Smart Cities:

Synergy of Technologies for a Better Urban Future

EELISA European University

EELISA Student Scientific Competition

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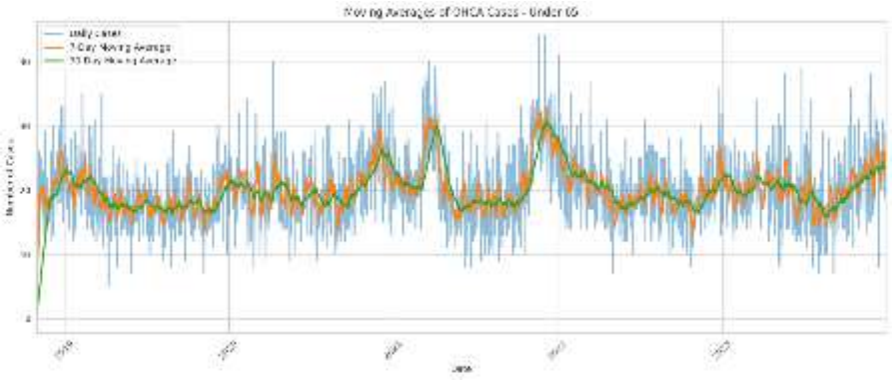
Introduction

What is a smart city?

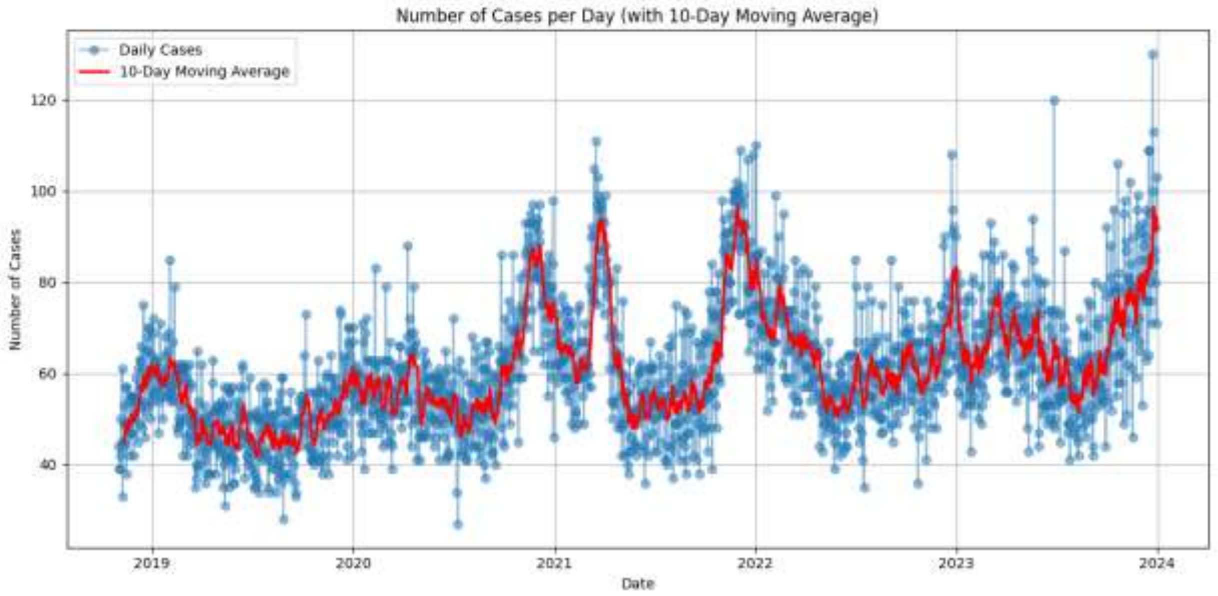
- Urban area that uses digital technology to collect data and operate services on many levels.
- Not defined by a single product or innovation
- Composite of cutting-edge technologies --> technological improvements
  - Data driven infrastructures
  - Smart healthcare systems and case prediction
  - Optimized traffic control
  - Optimized energy sustenance
  - Smart products



