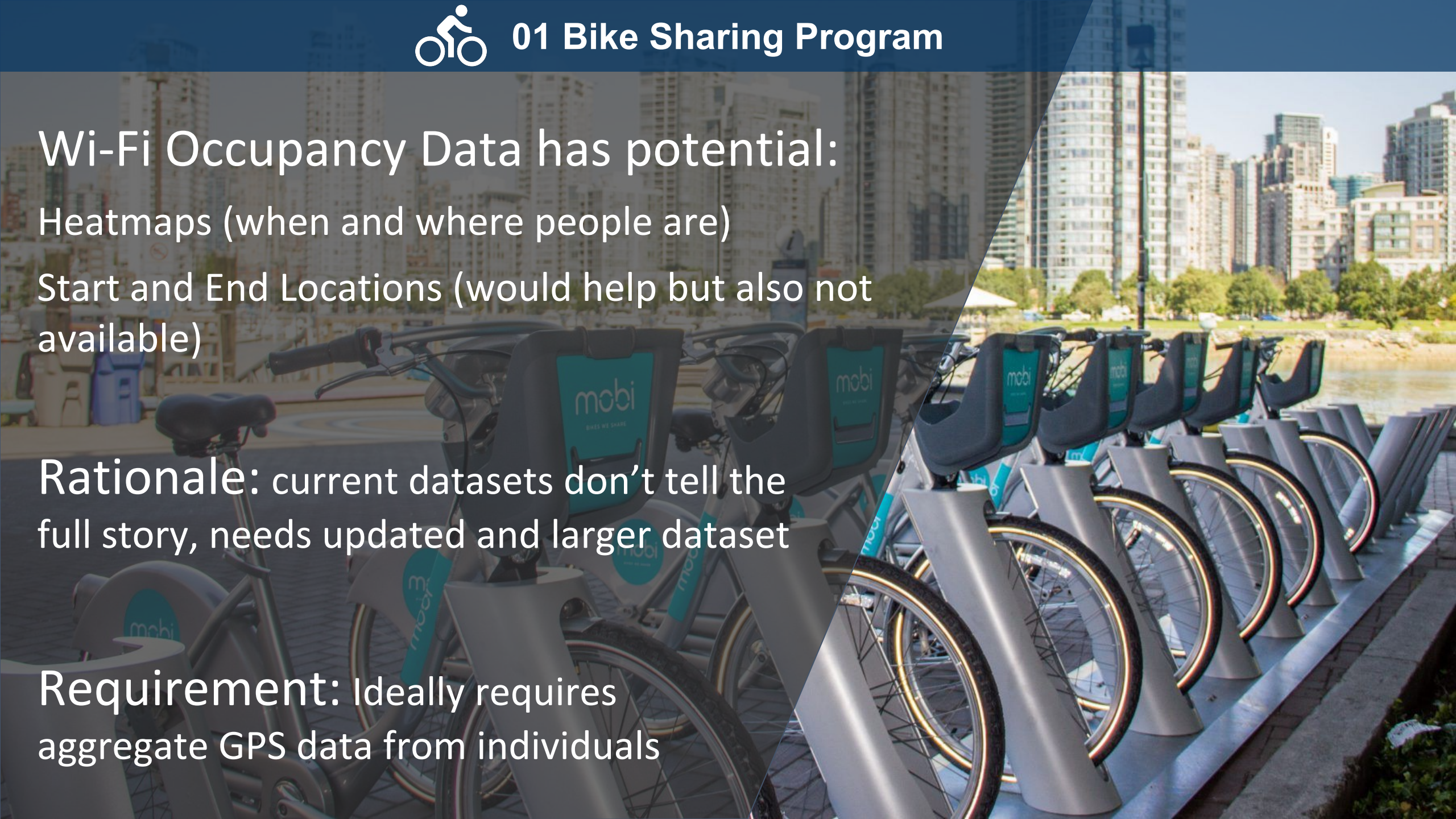
Wi-Fi Occupancy Data has potential:

Heatmaps (when and where people are)

Start and End Locations (would help but also not available)

Rationale: current datasets don't tell the full story, needs updated and larger dataset

Requirement: Ideally requires aggregate GPS data from individuals



02 Congestion Zones and Predictive Analytics

GPS Aggregate Data + Heatmap Data

=

Location + Size of Congestion Zones

Historical Congestion Locations + Size Data

=

Predictive Analytics for Campus Planning

03 Benchmarking Building Operations

- Building Ops currently deploying waste data collection system
- Waste collection types and quantity can be determined
- Wi-Fi occupancy data can be layered to create benchmarks per capita
- Compare building (labs, admin, student space, etc.)
- Identify outliers
- Reduction strategies can be developed and investigated

04 Strategy Verification

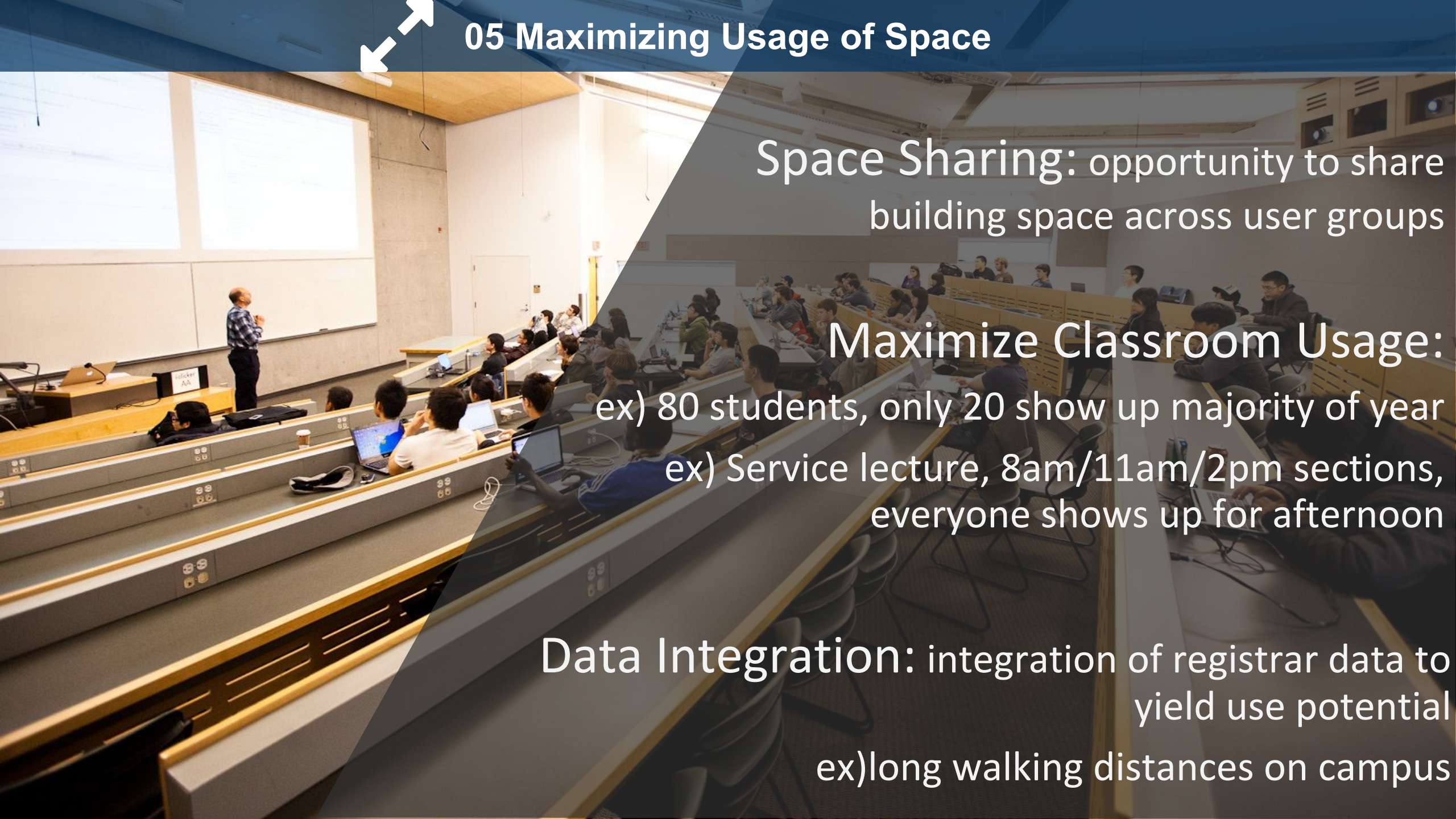
Long-term Strategy: can be used to store benchmark information

Compare Data: After implementation of new strategies, can compare to historic data

Compare Changes: can compare metrics in post strategy implementation

Evaluate and Revise Strategy

05 Maximizing Usage of Space



Space Sharing: opportunity to share building space across user groups

Maximize Classroom Usage:

ex) 80 students, only 20 show up majority of year

ex) Service lecture, 8am/11am/2pm sections, everyone shows up for afternoon

Data Integration: integration of registrar data to yield use potential

ex)long walking distances on campus

06 Seismic Upgrade Planning

Occupancy Data

Comparison: verify accuracy of alternate datasets by comparison

Seismic Upgrade

Planning: building seismic upgrade plans can developed, especially in schedule prioritization

07 Post Occupancy Reviews

Optimization of space and time using current data

Next, it will evolve to user satisfaction/user experience

How well are facilities meeting academic, research, administrative, and student needs? How can this data tell that story?

