



UBC SEEDS Project

Exploring the Potential of Wi-Fi based Occupancy Data

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Engineering
Leadership

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OF BRITISH COLUMBIA



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Agenda



1 Introduction

2 Stakeholder Interviews

3 Challenges and Recommendations

3 The Data

4 The Future

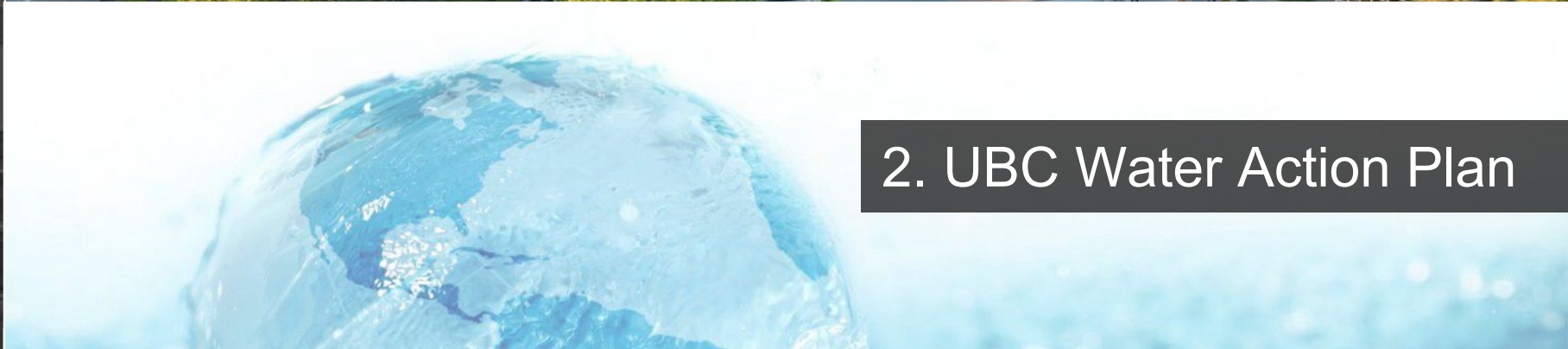


1 Introduction

Purpose



1. UBC Climate Action Plan



2. UBC Water Action Plan

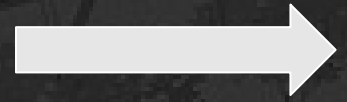


3. UBC "Sort It Out"

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

Supports

3 UBC Action Plans



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.



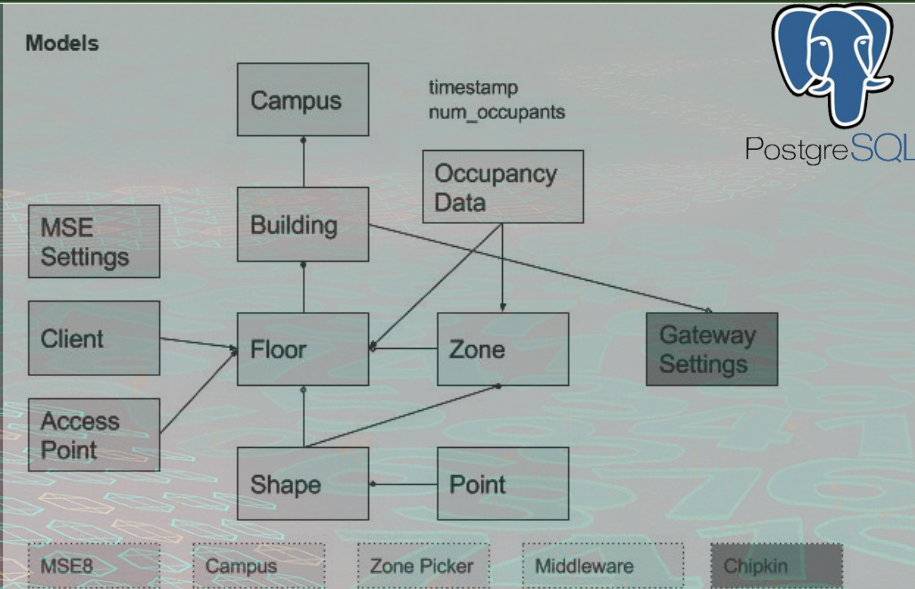
New Uses - This project uses the same occupancy data but explores other applications

Technical Method

Step 1: Database Query

Raw data acquired in postgresQL dump file

PostgreSQL Server was hosted and data tables extracted

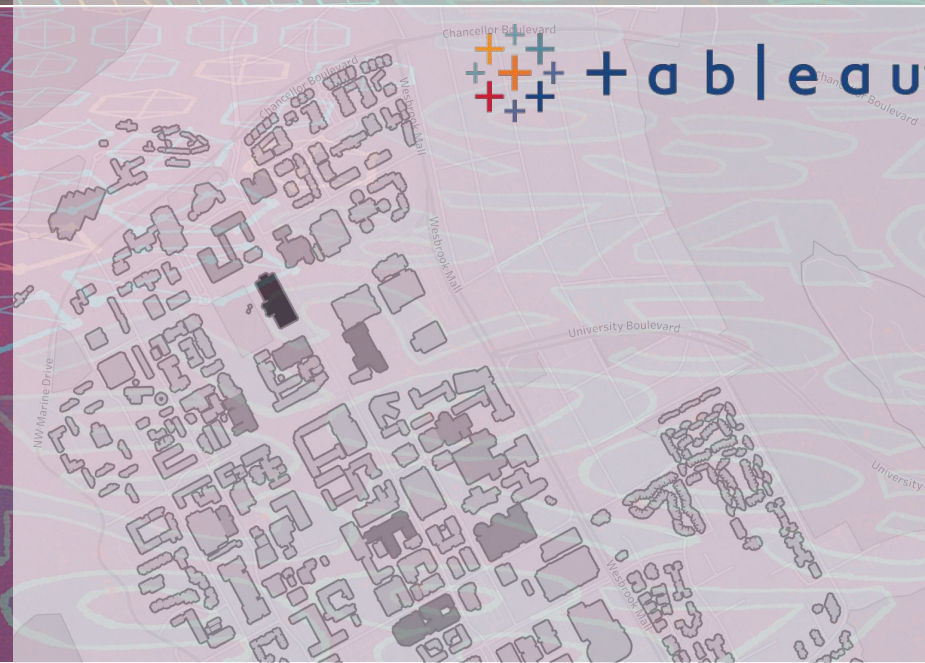


Step 2: Data Visualization

Data was wrangled, cleaned, stitched and joined

Tableau was used to visualize data

Visualizations were used as discussion starters for stakeholder interviews



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

A blurred photograph of three business professionals in a modern office setting. They are standing near a large window, and in the foreground, a conference table is covered with various data visualizations, including bar charts and line graphs, along with a pen and a tablet. The overall atmosphere is professional and collaborative.

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



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

Overview of Ideas from Stakeholders



01 Bike Sharing Program

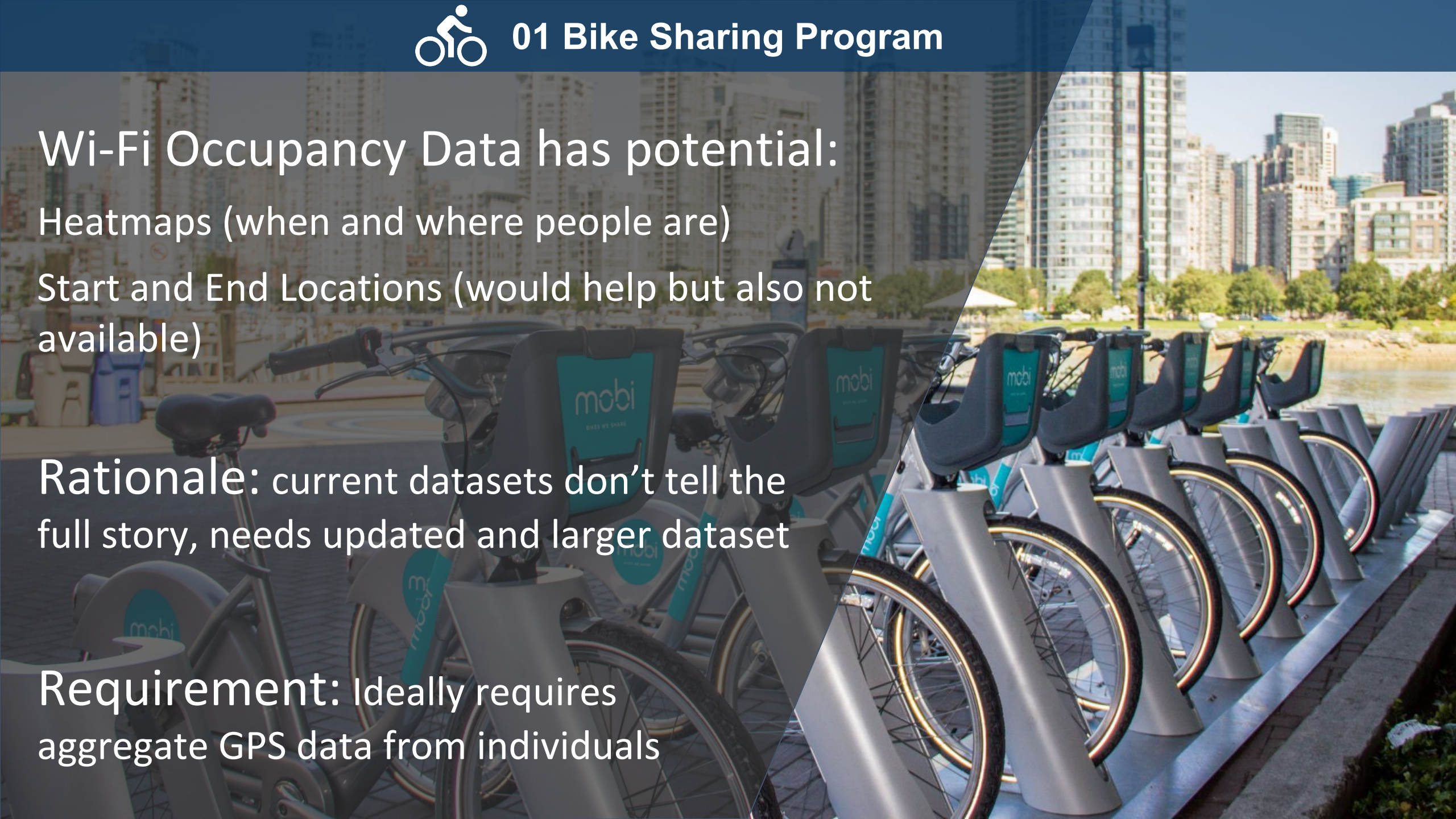
Wi-Fi Occupancy Data has potential:

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.)



