SNAP4SOLUTIONS

www.snap4solutions.org

ARTIFICIAL INTELLIGENCE

SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES

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

SNAP4CITY

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INTRODUCTION

Early machine learning solutions, ML, were mainly black box generating skepticism over their applicability in critical situations in which one should be requested to just trust them. On the other hand, ethical aspects (on data and processes) are very relevant and a wrong assumption in taking data and/or setting up solutions may lead to biased results/suggestions, which may correspond discriminations and may lead to unforeseen costs. This was a real concern for former solutions and for the first generations of machine learning.

Snap4 technology is providing **Big Data Analytic** with **Artificial Intelligence, AI,** for leveraging businesses and solutions in producing reliable predictions, prescriptions, early warning, classifications, detections, suggestions, and generation. In substance, Snap4 technologies lead to reduce costs and increase the efficiency of business and/or production processes. This implies to extract value from data, providing hints, prescriptions, suggestions, strategies, mitigations, and discovering information and implications never detected before, to learn and derive aspects of the phenomena up to now only observed and measured.

The applications can be in almost any domain of smart city and industry: mobility, health, energy, environment, waste, chemistry, manufactory, delivering, agriculture, boating, building, security, safety, etc.

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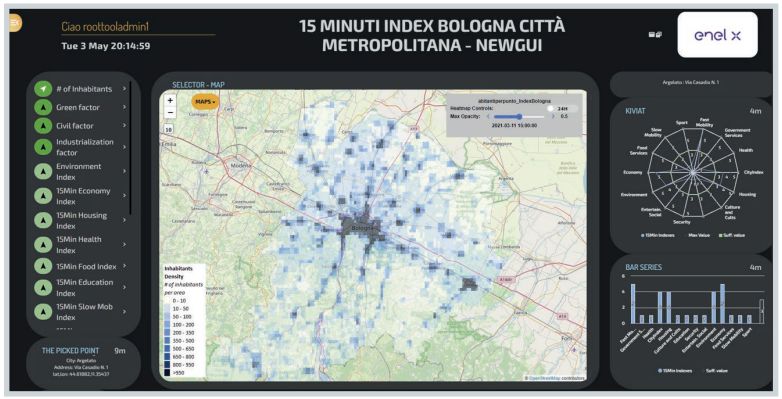
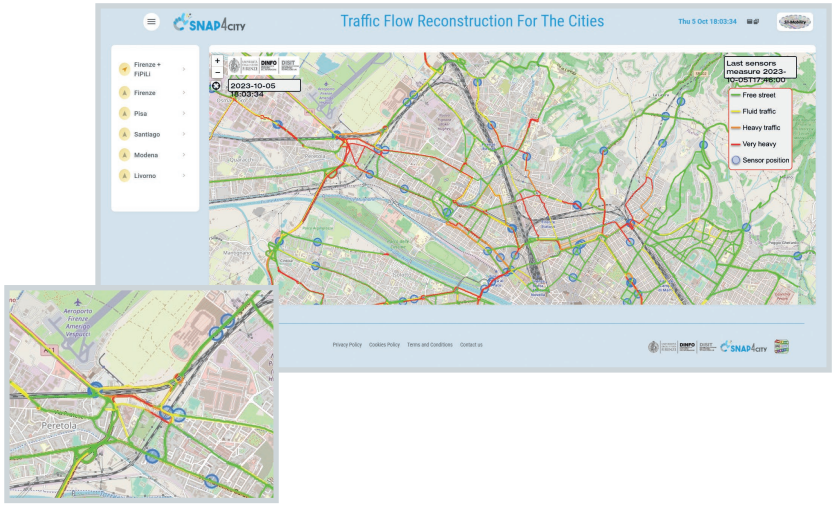
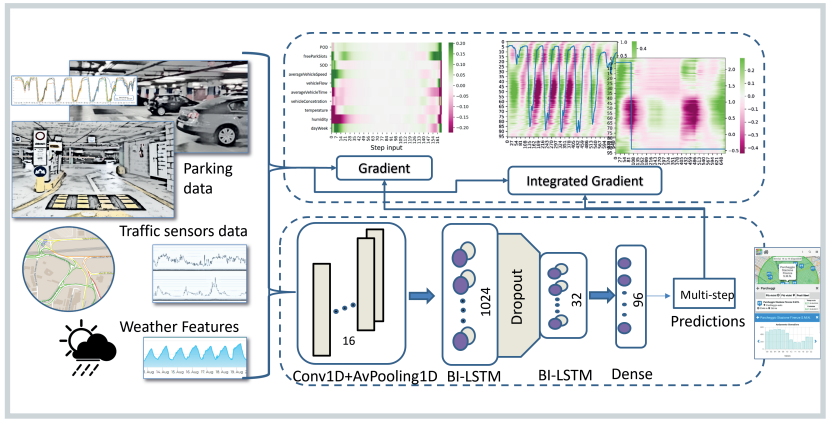
ADVANTAGES



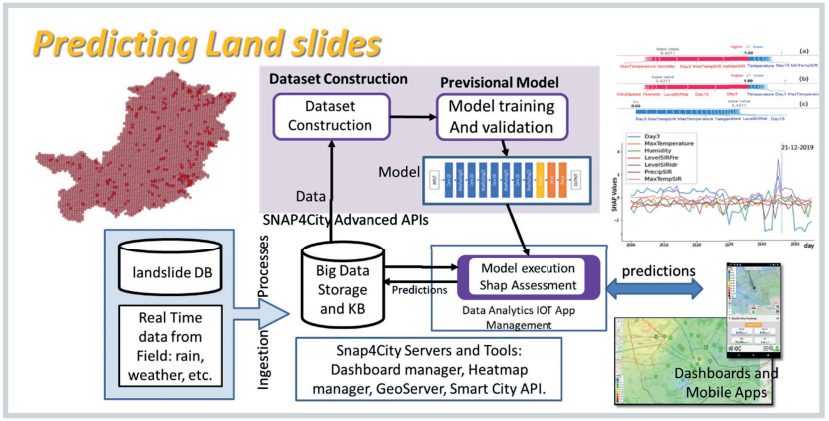


The resulting advantages can be for final users, for decision-makers and for the city/companies. Examples can be:

- monitoring and controlling traffic, making prediction, traffic flow reconstruction, simulating and performing what-if analysis for strategic plan minimizing traffic congestions.
- optimized positioning of bus stops, increasing the quality of transport experience and avoiding overcrowding, maximizing efficiency, minimizing costs, and decreasing the number of trips.
- parking predictions to reduce the social costs of looking for parking: reduction of fuel consumption, reduction of produced as NO2/ CO2 for the whole community, etc.
- optimized routing based on present and predicted conditions, regarding traffic and maintenance works, for private drivers and city operators. Thus, for emergency services, reducing travel time, pollution, and the time required to reach the objective and perform services.
- understanding city usage conditions, and city users' satisfactory and demanded services, etc. Increasing quality of services by solving the identified problems via collective intelligence.
- optimization of waste collection that reduces costs by minimizing the number of required trucks/trips and prevents waste from escaping bins through the use of predictive analytics. It is an advantage for the quality of life of city users and reduces administrative costs.
- predicting maintenance to reduce intervention costs, operating costs associated with unexpected faults and services/productions interruptions, avoiding damages provoked by faults, etc. This also implies a reduction of the costs of production improving efficiency and resilience.
- sharing service prediction to reduce the time need to get/find a suitable sharing vehicle. Thus, increasing the quality of service also increases its effectiveness.
- assessing and predicting reputations of services, attractions, based on social media, with the purpose of enhancing the quality of services, reducing prices increase, and promoting alternative offers and solutions.
- early warning about possible landslides in the territory by computing predictions about landslides.
- preparing the city and/or the industry to be more resilient to unexpected unknown events, natural or man-made disasters, by integrating simulations and ML/AI solutions enabling the what-if analysis in near real-time, increase resilience and capacity. Rapidly reacting to unanticipated, unforeseen events, so reducing the cost of recovery, which is the risk, and receiving advice to mitigate the risks and damages.
- Understanding the usage of city services to optimize energy and other resources needed for the expected serviceability and quality.



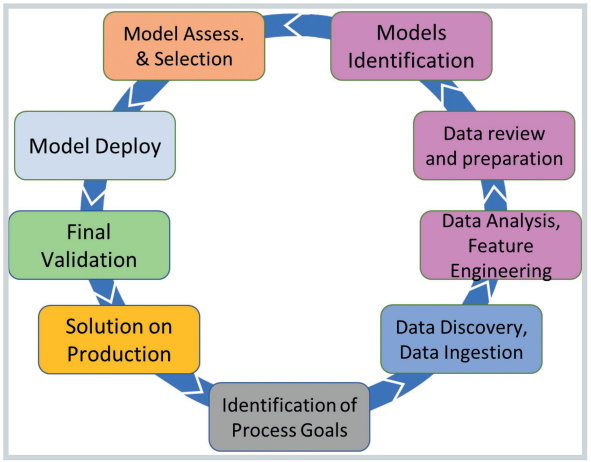
Snap4 AI/XAI solutions are capable to provide high precisions on predictions, classifications, prescriptions, suggestions and scenario generations and thus they can actually support decision makers as one of your best experts without humans' bias. Thus, they should be treated as one of trusted experts and put them in the loop with decision makers to collaborate creating tailored solutions, and strategies to mitigate and solve short- and log-terms problems, as well as to support processes of What-If analysis, which were previously developed solely through simulations on the basis of hypothesis. Decision-makers can get suggestions shortening boring activities and the AI can learn from the decision-makers' objections improving progressively AI capabilities and your preferences, taking into account additional aspects and elements. Extending this capability to allow entering in the loop the community of users, it would result in the production of new data for training (suggestions produced by the users to the AI, generative AI, as well as collective intelligence) which can be actually improve the AI precision and capability in modelling the phenomena and providing effective suggestions. Some of these approaches fit in the reinforced learning, transfer learning, fine tuning, and in the continuous learning techniques. Moreover, a relevant push has been provided by semantic reasoner tools, which started with the definition of ontologies and collecting data become actual expert systems which can be queries with semantic query language to perform inference and gest smart suggestions and results, neuro symbolic solutions. Examples are the graph neural network, graph data stores and the spatial, temporal and entities reasoners.



In recent years, AI has rapidly evolved and started to be used in complex systems and not only to make direct predictions and prescriptions. Thus, decision-makers started to test the new solutions expecting to see them respecting the ethics (on data and processes), with aim of trusting them as their best experts. To this end, **AI trustworthy, Data Ethics** and **AI Ethics** approaches have been created to serve the decision makers. Data Ethics refers to the aspects that may provoke a bias and ethical problems since the training; for example, training the AI with biased data, unbalanced distribution of cases, etc. Moreover, specific AI methodologies and solutions for **Explainable Artificial Intelligence, XAI**, are presently providing support in this direction since they are capable to explain the rationales behind the typical results provided (global explainable AI) and may provide specific description/ rational for each result/suggestion provided (local explainable AI). XAI typically adds value to the suggested decisions producing hints and discovering implications and correlations never detected before by humans. They are a source of information to train the decision-makers about what has been discovered to be relevant for the AI. On the other hand, the decision makers can also provide to the AI continuous and lifelong training inputs for improving the capabilities of the AI. Thus, in Europe (April 2019) and in recently in other countries normative are going to set up regarding the AI Ethics, proving guidelines on training AI for Ethics, thus for **AI trustworthy, Data Ethics** and AI Ethics.