Data for detection and prediction

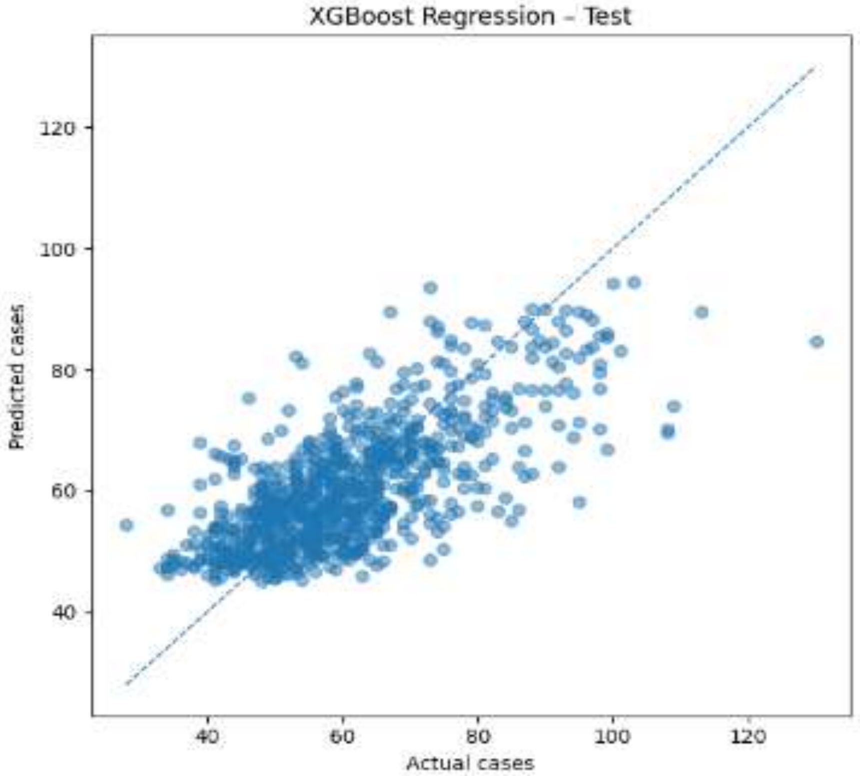
Importance of data - healthcare

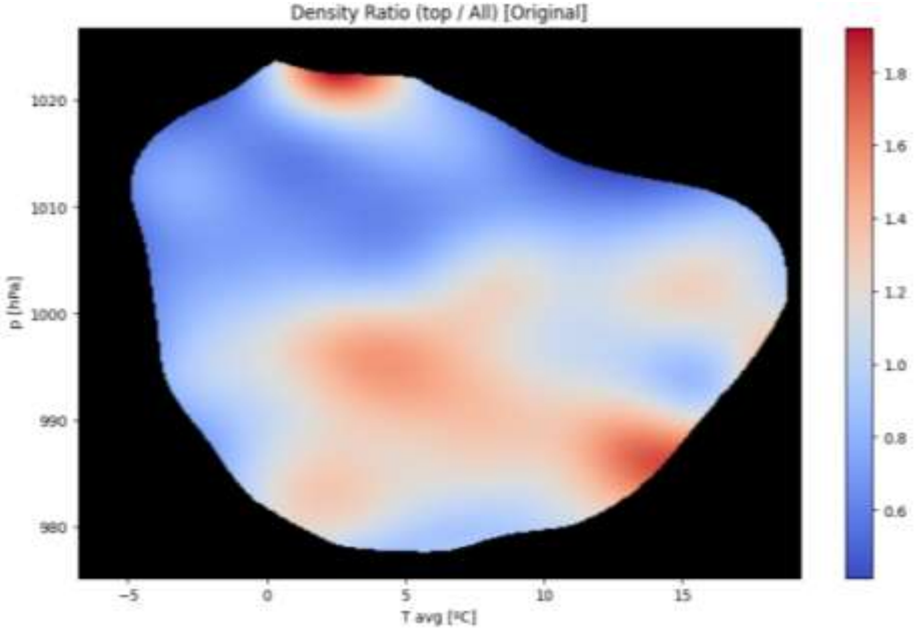
- Understanding and knowing when and how health hazards occurs is imperative
- **Goal:**
  - Predict daily incidences – with global parameters like weather
  - → Optimal hospital resource allocation
  - Identifying risk factors and high risk days
- **Algorithms tested on:**
- Hungarian OHCA database, meteorogical database
- Known risk factors:
  - Global: weather, social background, seasonal changes
  - Individual: age, sex, genetics, recreational drug consumption (e.g. tobacco, alcohol), obesity



