
UNIVERSITÀ DEGLI STUDI DI NAPOLI FEDERICO II

**DOTTORATO DI RICERCA / PhD PROGRAM IN
INFORMATION TECHNOLOGY AND ELECTRICAL ENGINEERING**

Activities and Publications Report

PhD Student: Franca Rocco di Torrepadula

Student DR number: DR995856

PhD Cycle: XXXVII

PhD Cycle Chairman: Prof. Stefano Russo

PhD program student's start date: 01/11/2021

PhD program student's end date: 31/10/2024

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PhD scholarship funding entity: Università Federico II

General information

Franca Rocco di Torrepadula received in year 2021 the Master Science degree in Computer Engineering from the University of Napoli Federico II. She attended a curriculum in Computer Engineering within the PhD program in Information Technology and Electrical Engineering. She received a grant from University of Napoli Federico II.

Study activities

Attended Courses

Year	Course Title	Type	Credits	Lecturer	Organization
1 st	Virtualization technologies and their applications	Ad hoc course	5	Dr. Luigi De Simone	ITEE
1 st	Statistical data analysis for science and engineering research	Ad hoc course	4	Prof. Roberto Pietrantuono	ITEE
1 st	Imprenditorialità Accademica	Ad hoc course	4	Prof. Pierluigi Rippa (DII)	UNINA Polytechnic and Fundamental Sciences School
1 st	Risk Assessment	MSc course	6	Prof. Alessandra De Benedictis	UNINA Polytechnic and Fundamental Sciences School
1 st	Software Products Management and Evolution	MSc course	6	Prof. Sergio Di Martino	UNINA Polytechnic and Fundamental Sciences School
2 nd	IoT Data Analysis	Ad hoc course	4	Dr. Raffaele Della Corte	ITEE
2 nd	Semantic artifacts and multimedia knowledge graphs for bio-data integration	Ad hoc course	2	Dr. Cristiano Russo	ITEE
3 rd	Ethics and AI	Ad hoc course	2.4	Prof. Guido Boella (UNITO)	Italian Society for Ethics of AI
3 rd	Strategic Orientation for STEM Research & Writing	Ad hoc course	5	Dr. Chie Shin Fraser	ITEE

Attended PhD Schools

Year	School title	Location	Credits	Dates	Organization
2 nd	2023 Spring School in Transferable Skills	Napoli, Italy (Virtual)	2	24-25/05/23	UNINA Department of Pharmacy

Attended Seminars

Year	Seminar Title	Credits	Lecturer	Lecturer affiliation	Organization
1 st	Cyber security in Akka Technologies	0.4	Dr. Luigi Villa	Akka Technologies	ITEE
1 st	Threat Hunting Essentials	0.4	Group-IB	Group-IB	ITEE
1 st	Threat Hunting Use-Cases	0.4	Group-IB	Group-IB	ITEE
1 st	The learning landscape in deep neural networks and its exploitation by learning algorithms	0.2	Prof. Riccardo Zecchina	Bocconi University in Milan	CQB
1 st	IEEE Authorship and Open Access Symposium: Tips and Best Practices to Get Published from IEEE	0.3	IEEE	IEEE	IEEE
1 st	Ciberconflitti e minacce per la pace e la stabilità internazionale. Riflessioni sulla guerra	0.4	Prof. S. P. Romano, Prof. G. Tamburrini	UNINA	Gruppo RUniPace
1 st	Explainable Natural Language Inference	0.3	Dr. Marco Valentino	DIETI	ITEE
1 st	An Introduction to Deep Learning for Natural Language Processing	0.2	Dr. Marco Valentino	DIETI	ITEE
1 st	Data Week 2022	1.4	Big Data Value Association and the EUHubs4Data project	Big Data Value Association and the EUHubs4Data project	Big Data Value Association and the EUHubs4Data project
1 st	Privacy-preserving machine learning	0.4	Dr. Vittorio Prodomo	Universidad Carlos III de Madrid	ITEE
1 st	15th International Conference on the Quality of Information and Communications Technology	3			University of Castilla-La Mancha
2 nd	Complex network systems: introduction and open challenges	0.4		Scuola Superiore Meridionale	Scuola Superiore Meridionale
2 nd	Cybercrime and Information Warfare: National and International Actors	0.4	Dr. Pierluigi Paganini	Cybaze SPA	DIETI
2 nd	Privacy and Data Protection	0.4	Dr. Stefano Mele	Gianni & Origoni	DIETI
2 nd	Introduction to GAP9 for Autonomous Nano-Vehicles	0.9	Prof. Francesco	UNIBO	UNIBO