DEVELOPMENT LIFE CYCLE

Nowadays is not enough to provide high precision in predictions, classification, counting, detecting, suggesting/prescripting and supporting decisions, the smart city and Industry 4.0 platforms must be capable to be intimately supported by AI/XAI methods to provide ethical, trustworthy and reliable solutions. And this integrated approach of AI trustworthy, Data Ethics and AI Ethics must be enforced into the development process (e.g., data analysis, data selection, data ingestion, data ethic, data review, AI technique selection, XAI selection).



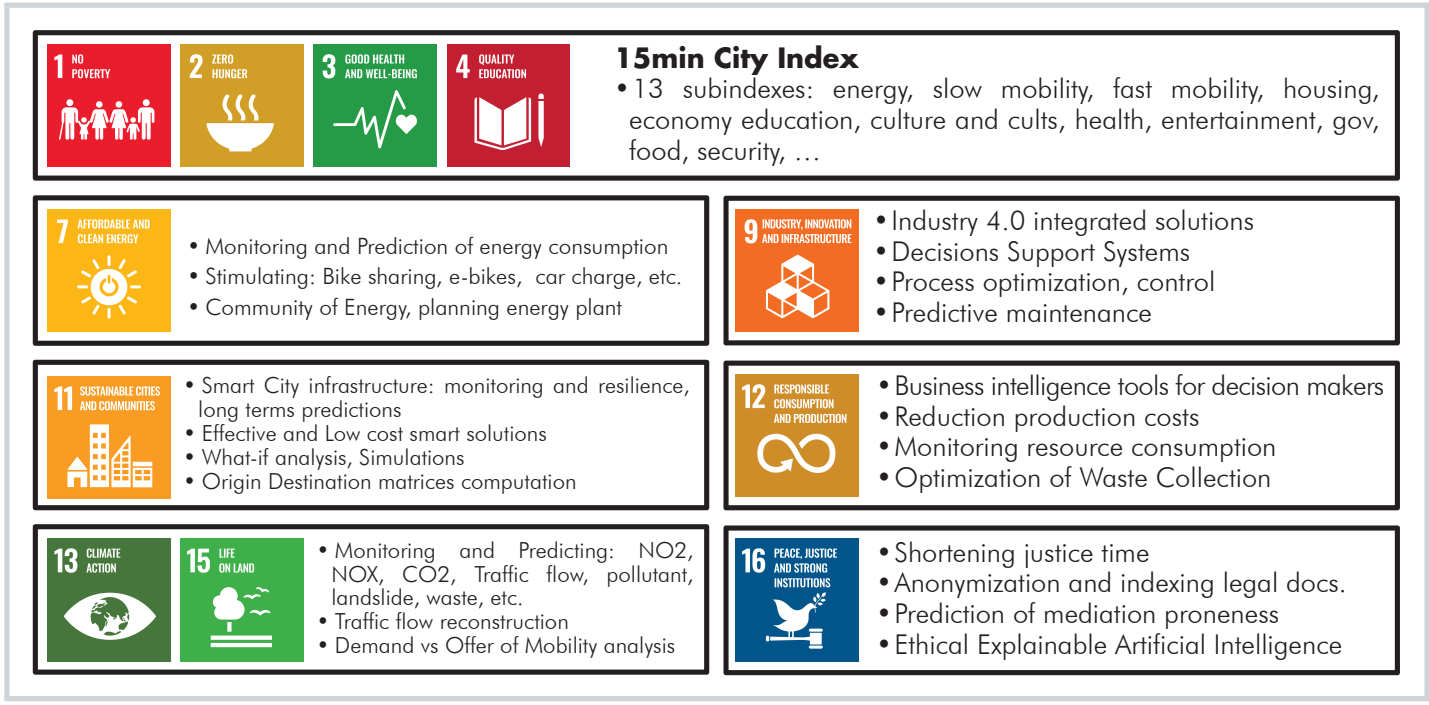
LEGAL ASPECTS AND PRIVACY

Moreover, any AI/XAI solution (including data ingestion, analysis, transformation, training, visualization, etc.) has to respect the data privacy, ethics, and thus has to be compliant with GDPR (General Data Protection Regulation of the European Commission) and/or similarly regulations in other non-European Countries (e.g., the California Consumer Privacy, CCPA). These aspects have to be addressed since the beginning of the life cycle, when the data discovery and data ingestion are performed, and in particular in the data analysis phase. This also means that the solution has to respect the **Data sovereignty** for which the data are subject to the laws and governance structures of the nation where they were collected. Specific licenses can be modelled and the development tools enabling the development of AI must guarantee the **Data sovereignty and GDPR**. On the other hand, the long experience in data analytics also demonstrated that in a large number of cases, several kinds of data can be found (or can be generated) to substitute those that are protected or too private to be used. Specific techniques for anonymization preserving validity may help in this sense and are getting a larger diffusion.

