UNIVERSITÀ DEGLI STUDI DI NAPOLI FEDERICO II

DOTTORATO DI RICERCA / PHD PROGRAM IN
INFORMATION TECHNOLOGY AND ELECTRICAL ENGINEERING

Activities and Publications Report

PhD Student: Francesco Cerasuolo

Student DR number: DR996623

PhD Cycle: XXXV III
PhD Chairman: Prof. Stefano Russo

PhD program student's start date: 01/11/2022
PhD program student's end date: 31/10/2025

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PhD scholarship funding entity: Università Federico II

General information

Francesco Cerasuolo received in year 2022 the Master Science degree in Computer Engineering from the University of Napoli Federico II. He attended a curriculum in Networking Engineering within the PhD program in Information Technology and Electrical Engineering. He received a grant from Università Federico II.

Study activities

Attended Courses

Year	Course Title	Type	Credits	Lecturer	Organization
1st	On the challenges and impact of Artificial Intelligence in the Insurance domain	Ad hoc course	3.0	Dr. Lorenzo Ricciardi Celsi, PhD, MBA	ITEE
1st	IoT Data Analysis	Ad hoc course	4.0	Prof. Raffaele Della Corte, DIETI	ITEE
1st	Data Analytics	MSc course	6.0	Prof. Domenico Ciuonzo, DIETI	ITEE
1st	Statistical data analysis for science and engineering research	Ad hoc course	4.0	Prof. R. Pietrantuono, DIETI	ITEE
1st	Using Deep Learning properly	Ad hoc course	4.0	Dr. Andrea Apicella, DIETI	ITEE
2nd	Ethics&AI	Ad hoc course	2.4	Italian Society for Ethics of AI	Italian Society for Ethics of AI
2nd	Hands-on Network Intrusion Detection via Machine and Deep Learning	Ad hoc course	4.0	Dr. Antonio Montieri, DIETI	ITEE
2nd	Strategic Orientation for STEM Research & Writing	Ad hoc course	5.0	Dr. Chie Shin Fraser	ITEE

Attended PhD Schools

Year	School title	Location	Credits	Dates	Organization
1nd	TMA Ph.D. School	Naples, Italy	2.0	26/06 - 27/06/2023	University of Napoli Federico II
2nd	TMA Ph.D. School	Dresden, Germany	2.0	21/05- 22/05/2024	Dresden University of Technology

Attended Seminars

Year	Seminar Title	Credits	Lecturer	Lecturer affiliation	Organization
1st	Crash Course on Data Excellence	0.4	Dr. Roberto Maranca	Data Excellence Vice President, Schneider Electric	University of Napoli Federico II
1st	Data mining the output of quantum simulator - from critical behavior to algorithmic complexity	0.2	Dr. Marcello Dalmonte	Abdus Salam ICTP Trieste	University of Napoli Federico II
1st	Connecting the dots: Investigating an APT campaign using Splunk	0.4	Dr. Antonio Forzieri	EMEA Cyber Security Specialization and Advisory Splunk Inc.	University of Napoli Federico II
1st	Complex Network Systems: introduction and open challenges	0.2	Dr. Pietro De Lellis	Scuola Superiore Meridionale	Scuola Superiore Meridionale
1st	Cybercrime and Information Warfare: National and International Actors	0.4	Dr. Pierluigi Paganini	Cybaze S.p.A.	University of Napoli Federico II
1st	Privacy and Data Protection	0.4	Dr. Stefano Mele	Partner at Gianni & Origoni, Head of Cybersecurity Law Department, co-Head of Data Protection Department	University of Napoli Federico II
1st	Automated Offensive Security: Intelligence is all you need	0.4	Prof. Simon Pietro Romano	University of Napoli Federico II	University of Napoli Federico II
1st	Digital Forensics	0.4	Group-IB	Group-IB	University of Napoli Federico II
1st	Threat Hunting & Incident Response	0.4	Group-IB	Group-IB	University of Napoli Federico II
1st	From Cyber Situational Awareness to Adaptive Cyber Defense: Leveling the Cyber Playing Field	0.4	Prof. Massimiliano Albanese	George Mason University	University of Napoli Federico II
1st	Industry 4.0 Fundamentals in Bosch Applications	2	Ing. Martino Bruni	Bosch Italy	Politecnico di Bari
1st	MLOps: Achieving Operational Velocity with Faster Delivery and Collaboration	0.2	Prof. Tarry Singh	CEO Real.AI & University of Texas at Dallas	University of Napoli Federico II
1st	How to Publish Under the CARE-CRUI Open Access Agreement with IEEE	0.3	Prof. Nino Grizzuti	University of Napoli Federico II	University of Napoli Federico II