			Conti		
2 nd	20th International Symposium on Web and Wireless Geographical Information Systems	1.7			Université Laval, Canada
2 nd	Ricerca e formazione nella società della transizione digitale	1	CINI	CINI	CINI
3 rd	Edoardo Giusto - Research past, present and future	0.2	Dr. Edoardo Giusto	UNINA	DIETI
3 rd	21th International Symposium on Web and Wireless Geographical Information Systems	2.1			Haute École d'Ingénierie et de Gestion du Canton de Vaud (HEIG-VD)

Research activities

Franca Rocco di Torrepadula participated in the research in the domain of Edge AI, particularly in its application to smart cities. The research primarily addressed the challenge of distributing artificial intelligence (AI) solutions across smart city infrastructures to overcome the privacy and latency limitations of traditional cloud-centric approaches. To achieve this, the candidate explored the integration of federated learning (FL), enabling collaborative and decentralized model training, with a main focus on incorporating domain-specific personalization to address data heterogeneity inherent in smart city environments.

Moreover, the candidate proposed a novel workflow based on Knowledge Distillation, a prominent model compression technique to optimize the resource and energy efficiency of machine learning (ML) models, without significantly compromising accuracy. This approach aimed to make AI solutions more sustainable and scalable in resource-constrained environments. Furthermore, the candidate investigated the use of tree-based models, particularly XGBoost, to enhance the explainability of ML models. This work resulted in the development of an edge-based, explainable demand prediction framework for public transportation systems, showcasing how explainable AI can be effectively applied to real-world urban challenges.

Tutoring and supplementary teaching activities

Franca Rocco di Torrepadula carried out tutoring and supplementary teaching activities within B.Sc. (“Calcolatori Elettronici”) and M.Sc. courses (“Computer Systems Design”, “Architetture dei Sistemi Digitali”, “Risk Assessment”) in the Computer Science programs at the Università degli Studi di Napoli Federico II. Within these courses, Franca Rocco di Torrepadula prepared several seminar lectures and exercises.

Credits summary

PhD Year	Courses	Seminars	Research	Tutoring / Supplementary Teaching
1 st	25	7.4	28	0.4
2 nd	8	5.2	45	0.52
3 rd	7.4	2.3	51	0.16

Research periods in institutions abroad and/or in companies

PhD Year	Institution / Company	Hosting tutor	Period	Activities
2 nd	University College of Dublin, Ireland	Prof. Gavin McArdle	24/01/2023-04/02/2023	Research on public transport service prediction. Joint scientific paper preparation for <i>W2GIS 2023</i>
3 rd	L3S Research Center, Leibniz Universität, Hannover, Germany	Prof. Wolfgang Nejdl	06/11/2023-06/03/2024	Research and laboratory activities on Federated Learning. Joint scientific paper preparation for <i>Machine Learning (Springer)</i> journal.

