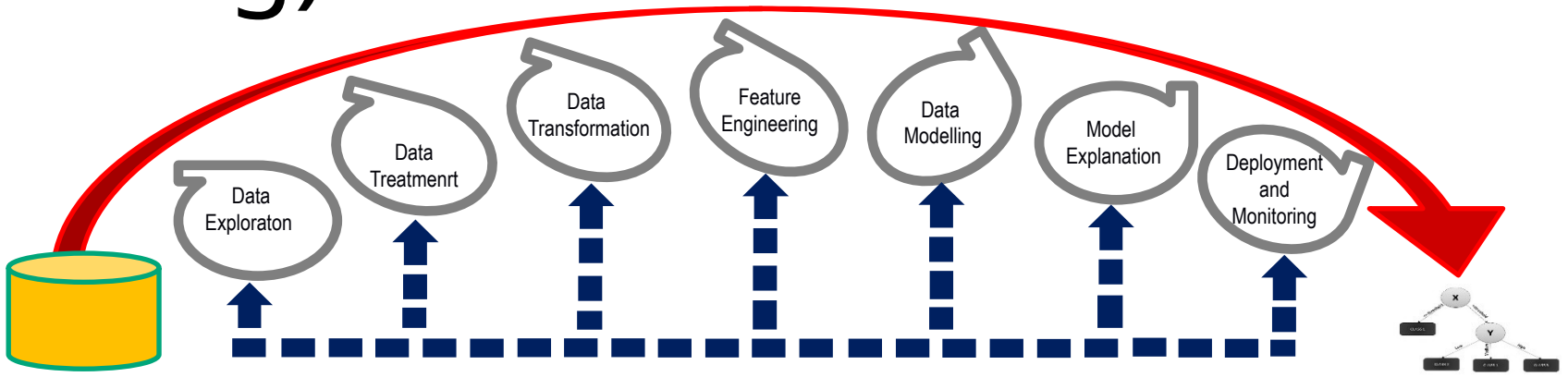
IARA: A Applied Research Center of Artificial Intelligence for Smart, Sustainable and Inclusive Cities

Professor André Carlos Ponce de Leon Ferreira de Carvalho
University of São Paulo, Brazil

Artificial Intelligence (machine learning)



End-to-end Machine Learning

- Data quality (1999)
- Automated Machine Learning (AutoML) - 2001
- EXplainable Artificial Intelligence (XAI)- 2000
- Continuous learning (2004)

IARA Applied Research Center

- Artificial Intelligence (AI) for Smart, Sustainable and Inclusive cities
  - One of the 12 centers supported by FAPESP, MCTI, CGI.br
- Hosted by University of São Paulo (USP)
  - Support from 11 Brazilian cities
  - Participation of ~40 Brazilian Science & Technology Institutions
    - More than 200 researchers
  - Collaboration with 20 international institutions
  - Additional funding from 3 companies



International collaborations

- ConceptionX (UK)
- Chalmers University of Technology (Sweden)
- Royal Institute of Technology, KTH (Sweden)
- Uppsala University (Sweden)
- Universidade de Aveiro (Portugal)
- Universidade de Nova de Lisboa (Portugal)
- Universidade de Porto (Portugal)
- Scuola Superiore Sant'Anna (Italy)
- Università Degli Studi di Milano (Italy)
- **The National Physical Laboratory (UK)**
- **University of London (UK)**
- **University of Bath (UK)**

- University of Cork (Ireland)
- University of Bordeaux (France)
- University of La Rochelle (France)
- University of Poitiers (France)
- University of Waikato (New Zeland)
- New South Wales University (Australia)
- North Carolina State University (USA)
- New York University (USA)
- University of Maryland (USA)
- University of Twente (Holland)
- University of Guelph (Canada)
- Université Laval (Canada)

