

# Visual Exploration of Urban Data

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# Big Data

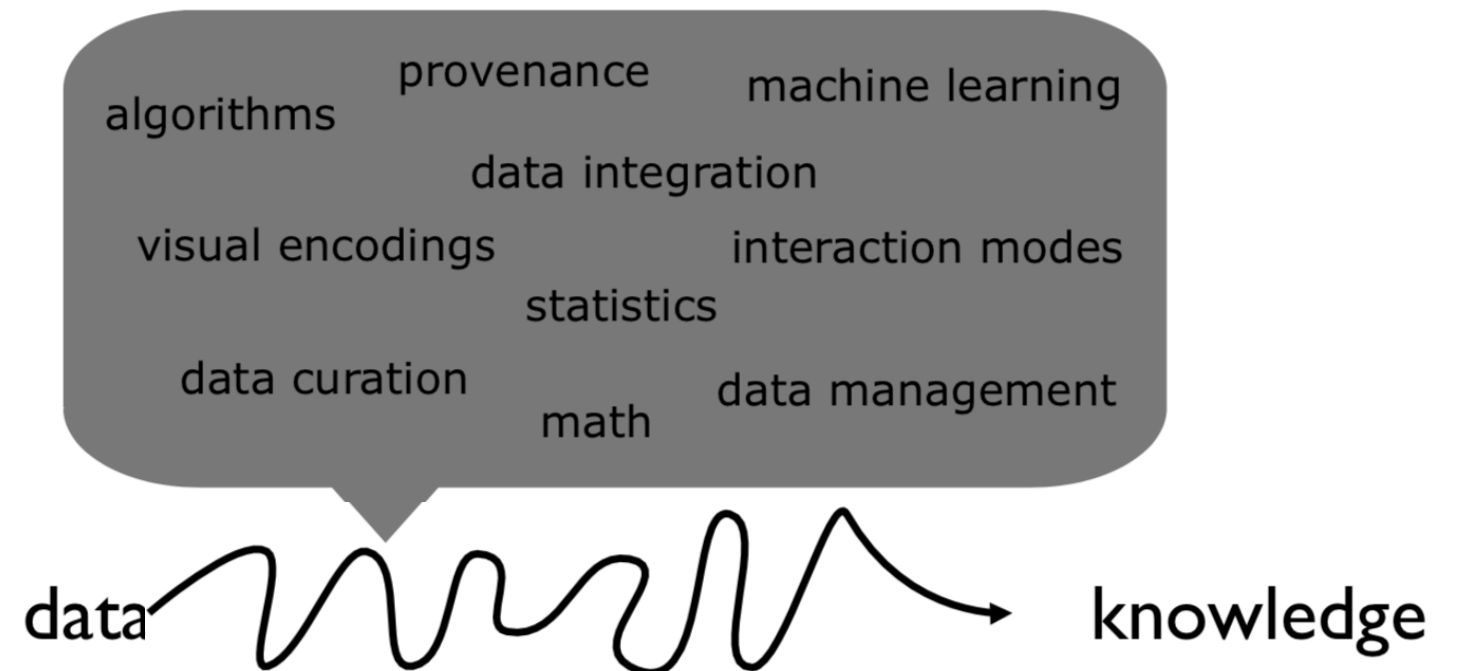
“Big data is an all-encompassing term for any collection of data sets so **large and complex** that it becomes **difficult** to process using **traditional** data processing applications.”

--- Wikipedia:Big\_Data

# Big Urban Data: What is hard?

- Scalability for batch computations is not the biggest problem
  - Lots of work on distributed systems, parallel databases, ...
  - Data were “in good hands”
- Scalability for people is!
  - Data owners are non-expert

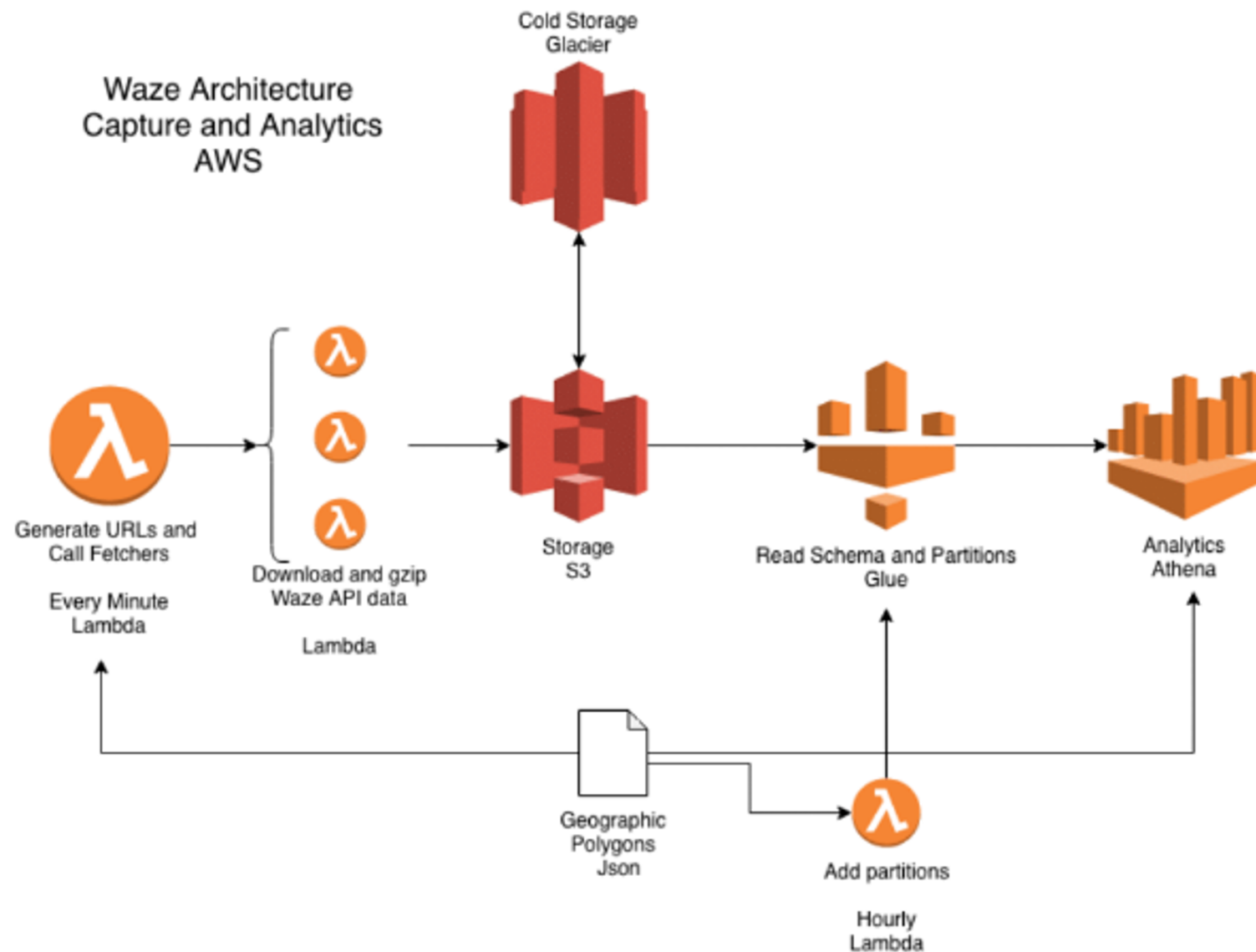
regardless of whether data are big or small



# Partial Products



# Waze Data ETL



Serverless model in which data is **captured**, **transformed** and **stored** minute by minute in a structure that allows for on-demand analysis at a fraction of the cost of local databases.

# Weekly Reports

Reports sent on Sundays since May last year.

The report provides an overview of cities highlighting 5 different occurrences:

- Traffic jams
- Accidents
- Holes
- Floods
- Defective traffic lights.