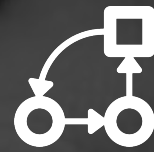
Identify outliers



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?

A person is captured in mid-air, jumping over a gap between two large, dark rock formations. The background features a range of jagged mountains under a bright, golden sky with scattered clouds, suggesting a sunset or sunrise. The overall scene is bathed in a warm, orange light.

3 Challenges and Recommendations

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)

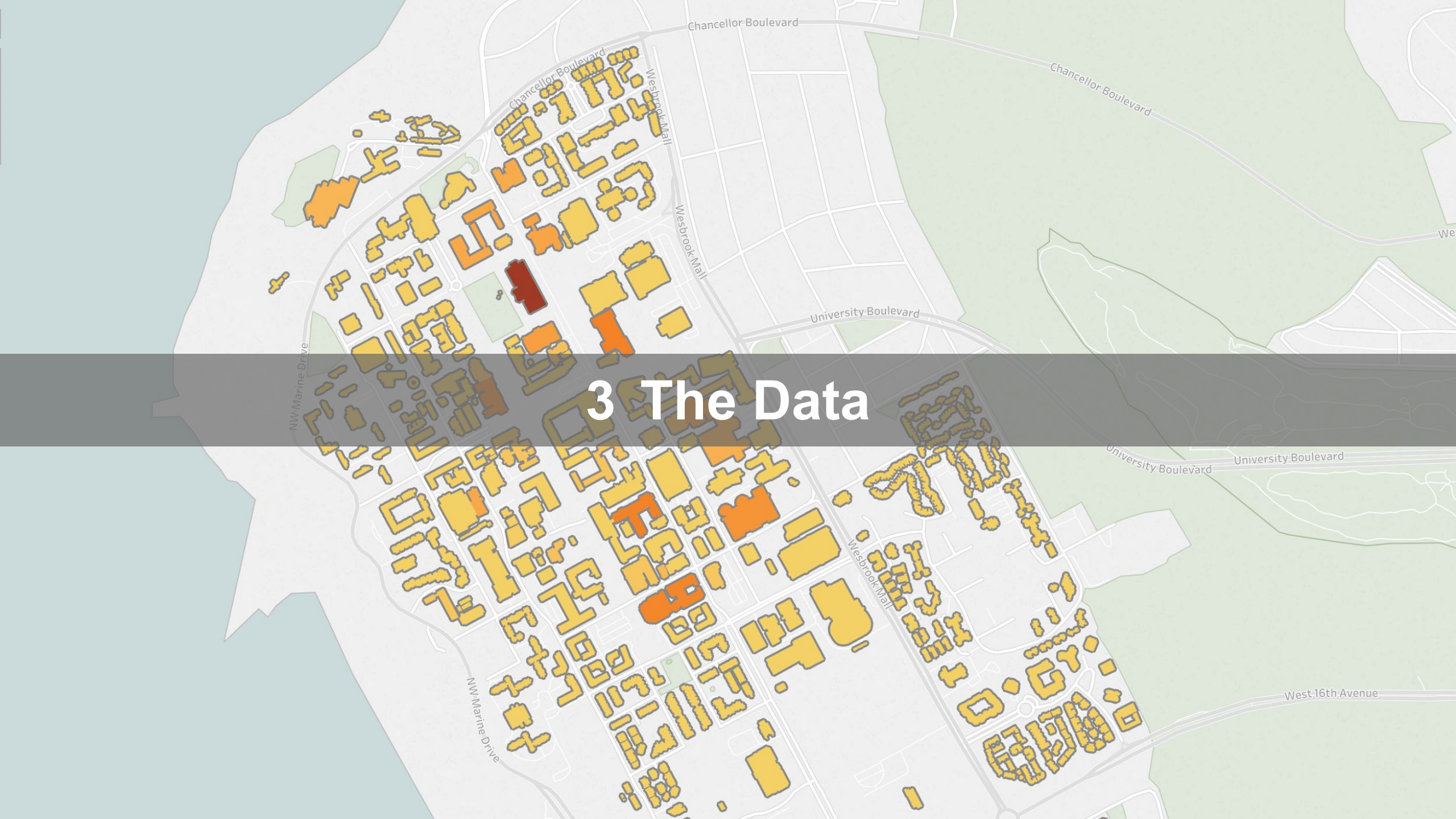
Recommendations

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



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

Data Availability



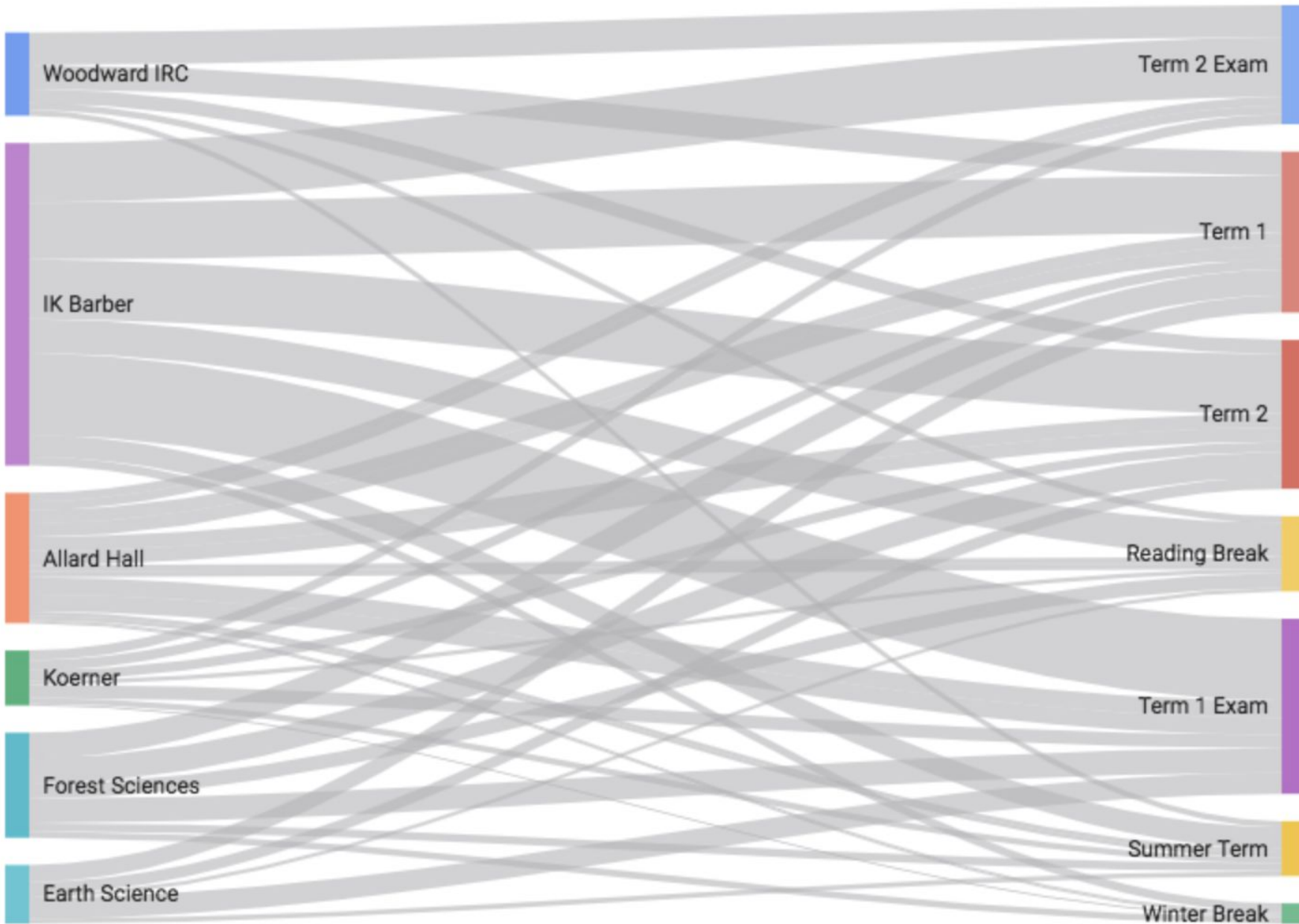
Graph shows all available datasets from May 1 2016 to June 1 2017

