NEXT GENERATION INTERNET

SUCCESS STORY BOOK

Part #2

The NGI Enrichers project has received funding from the European Union's Horizon Europe Research and Innovation Programme under grant agreement 101070125.

NGI ENRICHERS TRANSATLANTIC

NGI ENRICHERS: THE TRANSATLANTIC FELLOWSHIP PROGRAM

The NGI Enrichers program supports European NGI researchers and innovators to spend 3-6 months in the US or Canada to work and collaborate with US and Canadian hosts, to promote knowledge-sharing and establish long-term collaborations on NGI technologies, services, and standards. The program provides travel funding, living allowance, and visa for visiting fellows from Europe, and supports both fellows and their hosts, with bootcamps, mentors, visibility, community building and more. Running from September 1, 2022, to August 31, 2025, the program is funded by the European Commission and contributions from the implementing consortium partners.

NGI ENRICHERS: THE TRANSATLANTIC FELLOWSHIP PROGRAM

NGI Enrichers aims to:

- Reinforce EU-US-Canada cooperation in the area of Next Generation Internet, and to establish a continuous dialogue among US, Canada and European innovators.
- Increase inclusiveness, by supporting a human-centered approach to technology development that is aligned with European social and ethical values, as well as sustainability.
- Sustain high-quality jobs by targeting skills mismatches, the need to empower workers, and ethical considerations relating to technological progress

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Visit our Website:
https://enrichers.ngi.eu/

OBJECTIVES OF THE SUCCESS STORY BOOK

The primary objective of the Story Book is to celebrate and illustrate the journeys and accomplishments of the NGI Enrichers fellows. By highlighting their innovative projects and the significant impacts they have made, this Story Book aims to inspire, inform, and engage you, readers, showcasing the transformative power of dedicated efforts and visionary initiatives. This first part covers the cohorts who traveled to Canada and to the United-States between May and December 2023.

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ACKNOWLEDGING OUR NGI ENRICHERS IMPLEMENTING CONSORTIUM PARTNERS

2023 NGI ENRICHERS

Click on the fellow's name to be directed to their presentation page

Ahmet Nuri Ozcivan – Türkiye -Smart City Digital Twin Framework for Environmental Analysis

Ambra Mariani – Italy - Shielding Quantum Processing Units from Cosmic Rays to Reduce Errors

Chiara Casoni – Spain - Bridging Borders: Expanding a European SME Network into the US Market

Chiara Vercellino – Italy - NISQ-emu – NISQ-READY Quantum Algorithms for Industry 4.0

Emanuele Marino – Italy - Self-Assembled Lasers Make Multiple Wavelength Transmission Viable

Frederico Reghenzani – Italy - PAIRS – Pervasive, Advanced, and Intelligent Real-time Systems

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2023 NGI ENRICHERS

Click on the fellow's name to be directed to their presentation page

Francesco De Dominicis – Italy - ARQ – Abatement of Radioactivity for Qubits

Giulio Sidoretti – Italy - THORN-ML – Transparent Hardware Offloaded Resilient Networks for RDMA-Based Distributed ML Workloads

Jason Pereira – United Kingdom - Out-of-Distribution Generalization in Quantum Machine Learning

Jhonatan Tavori – Israel - Enhancing Privacy and Fairness in Federated Learning via Dynamic Adversarial Regularization

Marouane Tliba – France - Immersive User-Centric Quality of Experience (QoE)

Martina Motta – Italy - AI Fashion and Actuated Knitwear for Privacy Protection

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2023 NGI ENRICHERS

Click on the fellow's name to be directed to their presentation page

Marwan El Charzli – Switzerland - AI-enabled Raman spectroscopy for pathogen detection in the food industry

Miguel Cabrita – Portugal - Post-mortem wind turbine downtime analysis with AI

Nurcan Tüfekci – Türkiye - Virtual Privacy: Understanding the Privacy Experience of Turkish Immigrants in the USA

Sumeyye Kaynak – Türkiye - Resilient Earth – Data-Driven Solutions for Extreme Climate Events

Tommaso Carraro – Italy - Neuro-symbolic Cross-Domain Recommendation

Vasili Manfredi – Italy - PIXEL VR – Photorealistic Imaging and eXact Modeling for Enhanced Virtual Reality

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Smart City Digital Twin Framework for Environmental Analysis

Ahmet Nuri Ozcivan
Türkiye

Track
Smart Cities / Environmental Risk
Host Organization
University of Iowa, Iowa, USA

Software Development Engineer

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THE PROBLEM

Problem definition

- Extreme weather events are increasing, disrupting daily life and straining public infrastructure.
- Current response systems are hindered by scattered data, poor coordination, and limited decision-support tools.
- Need: A user-friendly online platform to help communities prepare and responds more effectively.

Solution:

- Use **Smart City Digital Twins,** virtual models of cities built on comprehensive and real-time data, for planning and disaster response.

Main target audiences/stakeholders:

- **General public:** Local residents including small and minority communities
- **Institutes:** Universities, research institutes, environmental protection services.
- **Decision makers**: urban planners, municipalities and state agencies.

Who else is already doing this, and why is there an opportunity?

Many cities and research institutions have developed DT systems for disaster management. These tools have shown value in improving urban planning and resilience. However, their use in **climate resilience** and **community benefit projects** remains limited. There is a clear gap when it comes to making these tools accessible and impactful for local communities.

To address this, our project proposes a **scalable, web-based Digital Twin framework** that

(1)Integrates key data sources and systems;

(2)Uses data analytics and web technologies;

(3)Provides advanced visualization and simulation tools.

Deliver a pilot Digital Twin Pilot product to strengthen urban resilience and preparedness.

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YOUR SOLUTION

- This projects proposes advanced **web-based Digital Twin (DT)** system integrated with **Smart City (SC)** concepts to enhance disaster management and environmental risk assessment.
- Our framework leverages AI, big data, and digital twin technologies to deliver predictive insights and improve disaster preparedness.
- This framework provides an intelligent, interactive solution that supports decision-making, impact analysis, and emergency planning for urban resilience.

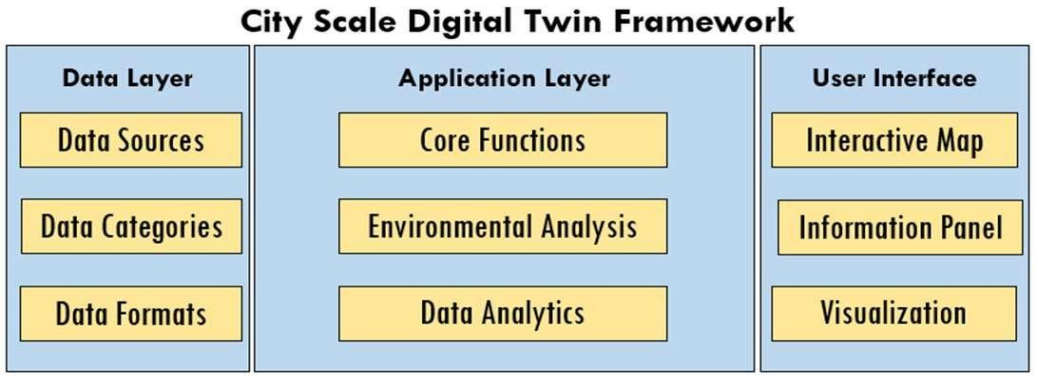
Differentiator: Fuses high-tech components to help cities better predict, understand, and respond to **environmental challenges**.

Competitive Advantage: Offers a **versatile**, **layered** visualization of city systems to identify cascading disaster impacts.

Opportunity: **Real-time data integration** with user-friendly visualization and analysis tools; pilot focuses on water-related disasters.

Technical Design: Web platform models disaster scenarios across regions, with an intuitive, **user-focused interface** as the DT system's core.

Size: Roadmap and **pilot in New Orleans** show practical application, enabling users to assess flood impacts and optimize responses..



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AHMET NURI OZCIVAN, RESEARCH FELLOW HYDROINFORMATIC LAB, UNIVERSITY OF IOWA

Short Bio: Dr. Ozcivan is an Electrical Engineer and Software Test Specialist. He is a visiting scholar at the University of Iowa HydroInformatics Lab (UIHILab). He received his PhD. in Electrical and Communication Engineering from Tohoku University, Japan. Dr. Ozcivan's research focuses on AI model development, data driven methods, software testing and behavioural driven data frameworks. Currently, he is conducting studies on development of digital twin systems equipped with next-generation web technologies focusing on environmental disasters.

Relevant publications/projects/results related to NGI

- Ozcivan A.N., Mermer O., Demir I., 'A comprehensive bibliometric study on digital twin frameworks on extreme climate events', 2025 (in preparation)
- Ozcivan A.N., Mermer O., Demir I., 'Web based analytical urban visualization and evaluation framework for natural hazards, 2025 (in review)
- Software Development: Smart City Digital Twin Framework (Web-based DT platform for city scale data analytic and environmental analysis)
- Smart City Digital Twin Framework for Environmental Analysis: Integrating AI, Urban Infrastructure and Real- time Data Analytics, Marie Sklodowska-Curie Postdoctoral Fellowship Programme, 2025 (in preparation)

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THE TEAM /EXPERTISE

Dr. Ibrahim Demir is the Director of UI Hydroinformatics Lab (UIHILab), and an Associate Professor at the Civil and Environmental Engineering, and Electrical and Computer Engineering departments at the University of Iowa. His research focuses on hydroinformatics, environmental information systems, scientific visualization, big data analytics, AI, intelligent systems and information communication. Dr. Demir currently serves as Associate Editor for Journal of Hydroinformatics (IWA) and Environmental Modeling and Software (Elsevier).

Dr. Omer Mermer is an Associate Research Scientist at University of Iowa HydroInformatic Lab (UIHI). He received his PhD. in Physics/Applied Engineering from University of Iowa. Dr. Mermer's research focuses on data driven approach, AI model development, feature engineering and intelligent sensor systems. Currently, he is conducting studies on ML/DL model development for HAB/streamflow prediction, AI based digital twin framework and next-gen web technologies.

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YOUR HOST ORGANIZATION

Host organization: University of Iowa Hydroinformatics Lab (UIHILab)
https://hydroinformatics.uiowa.edu/

- This project is conducted with University of Iowa Hydroinformatics Lab (UIHILab) and IIHR. UIHILab, which is leading in hydrology, environmental engineering, web technologies and Artificial Intelligence. research.
- UIHILab and team members has extensive experiences on the project related to the data analytics, web-based cyberinfrastructure, Environmental Information Systems. In this project, data preparation/pre-processing and data visualization and analytics will be realized by using on a high- performance computing cluster at the University of Iowa with GPU nodes (NVIDIA P100 GPUs and 1.5 TB RAM).
- University of Iowa-Information Tech Facility has 70 Linux workstations and more than 240 individual PCs supporting the local centralized facilities. There are also 30 PC-based servers handling web, ftp, and specialized database services.

NGI experience :

UIHILab has active role in NGI Enrichers Transatlantic Fellowship Programme to host fellows .

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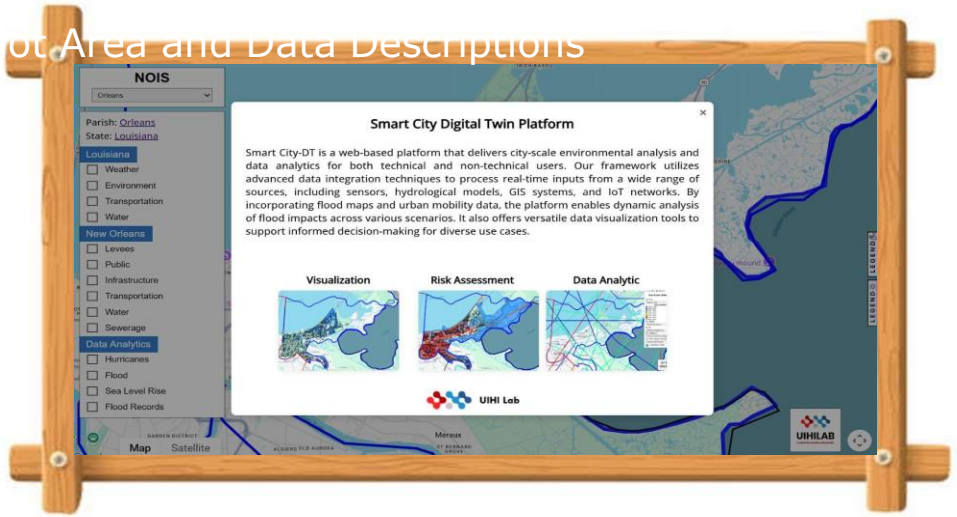
KEY RESULTS (1)

ot Area and Data Descriptions



- Reviewed 50+ research papers on digital twins and urban resilience.
- Selected New Orleans, LA as pilot site—prone to floods, hurricanes, and stormwater issues.
- Integrated multi-source data layers (e.g., NOAA,FEMA).
- Implemented application layer for Digital Twin modeling.
- Built a user interface with graphs, tables, and simulation tools

FIELD	Category	Display name
Louisiana	Weather	Weather, Daily Temperatures, Drought Map Drought Statistics, Rain (1981-2010) Max Temp (1981-2010), Wind Speeds, Hurricane
	Environment	Environment, Rivers, Streams, Surface Geology Soil Map, Coastal Zones
	Transportation	Transportation, Highways, Rail Network, Evacuation Routes
	Water	Water, Watershed Regions, Aquifers, Drinking Water Wells, Hydro Basins, LA Water Bottoms (SLABS) Levees, Flood Gauges, Dams, Inland Water Bodies
New Orleans	Levees	Levees, Gates, Boreholes, Crossings, Stations, Piezometers, Pump Stations, Relief Wells, Pipe Gates, Alignment Lines, Pipes, Closures, Embarkments, Flood Walls, Levee System Routes, Leveed Areas
	Public	Public, Population, Population Details, Public Facilities, Public Libraries, Police Stations, Schools, Universities
	Infrastructure	Infrastructure, Parcels, FIRM Panels, Building Footprints, Historic Places, Historic Districts, Archeological Areas, Historical Districts
	Transportation	Transportation, Roads, Highways, Railways, Federal and State Highways, Evacuation Spots, Evacuation Routes, Road Nodes, Road Edges
	Water	Water, Base Flood Elevation, Underground Tanks
Data Analytic	Impacts	Hurricanes, Flood (1%, 0.2%, reduction), Sea Level Rise
	Hurricanes	By year, By name, By ID, By Category
	Sea Level Rise	Sea Level Rise (0ft – 10ft)
	Flood Records	50 Years – 100 Years – 500 Years
	Storm Water	Sewerage, Water Buildings, Canals, Pump Stations, Rain Gauge Stream, Sewer Basins, Sewer Pump Stations, Manholes, Valves

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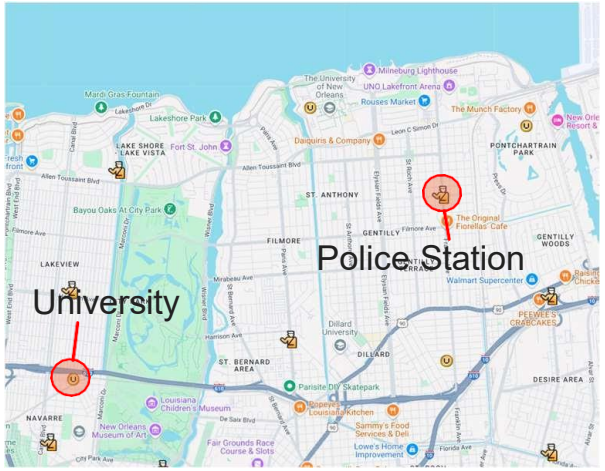
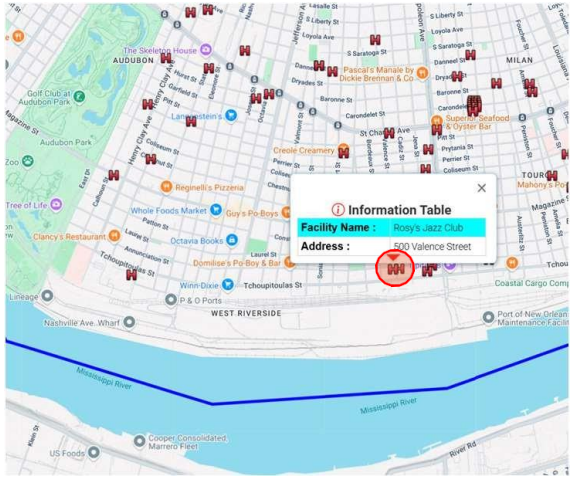
KEY RESULTS (2)

Buildings and Important Facilities

Police Stations and Universities



Historical Buildings



- Combine population & infrastructural data.
- Offer intuitive and comprehensive data visuals.
- Enable interactive user experience.

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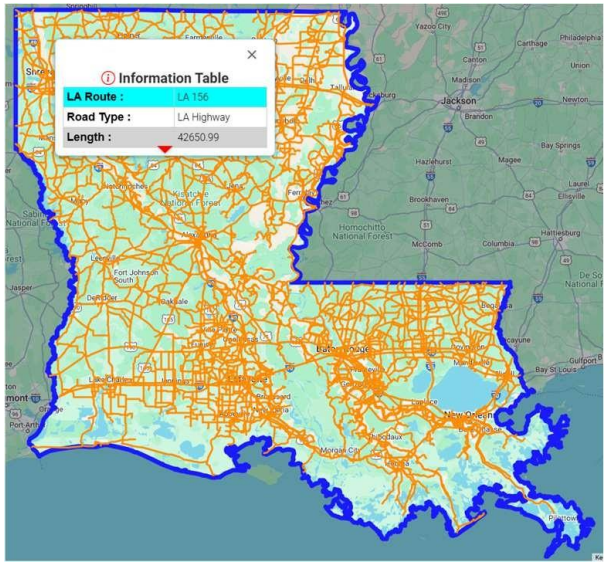
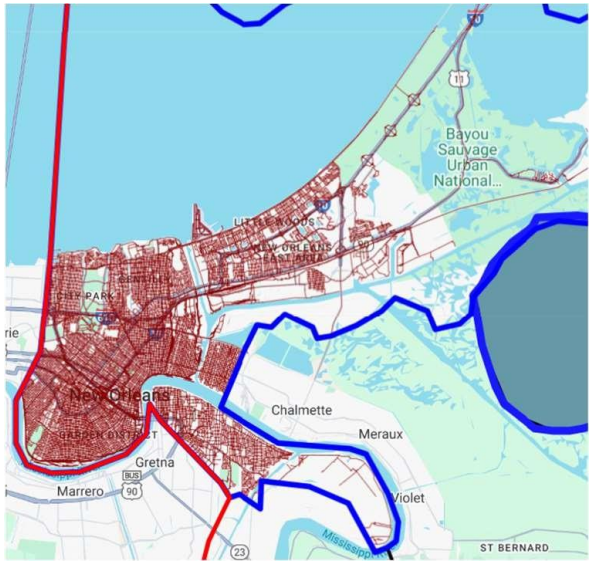
KEY RESULTS (3)

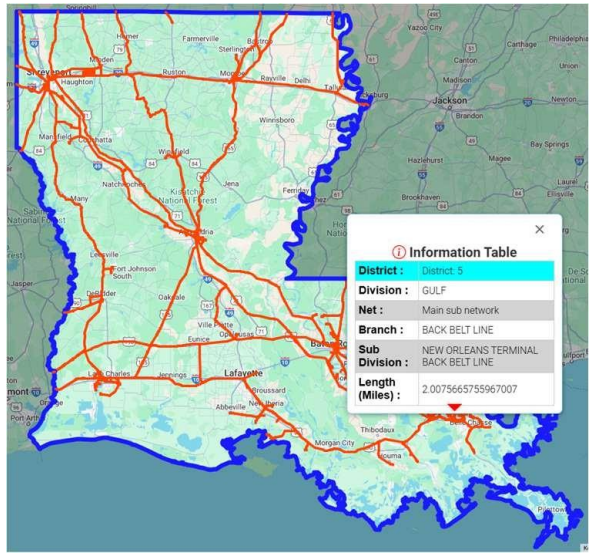
Highways



Public Roads



Railways



- View all road and rail types in New Orleans at state and parish levels.
- Road inundation analytic is critical

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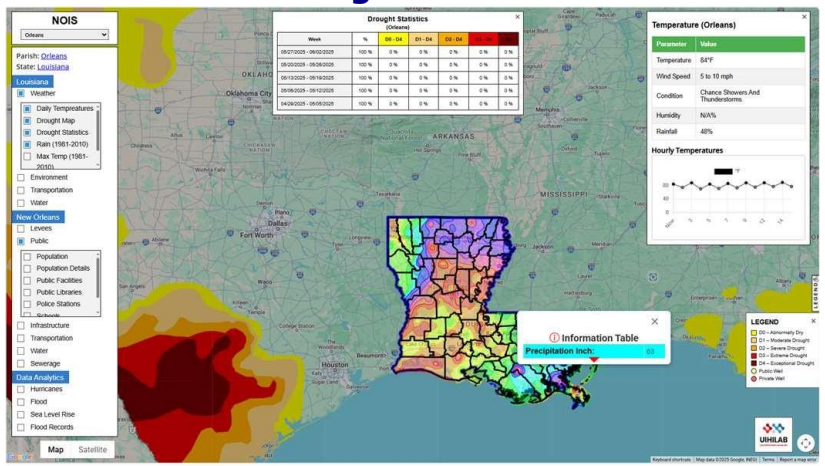
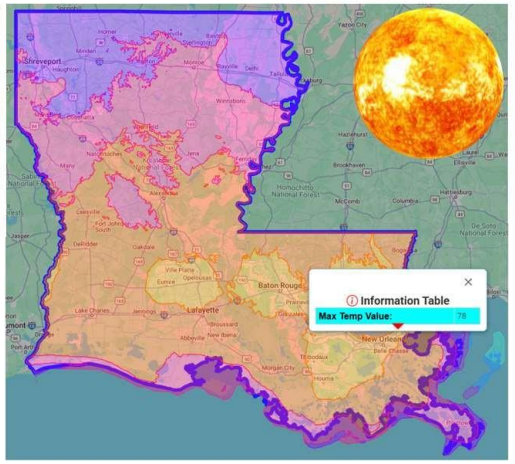
KEY RESULTS (4)

Recent Drought and Rain Info



Wind Zones

Max Temp History



- View past and current data.
- Informative panels highlight key historical events.

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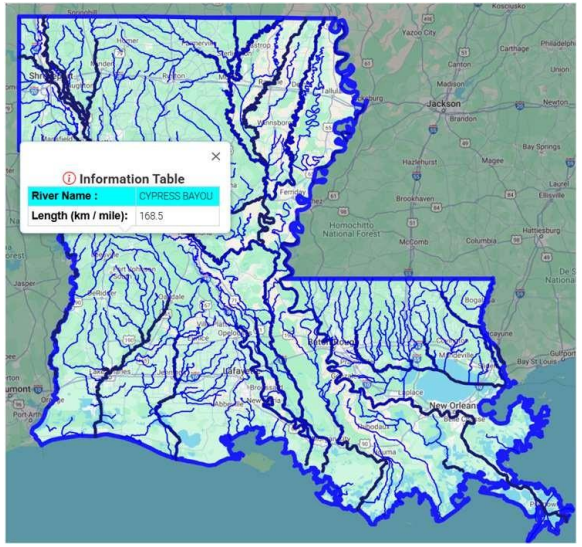
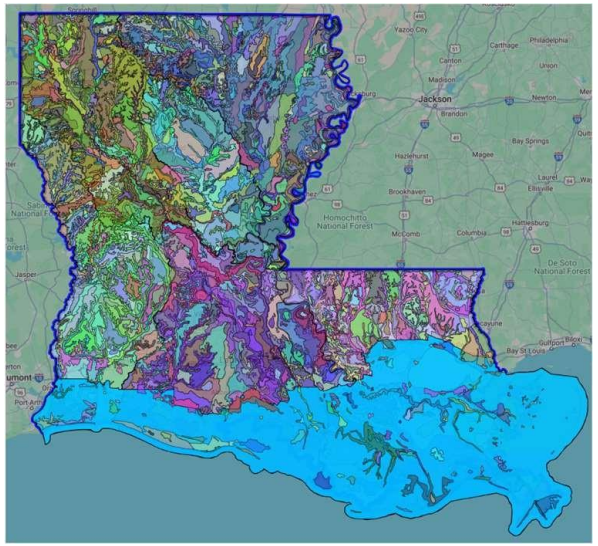
KEY RESULTS (5)

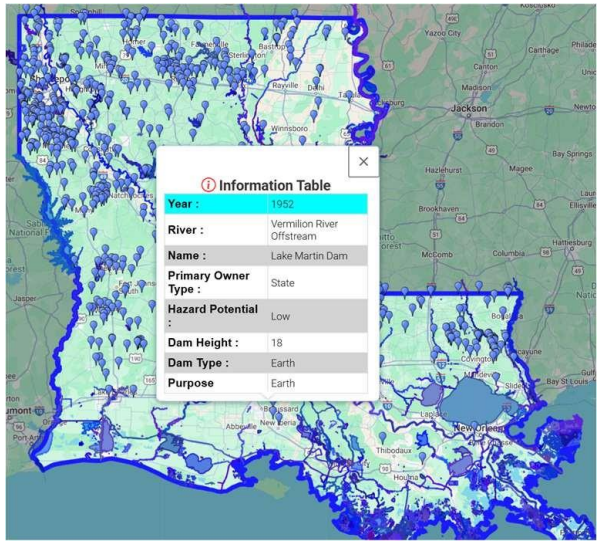
Watersheds and Streams



Surface Geo and Costal Zones



Water Bodies and Dams



- Interactive visualization of water bodies and potential flood sources

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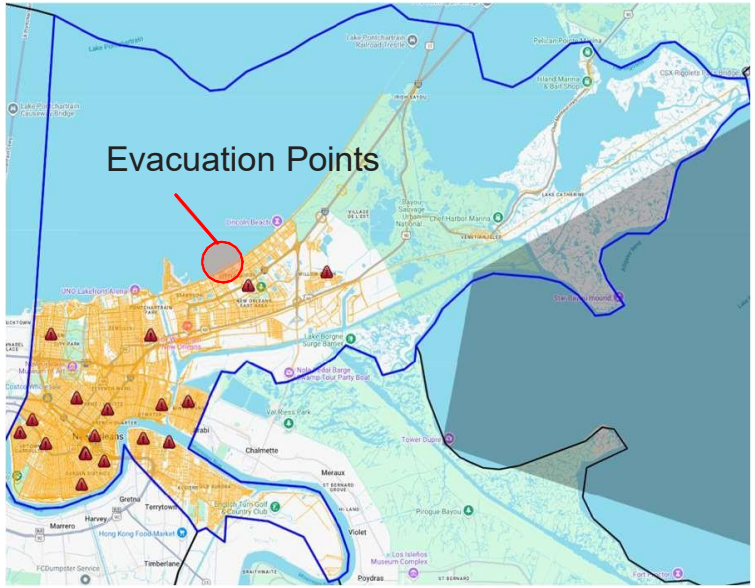
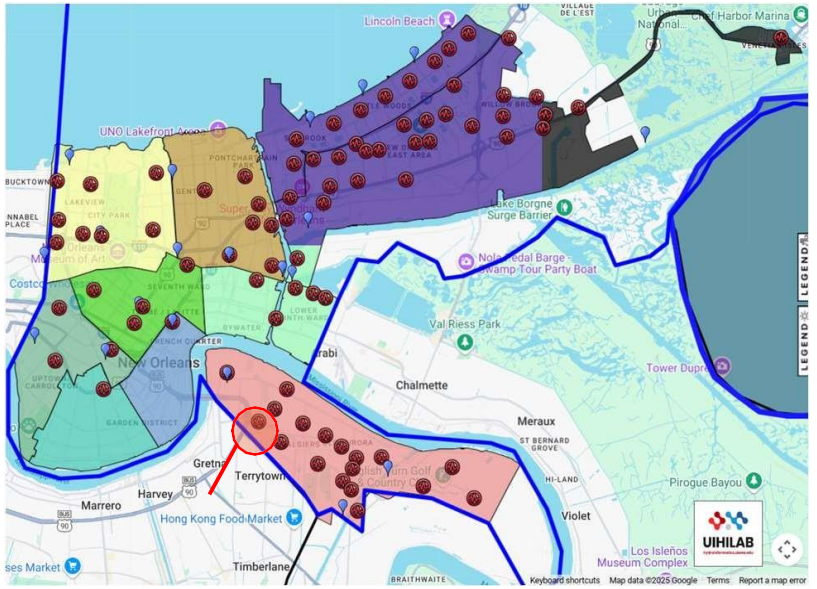
KEY RESULTS (6)

Sewer Analyze



Sewer Regions, Canals and Pumps



- Stormwater can damage infrastructure and require evacuation planning.
- Heavy rainfall may overwhelm drainage, causing urban flooding.
- In coastal areas, backflow at outfalls can flood upland drainage systems

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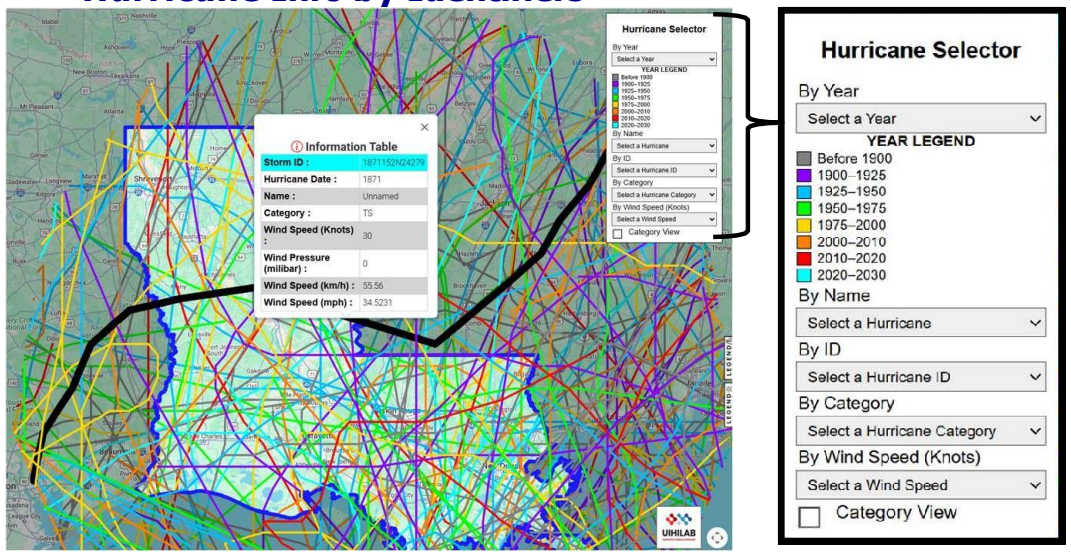
KEY RESULTS (7)

Use Case 2 : Hurricane Impact

Hurricane Info by Identifiers



Scenario Studies

Hurricane Katrina's floodwaters isolated entire districts and cut off evacuation routes.

- Destruction results from high winds, heavy rain, and storm surges.
- Consequences are both immediate and long-term.
- Flooding and surges damage water pipes, treatment plants, and sewage systems.

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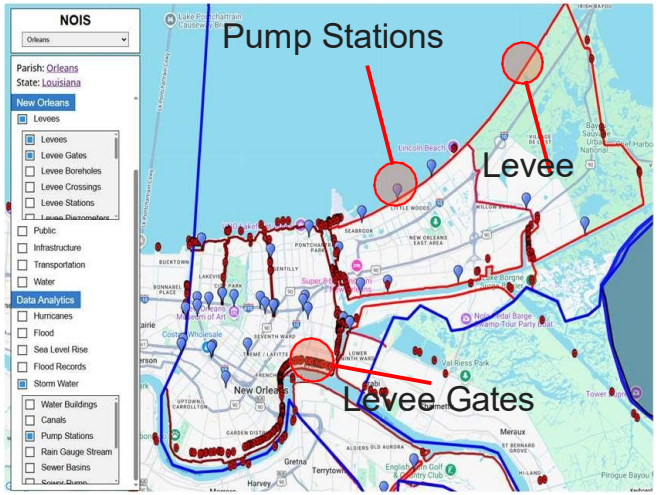
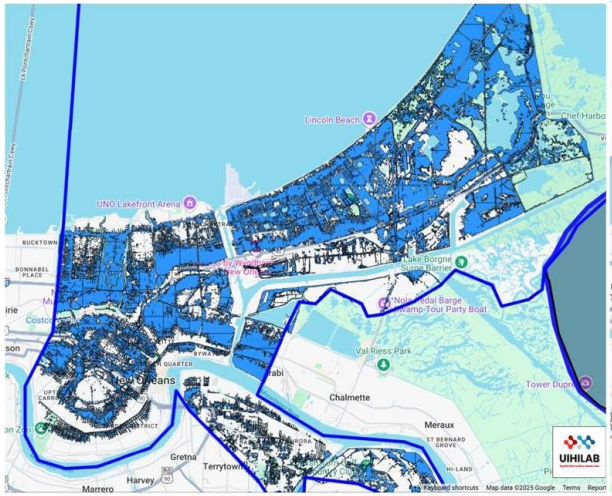
KEY RESULTS (8)

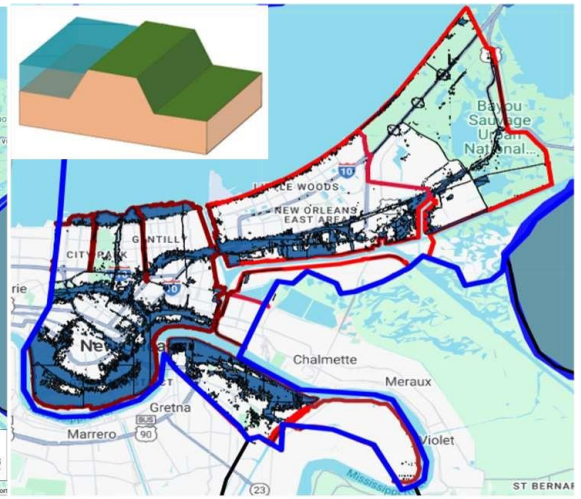
Levee Analysis



500-year Flood Map



Levee Impact on Flooding



- Distribution of levees and pump stations in mitigating flood risks across the region.
- Widespread flooding shown in 500-year flood scenario in low-lying areas.
- Levees significantly reduce flood extent and protect urban infrastructure.

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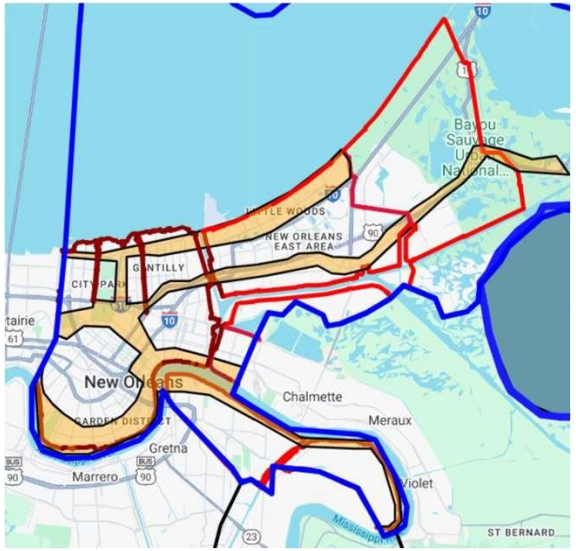
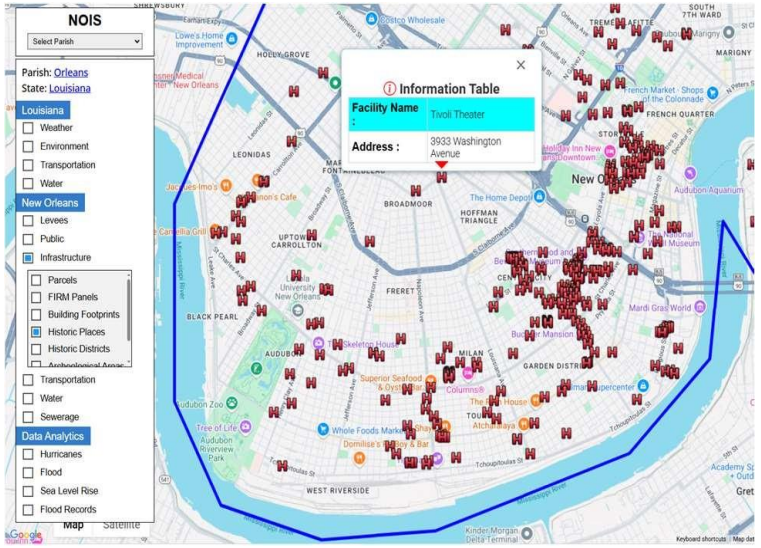
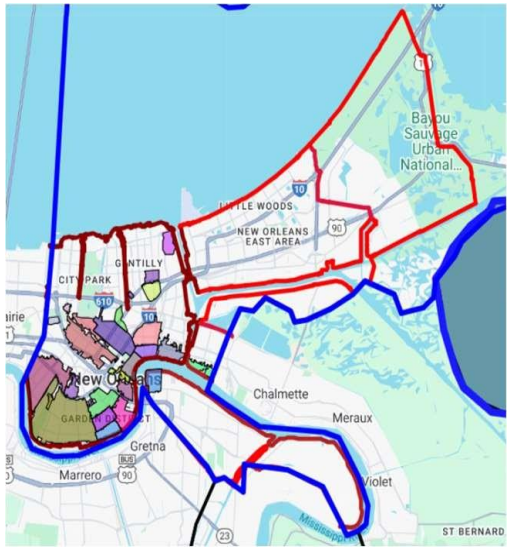
KEY RESULTS (9)

Archeological Areas



Historical Buildings, Districts and Levees





- Flood risk to archeological zones and heritage buildings.
- Structural damage from hurricane Katrina, Ida, and levee breaches.
- Historic districts vulnerable to water damage and collapse.
- Museums and archives rely on pumps for protection.

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KEY RESULTS (10)

Key achievements

- Conducting a comprehensive literature review
- Analysing current Digital Twin systems
- Preparing comprehensive dataset
- Developing **Smart City Digital Twin framework**
  - a user-friendly, web–based, versatile
- Advanced visualization for environmental variables
- Flood damage and risk analysis
- Storm Water Management.

Publication related to NGI Enrichers

- Ozcivan A.N., Mermer O., Demir I., 'Web based DT platform for city scale data analytic and environmental analysis, 2025 (in review)
- Ozcivan A.N., Mermer O., Demir I., 'The Evolution of Digital Twins in Hydrology and Environmental Science: From Physical Models to Autonomous Systems', 2025 (in review)
- Ozcivan A.N., Mermer O., Demir I., 'A comprehensive bibliometric study on digital twin frameworks on extreme climate events', 2025 (in preparation)

Impact of the fellowship

The NGI Enricher fellowship has significantly influenced both the direction of my projects and the advancement of my professional career.

Proposal developments

- Smart City Digital Twin Framework for Environmental Analysis: Integrating AI, Urban Infrastructure and Real-time Data Analytics, Marie Sklodowska-Curie Postdoctoral Fellowship Programme, 2025 (Under development)
- DT framework for Power Transmission Systems, UK (Under development)
- Smart City Digital Twin Framework for Disaster Risk Assessment, Finland (Not funded)
- BIM-Based Digital Twin Framework for Disaster Risk Assessment, Spain (Not funded)

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KEY RESULTS (II)

Initiative/Outcome	Description/Details
Development/advancement of innovative technologies	Online, user-friendly web platform for public interaction as a twin of the physical environment.
Testing technologies (demo, pilot)	Advanced DT (Digital Twin) platform applied to a demo zone in Louisiana, based on Orleans Parish.
Strengthening research collaboration with the US/Canada	Engaging with diverse research labs and federal agencies.
Building solid connections and partnerships in Europe and in the US/Canada	In US, utilizing USGS, FEMA, and NOAA data for public benefit.
Accelerated contacts/engagements with R&D partners for future collaborations	Establishing strong connections with USGS and FEMA.
Reinforced integration of social sciences and humanities in the project	Addressing social impacts of environmental effects through a public-serving web platform.
Expanding collaboration within the NGI community	Exploring further project opportunities with the NGI community.
Paper submission for further publication	Preparing peer-review journal articles.
Conference attendance with paper/poster/proceedings	To be presented at an international conference.
New Jo[illegible]opportunities	*Scaling the pilot study to a digital twin framework benefits administrative staff and the public in environmental decision-making.*

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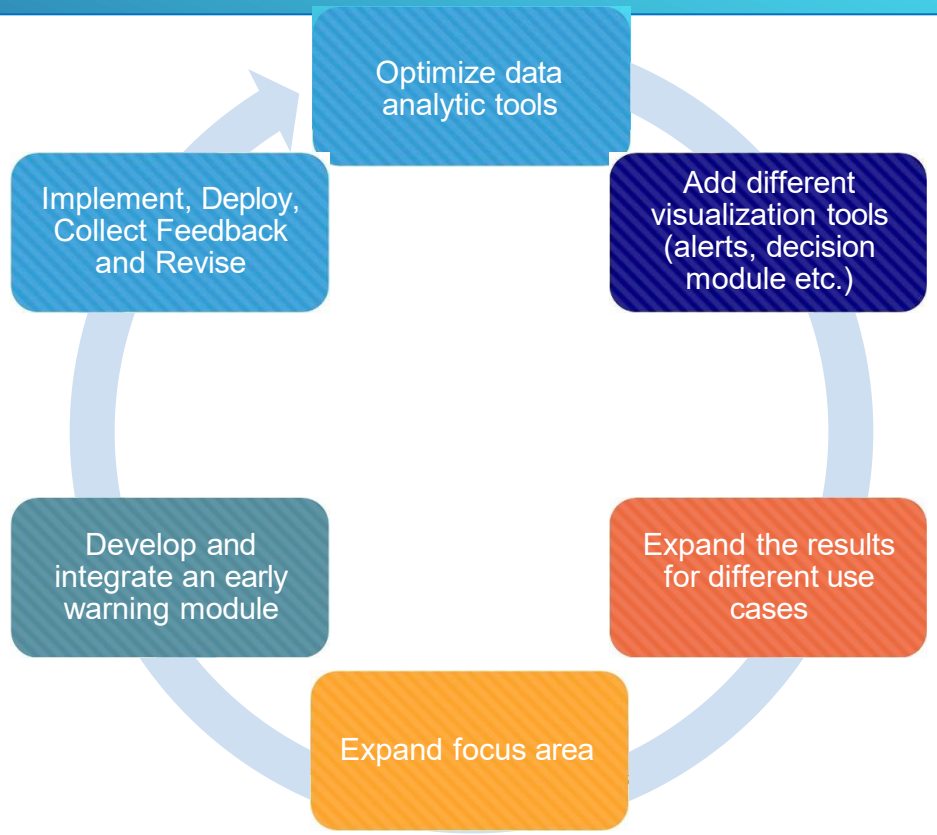
IMPLEMENTATION

Implement on advanced decision support modules

- Increase data analytic tools in web system.
- Develop early warning system for live tests and interaction.
- Expand results with different use cases and locations.

