Data Infrastructure for UDTs

Use case example 1: Crowd mobility

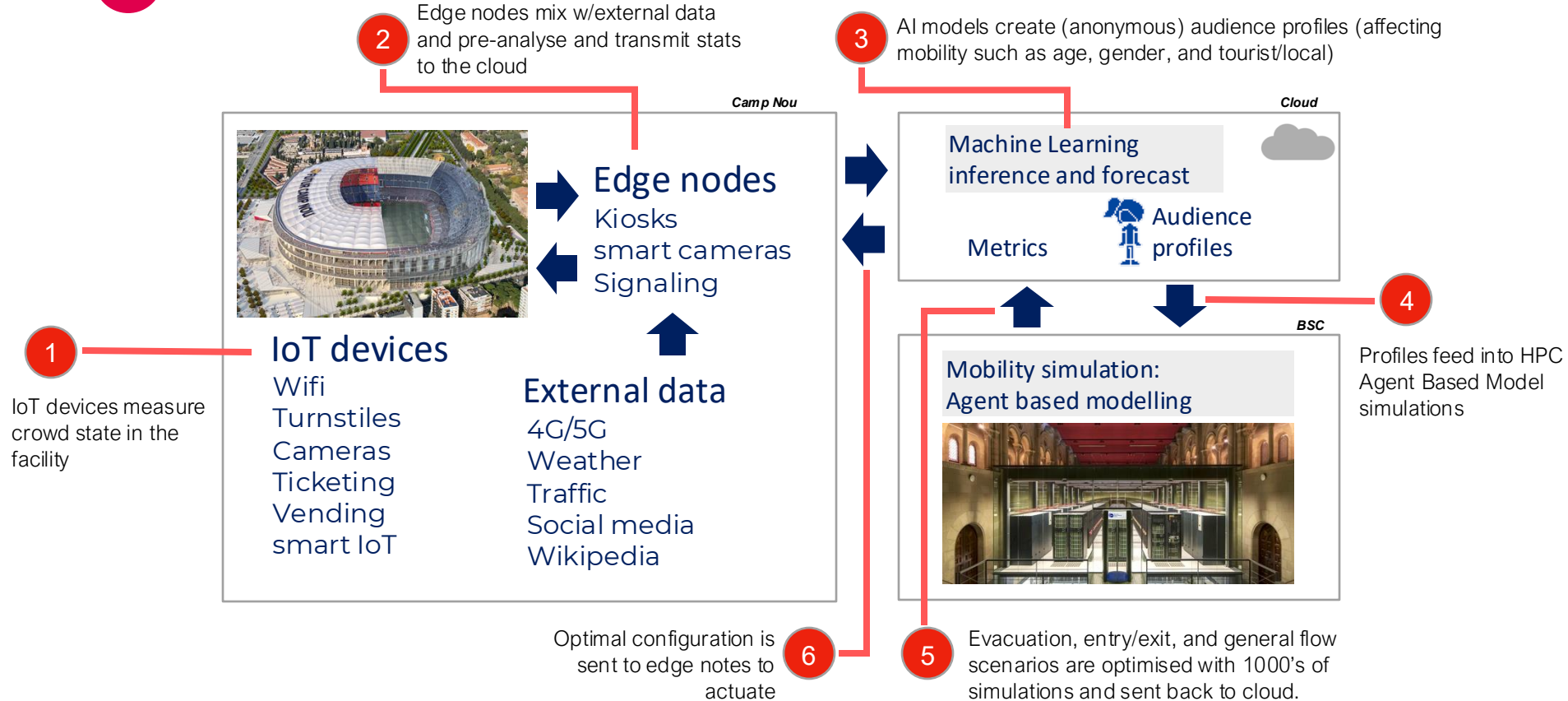01

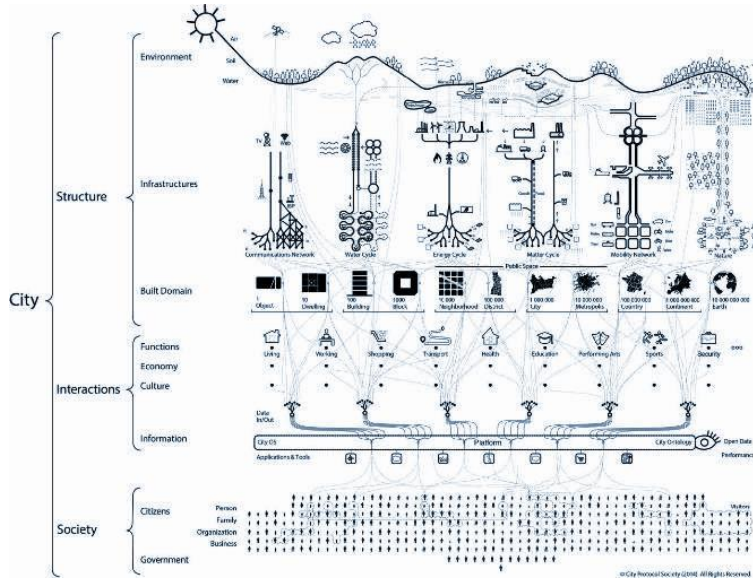P2

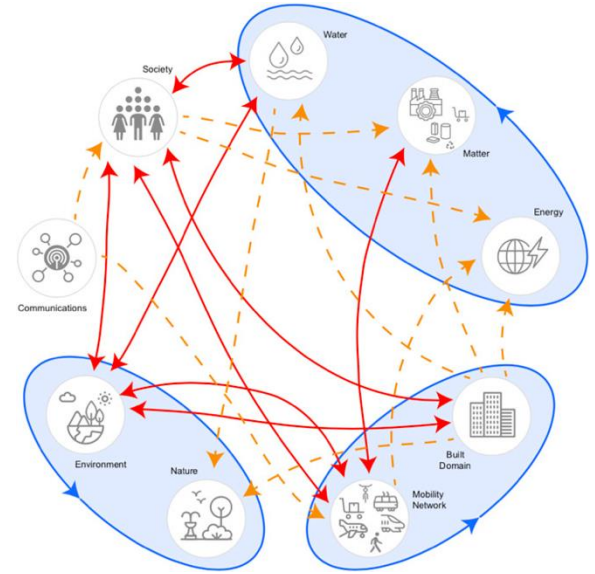P1

P0.5

PB

Use Case: The Camp Nou Digital Twin

2 Edge nodes mix w/external data and pre-analyse and transmit stats to the cloud

3 AI models create (anonymous) audience profiles (affecting mobility such as age, gender, and tourist/local)

Camp Nou

Cloud

Edge nodes
Kiosks
smart cameras
Signaling

Machine Learning inference and forecast

Metrics   Audience profiles

4

BSC

1

IoT devices measure crowd state in the facility

IoT devices
Wifi
Turnstiles
Cameras
Ticketing
Vending
smart IoT

External data
4G/5G
Weather
Traffic
Social media
Wikipedia

Mobility simulation: Agent based modelling

Profiles feed into HPC Agent Based Model simulations

Optimal configuration is sent to edge notes to actuate **6**

5 Evacuation, entry/exit, and general flow scenarios are optimised with 1000's of simulations and sent back to cloud.

4

BSC Barcelona Supercomputing Center *Centro Nacional de Supercomputación*

IoTwins

From anatomy to physiology of the city

Theoretical framework on how to simulate a complete city

Meta, I., Cucchietti, F. M., Navarro-Mateu, D., Graells-Garrido, E., & Guallart, V. (2022). A physiology-inspired framework for holistic city simulations. Cities, 126, 103553. https://doi.org/10.1016/j.cities.2021.103553