3 Challenges and Recommendations

Data @ UBC

Acquiring Data:

- Student projects
  - Short amount of time to complete
  - Department approvals take too long

Data Privacy:

- Innovation vs. Safety
  - Can completely change the way we operate campus
  - Can locate densely populated areas (security concerns)

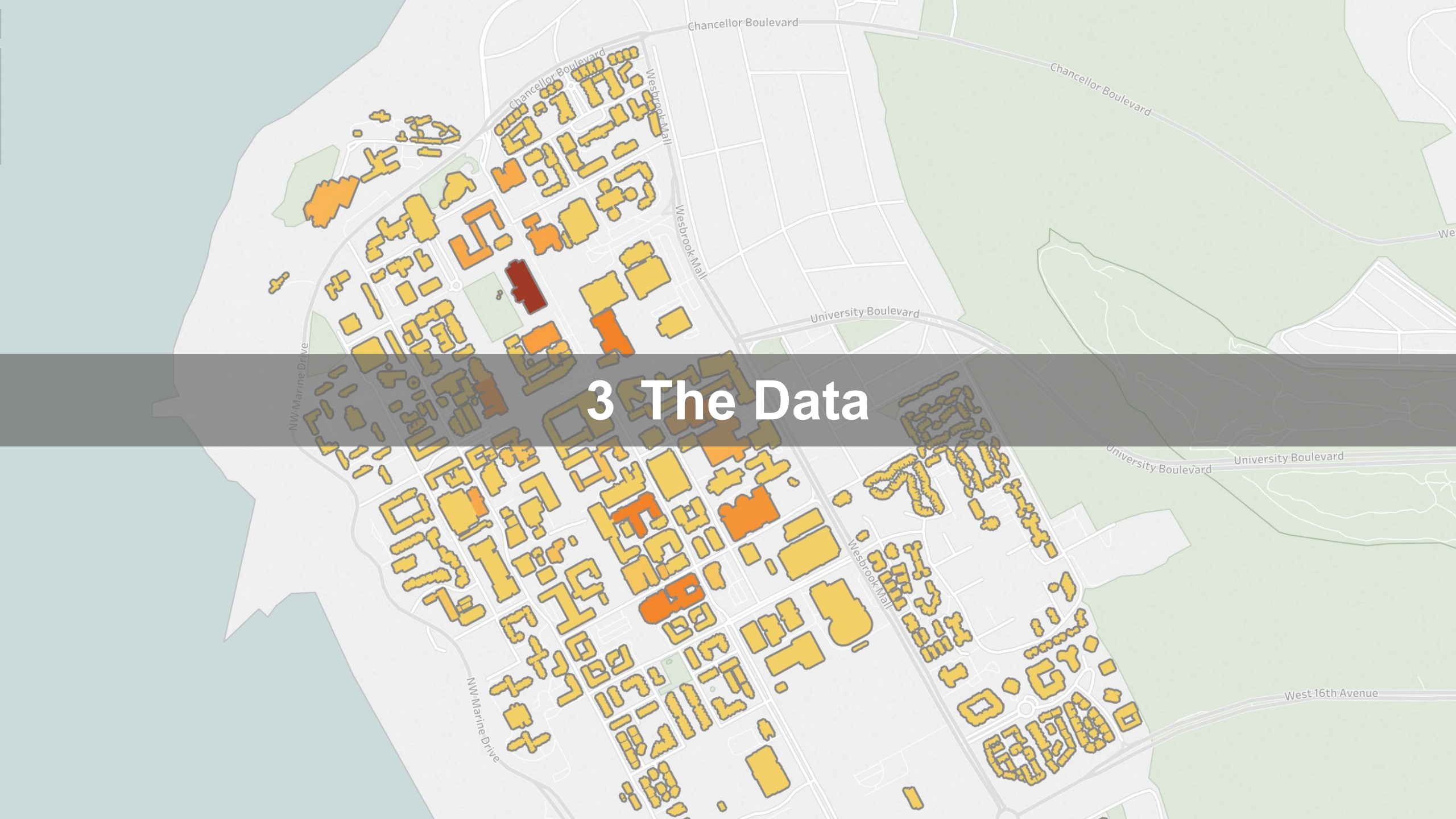
Recommendations

Open Data at UBC:

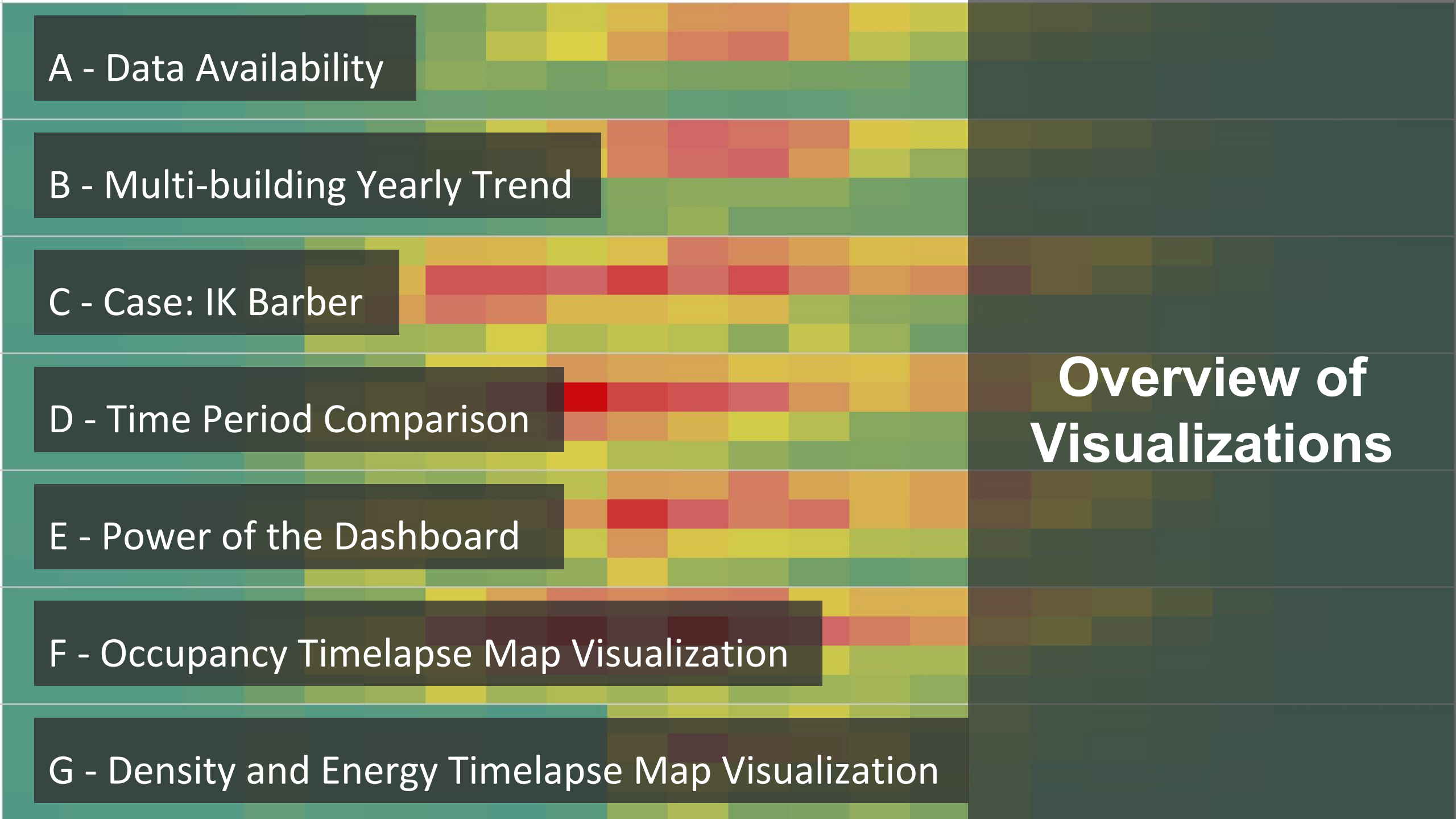
- Develop existing **open data platform** for student/staff use
- Develop **open data standards**
- Develop user **screening process** for sensitive data

Dataset Sharing:

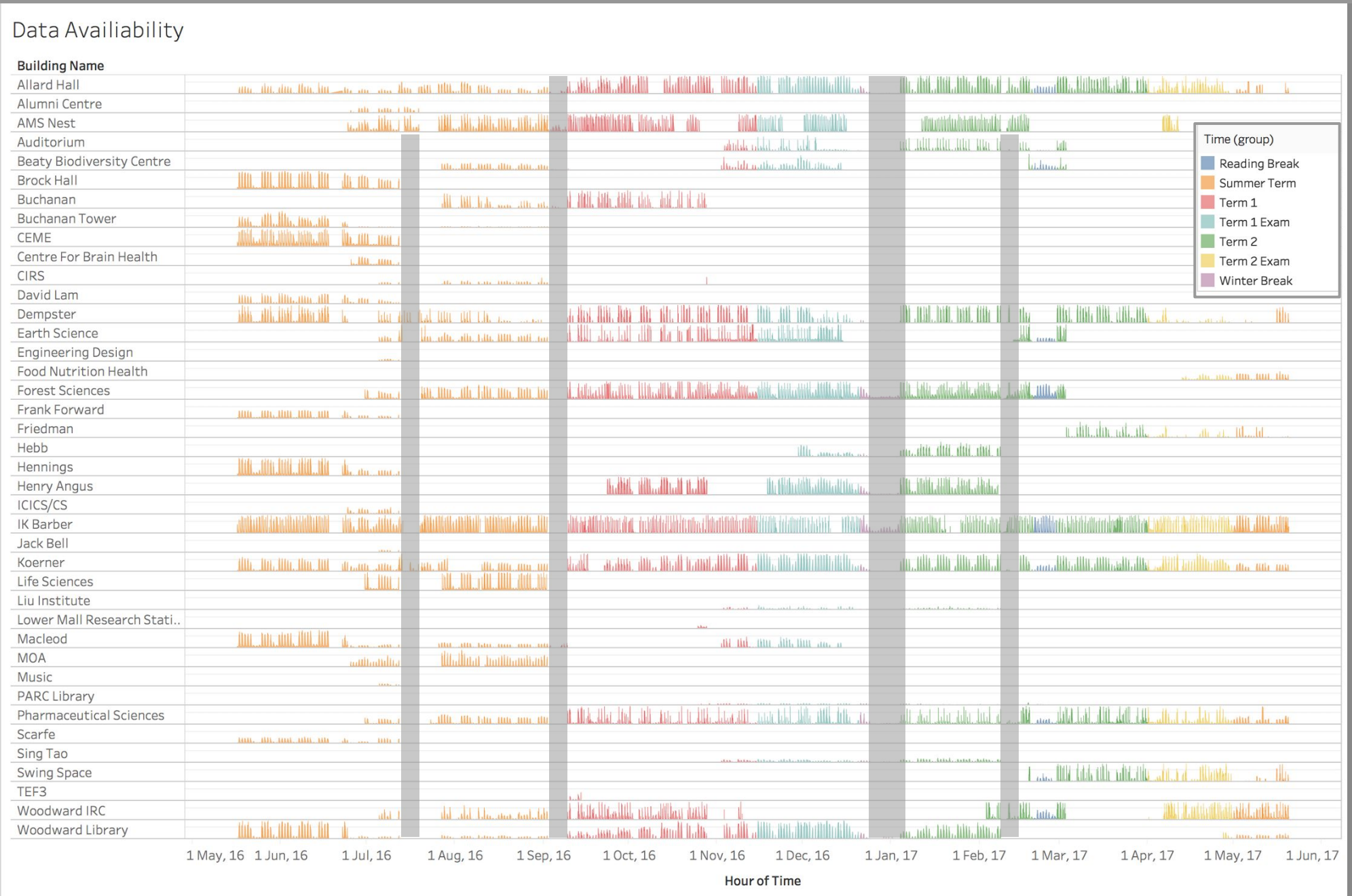
- Extremely versatile dataset
- Can be leveraged for wide range of student/staff projects


Chancellor Boulevard
Chancellor Boulevard
Chancellor Boulevard
Wesbrook Mall
Wesbrook Mall
University Boulevard
NW Marine Drive
University Boulevard
University Boulevard
Wesbrook Mall
NW Marine Drive
West 16th Avenue

