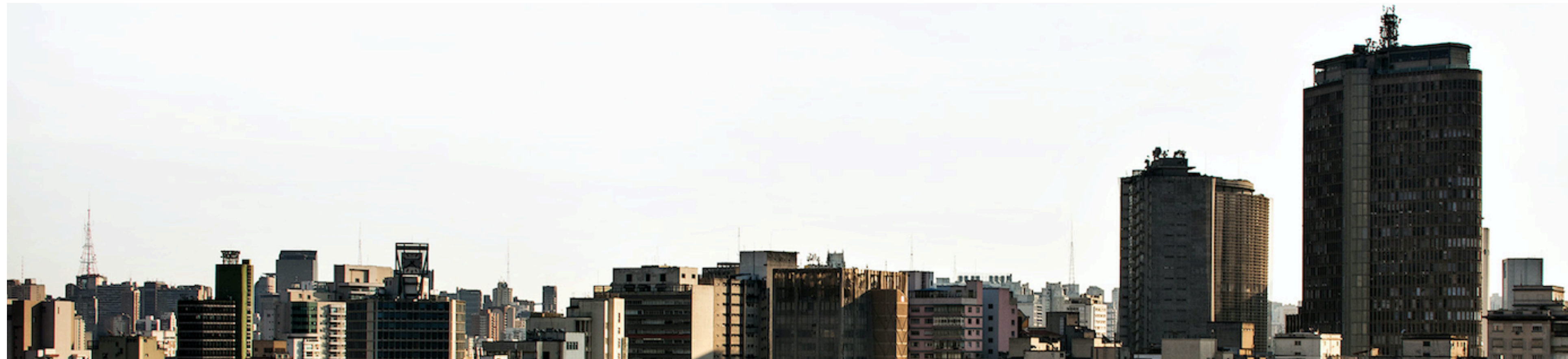# Improving the Quality of Life in Cities with Computer Science

Prof. Fabio Kon
Department of Computer Science
University of São Paulo, Brazil

Fulbright Visiting Professor
MIT Senseable City Lab

InterSCity lab in São Paulo

~20 people working

- interface between Computer Science and Cities

- 6-year funding (2017 to 2023)

- **InterSCity.org**

- Open Source software

- Open Datasets

Our view on Smart Cities

Although we don't ignore high-tech solutions for the elite, we prefer to focus on:

- people (technology is a

  means not an end)

- low-income populations

- developing countries
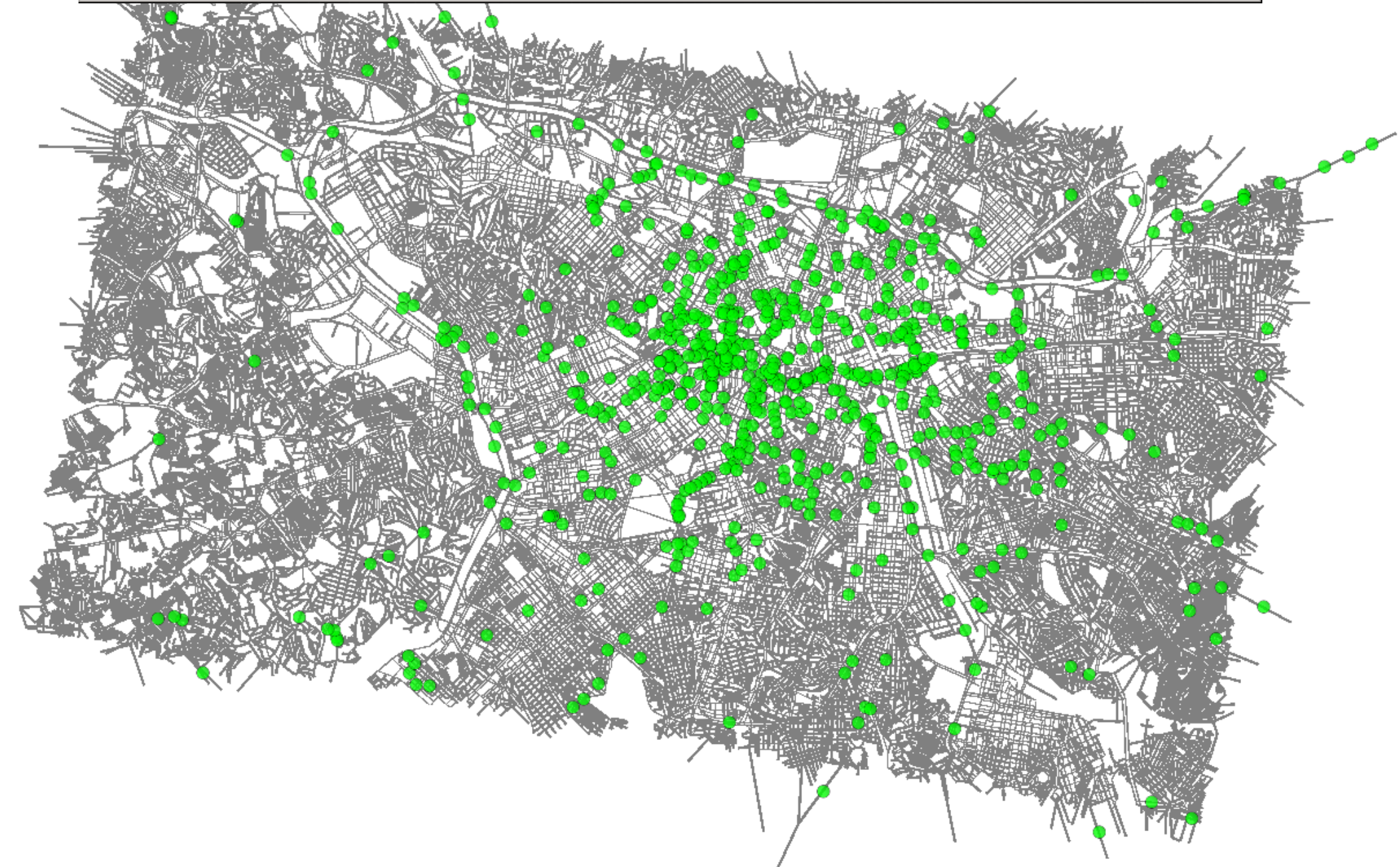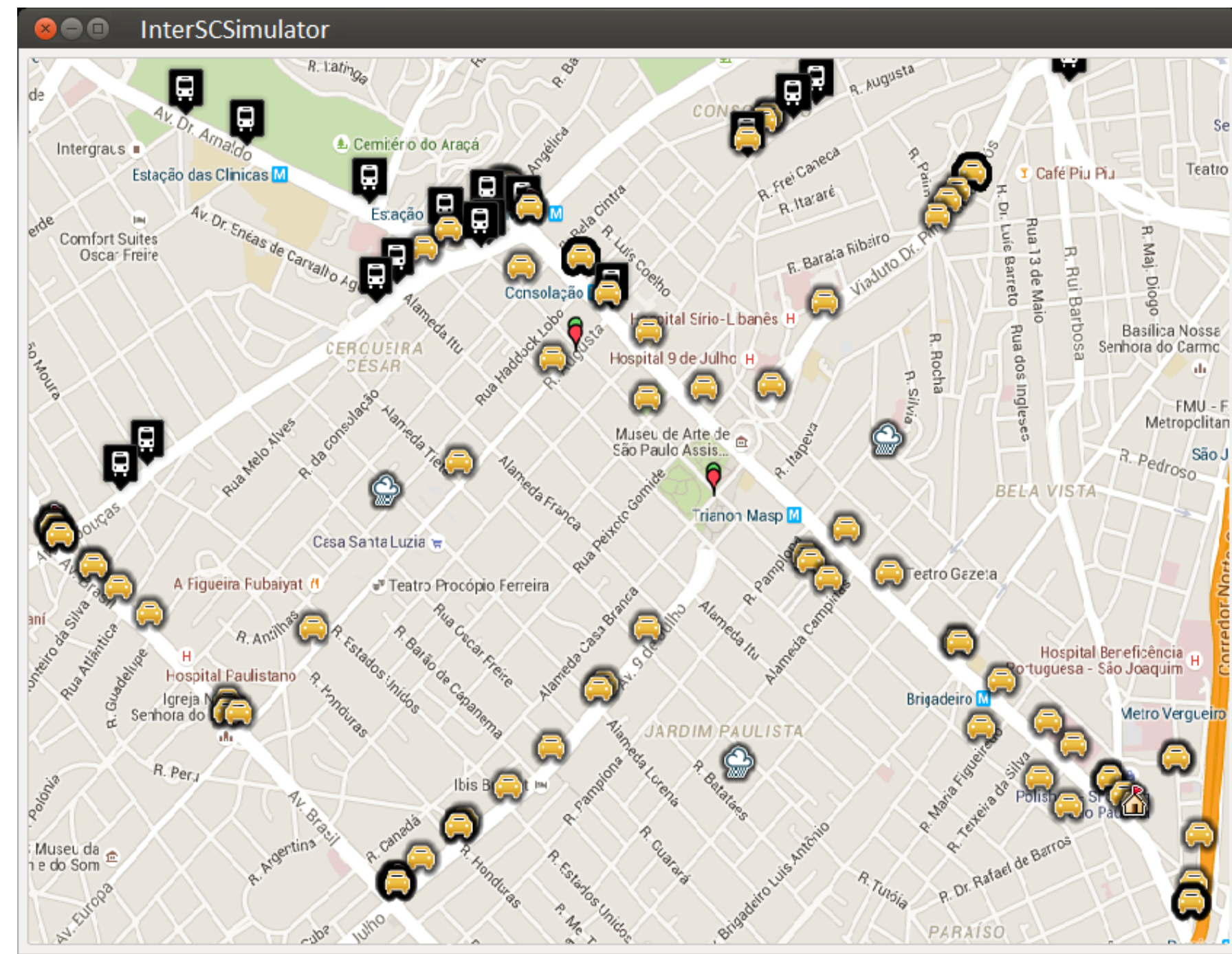
- underprivileged neighborhoods

Projects

1. City Simulator

2. Smart City Software Platform

3. Health Dashboard

4. Accessibility Ranking

5. Scipopulis Startup

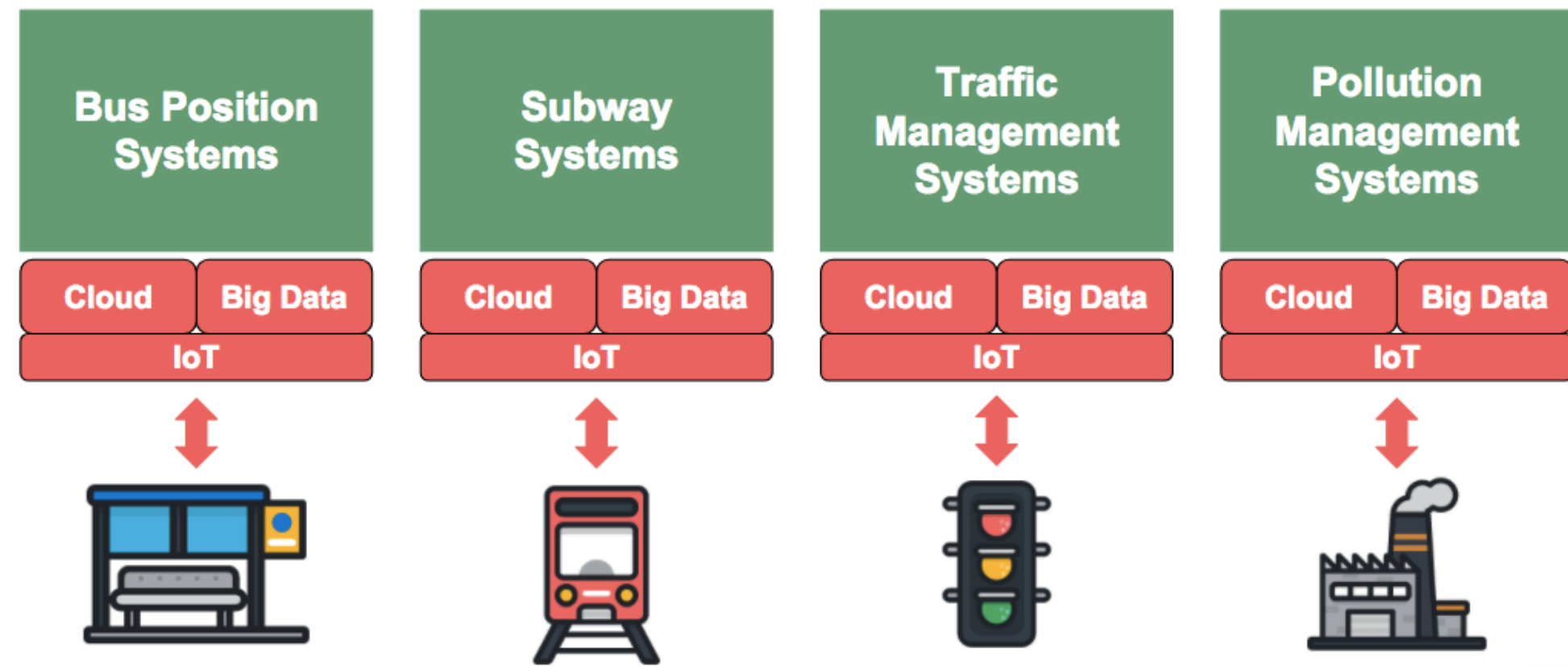6. BikeSCience @ MIT Senseable City Lab

1 - InterSCimulator

- Erlang-based large-scale simulator for Smart Cities

- Simulations with 17 million agents in super-real-time

- Multimodal transportation

  - cars, pedestrians, buses, subway, (bicycles).

  - Impact analysis of changes in the transportation infrastructure and associated costs.

  - Population from Paraisópolis favela (slum) in SP.

  - Challenges: (1) distribute computation across multiple (non-shared memory) machines (2) provide "programming" interface for non-programmers.
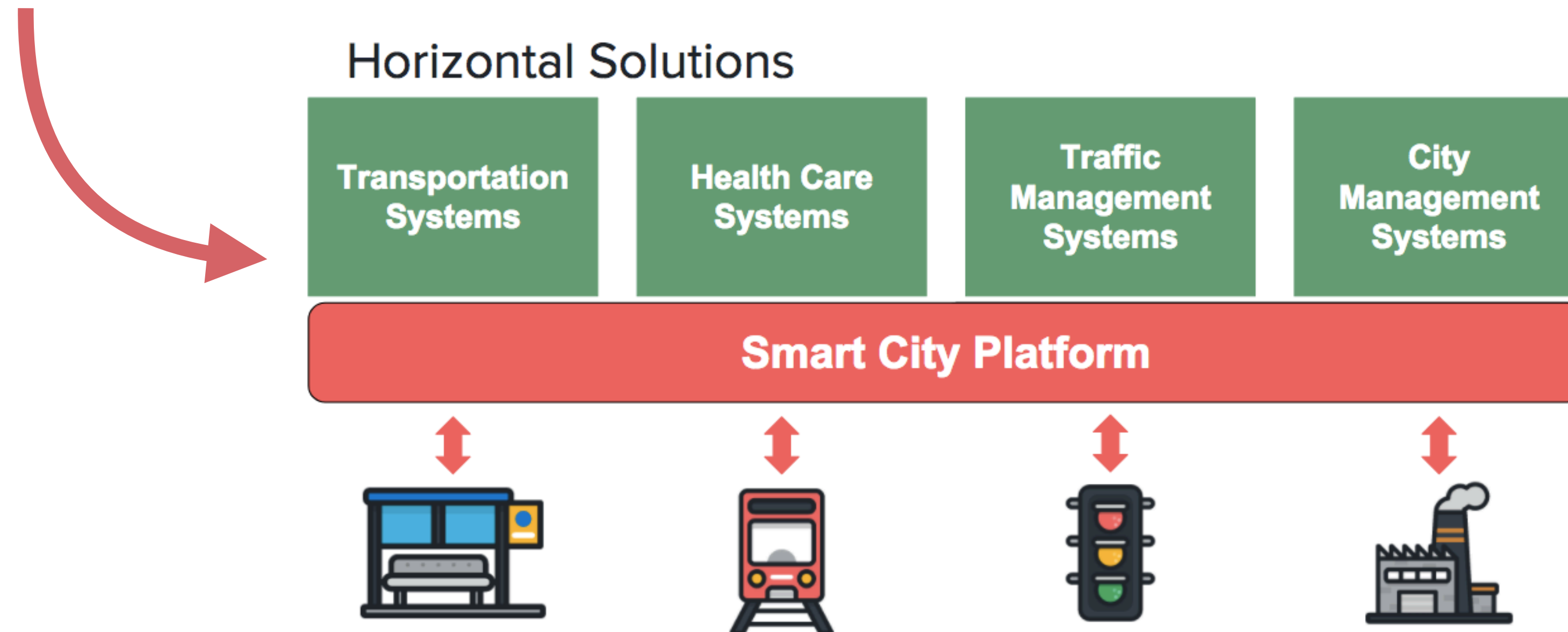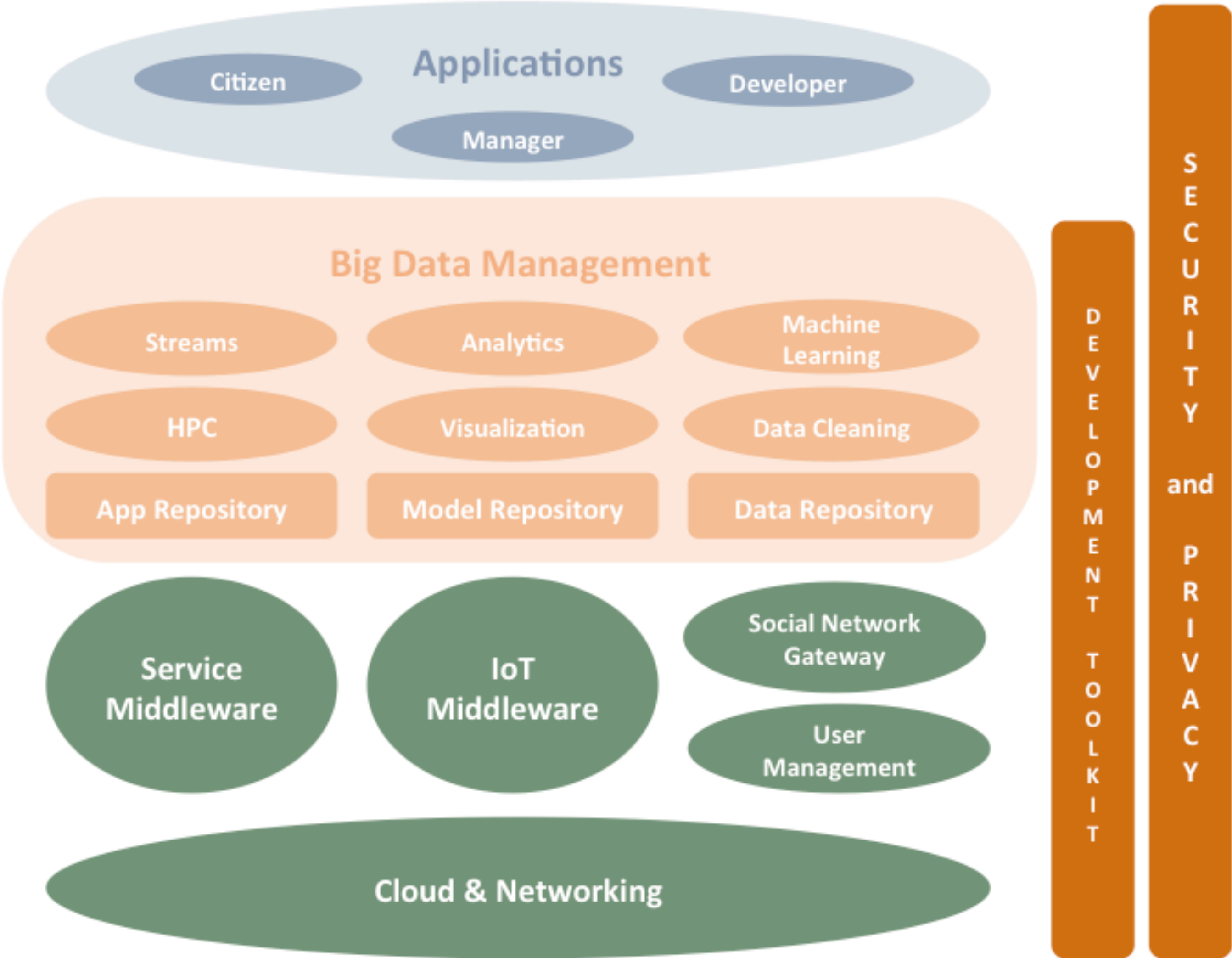
2- A generic Software Platform for Smart Cities

Traditional Solutions and Vertical Silos

Bus Position Systems — Cloud | Big Data | IoT

Subway Systems — Cloud | Big Data | IoT

Traffic Management Systems — Cloud | Big Data | IoT

Pollution Management Systems — Cloud | Big Data | IoT

Horizontal Solutions

Transportation Systems | Health Care Systems | Traffic Management Systems | City Management Systems
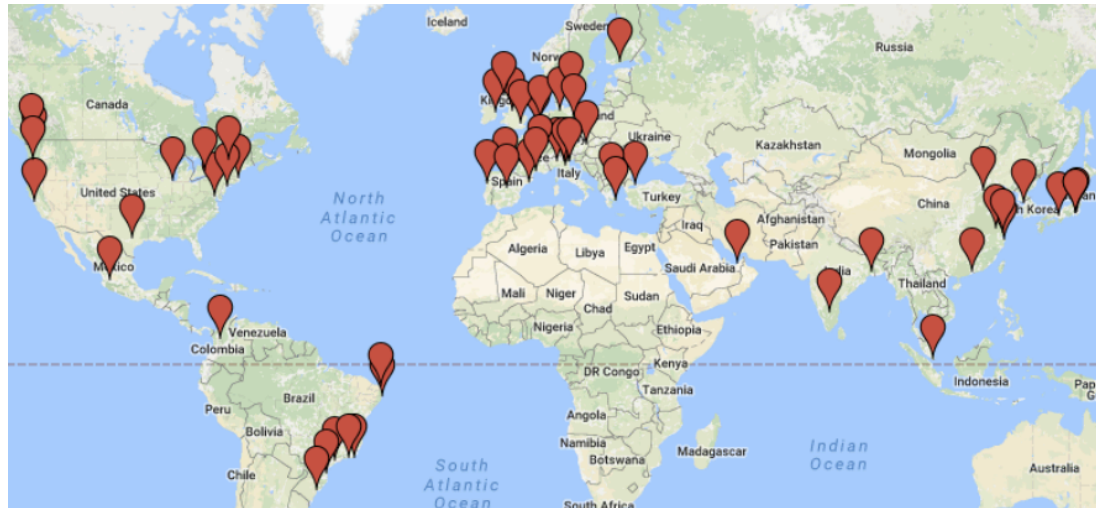
Smart City Platform