City physiology: The Camp Nou pilot

Modularity and adaptability tests
of the theoretical framework:

- ABM simulations of crowd
  mobility
  of crowds

- Layers and interactions
  - Constructed domain
  - Communication
  - Society
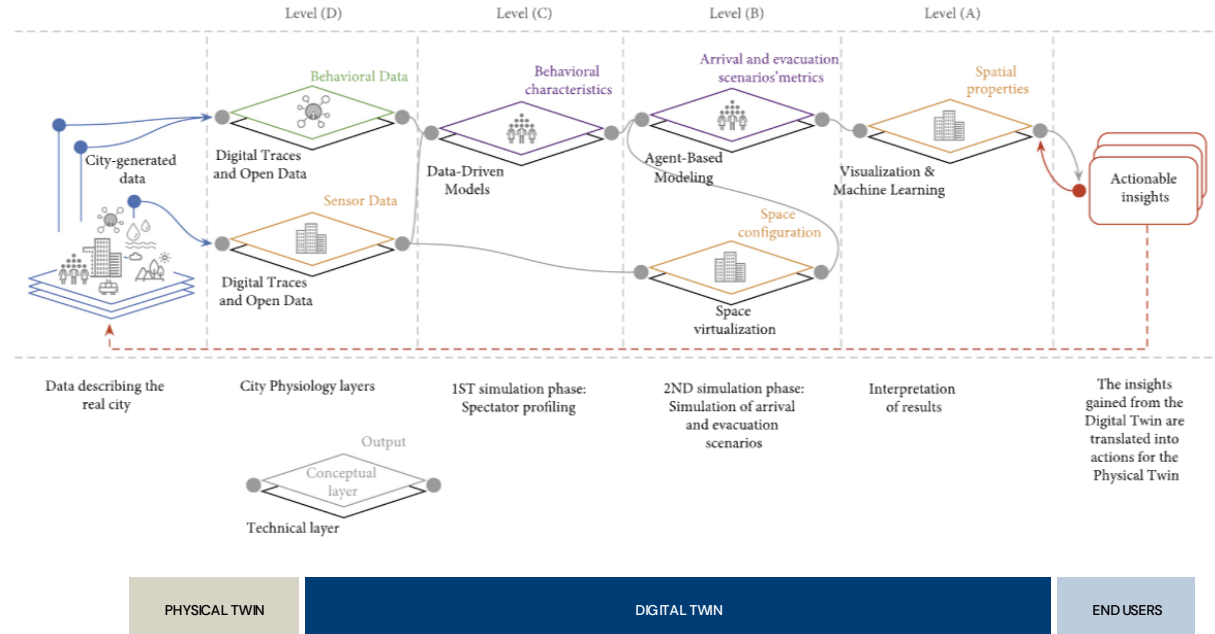
Irene Meta et al, The Camp Nou Stadium as a Testbed for City Physiology: A Modular Framework for Urban Digital Twins, Complexity, vol. 2021, Article ID 9731180, 2021. https://doi.org/10.1155/2021/9731180
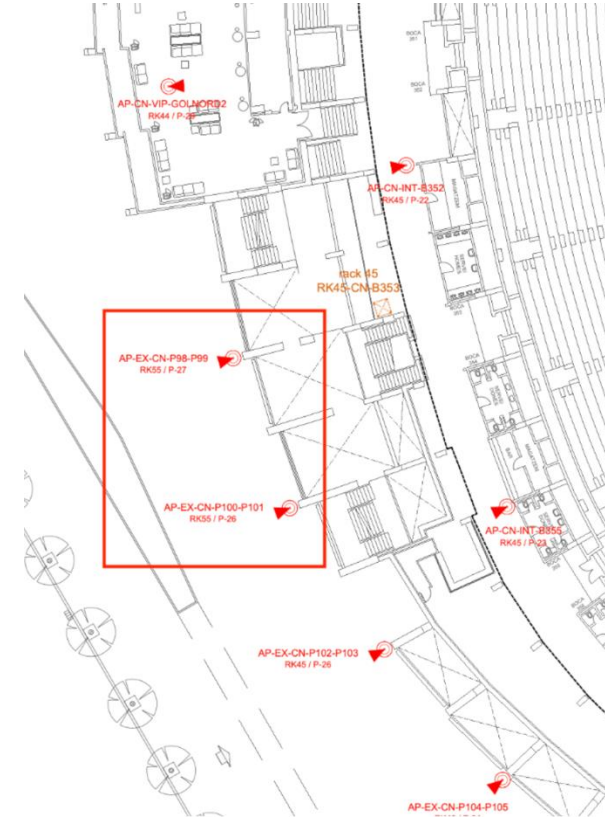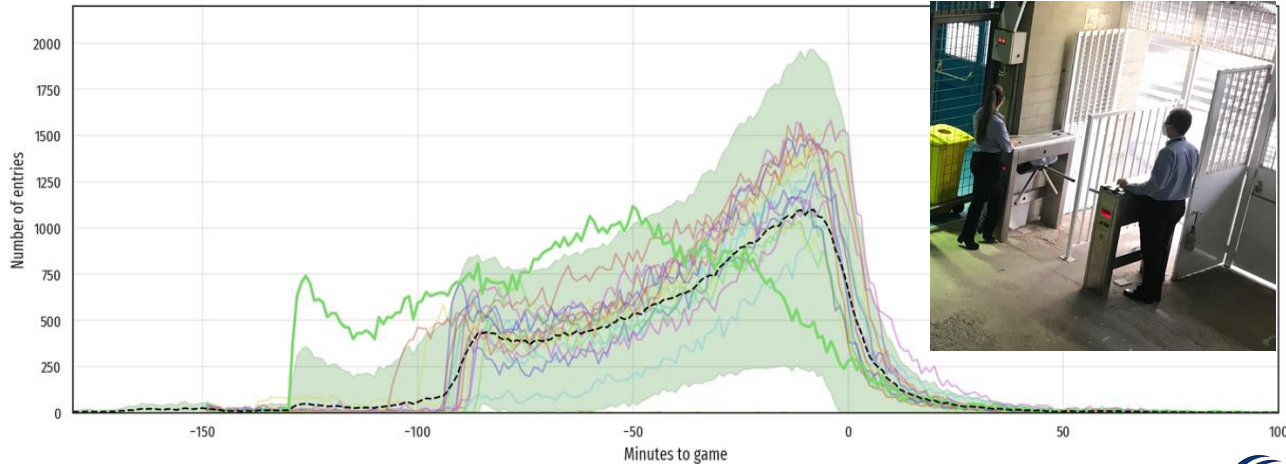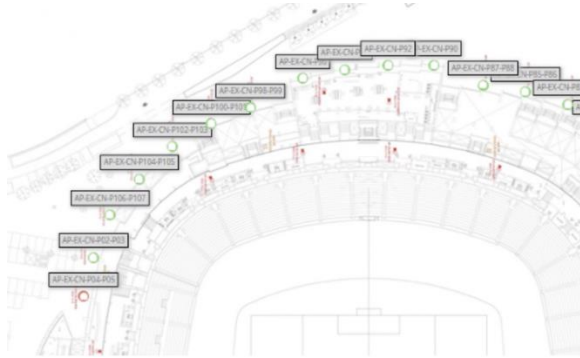
Sensors and IoT devices