3 The Data


A - Data Availability
B - Multi-building Yearly Trend
C - Case: IK Barber
D - Time Period Comparison
E - Power of the Dashboard
F - Occupancy Timelapse Map Visualization
G - Density and Energy Timelapse Map Visualization
Overview of Visualizations

A - Data Availability



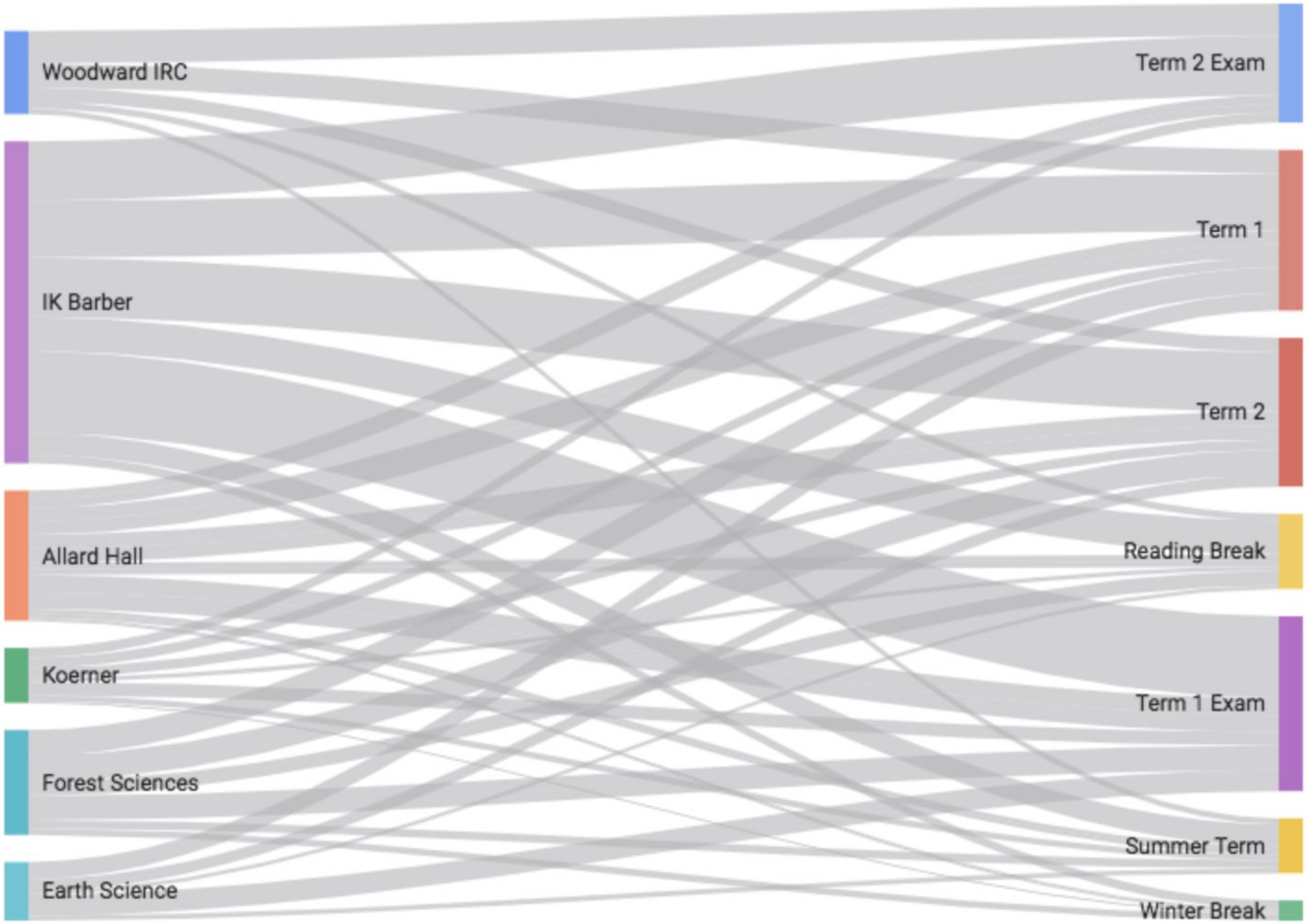
Graph shows all available datasets from May 1 2016 to June 1 2017

Colour describes time of the year

Few buildings with near complete datasets

Grey bands show large data gaps

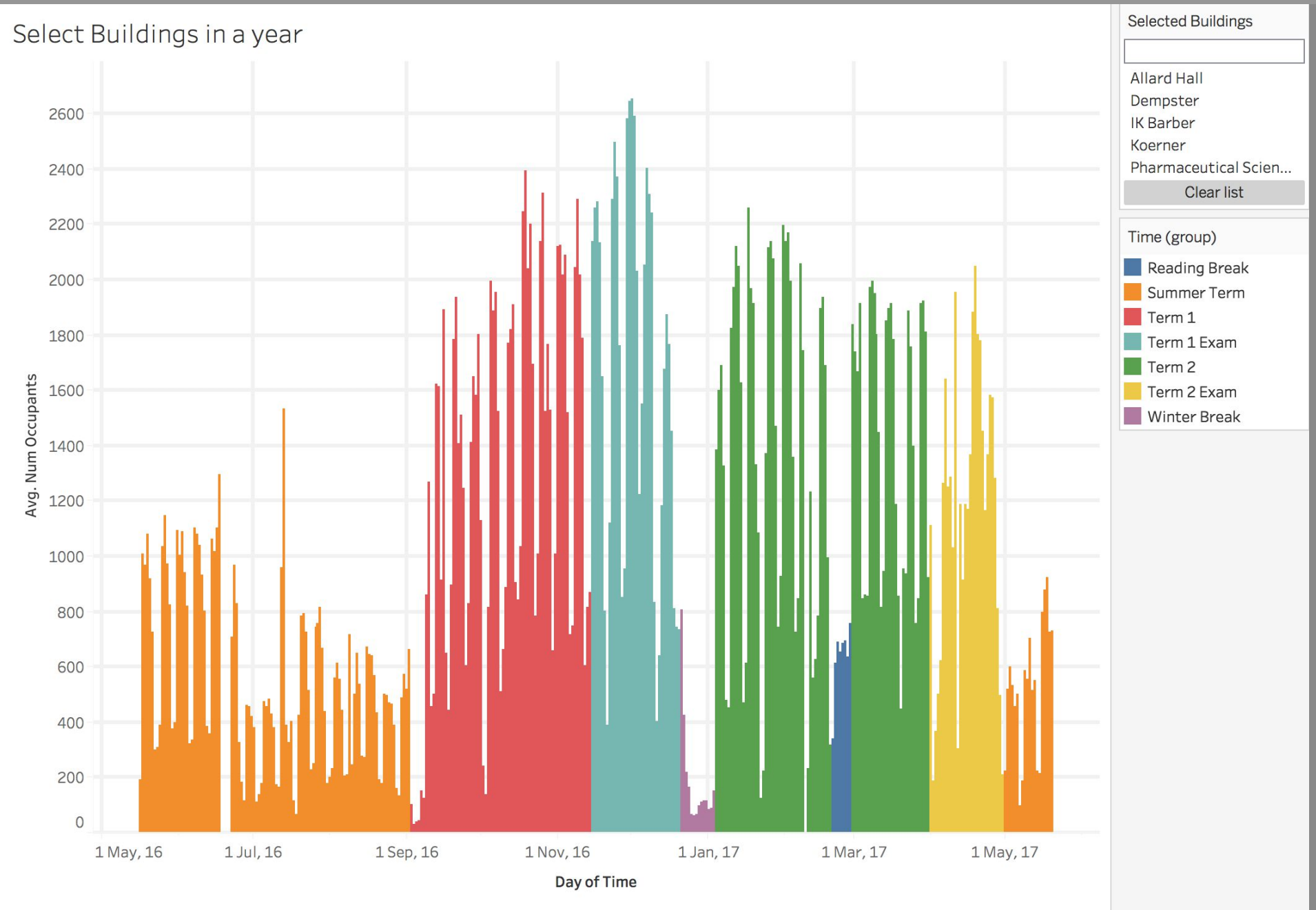
A - Data Availability



Graph shows select buildings and their yearly average occupancy from term 1 to summer break

These buildings give more precise view of occupancy per school period

B - Multi-building Yearly Trend



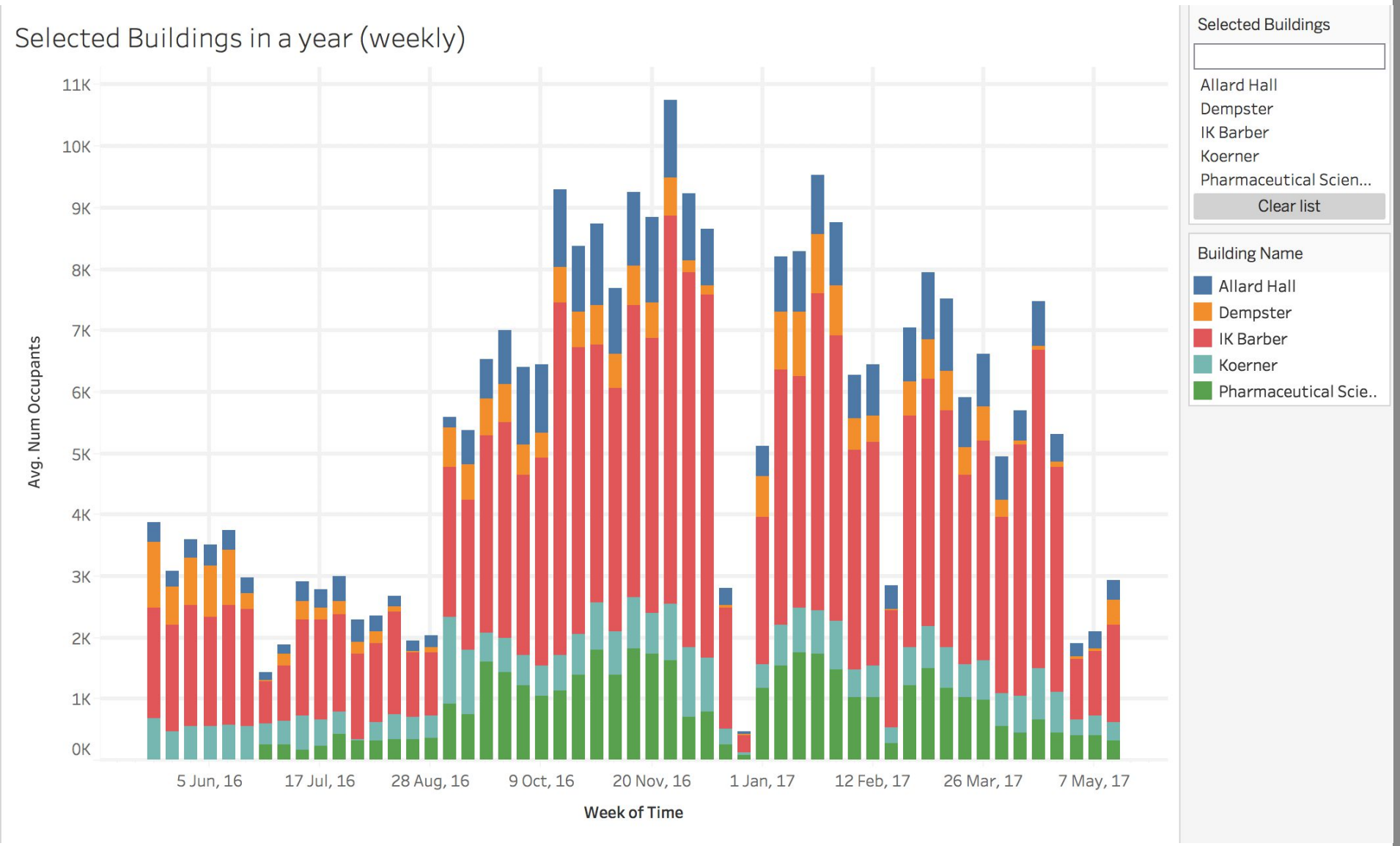
Graph shows select buildings and their daily average occupancy in one year from May 1 2016 to May 1 2017

