Optimizing CTA Ad Placements Through Foot Traffic and Exposure Analysis

A Datathon project prepared for:

Chicago Transit Authority

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Today's Agenda

I. Welcome & Introductions

II. Problem Statement

III. Key Findings

IV. Examples of Application

V. Q&A

Problem Statement

Advertising is a major non-fare revenue source for CTA.

The Chicago Transit Authority's current advertising strategy lacks a dynamic, data-driven framework to align ads with real-time commuter behavior and localized audience relevance. Key gaps include:

1. Under-captured Exposure from Dwell Time Variability

2. Mismatch Between Traffic Volume and Ad Quality

3. Inflexible Quality Score Integration

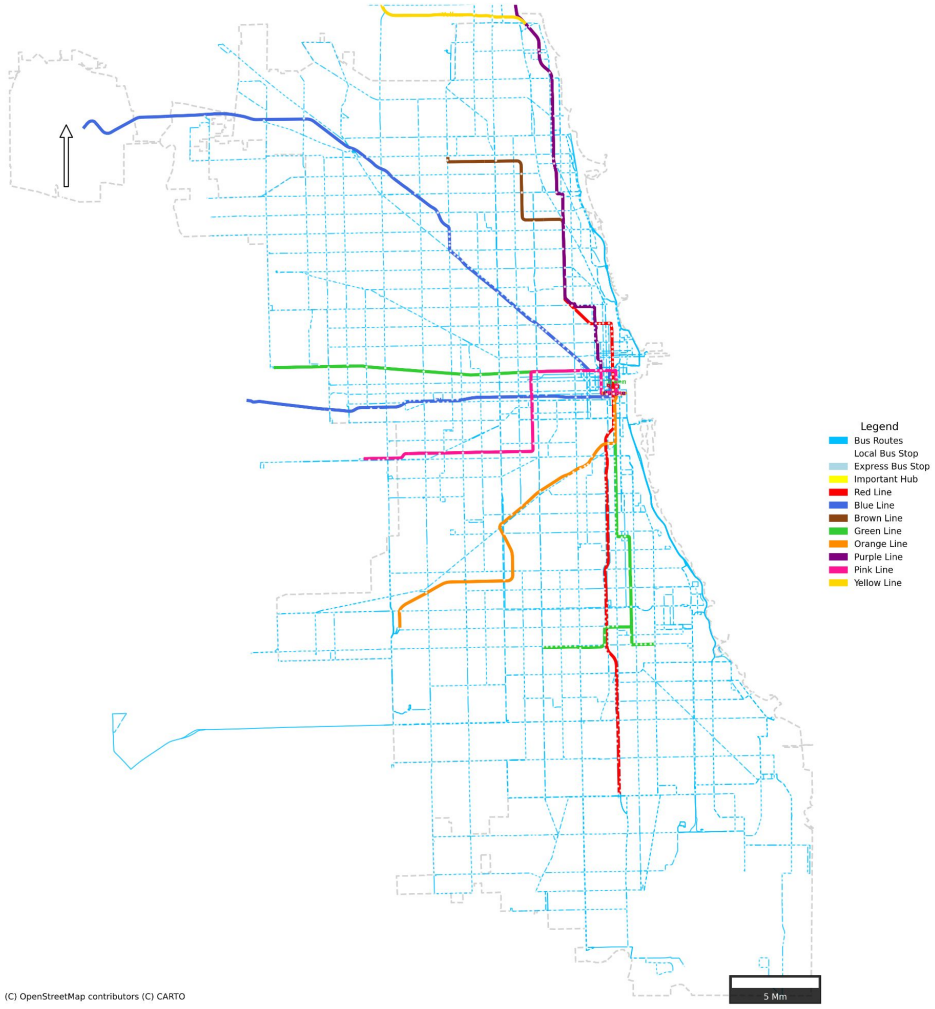
4. Inefficient Resource Allocation