- API
  - Coming from FCB edge
  - Anonymised WiFi APs data
  - Sensors (turnstiles etc.)
  - Cameras (delayed)
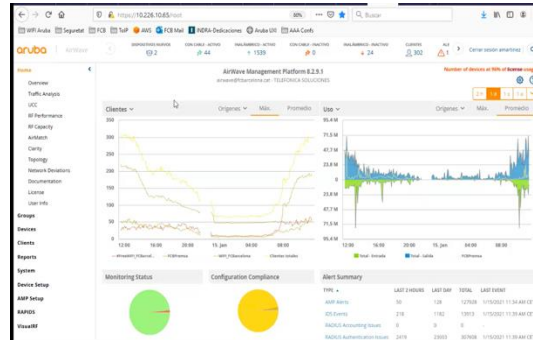
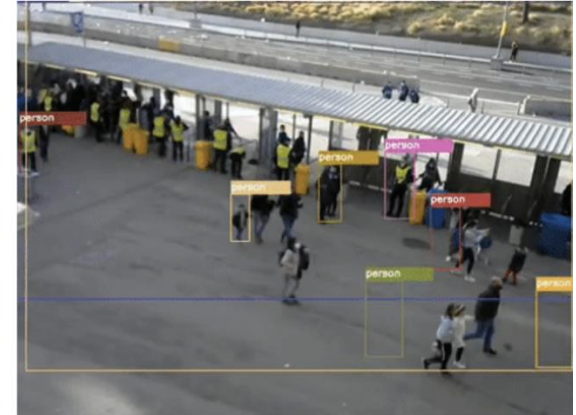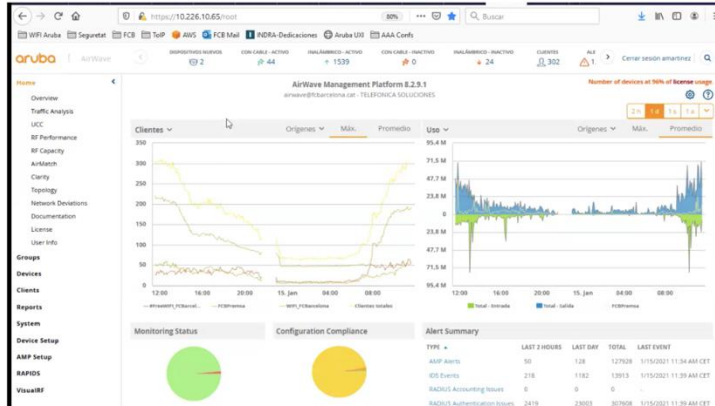2019-2020 curves of attendance

Data sources

Wifi APs
Turnstiles
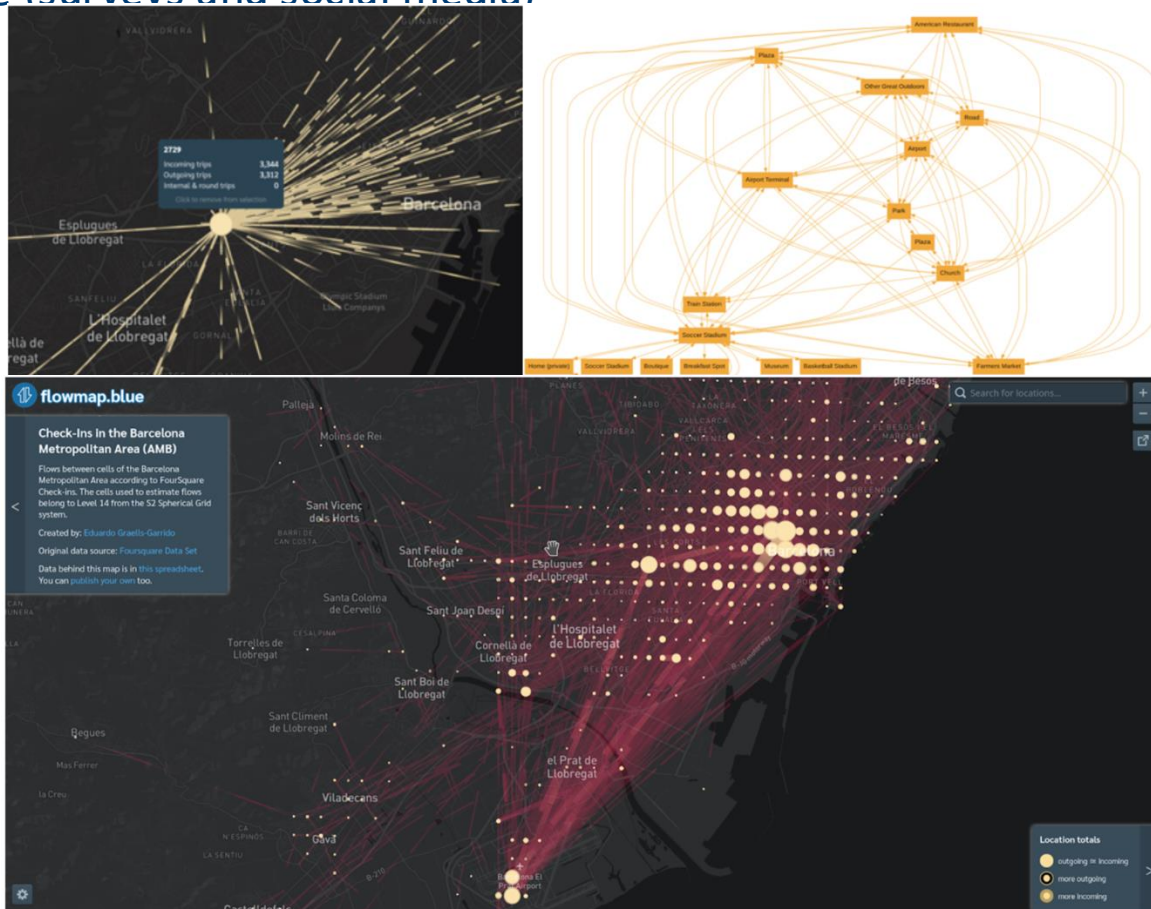Cameras
Ticketing
Vending
smart IoT