Implement at local authoroties

- Deploy and test the system for municipalities
- Continously improve the system according to the feedback from local authoroties.



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EXPECTED IMPACT

Human Centric & Public Benefit:

- **Digitalization and Interoperability:** Improves city management by combining areas like transportation, weather, and infrastructure into one system. Ensures systems work together by using open data standards, making it easy to connect with current systems.
- **Diversity and Equity:** Helps different groups, such as public transport users, city planners, and emergency workers. Makes disaster management tools easy to use and suitable for people from different backgrounds and locations.

Ethical Considerations:

- **Data Privacy and Sovereignty:** The project keeps urban and environmental data safe and private, using strong protection methods**.** It does not use any personal data or break privacy rules.
- **Fairness:** The project uses a diverse dataset for detection to avoid bias.
- **Transparency and Explainability:** The model, its data, and code will be shared openly on GitHub and UIHI Lab. Extra tools will help explain how the model works.

LESSONS LEARNED

What you wished you had known prior.

- Learning and adapting to new tools and mapping systems takes more time than anticipated.
- Data collection and preparation are more time-consuming than expected.

Good "surprises"

- The host laboratory had a well-established academic background and portfolio.
- Support from the host team significantly facilitated our progress.

Bad "surprises"

- Identifying the pilot area and sourcing relevant data took longer than planned.
- Customization and performance issues in web programming posed technical challenges.

Any challenges, personally and professionally

- Gained valuable skills in novel monitoring techniques and hydrology.

Impact of those lessons learned

- Data collection, preparation, and pre-processing are critical and time-intensive
- Future planning should account for this effort.

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Ahmet Nuri OZCIVAN

Software Development Engineer

Ahmet Nuri OZCIVAN

ahmettonuri@gmail.com, ahmetnuri-ozcivan@uiowa.edu

(N/A)

Profile

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Keep engaged with our NGI Fellows !

The NGI Enrichers project has received funding from the European Union's Horizon Europe Research and Innovation Programme under grant agreement 101070125.

Shielding Quantum Processing Units from Cosmic Rays to Reduce Errors

Ambra Mariani
Italy

Researcher affiliated with INFN

Track
Quantum Computing / Hardware Reliability
Host Organization
Fermilab, Illinois, USA

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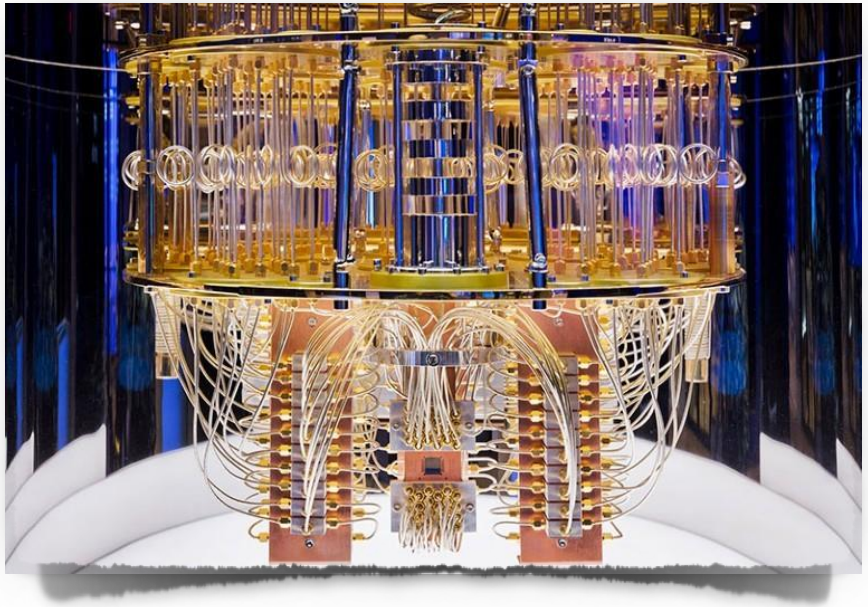
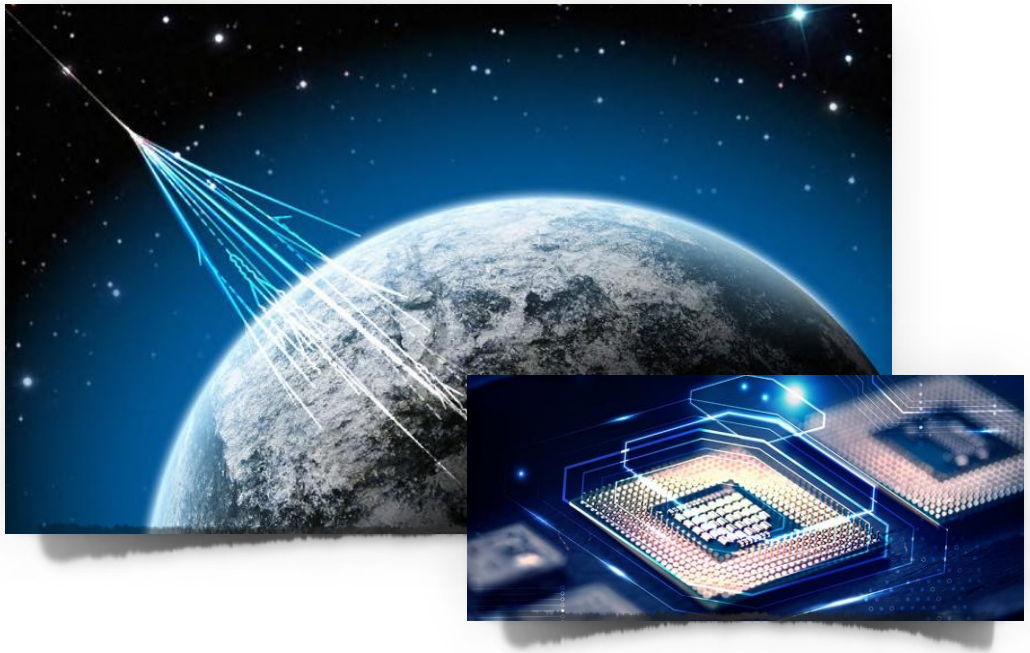
THE PROBLEM

Quantum computers are powerful tools for solving complex problems, but highly **error-prone.**





Cosmic-rays, particularly muons, are one **source of errors.**

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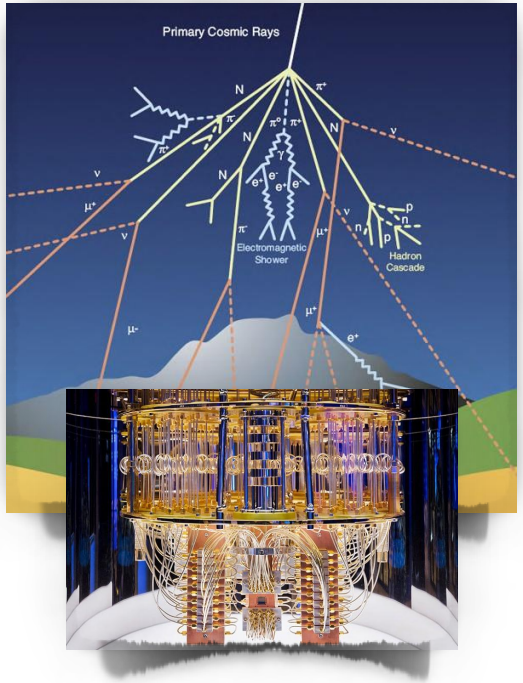
THE PROBLEM

When the ball hits the pin, **it disrupts the qubit's state**.

Information loss!

CURRENT SOLUTION: Deep-Underground labs



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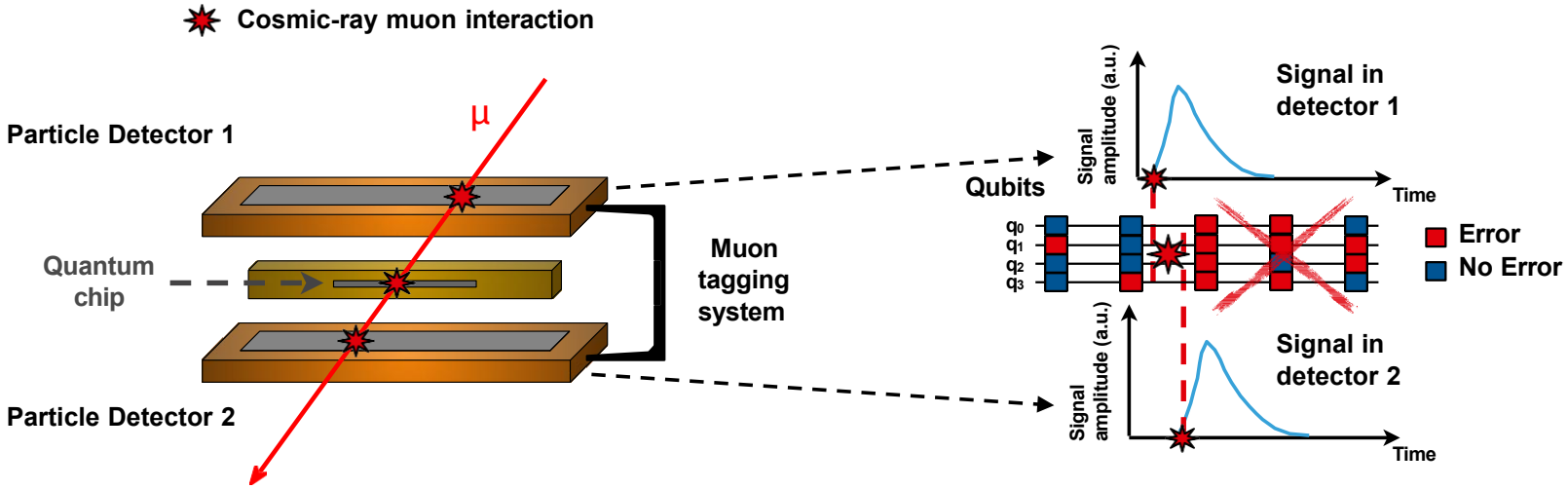
MY SOLUTION

A superconducting quantum chip equipped with a muon tagging system designed to detect and mitigate errors caused by cosmic-ray muons.



- Muons are quickly identified through nearly simultaneous signals from the two particle detectors.
- Operations affected by a muon impact are discarded, mitigating errors and improving the performance of the quantum chip.

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HOST ORGANIZATION & TEAM

SQMS
SUPERCONDUCTING QUANTUM MATERIALS & SYSTEMS CENTER

Fermilab's Superconducting Quantum Materials and Systems (SQMS) Center, Batavia, IL, U.S.

THE TEAM (besides me):

L. Cardani (INFN)

M. Vignati (La Sapienza)

A. Cruciani (INFN)

V. Pettinacci (INFN)

T. Roy (FNAL)

D. Van Zanten (FNAL)

M. Bal (FNAL)

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KEY RESULTS

(1) Detector Prototypes

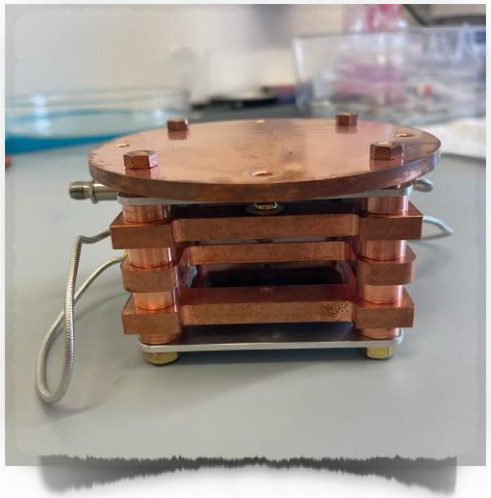
- Fabricated the first prototypes for the **muon tagging system**.
- Currently under testing in Rome to evaluate performance.

(2) Acquisition Software

- Developed a pilot version for data collection from four qubits.
- Supports analysis of **correlated errors** caused by muons.

(3) Dissemination

- Preparing **two papers**:
  - Data acquisition software;
  - Muon tagging system characterization.
- Results to be presented at **international conferences** to ensure visibility and impact.



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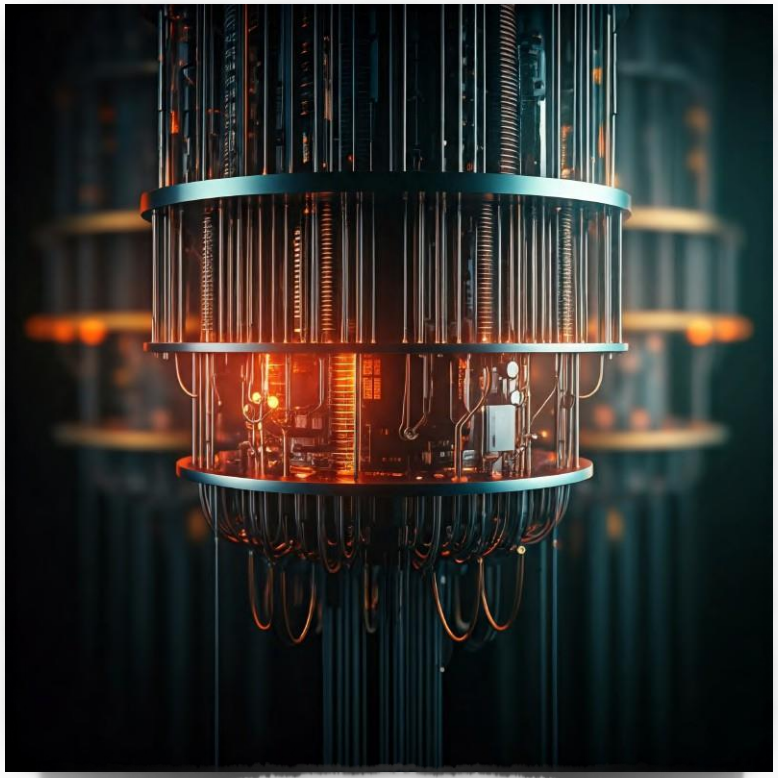
NEXT STEPS & EXPECTED IMPACT

NEXT STEPS:

- Test with Quantum Chip & Muon Tagging System
  - Assess error mitigation and its impact on qubit performance.
- Expand Software to Handle More Qubits
  - Paving the way for integration with full-scale quantum processors.

EXPECTED IMPACT:

- Advancing Quantum Technology
  - Improving quantum processor reliability and resilience to radiation.
- Practical & Scalable Solution
  - A more accessible alternative to underground labs for research and industry.



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Ambra Mariani

Researcher affiliated with INFN

Ambra Mariani

ambra.mariani@roma1.infn.it

Video

(N/A)

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Keep engaged with our NGI Fellows !

The NGI Enrichers project has received funding from the European Union's Horizon Europe Research and Innovation Programme under grant agreement 101070125.

Bridging Borders: Expanding a European SME Network into the US Market

Chiara Casoni
Spain

Head of Business Development & Partnerships at Gataca

Track
Digital Identity / Self-Sovereign Identity (SSI)
Host Organization
HIDWashington, D.C., USA

NGI ENRICHERS TRANSATLANTIC

THE PROBLEM:
GLOBAL SSI EFFORTS ARE SILOED

Self-sovereign identity technology (also referred to as decentralized identity, digital identity, or SSI) is gaining traction worldwide. Europe has launched a region-wide regulation, eIDAS 2.0, accelerating the adoption of this technology. In the United States, the DHS and its partner network, as well as other individual states, have launched their own initiatives to increase the awareness of SSI.

The market is moving fast in both regions, but as an SME, it is impossible to target both markets without losing significant resources along the way. Additionally, the US and EU efforts are being developed in parallel, and in order to assure we can target both markets, we must ensure interoperability.

Gataca, based in Spain, was lacking significant exposure in the US and resources, limiting our capacity to enter it successfully. HID, Gataca's partner, was interested in entering the space but lacked expertise.

In order to increase our impact in the US market and compete against US competitors, we needed Gataca's local presence in the US to guarantee an efficient analysis and execution of joint commercial strategies.

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THE SOLUTION:
COMBINE TECHNICAL EXPERTISE AND LAUNCH JOINT COMMERCIAL EFFORTS

Since 2018, Gataca has been developing and implementing SSI technology.

Gataca's technology includes:

1. **Mobile ID Wallet**: ID wallet in user's phone than can store tamper-proof identity credentials securely, and lets them easily prove who they are when accessing online services
2. **Gataca Studio**: An SSI platform that streamlines the issuance, verification, and management of identity credentials and enables 1-click onboarding and sign-in processes for users

By joining the HID team in the US, Gataca will be able to:

Deepen the relationship with HID

Accurately design a joint commercialization strategy

Provide teams with hands-on technical and commercial

Initiate commercialization efforts in-person

Market Size

The global decentralized identity market was valued in 2022 at $285M, and is expected to grow to $6.822 million by 2027, with a CAGR of % (Source: MarketsandMarkets).

In addition to deploying our technology in the European public and private sector, we've established ourselves as SSI domain experts. We have particpated in European projects such as NGI eSSIF-Lab, EBSI Early Adopters Programme, and EUDI Large Scale pilots.

👨‍💻 Technology differentiators

- Blockchain/infrastructure agnostic technology
- On-premise & SaaS deployment options
- Easy integration of traditional IDV provider technology

🎖️ Leadership differentiators

- Active participation in the definition of standards with standardization organizations and regulators
- Proven product market fit in Europe through existing contracts with governments, universities
- Sought-after leader in cross border interoperability**:** Gataca has represented Europe in bilateral conversaions between Canada and Africa

🤝 Commercial differentiators

- Partnership with global security manufacturer, HID

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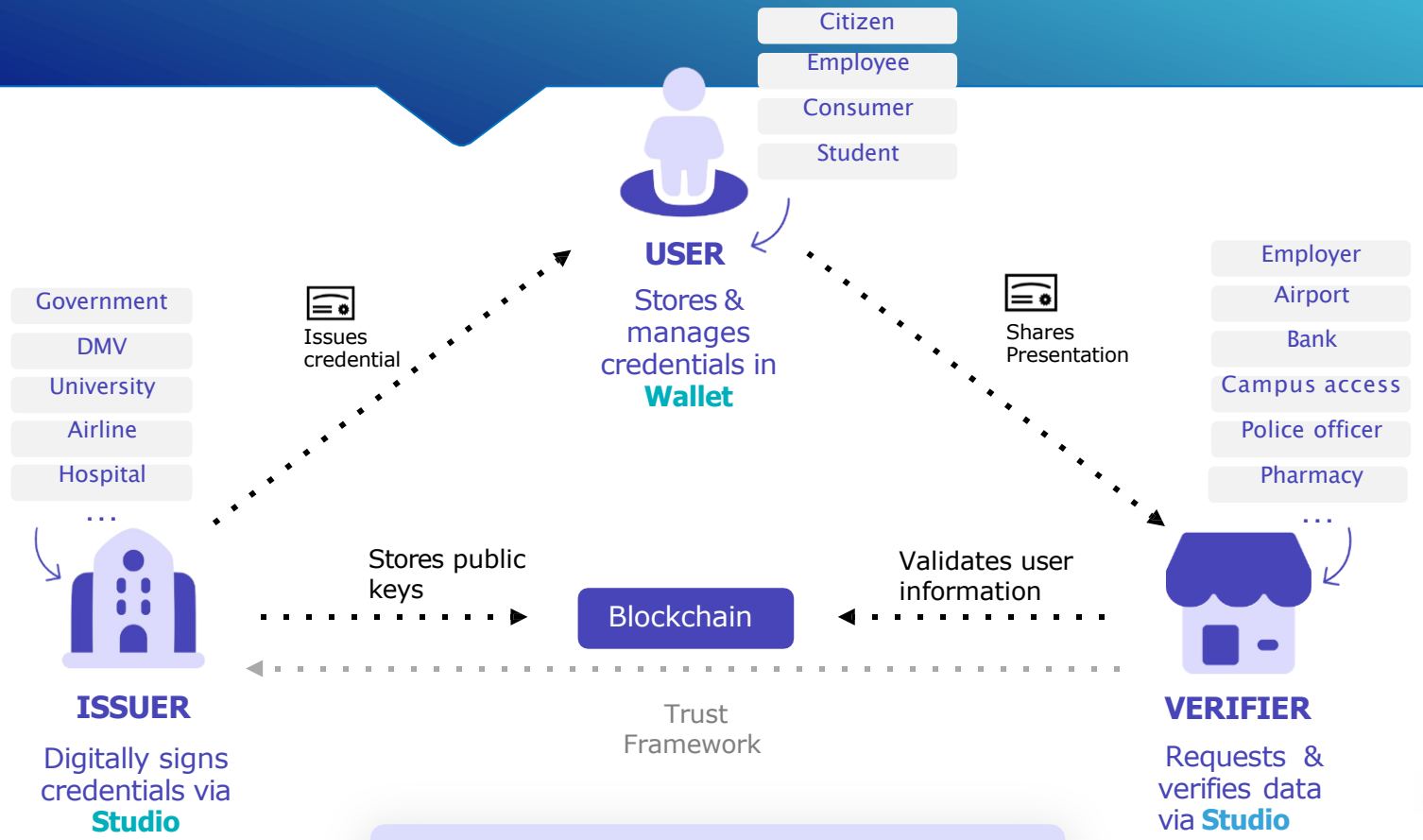
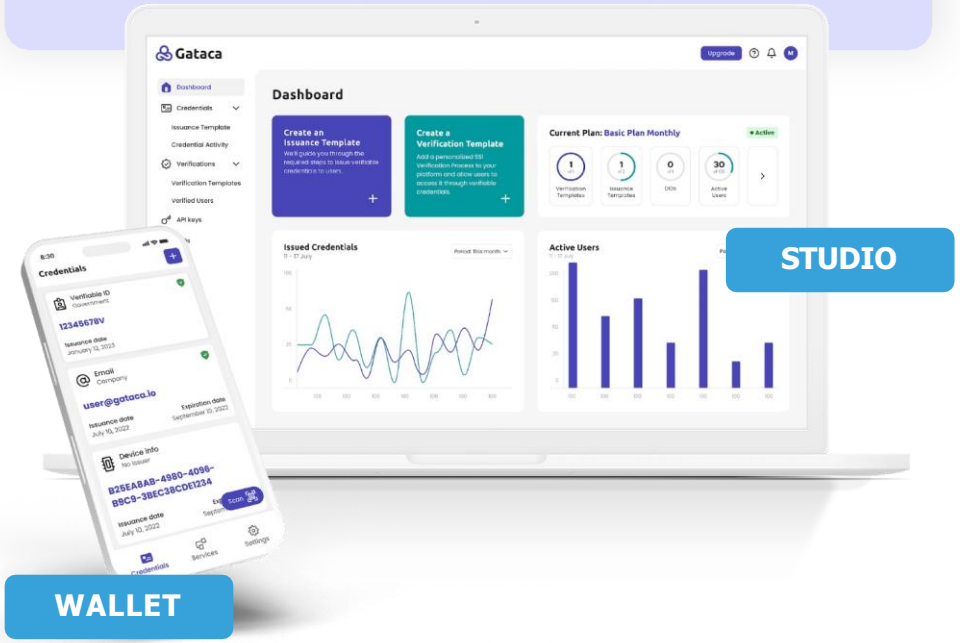
THE SOLUTION



Gataca provides the technology components and applications for each stakeholder.

- Issuers and Verifiers leverage **Gataca Studio's issuance and verification** capabilities
- Users leverage the **Gataca Wallet** to securely store, share, and control access to their personal data



SSI has 3 main stakeholders:

1. **Issuers** of ID Credentials
2. **Holders** of ID credentials (users)
3. **Verifiers** of ID credenitials (3rd parties

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CHIARA CASONI, BUSINESS DEVELOPMENT AT GATACA

I am currently the Head Of Business Development and Partnerships at Gataca.

I joined the team in the beginning of 2021, as the 5th team member, originally to lead marketing and communications efforts. After a year, I transitioned to lead business development and partnership efforts which include defining and executing the global outbound efforts for the company.

My responsibilities and achievements at Gataca include:

- Designed, launched, and currently leading the global **partnerships program** at Gataca
- Lead outbound efforts with **governments, universities and banks** in Europe
- Manage key commercial relationships with strategic partners
- **Finalist pitcher** at Web Summit 2022, and designated speaker at other conferences such as MWC, Identity Week, Global Platform Seminar
- During marketing role, **yearly marketing strategy design and execution including all content development**

Gataca's has won the following NGI Grants:

1. NGI Essif-Lab IOC - European Union's Horizon 2020 Research and Innovation Programme, under Grant Agreement Nº 871932
2. NGI Essif-Lab BOC - European Union's Horizon 2020 Research and Innovation Programme, under Grant Agreement Nº 871932

- ✓ Bachelors of Science in Economics & Entreprenership from Babson College, USA
- ✓ International experience working in US corporations & startups
- ✓ MIT MBA 2026 Candidate

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GATACA FOUNDING TEAM

IRENE HERNANDEZ
CHIEF EXECUTIVE OFFICER

- Founder & CEO of Gataca
- MIT Media Lab researcher, MIT MBA
- 15 years advising multinationals on IT strategies (Telefonica, Airbus, and Siemens)
- Blockchain and SSI educator (OBS Business School)
- International public speaker

SAMUEL GOMEZ
CHIEF TECHNOLOGY OFFICER

- Co-founder & CTO of Gataca
- European Commission SSI domain expert
- Blockchain professor
- 15 years software development
- Blockchain leader at Grant Thorton & Head of Tech team at BQ

JOSE SAN JUAN
CHIEF SECURITY OFFICER

- Co-founder & CTO of Gataca
- Cybersecurity expert with 10 years software development experience
- Cybersecurity & engineering leader at BBVA
- SSI interoperability leader – led the Verifier Universal Interface global interop initiative

Gataca

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HID STAKEHOLDERS

JEAN-BAPTISTE MILAN
DIGITAL IDENTITY
BIZDEV DIRECTOR

- 20 yrs in government identity programs
- Active contributor to ISO standards
- International public speaker
- Launched major national digital identity program
- Director of mobile identity business development at HID

KATHY ALSBROOK
VP SALES NORTH AMERICA

- 20 years of experience federal government projects
- Identity document security specialist
- VP Sales north America for HID

FABRICE JOGAND COULOMB
DIGITAL IDENTITY
PRODUCT MANAGER

- 20 yrs of experience in secure mobile credentials
- Active contributor to ISO standards
- Mobile identity product manager for citizen identity at HID

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KEY RESULTS (1)

At a high level, the key results of this fellowship revolve around:

- 🤝 Advanced solid connections & partnerships
- 👥 Create new contacts and engagements with SSI influencers in the US
- 🎤 Attend & speak at conferences with market decisionmakers
- 📣 Brand awareness of Gataca in the US east coast

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KEY RESULTS (2)

1. Advance solid connections & partnerships

We deepend our relationship with HID by focusing on **building trust** between the US based HID team and Gataca.

To build this trust we executed a **technical and commercial training** where both organizations were able to confirm their interest in moving forward with the collaboration, evaluate next steps, and establish expectations.

After conducting primary market research, we **established tasks** for both partners to execute such as US influencer engagement and in-person meetings.

2. Create new contacts and engagements with SSI influencers in the US

Through HID, we were able to **engage with US SSI influencers and stakeholders** such as the Better Identity Alliance, AAMVA, and Google.

Through weekly meetings, we **identified target government agencies** for joint approaches. HID took the lead in initiating conversations with these agencies, leveraging existing relationships.

These discussions helped with **mapping out the digital identity ecosystem** in the US, in an effort to understand which stakeholders to reach out to next.

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KEY RESULTS (3)

3. Attend & speak at conferences with market decisionmakers

We identified **federal events** (in Q4 2024) with high-level decision-makers, discarding regional events. This ensured our efforts were focused on engagements with key stakeholders at the federal level.

For the **private sector,** we targeted conferences centered on innovation and technology, particularly those attended by leading universities and research institutions from the US East Coast. These events provide valuable opportunities to showcase Gataca's cutting-edge solutions to a highly knowledgeable and influential audience, including academics, industry experts, and potential partners.

4. Brand awareness of Gataca in the US east coast

We focused on the **US East Coast** to increase Gataca's brand presence. Our efforts include **outbound campaigns** targeting the private sector through personalized outreach and digital marketing, while simultaneously engaging in discussions with public sector stakeholders to explore potential partnerships and collaborations.

By positioning Gataca as a leader in our field, we are striving to establish strong brand recognition and foster meaningful connections with private sector entities.

This **dual approach** aims to establish Gataca as a key player in both sectors.

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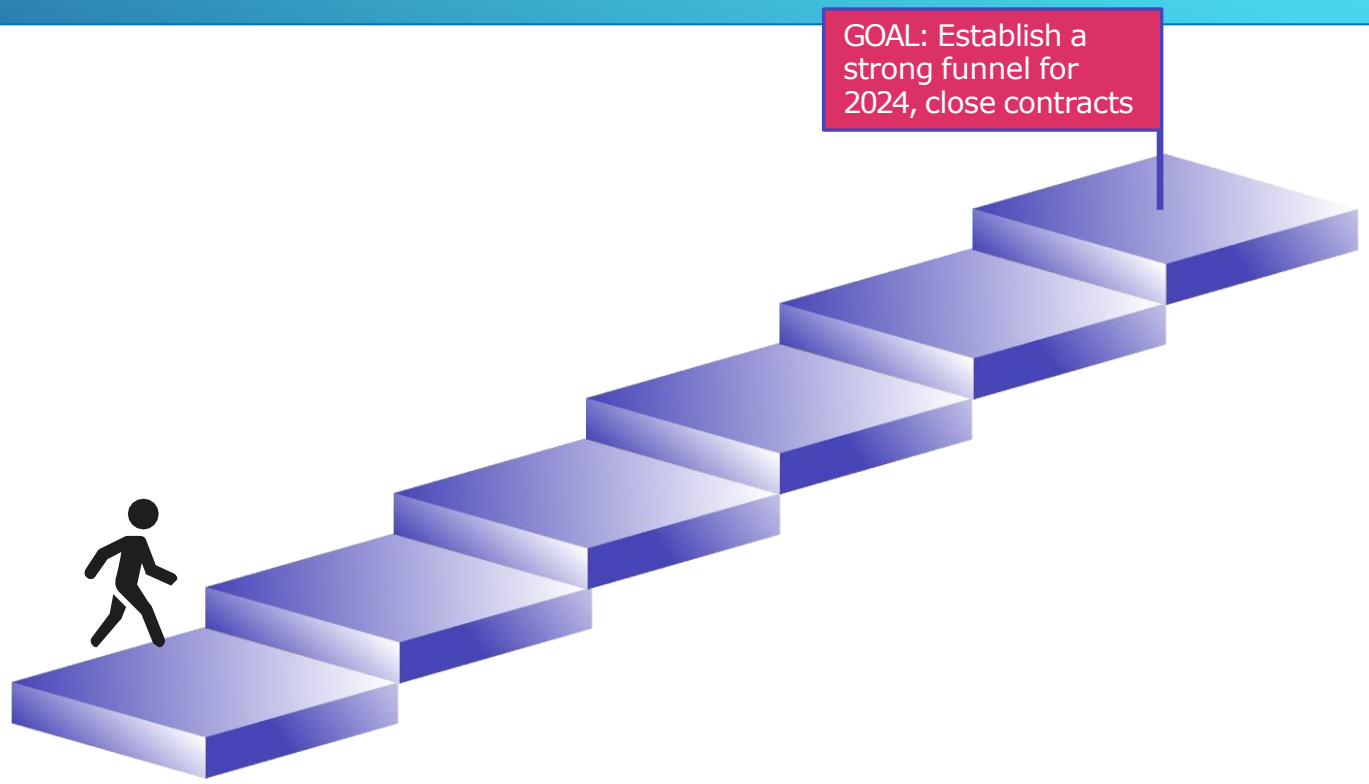
IMPLEMENTATION

Next 6-months

For the next 6 months, we will be executing the established go-to-market strategy. This includes:

1. Scheduling & attending in-person meetings with leads from our pre-defined list
2. Attending in-person federal sector events
3. Attending in-person private sector events (specific to our target markets)
4. Continuing to nurture our established connections



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EXPECTED IMPACT

Impact on Gataca

with NGI's human centric approach. Our core values are **Security, Privacy, and User Experience.** Our goal is for our technology to give users back control of their data in a user-friendly manner.

From our experience in the US, we have found that that organizations, both in the public and private sector, are still lacking information regarding the benefits and impact of self-sovereign identity. Nonetheless, we sense their openness to explore and implement the solution.

By nurturing our newly forged connections in the US, we hope our solution brings increased awareness of **data privacy and sovereignty, security, and users' rights** to US citizens.

Additionally, we hope to continue contributing to the US-EU interoperability efforts, to ensure the portability of ID Wallets worldwide.

Global impact

Gataca's mission is to develop highly secure digital identities that are privacy-preserving, user-friendly, and effortlessly integrated into existing systems.

We hope are project motivates the SSI community to increase knowledge sharing, active collaboration to ensure interoperability between providers, industries, and geographies.

This is the only way SSI, the most privacy preserving, secure, and user-friendly way authentication method, will globally empower citizens to control their personal data.

Additionally, these cross-region efforts can increase utility for the European Commission's new European Digital Identity.

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LESSONS LEARNED

US Track Record recommended

Without some type of US track record or evidence of work, it is difficult to approach US instititutions.

Local presence benefits

Having the US local presence enabled us to increase engagement as we were in the same timezone and could easily plan for in-person meetings.

In-person vs Online

Despite being in the same timezone and being willing to relocate to our lead's destination, we found it difficult to get in-person meetings scheduled. Individuals prefer online meetings.

Building trust

Establishing trust within the larger organization beyond the initial small group can lead to more robust collaborations. It's crucial to engage with key stakeholders at various levels to build a wider network of support.

Cultural Immersion

Experiencing the business environment firsthand can provide invaluable context for how to best engage with the market and stakeholders.

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Chiara Casoni

Head of Business Development & Partnerships at Gataca

Chiara Casoni

chiara@gataca.io

Video

www.gataca.io

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The NGI Enrichers project has received funding from the European Union's Horizon Europe Research and Innovation Programme under grant agreement 101070125.

NISQ-emu – NISQ-READY Quantum Algorithms for Industry 4.0

Chiara Vercellino
Italy

Expert Researcher at Fondazione LINKS - PhD Student in Computer Engineering

Track
Quantum Computing / Error Correction
Host Organization
Center Fermilab, Batavia, Illinois, USA

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THE PROBLEM

Current quantum computers (QC) are not yet exploitable for real industrial use cases.

- The **noise** limits the reliability of quantum systems.
- Hardware's **coherence time** bounds the complexity *(i.e., the depth) of* quantum algorithms, making the implementation of realistic use cases impractical.

Target Audience

- Industries seek quantum solutions for optimization, simulation, and machine learning.
- Research community is working on error correction and algorithm development.
- Technology developers need to innovate their quantum hardware and software ecosystems.

Opportunity

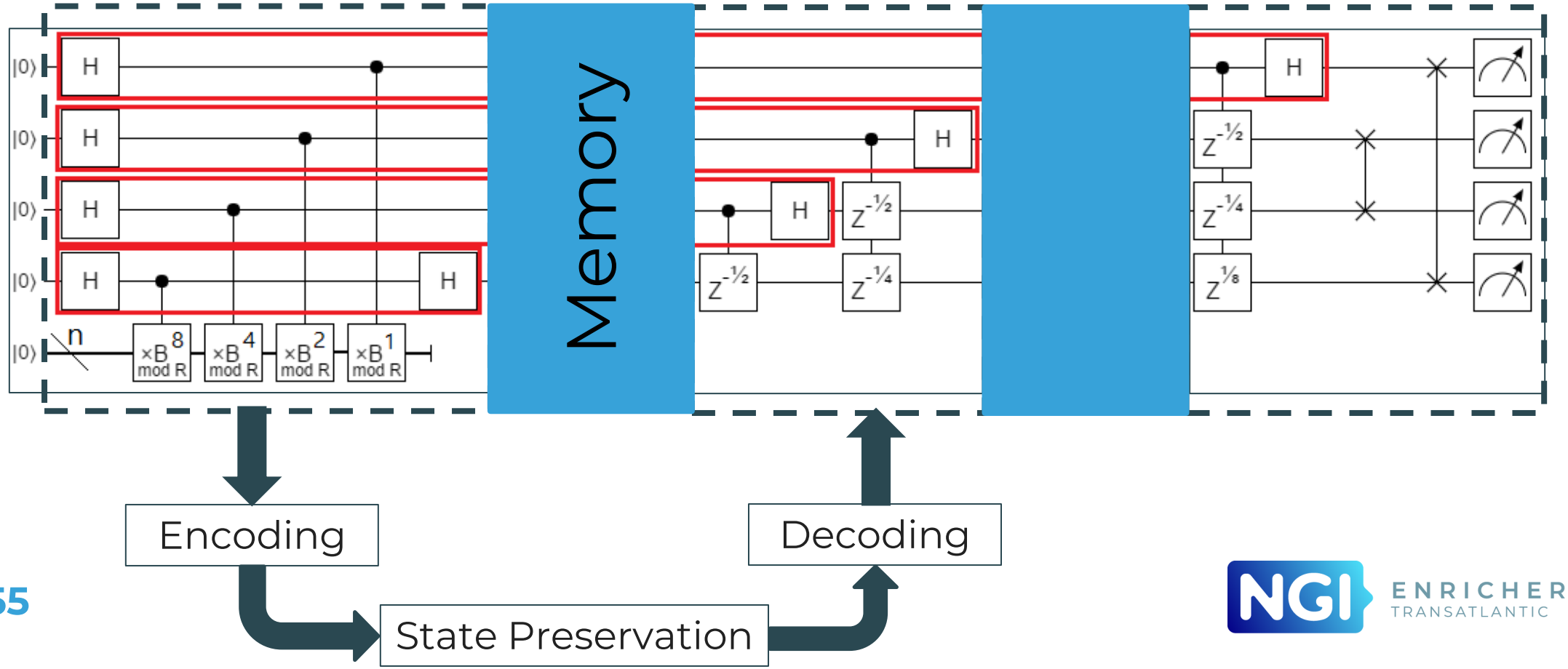
Gaps remain in integrating error correction schemes tailored to specific architectures, with a focus on addressing industrial end-user needs.

THE SOLUTION

Modular Quantum Error Correction (QEC) protocol → focus on superconducting quantum processing units (QPUs) to extends coherence time and improve reliability of quantum computations.

- Differentiate between **memory** and **computation stages** to favor a closed loop that maximizes the available lifetime of the QPUs while mitigating the effects of noise.
- Leverage cutting-edge superconducting hardware as a test case, working closely with hardware teams to define protocols that **fully adhere to the QPU characteristics**

THE SOLUTION



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CHIARA VERCELLINO, EXPERT RESEARCHER FONDAZIONE LINKS

Chiara Vercellino holds an MSc degree in Mathematical Engineering from Politecnico di Torino. She is currently a PhD student in Computer Engineering at Politecnico di Torino and an expert researcher in the Advanced Computing, Photonics, and Electromagnetics (CPE) area of Fondazione LINKS. Her primary focus is on **algorithms**, particularly **quantum machine learning** and **quantum optimization** for industrial applications. She is a member of the SRA-6 WGs "Energy Efficiency & Sustainability" and "Quantum+HPC" at ETP4HPC, as well as the QuIC Ecosystem working group.

NGI Sargasso OC4 : QRISTIN project

THE TEAM

Doğa Murat Kürkçüoğlu

Associate Scientist

Silvia Zorzetti

Quantum Ecosystem Thrust Leader

Olivier Terzo

CPE head of research domain

Stefano Lami

Chief Operating Officer

SQMS CENTER: HOST ORGANIZATION

The **Superconducting Quantum Materials and Systems (SQMS) Center**, established by the U.S. Department of Energy in 2020 and led by Fermilab, is dedicated to advancing quantum computing and sensing through superconducting technologies.

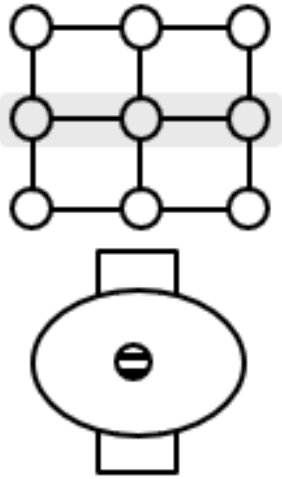
- **Mission**: Achieve breakthroughs in quantum science with long-coherence superconducting qubits and scalable quantum architectures.
- **Research Areas**: Quantum error mitigation, material science, and quantum device engineering, with state-of-the-art labs for developing qubits and cryogenic systems.
- **Collaborations**: Partners include Rigetti, Northwestern University, and NIST. The NGI Enrichers fellowship expands the collaboration network transatlantically, fostering innovation and knowledge exchange.

KEY RESULTS

Scientific Advancements

Designed a bi-modular QEC protocol:

- **Computation Module**: Executes algorithms using subsets of physical qubits to form logical qubits.
- **Memory Module**: Employs qudits to act as a robust memory, extending the quantum computer's lifetime.

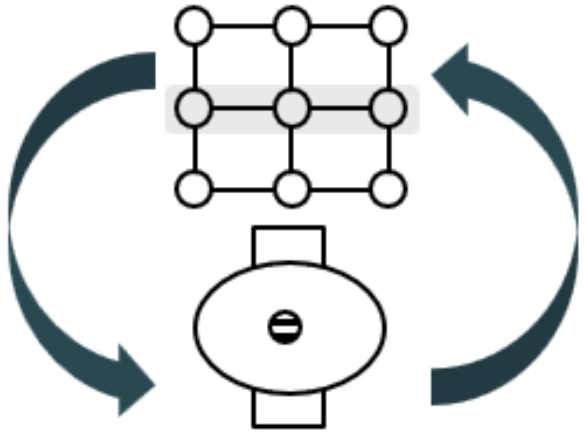


KEY RESULTS

Scientific Advancements

Achieved closed-loop communication:

- **Encoding Protocol**: transfer the quantum state from the computation module to the memory module.
- **Decoding Protocol**: transfer the quantum state from memory to the logical qubits, enabling a new round of computation



KEY RESULTS

Expanding Research Opportunities

NGI Enrichers Fellowship:

- Enabled pivotal connections within the **SQMS** Center (IL, US).
- Reconnected with **NASA's Quantum AI Laboratory** (CA, US), opening avenues to collaboration on new quantum algorithms/applications and generating interest in benchmarking activities.
- Provided awareness of the NGI Sargasso opportunity, leading to the submission and acceptance of a research proposal in partnership with **QuEra Computing** (MA, US).