Survey and proposed reference architecture for Smart City Software Platforms
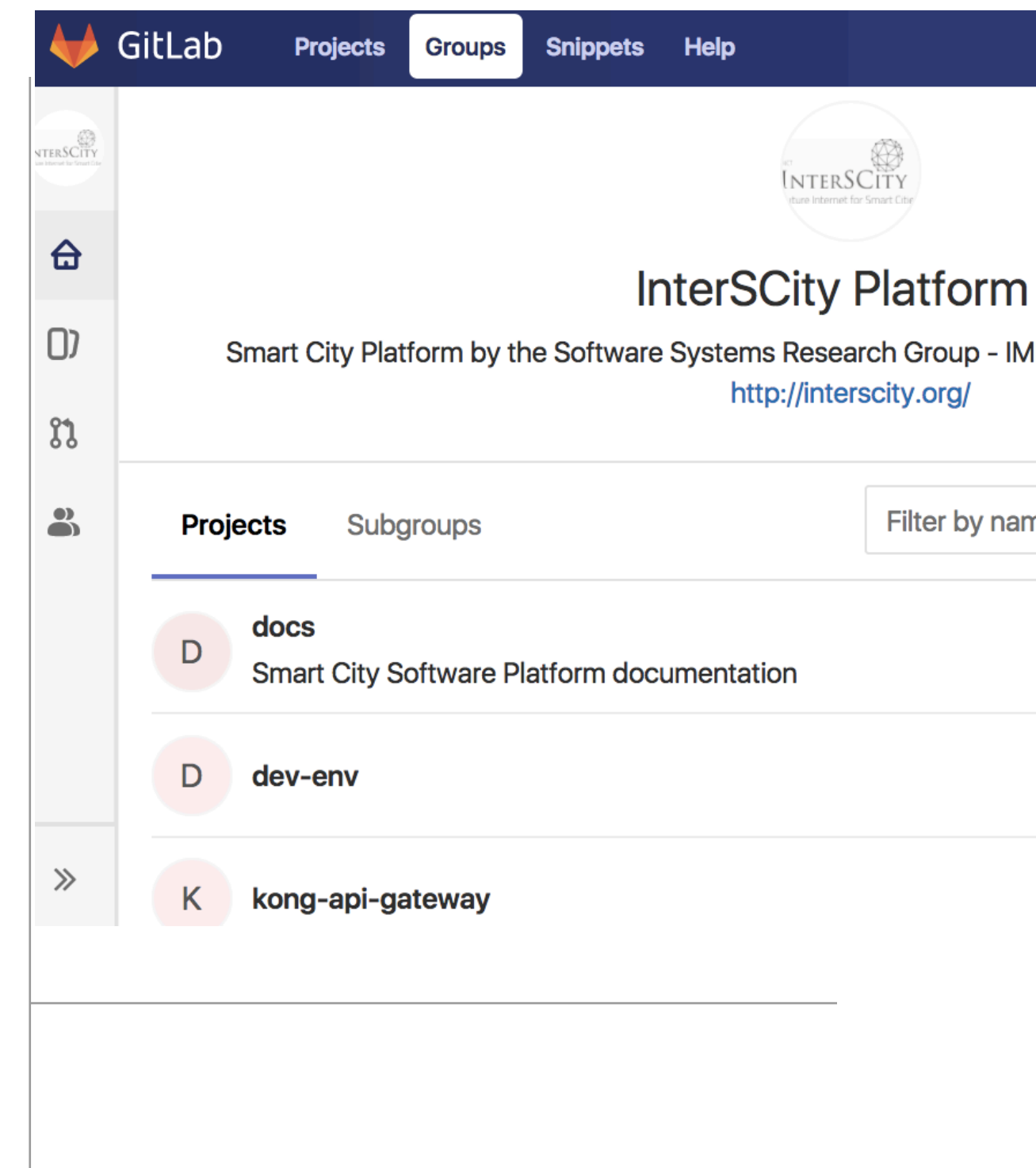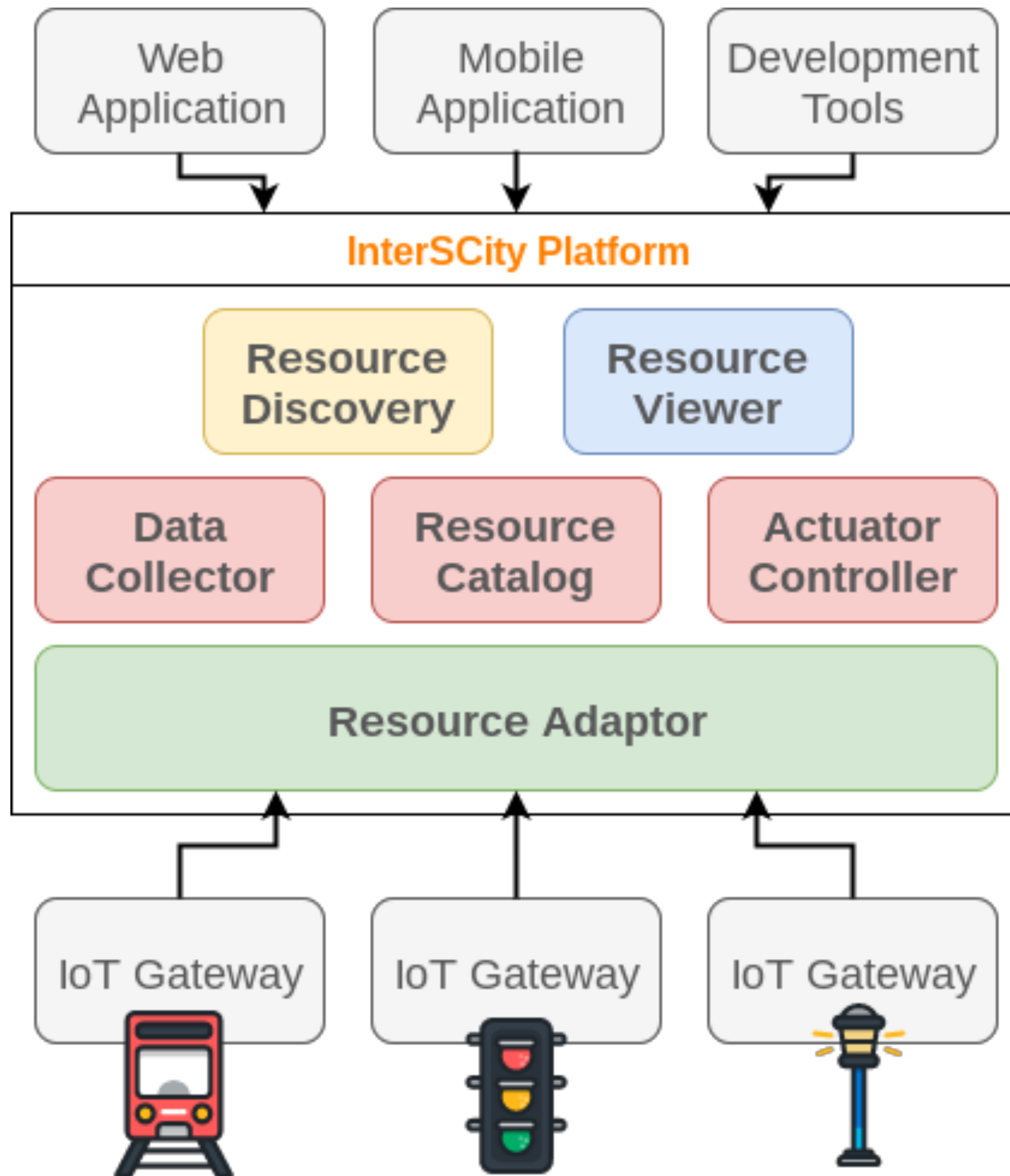
Software Platforms for Smart Cities:
Concepts, Requirements, Challenges, and a Unified Reference
Architecture

Eduardo Felipe Zambom Santana, University of São Paulo
Ana Paula Chaves, Federal Technological University of Paraná
Marco Aurelio Gerosa, University of São Paulo
Fabio Kon, University of São Paulo
Dejan S. Milojicic, Hewlett Packard Labs Palo Alto

Making cities smarter help improve city services and increase citizens' quality of life. Information and communication technologies (ICT) are fundamental for progressing towards smarter city environments. Smart City software platforms potentially support the development and integration of Smart City applications. However, the ICT community must overcome current significant technological and scientific challenges before these platforms can be widely used. This paper surveys the state-of-the-art in software platforms for Smart Cities. We analyzed 23 projects with respect to the most used enabling technologies, as well as functional and non-functional requirements, classifying them into four categories: Cyber-Physical Systems, Internet of Things, Big Data, and Cloud Computing. Based on these results, we derived a reference architec...

InterSCity Platform

Web Application

Mobile Application

Development Tools

InterSCity Platform

Resource Discovery

Resource Viewer

Data Collector

Resource Catalog

Actuator Controller

Resource Adaptor

IoT Gateway

IoT Gateway

IoT Gateway

GitLab   Projects   Groups   Snippets   Help

InterSCity Platform

Smart City Platform by the Software Systems Research Group - IMI

http://interscity.org/

Projects   Subgroups   Filter by nam

D   **docs**
Smart City Software Platform documentation

D   **dev-env**

K   **kong-api-gateway**

Design and evaluation of a scalable smart city software platform with large-scale simulations☆

Arthur de M. Del Esposte [a], Eduardo F.Z. Santana [a], Lucas Kanashiro [a], Fabio M. Costa [b], Kelly R. Braghetto [a], Nelson Lago [a], Fabio Kon [a,*]

[a] Department of Computer Science - University of São Paulo, Brazil
[b] Instituto de Informática - Universidade Federal de Goiás, Brazil

H I G H L I G H T S

- InterSCity platform microservices architecture provides elasticity and scalability.
- Simulation-based method for realistic smart city workload generation.
- Extensive analysis of the InterSCity architectural design points out its scalability.
- Experimental results demonstrate the high scalability of the InterSCity platform.

3 -

Health Dashboard

554.202
Internações Hospitalares
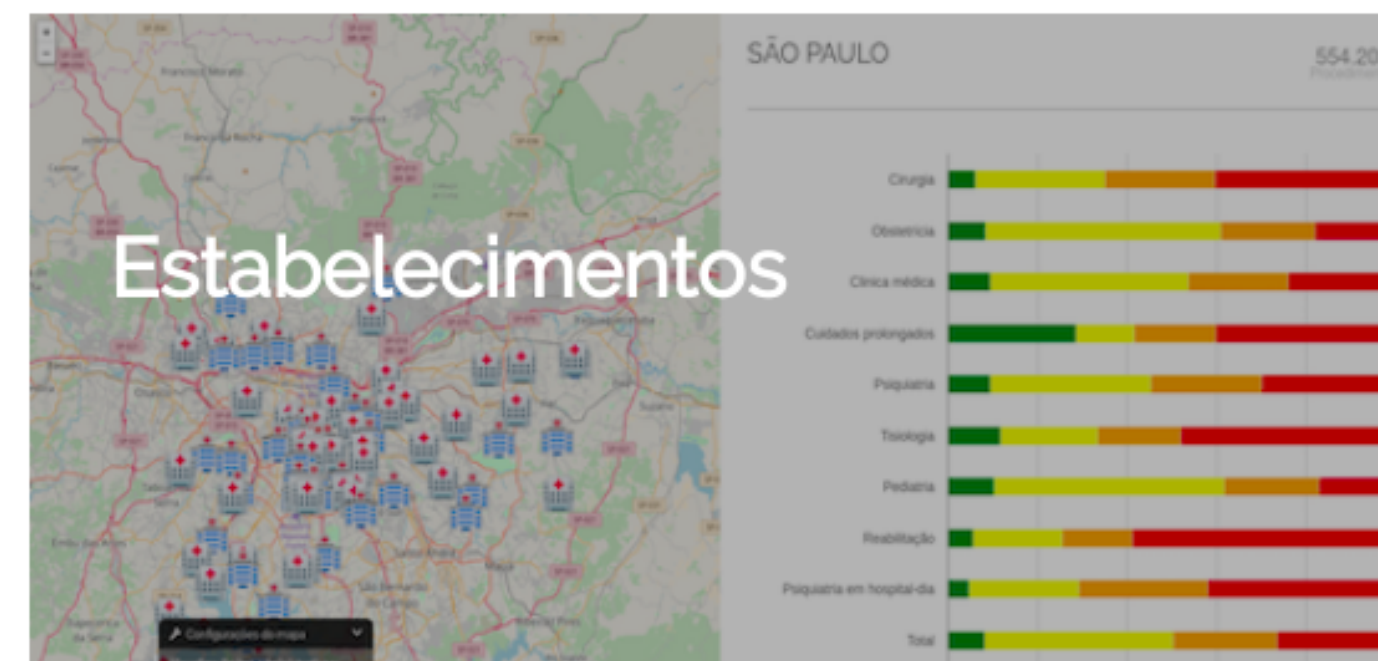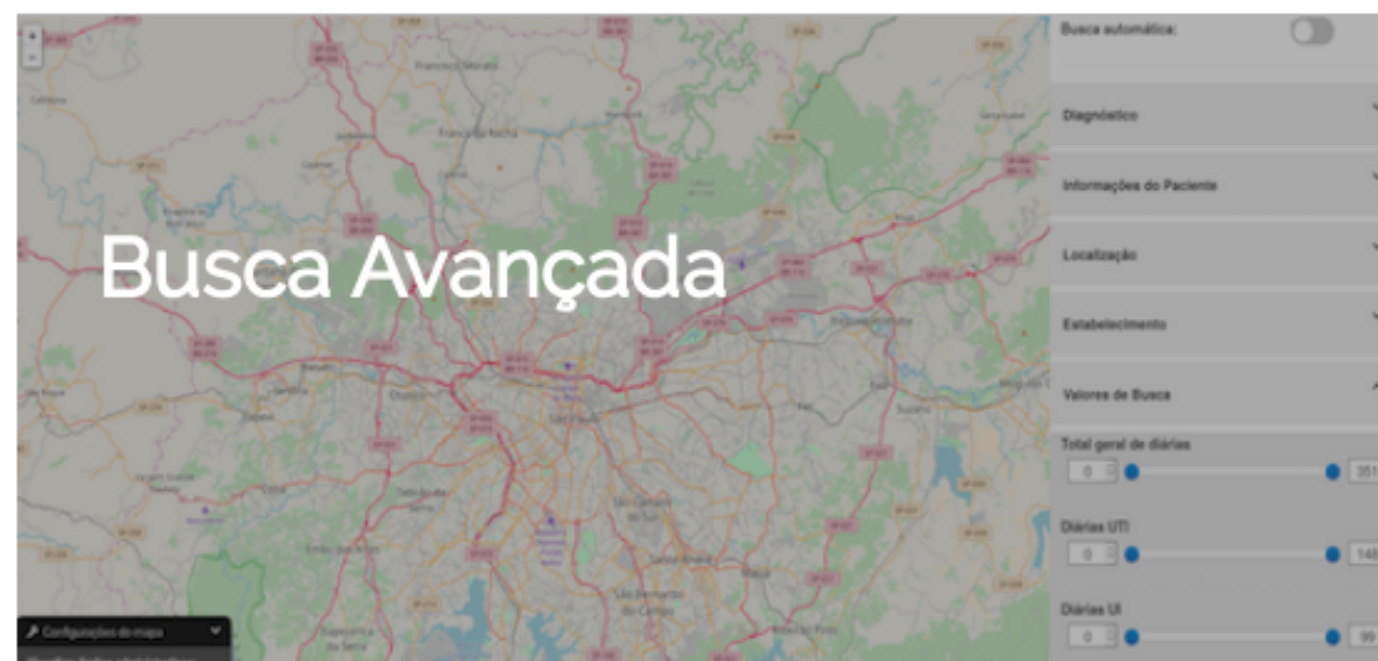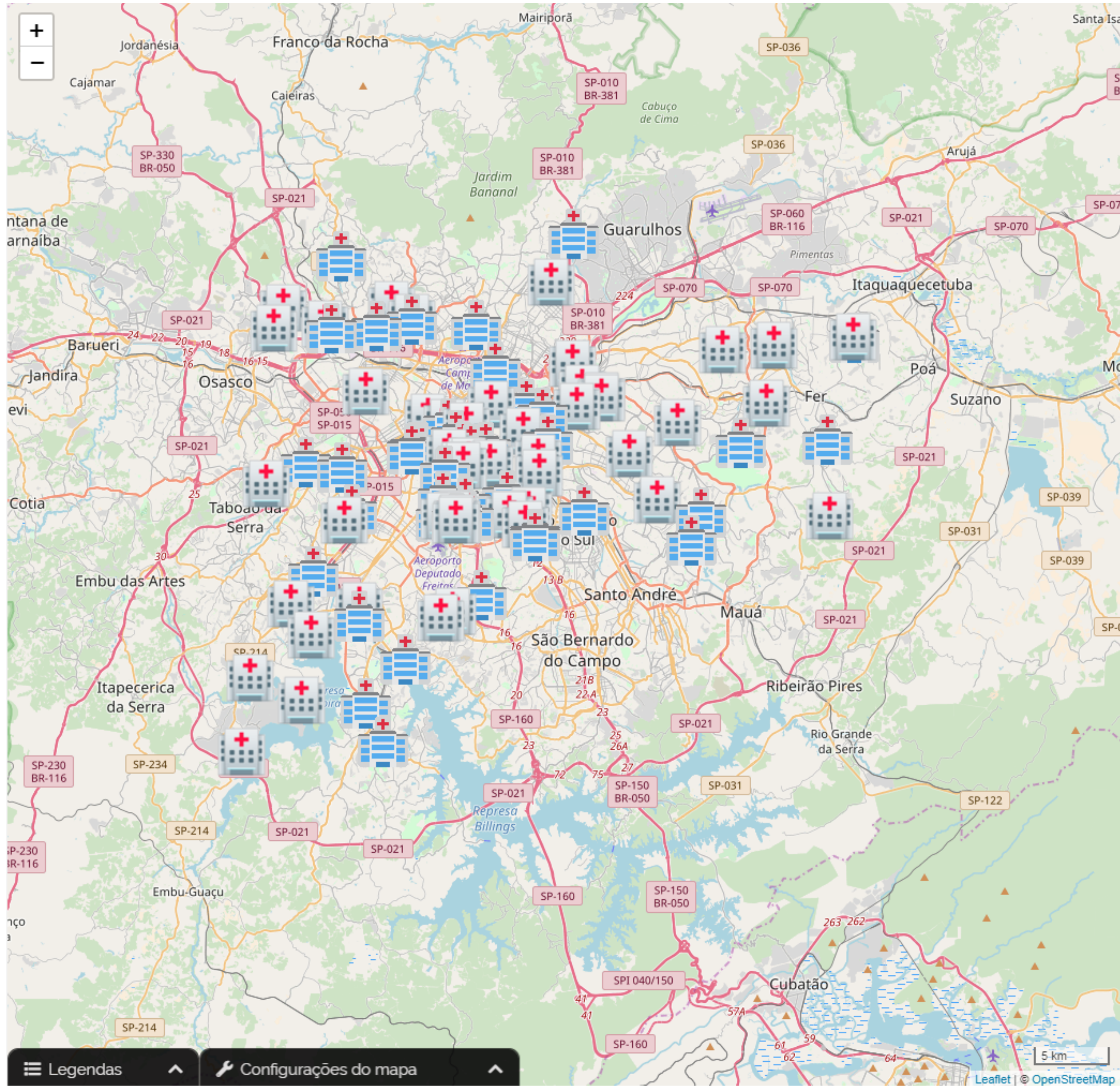
97
Estabelecimentos de Saúde
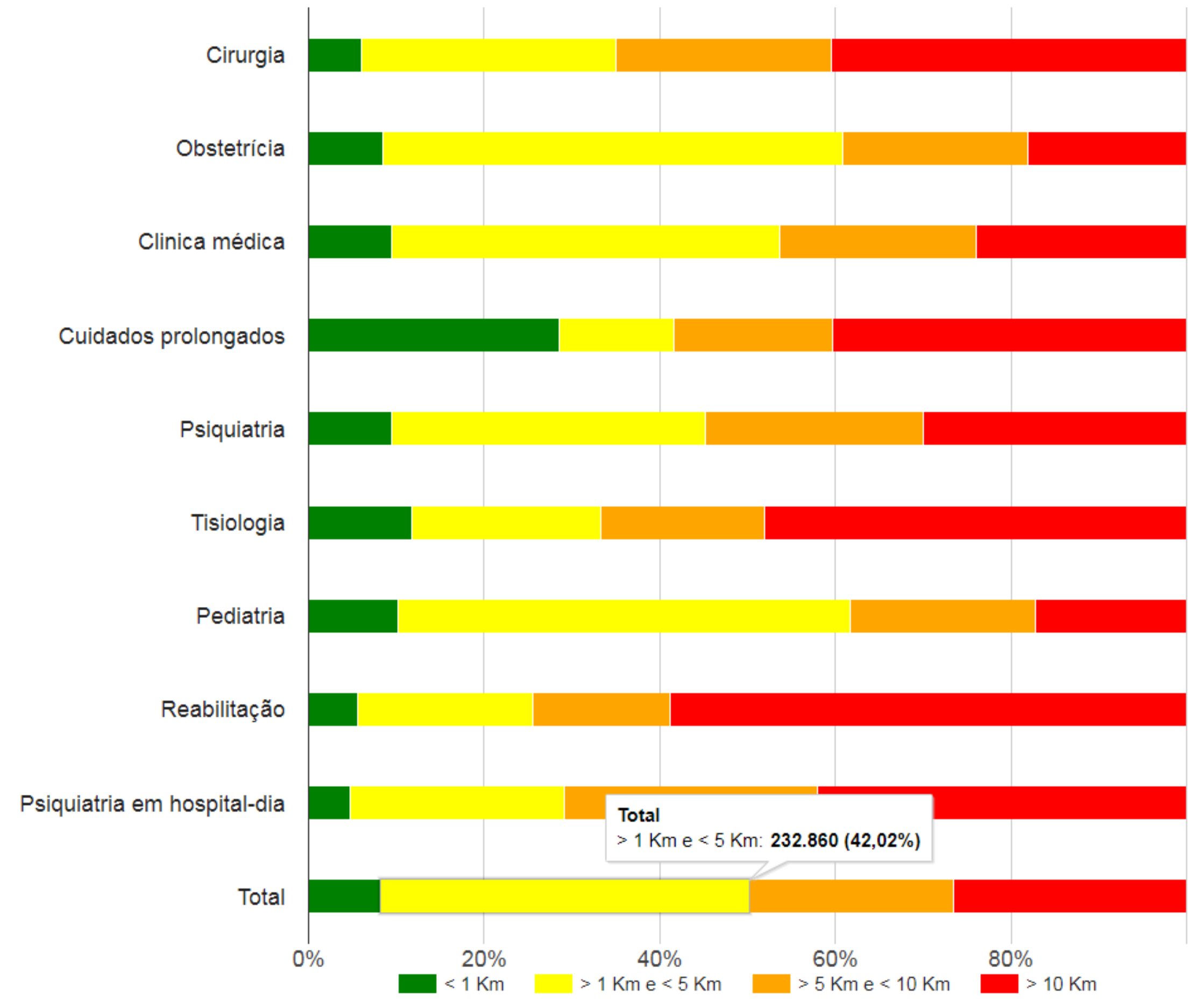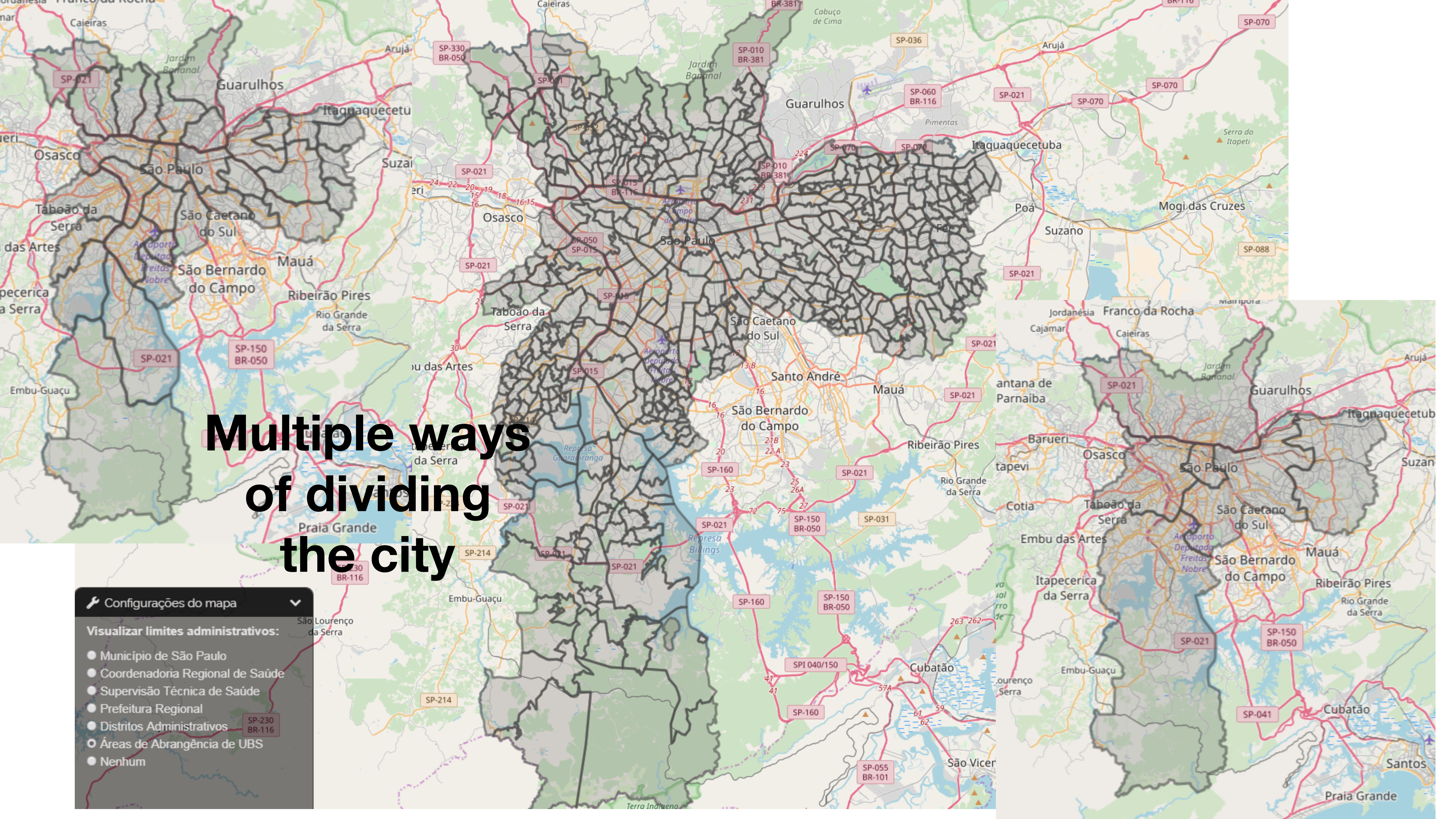
9
Especialidades