PhD Thesis

In the PhD thesis, Franca Rocco di Torrepadula investigated the integration of Edge AI solutions in smart cities to address critical issues related to privacy, energy efficiency, and model interpretability. Indeed, smart cities increasingly rely on artificial intelligence (AI), particularly deep learning (DL), to enhance urban services. While DL models achieve state-of-the-art performance across various applications, given their significant resource and energy demand, their deployment typically relies on centralized, cloud-based systems. This approach, however, raises several concerns regarding privacy and latency. Moreover, the “black-box” nature of DL models poses substantial interpretability challenges, which are essential for fostering trust, transparency, and accountability in AI systems deployed in urban environments. Ensuring privacy and interpretability is also a central concern in privacy regulations such as the European General Data Protection Regulation (GDPR), which emphasizes the need for safeguarding personal data while ensuring that AI-driven decisions are transparent and understandable.

To mitigate these issues, this thesis explores distributed AI paradigms, specifically federated learning (FL) and Edge AI, to bring computation closer to data sources. FL, in particular, allows

decentralized and collaborative model training without requiring data to be shared among entities, addressing privacy issues inherent in centralized AI systems. However, FL is often hindered by data heterogeneity, a common challenge in smart city environments due to the diverse nature of data sources. To overcome this, the thesis proposes a personalized FL framework tailored to the public transportation (PT) domain. This framework enables PT companies to collaboratively train AI models without sharing sensitive data, while managing data heterogeneity through a personalization mechanism, based only on publicly available information. The framework is validated in a large-scale urban scenario, demonstrating superior performance over traditional ML methods and the standard FedAvg algorithm.

In addition, the thesis addresses the resource limitations of edge devices by proposing a workflow for energy-efficient Edge AI applications. This workflow employs Knowledge Distillation (KD) to compress DL models, optimizing KD hyperparameters under energy constraints to reduce resource consumption without sacrificing model accuracy. The effectiveness of this approach is demonstrated through experiments on various ML architectures and datasets.

Finally, the research introduces a framework for designing explainable and edge-based machine learning models, leveraging XGBoost and post-hoc interpretation techniques. The methodology, validated in real-world urban settings, highlights its suitability for resource-constrained environments and supports low-carbon AI deployments, aligning with the growing need for transparent and sustainable AI solutions in smart cities.

Research products

Research results appear in 5 papers published in international journals, 5 papers under review in international journal, and 6 contributions to international conferences.

List of scientific publications

International journal papers

S. Di Martino, E. Landolfi, N. Mazzocca, F. Rocco di Torrepadula, L. L. L. Starace,
A visual-based toolkit to support mobility data analytics,
Expert Systems with Applications,
vol. 238, pp. 121949, 2024, DOI: 10.1016/j.eswa.2023.121949

A. Cilardo, V. Maisto, N. Mazzocca, F. Rocco Di Torrepadula,
An approach to the systematic characterization of multitask accelerated CNN inference in edge MPSoCs,
ACM Transactions on Embedded Computing Systems,
vol. 23(3), pp. 1-25, 2024, DOI: 10.1145/3611015

F. Rocco di Torrepadula, S. Di Martino, N. Mazzocca, P. Sannino,
A Reference Architecture for Data-Driven Intelligent Public Transportation Systems,
IEEE Open Journal of Intelligent Transportation Systems
vol. 5, pp. 469-482, 2024, DOI: 10.1109/OJITS.2024.3441048

F. Rocco di Torrepadula, E. V. Napolitano, S. Di Martino, N. Mazzocca,
Machine Learning for public transportation demand prediction: A Systematic Literature Review
Engineering Applications of Artificial Intelligence,
vol. 137, pp. 109166, 2024, DOI: 10.1016/j.engappai.2024.109166

L. L. L. Starace, F. Rocco di Torrepadula, S. Di Martino, N. Mazzocca,
Vehicular Crowdsensing with High-Mileage Vehicles: Investigating Spatiotemporal Coverage Dynamics in
Historical Cities with Complex Urban Road Networks,
Journal of Advanced Transportation,
2023(1), 8668473, 2023. DOI: 10.1155/2023/8668473

M. Barbareschi, A. Emmanuele, N. Mazzocca, F. Rocco di Torrepadula,
Designing On-Board Explainable Passenger Flow Prediction,
Expert Systems with Applications,
Under the 2nd round of revision

