UNIVERSITÀ DEGLI STUDI DI NAPOLI FEDERICO II

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

Activities and Publications Report

PhD Student: Andrea Vignali

Student DR number: DR996624

PhD Cycle: XXXVIII
PhD Chairman: Prof. Stefano Russo

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

Supervisor: Giancarlo Sperlì
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PhD scholarship funding entity: PNRR – DM 352

General information

Andrea Vignali received in year 2022 the Master Science degree in Computer Engineering from the University of Napoli Federico II. He attended a curriculum in Computer Engineering within the PhD program in Information Technology and Electrical Engineering. He received a grant from PNRR – DM 352. He also served as the student representative for the XXXVIII cycle (ITEE) and as the PhD student representative on the department council and the joint committee.

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	Ing. Lorenzo Riccardi Celsi	ITEE
1st	IoT Data Analysis	Ad hoc course	4	Prof. Raffaele Della Corte	ITEE
1st	Scientific Programming and visualization with Python	Ad hoc course	2	Prof. Alessio Botta	ITEE
1st	Statistical Data Analysis for Data and Engineering	Ad hoc course	4	Prof. Roberto Pietrantuono	ITEE
1st	Scienza moderna e Disciplina giuridica dell'Intelligenza Artificiale	Ad hoc course	6	Prof. Lucio Franzese	ITEE
1st	Semantic artifacts and multimedia knowledge graphs for biodata integration	Ad hoc course	2	Prof. Cristiano Russo	ITEE
1st	Artificial Intelligence and Natural Language Processing	Ad hoc course	3	Prof. Francesco Cutugno	ITEE
1st	Big Data Architecture and Analytics	Ad hoc course	5	Prof. Giancarlo Sperlì	ITEE
2nd	Hands-on Network Intrusion Detection via Machine and Deep Learning	Ad hoc course	4	Dr. Antonio Montieri	ITEE
2nd	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
1st	CNTC (Complex networks and telecommunications 3rd edition: Towards 6G)	Como , Italy	4	July 3-7, 2023	Lake Como School of Advanced Studies, Italy
2nd	Open and programmable 6G networks in the cloud/edge continuum: research challenges and experimentation tools in SLICES Research Infrastructures	Lipari, Italy	6	July 7-13, 2024	Lipari School on Advanced Networking Systems

Attended Seminars

Year	Seminar Title	Credits	Lecturer	Lecturer affiliation	Organization
1st	Stabilizer Renyi Entropy and Quantum Complexity	0.2	Prof. Alioscia Hamma	University of Napoli Federico II	DIPARTIMENTO DI FISICA "ETTORE PANCINI"
1st	Connecting the dots investigating an APT campaign using Splunk	0.4	Dr. Antonio Forzieri	EMEA Cyber Security Specialization and Advisory Splunk Inc.	DIETI
1st	Data Mining the output of quantum simulators – from critical behavior to algorithmic complexity	0.2	Dr. Marcello Dalmonte	International Centre for Theoretical Physics, Trieste	DIPARTIMENTO DI FISICA "ETTORE PANCINI"
1st	CRASH COURSE on DATA EXCELLENCE – PART I	0.4	Roberto Maranca	Schneider Electric	DIPARTIMENTO DI FISICA "ETTORE PANCINI" & DIETI
1st	Cybercrime and information warfare: national and international actors	0.4	Dr. Pierluigi Paganini	Cibhorus s.r.l.	DIETI
1st	Privacy and Data Protection	0.4	Dr. Stefano Mele	Cybersecurity Law Department	DIETI
1st	Automated Offensive Security: Intelligence is all you need	0.2	Prof. Simon Pietro Romano	University of Napoli Federico II	DIETI
1st	Progettazione di strategie di controllo in ambiente Simulink	0.6	Dr. Gianfranco Fiore	Mathworks	DIETI
1st	Game Theory for Information Engineering	0.6	Prof. Leonardo Badia	University of Padua	DIETI