8,43 km
Média de Deslocamento

SERVIÇOS

Busca Avançada

Estabelecimentos

SÃO PAULO

554.202
Procedimentos

Cirurgia
Obstetrícia
Clinica médica
Cuidados prolongados
Psiquiatria
Tisiologia
Pediatria
Reabilitação
Psiquiatria em hospital-dia

Total
> 1 Km e < 5 Km: **232.860 (42,02%)**

Total

0%   20%   40%   60%   80%

■ < 1 Km   ■ > 1 Km e < 5 Km   ■ > 5 Km e < 10 Km   ■ > 10 Km

Multiple ways of dividing the city

Configurações do mapa

Visualizar limites administrativos:

- Município de São Paulo
- Coordenadoria Regional de Saúde
- Supervisão Técnica de Saúde
- Prefeitura Regional
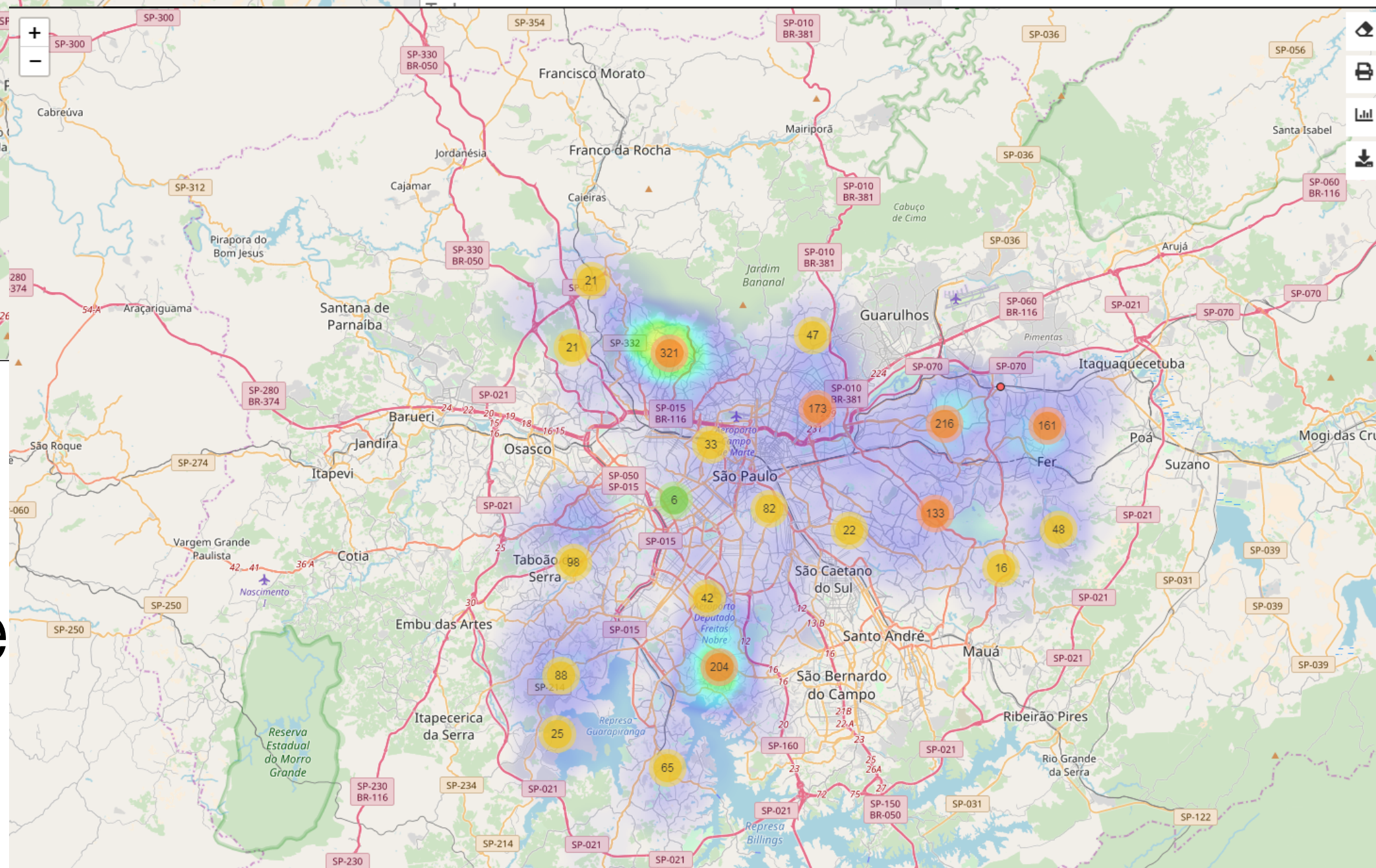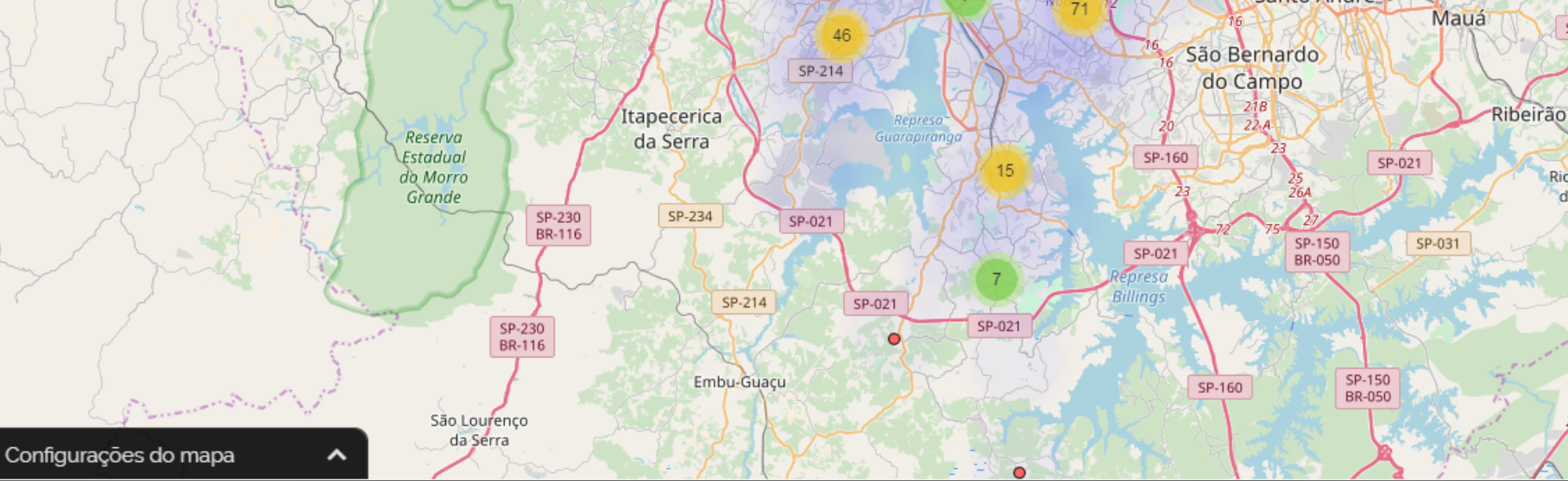- Distritos Administrativos
- Áreas de Abrangência de UBS
- Nenhum

Leukemia
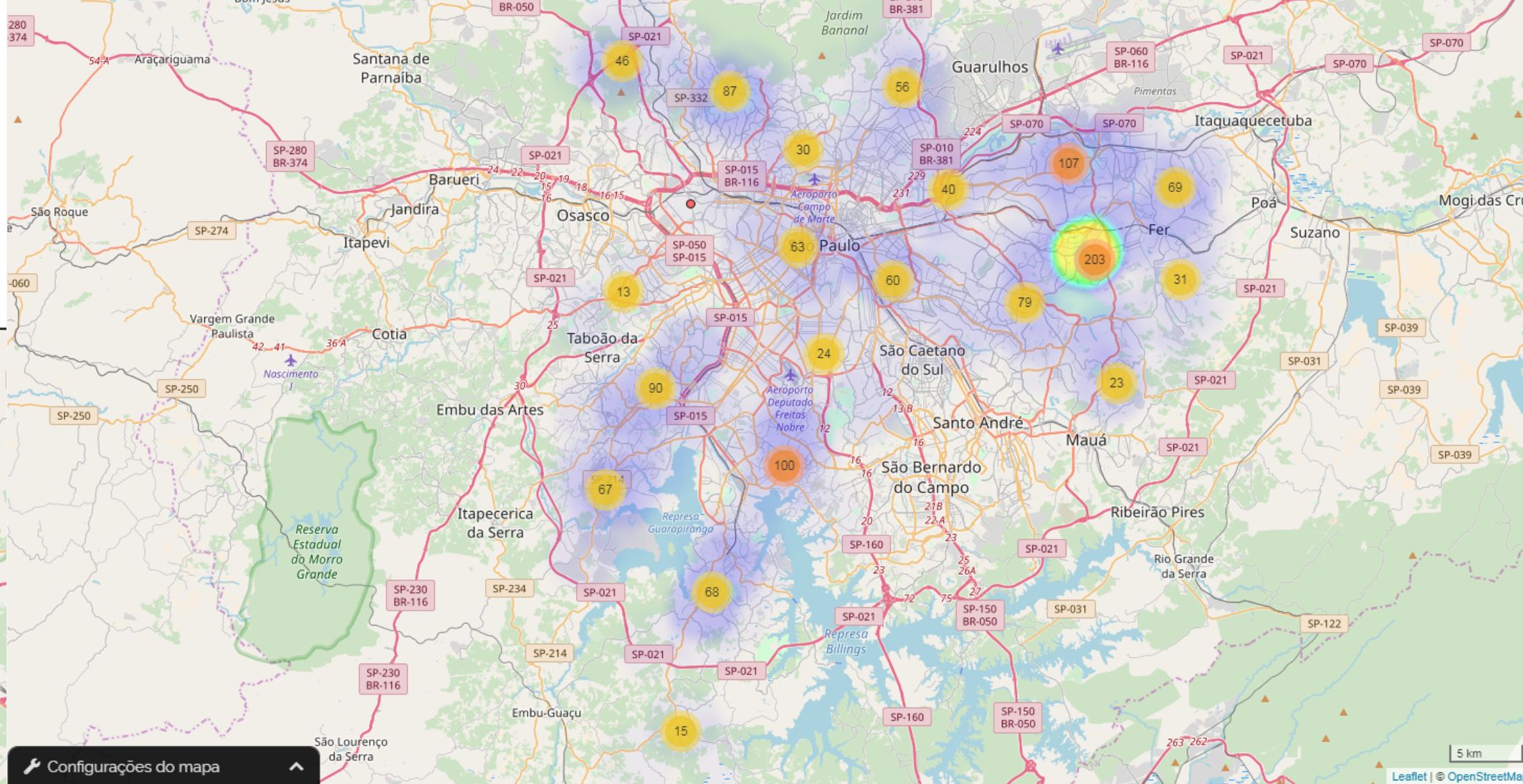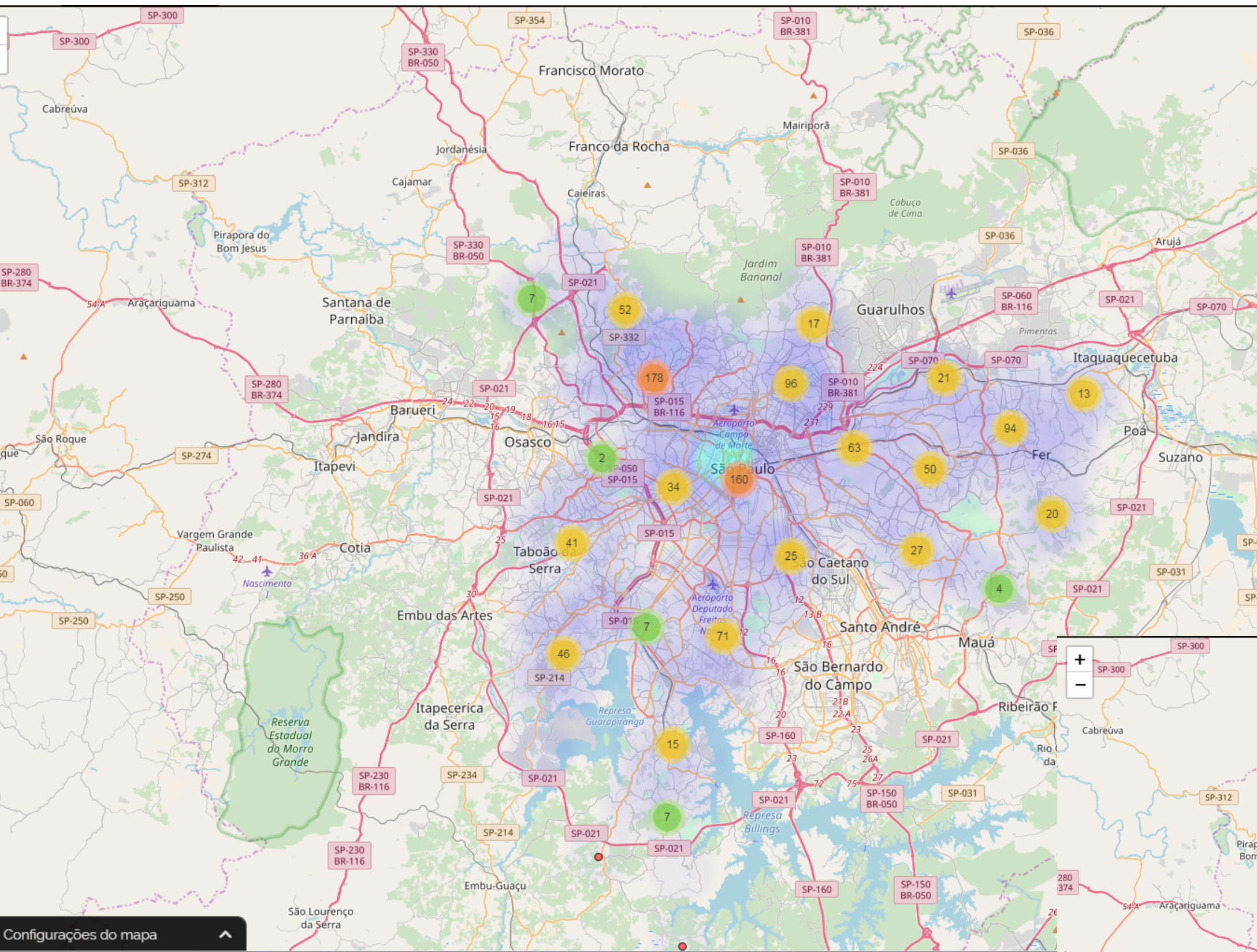
HIV

Dengue Fever

Competência (aaaamm)
Todos

Grupo do procedimento autorizado
Todos

Especialidade do leito
Todos

Caráter do atendimento
Todos

Diagnóstico principal (CID-10)
× C91 - Leucemia Linfóide

Diagnóstico secundário (CID-10)
Todos

Diagnóstico secundário 2 (CID-10)

Configurações do mapa

Grupo do procedimento autorizado
Todos

Especialidade do leito
Todos

Caráter do atendimento

Configurações do mapa

Busca automática:

Diagnóstico

Estabelecimento de ocorrência
Todos

Competência (aaaamm)
Todos

Grupo do procedimento autorizado
Todos

Especialidade do leito
Todos

Caráter do atendimento
Todos

Diagnóstico principal (CID-10)
× A90 - Dengue [dengue Clássico]