Healthcare – predictions (OHCA detection)

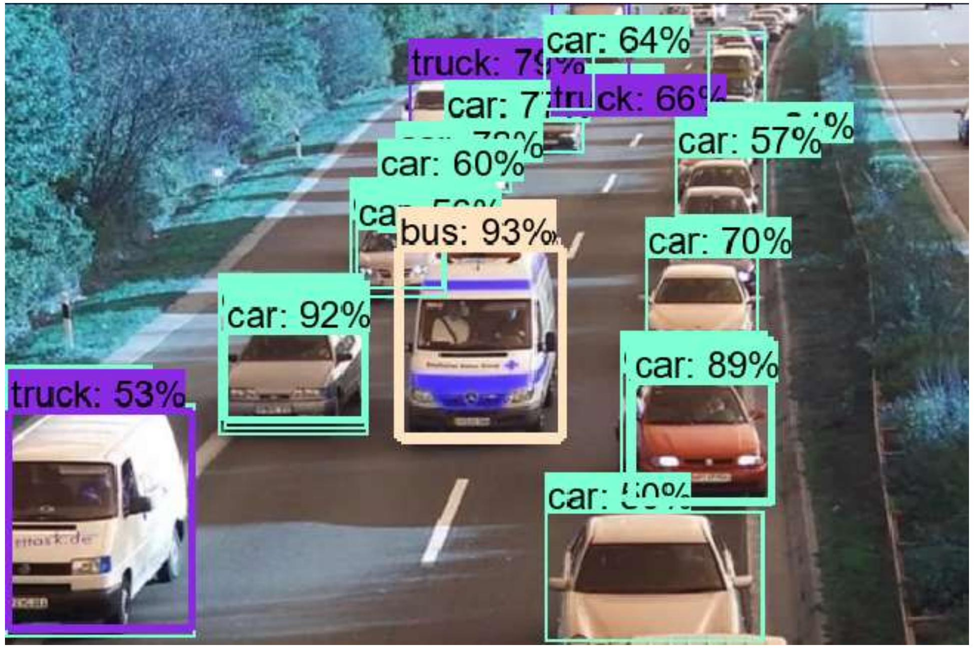
- General regressions usually fail
- Machine learning tool : XGBoost – decision trees
- XGBoost with all parameters
  - With previous days case numbers:
    - $R^2 = 0.5$
  - With out :
    - $R^2 = 0.24$
- Good fit for weakly corelating datasets
- Ways to enhance:
  - More information
  - Reliable healthcare
  - Outlier analysis





Importance of Data – Traffic Detection

- Information about current and exact traffic information is extremely relevant for optimization
  - Enhancing navigation
  - Identifying accidents
  - →Optimal traffic light control
- Known solutions for car detection using convolutional networks
- NOW: maritime surveillance with satellite imaginary