Additional funding from companies



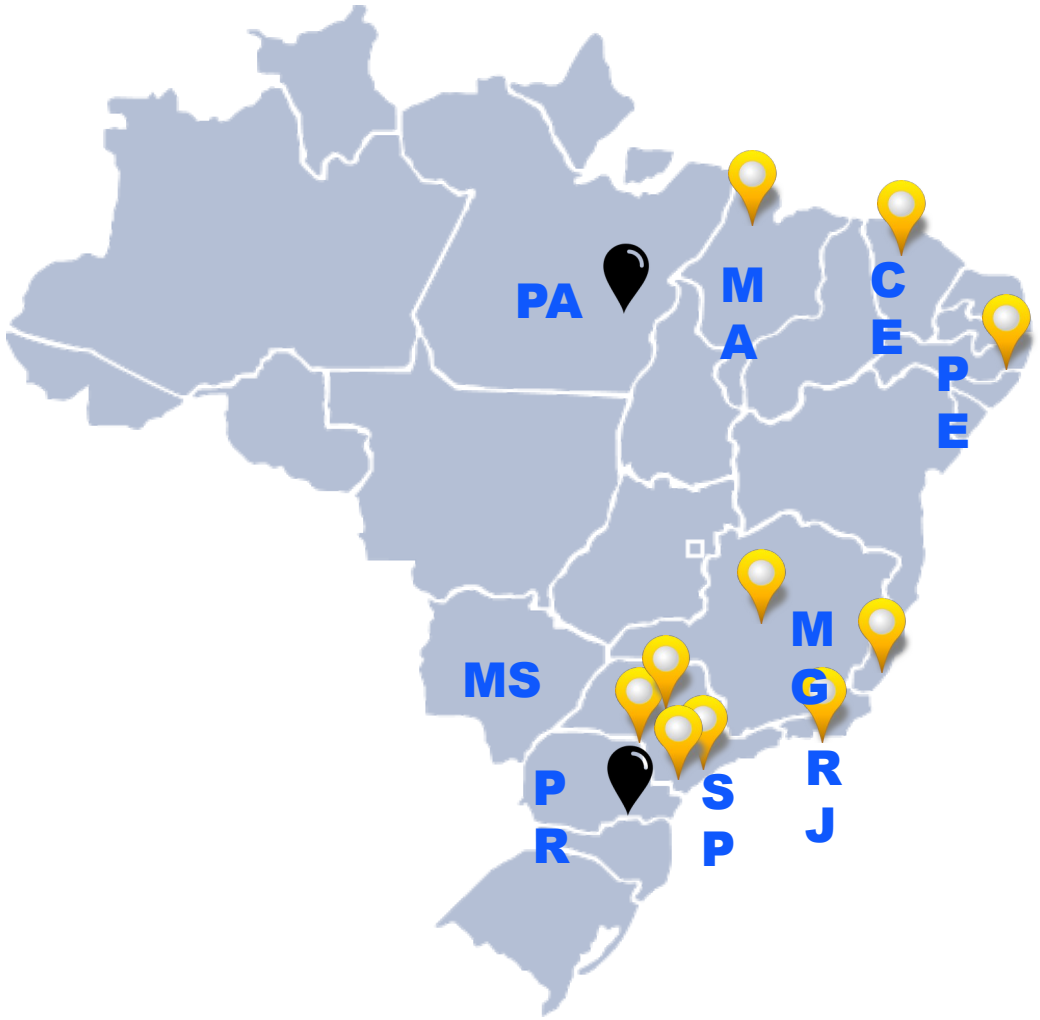
Additional funding from companies

Grupo SPLICE



jacto

Partner cities



- Albertina (MG)
- Alcântara (MA)
- **Canaã dos Carajás (PA)**
- Colatina (ES)
- Fortaleza (CE)
- **Guarapuava (PR)**
- Monteiro Lobato (SP)
- Niterói (RJ)
- Recife (PE)
- São Carlos (SP)
- São José dos Campos (SP)
- Sorocaba (SP)

Canaã dos Carajás (PA)

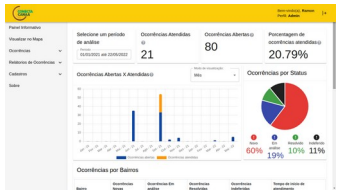
- Became a city in 1994
  - 11,000(2000)-77,000 (2020)
- Largest open iron mine
  - Part of royalties goes to the city **sustainable development fund**
    - Built campus for 2 public universities
- Target: City with the highest HDI in Brazil by 2030



https://agenciapara.com.br/noticia/50366/pib-apresenta-crescimento-em-134-municipios-do-estado-do-para

Canaã dos Carajás (PA)

- Smartphone app for citizen engagement
  - Request and monitor public services



- Car as a mobile sensor
  - Air quality assessment
  - Safety of bycicles and pedestrians
- Autism diagnosis in primary school classrooms
- Leishmaniosis prevention in still water



https://radio.ufpa.br/index.php/ufpa-noticias/4804/

Guarapuava (PR)

- Living lab for personalized, predictive digital health
- Monitor 4,500 people, in 15 years
  - Daily diet and physical activities
  - Clinical data
  - Genomics (metgenomics, nutrigenomic and ontogenomics) data
- Rare and complex genetic diseases
  - E.g.: Alzheimer's, Asthma, Depression, Diabetes, Parkinson’s, Cardiovascular, …. Diseases
- Pompeia (SP) and Guarapuava (PR)







Data Lake

- Storage of data with different format and from distinct domains
  - Complex data structure, stored in their raw, not pre-processed, state
  - Large volume, variety, continuously arriving and with concept drift
- Can be used to explore correlations between genomic data, images and medical records
  - Identify patterns, associations, causalities and trends
  - In addition to medical data, data from other domains that can affect public health
    - Environment, water and sewage treatment, education and city economic profile

AI4PEP network

- AutoAI-Pandemics: Democratizing Machine Learning for the Analysis, Study, and Control of Epidemics and Pandemics
  - Researchers from Bioinformatics, Artificial Intelligence, Data Science, Epidemiology and Clinical Medicine
  - Automated Machine Learning (AutoML)
    - Monitor epidemic and pandemic occurrence to support public policies
    - Support drug and vaccine design combining AI with omics (genomics, proteomics, metabolomics, ...)
    - Identify epidemic and pandemic related fake news and deep fake