4G/5G
Weather
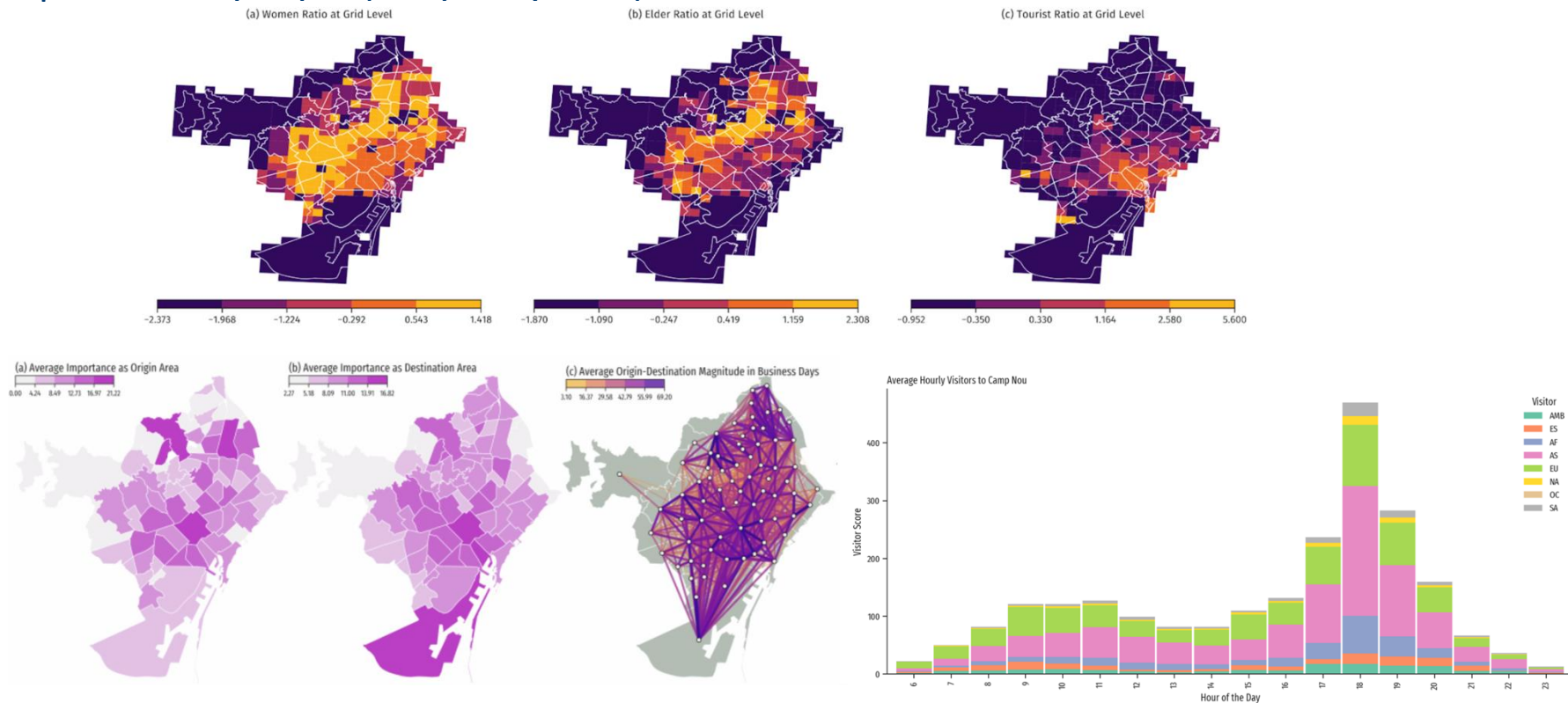Traffic
Social media
Wikipedia

Kiosks
smart cameras
Signaling

Data profiling

Source of people (surveys and social media)

Data profiling

Composition of people (telephony data)

(a) Women Ratio at Grid Level

(b) Elder Ratio at Grid Level

(c) Tourist Ratio at Grid Level

(a) Average Importance as Origin Area

(b) Average Importance as Destination Area

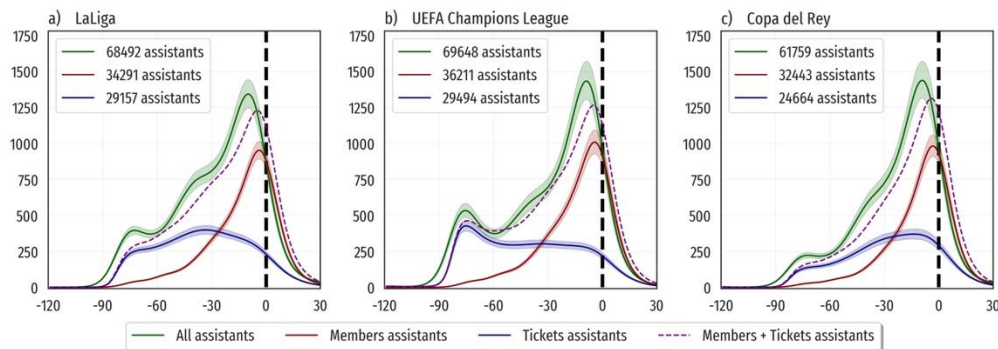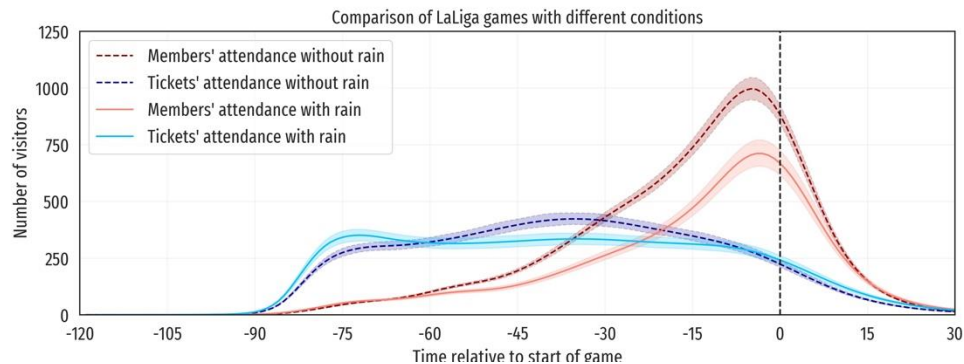(c) Average Origin-Destination Magnitude in Business Days
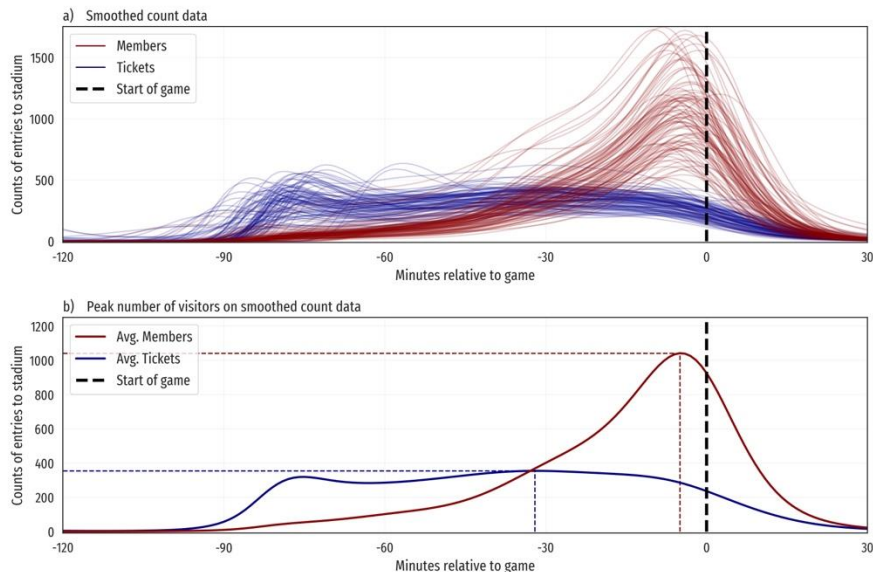
Average Hourly Visitors to Camp Nou