Term 1 exam highest average occupancy

Reading and winter breaks lowest occupancy

Consistent drops on weekends

B - Multi-building Yearly Trend

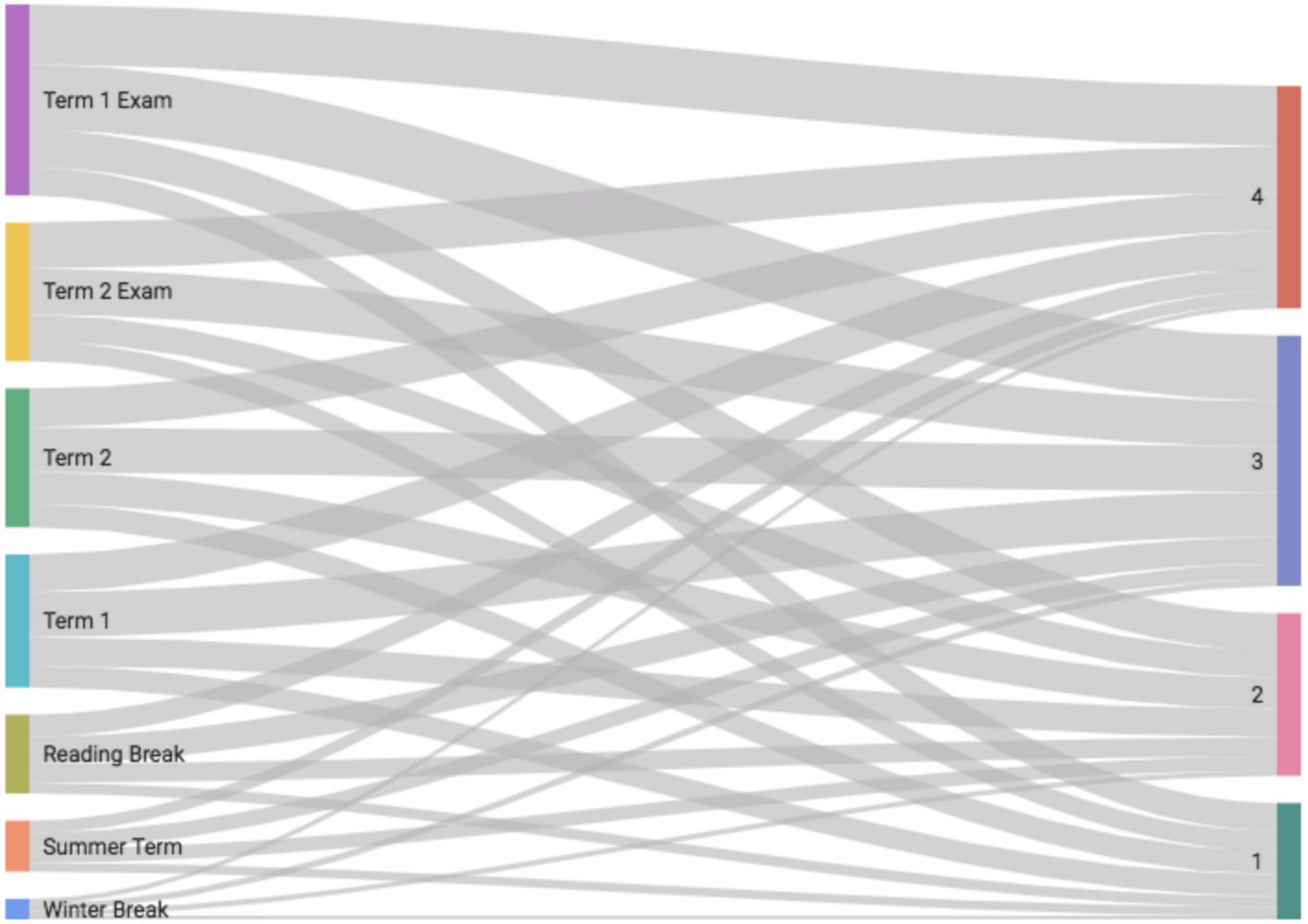


Graph shows select buildings and their weekly average occupancy in one year from May 1 2016 to May 1 2017

