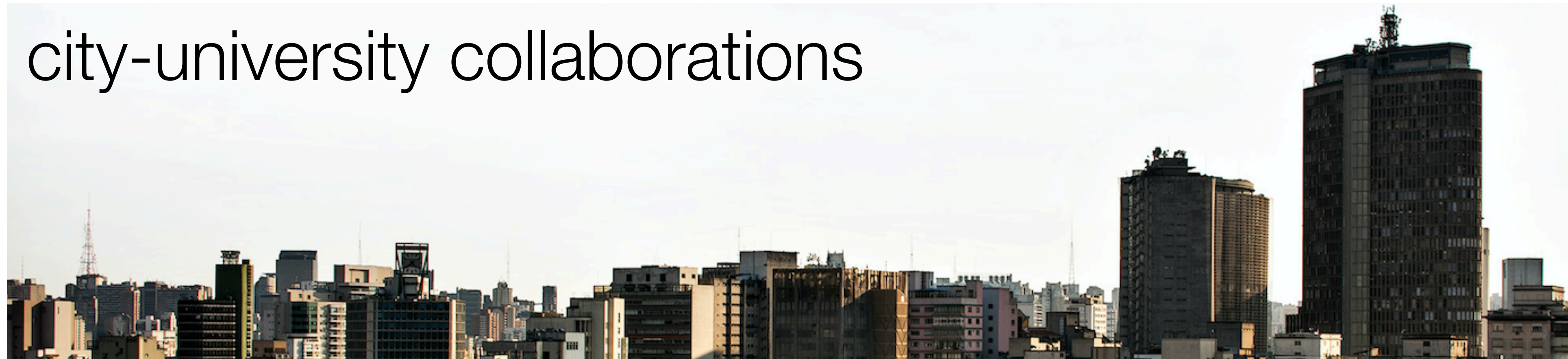# Software and science making cities better

city-university collaborations

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

Fulbright Visiting Professor
MIT Senseable City Lab

Collaborations

- 35 CS professors +

  - Architects, Urban Planners, Economists, Health Professionals, Transportation Engineers

- São Paulo City Hall (21M people in Great São Paulo)

- Smaller cities in Brazil (demands are different)

InterSCity lab in Brazil

~60 people working:

- USP, FGV, PUC-Rio, Scipopulis, UFABC, UFG, UFMA, UFMS, UFRJ, Unicamp, Unifesp

- interface between Computer Science and Cities

- 6-year funding (2017 to 2023)

- **InterSCity.org**

- Open Source software

- Open Datasets

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
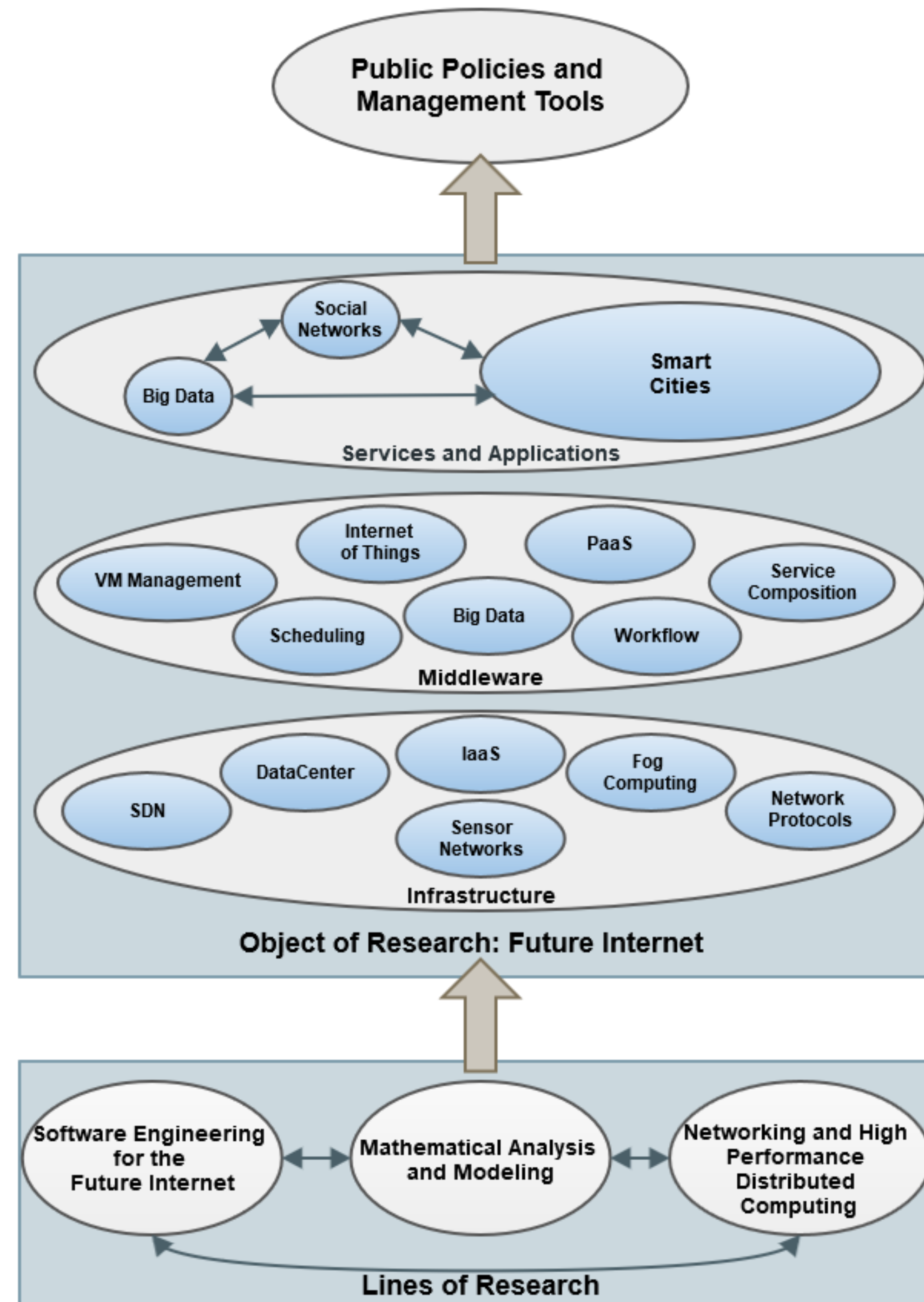**Software platform for Smart Cities**

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

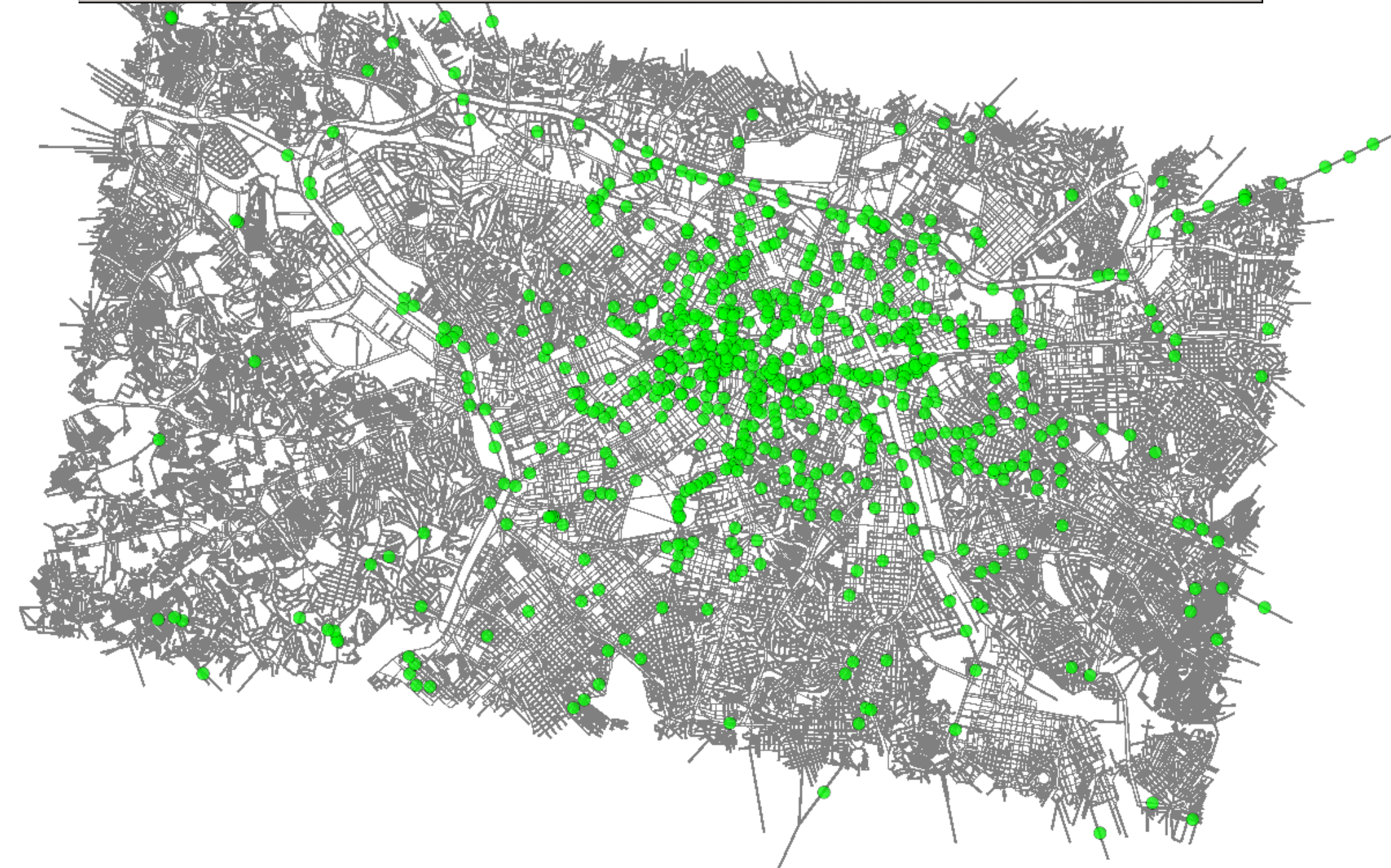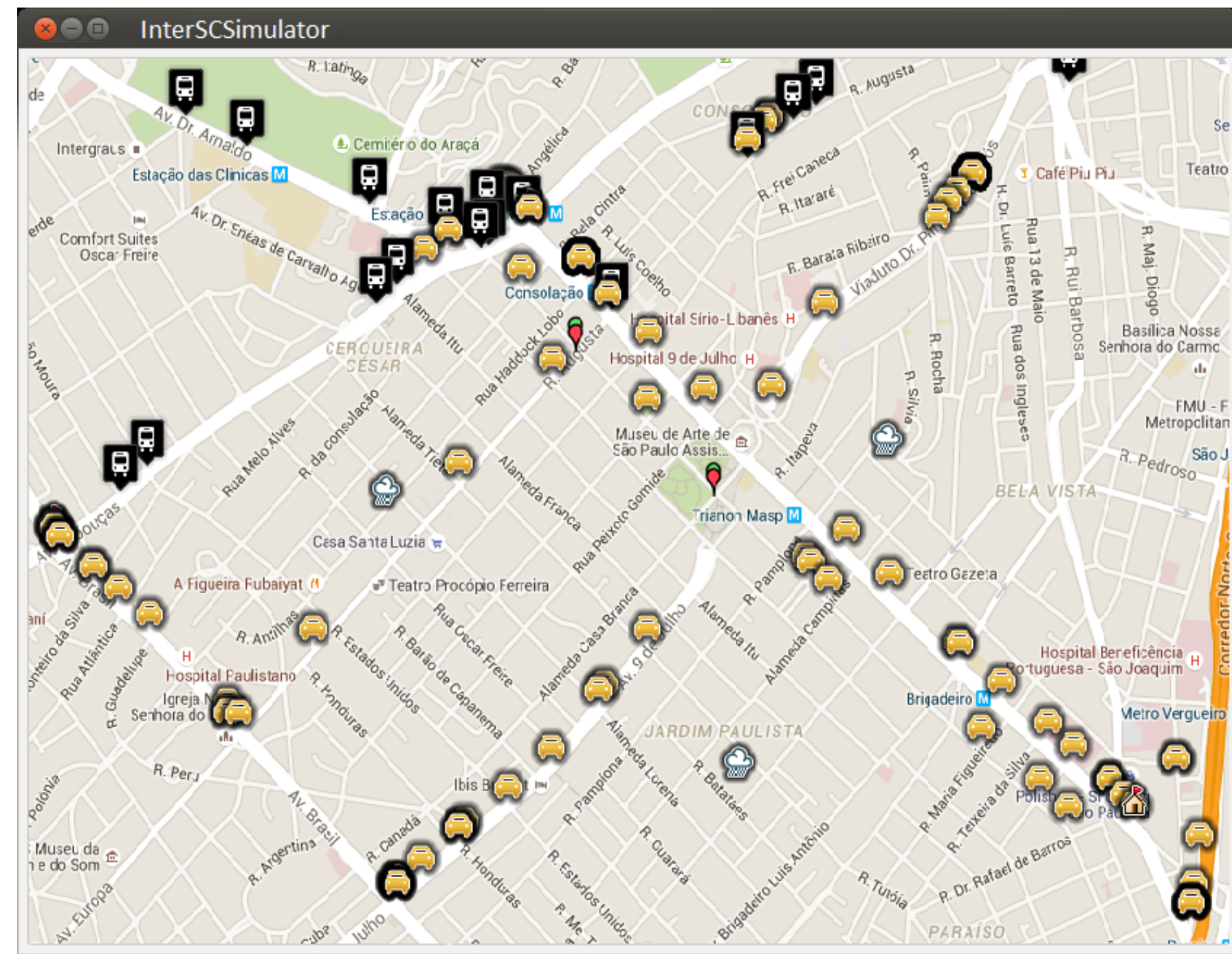# The InterSCity Project