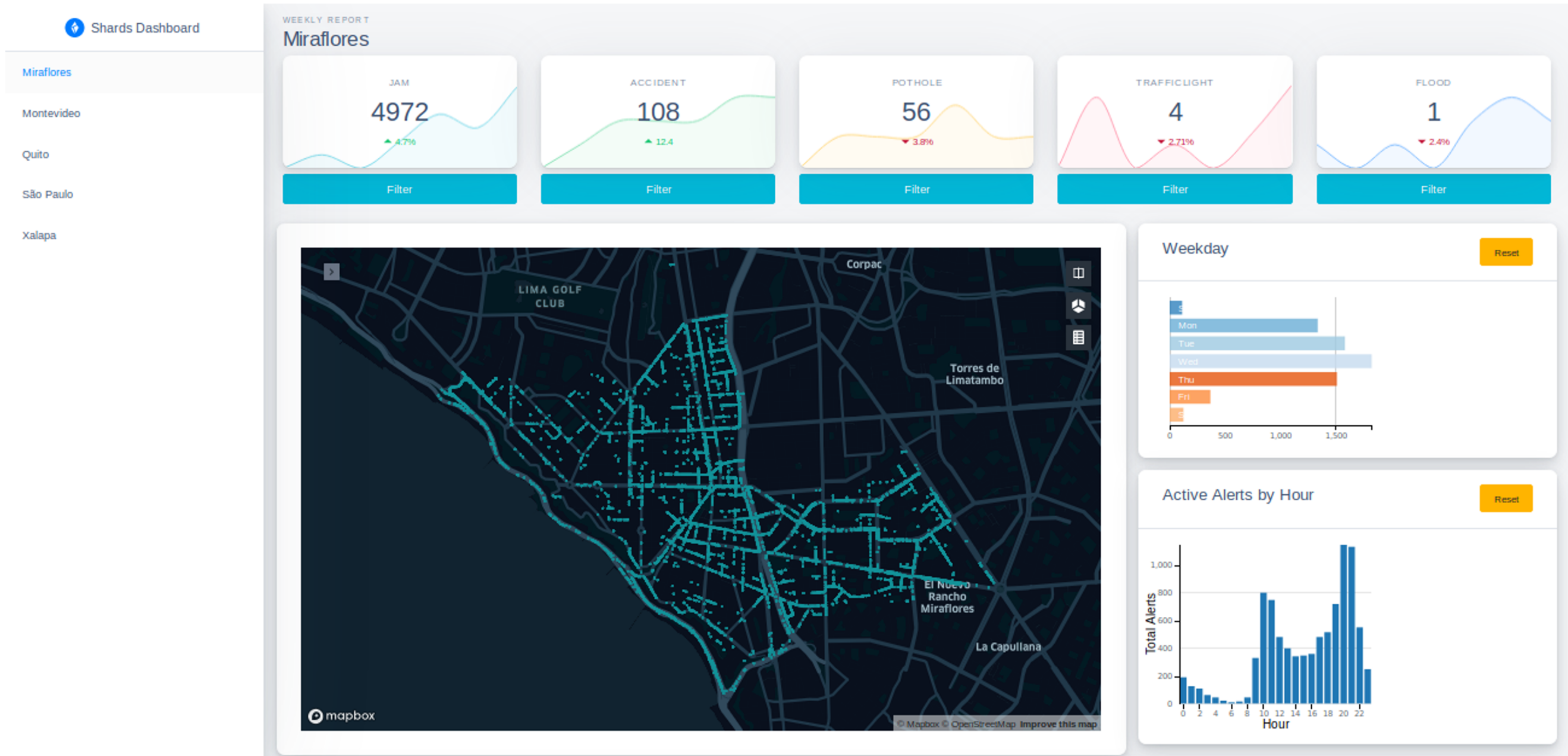
11

AGUJERO

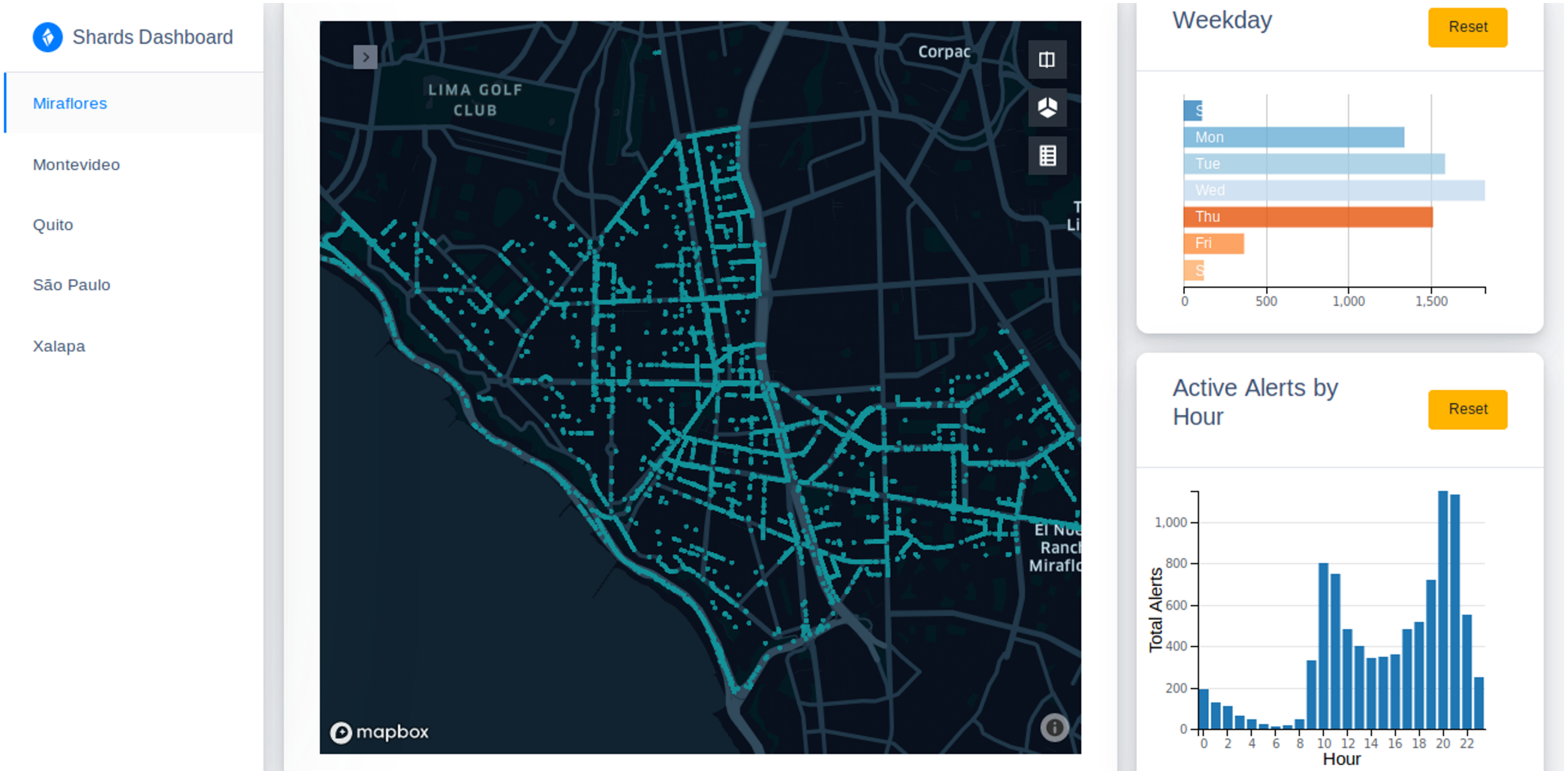


La imagen muestra el mapa de calor de todas las alertas del período y destaca los tramos de las calles que concentraron mayor cantidad de interacciones. [Haga clic aquí](#) para una versión interactiva del mapa.

# Weekly Reports 2.0 – Interactive Dashboard



# Weekly Reports 2.0 – Interactive Dashboard



# Hole Study

The study pointed out that most user interactions focus on few hole alerts

Concentrating the repair effort on certain locations would have a high impact on urban road users.

number of interactions	number of segments	percentage interactions	price share (%)	total cost (U\$)
35341	88	10.00	0.90	663,083.10
70920	277	20.00	2.30	1,775,394.00
106576	576	30.00	4.60	3,468,938.05
142098	1032	40.00	7.80	5,934,814.64
177623	1683	50.00	12.10	9,235,987.03
213181	2576	60.00	18.10	13,761,890.97
248708	3833	70.00	25.90	19,720,300.28
284252	5615	80.00	36.50	27,776,374.19
319791	8338	90.00	52.60	40,034,518.98
355331	16580	100.00	100.00	76,174,337.39