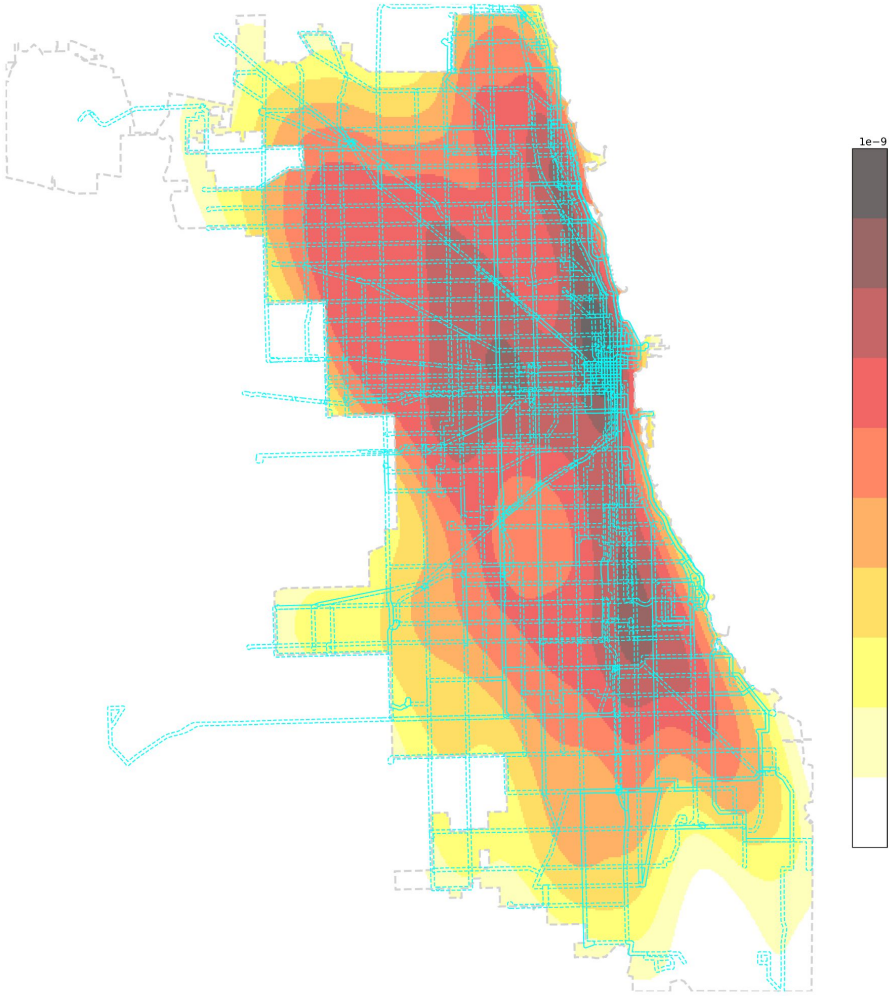
Result: Underutilized advertising spaces and lost potential revenue.

Objective:

Maximize advertising revenue by identifying high-exposure areas and recommending optimal reallocation of public transit ad placements.

Overview - Chicago Public Transit Map and Heat Map





Calculation Formula for Quality Score

$$\text{Quality Score} = \alpha \times \text{Income Match Score} + \beta \times \text{Race Match Score} + \gamma \times \text{Household Match Score} + \delta \times \text{Gender Match Score} + \epsilon \times \text{Age}$$

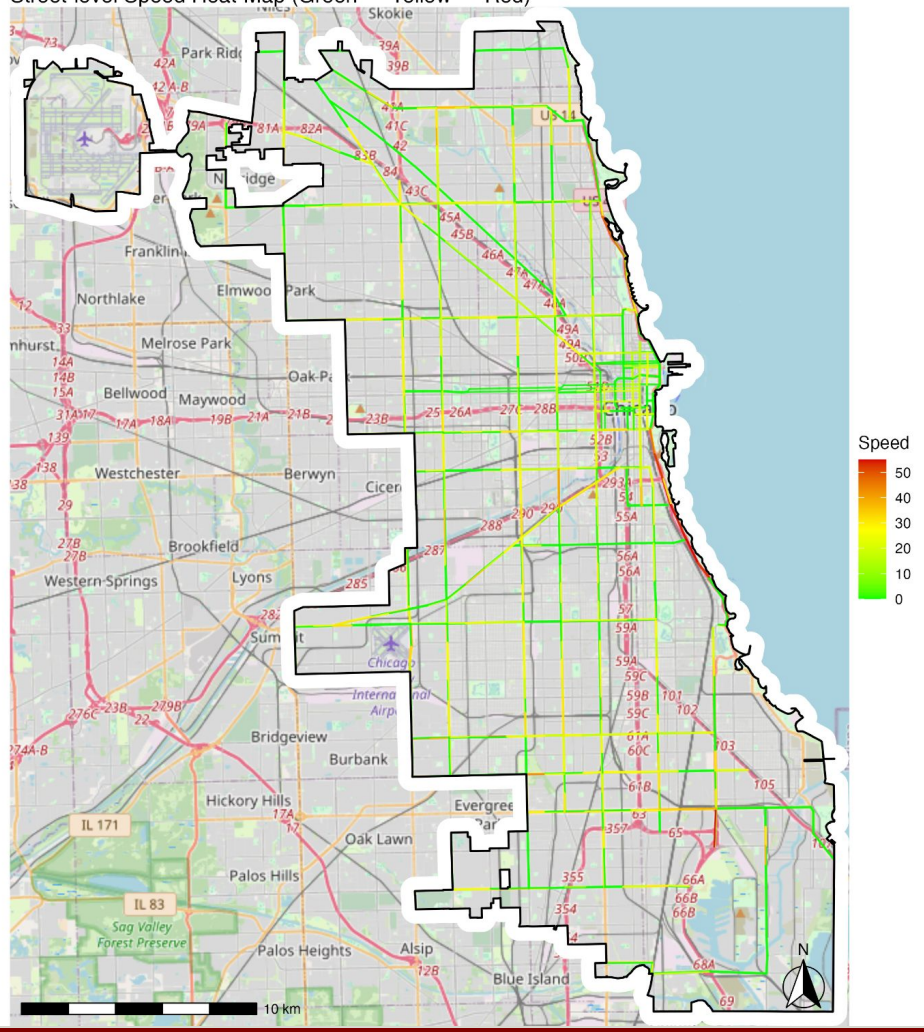
$$textIncomeScore = \min\left(1, \frac{\text{Median Income}}{\text{Target Income}}\right) \qquad [\text{Race Score} = \begin{cases} 1, & \text{if Dominant Race is in Preferred Race} \\ 0.5, & \text{otherwise} \end{cases}]$$