ML models: Predicting attendance

- Attendance influx
  - By gate and by minute
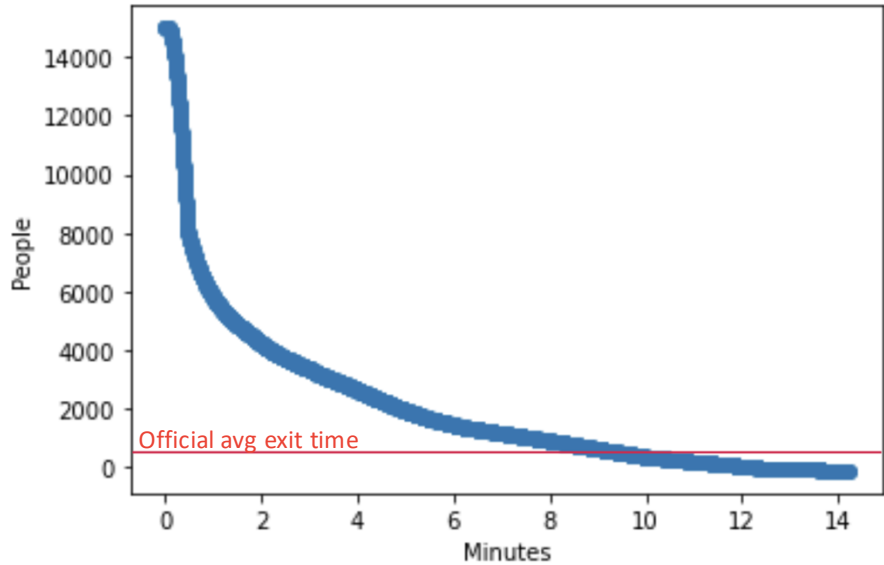 - Including profile

