DATA601-2023

GIS SMARTPHONE MOBILITY PROJECT

A Spatial Analysis of Smartphone Smuggling in Brazilian Prisons

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OVERVIEW

Geospatial analysis integrates GIS technology and geodata to provide visualization and insights to diverse fields of study and sectors.

In collaboration with the UC Department of Earth and Environment Sciences, this project focuses on detecting anomalies for unexpected patterns of mobile use inside major prisons in Rio de Janeiro & Sao Paulo, Brazil.

GOALS

Leveraging GIS and anomaly detection techniques, this project aims to:

- Explore and discover temporal spatial patterns
- Identify trends indicating illegal smartphone usage

a potential threat to the city's safety and security with its increasing prevalence.

METHODOLOGY

DATA PREPARATION

Extract, clean, wrangle & manipulate datasets.

Attributes	RIO	SP
File Size (Gzip)	480 GB	1.9 TB
Rows (billions)	2.9	19.3
Columns	7	7

DATA EXPLORATION

Understand the data's characteristics:

- Descriptive Analysis
- Temporal and Spatial trends

DATA MODELING

Detect anomaly using integrated techniques:

- Rule-based and Statistical
- K-means and Hierarchical cluster

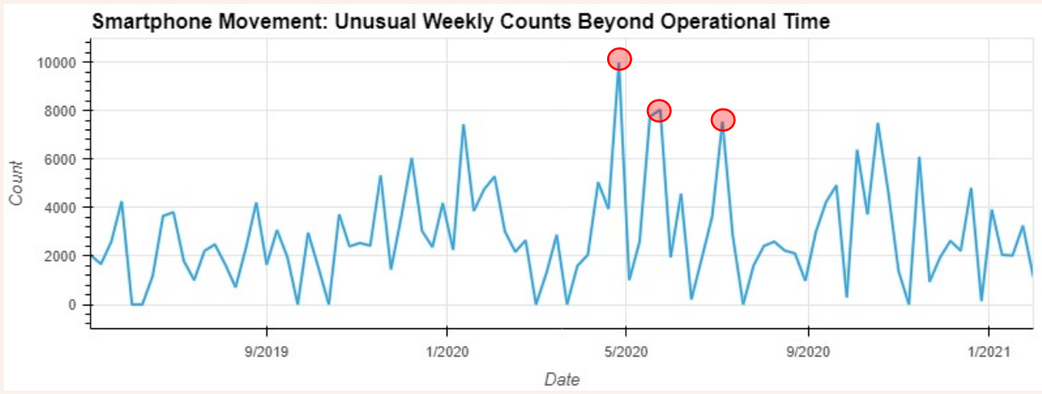
MODEL EVALUATION

Assess based on:

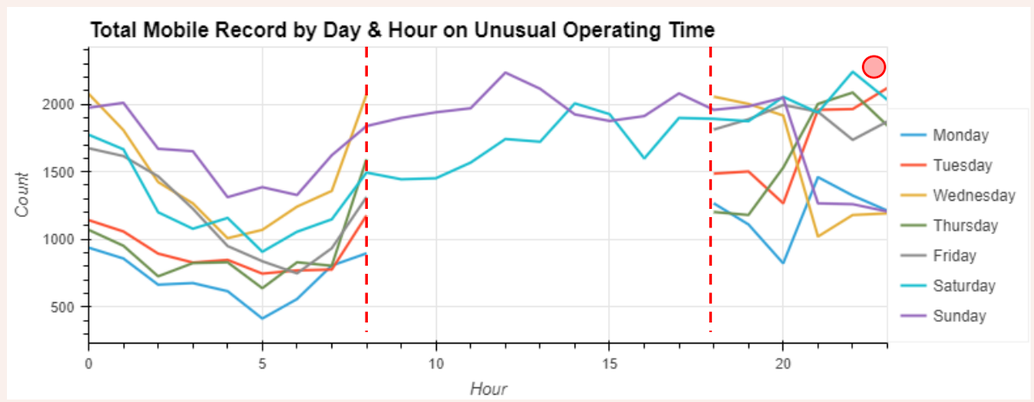
- Interpretability
- Ease of Deployment
- Model's Performance

RESULTS

EVOLUTION OF MOVEMENT INSIDE PRISON BEYOND NORMAL OPERATING TIME



- High movements between late April to July 2020.