KEY RESULTS

Expanding Research Opportunities

IEEE QCE24 conference in Montréal (CA)

Meeting at the Italian Consulate in Boston (MA, US)

MISTI MIT Global Experiences

FONDAZIONE links PASSION FOR INNOVATION

3-year collaboration agreement for the exchange of MIT researchers, faculty, and students with LINKS researchers

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IMPLEMENTATION

Next 6-month steps

Experimental validation

- Conduct experiments to test and refine the proposed solution.
- Measure and analyze performance against the established benchmark.

Scientific publication

- Prepare a publication including the results from the experiments.
- Share findings through conferences, journals, other academic platforms.

Seek further funding opportunities

- Explore new funding channels for continued research and development.
- Pursue support for testing the approach on real quantum hardware.

EXPECTED IMPACT

Global Impact in Human-Centric NGI Domains

- **Cooperation**: Foster strong international cooperation, advancing the global quantum computing community.
- **Digitalization**: Propel quantum computing's integration into industrial sectors, accelerating the digitalization of key industries.
- **Lifelong Learning & Openness**: Promote open-source tools and resources, supporting ongoing education in quantum computing.
- **User Experience**: Enhance the user experience by developing error-corrected quantum solutions that are stable, reliable, and easy to use.

LESSONS LEARNED

Work-Related Aspects:

- **Differences in research approach**: a predominantly individual-focused approach was experienced, contrasting with the team-oriented methods previously encountered.
- **Acquisition of new concepts**: rapid familiarization with the specific characteristics of superconducting hardware.

Personal Aspects:

- **Interpersonal interactions**: while interactions for professional needs are relatively straightforward, forming deeper personal connections has proven more difficult.

Impact of Lessons Learned:

- These experiences enabled adaptation to a different culture, contributing to both professional and personal growth.

Chiara Vercellino

Expert Researcher at Fondazione LINKS
PhD Student in Computer Engineering

Chiara Vercellino

chiara.vercellino@linksfoundation.com

Video

(N/A)

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Self-Assembled Lasers Make Multiple Wavelength Transmission Viable

Emanuele Marino
Italy

Junior Assistant Professor, Dept. of Physics and Chemistry, University of Palermo

Track
Optoelectronics / Quantum Dots
Host Organization
University of Pennsylvania, Pennsylvania, USA
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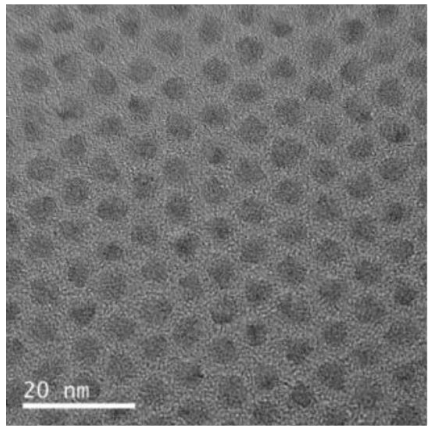
THE PROBLEM

- **OPPORTUNITY:** State-of-the-art commercial internet relies on glass optical fibers that transmit short pulses of light with a single wavelength (color). This sequence of pulses is then converted to a binary sequence and interpreted logically.
  By using multiple wavelengths, we can scale up internet speed while maintaining the same fiber-based infrastructure.
- **TARGET AUDIENCE:** This improvement would affect the entire internet industry, improving the progress of internet infrastructure in developing countries.
- **COMPETITION:** Frequency-comb lasers can already generate multiple wavelengths. However, these devices are complex and expensive to manufacture. Instead, we propose to develop a device that can be fabricated in under 5 minutes without the use of specialized equipment.

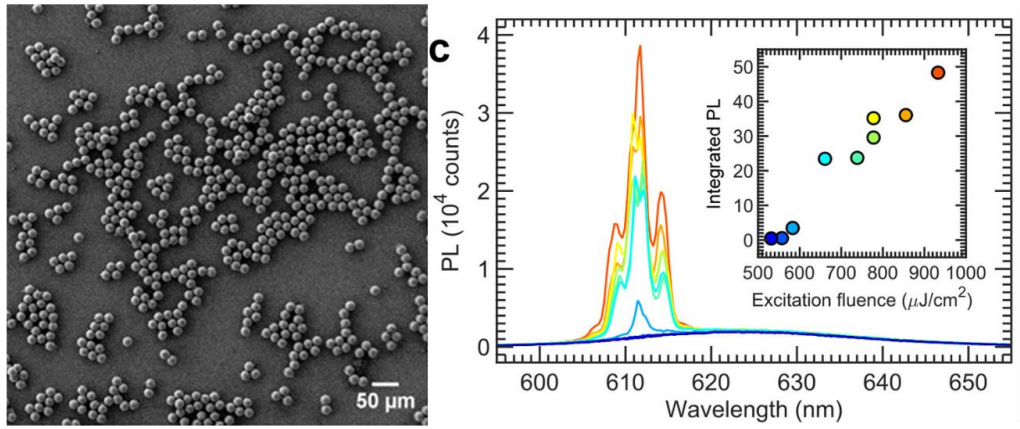
MY SOLUTION: SELF-ASSEMBLED QUANTUM-DOT MICROLASER

- **Technology:** Quantum dots are well known in the entertainment industry as excellent light emitters. I recently discovered that it is possible to modulate the emission spectrum with multiple peaks by packing quantum dots in a sphere (DOI: 10.1021/acs.nanolett.2c01011). Each peak corresponds to the natural resonance frequency of the sphere. **By tuning the peak positions and/or intensities with time, we can control as many logical inputs as there are resonances**.
- **Differentiator:** While frequency comb lasers can achieve this result, these devices are complex and expensive to manufacture. Furthermore, their coupling to the optical fiber is imperfect, with only 20% of the light being able to enter the fiber. My proposal revolutionizes these aspects by **(1) cutting down costs** by relying on inexpensive self-assembly instead of expensive microfabrication and **(2) by improving optical coupling** by placing the quantum dot microlaser directly on the fiber core.
- **Development:** In this project, I plan to develop new ways to modulate the natural frequencies of the quantum dot microlaser. Thermal modulation will bring a refractive index change that will affect the peak positions. Electrical bias should bring a comparable change by Joule effect, while also filling electronic traps. Optical excitation should simultaneously increase the temperature of the microlaser and fill traps. Therefore, I am confident I will be able to modulate the optical response of the microlaser by a combination of thermal, electrical, or optical triggers.

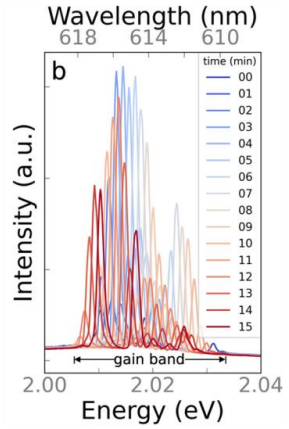
MY SOLUTION: SELF-ASSEMBLED QUANTUM-DOT MICROLASER



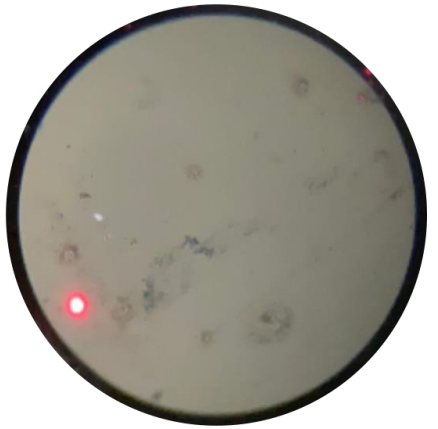
Quantum Dots



Quantum Dot Self-Assembly into Spherical Microlasers



Tunable Laser Frequencies



Fiber-Coupled Microlaser

EMANUELE MARINO, JUNIOR ASSISTANT PROF. DEPT. OF PHYSICS AND CHEMISTRY, UNIVERSITY OF PALERMO, ITALY

- **About me:** I am a Junior Assistant Professor at the University of Palermo, Italy. I have an extensive knowledge of quantum dot systems that I have gained during my international career at the University of Amsterdam (PhD in Physics) and at the University of Pennsylvania (postdoc in Chemistry and Materials Science).
- **My scientific interests and achievements:** I am interested in building new materials from the bottom-up based on semiconductor nanoscale building blocks known as quantum dots. So far, I have discovered new ways to assemble quantum dots into functional structures (critical Casimir and emulsion-based), studied their structural crystalline arrangement, and have just begun studying their fascinating optical properties. I have published 27 publications in high-impact, peer-reviewed journals such as Nano Letters, Advanced Materials, Nature Synthesis. I hold 1 patent and I have submitted 2 more on a method to fabricate uniform quantum dot microlasers. **I am one of the very few people who can lead this project to completion.**
- **My experience relevant to NGI:** Recently, I have discovered a method to fabricate quantum dot microlasers in under 5 minutes by using inexpensive oil-in-water emulsions (DOI: 10.1021/acs.chemmater.2c00039). This discovery has prompted a shift in my research interests towards applications. Designing the optical details of Next Generation Internet is a fantastic goal that I am excited to contribute to with this project.

THE TEAM: LABORATORY OF ADVANCED MATERIALS

I am a senior member of a group of talented physicists at the University of Palermo. The core interest of the group lies in advanced optical spectroscopy of new materials.

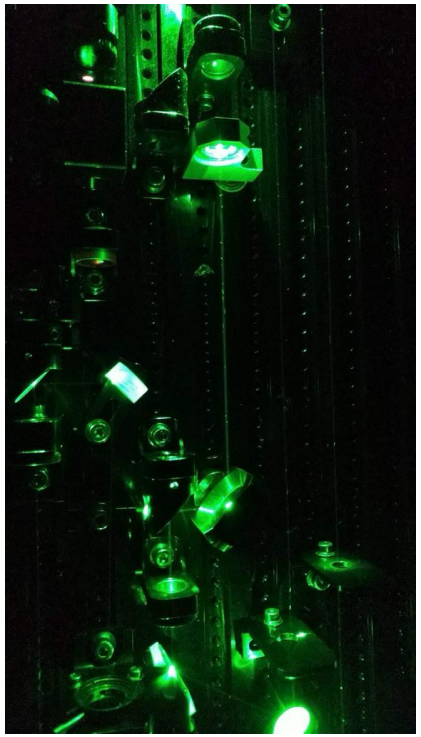
- **Fabrizio Messina**, Full Professor. Expert in fast and ultrafast optical spectroscopy. Main interests lie in the development of non-toxic materials for energy applications.
- **Alice Sciortino**, Assistant Professor. Expert in fast and ultrafast optical spectroscopy. Main interests lie in the integration of carbon-based nanomaterials in optoelectronic devices.

My collaboration with the University of Pennsylvania allows to bridge the gap between material synthesis and advanced optical characterization functional to device fabrication.

- **Cherie R. Kagan,** Professor of Electrical Systems and Engineering, device expert.
- **Chris B. Murray,** Professor of Chemistry and Materials Science, nanocrystal expert.
- **Cris Gonzalez**, Ph.D. Student.

HOST ORGANIZATION: KAGAN LAB @ PENN ENGINEERING

Group of Prof. Cherie R. Kagan, Dept. of Materials Science and Engineering University of Pennsylvania (photo on the right).



I have collaborated with the Kagan group during my postdoc at the University of Pennsylvania, resulting in many excellent publications on the topic on quantum dots (e.g. DOI: 10.1021/acs.nanolett.2c04498). Therefore, **I am certain the NGI project will quickly be integrated within the group activities**.

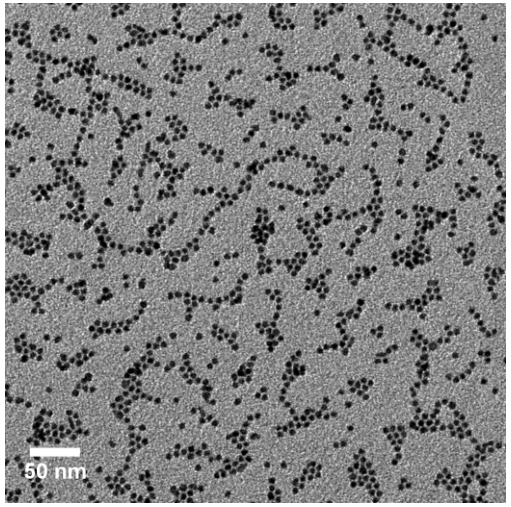
The Kagan lab maintains a laser lab powered by a tunable femtosecond **laser source coupled to an optical microscope** (picture on the left). Using this system, we will:

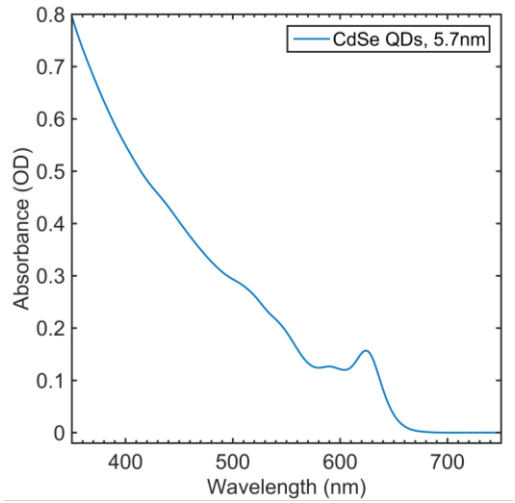
(1) Quantify the optical coupling between the microlaser and the optical fiber;
(2) Subject the microlaser to external stimuli (temperature, voltage, light) while monitoring the shift in the emission spectrum. We will quantify the magnitude and reversibility of the optical shift by using the sensitive detection setup able to collect light from a single microlaser.

NGI ENRICHERS TRANSATLANTIC

KEY RESULTS (1): NANOCRYSTAL SYNTHESIS

- **Synthesis of CdSe nanocrystals.** The procedure consists in the synthesis of CdSe cores by mixing Cadmium Oleate in 1-Octadecene with a dispersion of selenium in octadecene at 240 °C.
- **Characterization of CdSe nanocrystals** by measuring optical absorption/photoluminescence spectra and performing transmission electron microscopy.
- **Results shown below.**

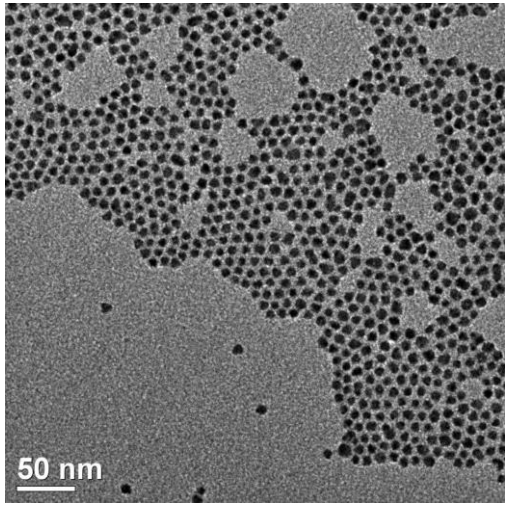


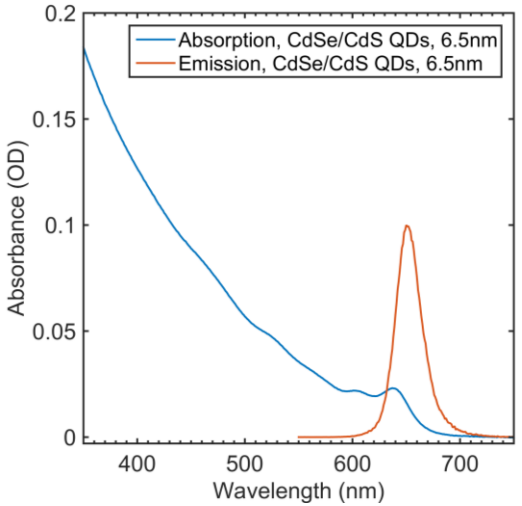


NGI ENRICHERS TRANSATLANTIC

KEY RESULTS (2): NANOCRYSTAL SYNTHESIS

- **Synthesis of CdSe/CdS core/shell nanocrystals.** The procedure consists in the epitaxial deposition of a CdS shell on the CdSe cores previously synthesized by the slow addition of cadmium oleate and 1-Octanethiol in 1-Octadecene at 310 °C.
- **Characterization of the CdSe/CdS nanocrystals** by optical absorption, emission, and transmission electron microscopy.
- **Results shown below.**

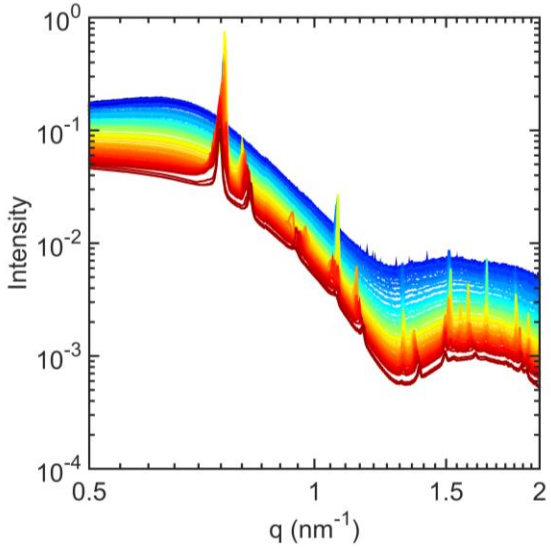


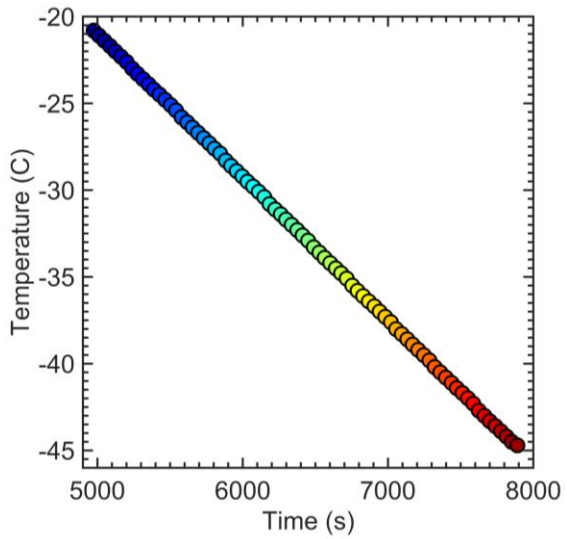


NGI ENRICHERS TRANSATLANTIC

KEY RESULTS (3): NANOCRYSTAL ASSEMBLY

- **Nanocrystal assembly:** Exploration of a new method to assemble CdSe/CdS nanocrystals into functional superstructures. The assembly process was induced by lowering the temperature of the nanocrystal dispersion to reach the crystallization temperature.
- **Structural characterization** of the growing crystalline structures of quantum dots by small-angle X-ray scattering.
- **Results shown below.**

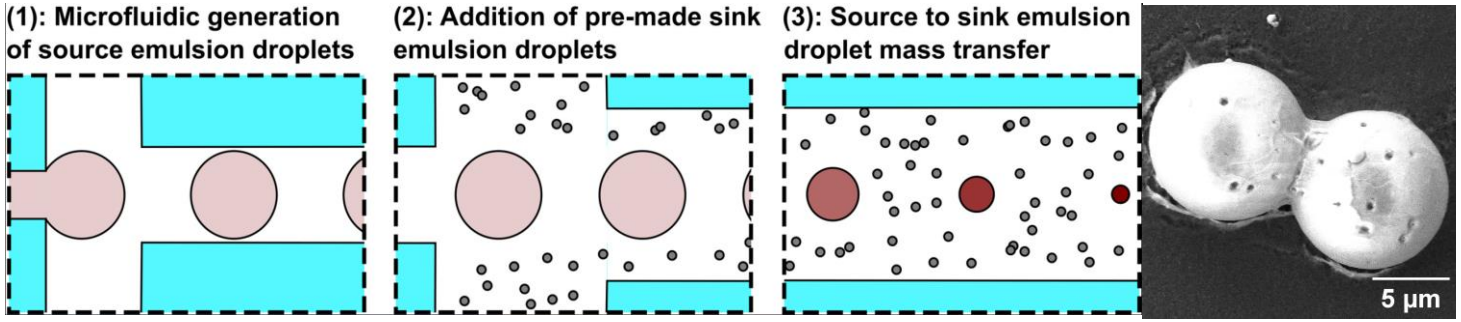


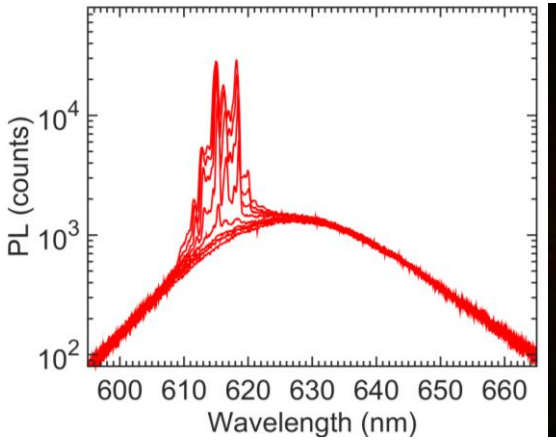


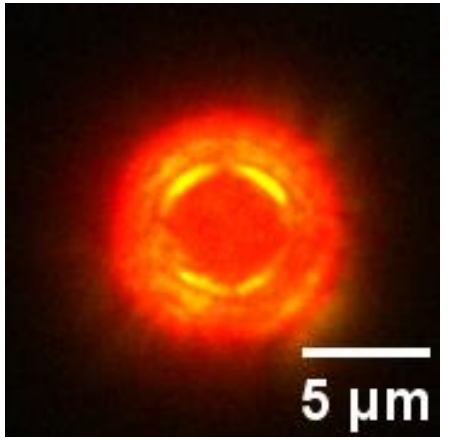
NGI ENRICHERS TRANSATLANTIC

KEY RESULTS (4): NANOCRYSTAL ASSEMBLY

- **Nanocrystal assembly:** Synthesis of nanocrystal superparticles capable of lasing action by using droplet microfluidics. Monodisperse toluene-in-water droplets are generated by droplet microfluidics. Toluene droplets are densified by removing toluene through the introduction of a secondary emulsion of hexadecane that acts as a “sink”.
- **Structural characterization** of the nanocrystal superparticles by using scanning electron microscopy.
- **Optical characterization** of the nanocrystal superparticles.
- **Results shown below.**







NGI ENRICHERS TRANSATLANTIC

IMPLEMENTATION

1. Data analysis of the collected data;
2. Preparation of drafts of papers to submit to high-impact peer-reviewed scientific journals:
3. Consideration of whether applying for a patent on some of the findings, study of prior art;
4. Submission of drafts to journals, follow up for revision and publication.

EXPECTED IMPACT

Our work on achieving multi-color, independently-controlled lasing from nanocrystal superparticles is only at the beginning, with a successful synthesis and initial optical characterization. Once collected additional data to prove our hypothesis, we will reach out to large companies (Google, IBM, Leonardo) to investigate whether they would be interested in funding some of our work to allow us to study the system further. Alternatively, we plan on applying for funding from the European Union (ERC) and local Italian government (PRIN).

LESSONS LEARNED

1. Contamination from previous users delayed the synthesis of our nanocrystals. We should have run a test synthesis highly sensitive to contaminations as a way to infer if the synthetic setup is working properly.
2. Superparticle synthesis was also affected by down time of scanning electron microscope to allow for feedback. It would have been useful to set up a system for in-line feedback instead.
3. Optical characterization was delayed by the move of the Kagan laboratory to a different building on Penn campus, causing down time of all optical equipment for 8 weeks. It would have been useful to schedule my visit at another time but unfortunately I was not made aware of this issue.

Emanuele Marino

Junior Assistant Professor, Dept. of Physics and Chemistry, University of Palermo

Emanuele Marino

emanuele.marino@unipa.it

Video

(N/A)

NGI ENRICHERS TRANSATLANTIC

Keep engaged with our NGI Fellows !

The NGI Enrichers project has received funding from the European Union's Horizon Europe Research and Innovation Programme under grant agreement 101070125.

PAIRS – Pervasive, Advanced, and Intelligent Real-time Systems

Federico Reghenzani
Italy

Assistant Professor (RTDA) at Politecnico di MilanoResearcher in the HEAP Lab

Track
AI / Embedded Systems
Host Organization
NJIT Newark, New Jersey, USA

NGI ENRICHERS TRANSATLANTIC

THE PROBLEM

Research question

How can we guarantee the **timing constraints** of intelligent devices that are nowadays increasingly interconnected and pervasive?

Motivation

AI/ML is increasingly present in our lives, but we must solve several technological challenges when AI/ML is used in **critical systems** (autonomous cars, domestic robots, …)

Critical systems

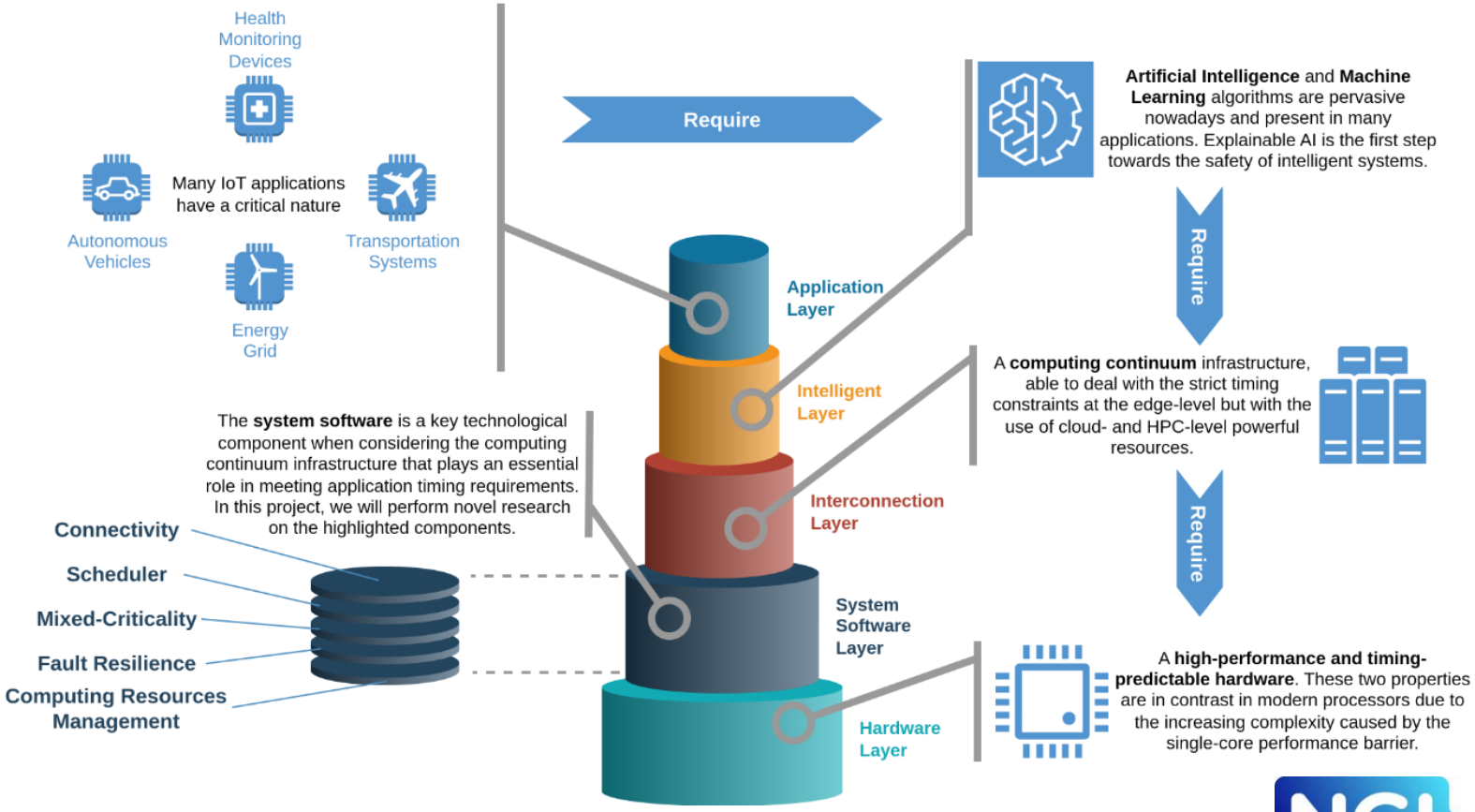
These system must not only produce a correct result, but it must produce it in a well-defined timely manner

- Several theoretical and practical open challenges

YOUR SOLUTION (1)

- When timing constraints are important, current industrial technology usually relies on old processors due to certification requirements
- The **system software layer** (including, scheduling, connectivity, etc.) plays a key role in satisfying timing constraints
- This project **PAIRS (Pervasive, Advanced, and Intelligent Real-time Systems)** worked to improve the scientific knowledge on the following **challenges**:
  - Can we design scheduling algorithms and resource management strategies to correctly run real-time tasks on modern processors? How do the large computational capabilities required by AI&ML impact the scheduling problem? How HPC systems can guarantee these timing constraints?
  - How to deal with mixed-criticality tasks running on the same device?
  - What is the scientific works on the real-time properties of the ROS 2 operating system?

YOUR SOLUTION (2)



NGI ENRICHERS TRANSATLANTIC

FIRST & LAST NAME, POSITION CURRENT ORGANIZATION

Assistant Professor (Researcher/RTDA) @ Politecnico di Milano

Academic career:

2024 – **Visiting researcher** @ New Jersey Institute of Technology (USA)
2024 – **Visiting researcher** @ European Space Agency (NL)
2023 – **Assistant professor** @ Politecnico di MIlano
- 2021 – **Post-doc** grant by European Space Agency

2021 – **PhD cum laude** in Information Technology @ Politecnico di Milano
- 2019/20 – **Visiting researcher** @ University of Central Florida (USA)
- 2018/20 – **Visiting researcher** @ ONERA (France)

Top-100 young computer science researchers by HLF Foundation

Output and projects:

- More than **50** publications in international journal and conferences (most of them on NGI topics)
- Participation to **7** EU H2020 and Horizon projects and technical responsible of **3** projects
- Currently funded by National Centre for HPC, Big Data and Quantum Computing (Italy)

THE TEAM /EXPERTISE

I'm part of the **HEAP Lab** @ Politecnico di Milano (Italy)

- Research group composed of ~25 people among professors, post-doc, PhD students, and research assistants
- The lab head is **prof. William Fornaciari**, associate professor, who participated to more than 30 EU-funded projects and have more than 15 years of experience in technology transfer
- The main research topics are:
  - Embedded Systems, RTOS, IoT
  - High-Performance Computing, Cloud Computing
  - Compilers, code analysis tools
- Heterogeneous Computing, Hardware design, Hardware Security

Further details are available on the lab website: https://heaplab.deib.polimi.it/

YOUR HOST ORGANIZATION

The selected host organization, part of NGI Enrichers program, is the **New Jersey Institute of Technology (NJIT)** and, in particular, the team of **Prof. Jing Li**:

- Prof. Jing Li has a strong expertise in real-time systems, as well as AI, parallel and cloud computing, and IoT systems, which are topics that perfectly fit the NGI mission
- Jing and I know each other before the NGI expedition but we never worked together.
- The NGI expedition allowed us to create a new link.

NGI ENRICHERS TRANSATLANTIC

KEY RESULTS - SCIENTIFIC

Accepted papers

Faster Classification of Time-Series Input Streams, K. Agrawal, S. Baruah, Z. Guo, J. Li, F. Reghenzani, K. Yang, J. Zhao

- I'll present this article at the *37th Euromicro Conference on Real-Time Systems* in Bruxelles, July 2025

Open research lines

Surveying current real-time analyses for ROS 2 approaches

Real-time properties of checkpoint/restore mechanisms in embedded systems

A speedup optimal scheduling algorithm for mixed-criticality systems

KEY RESULTS – NETWORKING 1

In July, I visited for a week **prof. Nathan Fisher** (full professor) and **prof. Zheng Dong** (assistant professor) at Wayne State University, Detroit, MI.

Results:

- We started working on a joint topic on real-time systems
  - We involved a master thesis student at POLIMI that is currently working on implementing our idea
- Identified possible areas of future cooperation

KEY RESULTS – NETWORKING 2

In September, I organized a joint visit at WashU, St. Louis, MO, that led several researchers to work together in a full intensive week:

- Prof. **Federico Reghenzani** (POLIMI, Italy, Assistant Professor)
- Prof. **Jing Li** (NJIT, NJ, Assistant Professor)
- Prof. **Sanjoy Baurah** (WashU, MO, Full Professor)

  Prof. **Kunal Agrawal** (WashU, MO, Full Professor)

  Prof. **Kecheng Yang** (TX State, TX, Associate Professor)
- Prof. **Zhishan Guo** (NC State, NC, Associate Professor)

  Jinhao Zhao (WashU, MO, PhD Student)

KEY RESULTS – NETWORKING 3

Prof. **Jing Li** and **I** started a collaboration with prof. **Daniel Casini**, Scuola Superiore Sant'Anna (Italy).

- A new collaboration for all of us
- Currently finalizing a paper submission
- Created a new link between USA and Italy

IMPLEMENTATION

Scientific results

- Other than the paper that has been already accepted, **1** paper is almost ready to be submitted (expected at the end of July 2025), and **2** papers are currently work in progress

Projects and funding

- Thanks to the expedition, we started to investigate possible NSF-MIUR funding opportunities, even if it is not easy to get transatlantic public funding for research (or, at least, less easy than funding within EU).

EXPECTED IMPACT

Safety

We need to *trust computers*, especially safety critical systems. Nowadays, such systems, equipped with AI and ML, are increasingly present in our lives. This research wants to advance scientific knowledge on the methodologies to develop them.

Cooperation and Openness

Summarizing the networking activities, the new link strengthening the Italy-USA scientific cooperation, including 2 Italian universities and 5 US university in 5 different states (NJ, MI, MO, NC, TX).

Science must be open, and I would like to cite the 1857 sign in my university:
"The edifice of science is the work not of a solitary mind, but of associated minds. It is therefore a necessity of scientific construction that it arises within the heart of a society, indeed of many societies"

LESSONS LEARNED

Changing visiting perspectives

This was not my first multi-months visiting experience. I went to France and USA (Florida) during my PhD, and in Netherlands just before the NGI experience. However, this was a completely different experience:

- First of all, my role: I was no more a student and the visit was very different, less focused on the technical aspects and more focused on network of contacts
- Secondly, the extensive (and unplanned) networking, including the travels to other universities, was extremely positive. I met several experts of my field and exchanged ideas with them.
- Thirdly, the topics. I mainly focused on practical aspects of my work, but I had to learn how to deal with different aspects, like strictly theoretical challenges.

Federico Reghenzani

Assistant Professor (RTDA) at Politecnico di MilanoResearcher in the HEAP Lab

Federico Reghenzani

federico.reghenzani@polimi.it

Video

Website

NGI ENRICHERS TRANSATLANTIC

Keep engaged with our NGI Fellows !

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ARQ – Abatement of Radioactivity for Qubits

Francesco De Dominicis
Italy

PhD Student in Astroparticle Physics at Gran Sasso Science Institute (GSSI)

Track
Quantum Computing / Radiation Mitigation
Host Organization
Fermilab – CenterBatavia, Illinois, USA

NGI ENRICHERS TRANSATLANTIC

THE PROBLEM

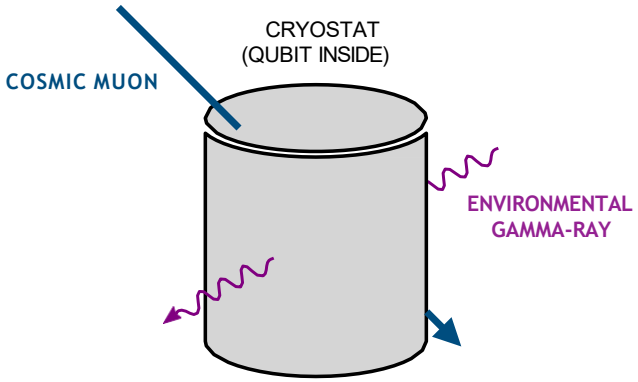
- Superconducting qubits are one of the most promising technologies for the realization of a fully-functioning quantum computer;
- However, recent years have seen growing concerns in the scientific community regarding their sensitivity to ionizing radiation and the errors in quantum computation that particle impacts can induce;
- Experiments carried in the past years have demonstrated that radioactivity can affect superconducting qubits, but the research on how to mitigate its impact is still at the beginning.

NGI ENRICHERS TRANSATLANTIC

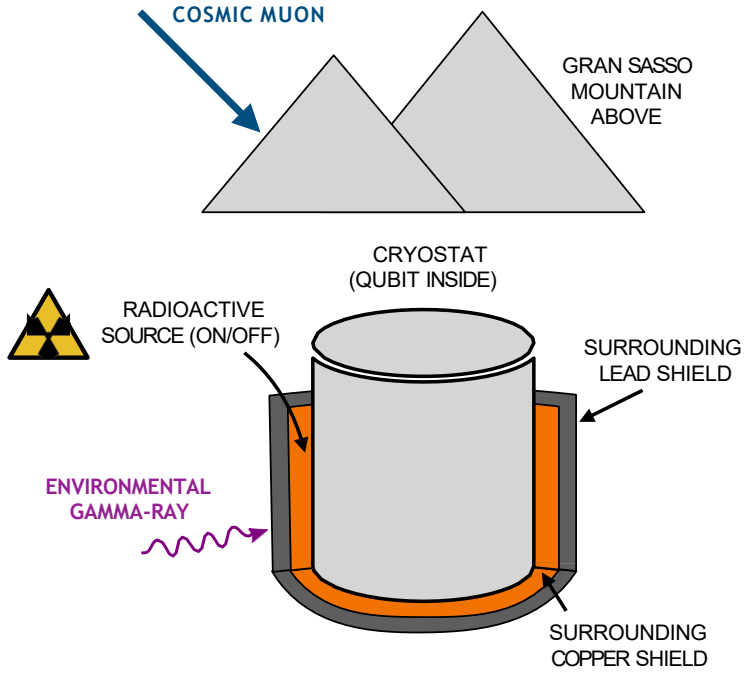
YOUR SOLUTION (I)

- Disentangling radioactivity from other phenomena affecting superconducting qubits is complicated;
- My solution consists in characterizing superconducting qubits both in a standard laboratory and in a low-radioactivity environment, so to compare the results;
- By simultaneously probing multiple qubits at the same time it is possible to understand how the effect of a particle impact propagates through the chip, helping in finding the best choices of materials and geometry to mitigate errors.

YOUR SOLUTION (2)



STANDARD LABORATORY



LOW-RADIOACTIVTY LABORATORY

COMPARE

NGI ENRICHERS TRANSATLANTIC

FRANCESCO DE DOMINICIS, PHD STUDENT GRAN SASSO SCIENCE INSTITUTE, ITALY

- PhD Student in Astroparticle Physics at Gran Sasso Science Institute, Italy;
- Focus on superconducting qubits, their sensitivity to radioactivity and their possible applications for particle physics experiments;
- Experience in characterizing transmon and fluxonium qubits;
- Worked on the commissioning of a low-radioactivity underground facility for qubit experiments;
- Development of a Monte Carlo simulation for estimating contribution to qubits of different radiation sources.

THE TEAM /EXPERTISE

The team of researcher working on this project with me:

- Dr Laura Cardani, researcher at Istituto Nazionale di Fisica Nucleare and PhD supervisor;
- Dr Nicola Casali, researcher at Istituto Nazionale di Fisica Nucleare;
- Dr Ivan Colantoni, researcher at Consiglio Nazionale delle Ricerche - Istituto di Nanotecnologia and Istituto Nazionale di Fisica Nucleare;
- Dr Angelo Cruciani, researcher at Istituto Nazionale di Fisica Nucleare;
- Dr Ambra Mariani, post-doctoral researcher at Istituto Nazionale di Fisica Nucleare;
- Dr Stefano Pirro, researcher at Istituto Nazionale di Fisica Nucleare;

Host organization contacts:

- Dr David van Zanten, associate scientist at Fermilab (dvanzant@fnal.gov);
- Dr Tanay Roy, associate scientist at Fermilab (roytanay@fnal.gov).

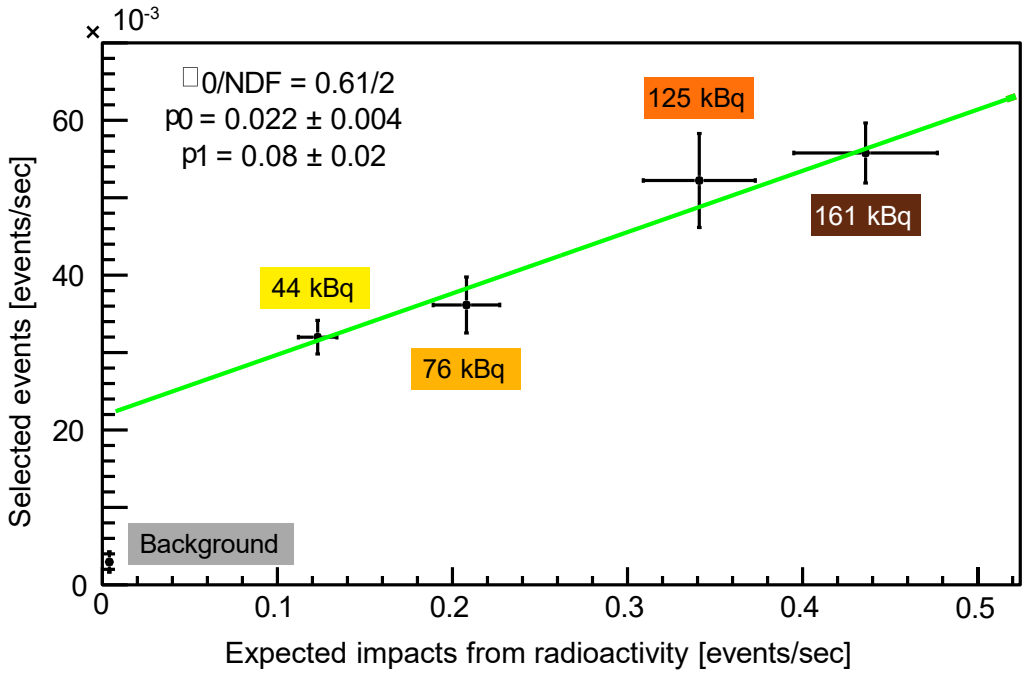
YOUR HOST ORGANIZATION

SUPERCONDUCTING QUANTUM MATERIALS & SYSTEMS CENTER

- My project has been carried at the Superconducting Quantum Materials and Systems (SQMS) Center in Fermilab (United States);
- The SQMS Center is one of the five research center on quantum information science funded by the U.S. Department of Energy;
- As of today it produced some of the best-performing transmon qubits available today, with coherence times up to 0.6 ms;
- Strong interest in investigating the sources of quantum decoherence, including radioactivity, that undermine qubit performances.