F. Rocco di Torrepadula, A. Somma, A. De Benedictis, N. Mazzocca,
Smart Ecosystems and Digital Twins: an architectural perspective and a FIWARE-based solution,
IEEE Software,
Under the 2nd round of revision

F. Rocco di Torrepadula, V. Maisto, A. Cilaro, N. Mazzocca,
Distilling Knowledge for Low-Carbon AIoT,
IEEE Transactions on Sustainable Computing,
Under the 1st round of revision

F. Rocco di Torrepadula, M. Fisichella, S. Di Martino, N. Mazzocca,
FedFlow: A Personalized Federated Learning Framework for Passenger Flow Prediction,
Machine Learning,
Under the 1st round of revision

R. Younis, F. Rocco di Torrepadula, Z. Ahmadi, S. Di Martino, A. Hakmch, M. Fisichella,
D-FLAMES2Graph: A Dynamic Federated Graph Aggregation Multivariate Time Series Classification
Framework,
IEEE Transactions on Knowledge and Data Engineering,
Under the 1st round of revision

International conference papers

A. De Benedictis, F. Rocco di Torrepadula, A. Somma,
A Digital Twin Architecture for Intelligent Public Transportation Systems: A FIWARE-Based Solution,
International Symposium on Web and Wireless Geographical Information Systems,
Yverdon-les-Bains, June 2024, pp. 165-182, Springer International Publishing, DOI: 10.1007/978-3-031-60796-7_12

F. Amato, S. Di Martino, N. Mazzocca, D. Nardone, F. Rocco di Torrepadula, P. Sannino,
Bus Passenger Load Prediction: Challenges from an Industrial Experience,
International Symposium on Web and Wireless Geographical Information Systems,
Virtual, April 2022, pp. 93-107, 2022, Springer Nature Switzerland. DOI: 10.1007/978-3-031-06245-2_9

A. Cilardo, V. Maisto, N. Mazzocca, F. Rocco di Torrepadula,
A Proposal for FPGA-Accelerated Deep Learning Ensembles in MPSoC Platforms Applied to Malware
Detection,
International Conference on the Quality of Information and Communications Technology. QUATIC,
Talavera de la Reina, Spain, September 2022, pp. 239-249, 2022, Springer International Publishing, DOI:
10.1007/978-3-031-14179-9_16

L. Dunne, F. Rocco Di Torrepadula, S. Di Martino, G. McArdle, D. Nardone,
Bus Journey Time Prediction with Machine Learning: An Empirical Experience in Two Cities,
International Symposium on Web and Wireless Geographical Information Systems,
Quebec, Canada, June 2023, pp. 105-120, Springer International Publishing, DOI: 10.1007/978-3-031-34612-5_7

S. Di Martino, N. Mazzocca, F. Rocco Di Torrepadula, L. L. L. Starace,
Mobility Data Analytics with KNOT: The KNime mObility Toolkit,
International Symposium on Web and Wireless Geographical Information Systems,
Quebec, Canada, June 2023, pp. 95-104, Springer International Publishing, DOI: 10.1007/978-3-031-34612-5_6

F. Rocco Di Torrepadula, D. Russo, S. Di Martino, N. Mazzocca, P. Sannino,
Using SUMO towards Proactive Public Mobility: Some Lessons Learned,
1st ACM SIGSPATIAL Workshop on Sustainable Mobility,
Hamburg, Germany, November 2023, pp. 51-58, ACM DOI: 10.1145/3615899.3627932

Patents and/or spin offs

None.

Awards and Prizes

Best presentation award at *International Symposium on Web and Wireless Geographical Information Systems (2023)* for the presentation of the paper “Bus Journey Time Prediction with Machine Learning: An Empirical Experience in Two Cities”.

Date 15/10/2024

PhD student signature

Franca Rocco di Torrepadula

Supervisor signature

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