- 3 lines of research

- 3 levels

Projects

1. City Simulator

2. Smart City Software Platform

3. Health Dashboard

4. Accessibility Ranking

5. Scipopulis Startup

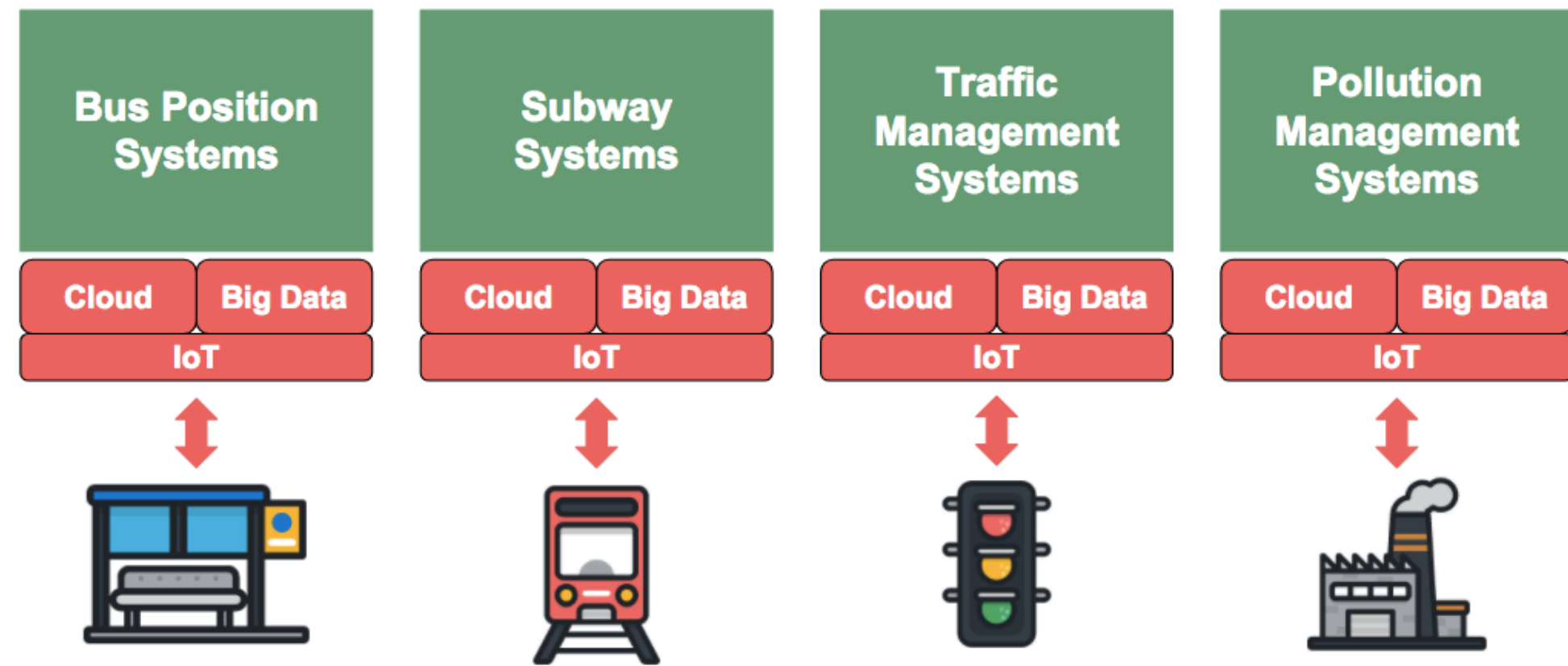6. BikeSCience @ MIT Senseable City Lab

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.

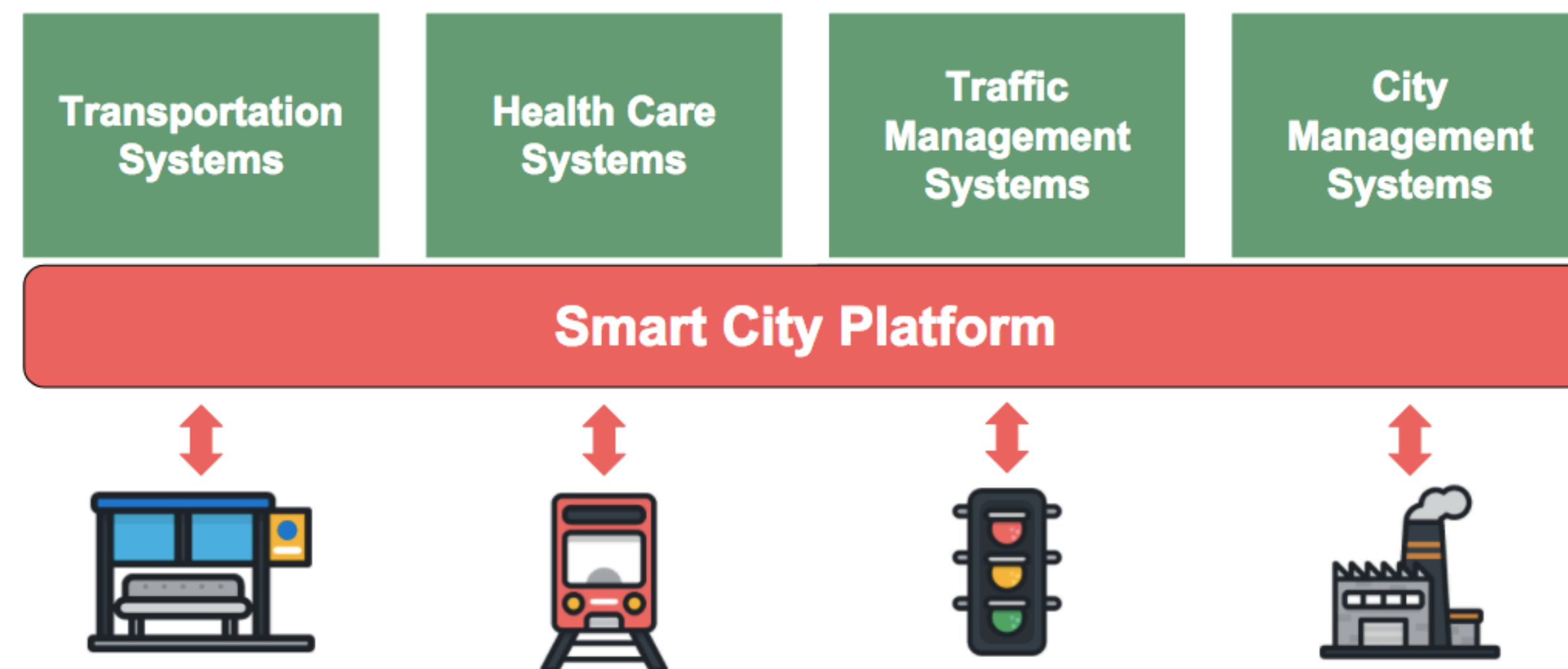 - Population from Paraisópolis favela (slum) in SP.
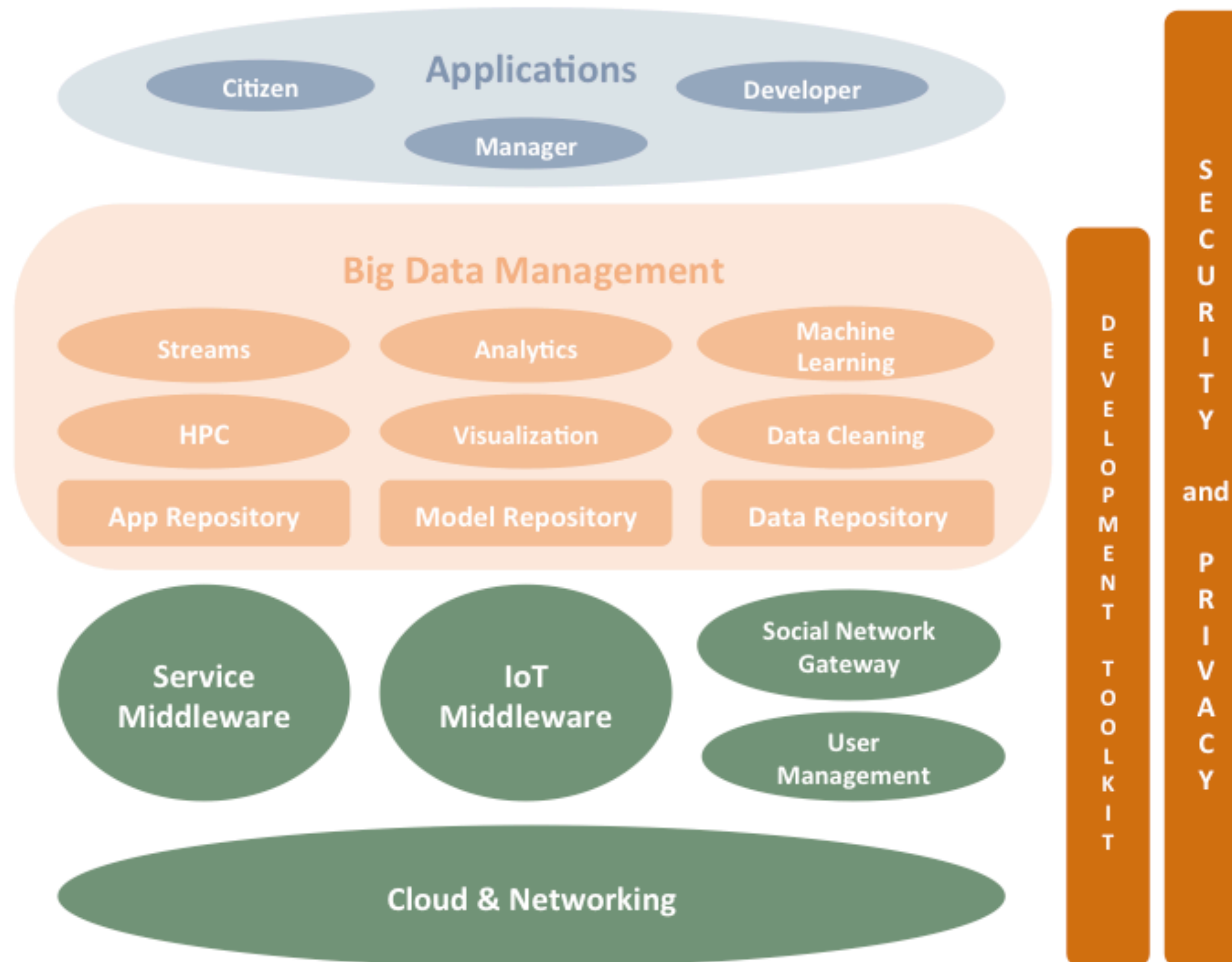
2- A generic Software Platform for Smart Cities

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

Applications

Citizen Developer Manager

Big Data Management

Streams Analytics Machine Learning

HPC Visualization Data Cleaning

App Repository Model Repository Data Repository

Service Middleware IoT Middleware Social Network Gateway

User Management

Cloud & Networking

DEVELOPMENT TOOLKIT

SECURITY and PRIVACY

**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

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
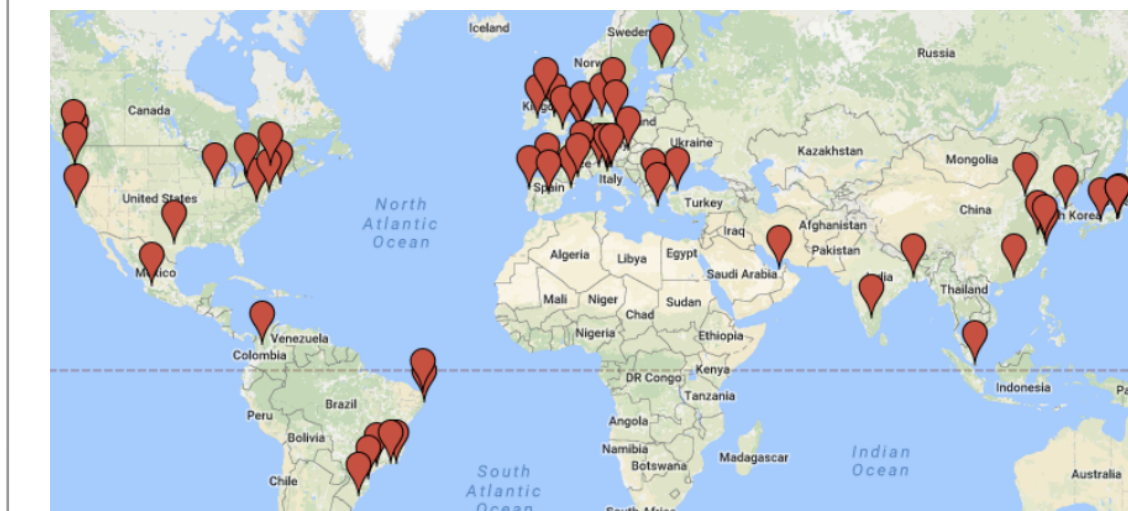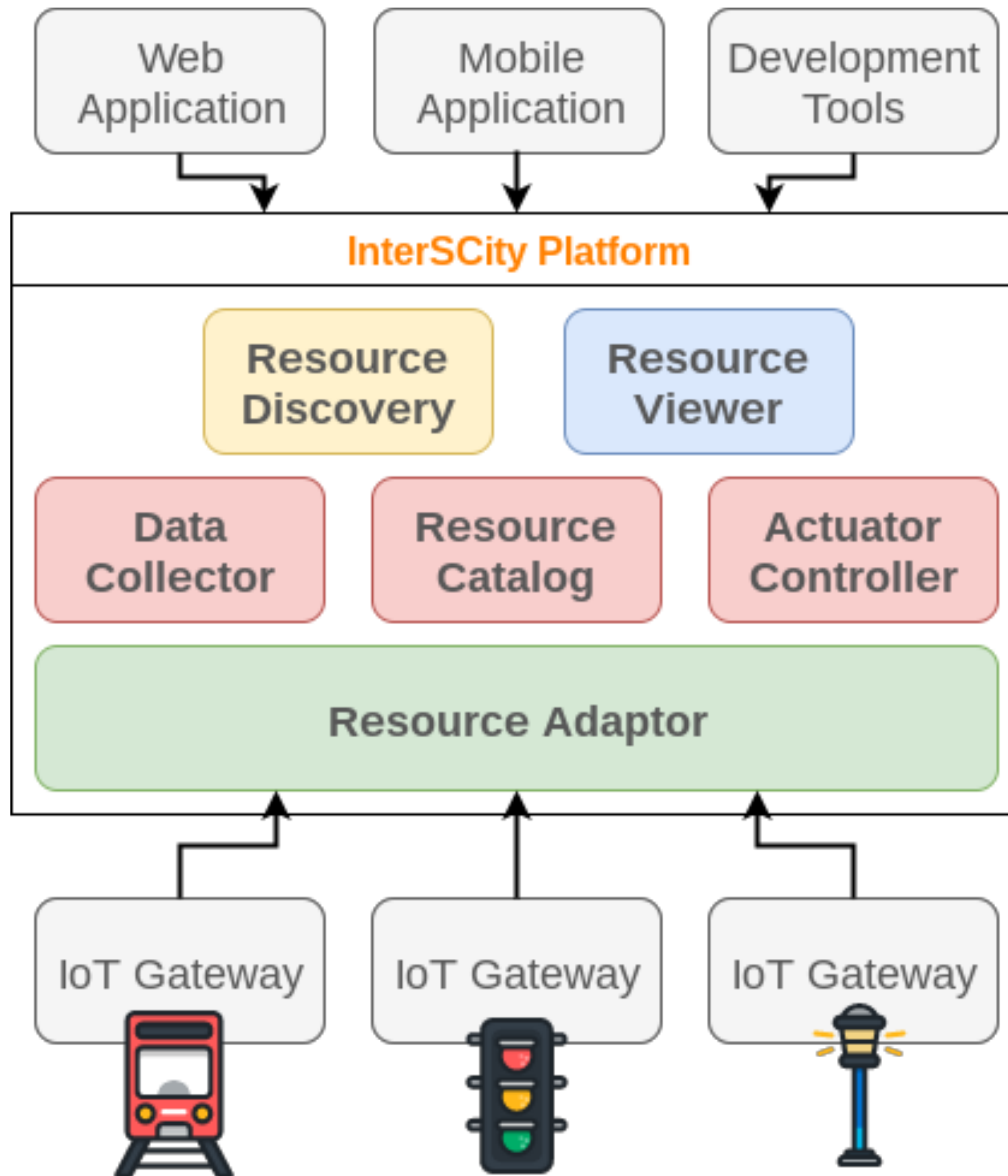
InterSCity Platform