KEY RESULTS (I)

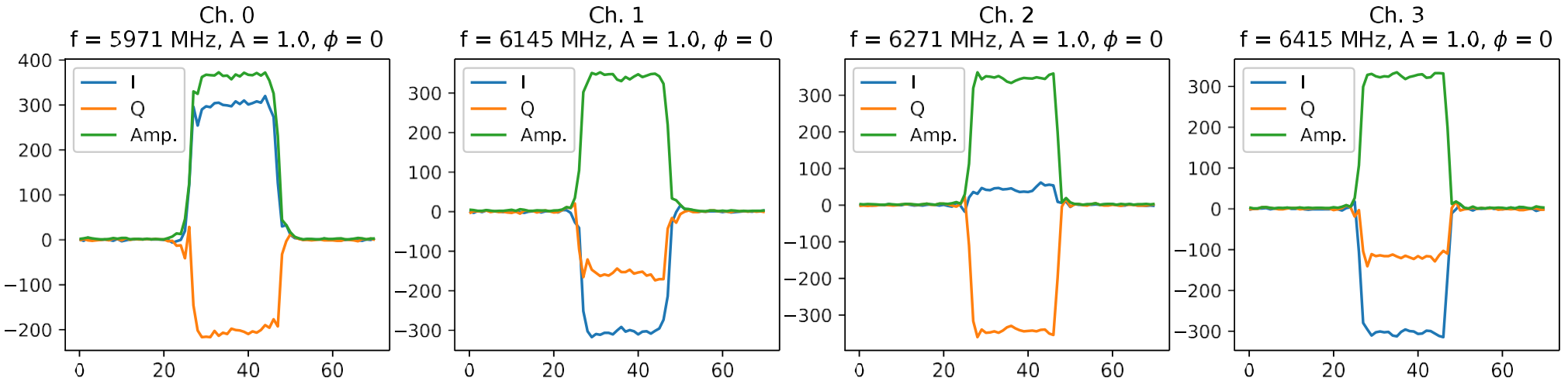
- Finalized the analysis of measurements done from October 2023 until February 2024;
- Measurements done on single qubits;
- Clear evidence that the experiment is capable of identifying single particle impacts in qubit chips;
- First time that gamma radiation is detected with superconducting qubits!



NGI ENRICHERS TRANSATLANTIC

KEY RESULTS (2)

- I developed a new firmware for the FPGA board used for qubit measurements;
- This new firmware is capable of simultaneously probe up to four qubits;
- First tests showed promising result, data taking starting in January 2025!



NGI ENRICHERS TRANSATLANTIC

KEY RESULTS (3)

- Measurements and results on single qubits have been reported on an article currently under peer review for publication (https://doi.org/10.48550/arXiv.2405.18355);
- Results have also been presented on several conferences, including:
  - RISQ Wokshop at Fermilab, US (May 2024);
  - Quantum Sensing 2024 in Paris (June 2024);
  - Applied Superconductivity Conference (ASC) 2024 in Salt Lake City, US (September 2024).

IMPLEMENTATION

Plan for the next 6 months

- September-December 2024: Test of the new firmware for simultaneous measurements on a 8-qubits chip and development of the data acquisition software;
- January - February 2025: First data taking on the new chip at LNGS and development of the best data analysis strategy;
- March 2025: Expected start of the measurements on different chips to compare materials and geometry.

EXPECTED IMPACT

- My project helped in strengthening the cooperation between European research institutions (GSSI, INFN) and the SQMS Center;
- Gained a shared knowledge on this technology between research centers;
- Laid the foundations for future collaborations.

LESSONS LEARNED

- While carrying this project I encountered a lot of unexpected complications that needed to be addressed, from the noise characterizing single-qubit measurements to the difficulties in developing the new firmware;
- Overcoming this difficulties, though, has been an opportunity for learning how to achieve results in a non-optimal situation and to adapt my strategies when unexpected problems arise.

Francesco De Dominicis

PhD Student in Astroparticle Physics at Gran Sasso Science Institute (GSSI)

Francesco De Dominicis

francesco.dedominicis@gssi.it
/ francesco.dedominicis@roma1.infn.it

Video

(N/A)

NGI ENRICHERS TRANSATLANTIC

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THORN-ML – Transparent Hardware Offloaded Resilient Networks for RDMA-Based Distributed ML Workloads

Giulio Sidoretti
Italy

Researcher at University of Rome Tor Vergata ; PhD in progress completed

Track
AI / Datacenter Networks
Host Organization
University of Colorado, Colorado, USA

111

NGI ENRICHERS TRANSATLANTIC

THE PROBLEM

Define the problem (need) being solved by your project. How do you identify it? And for whom / main target audiences - Machine learning uses substantial amounts of expensive computing resources in datacenters. When a large model is being trained, the load is shared among multiple servers, that use the network to synchronize. Whenever a network fault occurs, a cost is faced and keeping the down time to a minimum is beneficial. Existing state-of-the-art solutions do not consider faults happening at the network edge. This project is beneficial to Systems and networks engineers, cloud operators.

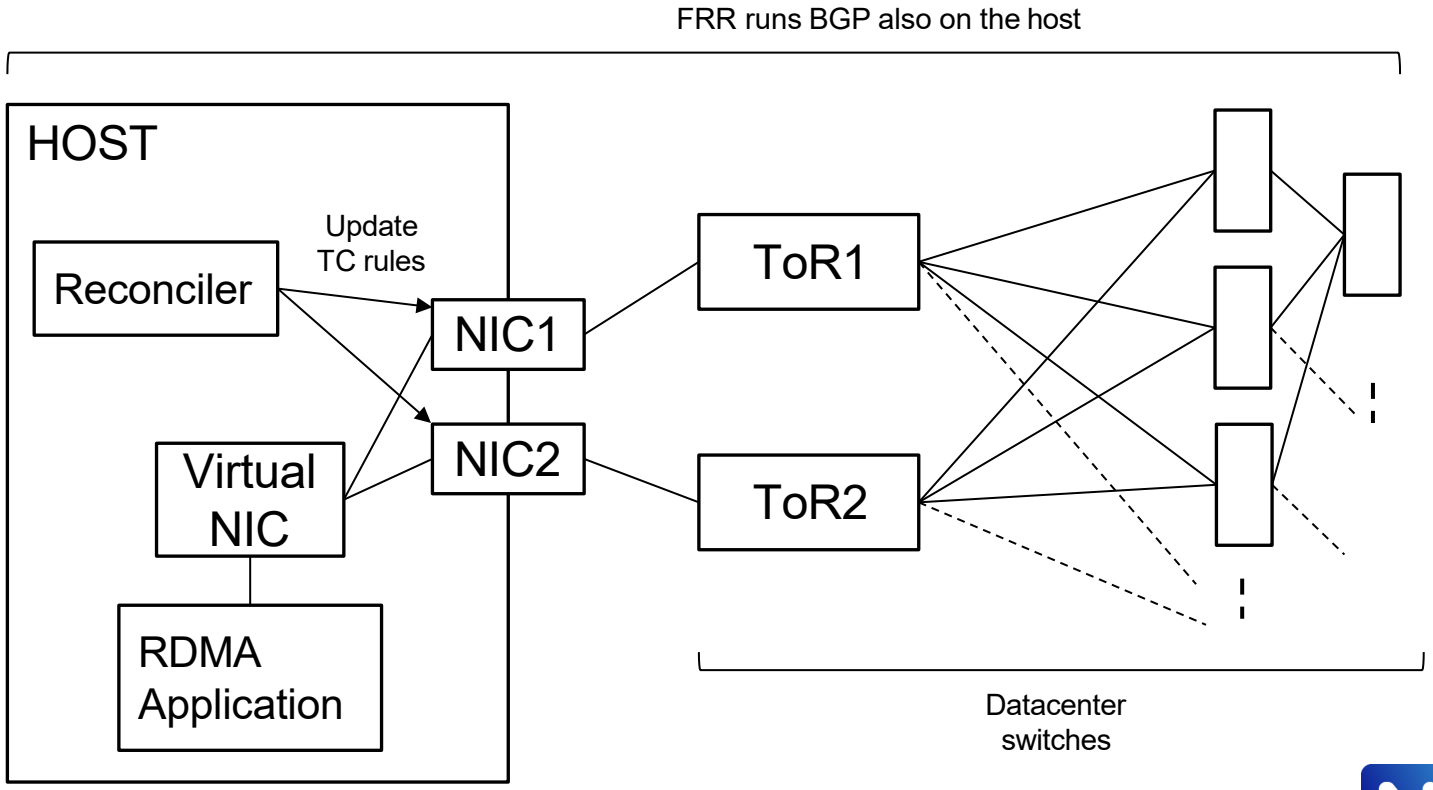
Who else is already doing this, and why is there an opportunity? – other commercial or academic solutions that try to solve the problem require additional dedicated hardware or modifying the applications.

YOUR SOLUTION (1)

Technology, differentiator, competitive advantage, opportunity (and size).

The technologies used are all open source. The solution is based on a redundant network architecture where EVPN is deployed using FRR, BGP, VXLAN and TC hardware offloading on programmable NICs. The solution can be deployed on generic hardware and is transparent to the application, unlike other similar existing ones. It is an opportunity for datacenters to have a more reliable infrastructure and better exploit the highly expensive computing resources, reducing downtime and consequently costs.

YOUR SOLUTION (2)



FIRST & LAST NAME, POSITION CURRENT ORGANIZATION

Giulio Sidoretti, researcher at the University of Rome, Tor Vergata, department of Electrical Engineering, where I have recently completed my Ph.D. I am now working as a researcher in Tor Vergata.

My NGI project produced a research work that has been submitted for publication and is now under review.

THE TEAM /EXPERTISE

At CU Boulder, I was working under the lead of Prof. Eric Keller. The other members of the team and coauthors of the publication that we submitted are: Maziyar Nazari, Daniel Noland, Erika Hunhoff, Tamara Silbergleit Lehman.

I was still in contact with my Ph.D. supervisor Prof. Domenico Salsano from Tor Vergata during my period in Boulder.

YOUR HOST ORGANIZATION

I was hosted in the Electrical, Computer and Energy Engineering (ECEE) department at Colorado University, Boulder, by Prof. Eric Keller. It was his first NGI experience.

KEY RESULTS (1)

Deployment of EVPN (Ethernet VPN) using FRR, BGP and VXLAN in the datacenter testbed. FRR (FRRouting) is an open-source protocol suite that we used to run BGP on the hosts and switches. The switches also run Linux. VXLAN is used as transport for the overlay VPN.

KEY RESULTS (2)

TC (Traffic Control) rules offloaded to the host NICs (Network Interface Cards), to have an EVPN solution with these characteristics:

1. Each host is connected to two switches and can tolerate a switch or link failure.
2. The ports on the host that are connected to the two switches are abstracted and appear as a single port to the application, regardless of the path taken by the network packets.
3. The hardware offload of TC rules allows faster RDMA (Remote Direct Memory Access) communication between the GPUs present on the various hosts where the machine learning training process is distributed. The GPU-to-GPU communication does not need to involve the host CPU, because the GPU can access the network interface directly (GPU direct).

Performance analysis of the deployed solution and scientific article submitted for publication, under review at the time of writing.

NGI ENRICHERS TRANSATLANTIC

IMPLEMENTATION

How would you implement your findings? Next 6-month steps (nonconfidential)

Depending on the reviews of the scientific paper, with the rest of the team, we will decide what to do next: Keep improving this work if needed, or eventually move onto another collaboration.

EXPECTED IMPACT

From the implementation of your findings, how are you going to impact your project and impact the world? Especially on the Human-centric NGI-relevant following domains:

The project produced a research paper and open source software, that will be available to the public once the paper will be published. It enables reducing the costs, computation, power and time needed by the machine learning task, while achieving higher resilience and reliability.

LESSONS LEARNED

What you wished you had known prior

Nothing

Any bad or good "surprises"?

I found a great environment and a great experience, both from a professional and personal point of view.

Any challenges, personally and professionally

From a professional point of view, it is hard to keep collaborating with companies (I have come in contact with a couple), as the visa for a foreigner is an obstacle.

Impact of those lessons learned

I have certainly learned many things on the USA and myself, this will further influence my professional and personal choices to come.

NGI ENRICHERS TRANSATLANTIC

Giulio Sidoretti

Researcher at University of Rome Tor Vergata ; PhD in progress completed

Giulio Sidoretti

giuliosidoretti@gmail.com

Video

(N/A)

NGI ENRICHERS TRANSATLANTIC

Keep engaged with our NGI Fellows !

The NGI Enrichers project has received funding from the European Union's Horizon Europe Research and Innovation Programme under grant agreement 101070125.

Out-of-Distribution Generalization in Quantum Machine Learning

Jason Pereira
United Kingdom

Postdoctoral Researcher at INFN
PhD in Quantum Communications, University of York

Track
Quantum Computing / Machine Learning

Host Organization
University of Southern California, Los Angeles, USA

NGI ENRICHERS TRANSATLANTIC

THE PROBLEM

- Scientists increasingly use machine learning to learn about physical processes from experiments. For instance, how will a medium of interest transform a state of light that is sent through it?
- Quantum machine learning promises to allow scientists to learn more about quantum systems using fewer experiments.
- Often, experimental limitations mean it is only possible to obtain partial data. Sometimes this partial data is not fully representative of the whole process.
- It is important to know how well a quantum machine learning model trained on partial data will “generalize” to new “out of distribution” data.
- What are the defining physical features of problems for which generalization is possible?

NGI ENRICHERS TRANSATLANTIC

YOUR SOLUTION (1)

- Previous research has largely focused on “in distribution” generalization: assuming that the partial data is representative of the problem as a whole.
- Some recent work has considered out of distribution generalization for learning quantum processes acting on qubit systems (discrete variables) – www.nature.com/articles/s41467-023-39381-w.
- This is important for quantum computing with qubits, but for many experimental settings (e.g. in quantum optics, or in cavity QED), it is more important to focus on continuous variable systems.
- Continuous variable systems are also important for quantum cryptography.
- I studied out of distribution generalization in continuous variable systems and found both analytical and numerical results.

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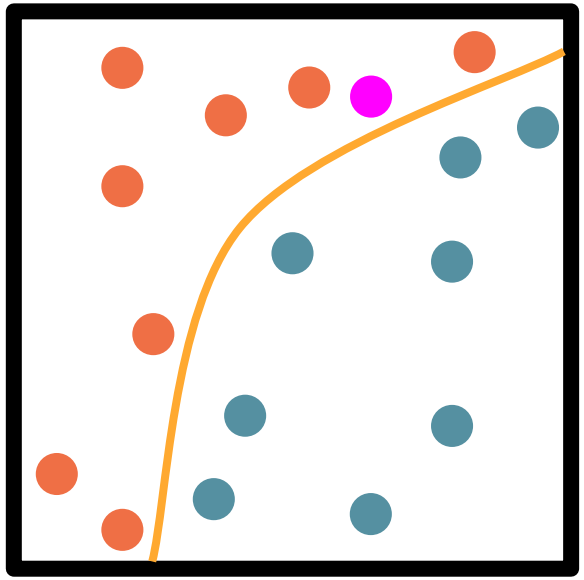
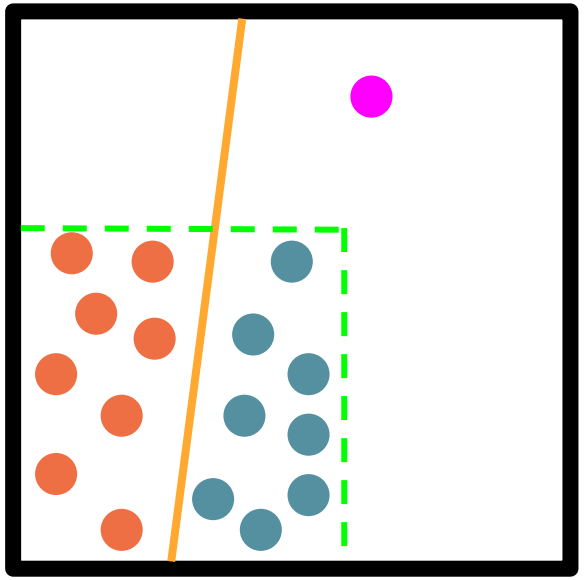
YOUR SOLUTION (2)

In distribution generalization: our training data is taken from the distribution we want to learn about. We are given two “classes” of dots - red and blue - and learn the yellow dividing line between them. We can then guess whether the new pink dot should be red or blue.



Out of distribution generalization: our training data is only taken from within the green dashed box. Since the pink dot is outside of this green box, we need to know if our prediction of its class is still reliable. In practice, we may want to predict the effect of a process on a quantum state, having only observed its effects on a different class of states.



PROFILE: JASON PEREIRA, POSTDOCTORAL RESEARCHER

Bio: MSci in Theoretical Physics from University College London (First Class Honours). PhD in Quantum Communications from the University of York.

Worked for two years as a postdoctoral research associate on the EU-funded QUARTET project. Worked for two years (including the duration of the project) for the INFN as a postdoctoral researcher (assegno di ricerca).

16 published papers (orcid.org/0000-0002-0568-5737).

2217 citations according to Google Scholar.

NGI related publications: Hacking Alice's box in continuous-variable quantum key distribution, Advances in quantum cryptography (related to quantum cryptography/secure online communications)

Generalization in Quantum Machine Learning: A Quantum Information Standpoint, Quantum-enhanced cluster detection in physical images (related to quantum machine learning)

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THE TEAM / EXPERTISE

Principal researcher: Leonardo Banchi
Associate professor at the University of Florence.
PhD in physics from the University of Florence. Earned Sergio Fubini PhD prize.
76 publications (orcid.org/0000-0002-6324-8754).
6334 citations according to Google Scholar.
Current projects: SQMS, PNRR (PE4,PE14), PRIN (to start), HORIZON-CL4 (to start)

Head of host group: Quntao Zhuang
Assistant professor at the University of Southern Carolina.
PhD in physics from the Massachusetts Institute of Technology.
98 publications (orcid.org/0000-0002-9554-3846).
3246 citations according to Google Scholar.
Earned the DARPA Young Faculty Award (2020 and 2022) and the National Science Foundation CAREER award (2022).

NGI ENRICHERS TRANSATLANTIC

YOUR HOST ORGANIZATION

Host organization: Zhuang group at the University of Southern California (Department of Electrical and Computer Engineering).

Led by Quntao Zhuang. Group currently has four postdoctoral researchers and two graduate students.

Group has expertise in the study of variational quantum circuits (relevant for the numerical studies) and in continuous variable quantum information.

Part of the Superconducting Quantum Materials and Systems Center (SQMS) project, led by Fermilab.

KEY RESULTS (1)

- Scientists learn about physical processes using data from experiments. It is often difficult to obtain an exact mathematical description of processes, so they increasingly apply machine learning to the data.
- When the outputs of those processes are quantum states, quantum machine learning promises to allow scientists to learn more from fewer experiments.
- When we apply machine learning, an important question is how our solution "generalizes", i.e., is our solution still reliable when applied to unseen data?
- We focused on the problem of learning CV quantum channels (processes). A channel transforms one quantum state into another. "Learning" a channel means understanding/being able to reproduce the input-output relations.
- Our key technical achievement was deriving a series of important results regarding out-of-distribution generalization when learning CV quantum channels using low energy coherent states.

KEY RESULTS (2)

- CV channels have infinite dimension, so it is very hard to probe them with every possible state. Instead, we probe the channel with a smaller set of input states and then extrapolate the results to all possible inputs.
- Coherent states are a particularly simple, classical set of inputs. Experimentally, it is simple to use low energy, coherent states to learn input-output relations.
- The difficulty is that the relations may be very different for low energy inputs and high energy inputs or for classical and non-classical inputs.
- We proved that if two channels are very similar for low energy coherent states, we can bound how similar they are for high energy coherent states.
- We then found a bound on how close they are for all (even non-classical) inputs.

KEY RESULTS (3)

- Put together, this means that if we learn a channel well enough for only low energy coherent states, we also know the input-output relations for any input.
- In other words, we showed that, for any target channel that we learn using low energy coherent states, **out-of-distribution generalization is always possible for every input state**.
- This is a very general result, with a direct impact on subjects such as quantum machine learning and quantum metrology and less direct implications for a wide variety of fields, including quantum cryptography.
- We also looked at a variety of specific examples, to obtain numerical results.

KEY RESULTS (4)

- There were also a number of non-technical achievements.
- Our results will be presented in a scientific paper. This will be a joint publication with the host group, boosting EU-USA scientific collaboration.
- The project enhanced collaboration between Quntao's group at USC and my group at the INFN, by building connections with the researchers at USC.

IMPLEMENTATION

- We have a paper in preparation (close to completion), presenting our results.
- This is likely to be published as a preprint within the next few weeks.
- It will then be submitted to a high impact scientific journal.
- There are a few possible avenues for follow-on research, which could potentially be explored by a future collaboration.

EXPECTED IMPACT

- Our result has implications across a wide variety of fields of quantum information/technology.
- Quantum machine learning will lead to advances in many fields of science, with knock-on effects on other aspects of technology.
- “Learning quantum channels” is a problem with broad applicability, since many technological tasks can be rephrased in this way, even beyond the obvious.
- One example, with implications for privacy, is quantum key distribution (QKD).
- If an eavesdropper can gain partial information about devices being used for QKD, it is important to know how well they can generalize this data to gain full information about the messages being sent. The degree to which this is possible will inform the standards used when designing QKD technology.

LESSONS LEARNED

- Working with Quntao's group, I was in a larger research group than any I had worked with previously. As such, I came to understand the pros and cons of different sizes of group.
- I learned that different research groups have different collaboration styles. For instance, Quntao's group meets weekly for a journal club discussion, presented each week by a different group member. This was an interesting idea, which I will take forward to new workplaces.

Jason Pereira

Postdoctoral Researcher at INFN PhD in Quantum Communications, University of York

Jason Pereira

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Video

(N/A)

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The NGI Enrichers project has received funding from the European Union's Horizon Europe Research and Innovation Programme under grant agreement 101070125.

Enhancing Privacy and Fairness in Federated Learning via Dynamic Adversarial Regularization

Jhonatan Tavori
Israel

Postdoctoral Researcher at Tel Aviv UniversityExpert in Privacy-Preserving Machine Learning

Track
AI / Privacy

Host Organization
University of Southern California, Los Angeles, USA

NGI ENRICHERS TRANSATLANTIC

THE PROBLEM

- **The problem. Our project addresses critical and unique security concerns in emerging NGI Autonomous V2X (Vehicle-to-Everything) systems:**
  - Navigation platforms rely on users input for decision-making, making them vulnerable to injection of false data into the system. By doing so, attackers may cause significant harm without the need to hack and disable physical servers, posing a concrete threat of disruptions. Recent demos showed how to produce fake traffic jams on platforms like Google's Waze.
  - This challenge puts at risk the integrity of real-time navigation platforms, and the advancement of future smart cities.
  - Thus, it is essential to enhance the resilience of these platforms and to guarantee their optimal performance, even when subjected to cyberattacks designed to inflict maximum harm.
- **Target audiences.** We developed new analytic techniques as well as practical applications. Thus, our target audiences include:
  - Our primary target audience includes European and US cities, regulators, and other global entities with a vested interest in advances in transportation technology for smart cities. These stakeholders have a strong interest in implementing measures that safeguard the robustness of vehicular networks to avoid security issues impeding the adoption of autonomous vehicles.
  - Researchers in other domains, including edge-cloud computing, IoT and other cyber-physical systems, may utilize the algorithmic and analytic advances to be achieved by this project, to advance and motivate further research.
- **Related Work, benchmarking competition – The Opportunity.**
  - Most of the existing attempts to prevent Sybil attacks focus on preventing bots from initially entering the system. Thus, our approach presents an opportunity as we intend to create a solution which ensures the resiliency, even when bots have already entered the system and were not caught by a detection software.

NGI ENRICHERS TRANSATLANTIC

OUR SOLUTION (1)

- **Technology.** We propose a **unique solution** which combines physical sensors and cameras along with an advanced network analysis to mitigate attacks. We integrate three key technological components: (1) **Sensor's infrastructures** - using sensors equipped with AI-enabled edge-computing, including cameras and LiDARs. (2) **Network analysis** – An advanced analysis of worst-case attacks on the target networks that pinpoints their potential vulnerabilities. (3) **Algorithmic development** – Constructing a mechanism for performing real-time decision-making based on the advanced analysis.

- **Differentiator.** The collaboration of the team members in this project allowed a unique and a singular opportunity to carry a theoretical-applicative NGI research. We utilize the exceptional COSMOS platform at Columbia University, a unique testbed that is not available in the EU. COSMOS features sensors like cameras and LiDARs, equipped with deep learning methods, as well as edge-cloud infrastructure.

- **Competitive Advantage.** Our team brings a lot of analytic experience in studying network attacks, including in the domain of vehicular networks. This unique combination creates a synergistic advantage for developing a qualitative concrete solution. Our strategy will focus on making adaptive improvements using feedbacks from experiments across a range of attack scenarios, iteratively optimizing our solution, and utilizing our network analysis to optimize the physical sensors deployment.

- **Opportunity and Size.** We target the growing autonomous driving market, encompassing car manufacturers as well as other transportation management firms. The network security aspect of this emerging technology holds the potential to attract substantial interest in Europe, and globally.

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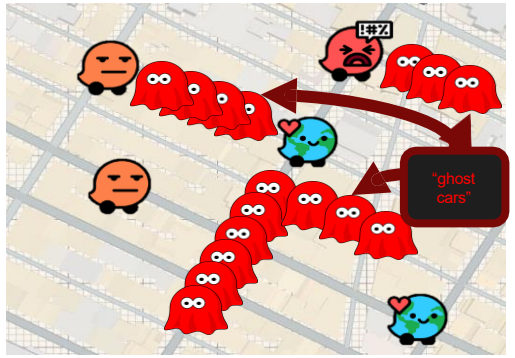
OUR SOLUTION (2)

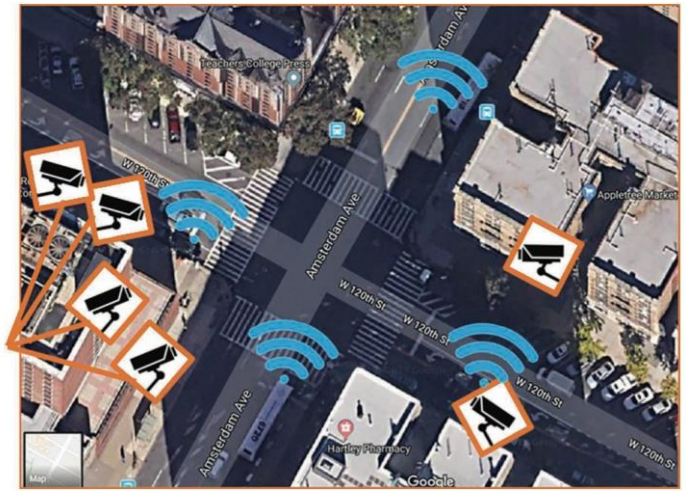
(1) Illustration of a Sybil Attack in New York City. All the red "ghosts" are bots generating fake location:

The real state of the road

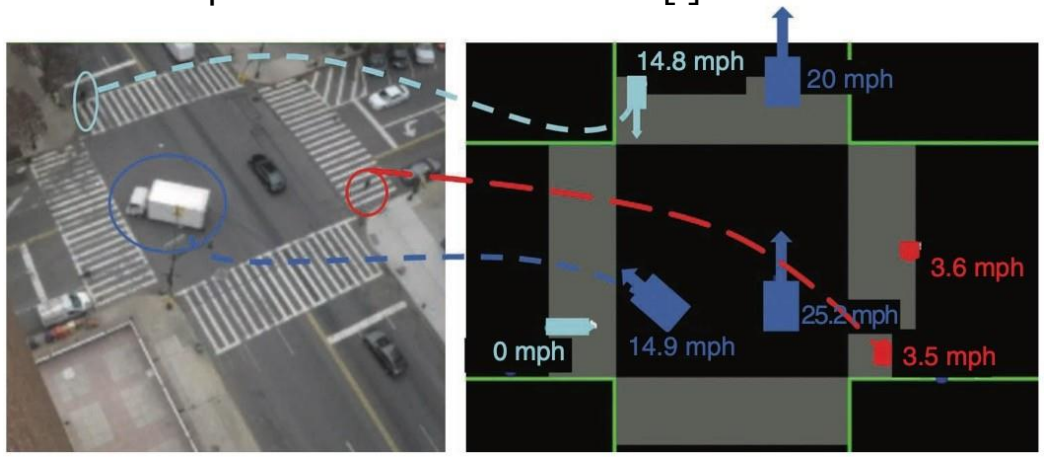


The reflected state of the road

(2) A Columbia Univeristy's COSMOS Site located at an intersection in New York, with sensors including cameras and edgle-cloud nodes [1]:



(3) The locations and velocity vectors of cars obtained using COSMOS' deep learning methods, which will be integrated in the proposed mechanism and compared with the reported mobile GPS data [1]:



[1] S. Yang, E. Bailey, Z. Yang, J. Ostrometzky, G. Zussman, I. Seskar, and Z. Kostic. Cosmos smart intersection: Edge compute and communications for bird's eye object tracking. In 2020 IEEE International Conference on Pervasive Computing and Communications Workshops (PerCom Workshops), pages 1–7.IEEE, 2020.

NGI ENRICHERS TRANSATLANTIC

JHONATAN TAVORI

Master of Science,
PhD Student at The School of Computer Science, Tel Aviv University

About Me. I'm a Ph.D. student at Tel Aviv University's School of Computer Science. I am enthusiastic about exploring new areas, conducting research, and teaching. My expertise is in conducting networking and security research.
My academic journey started in middle school, at the age of 13, when I began pursuing my Bachelor's degree in computer science. I completed my B.Sc. with the highest honors, achieving a Summa Cum Laude distinction. At the age of 17, I started my Master's studies, which I finished with distinction. During my studies, I've received multiple awards – I was included in the University President's list for achievements four years, received the Ministry of Education award for young students, and received an award for excellence academic achievements at my Master's.

NGI Experience. My research focuses on the operation of networks under malicious attacks, from both analytical and practical perspectives, aiming at making the next generation Internet more secure and efficient. Selected publications include:

1 J. Tavori and H. Levy. *Tornadoes In The Cloud: Worst-Case Attacks on Distributed Resources Systems.* In IEEE INFOCOM 2021.
2 J. Tavori and H. Levy. *A Queueing Approach for Vehicular Traffic Networks Sybil Attacks (poster).* In USENIX Security 2022.
3 J. Tavori and H. Levy. *How to Attack and Congest Delay-Sensitive Applications on the Cloud.* In IEEE INFOCOM 2023.

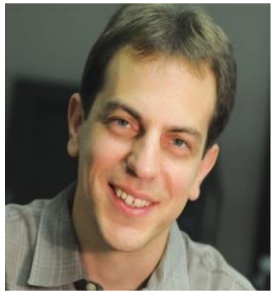
NGI Achievements. I was honored with the Innovation Scholarship of *Shlomo Shmeltzer Institute for Smart Transportation* for my research in the field of vehicular networks attacks and mitigations. I presented my research works at top-tier conferences, including *IEEE INFOCOM*, *USENIX Security Symposium* and *ACM SIGMETRICS Workshops*.
My Master's Thesis regarding the analysis of worst-case attacks on distributed resources systems has been recognized with distinction (Magna Cum Lauda). I've received the Computer Science School's Outstanding Teaching Assistant Award, for teaching the Communication Networks course at Tel Aviv University.

NGI ENRICHERS TRANSATLANTIC

THE TEAM & EXPERTISE

The team. Our team aims to collaborate between the research group led by Hanoch Levy at TAU, which focuses on computer communications networks, security, and performance evaluation of computer systems, and the Wireless and Mobile Networking (WiMNet) Lab led by Gil Zussman at CU, which focuses on research in the areas of wireless, mobile, and resilient networks and systems. The rich experience of Prof. Levy in resilience resource placement in cloud computing and of Prof. Zussman in resilience resource placement, including power grids, meet in this project for further advanced collaboration.

Mentors:



Gil Zussman is a Professor of EE and CS at Columbia University, and a Life Fellow of IEEE. He is the Head of the Electrical Engineering department at Columbia University. He received the Ph.D. degree in electrical engineering from the Technion in 2004 and was a postdoctoral associate at MIT in 2004–2007. He is a co-recipient of 7 paper awards including the 2011 IEEE Communications Society Award for Advances in Communication. He received the Fulbright Fellowship and the NSF CAREER Award. He has served on the technical program committees for several conferences, including IEEE INFOCOM and ACM MobiHoc.

Hanoch Levy is a Professor of CS at Tel Aviv University. He received his Ph.D. degree in computer science from the University of California–Los Angeles in 1984. From 1984 to 1987, he was a member of technical staff with the Department of Teletraffic Theory, AT&T Bell Laboratories. Since 1987, he has been with the School of Computer Science, Tel Aviv University, where he was the Department Chairman from 1998 to 2000 and the Head of the School from 2016 to 2018. From 1992 to 1996, he was with Rutgers University and from 2007 to 2008, he was with the Communication Systems Group at ETH Zurich. Hanoch is Jhonatan's PhD Advisor.

NGI ENRICHERS TRANSATLANTIC

THE HOST ORGANIZATION

Background: The **Wireless and Mobile Networking (WiMNet) Research Lab** at the **Department** of Electrical Engineering in **Columbia University** focuses on research in the areas of wireless, mobile, and resilient networks and systems. The WiMNet Lab is dedicated to advancing wireless networking technologies and applications. The lab is home to a city-scale advanced wireless testbed as part of the NSF PAWR COSMOS project, which enables real-world experimentation on next-generation wireless technologies and applications.

Context: The **NSF PAWR COSMOS** project in the WiMNet lab is designed to meet both quantitative and qualitative requirements associated with a fully programmable city-scale advanced wireless testbed facility. The COSMOS testbed has sensors (such as cameras and Lidars) as well as edge-cloud and networking infrastructure that will be used for conducting the proposed study. This platform allowed us to study and showcase our approach.

By combining the knowledge and experience of both research groups, the collaboration can expand both expertise and develop novel solutions that address real-world challenges in NGI, particularly in network resiliency.

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KEY RESULTS (1)

Main Findings:

- **Techniques**: Investigated performance analysis techniques with a focus on common cyberattack targeting edge-cloud systems and networks. Conducted an in-depth review of recent literature, reports, and state-of-the-art research on demonstrated attacks in this domain.
- **Development of a Cyberattack Model**: Studied a comprehensive mathematical model to analyze cyberattacks on vehicular networks, addressing critical aspects such as: Accounting for variability across diverse server locations, supporting scenarios where edge-servers face computational overload and factoring in real-world latencies that impact system performance.
- **Validation - COSMOS**: Evaluated the real-time requirement of the COSMOS testbed to better understand the effectiveness of it for our goals.

Main Output: The main results achieved so far have been submitted to a top-tier (A*) conference in the field of networked systems and are currently under review.

KEY RESULTS (2)

Referring to the suggested points:

- **Expanding collaboration within the NGI community:** Collaborated with multiple NGI researchers, sharing insights and receiving valuable feedback that enriched the project.
- **Technical integration of the products:** Successfully tested the real-time pipeline using data from NYC traffic cameras and confirmed its compatibility with navigation frameworks.
- **Paper submission for further publication:** Submitted a paper to a top-tier conference (A*) with joint authorship from the host organization, showcasing the collaborative nature of the project.
- **Strengthening research collaboration with the US/Canada:** Expanded research ties by collaborating with additional labs within the host institution, including one from a different department.
- **Building solid connections and partnerships in Europe and in the US/Canada:** Established meaningful connections with researchers from the host organization and fostered relationships that will support future cross- continental projects.

KEY RESULTS (3)

Outcomes of the Expedition: Project and Personal Reflections

- **Project Outcomes vs. Expectations**: We successfully collected and analyzed traffic data from several locations across NYC, exceeding initial expectations.
- **Personal Growth and Collaboration**: The interdisciplinary collaboration within this project not only enriched my research experience but also enhanced the scope and impact of the work.
- **Expected Results Toward the End of the Expedition**: The research outcomes are promising, and a practical implementation will be of a great impact. By refining and scaling the idea, I aim to contribute to practical solutions for smart city systems and establish a foundation for meaningful academic and industry collaborations.

IMPLEMENTATION

Next 6-Month Steps - The focus will be on developing, testing, validating, and expanding the applicability of our findings to maximize their real-world impact.

- **Real-World Testing and Validation**: Real-world testing and validation by deploying models within the COSMOS testbed in New York City. By simulating various attack vectors and observing how to respond, we can refine our approaches and ensure they are robust enough to handle actual cyber threats.
- **Impact Maximization and Future Expansion**: To achieve our goals, we plan to publish our research findings and methodologies in academic journals and conferences, increasing exposure and encouraging further research in this field. Collaborations with industry partners will ensure our solutions are practical and scalable, thus maximizing the project's impact.
- **Extending the Methodology**: We hope to extend our methodology to address security challenges in other areas, such as IoT systems and edge-cloud infrastructures.

EXPECTED IMPACT

Implementing our findings will significantly enhance both our project and its global **impact** by addressing
key **human-centric NGI domains**. we aim to impact not only the technological advancement of our project but also the global movement toward safer, more secure, and sustainable interconnected systems.

- **Autonomy**: By improving autonomous V2X systems, we ensure seamless real-time communication between vehicles and infrastructure.
- **Data Privacy, Sovereignty and Protection**: The project focuses on safeguarding data integrity within vehicular networks, preventing unauthorized access, and mitigating risks like data fraud or tampering.
- **Resiliency and Security**: Enhancing the robustness of vehicular networks ensures continuity even in the face of cyberattacks or technical failures. Our finding will protect navigation platforms against malicious attacks and ensure the safe operation of smart cities.
- **Sustainability**: By fostering smarter, more efficient vehicular systems, our findings contribute to eco-friendly transportation, which supports sustainable urban development.

NGI ENRICHERS TRANSATLANTIC

LESSONS LEARNED

- Adapting to a **new** environment and facilities.
- Managing **multiple** collaborations simultaneously, across various **time zones**.
- **Effective communication** and **flexibility** proved itself as the **key**.
- The experience enhanced my **adaptability** and collaboration skills.
- I believe this has prepared me for **future** international and large-scale projects.

Jhonatan Tavori

Postdoctoral Researcher at Tel Aviv UniversityExpert in Privacy-Preserving Machine Learning

Jhonatan Tavori

jhonatan.tavori@cs.tau.ac.il

Video

Profile

NGI ENRICHERS TRANSATLANTIC

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The NGI Enrichers project has received funding from the European Union's Horizon Europe Research and Innovation Programme under grant agreement 101070125.

Immersive User-Centric Quality of Experience (QoE)

Marouane Tliba
France

Postdoctoral Researcher at
University of Orléans
PhD in Computer Science

Track
AI / XR (Virtual, Augmented & Mixed Reality)
Host Organization
University of Illinois Chicago, Chicago, USA
153

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THE PROBLEM

Problem (Need)
Immersive 3D environments (VR/AR) often lack perceptually-aware systems, leading to suboptimal user experiences and high computational costs. Also, lack user-centric experience that adapts to individual user preferences and needs, resulting in a generic impersonal experience.

Identification
Performance gaps, user feedback, and research trends highlight the need for perceptual models tailored to 3D point clouds.

Target Audiences & Stakeholders

- End users: Gamers, educators, professionals
- Developers and designers: VR/AR content creators
- Tech companies: 3D rendering and cloud services
- Sectors: Healthcare, training, and simulations

Opportunity

Few competitors address personalized visual attention for 3D point clouds, creating a unique space for innovation in immersive technologies.

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YOUR SOLUTION (1)

We developed lightweight perceptual quality assessment and visual attention models for 3D point clouds, enhancing real-time immersive experiences.

Differentiator
Our solution integrates personalized gaze analysis and using deep learning, optimizing performance and user experience on edge devices. Also we are making it as open source tools which can be used as user-centric solution

Competitive Advantage
Efficient, accurate, and scalable across 3D content used for VR/AR/XR industries.

Opportunity
With the VR market valued at $59.96 billion in 2022 and a projected CAGR of 27.5% through 2030, our innovative, user-centric solution has significant growth potential, particularly in open-source development.