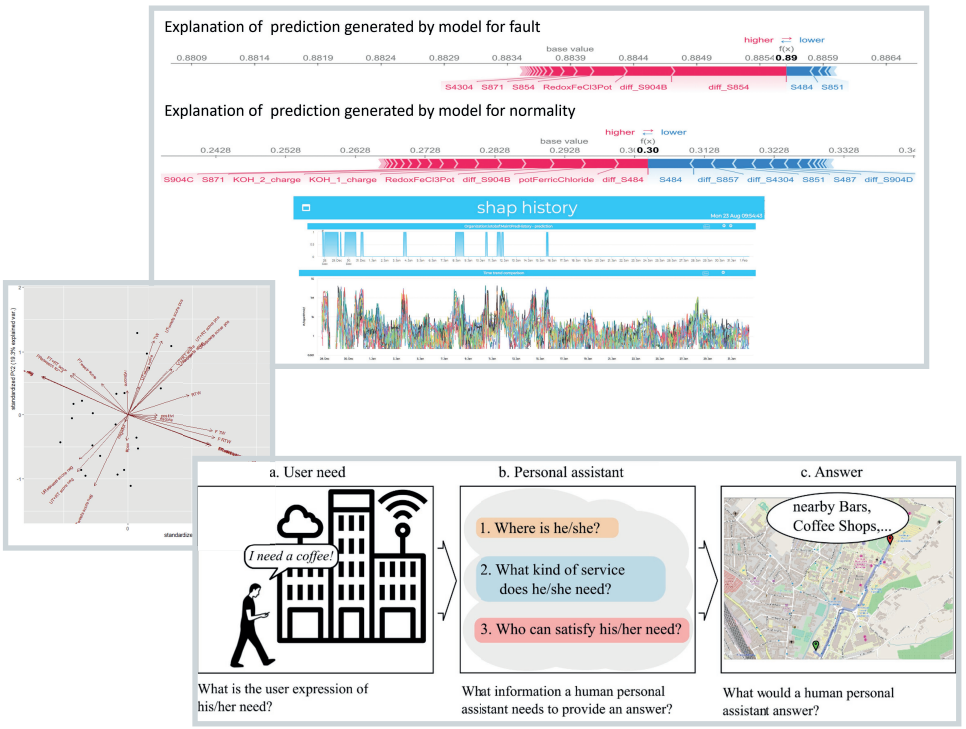
Thus, the first step to enforce the AI in your processes must pass from trusting and deep assessment / validation of the process and solutions proposed to verify its capabilities in being trustworthy, Ethics, and compliant with **GDPR, AI Regulation of EU act, etc**. In this phase, the methodologies of incidental finding have to be applied since, unexpected results and implications could be discovered, and in some cases could make evident the presence of hidden biased aspects on data and in the processes.

CHALLENGES

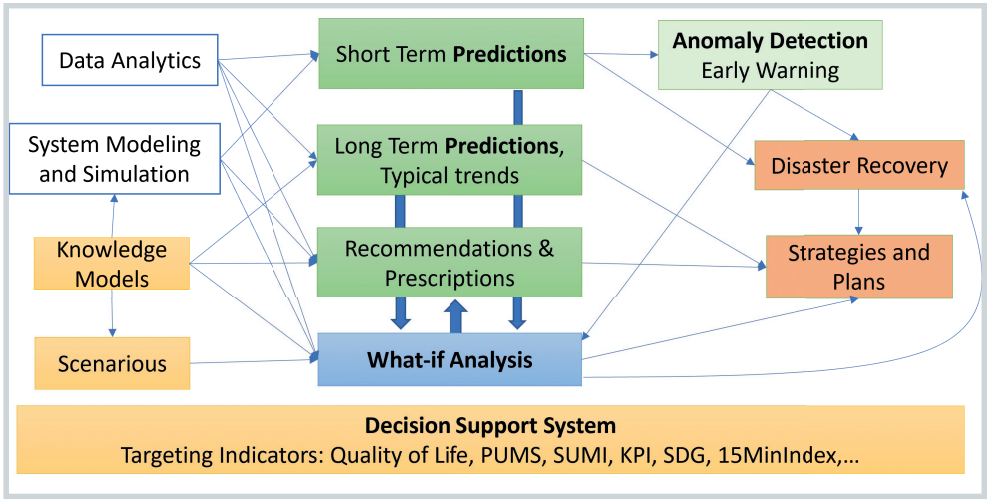
Among the most relevant challenges for the city in the coming years we see the energy and ecological transitions KPI (key performance indicators), the SDG (Sustainable Development Goals) (see https://www.snap4city.org/776), and the push to more livable cities according to 15 Min City Indexes and Driving urban transitions to a sustainable future, DUT. Sustainability and SDG are not something that one can solve with a single action. All the governs and institutions have identified hundreds of indicators which may influence the well-known SDG, SUMI, SUMP, PUMS, DUT and 15MinCityIndex (https://www.snap4city.org/652).
DISIT Lab has developed the 15MinCityIndex, adopted in the whole Italian territory with the ENEL-X platform. And a number of solutions which can positively impact on the SDG. The 15MinCityIndex itself may be used to learn how to improve the SDG for each single micro area of the territory.



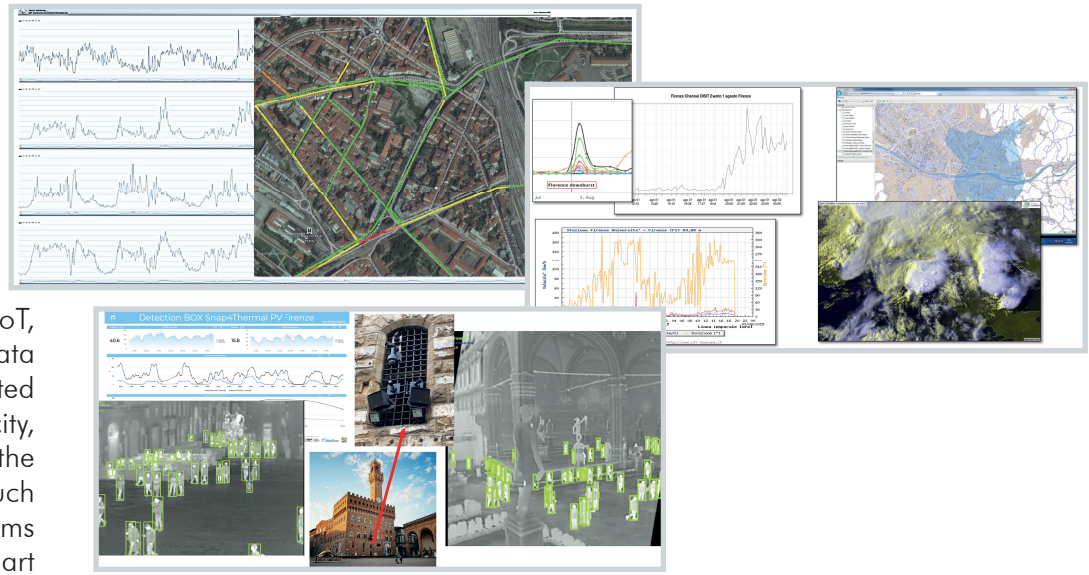
WHAT-IF ANALYSIS AND GENERATIVE AI SIMULATION