Smart City Platform by the Software Systems Research Group - IME

http://interscity.org/

Projects   Subgroups   Filter by nam

D   **docs**
Smart City Software Platform documentation

D   **dev-env**

K   **kong-api-gateway**

InterSCity: A Scalable Microservice-based Open Source Platform for Smart Cities

Arthur de M. Del Esposte[1], Fabio Kon[1], Fabio M. Costa[2] and Nelson Lago[1]

[1]Department of Computer Science, University of São Paulo, R. do Matão, 1010 - Cidade Universitária, 05508-090, São Paulo, São Paulo, Brazil

[2]Institute of Informatics, Federal University of Goiás, Alameda Palmeiras, Quadra D, Câmpus Samambaia, 74690-900, Goiânia, Goiás, Brazil

{esposte, kon, lago}@ime.usp.br, fmc@inf.ufg.br

Keywords: Smart Cities, Software Platform, Microservices, Scalability, Open Source Software

Abstract: Smart City technologies emerge as a potential solution to tackle common problems in large urban centers by using city resources efficiently and providing quality services for citizens. Despite the various advances in middleware technologies to support future smart cities, there are no universally accepted platforms yet. Most of the existing solutions do not provide the required flexibility to be shared across cities. Moreover, the extensive use and development of non-open-source software leads to interoperability issues and limits the collaboration among R&D groups. In this paper, we explore the use of a microservices architecture to address key practical challenges in smart city platforms. We present InterSCity, a microservice-based open source smart city platform that aims at supporting collaborative, novel smart city research, development, and deployment initiatives. We discuss how the microservice approach enables a flexible, extensible, and loosely coupled architecture and present experimental results demonstrating the scalability of the proposed platform.

INTRODUCTION

he rapid growth of cities around the world has cre-
ed large, densely populated urban centers charac-
rized by complex interconnected structural, social
d economic organizations. This urbanization phe-

et al., 2014). The Internet of Things (IoT), Big Data,
and Cloud Computing are key enabling technologies
of smart cities that offer a wide range of opportuni-
ties and challenges, both in the academy and industry.
To fully exploit the potential of these enablers, future
smart cities will demand a unified ICT infrastructure
to properly share their resources rather than relying

11

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

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
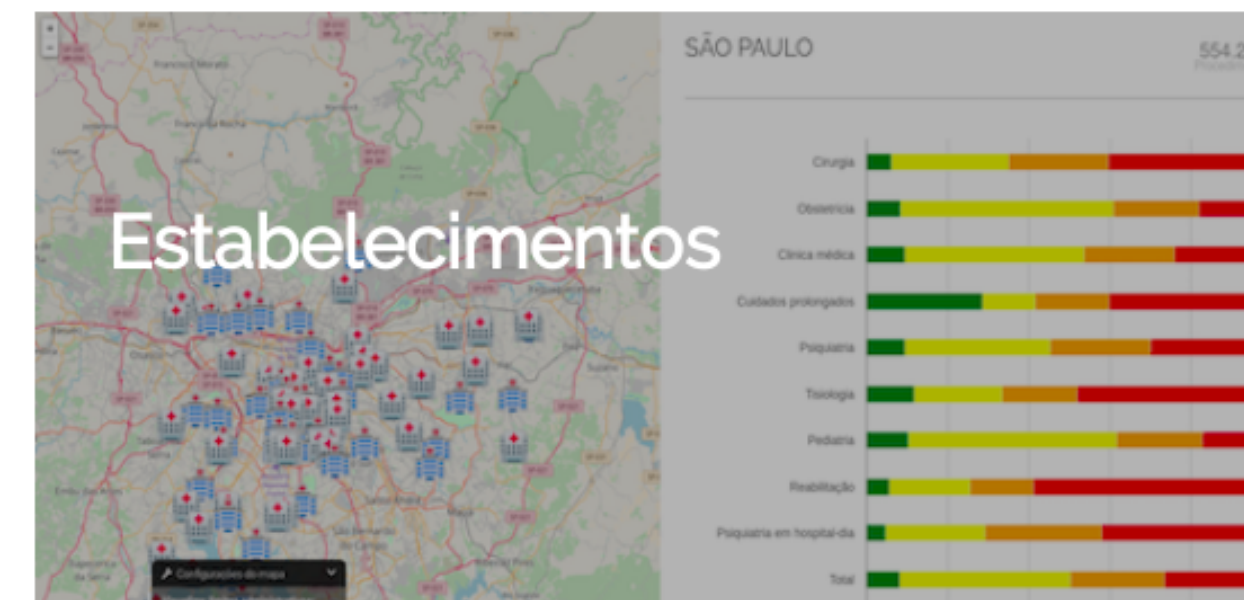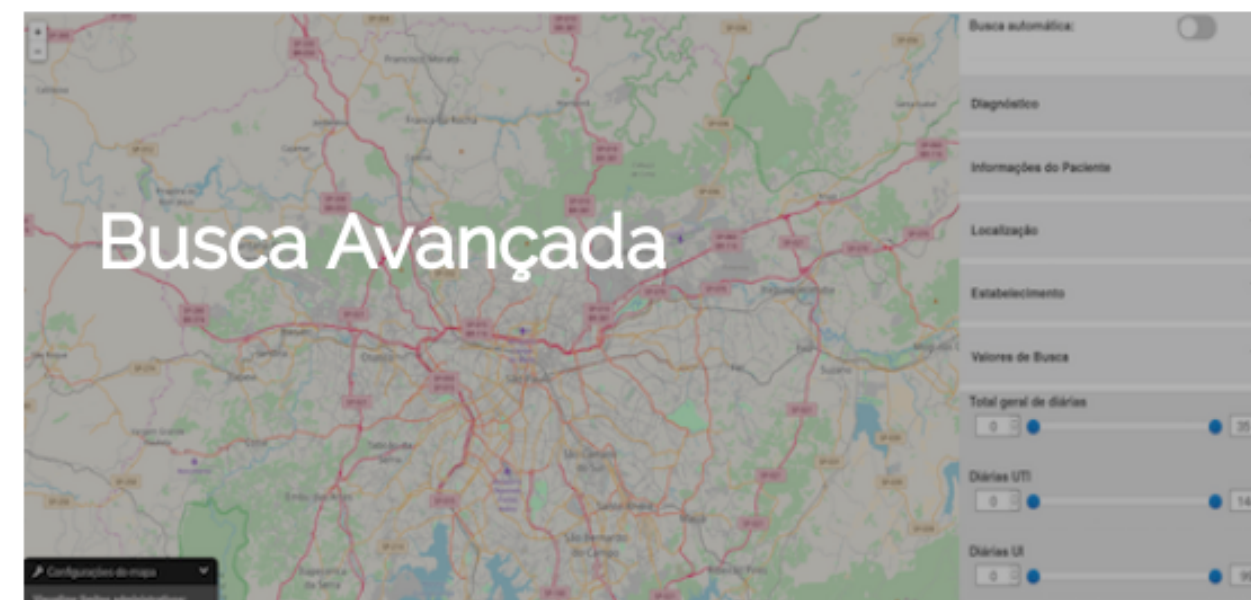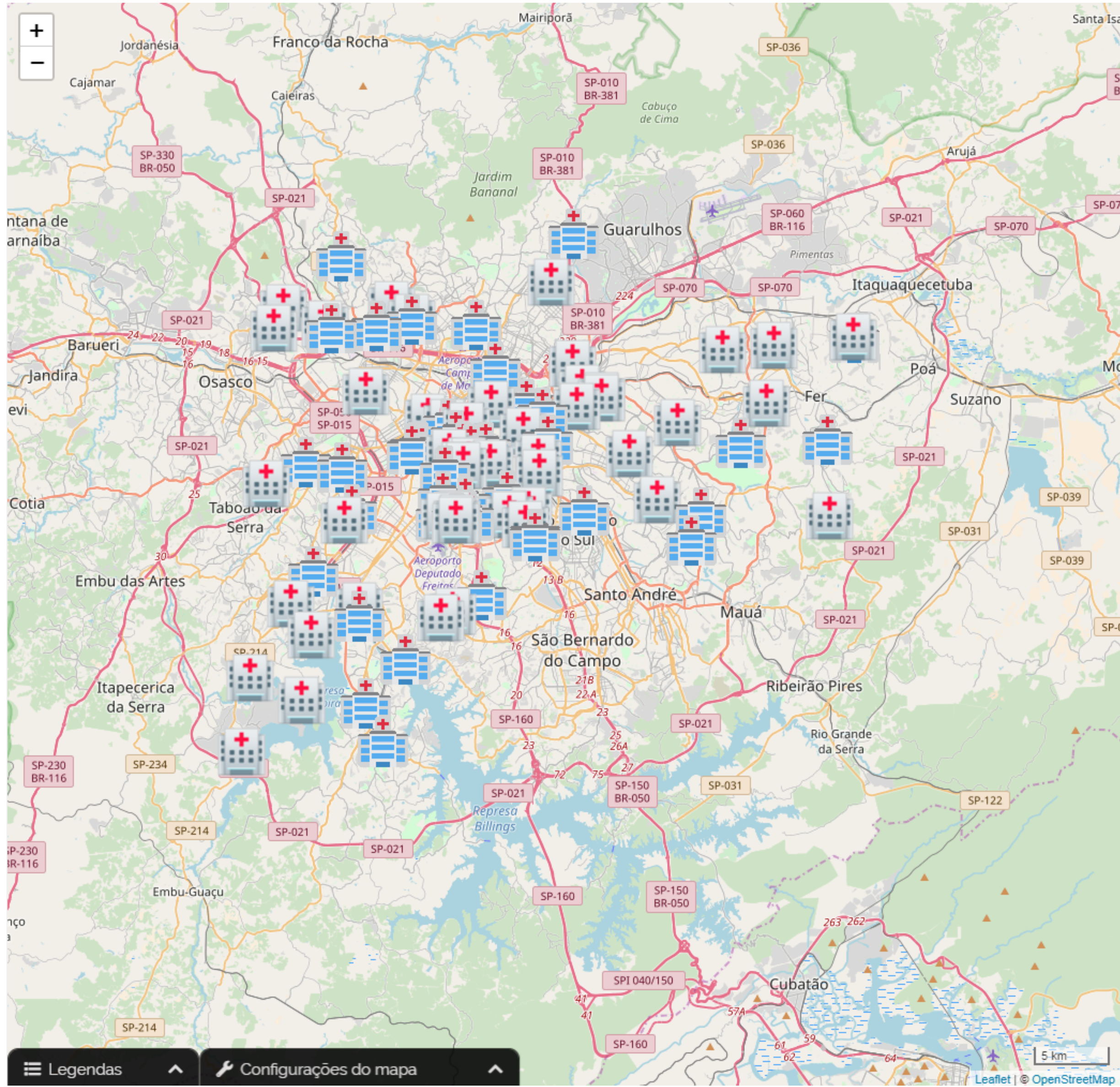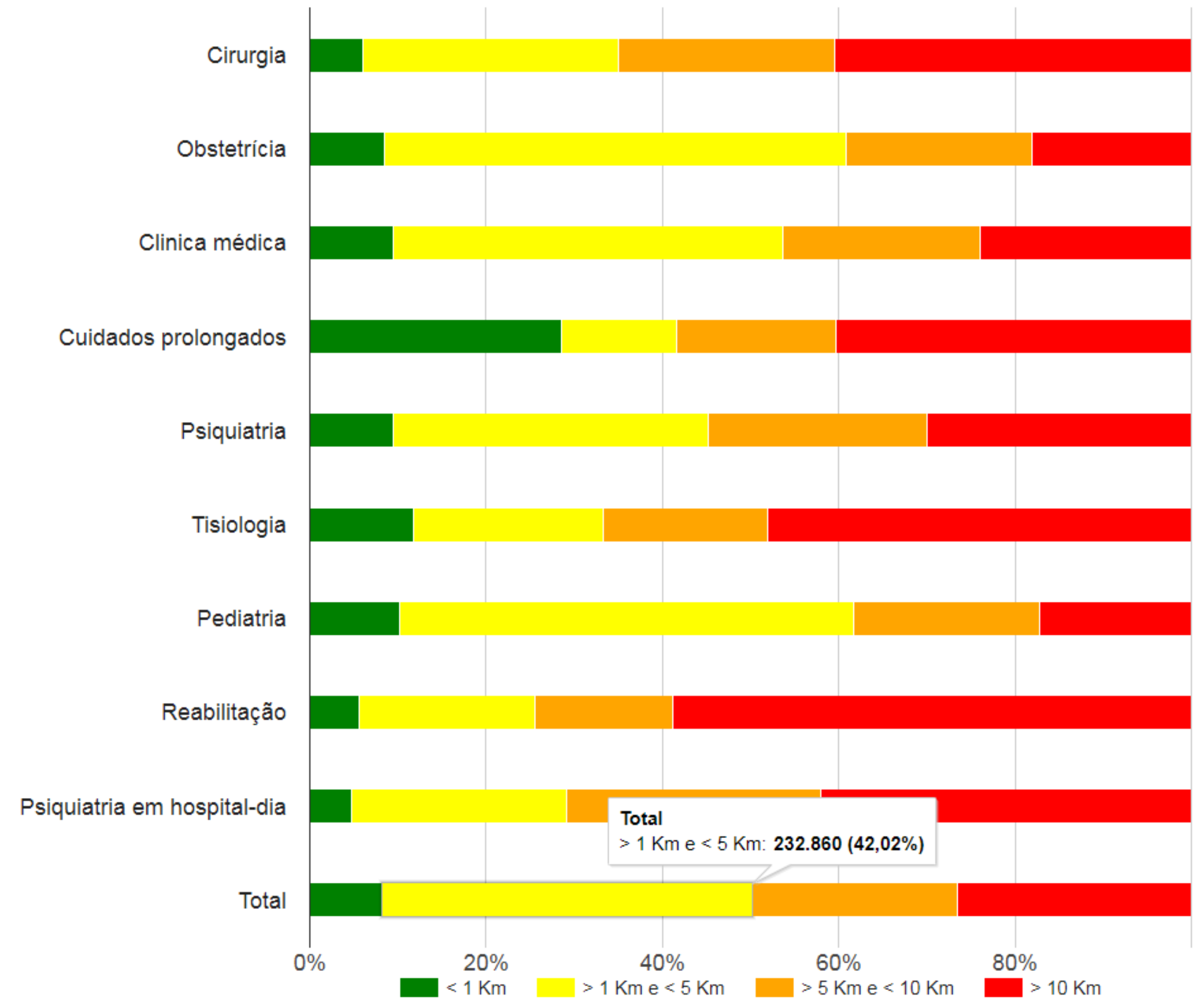
Multiple ways of dividing the city
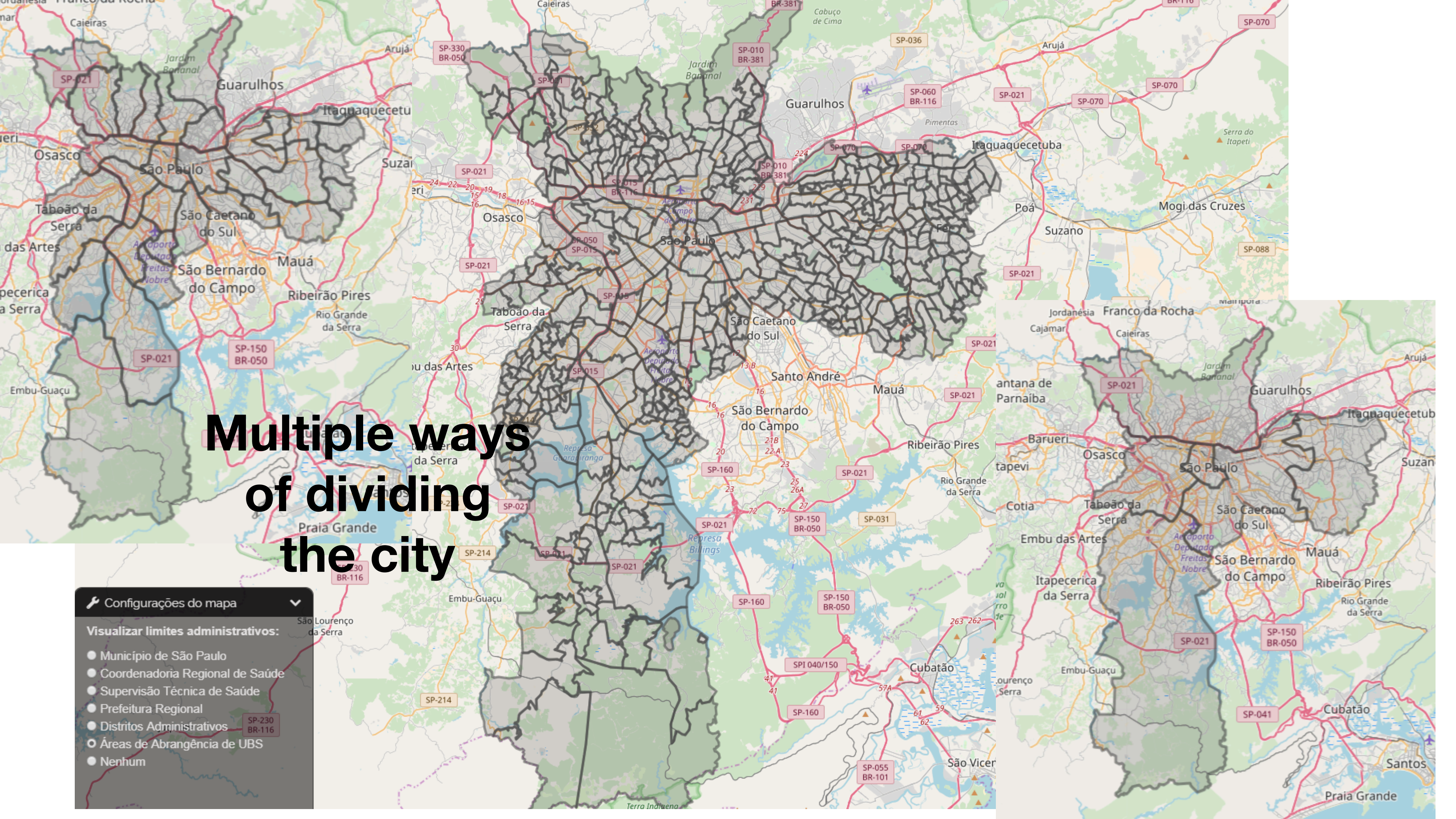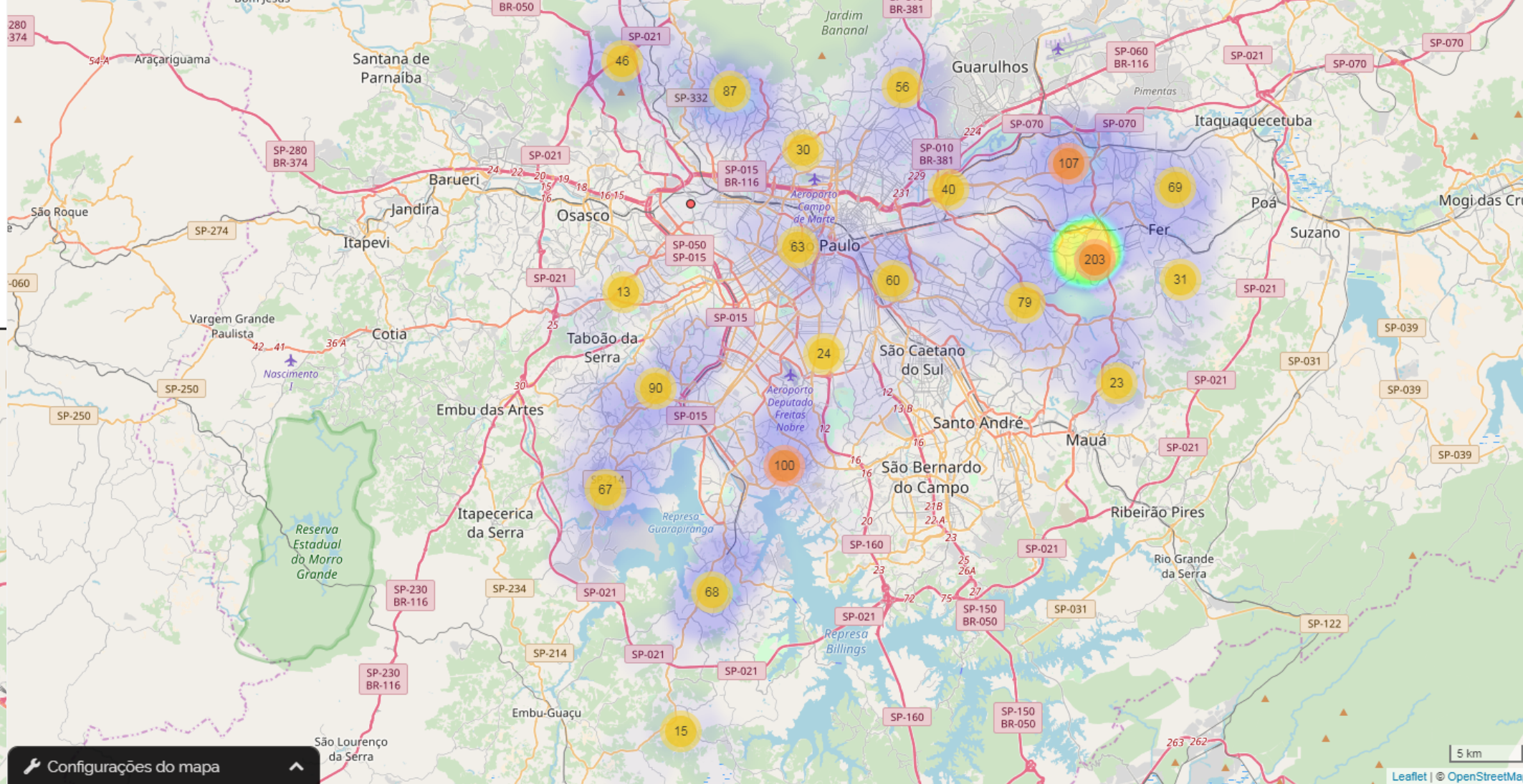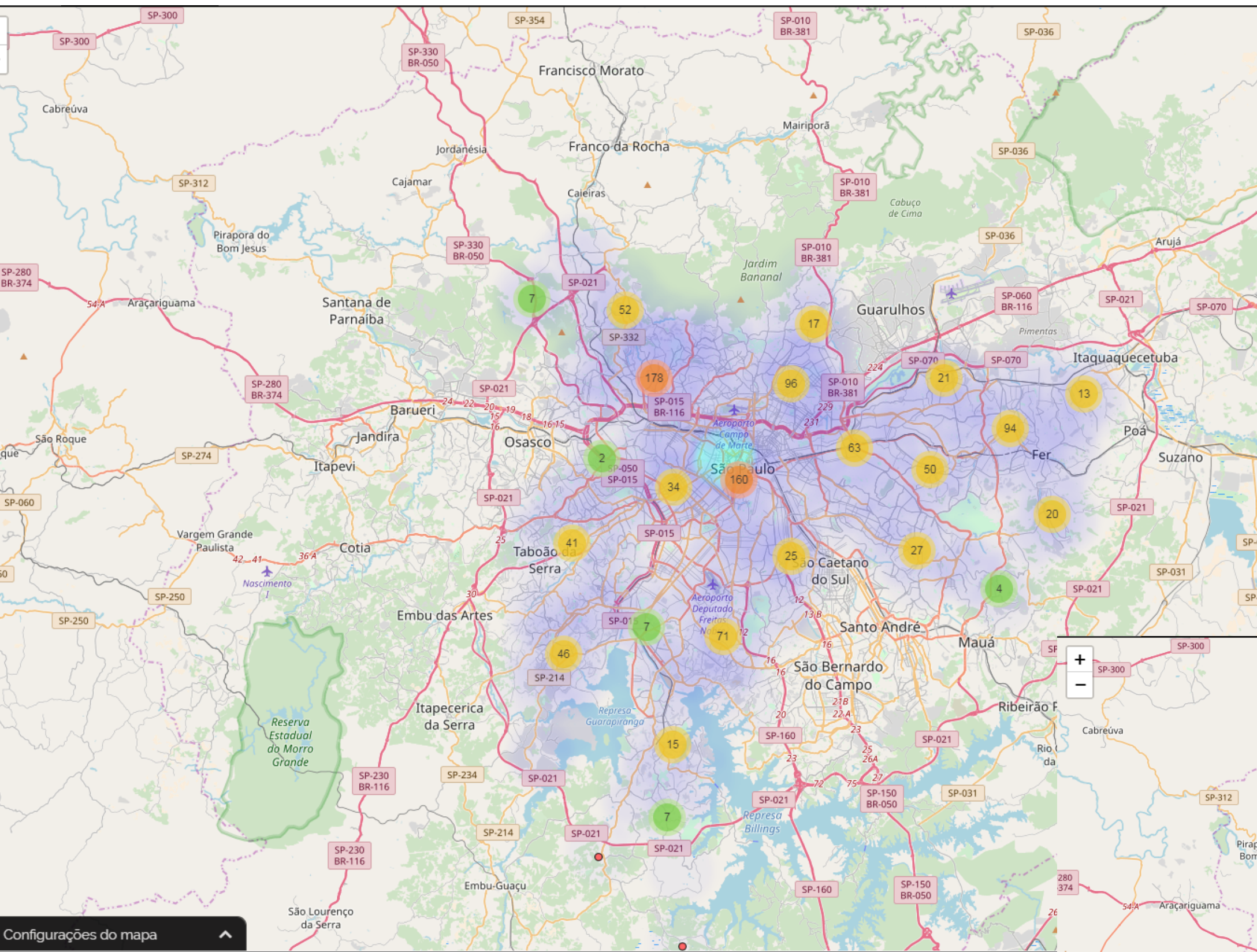
Configurações do mapa ⌄

