

# Heritage-Preserving Generative AI for Craftsmanship

## AUTHORS

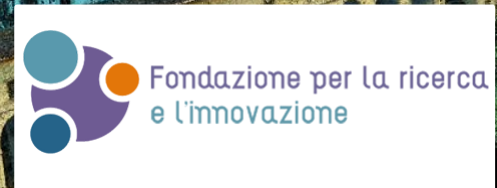
Enrico Collini<sup>1</sup>, Letizia Donati<sup>2</sup>, **Nicola Mitolo**<sup>1</sup>, Alessandro Monti<sup>2</sup>,  
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## AFFILIATIONS

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<https://www.snap4city.org>



# The Problem

## Craftsmanship is intangible heritage — and it is at risk

### A workshop's style is heritage

Leathercrafts transmits tacit expertise, decorative patterns and manual finishing across generations. The style itself is intangible cultural heritage.

### Generative AI promises speed

Diffusion models can explore dozens of design variants in seconds, with no physical prototype, no material, no waste.

### But the training data is generic

Models trained on web-scale images produce generic outputs. The result is stylistic homogenisation: the technology meant to serve heritage dilutes it.

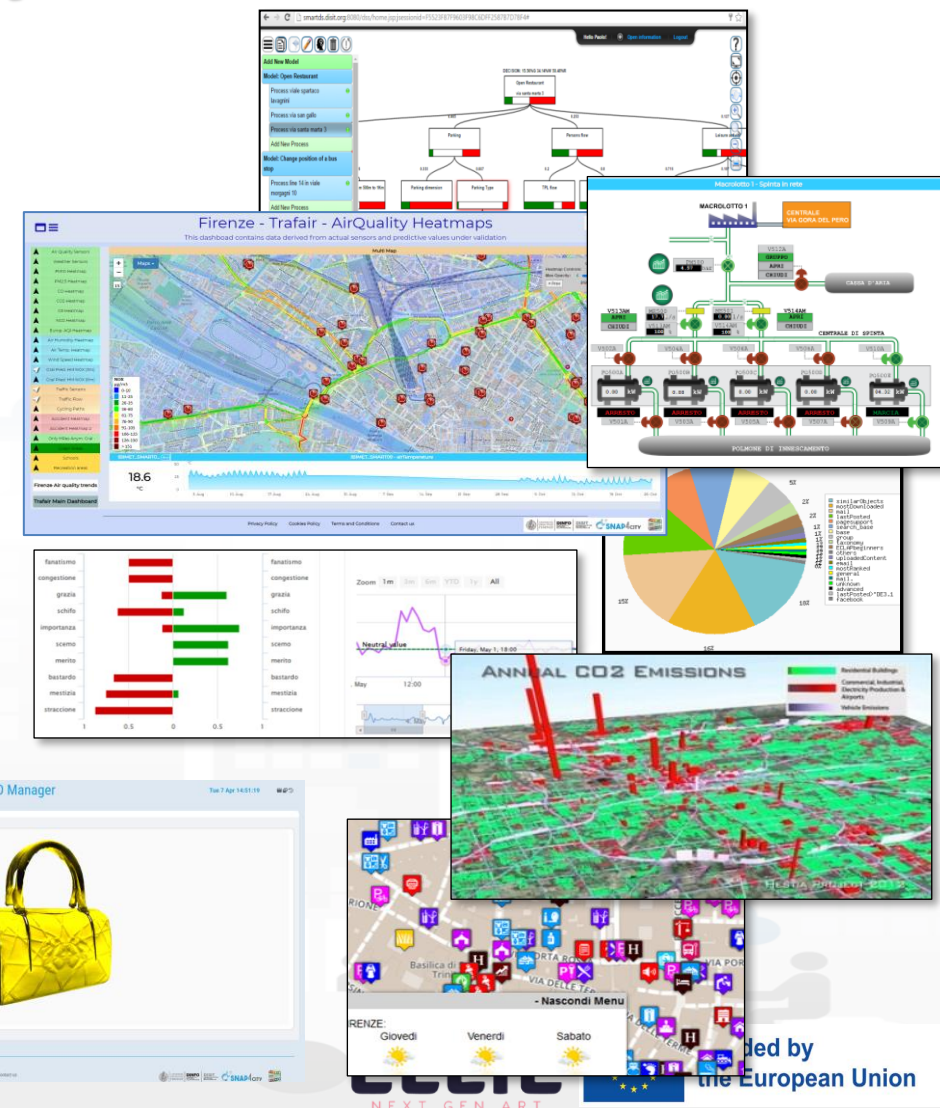


**Digital archive guided generations can support solutions that preserve heritage but need for platforms capable of securely managing this type of data.**



## An open ecosystem: AI Data-Driven System Infrastructure

- Decision Support system
- Assessment / Strategies
- Data Rendering,
  - visual analytics, business intelligence
- Data Analytics, ML, AI
- Data aggregation, Storage, indexing
- Data Ingestion