# Mobility Data



# Sensors Data



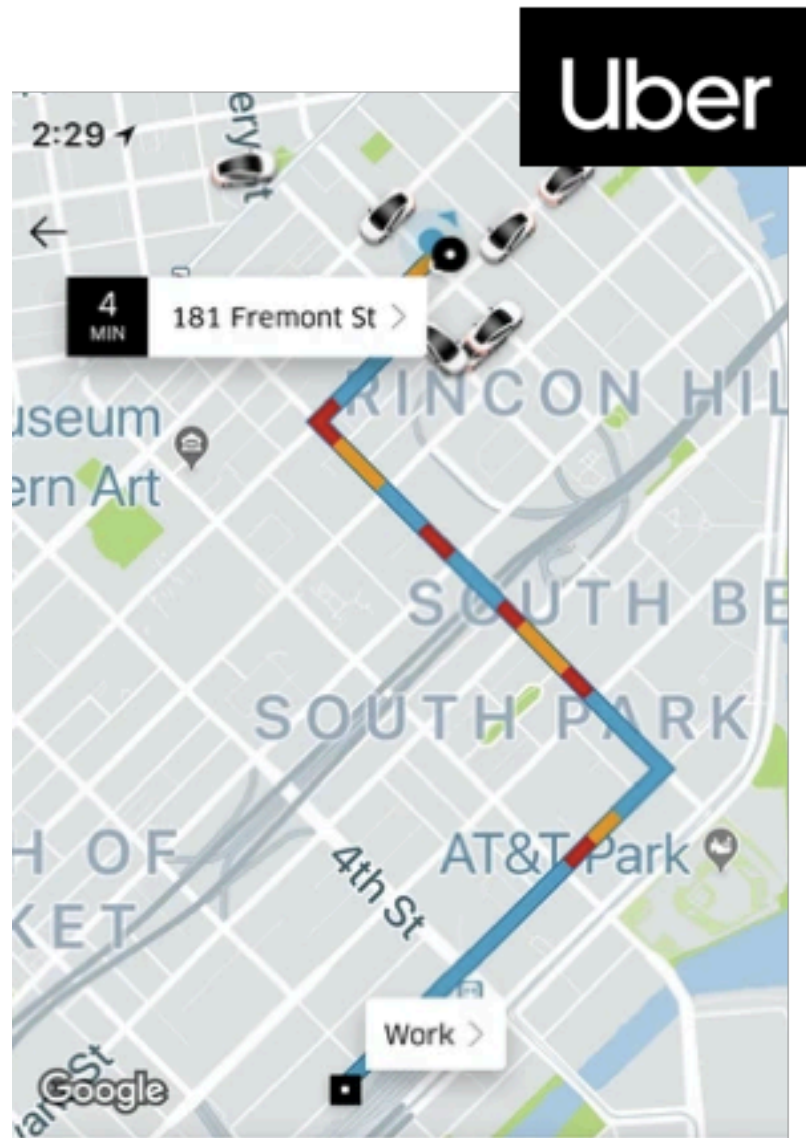
Universal



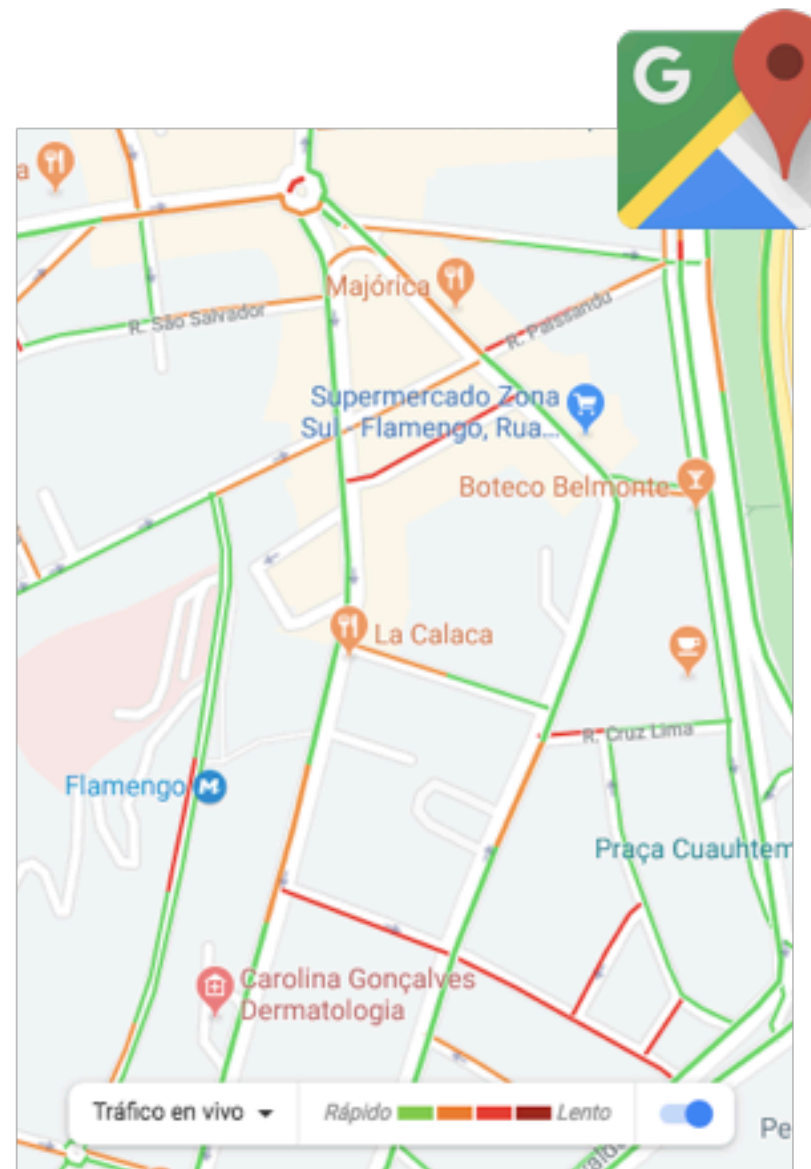
Dense



# Mobile Applications



Universal

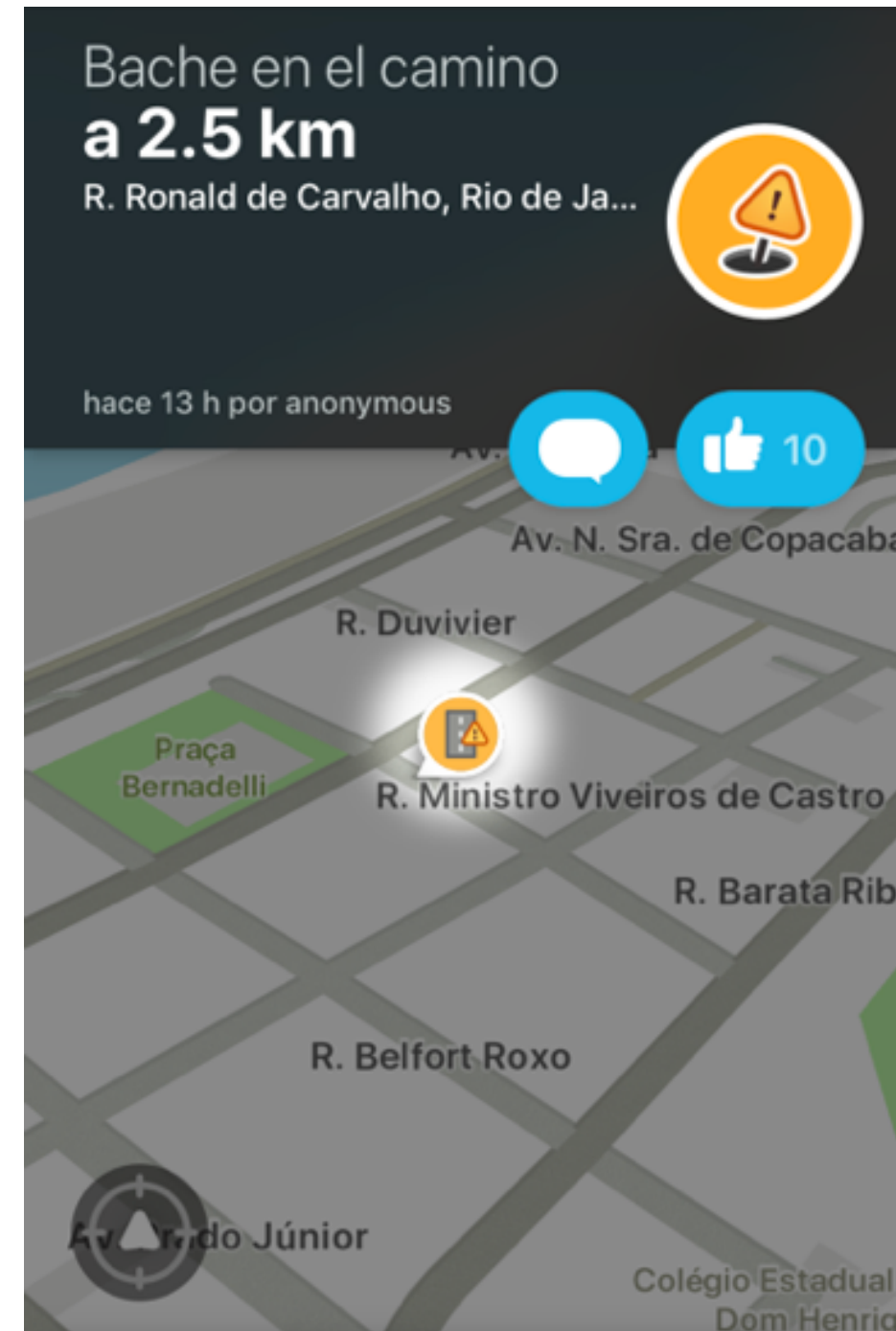


Dense



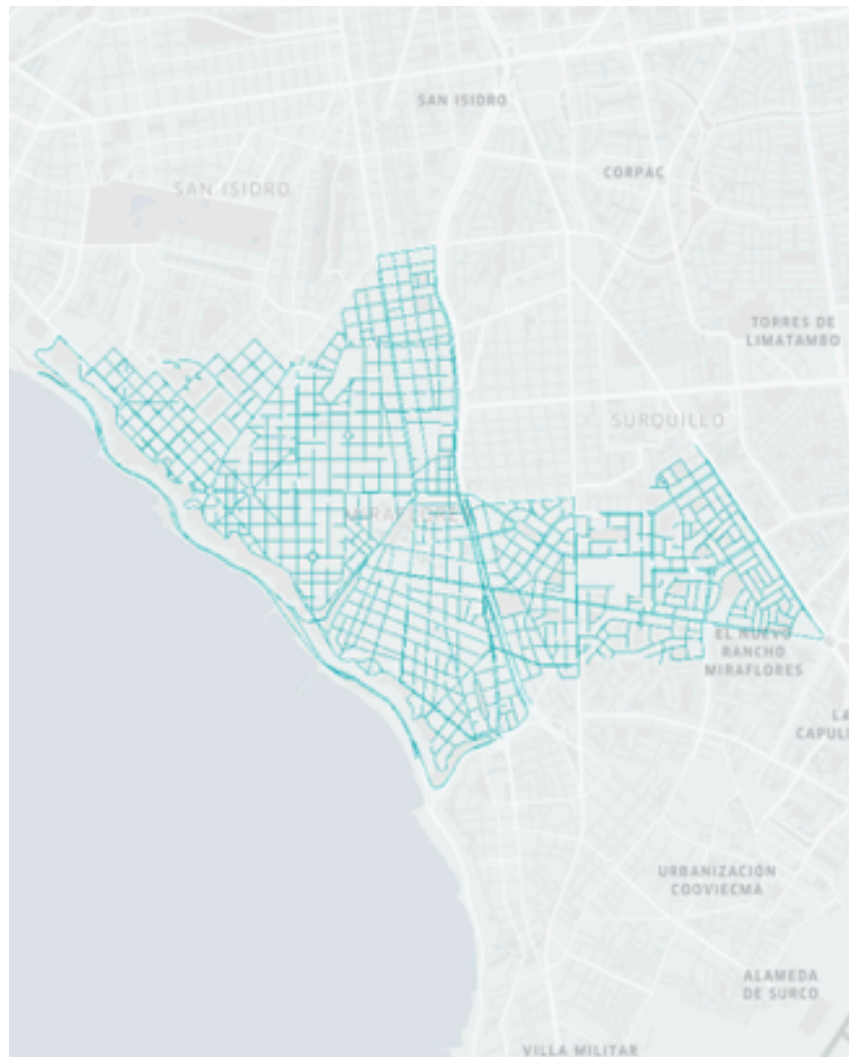


# Waze Data

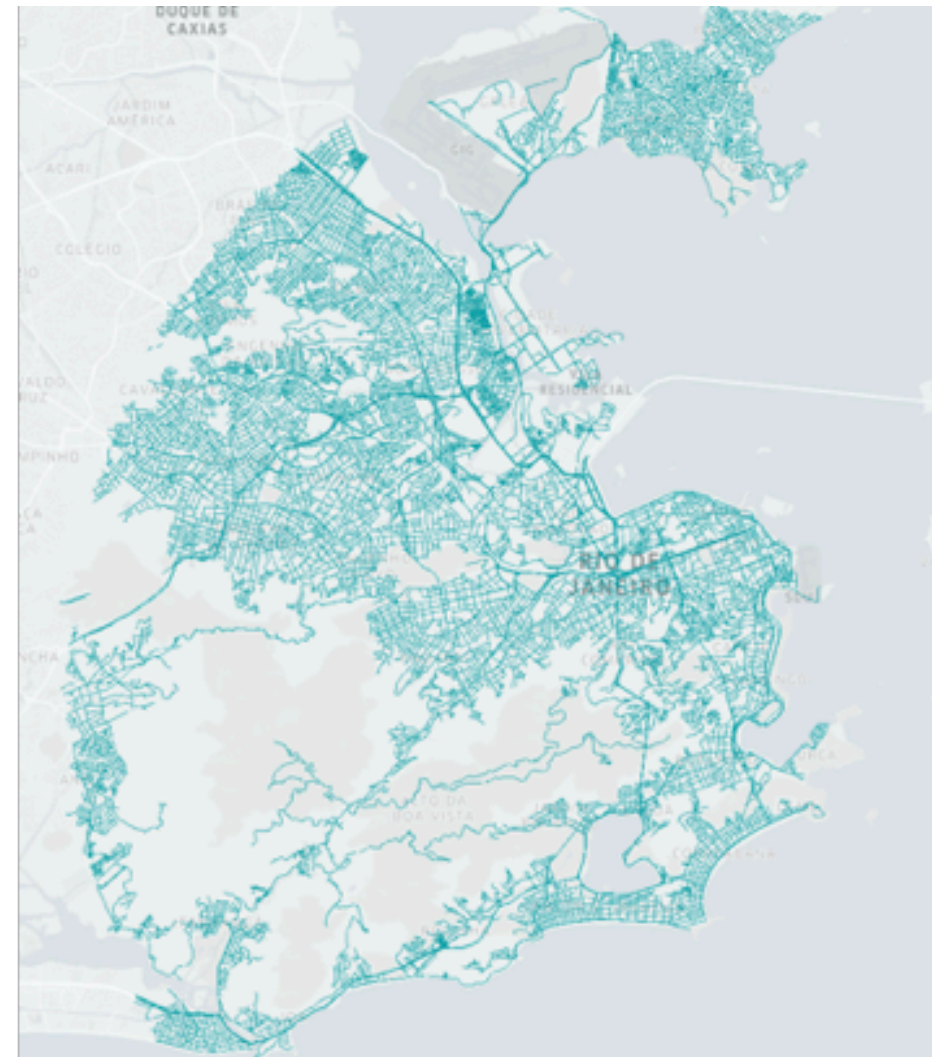


# OpenStreetMap

## Miraflores



## Rio de Janeiro





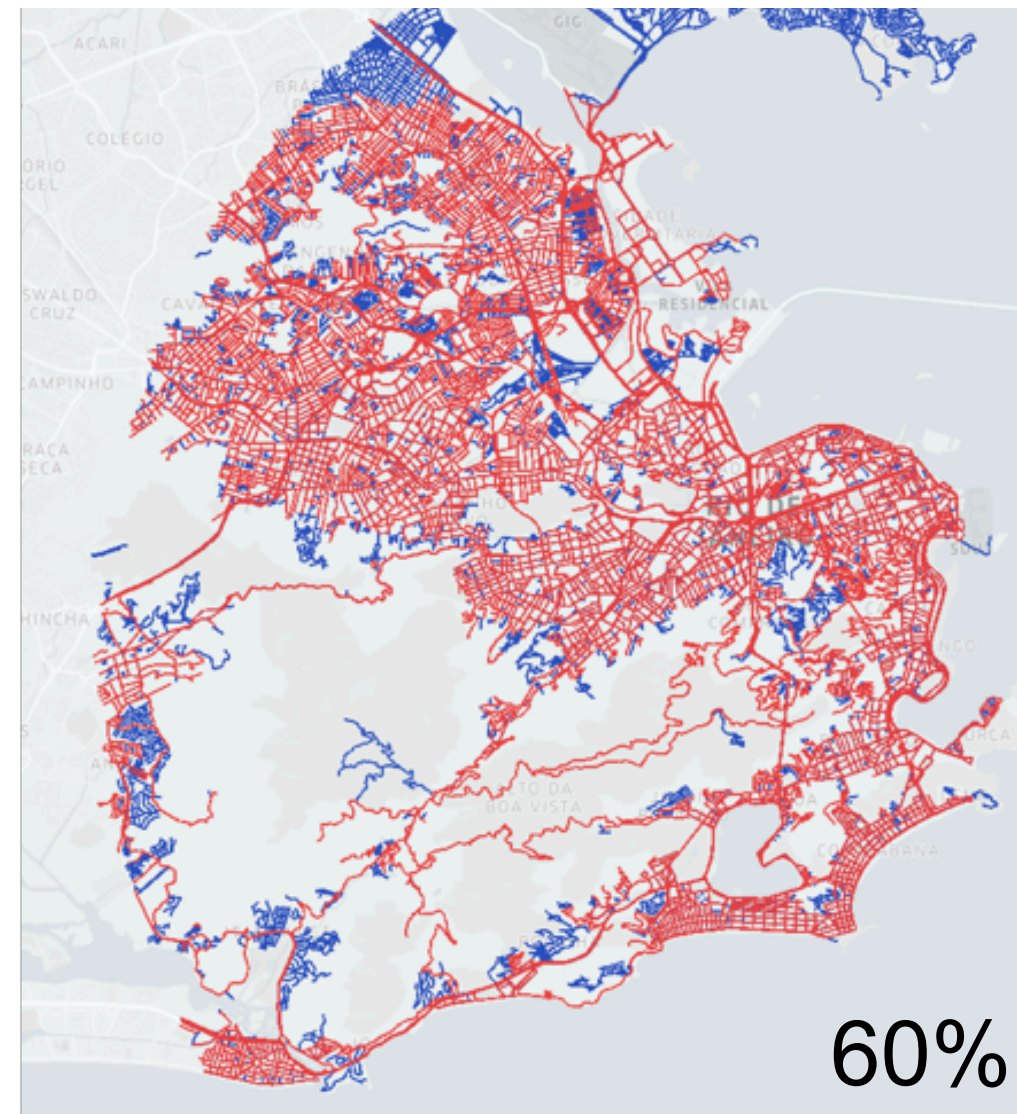
# Spatial Coverage

## Miraflores



■ Segment not Covered ■ Segment Covered

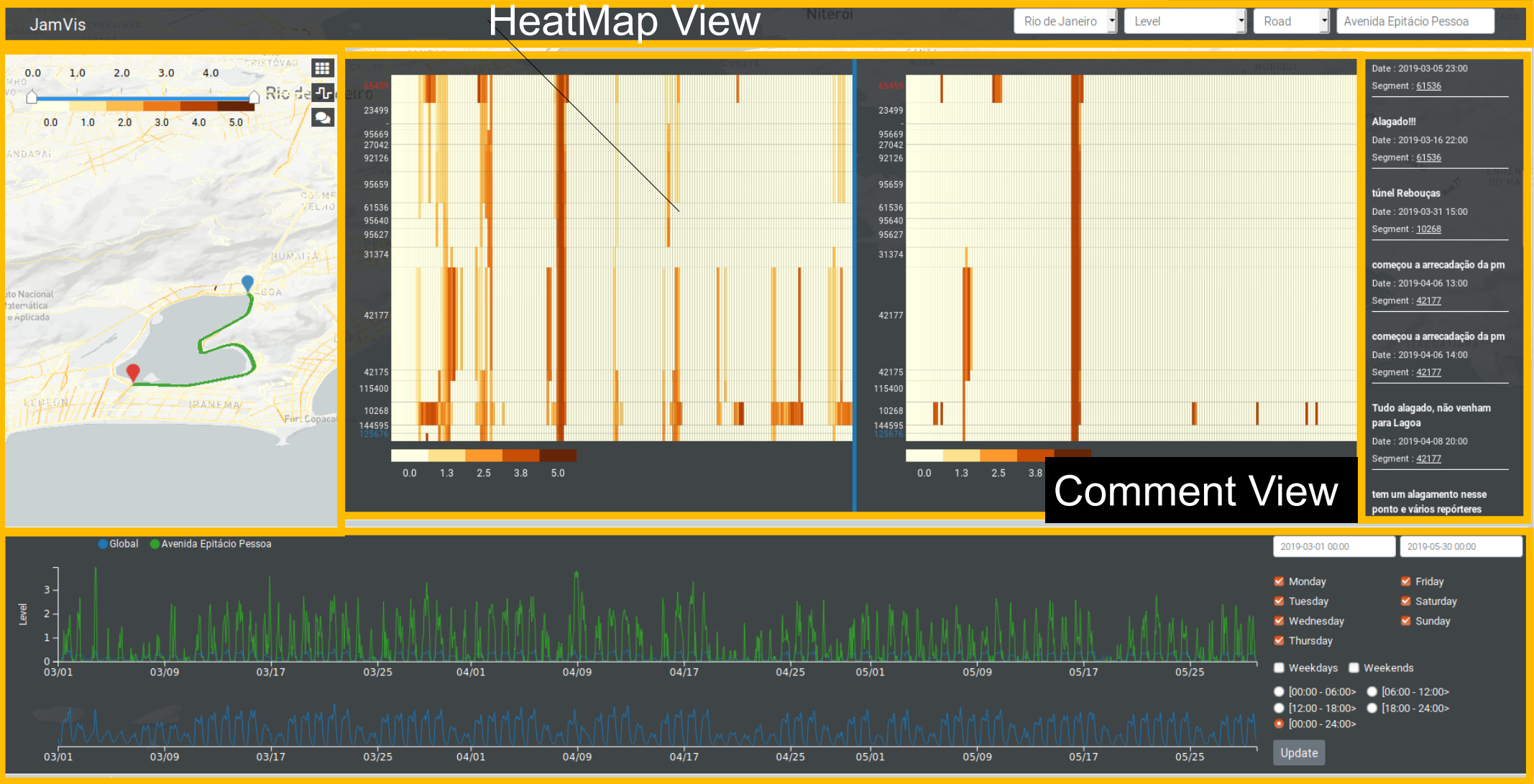
