



PhD in Information Technology and Electrical Engineering
Università degli Studi di Napoli Federico II

PhD Student: Enea Vincenzo Napolitano

Cycle: XXXVIII

Training and Research Activities Report

Year: First

Enea Vincenzo Napolitano

Tutor: Prof. Elio Masciari

Co-Tutor: Prof. Nicola Mazzocca

Date: December 10, 2023

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Author: Enea Vincenzo Napolitano

1. Information:

- PhD student: Enea Vincenzo Napolitano
- DR number: DR996971
- Date of birth: 17/06/1998
- Master Science degree: Data Science University: UNINA
- Doctoral Cycle: XXXVIII
- Scholarship type: RESTART
- Tutor: Prof. Elio Masciari
- Co-tutor: Prof. Nicola Mazzocca

2. Study and training activities:

Activity	Type ¹	Hours	Credits	Dates	Organizer	Certificate ²
IoT Data Analysis	Course	14	4	09-13-16-20-23-27/01/2023 - 09/02/2023	Dr. Raffaele Della Corte	Y
Using Deep Learning Properly	Course	10	4	10/01/2023 - 24/01/2023	Dr. Andrea Apicella	Y
Is control a problem solved for aerial Robotic Research?	Seminar	1	0.2	12/01/2023	Prof. Fabio Ruggiero	Y
Principi Architeturali	Seminar	3	0.6	30/01/2023	5G Academy	Y
Data Strategy	Seminar	3	0.6	03/02/2023	5G Academy	Y
Blockchain and 5G in Business	Seminar	3	0.6	13/02/2023	5G Academy	Y
Industry 4.0 Fundamentals in Bosch Application	Seminar	10	1	23-24-25-26/01/2023	Polytechnic of Bari	Y
Embracing Data Imperfections Via Domain Enriched Visual Task Learning	Seminar	1	0.2	13/02/2023	Prof. Antonio De Maio	Y
Algorithm Unrolling: Efficient, Interpretable Deep Learning for Signal and Image Processing	Seminar	1	0.2	14/02/2023	Prof. Antonio De Maio	Y
Study on Telecommunication Networks, 5G applications. Preparation of a survey paper on Load Balancing Prediction. Preparation of the conference	Research	-	5	-	-	-

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paper “How pandemic affected the adoption of e-Health system”						
How to Boost your PhD	Course	16	4	11-18-25/01 - 1-8-15-22/02 - 1/03/2023	Prof. Antigone Marino	Y
Statistical data analysis for science and engineering research	Course	12	4	06-08-10-13-15-16/02/2023	Prof. Roberto Pietrantuono	Y
MLOps: Achieving Operational Velocity with Faster Delivery and Collaboration	Seminar	1	0.2	02/03/2023	Prof. Carlo Sansone	Y
Unleashing the Power of LLMs: a Historical perspective on Generative AI	Seminar	1	0.2	02/03/2023	Prof. Carlo Sansone	Y
Analysis and control of functional brain networks	Seminar	1	0.2	09/03/2023	SS Meridionale	Y
The state of the art of AI and Physics-Based Simulations in drug discover	Seminar	1	0.2	17/03/2023	ICTH	Y
Enhancing qubit readout with Bayesian Learning	Seminar	1	0.2	05/04/2023	Department of Physics	Y
Study on Trajectory Mining and preparation of a seminar on the topic. Preparation of the doctoral paper “Trajectory Mining for Smart Cities: A Focus on Indoor Localization using 5G Technology”. Preparation of the paper “Evolving Justice Sector: An Innovative Proposal for Introducing AI-based Techniques in Court Offices”. Preparation of the extended abstract “Introducing AI-Based Techniques in the Justice Sector: A Proposal for Digital Transformation of Court Offices”.	Research	-	3	-	-	-

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Revision of the Paper “Data-Driven Public Transportation Demand Prediction: A Systematic Mapping Study”.						
I pilastri della Trasformazione Digitale	Course	10	3	17-18/04 – 5-8-10/5/2023	Prof. Nicola Mazzocca	Y
16th International Summer School on Software Engineering (ISSSE 2023)	Doctoral School	-	3	12-13-14-15/06/2023	University of Salerno	Y
Traffic Engineering with Segmented Routing: optimally addressing popular use case	Seminar	1	0.2	23/06/2023	Prof. V. Persico	Y
Study on Localization techniques, Indoor trajectory, Smart Cities. Preparation of the paper “Dossier Classification to Support Workflow Management Optimization”. Preparation of the doctoral paper “Intelligent Technologies for Urban Progress: Exploring the Role of AI and Advanced Telecommunications in Smart City Evolution”. Preparation of the paper “Can the Study of Trajectories Help to Extract Information from Business Processes?”. Preparation of the paper “A Joint Analysis of Trajectory Mining and Process Mining for Smartphone User Behaviour”. Preparation of the paper “Supporting Workflow Management with NLP Classification: an application in the context of Judicial System”.	Research	-	3	-	-	-
Scienza moderna e disciplina giuridica dell'Intelligenza	Course	22	6	07-09-14-16-21-23-	Prof. Lucio	Y