- Next: associate epidemics/pandemics with climate change

Loops project

- High prevalence of mouth cancer in Brazil (15,000 cases in 2025)
- AI to support diagnosis and prognosis of mouth cancer
  - Biomarkers extracted from histopathological mages
- Collect data from odontology clinics
  - Using images obtained by smartphones
    - Easy and low cost, can be used all over Brazil
- Challenges
- Photo Framing
- Brightness variation
  - Noise handling (e.g. use of flash)



https://dentalreach.today/how-to-use-your-mobile-phone-for-dental-photography/

Personalized hospital trajectory

- Explores alternatives for personalized health planning and modeling
  - Personalized sequence of hospital exams for cancer diagnosis
  - Combines machine learning and optimization
    - Predict disease status
    - Optimize the sequence of exams and treatments
- Reduce time to diagnosis
  - Can increase treatment success and decrease its costs
- University Hospital Southampton

Atypical growth prediction I

- Diagnosis of growth hormone deficiency (GHD) in childhood
  - Needs clinical and auxological evaluation (height and weight data on a growth chart)
    - Combined with neuroradiological studies, biochemical tests and the identification of low growth hormone (GH) secretion
      - Some exams have a high cost and need very specialized professionals
  - Criteria adopted for different countries vary
    - There is no test that is considered "gold standard“
- AM tool to recommend gold standard and reduce exam costs
  - Making the exam available in a larger number of poor regions of Brazil

Atypical growth prediction II

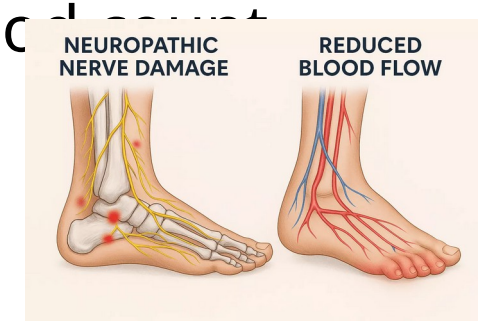
- To find factors that pass from generation to generation (intergenerational) to predict the growth of Brazilian children
  - Weight and length in the first 1000 days of life
  - Collect intergenerational variables from parents and babies since prenatal care
- AM system to estimate individual risk for short statur
  age and gain of inadequate weight, up to two years o
  - Automated risk scoring for children with low weight at birt



Monitoring of type 2 diabetes

- Development of an AI platform for monitoring diabetic patients
  - Stage classification and prediction of complicatio
  - Identification of vascular integrity, neurological integrity and rapid bloc
  - Condition monitoring using AI system
    - Images from photonic/electrical techniques
- Collecting data from 400 volunteers
  - 100 young and healthy, 100 young with diabetes, 100 senior and healthy and 100 senior with diabetes





Alzheimer and Dementia

- Two studies
  - Epidemiological analysis of mortality in Brazil using predictive modeling and temporal data analysis
    - Use of AI to identify mortality trends
  - Observational data analysis
    - Cognitively unimpaired individuals, mild cognitive impairment (MCI), and Alzheimer
      - Sociodemographic, clinical, biochemical, genetic, cognitive, and functional data
    - Use of AI to:
      - Identify minimal biomarkers and clinical subtypes for accessible primary care screening
      - Discover resilient phenotypes and their distinguishing characteristics
      - Investigate how socioeconomic and educational variables modulate relationship between biomarkers and cognitive status