## Rio de Janeiro



JamVis

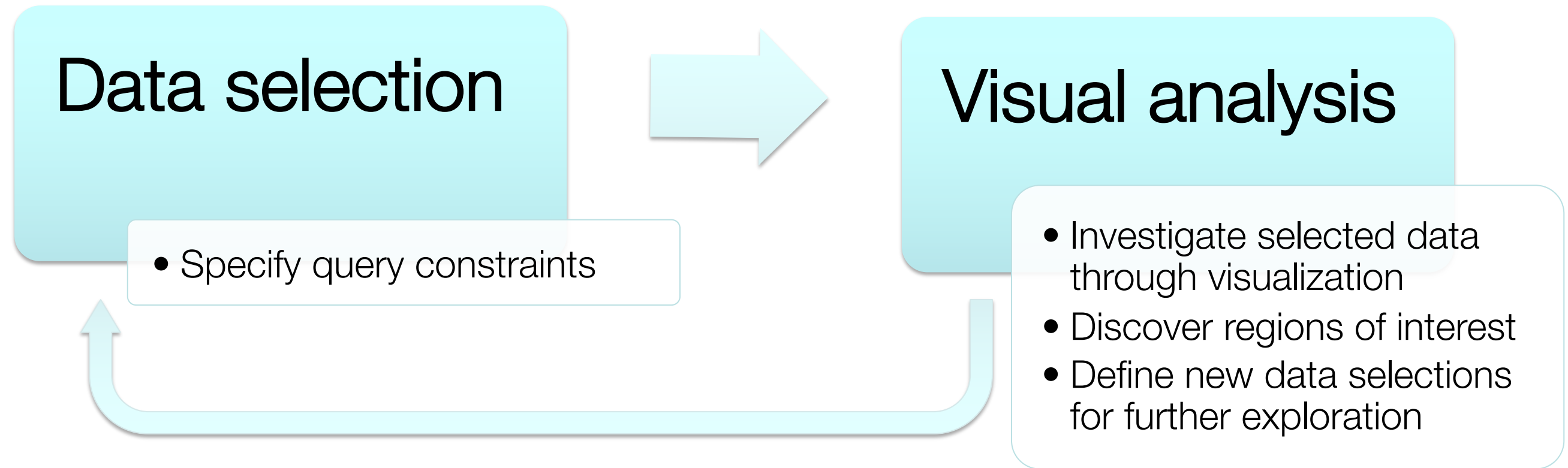
Control Panel

Map View



Temporal View

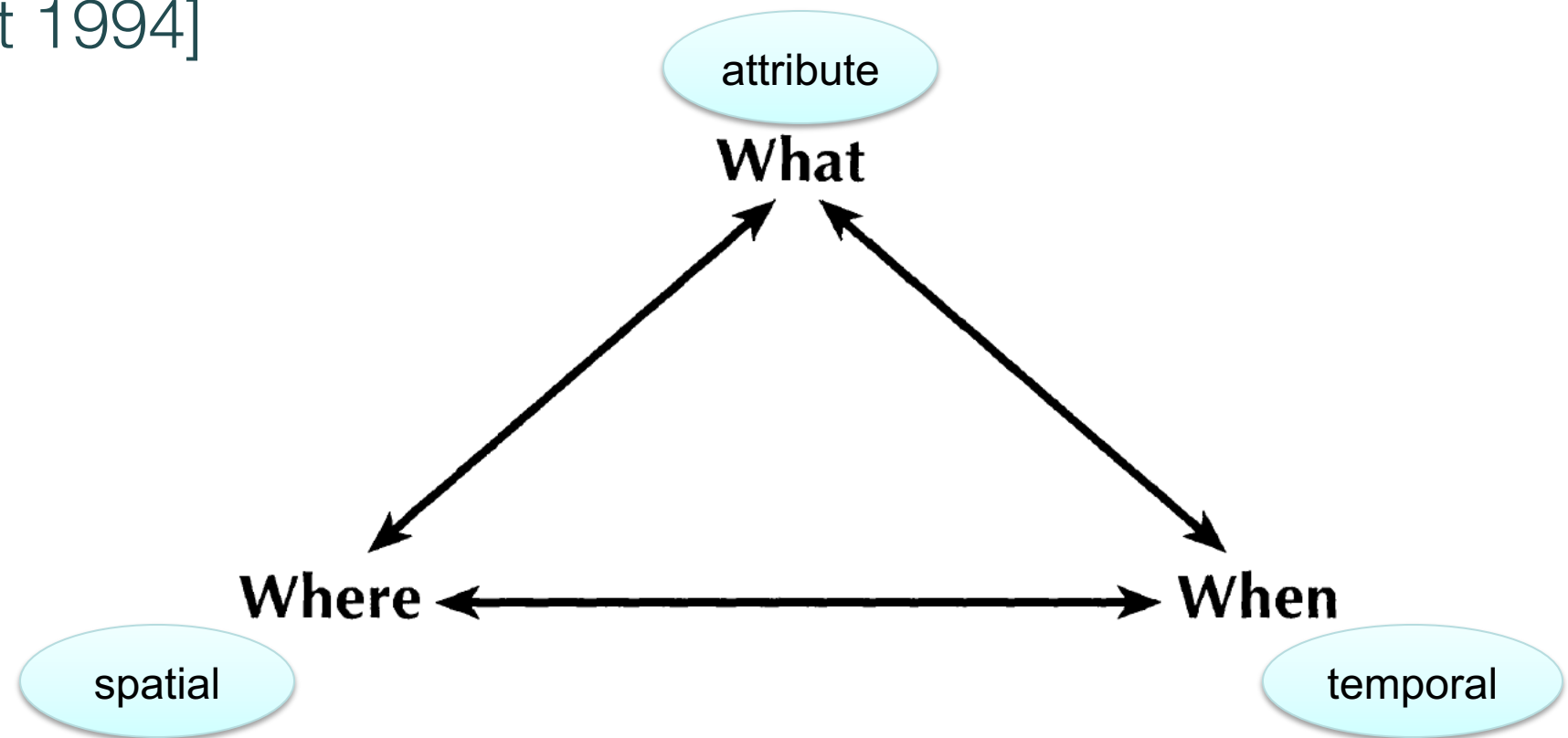
# Data Exploration: A Two-Phase Process



We unify the two phases of the process through visual operations

# Visual Query Model

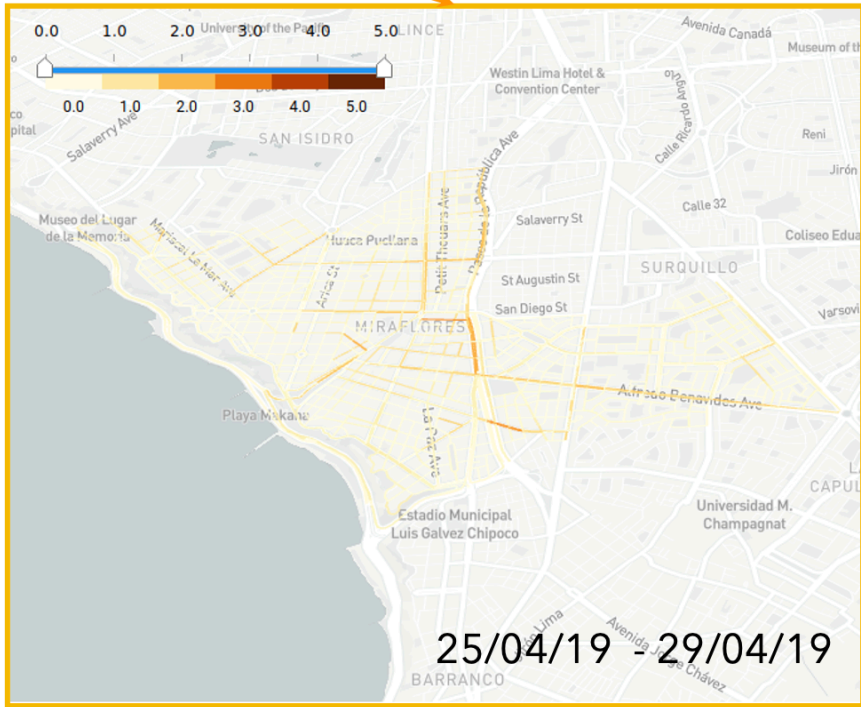
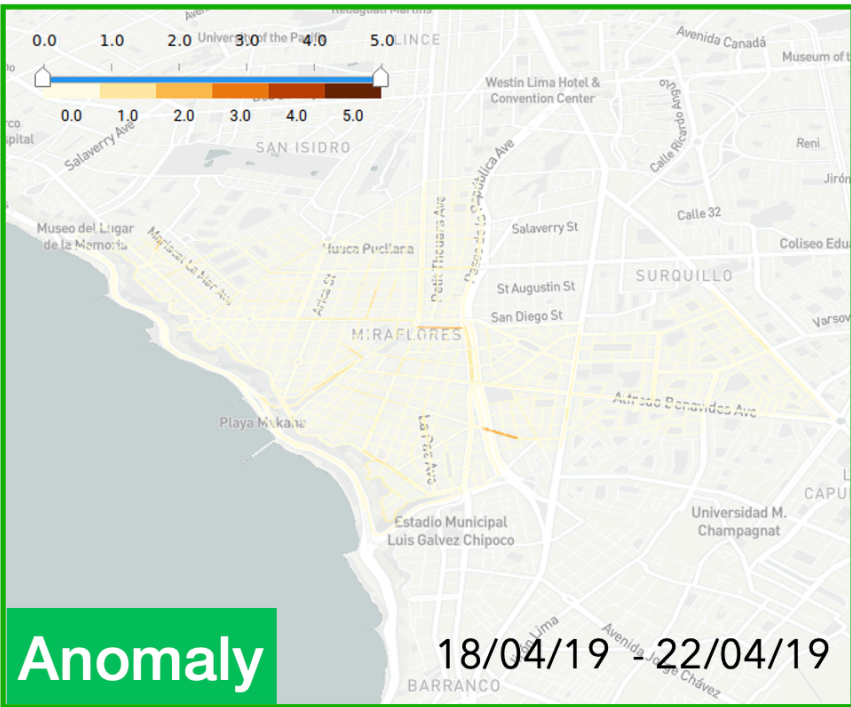
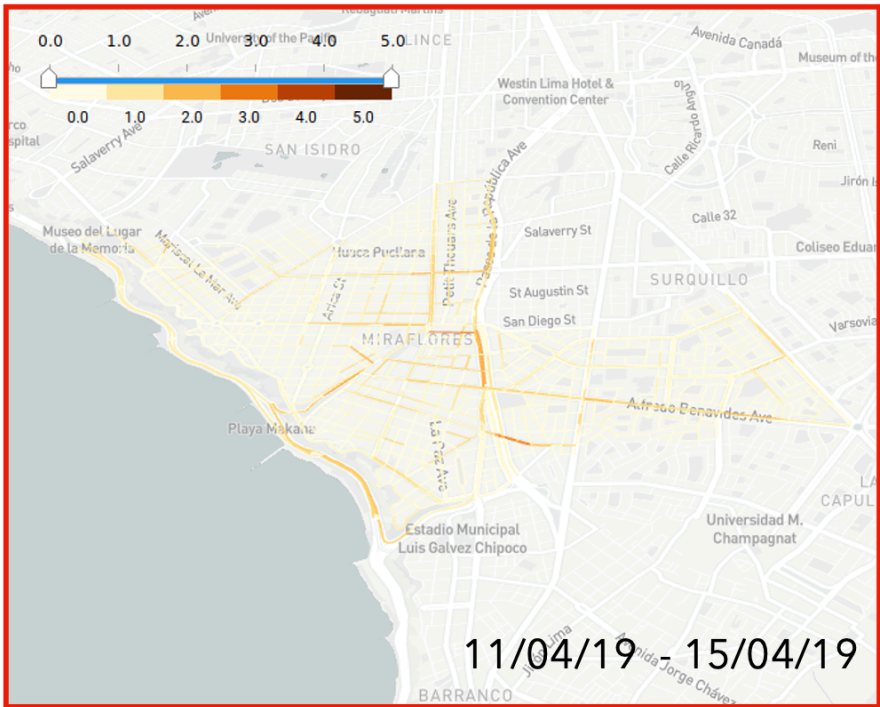
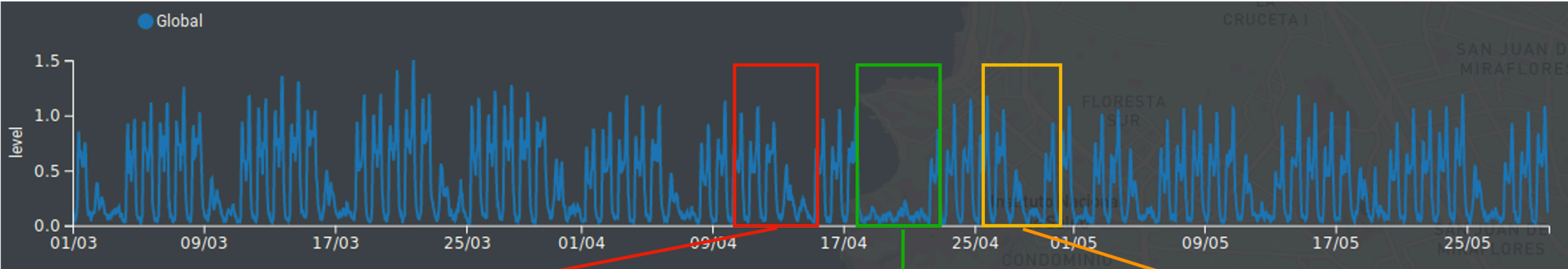
- Data selection by visual operations
- Each data slice can be assigned a different visual representation