Colour describes time of the year

Few buildings with near complete datasets

Grey bands show large data gaps

A - Data Availability

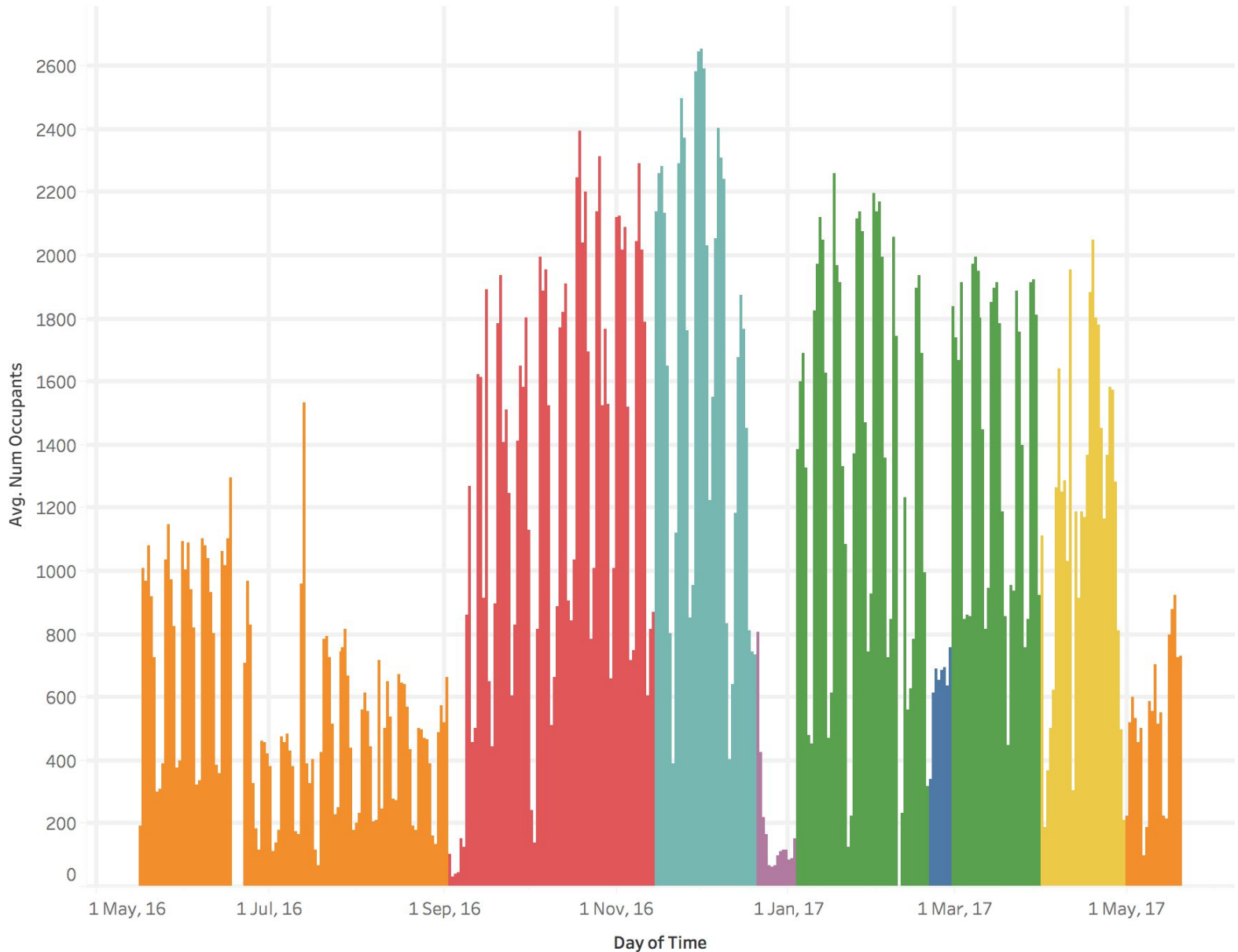


Graph shows select buildings and their yearly average occupancy from term 1 to summer break

These buildings give more precise view of occupancy per school period

B - Multi-building Yearly Trend

Select Buildings in a year



Selected Buildings

- Allard Hall
- Dempster
- IK Barber
- Koerner
- Pharmaceutical Scien...

Clear list

Time (group)

- Reading Break
- Summer Term
- Term 1
- Term 1 Exam
- Term 2
- Term 2 Exam
- Winter Break

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

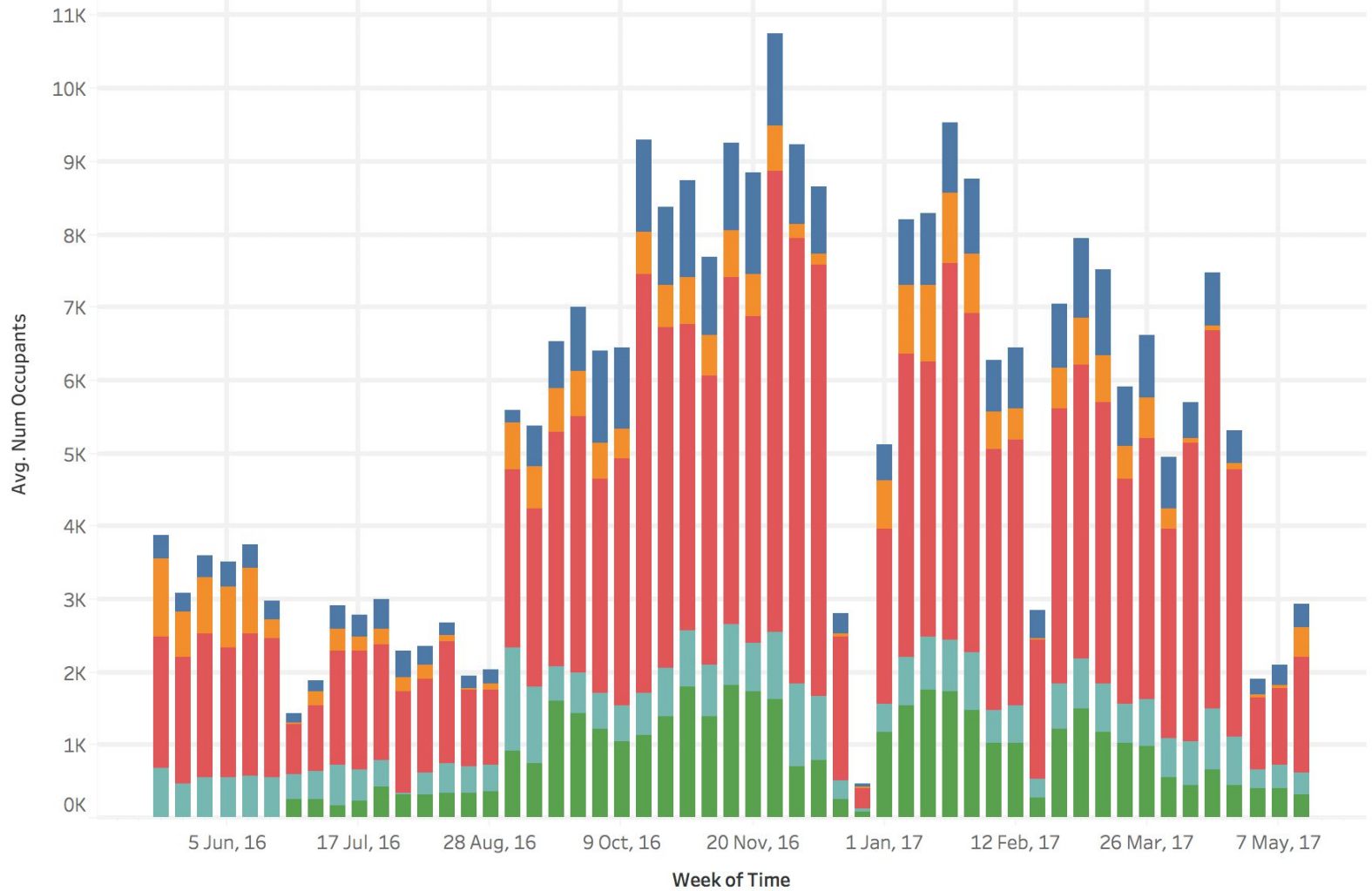
Term 1 exam highest average occupancy

Reading and winter breaks lowest occupancy

Consistent drops on weekends

B - Multi-building Yearly Trend

Selected Buildings in a year (weekly)



Selected Buildings

- Allard Hall
- Dempster
- IK Barber
- Koerner
- Pharmaceutical Scien...

Clear list

Building Name

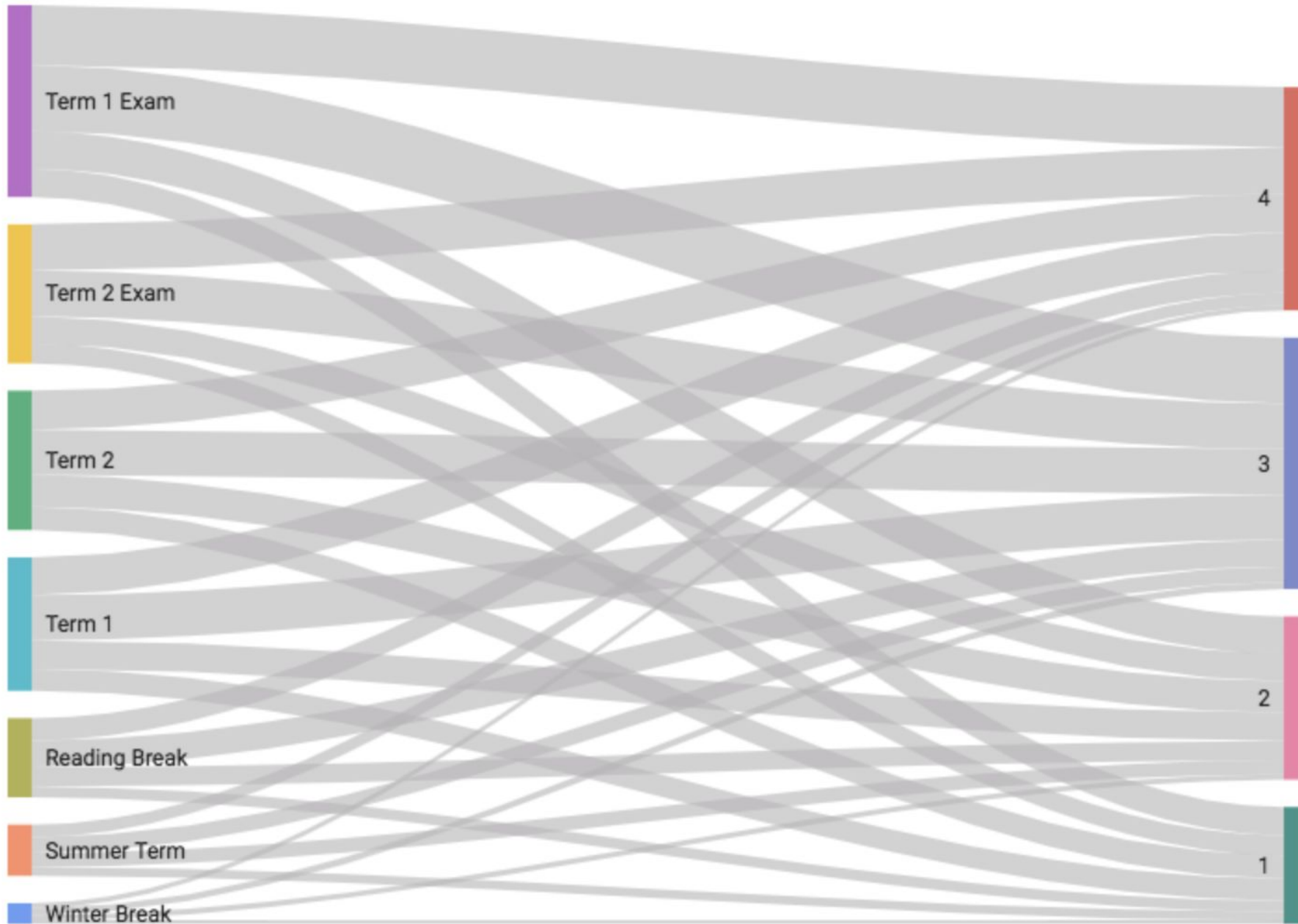
- Allard Hall
- Dempster
- IK Barber
- Koerner
- Pharmaceutical Scie..