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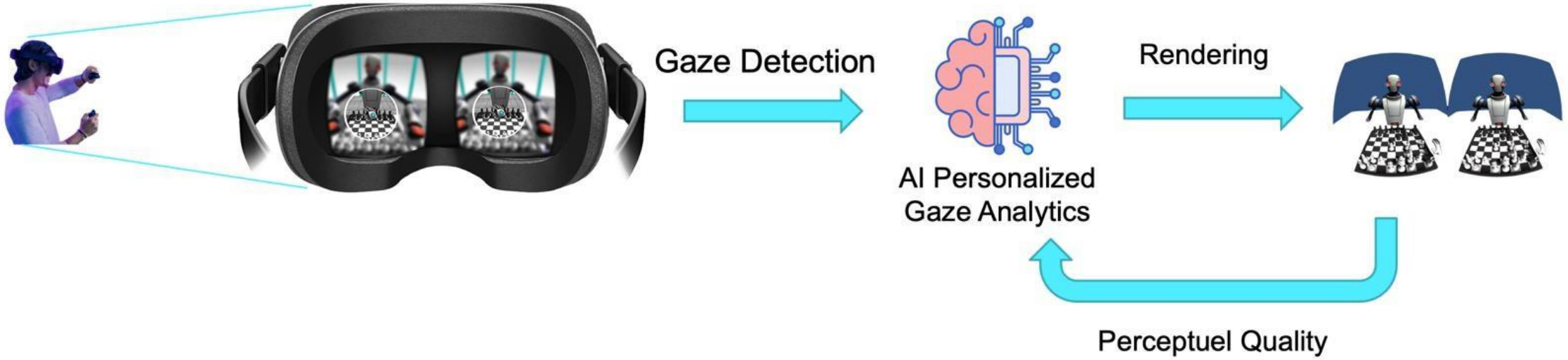
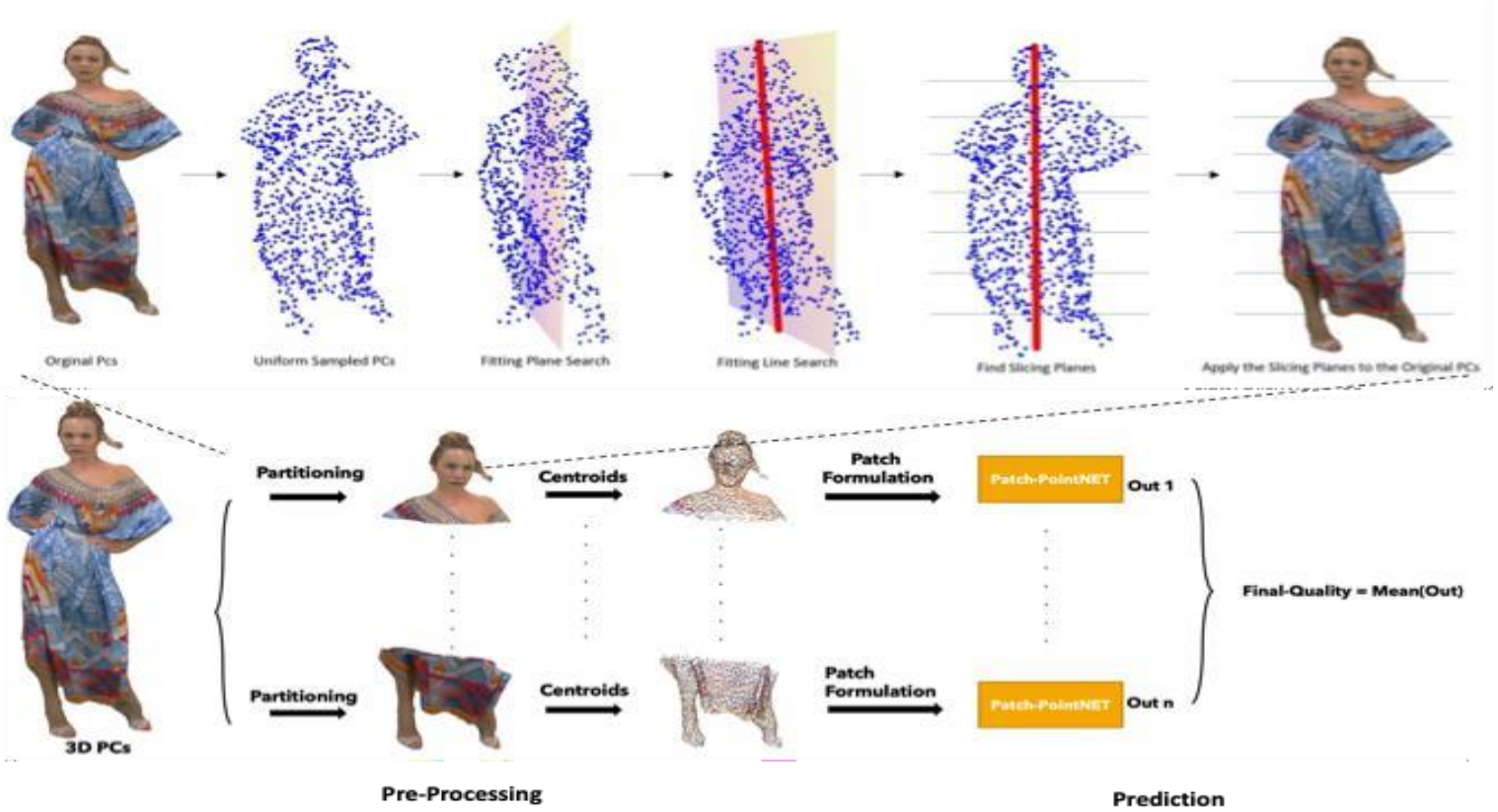
YOUR SOLUTION : OVERALL

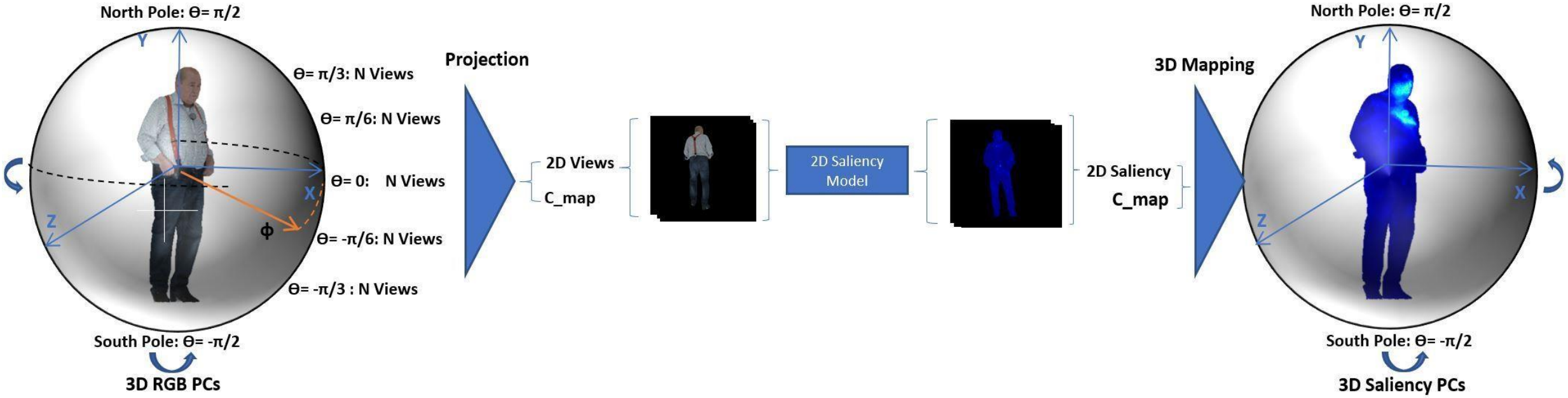


Utility: analyze personalized gaze patterns, optimizing scene generation based on user-centric feedback for an enhanced quality of experience.

YOUR SOLUTION : NOVEL USER PERCEPTUAL QUALITY DESIGN



YOUR SOLUTION : 3D VISUAL ATTENTION MODELING (AI GAZE DETECTION AND ANALYSIS)



MAROUANE TLIBA, POSTDOC AT UNIVERSITY OF ORLEANS

I hold a Ph.D. in Computer Science from the University of Orléans, specializing in deep learning for 3D application. My research focuses on enhancing Quality of Experience by developing perceptually-aware systems for virtual, augmented, and immersive digital spaces, bridging theoretical AI advancements with practical applications.

I have published in top level Computer Vision and Signal Processing Conferences (CVPR, ICASSP, ICIP, ACM MM, etc.)

NGI ENRICHERS TRANSATLANTIC

THE TEAM /EXPERTISE

- Advisors: Aladine Chetouani, Giuseppe Valenzise, Frederic Dufaux
- Team mates : Kerkouri Mohamed Amine, Emadeldeen Hamdan
- Host : Ahmet Enis Cetin *(aecyy@uic.edu*)

NGI ENRICHERS TRANSATLANTIC

YOUR HOST ORGANIZATION

University of Illinois Chicago, Department of Electrical and Computer Engineering

I selected Professor Cetin's Lab at UIC's Department of Electrical and Computer Engineering due to its renowned research in signal processing and computer vision, which aligns perfectly with my focus on advanced visual attention modeling and AI for optimizing immersive, user-centric experiences.

NGI Experience

This expedition provided invaluable insights through the expertise of the host lab, significantly advancing my research and fostering my professional growth.

NGI ENRICHERS TRANSATLANTIC

KEY RESULTS (1)

First Findings, Outputs, and Outcomes of the Expedition

Innovative Technologies Developed

- **Lightweight Perceptual Quality Model:** Achieved state-of-the-art accuracy and efficiency, designed for real-time edge deployment in immersive 3D environments.
- **Visual Attention Model:** Developed using self-supervised learning (e.g., DINO framework), enabling perceptually-aware rendering.
- **Tool for Dataset Collection:** Created an efficient eye-tracking and quality assessment tool for screen-based interaction setups.

NGI ENRICHERS TRANSATLANTIC

KEY RESULTS (2)

Findings, Outputs, and Outcomes of the Expedition

Sound Scientific Validation

- Obtained results demonstrate promising accuracy and efficiency, aligning with expectations for advancing immersive experiences in VR/AR/XR.

Collaboration and Dissemination

- Established key research partnerships on Eye-Tracking, and the development of generative AI application with UIC, Northwestern University and other U.S-based labs
- Submitted a workshop proposal on generative AI and visual attention modeling.
- **Tools Developed:** Designed a eye-tracking and quality assessment tool for screen-based user interaction, enabling simplified and efficient data collection.

KEY RESULTS (3)

Achievements vs. Expectations

Achievements Compared to Initial Expectations

- **Development:** Significant progress in designing perceptually-aware models for 3D point clouds, exceeding expectations in computational efficiency.
- **Testing and Prototyping:** Early-stage prototypes were validated for their usability and effectiveness in immersive environments.
- **Scientific Contributions:** Joint publications and collaborations with researchers in both teams from Europe and the U.S.

NGI ENRICHERS TRANSATLANTIC

KEY RESULTS (4)

Expected Results by the End of the Expedition

- Finalize and validate lightweight perceptual models for seamless deployment in real-world applications.

Long-Term Vision

- **Industry Standards:** Influence standards for perceptual quality assessment and visual attention modeling in 3D environments.
- **Global Partnerships:** Build a robust network of academic, industrial, and community partners for joint innovation.
- **Commercialization and Ecosystem Development:** Transition from prototypes to market-ready solutions, fostering an open-source ecosystem to drive adoption and further research.

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IMPLEMENTATION (1)

- **Refine Perceptual Quality Models**
  - Optimize for real-time performance on edge devices through iterative testing and user feedback.
- **Enhance Visual Attention Models**
  - Improve visual attention model and validate through user studies for better alignment with human attention.
- **Expand Dataset Collection**
  - Deploy the data collection tool to gather diverse data for benchmarking and validation.

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IMPLEMENTATION (2)

- **Validate and Demonstrate Prototypes**
  - Conduct pilot tests and showcase at workshops and conferences.
- **Strengthen Collaborations**
  - Plan other fellowships, foster partnerships, and submit joint funding proposals.
- **Disseminate and Engage Community**
  - Submit research papers, organize workshops, and release open-source tools.

NGI ENRICHERS TRANSATLANTIC

EXPECTED IMPACT

Impact of Findings on the Project and the World

1. Project Impact

- Optimized, user-centric VR/AR environments with real-time performance.
- Established benchmarks for 3D quality and visual attention modeling.
- Advanced immersive applications in education, healthcare, and entertainment.

2. Global Human-Centric NGI Impact

- **Privacy & Security**:: On-device data processing.
- **Sustainability & Green IT**:: Energy-efficient, eco-friendly models
- **Lifelong Learning & Social Participation:** Foster learning and collaboration in immersive spaces.

NGI ENRICHERS TRANSATLANTIC

LESSONS LEARNED

- **What I Wished I Knew:** Ho to adapt the recent advances of deep learning learning to challenging 3D contents.
- **Surprises:** Positive: Strong collaboration opportunities; Negative: Data collection challenges.

Challenges

- **Personal:** Balancing technical development, academic commitments, and the new life.
- **Professional:** Addressing high performance demands while ensuring model robustness.

NGI ENRICHERS TRANSATLANTIC

LESSONS LEARNED

Impact of Lessons Learned

- **Project Impact:** Refined my strategies for model optimization, and enhancing research efficiency.
- **Professional Growth:** Improved problem-solving, project management, and collaboration skills.
- **Future Plans:** Lessons will inform the next phases of development and future projects, ensuring faster, more targeted advancements.

NGI ENRICHERS TRANSATLANTIC

Marouane Tliba

Postdoctoral Researcher
at University of Orléans
PhD in Computer Science

Marouane Tliba

marouane.tliba@univ-orleans.fr

Video

Google Scholar

NGI ENRICHERS TRANSATLANTIC

Keep engaged with our NGI Fellows !

The NGI Enrichers project has received funding from the European Union's Horizon Europe Research and Innovation Programme under grant agreement 101070125.

AI Fashion and Actuated Knitwear for Privacy Protection

Martina Motta
Italy

Assistant Professor at Politecnico di MilanoExpert in Design, Knitwear Innovation, and Adversarial Fashion

Track
AI / FashionTech / Privacy

Host Organization
MIT ,Cambridge, Massachusetts, USA

NGI ENRICHERS TRANSATLANTIC

THE PROBLEM

- The improper use of facial recognition technology (FRT) and the Lack of legal design solutions to protect one’s biometric data and privacy.
- Our target market is people with strong ethical values and concerns linked to the diffusion of new Surveillance AI technologies.
- We are the first to address this need worldwide, offering a design product embedded with high tech. We have two patent and working on two new ones.

YOUR SOLUTION (1)

- **Technology** - Garments and textiles that, thanks to the technologies embedded in the pattern, prevent the collection of the wearer's biometric data without the need to cover the face.
- **Differentiator** - The competitive scenario lacks technology reliability and product industriality.
- **Development** - We are working on solutions to make our adversarial patterns dynamic and updatable to constantly respond to surveillance technology progresses. We foresee in the technology developed at MIT Media Lab a great opportunity to boost several aspects of the project.

YOUR SOLUTION (2)

1. FIRST STATIC ADVERSARIAL PATTERNS (what we have)

2. DYNAMIC ADVERSARIAL GARMENT (what we want to obtain)

NGI ENRICHERS TRANSATLANTIC

MARTINA MOTTA
Assistant Professor, Politecnico di Milano

Bio and achievements/successes

I am a researcher and professor in Design, focused on the textile and knitwear fields. My approach to technology is thus design driven and human centric, while a lot connected with the R&D progresses in manufacturing companies. Working on the convergence of advanced technology and traditional manufacturing, my research built a network of companies connected with the Politecnico Knitlab that work together with the academic team to pursue teaching and applied innovation results and improvements.

Among the others, I set a partnership with Shima Seiki, producer of industrial knitting machines and software. After their training courses I was able to integrate these technologies in the research activities and in the Fashion Design curricula of Politecnico di Milano. I supported them in testing new software and developed projects with their support (e.g. CAP_ABLE, PSYCOKNIT @Milan Design Week; BIOTAPE, @17th International Architectural Biennale in Venice; SENSEKNIT @MADE Expo, Milan.)

MARTINA MOTTA
Assistant Professor, Politecnico di Milano

Relevant publications:

- Motta, M. and Didero, R. (2024). **When technology becomes harmful. The contribution of designers at a crossroads between fashion, digital and ethics.** Chapter in “Designing ethically in a complex world”, edited by Caratti, E., Galluzzo, L. Milan, IT: FrancoAngeli.
- Motta, M., Didero R., Conti G., M. (2024). **A connection between Critical and Practice-Based Design Research in the Era of Surveillance**. Proceedings of D-tex International Conference
- Motta, M., and Dumitrescu, D. (2023). **Material practices in transition: from analogue to digital in teaching textile and fashion design.** DIID - Disegno Industriale Industrial Design Journal, No.1 — 2023: 908-917. ISSN 1594-8528
- Motta, M., Dumitrescu, D. (2022). **The role of teaching advanced technological knowledge to enhance experimental creativity in knit design**. In: Gianni Montagna and Cristina Carvalho (eds.) Human Factors for Apparel and Textile Engineering. AHFE Open Access, vol 32. AHFE International, USA.. *ISBN: 978-1-958651-08-7*
- Motta, M. (2022). **Translating the creative process of knitwear design: from manual to digital practices in a material-driven approach.** Proceedings of the 5th IHSI conference. *ISBN:978-1-7923-8988-7*

NGI ENRICHERS TRANSATLANTIC

MARTINA MOTTA
Assistant Professor, Politecnico di Milano

Most relevant research projects in the field:

- SMART-K, that studied for the Italian knitwear sector a set of new technological tools, to solve the loss of competitiveness
- Digiknit, that digitized the archive of the knitwear factory MF1 to improve the accessibility of tangible assets of the company to scientific communities, designers, professionals, and R&D operators in the textile-clothing sector.
- Con-text, that worked on the connection of competencies between young design professionals and the knitwear/textile manufacturing industry, rewriting the university curriculum and activating the dialogue with digital and analogue tools.
- Cap_able, a pilot project that built a startup in AI fashion for privacy protection, to study the impact of the product resulting from the ongoing on the theme and to research on the target person and to collect case studies and feedback to implement the direction of scientific research.

Achievements as NGI researchers/innovator

Patents: patent No. WO 2022/168014 and patent No. 102023000014442

Prizes:

- Honourable Mention Premio Compasso d'Oro 2020 for the project DigiKnit: Enhancing Archives as Corporate Material Culture through Intelligent Devices for Innovative Sharing of Local Knowledge. Research project also published on the ADI Design Index 2019.
- Targa Giovani ADI for the MA Thesis "Adversarial Knitted Fashion: CAP_ABLE". Designer: Rachele Didero | Supervisor: prof. Giovanni Maria Conti | Co-supervisor: Martina Motta. Project published on the ADI Design Index 2021.

THE TEAM / EXPERTISE

@Politecnico di Milano

- **Giovanni Maria Conti** – Ph.D., Associate Professor at Design Department and Coordinator of Knitwear design Lab – Knitlab of the Fashion Design Degree at Politecnico di Milano
- **Rachele Didero** - Ph.D. candidate in Design at Politecnico di Milano, currently visiting at MIT, Tangible Media Group.
- **Manuela Rubertelli** - Adjunct professor at the School of Design at Politecnico di Milano and research collaborator. Her professional expertise is product development in the textile and yarn sector, textile technologies and machinery.
- **Giulia Lo Scocco** – executive Ph.D. candidate in Design at Politecnico di Milano, working as R&D Manager in a knitwear company
- **Diego Dani** – Junior Researcher in Knitwear Design at the School of Design, Politecnico di Milano

THE TEAM / EXPERTISE

@MIT Media Lab

- **Zachary Lieberman** – Adjunct Associate Professor of Media Arts and Sciences @MIT Media Lab. Future Sketches research group.
- **Vera Van de Seyp** - designer, creative computing artist, and educator. She is a full-time research assistant in the Future Sketches group. Her work explores generative design tools, computational typography, and how artificial intelligence can help creatives. She teaches and gives workshops and lectures to inspire makers to code and make their own design tools.
- **Char Stiles** - master's student in the Future Sketches group. Char is a computational artist, educator, and programmer. She works creatively in the lower levels of graphical computational systems & makes jokes about how computers work, and researching the future of creative coding in performance.
- **Lingdong Huang** is a first-year master's student in the Future Sketches group. He is interested in making art with code.

YOUR HOST ORGANIZATION

This change opened a new opportunity for the project. Alongside the work on the tangible side of the products, FS research allowed me to explore the more intangible aspects of the project related to Computer Science. By studying and integrating the computational tools developed by FS, I explored new methods to generate, update, and personalize the adversarial patterns, plus effective ways to communicate the project value to the public.

I also worked closely with Vera van de Seyp and Dexter Callender, whose work touches coding with tangible outputs. Knitting is one of those outputs, and this is opening new research questions and themes for joint work, with future projects that could combine our diverse expertise.

KEY RESULTS

- Advancement in adversarial pattern development
- Testing interactive patterns
- Strengthening research collaboration with MIT
- Strengthening innovation collaboration with MIT
- Building connections and partnerships between Polimi and MIT
- Accelerated contacts with R&D partners for future collaborations
- Reinforced integration of computer science in the design project
- Fundraising - FIS call in Italy, NSF/MUR bilateral call Italy/US, MIT founds in US
- Mirrored fellowship from the host organisation to Europe
- Chapter published in a book – EU authors
- Project exhibited in Cambridge (MA) and Los Angeles (CA)
- Startup progress

KEY RESULTS

Advancements in adversarial pattern development and testing

Experiments towards dynamic adversarial knitted patterns with existing tools by Future Sketches:

- **Vera Van de Seyp's "Knitting Animation"**: adversarial patterns could become dynamic, and we could easily generate diverse versions from a single pattern to then test their adversarial efficacy.
- - **Vera Van de Seyp's "Computational Knitting Patterns"**: Adversarial patterns can be generated depending on the desired shape of the garment, maximizing the distribution of colors and motifs on the garment and its adversarial efficacy on different typologies of garments and dimensions.
- **Chelsi Cocking's "Photorythms":** adversarial patterns can be elaborated to generate new design while maintaining adversarial touchpoints

KEY RESULTS

Advancements in adversarial pattern development and testing

3 SETS OF TRIALS:
Upload image / Elaborate it / Verify the adversariality / Define parameters

Generation of adversarial patterns in a new way

Patterns placed as ready to be assembled

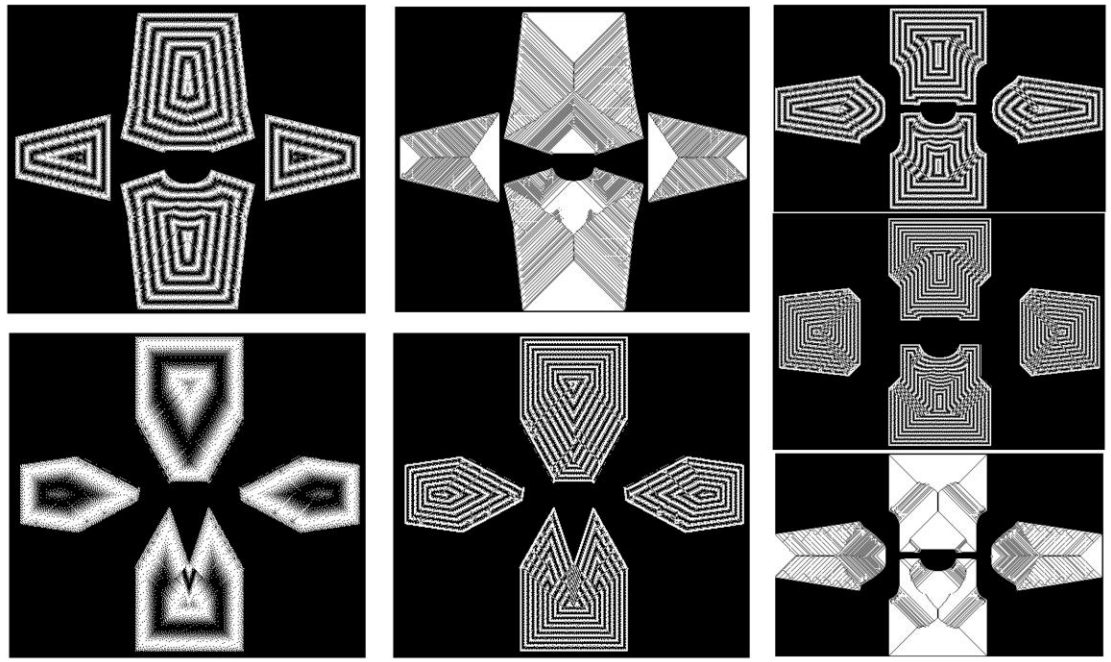
Computational elaboration of adversarial patterns to generate variations

Generation of new designs

A very first exploration towards personalization

KEY RESULTS

Advancements in adversarial pattern development and testing



KEY RESULTS

Strengthening research and innovation connections and fundraising

Definition of a common wider research topic of interest for future work with FS.

Study body movement using knitting as a medium – touching the several aspects of human gesture, privacy, freedom of movement, cultural heritage.

Relies on FS experiments like “Hand tracking” and “Hand Brushes”, and on the expertise in knitting of Polimi’s team.

Main themes:

(1) **Privacy:** a tangible map of our exposure;

(2) **Value:** the time spent to realize a garment, ethics and sustainability;

(3) **Connections:** between people, cultures, places.

***Project writing to apply for US funds @MIT Museum**

186

KEY RESULTS

Strengthening research and innovation connections and fundraising

Creation of a shared research pathway with Future Sketches and TMG, that focuses on the broader concept of AI Camouflage.

Here, the adversarial knitting represents a first pilot tangible experiment that generates knowledge for possible further developments in the domain of AI Camouflage.

***Project writing to apply for:**

- **NSF/MUR (joint call US and Italy)**
- **FIS3 (Italy)**

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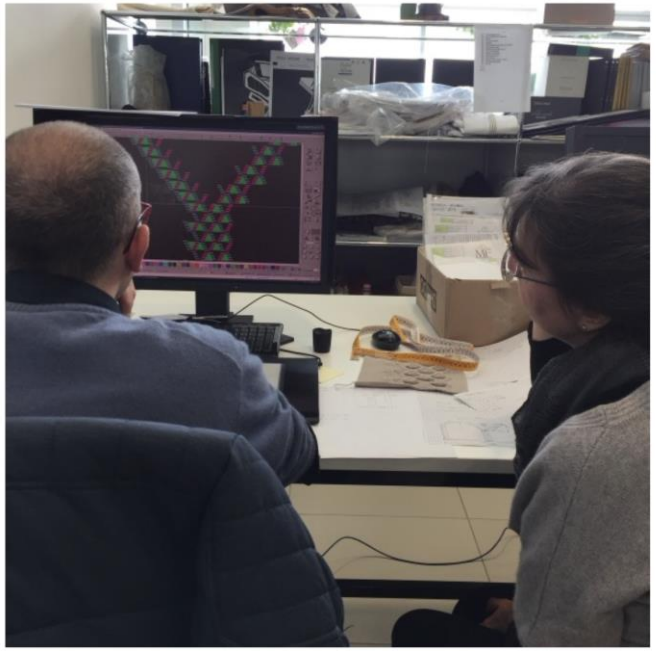
KEY RESULTS

Building connections and partnerships between Polimi and MIT

Series of joint workshops with FS around computation and knitting that can extend the experimentation with the above-cited results.



KEY RESULTS

Publications and exhibitions

Motta, M. and Didero, R. (2024). **When technology becomes harmful. The contribution of designers at a crossroads between fashion, digital and ethics**. Chapter in “Designing ethically in a complex world”, Milan, IT: FrancoAngeli.

Collaboration with Future Sketches to present the project at **Cambridge Science festival** in Cambridge, MA, September 2024 and at **Natural Intelligence** - **The Hive Gallery** in Los Angeles, December 2024.

IMPLEMENTATION

1. Results directly related to the project:

- Furtherly experimented at Polimi with the mutual support of Rachele Didero's Ph.D. research
- Furtherly experimented with one researcher travelling from MIT to Polimi Knit Lab (with pre-owned funds)
- used to implement the design pipeline in use for adversarial garments in Cap_able startup.
- Used as a research background to develop the shared research pathway on the broader concept of AI Camouflage. Here, the adversarial knitting represents a first pilot tangible experiment that generates knowledge for possible further developments in the domain of AI Camouflage.
- Used as the background knowledge for further experimentation with the planned joint workshops in 2025.

2. Results of future work:

- Research results presented at Milan Design Week 2025, inside the event “Interdependence” @Fabbrica del Vapore.
- Workshop results: Pitti Filati International Fair in Florence, July 2025
- Serve as the background for the writing of joint research projects

EXPECTED IMPACT

The program reinforced the integration between the aspects of the project related to social sciences and humanities (design, ethics, fashion culture, etc.) and computer science (computational calculation, AI, augm. reality) mastered at MIT.

The technical advancements we did are considered with the **human-centric approach** typical of design, and used to meet a concrete need by taking care of the **people's relationship and experience** with the product we propose.

It is one step ahead towards a tangible design product that impacts on the **ethical and social sustainability** of facial recognition, where the boundary between **security and control** is still blurred and many cameras do not **respect the privacy and data sovereignety of individuals,** often **harming human rights**.

Citizens will be able to act **to protect their data.**

The new research pathway on *AI Camouflage* will also work in the direction of a **sustainable co-existence of humans with AIs**, while the other research pathways on *Knitting as a movement to be traced* by FS tools will work on:

- ***Privacy: creating a tangible map of our exposure***
- ***Value: the time spent to realize a garment, ethics and sustainability***
- ***Connections: between people, cultures, places***

LESSONS LEARNED

Challenges

A different structure. And a different way of doing research.

One project at a time. The US approach I met was much more on single researchers developing their own projects rather than teamwork.

Promoting myself. Being used to discussing everything with my team and using the “we” instead of the “I”, it has been hard for me to find a way to promote my research as ”mine” when it is the result of the joint effort of my entire team in Milan.

Timing. Summer is definitely the wrong time to be involved in the MIT community and life.

Lessons learned

Contaminate. Explore coding and computer science, contaminating my humanities background with technological notions and reinforcing the integration between the two aspects is beneficial.

Speak with people. establish close connections and research collaboration between my research group in Knit Design @ Polimi and Future Sketches research group at MIT Media Lab. The contacts accelerate ideas for future research paths, future joint activities -research, dissemination and education activities–.

Martina Motta

Assistant Professor at Politecnico di MilanoExpert in Design, Knitwear Innovation, and Adversarial Fashion

Martina Motta

martina.motta@polimi.it

Video

(N/A)

NGI ENRICHERS TRANSATLANTIC

Keep engaged with our NGI Fellows !

The NGI Enrichers project has received funding from the European Union's Horizon Europe Research and Innovation Programme under grant agreement 101070125.

AI-enabled Raman spectroscopy for pathogen detection in the food industry

Marwan El Chazli
Switzerland

Researcher at EPFL
Co-founder of Myriad Optics

Track
AI / HealthTech / Biosensors

Host Organization
Johns Hopkins University, Baltimore, Maryland, USA

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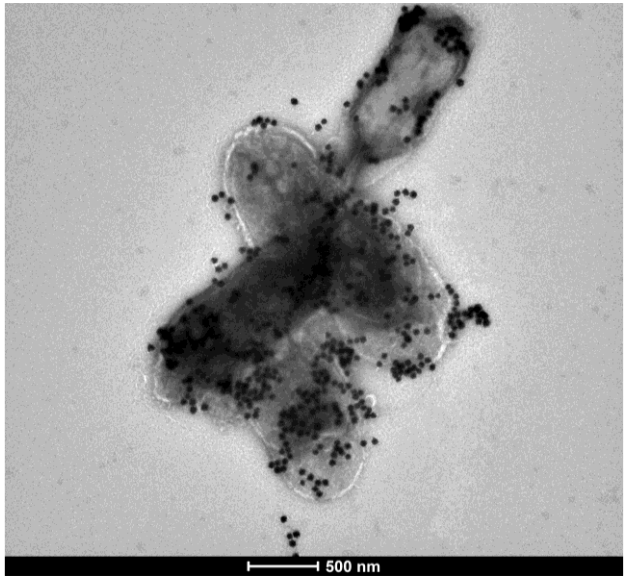
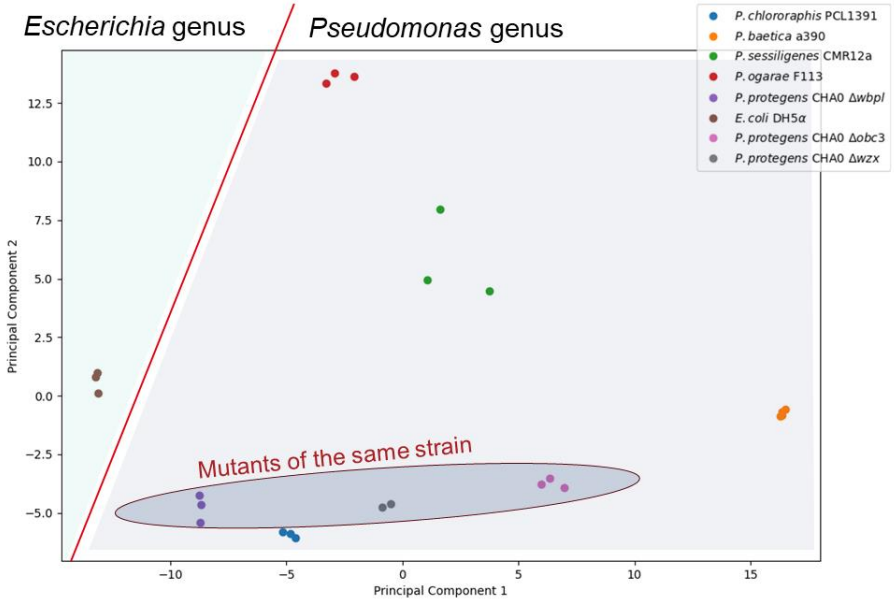
YOUR SOLUTION (2)

Gold nanoparticles (small black dots) modified with our novel protocol stick to the bacteria



A machine learning algorithm identifies different species and strains of bacteria



NGI ENRICHERS TRANSATLANTIC

FIRST & LAST NAME, POSITION CURRENT ORGANIZATION

Academic work

- Earned the maximum grade of 6/6 for my masters' thesis, which was also nominated for the Swiss Photonics award.
- Co-authored a paper on novel wearable biosensors for the detection of Cortisol in human sweat.

Some of my non-academic work

- **Outreach & Scientific Communication work:**
  - Represented young voices on a panel with UN Secretary-General António Guterres in Geneva in 2020
  - Worked as scientific communicator at EPFL from 2021 to 2023, translating scientific research into articles for the wider public
  - Worked as a scientific correspondent for a Swiss newspaper (Heidi.news) for 6 months in 2019-2020
  - Guest lecturer on food safety at the Swiss Hotel Management School in 2023
- **Others:**
  - Co-founded the EPFL Entrepreneur Club in 2019
  - Selected to be among 60 "Global Changemakers" at the Global Youth Summit in 2018.
  - Co-founder of Myriad Optics, an EPFL spin-off focused on new technologies for the detection of foodborne pathogens.

THE TEAM / EXPERTISE

Tell us about your team:

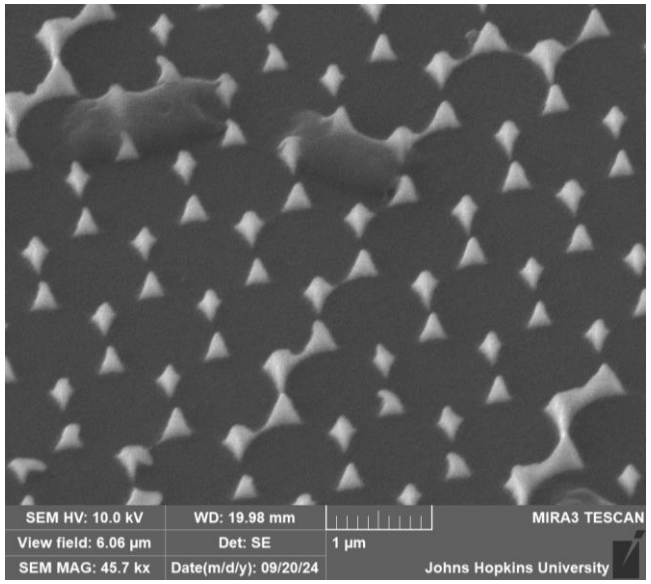
- **Supervisor:** Christophe Galland, EPFL Professor, PhD at ETH Zürich (2006) in Physics, Post doctorate at Los Alamos National Laboratory
- **Microbiology collaborator:** Jordan Vacheron, Senior Scientist in the Department of Fundamental Microbiology at the University of Lausanne
- **Mentor/Advisor in Biochemistry:** Juan Francisco Bada, Postdoctoral researcher at EPFL, PhD in Biochemistry from the University of Oxford (2019)
- **Mentor/Advisor in Raman spectroscopy/Optics:** Ata Golparvar, Doctoral student at EPFL, Masters in Electronics Engineering from Sabanci University
- **Host organization contact:** Ishan Barman, Professor at the Johns Hopkins University, PhD and post-doc at MIT.

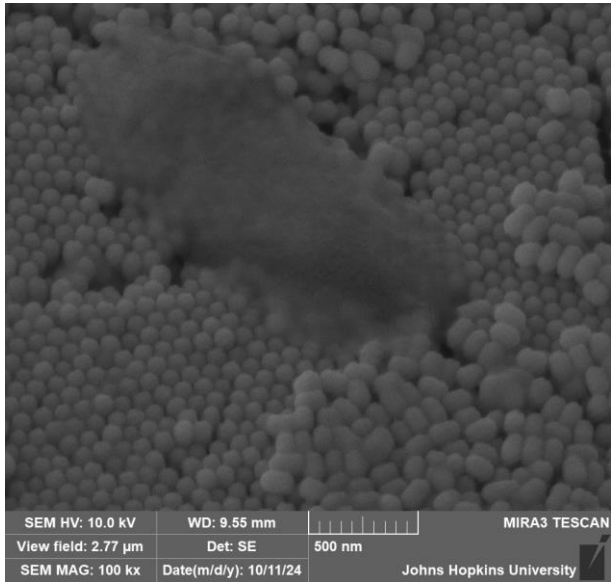
YOUR HOST ORGANIZATION

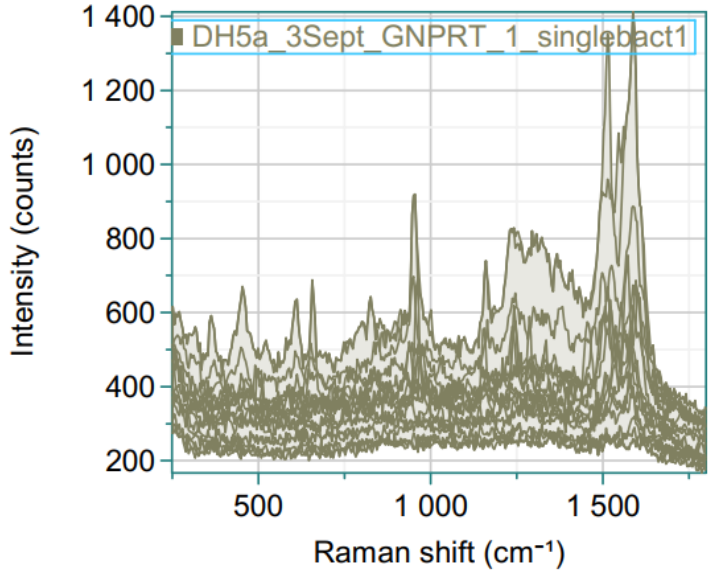
- **My host organization is The Barman Laboratory, in the department of mechanical engineering of the John Hopkins Whiting School of Engineering**
- **Why?** The Barman lab is leading the way in terms of using optical spectroscopy (particularly Raman spectroscopy, the same technique I use in my project) to detect biological organisms. The lab displays a remarkable ability in developing multidisciplinary projects to achieve innovative solutions, by integrating optics, microfabrication, microfluidics and artificial intelligence (among others) to reach its goals.
- Thus, this lab provides an ideal environment to pursue an interdisciplinary project like this one since it has both the expertise and the infrastructure needed in all the necessary topics. In the specific context of trying to develop an AI model for the identification of bacterial strains, the lab's recent work on using Raman spectroscopy and AI for the detection of SARS-CoV-2 is of particular interest.

KEY RESULTS (1)

1) The main goal of the project was to explore the use of Surface-Enhanced Raman Spectroscopy (SERS) substrates for the label-free detection of bacteria. Label-free detection is a very interesting approach as it would allow us to detect any kind of bacteria, using machine learning. A first task I undertook in this project was to use various gold SERS substrates (Fig 1 and 2) and acquire data with them (Fig 3).

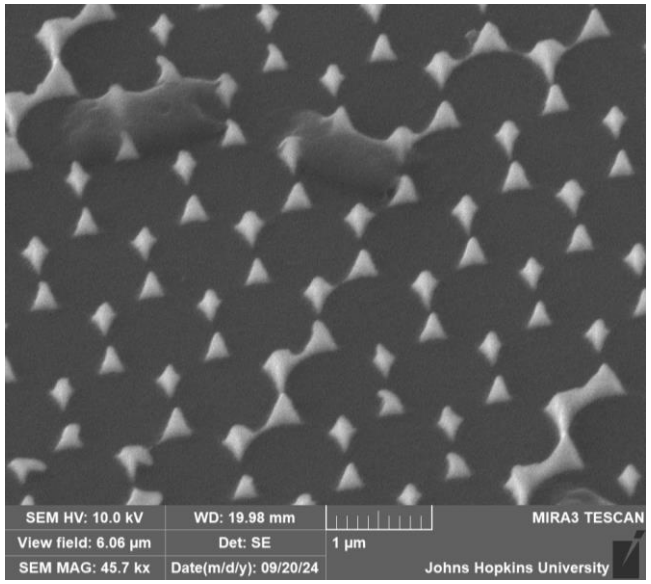


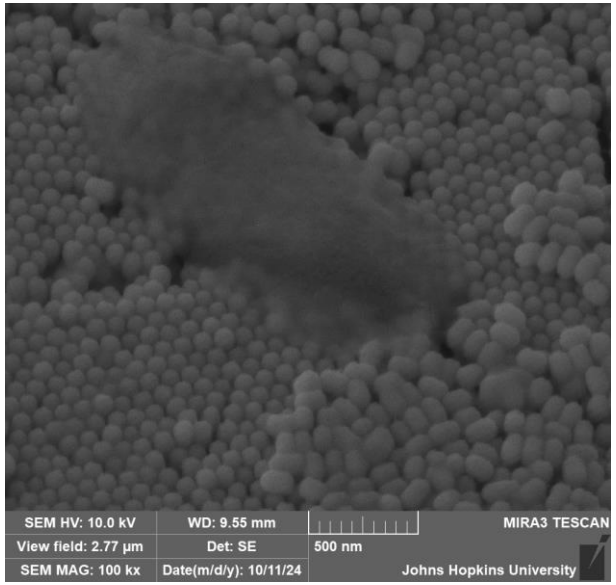


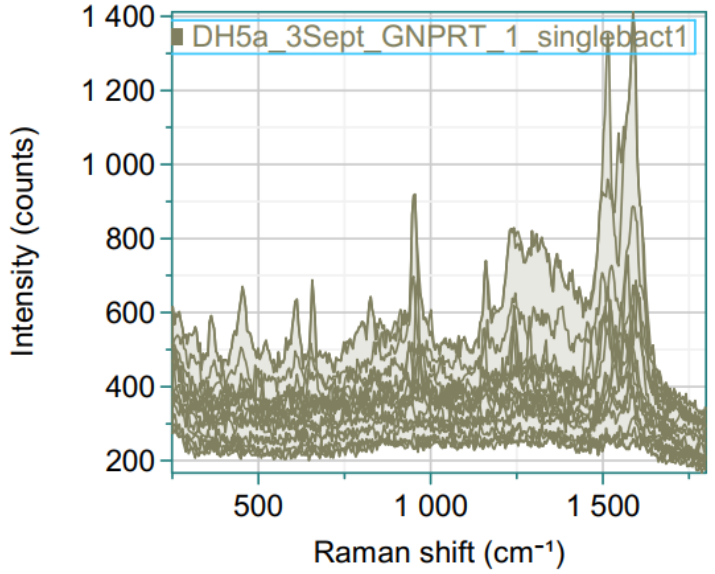


KEY RESULTS (1)

Unfortunately, label-free data tended to be very heterogeneous, complex and dependent on measurement and environmental parameters. I worked on trying to reduce that variability, to make the data suitable for machine learning, but the progress in that direction was limited, so instead we reoriented to “labelled” methods.