  - Spatial context is maintained in the map view
- Query Expressiveness [Peuquet 1994]
  - when + where  $\rightarrow$  what
  - when + what  $\rightarrow$  where
  - where + what  $\rightarrow$  when



# Case Study 1



# Miraflores



Holy Week

# Case Study 2



# Bloco



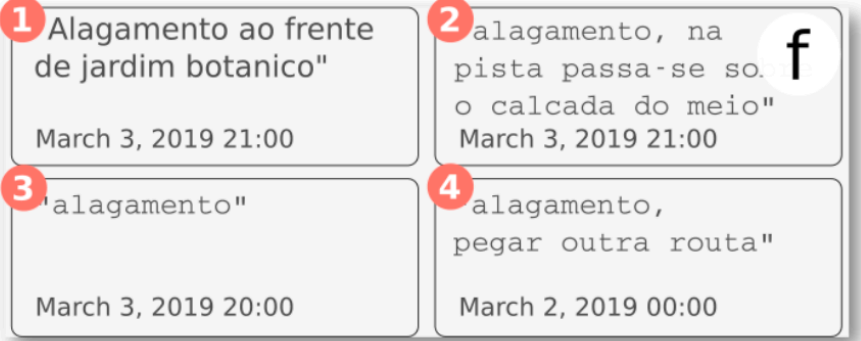
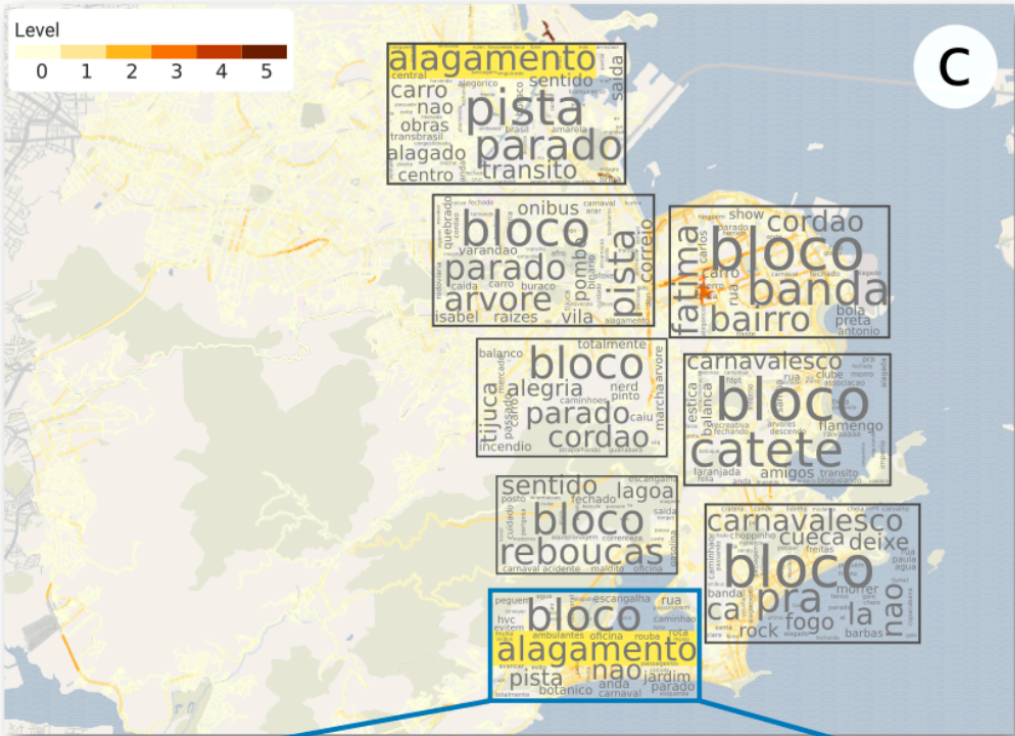
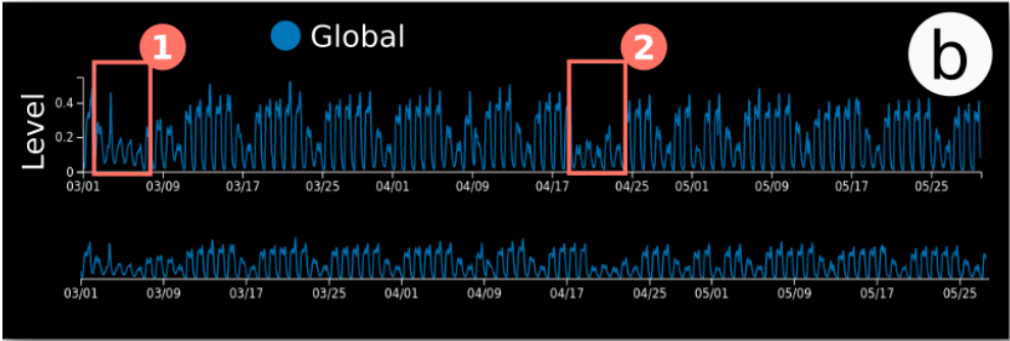
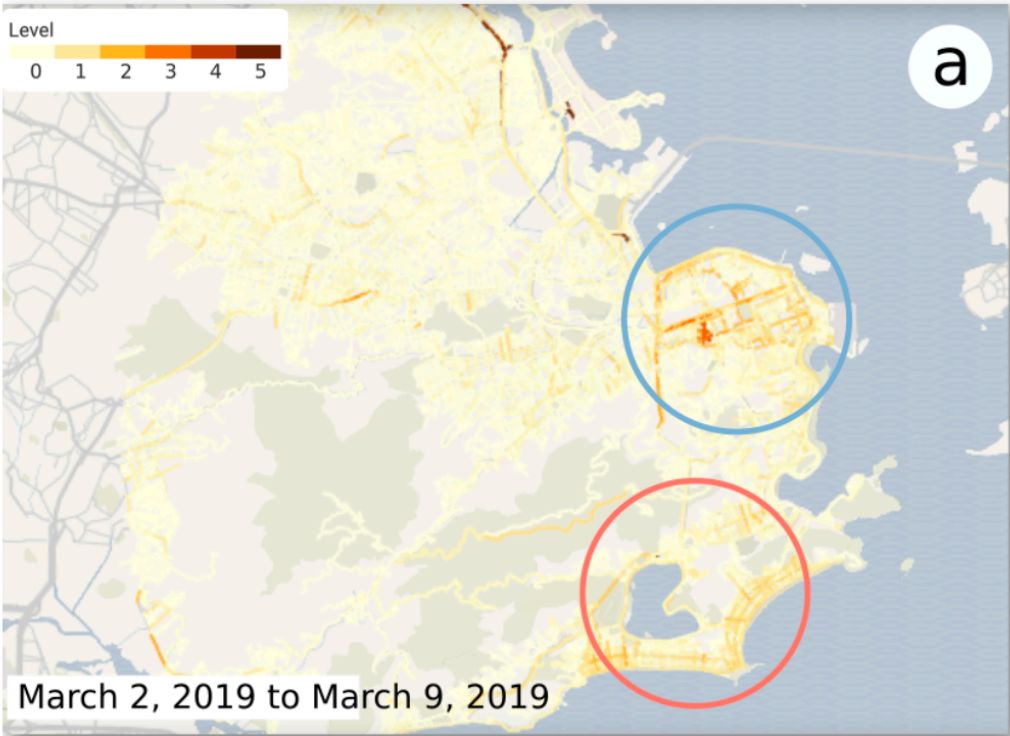
Source: <https://veja.abril.com.br/entretenimento/confira-o-roteiro-de-blocos-desta-segunda-feira-no-rio/>