1st	Migration of legacy IT infrastructure into the cloud: approaches and strategies	0.4	CTO Epsilon S.r.l.	University of Napoli Federico II	University of Napoli Federico II
1st	Traffic Engineering with Segment Routing: optimally dealing with most popular use-cases	0.2	Prof. Pascal Merindol	University of Strasbourg	University of Napoli Federico II
1st	BGP & Hot-Potato Routing: graceful and optimal convergence in case of IGP events	0.2	Prof. Pascal Merindol	Prof. Pascal Merindol	University of Napoli Federico II
2nd	Robotics Meet AI & 5G - The future is now	0.4	Prof. Siciliano	University of Napoli Federico II	University of Napoli Federico II
2nd	Economic Fitness: Concepts, Methods and Applications	0.3	Dr. Luciano Pietronero	Enrico Fermi Research center	Scuola Superiore Meridionale
2nd	Media Forensics in the era of Generative AI	0.4	Prof. Verdoliva	University of Napoli Federico II	University of Napoli Federico II
2nd	Open Science and Open Access	0.3	IEEE	IEEE	IEEE
2nd	Sustainable IT: Strategies and best practices for a green engineering future	0.6	5G Academy - Capgemini	5G Academy - Capgemini	5G Academy - Capgemini
2nd	Social Network Analysis Methods and Applications	0.4	Prof. Tanmoy Chakraborty	IIIT-Delhi	University of Napoli Federico II
2nd	Introduction to large language models: evolution and the current state	0.4	Prof. Tanmoy Chakraborty	IIIT-Delhi	University of Napoli Federico II
2nd	Keynotes of International Federation for Information Processing (IFIP) Networking Conference	0.8	IEEE ComSoc	IEEE ComSoc	IEEE ComSoc
2nd	Keynotes of IEEE Symposium on Computers and Communications (ISCC)	0.6	IEEE ComSoc	IEEE ComSoc	IEEE ComSoc

Research activities

Francesco Cerasuolo's research focuses on the application of Artificial Intelligence (AI) to enhance the analysis, adaptability, and security of modern communication networks. His work investigates

how data-driven models can autonomously learn from evolving Internet traffic, addressing challenges related to scalability, privacy, and explainability in complex network environments.

A central part of his research concerns Network Traffic Classification (NTC) and Network Intrusion Detection (NID), where he studies Class Incremental Learning (CIL) and Federated Learning (FL) techniques to enable DL models to incorporate new traffic types or attack classes without retraining from scratch. These approaches improve adaptability and ensure privacy-preserving learning across distributed network infrastructures.

Francesco's research also explores eXplainable AI (XAI) methodologies to interpret model decisions, strengthening transparency and trust in AI-driven network systems. His investigations extend to model robustness and cross-domain generalization, with applications in smart cities and Internet of Things (IoT) ecosystems.

Overall, his research contributes to developing adaptive, interpretable, and privacy-preserving AI solutions for intelligent network management and cybersecurity, bridging technical innovation with practical, data-driven decision support.

Tutoring and supplementary teaching activities

During the three-year PhD Programme, I carried out tutorship and supplementary teaching activities during *Computer Networks* and *Fondamenti di Informatica* courses for Bachelor's Degrees in Computer Engineering, *Internet Data Analysis and Data Analysis and Cybersecurity* courses for Master's and Bachelor's Degrees in Computer Engineering.

Details on my tutorship activities are listed in the following:

- Co-supervisor of a Master's thesis in Computer Engineering, *Internet Data Analysis* course (5 hours)
- Teaching activities and laboratory activities during the *Data Analysis and Cybersecurity course,* Master's Degree in Computer Engineering, Prof. Pescapé (10 hours)
- Supplementary Teaching Activities during the *Computer Networks* course, Bachelor's Degree in Computer Engineering, Prof. Pescapé (5 hours)
- Teaching activities and Laboratory activities during the *Internet Data Analysis* course, Master Degree in Computer Engineering, Prof. Pescapé (14 hours)
- Supplementary teaching activities during the *Computer Networks* and *Fondamenti di Informatica* courses in Bachelor's Degree in Computer Engineering, Prof. Pescapè and Prof. Persico (5 hours)

Credits summary

PhD Year	Courses	Seminars	Research	Tutoring / Supplementary Teaching
1st	21	8.9	31	0
2nd	11.4	6.2	52	1.6
3rd	0	0	60	1.6

Research periods in institutions abroad and/or in companies

PhD Year	Institution / Company	Hosting tutor	Period	Activities
2nd 3rd	University of Edinburgh, Edinburgh	Prof. Paul Patras	3/10/2024 - 3/03/2025	Study and research activity concerns the design, implementation, and evaluation of memory-free approaches for class incremental learning in the context of traffic generated by mobile apps.

PhD Thesis

In the PhD Thesis, Francesco Cerasuolo investigates intelligent and adaptive solutions for modern network traffic management.

In recent years, managing networks has become an increasingly critical task, mainly due to the huge growth and continuous evolution of network traffic. This dynamic scenario poses challenges in identifying what is flowing through the network, affecting traditional approaches—i.e., port-based, Deep Packet Inspection (DPI)—as well as more recent Machine Learning (ML) and Deep Learning (DL) ones. Notably, the latter struggle when facing unseen traffic patterns, lack of transparency that hinders trust in Artificial Intelligence (AI) based systems, and rely on a huge amount of data, whose sharing raises privacy concerns.