Colours show the contributions made by each of the selected buildings

IK Barber has the most occupants throughout the year

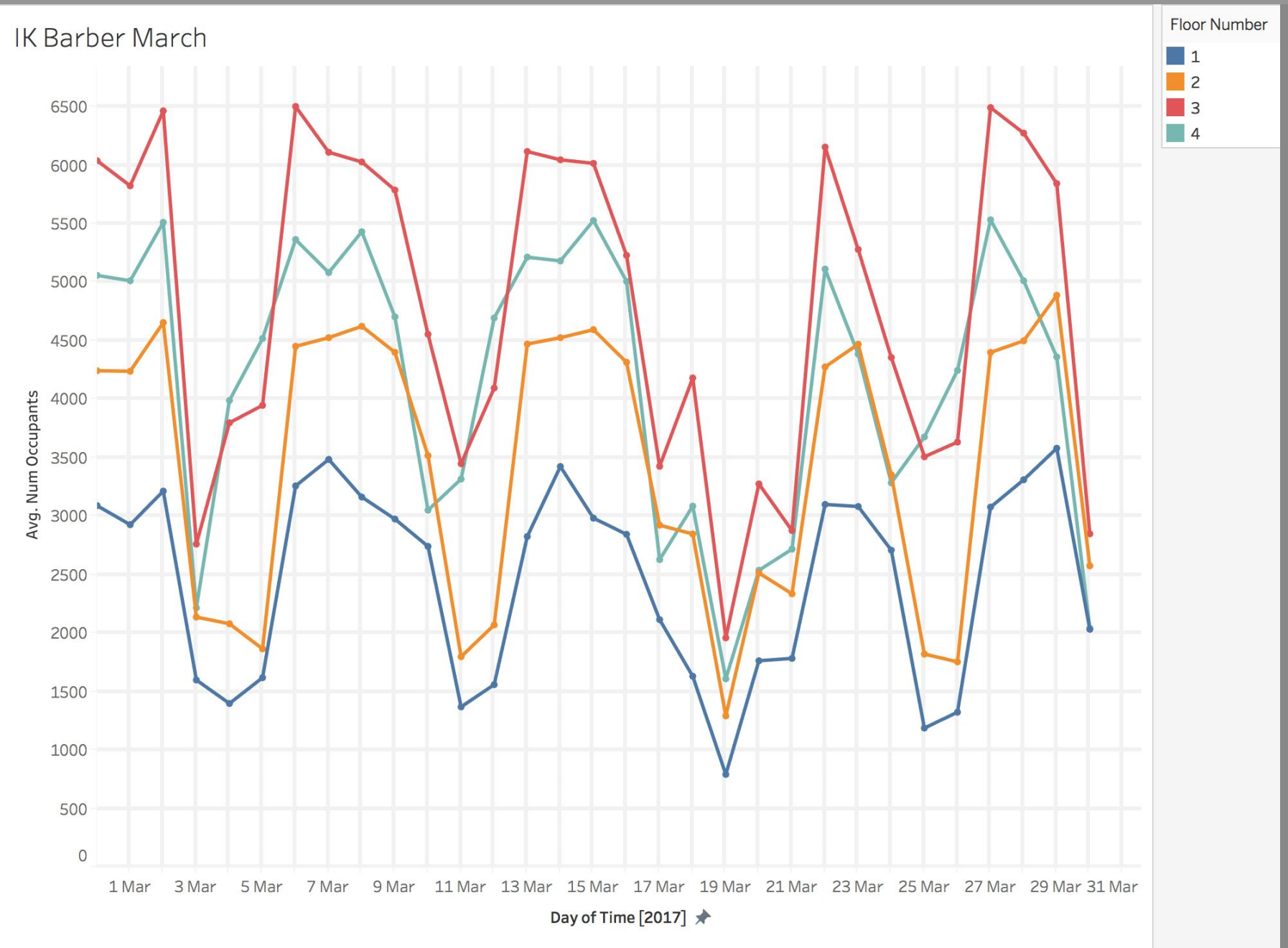
C - Case: IK Barber



Graph shows IK Barber and it's yearly average occupancy

This shows how each floor contributed to the different school periods

C - Case: IK Barber During March

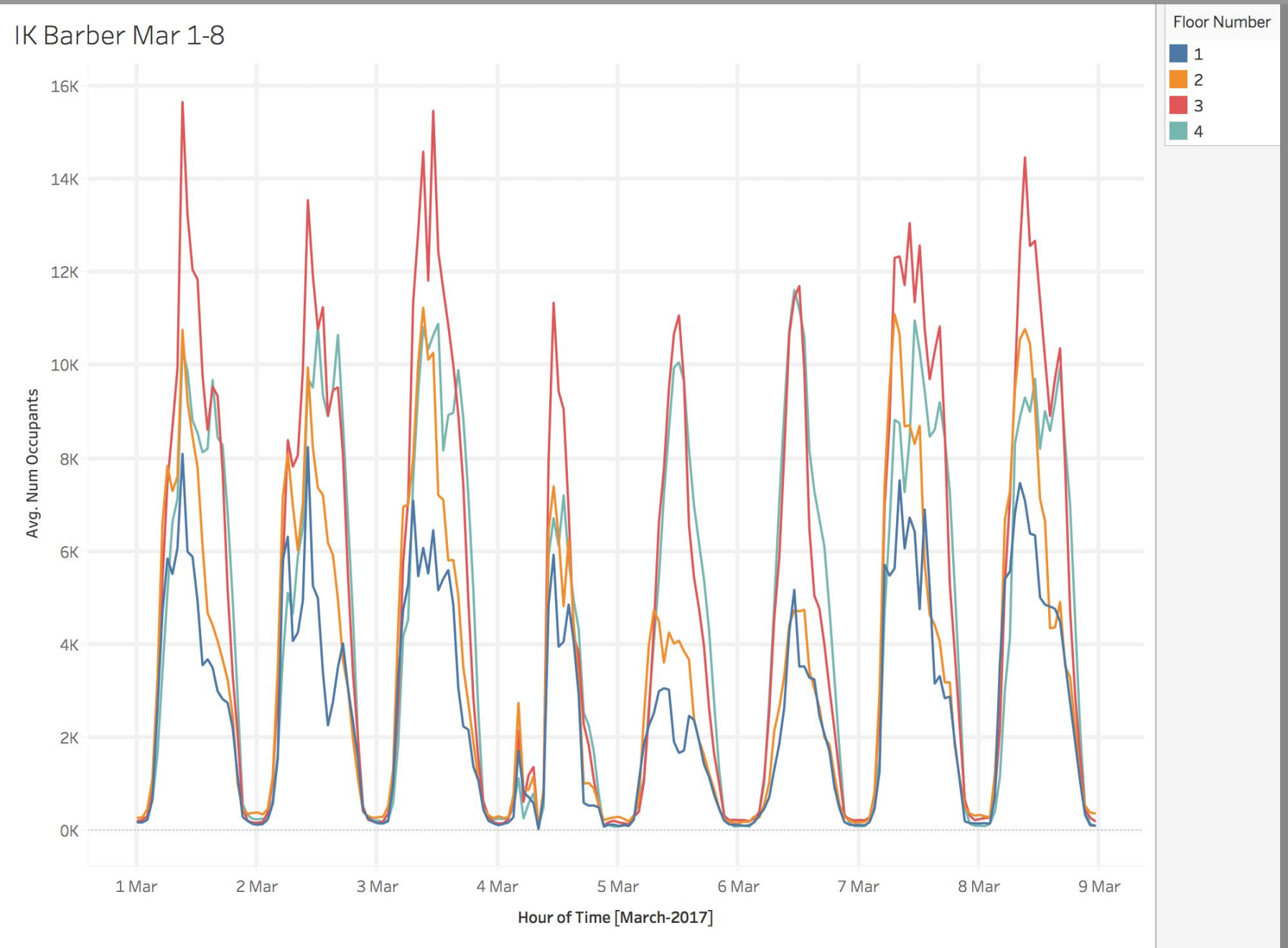


Graph shows IK Barber in March and their daily average occupancy

3rd and 4th floors have highest occupancy

Weekend occupancy significantly lower

C - Case: IK Barber From March 1 to March 8

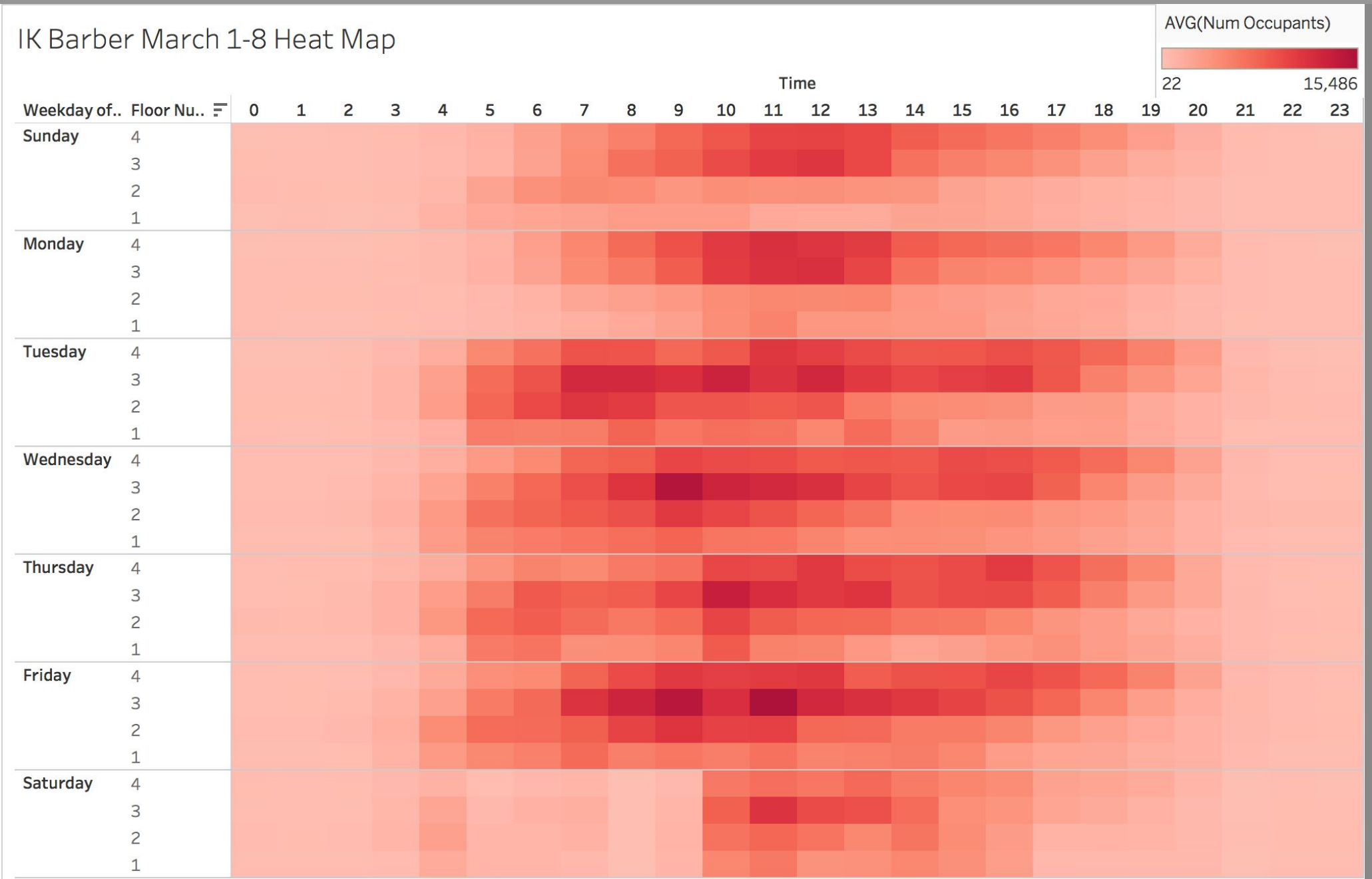


Graph shows IK Barber for 1 week in March and their hourly average occupancy

3rd and 4th floors have highest occupancy

Each day has unique profile, no two days are the same

C - Case: IK Barber From March 1 to March 8

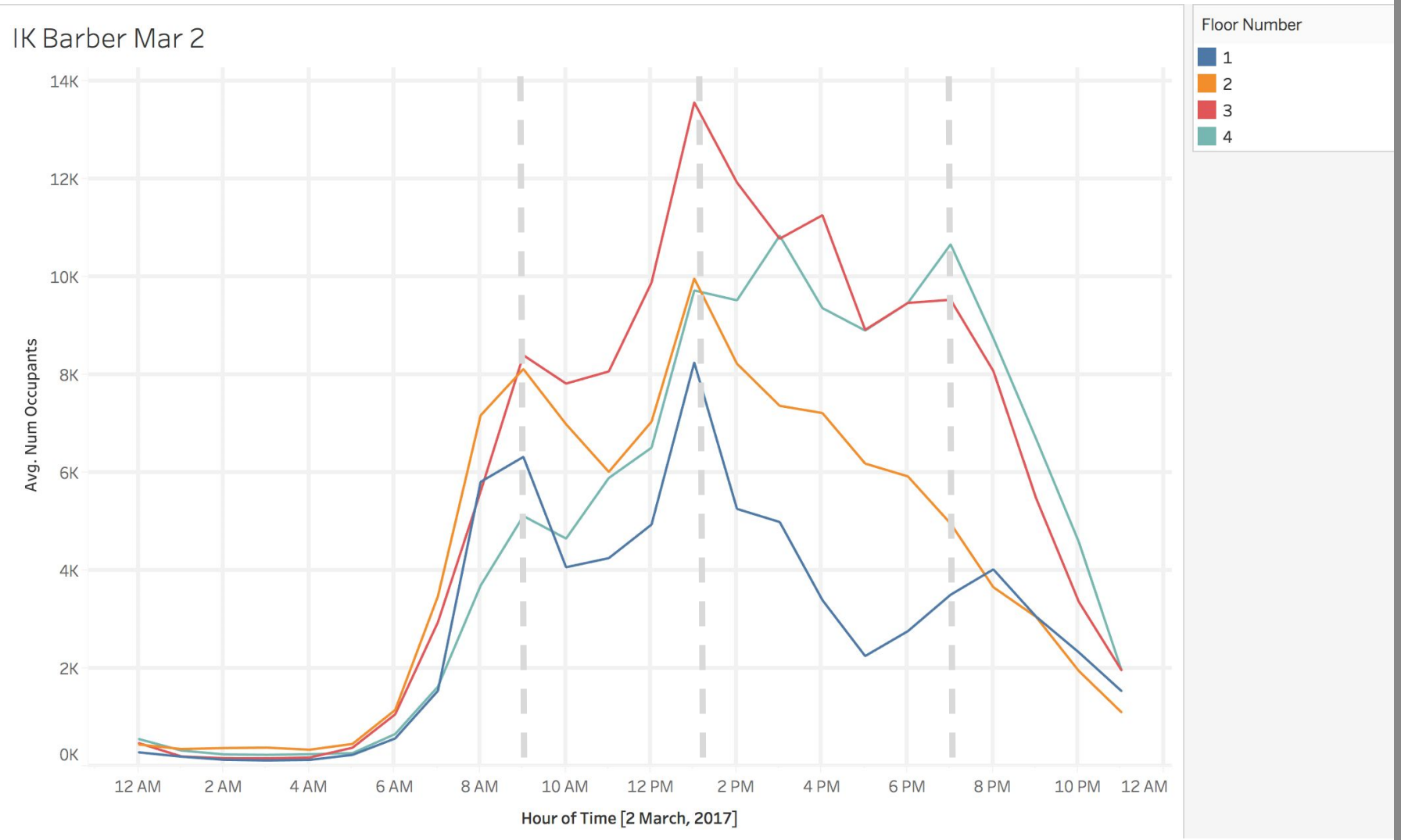