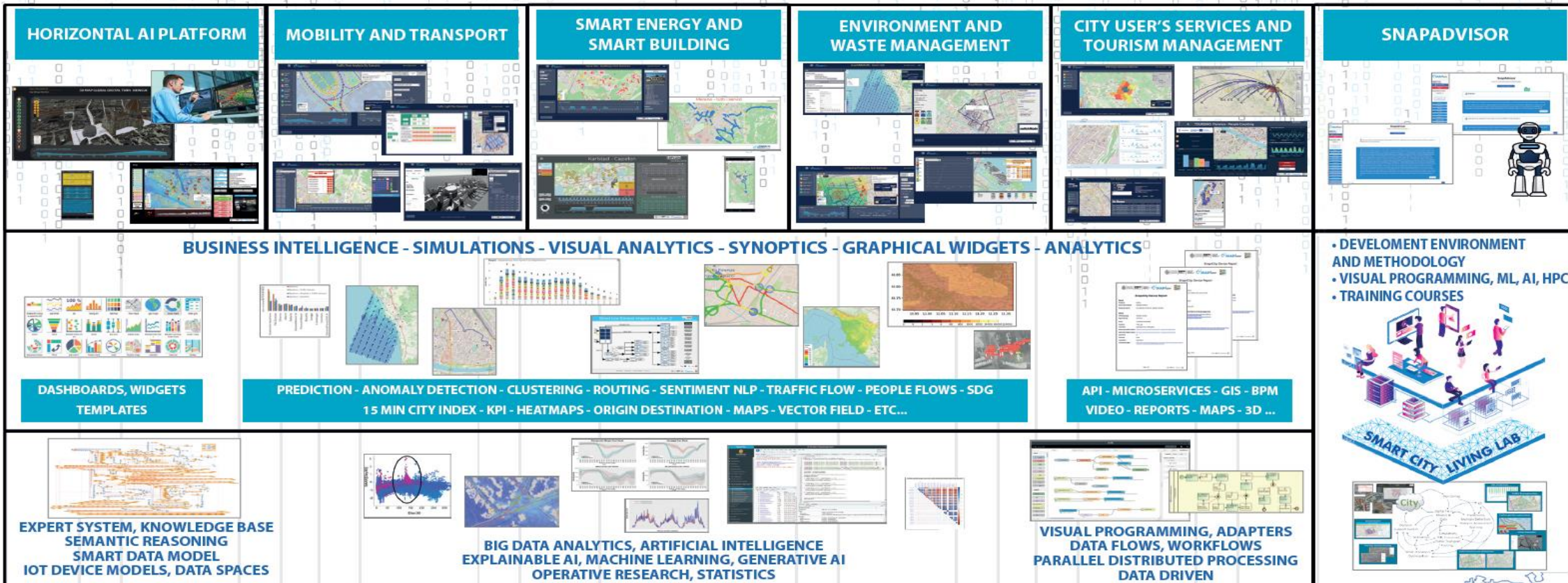


# THE POWER OF ARTIFICIAL INTELLIGENCE AT THE SERVICE OF YOUR OPERATIONS

[www.snap4city.org](http://www.snap4city.org)



OPERATION AND PLAN - CONTROL ROOMS - DECISION SUPPORT SYSTEMS - WHAT-IF ANALYSIS - OPTIMIZATION - APPLICATIONS



FULL INTEROPERABILITY, ANY: DATA, BROKERS, NETWORKS AND VERTICALS

NATIVE AND EXTERNAL APPLICATIONS

Smart Parking

Smart Light

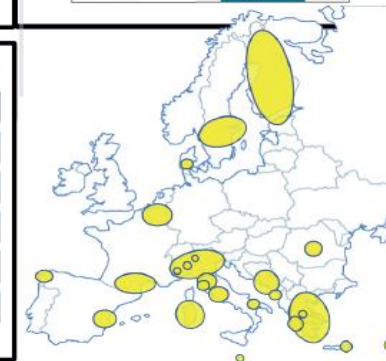
Smart Waste

Smart Energy

Smart Building

Smart Tourism

...



