

Como a Ciência da Computação pode melhorar a vida nas cidades



Prof. Fabio Kon
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University of São Paulo, Brazil

INCT Future Internet for Smart Cities
interscity.org



We live in cities

- old methodology: ~55% of the people (UN)
- **newer methodologies: >80% (European Commission)**
 - Satellite images
 - Image Processing / Machine Learning
 - Population databases

Urban public policies

- Most of the times:
 - Designed with no scientific basis at all
- A few times:
 - Based on methods and technologies from the XX century

Evidence-based public policies

1. Create and collect rigorous scientific evidence of what works, including costs and benefits
2. Monitor the execution of programs and measure the impact
3. Use scientific evidences to improve the programs, increase their scale and cancel the programs that don't work.
4. Promote innovation and test new approaches.

INCT InterSCity Collaborations

- 35 Computer Science professors +
- Architects, Urban Planners, Economists, Health Professionals, Transportation Engineers
- City governments (unfortunately, very weak collaboration)

InterSCity lab in Brazil

~60 people working:

- USP, PUC-Rio, Scipopolis, UFABC, UFG, UFMA, UFMS, UFRJ, Unicamp, FGV, Unifesp
- FAPESP / CNPq / CAPES (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

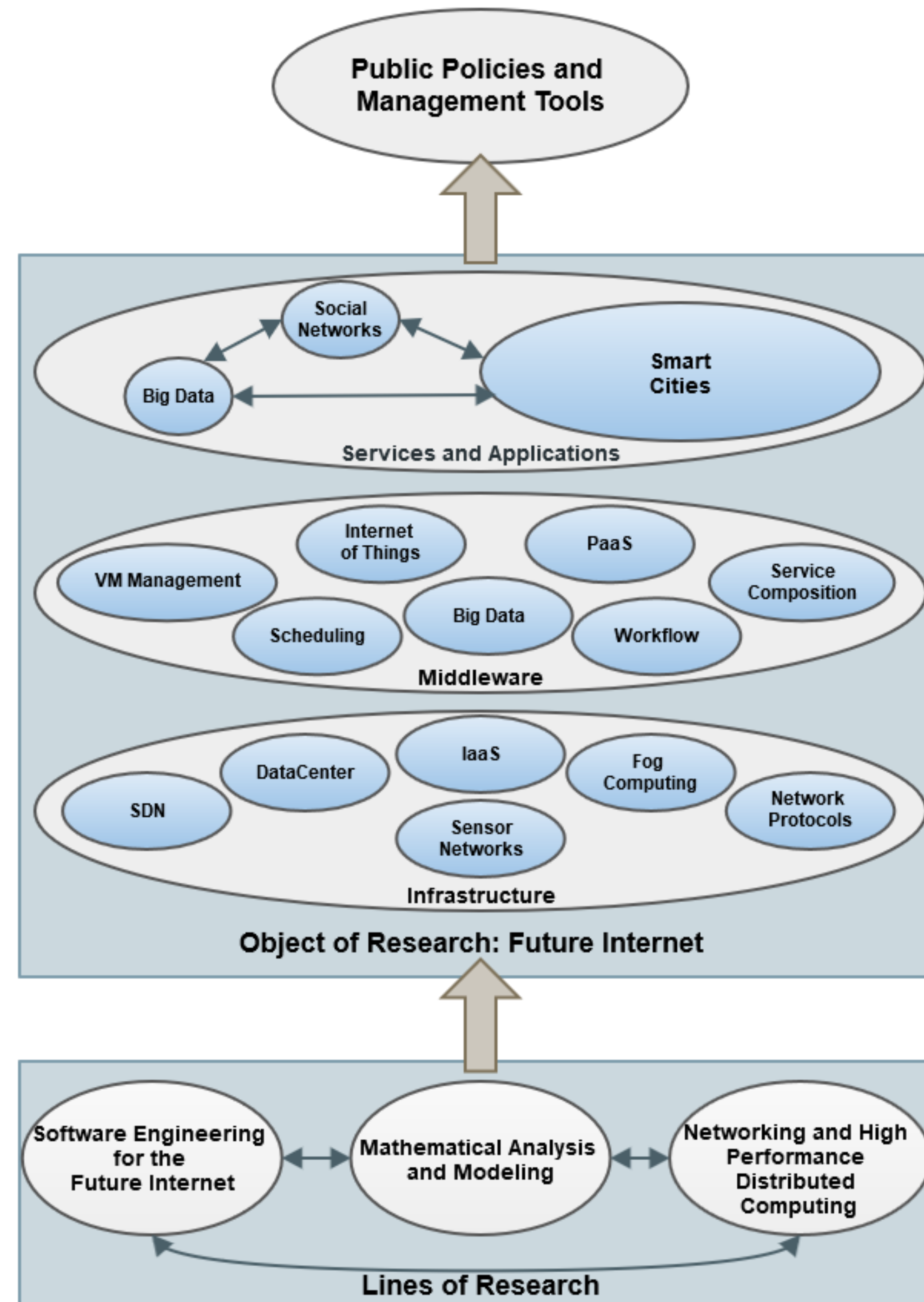
Although we don't ignore high-tech solutions for the elite, we prefer to focus on:

- people (technology is a means not an end)
- low-income populations
- developing countries
- underprivileged neighborhoods



The InterSCity Project

- 3 lines of research
- 3 levels

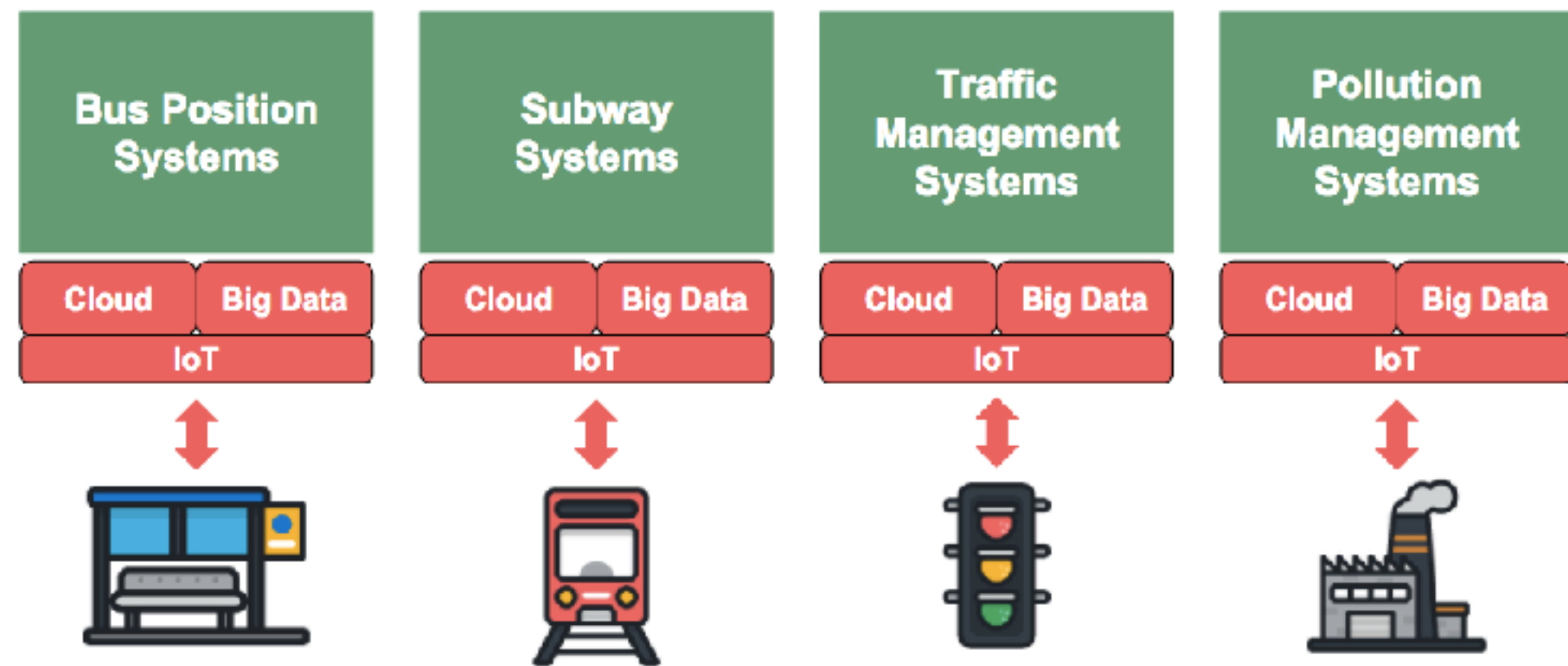


Projects

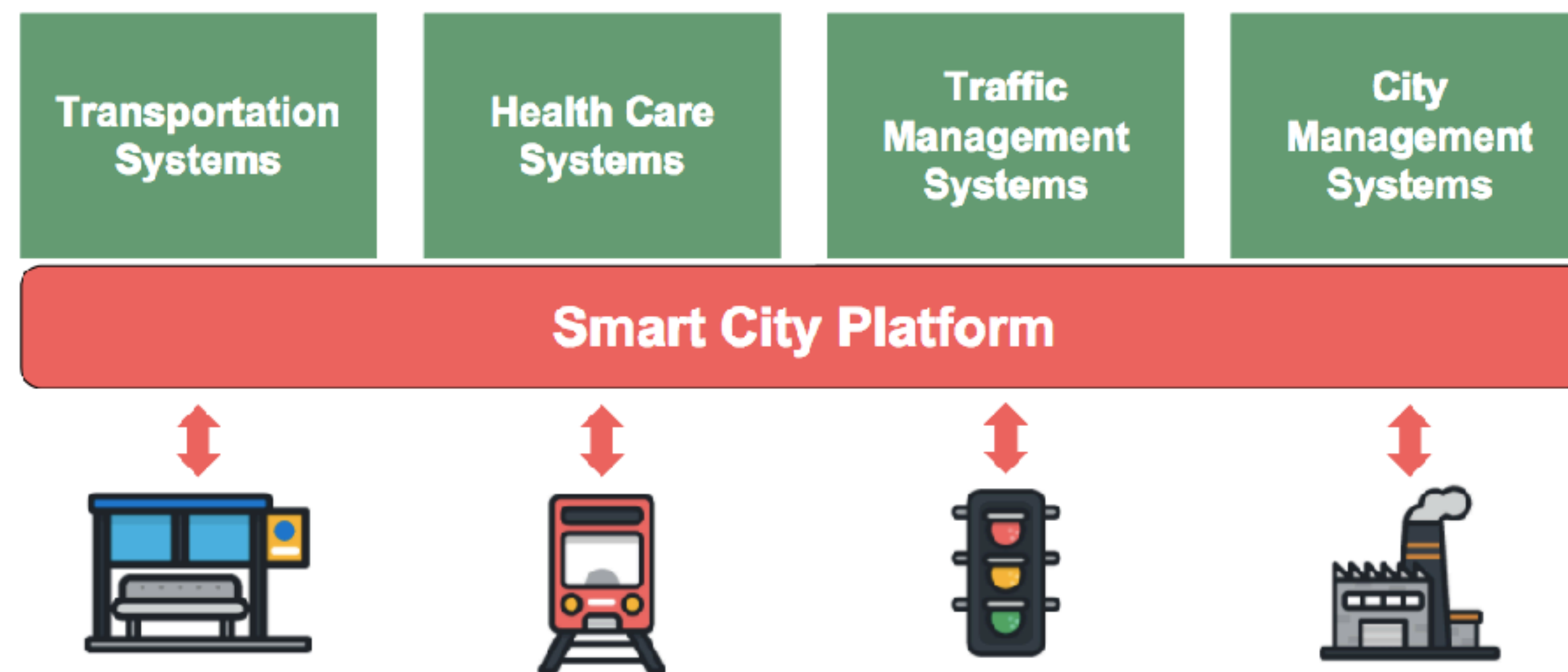
1. Smart City Software Platform
2. City Simulator
3. Health Dashboard
4. Accessibility Ranking
5. Scipopulis Startup
6. BikeSCience @ MIT Senseable City Lab

1 - A generic Software Platform for Smart Cities

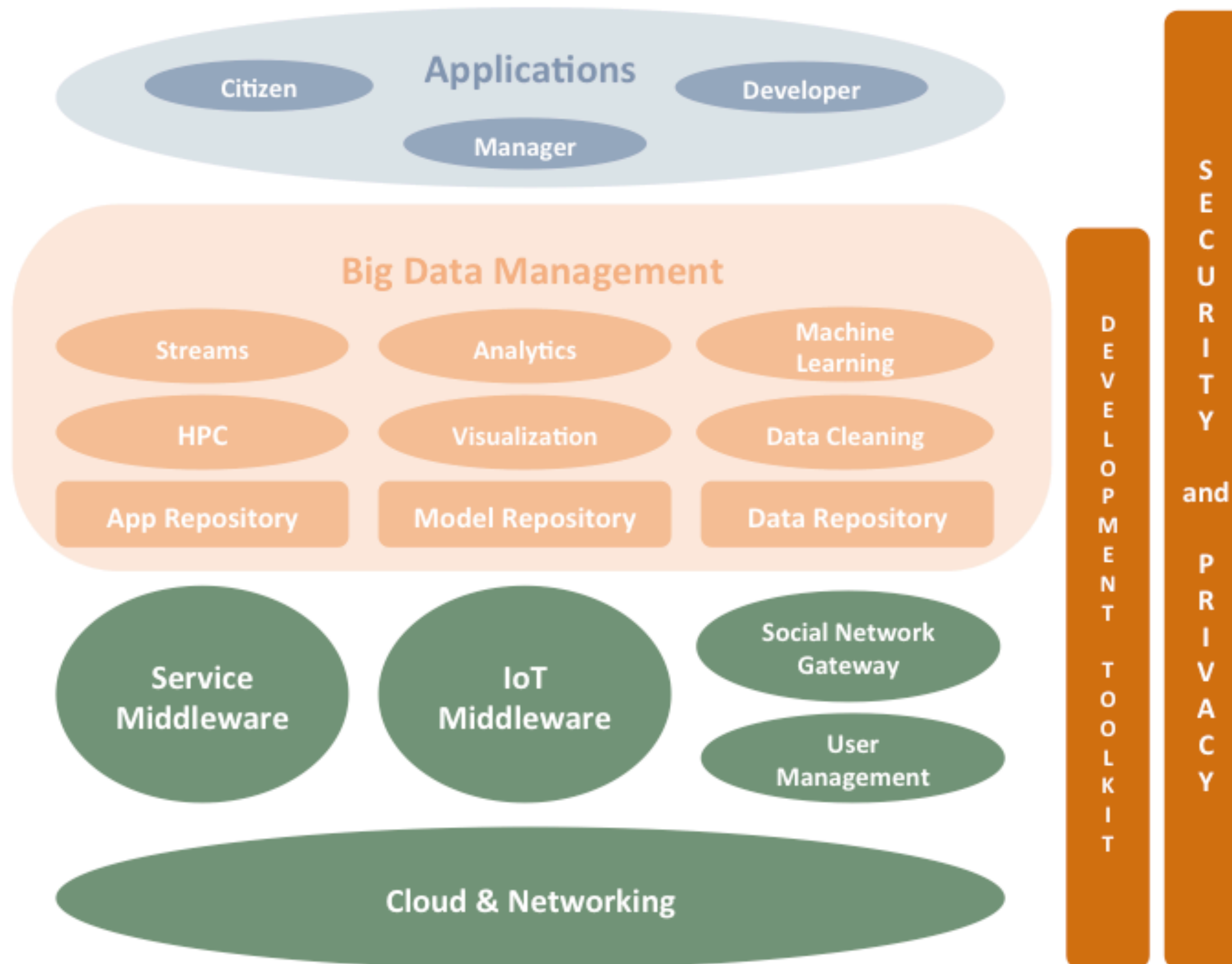
Traditional Solutions and Vertical Silos



Horizontal Solutions



Survey and proposed reference architecture for Smart City Software Platforms



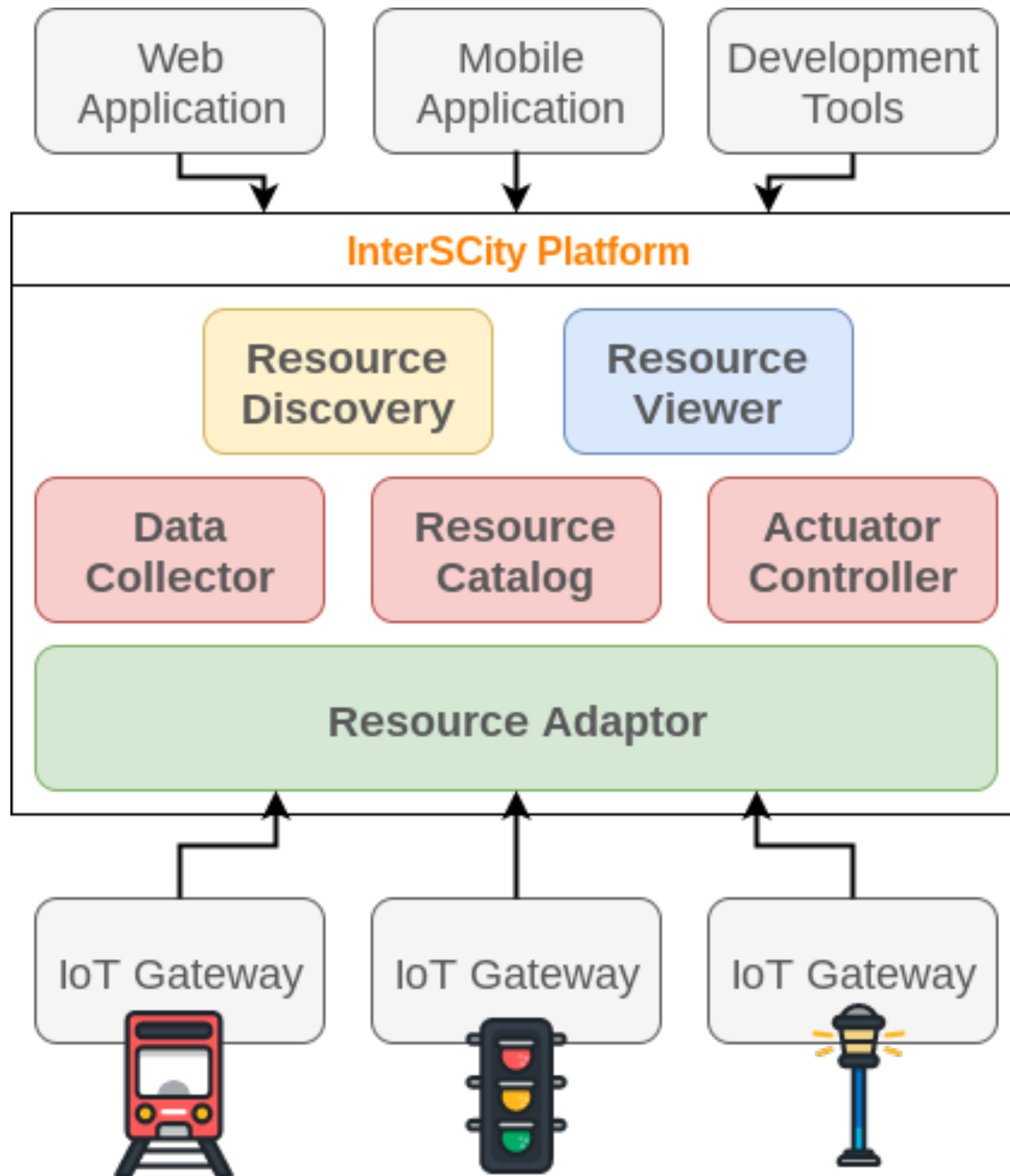
ACM Computing Surveys

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 Aurélio Gercsa, University of São Paulo
 Fabio Kon, University of São Paulo
 Dejan S. Milošević, 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 devised a reference archite...





GitLab Projects Groups Snippets Help

InterSCity Platform
Smart City Platform by the Software Systems Research Group - IMI
<http://interscity.org/>

Projects Subgroups Filter by name

- docs Smart City Software Platform documentation
- dev-env
- kong-api-gateway

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

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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

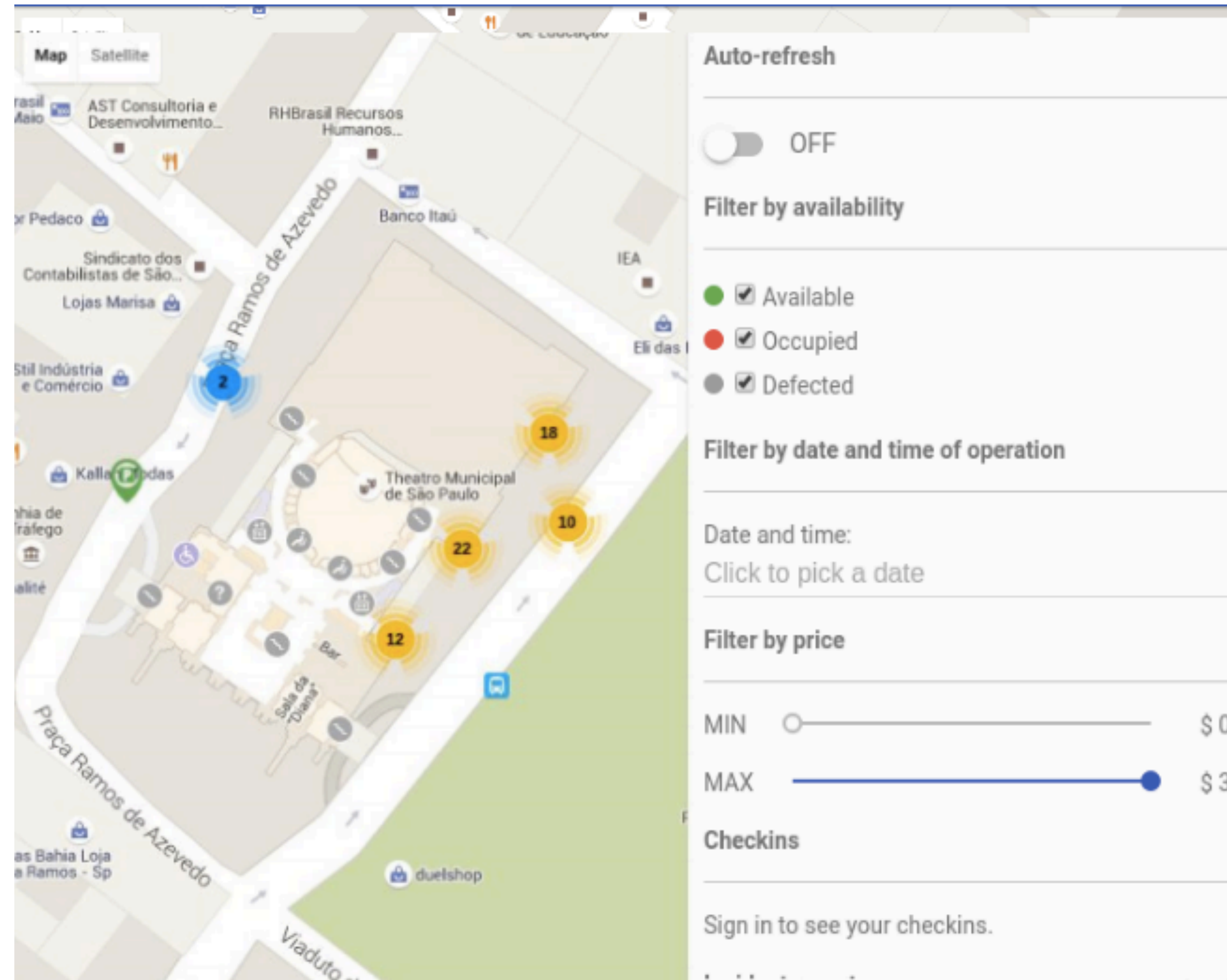
The rapid growth of cities around the world has created large, densely populated urban centers characterized by complex interconnected structural, social and economic organizations. This urbanization phenomenon has led to a growing demand for smart cities (e.g., [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100]). The Internet of Things (IoT), Big Data, and Cloud Computing are key enabling technologies of smart cities that offer a wide range of opportunities 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