# Bloco

Overview

Details



# Case Study 3

# Monday, April 8, 2019

RIO DE JANEIRO

## Chuva forte causa deslizamentos, morte e deixa o Rio em estágio de crise

Bombeiros buscam por 3 crianças que teriam sido soterradas. Prefeitura recomenda que população fique em lugar seguro após acionar 39 sirenes. Escolas suspenderam aulas na terça.

Por G1 Rio, TV Globo e GloboNews

08/04/2019 14h53 · Atualizado há 4 meses



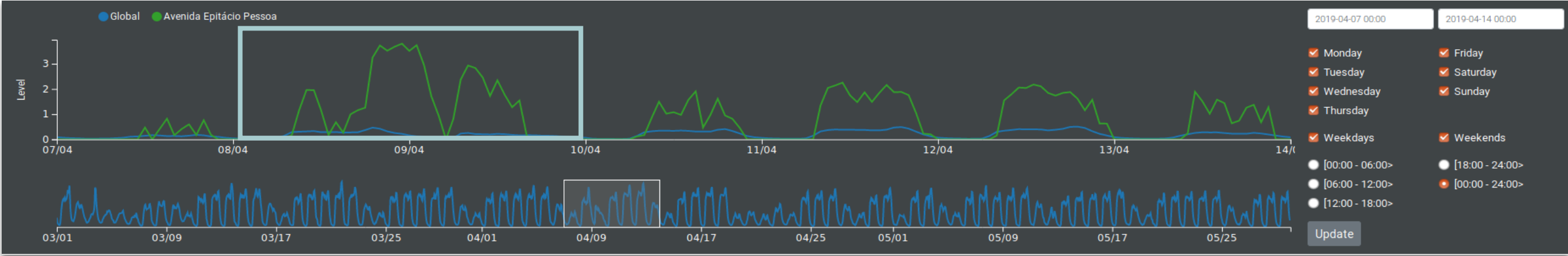
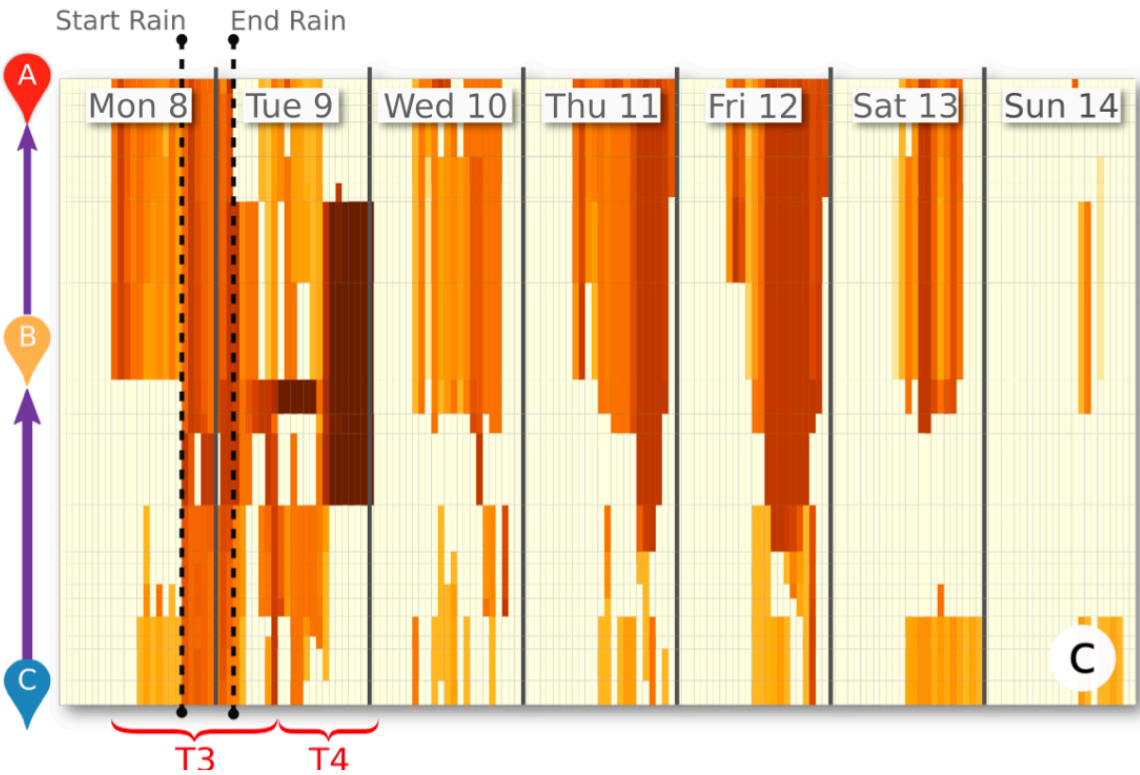
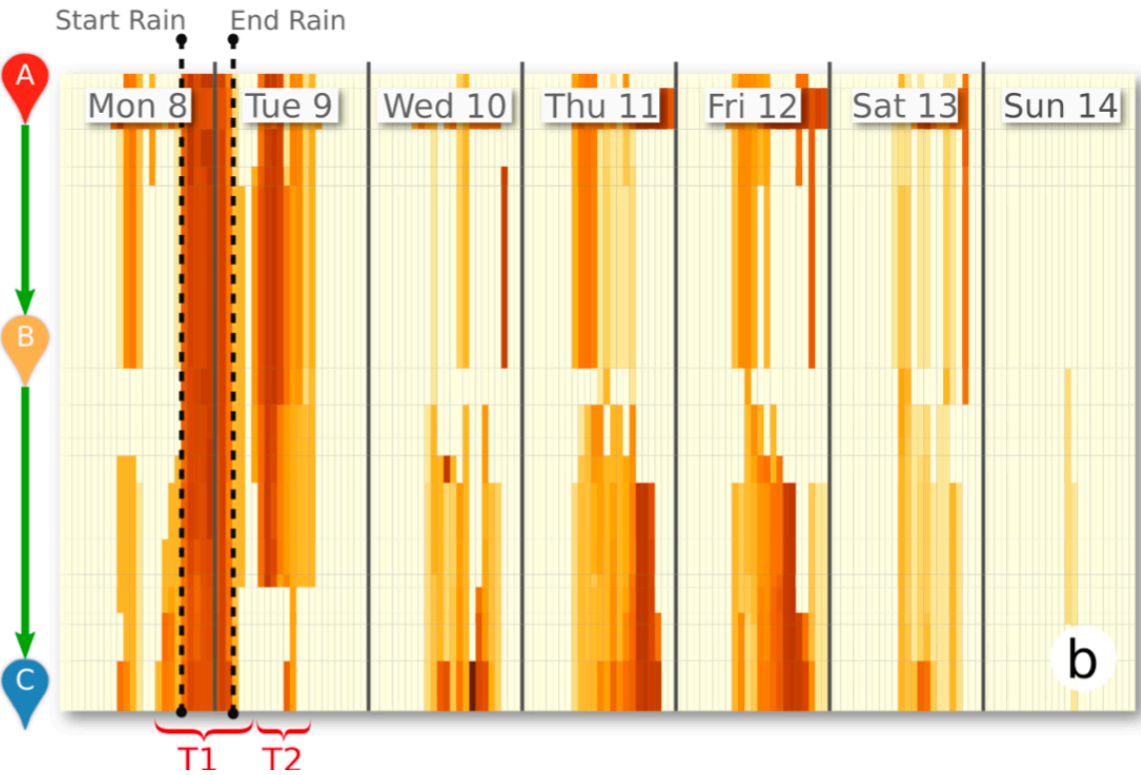
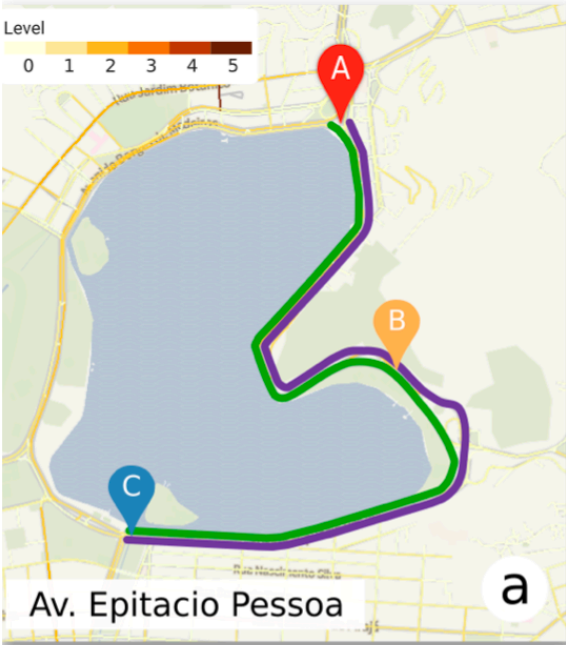