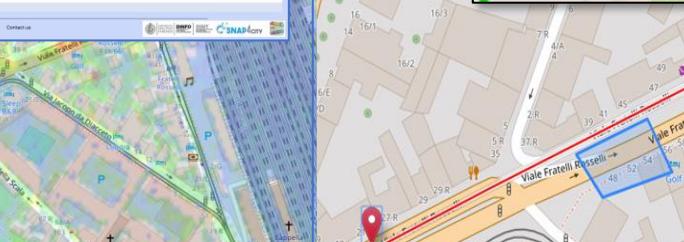
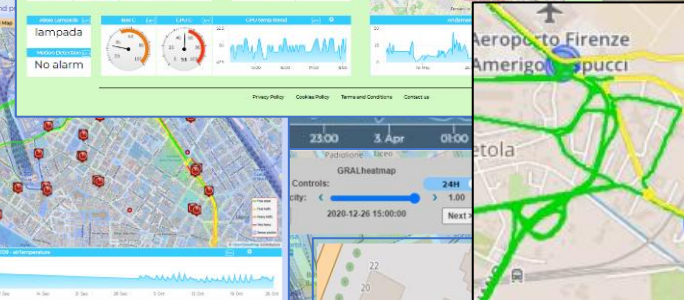
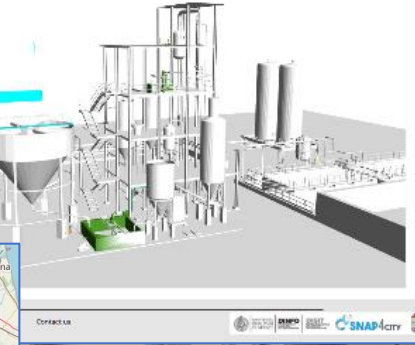
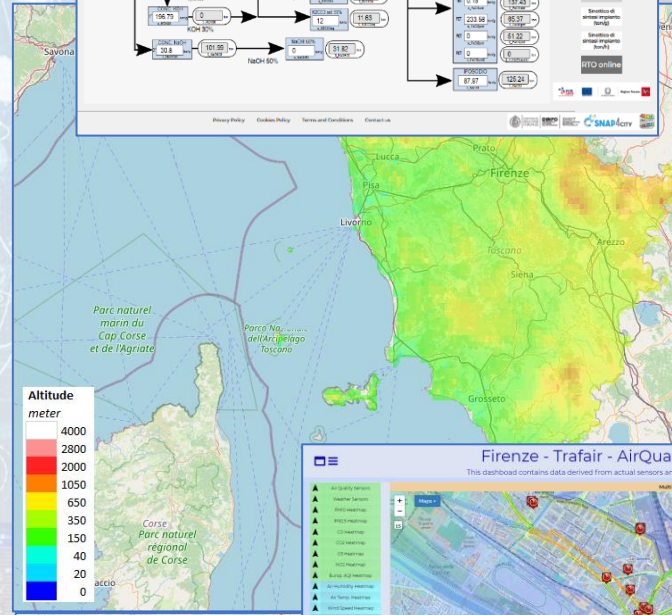
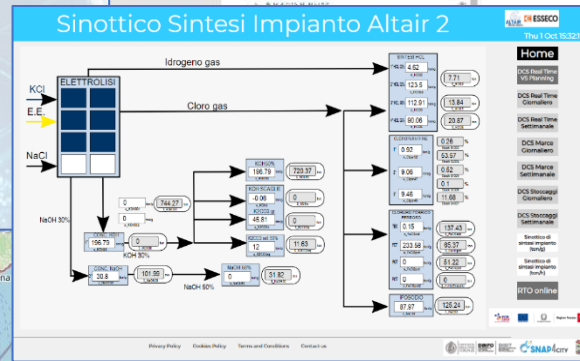
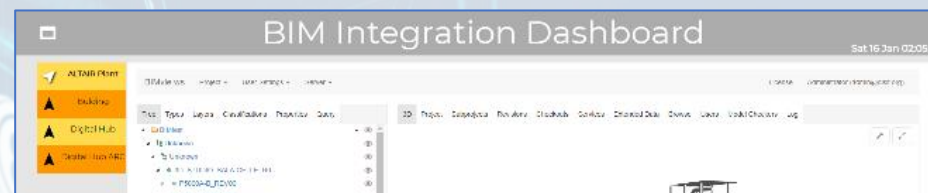
FREE TRIAL



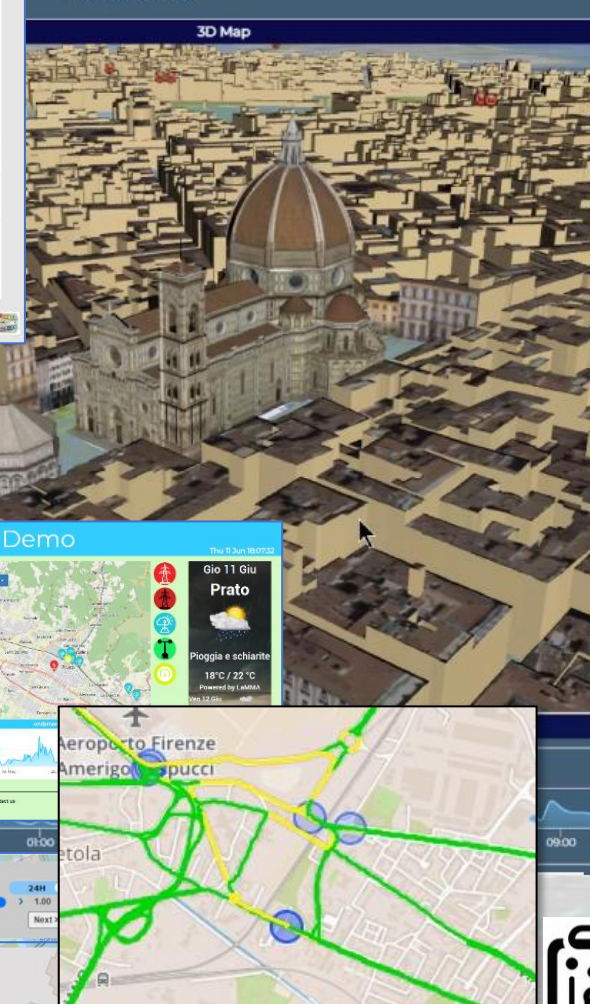


# High Level Types

- POI, IOT Devices, shapes,...
  - FIWARE Smart Data Models,
  - IoT Device Models
- GIS, maps, orthomaps, WFS/WMS, GeoTiff, calibrated heatmaps, ..
- Satellite data, any kind..
- traffic flow, typical trends, ..
- Vector fields + heatmaps, ..
- trajectories, events, workflow, ..
- 3D Models, BIM, Digital Twins, ..
- OD Matrices of several kinds, ..
- Dynamic icons/pins, ..
- Synoptics, animations, ..
- KPI, personal KPI,..
- social media data, TV Stream,
- routing, multimodal, constraints, ..
- scenarios, ....
- etc.



