TUSCANY X.0

Intelligenza Artificiale: Applicazioni Industriali e per le Amministrazioni Locali

Paolo Nesi, paolo.nesi@unifi.it
Dipartimento di Ingegneria dell'Informazione, DISIT Lab
Https://www.disit.dinfo.unifi.it

Digitale a KM Ø:

L'Università di Firenze incontra le imprese per Tuscany X.0

Martedì 15 ottobre 2024 | ore 9.30

FIRSTLab: Campus delle Scienze Sociali di Novoli
Via Lelio Torelli 2-4, Firenze

UNIVERSITÀ DEGLI STUDI FIRENZE
DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE
DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB DISTRIBUTED DATA INTELLIGENCE AND TECHNOLOGIES LAB

CC BY NC ND
SOME RIGHTS RESERVED

TUSCANY X.0
EDIH European Digital Innovation Hubs Network

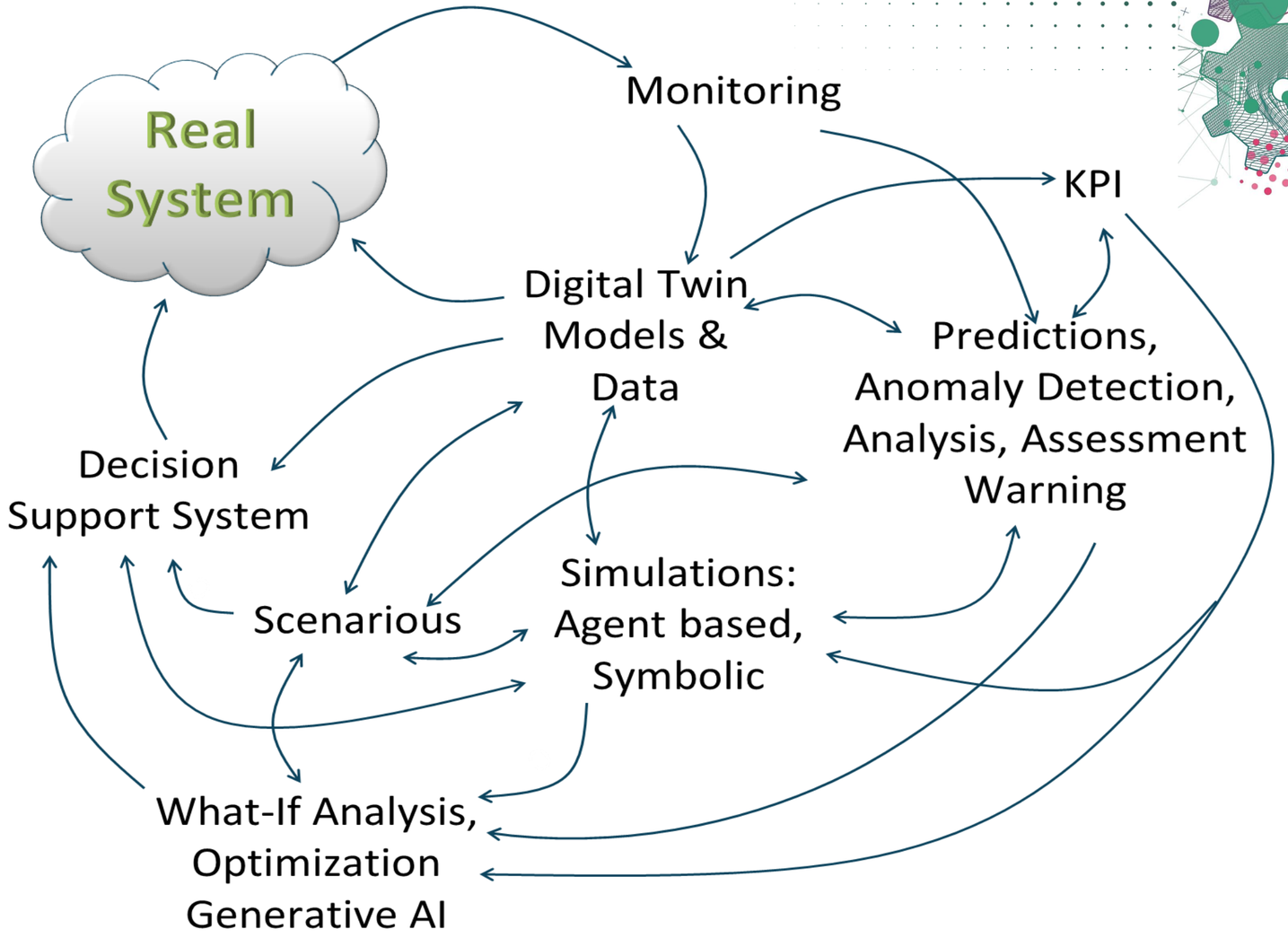
Finanziato dall'Unione europea NextGenerationEU

Domini Applicativi

- **Manifattura**: visione, riduzione dei tempi di produzione, riduzione dei cost di manutenzione, manutenzione predittiva, simulazione fluidodinamica, simulazione di produzione, predizione costi materie prime, etc.
- **Commercio / retail**: riconoscimento di comportamenti, generazione suggerimenti, etc.
- **Salute**: diagnostica, riconoscimento, classificazione, predizione, Virtual Assistant, riabilitazione, genomica, etc.
- **Robotica**: comprensione percorsi, classificazione, decisione, etc.
- **Sviluppo di soluzioni ICT**: coding/generazione, testing, etc.
- **Mobilità e Trasporti**: gestione flotte, routing, ottimizzazione, manutenzione, riduzione missioni, etc.
- **Ambiente**: emissioni, stima/identificazione perdite, raccolta rifiuti, etc.
- **Security in spazi pubblici**: visione, classificazione, predizione
- **Media**: classificazione, riconoscimento, ricerca img/video, comprensione del testo, etc.
- **Agricoltura**: visione, classificazione, predizione, controllo, etc.
- Etc.

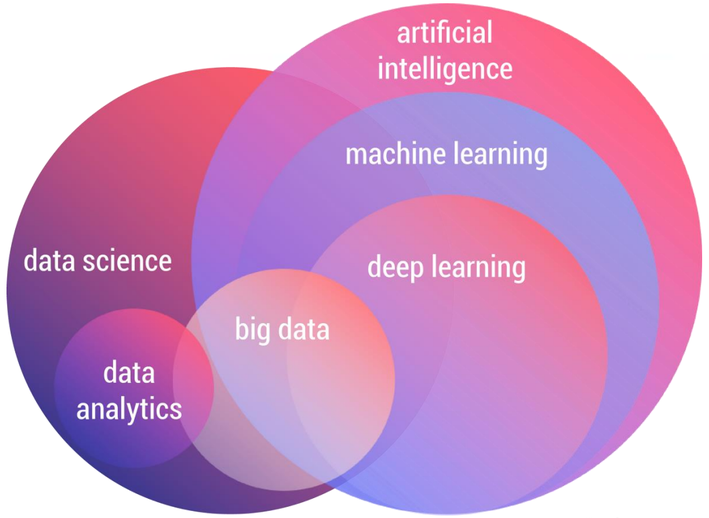
A che serve l'Intelligenza Artificiale

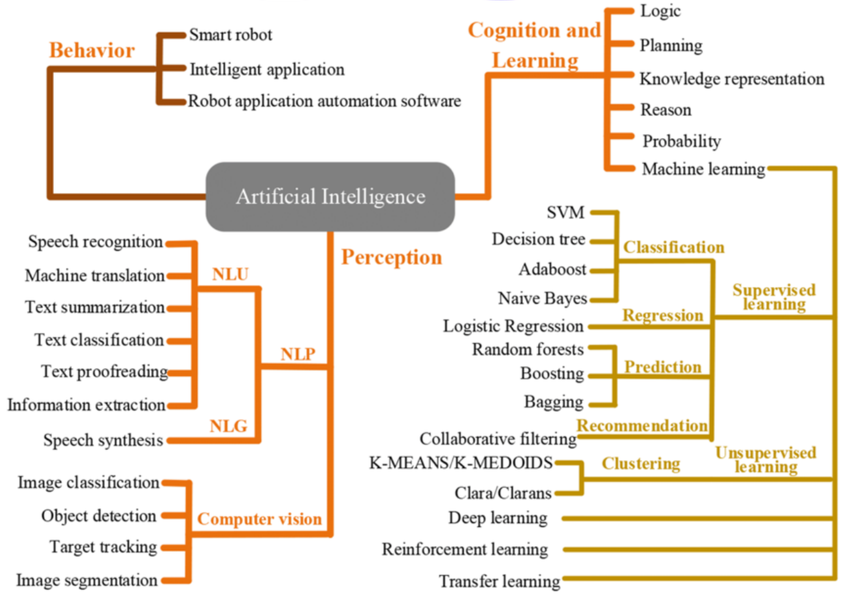
- **Target**:
  - Predizioni, early warning (anomaly detection)
  - classificazione, riconoscimento
  - Simulazione, ottimizzazione
  - generazione di soluzioni
- **Dove la troviamo**
  - **Operation and planning**
  - Dashboards
    - Business/Visual Intelligence
    - What-if analysis
  - Decision Support Systems