KEY RESULTS (1)

Labelled methods consist in linking antibodies specific to our target (in this case, specific species of bacteria) to Raman-tagged gold nanoparticles (Fig 3). In our case, we showed that the antibody-tagged nanoparticles had a very high specificity to E. coli bacterial cells and were a viable solution for identification (Fig 4)

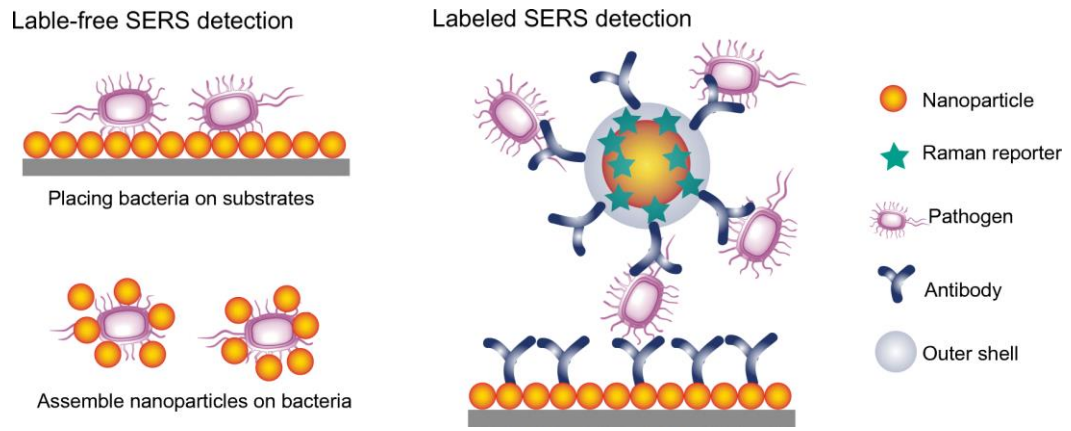


Fig 3: labelled vs label-free methods

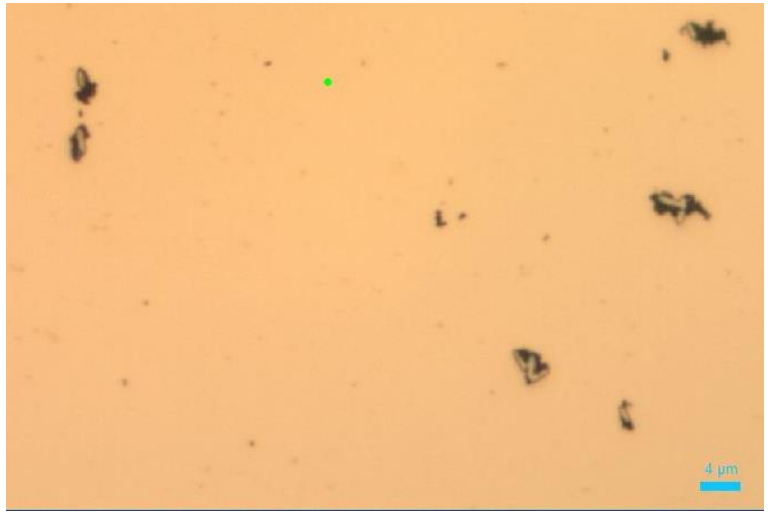


Fig 4: white rod shapes are bacteria and black dots are aggregated gold nanoparticles

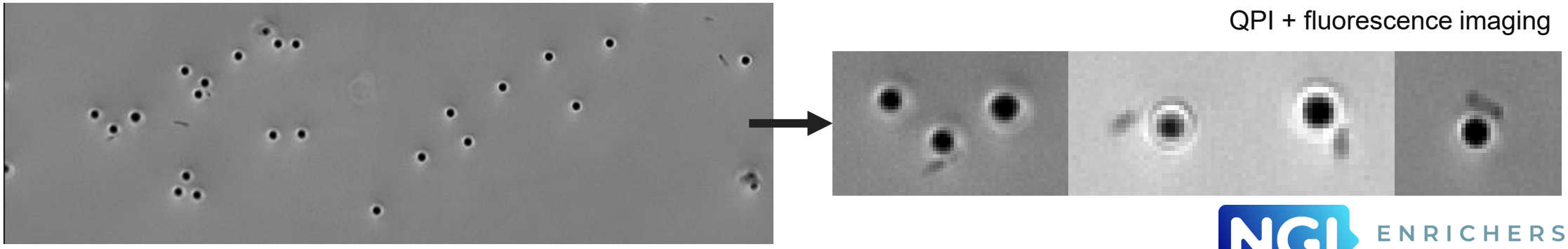
NGI ENRICHERS TRANSATLANTIC

Key results (1)

QPI – Phase-tagging of bacteria with antibody-coated polystyrene beads

In parallel, I explored a technique I was not familiar but in which the Barman lab is specialized in: quantitative phase imaging (QPI), which images the differences of refractive index in a sample. The concept here was to use polystyrene beads (which have a strong contrast on QPI) coated with antibodies to catch bacterial cells and allow their identification. Then, by multiplexing with beads of different phase contrasts (polystyrene, iron oxide, etc.) we can confirm/reject the presence of target bacteria.

We made a small proof of concept with antibody-conjugated polystyrene beads which were easy to spot on QPI and allowed us to confirm the presence of E. coli in samples (Fig 5).



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KEY RESULTS (2)

- I reached out to the Johns Hopkins Hospital and conducted an hour-long interview and discussion to explore how this technology could help the hospital's work in identifying bacteria from patient samples. We hope to set-up a collaboration in the future as our technology matures.
- I visited San Francisco and Stanford to meet with Swissnex, the Swiss office bridging between Swiss innovators and US partners. I also visited and connected with the MISTA Innovation Center, a major food tech hub close to Silicon Valley, in addition to visiting the laboratory of Jennifer Dionne, a leading researcher on the use of Raman spectroscopy for the detection and identification of bacteria.

IMPLEMENTATION

How would you implement your findings? Next 6-month steps (nonconfidential)

- Our next steps will be to confirm the use of labelled methods for bacterial detection by benchmarking it with other existing methods. We will continue the tests in Switzerland with a goal of confirming them by the middle of 2025.
- Additionally, we are planning a publication on the Quantitative Phase Imaging experiments that were conducted.

EXPECTED IMPACT

- This technology, when implemented, would represent a massive step forward in the digitalization of quality control in the food industry, by leveraging AI to deliver results in just a few hours instead of several days. This will have major consequences on the public health impact of food contaminations, on the amount of food waste and the bottom line of food producers. We intent to commercialize that technology in a way to maximize its impact over the next 5-10 years.

LESSONS LEARNED

- The biggest challenge I found was the balance between my work in the US and managing my team in Switzerland. Both represented a significant workload and the time difference with Switzerland represented sometimes a challenge due to the limited number of common working hours I had with my colleagues in Switzerland. This challenge pushed me to better organize myself and set priorities, as there was very little time to be wasted.

Marwan El Chazli

Researcher at EPFL
Co-founder of Myriad Optics

Marwan El Chazli

marwan.elchazli@epfl.ch

Video

(N/A)

NGI ENRICHERS TRANSATLANTIC

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The NGI Enrichers project has received funding from the European Union's Horizon Europe Research and Innovation Programme under grant agreement 101070125.

Post-mortem wind turbine downtime analysis with AI

Miguel Cabrita
Portugal

AI Enabler & Co-founder at Enlightenment.AI (EAI)

Track
AI / EnergyTech / Industrial Automation
Host Organization
EDP Renewables North America, Texas, USA

NGI ENRICHERS TRANSATLANTIC

THE PROBLEM

In this project we tackle the challenge of reconciling downtime data between manufacturers and energy-generating asset owners.

Currently, downtime data requires manual correction to determine responsibilities and negotiate liquidated damages or bonuses, while also improving data quality. Existing solutions focus on monitoring, diagnostics, and optimization but do not tackle this specific business need.

The opportunity lies in creating a trusted system that automates data correction by incorporating various sources of information and providing clear explanations for decisions. This would streamline the reconciliation process and foster trust between all stakeholders involved.

NGI ENRICHERS TRANSATLANTIC

YOUR SOLUTION (1)

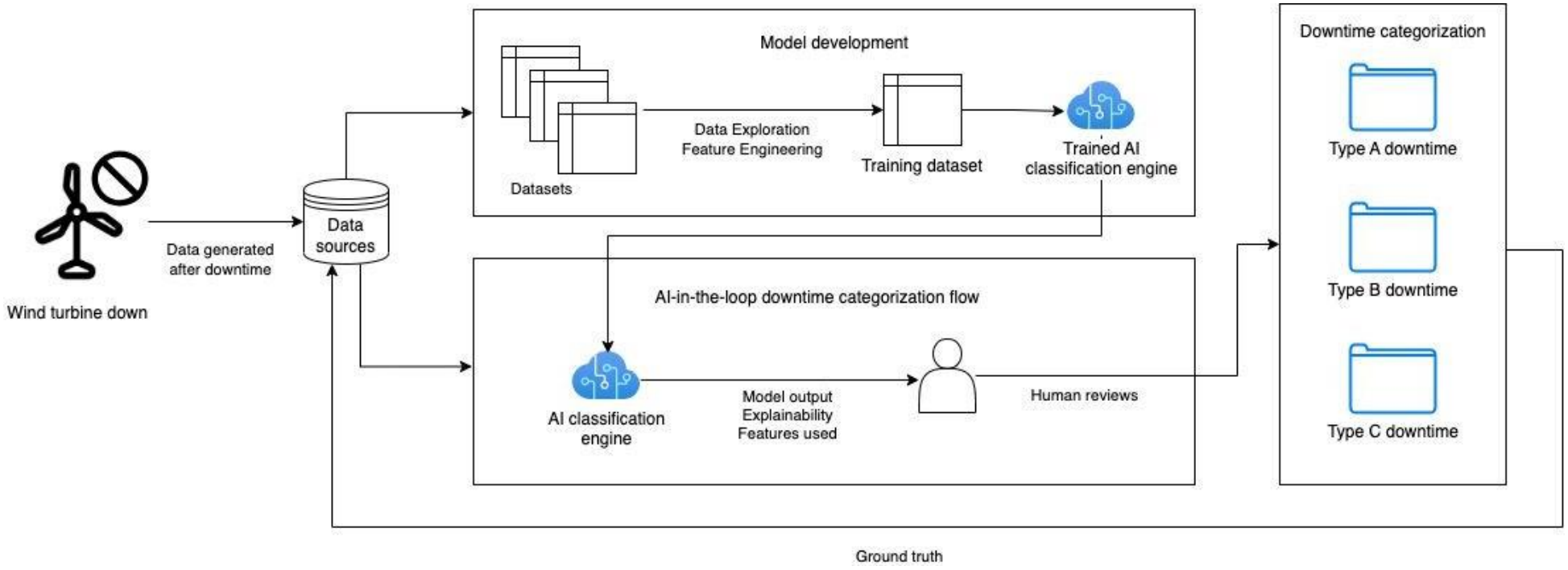
We've collected and engineered data to improve decision-making and built custom machine-learning models that learn from previous manual corrections. These models were deployed in the host company's Azure infrastructure, allowing the business to leverage data and AI for downtime reconciliation. This technology reduces manual, error-prone work and delivers faster, and accurate results.

Besides savings in time in automating data corrections, this solution is faster to adapt to new faults and contributes to faster reporting for liquidated damages and bonuses.

The opportunity is significant since the downtimes discussed can be valued in the millions of dollars annually.

NGI ENRICHERS TRANSATLANTIC

YOUR SOLUTION (2)



MIGUEL CABRITA, AI ENABLER @ ENLIGHTENMENT.AI

Miguel Cabrita has a background in applied mathematics and computational analysis. As the co-founder of EAI, he has spent over seven years helping companies leverage data and AI to drive business value.

He has led AI initiatives that earned international recognition, such as “Best Technology Initiative - Europe” at the Financial Innovation Awards and “Best Digital Strategic Tool” at the Portugal Digital Awards.

His work spans various industries, where he developed cutting-edge data science solutions to improve operational efficiency.

NGI ENRICHERS TRANSATLANTIC

THE TEAM / EXPERTISE

- **Manuel Levi** - Co-founder at EAI. Worked with Data and AI for over 12 years with various market leaders in Singapore, London, Denmark and Portugal. Research scientist for top research labs including MIT's Singapore lab - SMART, and CDV or AmILab in Portugal.

- **EAI** is part of the National Scientific and Technological System (SCTN), and partners with other companies in the group to develop innovative products.

- **John Stretton** - Process Automation Associate Director at EDPR NA. Engineer, application designer, and process improvement expert, helping shape the company's vision for digitalization and automation initiatives, from both the business and technical perspectives.

- **Justin Clark** - Process Automation Lead Expert at EDPR NA. Conceptualized and executed over 200 automation designs, encompassing diverse facets such as user interface automation, API-driven system integrations, and robust data management solutions.

NGI ENRICHERS TRANSATLANTIC

YOUR HOST ORGANIZATION

EDP Renewables North America (EDPR NA) is a leader and innovator in the renewable energy industry, with a strong track record in developing, constructing, and operating renewable energy projects. Collaborating with EDPR NA allowed us to work with industry experts and strengthen EAI's presence in the US renewable energy market, potentially laying the groundwork for a long-term partnership.

I joined the Business Process Enablement department, which incorporates an Innovation area. This provided the perfect setting to explore AI applications to improve concrete challenges in their operations. Through this initiative, EDPR NA's stakeholders sparked discussions on how AI could be further integrated into other areas of their operations.

The collaboration was mutually beneficial with EDPR NA having a novel AI approach to solve a critical problem, and EAI deepening its understanding of the renewable energy industry and establishing connections in the US and within the industry.

NGI ENRICHERS TRANSATLANTIC

KEY RESULTS (1)

During the project, we identified key issues in the manual data editing process for wind turbine downtime events, such as its time-consuming and error-prone nature. We developed machine learning models to automate this task, significantly improving data accuracy and reducing manual workload.

The models, achieving up to 90% accuracy on some sites, have been integrated into the client's Azure infrastructure for validations, moving from a Technology Readiness Level (TRL) of 1to 5, Pre-prototype tested in lab. This marks a significant step toward automating and optimizing downtime reconciliation, which was previously handled manually.

The models will be running daily, providing reliable data corrections and supporting business decisions, and areas for further improvement will be identified. Our work has set the stage for a more automated and standardized approach to downtime data management, which can be further scaled and adapted to other sites and use cases.

NGI ENRICHERS TRANSATLANTIC

KEY RESULTS (2)

The project has strengthened research and innovation collaboration between EAI and EDPR NA, creating a solid foundation for future joint ventures. Our involvement in industry events has also led to valuable connections within the renewable energy sector in the US, enhancing our visibility and credibility, with the Greater Houston area now in second place among our LinkedIn visitors, contributing to 11.4%.

Through this collaboration, we have accelerated our business partnerships by securing a new client in the US market and engaging in discussions for future projects helping position EAI as an important player in Strategic AI applications for businesses.

KEY RESULTS (3)

We successfully deployed our machine learning models within EDPR NA's Azure infrastructure, proving the system's technical feasibility and scalability. This achievement sets the stage for broader adoption and potential commercial applications in the renewable energy sector.

Our experience with the NGI Enrichers program has also expanded our collaboration opportunities within the NGI community. We have applied for additional funding through the NGI Sargasso open call to further our research. If successful, we plan to incorporate and interpret more data sources, using Explainable AI (XAI) and Generative AI to enhance trust and transparency in downtime data reporting.

IMPLEMENTATION

In the next six months, we plan to formalize our collaboration with EDPR NA and secure additional funding to continue our research. We will expand our work to include more data sources and refine our AI models.

The goal is to enhance the solution’s capabilities, improve data accuracy, and support a broader range of energy assets. This will set the foundation for a potential product launch targeting both energy asset owners and manufacturers.

Additionally, we will focus on integrating feedback from stakeholders to ensure the platform meets industry needs and prepares for broader commercialization.

EXPECTED IMPACT

Our findings will drive digitalization in the renewable energy sector by automating the reconciliation of downtime data, reducing manual work, and enhancing efficiency. This approach improves interoperability, allowing seamless communication and data exchange between asset owners and manufacturers, while integrating various systems and AI models.

We also focus on transparency by providing clear explanations for AI-generated decisions, fostering trust and accountability. By improving user experience through intuitive data handling and insights, we empower stakeholders to make informed decisions, enhancing overall productivity and collaboration.

LESSONS LEARNED

Despite thorough planning and stakeholder involvement, unexpected challenges arose during the project. Integration difficulties required us to adapt our implementation to align with changing system requirements. This led to adjustments and rework that impacted our timelines but also provided valuable insights into the flexibility needed for future projects.

We also faced initial hesitancy in data sharing due to concerns around data security and system familiarity. Clear communication and demonstrating the non-intrusive nature of our solution helped build trust and improve collaboration. These experiences reinforced the importance of adaptability, proactive communication, and understanding stakeholder needs in complex projects.

Miguel Cabrita

AI Enabler & Co-founder at Enlightenment.AI (EAI)

Miguel Cabrita

mcabrita@eai.company

Video

(N/A)

NGI ENRICHERS TRANSATLANTIC

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The NGI Enrichers project has received funding from the European Union's Horizon Europe Research and Innovation Programme under grant agreement 101070125.

Virtual Privacy: Understanding the Privacy Experience of Turkish Immigrants in the USA

Nurcan Tüfekci

Türkiye

PhD Candidate in Sociology at Ankara Yıldırım Beyazıt UniversityResearcher at SONG Lab, UMBC

Track

Sociology / Privacy / Human-Centric Internet

Host Organization

University of Maryland, Baltimore County (UMBC), Maryland, USA

NGI ENRICHERS TRANSATLANTIC

THE PROBLEM

Define the problem (need) being solved by your project. How do you identify it? And for whom / main target audiences - it may also include relevant stakeholders.

The project focuses on discussing the impact of technology and society on each other regarding privacy in virtual space. The development of technology is not independent of society. The project aims to explore the impact of technology and society on each other through the privacy experiences of immigrant Turkish communities.

Who else is already doing this, and why is there an opportunity? i.e., benchmarking competition.

Due to the limited number of studies addressing the privacy experience of Turkish immigrants in the virtual world and the lack of studies addressing the issue of privacy among Turkish immigrants living in the United States, it is thought that the project will be an original study in terms of its subject, context, and model.

YOUR SOLUTION (1)

Technology, differentiator, competitive advantage, opportunity (and size).

Solving the privacy problem in the virtual world will provide access to many users, which will benefit society and technology companies (Meta 'Facebook,' X 'Twitter,' Apple, Google, etc.). In other words, the results will shed light on technology companies (Meta 'Facebook,' X 'Twitter,' Apple, Google, etc.) to design and develop next-generation internet programs.

FIRST & LAST NAME, POSITION
CURRENT ORGANIZATION

Bio and achievements/successes

PhD Candidate Tufekci worked as a researcher in the Song Lab Department of Information Systems at UMBC as part of the NGI Enrichers fellowship program. Her educational background includes a bachelor's degree in Family and Consumer Sciences, a master's degree in Women's Studies, and a master's degree in Family and Consumer Sciences. She is currently pursuing a Ph.D. in the Department of Sociology at Ankara Yıldırım Beyazıt University in Turkey. Her research interests include migration, refugees/asylum seekers, women, families, the virtual world, and its impact on society. She has successfully completed the project NGI Enichers Cohort 2, 2024.

List any relevant publications/products/projects/results related to NGI

Within the scope of the Virtual Privacy project, an article will be published, a presentation or poster presentation will be made at a congress, and a policy statement will be presented to companies (Meta 'Facebook,' X 'Twitter,' Apple, Google, etc.) within the next 1 year.

List any relevant honors and/or prizes related to NGI

She was found to be a short-term researcher at the Song Lab, Department of Information Systems, UMBC, as part of the NGI Enrichers Fellowship Program Cohort 2 Project (2022-2025).

THE TEAM / EXPERTISE

Other Founders, support team, mentors and advisors - names, titles, achievements + including host organization contact

My host institute:

Houbing Herbert Song, Ph.D., IEEE Fellow, ACM Distinguished Member

WoS Highly Cited Researcher in Computer Science

ACM Distinguished Speaker & IEEE Distinguished Visitor & IEEE Distinguished Lecturer

Founding Center Director, NSF IUCRC Center for Aviation Big Data Analytics (Planning)

Associate Director (Leadership), DOT Tire 1 UTC Transportation Cybersecurity Center for Advanced Research and Education (CYBER-CARE)

Director, Security and Optimization for Networked Globe Laboratory (SONG Lab)

E-Mail and Phone: songh@umbc.edu Phone: 410-455-8628

Department Web Address: https://informationsystems.umbc.edu/

Address: Department of Information Systems, University of Maryland, Baltimore County, Room 427; Information Technology & Engineering 1000 Hilltop Circle, MD 21250, Baltimore/ Maryland/ USA

YOUR HOST ORGANIZATION

Background, context, department, NGI experience

University of Maryland, Baltimore County (UMBC), Department of Information Systems/SONG Lab

Department Web Address: https://informationsystems.umbc.edu/

Address: Department of Information Systems, University of Maryland, Baltimore County, Information Technology & Engineering 1000 Hilltop Circle, MD 21250, Baltimore/ Maryland/ USA

SONG Lab hosts NGI Enrichers projects.

KEY RESULTS (1)

First Findings, Outputs, and Outcomes of your expedition on your project and yourself versus your expectations + expected results toward the end of the expedition

- Sound Scientific Validation- in progress
- Advancing standards- in progress

KEY RESULTS (2)

- Strengthening research collaboration with the US – in progress
- Building solid connections and partnerships in Europe and in the US – in progress
- Reinforced integration of social sciences and humanities in the project – in progress

KEY RESULTS (3)

- Expanding collaboration within the NGI community
- Paper submission for publication – jointly with the host organization
- Conference attendance with paper or poster paper proceedings – jointly with the host organization
- Career advancement

IMPLEMENTATION

How would you implement your findings? Next 6-month steps (nonconfidential)

The findings will be analyzed. The data obtained will be scientifically verified, determining the privacy experiences of users in the virtual world and revealing the impact of societies and technology on each other. As stated in the project objectives, the data obtained will be scientifically validated, a policy paper will be prepared, an article will be published, and a paper or poster paper will be presented at an academic conference.

EXPECTED IMPACT

From the implementation of your findings, how are you going to impact your project and impact the world? Especially on the Human-centric NGI-relevant following domains:

The Project will contribute to data privacy and sovereignty, social participation, and user's experience

LESSONS LEARNED

What you wished you had known prior.

Any bad or good "surprises"?

It was a challenging experience to reach participants during the summer.

Any challenges, personally and professionally

Conducting the research during the summer (as participants were on vacation) was a professional challenge. Also, the summer period was a challenge in gaining personal experience. Opportunities for social interaction were limited during this period.

Impact of those lessons learned

In my future expeditions, I will make sure to be in the US during the academic year, and I will try to convince the fellowship program (if I have to go during the summer) ☺

Nurcan Tüfekci

PhD Candidate in Sociology at Ankara Yıldırım Beyazıt UniversityResearcher at SONG Lab, UMBC

Nurcan Tüfekci

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ntufekci24@gmail.com

(N/A)

Profile

NGI ENRICHERS TRANSATLANTIC

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The NGI Enrichers project has received funding from the European Union's Horizon Europe Research and Innovation Programme under grant agreement 101070125.

Resilient Earth – Data-Driven Solutions for Extreme Climate Events

Sumeyye Kaynak
Türkiye

Assistant Professor at Sakarya University
PhD in Computer Engineering

Track
AI / Environmental Intelligence / Disaster Management

Host Organization
University of Iowa, Iowa, USA

NGI ENRICHERS TRANSATLANTIC

THE PROBLEM

Present the problem:

- There is a need to develop of a generalized web-based decision support framework that can support preparedness, prevention and response to extreme climate events.
- The need for such a framework is identified through increasing occurrences of extreme climate events and the challenges faced in effectively managing these crises due to fragmented data, lack of coordination, and inadequate preparedness tools.

Who is the main target audiences?

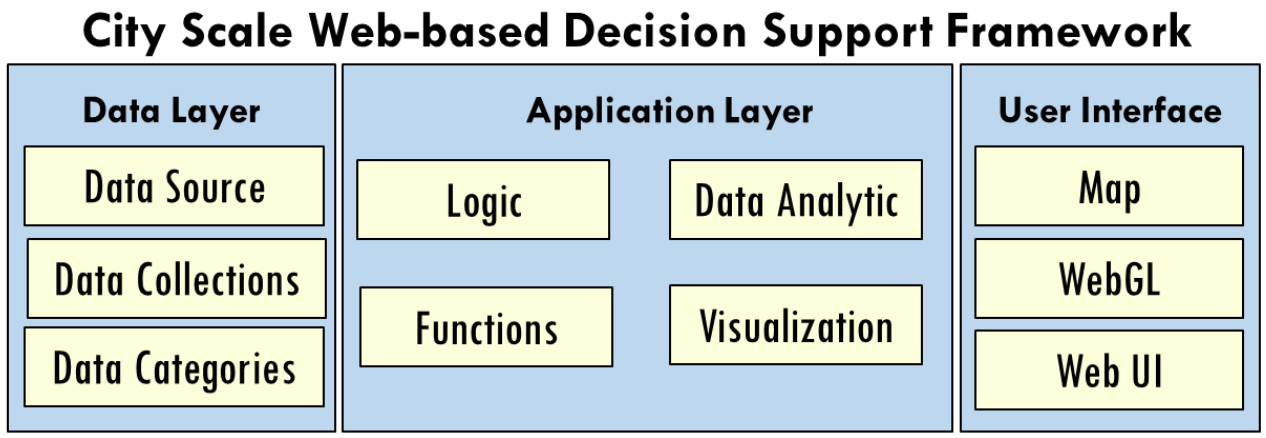
- Public, city planners, emergency services and first responders, public health authorities, environmental agencies and community organizations, government authorities

Who else is already doing this? and why is there an opportunity?

Studies on a generalized decision support framework (DSF) for extreme climate events are at the level of basic model development. No study has been found that develops a generic user-friendly web-based DSF supported by data-driven technologies and AI that can address localized requirements for non-technical users. **To address this gap, this project aims to develop generalized, scalable and web-based framework, using novel data driven and web technologies for visualization, data analytic and simulation-based analysis.**

OUR SOLUTION

- This project proposes a modular web-based decision support framework designed to integrate flooding with transportation networks and other critical infrastructure systems. Unlike existing models, our framework provides a holistic, multi-layered view of urban systems, enabling decision-makers to analyze the cascading impacts of disruptions.
- Our framework leverages advanced data integration techniques to process real-time feeds from diverse sources, such as sensors, hydrological models, GIS systems, and IoT networks.
- This framework provides an interactive, layered visualization platform that empowers users to explore transit coverage, analyze flood impacts, and optimize emergency response strategies.



Differentiator: Modular Design, High-Performance Visualization, Multi-Domain Integration, User-Centric Interface, Data Analytics

Competitive advantage: Adaptability, Real-Time Insights, Accessibility, Interoperability, Holistic Approach

NGI ENRICHERS TRANSATLANTIC

SUMEYYE KAYNAK, ASSISTANT PROFESSOR SAKARYA UNIVERSITY

Short Bio: Dr. Kaynak works as an Assistant Professor at Sakarya University. She received her PhD. in Computer Engineering from Sakarya University. Dr. Kaynak's research focuses on data driven approach, AI model development, feature engineering, big data, blockchain and intelligent sensor system. Currently, she is conducting studies on digital twin technologies, big data, data mining, and artificial intelligence and next-gen web technologies.

Experience:

S. Kaynak, B. Kaynak, C. Erazo Ramirez and I. Demir, Geo-WC: Custom Web Components for Earth Science Organizations and Agencies, Environmental Modelling and Software, 2024 (In review)

S. Kaynak, B. Kaynak, O. Mermer, I. Demir, Development of a City-Scale Web based Decision Support Framework for Flood Impact Analysis: A Multi-Layered Approach for Hydrological Data Monitoring Interaction and Visualization , 2025 (In review)

MY HOST ORGANIZATION

University of Iowa Hydroinformatics Lab (UIHILab)

UIHILab and team members has extensive experiences on the project related to the data analytics, web-based cyberinfrastructure, Environmental Information Systems and they are working very closely with the Iowa Dept. of Transportation, City Development Offices, Non-profit organizations.

Civil and Environmental Engineering

University of Iowa Hydroinformatics Lab (UIHILab) has already been hosted visitors as NGI partner.

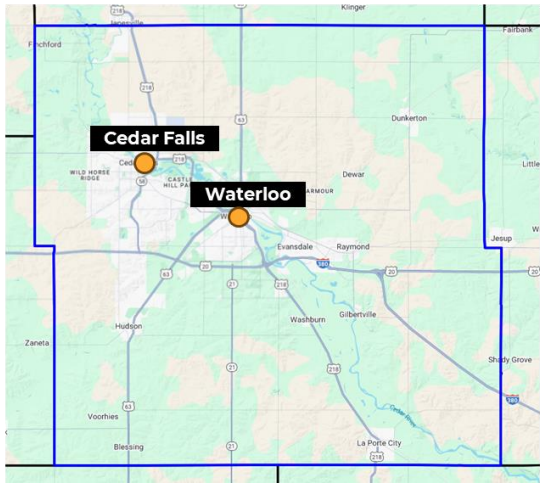
THE TEAM / EXPERTISE

Ibrahim Demir, PhD, Dr. Demir is the Director of UI Hydroinformatics Lab (UIHILab), and an Associate Professor at the Civil and Environmental Engineering, and Electrical and Computer Engineering departments at the University of Iowa. His research focuses on hydroinformatics, environmental information systems, scientific visualization, big data analytics, AI and intelligent systems, and information communication. Dr. Demir currently serves as Associate Editor for Journal of Hydroinformatics (IWA) and Environmental Modeling and Software (Elsevier).

Ömer Mermer, PhD, Dr. Mermer is a Associate Research Scientist at University of Iowa HydroInformatic Lab (UIHI). Dr. Mermer's research focuses on data driven approach, AI model development, feature engineering and intelligent sensor system. Currently, he is conducting studies on ML/DL model development for HAB/streamflow prediction, AI based digital twin framework and next-gen web technologies.

KEY RESULTS (1)

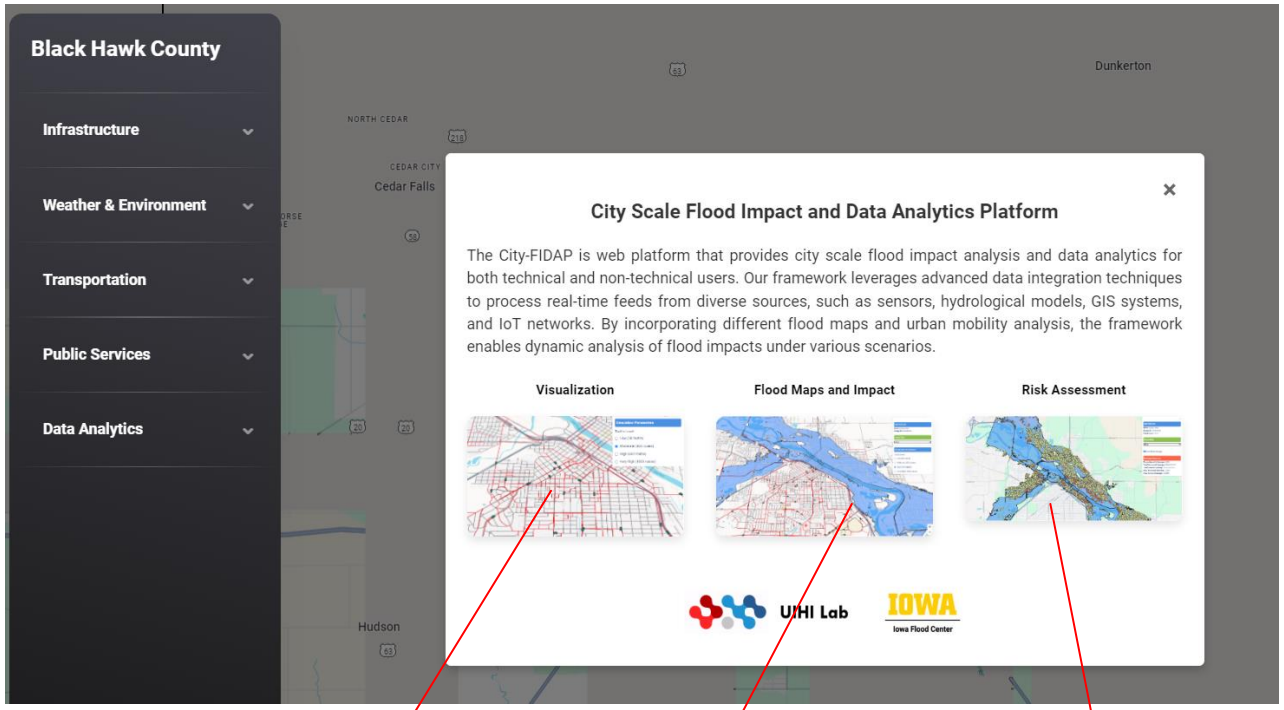
Study area: Black Hawk County, Iowa, US



Data Categories

Infrastructure Data	Weather & Environment
• Buildings • Bridges • Bicycle amenities • Railway crossing • Railway bridge • Electric power plants • Wastewater treatment plants • Groundwater wells	• Weather • Air quality • Drought maps • Flood maps • Sensor data
Transportation	**Public Services**
• Road network • Public transit network • Bicycle network	• Demographic data • Schools • Police stations • Fire stations • Care facilities • Communication facilities

City Scale Flood Impact and Data Analytic Framework



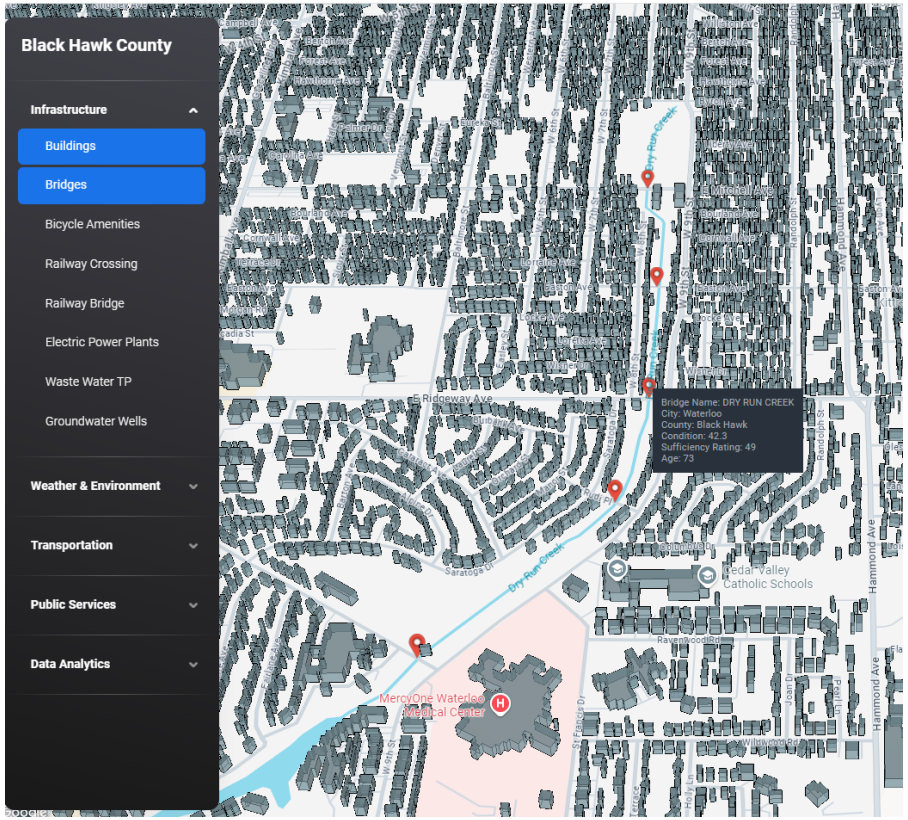
- Traffic flow
- Bus routes
- Train routes