# Monday, April 8, 2019



Av. Epitacio Pessoa

# Av. Epitacio Pessoa





# Av. Epitacio Pessoa



jams

Irregularities

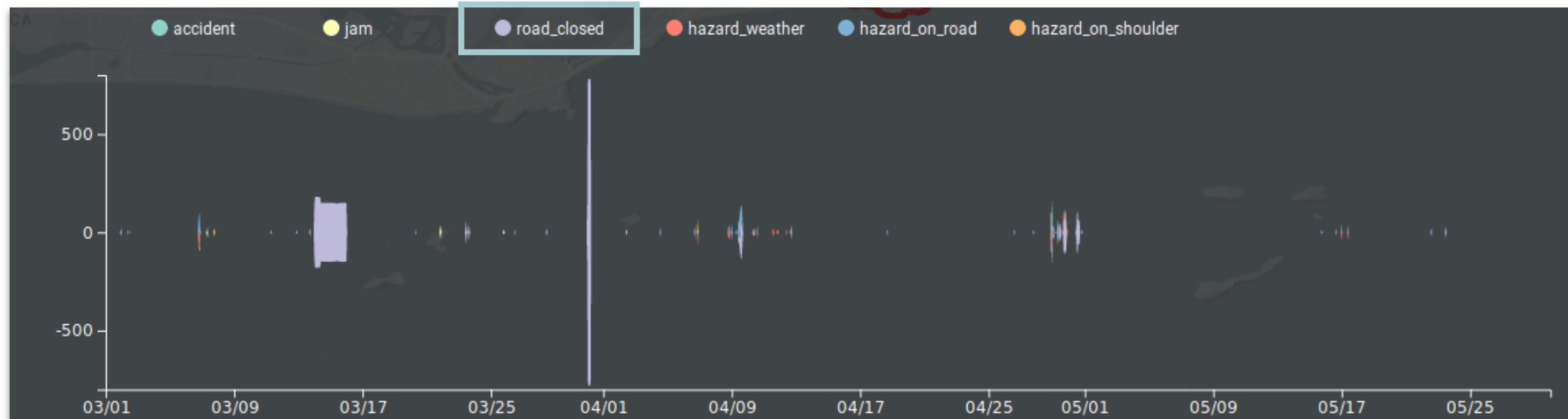
# Case Study 4

# Tree Falls



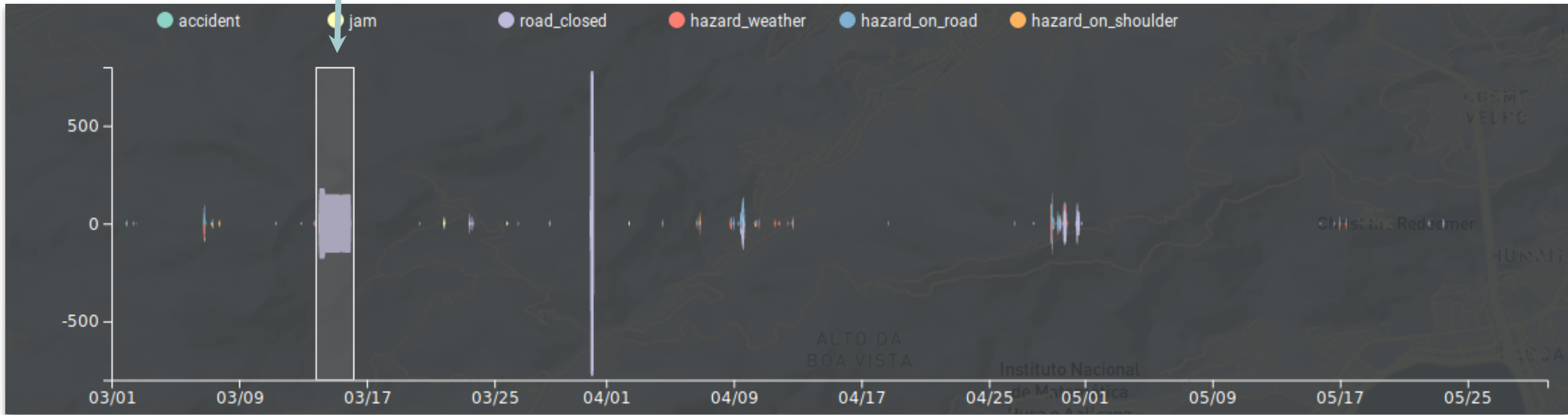
# Tree Falls

Search

# Tree Falls

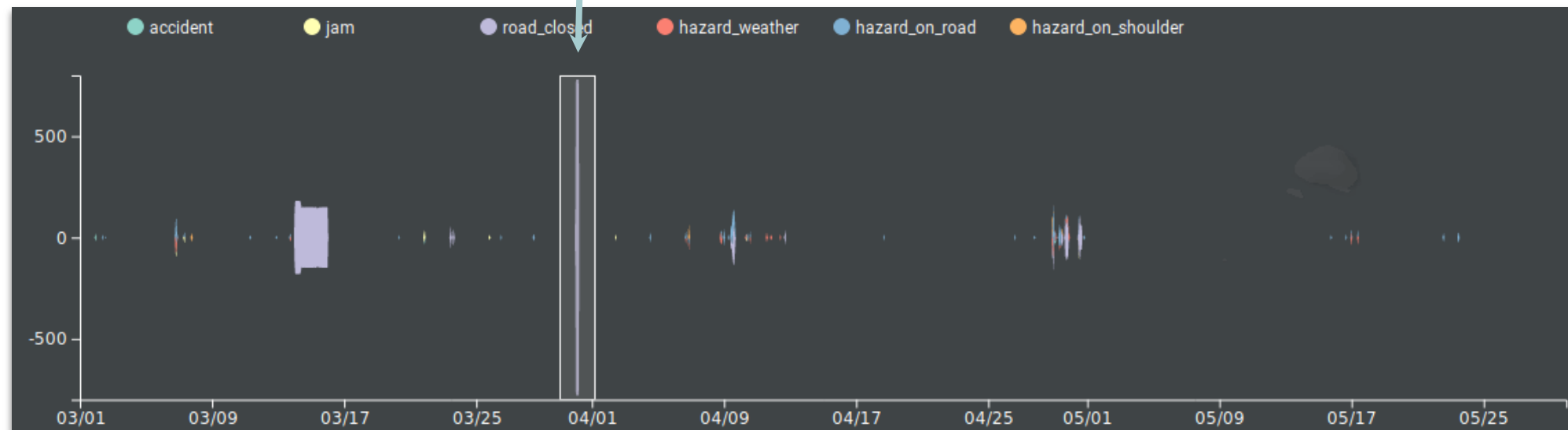
14/03 00:00 - 16/03 00:00





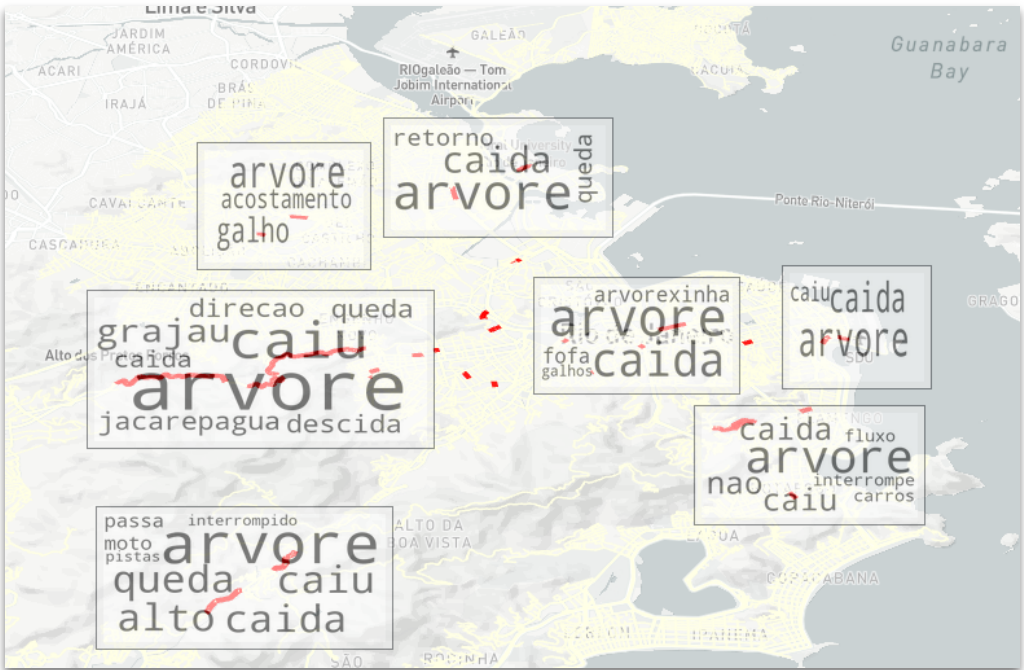
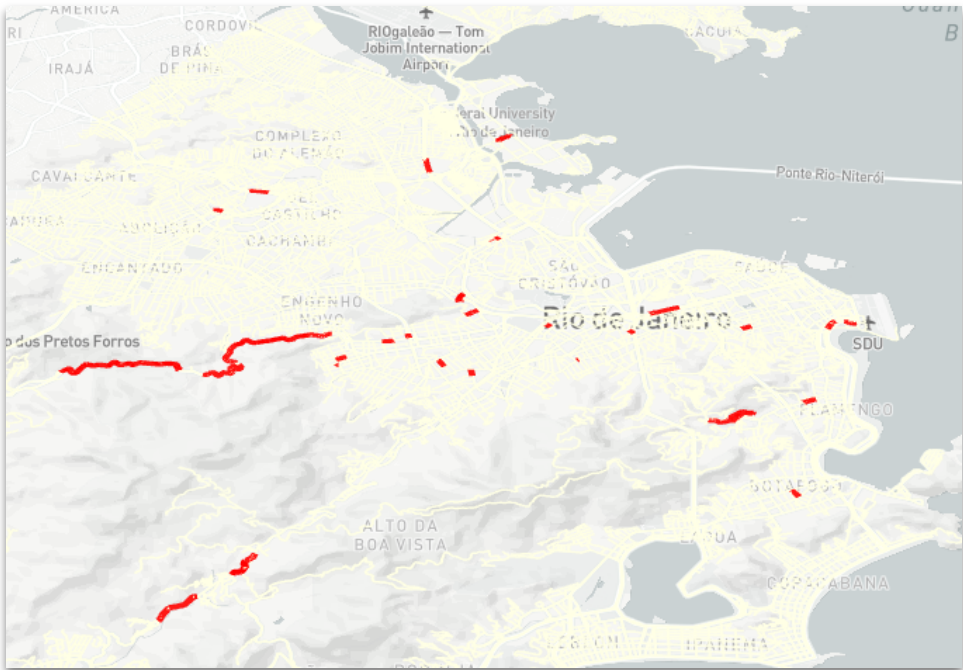
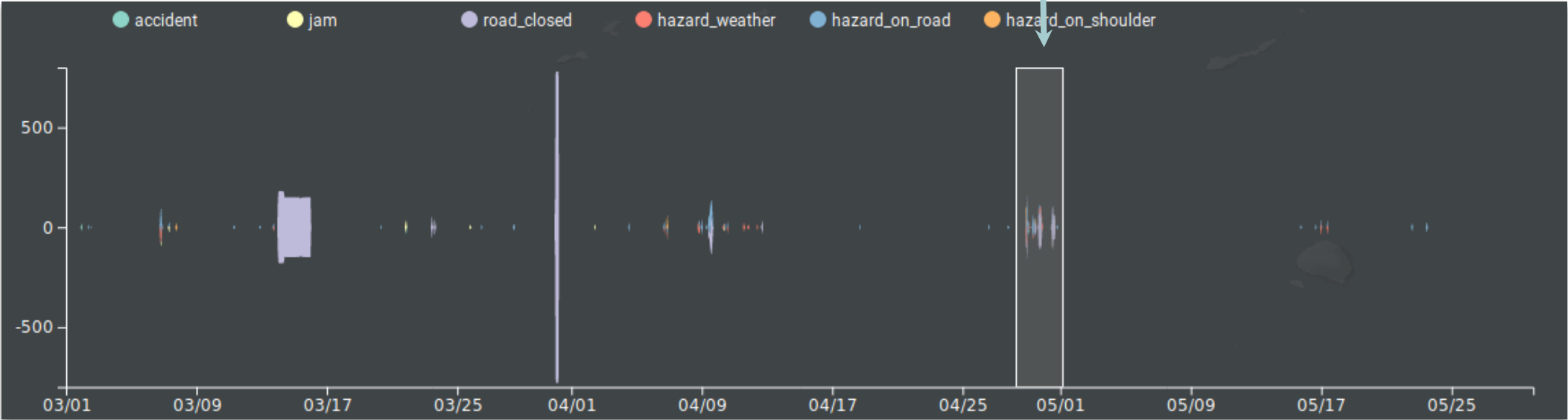
# Tree Falls

31/04 00:00 - 31/04 05:00



# Tree Falls

28/04 00:00 - 30/04 00:00



# Tree Falls on 28/04/2019

RJ em estado de alerta: Entenda como fica o seguro auto em casos de ventania e queda de árvores

30/04/2019 / FONTE: CQCS | Sueli Santos

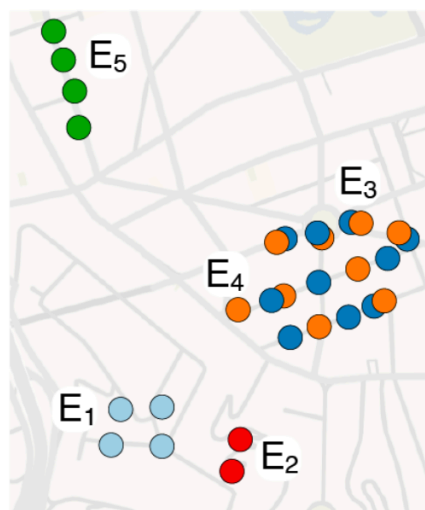


Neste domingo (28/04) o Rio de Janeiro e outras cidades do sudeste sofreram com a ventania e chuvas fortes por conta do fenômeno muitos carros sofreram pois a prefeitura confirmou até às 09h30 de ontem (29/04) a queda de 113 árvores e galhos. Em entrevista ao CQCS Dorival Alves, vice-presidente de marketing da Fenacor alerta sobre o seguro auto nesses casos.