Ship Detection

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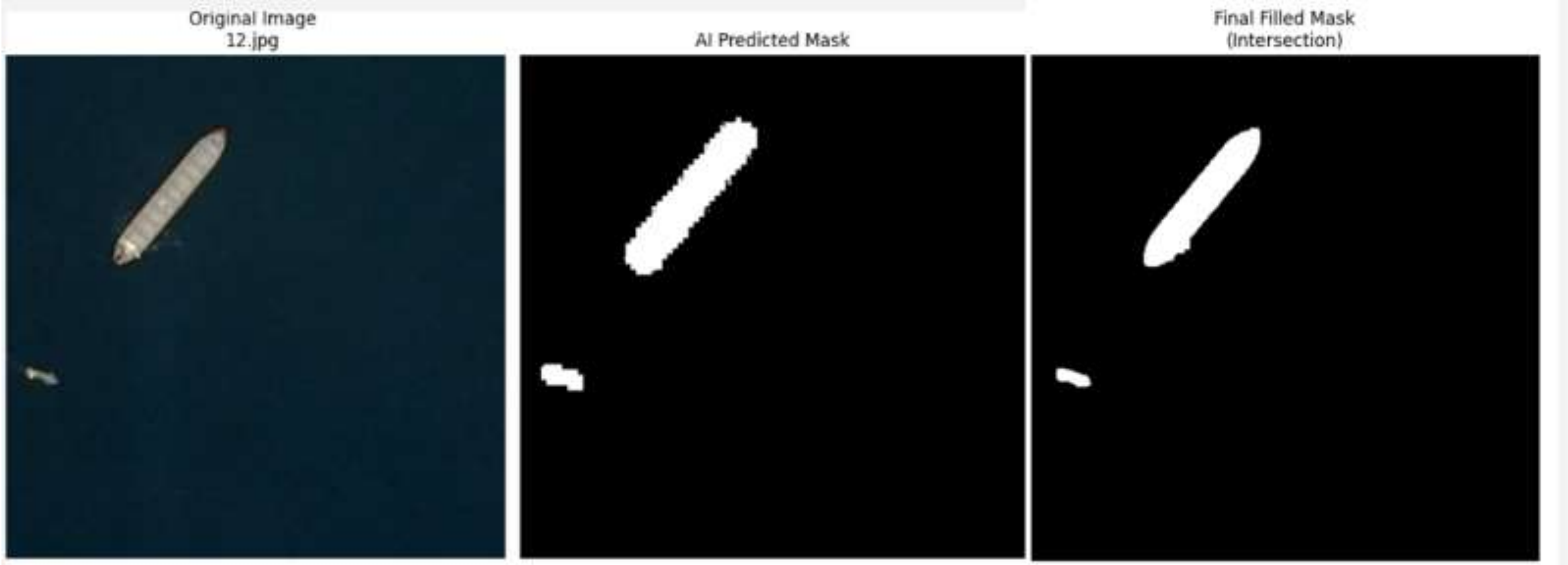
- Masked R-CNN
- ResNet50 backbone
- 384^2 RGB input
- 384^2 grayscale
- Optimizer: Adam
- Learning rate: 10e-4
- Loss: BCE
- Sigmoid activation

Layer (type)	Output Shape	Param #
input_image (InputLayer)	(None, 384, 384, 3)	0
functional_3 (Functional)	[(None, 96, 96, 256), (None, 48, 48, 512), (None, 24, 24, 1024)]	8,589,184
conv2d_3 (Conv2D)	(None, 24, 24, 256)	2,359,552
conv2d_transpose_8 (Conv2DTranspose)	(None, 48, 48, 256)	590,080
conv2d_transpose_9 (Conv2DTranspose)	(None, 96, 96, 256)	590,080
conv2d_transpose_10 (Conv2DTranspose)	(None, 192, 192, 256)	590,080
conv2d_transpose_11 (Conv2DTranspose)	(None, 384, 384, 256)	590,080
mask_output (Conv2D)	(None, 384, 384, 1)	257

Total params: 13,309,313 (50.77 MB)
Trainable params: 13,278,721 (50.65 MB)
Non-trainable params: 30,592 (119.50 KB)