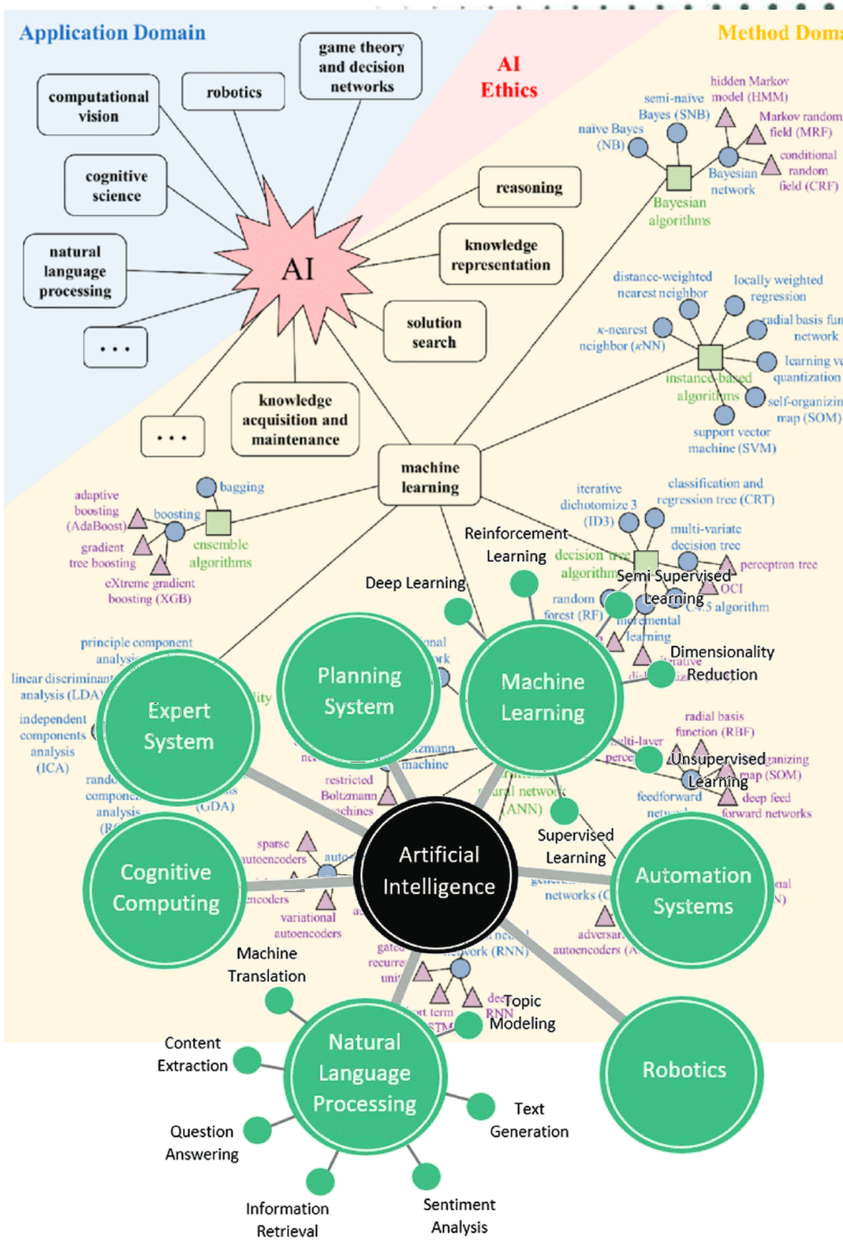


UNIVERSITÀ DEGLI STUDI FIRENZE
DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE
DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB
DISTRIBUTED DATA INTELLIGENCE AND TECHNOLOGIES LAB
EDIH European Digital Innovation Hubs Network
Finanziato dall'Unione europea NextGenerationEU

Che cosa è AI?







UNIVERSITÀ DEGLI STUDI FIRENZE

DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB
DISTRIBUTED DATA INTELLIGENCE AND TECHNOLOGIES LAB

TUSCANY X.0

EDIH European Digital Innovation Hubs Network

Finanziato dall'Unione europea NextGenerationEU

Parole chiave

MACROAREA	MICROAREA	KEYWORDS
Artificial Intelligence	ML, KE, NLP, AI, RL, TL, FL, DL, XAI, BERT, GNN, GCN, PINN, GPT, LLM, CV/PR, clustering, etc.	Predictions, prescriptions, classifications, optimisations, etc.
Big Data, Data Analytic, Architectures	Scalability, GDPR, HPC, CPU/GPU cluster, big storage, Data Space, Data Models, Data Lake, Data warehouse, ETL/LT,..	What-if analysis, Visual Analytics, Business Intelligence, Visual Intelligence, MLOps, …
Digital Twin Modeling and Execution	IoT, WoT, IoE, Metaverse, AR, VR, … MicroServices, SOA, …	Decision Support Systems, DSS, Simulation & Optimization

UNIVERSITÀ DEGLI STUDI FIRENZE
DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE
DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB DISTRIBUTED DATA INTELLIGENCE AND TECHNOLOGIES LAB
European Digital Innovation Hubs Network
Finanziato dall'Unione europea NextGenerationEU

Legenda

- AI: Artificial Intelligence
- BERT: Bidirectional Encoder Representations from Transformers
- CV/PR: Computer Vision / Pattern Recognition
- DL: Deep Learning
- DSS: Decision Support Systems
- ETL/LT: Extract Transform Load/LD
- FL: Federated Learning
- FT: Fine Tuning
- GCN: Graph Convolutional Network
- GDPR: General Data Protection Regulation
- GIS: Geographic Information Systems
- GNN: Graph NN
- GPT: Generative Pretrained Transformer
- HPC: High Performance Computing
- IoE: Internet of Everything
- IoT: Internet of Things
- ITS: Intelligence Transport Systems
- KE: Knowledge Engineering
- LLM: Large Language Models
- ML: Machine Learning
- MLOps: ML Operation
- NLP: Natural Language Processing
- NN: Neural Network
- PINN: Physically Informed NN
- RI: Reinforced Learning
- TL: Transfer Learning
- WoT: Web of Things
- XAI: Explainable AI

UNIVERSITÀ DEGLI STUDI FIRENZE
DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE
DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB DISTRIBUTED DATA INTELLIGENCE AND TECHNOLOGIES LAB
European Digital Innovation Hubs Network
Finanziato dall'Unione europea NextGenerationEU

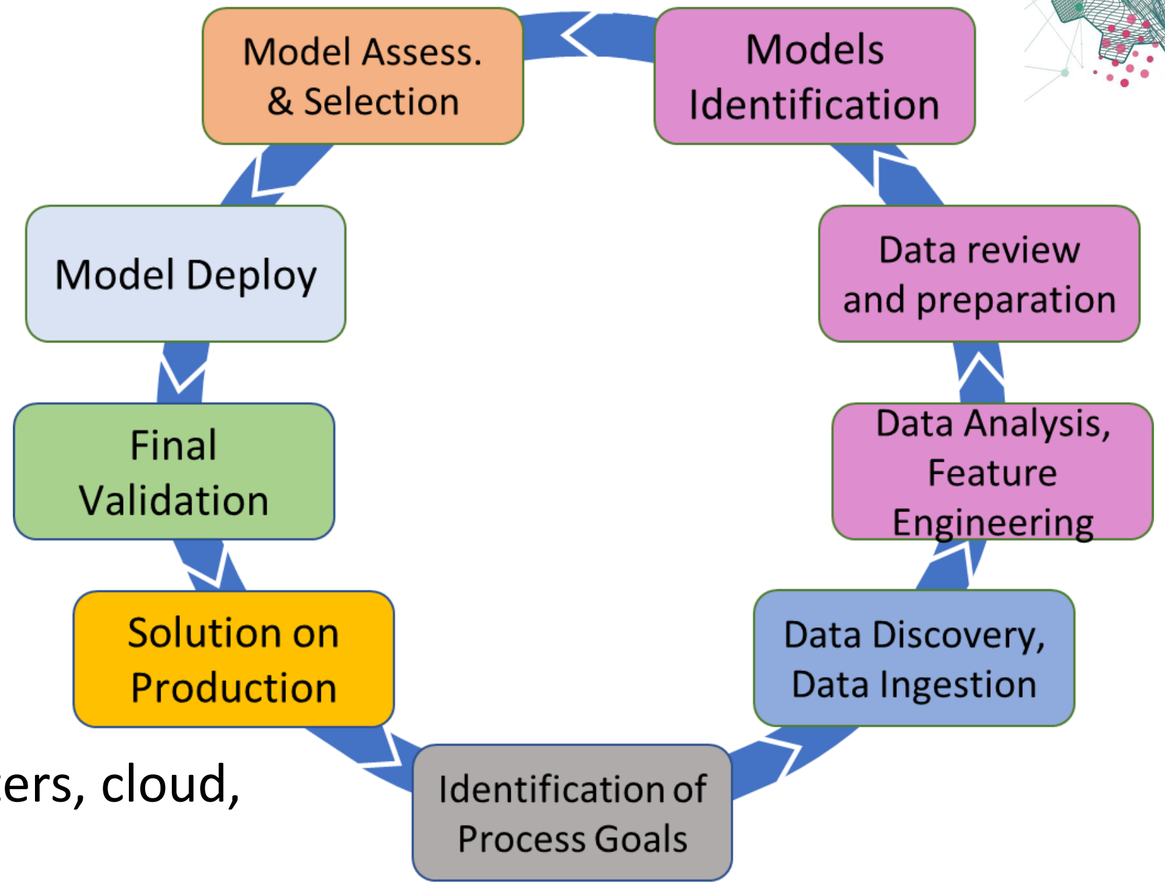
Il processo di sviluppo

Data: IoT/WoT, Standards, modellazione, data space, formats, protocols, processes, etc.