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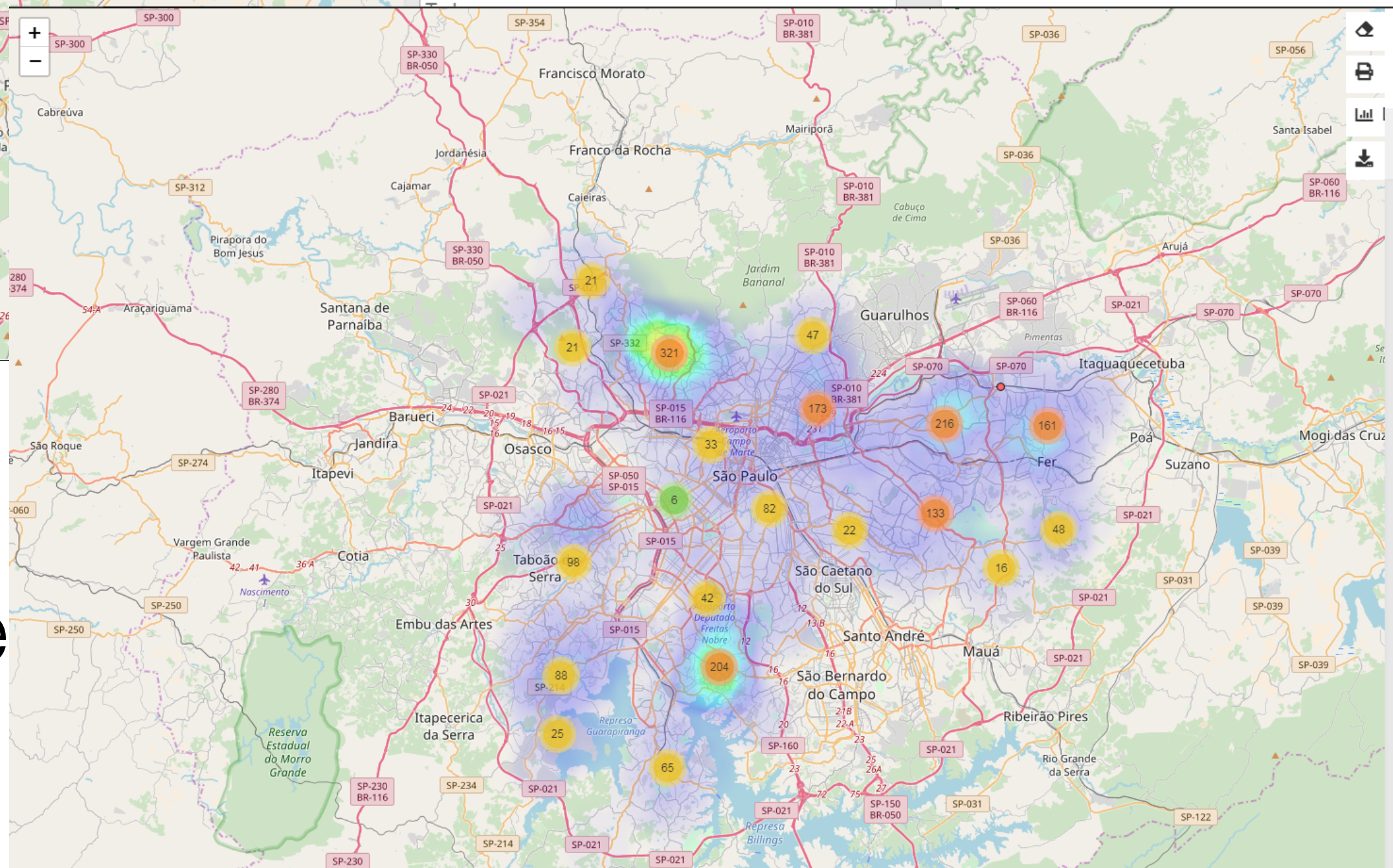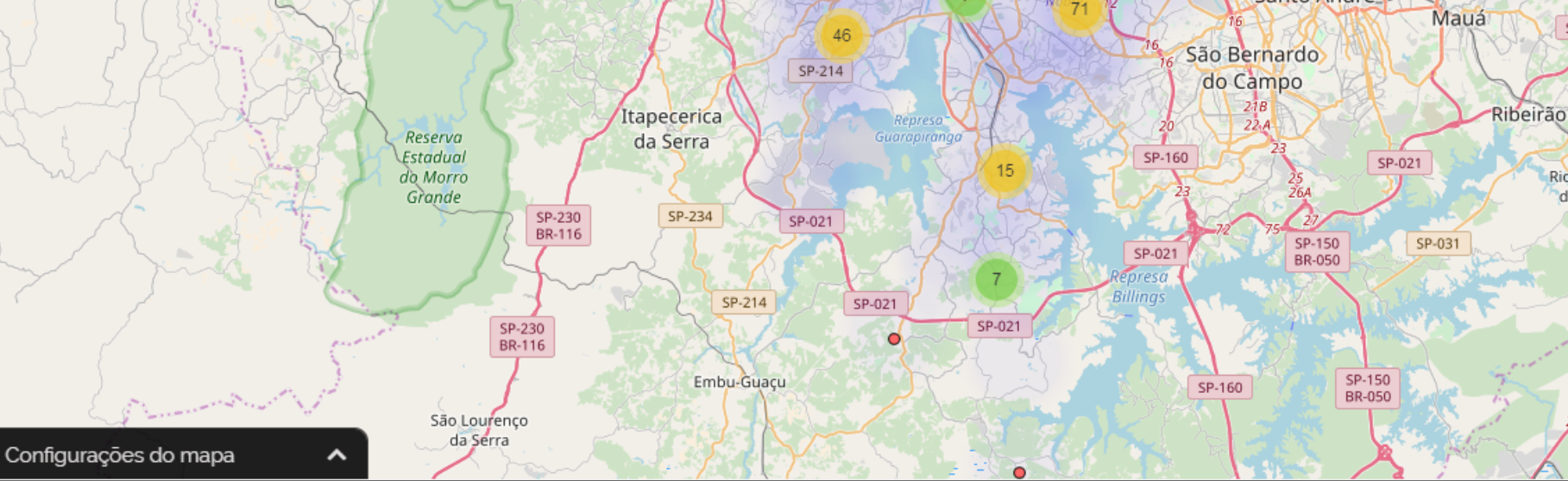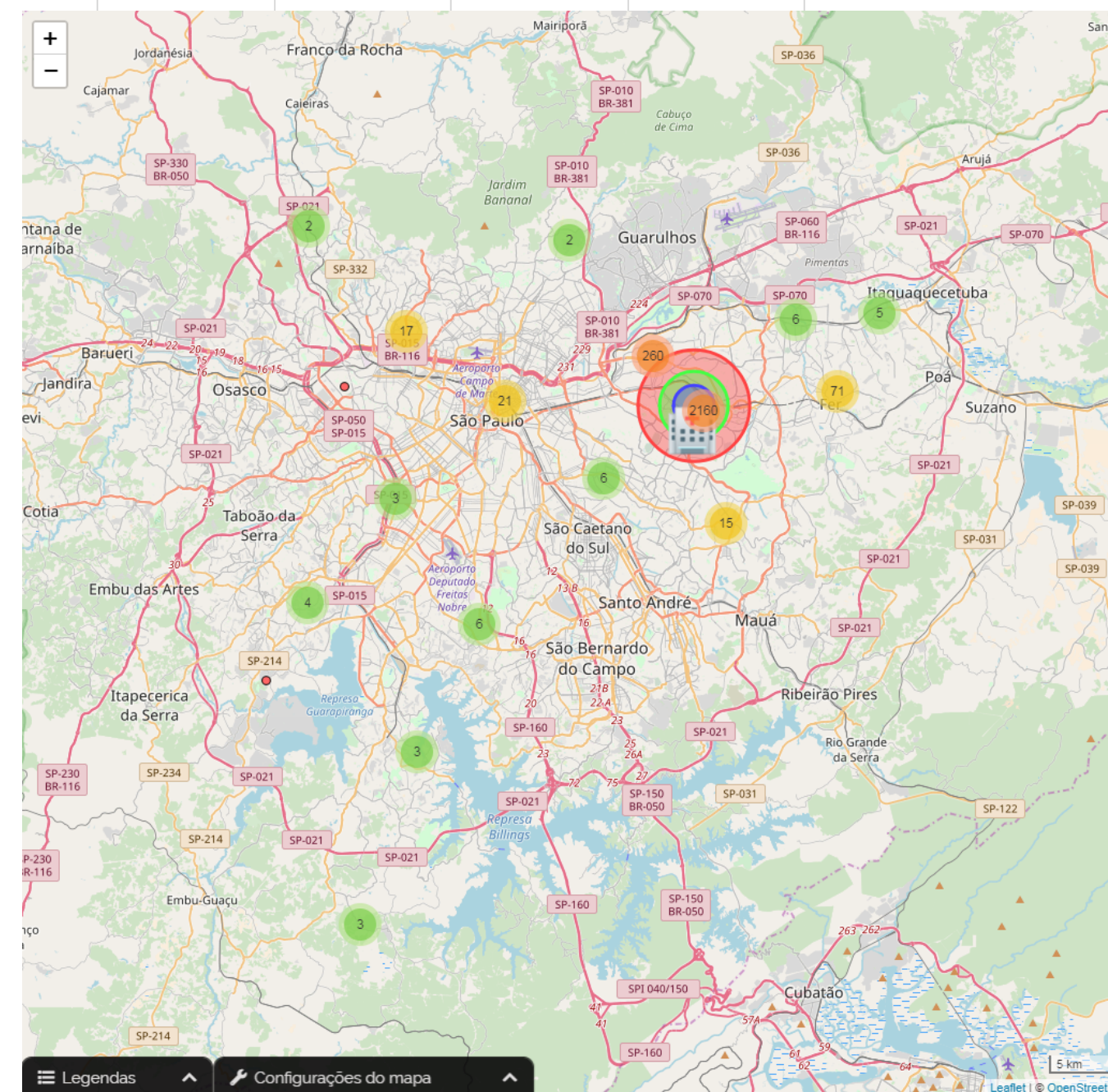
Diagnóstico secundário (CID-10)
Todos
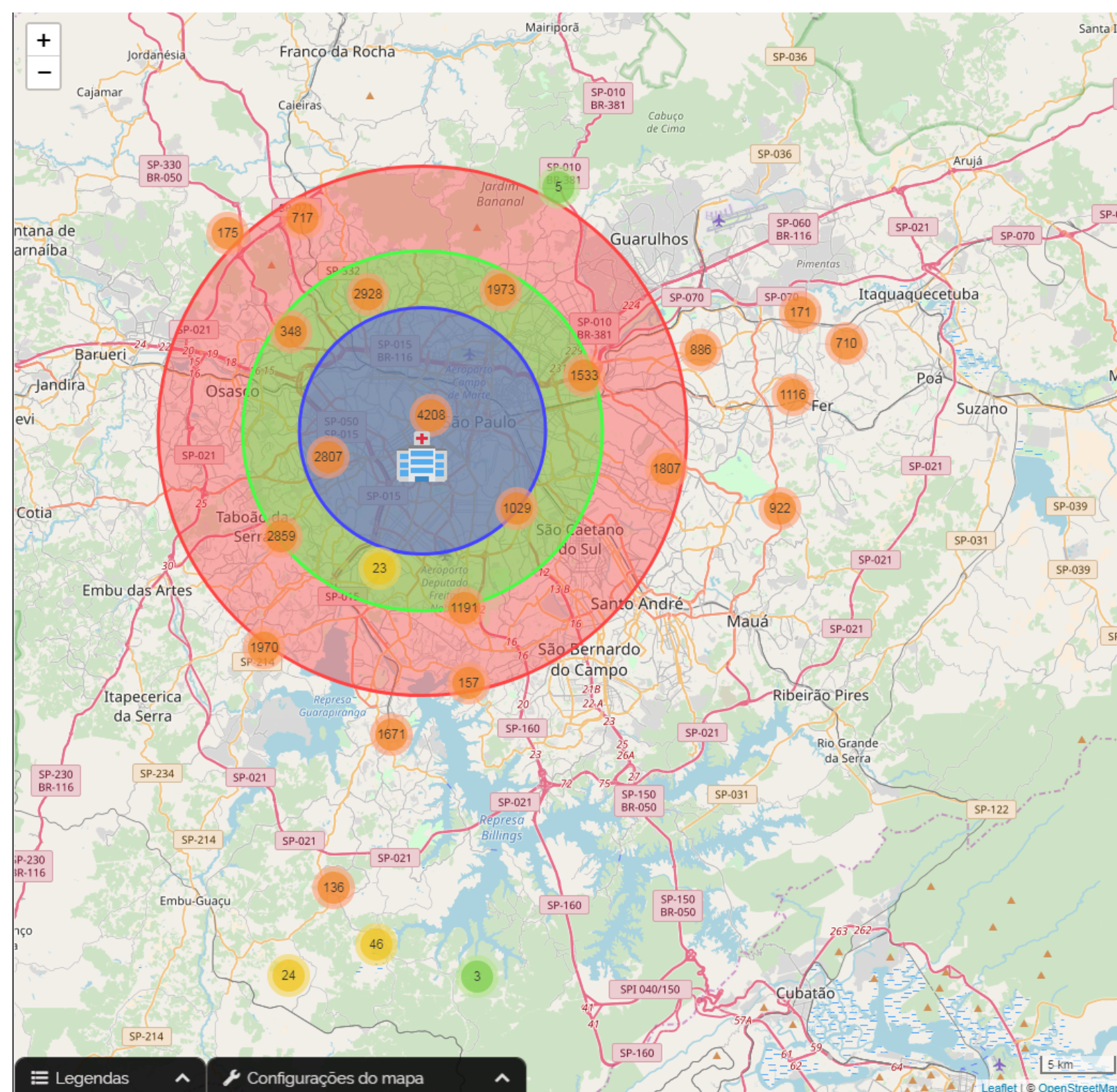
HC DA FMUSP HOSPITAL DAS CLINICAS SAO PAULO