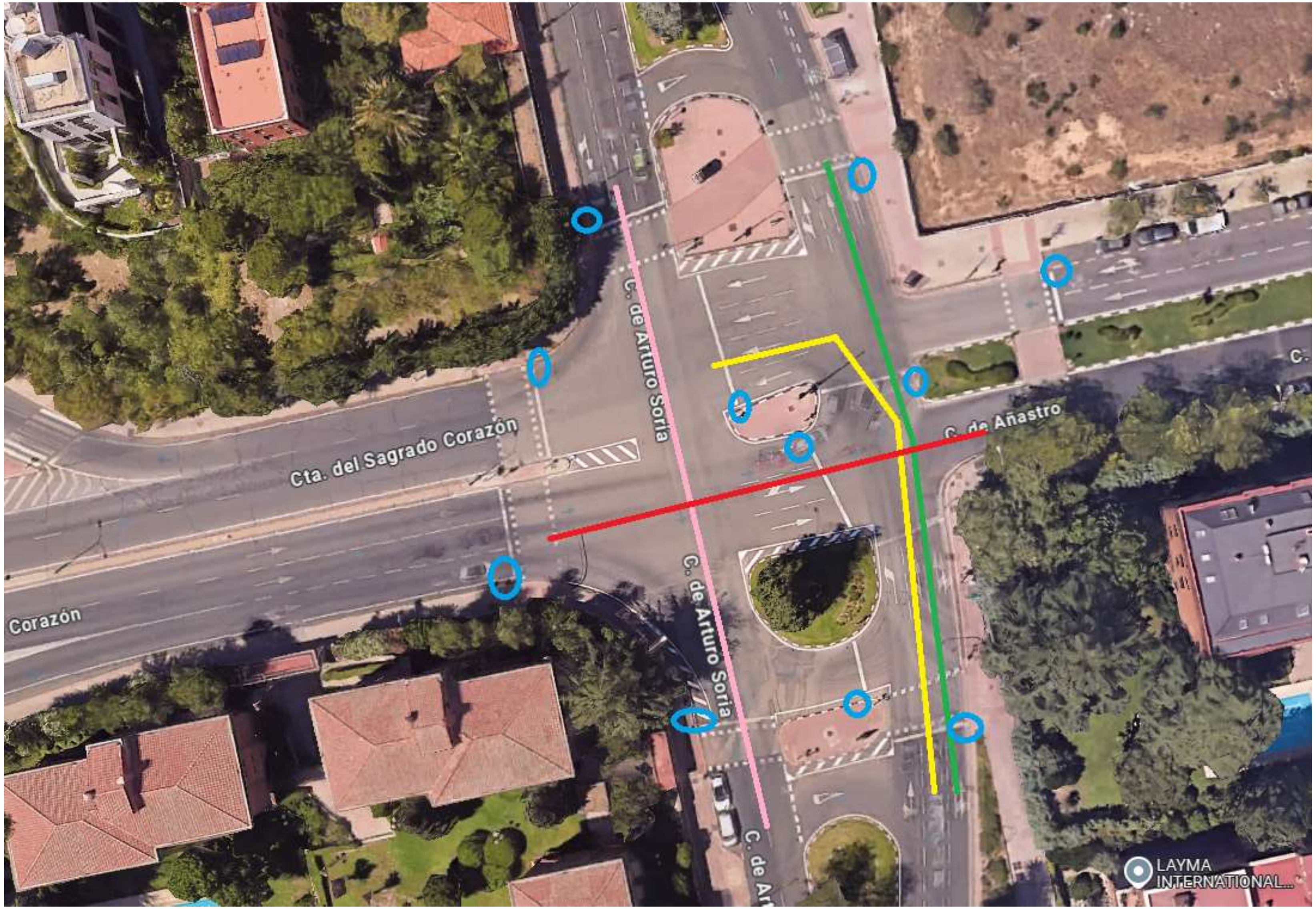
- Accurate detection (Val_loss = 0,0056), but crude outline
- **Post processing** for exact outline:
  - Ocen removal
  - Canny edge detection (gradient change)
  - Filling inside edges



Traffic optimization

Smart traffic lights

- Sensors and cameras
- Intelligent and automated
- Image detection, machine learning, prediction