Exemplos de uso da plataforma

Smart Parking APP

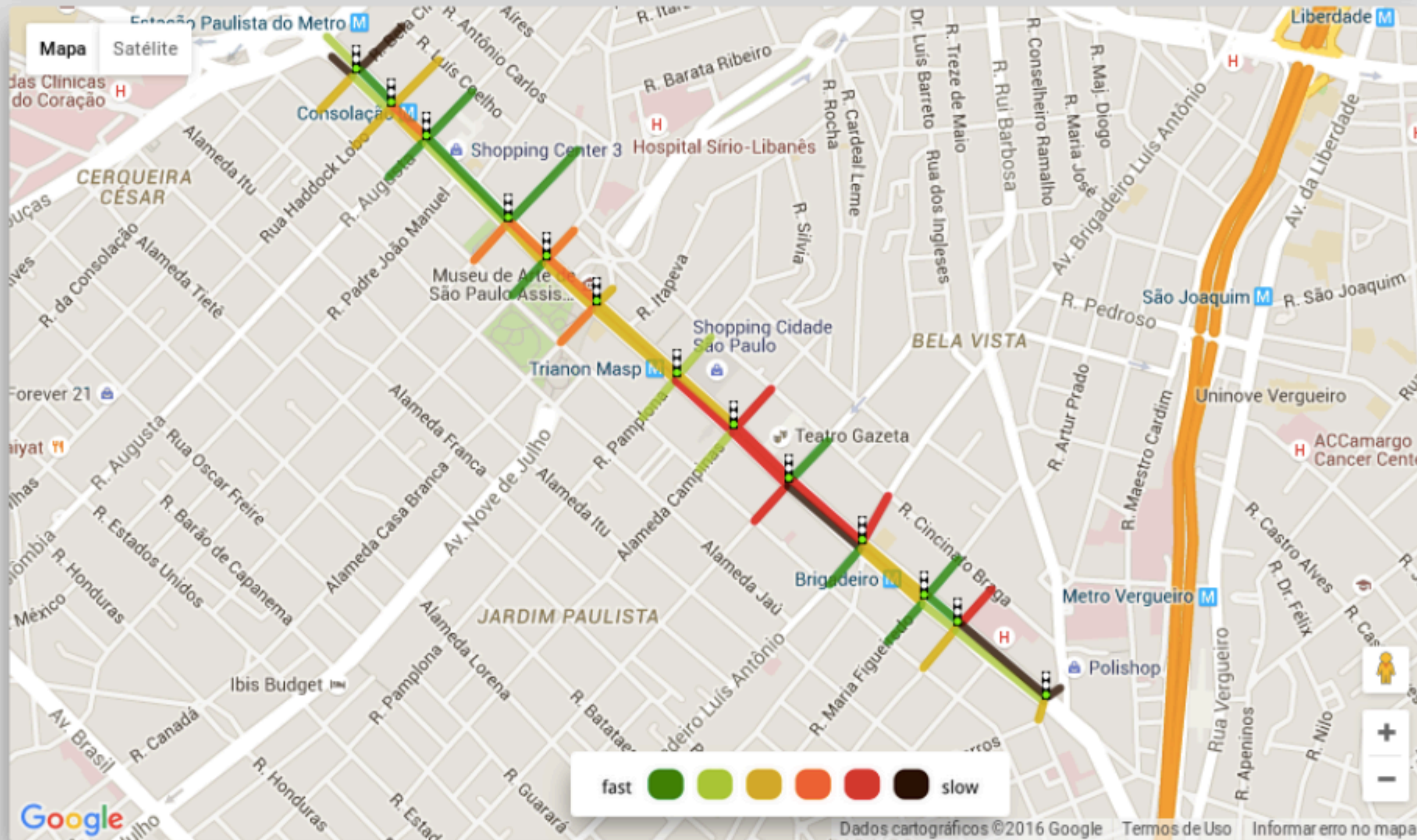
single-page app that helps users in the hard task of finding available parking spots around the city.

It used the platform services to access simulated data.



Exemplos de uso da plataforma

Smart Traffic Lights



controls

enable

- traffic lights
- traffic data

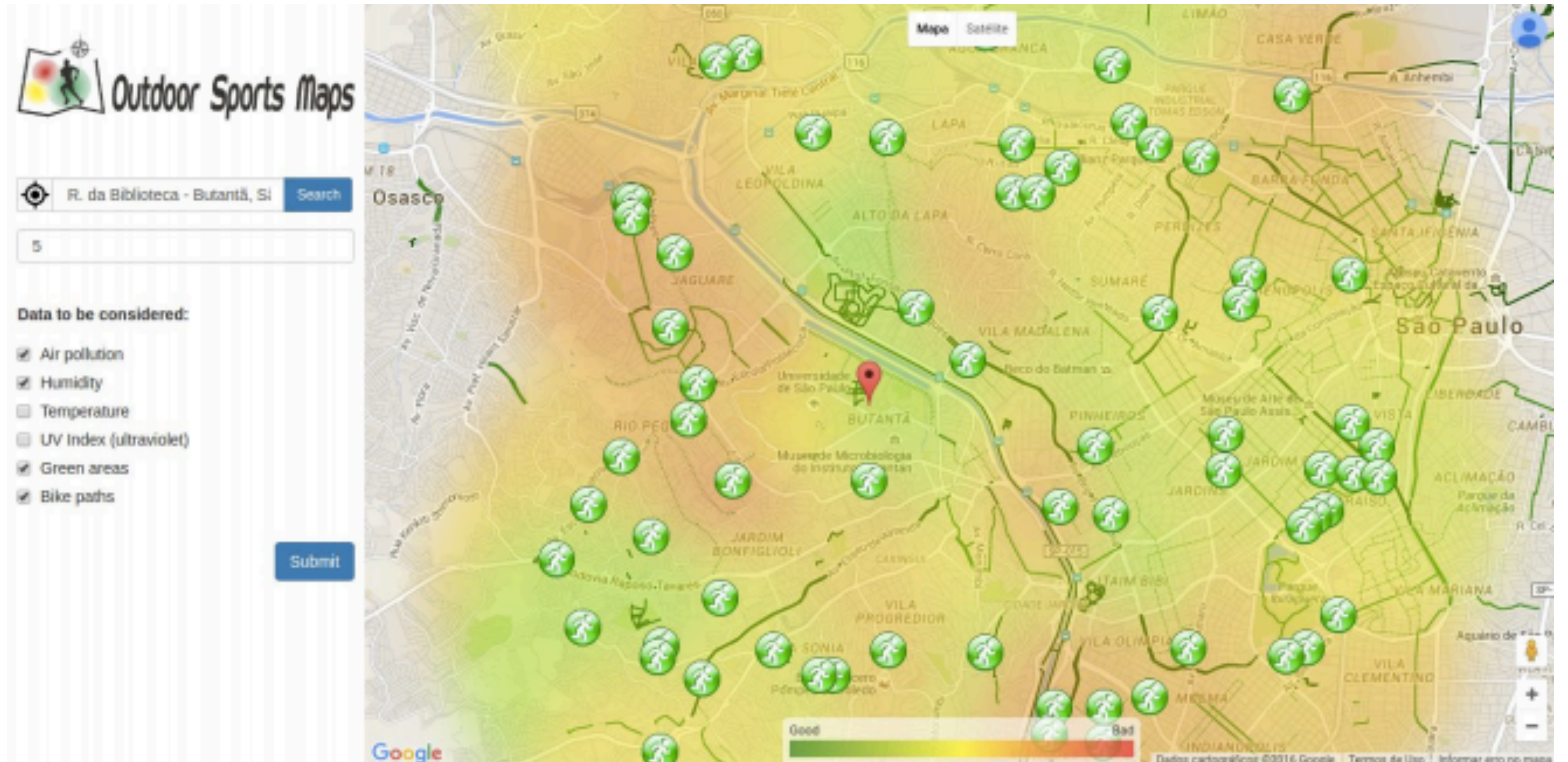
show

- traffic speed
- number of vehicles

time



Outdoor Sports Map



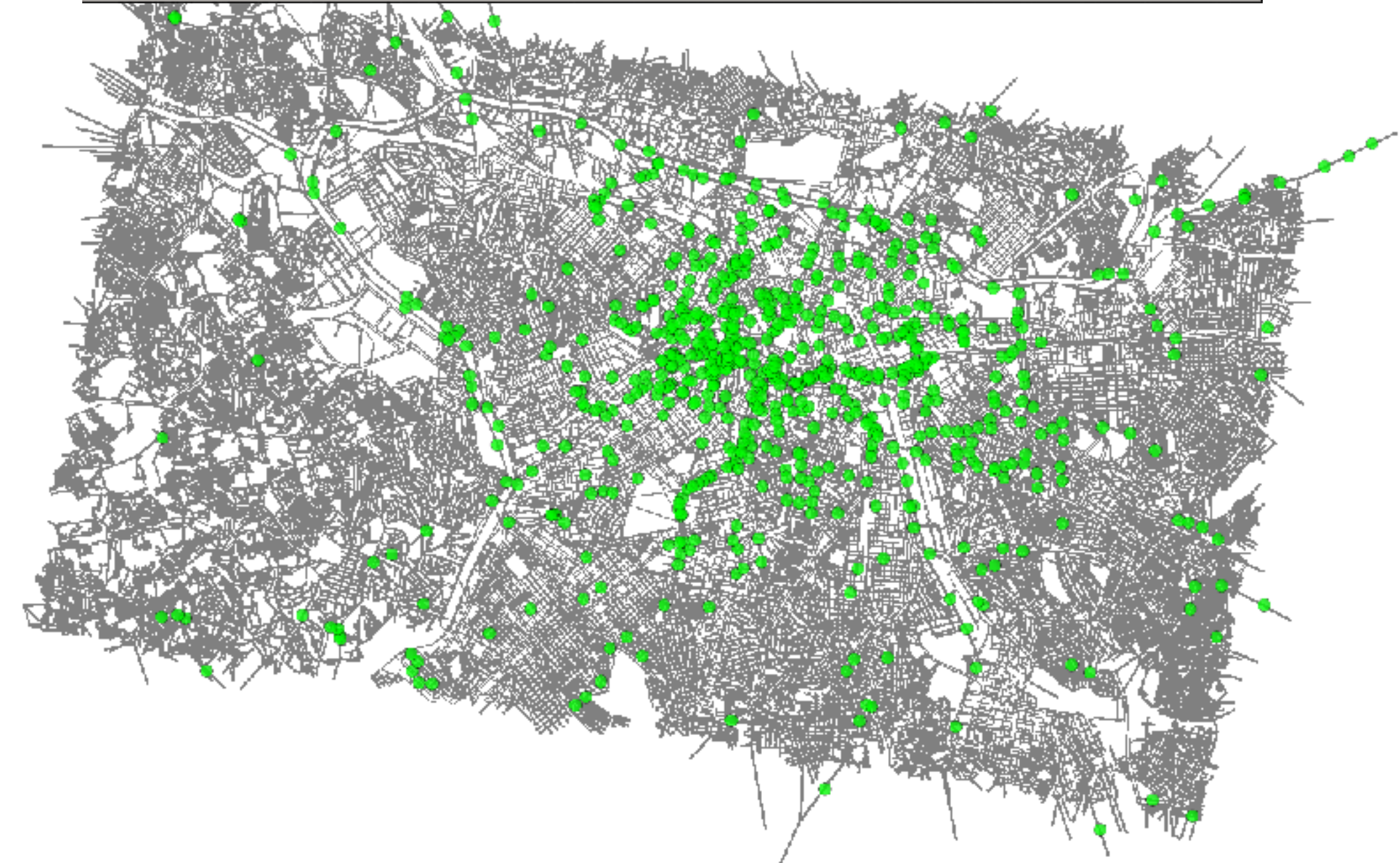
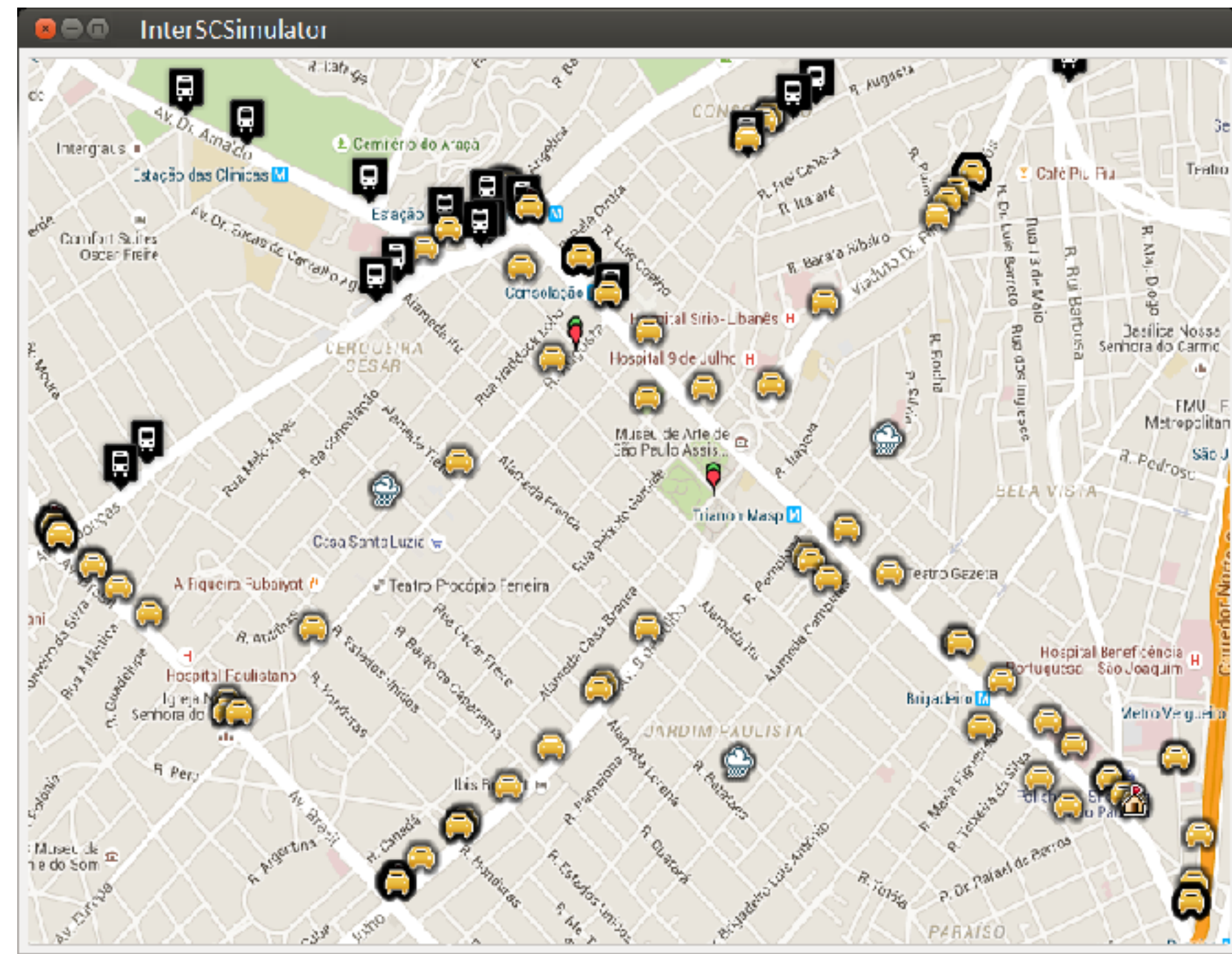
Other uses

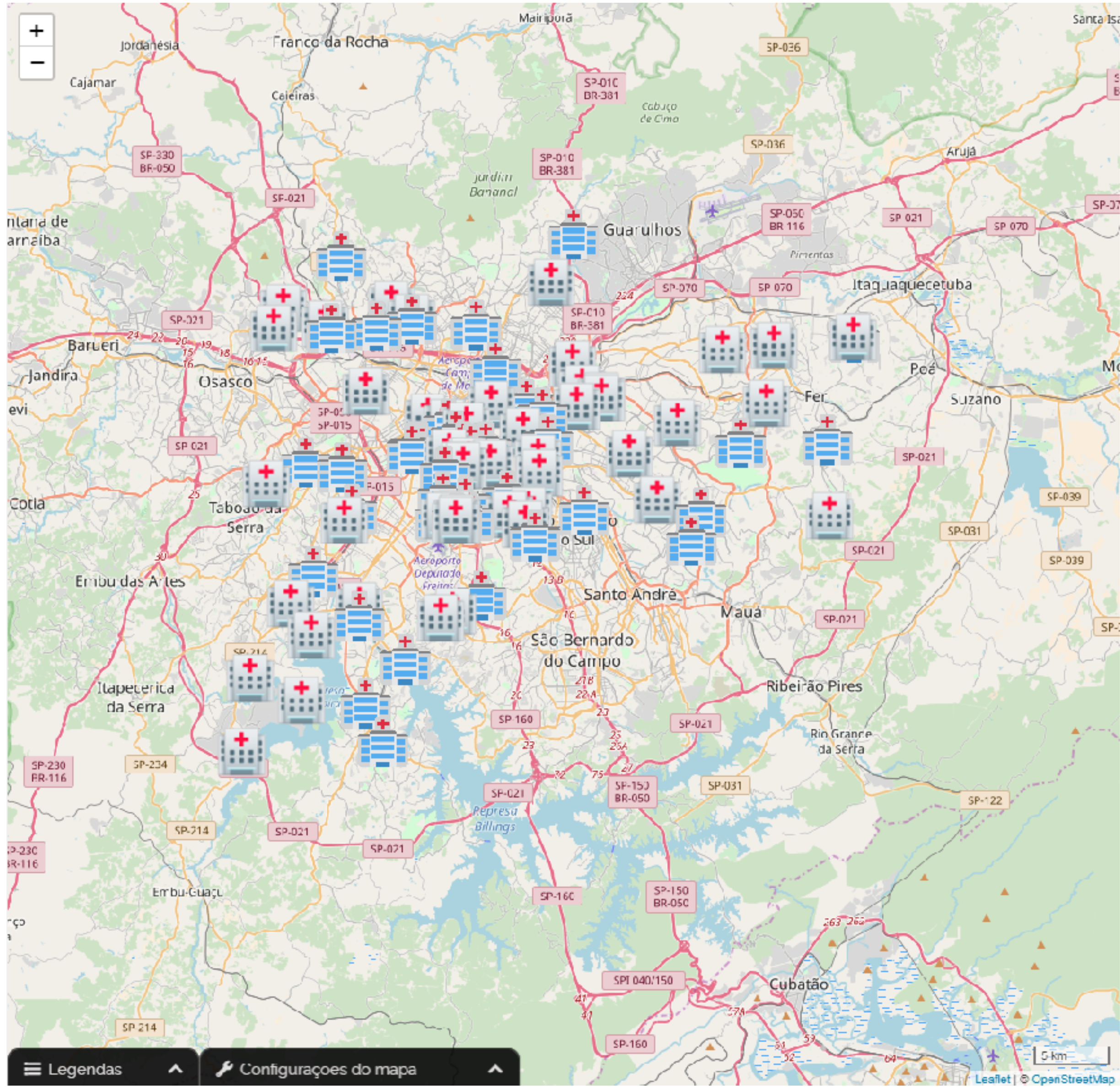
- Smart City Hackathons
- Graduate Course at USP
- Undergraduate Course at UFMA
- Research (MSc, PhD, and post-doc @ USP/Puc-Rio/UFMA)

- In the future: real cities?

2 - InterSCimulator

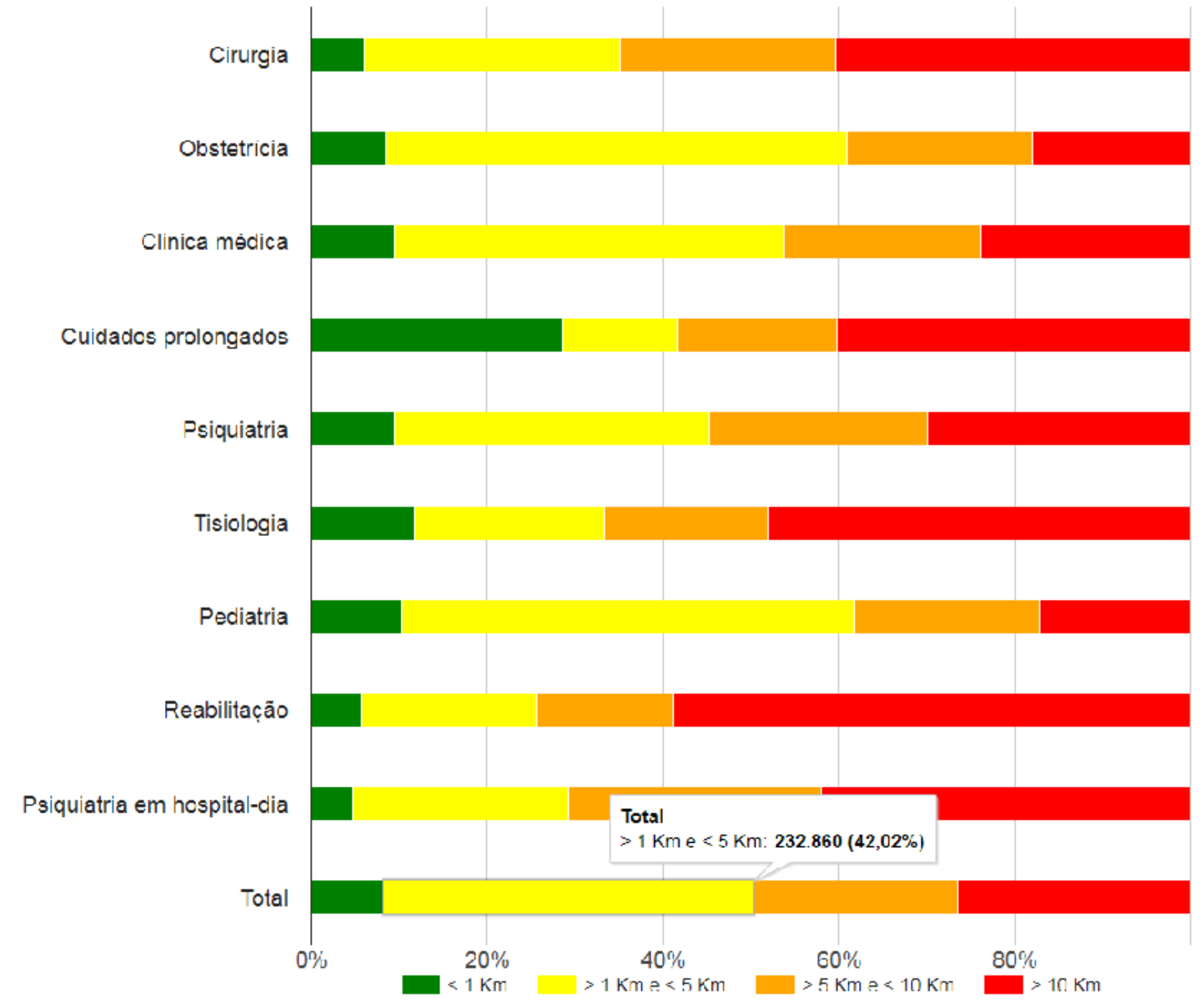
- Erlang-based large-scale simulator for Smart Cities
- Simulations with 17 million agents in super-real-time
- Multimodal transportation
 - cars, pedestrians, buses, subway, (bicycles).
 - Impact analysis of changes in the transportation infrastructure and associated costs.
 - Population from Paraisópolis favela (slum) in SP.