Diagnóstico secundário (CID-10)
Todos
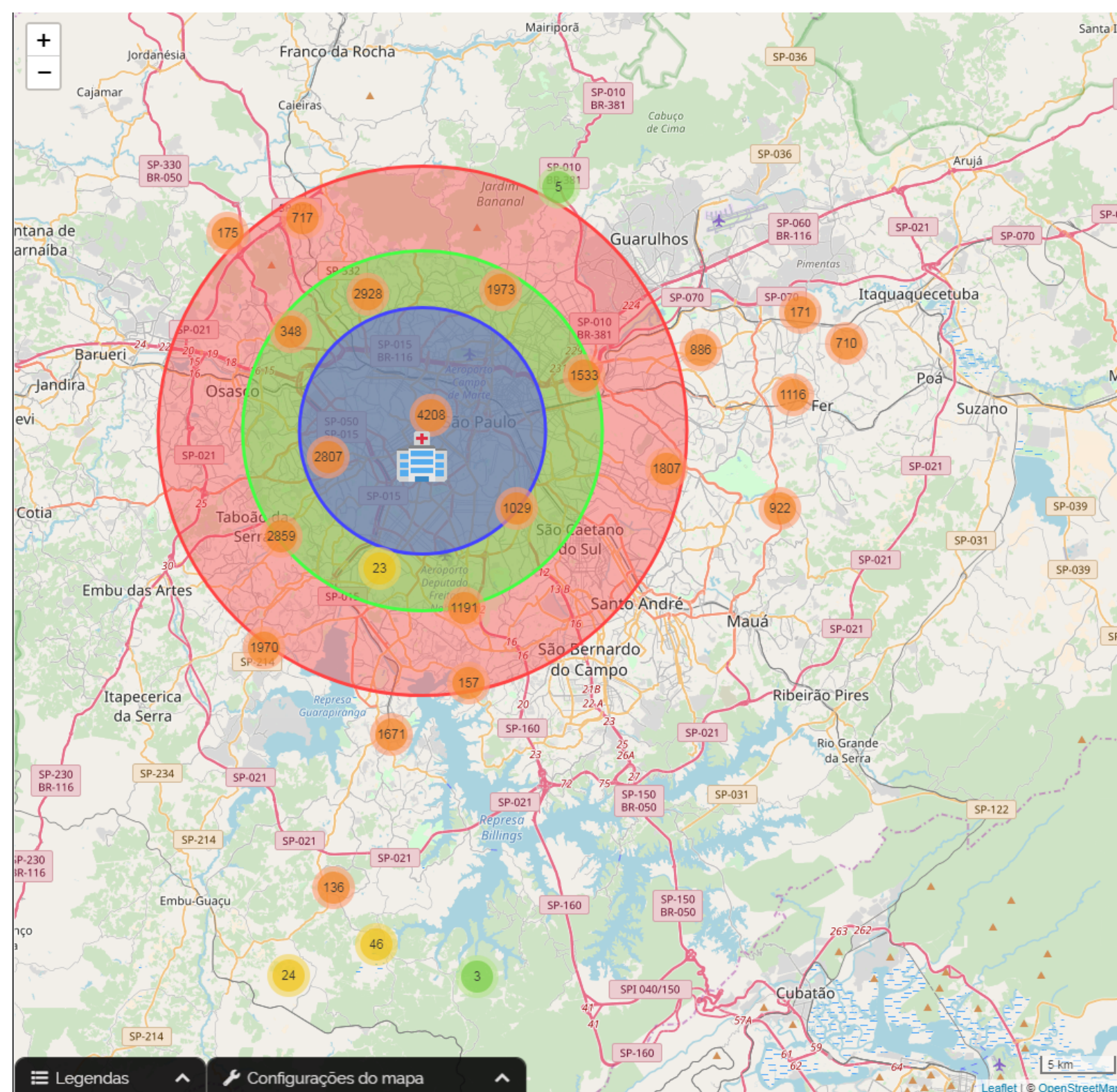
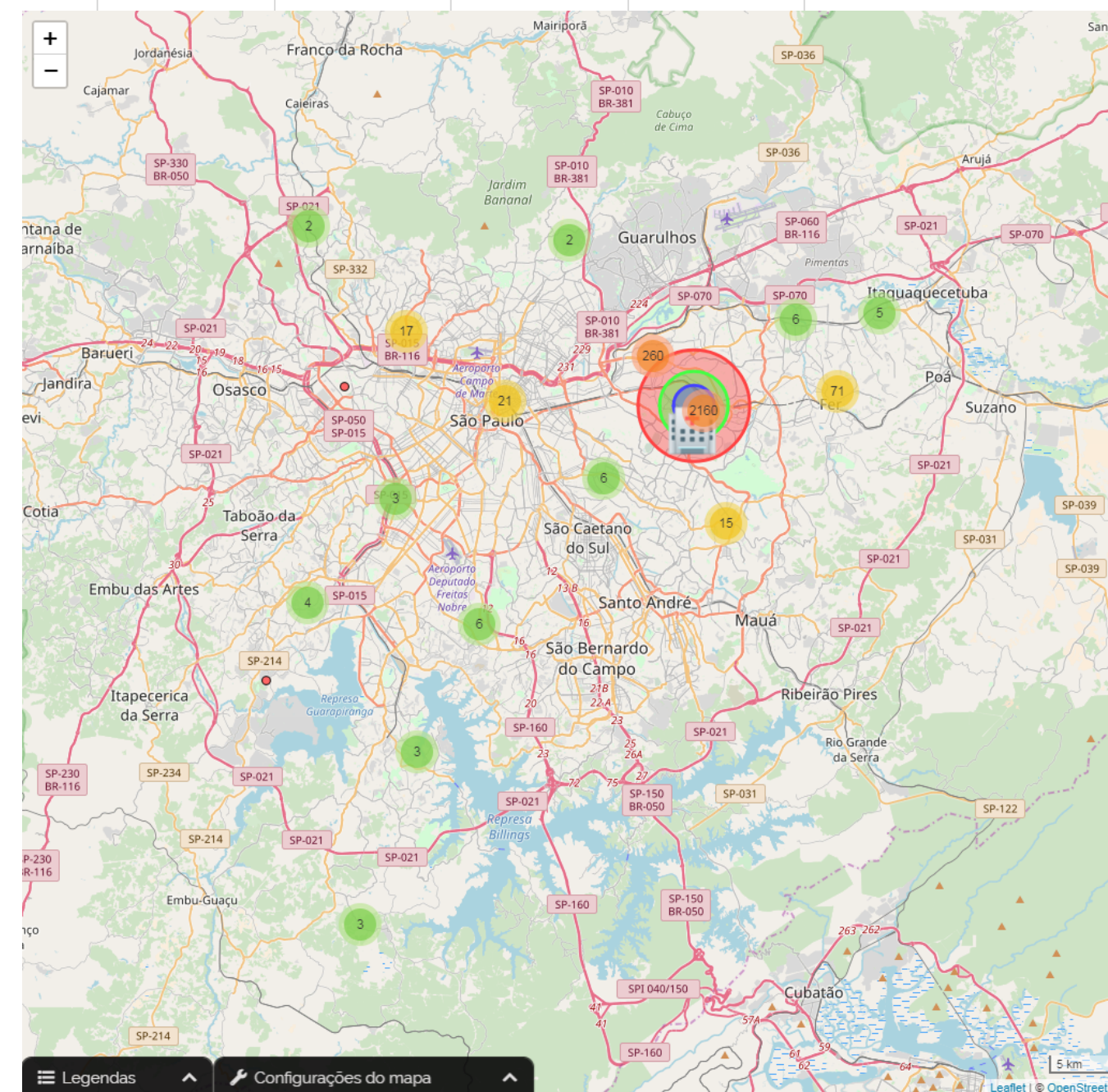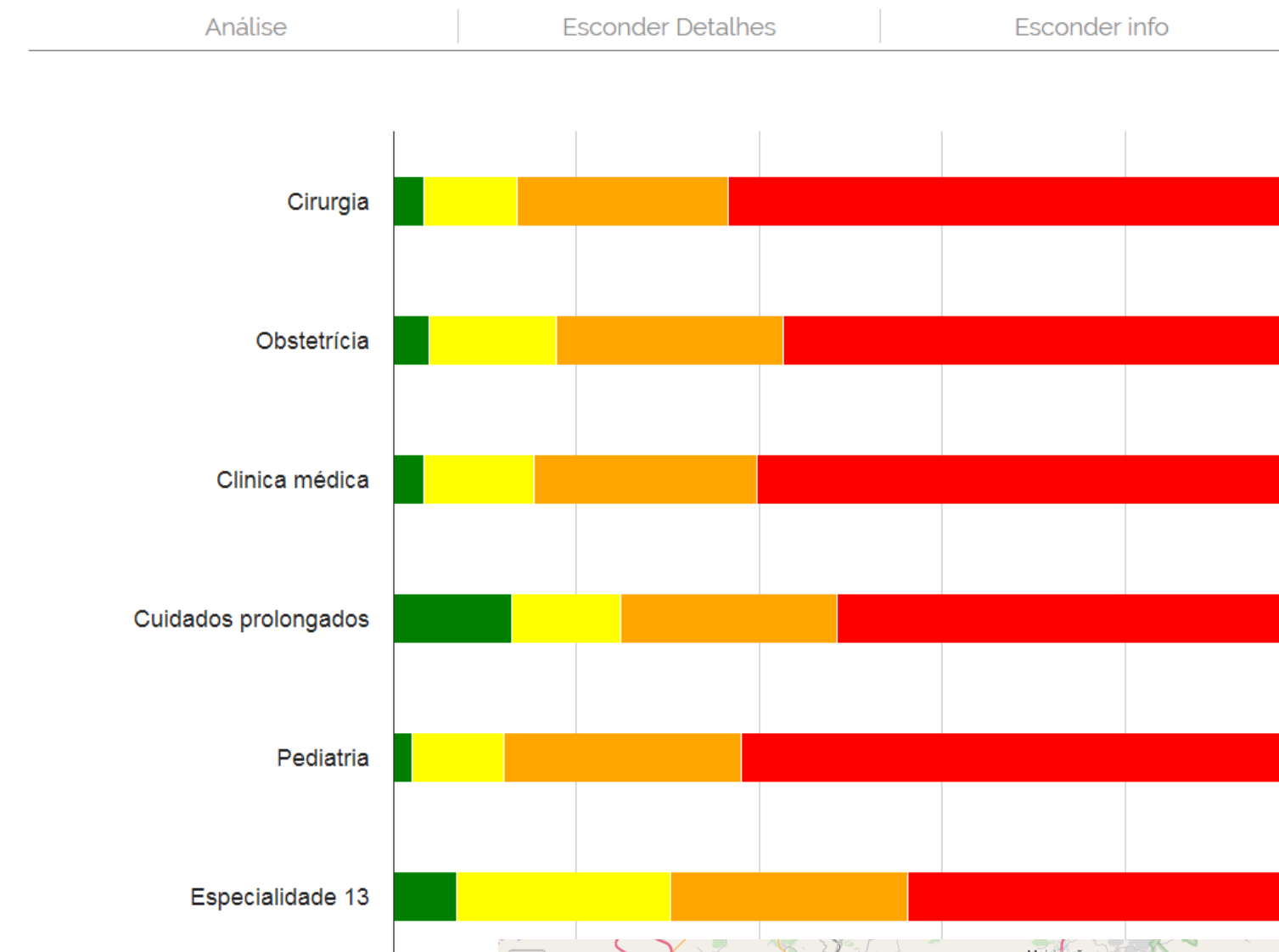HC DA FMUSP HOSPITAL DAS CLINICAS SAO PAULO

29.415
Procedimentos

Telefone: (11)3087-5456
Leitos: 1506
Distrito Administrativo: JARDIM PAULISTA
Prefeitura Regional: PINHEIROS
Supervisão Técnica de Saúde: LAPA / PINHEIROS
Coordenadoria Regional de Saúde: OESTE

Análise — Esconder Detalhes — Esconder info

Cirurgia
Obstetrícia
Clinica médica
Cuidados prolongados
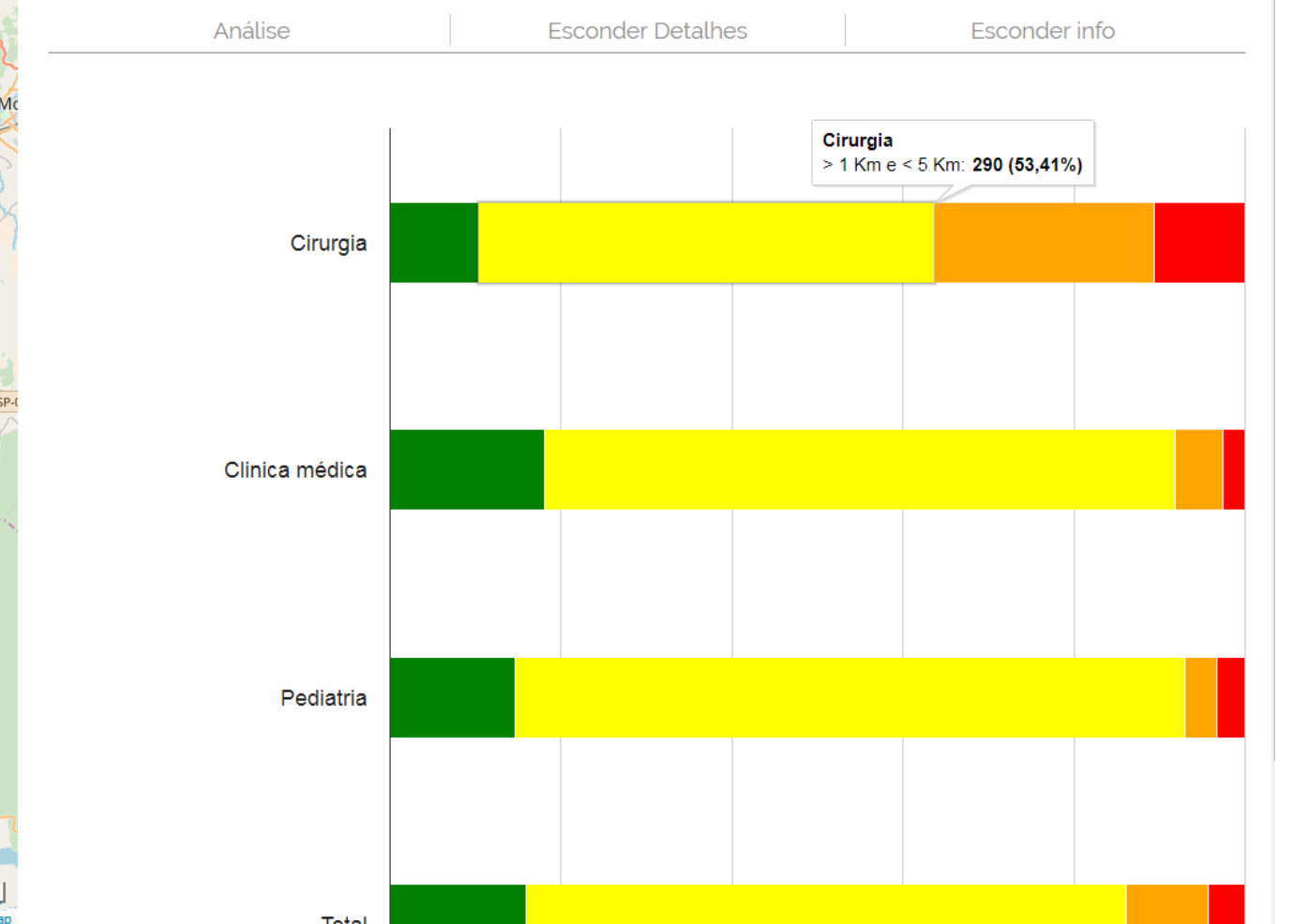Pediatria
Especialidade 13
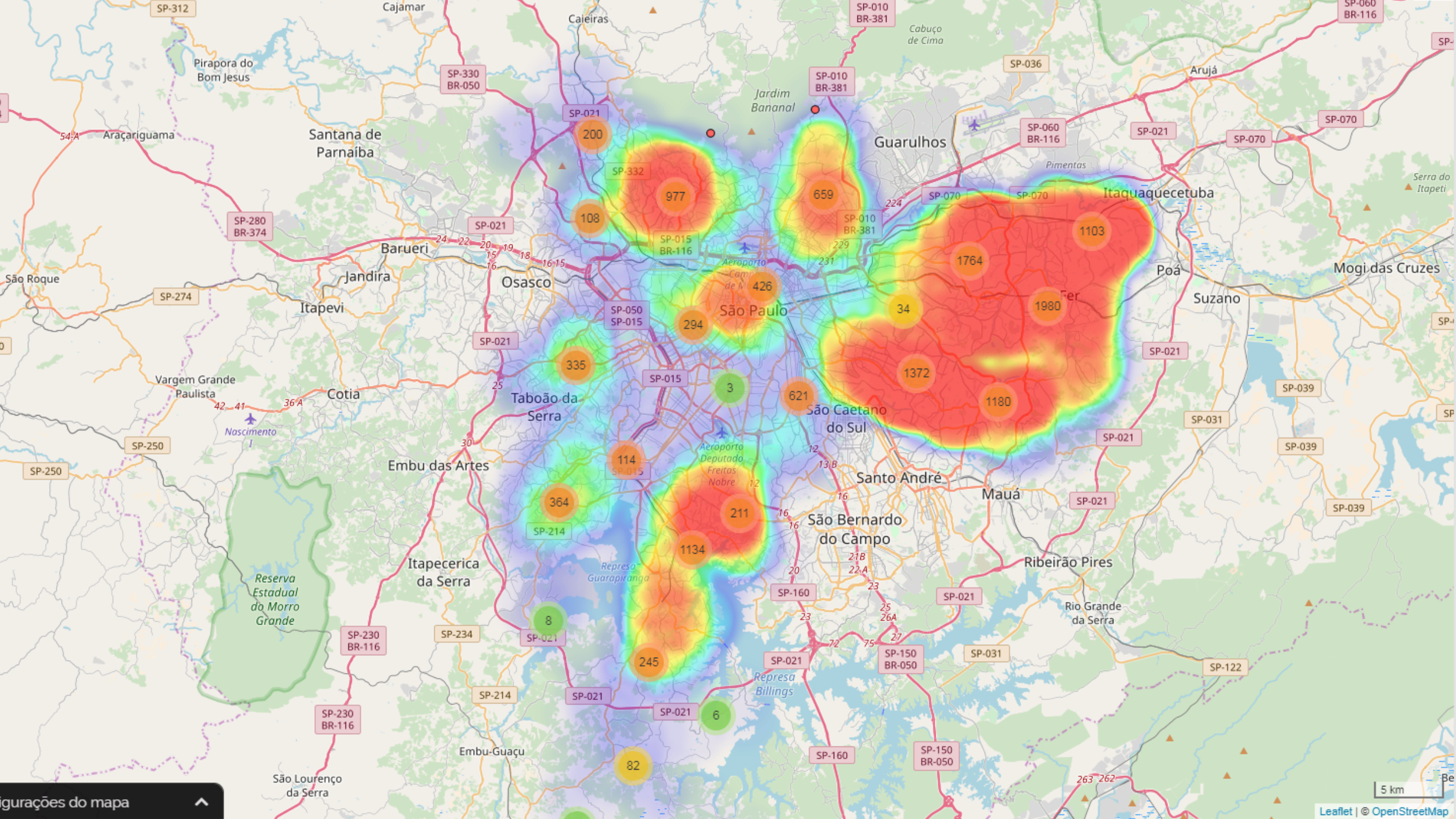
Metropolitan Hospital

HOSP MUN DOUTOR ALEXANDRE ZAIO

2.586
Procedimentos

Telefone: (11)3394-9210
Leitos: 42
Distrito Administrativo: VILA MATILDE
Prefeitura Regional: PENHA
Supervisão Técnica de Saúde: PENHA
Coordenadoria Regional de Saúde: SUDESTE

Análise — Esconder Detalhes — Esconder info

Cirurgia
> 1 Km e < 5 Km: **290 (53,41%)**

Clinica médica
Pediatria
Total

Regional Hospital

Hypertension
(most frequent)

>20Km
to get service

Estabelecimento de ocorrência

Todos

Competência (aaaamm)

Todos

Grupo do procedimento autorizado

Todos

Especialidade do leito

Todos

Caráter do atendimento

Todos

Diagnóstico principal (CID-10)

Todos

Diagnóstico secundário (CID-10)

× I10 - Hipertensão Essencial (primária)   ×

Diagnóstico secundário 2 (CID-10)
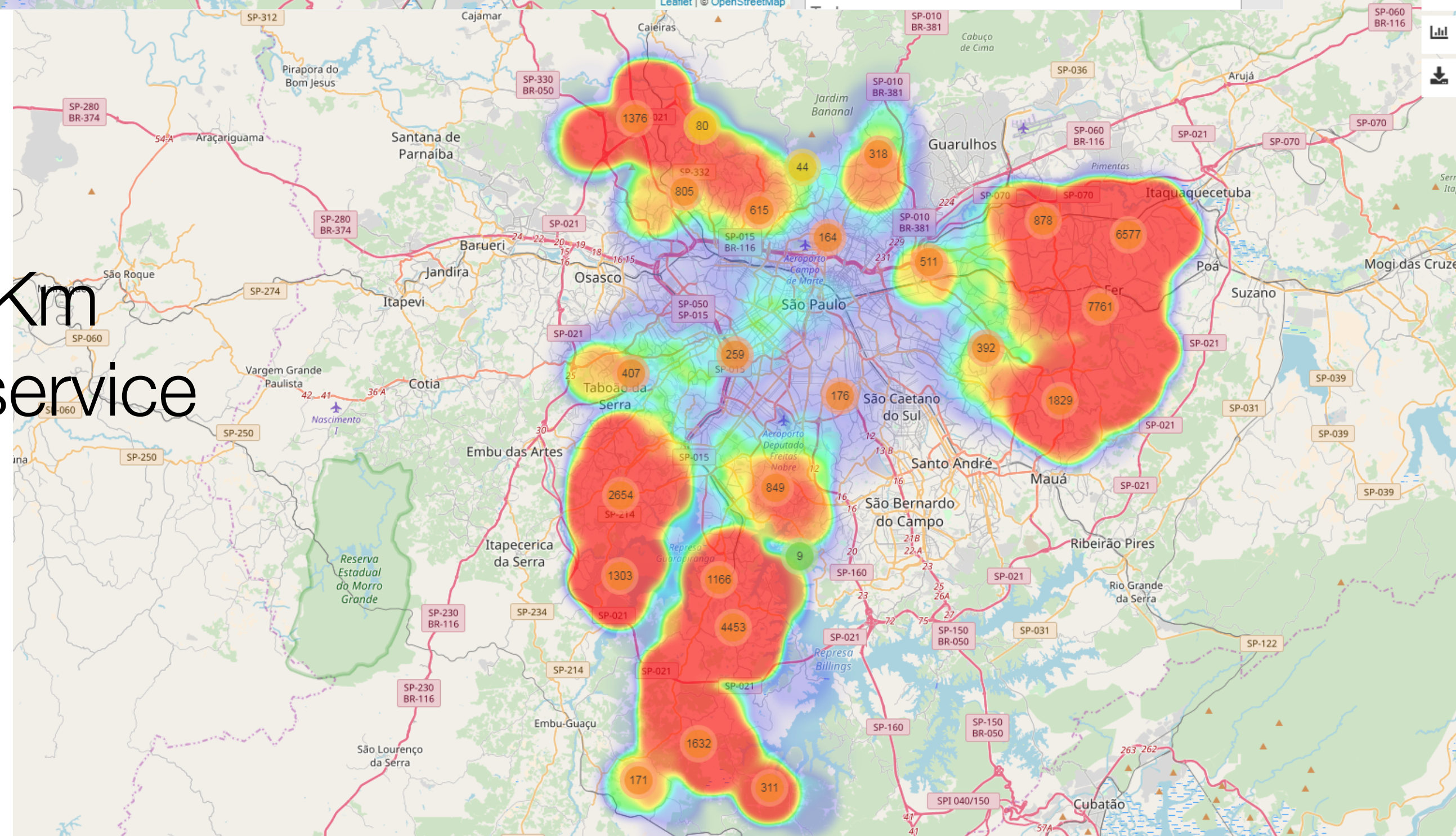
Localização