Moreover, the most recent techniques of **transfer learning, augmented learning, fine tuning, generative AI**, etc., can drastically reduce the costs for setting up AI solutions by starting from similar previous AI/XAI models also developed in similar contexts. The approach is reducing the amount of data and cases needed for training the AL in the new conditions by exploiting pretrained models. These approaches imply that obtaining an affordable AI is not a matter of API or data models, while is more an issue of AI/XAI models which should technically pass from a training experience to a next conserving the AI architecture in primis and thus also the data semantics, the format is less relevant technical aspects, also via neuro-symbolic approaches. In this sense, Snap4City with its Knowledge Base ontology, Km4City, can be a key to make any data interoperable at semantic level. Mechanism of federated learning allows us to accelerate the training process using data and experiences from several cities and sites at the same time.



DATA MODELING AND INTEROPERABILITY

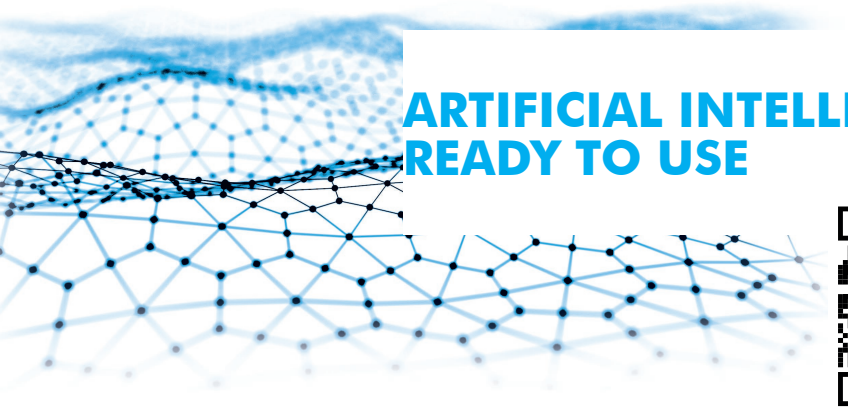


The world of Internet of Things, IoT, and of the Web of Thinks, WoT, and its integration with Big Data are mature regarding the data collections, in the sense that any kind of data can be collected and aggregated into the most powerful platforms for smart city, Industry 4.0, health, energy, environment, mobility, etc. On the other hand, for most of those domains the actual needs are much wider. Snap4City/Industry is one of the most powerful platforms in terms of interoperability with high level types, FIWARE Smart Data Models, IoT Device Models, GIS data, satellite data, Origin Destination matrices, trajectories, shapes, traffic flow, flows in 3D, 3D Digital representation for cities, BIM, typical time trends, trajectories, etc.

Snap4City/Industry includes Km4City ontological and semantic model (https://www.km4city.org) to guarantee the data interoperability with FIWARE Smart Data Models, IoT Data Models, and a large range of High Level Types, providing a number of real-time open source solutions to support decision makers in cities and large industries to ground their daily operational actions on solid ethical and explainable artificial intelligent predictions, deductions and assessments. It provides a complete understanding of the context and its trends, receiving early warning, anomaly detections, and performing simulations and what-if analysis. This information is used to suggest strategic and real time interventions to improve city services and general quality of life, reduce congestions, costs, in multiple domains (e.g., mobility, transport, energy, government, tourism, security, safety, environment, civil engineering).

In this large range of solutions, Snap4 technology is compliant and interoperable with more than 180 protocols fully integrating legacy systems, and it is interoperable with any GIS (Geographical Information Systems), BIM (local Digital Twin), CKAN (open data networks), Satellite, and IoT Networks protocols (IoT protocols), WoT protocols, mobility and transport protocols, Mobility as a Service protocols, services and databases. https://www.snap4city.org/283 , https://www.snap4city.org/65

The push on AI has been recently associated to the Digital Twin. Digital Twin aims are creating a digital counterpart of the physical entities and lead them working together. On the other hand, most of the physical solutions are not smart at all, this means that the Digital Twin will become the intelligent engine of the physical one in most of those cases. The Snap4 technology Digital Twin (https://digitaltwin.snap4city.org) integrate all the different data of a city and/or of building allowing to represent and manipulate them in 3D: building, traffic flow, busses, trees, furniture, IoT devices and sensors, KPI, BIMs, etc.



ARTIFICIAL INTELLIGENCE READY TO USE

Snap4City means: **Smart aNalytic APp builder for sentient Cities and IOT.**

Snap4City has been designed since the 2017 to be AI enabled, respecting ethics, secure passing the PENtest and GDPR compliant. Snap4City has developed a large number of solutions in the context of Smart City and Industry 4.0. Snap4City fully supports the development of real time data analytic processes through ML, AI, ethic trustworthy XAI via languages such as Python, R-Studio, also exploiting Tensor Flow, Pandas, Keras, and any kind of library for data analytics, ML and AI. Snap4City is distributing a number of Open-Source data analytics tools and algorithms for: prediction, anomaly detection, classification, detection, constrained routing, optimisation, analysis of demand vs offers of transportation, and many others have been published on international top level journals and can be customized on demand on your cases. Data Analytics is fully integrated into What-IF analysis tools in control rooms and for operators, defining scenarios and solutions. Snap4City has a consolidated experience in the development, validation and transfer AI/XAI solutions (see course https://www.snap4city.org/577). Most of the DISIT lab solutions are based on ML, Deep learning, AI, XAI, natural language processing (NLP), sentiment analysis (SA), semantic reasoning and computing, neuro symbolic, generative AI, etc. In the following, a number of examples are listed, while more details can be recovered from the Snap4City course and from technical notes: https://www.snap4city.org/4.