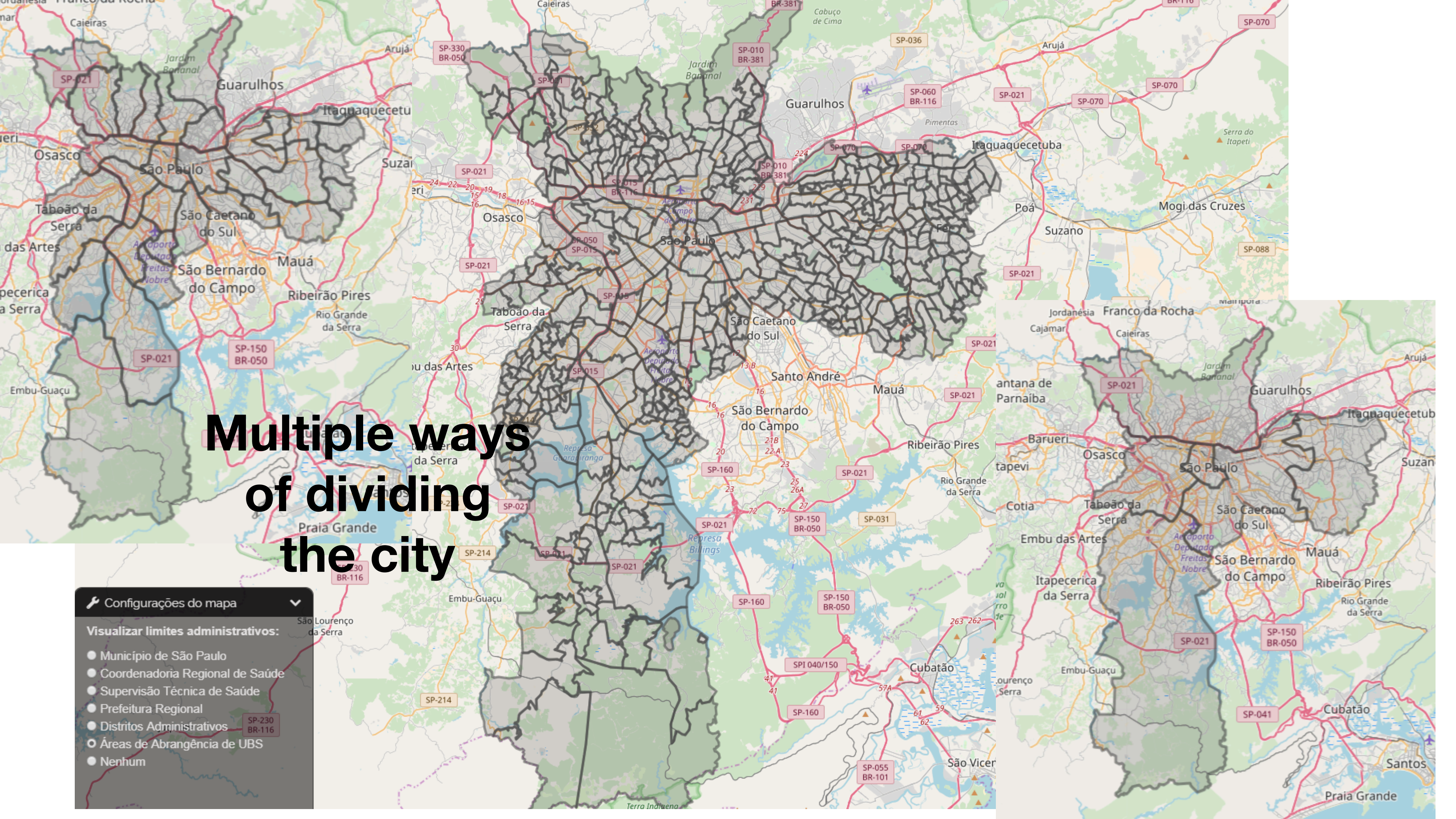


SÃO PAULO

554.202
Procedimentos



Multiple ways of dividing the city

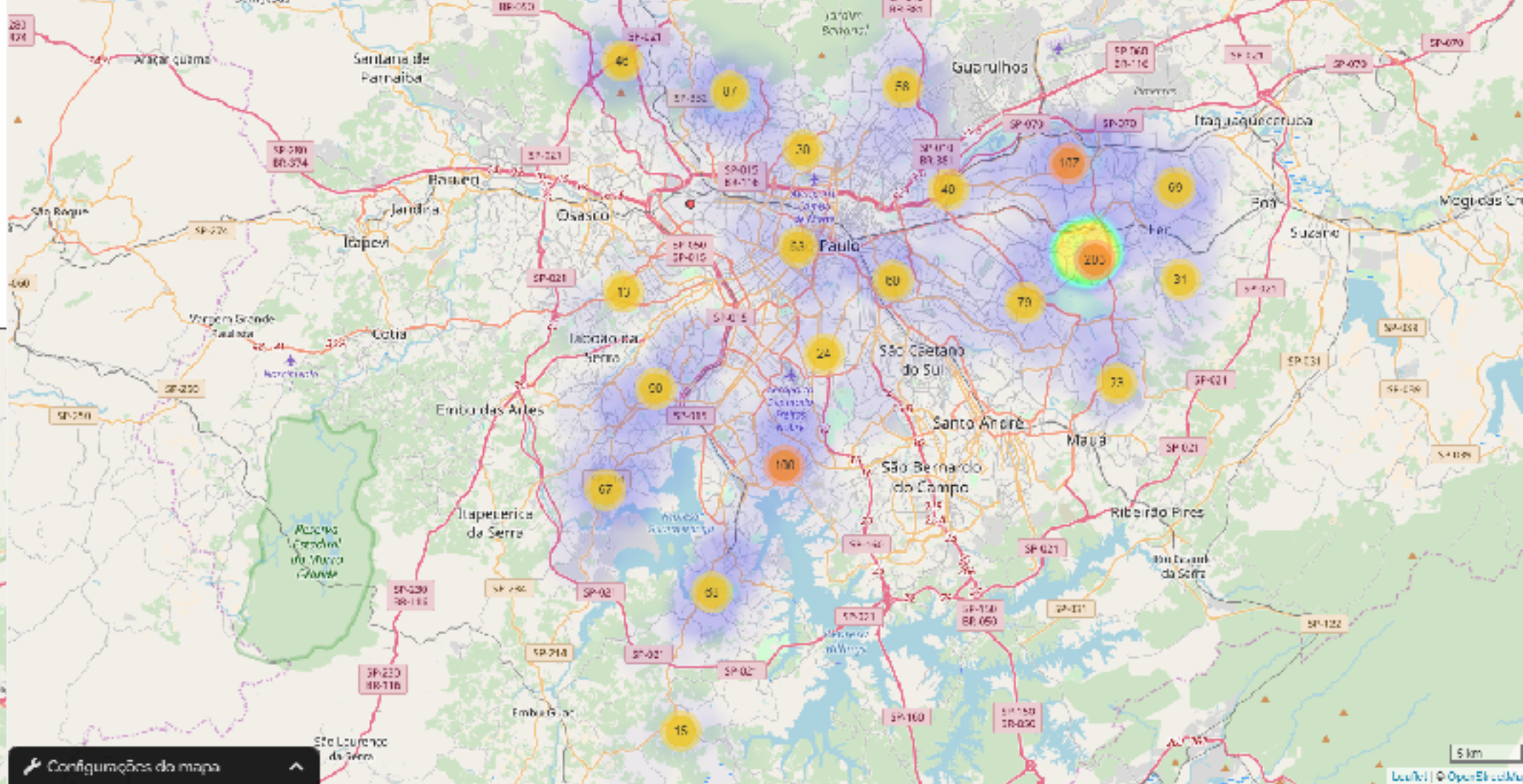
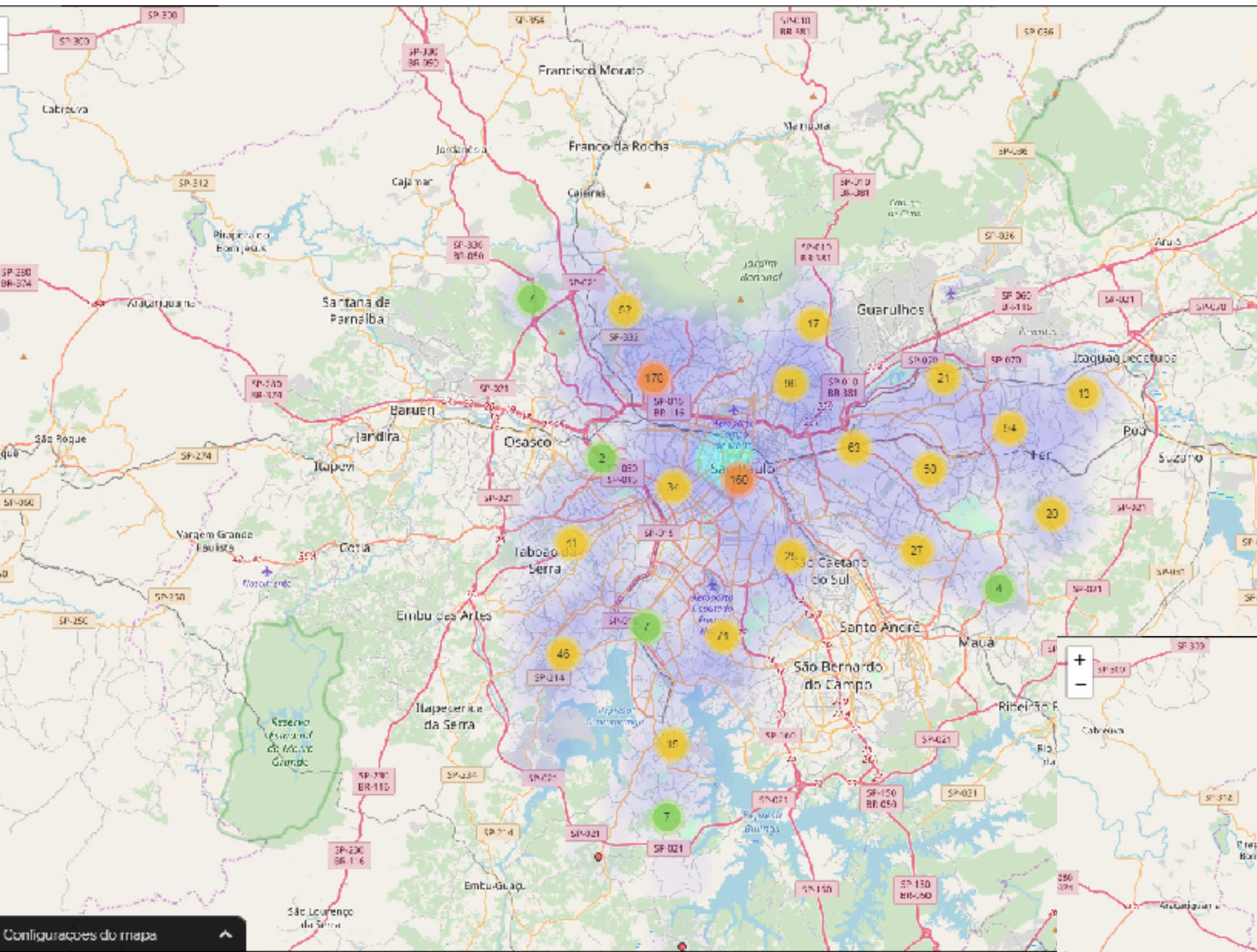


Configurações do mapa

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

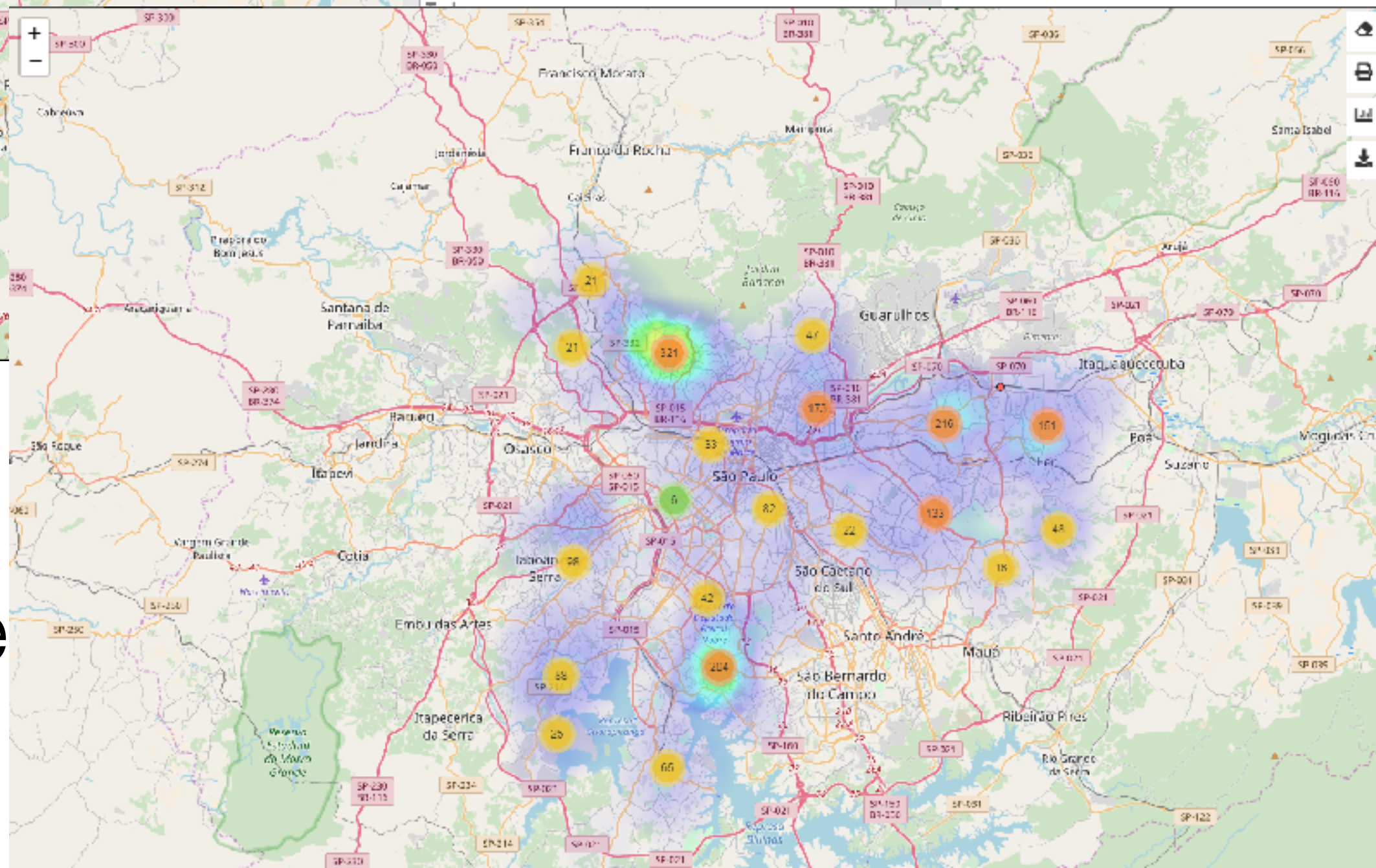
Leukemia



Competência (aaaaamm)	Todos
Grupo do procedimento autorizado	Todos
Especialidade do leito	Todos
Caráter do atendimento	Todos
Diagnóstico principal (CID-10)	<input type="text" value="C81 - Leucemia Linfóide"/>
Diagnóstico secundário (CID-10)	Todos
Diagnóstico secundário 2 (CID-10)	

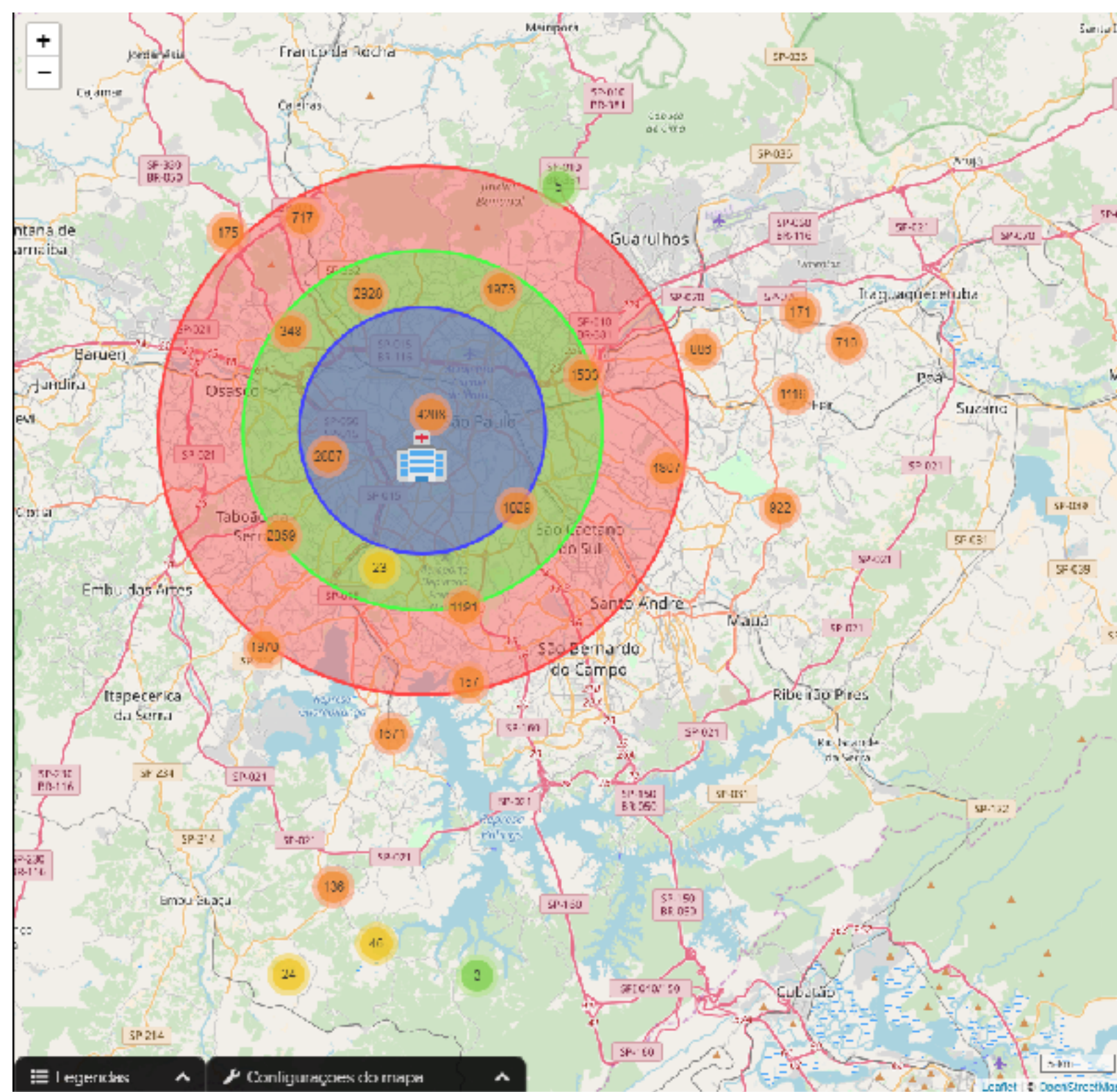
Grupo do procedimento autorizado	Todos
Especialidade do leito	Todos
Caráter do atendimento	

HIV



Busca automática:	<input type="checkbox"/>
Diagnóstico	
Estabelecimento de ocorrência	Todos
Competência (aaaaamm)	Todos
Grupo do procedimento autorizado	Todos
Especialidade do leito	Todos
Caráter do atendimento	Todos
Diagnóstico principal (CID-10)	<input type="text" value="A80 - Dengue [dengue Clássico]"/>
Diagnóstico secundário (CID-10)	Todos