- Transportation
- Urban critical systems

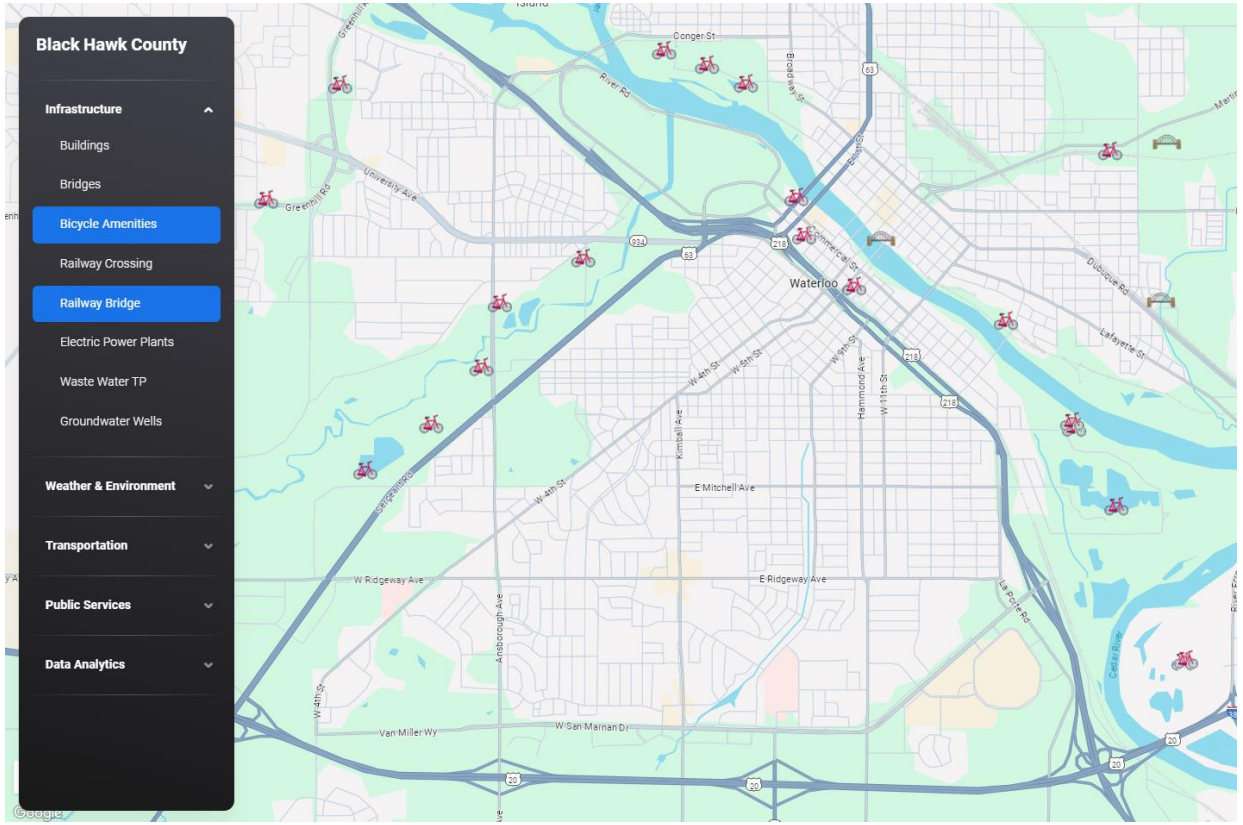
- Risk Analysis
- Damage Analysis

KEY RESULTS (2)
INFRASTRUCTURE

Buildings and Bridges

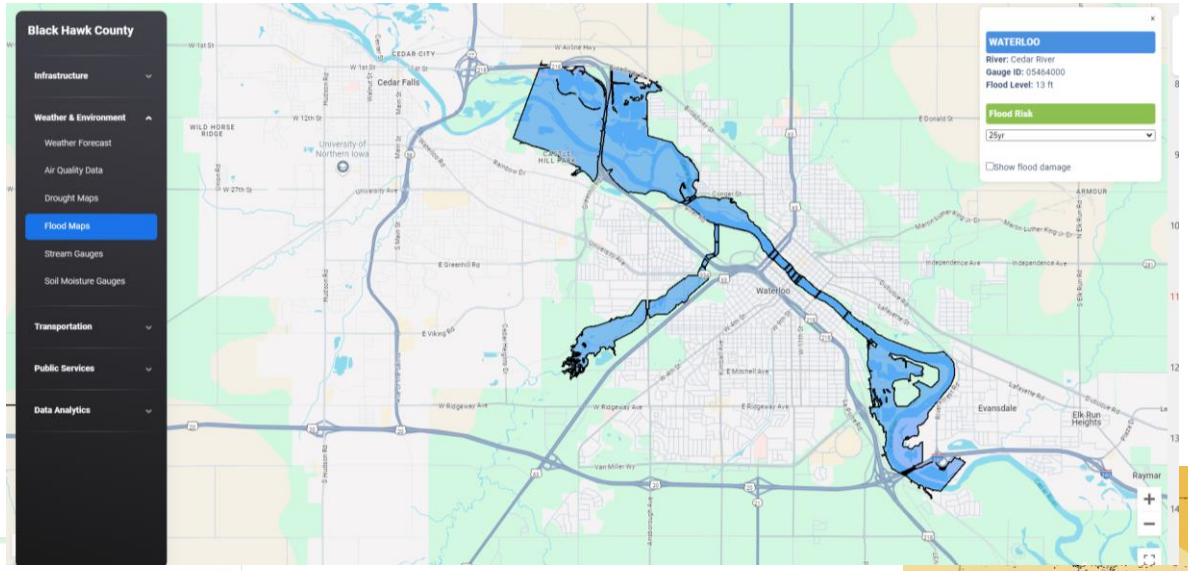


Bicycle Amenities and Railway Bridges

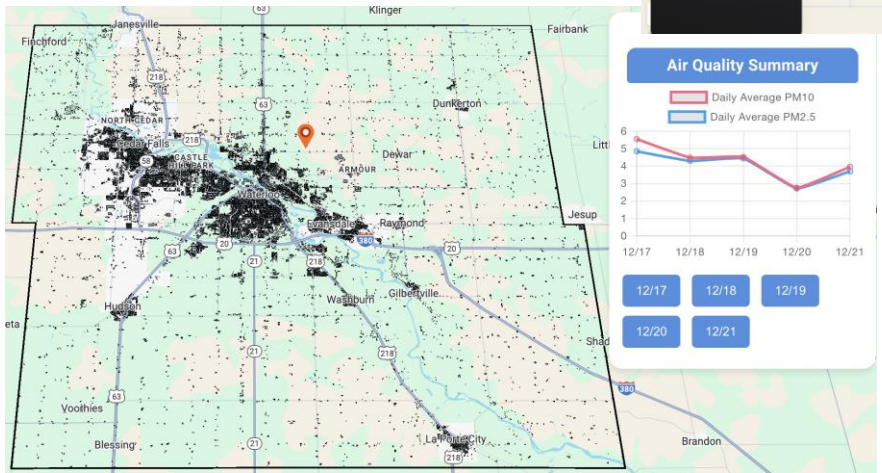


KEY RESULTS (3)
WEATHER& ENVIRONMENT

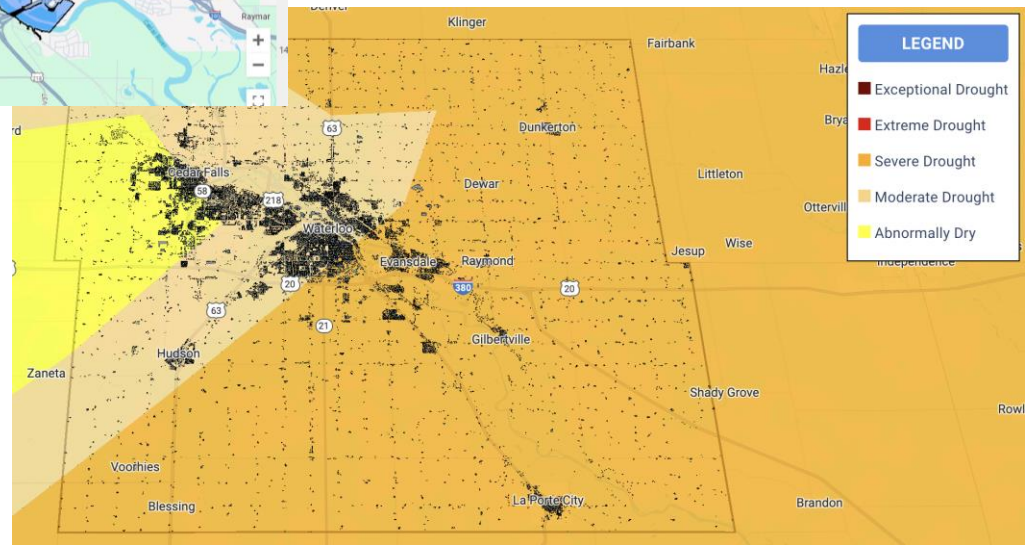
Flood maps



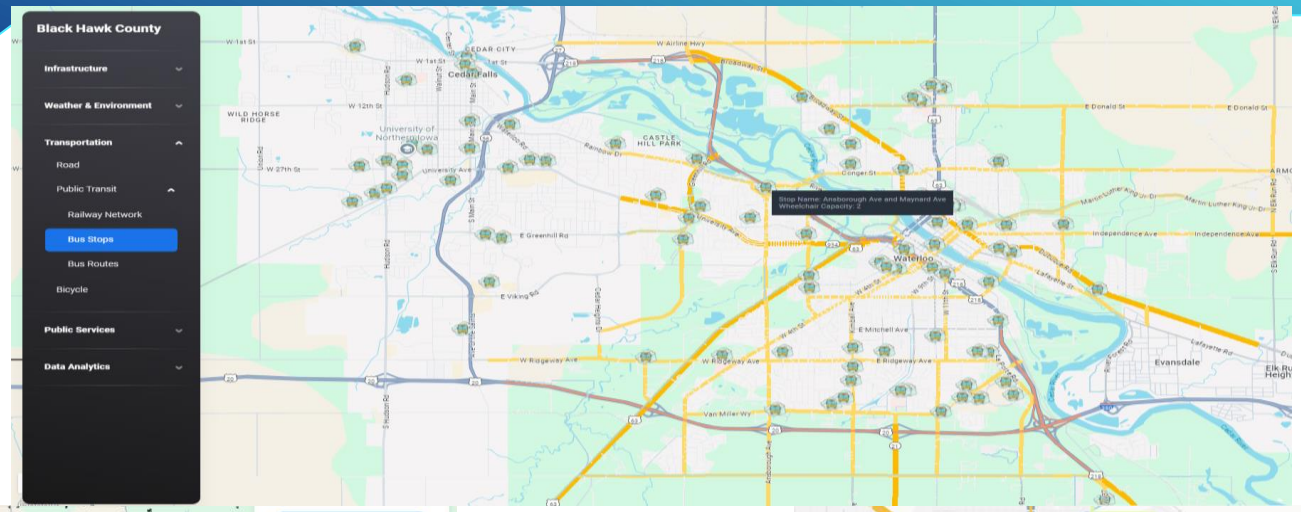
Air quality

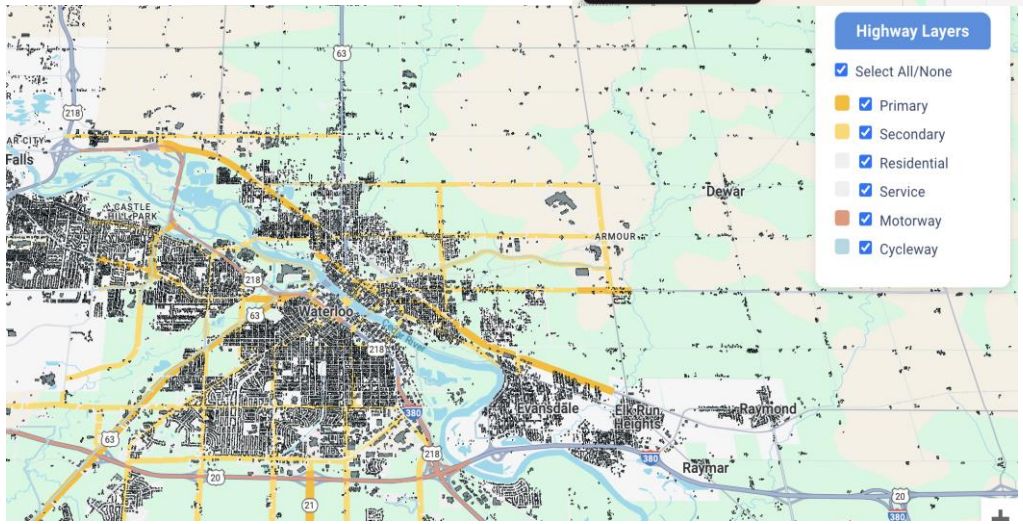


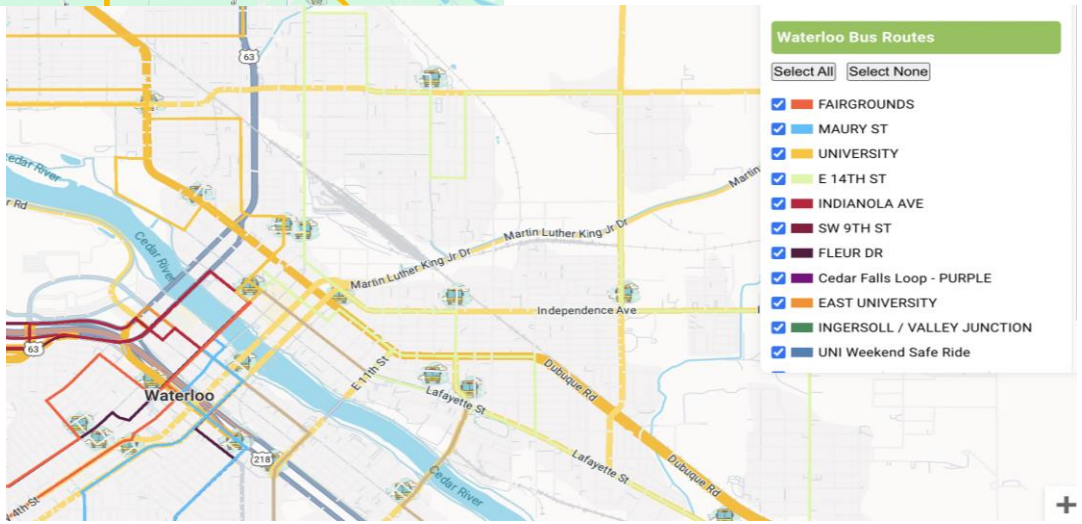
Drought maps



KEY RESULTS (4)
TRANSPORTATION

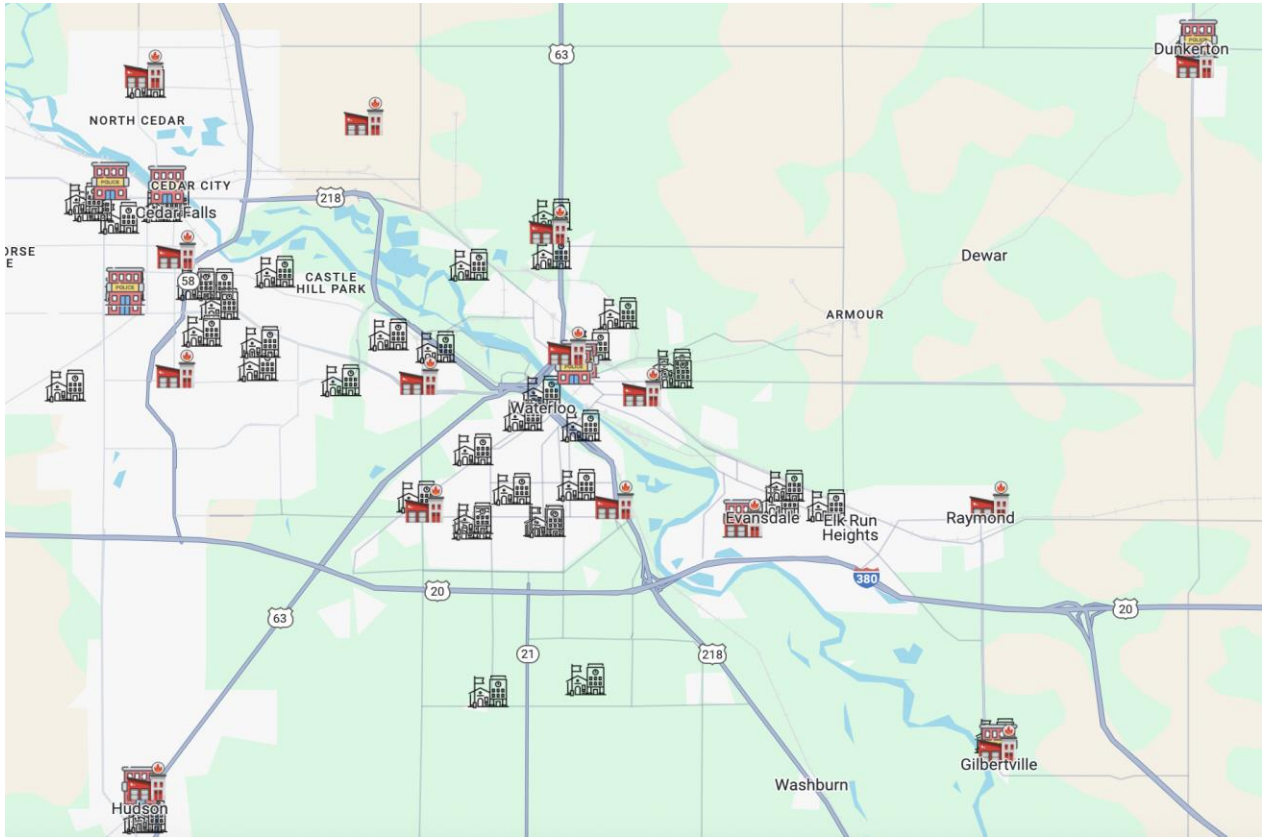




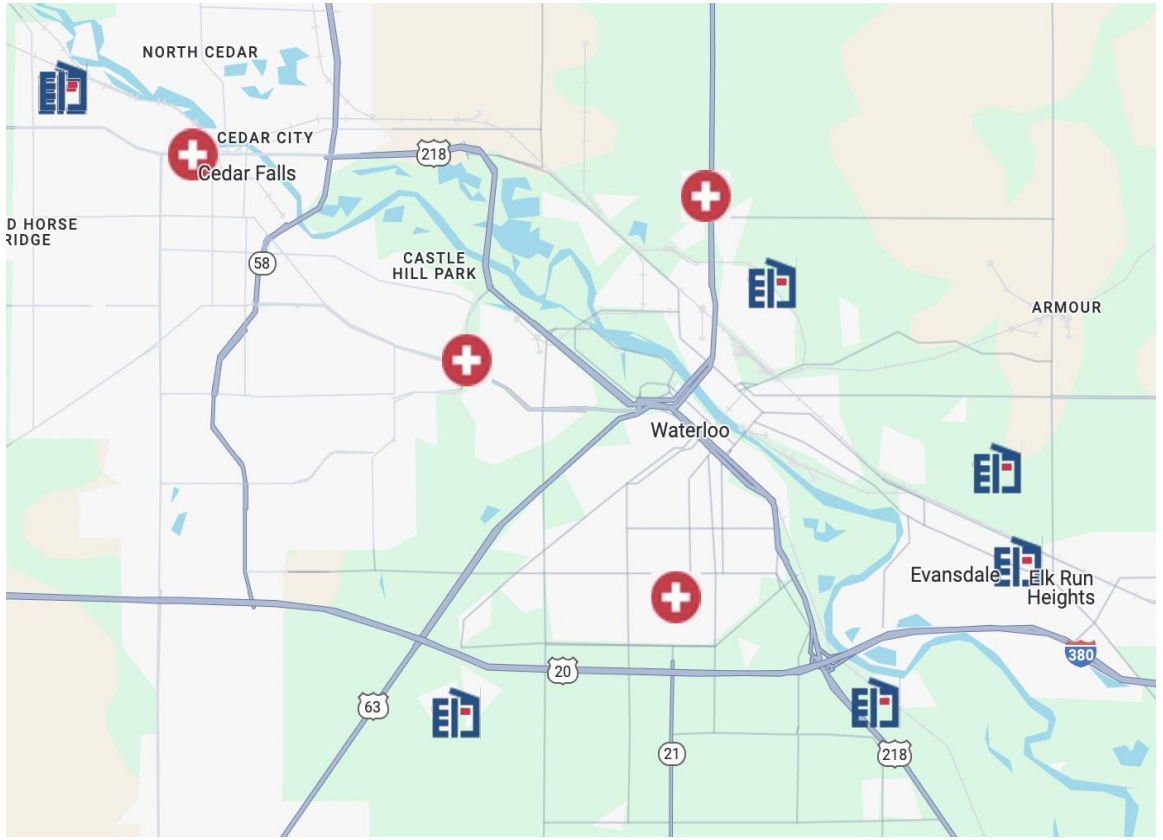


KEY RESULTS (5)
PUBLIC SERVICES

School & Police stations & Fire stations

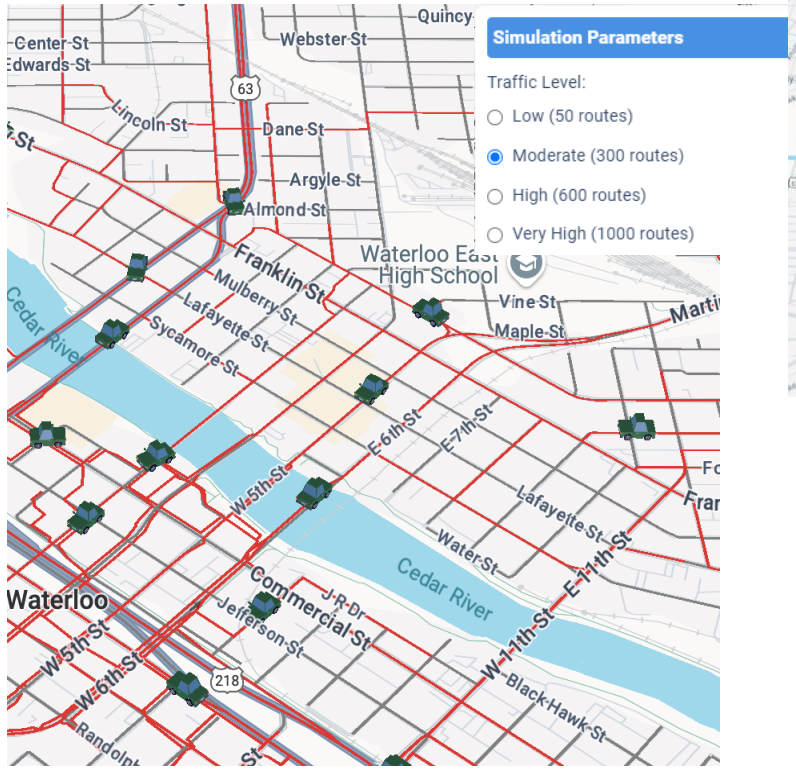


Care facilities & Communication facilities



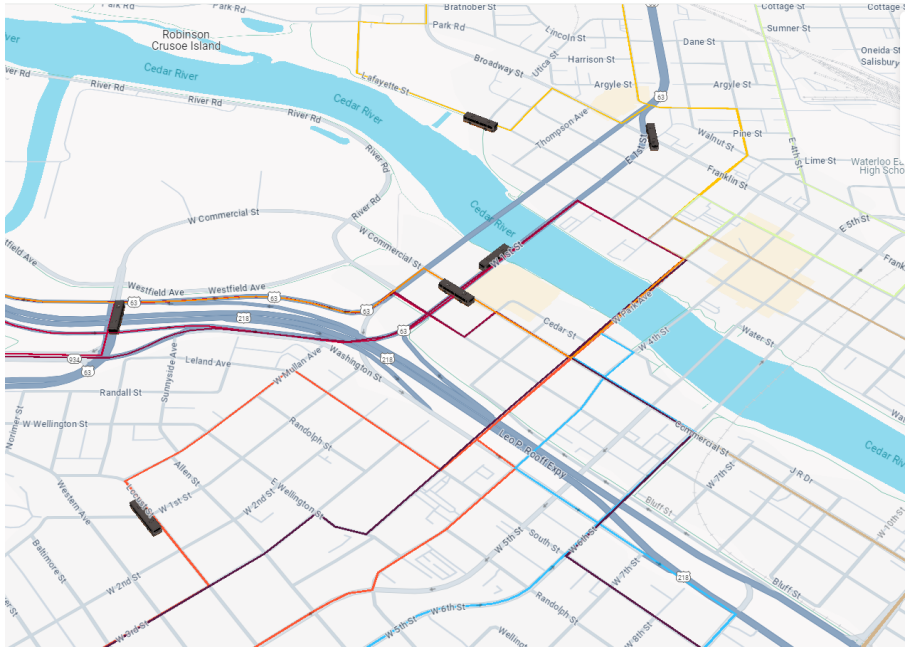
KEY RESULTS (6)
DATA ANALYTICS

Traffic flow



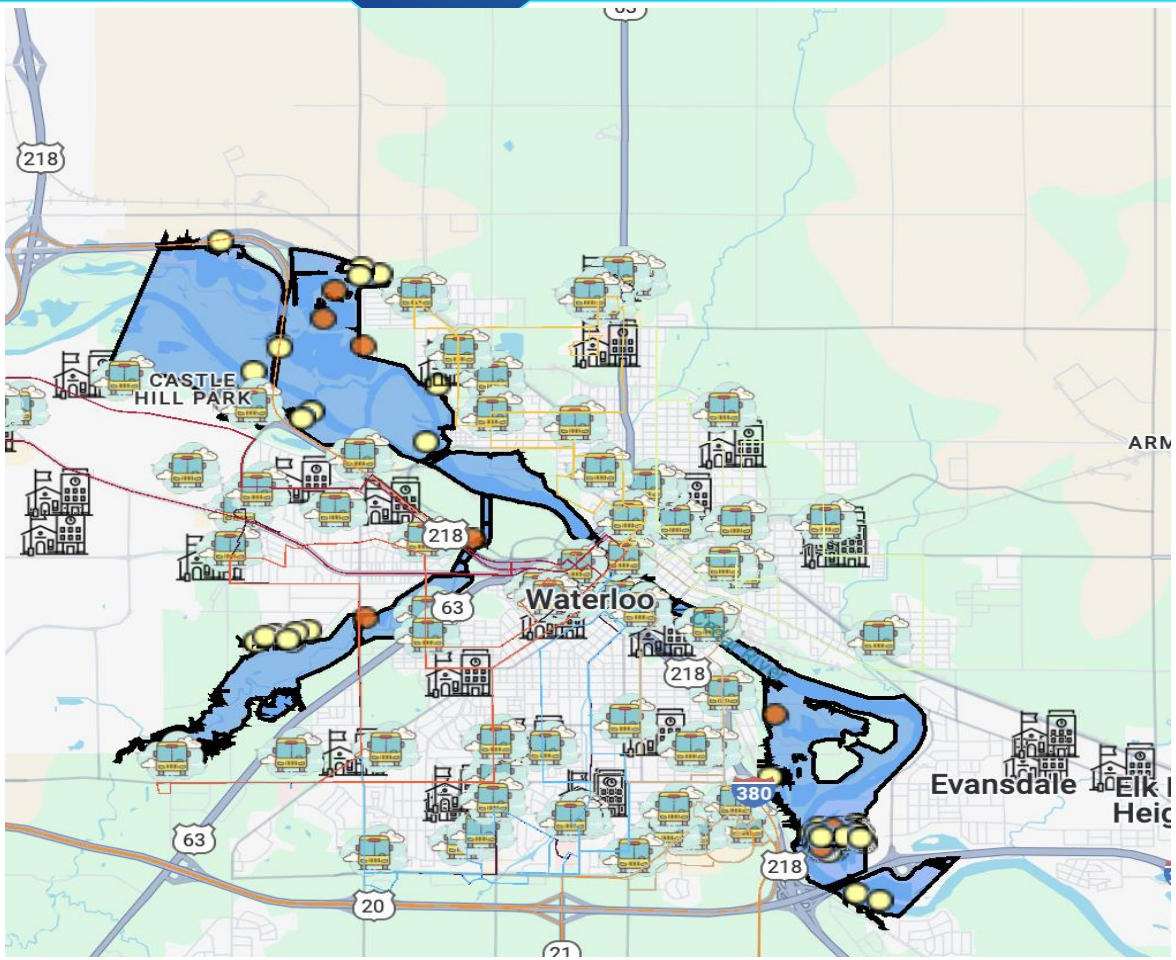
Train Flow

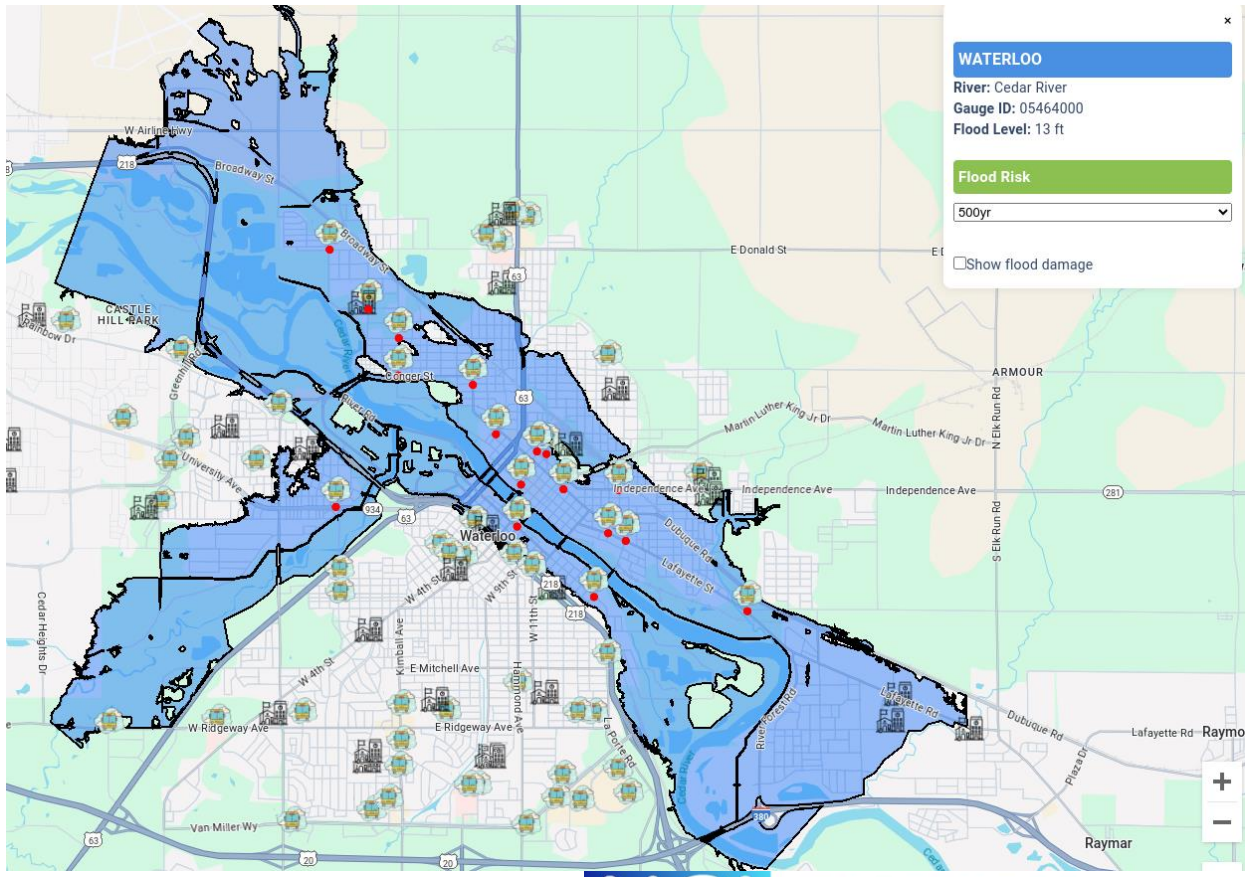
Bus Flow



KEY RESULTS (7)

USE CASE 1: SCHOOL ACCESSIBILITY DURING EMERGENCY SITUATIONS: VISUALIZATION AND FLOOD IMPACT ASSESSMENT





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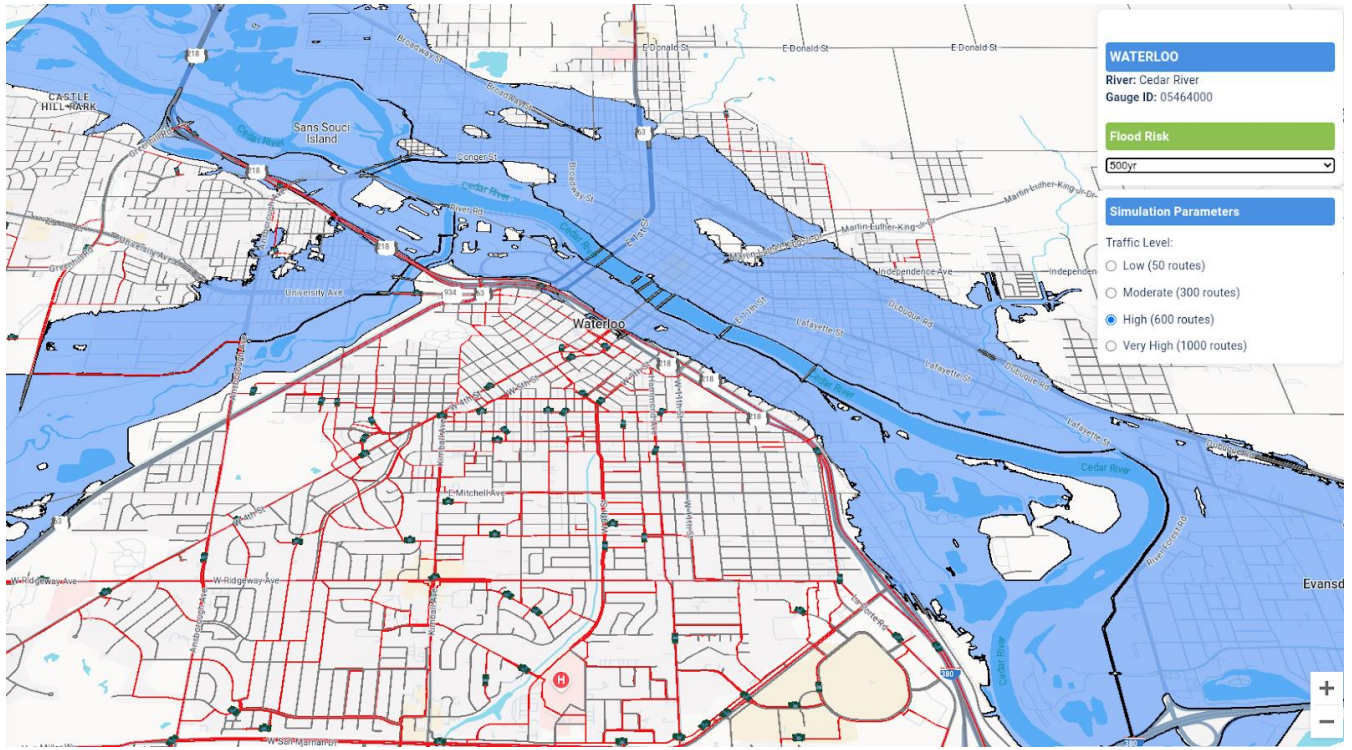
KEY RESULTS (8)

USE CASE 2: FLOOD IMPACT ON TRANSPORTATION



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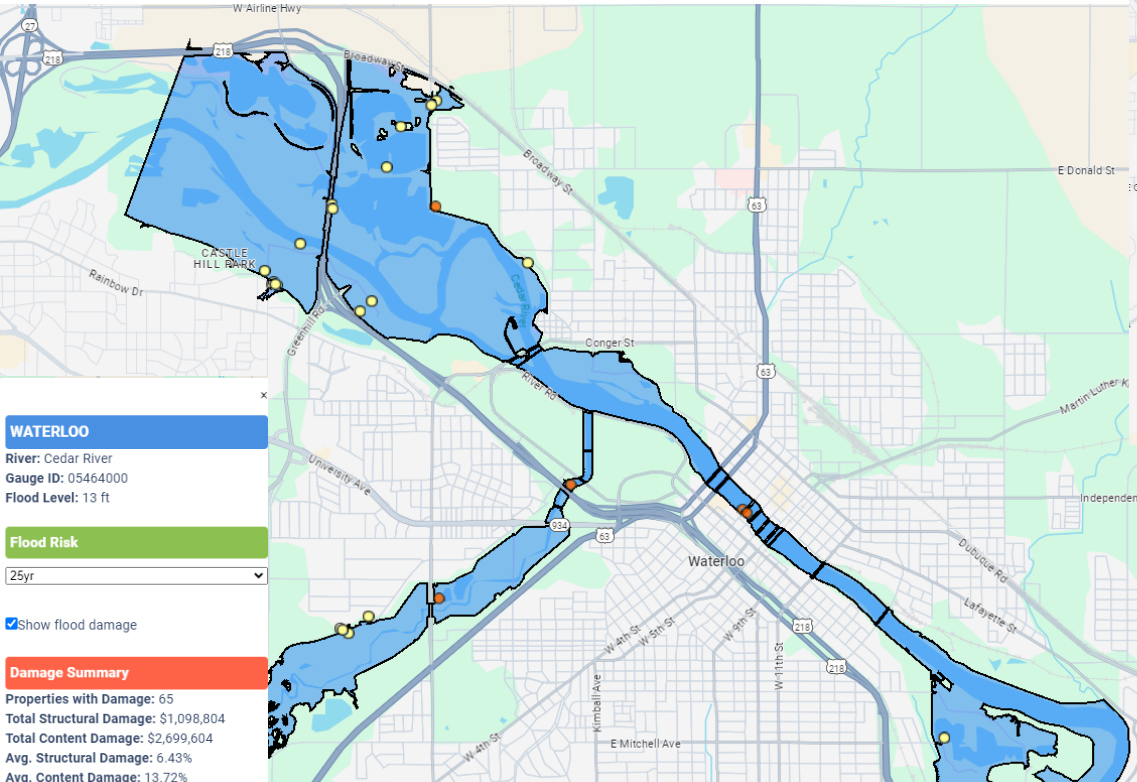
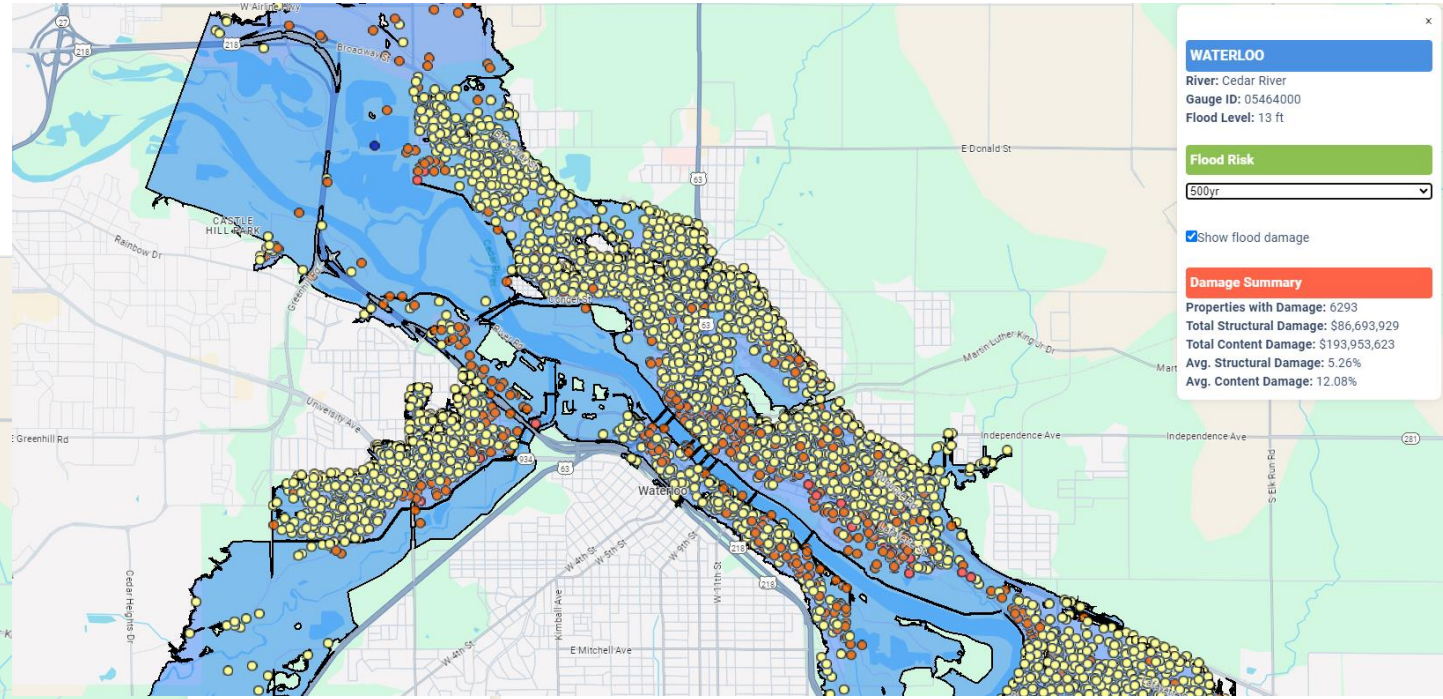
KEY RESULTS (9)

USE CASE 3: FLOOD DAMAGE ANALYSIS





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KEY RESULTS (10)
SUMMARY

Key Achievements:

- In-depth literature review
- Comprehensive dataset
- Decision Support Framework
  - Web based, generalized
  - City scale
  - User friendly
- Data Analytic Tools
  - Risk Analysis
  - Damage Analysis
  - Traffic flow
  - Bus routes
  - Train routes
- Flood impact analysis on
  - Transportation
  - Urban critical systems
- Journal articles and Conference presentations

Position:

- **NGI Fellow** for 6 months between March-Nov 2024
- **Assistant Prof.** at Sakarya Uni

Publication related to the NGI:

- City-Scale Web based Decision Support Framework for Flood Impact Analysis: Integrating Urban system and real-time data, 2025 (in review)
- Web based Hydrological Data Monitoring Interaction and Visualization , 2025 (in preparation)

Other projects

- Geo-WC: Custom Web Components for Earth Science Organizations and Agencies,Web based Hydrological Data Monitoring Interaction and Visualization
- HydroSignals: Integrating Web Technology and Intelligent Assistants for Advanced Hydrological Monitoring

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KEY RESULTS (10)

1. Development/advancement of innovative technologies (TLR, …):	Developed an adaptable and scalable digital twin system with distinct modules for infrastructure, transportation, weather, and public services.
2. Testing technologies (demo, pilot..):	Conducted pilot studies in simulated urban environments, focusing on flood risk management and evacuation route optimization
3. Testing technologies on the market in the US:	Engaged with potential adopters, validating system applicability in urban disaster response scenarios
4. Sound Scientific Validation:	Submitted the findings to a peer-reviewed journal, currently under review.
5. Strengthening research collaboration with the US/Canada:	Established partnerships with academic institutions in the US.
6. Building solid connections and partnerships in Europe and in the US/Canada:	Established professional relationships with researchers in Europe and North America, creating opportunities for future collaborations and joint initiatives.
7. Expanding collaboration within the NGI community:	Established connections with researchers from diverse disciplines within the NGI community, fostering opportunities for interdisciplinary collaboration on future projects.
8. Paper submission for further publication – indicate, only EU author(s), or jointly with the host organization:	A paper has been submitted for peer review, co-authored with researchers from the host organization. The findings focus on the modular architecture and real-time analytics of the digital twin framework. A collaborative paper involving researchers from the host organization and the European Union was successfully accepted for publication. (project name: HydroLang)

IMPLEMENTATION

- To optimize data analytic tools
- To add different visualization tool like alert, decision module, …
- To expand our results to the different use cases
- To develop early warning system
- To Implement and deployment
- To get feedback from local authorities

EXPECTED IMPACT

Data Privacy and Sovereignty:
- Ensures secure, privacy-preserving data handling and robust protection measures.

Inclusion and Equity
- Features user-friendly, accessible interfaces for diverse and marginalized users.

Sustainability and Green IT
- Optimizes resource usage and recalculates transportation routes during floods for efficiency.

Cooperation and Social Participation
- Fosters collaboration among researchers, governments, and citizens.

Digitalization and Interoperability
- Integrates urban domains via open standards for seamless system compatibility.

Diversity and Equity
- Supports diverse user needs with adaptable disaster management tools across socio-economic contexts.

LESSONS LEARNED

Surprises:

- **Data collection and preparation:** took longer than we thought. It was difficult to find the data we wanted for Waterloo, which we chose as a pilot region.

Challenges:

- **Integration of Google Maps with Deck.gl:** The main challenge we faced was integrating Google Maps with Deck.gl, a React-based visualization library. Google Maps cannot be directly used as a React component, which makes its integration with React applications cumbersome.
- **How React Google Maps Addressed This Problem:**

To address this issue, we used the React Google Maps library (https://visgl.github.io/react-google-maps/). This library simplifies the integration by wrapping Google Maps within a React component, allowing us to add Google Maps to our React application more easily. React Google Maps handles the rendering and lifecycle management of Google Maps, which eliminates the need for manual implementation and reduces development time and effort.

- **Remaining Challenges:**
  - Limited Advanced Features
  - Customization Limitations:
  - Performance Concerns:

Sumeyye Kaynak

Assistant Professor at Sakarya University
PhD in Computer Engineering

Sumeyye Kaynak

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(N/A)

Profile

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Keep engaged with our NGI Fellows !

The NGI Enrichers project has received funding from the European Union's Horizon Europe Research and Innovation Programme under grant agreement 101070125.