Mobility and Transport

- Impact on planned changes in city viability for: public transport, traffic, parking, people flow, etc.
- Public Transportation: Ingestion and modelling of GTFS, Transmodel, NeTex, etc. (DP)
  - Analysis of the demand mobility vs offer transport of according to public transportation and multiple data sources (Simulation)
  - Assessing quality of public transportation (analysis)
- Accidents heatmaps, anomaly detection (analysis, ML)
- Predictions for: traffic flow, smart parking, smart bike sharing, people flows, etc. (ML, DL)
- What if analysis: routing, traffic flow, demand vs offer, pollutant, etc. (Simulation + ML)
- Traffic flow reconstruction from sensors and other sources (simulation + ML)
- Counting and Tracking people via different kind of sensors and thermals cameras
- Tracking fleets via devices: OBU, OBD2, mobile apps, etc. (DP)
- Routing and multimodal routing (multistop travel planning), constrained routing, dynamic routing (DA)
- Computing Origin Destination Matrices from different kind of data (analysis, DP, DP)
- Computing typical trajectories on the basis of tracks (analysis, ML)
- Computing Messages for Connected drive (DP)
- Slow and Fast Mobility 15 Minute City Indexes (analysis, DP, …ML)
- Computing and comparing traffic flow on devices and at the city border (analysis)
- Typical time trends for traffic flow and IoT Time series. (analysis, ML)
- Impact of COVID-19 on mobility and transport
- Computing SUMI, PUMS, etc. (mainly DP)

City Users and Social

- People detection and classification: persona, strollers, bikes, etc. (ML, DL)
- People counting and tracking, head counting (via thermal cameras, ML, DL)
- People flows prediction and reconstruction, (ML, DL)
- Wi-Fi data, mobile apps data, Mobile Data, etc.
- User's behaviour analysis, People flow analysis from PAX Counters and heterogenous data sources (ML, AI)
  - origin destination matrices, hot places, time schedule, Recency and frequency, permanence, typical trajectory, etc.
  - Recency and frequency, permanence, typical trajectory, etc.
- Computing User engagement and suggestions for sustainable mobility (Rule Based, ML)
- Social media analysis on specific channel, specific keywords: see Twitter Vigilance,
  - Reputation, service assessment: MultiLingual NLP and Sentiment Analysis, SA
  - Tweet proneness, retweet-ability of tweets, impact guessing
  - Audience predictions on TV channels and physical events, locations
  - Prediction of attendance of events and on attractions
- Virtual Assistant construction, LLM, NLP, Sentiment Analysis (DL, NLP)
- 15 Minute City Index , etc. (modeling and computability)
- Computing SDG, etc., (DP)

Environment and Weather

- Pollutant Predictions: short, long and very long term European Commission KPIs
  - NOX, PM10 pollution on the basis of traffic flow, 48 hours (ML, AI, DL)
  - Cumulated NO2 average value over the year, ……. (ML, AI, DL)

- Computation of CO2 on the basis of traffic flows (DP), computing emission factor (DA)
  - each road for each time slot of the day
- Prediction of MicroClimate conditions for diffusion (ML, AI): NO2, PM10, PM2.5, etc.
- Prediction of landslides, 24 hours in advance (AI, DL)
- Heatmaps production, dense data interpolation (DP) for
  - Weather conditions: temperature, humidity, wind, DEW
  - Pollutants and Aerosol: NO, NO2, CO2, PM10, PM2.5, etc.
- Impact of COVID-19 on Environmental aspects (DP)
- Optimisation of waste collection schedule and paths (DP, ML)
- Computing SDG, SUMI, PUMS, .. (mainly DP)

Energy and Control, Security

- Smart Light Solutions: monitoring luminaries, profiling luminaries, managing error conditions (DP)
- Design by Simulation of Photovoltaic Plants: using real statistical data from the area (ML, Dp)
- Energy Community: Energy Districts (in Italy, CER) (ML, DP)
  - Monitoring, design and simulation of energy community
- Monitoring and controlling recharging stations, recharging poles
- Monitoring energy production and consumption over: plant, building, floors, offices, server rooms, etc.
- Monitoring healthiness of Smart City Network of devices
- Monitoring critical areas for: people, traffic, boats, etc