Dengue Fever

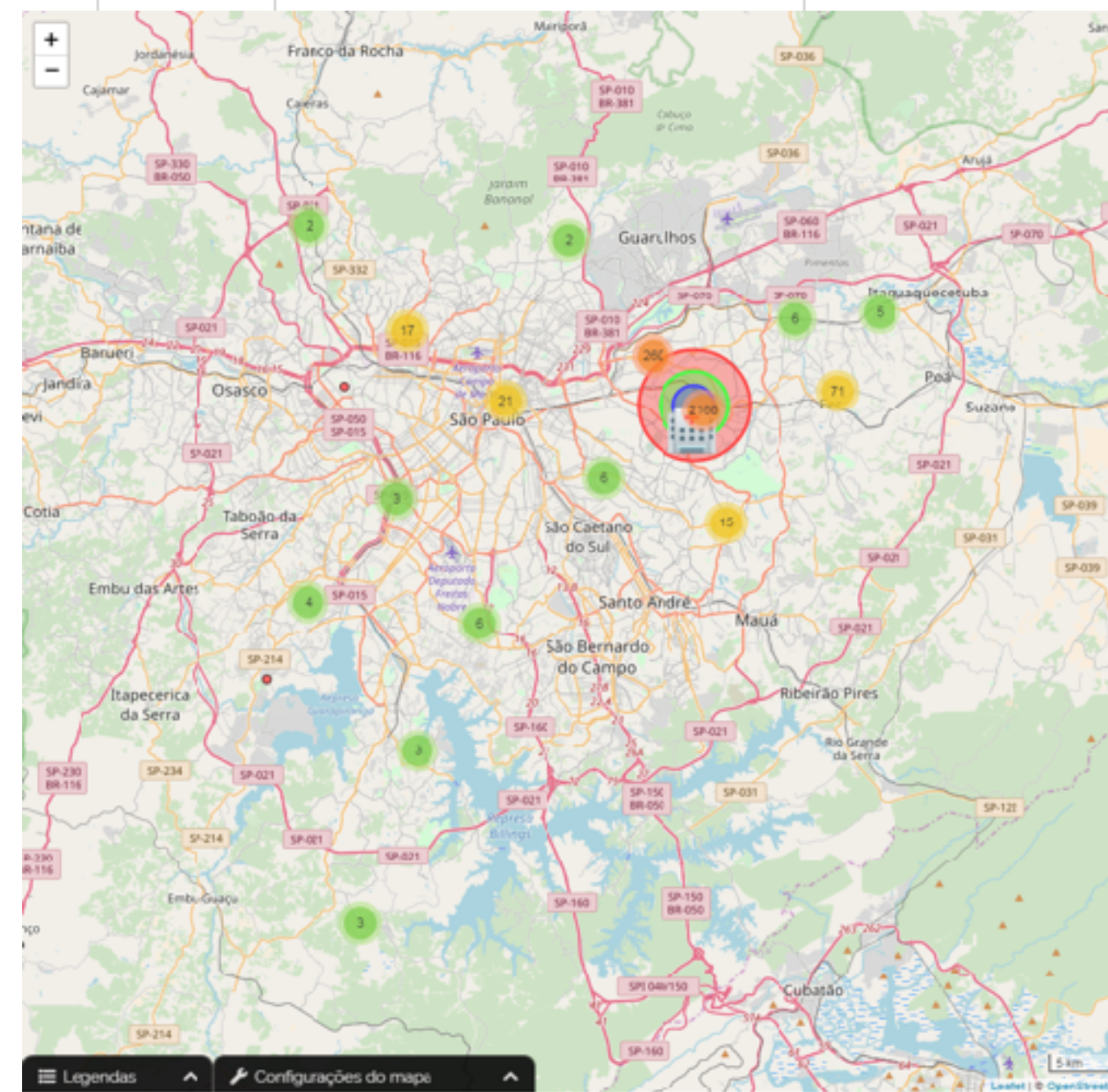
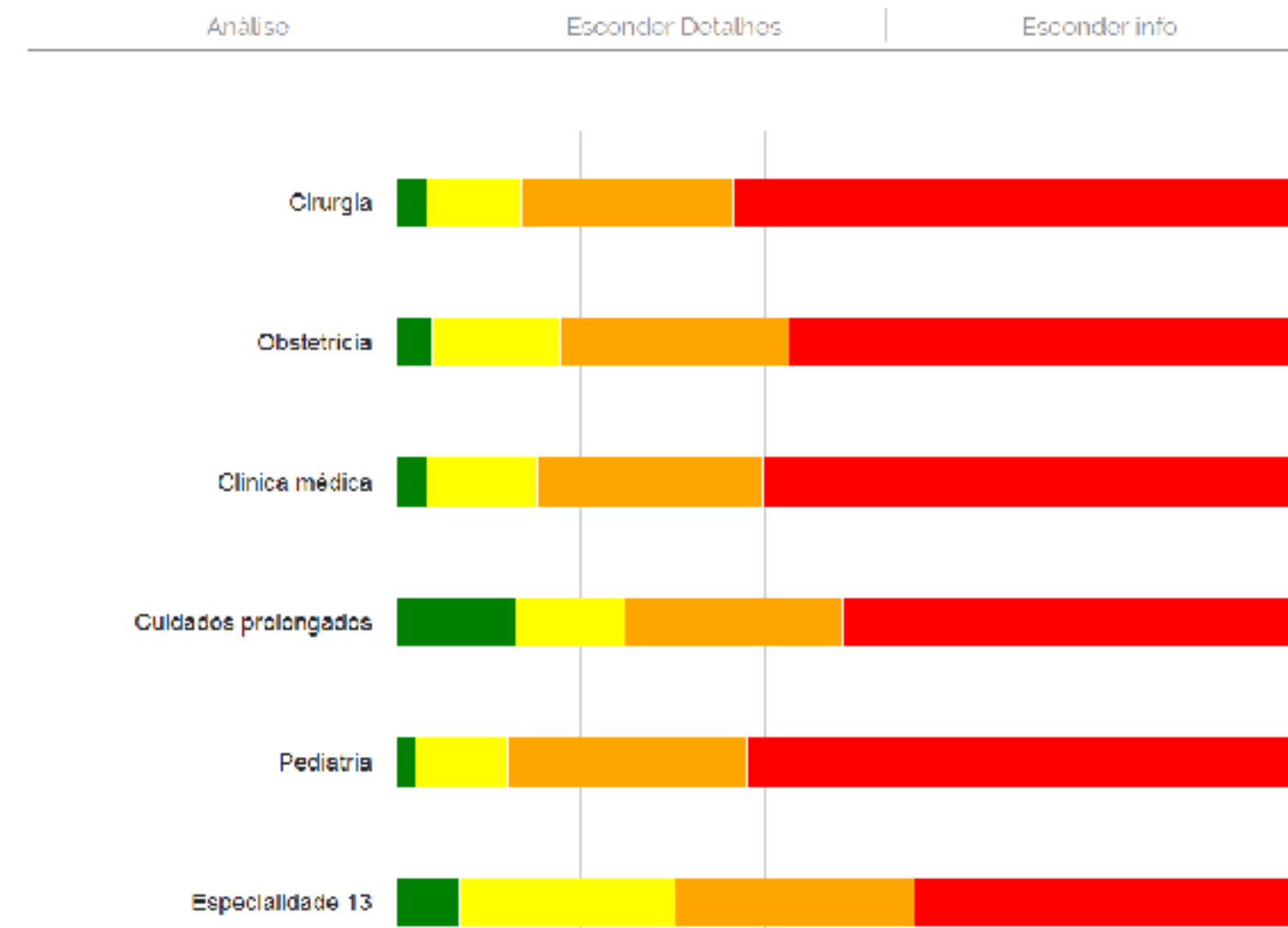


HC DA FMUSP HOSPITAL DAS CLINICAS SAO PAULO

29.415
Procedimentos

Telefone: (11)3097-5456
 Leitos: 1508
 Distrito Administrativo: JARDIM PAULISTA
 Prefeitura Regional: PINHEIROS
 Supervisão Técnica de Saúde: LAPA / PINHEIROS
 Coordenadoria Regional de Saúde: OESTE

Metropolitan Hospital

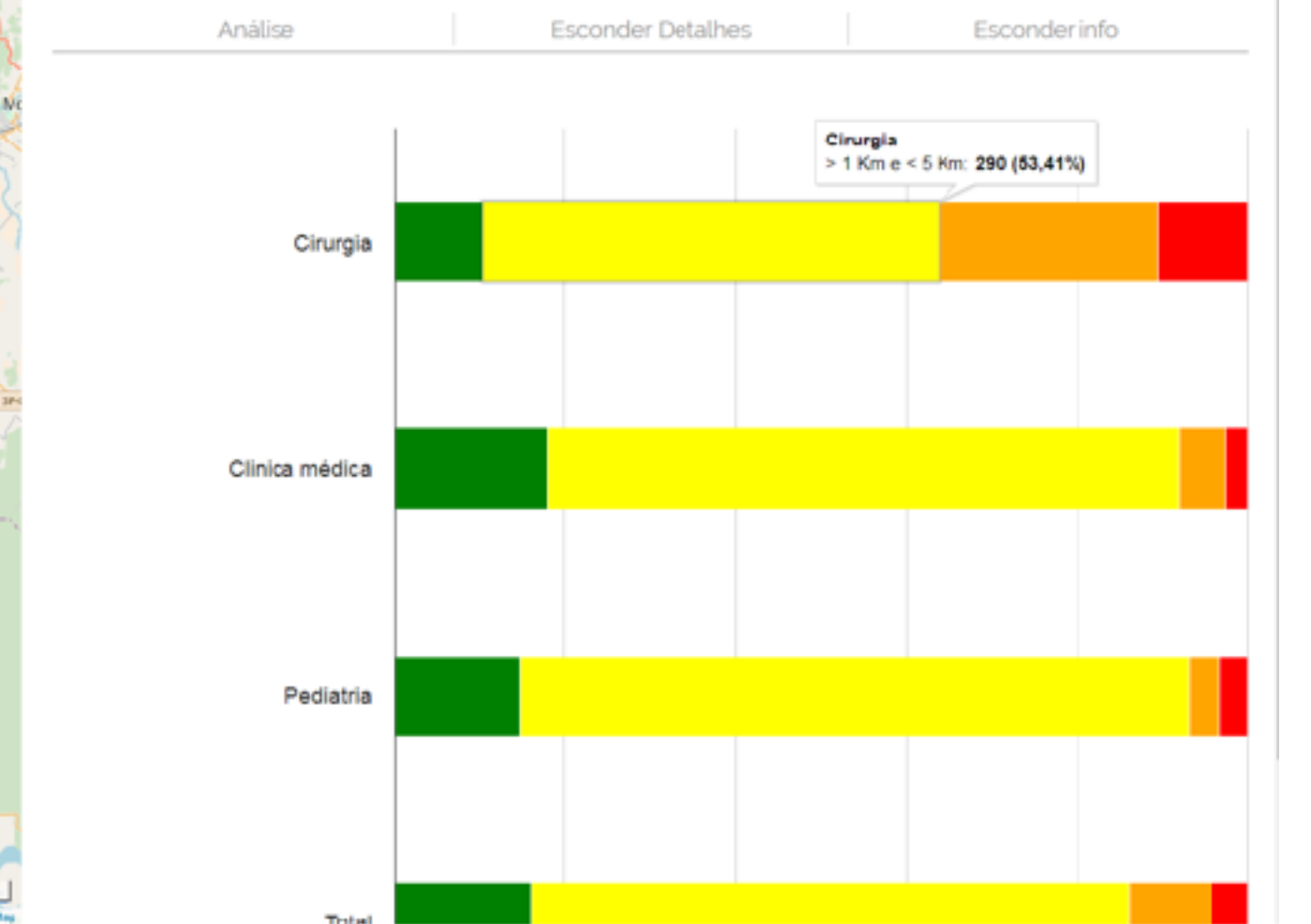


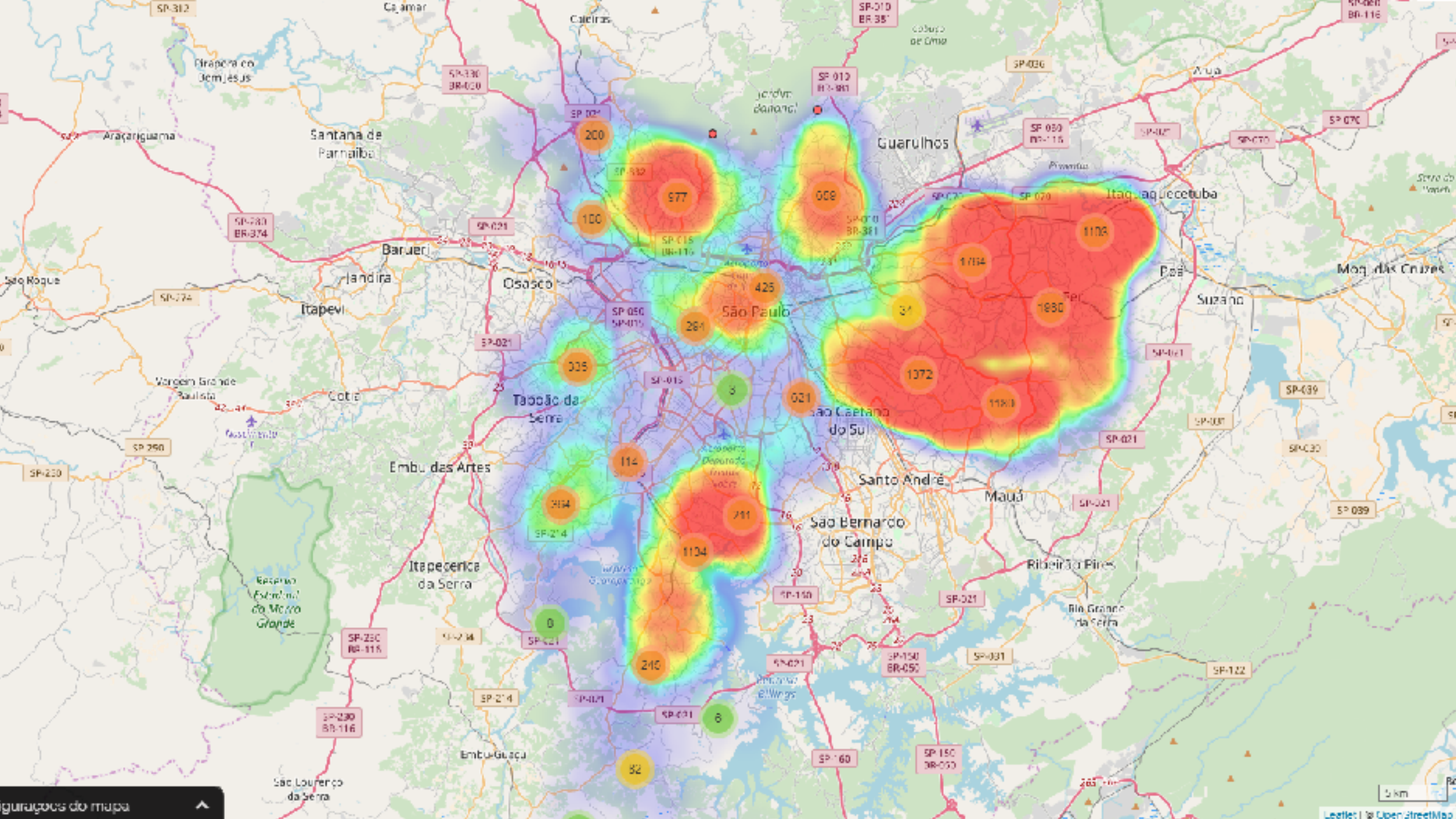
HOSP MUN DOUTOR ALEXANDRE ZAIO

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

Regional Hospital





Estabelecimento de ocorrência
 Todos

Competência (aaaa-mm)
 Todos

Grupo do procedimento autorizado
 Todos

Especialidade do leito
 Todos

Caráter do atendimento
 Todos

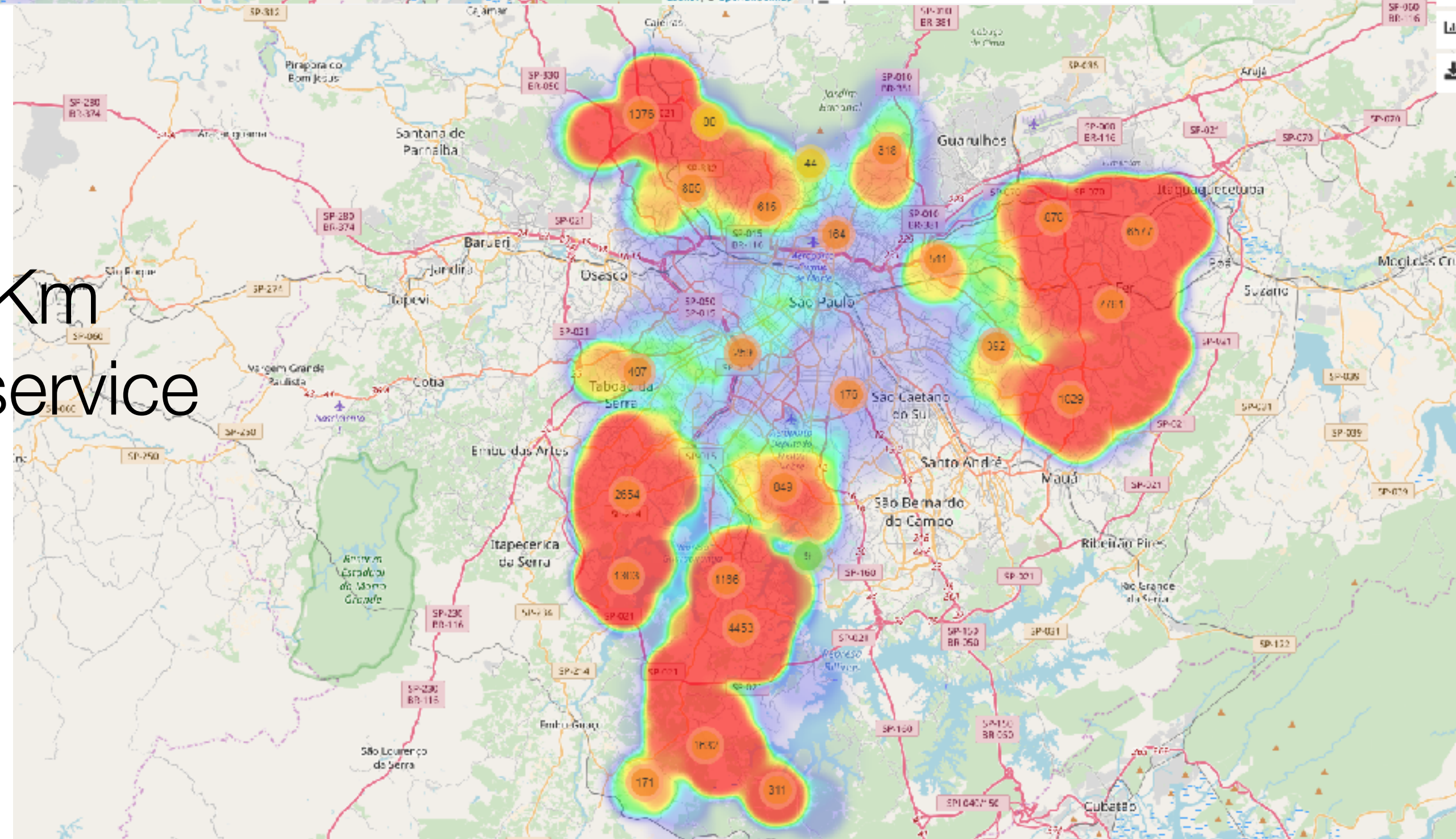
Diagnóstico principal (CID-10)
 Todos

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

Diagnóstico secundário 2 (CID-10)
 -

Hypertension
 (most frequent)

>20Km
 to get service



Localização

Estabelecimento

Valores da Busca

Total geral de diárias
 0 351

Diárias UTI
 0 148

Diárias UI
 0 99

Dias de permanência
 0 351

Valor da parcela
 0 110781

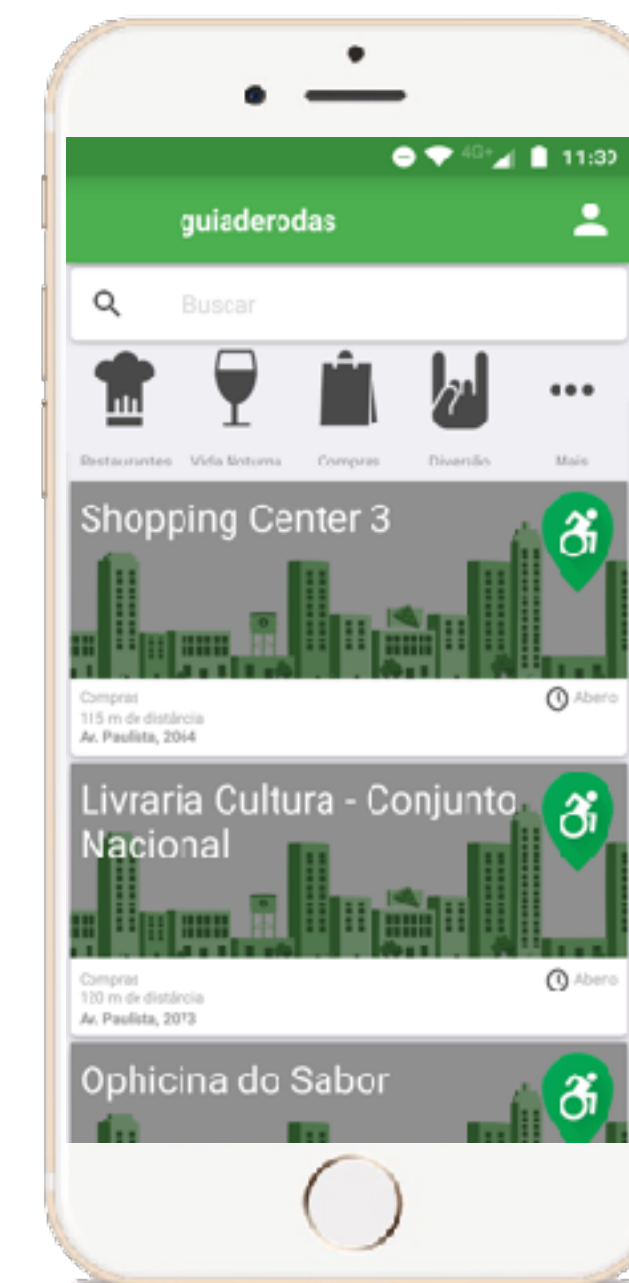
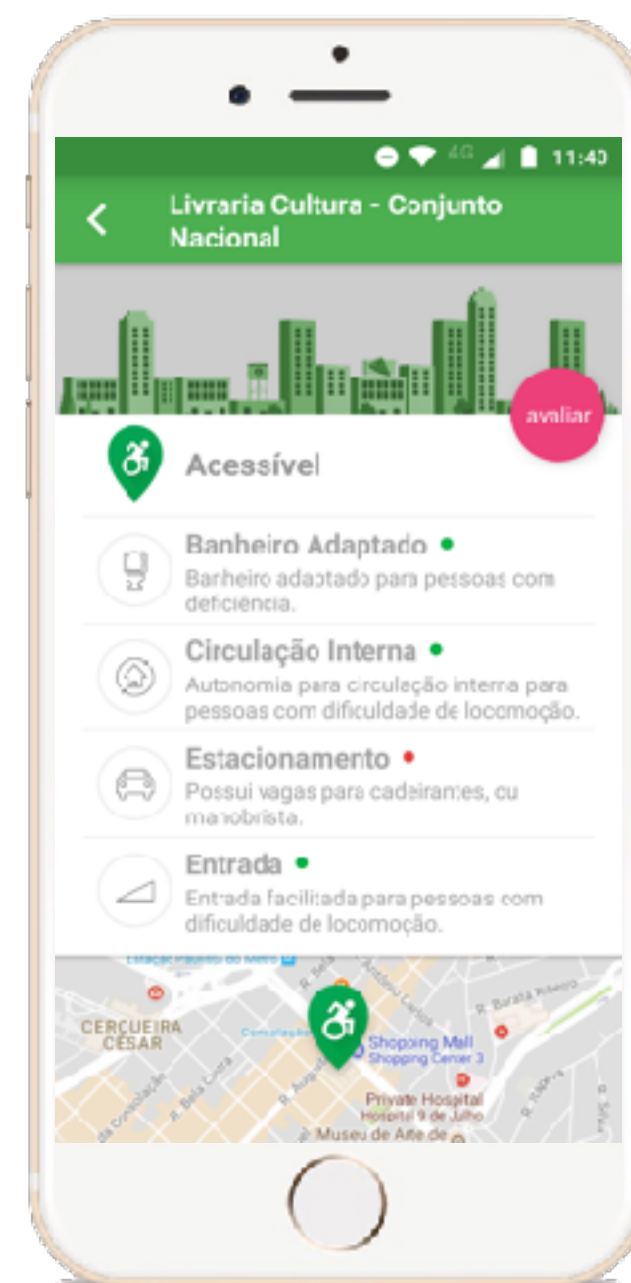
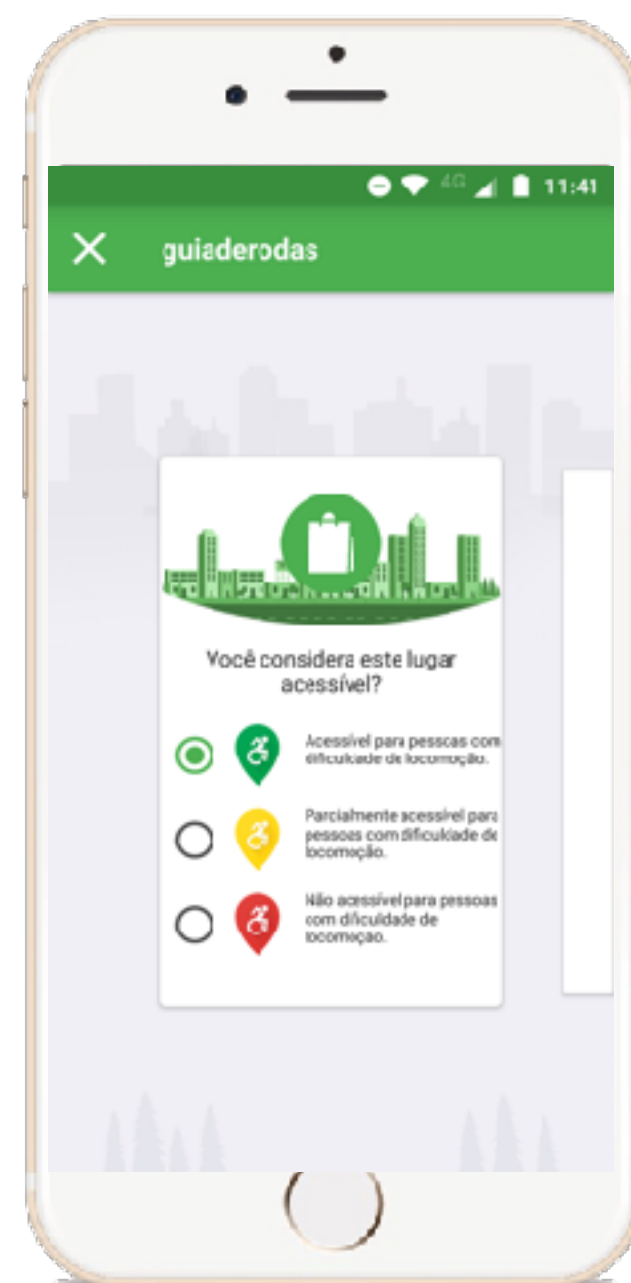
Distância de deslocamento(Km)
 20 53