Inteli.gente platform

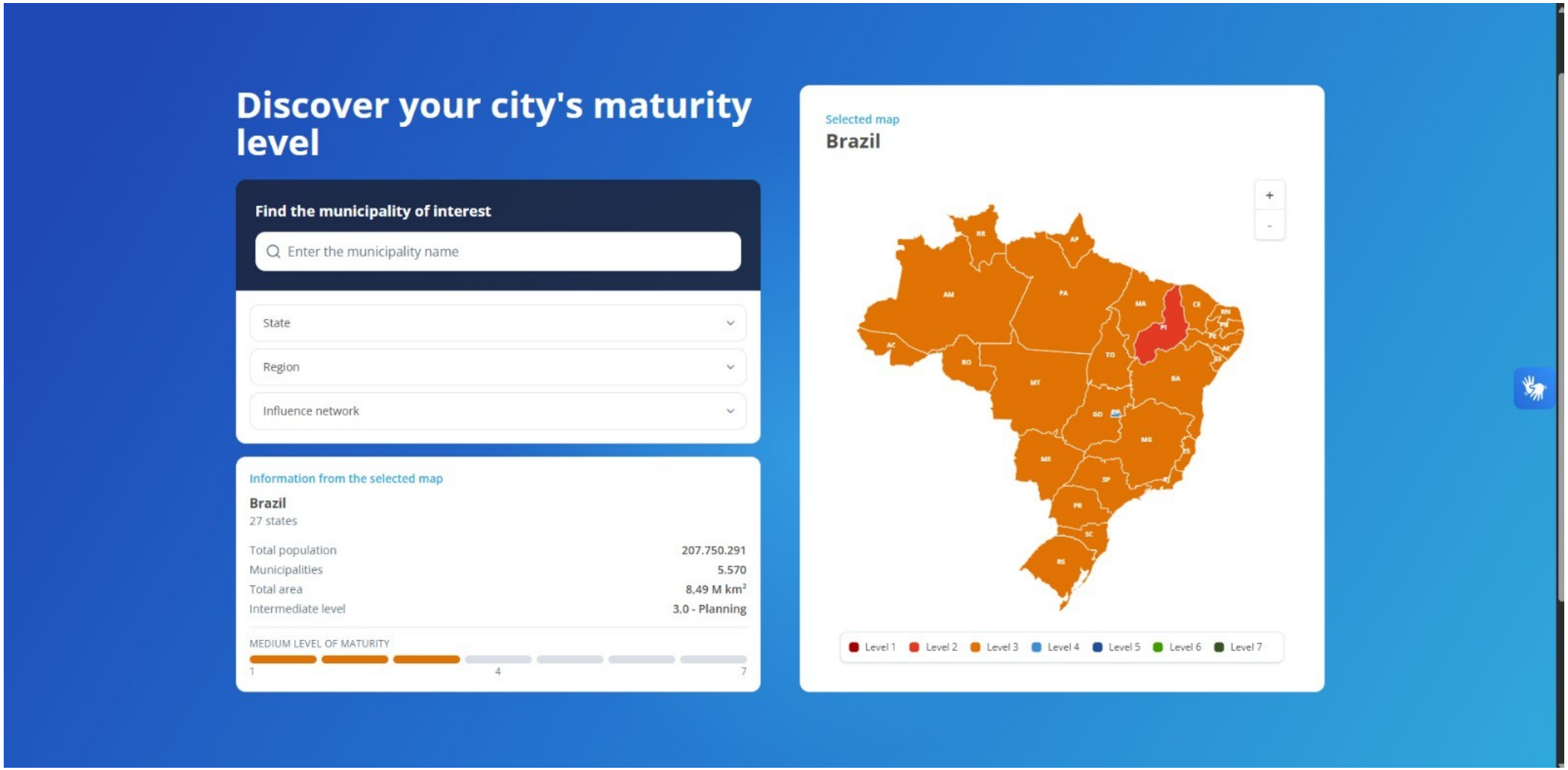
- Collaboration with United for Smart Sustainable Cities (**U4SSC**)
  - International platform that proposes a set of KPIs for sustainable and smart cities
  - Coordinated by:
    - International Telecommunication Union (**ITU)**: UN Agency for Information and Communication Technology (ICT)
    - The United Nations Economic Commission for Europe (**UNECE**): One of the 5 regional committees of the UN economic and social council