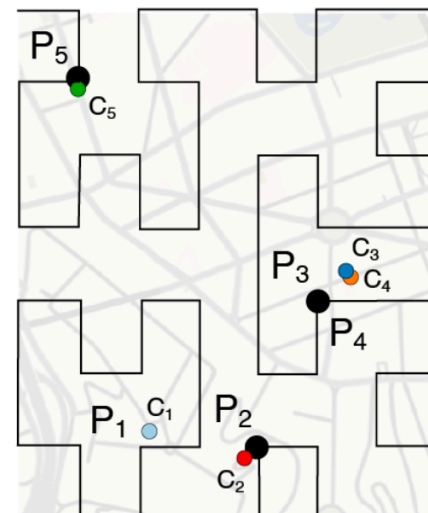


# Case Study 5

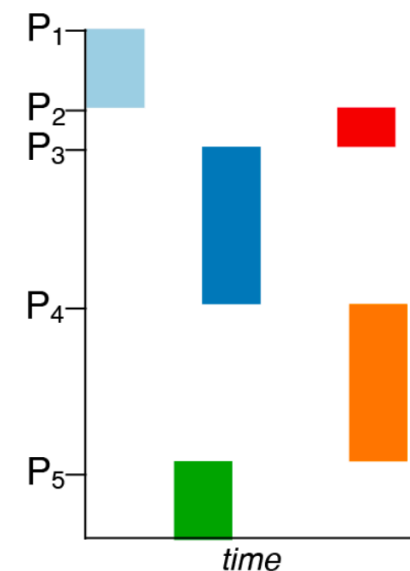
# Exploring Events



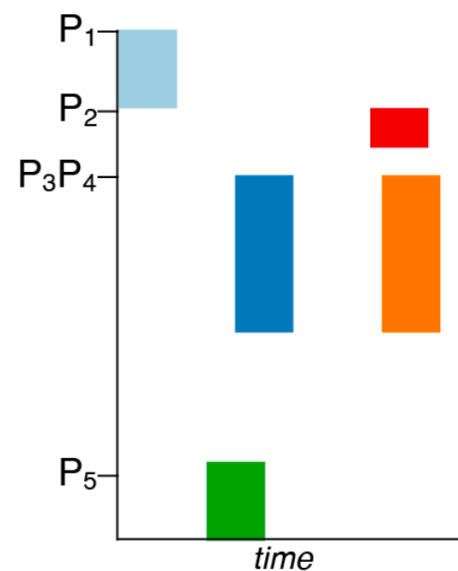
(a) Spatial Distribution



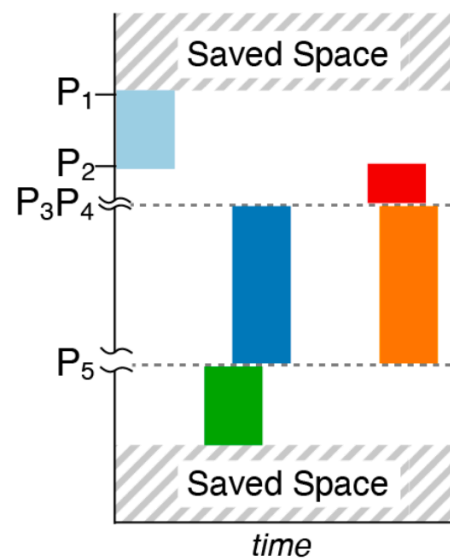
(b) Hilbert Curve



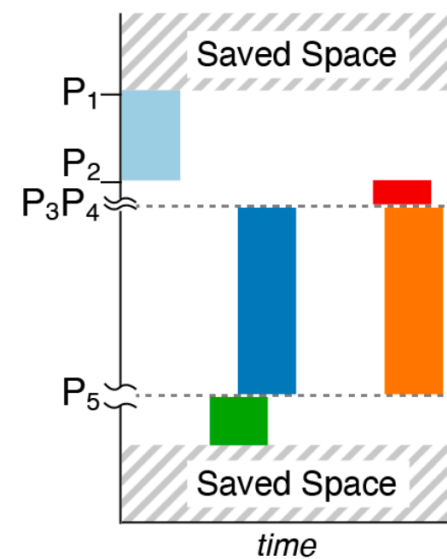
(c) Hilbert Position



(d) Hilbert with Overlapping

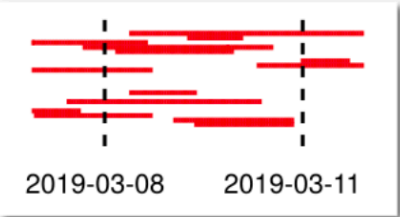


(e) Removing Gaps

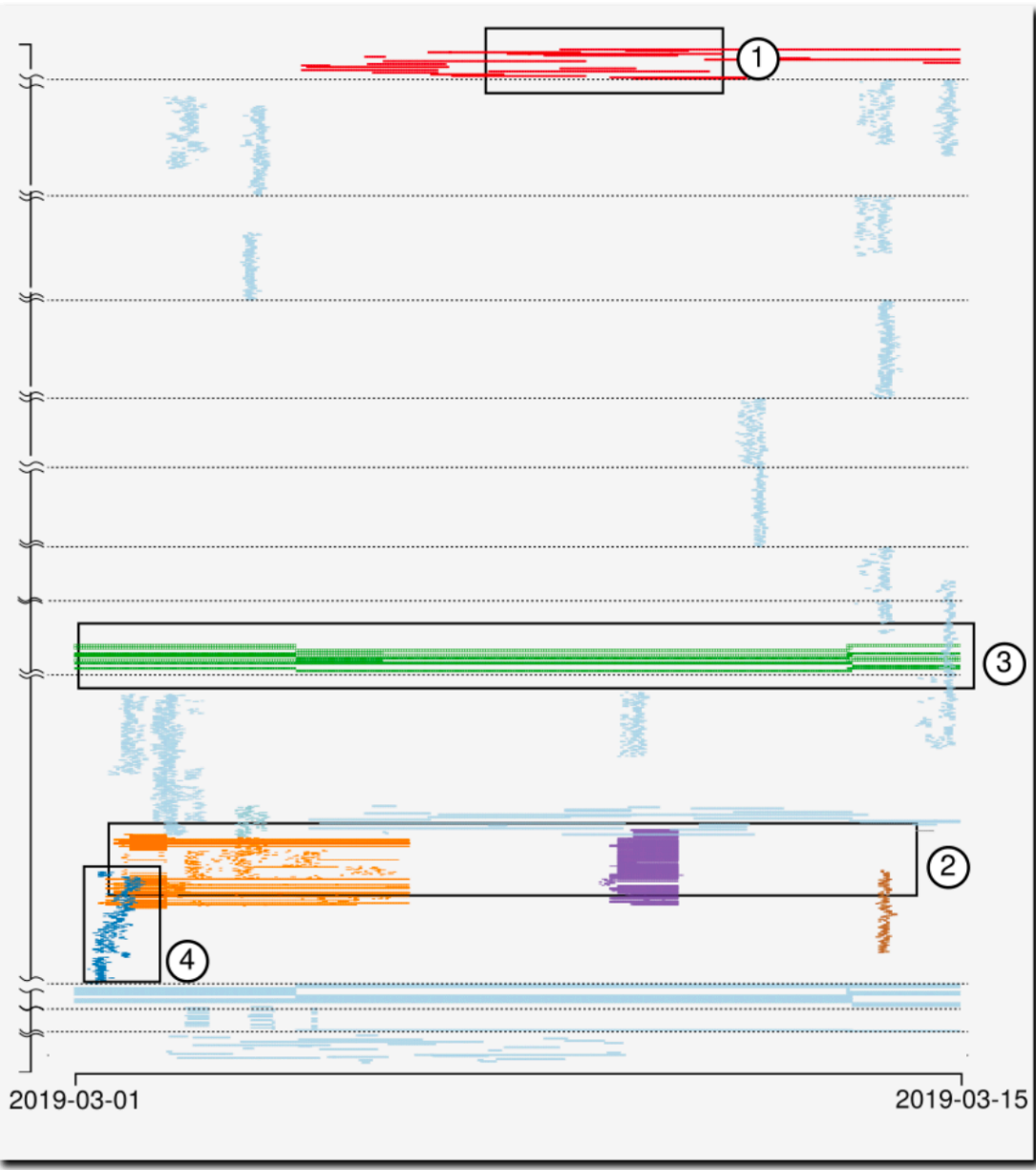
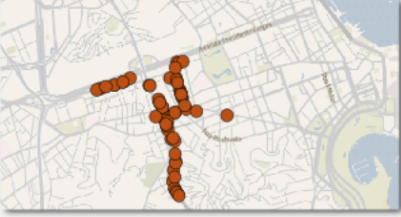
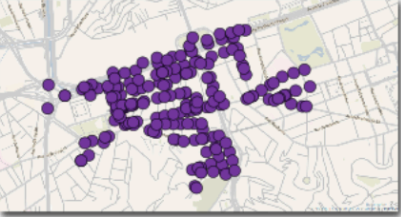
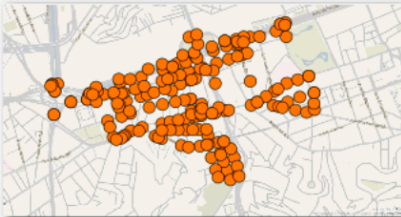


(f) ST-Heatmap

(a) Pot Holes



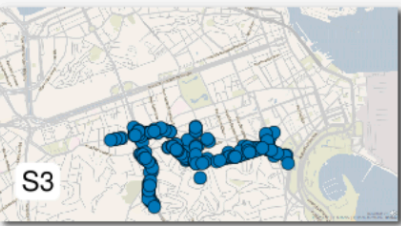
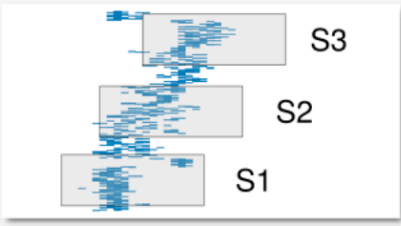
(b) Local Events



(c) Road Works



(d) Traffic Jams



Thanks!