$$[\text{Household Score} = \begin{cases} \min\left(1, \frac{\text{Max Household Size}}{\text{Average Household Size}}\right), & \text{if Max Household Size is specified} \\ \min\left(1, \frac{\text{Average Household Size}}{\text{Min Household Size}}\right), & \text{if Min Household Size is specified} \\ 1, & \text{otherwise} \end{cases}]$$

$$\text{Gender Score} = 1 - |\text{Gender Ratio} - \text{Target Gender Ratio}|][\text{Age Score} = \begin{cases} 1, & \text{if Dominant Age Category matches Target Age Category} \\ 0.5, & \text{otherwise} \end{cases}$$

Dwell Time Analysis

Street-level Speed Heat-Map (Green → Yellow → Red)



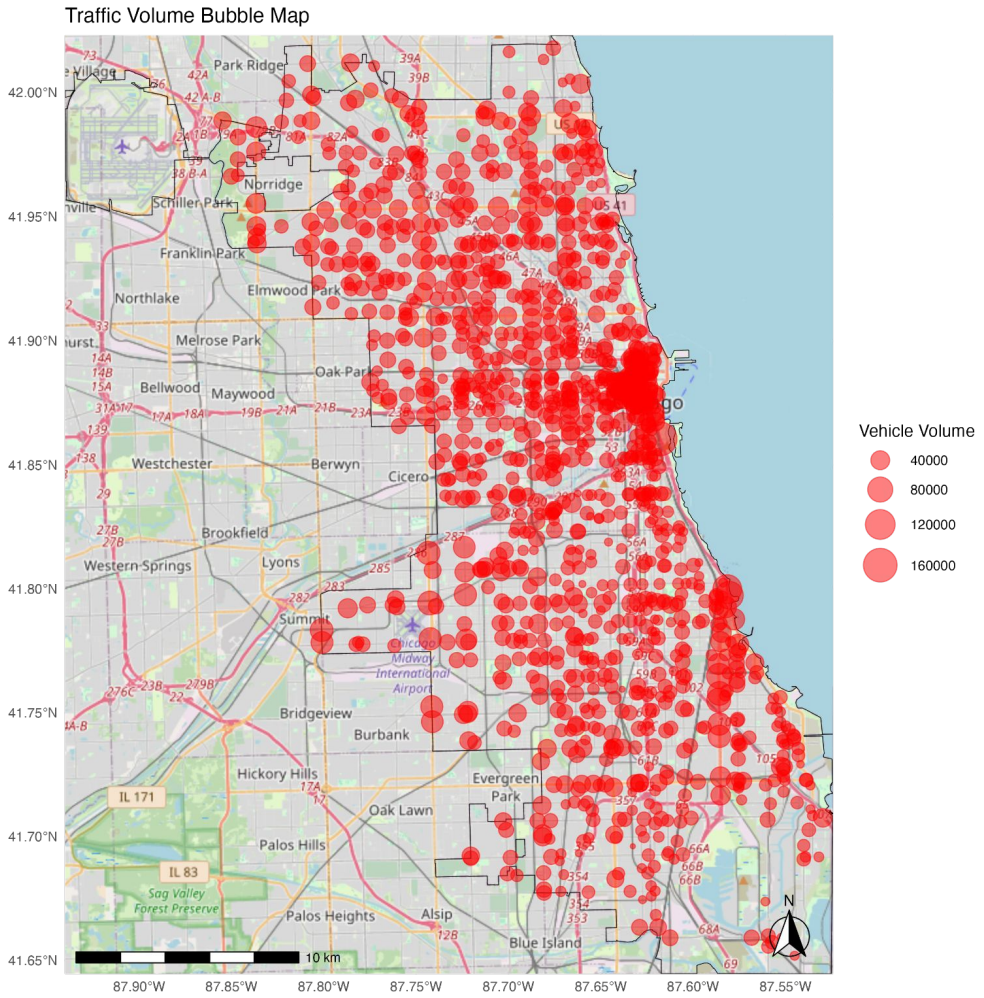
Objective:
Identify areas with longer dwell times to pinpoint higher advertising exposure opportunities.