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
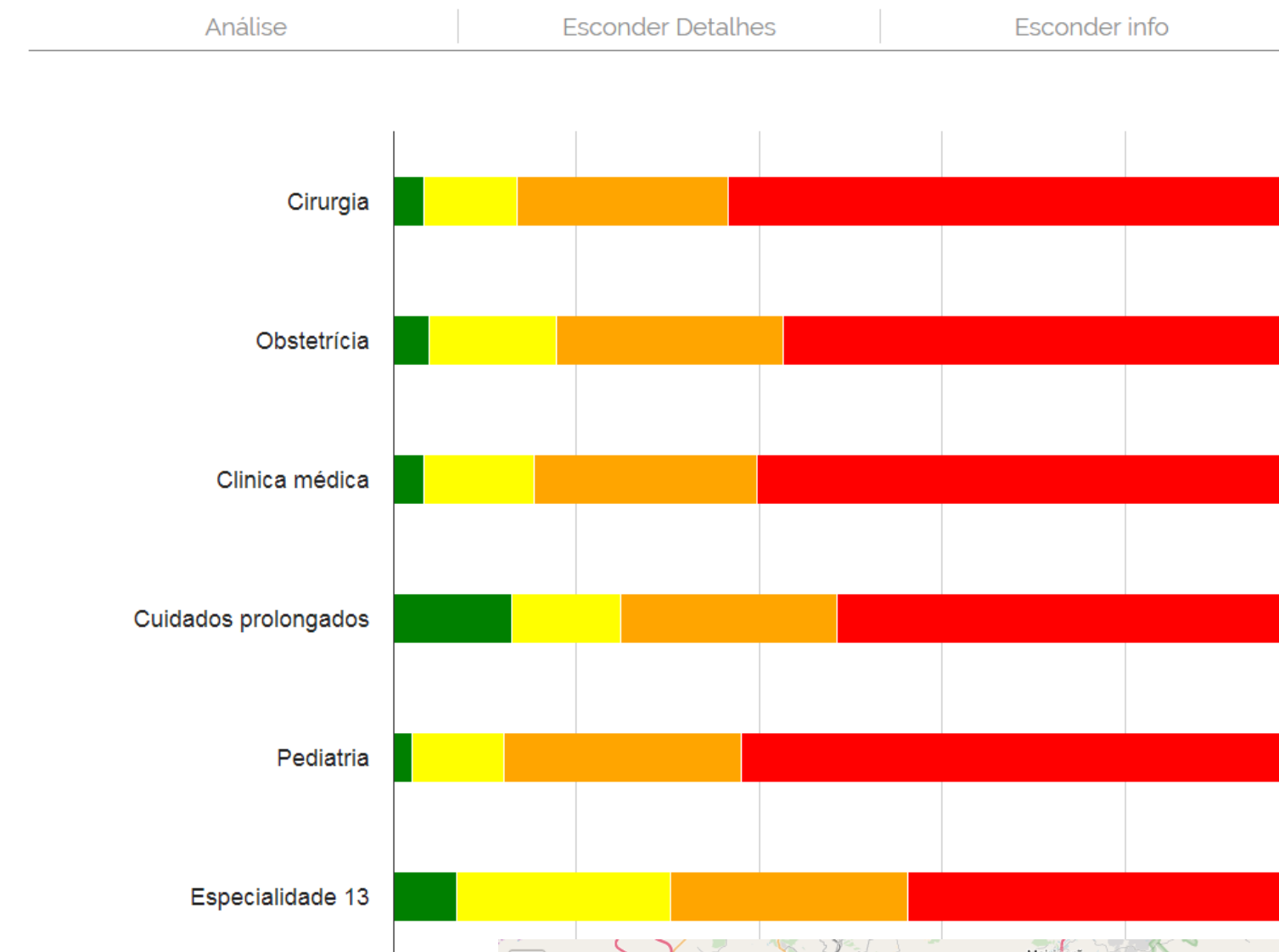
Regional Hospital