- Digital Twin Global - Fire demonstrator



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DEGLI STUDI  
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DINFO  
DIPARTIMENTO DI  
INGEGNERIA  
DELL'INFORMAZIONE

DISIT  
DISTRIBUTED SYSTEMS  
AND INTERNET  
TECHNOLOGIES LAB



# Standards and Interoperability



## Compliant with:

- **IoT:** NGSI V2/LD, LoRa, LoRaWan, MQTT, AMQP, COAP, OneM2M, TheThingsNetwork, SigFOX, Libelium, IBIMET/IBE, EnOcean, Zigbee, DALI, ISEMC, Alexa, Sonoff, HUE Philips, Tplink, BACnet, TALQ, Protocol Buffer, KNX, OBD2, Proximus, ..
- **IoT model:** FIWARE Smart Data Model, Snap4City IoT Device Models
- **General:** HTTP, HTTPS, TLS, Rest Call, SNMP, TCP, UDP, SOAP, WSDL, FTP, FTPS, WebSocket, WebSocket Secure, GML, WFS, WMS, WCS, RTSP, ONVIF, AXIS TVCam, CISCO Meraki, OSM, Copernicus, The Weather Channel, Open Weather, OLAP, VMS Milestone, TIM, HERE, OGC, ....
- **Formats:** JSON, GeoJSON, XML, CSV, GeoTIFF, OWL, WKT, KML, SHP, db, XLS, XLSX, TXT, HTML, CSS, SVG, IFC, XPD, OSM, Enfuser FMI, Lidar, glTF, GLB, DTM, GDAL, Satellite, D3 JSON, ...
- **Database:** Open Search, MySQL, Mongo, HBASE, SOLR, SPARQL, ODBC, JDBC, Elastic Search, Phoenix, PostGres, MS Azure, ..
- **Industry:** OPC/OPC-UA, OLAP, ModBUS, RS485, RS232, ..
- **Mobility:** DATEX, GTFS, Transmodel, ETSI, NeTEx, ..
- **Social:** Twitter, FaceBook, Telegram, ..
- **Events:** SMS, EMAIL, CAP, RSS Feed, ..
- **OS:** Linux, Windows, Android, Raspberry Pi, Local File System, AXIS, ESP32, etc.

<https://www.snap4city.org/65>





# Available AI Solutions on Snap4City

<https://www.snap4city.org/997>

**More than 80 Available Solutions & 300 AI applic.**

- **Mobility and Transport**
- **Environment, Weather, Waste, Water**
- **City Users Behaviour and Social analysis**
- **Energy and Control**
- **Tourism and People**
- **Security and Safety**
- **Cultural Heritage**
- **High Level Decision Support Solutions**
  - Asset management
  - Resilience and Risks Analysis
- **Low level Techniques**

<https://www.snap4city.org/download/video/course/p4/>



[https://www.snap4city.org/download/video/DPL\\_SNAP4SOLU.pdf](https://www.snap4city.org/download/video/DPL_SNAP4SOLU.pdf)