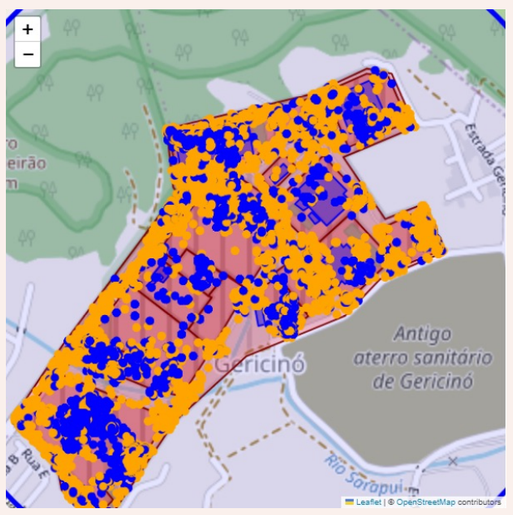
- Device usage increases at 8pm followed by a decline after midnight.
- Saturdays recording the highest count.

The findings of this study validate the presence of smuggled smartphones in Brazilian prisons.

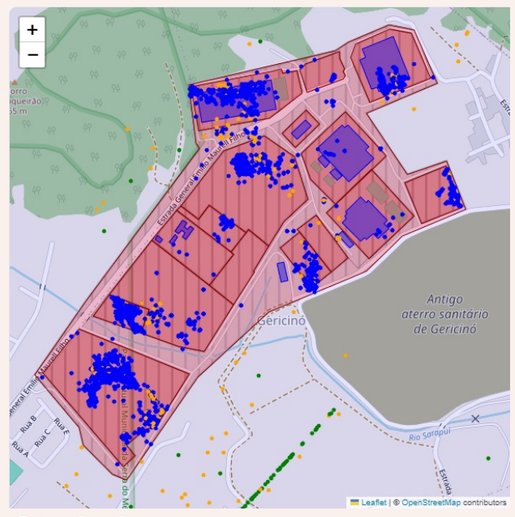
- Smartphone usage inside prisons occurs sporadically.
- Some areas exhibited a concentration of unusual mobile phone activity, indicating unauthorized communication by inmates.
- Implementing stronger security measures and stricter enforcement policies is crucial to addressing potential security risks.

SPATIAL PATTERNS AND CHARACTERISTICS OF MOBILE DEVICE USAGE

LEGEND: *BLUE-INSIDE ONLY, YELLOW-BOTH, GREEN-OUTSIDE ONLY*



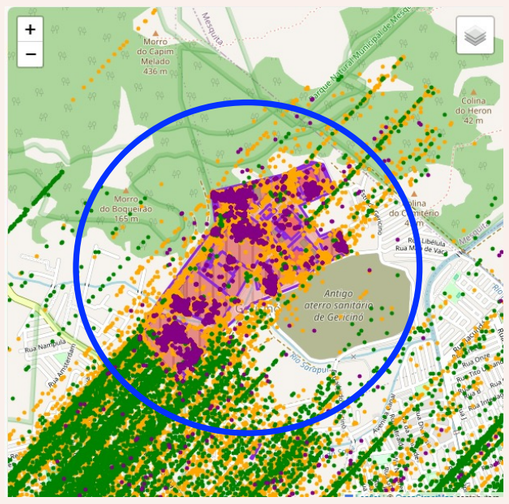
Rule-Based Method
Labeling daily movement to inside, outside, and both aids activity visualization.



Statistics (Frequency and Consistency)

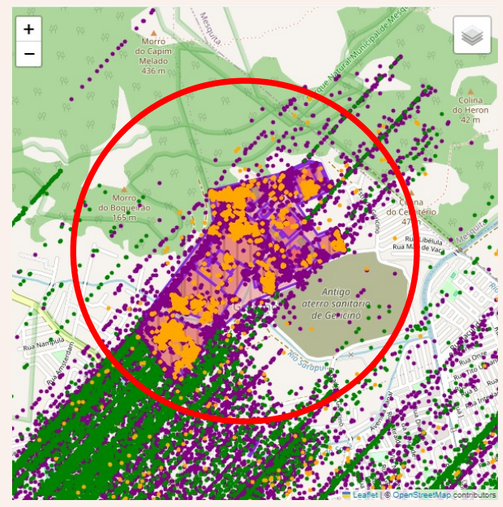
- Captured more features.
- Better association with anomalous patterns in blue.

NOTE*: COLORS ARE BASED ON CLUSTER ASSIGNMENT*



K-means Clustering

- 6 clusters *(elbow method)*
- Silhouette score of 0.40
- Three clusters inside prison. The Violet cluster is assumed anomaly.



Hierarchical Clustering (AHC)

- 4 clusters *(dendogram)*
- Silhouette score of 0.36
- Two clusters identified the prison boundary, with yellow cluster assumed an anomaly.

For presentation purposes, all visualizations pertain to Gericino Complex, Rio de Janeiro.