Período

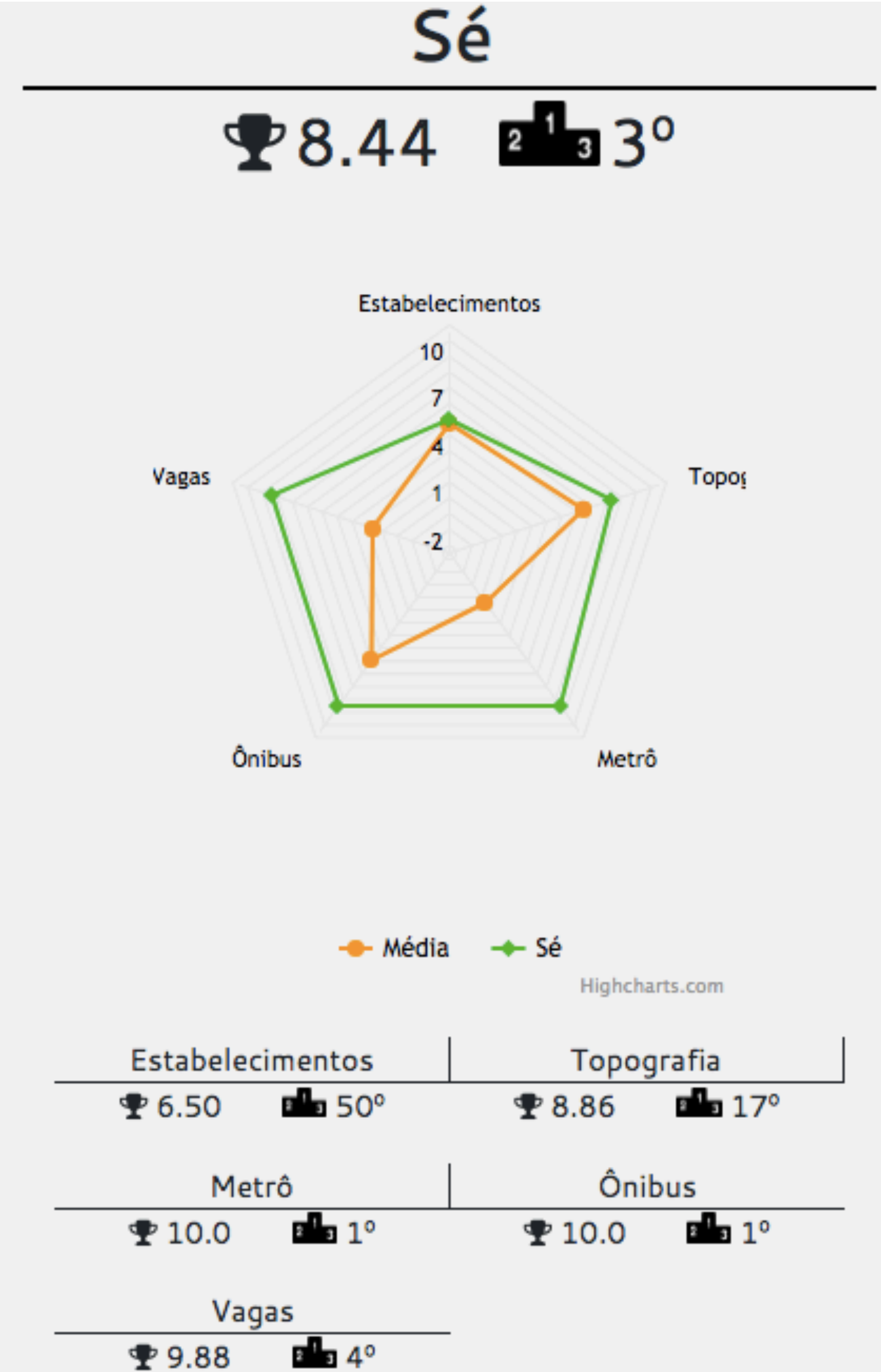
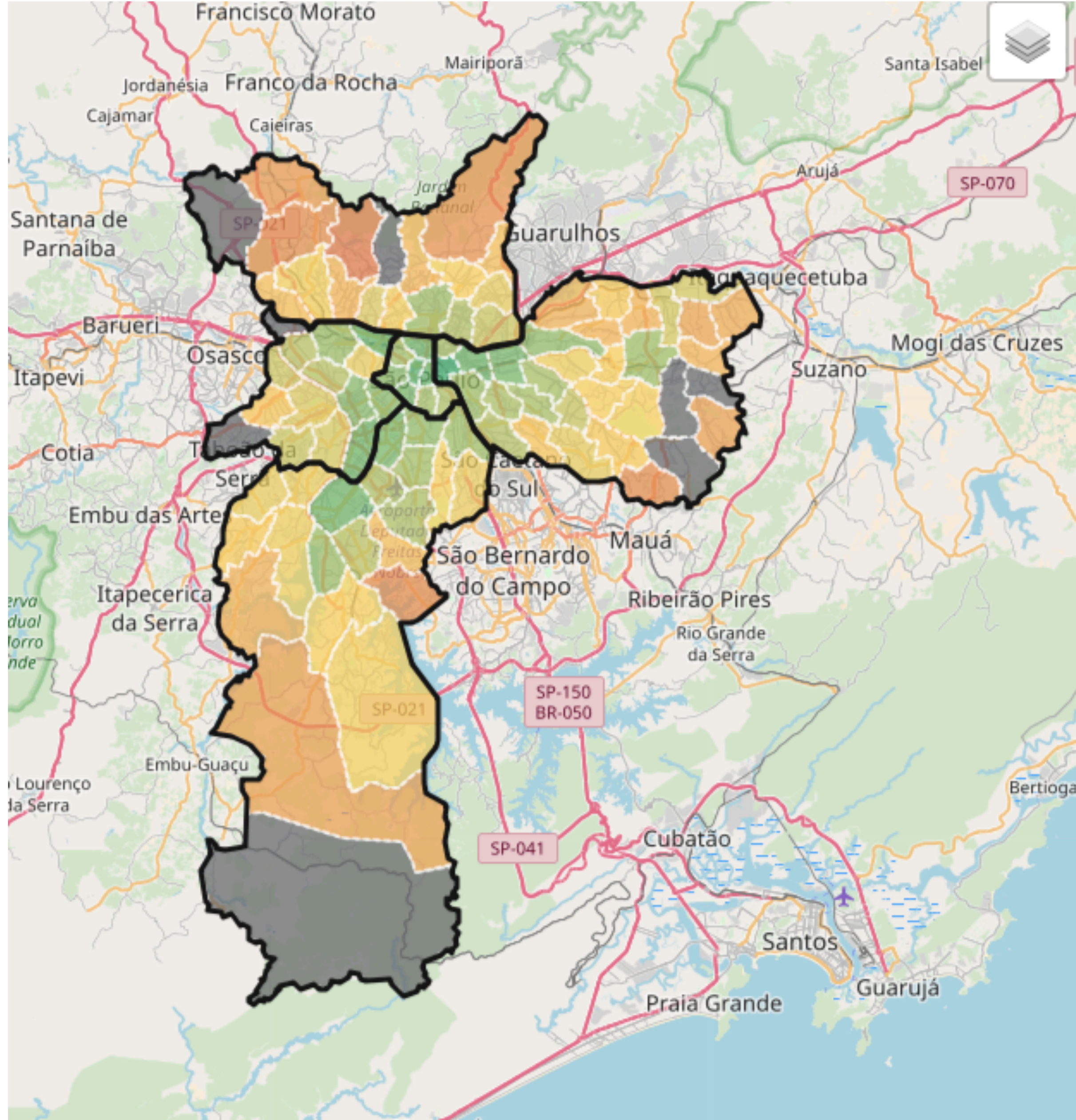
Health Dashboard Challenges

- 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 health officials?
- Develop models to support long-term planning?

4 - Crowdsourcing startup App: *guiaderodas*



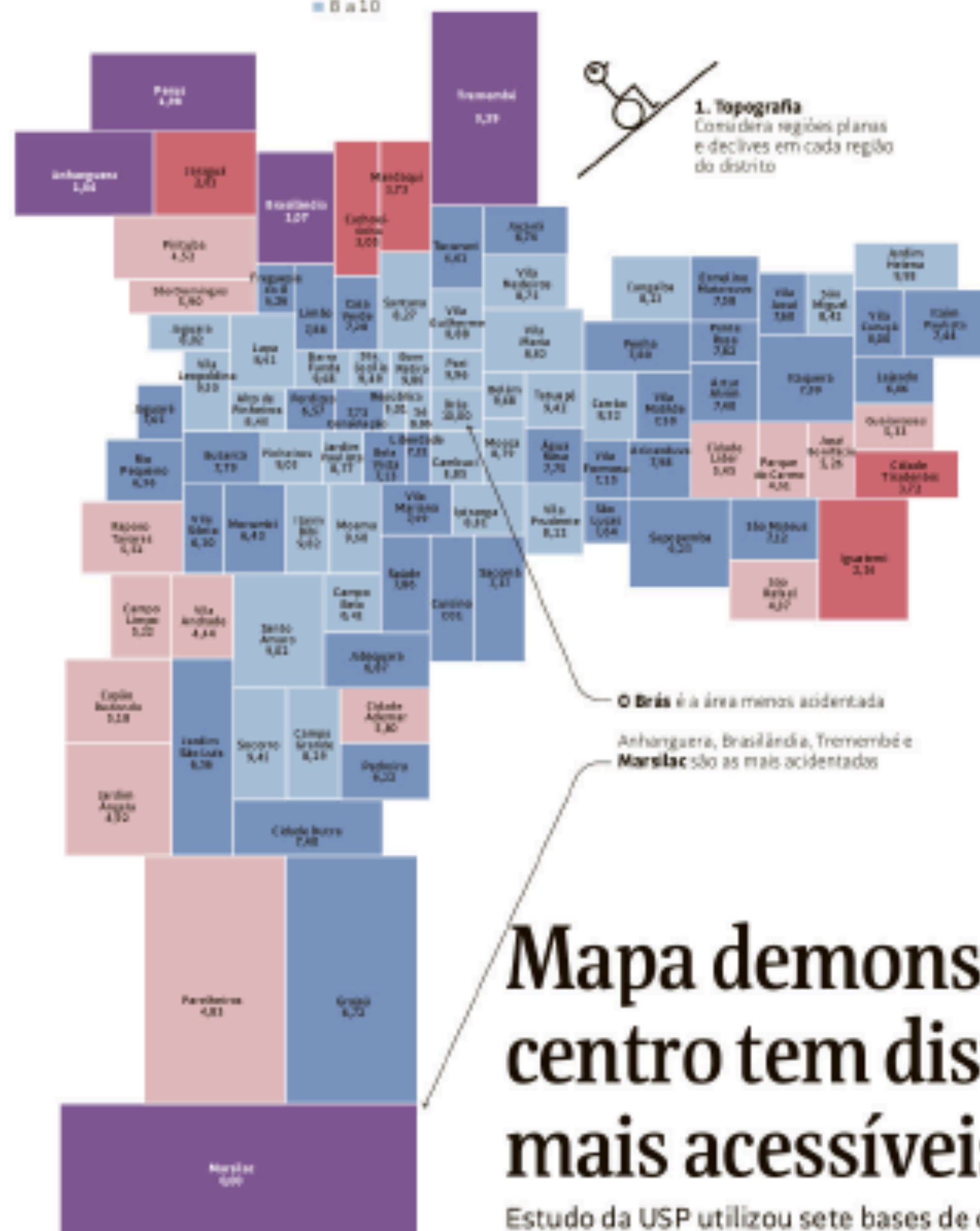
Accessibility Ranking



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



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

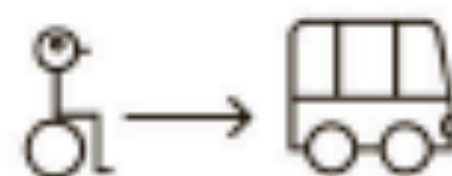


2. Ônibus acessíveis
Considera o percentual de ônibus acessíveis nas linhas que cruzam o distrito

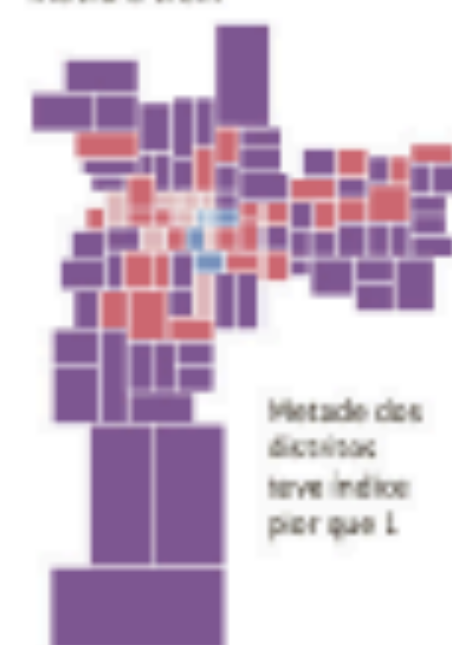


Quem pode ser prejudicado pela falta de acessibilidade

- > 674 mil pessoas com deficiência motora vivem em São Paulo (2010)
- > 50% dos moradores da cidade têm excesso de peso (2015)
- > 20% da população paulista na sexta idade em 2030
- > 577 mil bebês (portanto crianças de colo) nasceram no município entre jan.15 e dez.17



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



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



Jairo Marques e Fábio Takahashi

... com nota dez pelas condições de terreno. O bairro tem poucos degraus e o ambiente é muito grande. As travessias de rua também são problemáticas. É complicado de usar



Scipopulis' COLETIVO APP

(for citizens)

ESPERÔMETRO
TEMPO DE ESPERA SEMANAL

30 min
MÉDIA

1h30m
TOTAL

30 min
ATUAL

638H 0,05 24

45 min

3x mais que o normal

JD. Maria Luiza

2 Amigos

753H

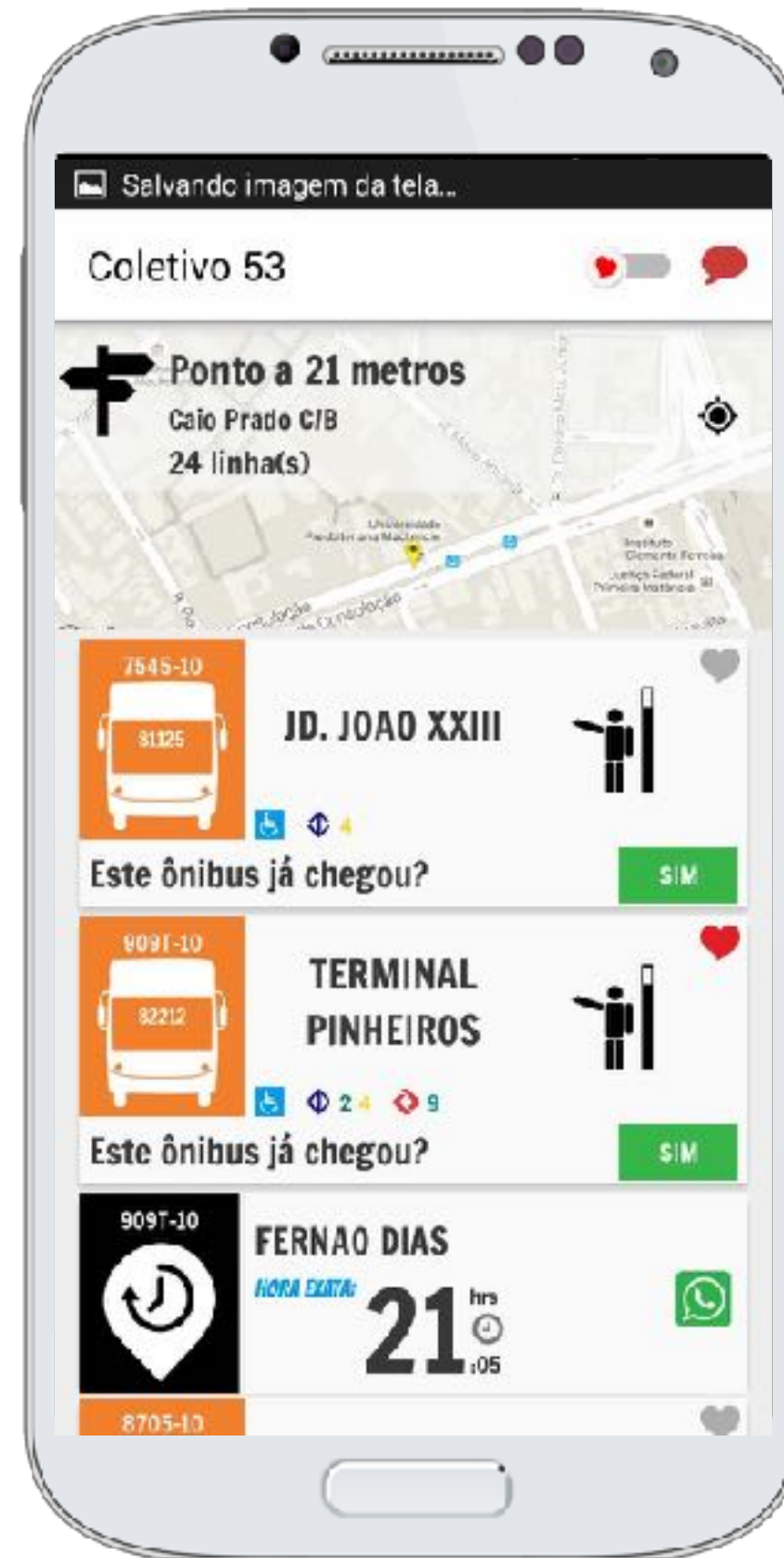
Como é que está esse ônibus?

#evoucommoto #daparaseria #atasardinha

Acidente na Rubem Berta, 978.

35 min

Vai de Metro que ônibus não dá!



SCIPOPULIS São Paulo
Dia de referência 12/05/2017

RELATÓRIO DIÁRIO

RANKING DAS LINHAS MAIS LENTAS

Pico da manhã

1º	6008-21-0Term. Sto. Amaro	9.9 km/h
2º	5100-10-1Term. Pinheiros	10.4 km/h
3º	6805-10-0Term. João Dias	15.5 km/h

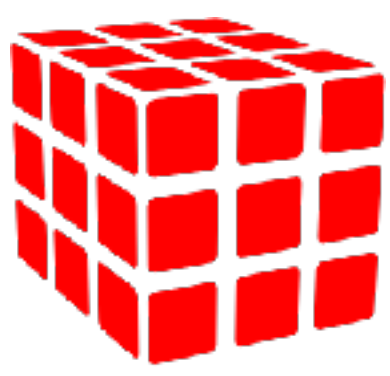
Pico da tarde

1º	5100-10-0Term. Pq. Dom Pedro II	8.4 km/h
2º	930P-10-0Term. Pinheiros	8.6 km/h
3º	6805-10-1Term. Capelinha	8.9 km/h