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

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

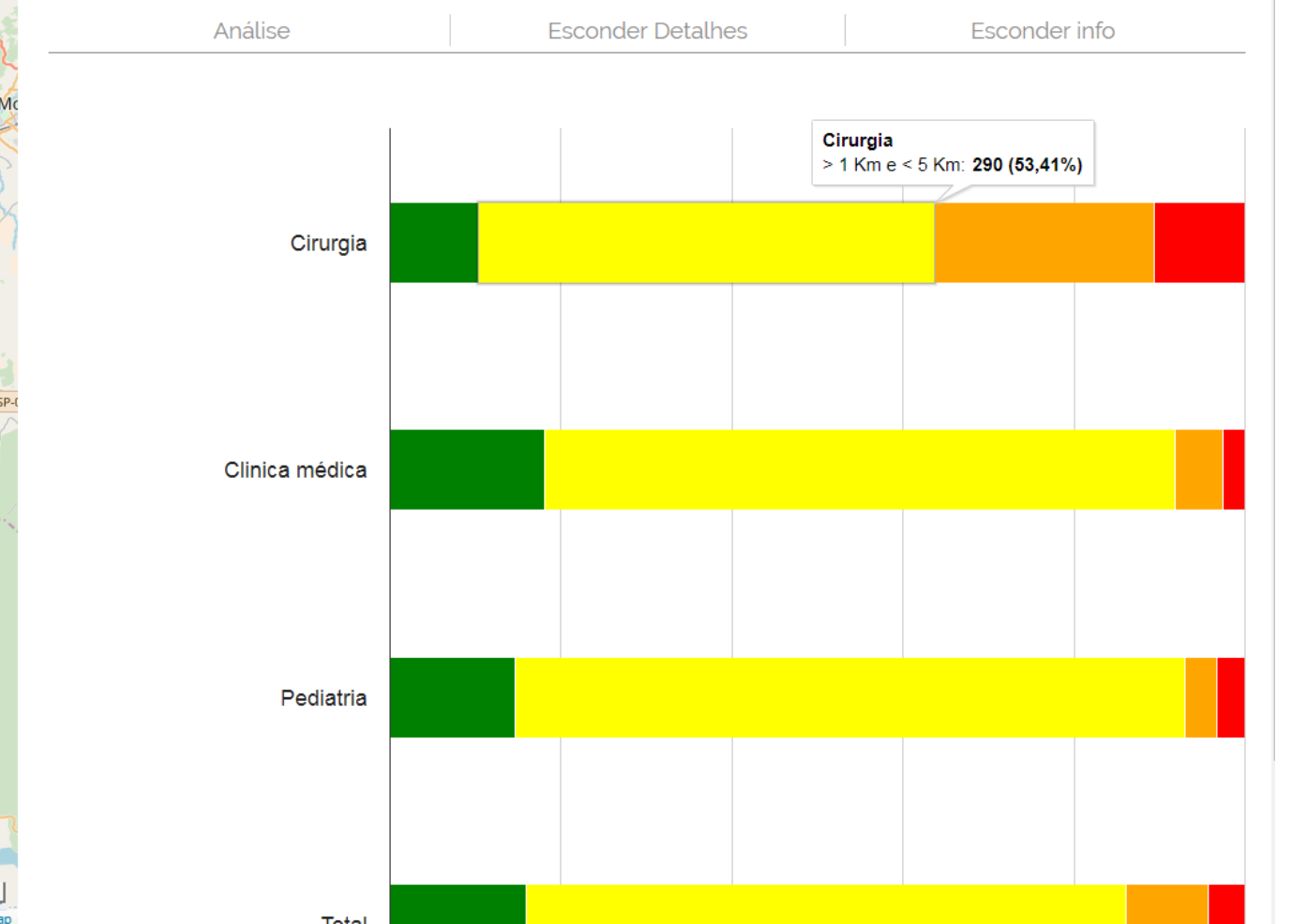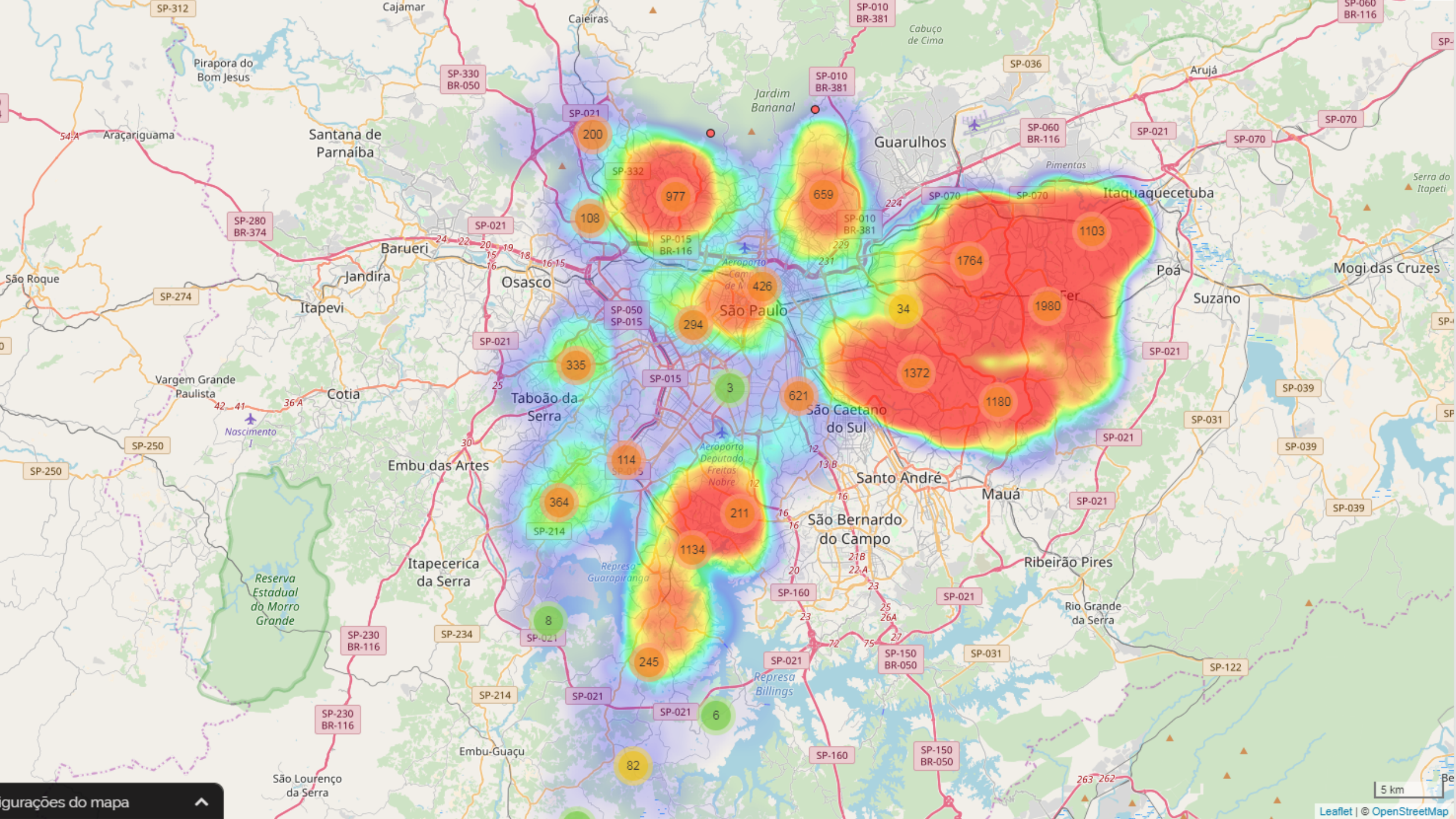**Diagnóstico principal (CID-10)**
Todos

Diagnóstico secundário (CID-10)
× I10 - Hipertensão Essencial (primária)   ×

Diagnóstico secundário 2 (CID-10)