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

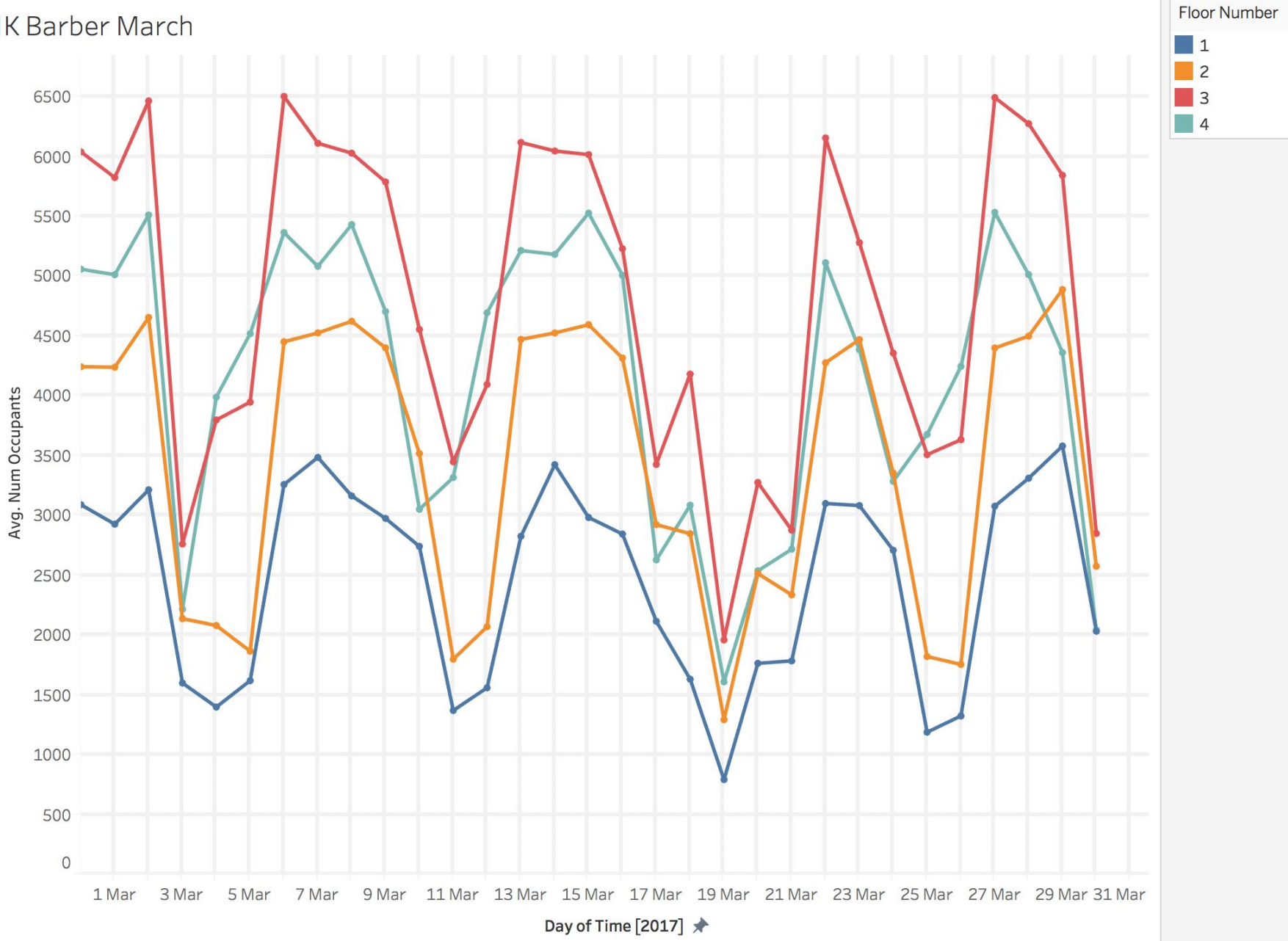


Graph shows IK Barber and it's yearly average occupancy

This shows how each floor contributed to the different school periods

C - Case: IK Barber During March

IK Barber March



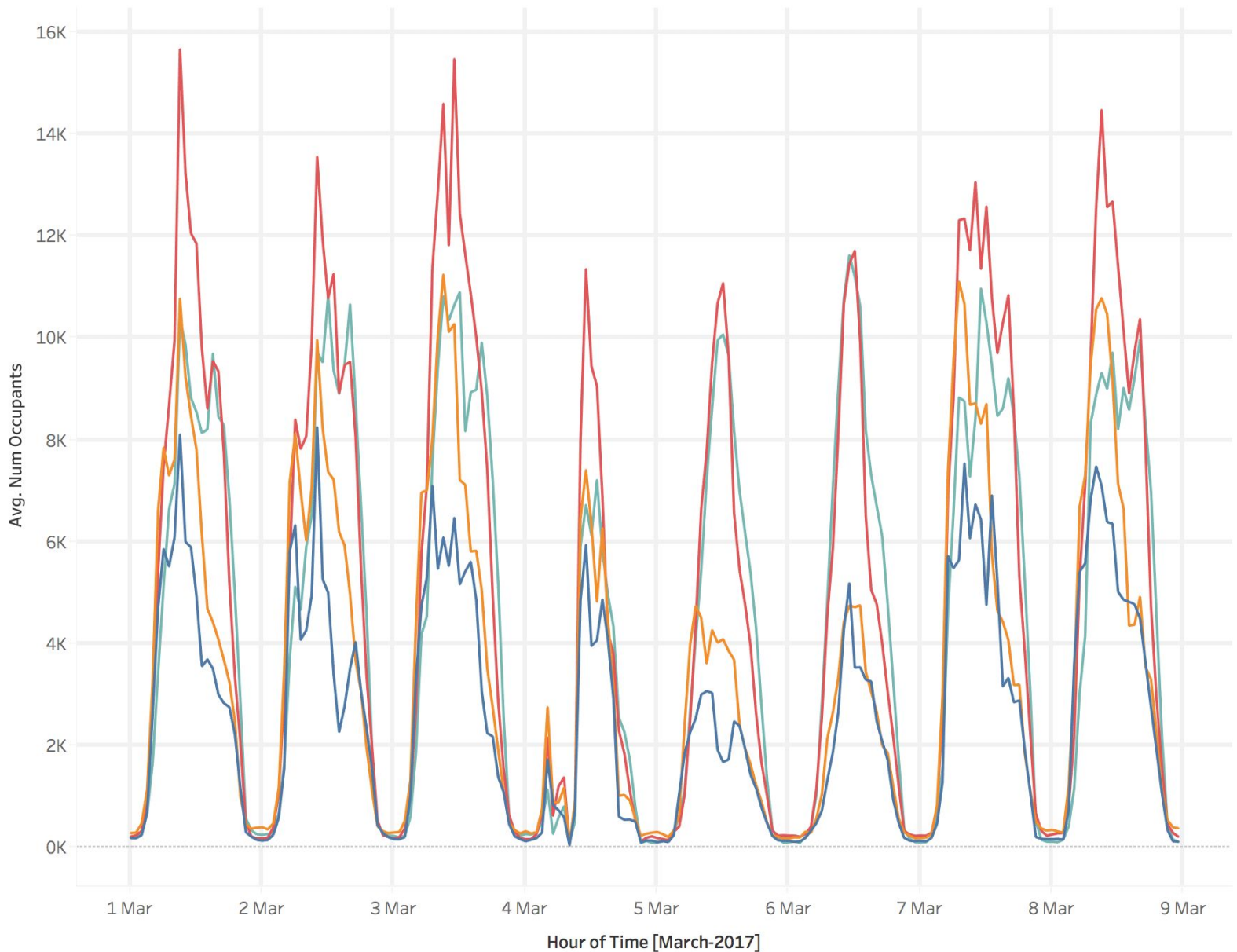
Graph shows IK Barber in March and their daily average occupancy

3rd and 4th floors have highest occupancy

Weekend occupancy significantly lower

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

IK Barber Mar 1-8



Floor Number

- 1
- 2
- 3
- 4

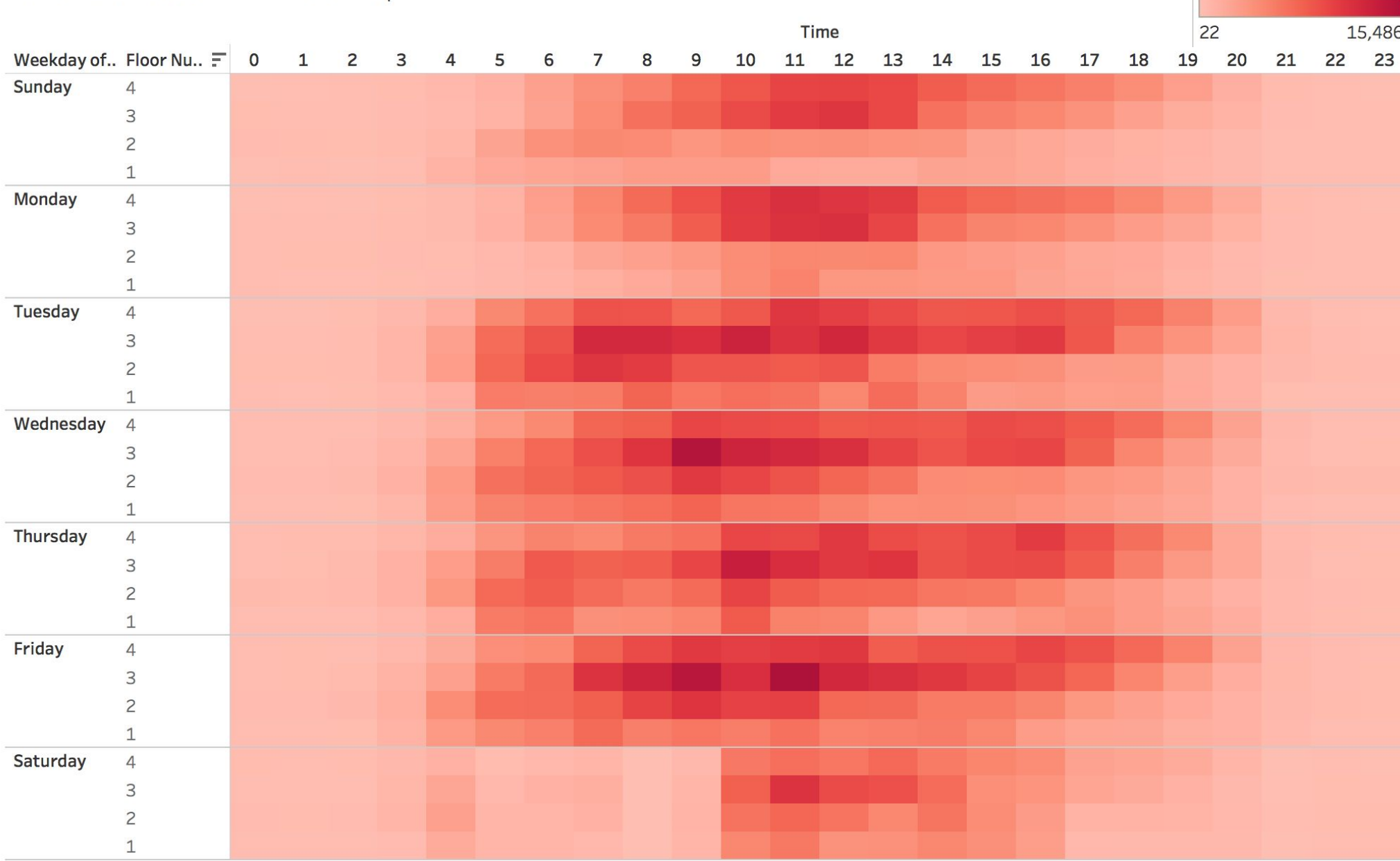
Graph shows IK Barber for 1 week in March and their hourly average occupancy