Management and strategies

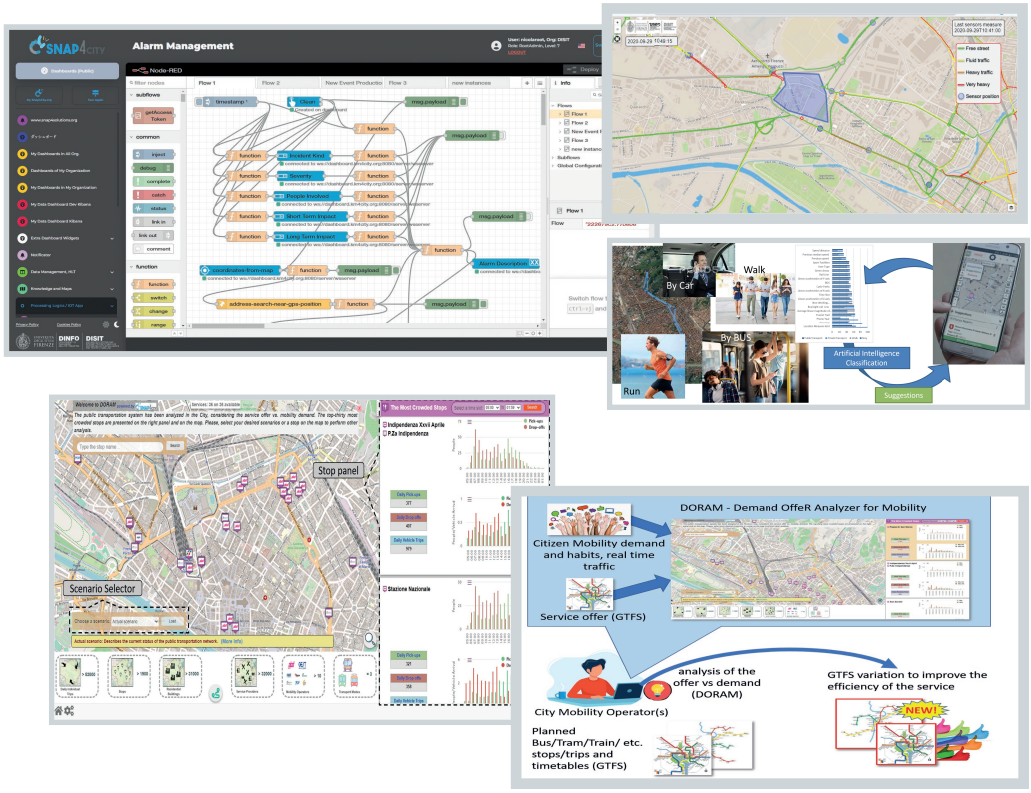
- Estimation of KPI and local indexes for: quality of life (15MinCityIndex, SUMI, SDG, ..)
- What-if analysis, dynamic routing, origin destination matrices production from a large range of sources
- Planning and Monitoring renovation works via objective KPIs
- Managing Maintenance and teams
- Predictive Maintenance and costs predictions: chemical plant, vehicles, boats (XAI)
- Production Optimization
- Resilience analysis wrt European Guidelines on Resilience of critical infrastructure, and
- Risk analysis: natural and non-natural disaster (XAI)

Semantic Reasoning

- Ontology Modelling and integration, expert system construction
- Multilingual Sentiment Analysis, transformers, BERT, Multilingual
- Knowledge modelling and reasoning on RDF stores: spatial, temporal, relational
- Virtual Assistant construction, virtual expert of the city.

Time Series, Matrices, Images, Maps and 3D Digital Models

- Time Series Anomaly detection
- Data quality assessment and control
- Short, long and very long term predictions
- Interpolation of scattered Data on regular grid for calibrated heatmaps
- Conversion of Satellite data images into regular ground images/heatmaps measures
- Extraction information from Orthomaps, LIDAR, etc., regarding city structures
- 3D Digital Twin of Cities and Objects: pattern extraction, 3D model reconstruction.
- Ontology Modelling and integration, expert system construction
- Knowledge modelling and reasoning on RDF stores: spatial, temporal, relational.



In 2019, DISIT Lab (University of Florence) turned out to be the winner of the Select4Cities PCP of EU and one year later won the ENEL-X open data challenge in 2020. Currently, Snap4City is one of the platforms of the EOSC (European Open Science Cloud), library of Node-RED, and DISIT Lab is proud to be a Gold Member of FIWARE and an official FIWARE Platform and Solution, certified Consultant, certified Trainer, provides two certified FIWARE Experts; and awards from DMS, ICCSA. DISIT Lab and other partners participated providing Snap4City solutions and a strong number of innovations in a number of EC projects (RESOLUTE, REPLICATE, TRAFAIR, MOBIMART, Select4Cities, Snap4City, WEEE, Panacea, Impetus, Tuscany X.0 EDIH, etc.), and national/regional (Sii-Mobility, MOSAIC, ALMAFLUIDA, SODA, Pretto, Enterprise, ES THE, CN MOST, etc.), and in many direct contracts.

PAOLO NESI

Prof. Eng. PhD **Paolo Nesi** is a professor at the University of Florence, UNIFI, working at DINFO, Department of Information Engineering (Computer Science Department), Chair of DISIT Lab of UNIFI, and chair of https://www.Snap4City.org which is an official platform of FIWARE, platform of EOSC, Library on Node-RED, etc. P. Nesi main research topics are: big data analytics, AI/XAI, distributed systems, IoT, Cloud, security and privacy. He has more than 30 years of experience in developing predictive and prescriptive solutions based on semantic computing, machine learning, artificial intelligence, explainable AI, natural language processing, computer vision, etc., in a large range of domains, more than 400 international papers. He founded and is the Director of the DISIT LAB (https://www.disit.org). He has been scientific coordinator of large international research and innovation projects such as: Snap4City H2020 EC, Resolute H2020, Sii-Mobility national mobility and transport action in Italy, AXMEDIS EC, ECLAP EC, etc., and smart solutions responsible of many others such as Replicate H2020 EC, Trafair CEF, ICARO Cloud, HeritData EC, Mobimart EC, Weee Life, etc. He has been chair of IEEE SC2, IEEE ICSM, IEEE ICECCS, AXMEDIS, DMS, .. and programme chair of many others. He is editor of international journals, member of the national Italian center of mobility, member of the CBDAI (Center for Big Data and Artificial Intelligence of the Tuscany Region), member of the EDIH Tuscany-X board, board of the CN Most (national mobility and transport center), scientific board member of the PhD-AI National PhD Course on Artificial Intelligence, certified FIWARE Expert, scientific board member PhD course of UNIFI on Information Engineering, scientific advisory board member of a number of EC International Projects and of BBC. He has been the recipient of a number of Awards as: recognized top 15 researchers worldwide in the area of software engineering for two years, Snap4City First place awards, best paper awards, etc., and It has been co-chair of SMR MPEG-4. P. Nesi is a member of IEEE, ACM, AI*IA, CINI, CNIT, ISO, FIWARE, Gaia-X.