- GDPR, AI-Act, Licensing, etc.

Artificial Intelligence Techniques and Life Cycle

- **AI Architecture**:
  - Data mining, knowledge inference, ML (RF, XGBoost, …),
  - Deep Learning, Reinforced Learning, Generative AI, etc.
- **Comprensione**:
  - Explainable AI (XAI), relevance (per esempio: SHAP, Lime)
- **Riduzione dei costi di learning**:
  - Fine tuning, transfer learning, federated learning, etc.
- **Ibridazione dei paradigmi**:
  - Neuro-Symbolic, PINN, KB → NN, NN → KB
- **Tecniche di calcolo/arc.**: MLOps, HPC, CPU/GPU clusters, cloud, container, microservizi, SOA, etc.



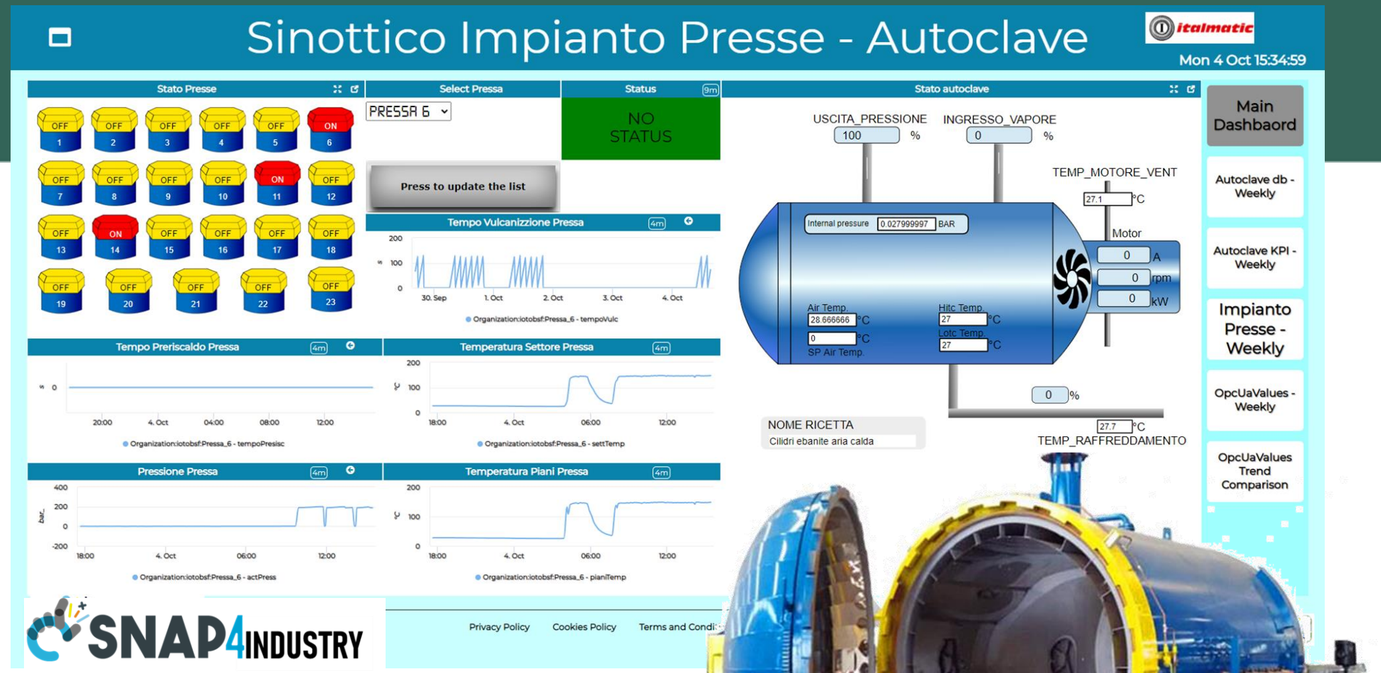
UNIVERSITÀ DEGLI STUDI FIRENZE
DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE
DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB DISTRIBUTED DATA INTELLIGENCE AND TECHNOLOGIES LAB
European Digital Innovation Hubs Network
Finanziato dall'Unione europea NextGenerationEU

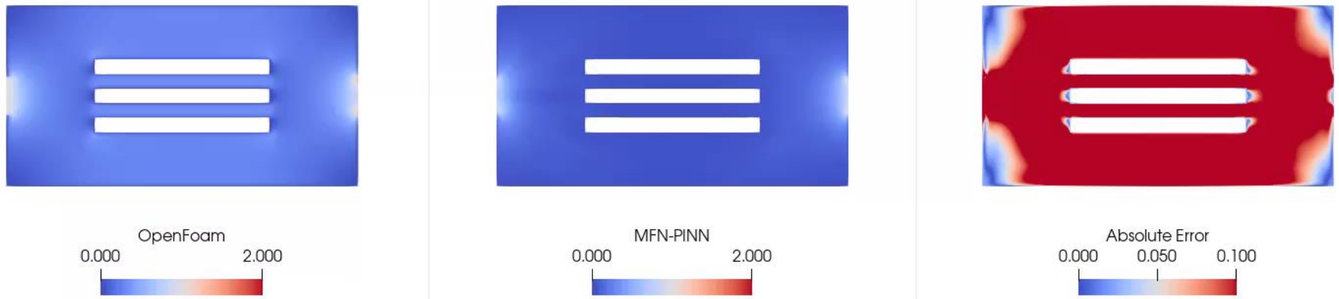
Real Cases from DISIT Lab

- **Smart Manufacturing**: PINN per la fluidodinamica, etc.
- **Smart Retail:** raccomandazioni, suggerimenti per il retail,
- **User Behavior:** People Counting and Trajectories, termiche per la sicurezza, il conteggio e la stima di traiettorie, etc.
- **Predictive maintenance**: predizione della manutenzione in impianti a produzione continua
- **Predictions on Time Series**: traffic, pollution, presenze, parcheggi, consumi, costi, etc.; ALSO for **early warning:** accidents, maintenance, et
- **Routing Optimization**: reduction of costs, waste collection optimization, pooling, delivering optimization, optimisation of resources, etc.
- **Traffic Light Optimization**: semafori con RL, infrastrutture (generative A
- **What-if-Analysis and Infrastructure Optimization**.
- **Virtual Assistant:** text analysis e classificazione, predizione della probab di mediazione, richieste in linguaggio naturale su testi forniti con LLM
- **Digital Twin**: 3D production and optimized rendering, Virtual Reality, Augmented Reality, etc.
- ***Smart Light Management****: gestione dell'illuminazione, profiling, adaptation on Traffic flow.*
- ***Etc.***

Smart Manufacturing

- **Autoclave:** curation process for: composite materials, rubber, ..
  - **Reduction of computing costs** for simulating load effect into the autoclaves curing process
  - **Similar to design problems to be validated in wind galleries**
- **Solving Navier-Stokes PDE** (partial differential equations) equation,
  - **PINN plus new** Transfer Learning techniques
  - Precision on steady and transitory cases
  - Validation wrt Open Foam
  - Reduction of computational time
- **Videos** on https://www.snap4city.org/1010





TUSCANY X.0

EDIH European Digital Innovation Hubs Network

Finanziato dall'Unione europea NextGenerationEU

UNIVERSITÀ DEGLI STUDI FIRENZE

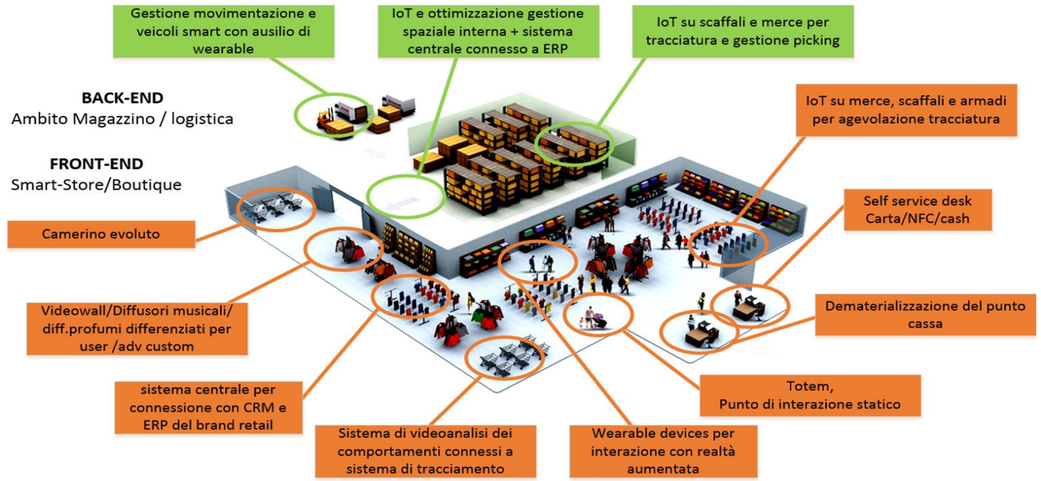
DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