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Artificiale				28-30/06 – 06-07- 10/07/2023	Franzese	
Academic Entrepreneurship	Course	17	4	29-31/05 - 05-15-20- 22/06/2023	Prof. Pierluigi Rippa	Y
Study on Digital Twins. Preparation of the paper “Digital Twins for Traffic Congestion in Smart Cities: a novel solution using Data Mining techniques”.	Research	-	0,4	-	-	-
Ricerca e formazione nella società della transizione digitale	Seminar	-	1	22/09/2023	CINI	N
Come scrivere un articolo scientifico?	Seminar	1.5	0.3	26/09/2023	Springer	Y
Come funzionano le riviste?	Seminar	1.5	0.3	27/09/2023	Springer	Y
Focus on Smart City with study on Smart Roads, Platoons. Exploration of Smart Environment with study on 6G, differences with 5G and 4G, Intelligent Reflecting Surfaces, Smart Propagation Environment, Beamforming and Beam Steering. Beginning of the AI carbon emissions study.	Research	-	4	-	-	-
Percorso per il rafforzamento delle competenze sulla progettazione europea	Course	17	3,4	14-28/09 12-26/10 09- 23/11/2023	Ministero dell'Univer sità e della Ricerca, Ateneo Federico II	N
Research and study on the carbon footprint of ICT systems, specifically AI models, and HPC. Study on Greenhouse Gases and methodologies for measuring and estimating emissions. Preparation of a literature review on CO2 emission measurement techniques of AI models.	Research	-	2	-	-	-

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Preparation of the paper: "The Environmental Cost of High Performance Computing System Simulation".						
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- 1) Courses, Seminar, Doctoral School, Research, Tutorship
- 2) Choose: Y or N

2.1. Study and training activities - credits earned

	Courses	Seminars	Research	Tutorship	Total
Bimonth 1	8	4.4	5	0	17.4
Bimonth 2	8	1	3	0	12
Bimonth 3	6	0.2	3	0	9.2
Bimonth 4	10	0	0.4	0	10.4
Bimonth 5	0	1.6	4	0	5.6
Bimonth 6	3.4	0	2	0	5.4
Total	35.4	7.2	17.4	0	60
Expected	30 - 70	10 - 30	80 - 140	0 - 4.8	

3. Research activity

Research Topic

The focus of the research is on the development of smarter and more environmentally friendly cities. The aim is to use advanced technologies, such as 5G and digital services, to improve urban efficiency. One use case explored is the optimization and digitalization of public offices (especially in the justice sector) for e-government.

A key aspect of the research is to analyze how people and things move around the city, using data to improve transport and public services. The research will also provide ideas and strategies for planning future cities that are technologically advanced but also sustainable, with a focus on the environment and the responsible use of new technologies.

Methodology

The methods used can be divided into:

- **Data Analysis and Data Mining:** This part of the research focuses on the use of trajectory mining and the analysis of public transport passenger data.
Trajectory mining is a data mining technique employed to analyze the temporal and spatial motion data of objects or individuals. Trajectories can be expressed as a sequence of spatio-temporal points or as continuous paths in the space-time domain. The primary objective of trajectory mining is to uncover significant patterns, including frequent routes, aberrant behaviors, and mobility trends. Various techniques are encompassed within trajectory mining, such as trajectory clustering,

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trajectory segmentation, trajectory pattern mining, spatio-temporal analysis of trajectories, trajectory classification and trajectory prediction models.

The aim is to study models of the movement of people and vehicles, both indoors and outdoors, as well as operational processes in the city, to identify ways of optimising transport and urban services.

- Simulation and digital modelling: This research phase will combine different techniques to explore the potential for improving smart cities: such as digital twins to simulate and predict the effectiveness of urban policies, exploration of 5G to improve connectivity and efficiency of urban services.
- Assessing the environmental impact of technology: An important aspect of the research is the assessment of the environmental impact of advanced technologies, such as High Performance Computing (HPC) and Artificial Intelligence (AI). This study aims to promote a more sustainable use of technologies by considering their environmental impact.

Results

The initial phase of my research on 'Advanced Technologies for Sustainable Smart Cities' focused mainly on an in-depth theoretical analysis of several key issues.