    - **UN-Habitat**: UN Agency to promote more social and sustainable cities
  - Assessment of the maturity level of Brazilian cities

Inteli.gente

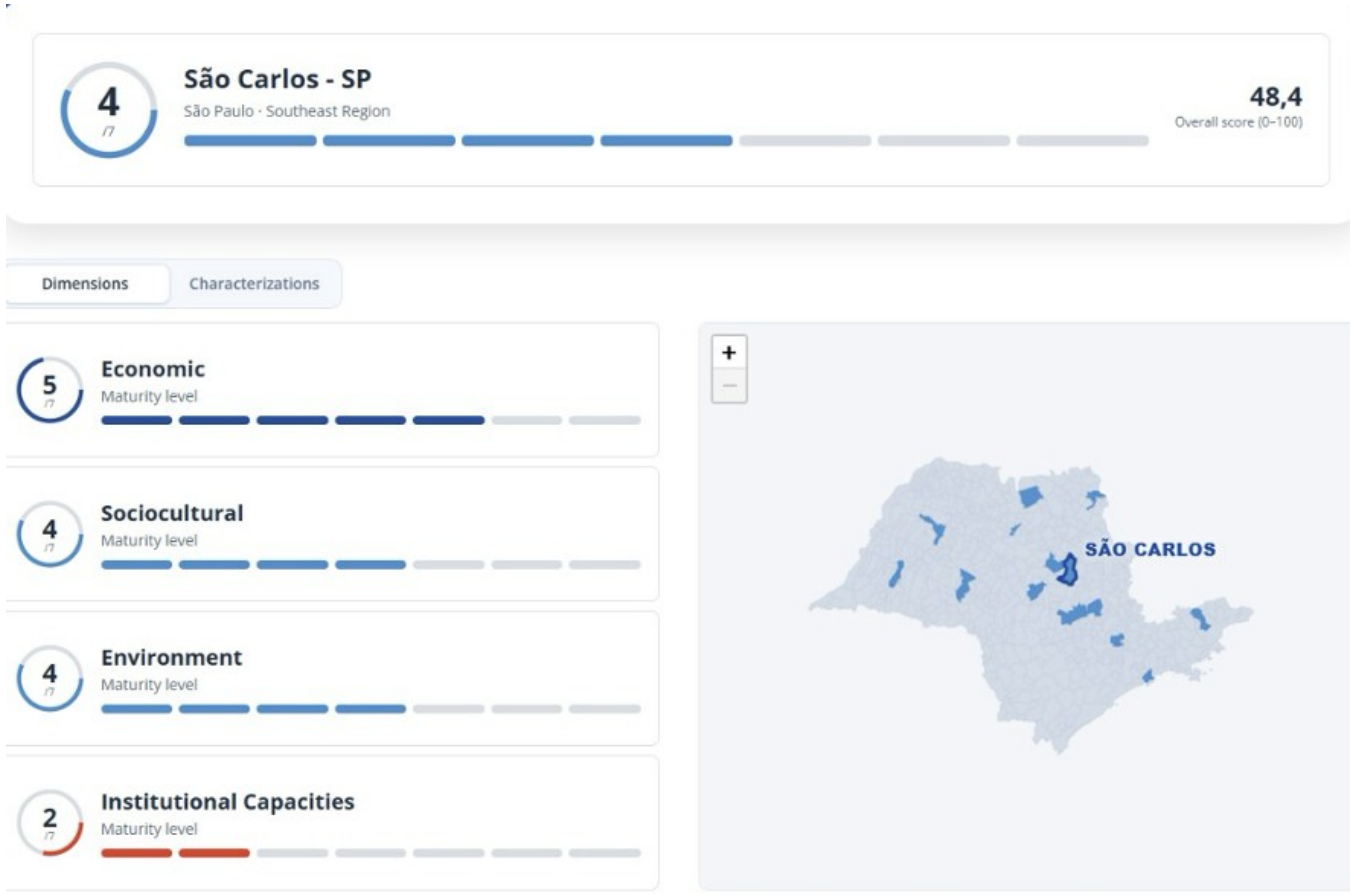
- First version designed by the Ministry of Science, Technology and Innovations and Ministry of Regional Development in Brazil
- Uses 43 indicators in 4 dimensi
  - Economical
  - Sociocultural
  - Environmental
  - **City management**
- IARA is in charge of the platform