Leaflet | © OpenStreetMap

Informações do Paciente
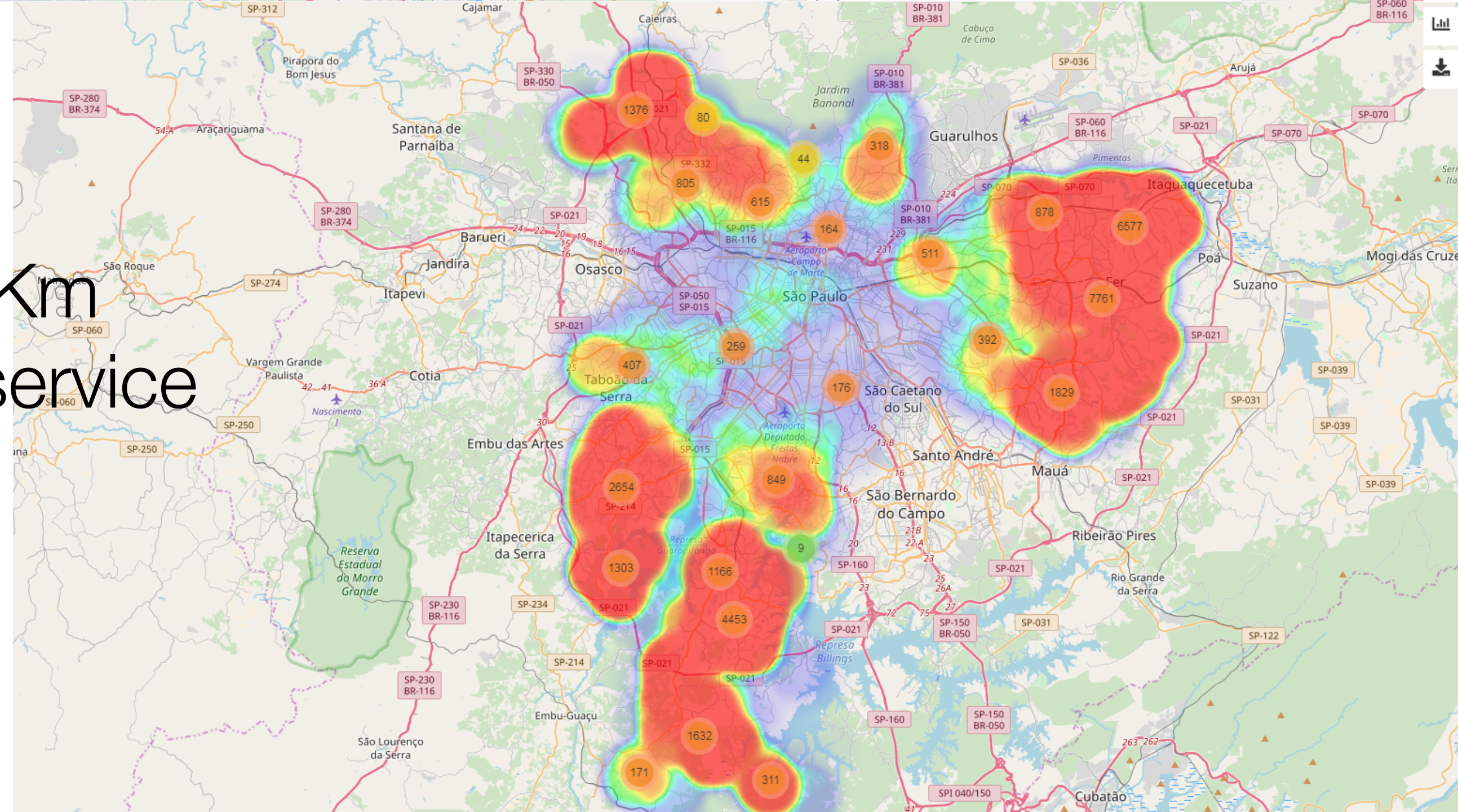
Localização

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

4 -
Crowdsourcing startup App: *guiaderodas*

Accessibility Ranking

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
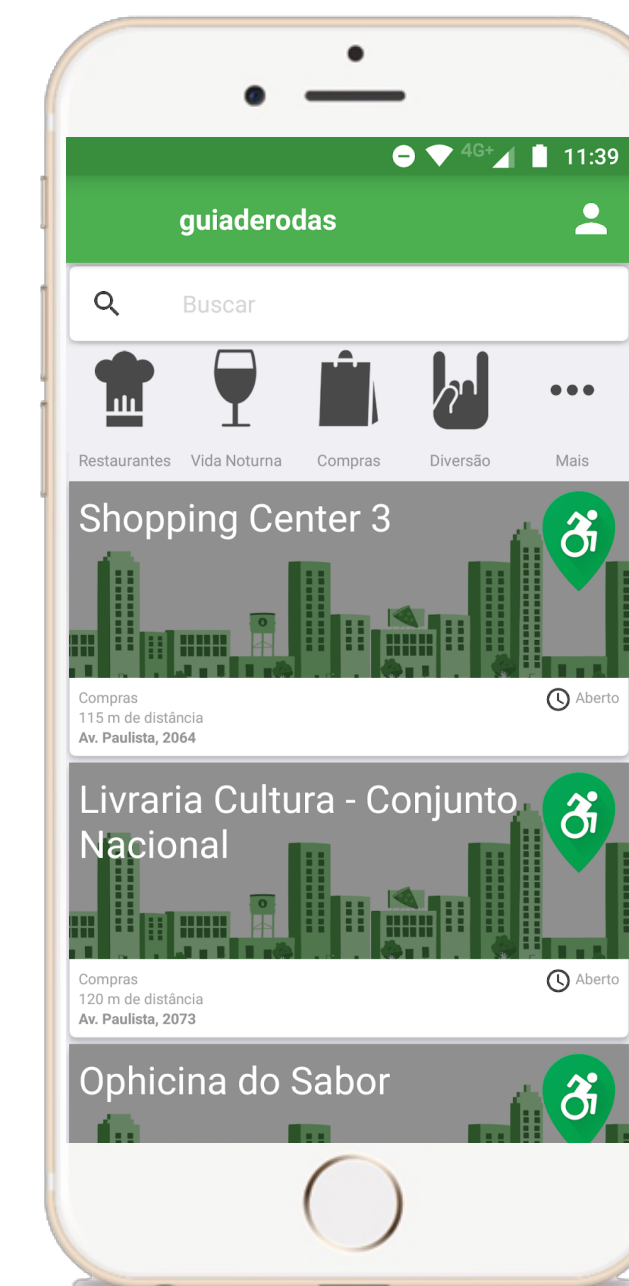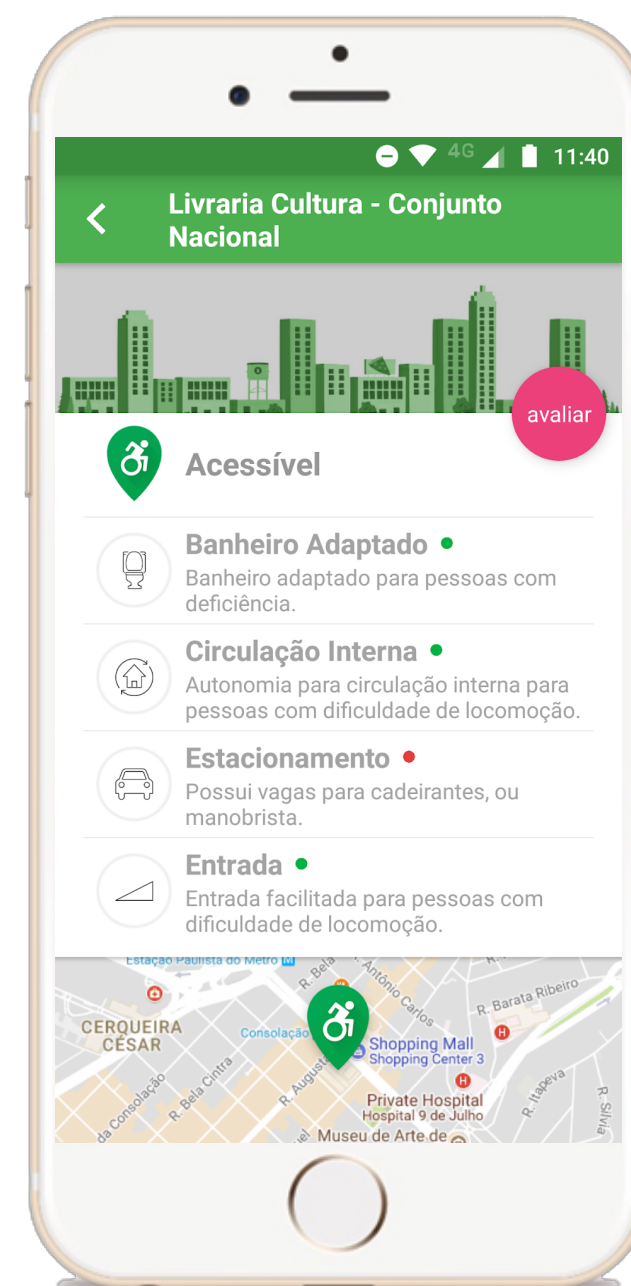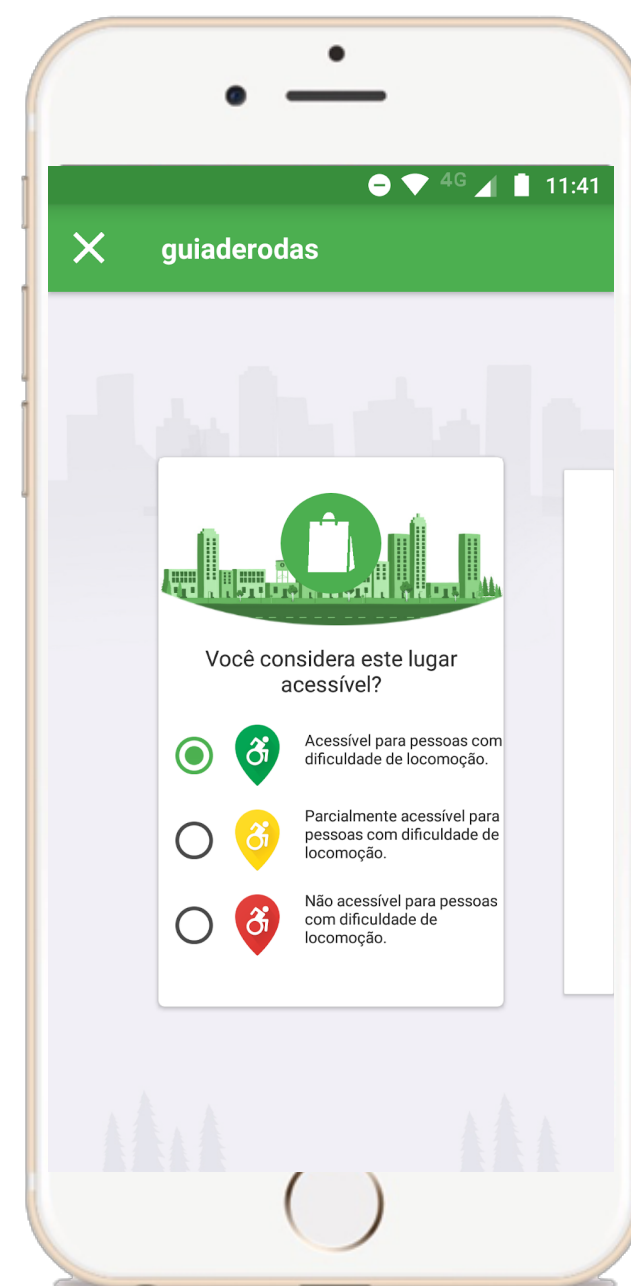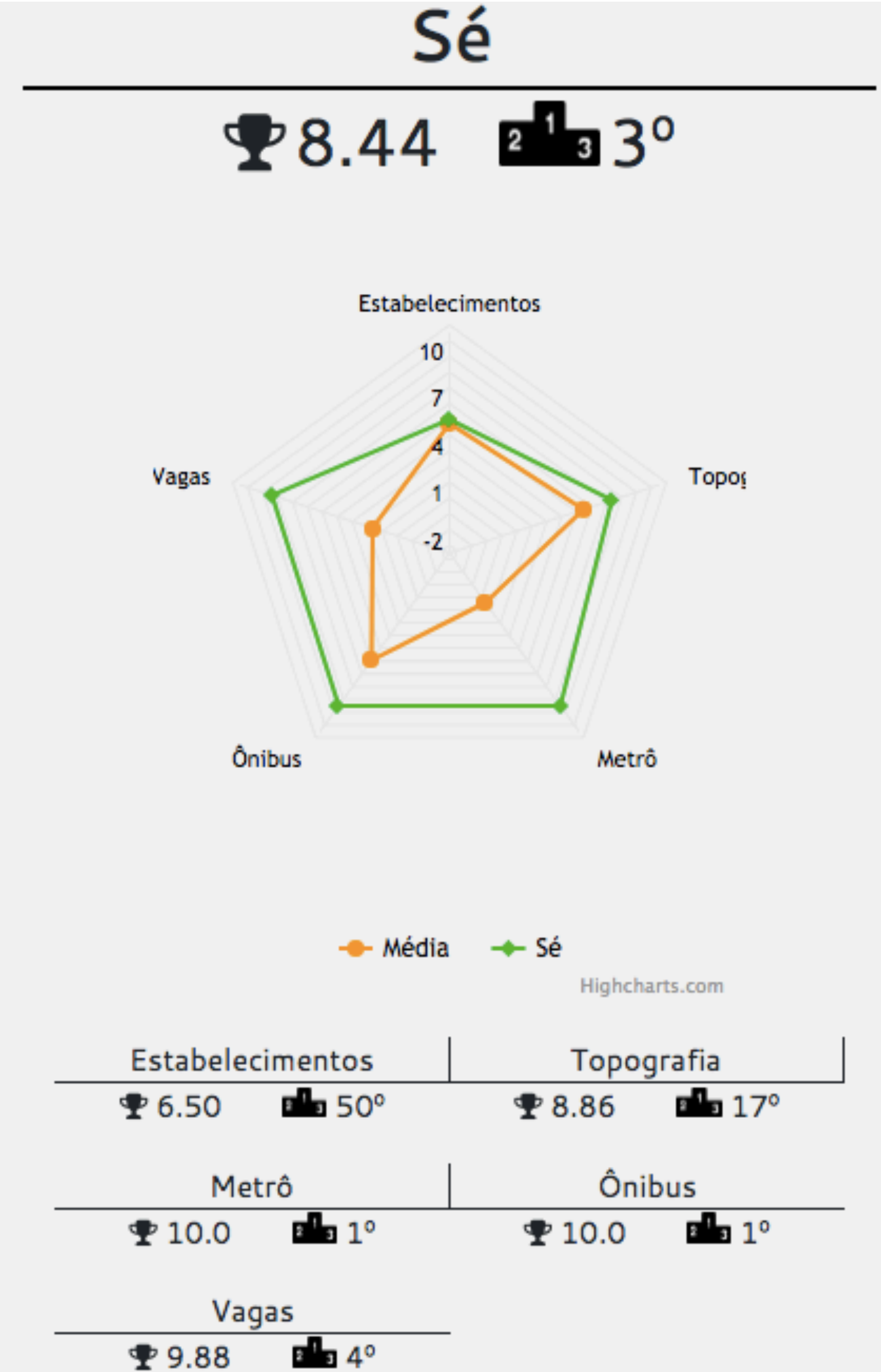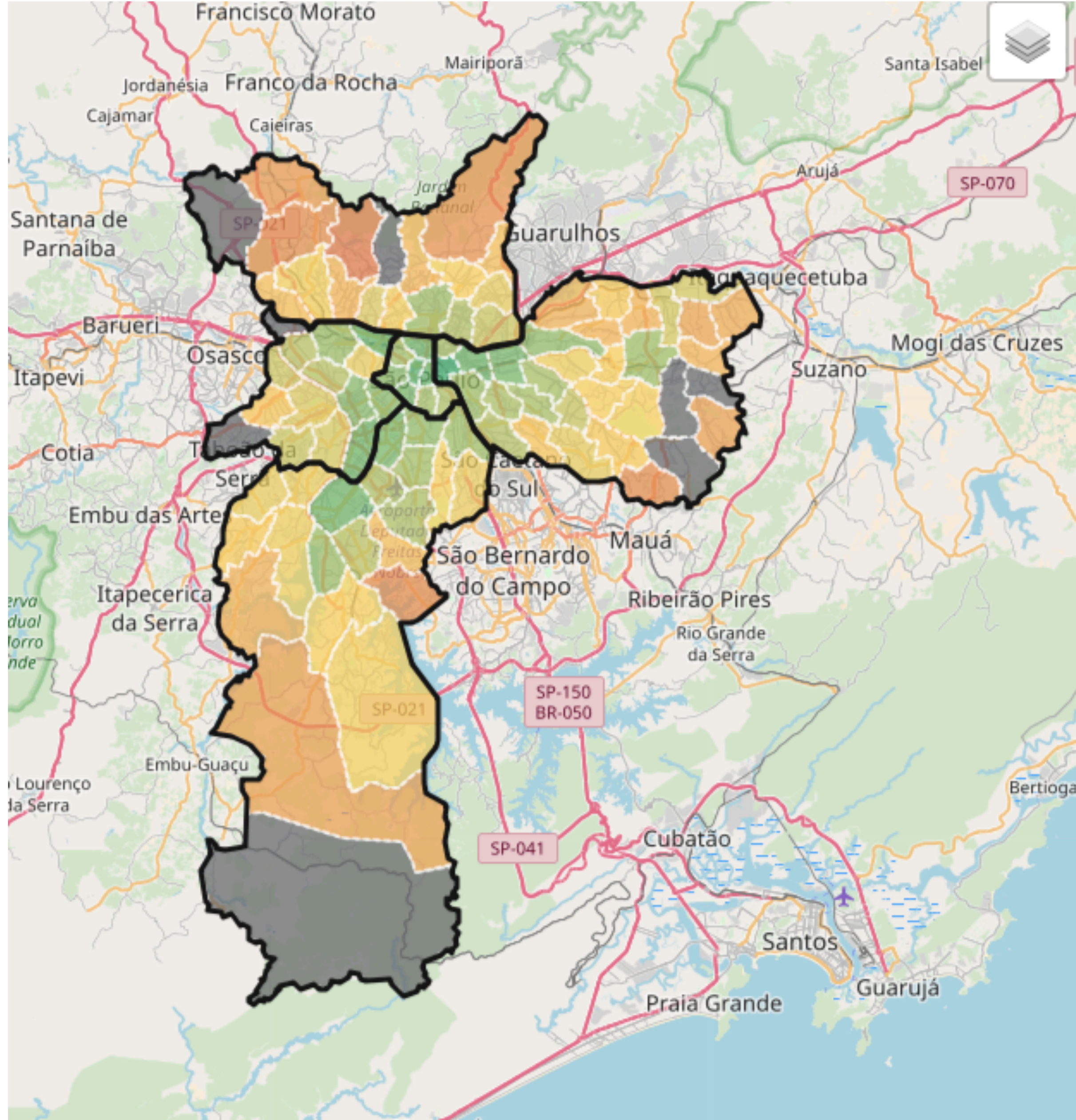
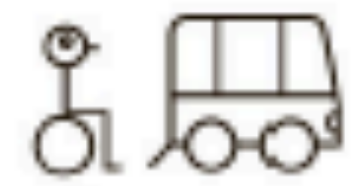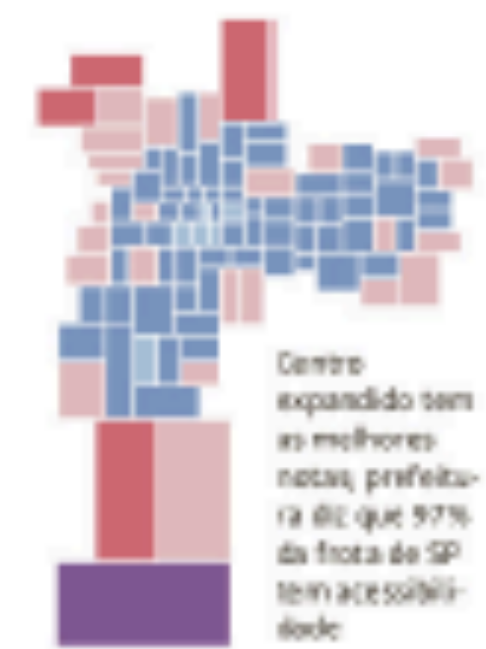**Quem pode ser prejudicado pela falta de acessibilidade**

➤ 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
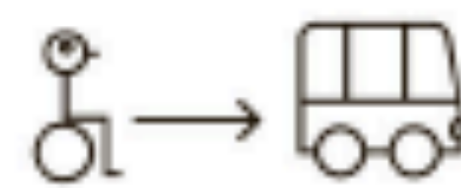
3. Distância até o transporte
Considera o deslocamento médio até as estações de metrô e trem