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

IK Barber March 1-8 Heat Map



AVG(Num Occupants)



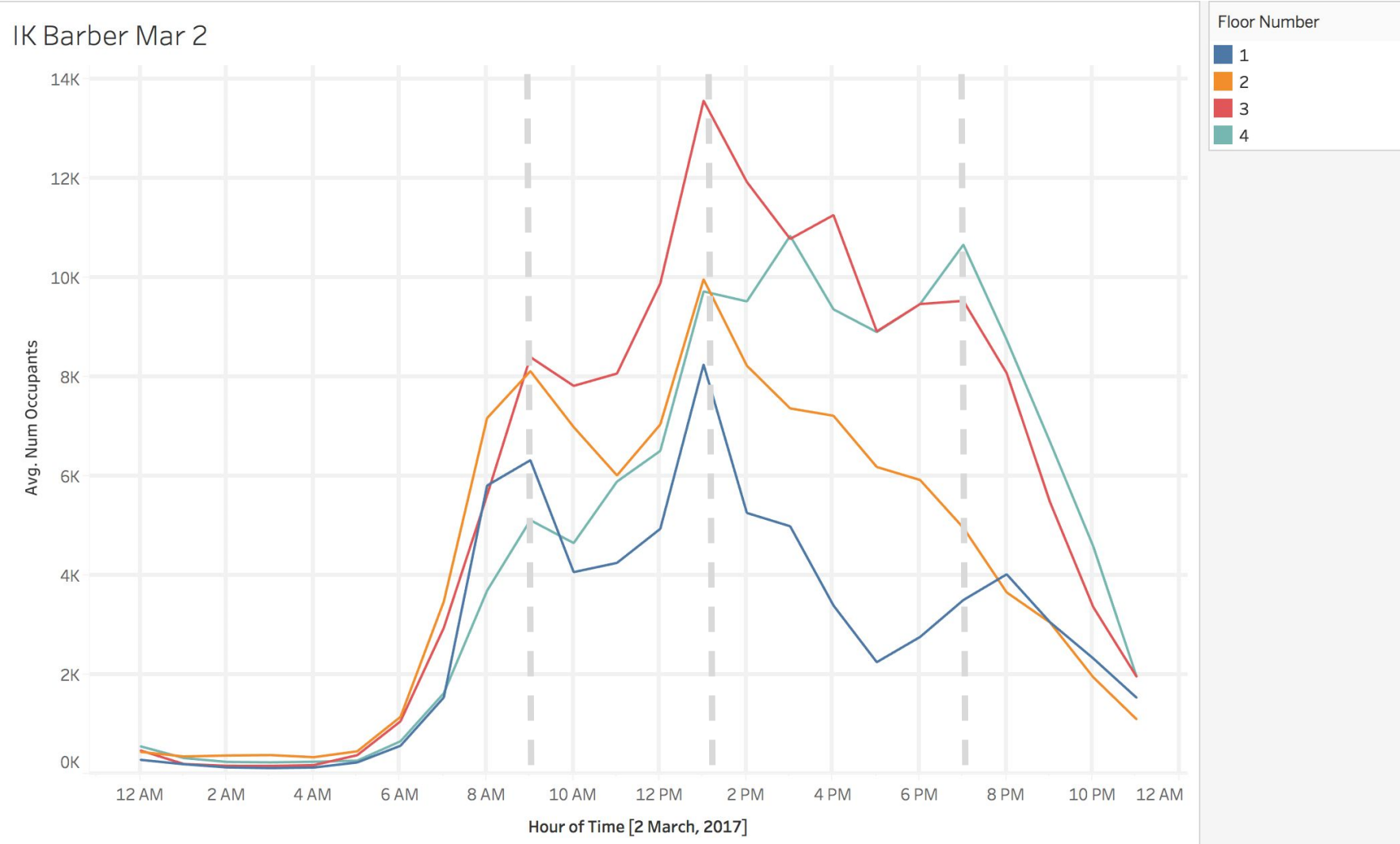
22 15,486

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

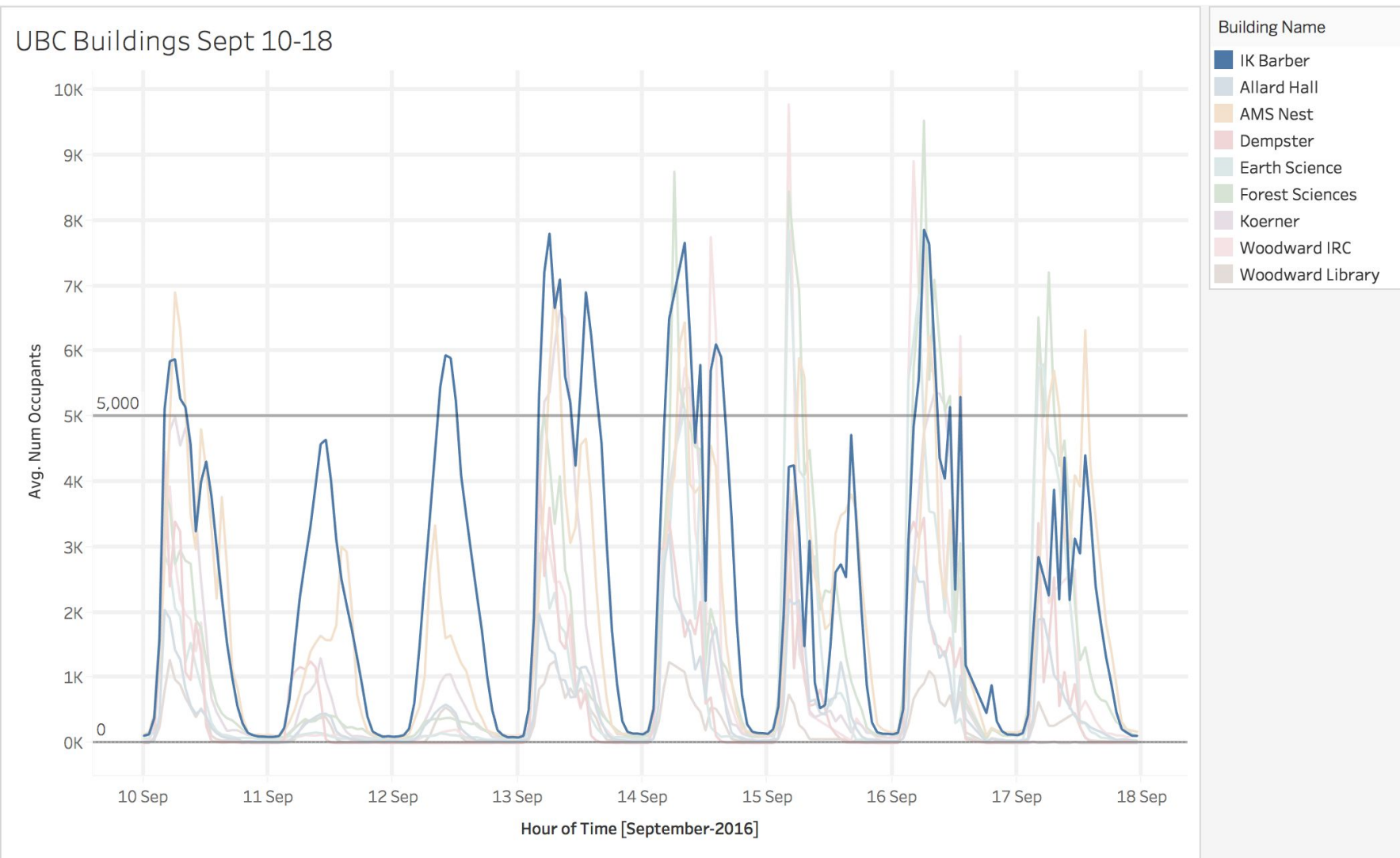
C - Case: IK Barber on March 2



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



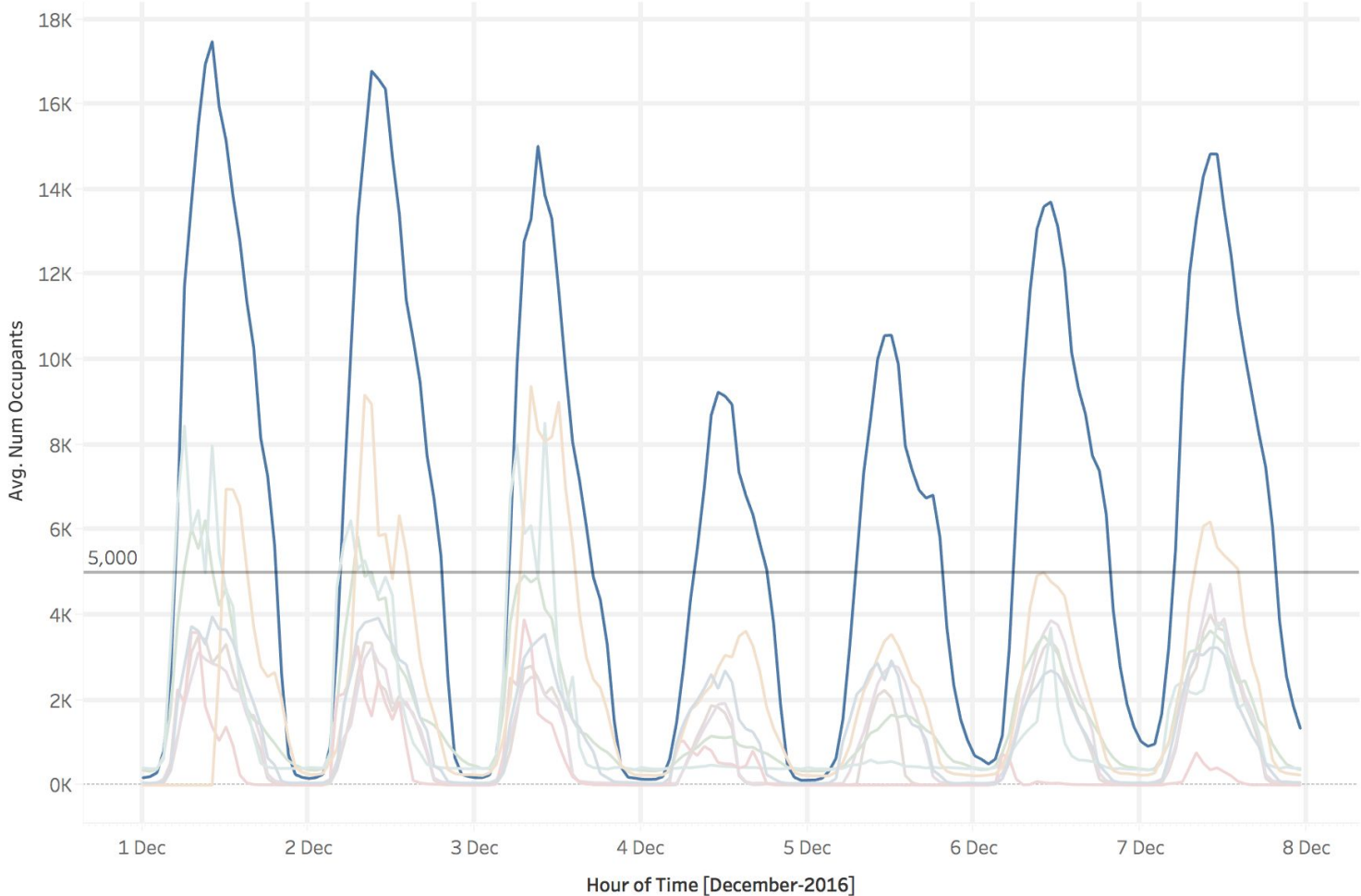
This graph shows hourly average occupancy during second week of first term

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