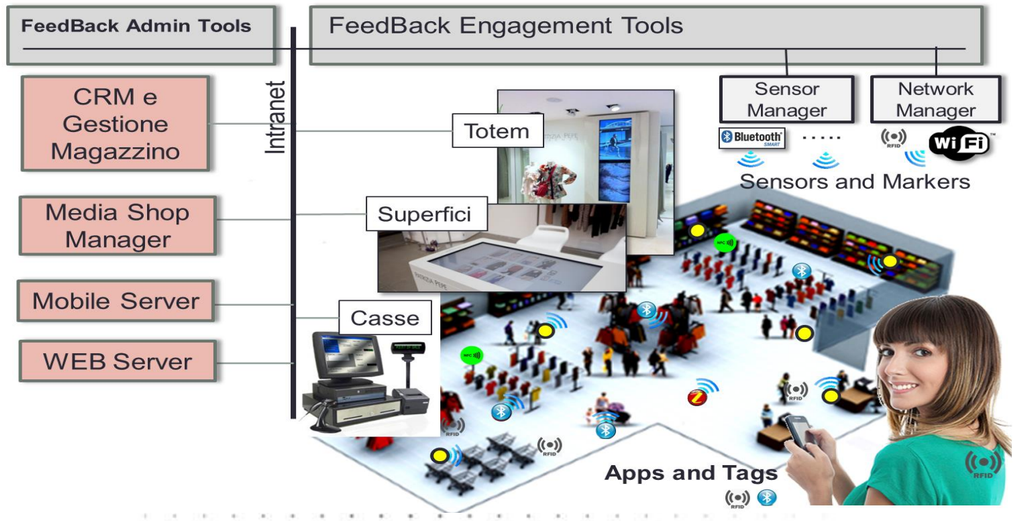
DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB DISTRIBUTED DATA INTELLIGENCE AND TECHNOLOGIES LAB

Smart Retail

feedback

- **Goals and drivers:**
  - adaptive user engagement,
  - Improving customer experience
  - Increasing of sales, understand use behaviour
- **How**
  - Advanced user profiling, user behaviour analysis
  - Predictive models for engagement
  - IoT and integrated instrumentation
  - Digital Twin of customer and related experience
- **AI injection**
  - Clustering of user, product, behaviour, ..
  - Classification, recognition in real time
  - Production of suggestion in real time (retail) and for on-line selling





TUSCANY X.0

EDIH European Digital Innovation Hubs Network

Finanziato dall'Unione europea NextGenerationEU

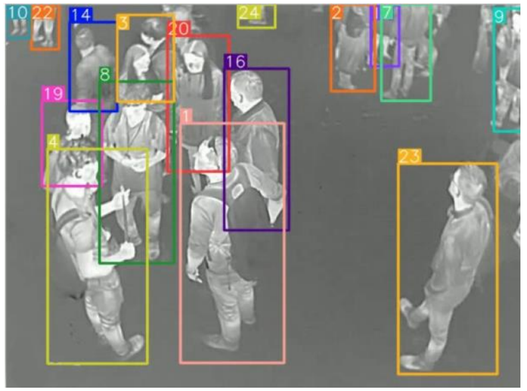
UNIVERSITÀ DEGLI STUDI FIRENZE

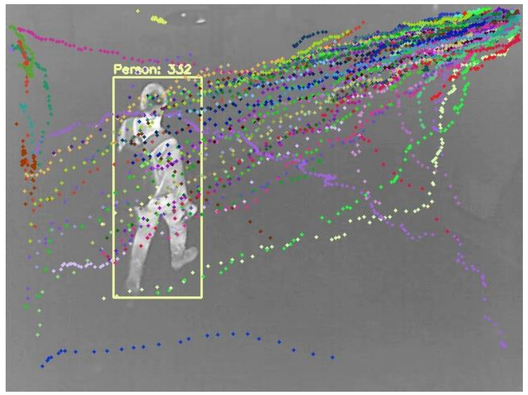
DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

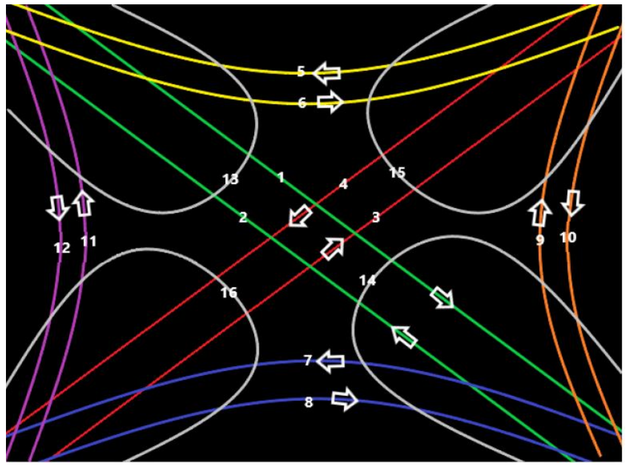
DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB DISTRIBUTED DATA INTELLIGENCE AND TECHNOLOGIES LAB

User Behaviour: People Counting, Tracking, etc.

- **Analisi del comportamento** in spazi aperti o chiusi
  - **HUB, metro, stazioni, linee di produzione, parcheggi, aree critiche nelle città,**
  - **centri commerciali, retail, etc.**
- **Thermal Cameras**
  - GDPR compliant
- **AI injection**
  - classificazione e conteggio
  - Identification of critical situations
  - Early warning
  - Integrazione con PAX counters, e con dati ODM di operatori
- **Stima in tempo reale**
  - Direttamente sulla telecamera
  - Elevata precisione e affidabilità
  - Usate da: Cuneo, Firenze, Genova, etc.







TUSCANY X.0

EDIH European Digital Innovation Hubs Network

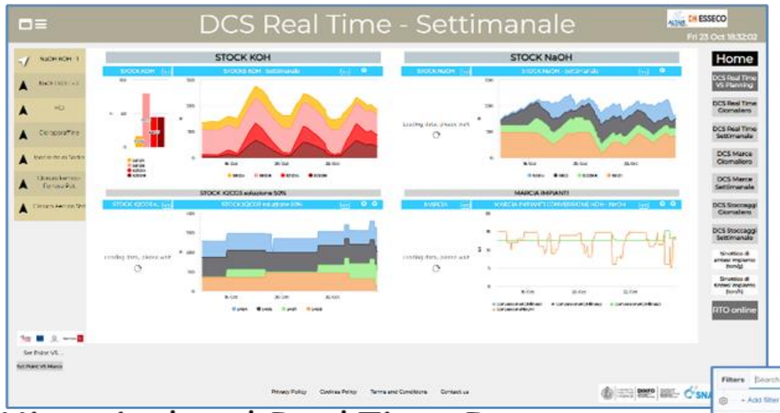
Finanziato dall'Unione europea NextGenerationEU

UNIVERSITÀ DEGLI STUDI FIRENZE

DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

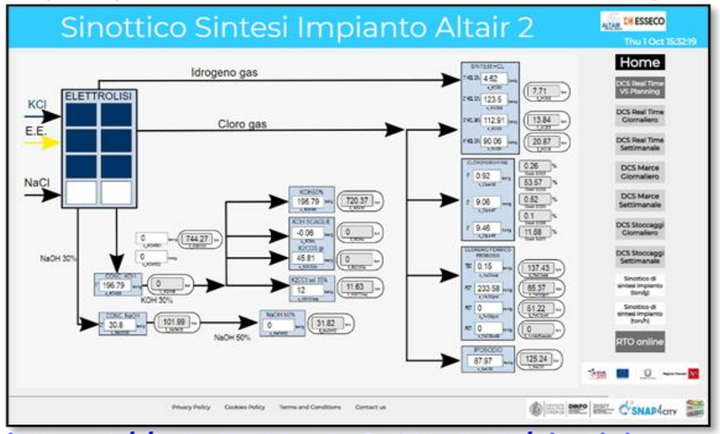
DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB DISTRIBUTED DATA INTELLIGENCE AND TECHNOLOGIES LAB