Busy intersection, jammed on peak hours

A lot of time lost

Stressed people going to work can lead do dangerous maneuvers

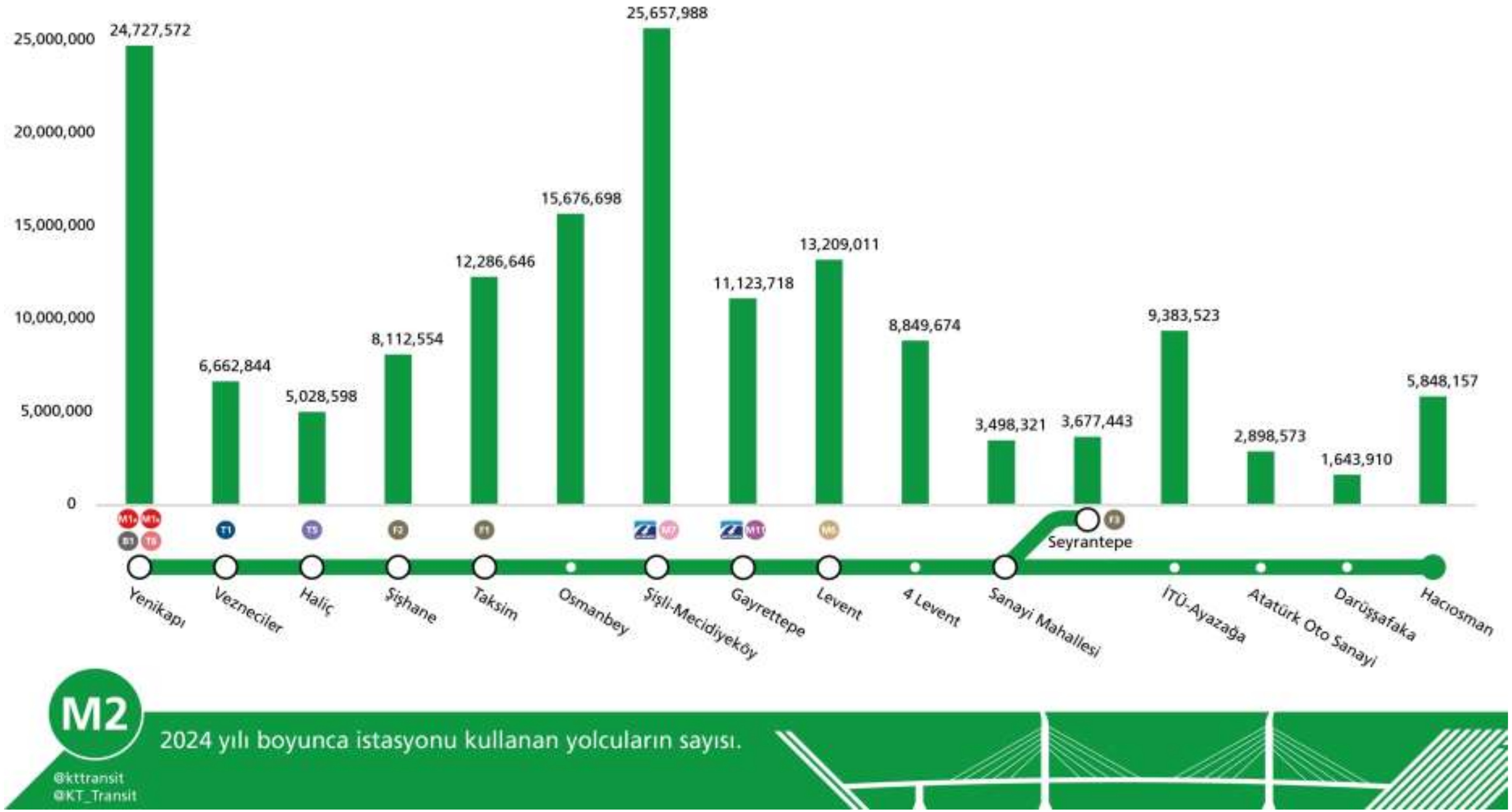
A crossroads in the east of Madrid

Benefits of smart traffic lights

- Reduced journeys times
- Less CO2 emissions
- Avoiding dangerous and stressed behaviors
- Less accidents
- Flow management adapted to the reality of human behavior: flexible and accessible

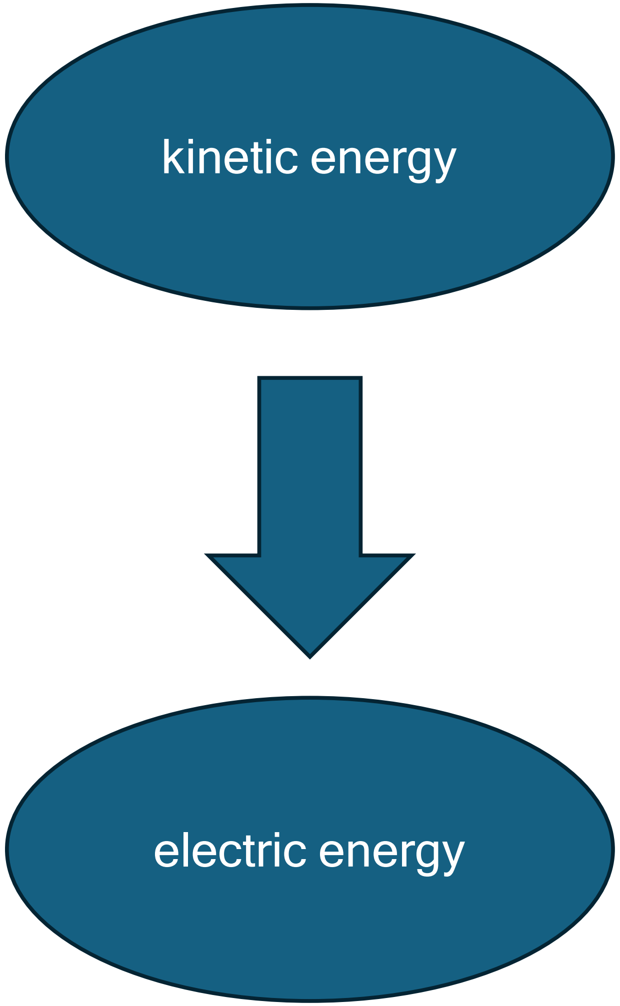
Smart energy generation

37000 people on average/day



Station-Based Passenger Usage on the M2 Metro Line in 2024

Power management and sustainability



small amounts of energy for LED signs/traffic lights
(10 bulbs for 20s)