VELOCIDADE DOS ÔNIBUS NO DIA

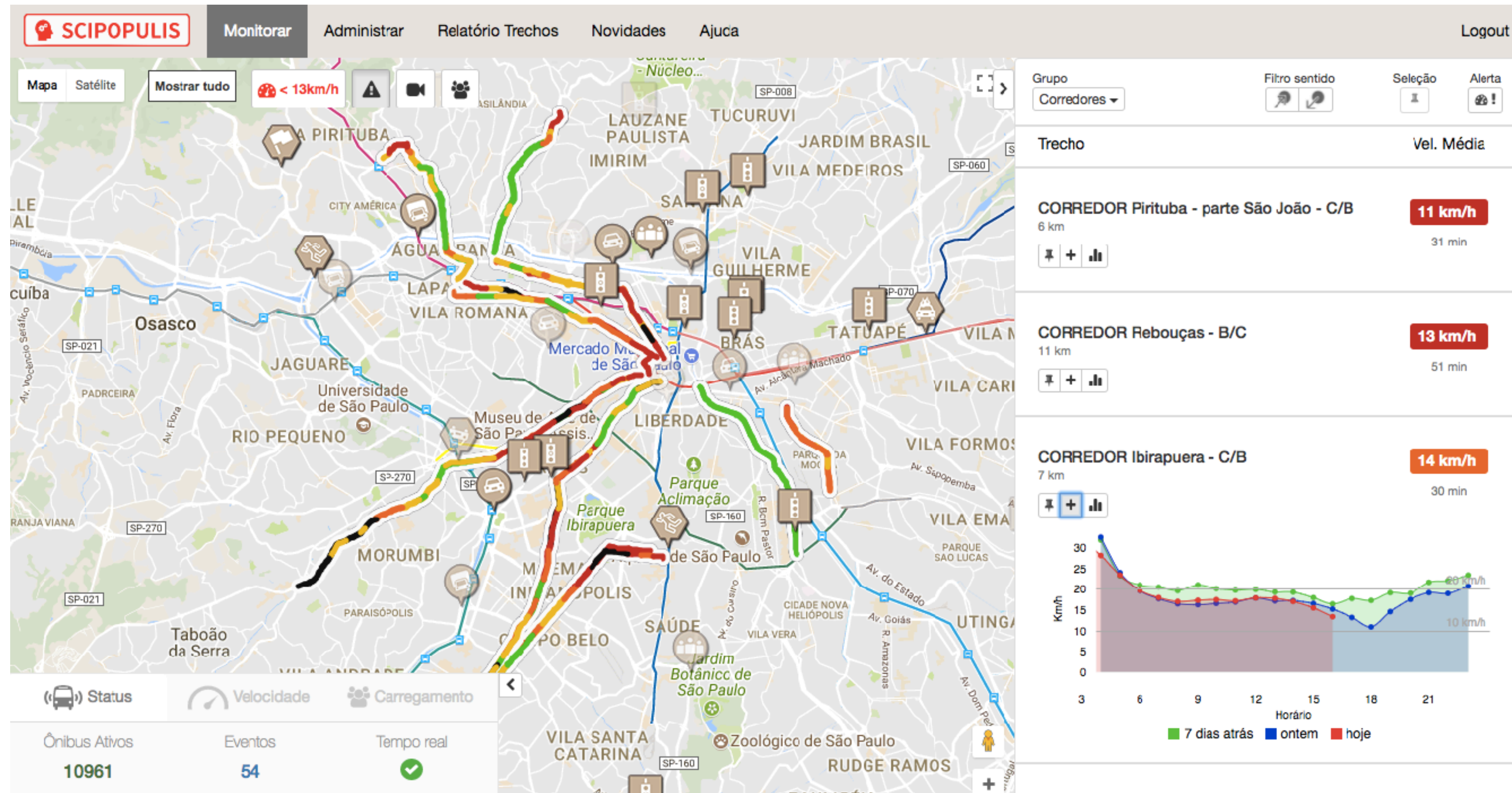
CIRCULAÇÃO DE ÔNIBUS



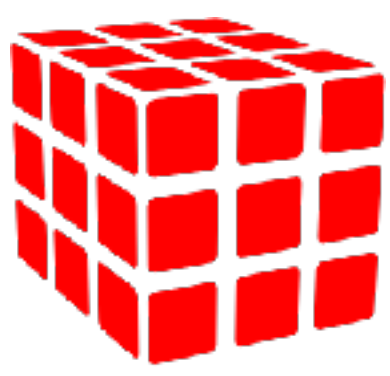


REAL TIME DASHBOARD

(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

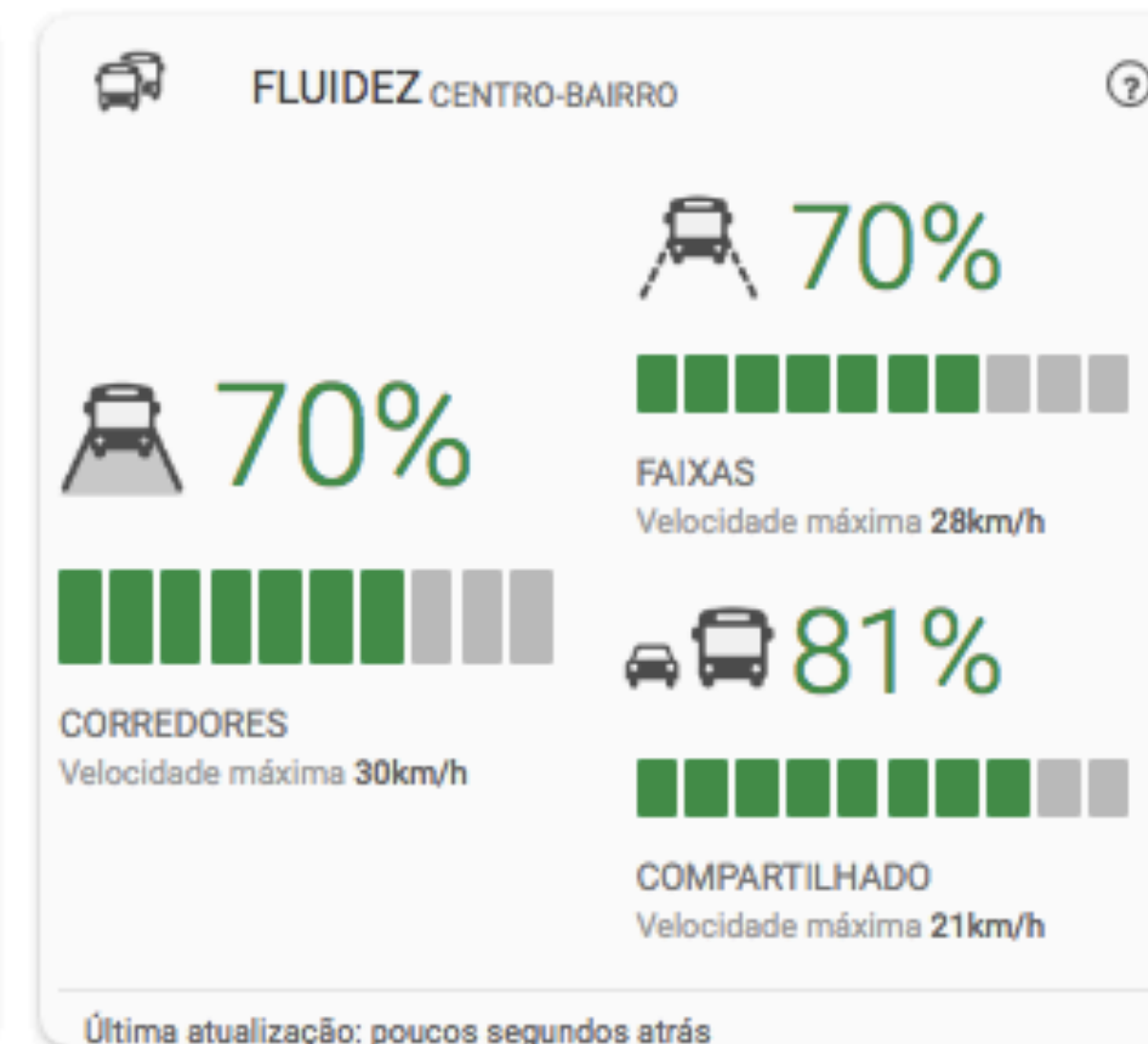
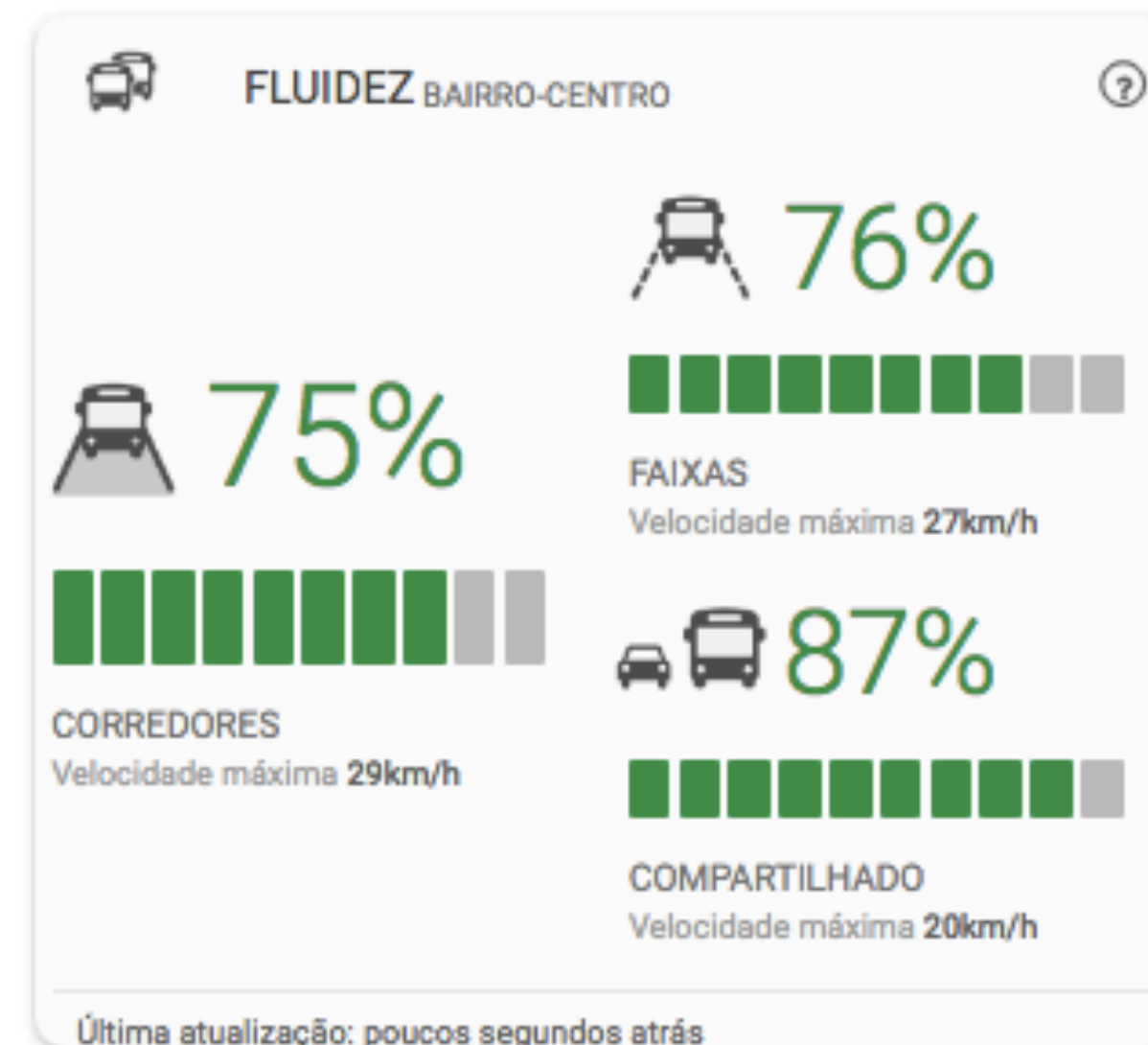
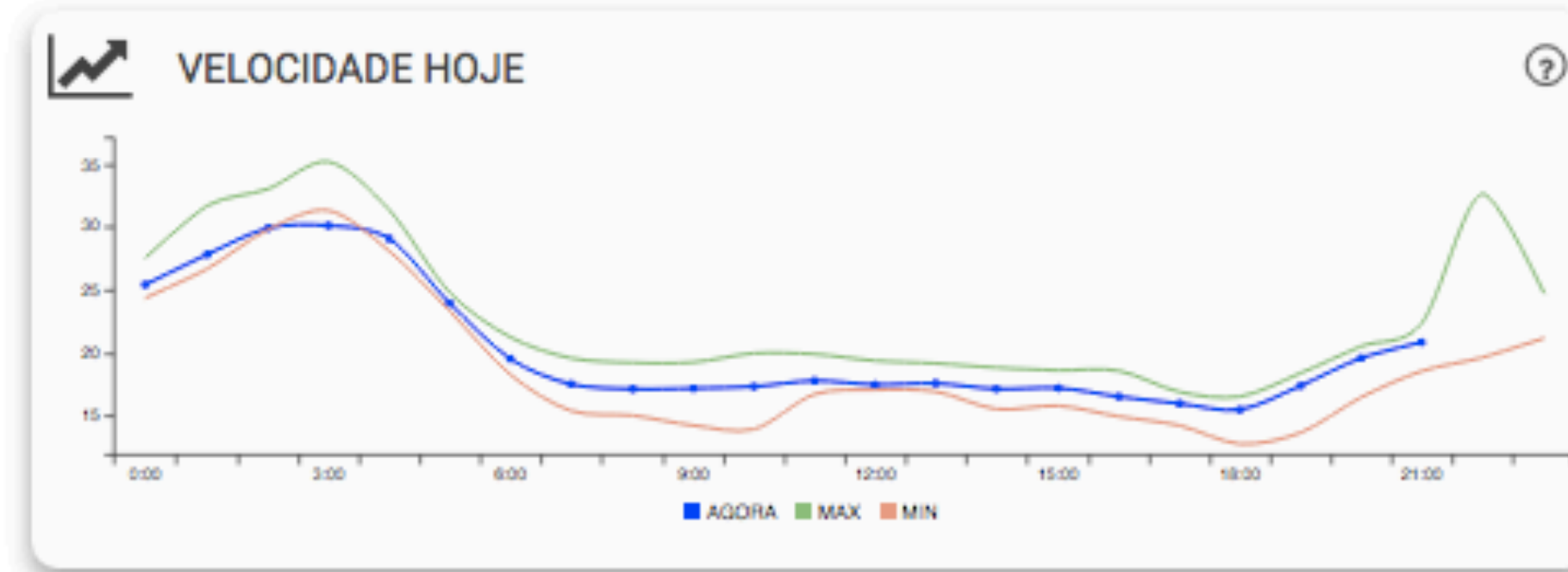
(CONSOLIDATED BUS SPEEDS for citizens)

PAINEL DA MOBILIDADE

FLUIDEZ

VELOCIDADES

TEMPO



Semáforos em funcionamento 6246 (99.24%)

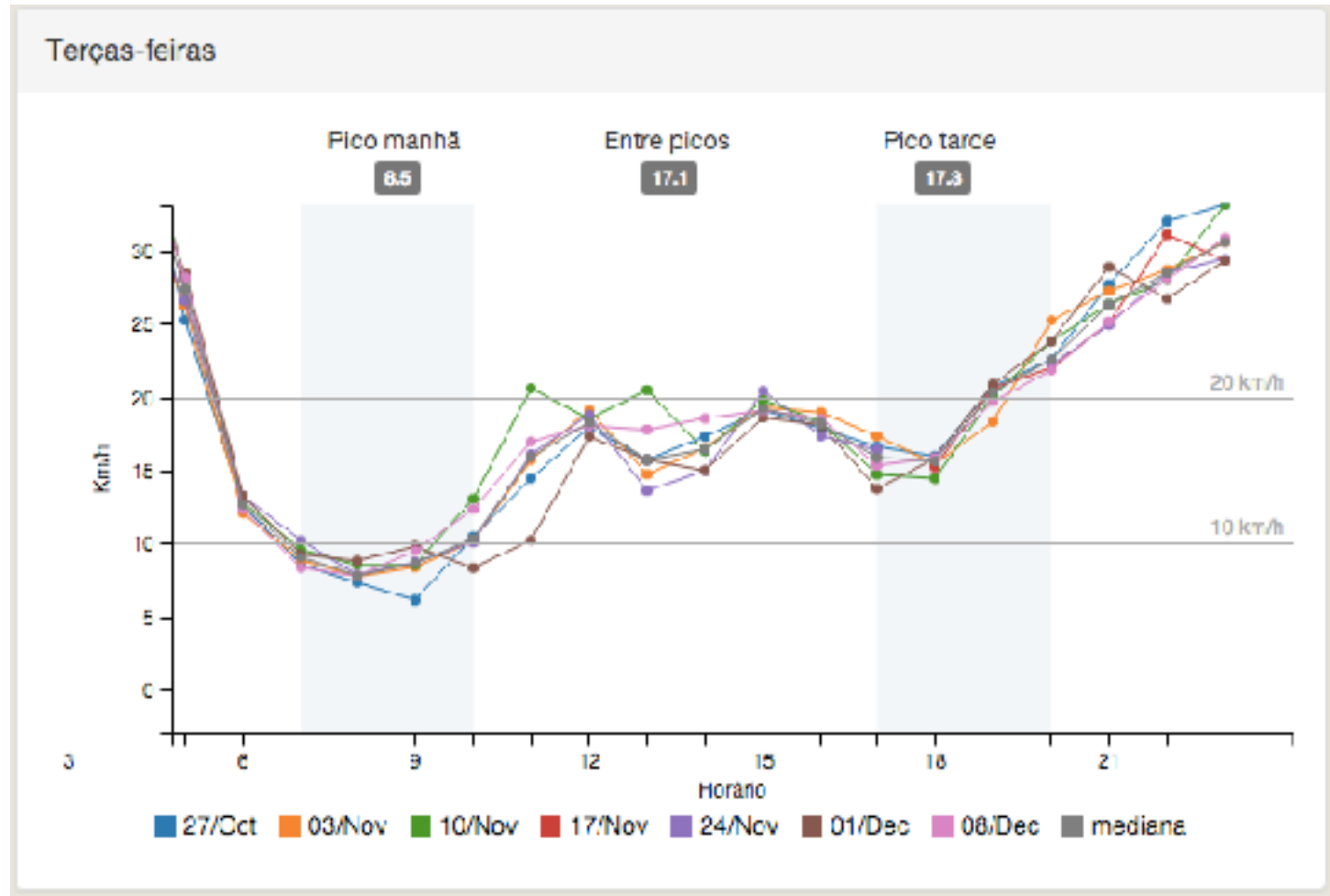
Total de ocorrências de trânsito hoje 214 / Média de ocorrências 130



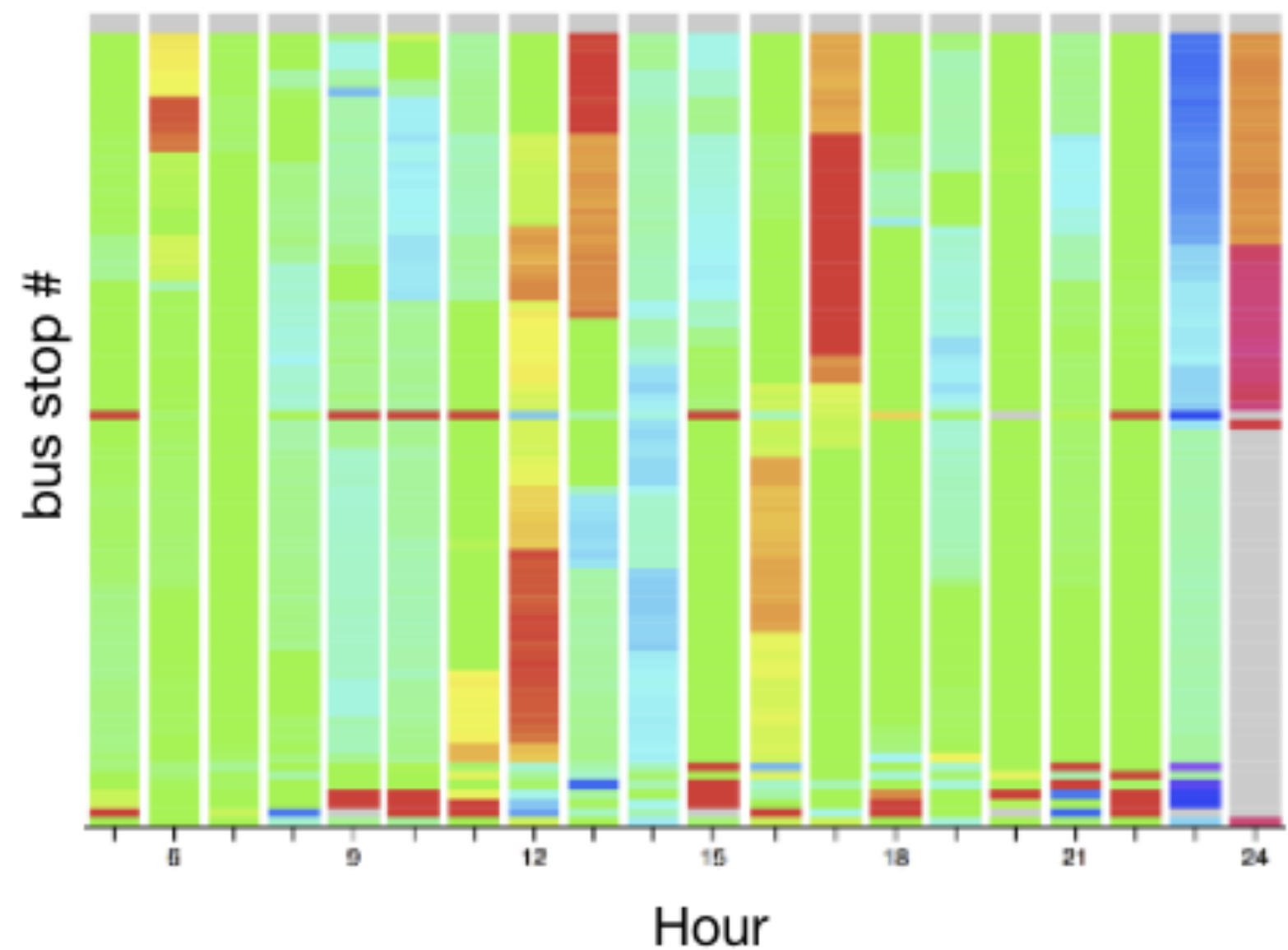


DATA ANALYSIS and visualization

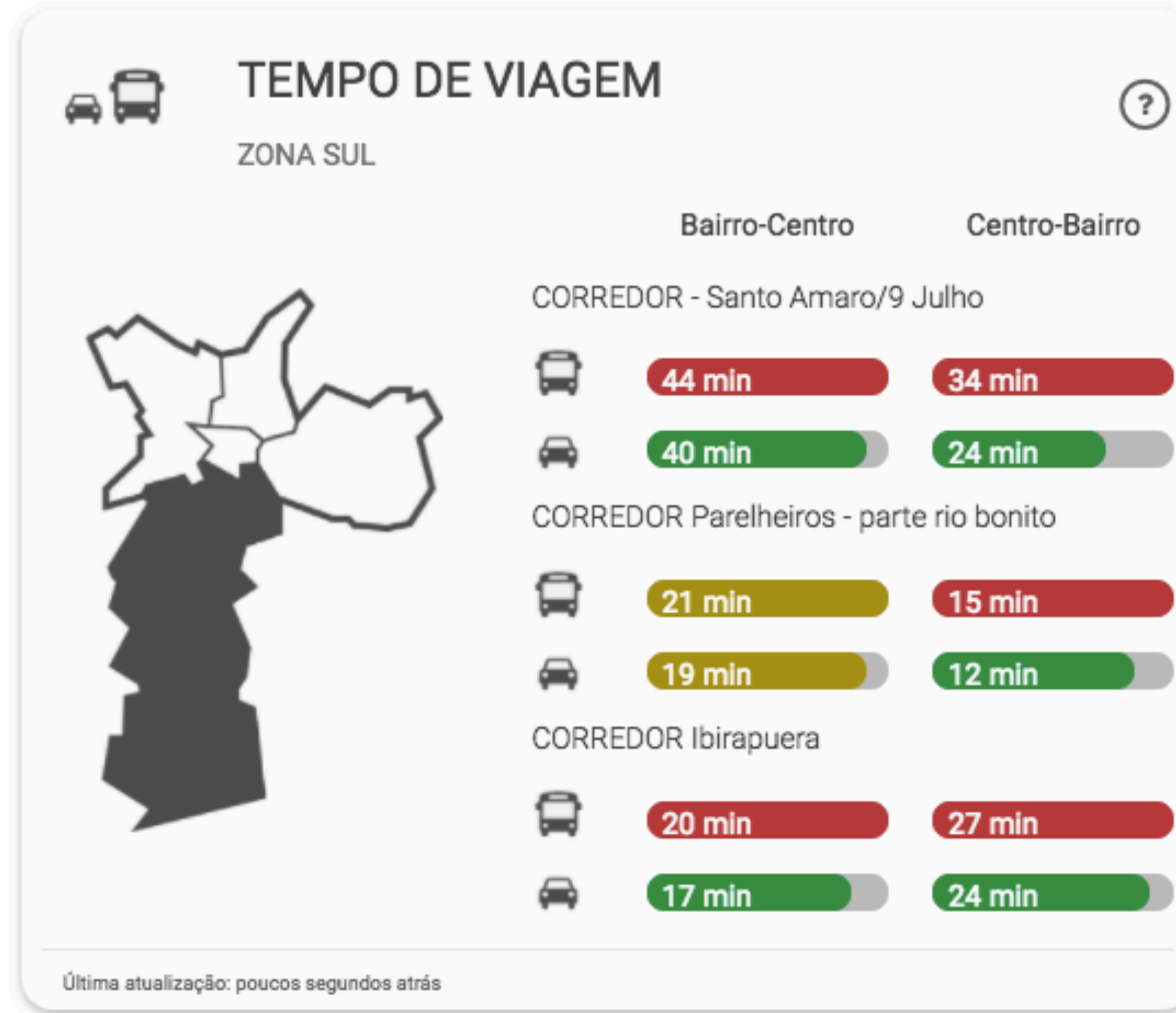
Historical data



Headway discrepancy per bus stop



Comparing bus x auto



TIETE LOCAL

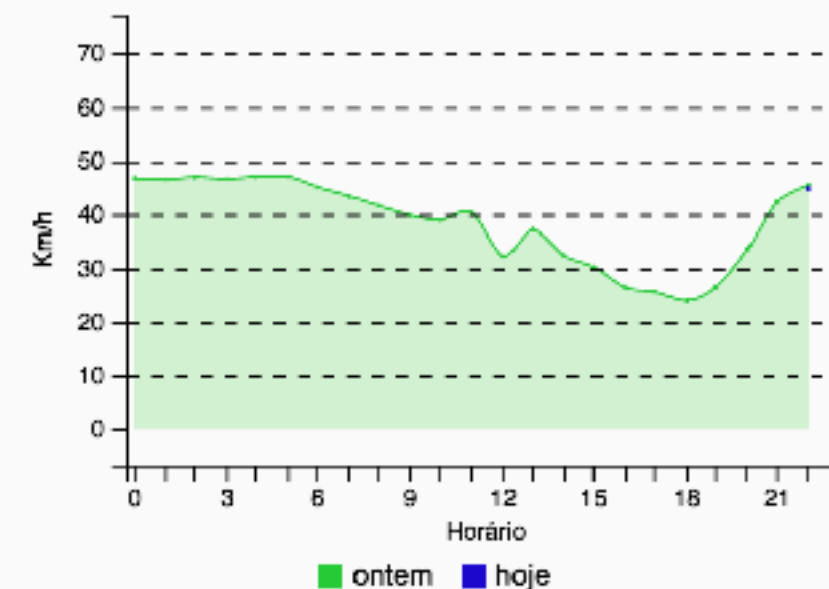


TEMPO REAL

Trecho: PTEDOLIMAO_PTEFRANC...