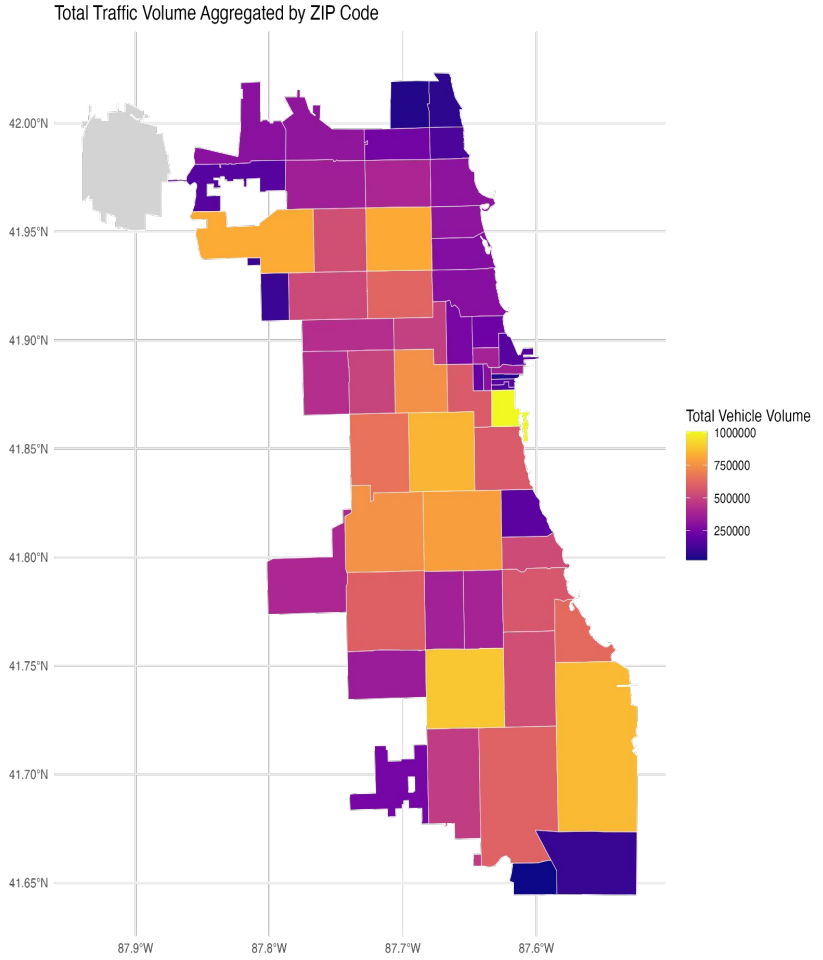
Method:
Analyzed street-level speed data; slower speeds indicate longer stops and greater rider attention.

Key Insight:

- Downtown core and major transfer corridors show the longest dwell times
- High-priority areas for advertising placements

Foot Traffic Analysis





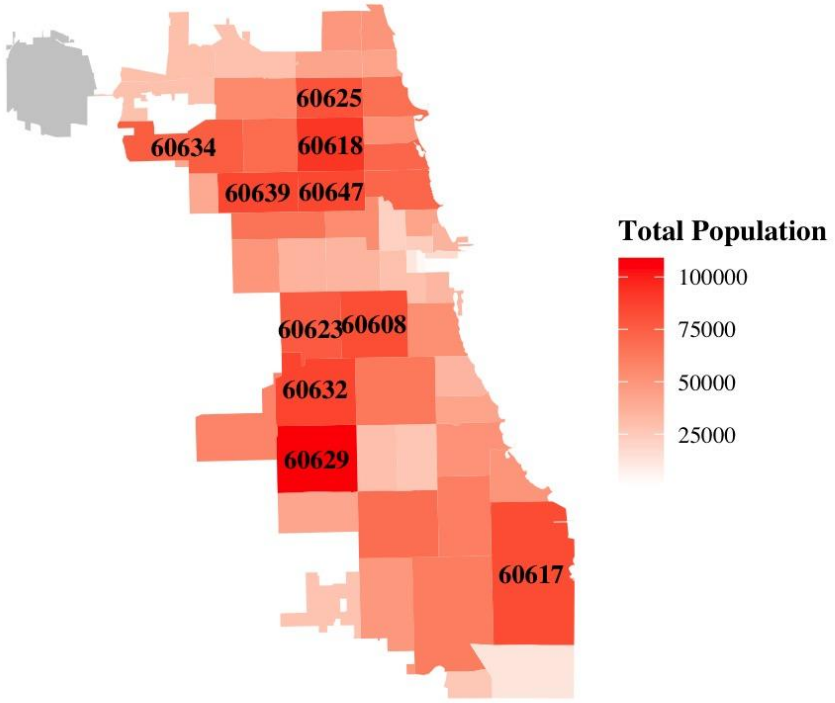
Objective:
Analyze traffic volumes to identify areas with the highest potential rider exposure.