Reality of the system

Benefits

- renewable energy
- data collection
- sustainability
- no limitations

Risks

- high cost (110€ each)
- mentainence
- energy storage
- low power output
- space for wiring

Most optimal placements

-busy metro stations
-concerts/festivals

-schools/universities
-playgrounds

Japan (Tokio)
Shibuya station

-since 2008

-400000 commoners pass daily

-140 Wh/day

-150 €/m² (installed)

Interaction of the people and the city

StepVOLT

European University

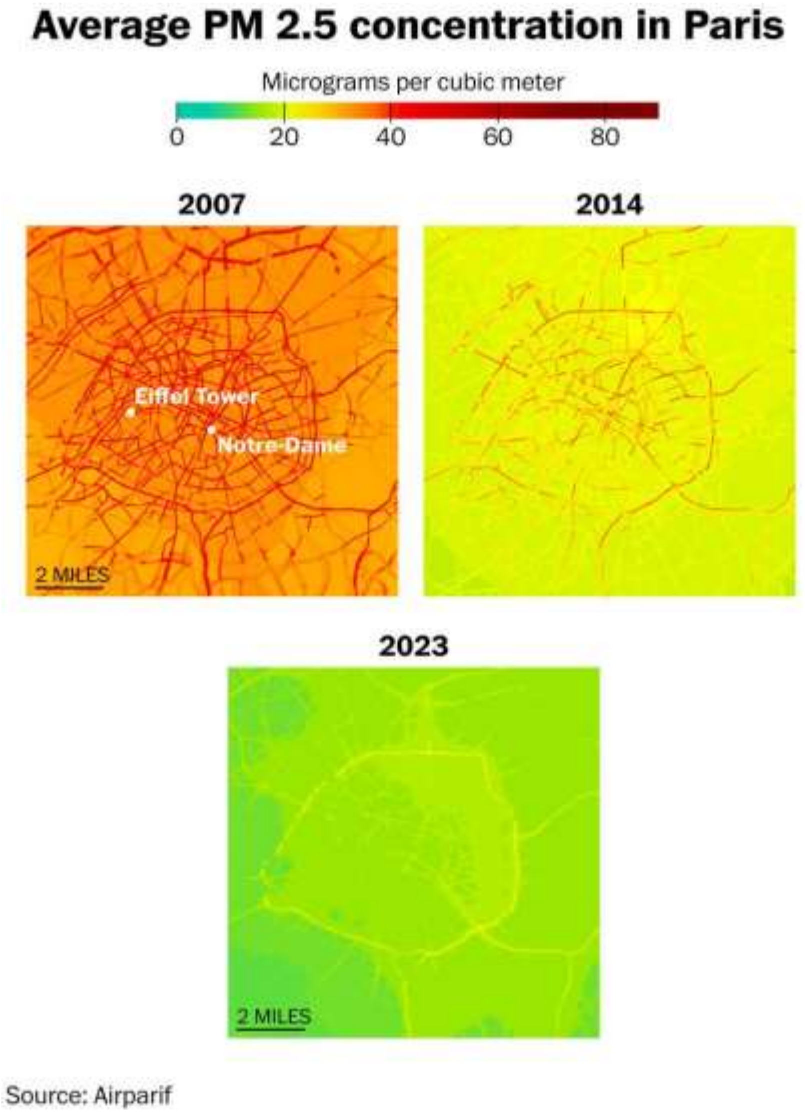
Modular Kinetic Tile + Display Unit

Core Part:

- **Pressure-sensitive kinetic tile** (like Pavegen): captures kinetic energy from footsteps, converts it into electricity.
- Modular and replaceable – tiles can be laid in rows in metro entrances, parks, or walking corridors.

Detachable/Changeable Add-ons:

- **Swappable display modules** (LED/OLED) with solar backup.
- **Customizable shell casing** or art-skin: community can redesign the housing.