Sentido: AYRTONSENNA

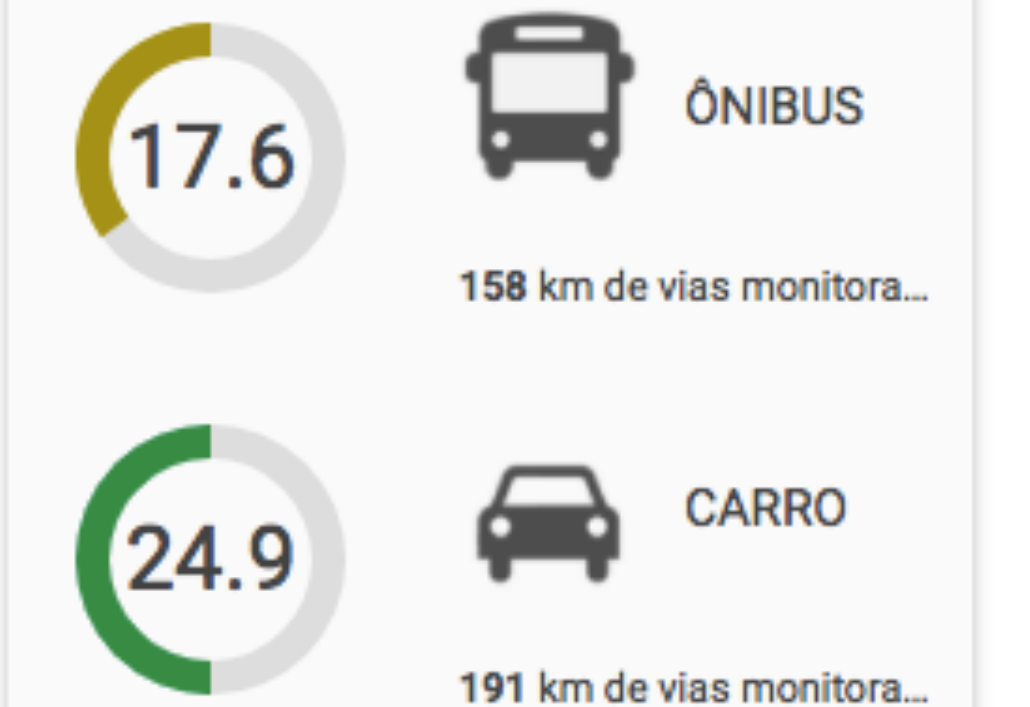
2Km em 2 minutos



VELOCIDADE MÉDIA AGORA



VELOCIDADES

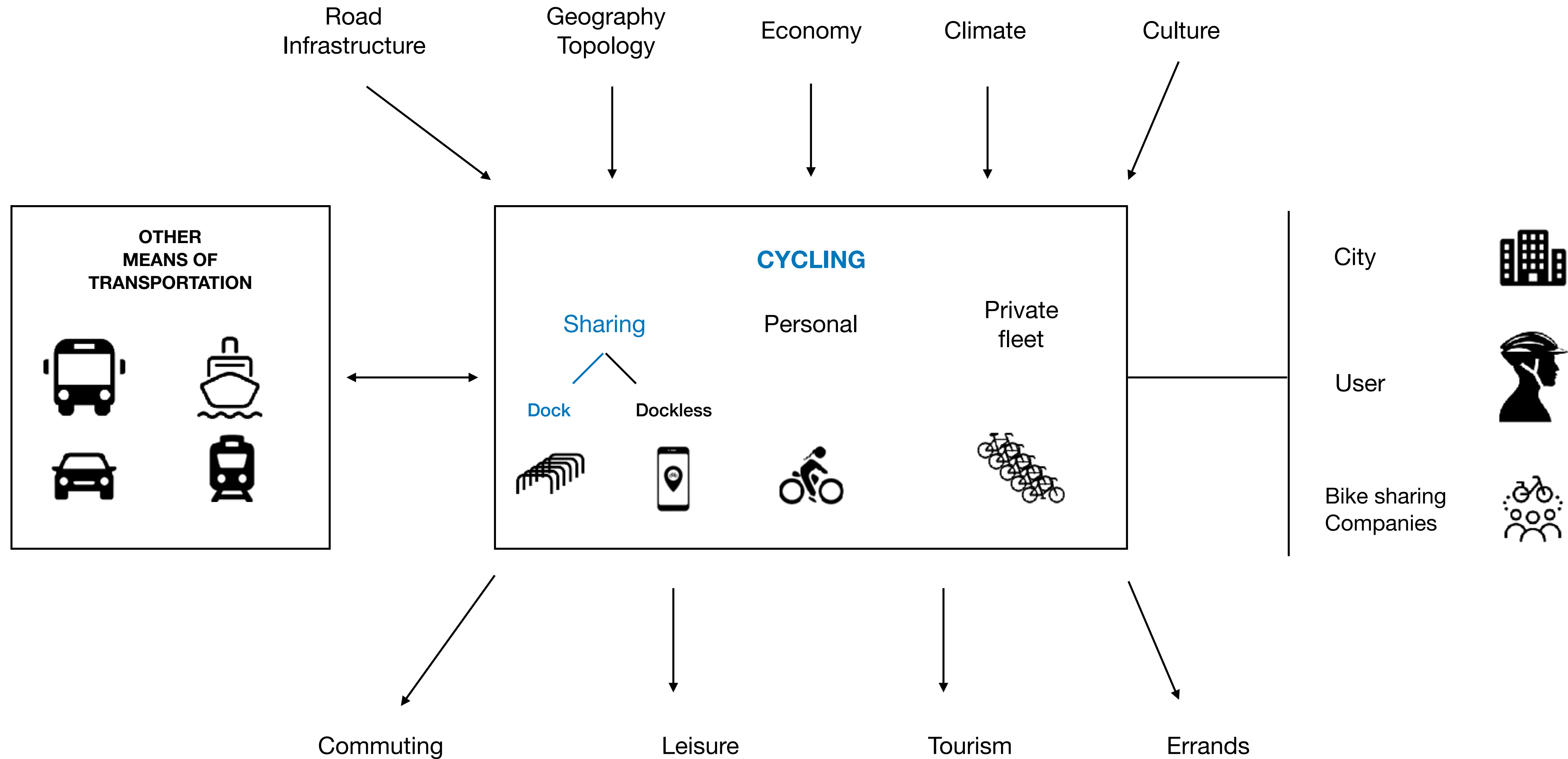


Última atualização: 2 meses atrás

BikeScience w/ MIT Senseable City Lab

- Use of bikes for urban transportation is increasing
 - 18+ million shared bikes, increasing rapidly
- Bike transportation has numerous advantages:
 - for the city
 - for the planet
 - for the user
- But it is highly under-utilized

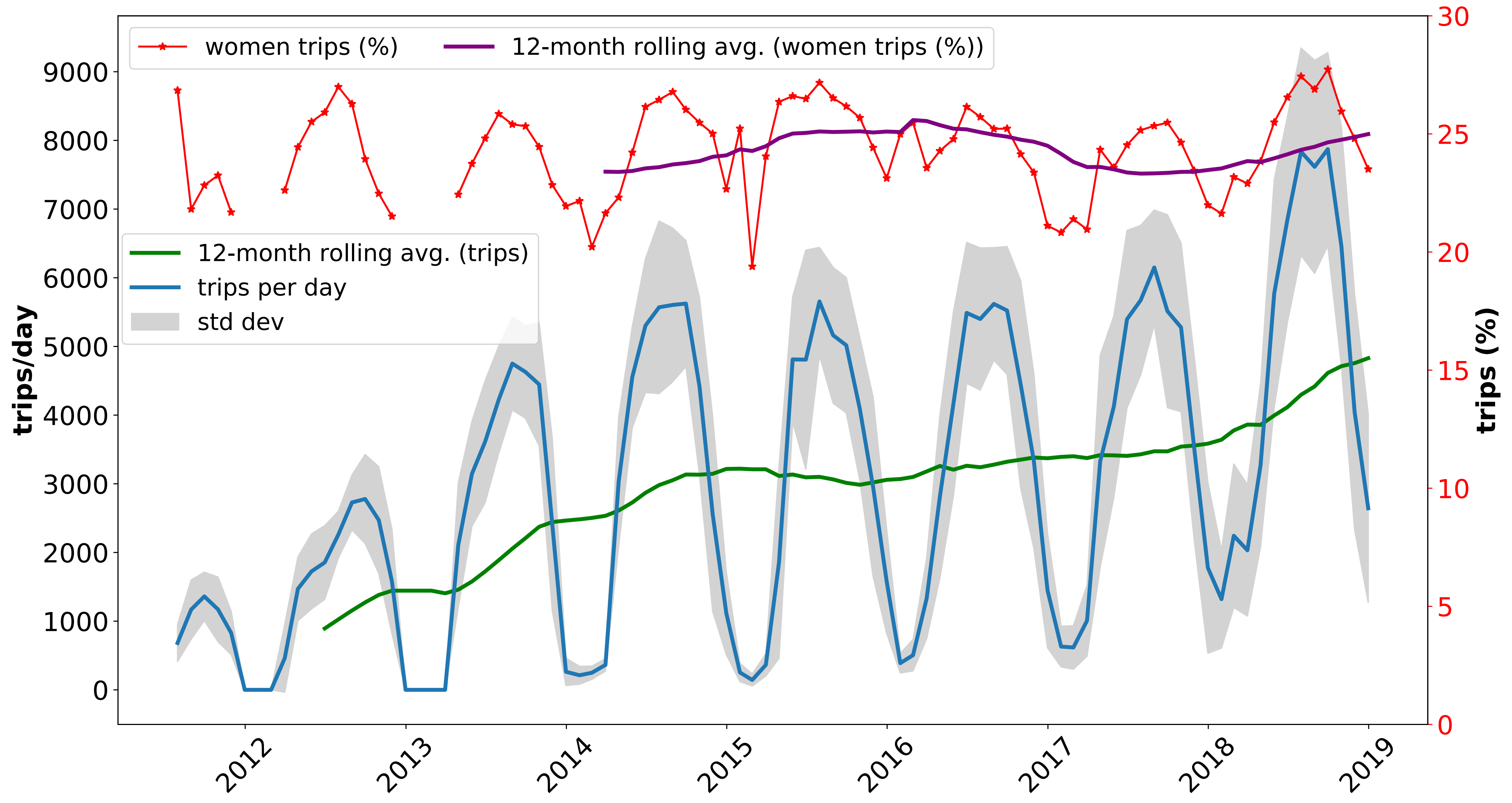
How can we foster cycling as a serious means of urban transportation



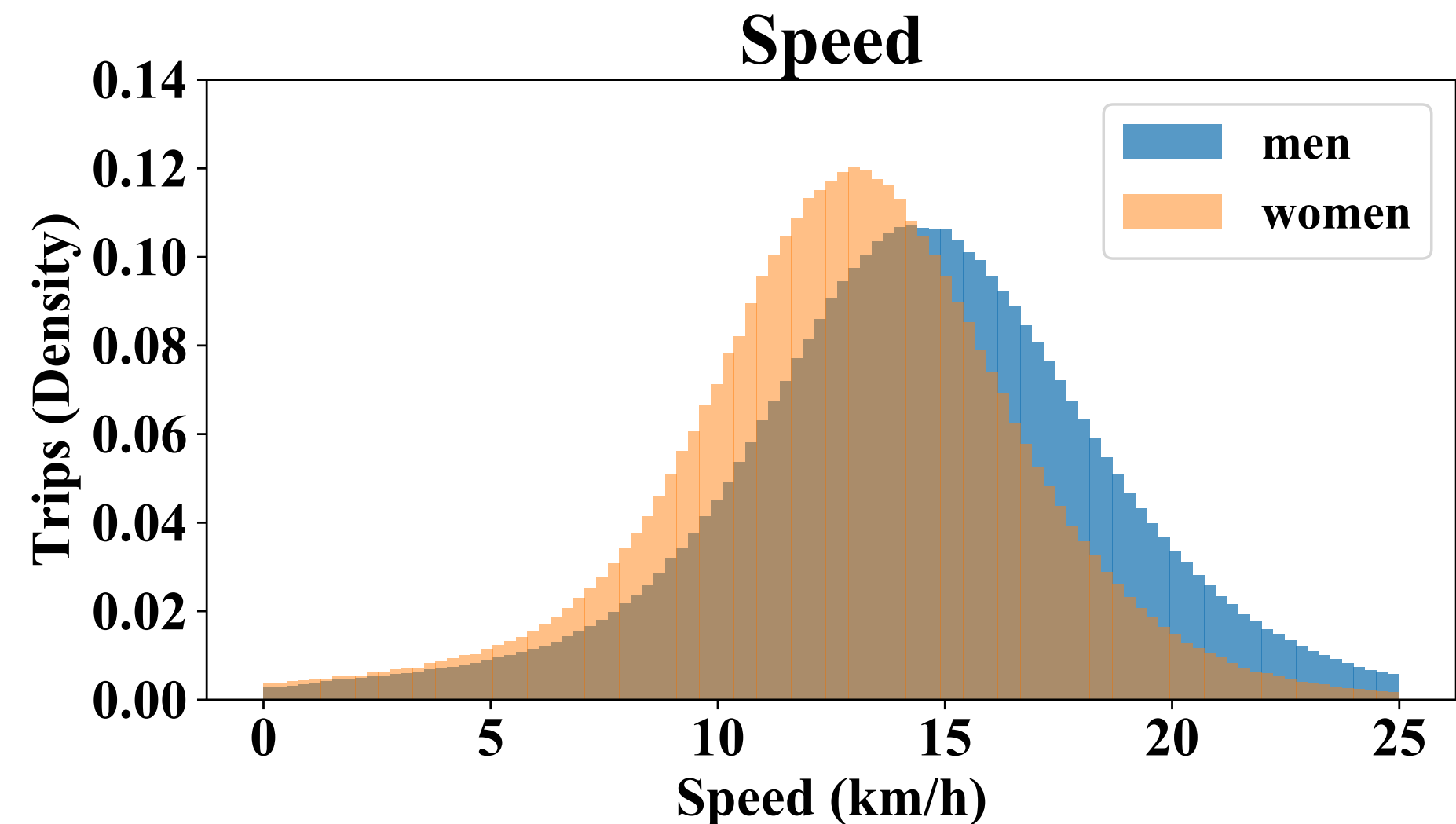
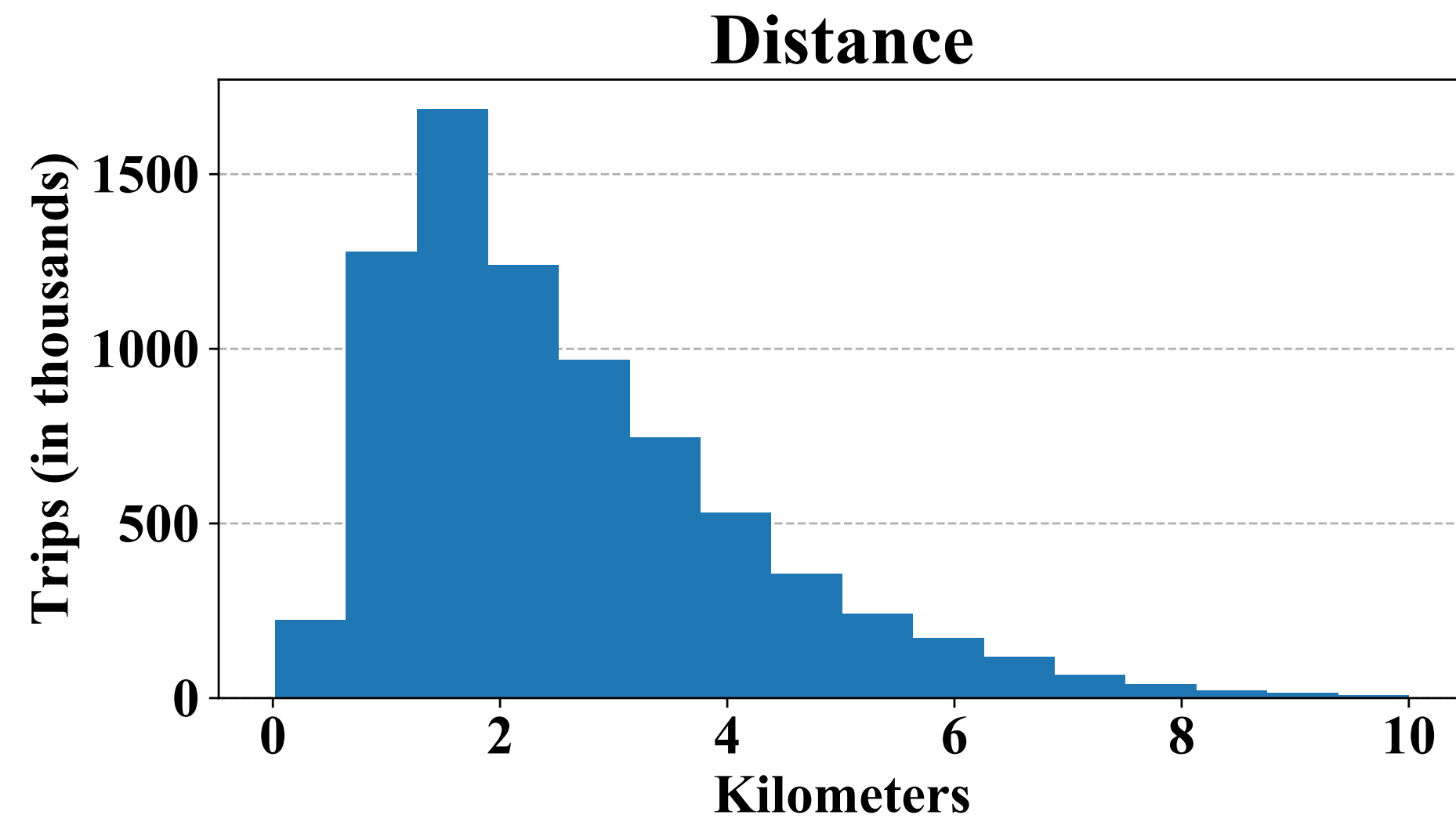
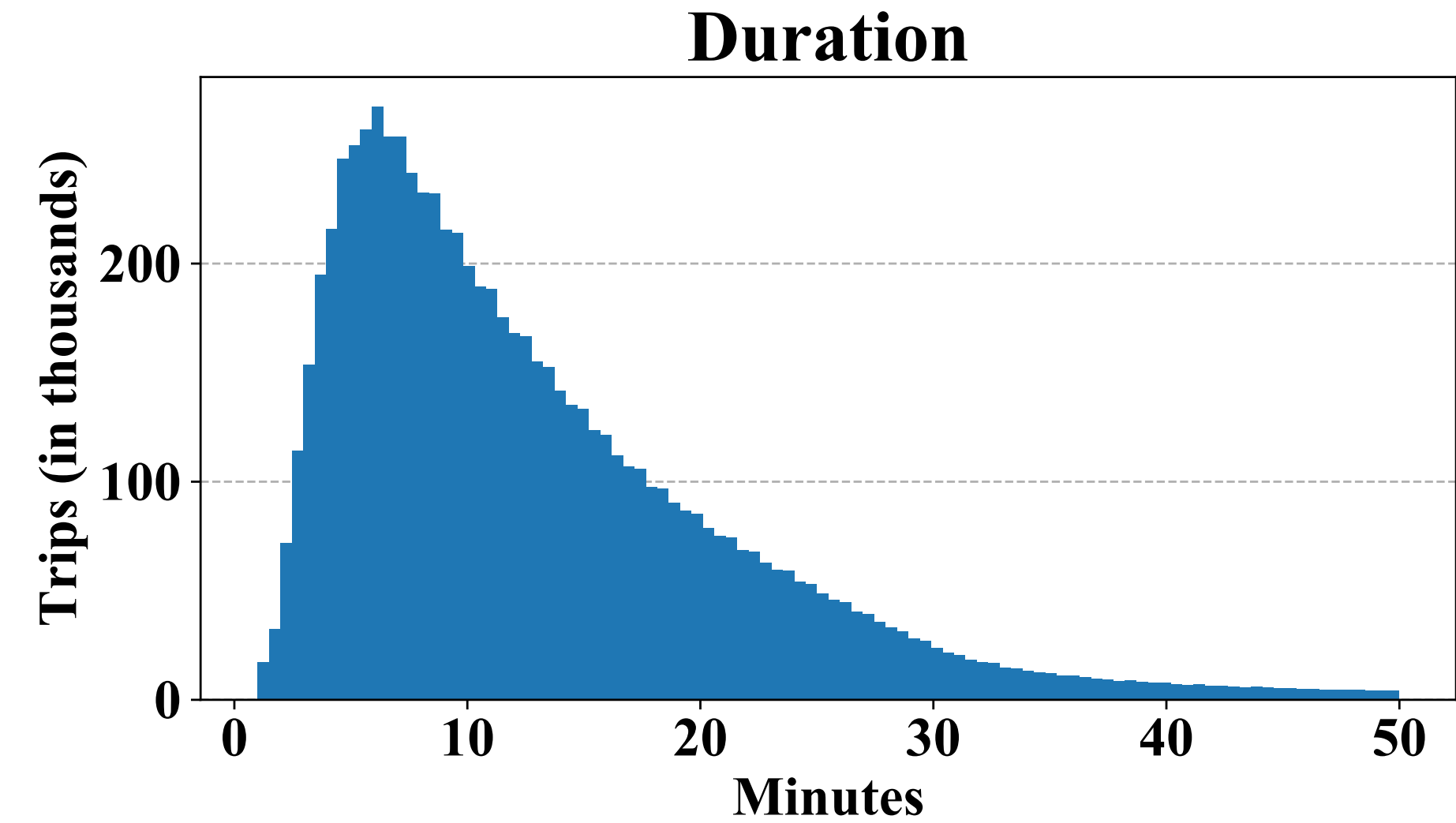
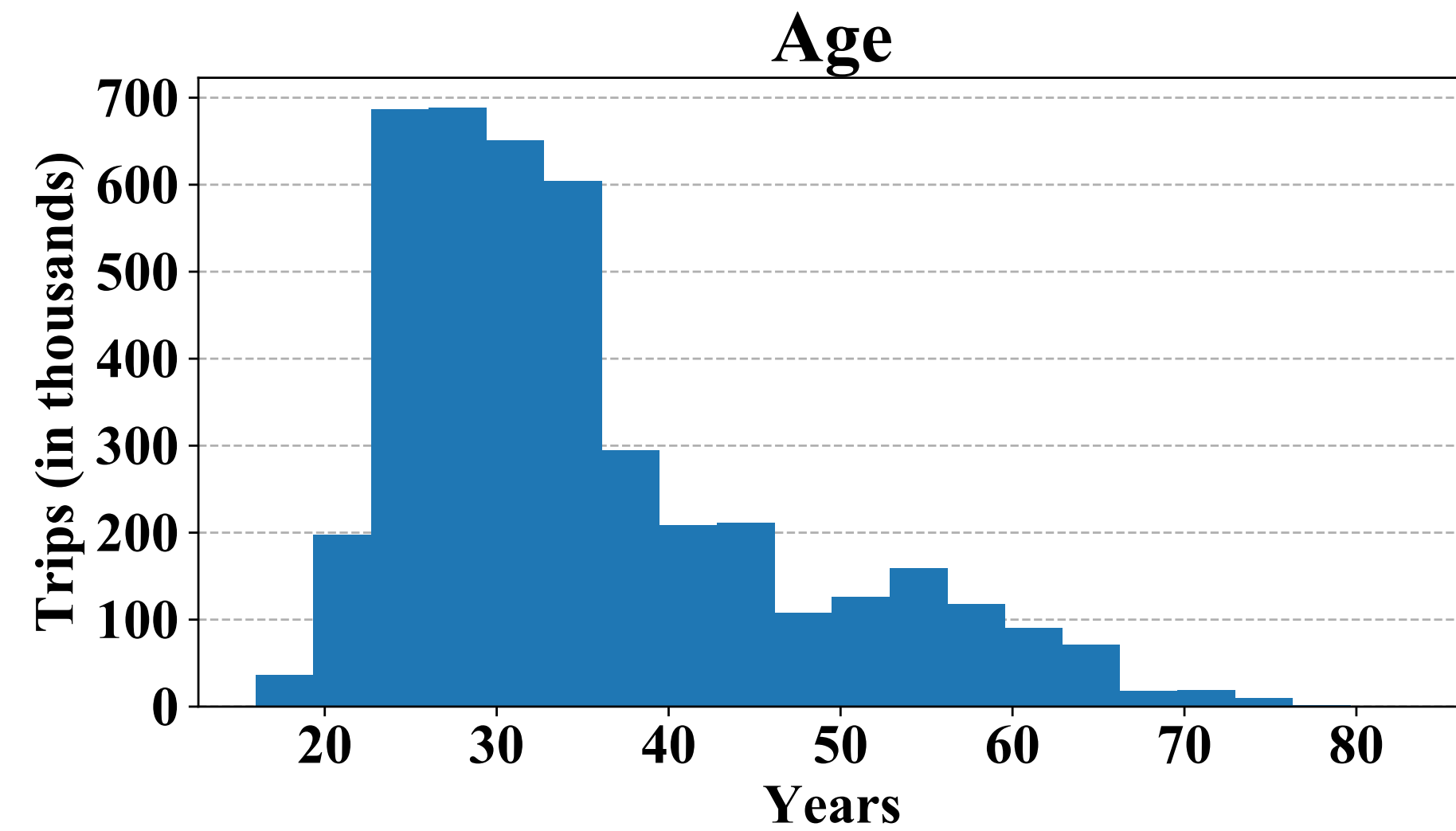
Bike Data Science