Key Insights:

- High traffic volumes are concentrated in downtown, near major highways, and along key north-south corridors.
- Areas with heavier traffic are prime locations for advertising visibility and engagement.

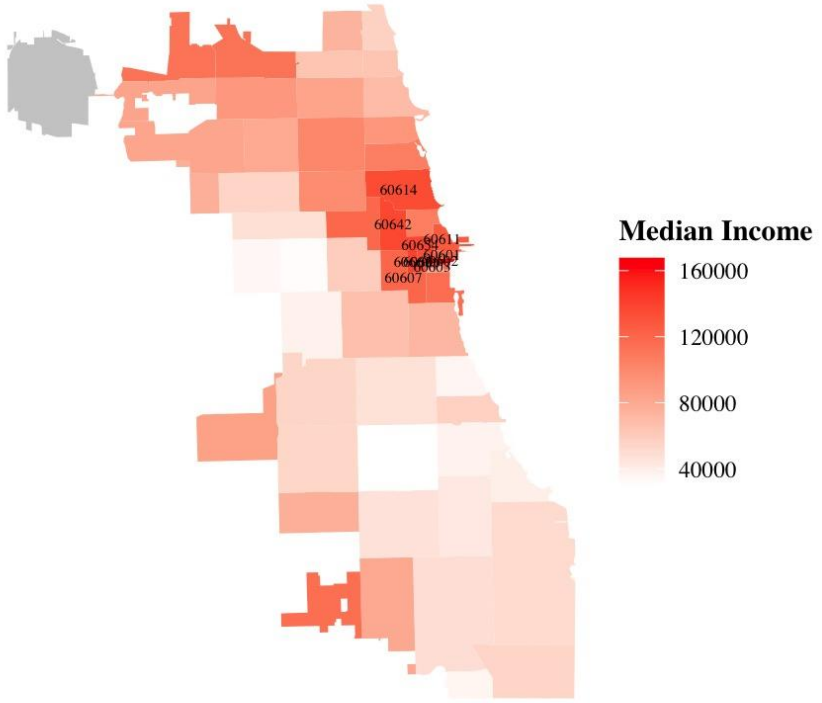
Sociodemographic

Distribution of Total Population by ZIP Code



Top 10 ZIP codes labelled

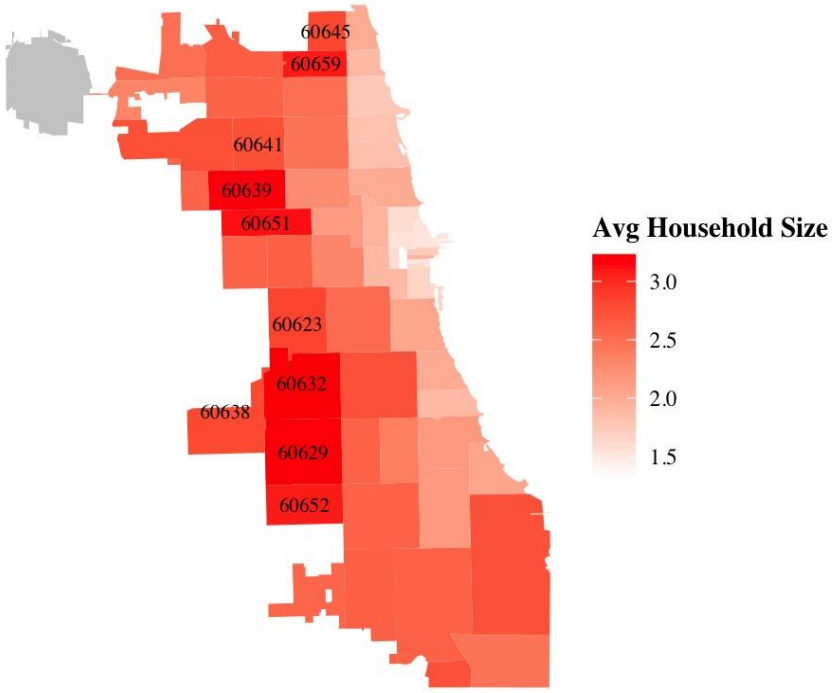
Distribution of Median Income by ZIP Code