Barcelona Supercomputing Center
Data Analytics & Visualization Group

Prediction dashboard

And alerting system

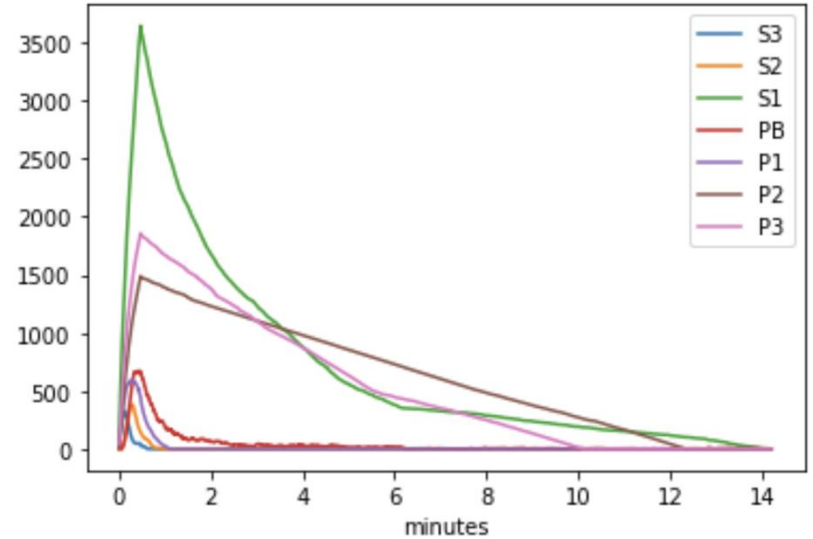Barcelona Supercomputing Center
Data Analytics & Visualization Group
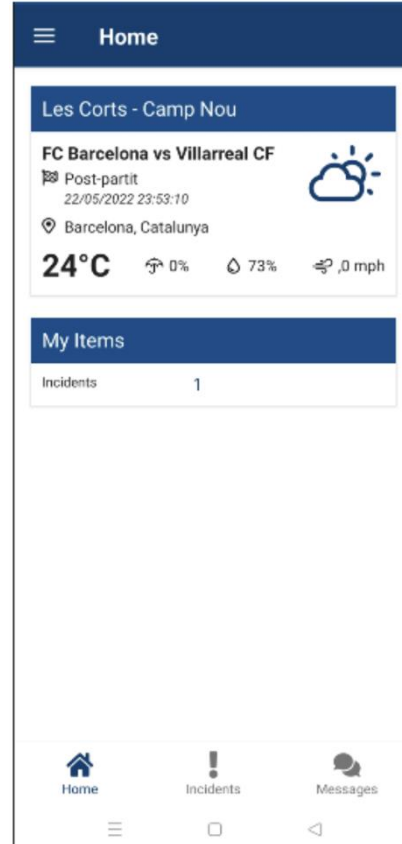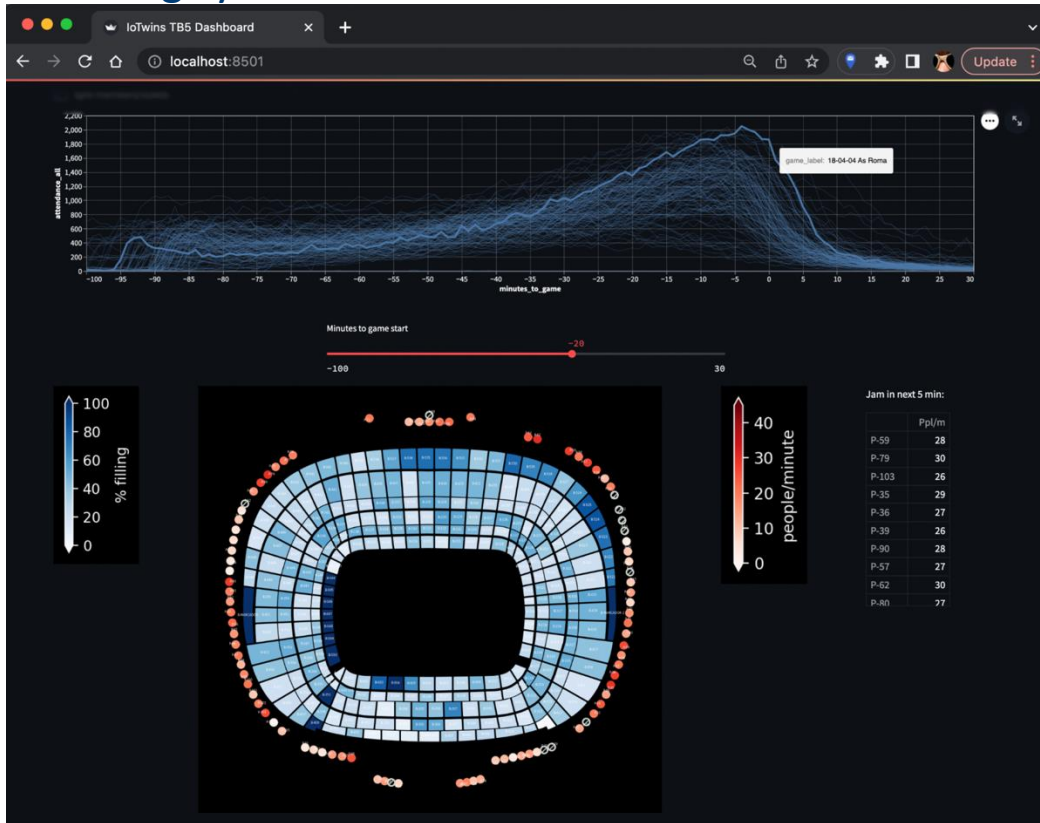
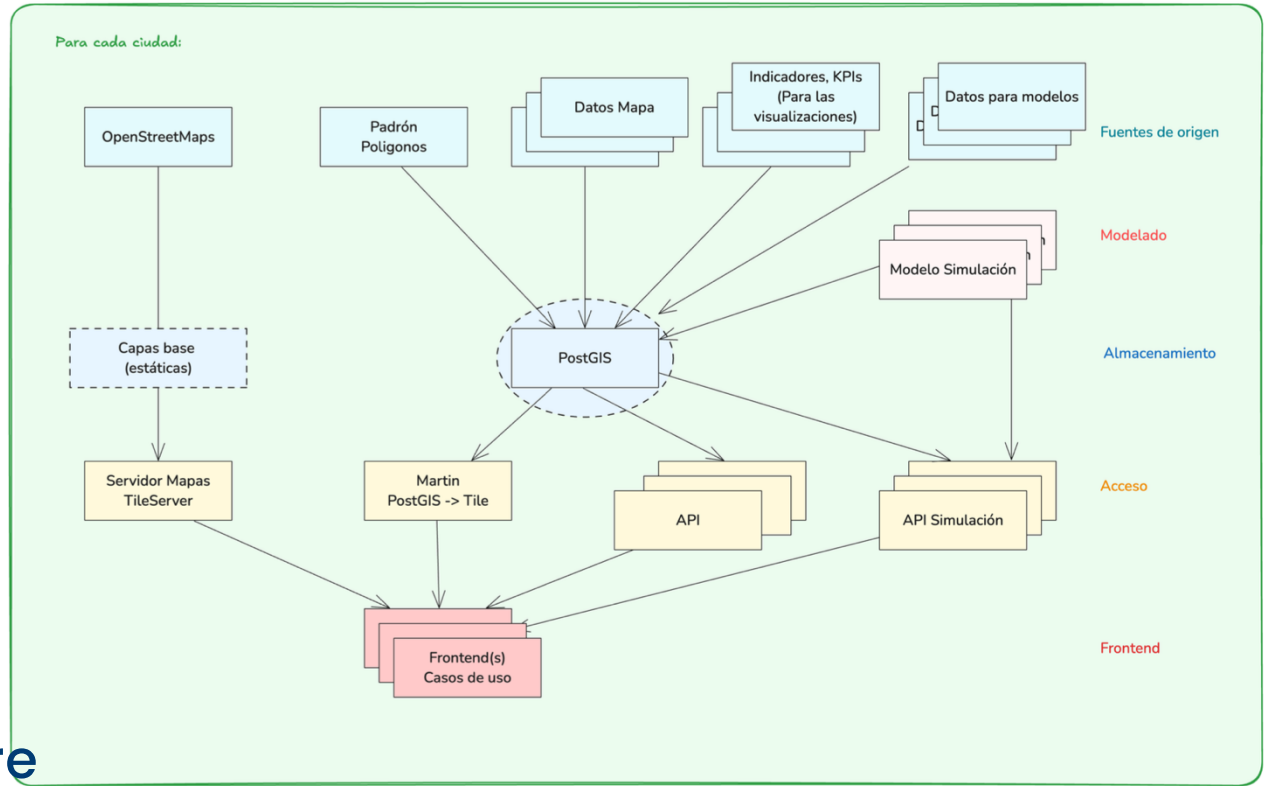# Evacuation simulation