Particular attention was given to the study of Trajectory Mining, a key technique for understanding and optimizing movements and flows within cities. Through an extensive review of the existing literature, I explored various applications and possibilities of this technique in the urban context; the possibility of using this technique also indoors was extensively evaluated, assessing its positive and negative aspects. The combined use with Process Mining techniques to extract user behavior has been explored.

The aim is to use outdoor Trajectory Mining to manage traffic in the most efficient way (evaluating sustainability and usefulness) and indoor Trajectory Mining for efficient processing inside public buildings.

In addition, I have conducted an in-depth study of the CO2 emissions associated with the use of artificial intelligence, analyzing various research studies to assess the environmental impact of these advanced technologies. The aim is to create a sustainability metric that can assess how sustainable an improvement to an AI model is, considering the balance between the level of improvement and the emissions associated with that improvement.

Furthermore, my research included the development of a practical digital transformation project in the judicial offices of Naples. This project contributed to a concrete digitization process, providing an applicable model for improving efficiency and sustainability in public administration offices.

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4. Research products:

Published:

- **Napolitano, E. V.** (2023, August). Intelligent technologies for urban progress: exploring the role of ai and advanced telecommunications in smart city evolution. In *European Conference on Advances in Databases and Information Systems* (pp. 676-683). Cham: Springer Nature Switzerland.
- Amato, F., Fioretto, S., Forgillo, E., Masciari, E., Mazzocca, N., Merola, S., & **Napolitano, E. V.** (2023, July). Evolving Justice Sector: An Innovative Proposal for Introducing AI-Based Techniques in Court Offices. In *International Conference on Electronic Government and the Information Systems Perspective* (pp. 75-88). Cham: Springer Nature Switzerland.
- Fioretto, S., Masciari, E., & **Napolitano, E. V.** (2023). Dossier classification to support workflow management optimization. *Numerical Computations: Theory and Algorithms NUMTA 2023*, 102.
- **Napolitano, E. V.**, Fioretto, S., Masciari, E., & Anniciello, A. (2023, May). How Pandemic Affected the Adoption of e-Health Systems. In *Proceedings of the 27th International Database Engineered Applications Symposium* (pp. 94-98).
- **Napolitano, E. V.** (2023). Trajectory Mining for Smart Cities: A Focus on Indoor Localization using 5G Technology. *31st Symposium on Advanced Database Systems*
- Amato, F., Fioretto, S., Forgillo, E., Masciari, E., Mazzocca, N., Merola, S., & **Napolitano, E. V.** (2023). Introducing AI-Based Techniques in the Justice Sector: A Proposal for Digital Transformation of Court Offices. *31st Symposium on Advanced Database Systems*

Submitted:

- Rocco di Torrepadula, F., **Napolitano, E. V.**, Di Martino, S. and Mazzocca, N. (2023). Data-Driven Public Transportation Demand Prediction: A Systematic Mapping Study.
- Masciari, E., and **Napolitano, E. V.** (2023). The Environmental Cost of High Performance Computing System Simulation. *10th Special Session on High Performance Computing in Modelling and Simulation (HPCMS) at PDP 2024*

Accepted:

- Fioretto, S., Masciari, E., & **Napolitano, E. V.** (2023). A Joint Analysis of Trajectory Mining and Process Mining for Smartphone User Behaviour. *11th edition of the Workshop New Frontiers in Mining Complex Patterns (NFMCP)*

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- Fioretto, S., Masciari, E., & **Napolitano, E. V.** (2023). Can the Study of Trajectories Help to Extract Information from Business Processes?. *2nd International Workshop on Process Management in the AI era (PMAI23 @IJCAI)*
- Anniciello, A., Fioretto, S., Masciari, E., & **Napolitano, E. V.** (2023). Digital Twins for Traffic Congestion in Smart Cities: a novel solution using Data Mining techniques. *15th International Joint Conference on Knowledge Discovery, Knowledge Engineering and Knowledge Management.*

5. Conferences and seminars attended

Conferences:

- *SEBD 2023, 31st Symposium on Advanced Database Systems*, Galzignano Terme, Italy, 02-05/07/2023; presented the papers: “*Trajectory Mining for Smart Cities: A Focus on Indoor Localization using 5G Technology*” and “*Introducing AI-Based Techniques in the Justice Sector: A Proposal for Digital Transformation of Court Offices*”
- *ADBIS23, 27th European Conference on Advances in Databases and Information Systems*, Barcellona, Spain, 03-05/09/2023; presented the paper: “*Intelligent technologies for urban progress: exploring the role of ai and advanced telecommunications in smart city evolution*”