Google Scholar: *https://scholar.google.com/citations?user=c2S3Ni0AAAAJ&hl=en*
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SNAP4CITY

NOTES

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ONLINE TRAINING MATERIAL OVERVIEW

https://www.snap4city.org/944

The training course is open to everybody free of charge and includes frontal slides, full accesss to the platform and development tools, and exercises during the courses.
Participants should be registered on https://www.snap4city.org performing the free registration as free *DISIT Organization* or on their own Organization if they have one on Snap4City.

- **Overview:**
  - Needs of the Operators vs platform
  - Platform Overview: from data to interactive tools
  - Data Analytics, Artificial Intelligence
  - Some Cases by Domains: solutions vs analytics
  - Other Cases and scenarios
  - Overview of the next parts of the Course
- **Dashboard production and management**
  - Dashboards Purposes and Uses
  - Main Data Kinds: data vs representations
  - Dashboards Main Concepts and simple Widgets
  - Creating a Snap4City Dashboard, wizard
  - Multi Data Map Widget
  - High Level Types, video, external services, synoptics
- **IOT App, Process Logic, Server Side Business Logic**
  - IoT Network, Device, Edge, Broker
  - Node-RED
  - Exploiting/Generating data by using: IoT App/Proc. Logic
  - Server Side Business Logic
- **Data Analytics and Artificial Intelligence**
  - Why and Where use DA, AI and XAI --> General Life Cycle
  - Data Processing
  - What is Data Analytics, DA and Artificial Intelligence, AI
  - List of the most relevant available DA and AI Solutions
  - Predictions and Anomaly detections
  - How AI/XAI, and Life Cycle
  - Using DA, AI, XAI in Snap4City infrastructure
  - Data Analytics <--> IoT App / Proc.Logic
  - Decision Support Systems and What-If Analysis
  - Routing, Multimodal Routing, Dynamic Routing
  - Business Intelligence and Visual Analytics
- **Data Ingestion and Interoperability**
  - Overview of Snap4City Data Storage and Stack
  - Knowledge Base: Modelling and Setting Up
  - High Level Types vs Ingestion Process
  - Data Ingestion Strategy and Orientation
  - Digital Twin Data Inspector vs Data Processes Details
  - An Integrated Example for Time Series
  - Entities Ingestion with Data Table Loader
  - High Performance Ingestion via Python
  - FIWARE Smart Data Models on Snap4City
- **Snap4City Platform Architecture, Interoperability, Management and Deploy**
  - Snap4City Architecture
  - Interoperability of Snap4City Platform
  - Interoperability with respect to Hardware staff
  - Adding Features and Modules to Snap4City
  - FIWARE and Snap4City
  - Snap4City vs State of the Art Solutions
  - Smart City planning with Snap4City Team Support
  - The Role of the Living Lab Support
  - Snap4City Platform: Administration Overview
  - Snap4Tech: Smart Solutions as a Service
  - Deploy Snap4Tech solutions: Docker Based
- **Exploiting Snap4City API, and Web/ Mobile Applications SDK**
  - Smart City API: Internal and External
  - Concepts and tools for using Knowlege Base, ServiceMap, API
  - Federated Knowledge Bases and Smart City APIs
  - Advanced Smart City API
  - Access to Protected data
  - Forging and managing: Mobile and Web Apps, MicroApplications
  - Web and Mobile App Development Kit
  - training material
- **Developing Smart Applications & Business Intelligence Solutions**
  - Developing in the smart city IoT/WoT context
  - Smart Solutions Development Life Cycle
  - Analysis for Innovation (Co-Creation and Co-Working)
  - Design: Data, Data Models, Data Relationships
  - Design & Develop: Data Processes Proc.Logic / IoT App
  - Design & Develop of Data Analytics
  - Design & Develop: user interfaces, visual tools
  - Visual Analytic vs Data Analytics: Client Side Business Logic Intelligence
  - Design and Control of Smart Applications
  - What is missing here and you can get from former course.

- **SCENARIOUS**
  https://www.snap4city.org/4

- **ORGANIZATIONS**
  https://www.snap4city.org/download/video/cov/

- **INTEROPERABILITY**
  https://www.snap4city.org/283

- **APPLICATIONS / PROCESSING**
  https://www.snap4city.org/22

- **INSTALLATIONS**
  https://www.snap4city.org/471

- **CLIENT SIDE BUSINESS LOGIC**
  https://www.snap4city.org/911

- **INNOVATIONS**
  https://www.snap4city.org/343

- **MOBILE APPS**
  https://www.snap4city.org/489

- **ARTIFICIAL INTELLIGENCE**
  https://www.snap4city.org/524

- **ARTICLES**
  https://www.snap4city.org/78

- **SNAP4INDUSTRY**
  https://www.snap4industry.org

- **DEVELOPMENT LIFE CYCLE**
  https://www.snap4city.org/download/video/Snap4Tech-Development-Life-Cycle.pdf

- **TECHNICAL OVERVIEW**
  https://www.snap4city.org/download/video/Snap4City-PlatformOverview.pdf

- **SNAP4CITY FIWARE IMPACT STORY**
  https://www.snap4city.org/drupal/sites/default/files/files/FF_ImpactStories_Snap4City.pdf

SNAP4CITY

KM4CITY

CITY

INDUSTRY

ARTIFICIAL INTELLIGENCE

www.snap4city.org

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