UBC Buildings Dec 1-8



- Building Name
- Allard Hall
 - AMS Nest
 - Dempster
 - Earth Science
 - Forest Sciences
 - IK Barber
 - Koerner
 - Woodward Library

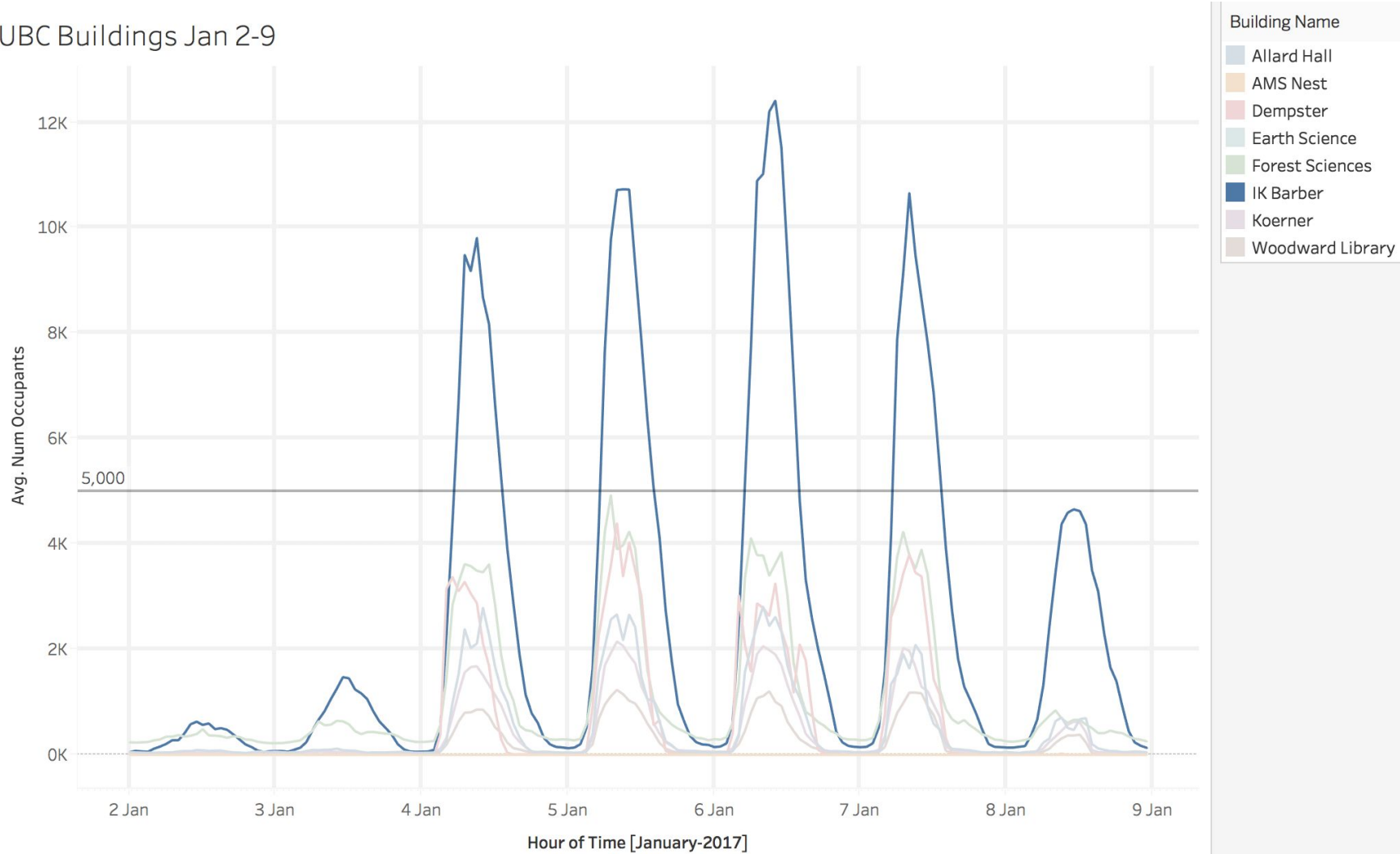
This graph shows hourly average occupancy in a selected week during first term exam

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

UBC Buildings Jan 2-9



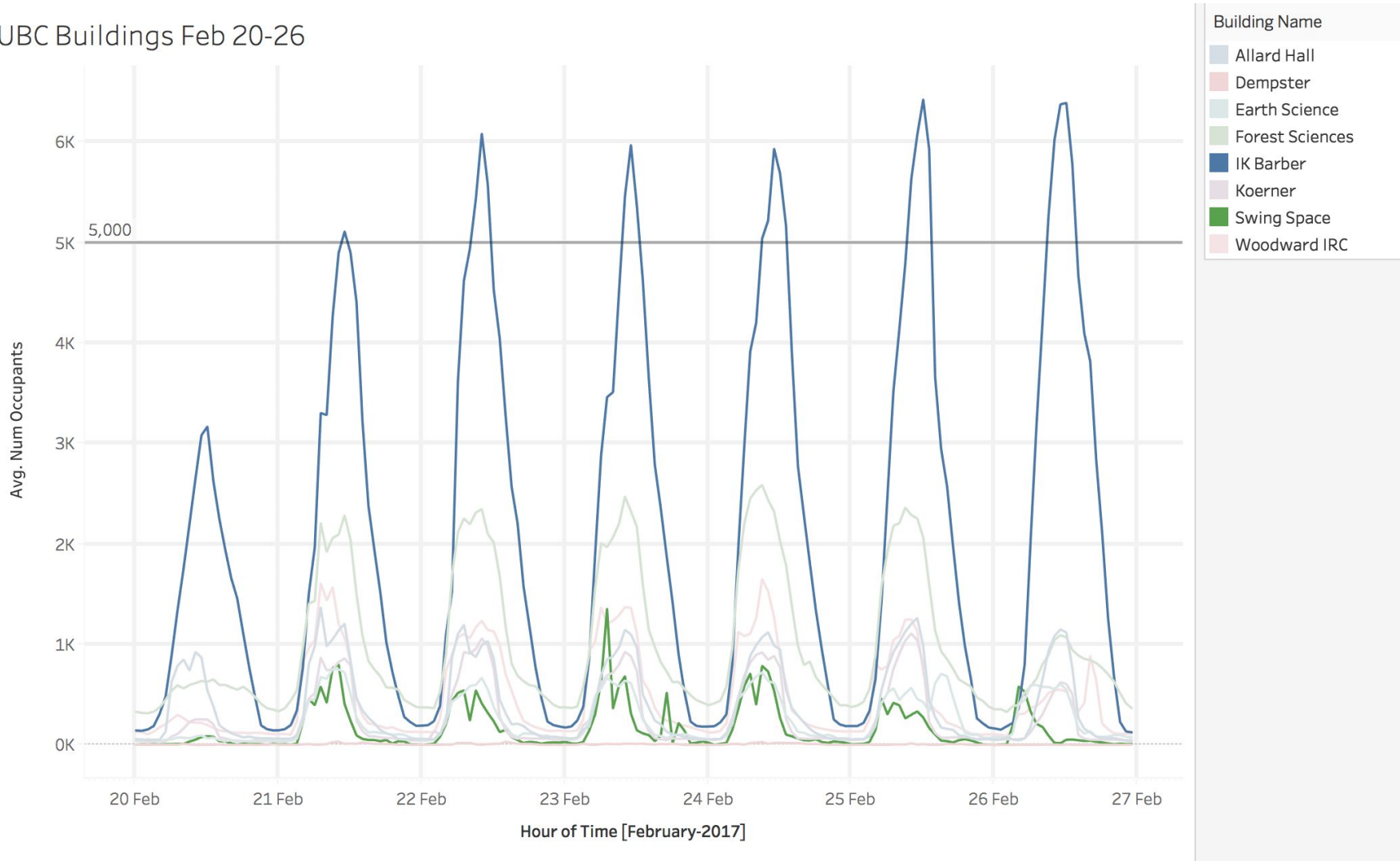
This graph shows hourly average occupancy during first week of second term