Heat Map shows IK Barber for 1 week in March and their hourly average occupancy

In general, 3rd and 4th floors have highest occupancy

Each day has unique profile

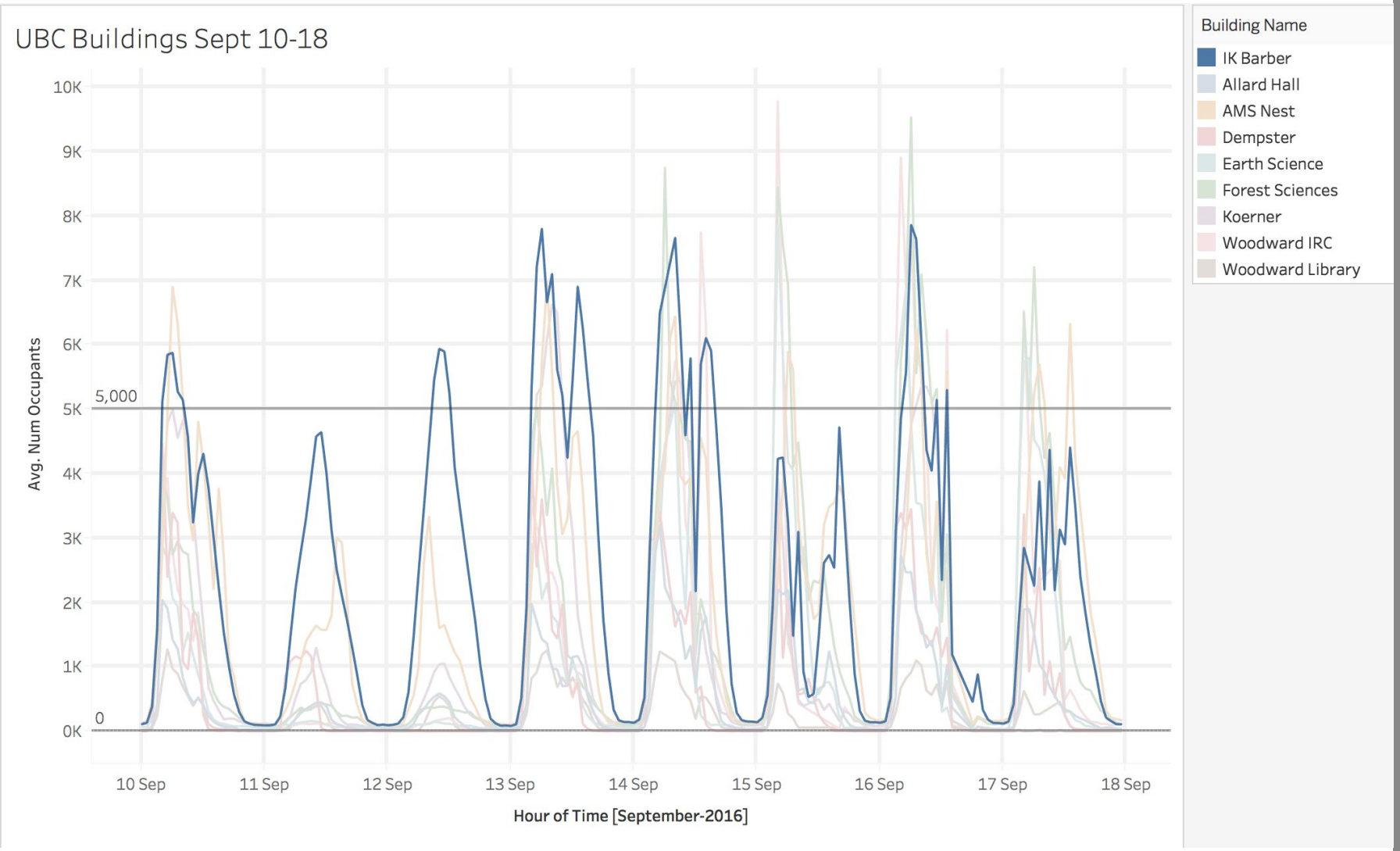
C - Case: IK Barber on March 2



Graph shows IK Barber on March 2, 2017 and their hourly average occupancy

Highest use during 9am, 1pm and 7pm, shown in dashed lines

D - Time Period Comparison: First Term

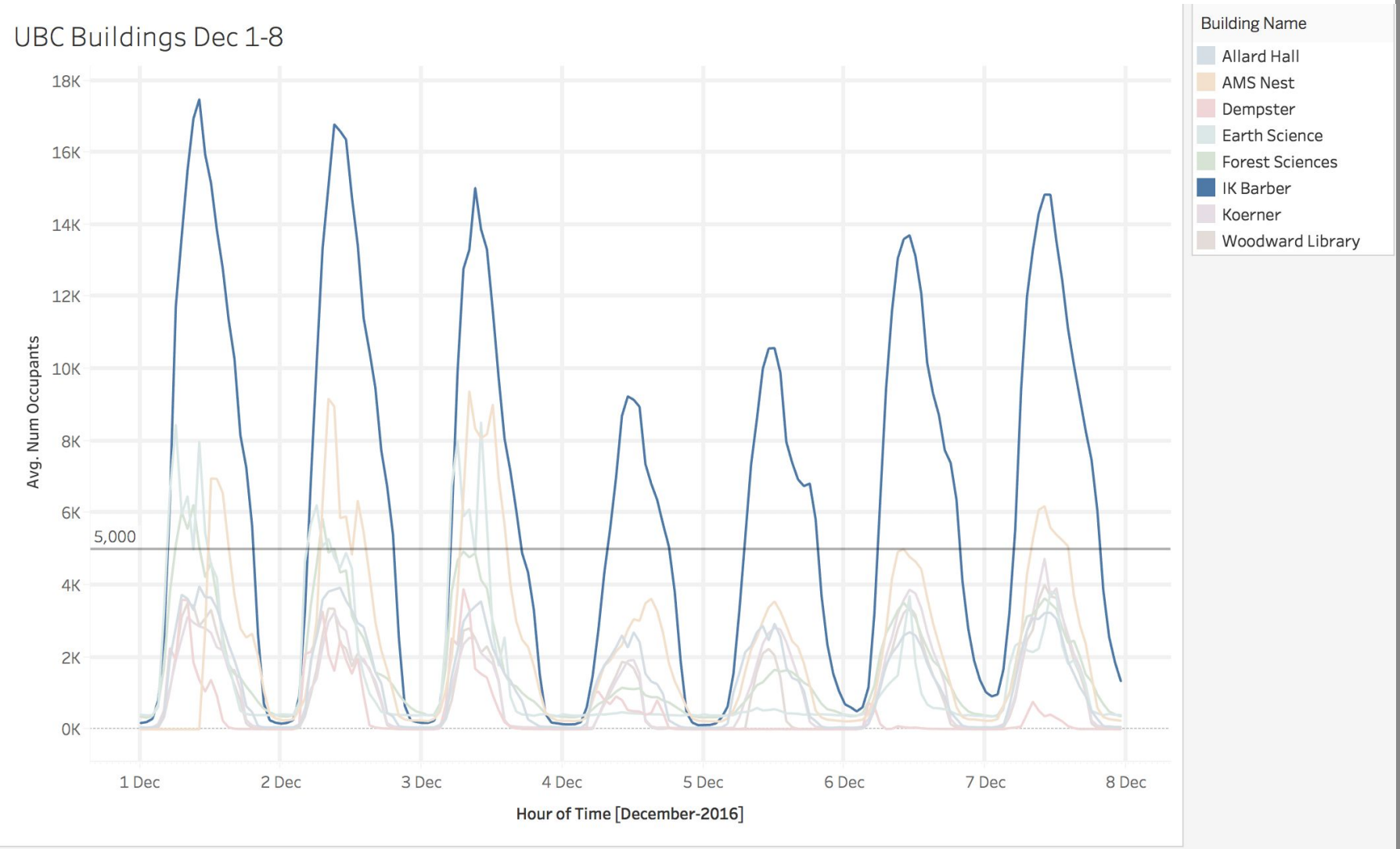


This graph shows hourly average occupancy during second week of first term

IK Barber is highlighted, other building data are visualized to compare

The 5000 average occupant reference line is used to compare other times of the year

D - Time Period Comparison: First Term Exam

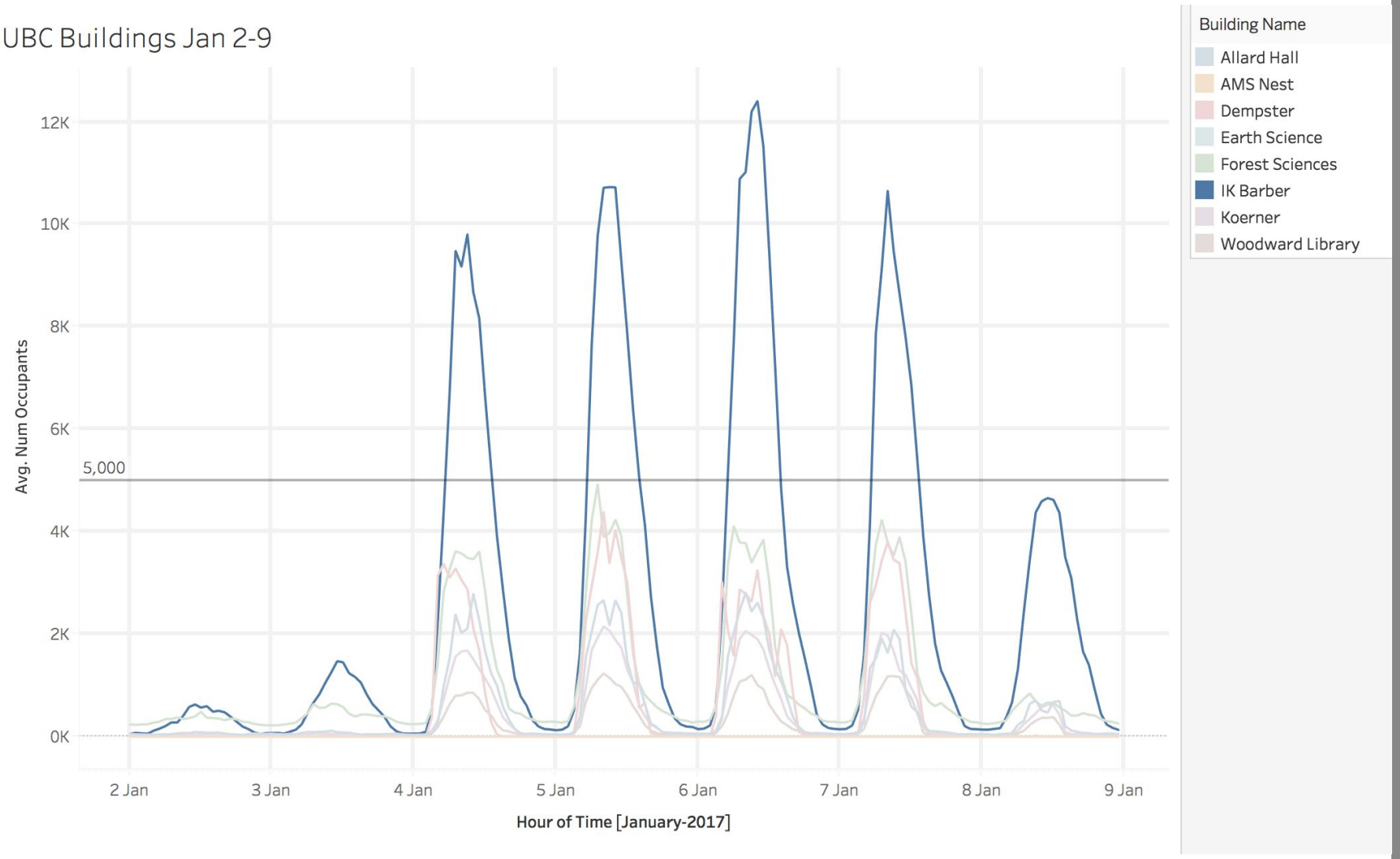


This graph shows hourly average occupancy in a selected week during first term exam