Gol Nord exit flow

Exit flow by floor

Halfway conclusions

- Coupling of models/data can give more power than single, complex models
  - Different, slightly overlapping sources
  - Privacy by design
  - But, joining, fusing data is hard
    - Ontologies help in the long run
- Do you really need real time?
  - Urgent response, yes. Planning, not so much
  - Easier/cheaper to buy historical data
- How much detail do you really need
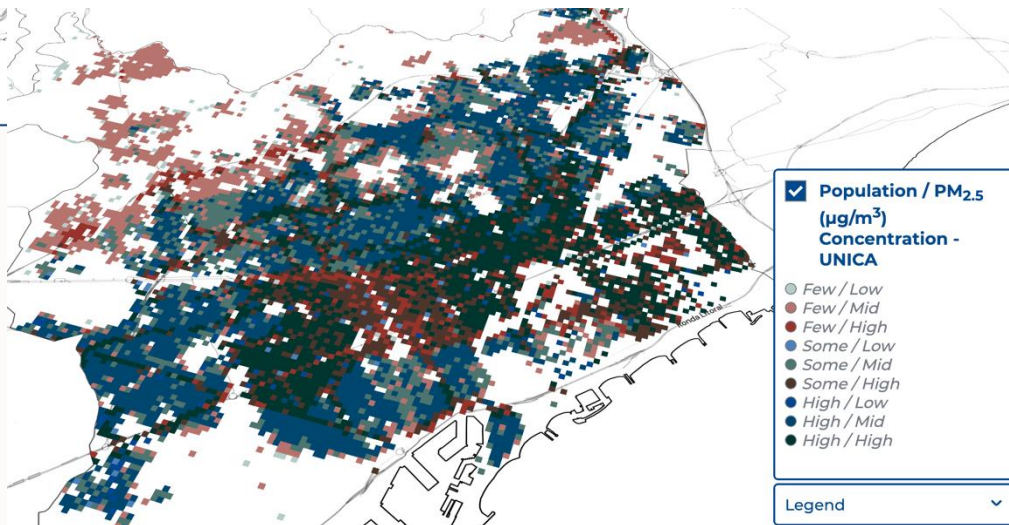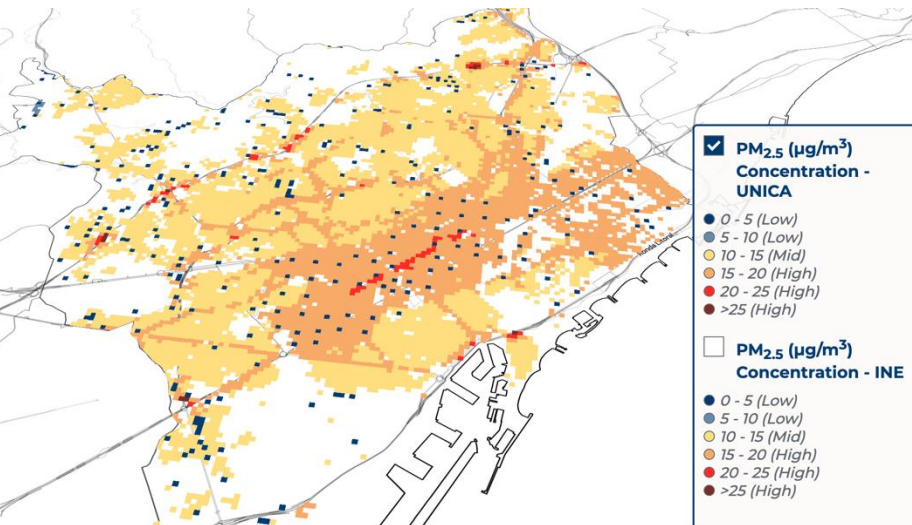 - Anonymisation destroys it anyway

More use cases

Use case architecture

https://air-quality-vmaps-c24Oae.gitlab.io/

Metrics to optimize are key

https://air-quality-vmaps-c240ae.gitlab.io/

Interpolated Attributable Deaths - UNICA

- 0
- 0.7

Legend

Proximidad

Este estudio visualiza a través del prisma de la proximidad el grado de accesibilidad a puntos de interés en 140 ciudades españolas de más de 50.000 habitantes. Será la base para el desarrollo del caso de uso de Proximidad, como una herramienta con la que las y los responsables de las políticas urbanas podrán determinar fácilmente la disposición a los servicios públicos vitales para la ciudadanía.