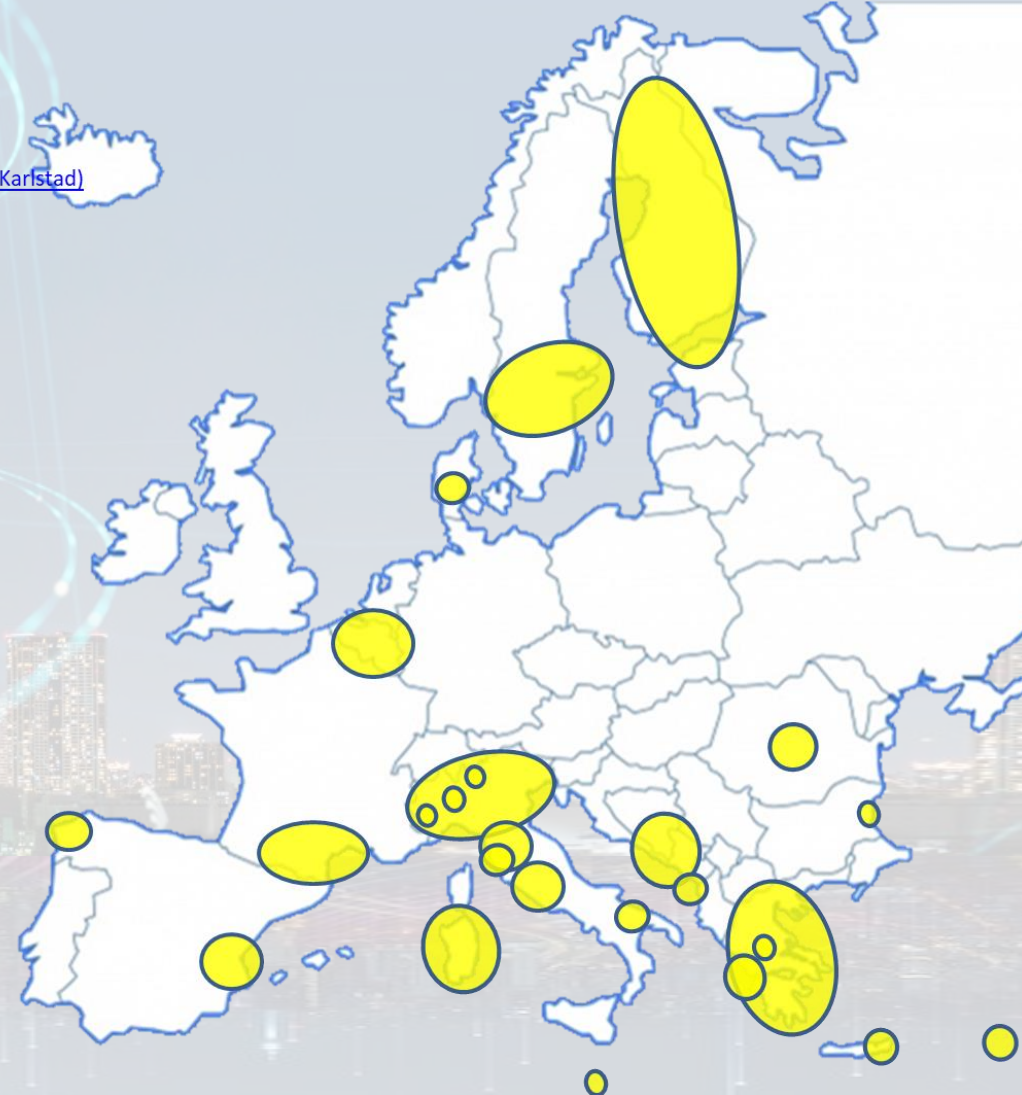




- 11 running installations in Europe
  - Snap4city.org, Greece, Merano, Cuneo, ...
  - Toscana, Pisa, Sweden, ISPRA, Snap4.eu,
  - Altair, Italmatic, M4F, Romania, ....
- 20 projects, 12 pilots on 10 Countries
  - >40 cities/area
- **Widest MULTI-tenant deploy has**
  - 26 Organizations / tenant
  - > 8850 users on
  - > 1800 Dashboards
  - > 17 mobile Apps
  - > **2.2 Million of structured data per day**
  - > 580 IoT Applications/node-RED
  - > 850 web pages with training
  - > 85 videos, training videos

#### Main Organizations/areas

- [Antwerp area \(Be\)](#)
- [Bari \(I\)](#)
- [Bisevo, Croatia](#)
- [Bologna \(I\)](#)
- [Brasov \(Ro\)](#), by ICEBERG
- [Capelon \(Sweden: Västerås, Eskilstuna, Karlstad\)](#)
- [Cuneo \(I\)](#)
- [DISIT demo \(multiple\)](#)
- [Dubrovnik, Croatia](#)
- [Firenze area \(I\)](#)
- [Garda Lake area \(I\)](#)
- [Greece \(Gr\)](#)
- [Helsinki area \(Fin\)](#)
- [Limassol \(Cy\)](#)
- [Livorno area \(I\)](#)
- [Lonato del Garda \(I\)](#)
- [Malta \(Malta\)](#)
- [Merano \(I\)](#)
- [Modena \(I\)](#)
- [Mostar, Bosnia-Herzegovina](#)
- [Oslo & Padova \(Impetus\)](#)
- [Pisa area \(I\)](#)
- [Pistoia \(I\)](#)
- [Pont du Gard, Occitanie \(Fr\)](#)
- [Prato \(I\)](#)
- [Rhodes \(Gr\)](#)
- [Roma \(I\)](#)
- [Santiago de Compostela \(S\)](#)
- [Sardegna Region \(I\)](#)
- [Siena \(I\)](#)
- [SmartBed \(multiple\)](#)
- [Toscana Region \(I\), SM](#)
- [Valencia \(S\)](#)
- [Varna \(Bulgaria\)](#)
- [Venezia area \(I\)](#)
- [WestGreece area \(Gr\)](#)



- + Israel, Colombia, Brasile, Australia, India, China, etc.



# Snap4City in Ellie



- Snap4City provides the secure data and AI infrastructure
- It combines semantic Big Data management, AI services, authentication, authorization, RBAC, and GDPR-aligned governance.
- The platform protects proprietary workshop assets: archive images, product metadata, construction techniques, and generated designs.
- Identity management, resource ownership, and delegation mechanisms ensure that only authorised users can access data, outputs, and AI services.
- ClearML-based MLOps orchestrates model deployment and routes computational tasks to available GPU resources.

**Nome articolo / modello:**

SHOPPING BIANCO-GIALLO

**Link cartella Drive:**[https://drive.google.com/drive/folders/19TltM6Ml\\_V\\_8oY4MzNez2H3eqnqClcmJ?usp=de-link](https://drive.google.com/drive/folders/19TltM6Ml_V_8oY4MzNez2H3eqnqClcmJ?usp=de-link)**Codice articolo:**

SAP/AEN 016/ PT

**Anno di produzione:**

2025

**Tipologia borsa:**

Shopping

**Dimensioni:**

Altezza: 26cm | Larghezza: 30cm | Profondità: 15cm

**Materiale esterno:**

Pelle di vitello

**Colore esterno:**

esterno bianco e giallo

**Materiale interno:**

fodera in microfibra

**Colore interno:**

interno sabbia

**Costruzione:**

"Costruzione "a costa viva", si riferisce ai bordi laterali che sono tutti tagliati al netto del modello e rifiniti con varie fasi: Abrasione; Lucidatura; Applicazione di colore; Seconda lucidatura; Seconda applicazione di colore; Eventuali rifiniture finali.

Costruzione "in forma", si ottiene montando i vari componenti del corpo borsa su una forma di legno per ottenere la sagoma esatta del progetto. Le varie parti vengono incollate e poi cucite con una speciale macchina da cucire detta "a colonna".



# Solution Workflow

## 1 · Secure Archive Digitization

Metadata annotations by artisans with archival photos of crafts are handled in Snap4City, with controlled access, ownership, and GDPR-aligned governance.