IK Barber is highlighted, other building data are visualized to compare

Daily maximum values are much higher than during first term

D - Time Period Comparison: Second Term

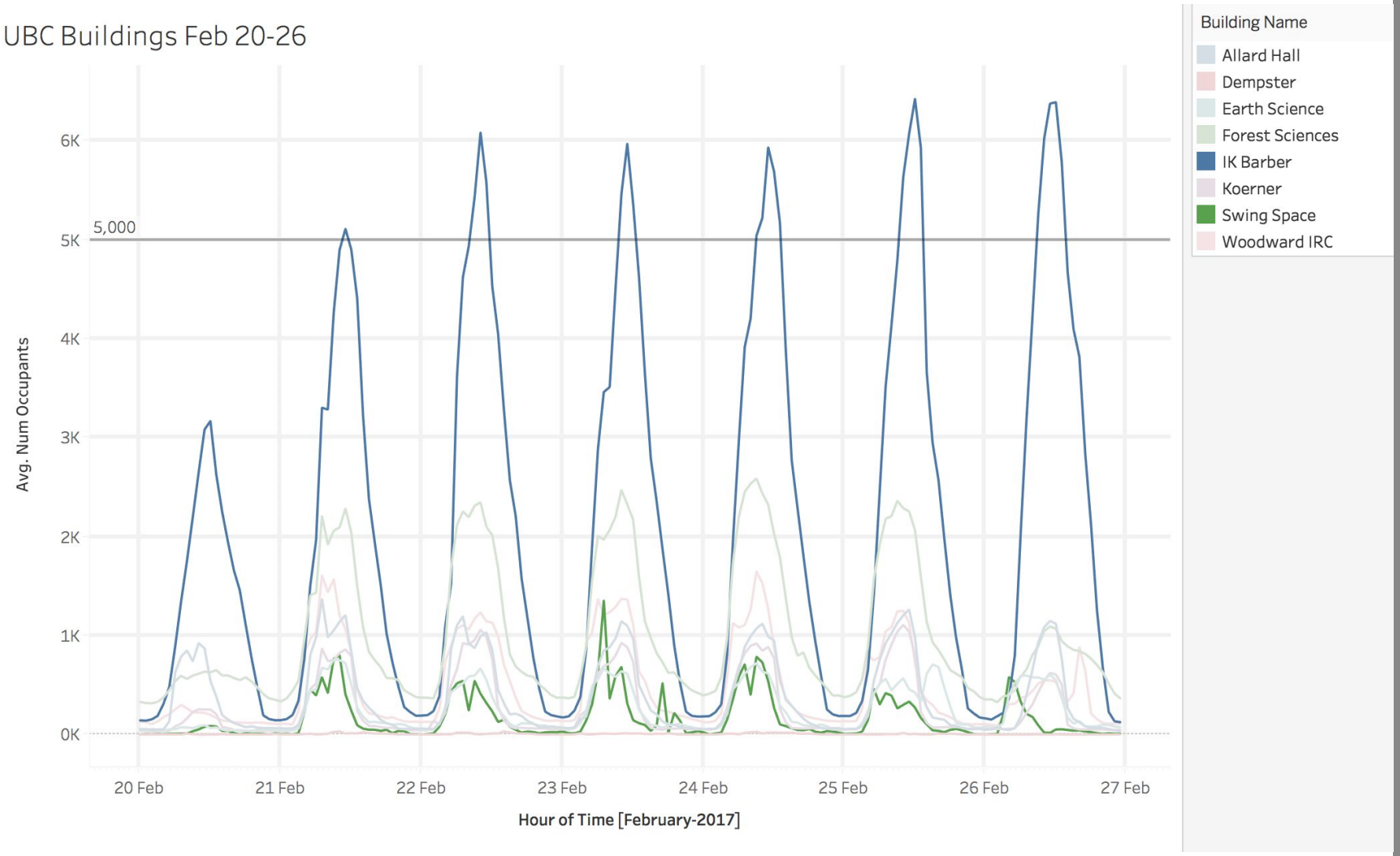


This graph shows hourly average occupancy during first week of second term

IK Barber is highlighted, other building data are visualized to compare

Daily maximum values are lower than during first term exam but higher than first term

D - Time Period Comparison: Reading Break

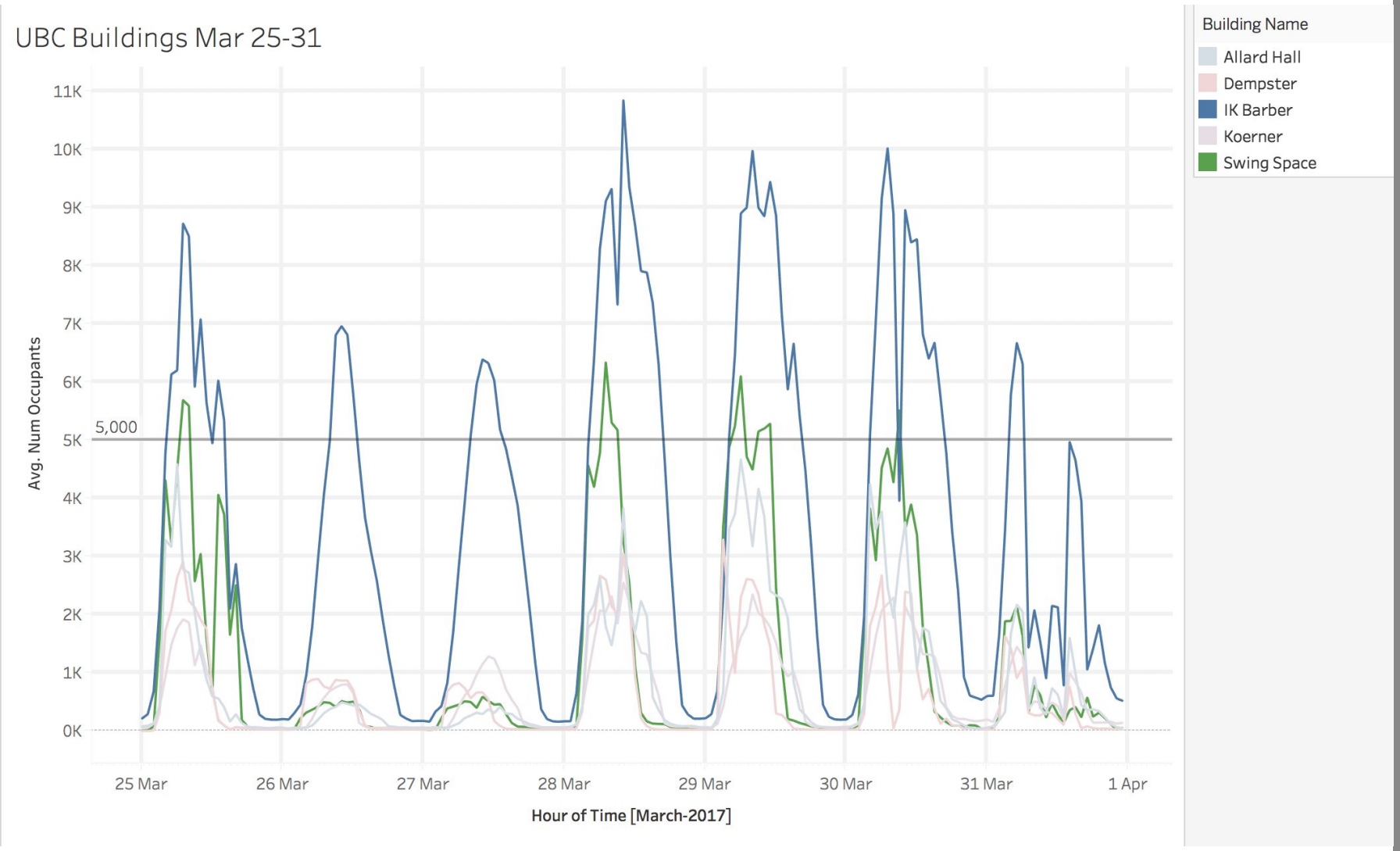


This graph shows hourly average occupancy during reading break

IK Barber is highlighted, other building data are visualized to compare

Daily maximum values are similar to first term and lower than other weeks of second term