- Analyzing millions of bike trips from 20 cities
 - Starting with Greater Boston (and São Paulo)
 - Dock-based vs. Dockless
- Greater Boston:
 - 8 million trips since 2011

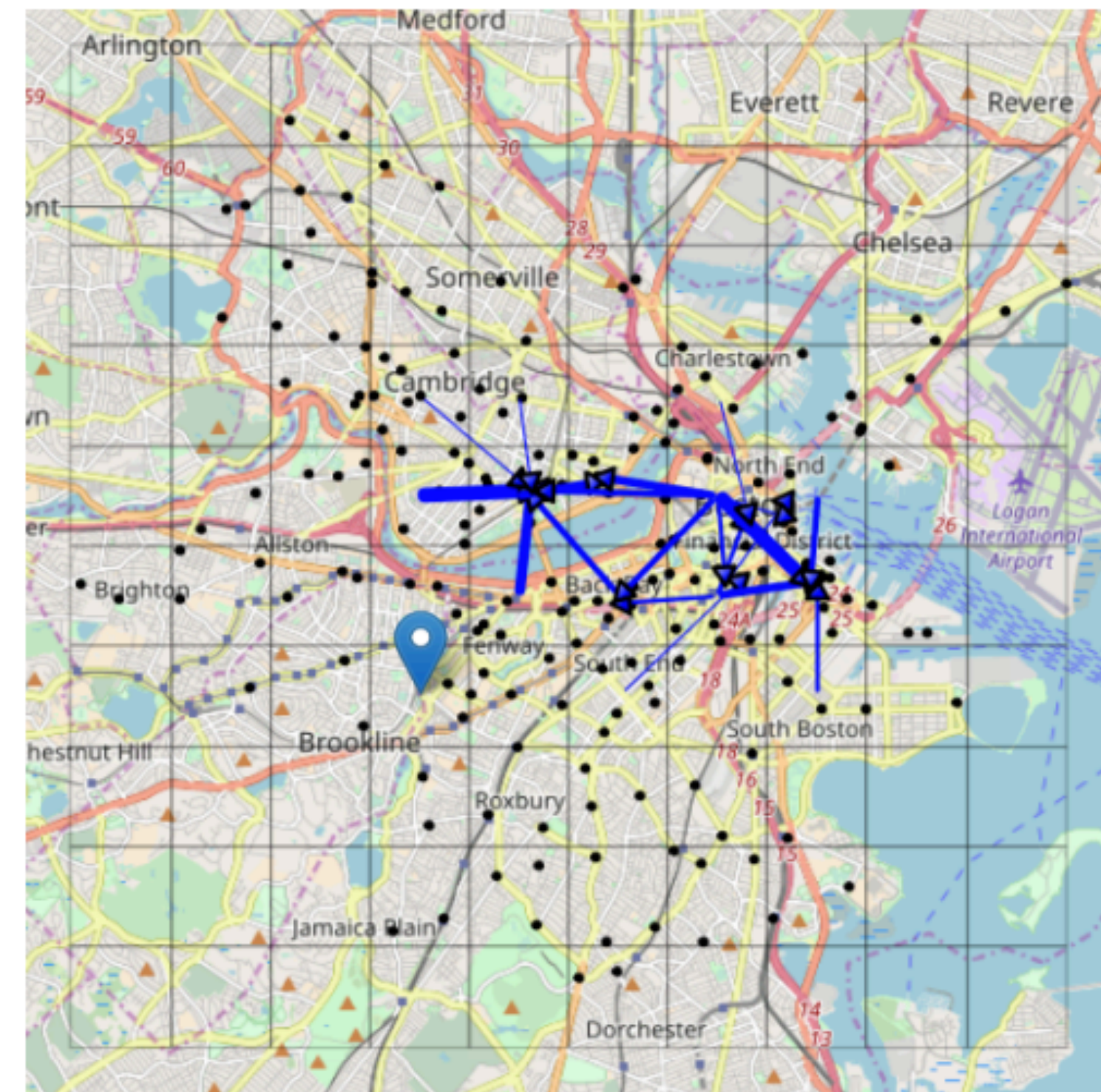
Boston bike-sharing evolution



Descriptive Statistics



Bike Mobility Flows



(a) 10x10 grid - across cities



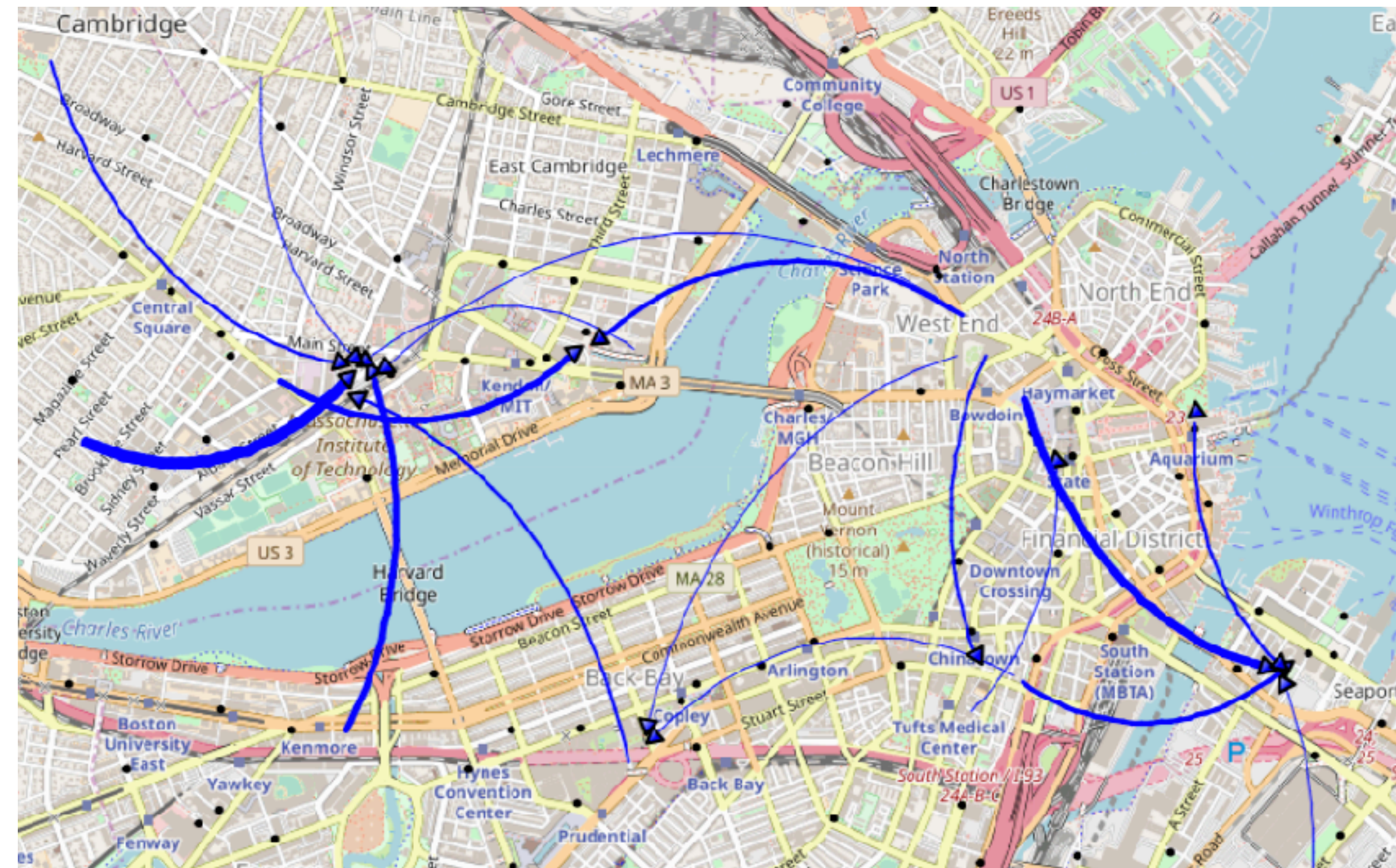
(b) 20x20 grid



(c) 30x30 - flows within a neighborhood

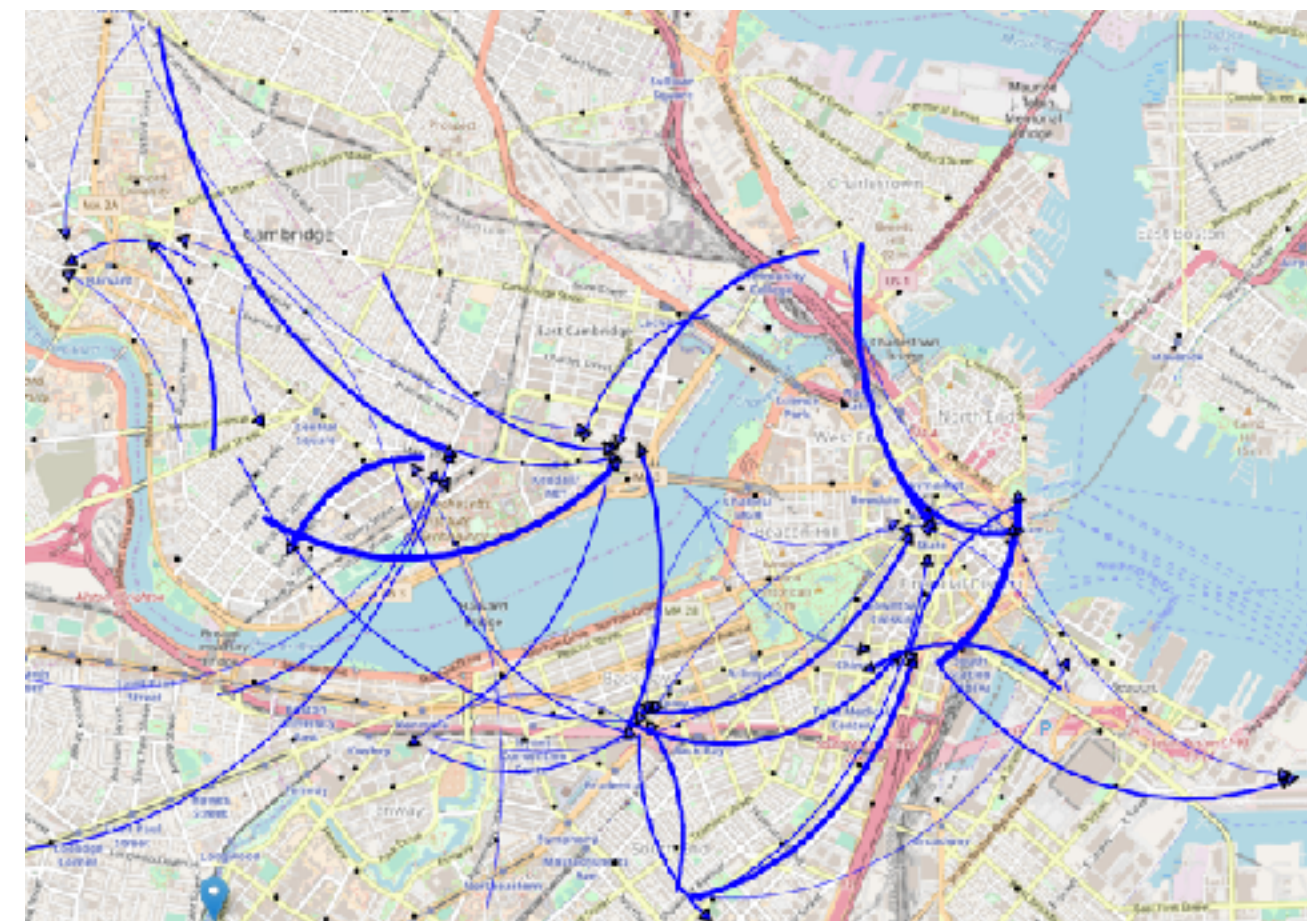
Supporting Public Policy: Flow popularity and infrastructure investments

Tier 4: 18 flows → 1% of flows

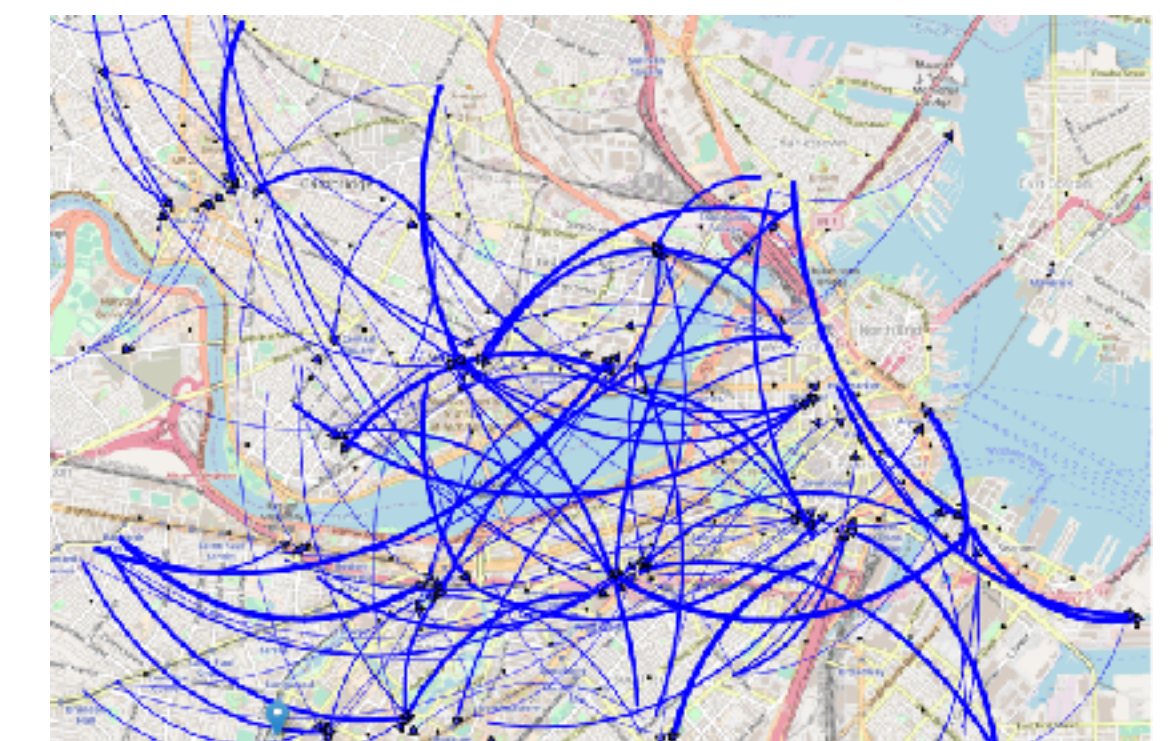


Total: 1629 different flows

Tier 3: 46 flows → 3% of flows



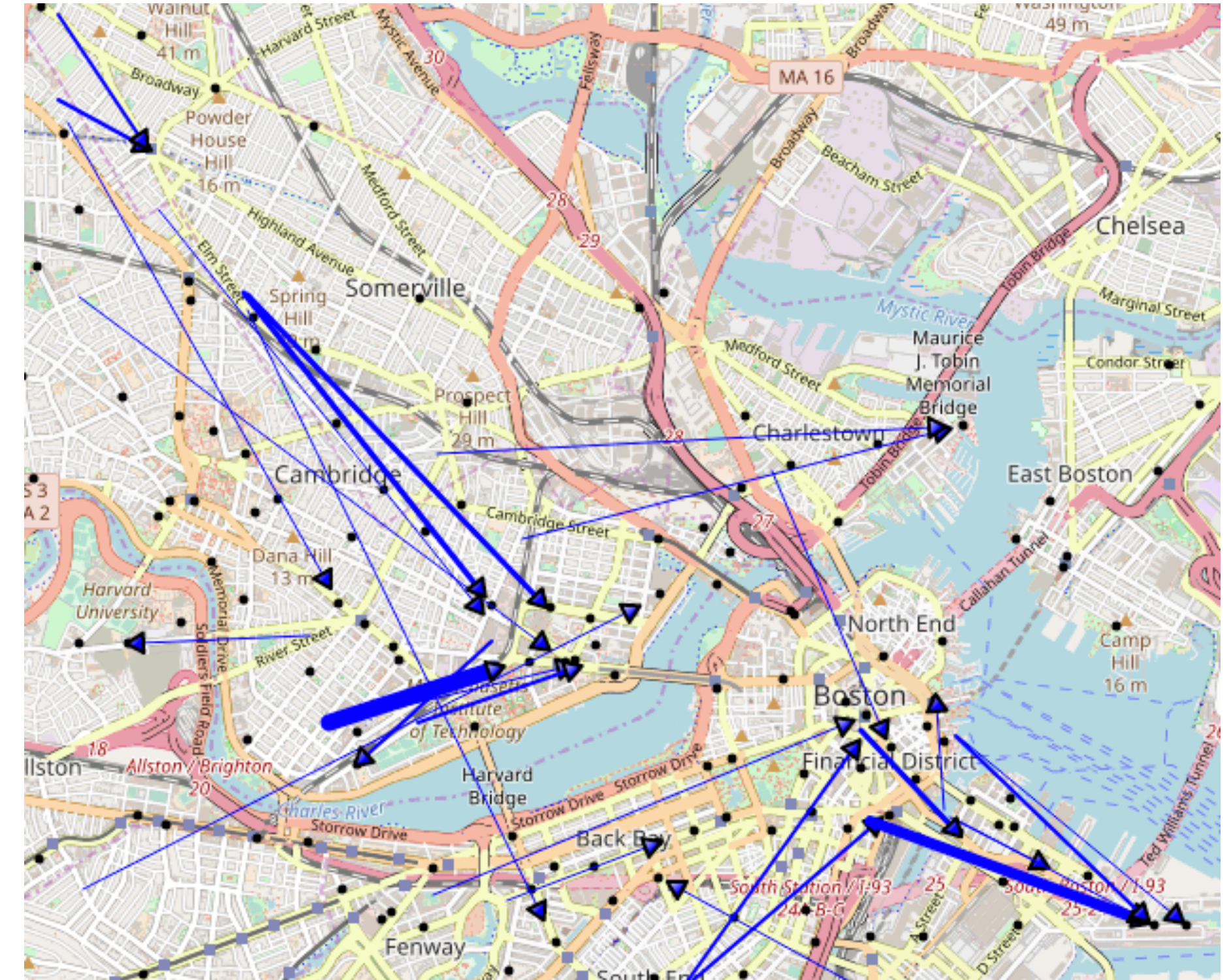
Tier 2: 119 flows → 7% of flows



Tier 1: 1446 flows - 89% of flows

Profile of Speeders ($>15\text{Km/h}$ - 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)



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 collaborations

A wide-angle photograph of a city skyline at sunset. The sky is a mix of light blue and orange, with the sun low on the horizon. The buildings are silhouetted against the bright sky, with some windows reflecting the light. The foreground is dark, suggesting a high vantage point.

Contact

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(PhD and post-doc fellowships available)