Estabelecimento

Valores de Busca

Total geral de diárias

0   351

Diárias UTI

0   148

Diárias UI
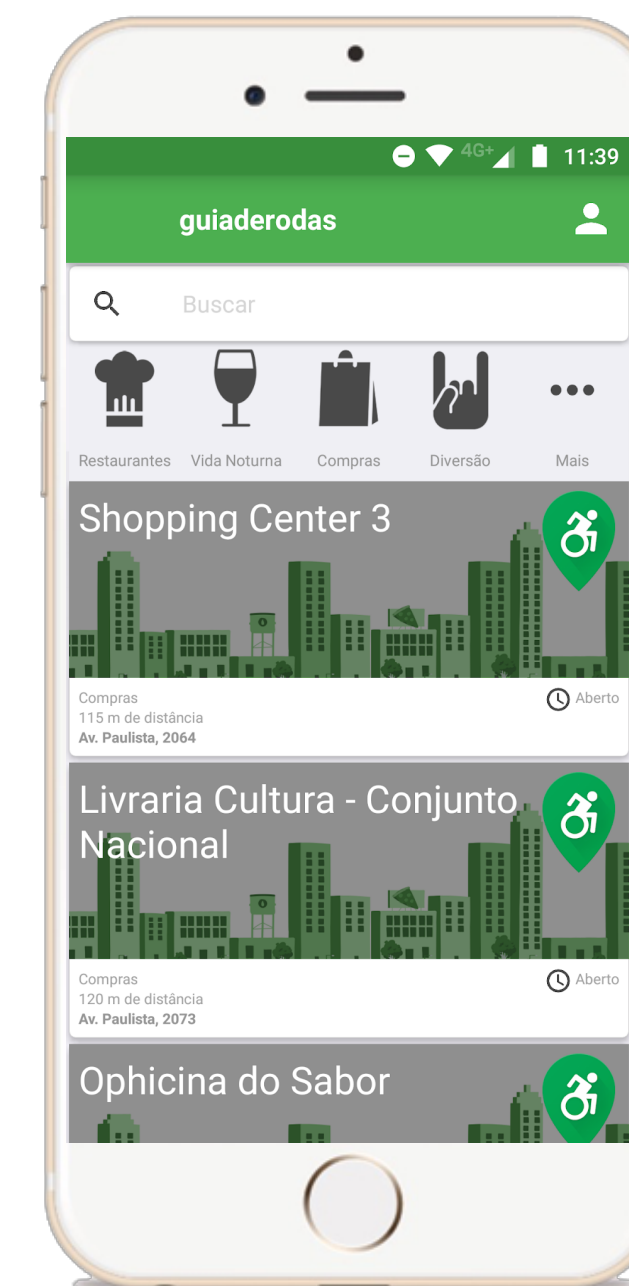
0   99

Dias de permanência
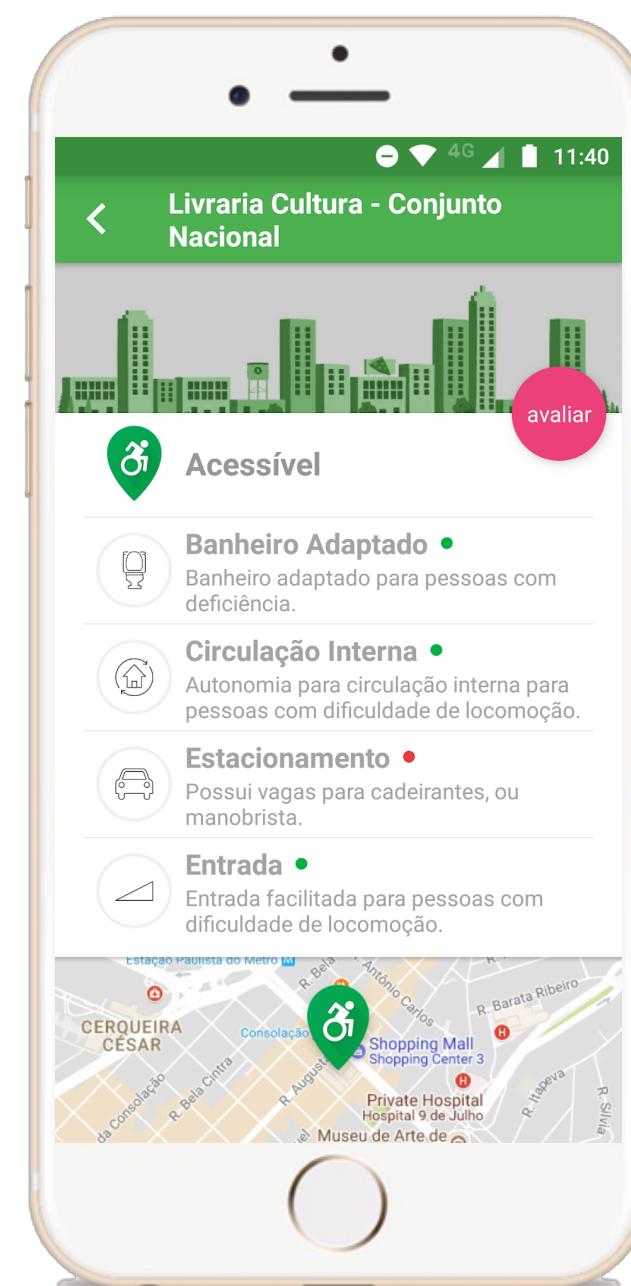
0   351

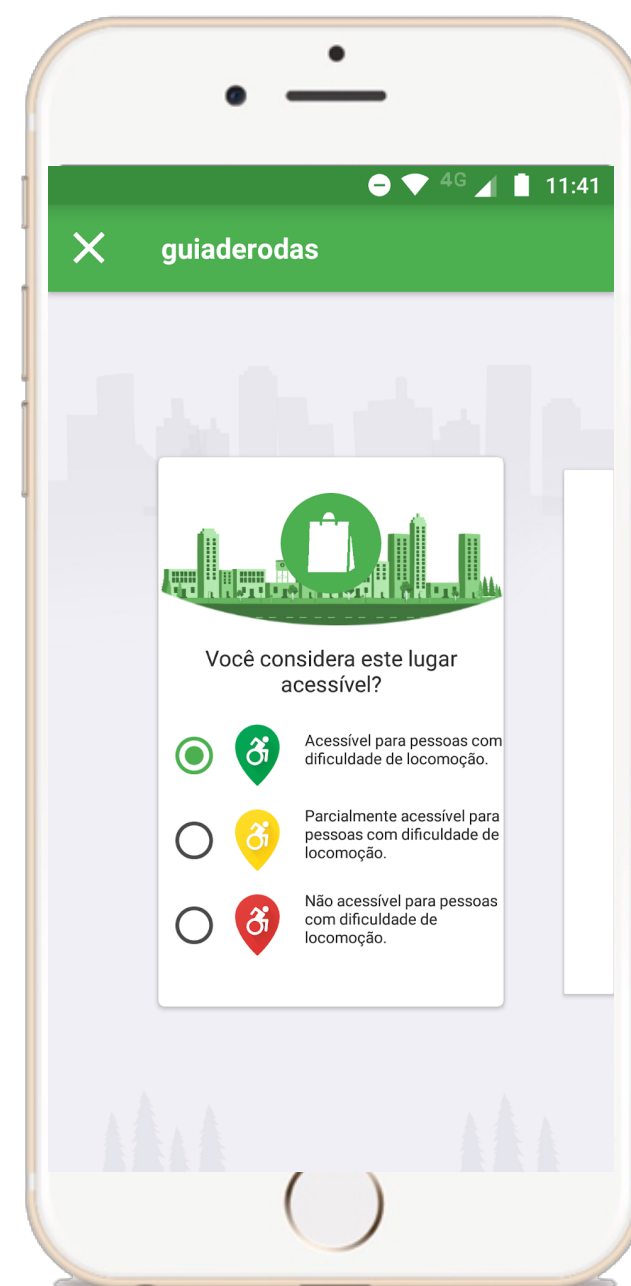Valor da parcela

0   110787

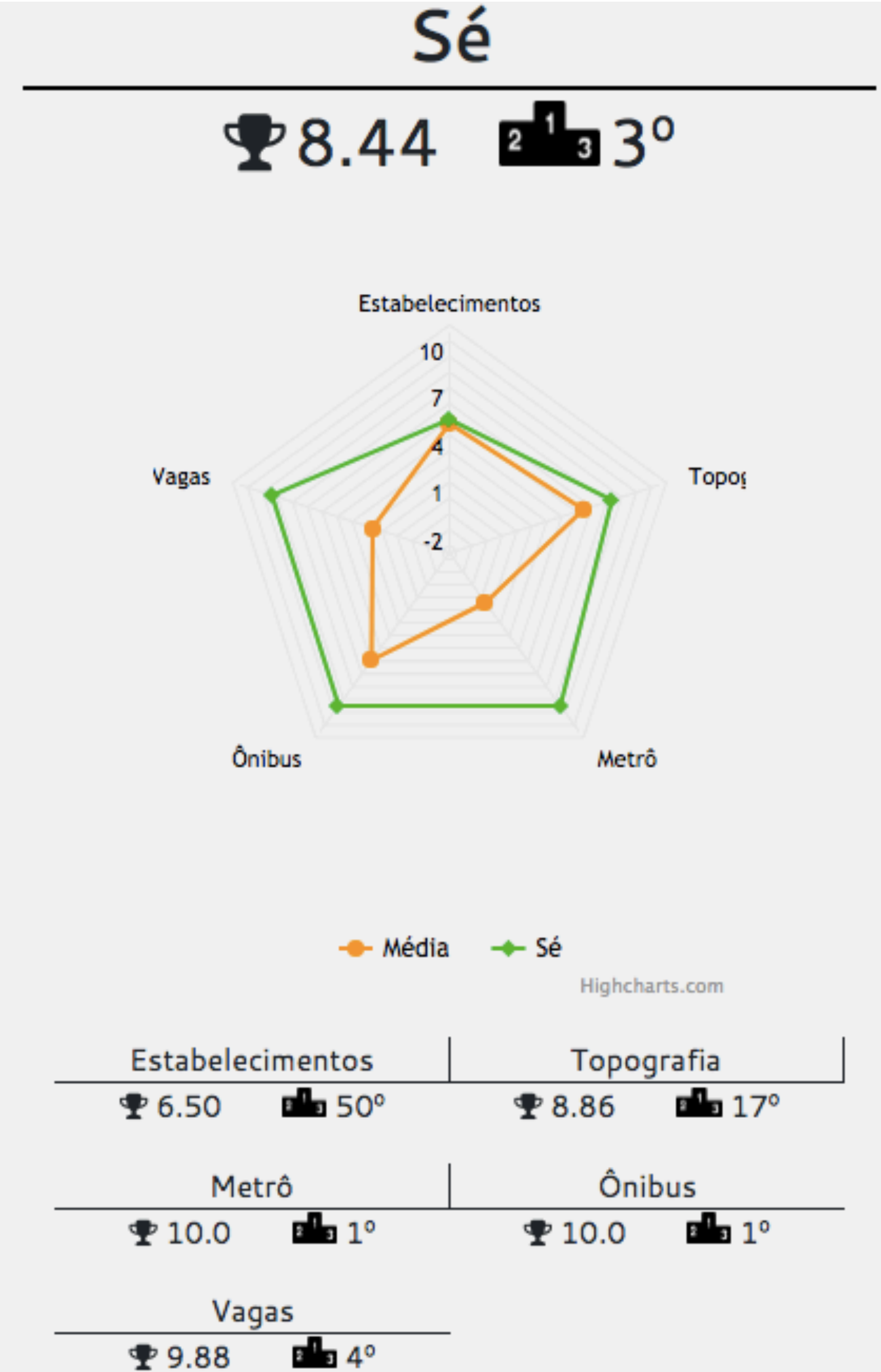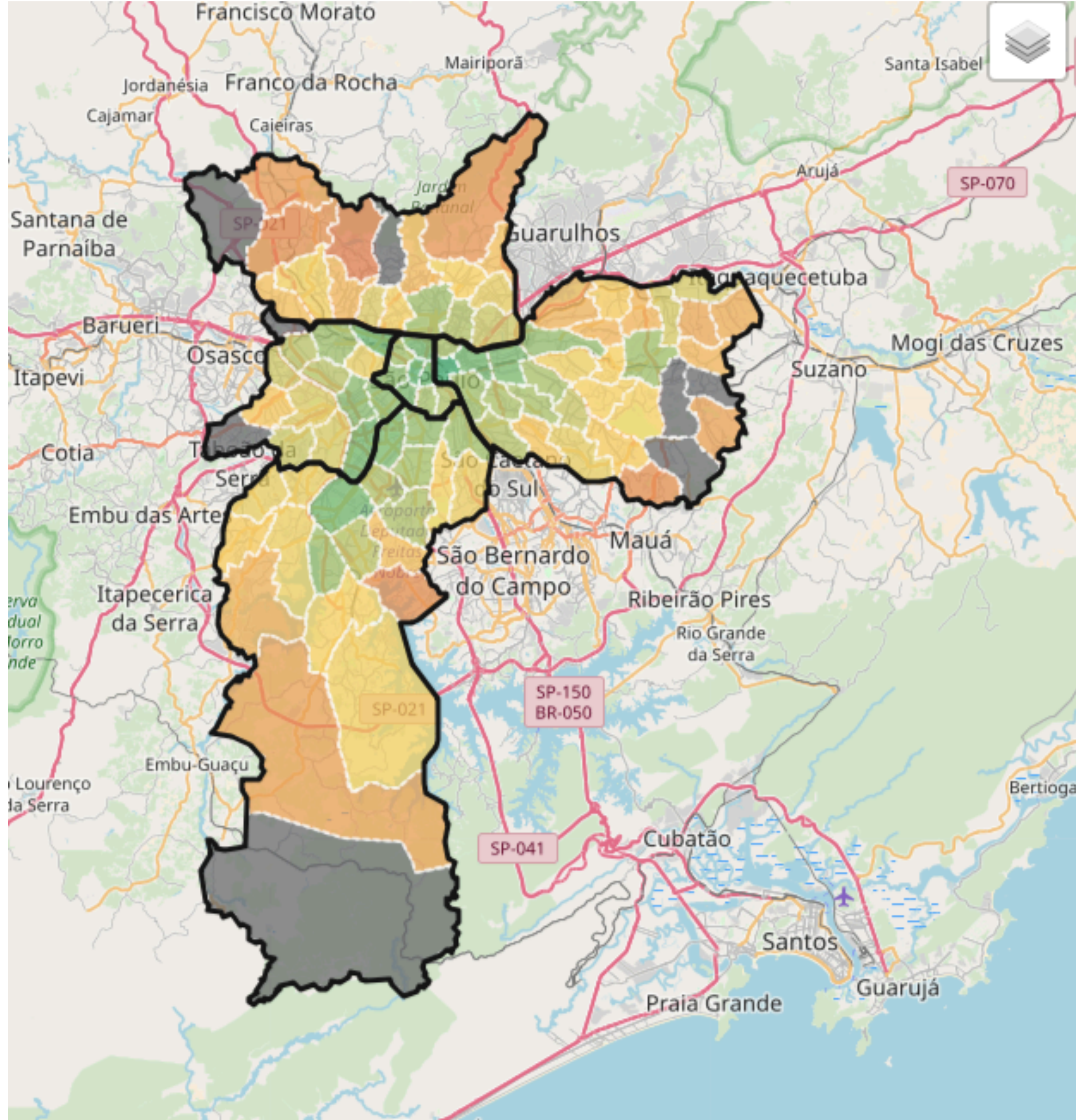Distância de deslocamento(Km)

20   53

Período

até

Health Dashboard Challenges

- At the moment it's a useful interactive tool for the public health professional

- But can we automate part of the work?

- Using ML to detect different patterns for different kinds of diseases?

- Using AI to trigger warnings to the Health officials?

- Develop models to support long-term planning?
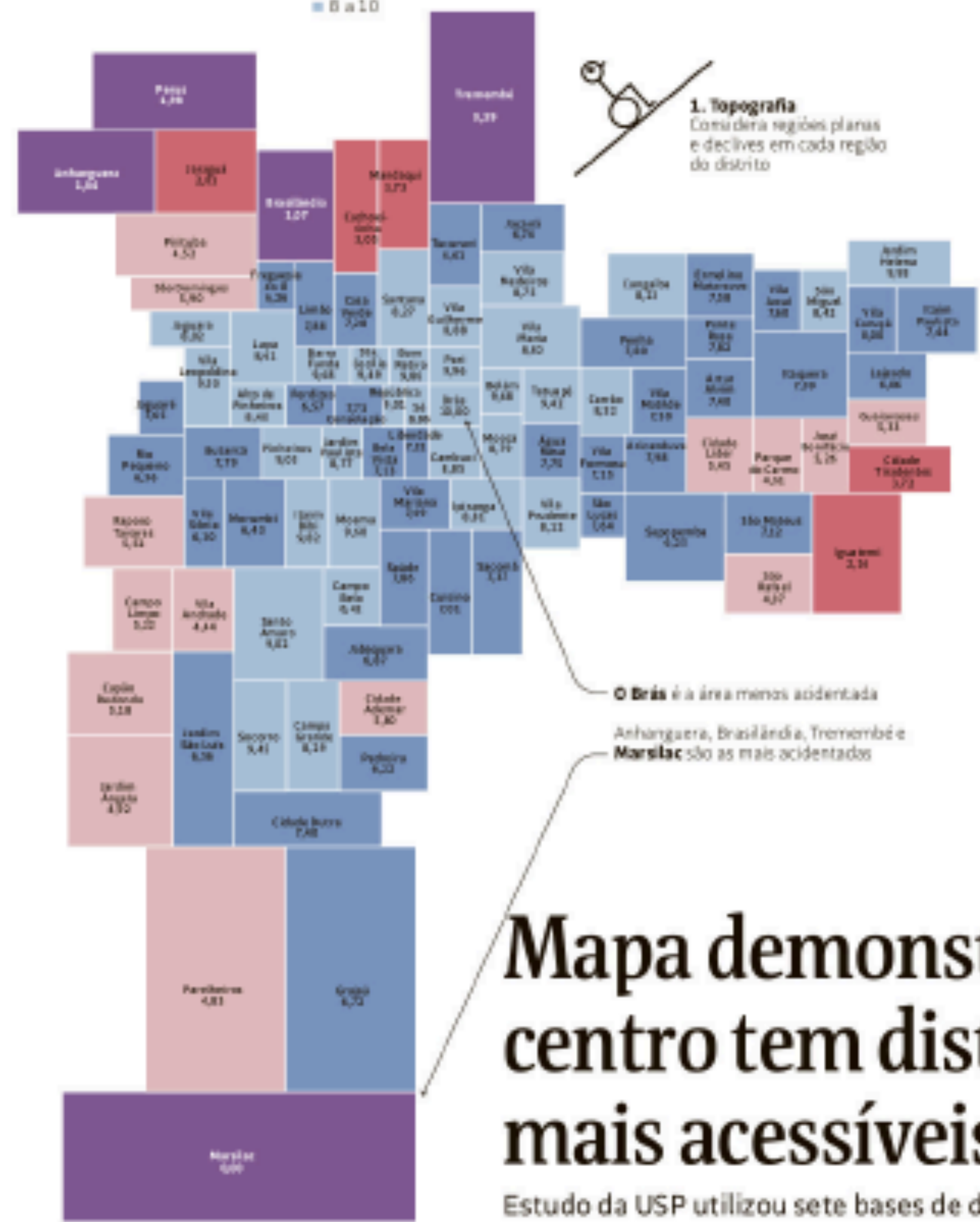
4 -
Crowdsourcing startup App: *guiaderodas*

Accessibility Ranking

Sé

🏆 8.44   🏅 3º

Média ● — ● Sé

Highcharts.com

Estabelecimentos		Topografia	
🏆 6.50	🏅 50º	🏆 8.86	🏅 17º

Metrô		Ônibus	
🏆 10.0	🏅 1º	🏆 10.0	🏅 1º

Vagas	
🏆 9.88	🏅 4º

Estudo mostra o nível de acessibilidade por região em São Paulo

Cada distrito recebeu uma **nota de 0 a 10** em cinco indicadores, as periferias tiveram os piores índices

- 0 a 2
- 2 a 4
- 4 a 6
- 6 a 8
- 8 a 10

1. Topografia
Considera regiões planas e declives em cada região do distrito

Quem pode ser prejudicado pela falta de acessibilidade

➤ 674 mil pessoas com deficiência motora vivem em São Paulo (2010)

➤ 50% dos moradores da cidade têm excesso de peso (2015)

➤ 20% da população paulistana será idosa em 2030

➤ 577 mil bebês (portanto crianças de colo) nasceram no município entre jan.15 e dez.17

O Brás é a área menos acidentada

Anhanguera, Brasilândia, Tremembé e **Marsilac** são as mais acidentadas

Mapa demonstra que centro tem distritos mais acessíveis de SP
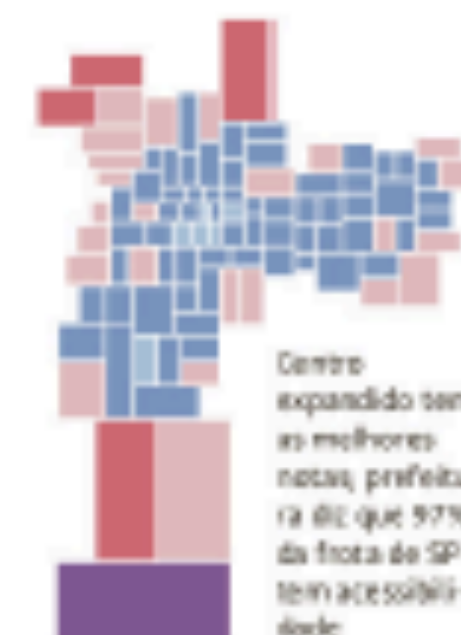
Estudo da USP utilizou sete bases de dados para montar ranking de mobilidade; periferia fica com piores posições

1. Ônibus acessíveis
Considera o percentual de ônibus acessíveis nas linhas que cruzam o distrito

Centro expandido tem as melhores notas, prefeitura diz que 97% da frota de SP tem acessibilidade
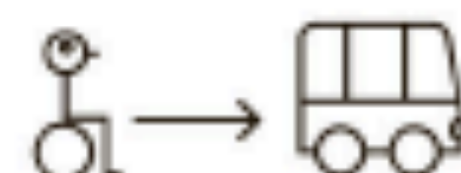
3. Distância até o transporte
Considera o deslocamento médio até as estações de metrô e trem