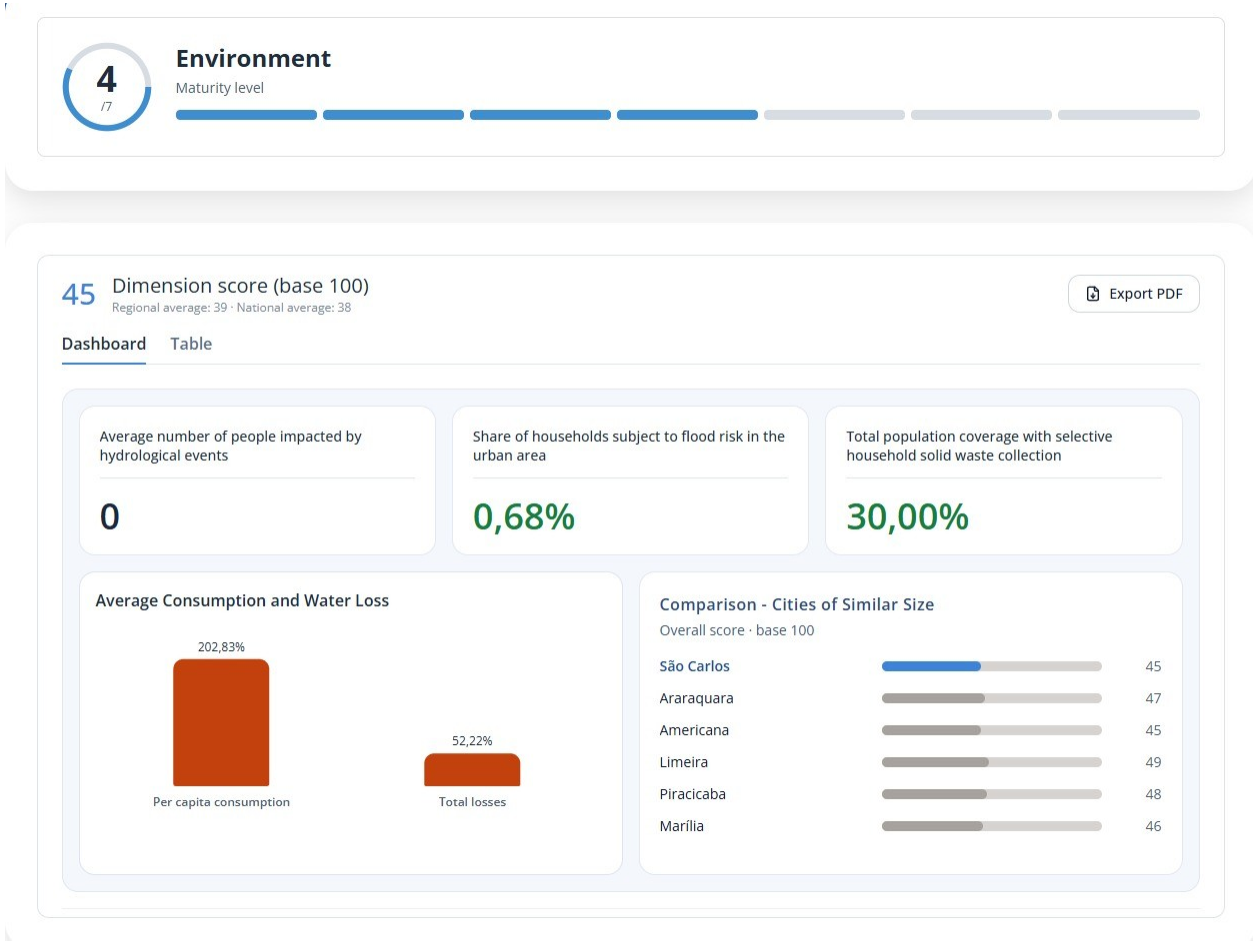
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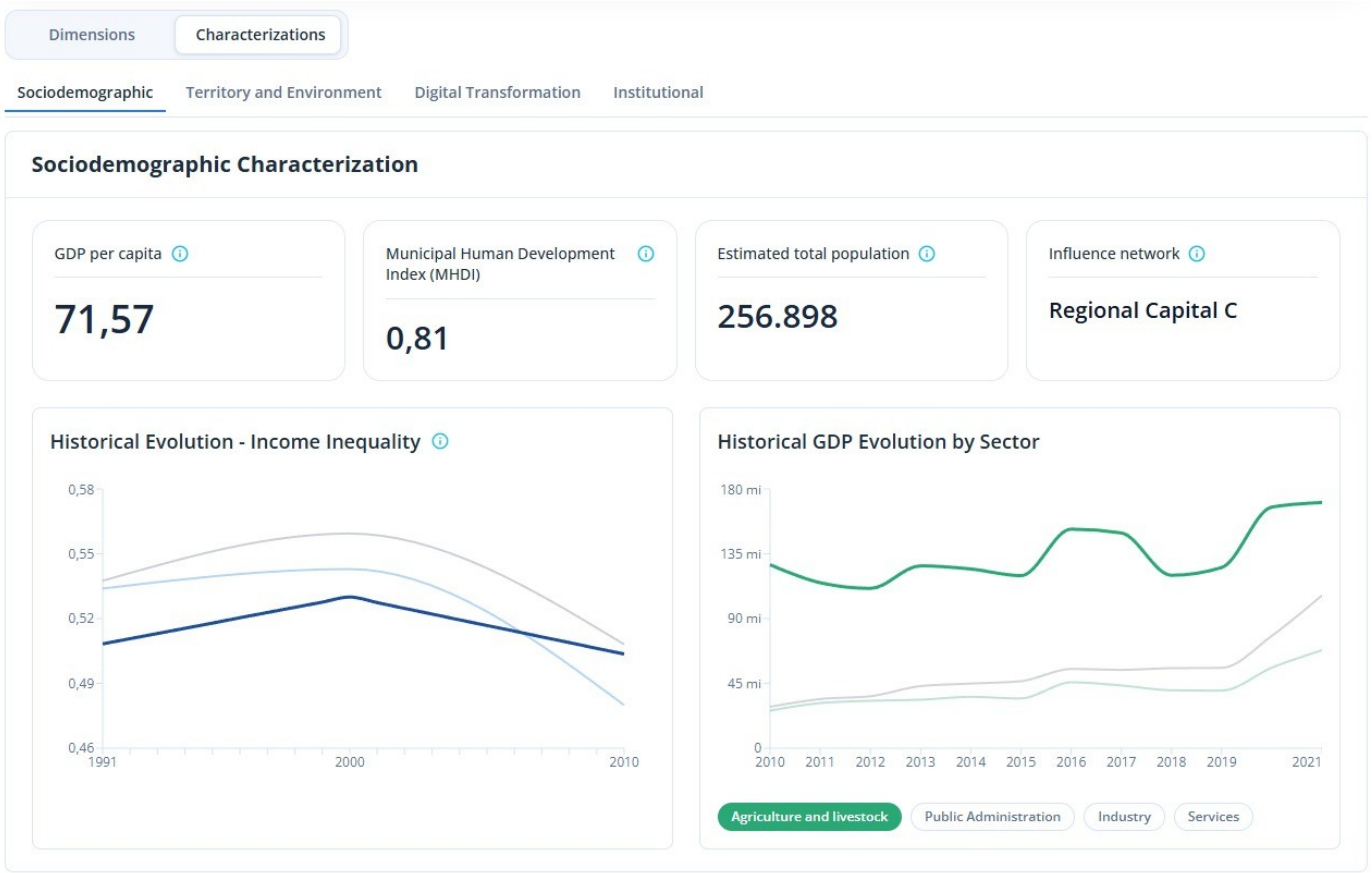
