Ocupado

Visualizing Location-Based Counts **Over Time Across Buildings**

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michaeloppermann.com/work/ocupado



THE UNIVERSITY OF BRITISH COLUMBIA









Previous measurement required physical counting or installation of additional hardware.



Previous measurement required physical counting or installation of additional hardware.

Previous visualization attempts were limited in space and time.

OCUPADO sandbox				Campus			Q Search buildings
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time







time





















Location-Based Counts

- Regular intervals (e.g., every 5 minutes)
- Spatial hierarchy (Zone → Floor → Building → Campus)
- No trajectories or device identifiers are recorded
- Intrinsic privacy advantages

Data



Automated HVAC control

Data









Decision making



WiFi connections as a proxy for occupancy



WiFi connections as a proxy for occupancy



Interviews with potential stakeholders





Focus Domains

- Space planning
- Building management
- Custodial services
- Classroom management
- Data quality control

Focus Domains

- Space planning
- Building management
- Custodial services
- Classroom management
- Data quality control



Semi-structured discussions and live demos

Tasks

Confirm assumptions or previous observations. Do students occupy room x in evenings or on weekends?

Tasks





Which rooms are empty/busy?

Tasks





Monitor the current/recent utilization rate.



Space usage improved after renovation.

Tasks





Monitor the current/recent utilization rate.



Communicate space usage and justify decisions.



Validate the data (quality control).

- Check minimum size of a room that can be captured.

Zone

Regions of interest



Floor



Building



Regions of interest





Periods of interest



Regions of interest



Periods of interest



→ Individual measures vs. temporal rollup

Visualization Prototypes

Sandbox

Data sketches, static data export

Campus Explorer

Live-data stream, cross-building analysis



Building Long-term

Region Compare



Visualization Prototypes

Sandbox

Data sketches, static data export





Visualization Prototypes

Sandbox

Data sketches, static data export



Time

Campus Explorer



Campus

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OCUPADO campus explorer

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A ACTIVITY PATTERNS





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campus explorer					Campus	Q	Search buildings
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Campus

ACTIVITY PATTERNS

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Q Search buildings

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Building Recent Interface

OCUPADO building recent







OCUPADO building recent







Building Long-Term Interface

OCUPADO building long term



Building X

OCUPADO building long term



Building X

	avg. activity
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OCUPADO building long term



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Building X				
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Region Compare Interface



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Region Subset Views



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ctaposition	Repeating patterns, trends, outliers (contiguous)



et	Comparisons
taposition	Repeating patterns, trends, outliers (contiguous)
taposition	Repeating patterns, trends, outliers (<i>non-contiguous</i>)



et	Comparisons
ctaposition	Repeating patterns, trends, outliers (contiguous)
ctaposition	Repeating patterns, trends, outliers (non-contiguous)
gregation	Typical utilization profiles



et	Comparisons
ctaposition	Repeating patterns, trends, outliers (contiguous)
ctaposition	Repeating patterns, trends, outliers (non-contiguous)
gregation	Typical utilization profiles
position	Within-session patterns, outliers



et	Comparisons
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gregation	Typical utilization profiles
position	Within-session patterns, outliers



et	Comparisons
ctaposition	Repeating patterns, trends, outliers (contiguous)
ctaposition	Repeating patterns, trends, outliers (non-contiguous)
gregation	Typical utilization profiles
position	Within-session patterns, outliers
position	Within local spatial neighborhood
ntainment sted)	Across distributed regions

Usage

- Deployed Ocupado tools for the UBC Vancouver campus and Cisco's Innovation Centre in Toronto.
- Industry collaborator adopted Ocupado as a front-end for their WiFi data collection platform.

michaeloppermann.com/work/ocupado

Ocupado: Visualizing Location-Based Counts Over Time Across Buildings

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Figure 1: Building Recent Interface, overview window. (a) Floor plans sized to all fit within one screen with zone-level superimposed circle symbols showing live device counts. (b) Per-floor aggregate trend charts showing device counts over past 12 hours and prediction for the next 3 hours (red dashed line). (c) Alternative sidebar showing aggregate per-floor usage for typical day vs. current live data.

Abstract

Understanding how spaces in buildings are being used is vital for optimizing space utilization, for improving resource allocation, and for the design of new facilities. We present a multi-year design study that resulted in Ocupado, a set of visual decision-support tools centered around occupancy data for stakeholders in facilities management and planning. Ocupado uses WiFi devices as a proxy for human presence, capturing location-based counts that preserve privacy without trajectories. We contribute data and task abstractions for studying space utilization for combinations of data granularities in both space and time. In addition, we contribute generalizable design choices for visualizing location-based counts relating to indoor environments. We provide evidence of Ocupado's utility through multiple analysis scenarios with real-world data refined through extensive stakeholder feedback, and discussion of its take-up by our industry partner.

1. Introduction

Efficient space utilization is a challenge for many organizations. Monitoring and analyzing building occupancy over time can lead to valuable insights and data-informed decisions [VvdSK*15; VAL171 New methods are emerging for implicit and explicit ocdata sources to be leveraged in many new decision-making contexts, but current visual data analysis tools do not suffice to support decision-making about indoor space usage over time.

Previous attempts to visualize occupancy, and other indoor sensor data, are limited to very small regions such as single rooms





- Analysis and abstraction of data and tasks for studying space utilization.
- Ocupado, a set of visual decision support tools.
- Generalizable design choices for visualizing non-trajectory spatiotemporal data relating to large-scale indoor environments.
Ocupado

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Floor 5