Metade dos distritos teve índice pior que 1

4. Vagas de estacionamento
Considera vagas de rua para idosos e cadeirantes em relação à área do distrito
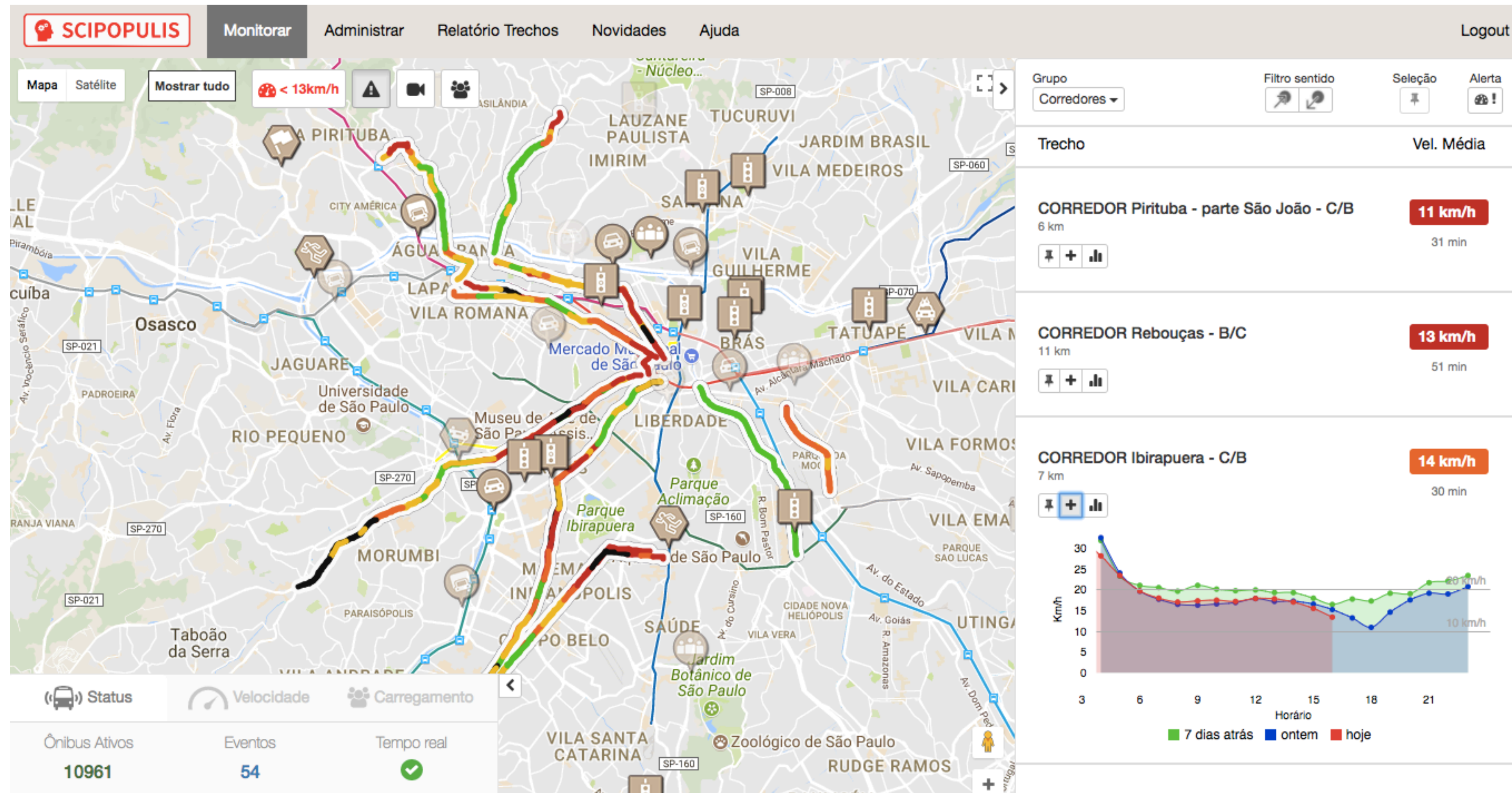
Jairo Marques e Fábio Takahashi

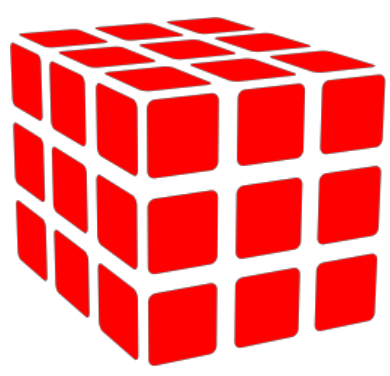# Scipopulis' COLETIVO APP
(for citizens)

REAL TIME DASHBOARD
(for system operators)

- In use by the São Paulo secretary of transportation
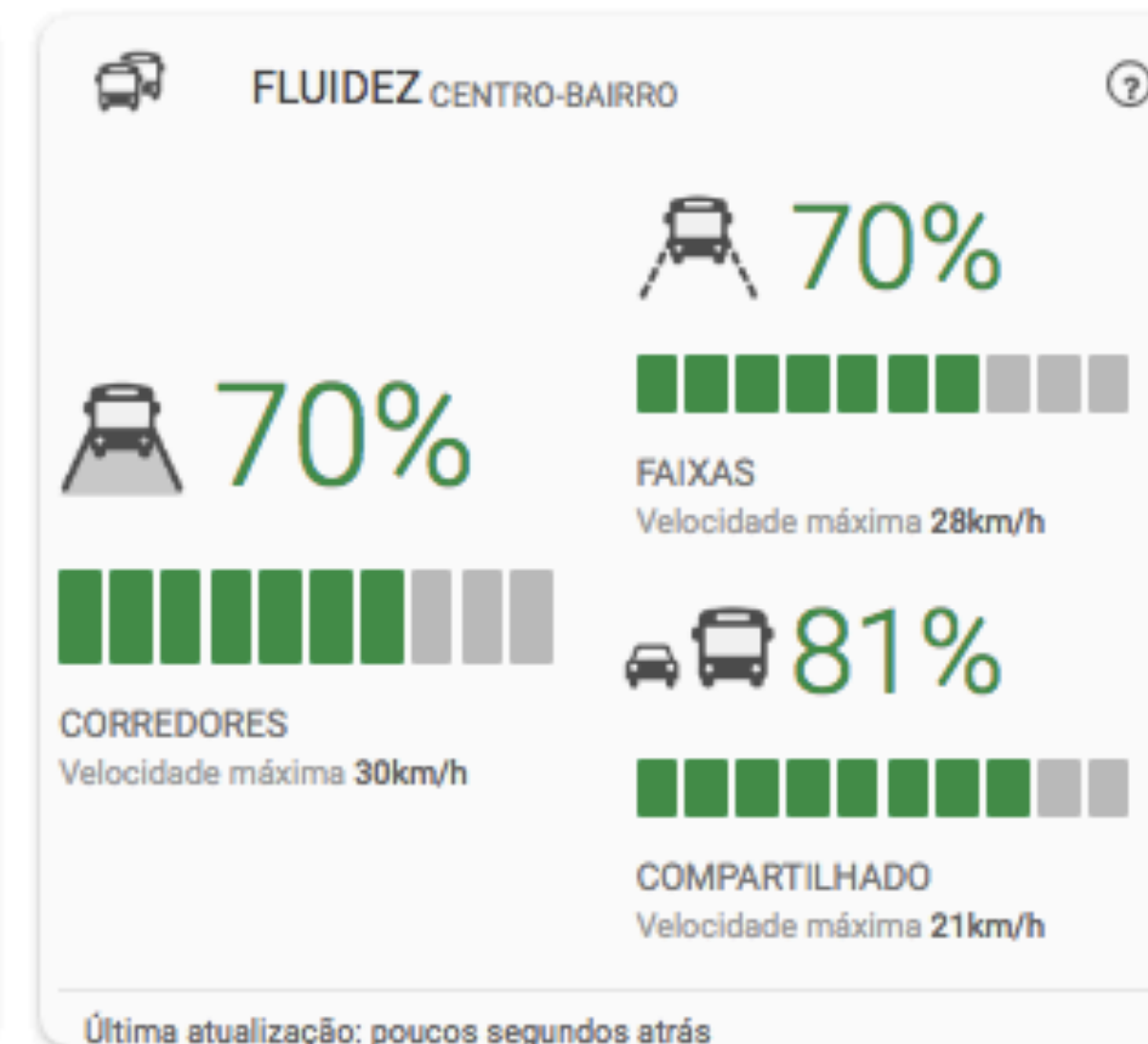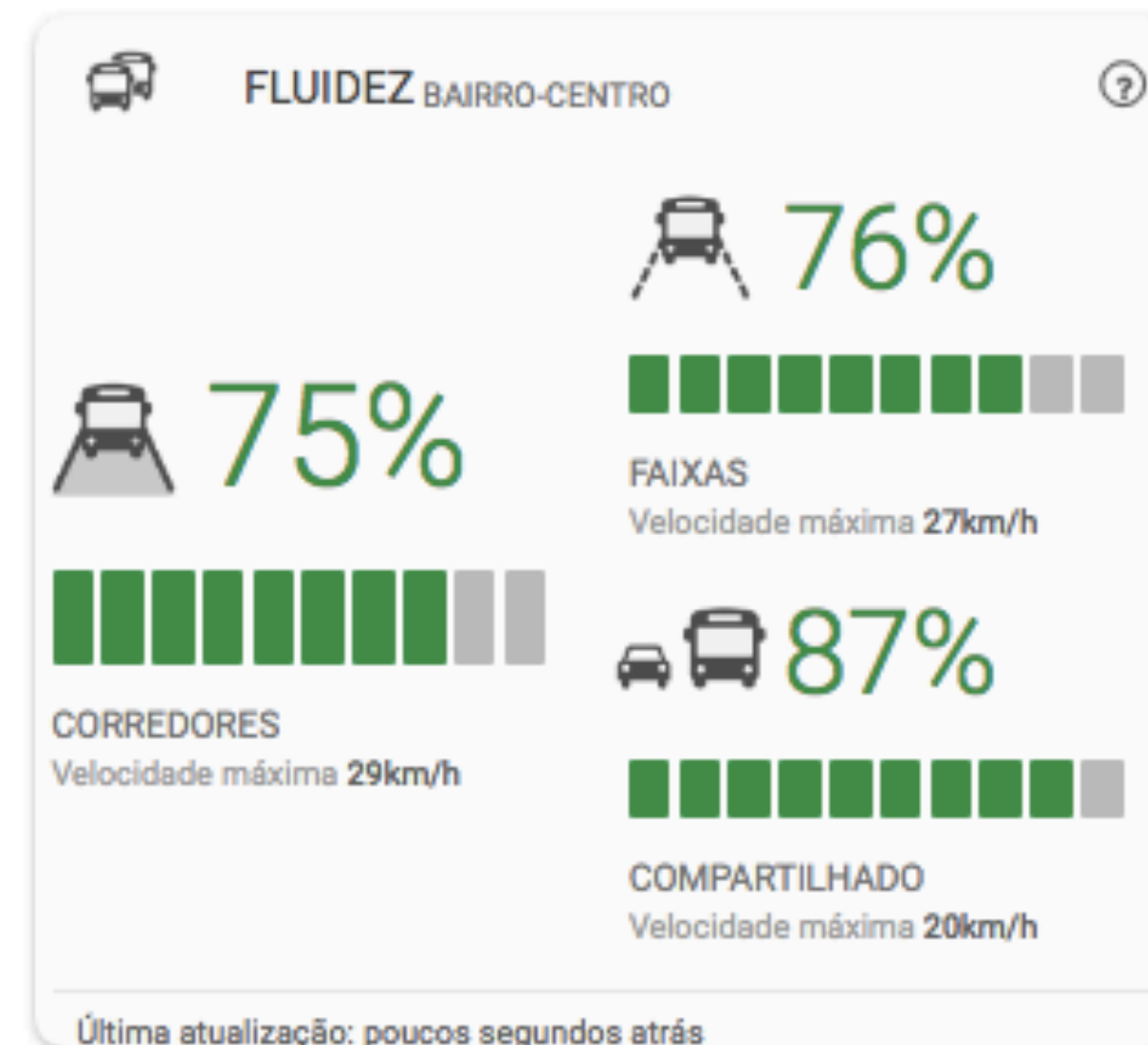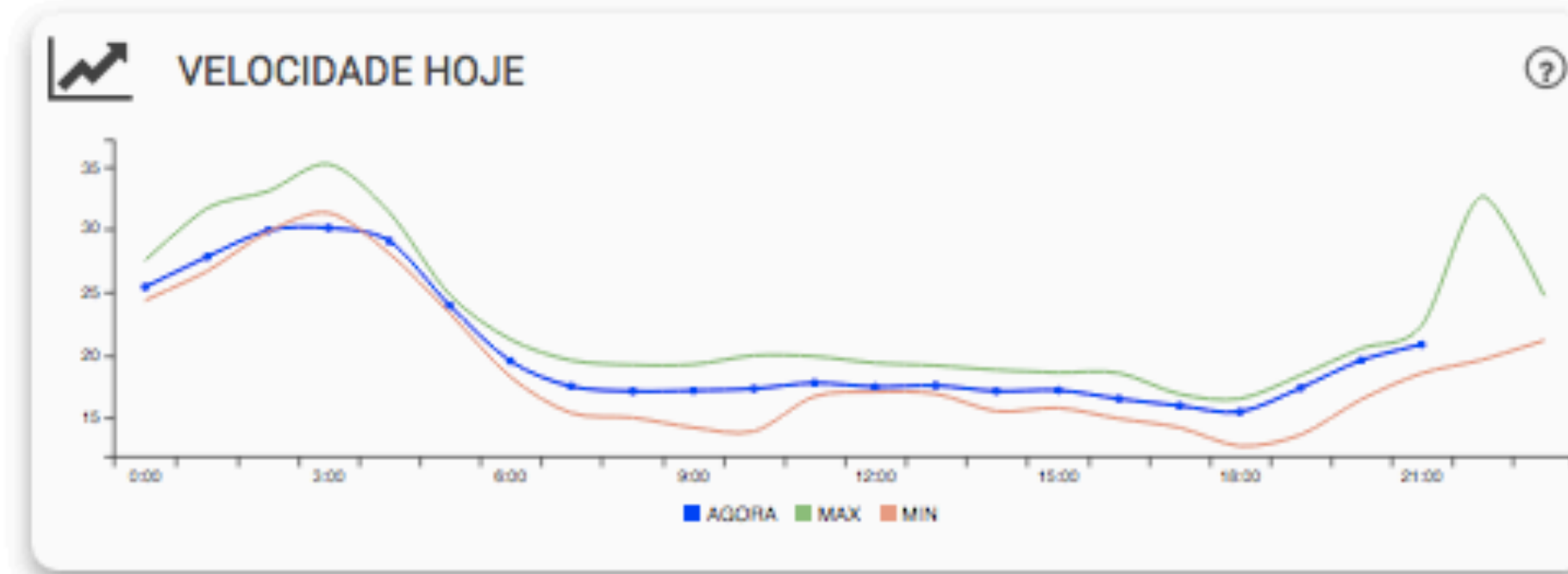- in test at: Rio de Janeiro, Curitiba, Santiago (Chile), Brasilia, etc.

MOBILITY PANEL
(CONSOLITADED BUS SPEEDS for citizens)
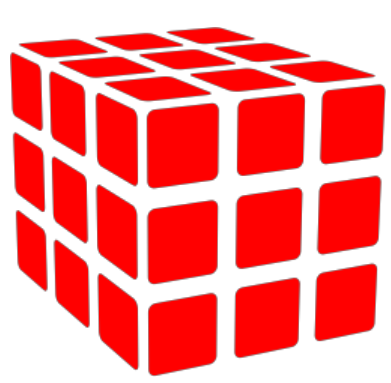
DATA ANALYSIS and visualization

Historical data

Comparing bus x auto

Terças-feiras

Pico manhã 8.5   Entre picos 17.1   Pico tarde 17.3

27/Oct 03/Nov 10/Nov 17/Nov 24/Nov 01/Dec 08/Dec mediana
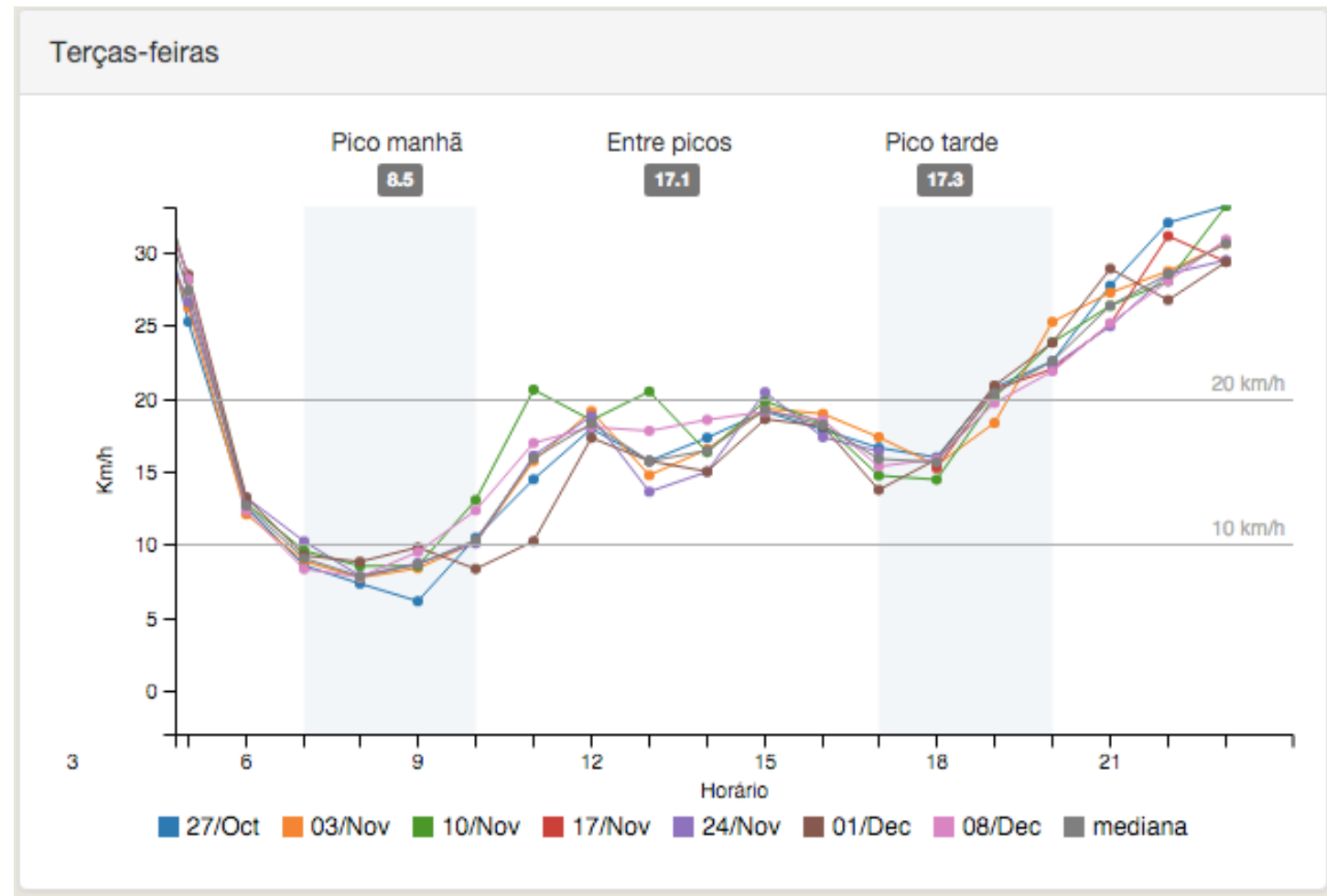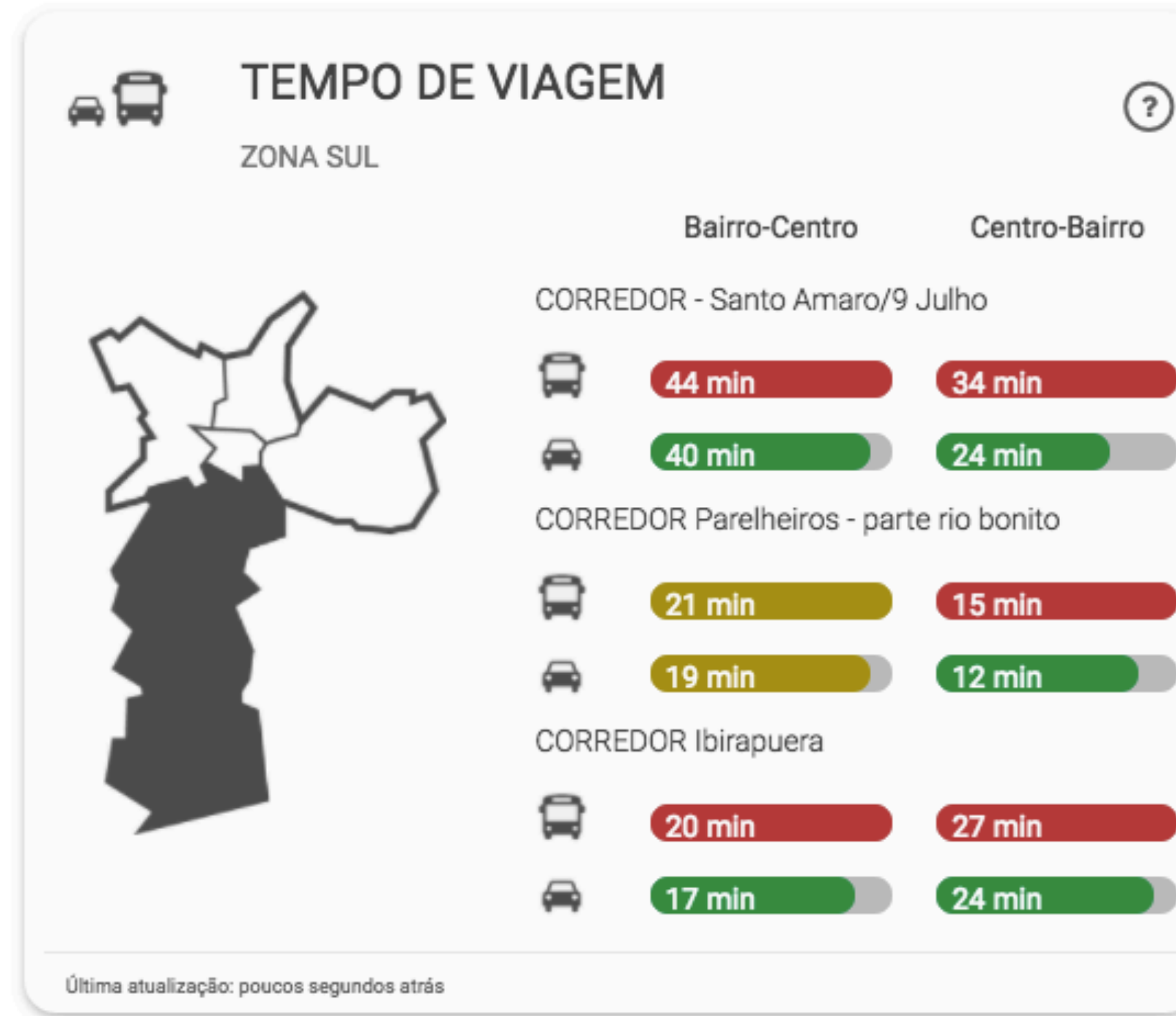
Headway discrepancy per bus stop

bus stop #

Hour

VELOCIDADE MÉDIA AGORA

CENTRO-BAIRRO

16.2   14.1

FAIXAS
Velocidade
habitual

CORREDORES
Velocidade média habitual
17.0km/h

13.9

COMPART
Velocidade
habitual

Última atualização: poucos segundos atrás

TEMPO DE VIAGEM

ZONA SUL

	Bairro-Centro	Centro-Bairro
CORREDOR - Santo Amaro/9 Julho		
🚌	44 min	34 min
🚗	40 min	24 min
CORREDOR Parelheiros - parte rio bonito		
🚌	21 min	15 min
🚗	19 min	12 min
CORREDOR Ibirapuera		
🚌	20 min	27 min
🚗	17 min	24 min

Última atualização: poucos segundos atrás

TIETE LOCAL

45.9

TEMPO REAL

Trecho: PTEDOLIMAO_PTEFRANC...