## 3 · Heritage Knowledge Retrieval

A Retrieval-Augmented Generation (RAG) enables retrieval of images, metadata, techniques, and historical references.

## 5 · New Craft design generation

The enriched prompt, together with optional reference images, is sent to the generative AI models to produce new design concepts that reflect the workshop's visual identity, materials, and craftsmanship.

## 2 · Artisan Design Request

The artisan submits a design descriptive request of the desired product, style, materials, or design specific reference bag or digitized collections.

## 4 · LLM augmented prompt for generation

An LLM exploits this information to augment the generative AI prompt request



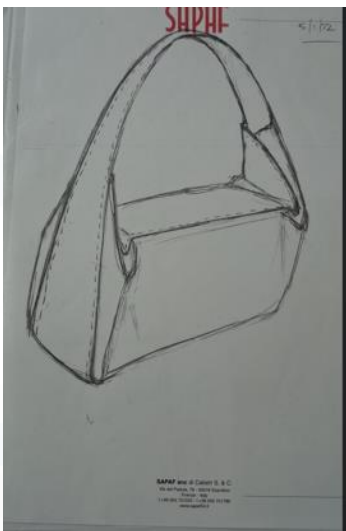
### Iterative Feedback

Artisans can propose new modification from the AI generated image



# Realistic Generation from Hand drawn initial sketch

- Artisans often start the design process with hand-drawn sketches, before selecting materials and developing physical prototypes.

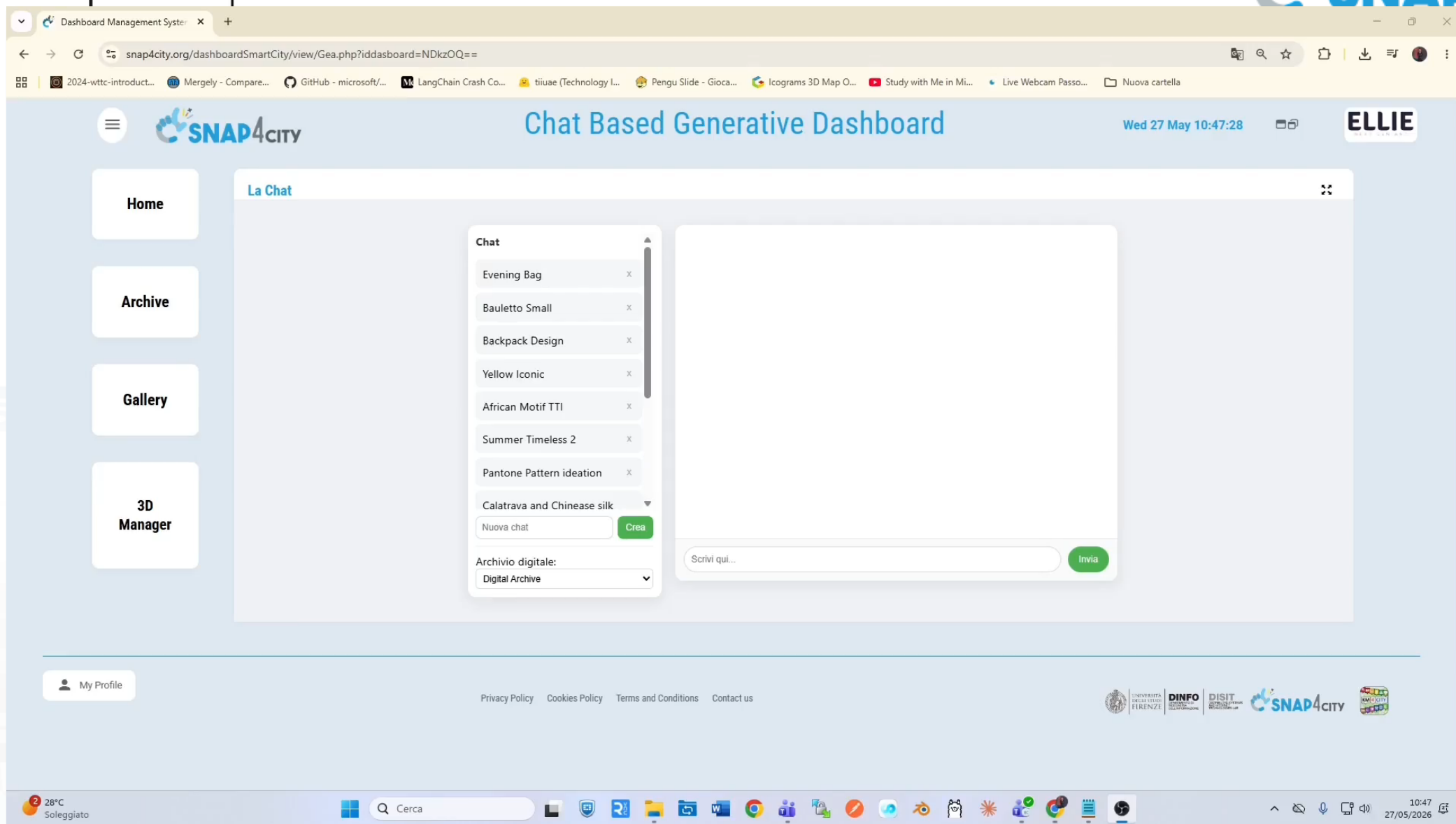


*“Generate a realistic leather bag from the provided hand-drawn bag sketch. Use the input image as the definitive design reference, preserving the original silhouette, proportions, contours. Render the bag in rich brown leather. Add 3D floral details in the front part of the bag”*



- The resulting visual prototype helps artisans explore alternatives earlier, before investing time and resources in material selection and prototyping.
- Artisans responded positively, recognising the value of turning sketches into AI-assisted visual prototypes.