Neuro-symbolic Cross-Domain Recommendation

Tommaso Carraro
Italy

PhD Candidate in University of Padova ; Research fellow at Fondazione Bruno Kessler

Track
AI / Recommender Systems / Neuro-Symbolic Computing

Host Organization
Rutgers University, New Jersey, USA

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THE PROBLEM

Recommender systems are tools that suggest items according to user preferences

- Mitigate **information overload**
- Used by commercial platforms and e-services (e.g., Spotify, Amazon, Netflix)

Historical limitations

- Data sparsity, cold-start, explainability

Problems of current state-of-the-art

- Modern approaches are based on deep learning
- Neural networks cannot
  - Deal with **sparse structures**
  - Learn in the **absence** of data
  - **Explain** their predictions

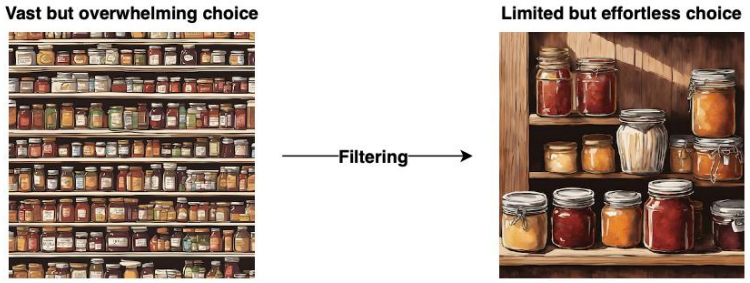

Fig. 1: Information overload

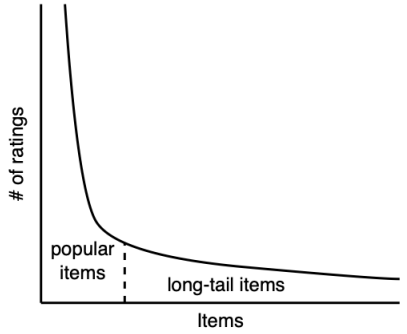

Fig. 2: Long-tail distribution of user-item ratings

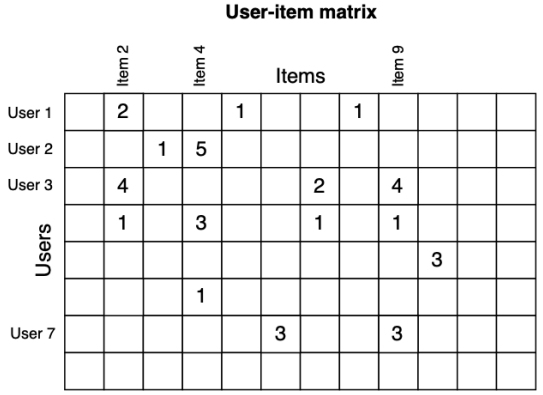

Fig. 3: Sparse user-item matrix

Fig. 4: Example of explanation in Netflix

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SOLUTION: NEURO-SYMBOLIC CROSS-DOMAIN RECOMMENDATION

Cross-Domain Recommendation

- Transfer **pre-trained** information from a source domain to compensate for **sparsity** and **cold-start** in the target domain

Neuro-Symbolic integration

- Integrate (deep) learning with (logical) reasoning to obtain the **best** from both words
- Few-shot learning, zero-shot learning, interpretability by design

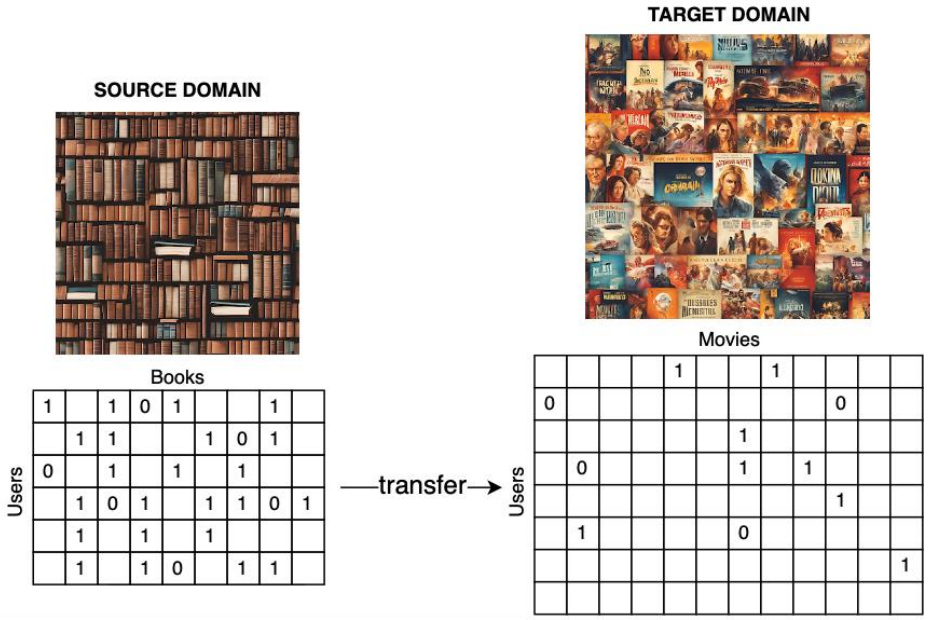


Fig. 5: Cross-domain recommendation illustration

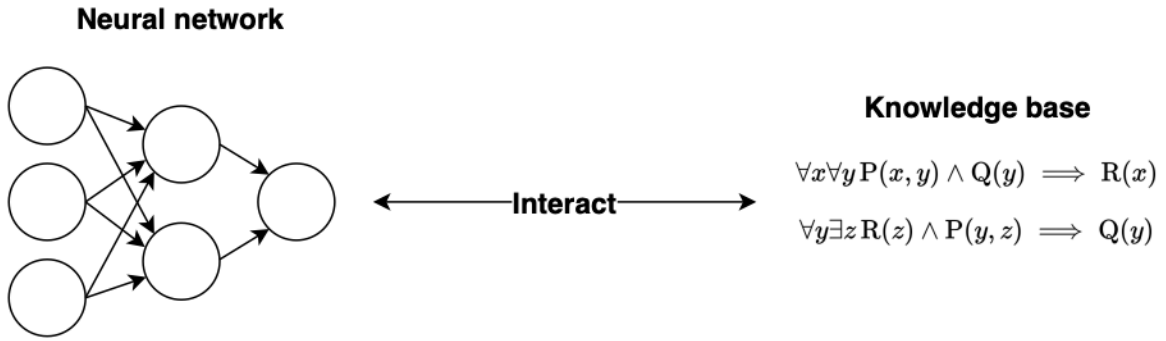


Fig. 6: Neuro-Symbolic integration illustration

SOLUTION: GRAPHICAL ILLUSTRATION

A knowledge graph is used as the **bridge** to connect cross-domain items

- Based on this connection and what is **learned** in the source domain, knowledge can be transferred to **regularize** the model trained in the target domain

- Knowledge is transferred through **logical reasoning** with a special training method called Logic Tensor Networks

- **Advantages**: sparsity and cold-start mitigation, explainability by design

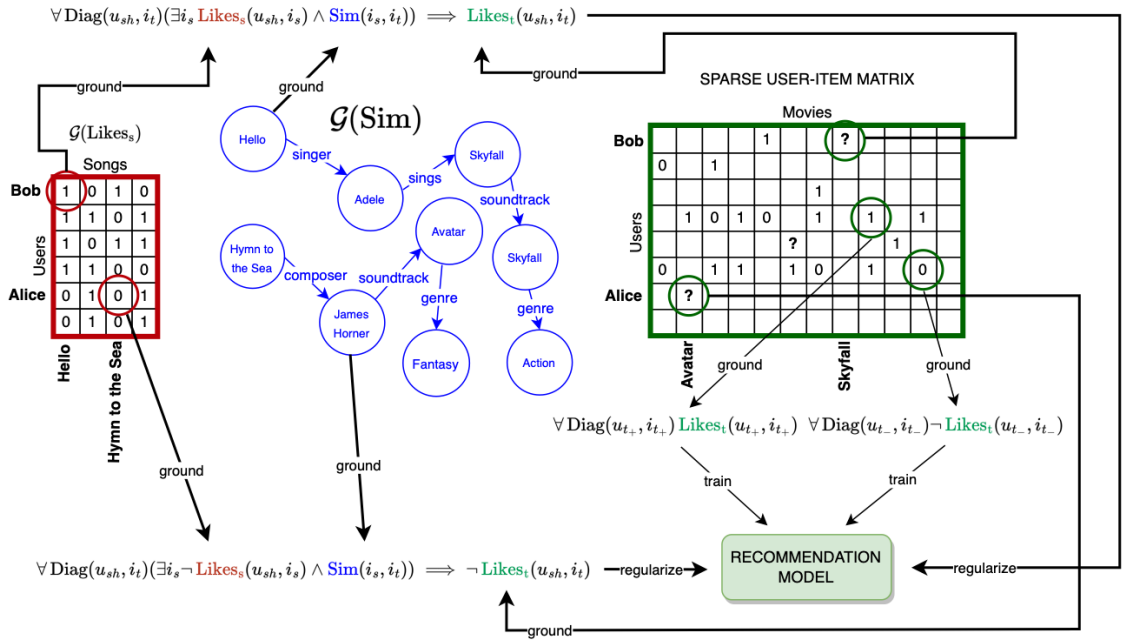


Fig. 7: Neuro-Symbolic Cross-Domain recommendation approach illustration

TOMMASO CARRARO, PH.D. CANDIDATE IN CS UNIVERSITY OF PADOVA

Short bio:

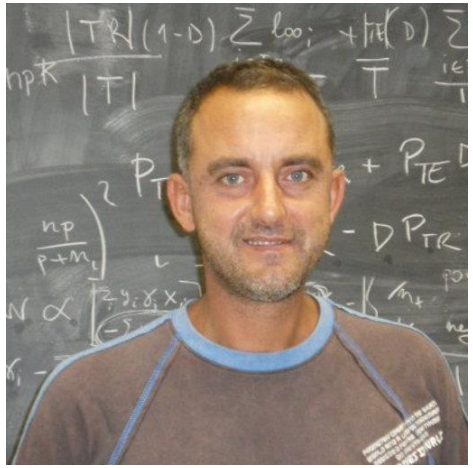
- Current position: **Ph.D. Candidate** in Brain, Mind, and Computer Science doctoral program of the University of Padova
- 1-year research fellow at Fondazione Bruno Kessler, a research center in Trento, Italy
- Master's degree in Computer Science (grade: 110/110 with honours)
- Bachelor's degree in Computer Science (grade: 110/110 with honours)
- High School diploma in Computer Science
- Teaching assistant during the first two years of my Ph.D.
- **Research interests**: Neuro-Symbolic AI, Recommender Systems

Relevant publications:

- Tommaso Carraro, Alessandro Daniele, Fabio Aiolli, Luciano Serafini. Mitigating Data Sparsity via Neuro-Symbolic Knowledge Transfer. 46th European Conference on Information Retrieval (ECIR'24), Glasgow, UK. DOI: https://doi.org/10.1007/978-3-031-56063-7_15
- Tommaso Carraro. Overcoming Recommendation Limitations with Neuro-Symbolic Integration. 17th ACM Conference on Recommender Systems (RecSys'23), Singapore, SG. DOI: https://doi.org/10.1145/3604915.3608876
- Tommaso Carraro. (2023). LTNtorch: PyTorch implementation of Logic Tensor Networks. DOI: https://doi.org/10.48550/arXiv.2409.16045
- Tommaso Carraro, Alessandro Daniele, Fabio Aiolli, Luciano Serafini. Logic Tensor Networks for Top-N Recommendation. 21st International Conference of the Italian Association for Artificial Intelligence (AIxIA'22), Udine, Italy. DOI: https://doi.org/10.1007/978-3-031-27181-6_8

THE TEAM / EXPERTISE

Luciano Serafini
Position: Head of Unit
Project role: advisor
Interests: logical representation and reasoning
Affiliation: Fondazione Bruno Kessler
Scholar: link



Fabio Aiolli
Position: Associate professor
Project role: advisor
Interests: recommender systems and explainability
Affiliation: University of Padova
Scholar: link

Yongfeng Zhang
Position: Assistant professor
Project role: international host
Interests: recommender systems, fairness, explainability, LLMs
Affiliation: Rutgers University
Contact: yongfeng.zhang@rutgers.edu
Scholar: link

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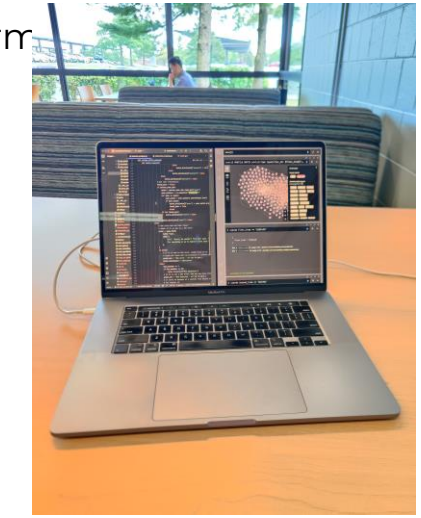
HOST ORGANIZATION: RUTGERS UNIVERSITY DEPARTMENT OF COMPUTER SCIENCE - THE WISE LAB

- **Strengths** of the organization
    - Very **active** in the field of recommender systems with an incredible publication record
    - **Shared** research interests with the NGI project: Neuro-Symbolic Recommendation and Explain
- I collaborated with the Ph.D. students of The Wise Lab, supervised by Prof. Zhang
    - **Daily** activities
        - Discussions with students
        - Collaborations in different projects and the NGI project
    - **Weekly** activities
        - Preparation of a weekly report containing all the updated inform
        - In-person or remote one-on-one meeting with Prof. Zhang



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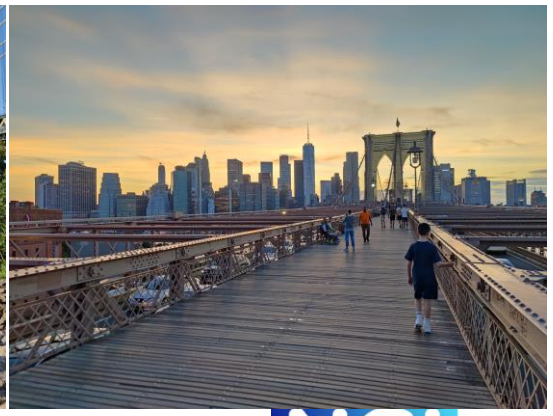
NGI EXPERIENCE: NOT ONLY RESEARCH









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KEY RESULTS: SEMANTIC CROSS-DOMAIN DATASET

Step for the creation:

- We started from Amazon datasets (Movies and TV, Books, CDs and Vinyl) to create 6 cross-domain scenarios (Table 7.4)

- We augmented Amazon item **metadata** (item title, release date, author (for books), artist (for music), director (for movies)) with web **scraping** on the Amazon website

- We **mapped** Amazon items to entities in the Wikidata knowledge base (see Table 7.3)

- We used Neo4j to load a Wikidata database and find **paths** between cross-domain items

- In the first version, we generated the **shortest path** between each pair of cross-domain items (see Table 7.4)

Statistic	Books	CDs and Vinyl	Movies and TV
#Items	367,982	64,443	50,052
#Linked items	56,665 (15.40%)	46,021 (71.41%)	34,646 (69.22%)
#Linked items(title+person+date)	2,536 (4.48%)	10,400 (22.60%)	751 (2.17%)
#Linked items(title+person)	16,854 (29.74%)	23,634 (51.35%)	2,665 (7.69%)
#Linked items(title+date)	6,830 (12.05%)	6,242 (13.56%)	8,101 (23.38%)
#Linked items(title)	30,445 (53.73%)	5,745 (12.48%)	23,129 (66.76%)

Table 7.3: Entity linking statistics.

Cross-domain dataset	#Linked source items (≥ 300 ratings)	#Linked target items (≤ 5 ratings)	#Shared users	#Combinations of cross-domain linked items	#Paths found
Books → Movies	1,003	2,997	37,388	3,005,991	2,573,795 (85.62%)
Books → Music	1,003	7,050	16,738	7,071,150	6,062,462 (85.74%)
Movies → Books	640	6,308	37,388	4,037,120	3,186,103 (78.92%)
Movies → Music	640	7,050	18,031	4,512,000	4,250,508 (94.20%)
Music → Books	71	6,308	16,738	447,868	356,964 (79.70%)
Music → Movies	71	2,997	18,031	212,787	202,349 (95.09%)

Table 7.4: Statistics of the path-finding procedure for each pair of datasets in our cross-domain recommendation scenario. The statistics are computed based on the items linked to Wikidata.

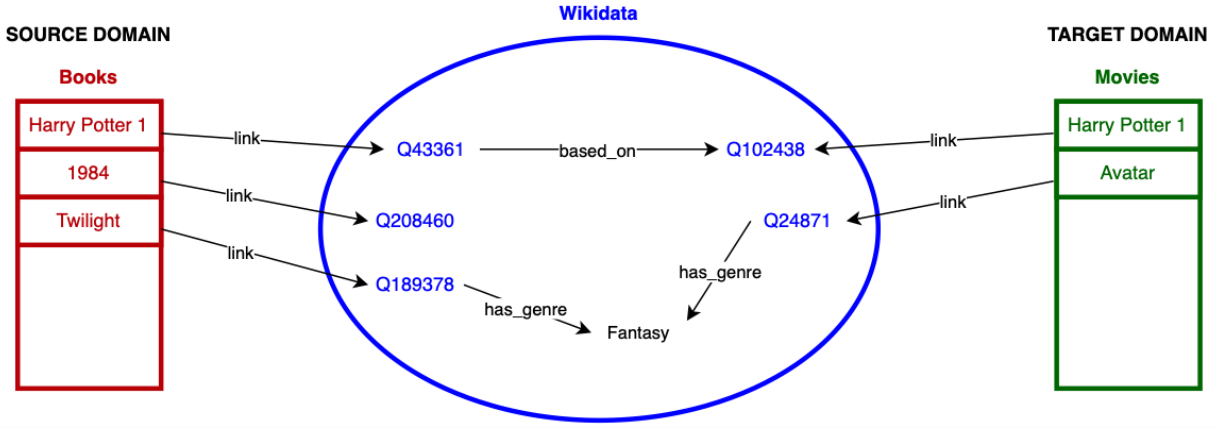

Fig. 8: Illustration of the entity linking and path finding procedures used for the creation of the dataset

KEY RESULTS: NEURO-SYMBOLIC CROSS-DOMAIN RECOMMENDATION APPROACH

Steps for the training of the model

1. a recommendation model is **first trained** on the **source** domain ratings

- predictions are used to understand if a positive or negative signal has to be transferred to the target domain

2. an additional recommendation model is trained on the **target** domain ratings

- when a rating is **missing** in the target domain, knowledge graph paths are used to understand to which items the target item is **connected** in the source domain

- if the user **likes** the item in the source domain, the connected item is **recommended** in the target domain

- explanations are **model intrinsic** as the knowledge graph path connecting the target item to the source item can be **directly** used as an explanation (see Figure 9)

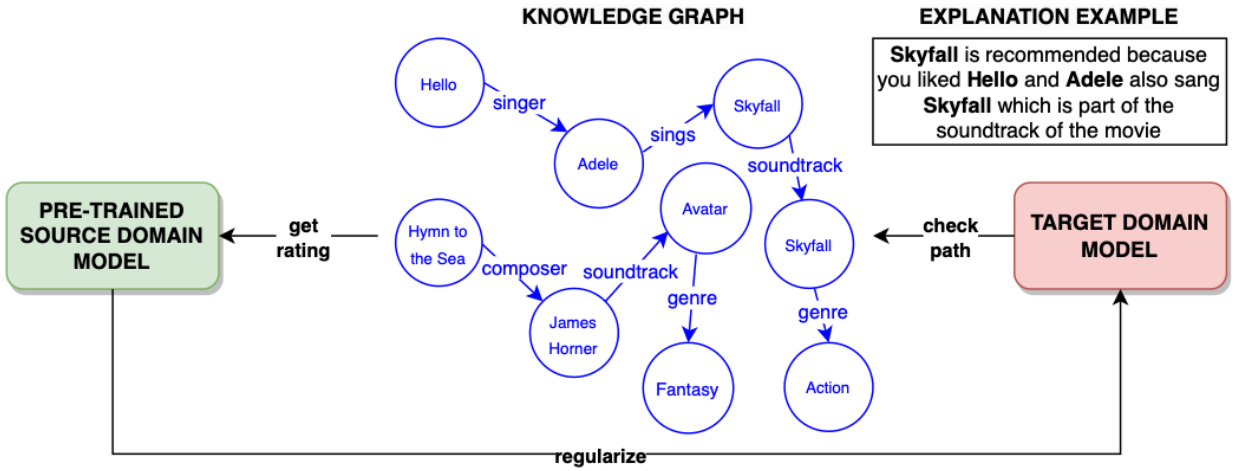

Fig. 9: Illustration of the training of the Neuro-Symbolic Cross-Domain recommendation approach. The knowledge graph (in the middle) bridges the two domains and the predictions of the model pre-trained in the source domain (in green) are used as guidance to regularize the model trained in the target domain (in red). An explanation example based on this subgraph is given.

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KEY RESULTS: FINAL RESULTS AND DISCUSSION

The final model can **outperform** the Matrix Factorization baseline on a range of tasks with different sparsity

- Cold-start has been mitigated effectively as the model has been designed to transfer knowledge only to **cold-start users**
- Sparsity has been mitigated effectively and **implicitly** by mitigating cold-start (cold-start user cases determine the most sparse row vectors in the user-item matrix)
- The model can generate **intuitive explanations** using the knowledge graph paths (see previous slide)
- The dataset is available at this repository: https://github.com/tommasocarraro/SemNeSyKTRecSys
- The experiments will be published in the same repository once they have been organized and summarized

IMPLEMENTATION: STEPS FOR NEXT 6 MONTHS

We compared our approach with a single and basic model (i.e., Matrix Factorization)

- The experiments were designed to understand if **recommendation limitations** could be mitigated with a Neuro-Symbolic approach
    - We regularized the Matrix Factorization model with knowledge coming from an additional domain and investigated whether this **knowledge transfer** was effective in mitigating the aforementioned limitations
- Additional experiments are needed to position our model in the **state-of-the-art**
    - Implement deep cross-domain state-of-the-art recommendation approaches (e.g., PTUPCDR) and investigate if our approach is more effective at **transferring** knowledge and **explaining** cross-domain recommendations
    - **Compare** our approach with other Neuro-Symbolic approaches existing in the literature (e.g., NCR)
    - Once a complete set of diverse baselines is implemented and compared with our approach, this work will be ready to be sent to an **important conference** in the field (e.g., RecSys)

EXPECTED IMPACT

By mitigating **major** recommendation limitations, our approach will improve:

- **Transparency**: thanks to model intrinsic explanations based on knowledge graph paths, users will be able to understand the reasons behind cross-domain recommendations, which is something missing or **not effectively addressed** in modern recommender systems (see basic explanations in Netflix (e.g., 99% compatible) or Amazon (e.g., people who ordered this, also ordered this), which are not personalized)

- **User's experience**: by mitigating important issues such as sparsity and cold-start, users will receive more accurate recommendations. The information transferred from the source domain will help to **compensate** for missing ratings in the target domain. Consequently, there will be **more data** to train the recommender system, and **more accurate** recommendations will be generated. This, plus the availability of **user-friendly** explanations, will inevitably enhance the user's experience and **trust** in the system

LESSONS LEARNED

- In the USA, University campuses are not usually operative during summer, and if there is a summer semester, a few people will usually be present. This made my experience less pleasant as it was difficult to create friendship relationships. Student places like libraries or dining areas were also closed or partially operative during the summer semester
- In the USA, senior students (e.g., Ph.D.) participate in internships with tech companies during the summer semester. This resulted in 3 months of work alone as all my colleagues were out of the office for their internship experiences
- The team was not very inclusive or open. I proposed to have group meetings to know each other but the professor was more focused on the research and results of his students, so he did not promote this proposal and we never had a group meeting
- Most of the students were working from home for the entire period of the expedition, so I was used to working alone the entire day, and this made it difficult to create collaborations with them
- It has been very difficult to adapt or make new friends due to the very different culture compared to Europe. In Europe, we enjoy life more, and for us, social relationships are very important. In the USA, they are more focused on their job and are usually very busy because of this
- In the USA, the quality of life is low compared to Europe, so I doubt if it is worth it to move to the USA for a career by compromising life quality. Maybe, New Jersey was not my place and additional visits are necessary to better understand this point
- Even if it is difficult to build social relationships, the few moments I had the pleasure to share with USA people have been very pleasant. They were so kind, offered me dinner in many situations, we went out together biking and doing other activities
- The major challenge for me has been the lack of public transportation. My flatmate told me that New Jersey is one of the states with the best operating public transportation. However, we are far from Europe in this aspect. I had to rent a car for most of my visit because even going to the University or to the grocery store was impossible without a car. Without a car, you are very limited in the USA

Tommaso Carraro

PhD Candidate in University of Padova ;
Research fellow at Fondazione Bruno Kessler

Tommaso Carraro

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Video

Google Scholar
GitHub ; ORCID

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Keep engaged with our NGI Fellows !

The NGI Enrichers project has received funding from the European Union's Horizon Europe Research and Innovation Programme under grant agreement 101070125.

PIXEL VR – Photorealistic Imaging and eXact Modeling for Enhanced Virtual Reality

Vasili Manfredi
Italy

PhD Student at Politecnico di Milano ; 3D Artist, VR Visualizer, Architect

Track
VR / Photogrammetry / Cultural Heritage

Host Organization
Carleton University, Ottawa, Ontario, Canada

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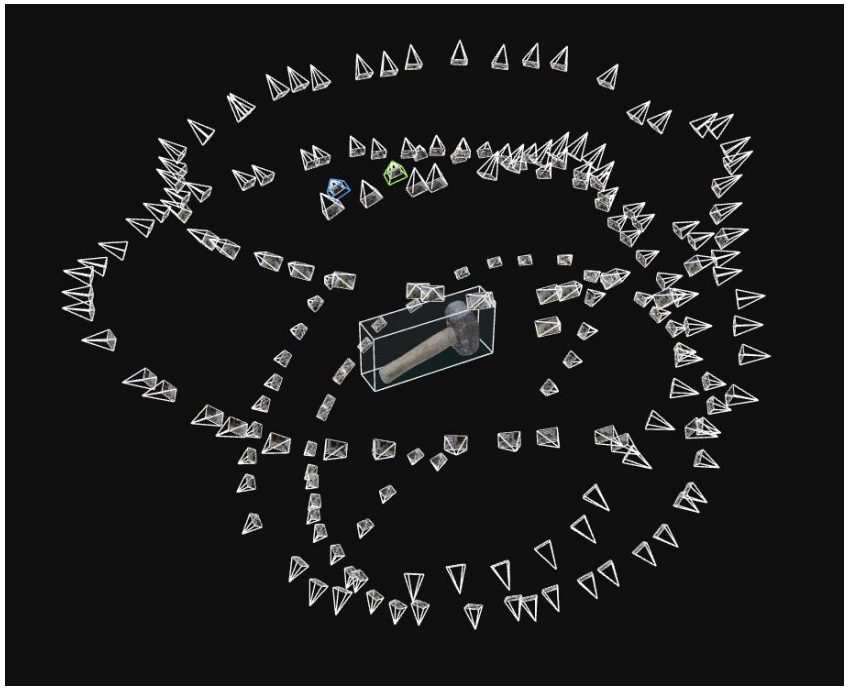
THE PROBLEM



Photogrammetric surveys are an excellent way to store and visualize data, the outcome are photorealistic tridimensional models, geometrically accurate with enhanced materials information.

The main **issue** that prevent a wide-spread usage of this technology in different disciplinary sectors are the **dataset's size**, hundreds of gigabytes of complex tridimensional mesh.

THE PROBLEM

By now, to visualize in virtual environment using VR (Virtual Reality) headsets, photogrammetric models needs to be linked to a High-End desktop computer. Due to their **costs**, and in terms of **hardware computing**, **data storage** and **power usage**, optimization of the surveys are needed. The **optimization processes** are **complex** and **time-consuming process** that involves hiring an experienced 3D artist.

THE PROBLEM

We are seeing, more and more, a **democratization** of photogrammetry thanks to new **low-cost hardware** such as smartphones and low-cost cameras, **free** and **open-source software**. Consequently surveys might be done by various figures, not only by experts, and potentially used by archeologist, architects, museums, students, tourists, edu-games users. Currently, only the gaming industry is working on this topic leaving small businesses, architects, archeologist and governmental departments working on unoptimized huge datasets. Therefore, the opportunity is to create a **user-friendly environment** that, even without major competences, is possible to **reduce** the **datasets size** without compromising the overall **photorealistic quality** and create optimized VR (Virtual Reality) ready photorealistic models rendered by standalone VR headsets that are not relying on High-end Desktop computers.

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YOUR SOLUTION (1)

The main **solution** to address this topic is in the usage of a **quad-decimating/collapsing workflow**, that means that, from the triangulation derived by the photogrammetric survey, the tridimensional mesh is converted into quads and then **collapsed recursively** in larger quads/triangles. This methodology doesn't address the issues with organic shapes, so, has been implemented a python script that generates vertices clusters based on the shape of the subject and simplify it by a ratio. Then, the high-resolution model is used as source to transfer the photorealistic details, textures and data, to the low-resolution one, creating a reprojection of the photorealistic details on the optimized model. The **differentiator** is that, until now, the whole optimization process was done tailor made, which required a high skilled 3D artist, with the **Add-on application**, the whole process is done **automatically,** saving time and giving a reliable outcome. The **advantage** of this application is mainly a **highly optimized photorealistic tridimensional model** and a completely automated process tasks. The whole process is processed with open source and free software, which not requires substantial investments. The main opportunity is to reducing the file size without compromising the overall visual quality, that means that hardware, such as VR headsets, are capable to rendering models without using Desktop's computing capabilities, reduction in disk space usage and less resource usage.

YOUR SOLUTION (1)

Study Cases:

The workflow and the Add-on have been tested on **different** photogrammetric surveys **scenarios**: different survey scale, datasets size, survey hardware and different shapes.

The outcome are highly optimized meshes that, mostly, are keeping the visual's data with, in the most cases, a reduction percentage of more than 98%.

All the calculation and optimization processes have been done by a Dell XPS 9500, I7 10750H, GTX 1650 Ti, 16 GB of Ram.

YOUR SOLUTION (2)

Study Case: Bytown Museum

The study case “Bytown Museum” has been surveyed by CIMS. The survey collected more than 1,000 pictures. The outcome model was around 300 Millions triangles and was optimized to less than 2,000 triangles.

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YOUR SOLUTION (2)

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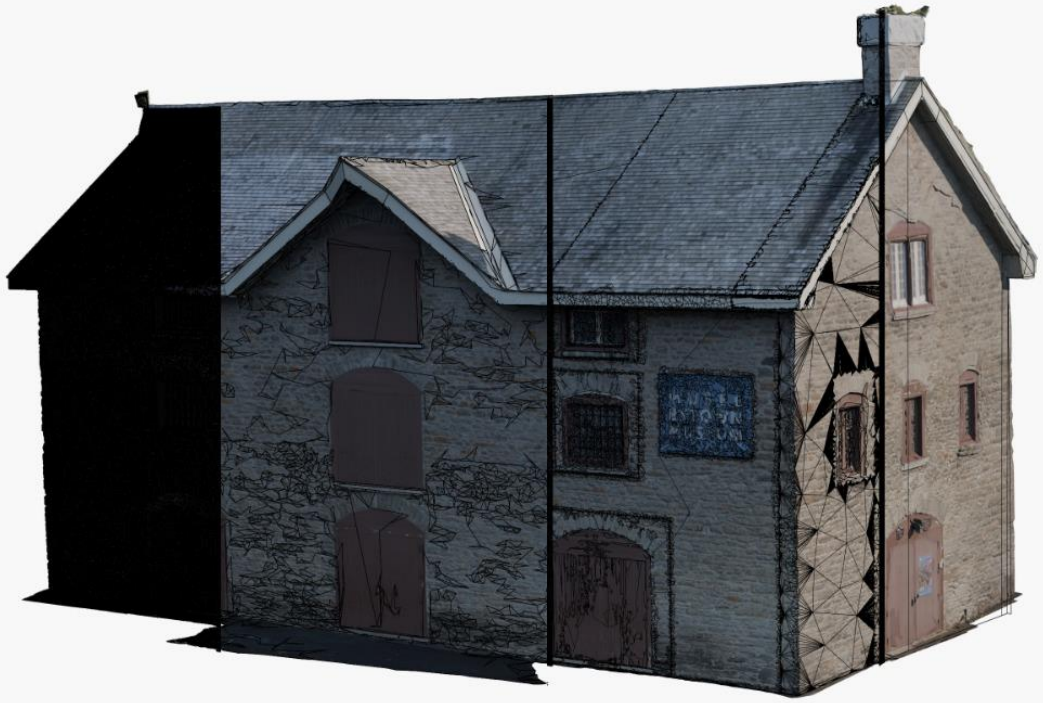
YOUR SOLUTION (2)



Study Case: Bytown Museum

Since the study case “Bytown Museum” was surveyed by CIMS, it was the main subject that has been used to test different decimation workflow.

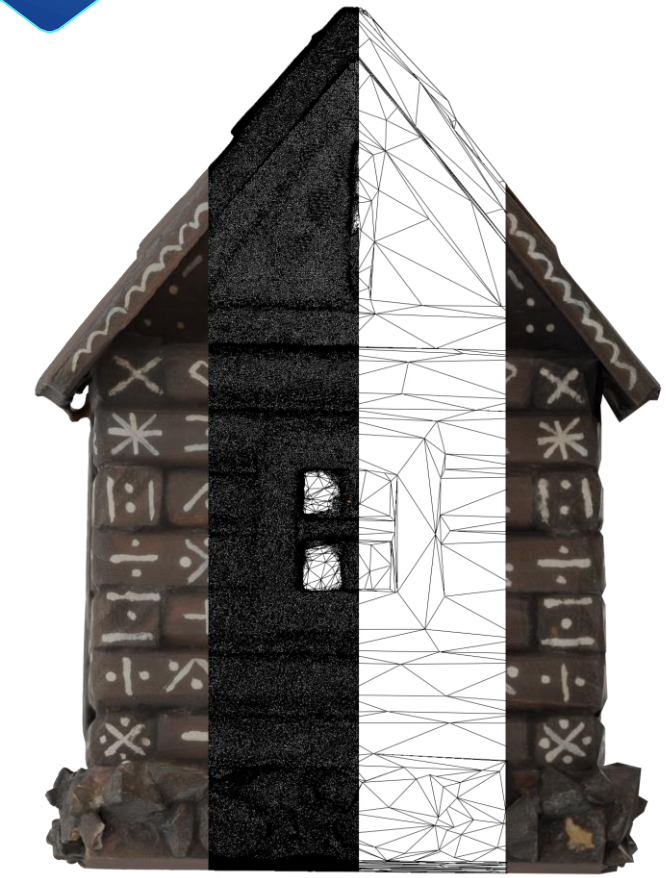
YOUR SOLUTION (2)

Study case: High relief

The photogrammetric dataset “High Relief” is an open dataset. It is a small dataset, around 14 images, high-poly model was 5 Millions triangles to an optimized model of 4,000 triangles.

YOUR SOLUTION (2)

YOUR SOLUTION (2)



Study case: Small Cottage

The photogrammetric dataset “Cottage” is an open dataset. It is a medium dataset, around 197 images, high-poly model 5 Millions triangles to an optimized model around 3,000 triangles.

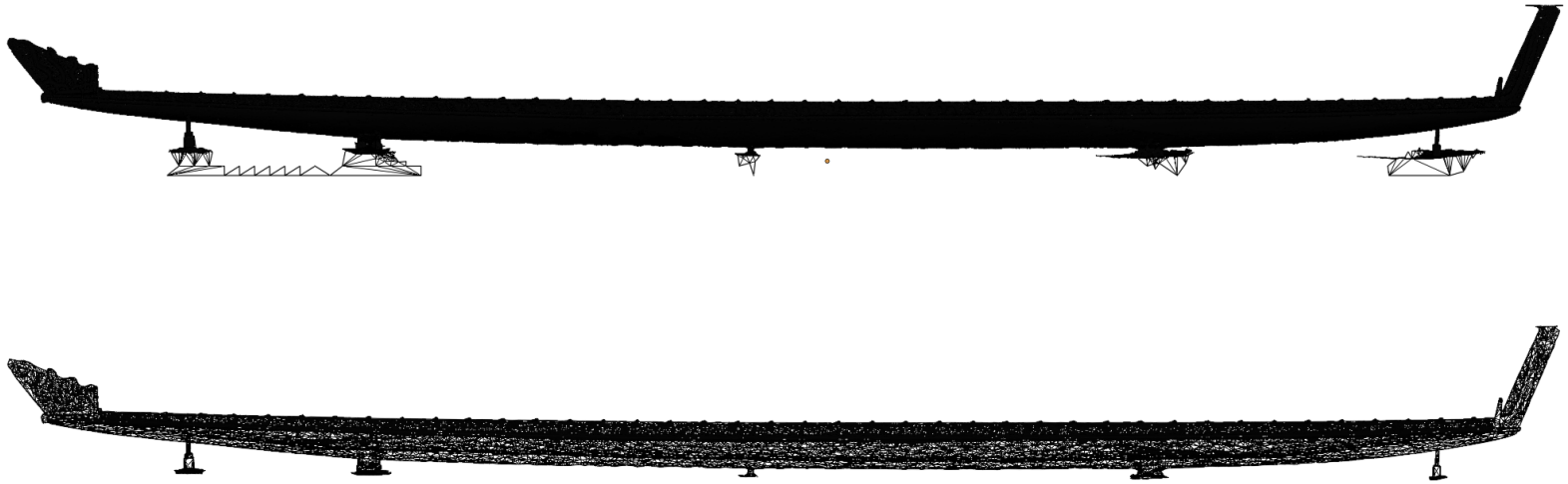
YOUR SOLUTION (2)

YOUR SOLUTION (2)

Study case: Hammer

The photogrammetric dataset “Hammer” is an open dataset. It is a medium dataset, around 190 images and merge photogrammetric survey with laser scan survey. The high-poly model around 9 Millions triangles to an optimized model around 2,000 triangles.

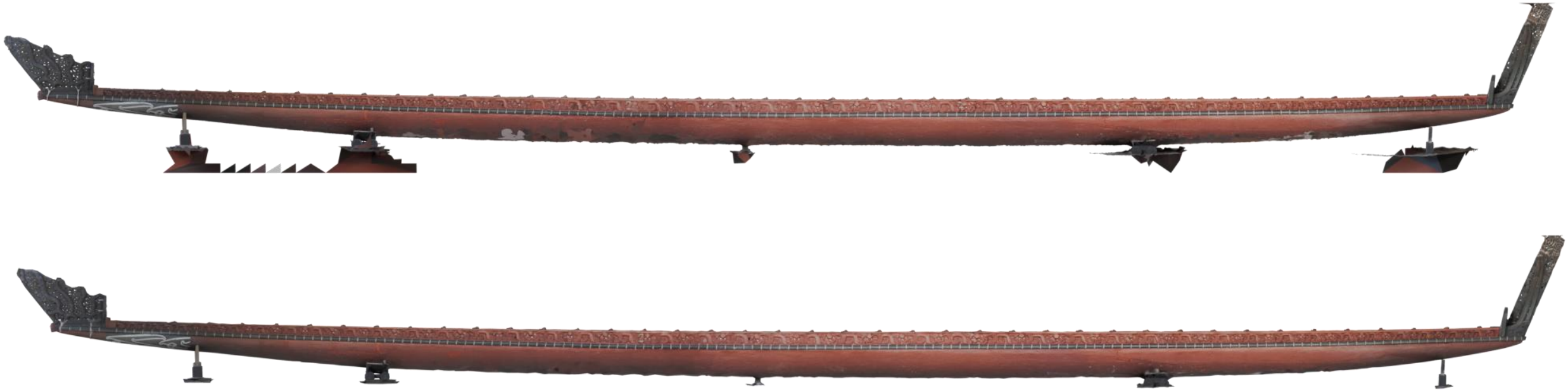
YOUR SOLUTION (2)



Study case: Waitangi War Canoe

The photogrammetric dataset “Waitangi war canoe” is an open dataset. It is a large dataset, around 2,000 images and merge LiDAR data with photogrammetric data. The high-poly model around 80 Millions triangles to an optimized model around 27,000 triangles.

YOUR SOLUTION (2)



DATA

Hardware: **Dell XPS 15 9500**	**Face count**	**Texture size** **(D+N)**	**Fbx size**	**Rendering time Path Tracing** **2K_denoised**
Cottage	5,508,998	62,354 KB	126,727 KB	5.37 Minutes
Cottage_Optimized	3,349	29,482 KB	254 KB	1.50 Minutes
Reduction percentage	99,94%	52.71%	99.79%	72.06%
High Relief	5,753,745	58,612 KB	203,182 KB	7.13 Minutes
High Relief_Optimized	4,036	37,702 KB	5 KB	3.22 Minutes
Reduction percentage	99,93%	35.67%	99.99%	54.83%
Hammer	9,238,698	42,088 KB	207,098 KB	1.25 Minutes
Hammer_Optimized	2,894	48,000 KB	137 KB	0.39 Minutes
Reduction percentage	99,97%	-14.04%	99.93%	68.8%
Canoe	80,000,701	84,847 KB	1,021,474 KB	57.57 Minutes
Canoe_Optimized	27,538	52,800 KB	1,452 KB	1.13 Minutes
Reduction percentage	99,97%	37.77%	99.85	98.03%
Bytown Museum	305,000,000	320,936 KB	364,091 KB	7,21 Minutes
Bytown Museum_Optimized	1,400	24,000 KB	466 KB	1.39 Minutes
Reduction percentage	99,99%	92.52%	99.87	80.72%

Data:

The final data table shows that the overall optimization works as intended, reducing generally the size of the studied cases and decreasing drastically the rendering time. The outcome are photorealistic models VR ready.

FIRST & LAST NAME, POSITION
CURRENT ORGANIZATION

Bio

Vasili Manfredi, Ph.D student at Polimi, 3D artist, VR visualizer and Architect. Worked in various project in Polytechnic of Milan as 3D artist, tutor, TA and VR experience developer.

List any relevant publications/products/projects/results related to NGI:

Pixel VR_AddOn, Bolognesi, C. M. and Manfredi, V.: OPTIMIZATION OF VR APPLICATION IN TEXTURING CULTURAL HERITAGE, Int. Arch. Photogramm. Remote Sens. Spatial Inf. Sci., XLVIII-2/W4-2024, 73–78, https://doi.org/10.5194/isprs-archives-XLVIII-2-W4-2024-73-2024, 2024

THE TEAM / EXPERTISE

Carleton University, Canada

CIMS LAB, Canada

Stephen Fai, CIMS Director, Carleton University Associate Professor, former Director of Azrieli School of Architecture.

Lara Chow, CIMS Associate Director.

Cecilia Bolognesi, Associate Professor of Polytechnic of Milan, former Scientific director of Virtual and Physic modeling laboratory “LaborA”.

Deida Bassorizzi, Ph.D student in Polytechnic of Milan.

Alex Robu, IT and coding expert.

Domenico D’Uva, Ph.D Ing in Polytechnic of Milan.

YOUR HOST ORGANIZATION

Carleton Immersive Media Studio

The Carleton Immersive Media Studio (CIMS) is a Carleton University Research Centre (CURC) affiliated with the Azrieli School of Architecture and Urbanism in the Faculty of Engineering and Design. Over the past decade, CIMS has built an international reputation working with public, private, and not-for-profit partners.

It demonstrates the value of new and emerging digital technologies for architectural rehabilitation, heritage conservation, and the Architecture, Engineering, Construction, and Operations (AECO) industry more generally.

KEY RESULTS (1)

The expedition led to a **general improvement** of pre-processing, processing and post-processing techniques, from the raw data to the post-processed one to maximize the quality and the density of the point cloud generation from the photogrammetric survey. We were able to define the best decimation workflow to optimize and improve current techniques of mesh generation. We automated most of workflow processes. Has been defined a workflow for texture's super-sampling technique and has been tested for performance and visual improvements.

KEY RESULTS (2)

Has been created an Add-on for Blender that automate the most complex processes of mesh optimization and has been tested on CIMS related projects. The outcome are geometry optimization, geometry reduction, file size reduction up to 99%, better UV management, higher quality texture with less disk space usage, faster rendering times, responsiveness in Virtual Environment and lower time-consuming processes.

KEY RESULTS (3)

The Host organization is still in contact with me for work related collaborations and we are open on more researcher exchange with Politecnico di Milano. I've been in contact with major Canadian's heritage firms and cultural associations and collaborated with them in optimization of Cultural Heritage surveys. One paper has been published in February (ISPRS Journal) and poster presented at 3DArch workshop in Siena (CIPA related conference). Once concluded the research, one more paper is planned on the last part of the research, the automation of photogrammetric optimization processes in collaboration with Carleton University, CIMS and Politecnico di Milano.

KEY RESULTS (3)

The expedition was planned on defining the best photogrammetric datasets optimization workflow leading to a VR application. The first three months of the expedition were on the definition of this methodology. After researching discussion with CIMS co-worker we find out that, instead of creating a VR application, would it be more interesting and technology advancing to intervene in the improvement of the general workflow and the automation of that. Which led to even more interesting results in terms of optimization and led me to enhancing my studies on different topics. By collaborating with CIMS related projects we created and built a strong connection, workwise and human wise.

IMPLEMENTATION

How would you implement your findings?

Currently, the Add-on is still on the Alpha version, in the next six months the Pixel VR add-on will implement functions to automate the photogrammetric computational workflow from Reality Capture to Blender. Will be opened a GitHub space to collaborate with others on the Pixel VR project. Other implementations are a quad-remeshing tool to avoid relying on other software, “one button compute”, to proceed automatically on all the workflow processes instead of tweaking options and enhancing user-friendly UI.

EXPECTED IMPACT

Autonomy, Cooperation, Data privacy and sovereignty, Data protection, **Digitalization**, Diversity, Equity, Green IT & Respect for the environment, Inclusion, **Interoperability**, Lifelong learning, Openness, Resiliency, Security, Social participation, **Sustainability**, Transparency, User's Rights, **User's Experience**, Other.

The main impact will be an easy and ready-to-use process that relies on free and/or open-source software that could lead to a less economical impact on small businesses, professionals, students. It gives the opportunity to users to be autonomous on creating VR ready models without compromising the quality. The main result from this processes are tridimensional models that are up to 99% smaller in their size without compromising the visual data and enhancing the interoperability of the models, using less hardware resources, the opportunity to lower the costs of headsets. The idea is a sort of democratization of processes, giving the source access of the Add-on, and giving the opportunity to everyone to learn and process photogrammetry models.

LESSONS LEARNED

The overall experience was outstanding. Be in a completely different research environment gave me the opportunity to learn, work and be friend with amazing people. I feel grown from a human and working point of view.

Vasili Manfredi

PhD Student at Politecnico di Milano ; 3D Artist, VR Visualizer, Architect

Vasili Manfredi

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Video

(N/A)

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Keep engaged with our NGI Fellows !

The NGI Enrichers project has received funding from the European Union's Horizon Europe Research and Innovation Programme under grant agreement 101070125.