Top 10 ZIP codes labelled

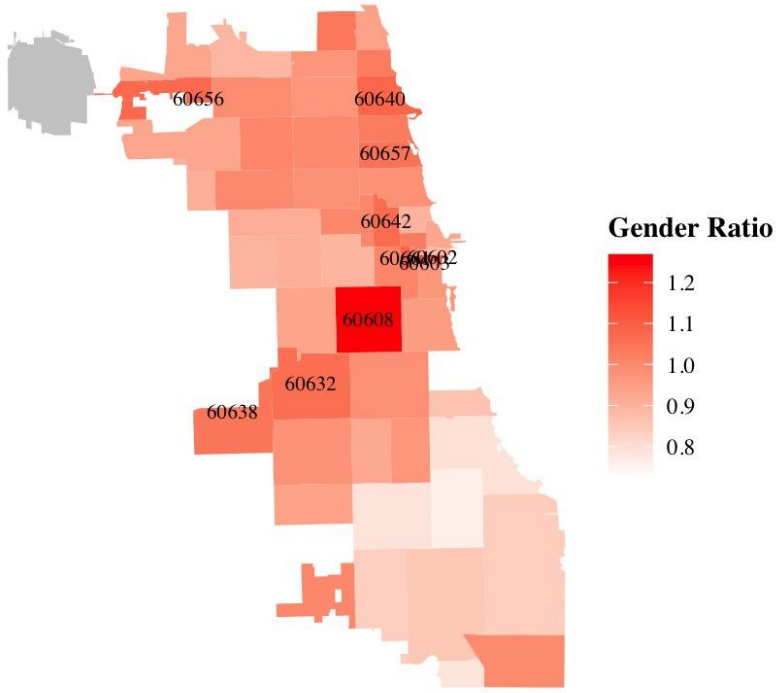
Sociodemographic

Distribution of Average Household Size by ZIP Code



Top 10 ZIP codes labelled

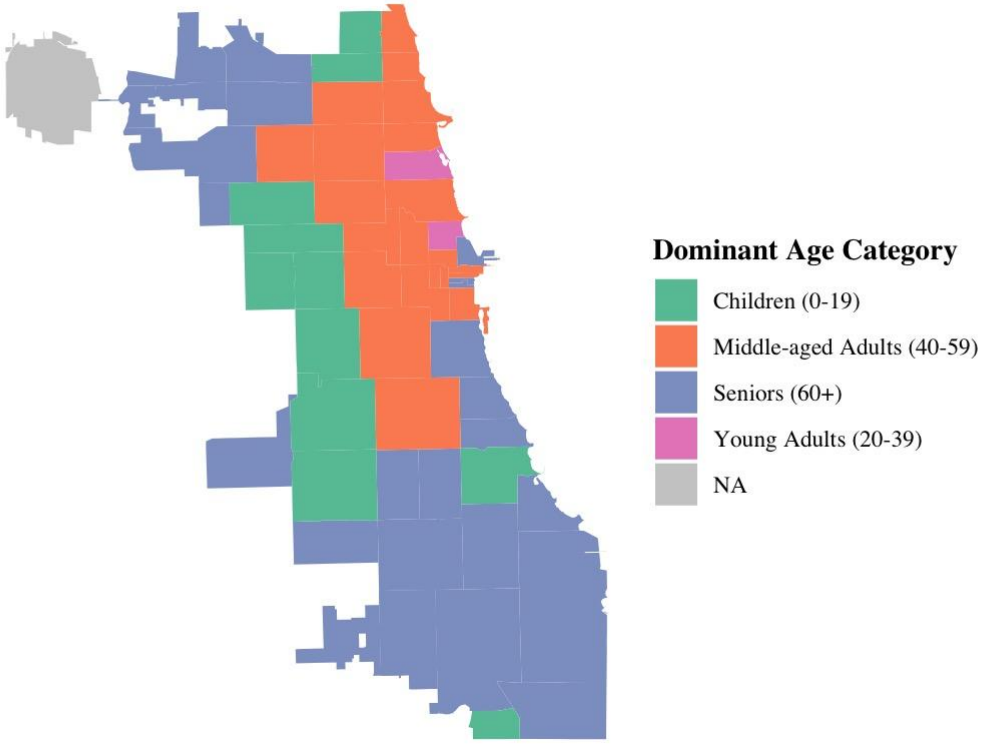
Distribution of Gender Ratio by ZIP Code