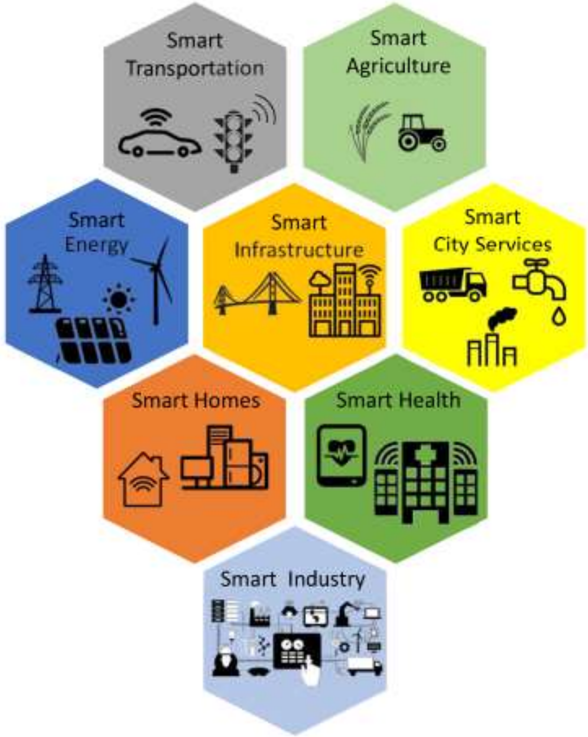


Interaction Logic

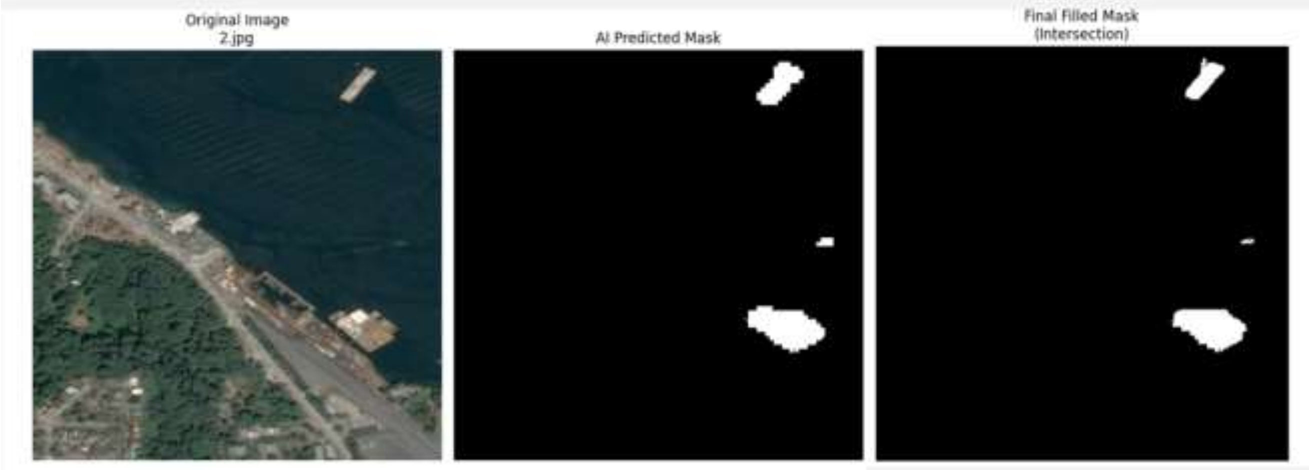
- Every step generates a small amount of electricity (measured in Wh).
- That energy is tracked *per tile* and *per user (optional with card/sensor use)*.
- The display shows:
- 🌱 “You generated X watt-hours today!”
- 🚇 “By using M2 Line instead of driving, you saved Y kWh.”
- 🔋 “Your steps powered 2 minutes of metro lighting today.”

Can also show:

- **Leaderboard**
- **Monthly collective community goals**
- **Gamified messages** (e.g. “You’ve just powered a streetlamp for 15 seconds 💡”)


Smart Transportation
Smart Agriculture
Smart Energy
Smart Infrastructure
Smart City Services
Smart Homes
Smart Health
Smart Industry

Q&A


Original Image
2.jpg
AI Predicted Mask
Final Filled Mask
(Intersection)


AIR QUALITY INDEX
GOOD
REGIONAL IMPROVEMENTS:
+30% OVER THE PAST YEAR