D - Time Period Comparison: Late Second Term

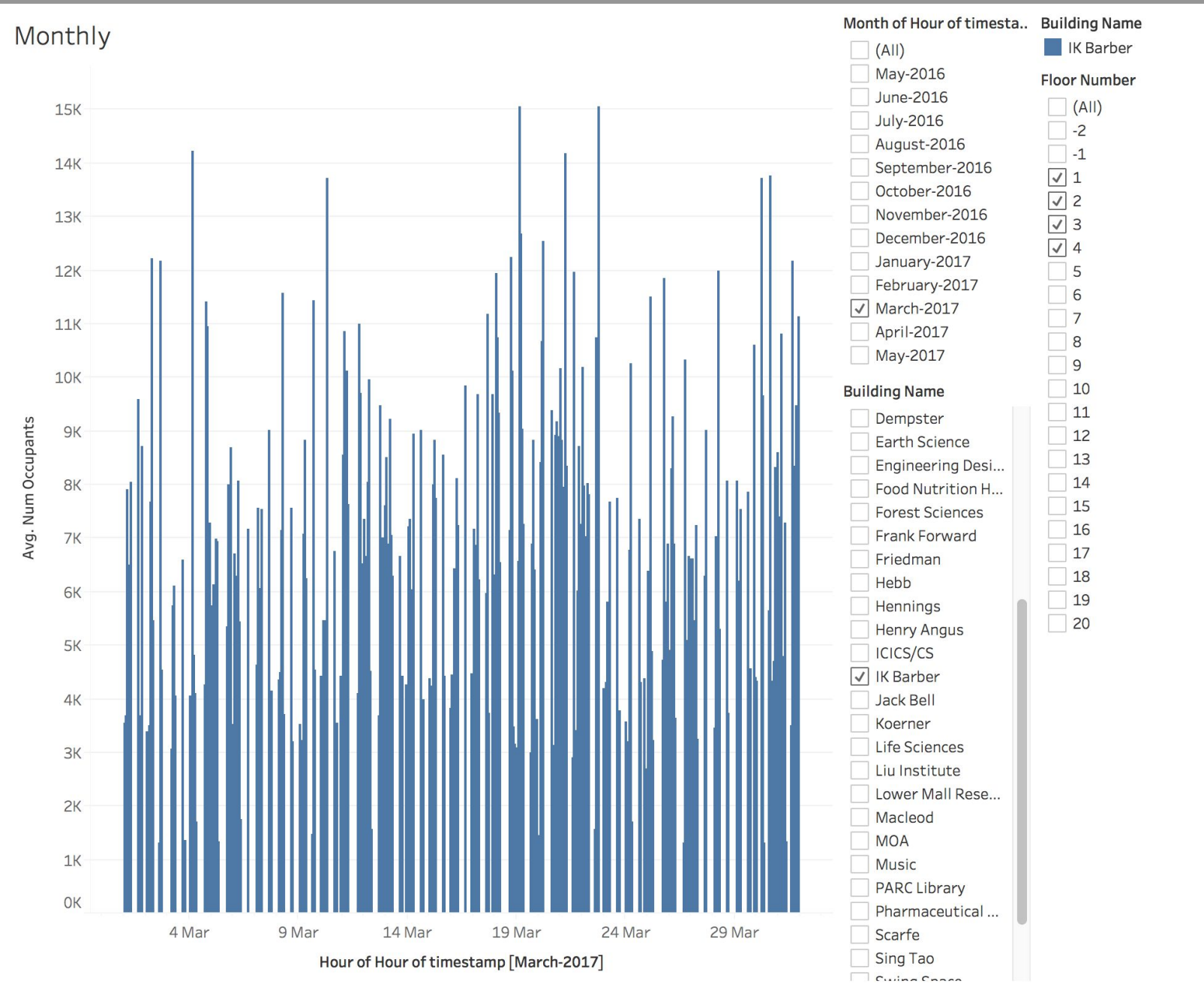


This graph shows hourly average occupancy during second term before exams start

IK Barber is highlighted, other building data are visualized to compare

Daily maximum values are similar to other second term weeks

E - Power of the Dashboard



Dashboards are increasingly used by organizations:

- Interactive
- Effective at communication
- Compared with spreadsheets, are easy to use and intuitive
- Easy to compare data trends
- Visuals help form user insights

F: Occupancy Timelapse Map Visualizations

Timelapse map visualizations:

Can communicate large GIS datasets in short amount of time - more efficient than reports, spreadsheets or graphs

Easy to understand and to form user insights

F: Occupancy Timelapse Map Visualizations

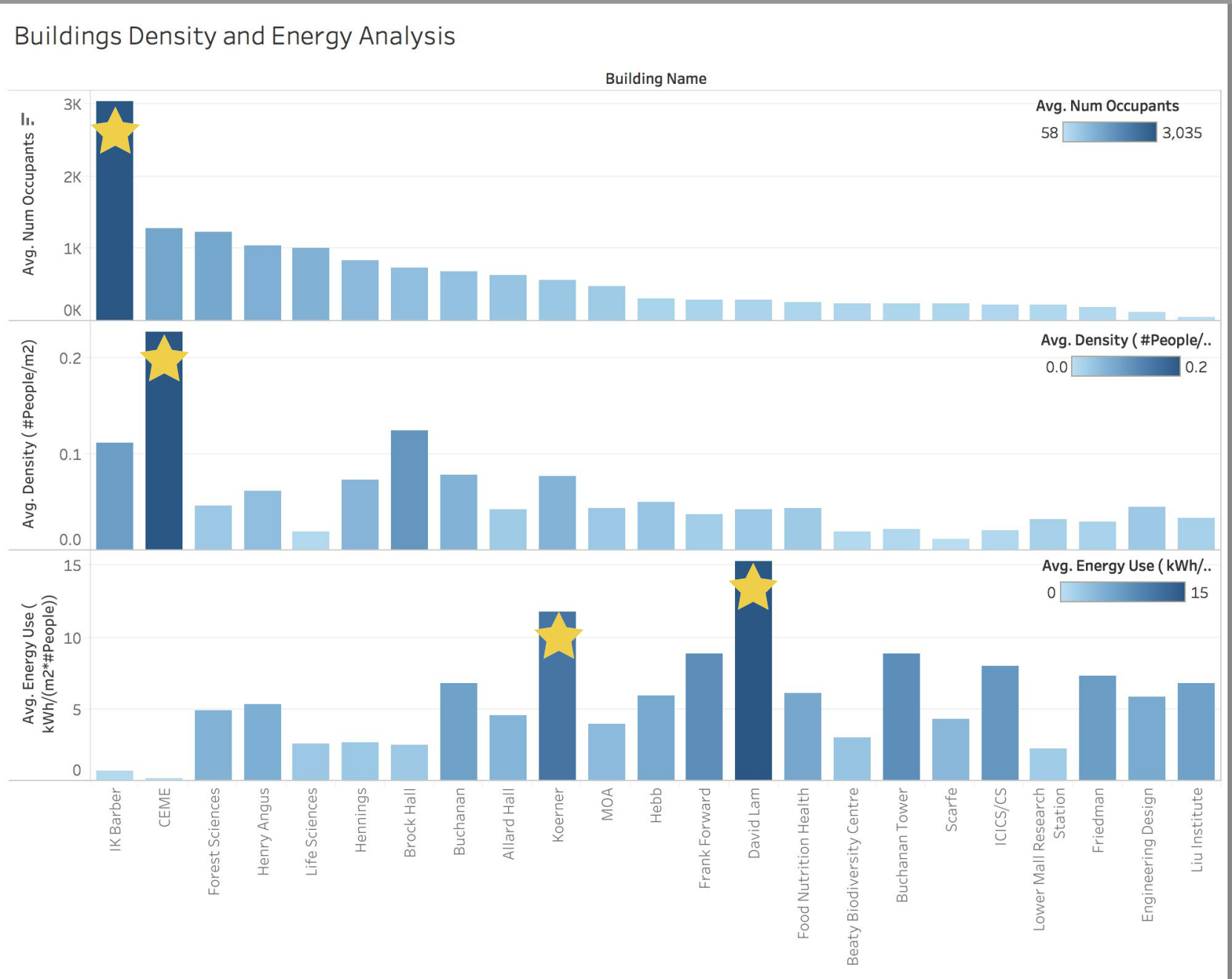
Occupancy timelapse visualization:

Yearly average of all buildings in 24 hours

IK Barber has highest occupancy

Link to video: https://drive.google.com/open?id=1bOYzBjflnYiktMP7z2sOiINpcPfrgIAM

G: Occupancy Timelapse Map Visualizations



Occupancy not the whole story: occupancy density and energy use per capita per area are more useful metrics

IK Barber Highest Occupancy

CEME highest Density

David Lam and Koerner uses the most energy per capita per area

G: Density and Energy Timelapse Map Visualizations

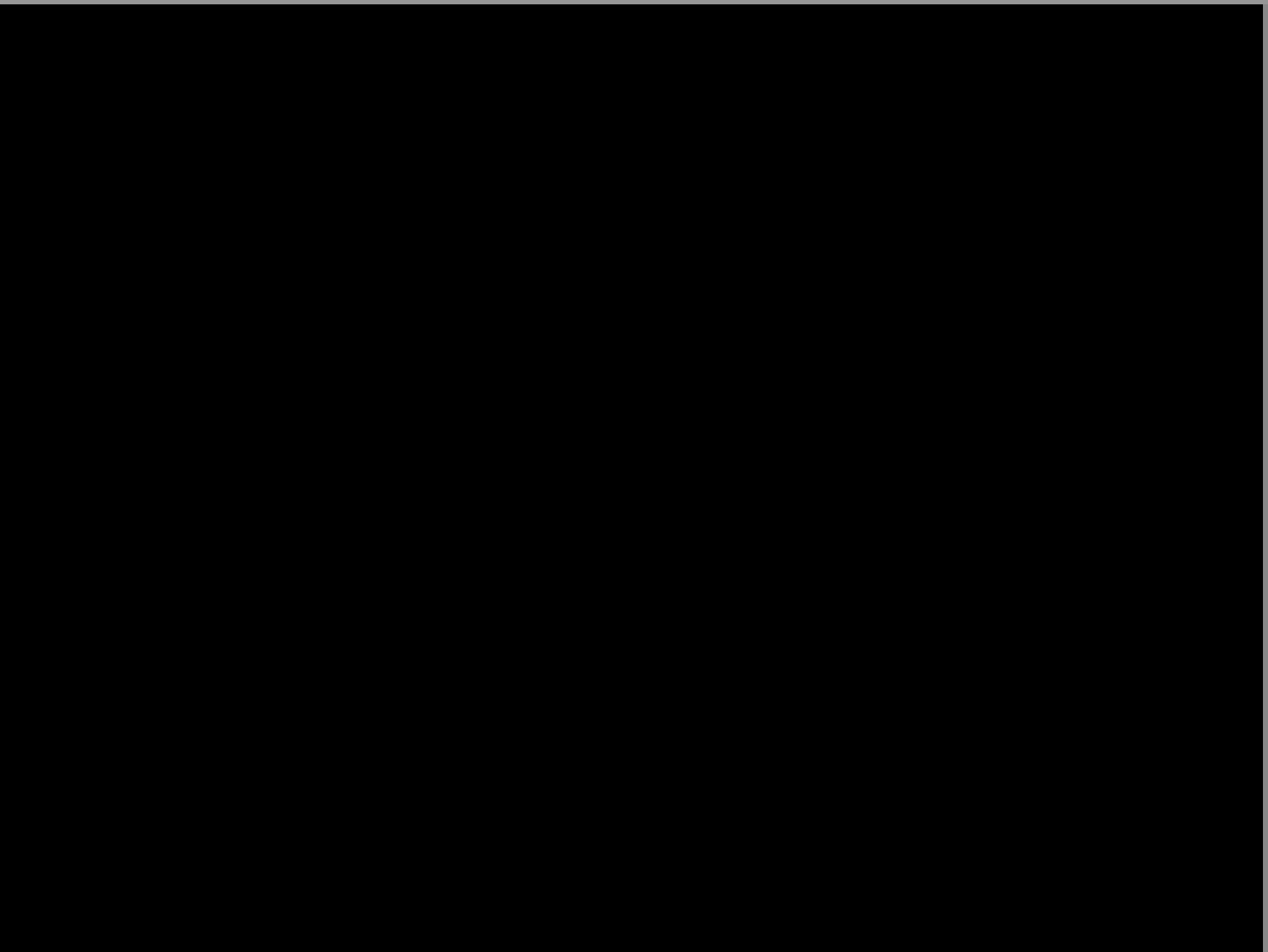
Occupancy density timelapse visualization:

Yearly average of all buildings in 24 hours

CEME has the highest occupancy density

Link to video: https://drive.google.com/open?id=1xEPQiedoE29ZxlqZUHkmWD-dzNR8A2Iw

G: Density and Energy Timelapse Map Visualizations



Occupancy energy use per capita per area visualization:

Yearly average of all buildings in 24 hours

David Lam and Koerner has the highest occupancy energy use per capita per area

Link to video: https://drive.google.com/open?id=1-b0xXCjCeCAz-WF-4K8znNr_YQa-rG1N

5 The Future

Stakeholder Discussion