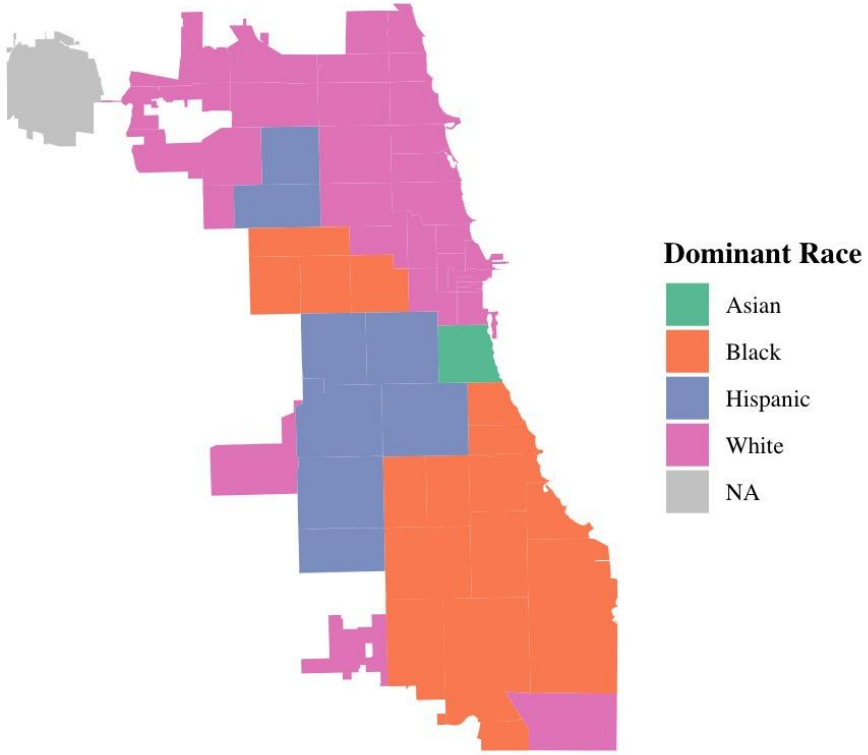
Top 10 ZIP codes labelled

Sociodemographic

Distribution of Dominant Age Category by ZIP Code



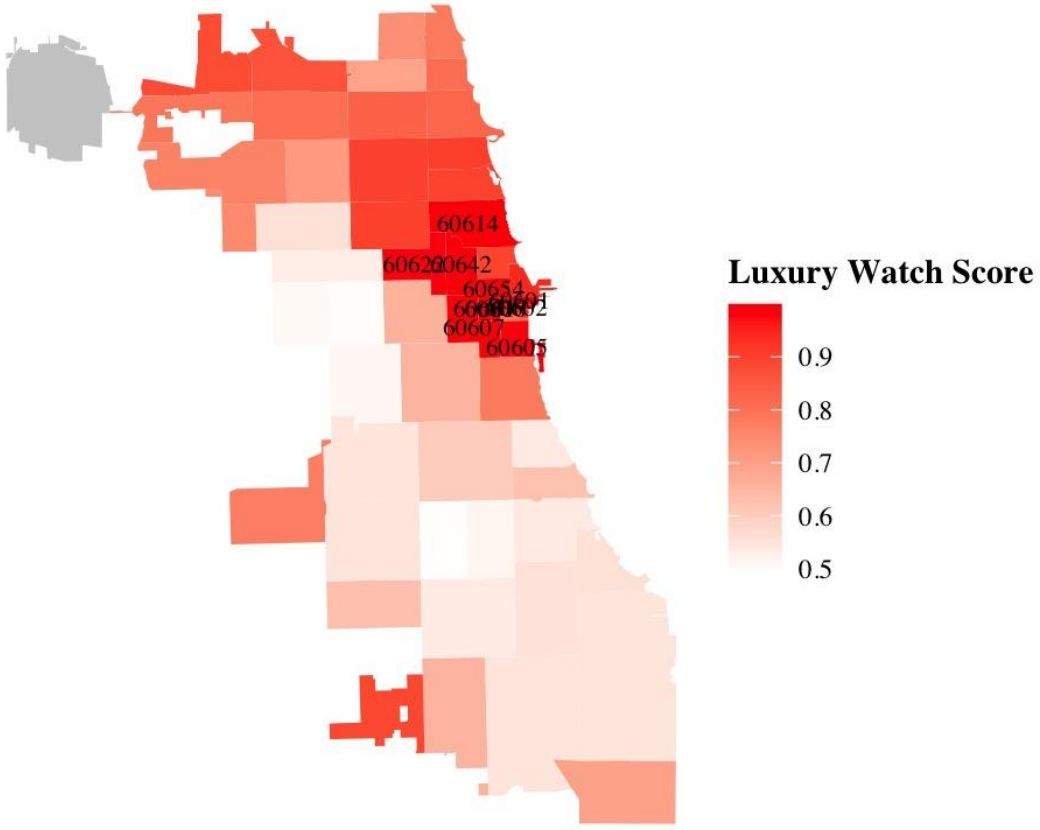
Distribution of Dominant Race by ZIP Code



Application Example: Luxury Watch

$$[\text{Quality Score} = 0.4\times\text{Income Match Score}+0.2\times\text{Race Match Score}+0.2\times\text{Household Match Score}+0.1\times\text{Gender Match Score}+0.1\times\text{Age}]$$