Predictive Maintenance

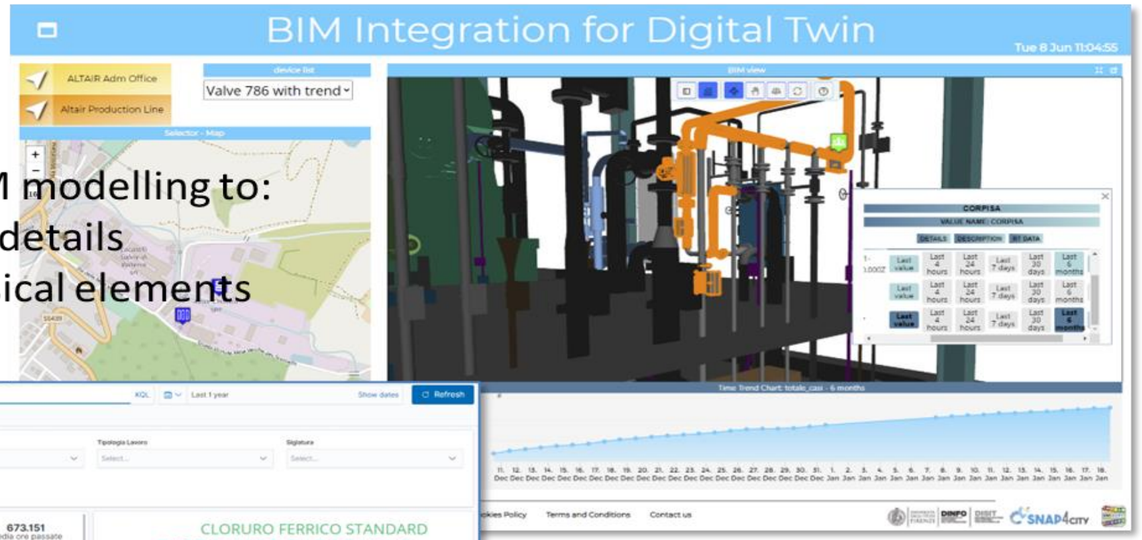


Historical and Real Time Data

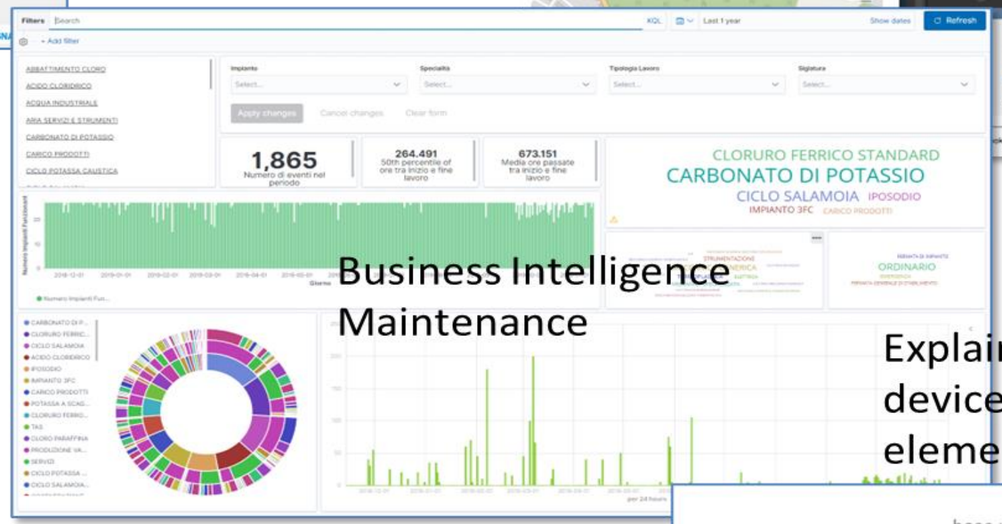
Synoptics for real time monitoring



https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzA1NA==



Map and 3D BIM modelling to:
-- represent the details
-- associate physical elements with data



Business Intelligence Maintenance

Explainable AI to map critical values of devices and detection to physical elements in the plant

TUSCANY X.0

EDIH European Digital Innovation Hubs Network

Finanziato dall'Unione europea NextGenerationEU

UNIVERSITÀ DEGLI STUDI FIRENZE

DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB
DISTRIBUTED DATA INTELLIGENCE AND TECHNOLOGIES LAB

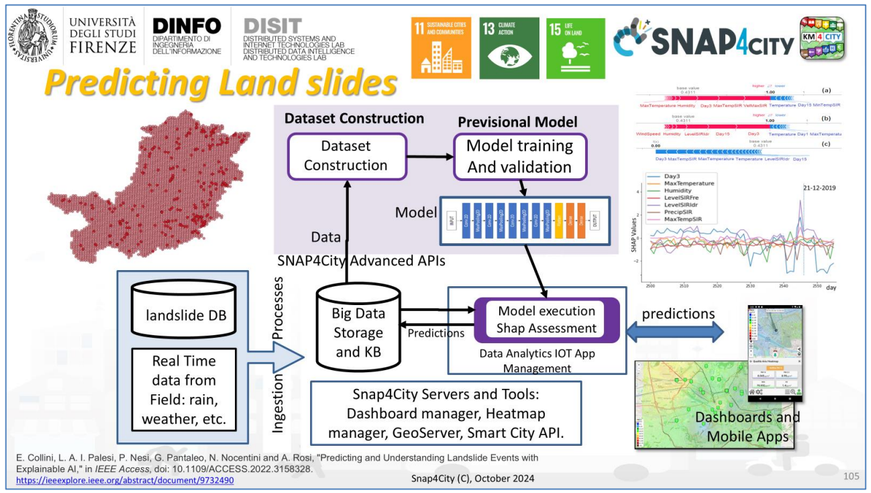
Predictions on .....selected.....

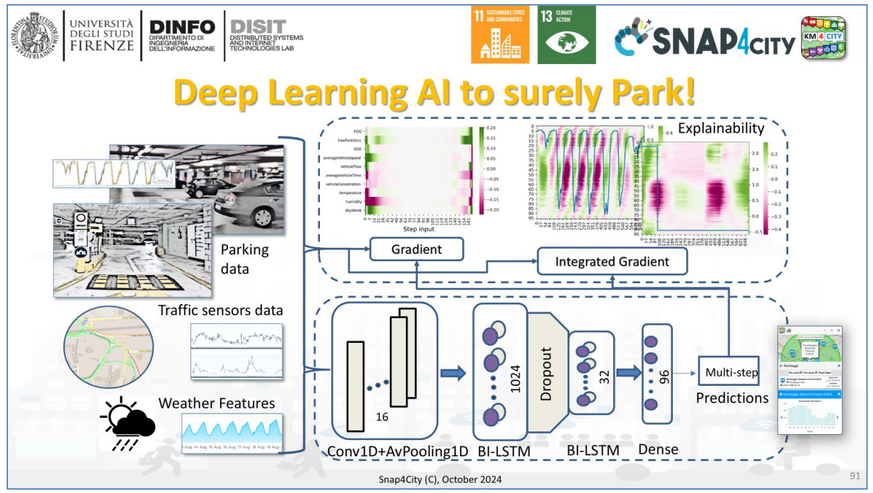
Aim in operation:

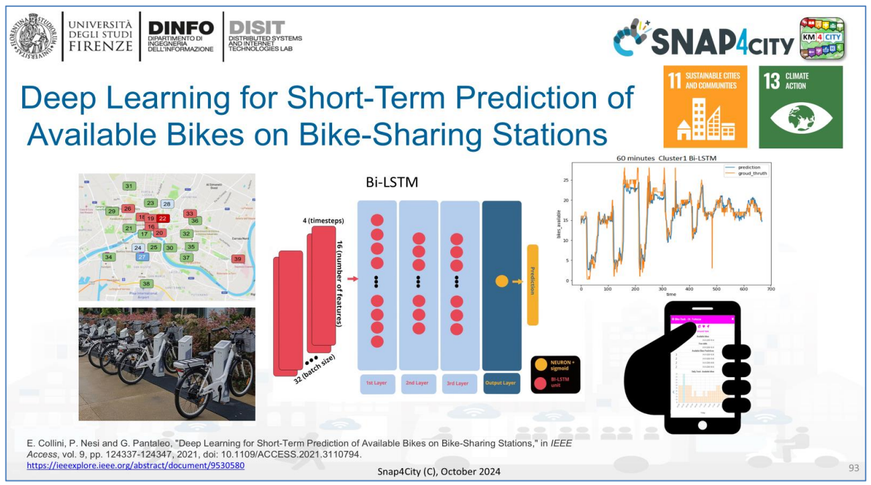
- Short Term predictions
- Reduction of costs, prevention
- Early warning of critical conditions
- Reduction of emissions
- Seasonality

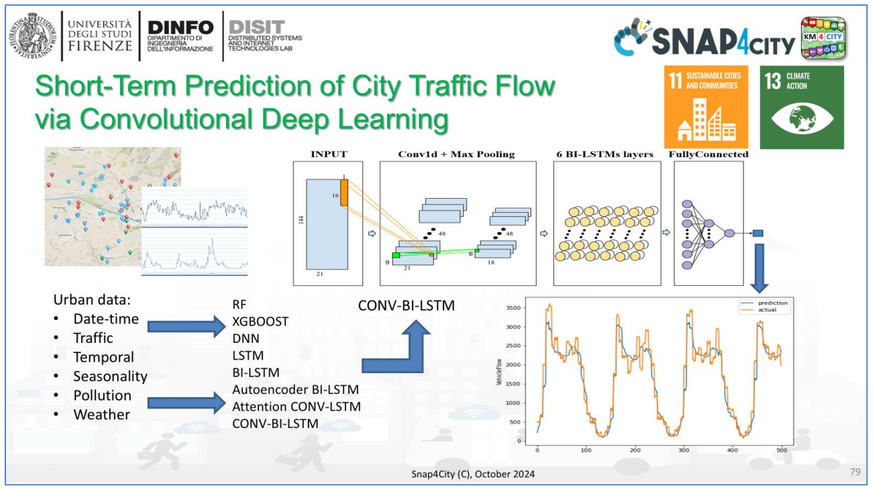
AI inject:

- Deep Learning
- Data integration
- XAI addition for suggestions









TUSCANY X.0

EDIH European Digital Innovation Hubs Network

Finanziato dall'Unione europea NextGenerationEU

UNIVERSITÀ DEGLI STUDI FIRENZE

DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB
DISTRIBUTED DATA INTELLIGENCE AND TECHNOLOGIES LAB

Routing Optimization

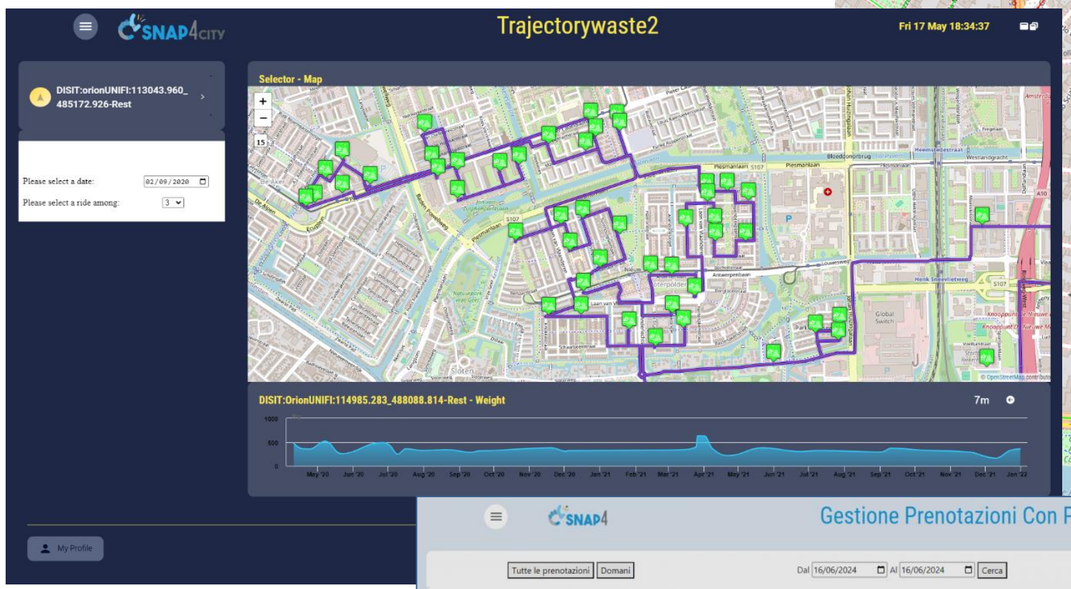
SNAP4CITY

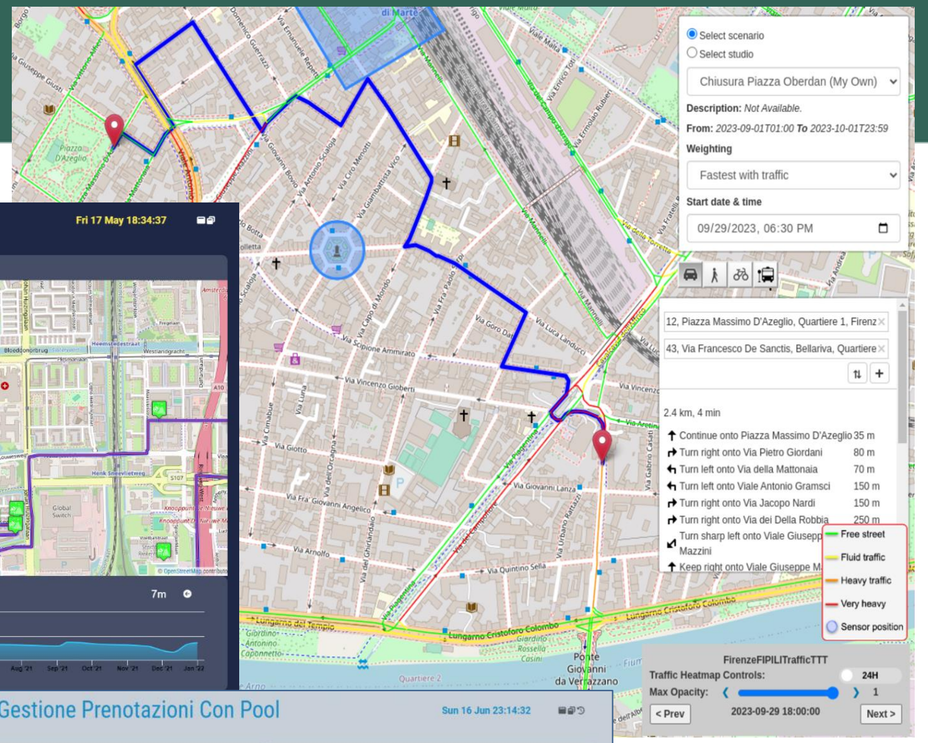
Goals on planning:

- Reduction **of costs on plan**
- **waste collection** optimization, Reduction of Km
- **car pooling trajectories** optimization for maximize the pool usage
- **delivering optimization**, reduction of travel time, reduction of Km
- etc.

Dynamic Routing on operation:

- React in operation to define immediate routing solutions: rescue teams, ambulance, etc.
- Recovery from failure





TUSCANY X.0

EDIH European Digital Innovation Hubs Network

Finanziato dall'Unione europea NextGenerationEU

UNIVERSITÀ DEGLI STUDI FIRENZE

DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB DISTRIBUTED DATA INTELLIGENCE AND TECHNOLOGIES LAB

Traffic Light Optimization

Aims, Multiple Objectives

- Decongestion, reduction of emission
- Reduction of travel time
- Synchronization, green wave
- public and private traffic, tramway priority
- Micro and Macro Scales

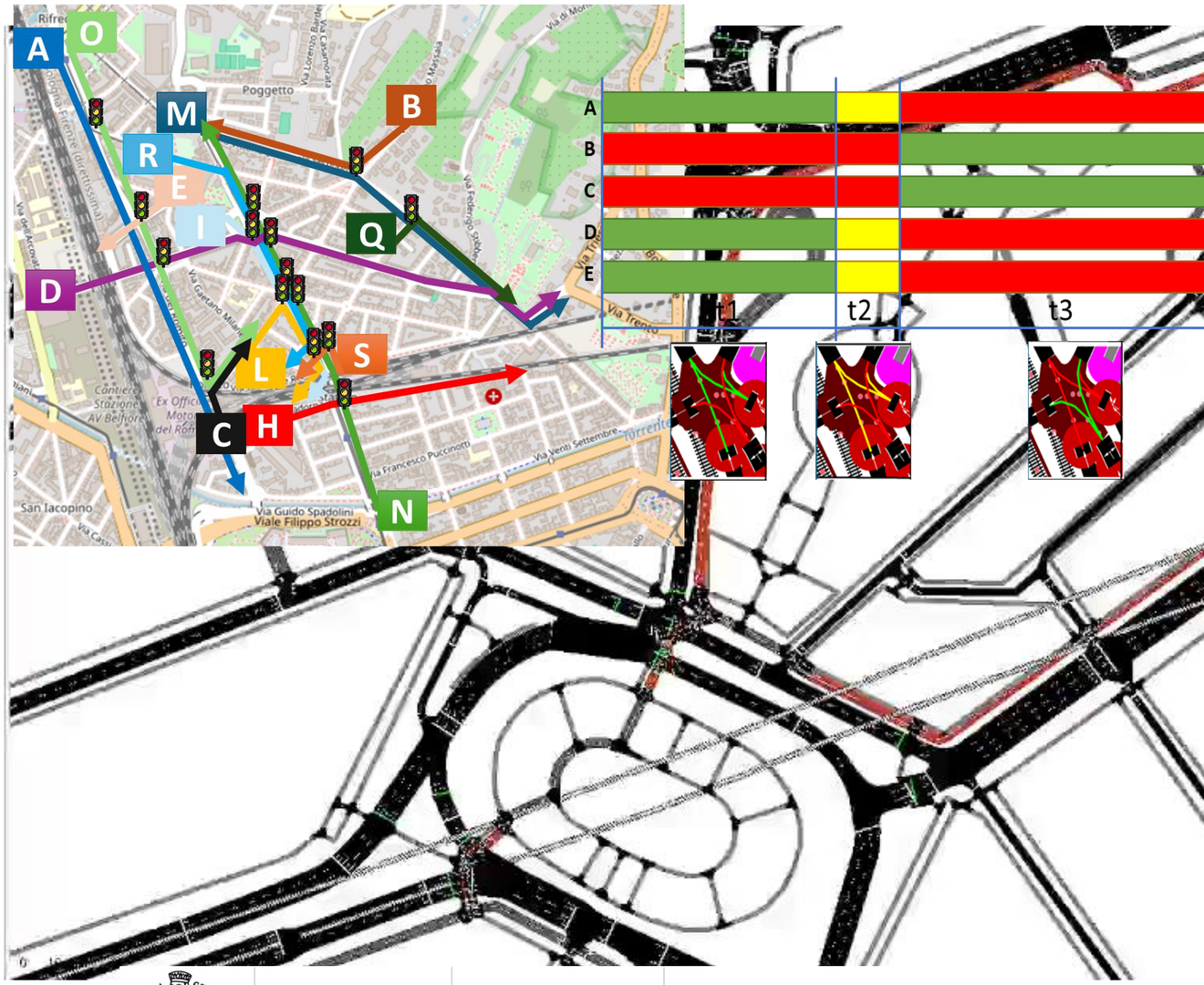
AI: Genetic Algorithms, Reinforced Learning

- Multiple Traffic Light Plan generation
- Fixed and Actuated Cycles
- Adjusted on Demand, in operation

Validation/integ. with ***SUMO*** simulation

- Travel Time, waiting time, waiting count
- Specific travel time on directions
- CO2 emissions, etc.