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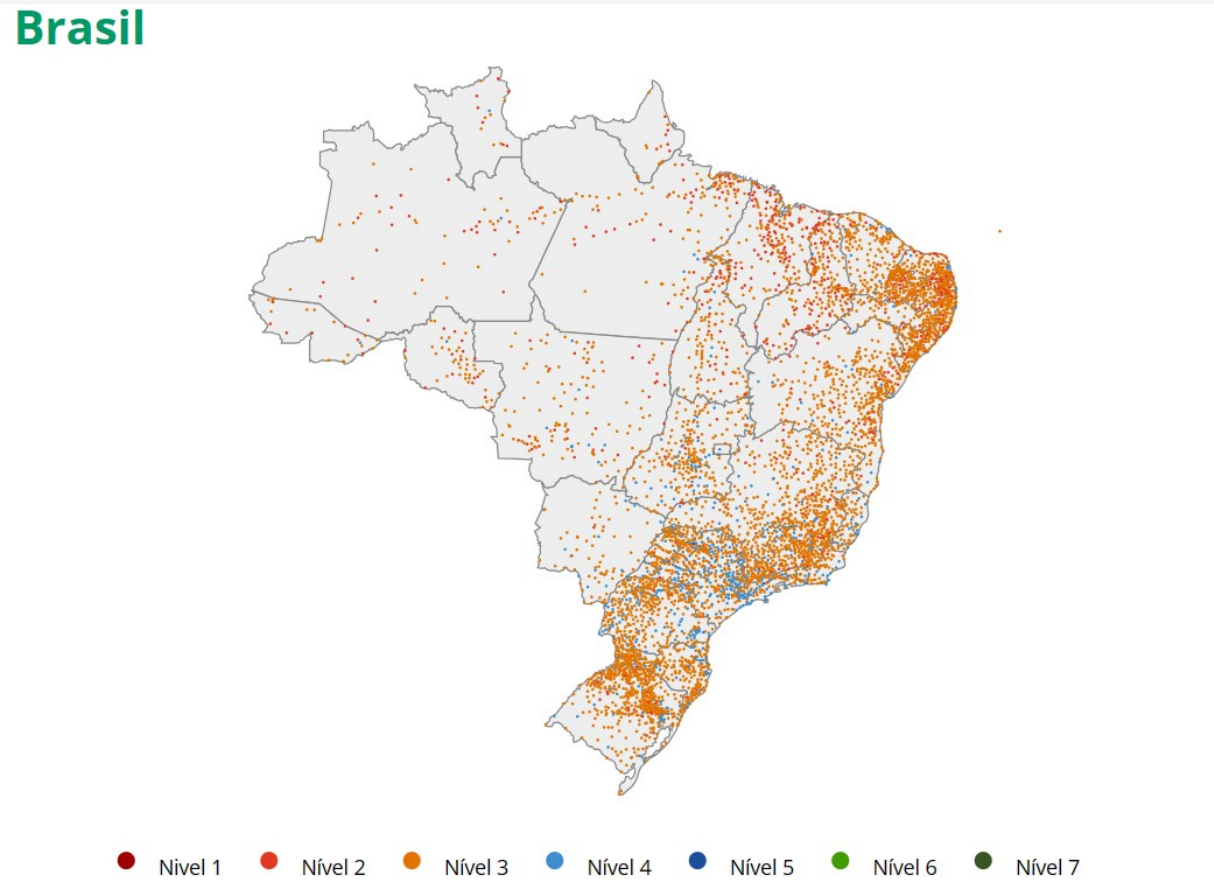