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

UBC Buildings Feb 20-26



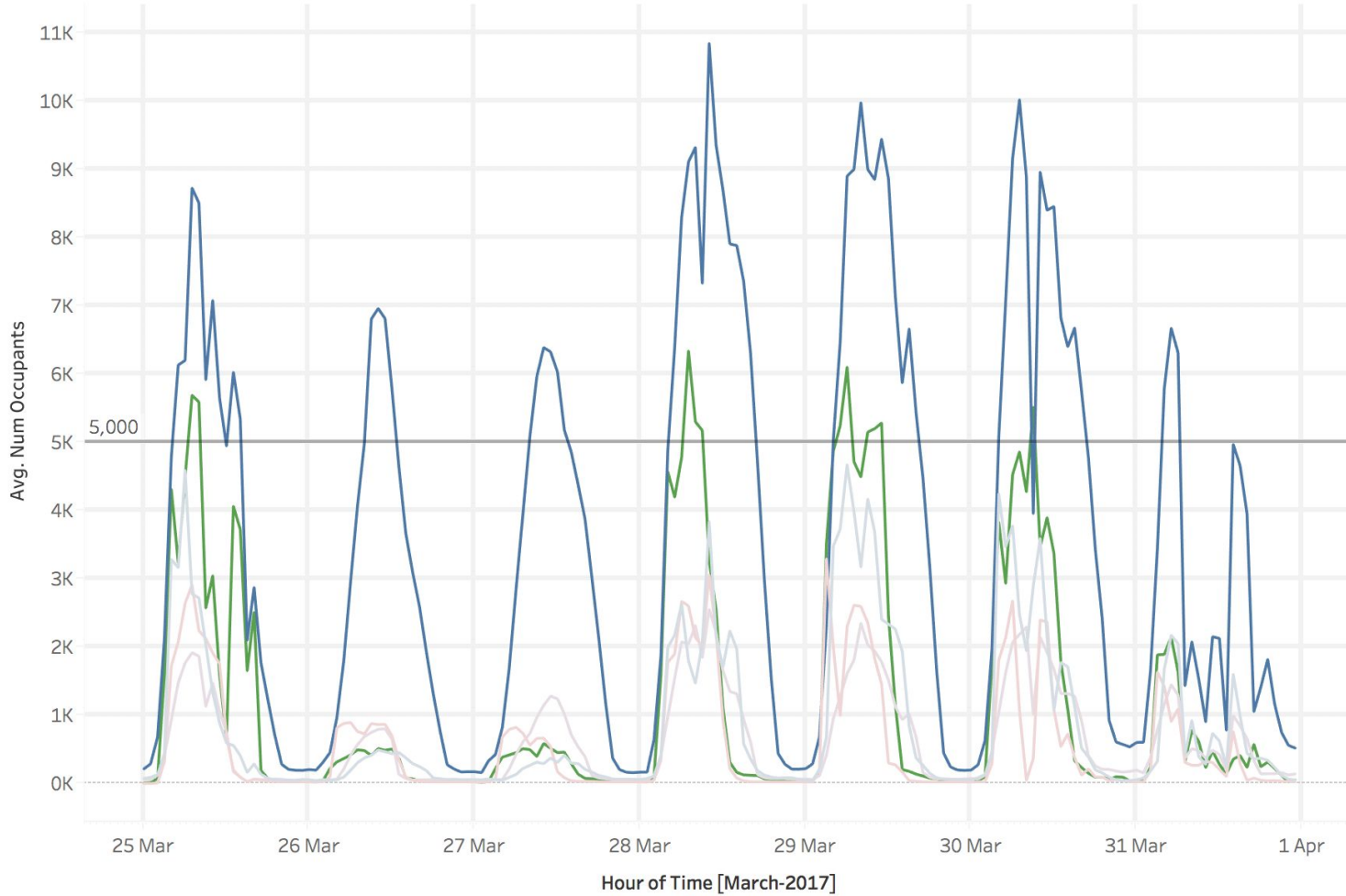
This graph shows hourly average occupancy during reading break

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

UBC Buildings Mar 25-31



Building Name

- Allard Hall
- Dempster
- IK Barber
- Koerner
- Swing Space

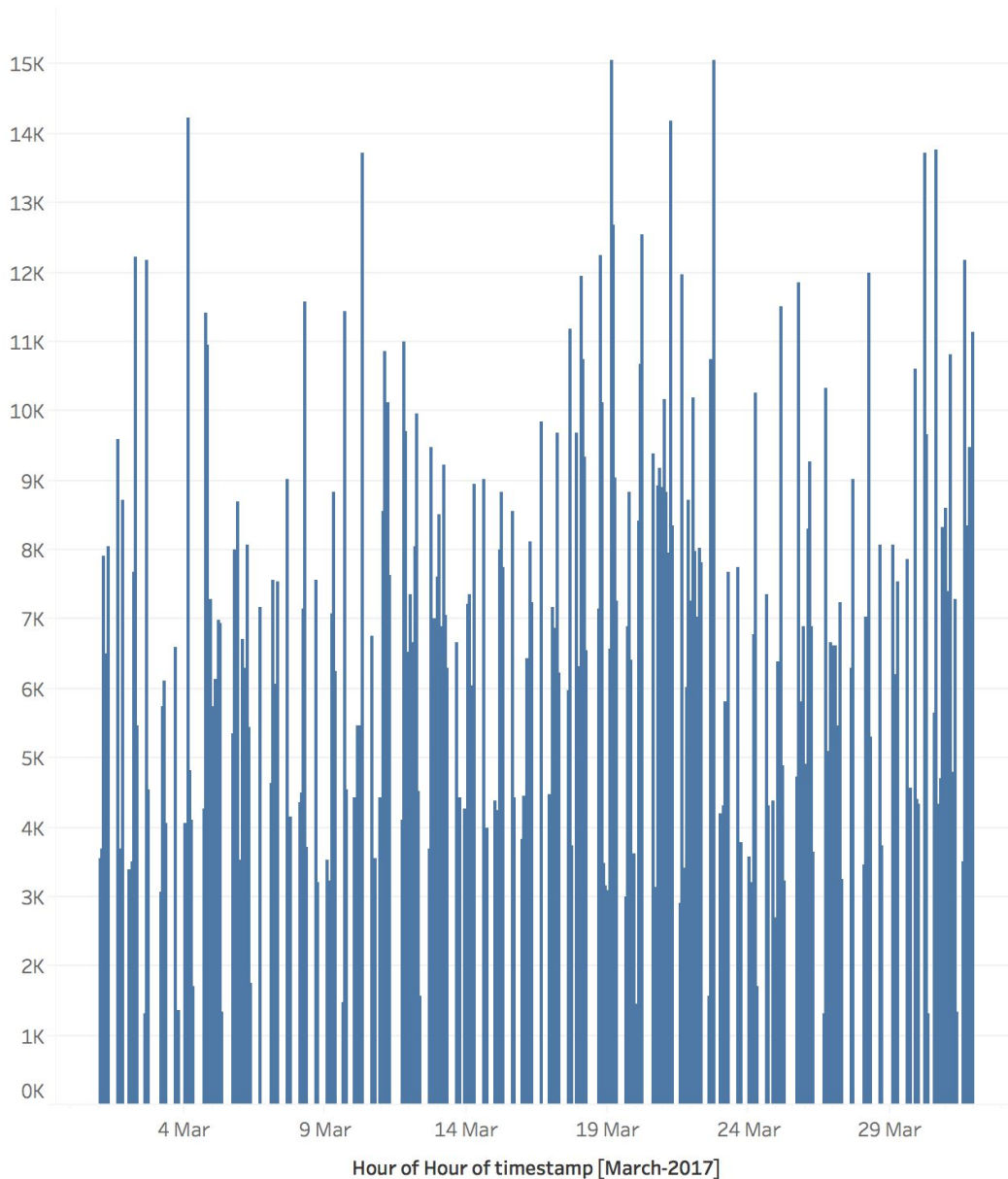
This graph shows hourly average occupancy during second term before exams start

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

Monthly



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

IK Barber

Floor Number

- (All)
- 2
- 1
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10
- 11
- 12
- 13
- 14
- 15
- 16
- 17
- 18
- 19
- 20

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
- Swing Space

Dashboards are increasingly used by organizations:



Interactive



Effective at communication



Compared with spreadsheets, are easy to use and intuitive

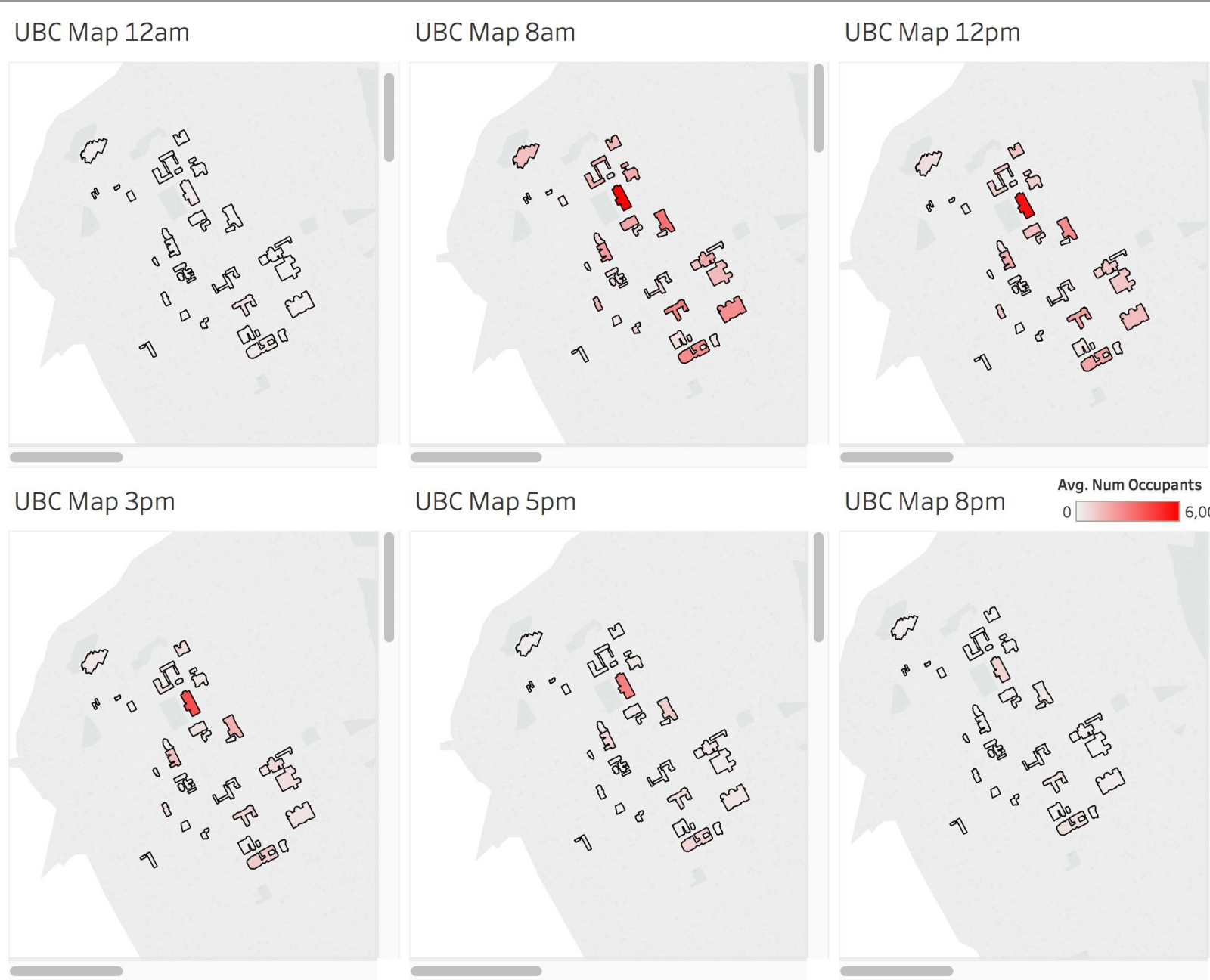


Easy to compare data trends



Visuals help form user insights

F: Occupancy Timelapse Map Visualizations

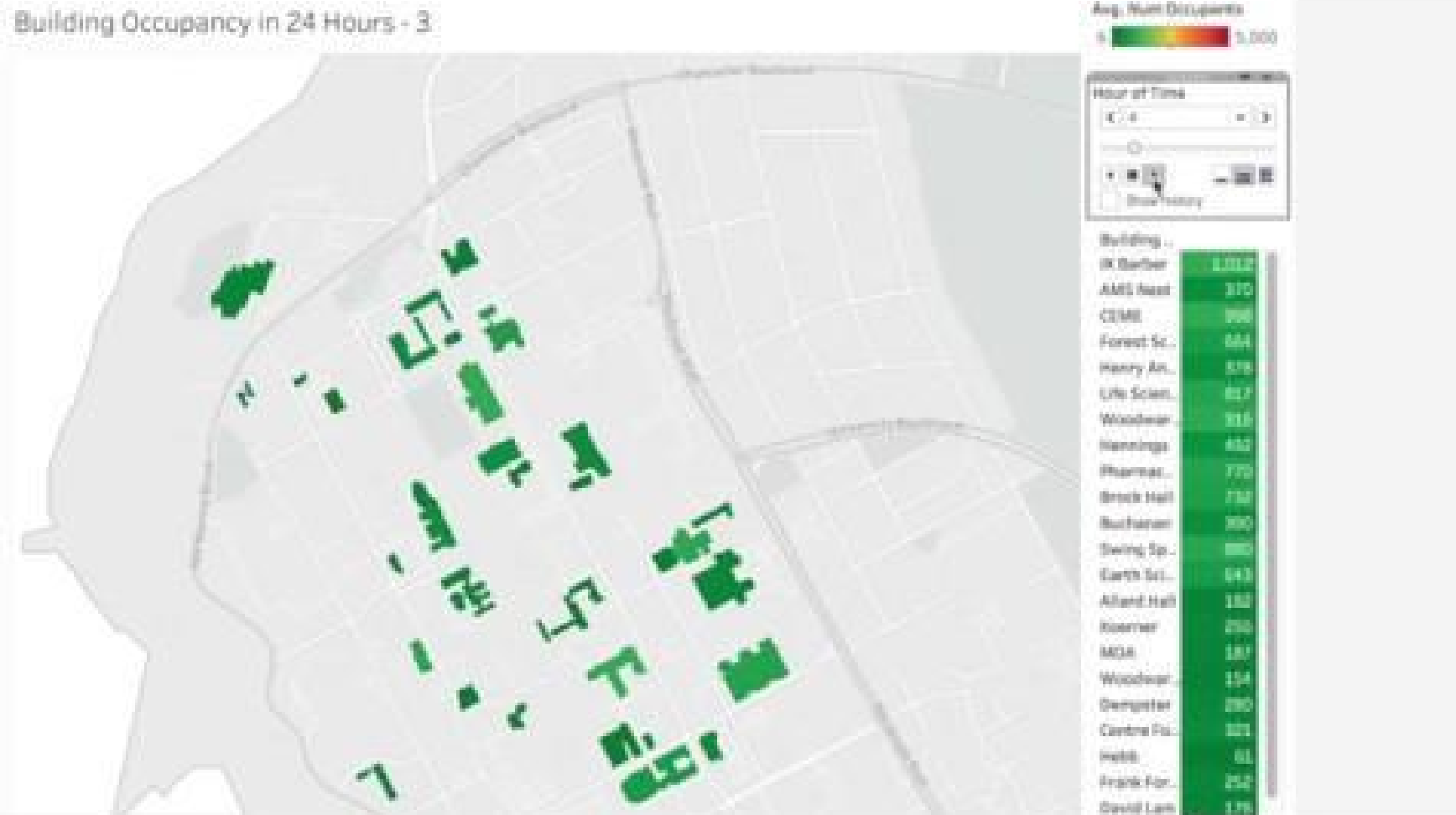


Timelapse map visualizations:

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

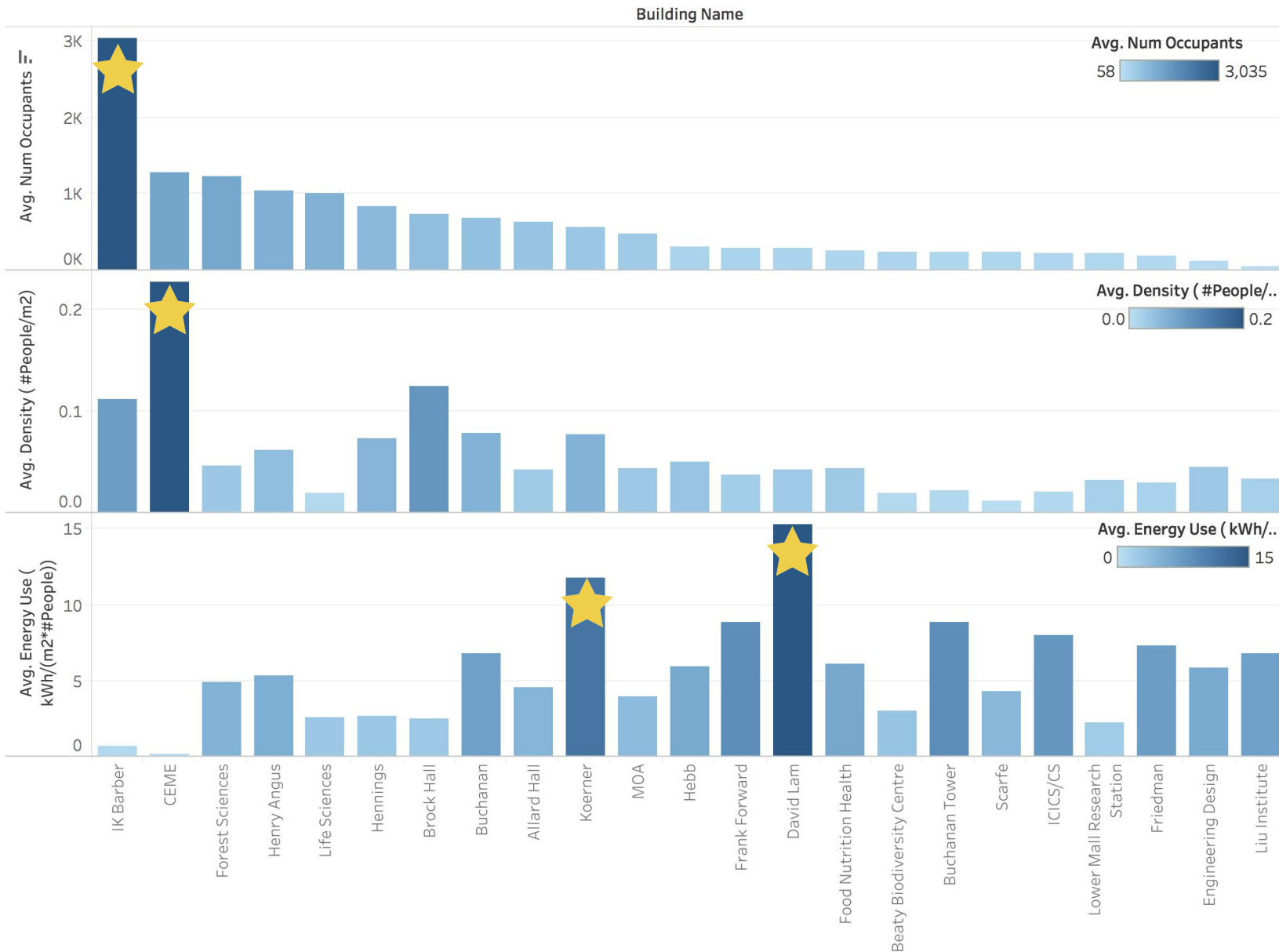
IK Barber has highest occupancy

Link to video:

<https://drive.google.com/open?id=1bOYZBjflnYiktMP7z2sOilNpcPfrglAM>

G: Occupancy Timelapse Map Visualizations

Buildings Density and Energy Analysis



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

Density in 24 Hours Map - 12



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-dzNR8A2lw>

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

The image features a complex network graph on a black background. A central vertical column of nodes is connected to a dense web of other nodes. The nodes are represented by circles of various colors, including red, blue, green, yellow, and purple. The connections are thin, multi-colored lines that crisscross the entire frame, creating a highly interconnected and visually busy network structure. The overall appearance is that of a large-scale, multi-modal network visualization.

5 The Future

Stakeholder Discussion

MARINA
DISTRICT

CHINATOWN

LOWER
PACIFIC
HEIGHTS

SOUTH
BEACH

San Francisco

1047  (68110/km²)

Near 86 Golden Gate Ave