This thesis focuses on the incremental Network Traffic Classification (NTC), considering two valuable domains: mobile network traffic and network attack traffic. To this aim, it introduces MEMENTO, a novel Class Incremental Learning (CIL) approach, to design (i) incremental Traffic Classifier (TC), capable of identifying newly released applications (apps) without losing the ability to recognize already known ones; (ii) adaptive Network Intrusion Detection System (NIDS), able to detect zero-day attacks while preserving knowledge of known attacks and legitimate traffic.

In addition, this thesis leverages CIL approaches to facilitate the deployment and adaptation of NTC across different network environments, allowing models to adjust to known traffic types while accommodating new ones. Furthermore, to enable collaborative and privacy-preserving NTC process, we bridge the gap between CIL and Federated Learning (FL), devising a Federated Class Incremental Learning (FCIL) procedure for MEMENTO. Finally, to address the limitations in transparency of AI solutions, this thesis investigates the results of MEMENTO through eXplainable AI (XAI) techniques.

Research products

Research results appear in *5* papers published in international journals (*1* paper further is currently under review), *7* contributions to international conferences.

List of scientific publications

International journal papers

R. Carillo, **F. Cerasuolo**, G. Bovenzi, D. Ciuonzo, A. Pescapè,
Explainable federated class incremental learning for Encrypted Network Traffic classification,
Elsevier Computer Networks,
vol. 269, 2025, doi: 10.1016/j.comnet.2025.111448

F. Cerasuolo, G. Bovenzi, D. Ciuonzo, A. Pescape,
Attack-adaptive network intrusion detection systems for IoT networks through class incremental learning,
Elsevier Computer Networks,
vol. 263, 2025, doi: 10.1016/j.comnet.2025.111228

F. Cerasuolo, G. Bovenzi, D. Ciuonzo, A. Pescapè,
Adaptable, incremental, and explainable network intrusion detection systems for internet of things.
Elsevier Engineering Applications of Artificial Intelligence,
vol. 144, 2025, doi: 10.1016/j.engappai.2025.110143

G. Bovenzi, **F. Cerasuolo**, D. Ciuonzo, D. Di Monda, I. Guarino, A. Montieri, V. Persico, A. Pescapé,
Mapping the landscape of generative AI in network monitoring and management,
IEEE Transactions on Network and Service Management,
vol. 22, doi: 10.1109/TNSM.2025.3543022

F. Cerasuolo, A. Nascita, G. Bovenzi, G. Aceto, D. Ciuonzo, A. Pescapé, D. Rossi,
MEMENTO: A Novel Approach for Class Incremental Learning of Encrypted Traffic,
Elsevier Computer Networks,
vol. 245, 2024, doi: 10.1016/j.comnet.2024.110374

International conference papers

R. Carillo, **F. Cerasuolo**, A. Pescapè, E. Kanaki, P. Chatzimisios,
Federated Incremental Learning for Encrypted Network Traffic Classification,
2025 IEEE International Conference on Blockchain Computing and Applications (BCCA),
Dubrovnik, Croatia, October 2025, pp. 1-6

F. Cerasuolo, G. Bovenzi, A. Montieri, A. Pescapè,
Class Incremental Learning for Network-Agnostic Intrusion Detection Systems
2025 IEEE Research and Technologies for Society and Industry (RTSI),
Gammarth, Tunisia, August 2025, pp. 1-6

F. Cerasuolo, I. Guarino, V. Spadari, G. Aceto, A. Pescapè,
XAI for interpretable multimodal architectures with contextual input in mobile network traffic classification,
2024 IFIP Networking Conference,
Thessaloniki, Greece, June 2024, pp. 757-762, doi: 10.23919/IFIPNetworking62109.2024.10619769

F. Cerasuolo, G. Bovenzi, V. Spadari, D. Ciuonzo, A. Pescapè,
Explainable Few-Shot Class Incremental Learning for Mobile Network Traffic Classification,
2024 IEEE Global Communications Conference,
Cape Town, South Africa, December 2024, doi: 10.1109/GLOBECOM52923.2024.10901329

V. Spadari, **F. Cerasuolo**, G. Bovenzi, A. Pescapè,
An MLOps Framework for Explainable Network Intrusion Detection with MLflow,
2024 IEEE Symposium on Computers and Communications (ISCC),
Paris, France, June 2024, pp. 1-6, doi: 10.1109/ISCC61673.2024.10733700

F. Cerasuolo, G. Bovenzi, C. Marescalco, F. Cirillo, D. Ciuonzo, A. Pescapè,
Adaptive intrusion detection systems: Class incremental learning for IoT emerging threats.
2023 IEEE International Conference on Big Data,
Sorrento, Italy, December 2023, pp. 3547-3555, doi: 10.1109/BigData59044.2023.10386129

A. Nascita, **F. Cerasuolo**, G. Aceto, D. Ciuonzo, V. Persico, A. Pescapè,
Explainable Mobile Traffic Classification: the case of Incremental Learning,
19th International Conference on emerging Networking EXperiments and Technologies (CoNEXT 2023), Workshop on 'Explainable and Safety Bounded, Fidelitous, Machine Learning for Networking,
Paris, France, December 2023, pp. 25–31, doi: 10.1145/3630050.3630178

Date 26/10/2025

PhD student signature 

Supervisor signature