Reductions from 5% to 15%



TUSCANY X.0

EDIH European Digital Innovation Hubs Network

Finanziato dall'Unione europea NextGenerationEU

UNIVERSITÀ DEGLI STUDI FIRENZE

DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB DISTRIBUTED DATA INTELLIGENCE AND TECHNOLOGIES LAB

What-if-Analysis and Infrastructure Optimization ….

Aim of Decongestion, Sustainability

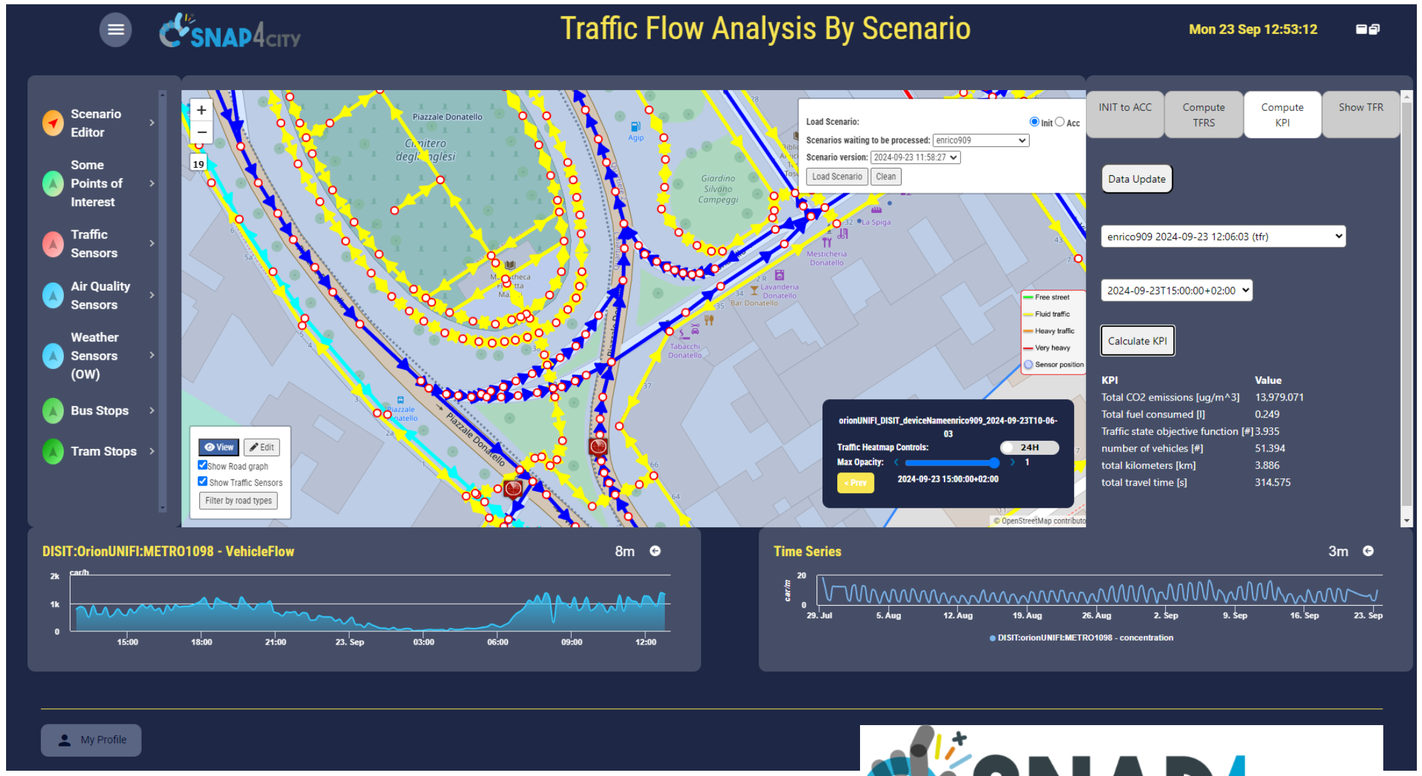
- Reduction of emissions, # stops
- Reduction of travel time

What-if analysis on Operation/Plan

- Working by scenarios making Hyp.
- Simulating the results on conditions
  - **Generative AI and/or neuro-Symbolic**
- Computing KPI and providing suggestions

Optimisation on Plan

- Making Scenario for the context
- Defining constraints and conditions
- Asking to AI to **generate best solutions**
- **Offering Optimal Solution** in terms of
  - Solutions and Explanations



SNAP4CITY

TUSCANY X.0

EDIH European Digital Innovation Hubs Network

Finanziato dall'Unione europea NextGenerationEU

UNIVERSITÀ DEGLI STUDI FIRENZE

DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB DISTRIBUTED DATA INTELLIGENCE AND TECHNOLOGIES LAB

Virtual Assistants, Answering systems

Aim, Cost reduction in managing

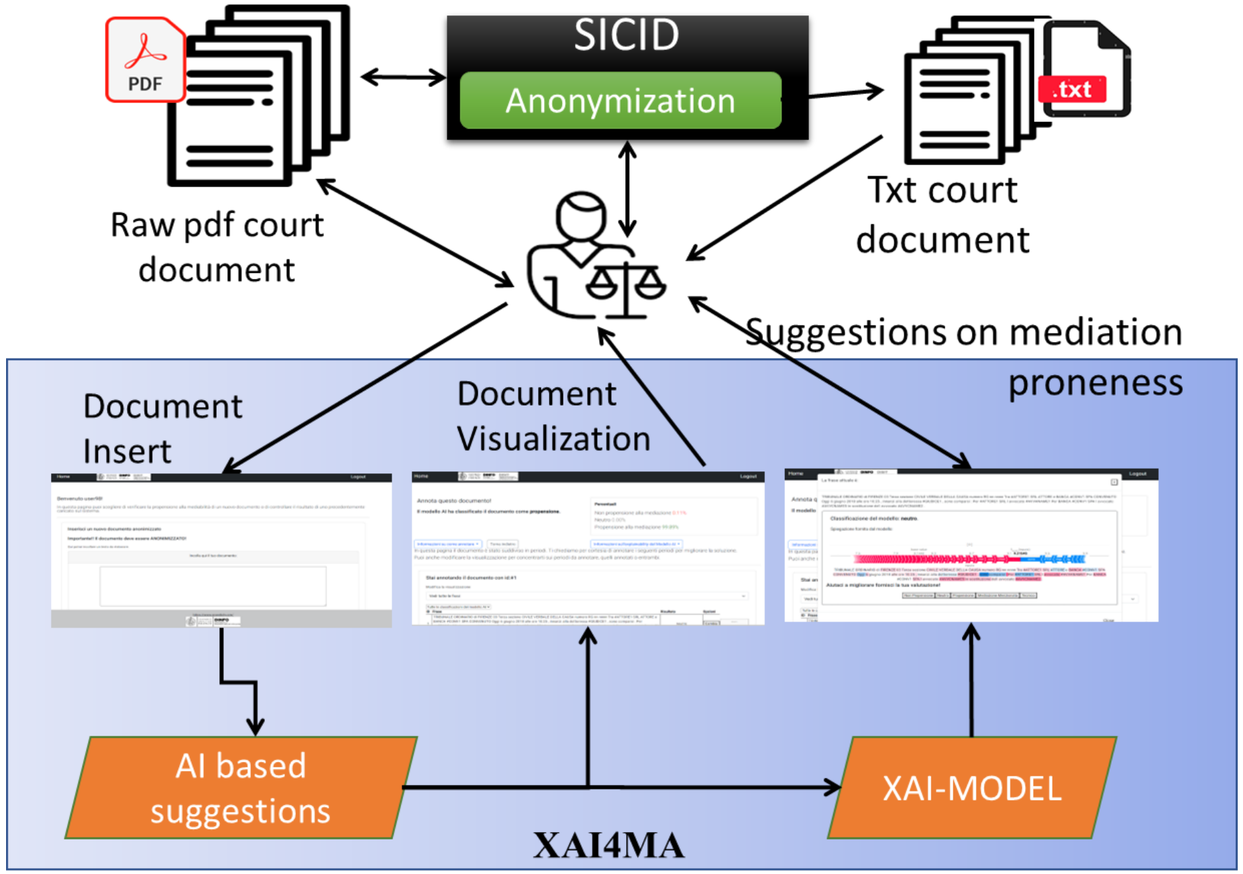
- Large volume of text, short time
- Getting fast non bias answers

AI support for:

- Text analysis and classification,
- Text comprehension, BERT/LLM
- Natural language queries and answers with LLM/RAG
- XAI support for explanations

Multiple Actual Examples

- prediction of the probability of mediation
  - **Tribunale di Florence**
- DSS on disputes
  - **Careggi Legal Office**
- Answers/Help on manuals
  - **Assistant for Snap4City**
- Answers on tourist information
  - **PAVAL Assistant**