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)
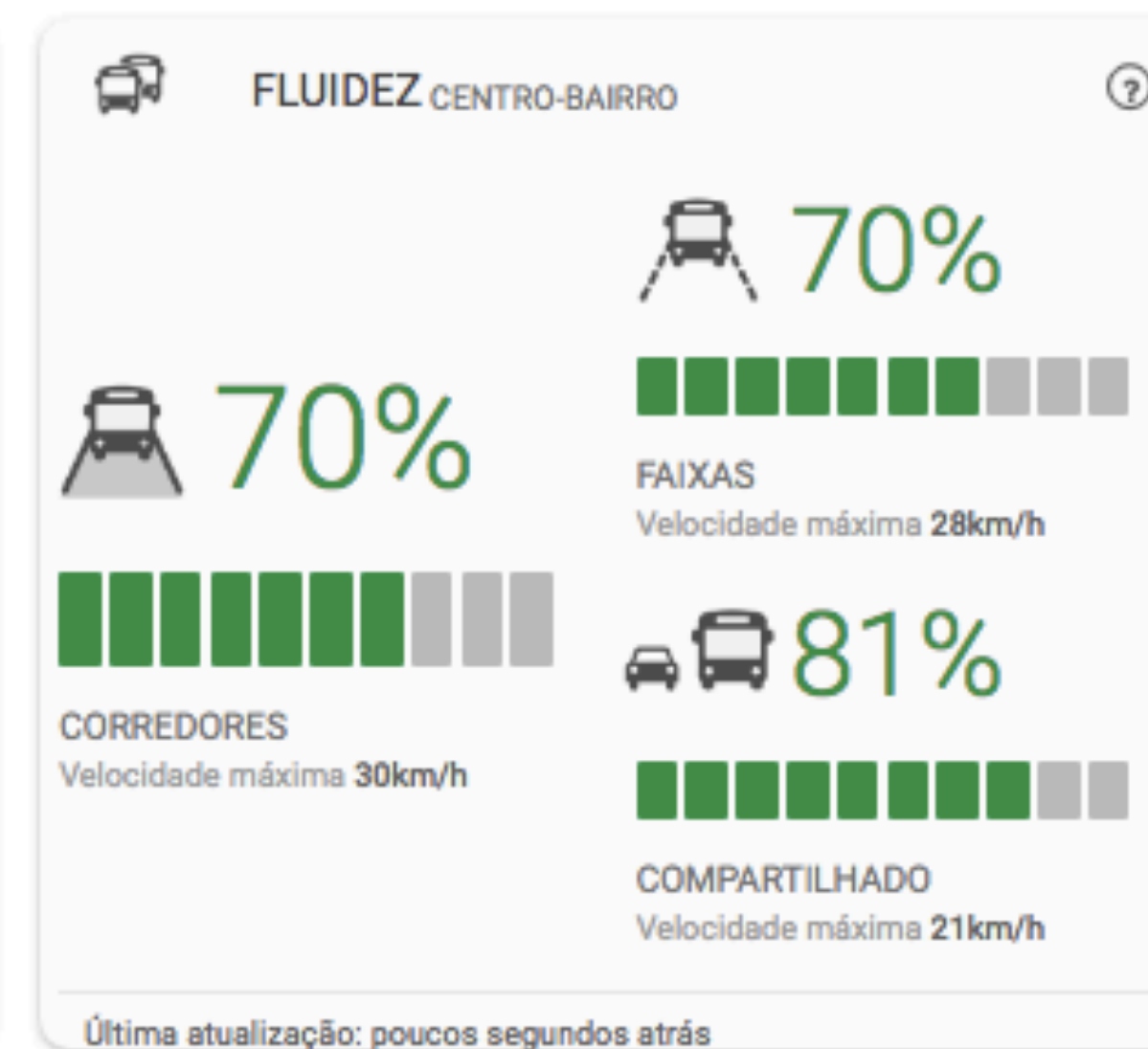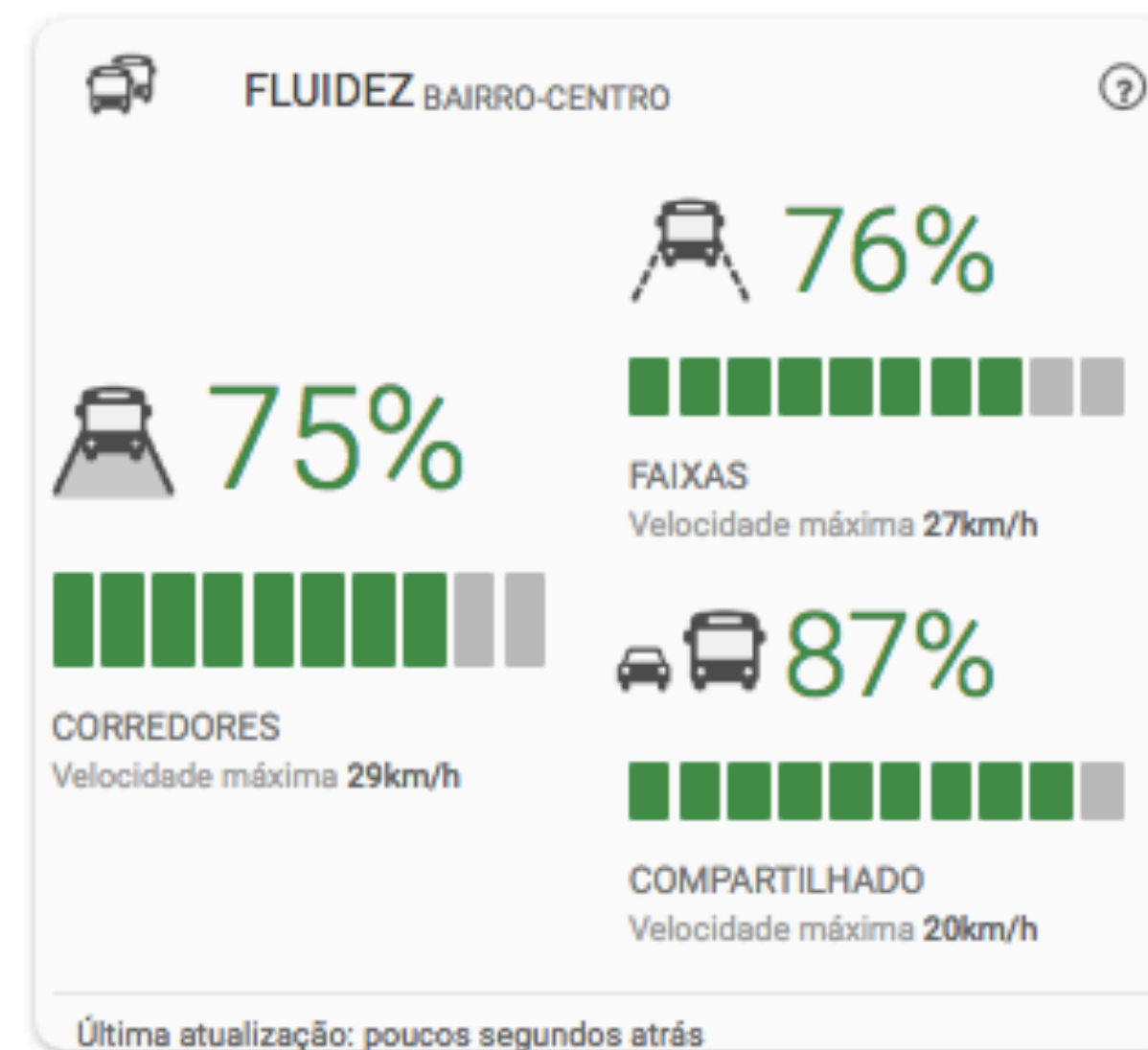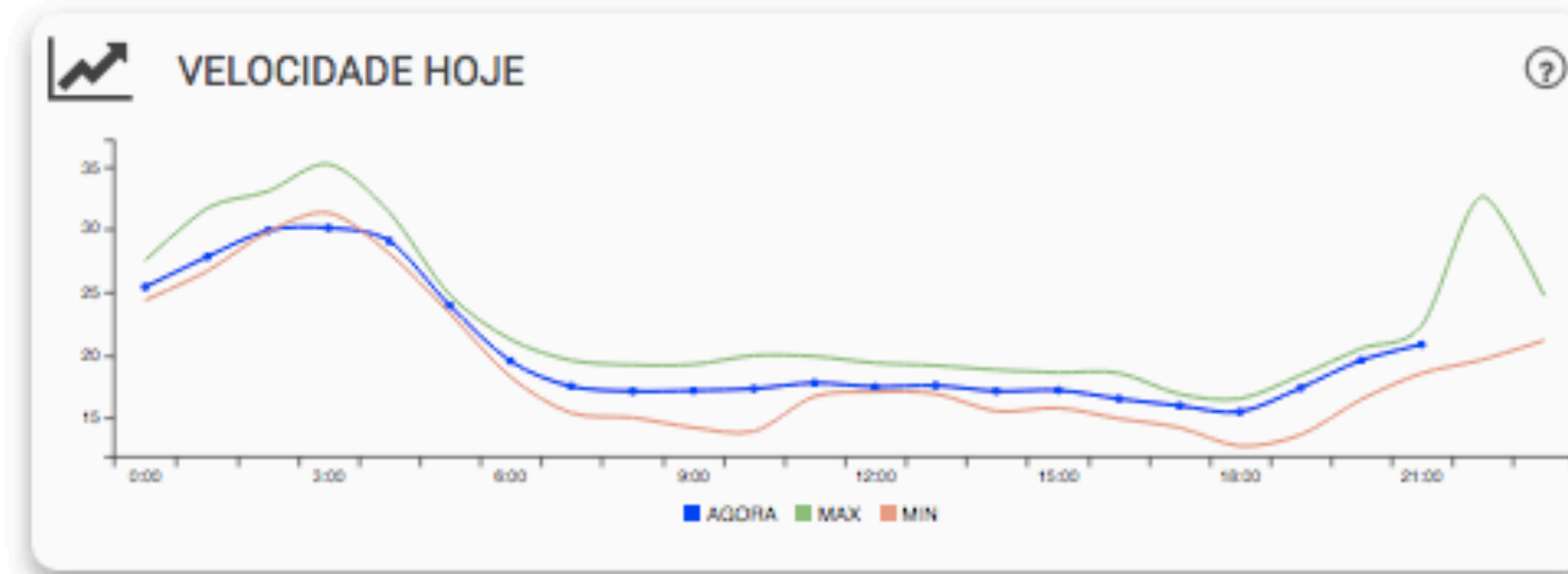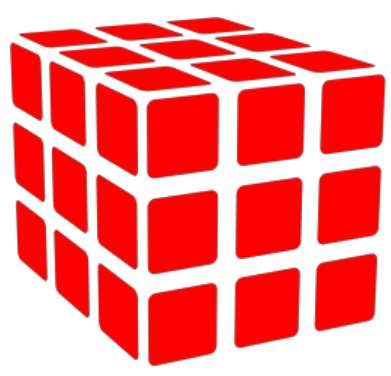
DATA ANALYSIS and visualization

Historical data

Comparing bus x auto

Terças-feiras

Pico manhã 8.5   Entre picos 17.1   Pico tarde 17.3

20 km/h
10 km/h

Horário

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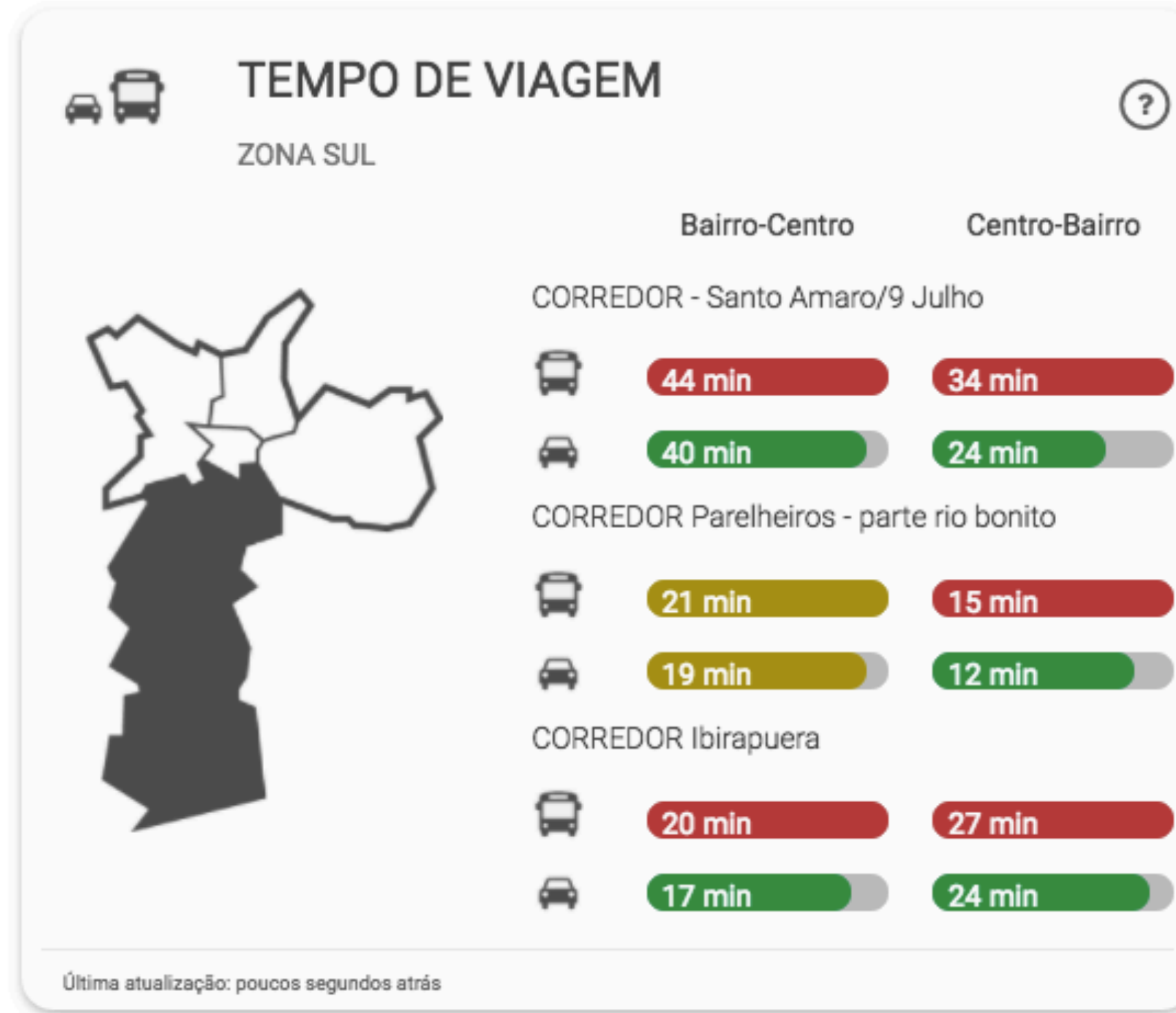
Headway discrepancy per bus stop

bus stop #

Hour

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

Km/h — Horário

■ ontem ■ hoje

VELOCIDADE MÉDIA AGORA
CENTRO-BAIRRO

16.2   **14.1**

CORREDORES
Velocidade média habitual
17.0km/h

FAIXAS
Velocida
habitual

13.9

COMPART
Velocida
habitual

Última atualização: poucos segundos atrás

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

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

- Two papers to be submitted soon!

The Future

- Advanced collaborative research among InterSCity partners

  - Middleware implementation: scalability, performance, usability by developers

  - Big Data processing, analysis, and visualization

  - Machine Learning to improve city services

- Establish and strengthen international collaborations

Contact

kon@ime.usp.br

interscity.org

(post-doc fellowships available)