Sentido: AYRTONSENNA

2Km em 2 minutos

ontem   hoje

VELOCIDADES

17.6   ÔNIBUS
158 km de vias monitora...

24.9   CARRO
191 km de vias monitora...

Última atualização: 2 meses atrás

visualizing the lab's ongoing projects, july 2018

Leadership

Carlo Ratti
Assaf Biderman
Erin Schenck
Rex Britter
Fábio Duarte
Paolo Santi
Rachel Seavey

Researchers

Ricardo Alvarez
Amin Anjomshoaa
Samuel Anklesaria
Iva Bojic
Bill Cai
Louis Charron
Cheng Dai
Priyanka deSouza
Fábio Duarte
Umberto Fugiglando
Banti Gheneti
Lenna Johnsen
Erkan Kayacan
Dániel Kondor
Xiaojiang Li
Qianhui Liang
Iñigo Lorente
Thomas Matarazzo
Luis Mateos
Drew Meyers
Sebastiano Milardo
Kevin O'Keeffe
Gonzalo Ortega
Shinkyu Park
Lea Rausch
Helena Hang Rong
Paolo Santi
Mohit Shah
Wonyoung So
Mohammad Vazifeh
Wei Wang
Longxu Yan
Yuji Yoshimura
Snoweria Zhang

Projects

Autotram Melbourne
CitiVan
City Image
City Scanner
DrivingDNA
Escape
Good Vibrations
Keep it cool
Minimum Fleet
MRT optimization
Responsive Environments
Roboat
Safe Open Mobility
Shareable Cities
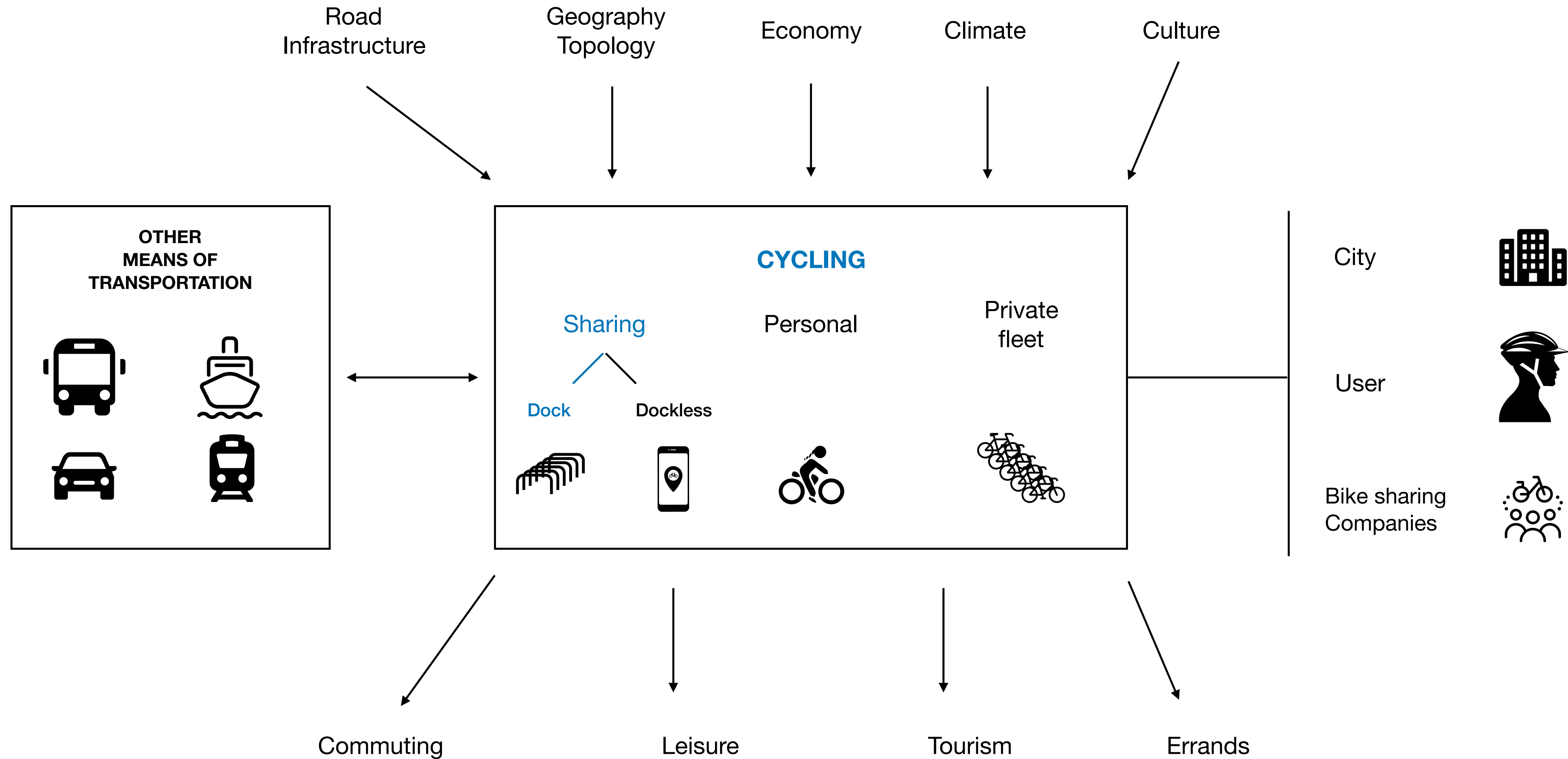Shareable Parking
Treepedia
Underworlds
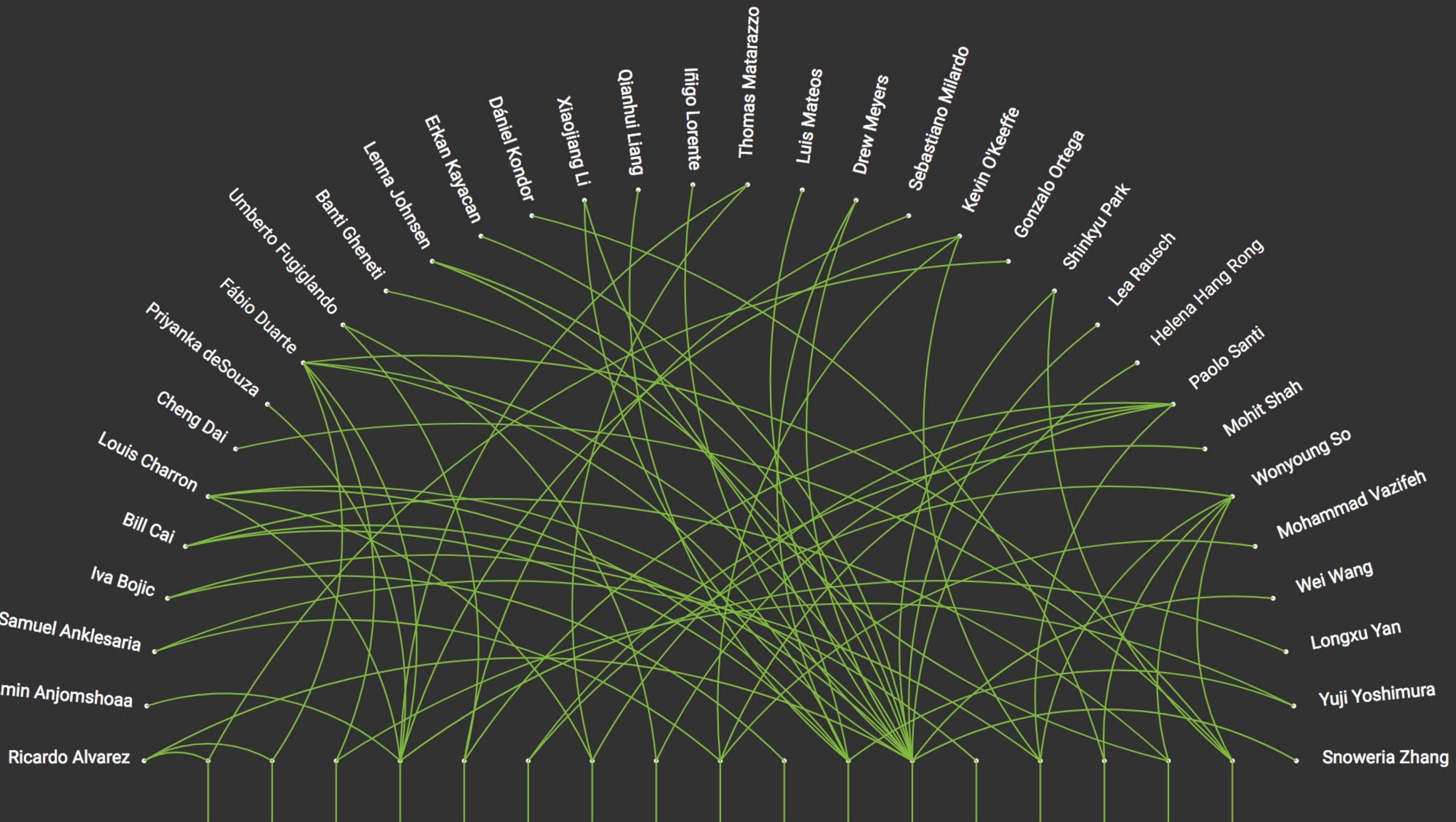
BikeScience @ MIT Senseable City Lab

- Use of bikes for urban transportation is increasing

  - 15+ million shared bikes, increasing rapidly

    - (just a small fraction) of the total # of trips

- Bike transportation has numerous advantages:

  - for the city

  - for the planet

  - for the user

Bikes are underutilized

- London - bikes are faster

  - than public transport for most trips < 8 miles [Properly 2013]

  - 1/3 of current car trips [City of London 2017]

- USA [Dept. of Transportation 2017]