The screenshot shows a web browser window displaying the SNAP4City dashboard. The browser's address bar shows the URL `snap4city.org/dashboardSmartCity/view/Gea.php?iddasboard=NDkzOQ==`. The dashboard has a light blue header with the SNAP4City logo, the title "Chat Based Generative Dashboard", the date and time "Wed 27 May 10:47:28", and the user name "ELLIE". On the left, there is a sidebar with buttons for "Home", "Archive", "Gallery", and "3D Manager". The main content area is titled "La Chat" and contains a chat interface. On the left of the chat area is a list of chat topics: "Evening Bag", "Bauletto Small", "Backpack Design", "Yellow Iconic", "African Motif TTI", "Summer Timeless 2", "Pantone Pattern ideation", and "Calatrava and Chinease silk". Below this list is a "Nuova chat" input field and a "Crea" button. To the right of the list is a large empty chat window. At the bottom of the chat window is a text input field with the placeholder "Scrivi qui..." and an "Invia" button. The footer of the dashboard includes a "My Profile" button, links for "Privacy Policy", "Cookies Policy", "Terms and Conditions", and "Contact us", and a row of logos for the University of Florence, DINFO, DISIT, SNAP4City, and the European Union. The Windows taskbar at the bottom shows the system clock as 10:47 on 27/05/2026, the weather as 28°C and "Soleggiato", and various application icons.

# The Validation Phase

Four company representatives:  
the owner, the CFO, and two  
product development and  
sales professionals involved

**8.3**  
out of 10, average

## 1 Innovative design detail

Material textures, decorative elements, stylistic proposals

## 2 Structural plausibility

Proportional handles, coherent geometry, buildable shapes

## 3 Coherence with the collection

Recognisable as belonging to this workshop, not a generic bag

### Where we are honest about the limits

- Qualitative evaluation, single workshop, 30 annotated artefacts
- Some distinctive construction details are still not faithfully reproduced
- Retrieval quality itself has not yet been measured

*Archive digitisation remains the bottleneck: more references, better retrieval, better generation.*



# Conclusions

- The proposed solution demonstrates that RAG AI generation preserves a workshop's heritage with respect to global, general-purpose generative models.
- Heritage data—including archival images, techniques, product information, and design knowledge—is proprietary and must be managed in secure, protected environments.
- Snap4City enables this approach by providing controlled data management, access permissions, governance, and integrated AI services.



- Snap4City at OSAKA with OPTIFaaS and CN MOST
- SMART3R-FLITS: SMART Transport for TRavellers and Freight Logistics Integration Towards Sustainability
- SOLUTION: Security, Smart City Asset Management for Cuneo, Italy [PDF](#)
- ENERGIA: R&S di autoclave a mandrini multipli nel curing di serbatoi in composito per storage di H2 mediante ottimizzazione energetica machine learning.
- UrbanDT4TF: Urban Digital Twin for Traffic Flow
- ELLIE: On the Use of Internet of Senses for the Cultural Heritage
- Snap4Rhodes: The "Single Smart City & Cyber Security Monitoring Platform" for the Municipality of Rhodes
- SADI-MIAC: Integrated Decision Support System with Digital Twin Models and Artificial Intelligence for Business
- SADI-MIAC: Sistema di Assistenza alle Decisioni Integrato con Modelli Digital Twin e Intelligenza Artificiale per le attività commerciali
- SCENARIO: City Users' Participation and Engagement with Snap4City, [PDF](#)
- OPTIFaaS: Operation and Plan, Transport Infrastructure and Facilities Support as a Service
- SOLUTION: 15MinCityIndex: understanding city areas by means of 13 different aspects, [PDF](#)
- SOLUTION: Energy Management and Control, [PDF](#)
- SOLUTION: Environment Control, Predictions & Prescriptions, [PDF](#)
- SOLUTION: Smart Light Control and Light Adaptive with Traffic Density [PDF](#)
- SOLUTION: Smart Tourism Management with Snap4City [PDF](#)
- SOLUTION: Traffic Infrastructure Optimisation: reducing travel time and emissions [PDF](#)
- SOLUTION: Traffic Light Plan Optimisation: reducing travel time, number of stops for vehicles and tramway lines: [PDF](#)
- SOLUTION: Snap4Building: monitoring, managing, controlling infrastructures [PDF](#)
- SOLUTION: Snap4City integration with Milestone X Protect, VMS, Video Management System [PDF](#)
- SOLUTION: Snap4City Digital Twin, [PDF](#)
- SOLUTION: eShare in a Snap - The innovative car sharing and car pooling service, [PDF](#)
- SOLUTION: Snap4City Smart Parking Manager and mobile App supports [PDF](#)
- SOLUTION: Exploit Snap4City in different Smart Waste use cases, waste manager, [PDF](#)
- eShare in a Snap - The innovative car sharing and car pooling service
- Digital Twin Cityverse FAQ to Snap4City
- AMMIRARE: make the beach system more resilient to climate change risks through the implementation of natural based solutions
- TOURISMO: TOURism Innovative and Sustainable Management of fLOws
- CAI4DSA: Collaborative explainable neuro-symbolic AI for Decision Support Assistant
- SASUAM: Solutions for Safe, Sustainable and Accessible Urban Mobility
- SCENARIO: Exploit Snap4City in different Smart Waste use cases
- SCENARIO: Smart City Asset Management for Cuneo, Italy
- Snap4City: Smart City Asset Management for Cuneo, Italy [PDF](#)
- Smart Light Control and Light Adaptive with Traffic Density (the actual case of Merano) [PDF](#)
- Key Performance Indicators KPIs for mobility e trasporti, MaaS, parcheggi, inquinamento [\(ITA\)](#)
- Snap4City integration with Milestone X Protect, VMS, Video Management System [PDF](#)
- SCENARIO: Smart Light Control, 2023, CAPELON, [PDF](#)
- Florence HeritData FactSheet: <https://www.snap4city.org/drupal/sites/default/files/files/FACTSHEET%20FLORENCE.pdf>
- SCENARIO: Smart City Living Lab in Romania, [PDF](#)
- Snap4PVenergy: Online Photovoltaic System Simulator
- SCENARIO: Fashion Retail Recommendation System via Multiple Clustering Approach
- SCENARIO: Energy Community, CER, SELFUSER
- SCENARIO: Supporting Decision Makers in Real Time about Quality Lab Analyses on the production process, [PDF](#)
- Herit-Data and Snap4City: to better manage tourism flows, [PDF](#)
- Digital Twin Local and Global, [PDF](#)
- Social Media Analysis: Twitter Vigilance, [PDF](#)
- GDPR Compliant People Detection and Counting using Thermal Cameras, [PDF](#)
- Artificial Intelligence Predicts Landslides in Florence Area, [PDF](#)
- Available Parking Slots Prediction, [PDF](#)
- Available Bikes and Free Slots Prediction On Bike Sharing Stations, [PDF](#)
- Long Term Prediction of NO2 KPI of European Commission reference values, [PDF](#)
- Inventory of transferable digital applications and solutions for the tourism ecosystem
- Scenario: AMPERE Operator Manual
- Scenario: IMPETUS Intelligent Management of Processes, Ethics and Technology for Urban Safety (Oslo and Padova)