Inteli.gente



Maturity level of Brazilian cities

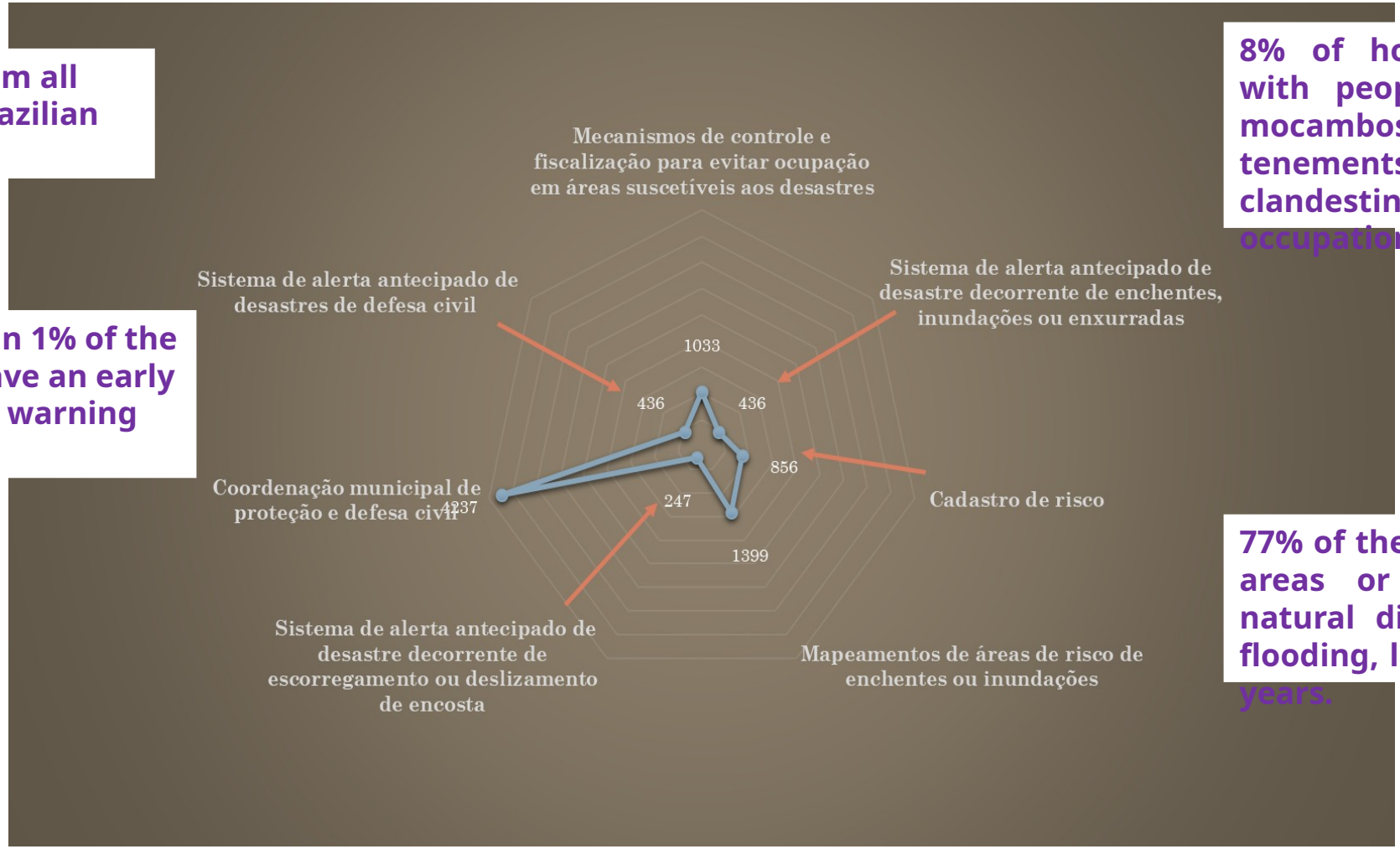
- Most cities are in the first levels between 3 (Planning) and 4 (Alignment)
  - Planning: there are **approved** actions to improve and use ICTs in services and solutions
  - Alignment : there are actions **implemented** to improve and use ICTs in services and solutions



Vulnerability and natural disasters

Data from all 5.571 Brazilian cities.

Less than 1% of the cities have an early disaster warning system.



8% of households (24 million) with people living in: Favelas, mocambos, stilt houses, tenements, irregular and/or clandestine allotments, housing occupations.

77% of the cities (4,264) have risk areas or have suffered from natural disasters, e.g., draught, flooding, landslides, in the last 4 years.

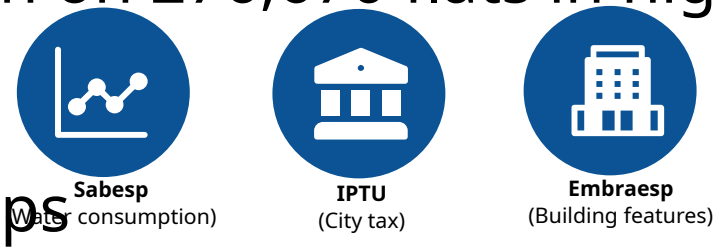
Sewage content analysis

- Center for the Development of Hydrosanitary Health and Quality of Life
  - Science for the development calls
  - Use of AI to detect contaminants and predict epidemiological outbreak
    - Integrate epidemiological, environmental and chemical data
    - Improve public health monitoring and urban sustainability
  - Chemistry, microbiology, sanitary engineering, artificial intelligence and public health experts
- Analysis of sewage in retention lakes in a sewage treatment plant
  - Retentetion lakes



Water consumption estimation

- For new flats in the city of São Paulo (more than 1,4 million flats)
  - Sabesp uses a simple equation to estimate consumption, using
    - Total area, number of bathrooms, number of bedrooms and size-garage
  - Reducing the need of demographic or income data
    - difficult to obtain, outdated or biased, Privacy protection
  - Water consumption (3-year period) measured in m^3 per month
  - Public databases with detailed information on 276,670 flats in high-rise buildings (21 variables per building)
  - Discrepancies solved with web-scraping and city maps
    - Reduced estimation error by more than 50%



Optimization of flight routes

- AI system for the prediction of flight delays
  - Using flight plan, position monitoring and climate
  - Reduction of holding
    - Maneuver to delay an aircraft already in flight
    - Reduction of fuel consumption
  - Improvement of arrival time predictabi
    - Passenger waiting time
    - Use of airport infrastructure



AI Safety report

Department for Science, Innovation & Technology

LONDON FAPESP WEEK June, 2-4th 2026

- Internationally shared understanding of AI risks
  - UK Government Department of Science, Innovation and Technology
  - Representatives from more than 30 countries, EU, OECD and UN
    - Identify risks and methods to assess and how to manage them
    - Sent to governments of participating countries, unions and institutions
  - To inform, not to recommend



Thank you

André Carlos Ponce de Leon Ferreira de Carvalho
andre@icmc.usp.br
University of São Paulo