  - 35% of car trips are < 2 miles / 46% < 3 miles

  - 1% of trips are on a bike

How can we foster cycling as a serious means of urban transportation

Road Infrastructure

Geography Topology

Economy

Climate

Culture

OTHER MEANS OF TRANSPORTATION

CYCLING

Sharing

Personal

Private fleet

Dock

Dockless

City

User

Bike sharing Companies

Commuting

Leisure
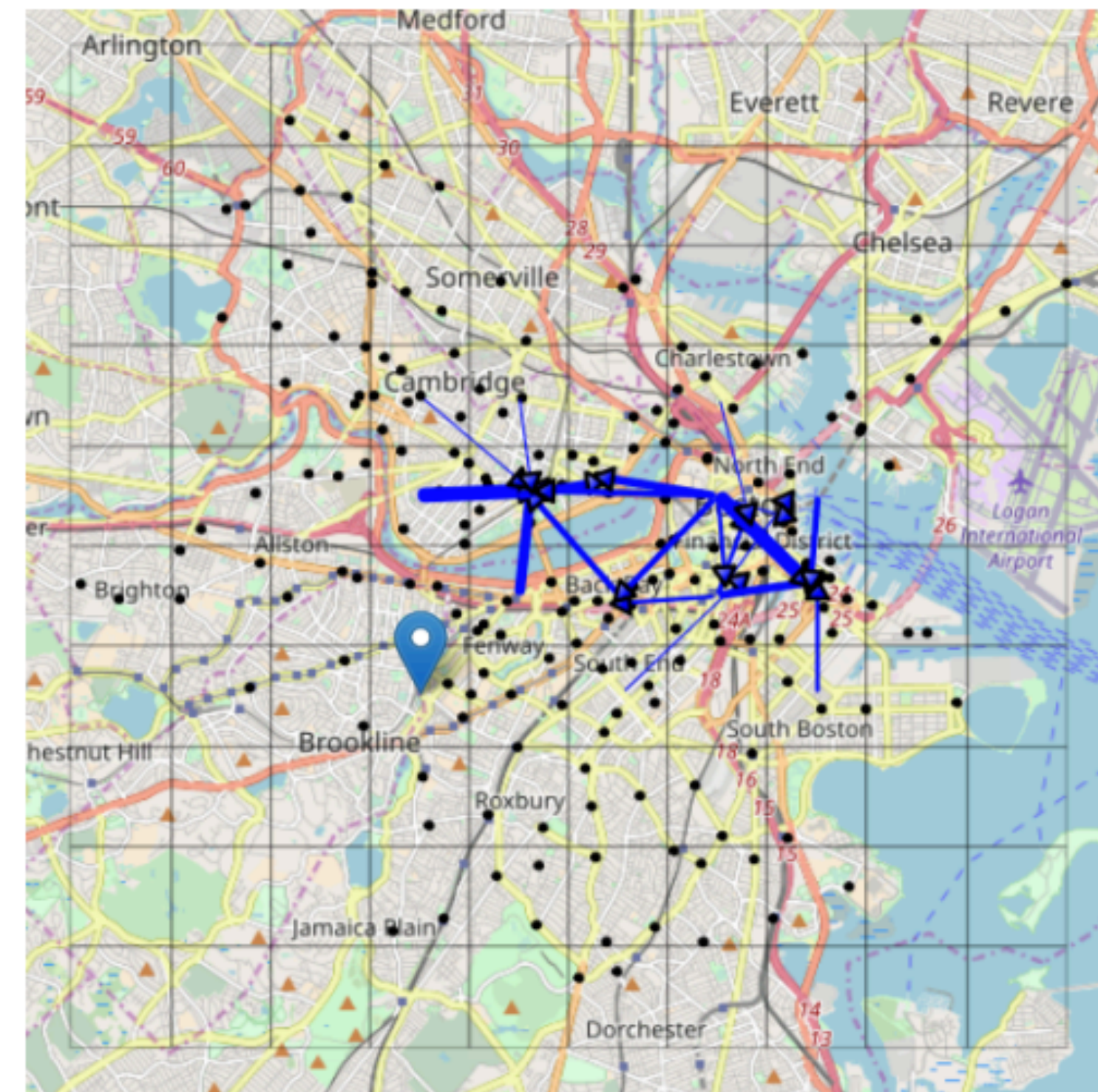
Tourism

Errands

Bike Data Science

- Analyzing millions of bike trips from 20 cities

  - Starting with Greater Boston and São Paulo

  - Dock-based vs. Dockless

  - ~2 million trips from each city

Descriptive Statistics
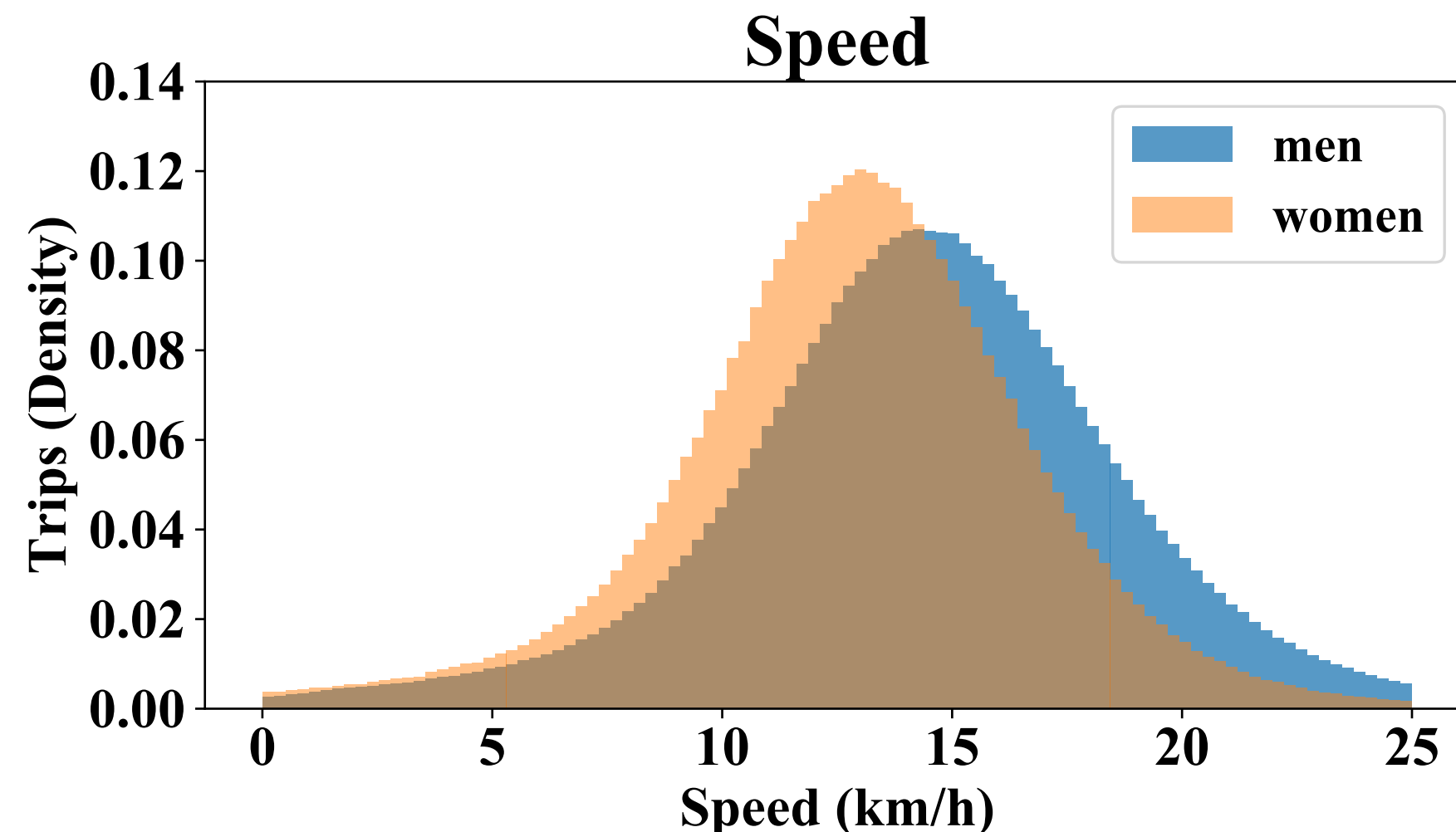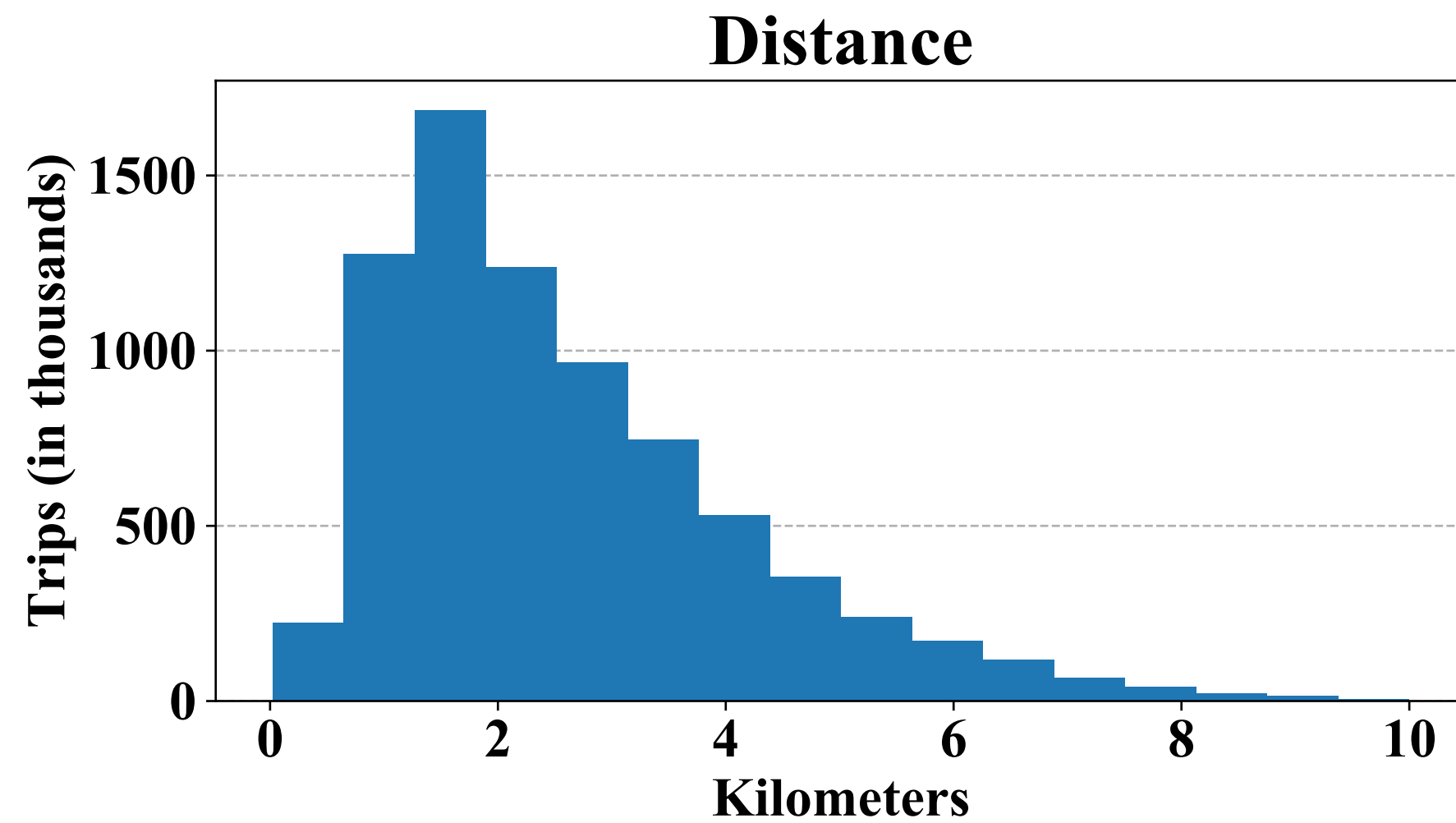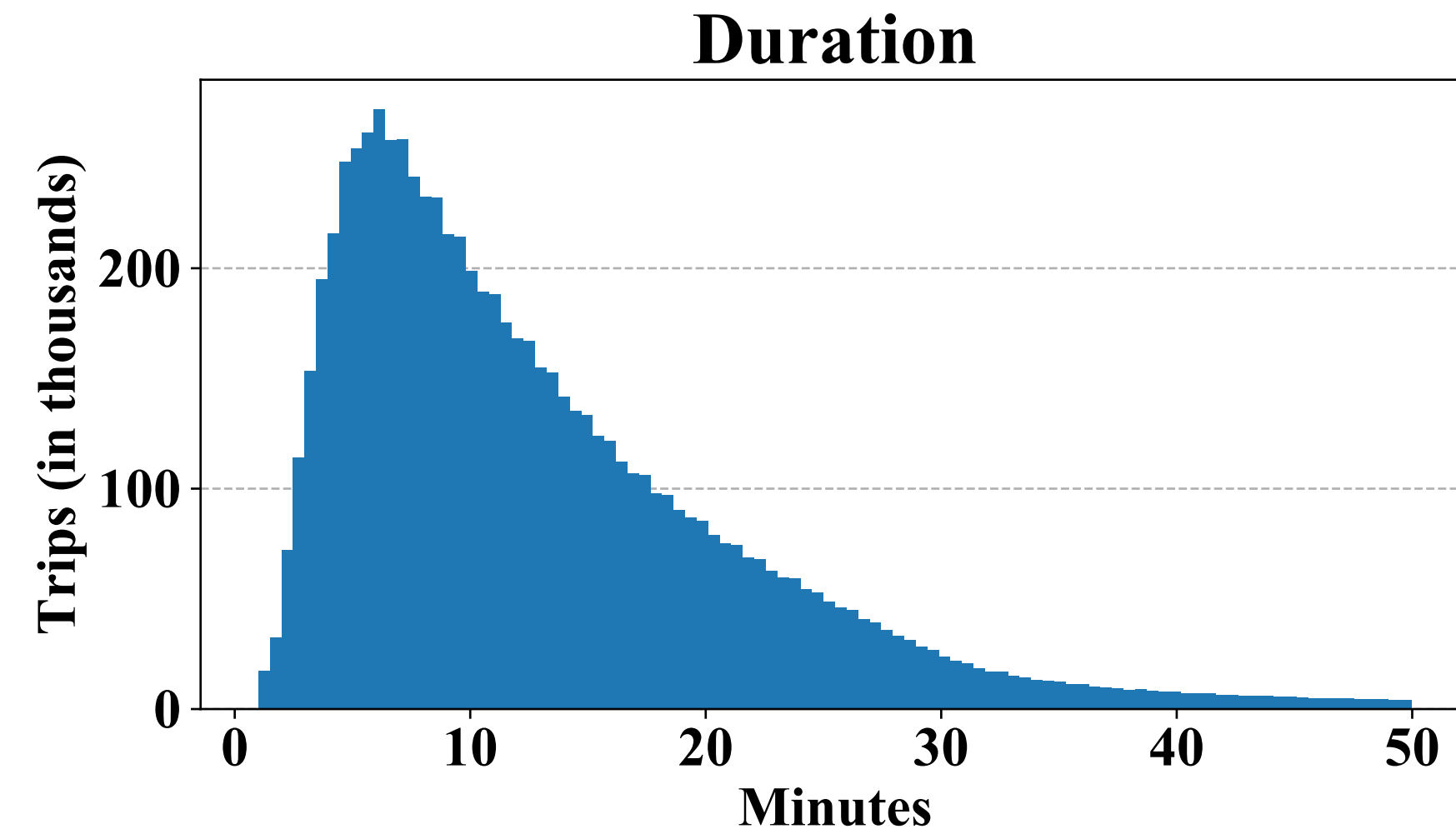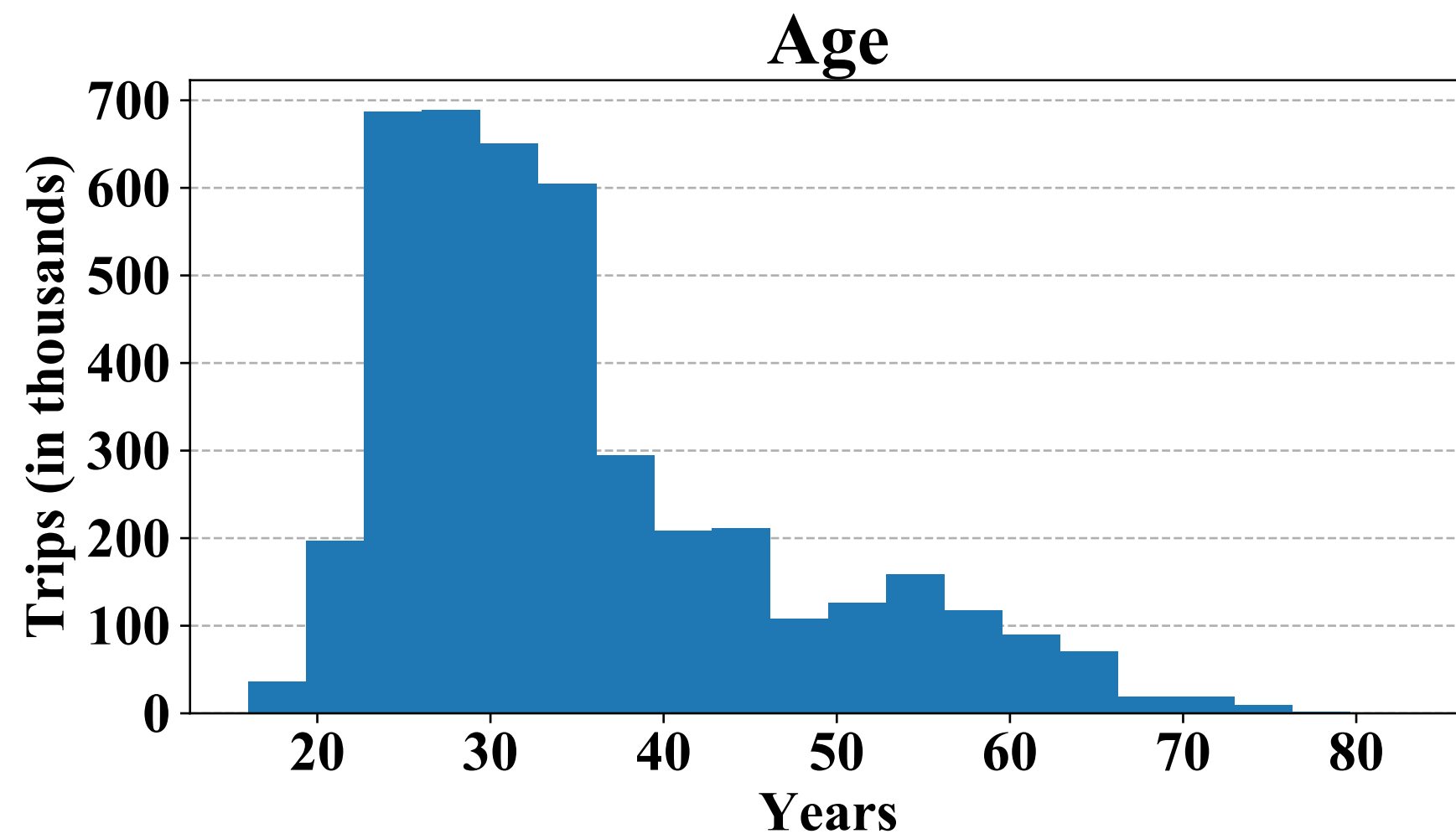
Bike Mobility Flows
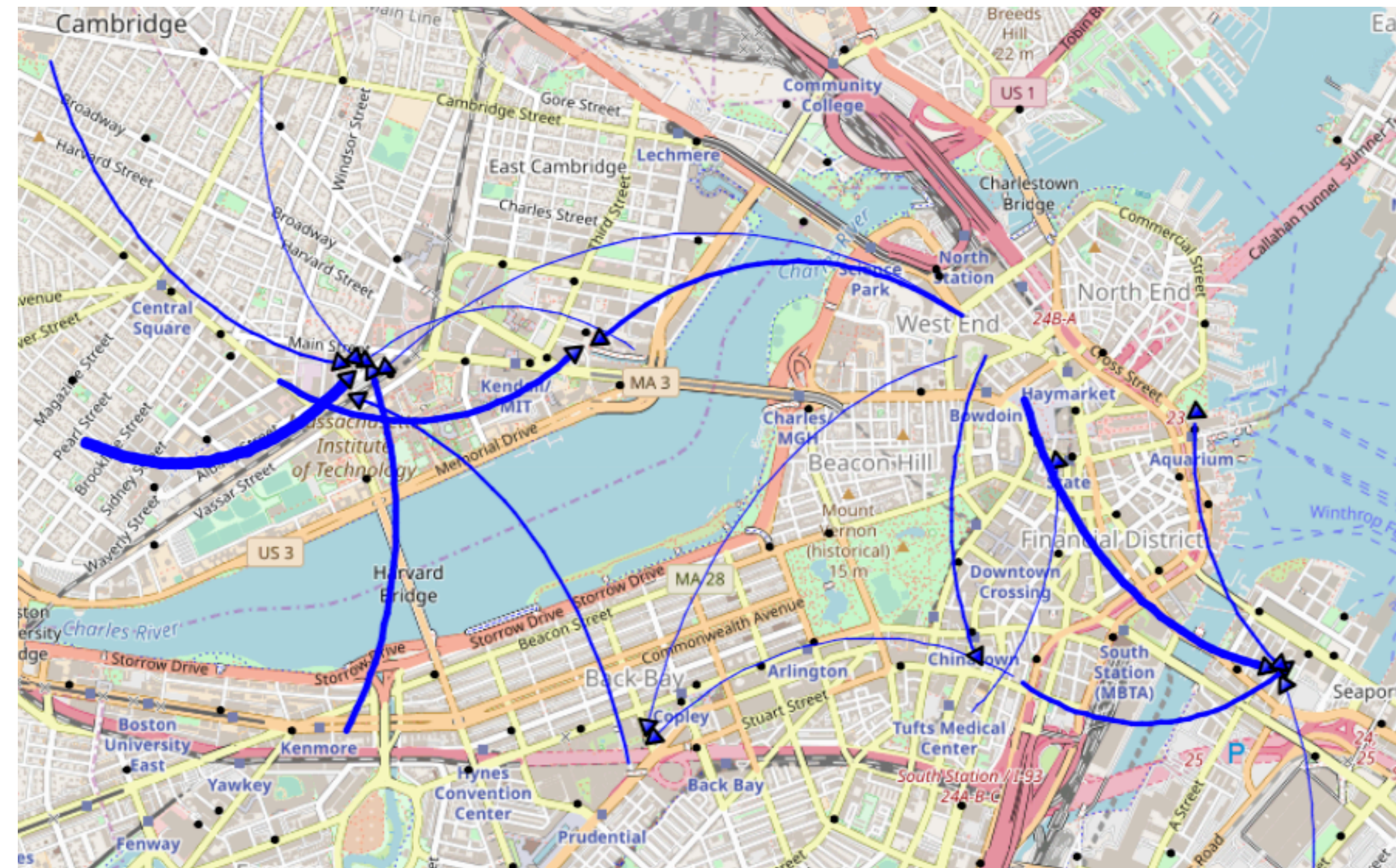

(a) 10x10 grid - across cities

(b) 20x20 grid

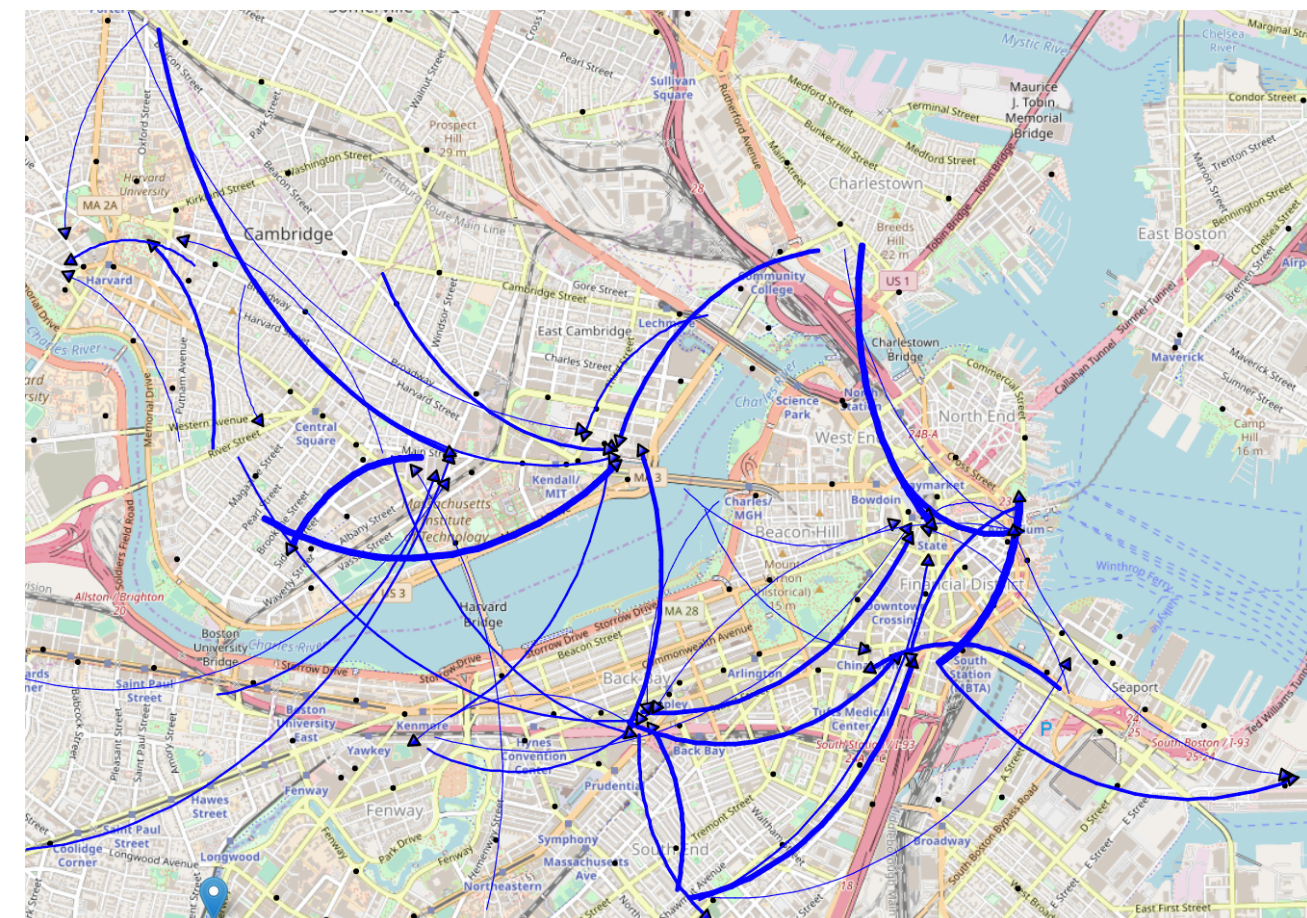(c) 30x30 - flows within a neighborhood

Supporting Public Policy:
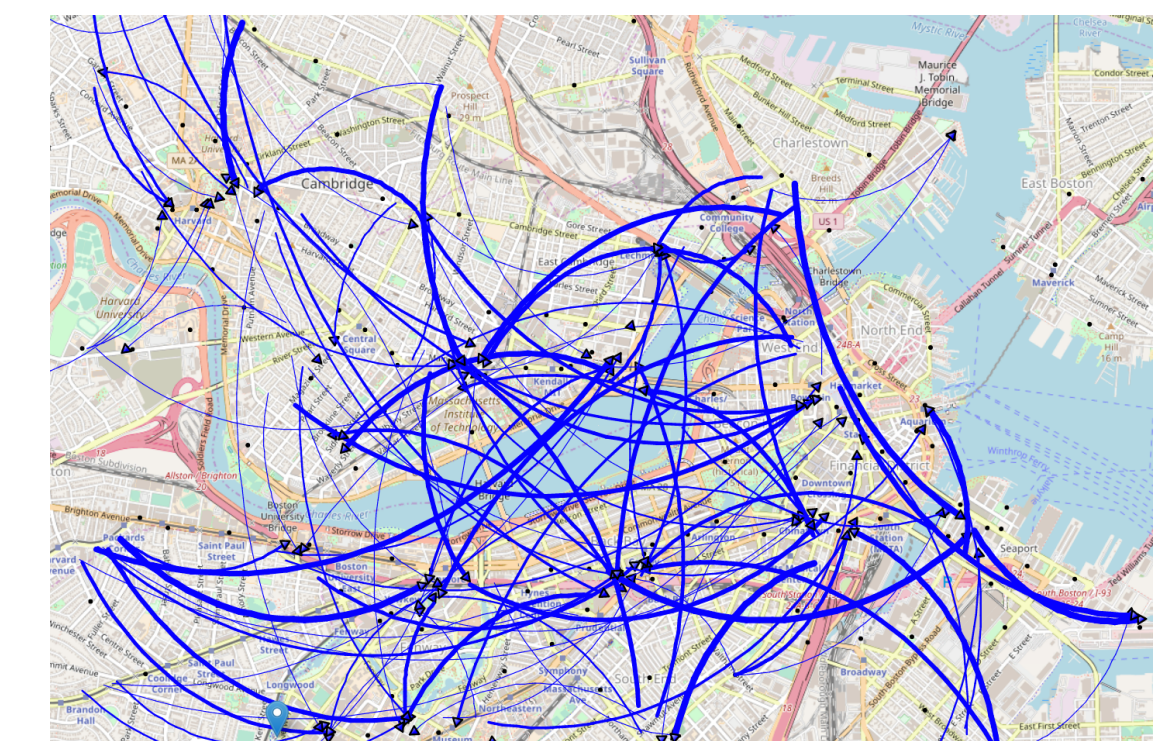# Flow popularity and infrastructure investments

Tier 4: 18 flows ➡ 1% of flows

Total: 1629 different flows

Tier 3: 46 flows ➡ 3% of flows

Tier 2: 119 flows ➡ 7% of flows

Tier 1: 1446 flows — 89% of flows

Profile of Speeders (>15Km/h - euclidean distance)

- 4.5% of trips

- 90% are men / 10% are women

- 50% of them are between 18 and 30 years old

- They are present in all age ranges under 52…

  - but higher tendency to drive dangerously fast: 25 to 30

- Speedy trips length is 20% longer

  - (they might speed because they need to go farther away)

- Speedy trips duration is half of the average (they want to get there quickly)

- A subscriber (normally a resident) is 5 times more likely to be a speeder than an isolated customer (normally a tourist)
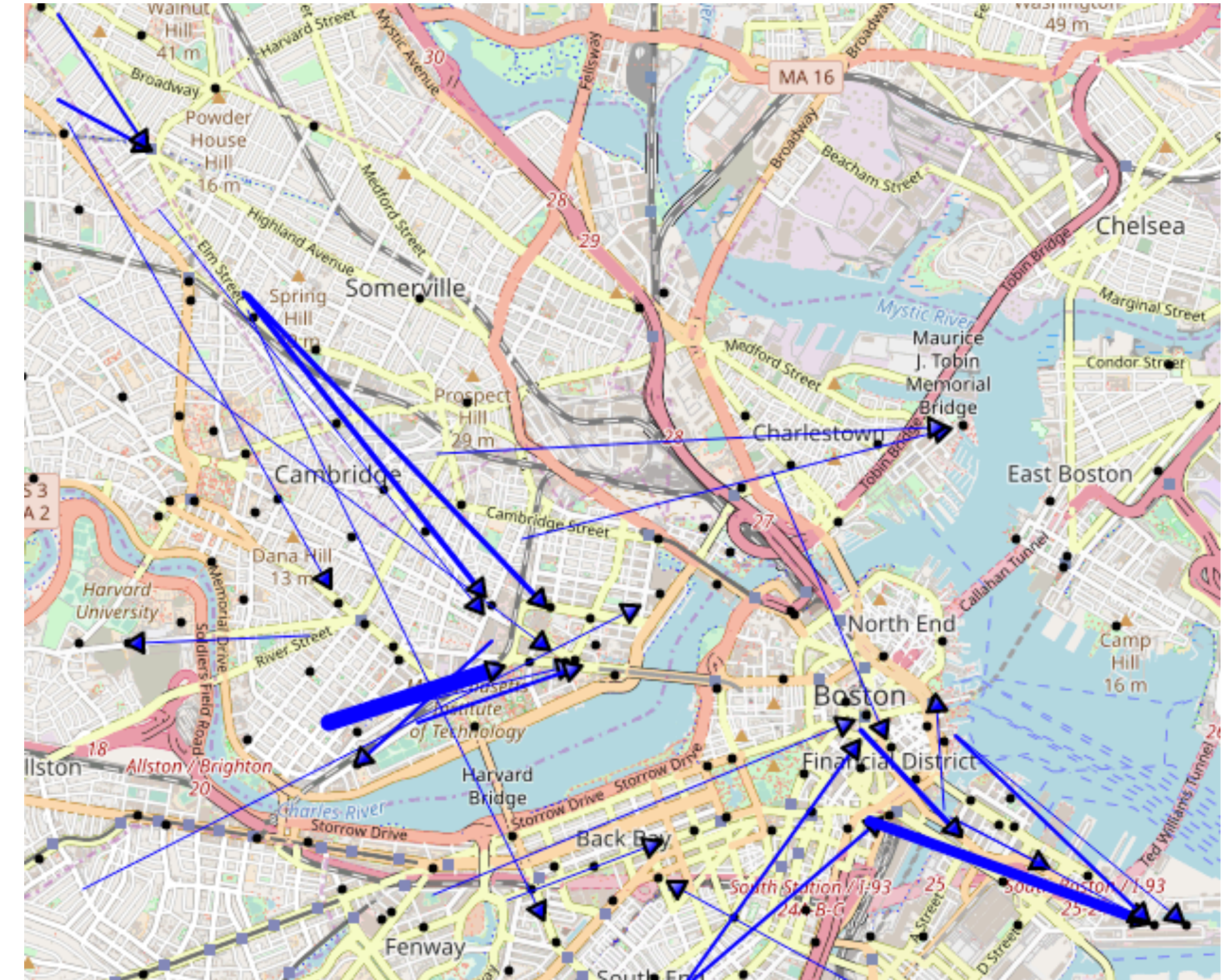
Next steps

- Analyze flows in 20 cities identifying

  - common patterns and different classes of cities

- Analyze relations with socioeconomic and topographic data from city districts ➔ develop ML model

- Analyze data from dockless systems

Contact

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(FAPESP post-doc fellowships available)

Our view

Smart City =
"a city in which its social, business, and technological aspects are supported by ICT to improve the quality of life of its citizens in an integrated, affordable, and sustainable way."

we're interested in developing a
Software platform for Smart Cities