<https://www.snap4city.org/4>



- **UrbanDT4TF**, CN HPC: Digital Twin mobility, <https://www.snap4city.org/drupal/node/1057>
  - **DI-DTPlatform**, CN HPC: Digital Twin, mobility, environment, <https://www.snap4city.org/drupal/node/1097>
  - **Sasuum**, CN MOST, PNRR: AI, mobility, <https://www.snap4city.org/drupal/node/999>
  - **OPTIFaaS**, CN MOST, PNRR: AI, mobility, DSS, <https://www.snap4city.org/drupal/node/1008>
  - **LeverageOPTIFaaS**, CN MOST: PNRR, mobility, <https://www.snap4city.org/drupal/node/1064>
  - **TOURISMO**, Interreg, EC: Tourism, NLP, DSS, <https://www.snap4city.org/drupal/node/1001>
  - **ELLIE**, Horizon Europe, EC: AI, VR, <https://www.snap4city.org/drupal/node/1056>
  - **CN MOST**, PNRR: sustainable mobility, platform, <https://www.snap4city.org/drupal/node/1050>
  - **ISPRA JRC contract**, EC: DSS, SOC, control room, energy, <https://www.snap4city.org/drupal/node/970>
  - **AMMIRARE**, Interreg, EC: AI, environment, Big Data, <https://www.snap4city.org/drupal/node/1002>
  - **CAI4DSA**, FAIR PE1, PNRR: AI, Neuro-Symbolic, PINN, NG-DSS, <https://www.snap4city.org/drupal/node/1016>
  - **SADI-MIAC**, RT, partner: AI, Tourism, Retail, Computer Vision, <https://www.snap4city.org/drupal/node/1055>
  - **SMART3R**, PRIN UNICagliari: mobility, DSS, <https://www.snap4city.org/drupal/node/1087>
  - **Tuscany X.0, EDIH**, TestBeforeInvest, Training on AI, Big Data, Security, HPC: <https://www.tuscanyx.eu/>
  - **Reg4IA**, AI for regional public administration, A project of presidency of national council
  - **SmartCyprus**, a project of Cyprus Ministry of Digital Innovation and Policy
  - **The IE**, PNRR: AI, NLP, LLM, Legal Aspects
  - **BullVIT**, RT, conv: AI, NLP, LLM on commercial phases
  - **Energia**, RT, conv: AI, PINN, DSS, on manufacturing
  - **RFI contract**: mobility, AI, DSS
  - **Salerno Port**: AI for container ID recognition and tracking
  - **Talent Hub**, ECRF, conv: NLP, match demand vs offer
- + currently: Merano, Salerno, Cuneo, Rhodes, Reverberi, Florence, IDTS, ALTAIR, etc.

# Booklets

- Smart City



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- Industry



[https://www.snap4city.org/download/video/DPL\\_SNAP4INDUSTRY.pdf](https://www.snap4city.org/download/video/DPL_SNAP4INDUSTRY.pdf)

- Artificial Intelligence



[https://www.snap4city.org/download/video/DPL\\_SNAP4SOLU.pdf](https://www.snap4city.org/download/video/DPL_SNAP4SOLU.pdf)



# Thank you for your attention

## AUTHORS

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## AFFILIATIONS

1 University of Florence

2 Foundation for Research and Innovation



3 - 5 NOV 2026 | BARCELONA

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