Stakeholders need to define metrics

Compute resources help cache data

Models + data can complement each other
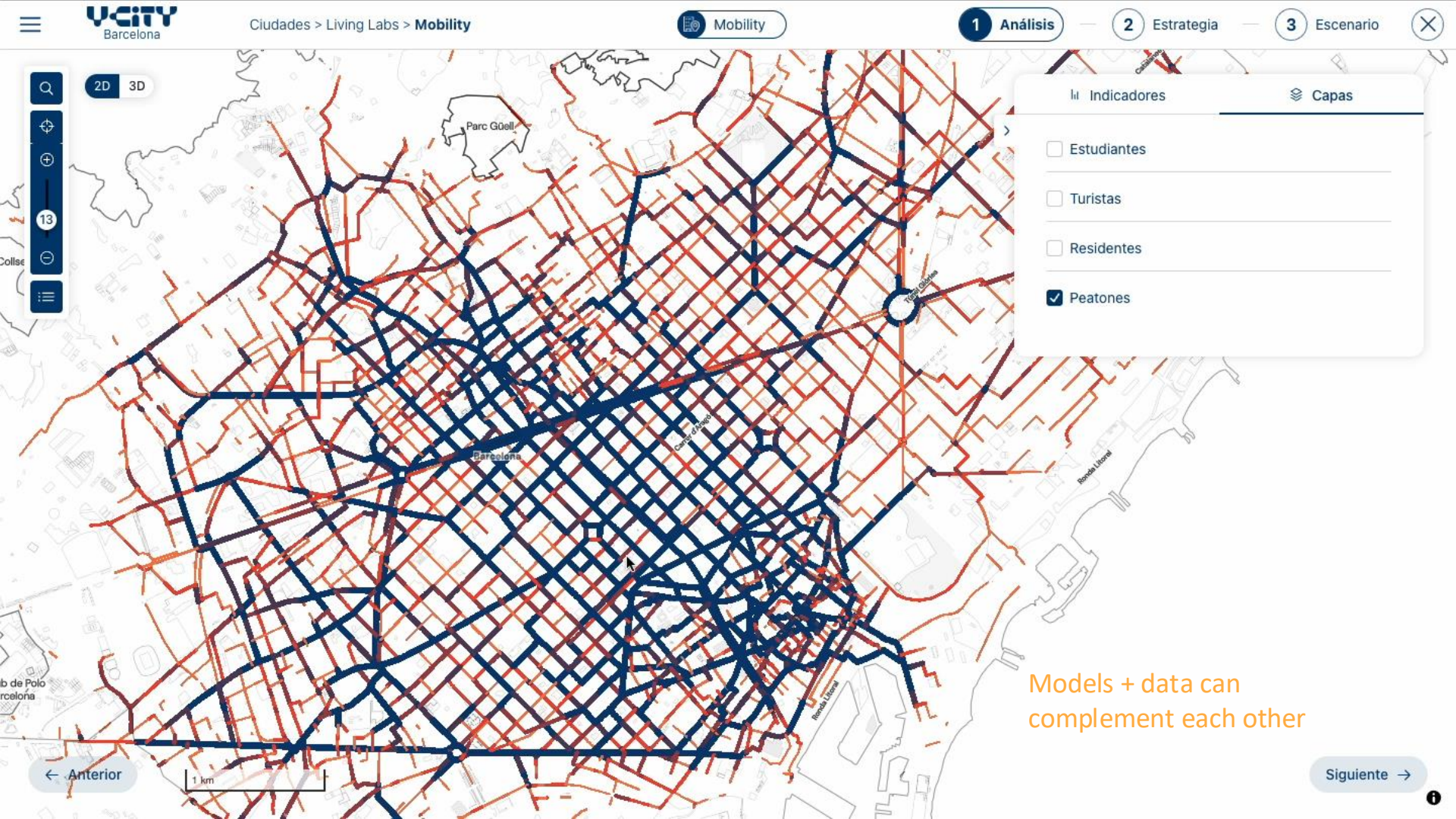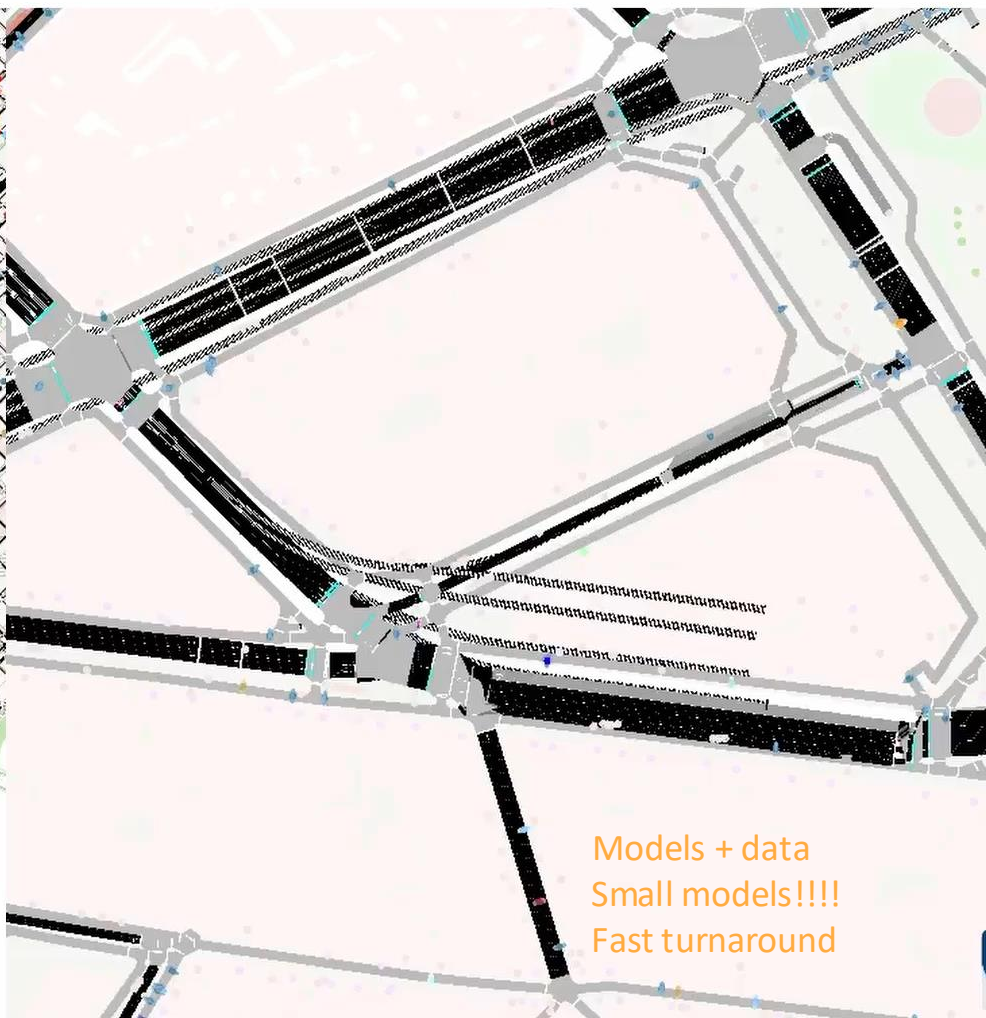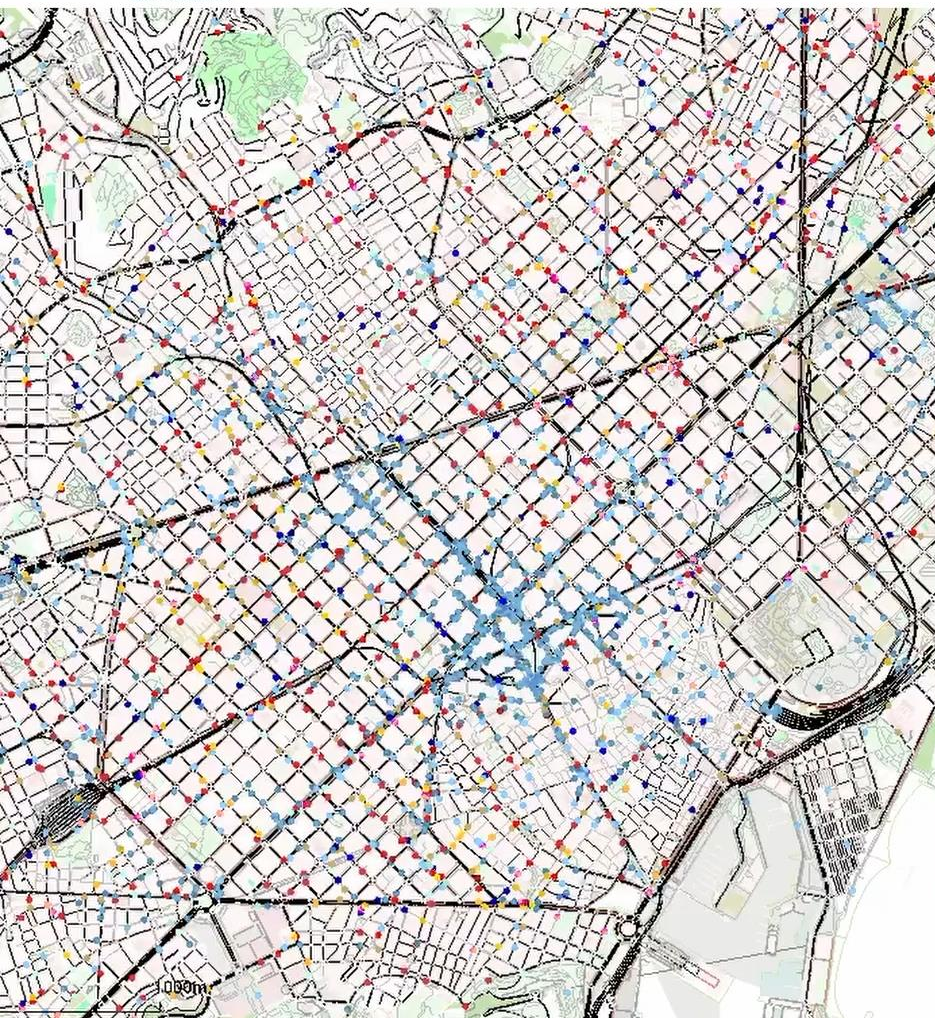
Models + data
Small models!!!!
Fast turnaround

Collected conclusions

- Small models, perhaps not hyper precise, might be a better bet, specially to start
    - E.g. Openstreetmaps vs hand made maps for traffic simulators
- Coupling of models/data can give more power than single, complex models
    - Maybe focus on coverage, not depth
    - Eg: Air quality + demographics + traffic
    - Privacy by design
- Metrics to optimize are key
    - Stakeholders need to define those
- Joining, fusing data is hard
    - Ontologies help in the long run
- Do you really need real time?
    - Urgent response, yes. Planning, not so much
    - Cheaper to buy historical data
- How much detail do you really need
    - Anonymisation destroys it anyway

The UNICO-GDU-HPC project, part of the UNICO I+D Cloud programme, has the Ministry for Digital Transformation and of Civil Service and the EU-Next Generation EU as financing entities, within the framework of the PRTR and the MRR.