Distribution of Luxury Watch Score by ZIP Code



Top 10 ZIP codes labelled

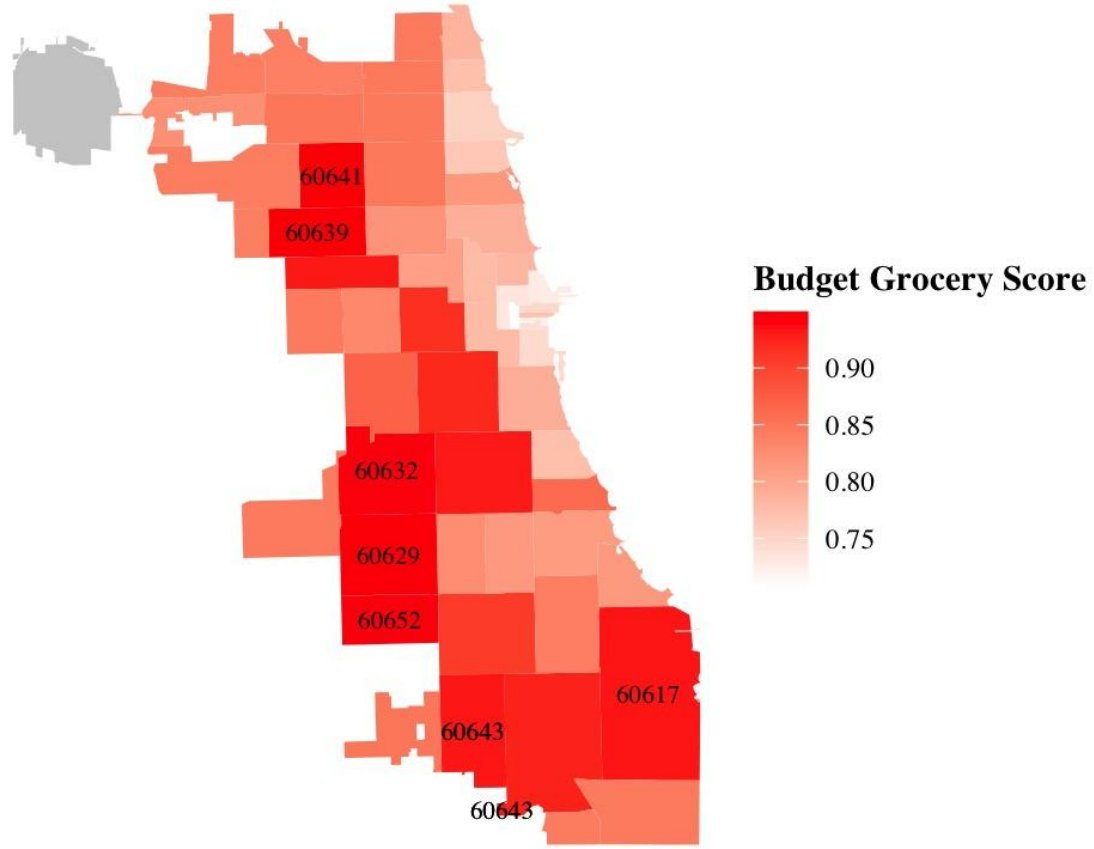
Weights explanation:

- **Income (0.4):** High disposable income is critical for luxury products.
- **Race (0.2):** Targeted marketing based on race demographics.
- **Household (0.2):** Smaller households often correlate with higher disposable income.
- **# Gender (0.1):** Slight male preference, but gender balance is still important.
- **# Age (0.1):** Middle-aged adults are primary buyers of luxury watches.

Application Example: Budget Grocery

$$\text{Quality Score} = 0.3\times\text{Income Match Score}+0.2\times\text{Race Match Score}+0.3\times\text{Household Match Score}+0.1\times\text{Gender Match Score}+0.1\times\text{Age}$$

Distribution of Budget Grocery Score by ZIP Code



Top 10 ZIP codes labelled

Weights explanation:

- **Income (0.3):** Affordability is key for budget products.
- **Race (0.2):** Cultural targeting for community-based marketing.
- **Household (0.3):** Larger households tend to be more price-sensitive.
- **Gender (0.1):** Balanced gender targeting for grocery products.
- **Age (0.1):** Young adults tend to be frequent grocery shoppers.

Policy Recommendation

- Reallocate advertising placements based on quality scores — combining foot traffic, dwell time, and demographics — to maximize the marginal revenue product (MRP) of available advertising spaces.
- This strategy employs principles of constrained resource allocation and profit maximization, ensuring that scarce advertising inventory is deployed where it yields the greatest economic return.
- By aligning advertising inventory with its true marginal value, this new proposed method could assist CTA to unlock previously unrealized revenue streams without raising operational costs or fares.

Questions?

Thank you