TUSCANY X.0

EDIH European Digital Innovation Hubs Network

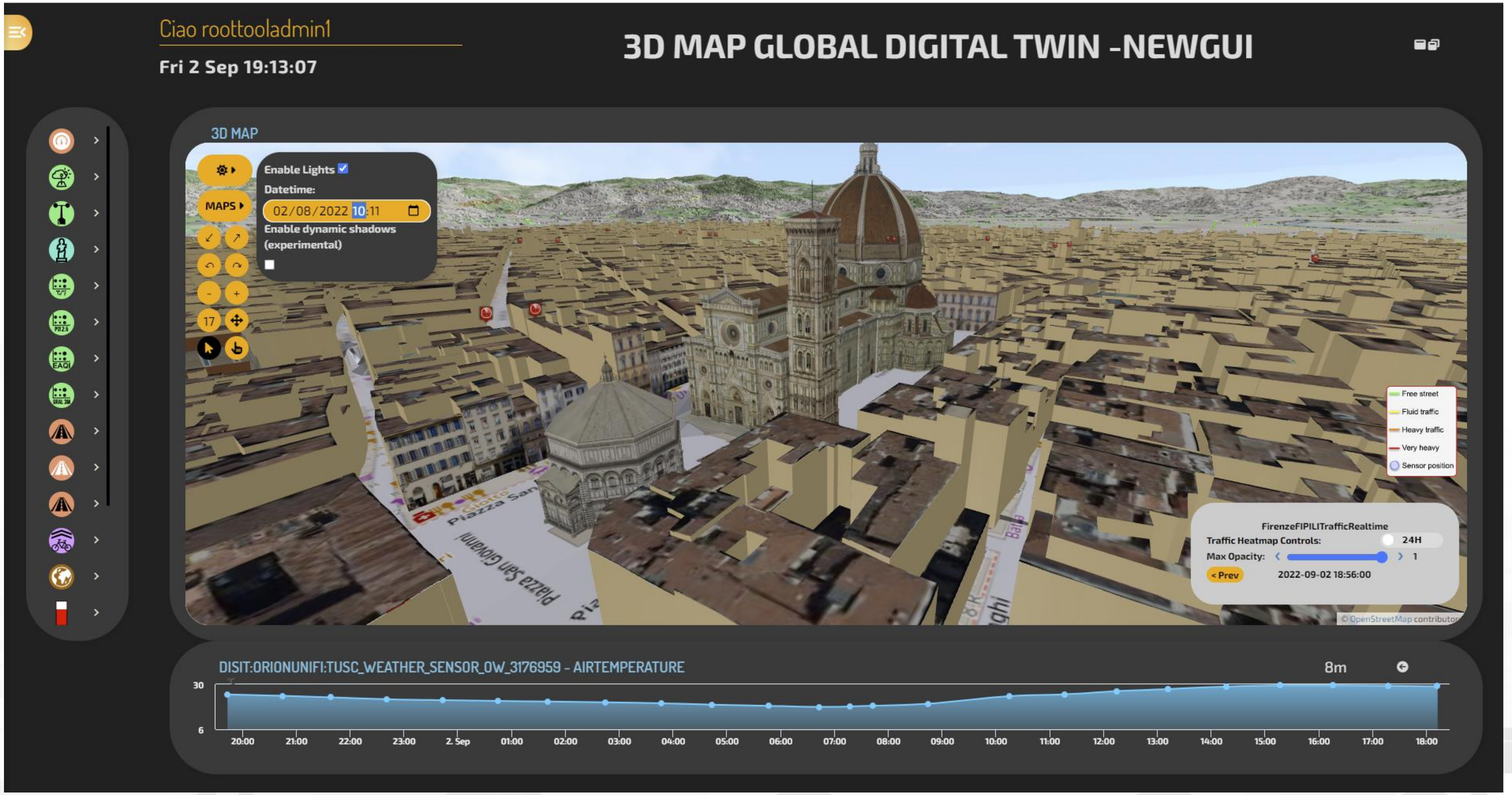
Finanziato dall'Unione europea NextGenerationEU

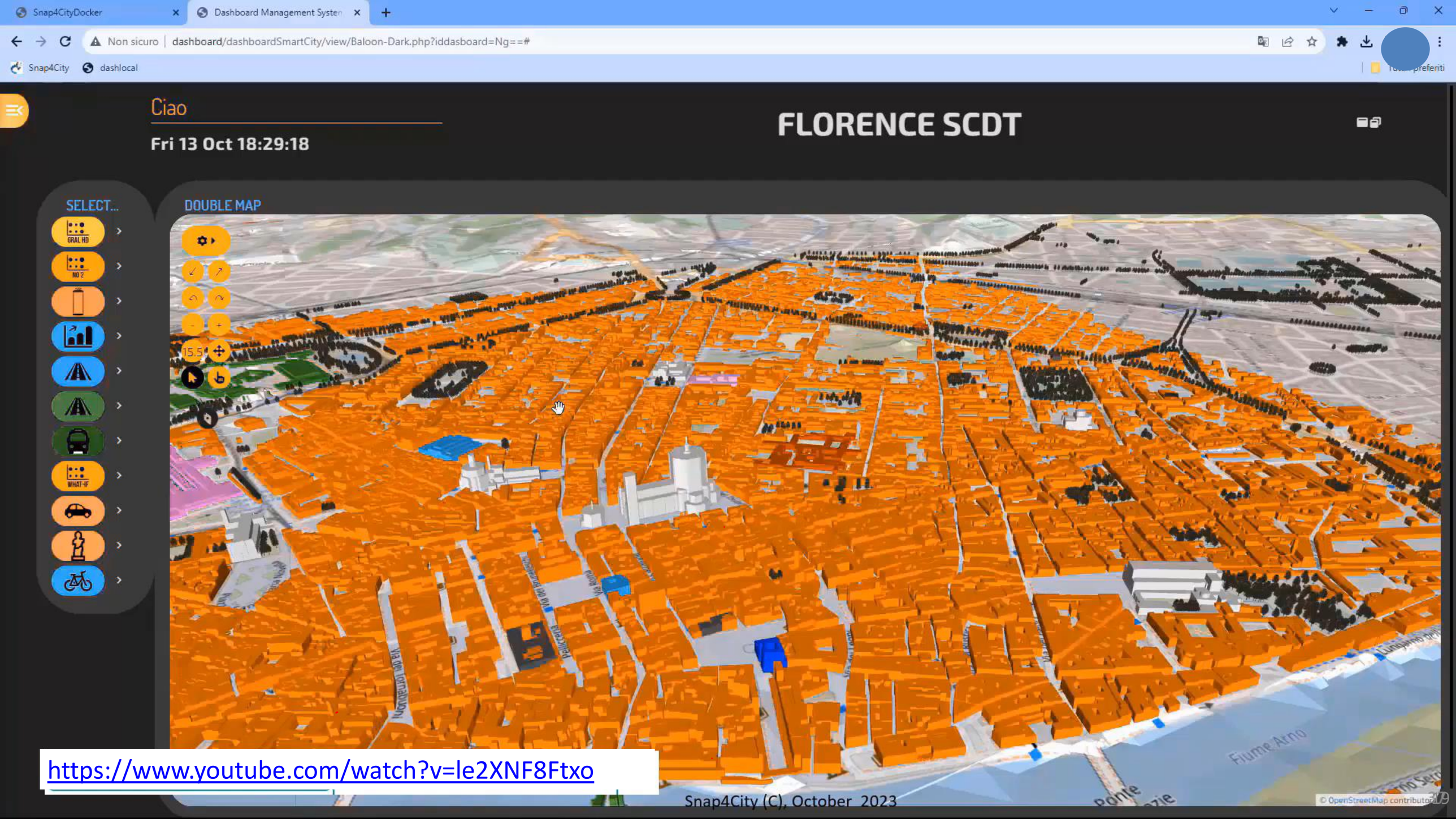
UNIVERSITÀ DEGLI STUDI FIRENZE

DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB DISTRIBUTED DATA INTELLIGENCE AND TECHNOLOGIES LAB

3D Digital Twin





https://www.youtube.com/watch?v=le2XNF8Ftxo

SERVIZI sui contenuti descritti in queste slide

TEST BEFORE INVEST

- Analisi del vostro problema
- Studi di Fattibilità
- POC con vostri dati
- Co-progettazione
- Attività di ricerca congiunta

SKILLS & TRAINING

- Corsi mutuati dai corsi universitari, su AI, ML, DL, XAI, NLP, Big Data, KE, Ricerca Operativa, Statistica, etc.
- Corsi su piattaforma
  - Digital Twin IoT Snap4City
- Corsi on demand

UNIVERSITÀ DEGLI STUDI FIRENZE

DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB
DISTRIBUTED DATA INTELLIGENCE AND TECHNOLOGIES LAB

TUSCANY X.0

EDIH European Digital Innovation Hubs Network

Finanziato dall'Unione europea NextGenerationEU

SNAP4CITY

Official Training of EDIH
Selezionato ed Erogato (2023) per
EDIH European Accademy

https://www.snap4city.org/944

1st part	2nd part	3rd part	4th part	5th part	6th part	7th part	8th
Overview	Dashboards	IOT App, IOT Network	Data Analytics	Data Ingestion processes	System and Deploy Install	Smart City API: Web & Mob. App	Design and Develop Smart Solutions

CONTATTI

Paolo Nesi, paolo.nesi@unifi.it
Dipartimento di Ingegneria dell'Informazione, DISIT
Cell: 335-5668674, Lab Https://www.disit.dinfo.unifi.it

https://www.snap4city.org
https://www.snap4industry.org

UNIVERSITÀ DEGLI STUDI FIRENZE
DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE
DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB DISTRIBUTED DATA INTELLIGENCE AND TECHNOLOGIES LAB

TUSCANY X.0
EDIH European Digital Innovation Hubs Network
Finanziato dall'Unione europea NextGenerationEU