1st	From Cyber Situational Awareness to Adaptive Cyber Defense Leveling the Cyber Playing Field	0.4	Prof. Massimiliano Albanese	George Mason University - USA	DIETI
1st	Threat Hunting & Incident Response	0.4	Vladimir Kurdin	Group-IB	DIETI
1st	Malware Analysis	0.4	Dr. Gaetano Pellegrino	Infoblox	DIETI
1st	Principi Architetturali – TOGAF 1	0.6	Alberto Curcio, Pietro Boscolo	5G Academy UNINA	DIETI
1st	Data Strategy	0.6	Lorenza Catalano	5G Academy UNINA	DIETI
1st	Blockchain and 5G business	0.6	Luca Confronto	5G Academy UNINA	DIETI
1st	Algorithm Unrolling: Efficient, Interpretable Deep Learning for Signal and Image Processing	0.2	Prof. Vishal Monga	Pennsylvania State University - USA	DIETI
1st	Il cloud e gli hyperscalers + high performance computing	0.6	Giovanni Vendramel	5G Academy UNINA	DIETI
1st	-Open Access and Transformative Agreements in Italy: the Current State of the Art -How to Publish Open Access Articles with IEEE under the CARE CRUI Agreement -Additional Insights on Open Access Publishing	0.3	Nino Grizzuti, Eszter Lukacs, Stefano Bianco	IEEE	CARE-CRUI, IEEE
1st	MLOps: Achieving Operational Velocity with Faster Delivery and Collaboration	0.2	Prof. Tarry Singh	Real.AI & University of Texas at Dallas - USA	DIETI
1st	Traffic Engineering with Segmented Routing: optimally addressing popular use cases	0.2	Prof. Pascal Merindol	University of Strasbourg - France	DIETI
1st	BGP & Hot-Potato Routing: graceful and optimal convergence in case of IGP events	0.2	Prof. Pascal Merindol	University of Strasbourg - France	DIETI
1st	"RICERCA E FORMAZIONE	1	Multipli	CINI	CINI

	NELLA SOCIETÀ DELLA TRANSIZIONE DIGITALE"				
2nd	Introduction to Multi-Agent Reinforcement Learning	0.4	Prof. Beniamino Di Martino	University of Napoli Federico II	DIETI
2nd	Progetto RAIL	0.3	Prof. Valeria Vittorini	University of Napoli Federico II	DIETI
2nd	Behind the scene of the vehicle SOC	0.2	Brett Powers, Tammy Levy, Yaniv Maimon	Security Operations	DIETI
2nd	Media Forensics in the era of Generative AI	0.4	Prof. Luisa Verdoliva	University of Napoli Federico II	DIETI
2nd	Hominis	1	Prof. Carlo Sansone	University of Napoli Federico II	DIETI
2nd	Applicazioni dell'Intelligenza Artificiale ai Sistemi Informativi del Ministero della Giustizia	0.2	Prof. Beniamino Di Martino	University of Napoli Federico II	DIETI
2nd	Social Network Analysis: Methods and Applications	0.4	Prof. Giancarlo Sperlì	University of Napoli Federico II	DIETI
2nd	Introduction to Large Language Models Evolution and the current state	0.4	Prof. Giancarlo Sperlì	University of Napoli Federico II	DIETI
2nd	Intelligent Agent Networks: Emerging Properties of AI Agents and Applications in Cybersecurity, Health, and Online Education	0.2	Kenneth Corrêa	Fundação Getulio Vargas	MIT-CSAIL
3rd	Sovranità digitale cos'è e quali sono le principali minacce al cyberspazio nazionale	0.3	Prof/Dr. Roberto Baldoni	Embassy of Italy in Washington DC	ITEE
3rd	Argumentation-Based Reasoning Frameworks for Public Interest Communication in Healthcare	0.4	Prof. Sergio Flesca	DIMES - University of Calabria	ITEE

Research activities

Andrea Vignali contributed to two main research areas: Natural Language Processing (NLP) and Anomaly Detection.
In NLP, he focused on addressing data scarcity in tasks such as Named Entity Recognition (NER), designing several data augmentation techniques for few-shot domains, particularly in the biomedical field. He also explored the role of Large Language Models (LLMs) and transformer architectures in Software Engineering applications such as code translation and test case prioritization (activity conducted within AKKA Italia s.r.l.), and other domains such as Law and Finance.
In Anomaly Detection, he investigated cyber-physical systems (CPS) and attack detection using heterogeneous data sources, including sensor/actuator readings and network traffic. His work involved a comprehensive study in terms of effectiveness and efficiency of unsupervised anomaly detection models and graph attention networks for spatio-temporal anomaly analysis, as well as the design of data fusion techniques to enhance detection performance.
Finally, he bridged these two research areas within the domain of cybersecurity, investigating the use of LLMs and the vast amount of unstructured data available in security databases to model exploits. Building on this foundation, he developed a novel method for automatically discovering exploit chains in complex network environments through AI planning (activity conducted within ALFALab@MIT CSAIL).

Tutoring and supplementary teaching activities

Credits summary

PhD Year	Courses	Seminars	Research	Tutoring / Supplementary Teaching
1st	33	9.1	19.6	0.3
2nd	15	3.5	42.26	0.24
3rd	0	0.7	59.3	0

Research periods in institutions abroad and/or in companies

PhD Year	Institution / Company	Hosting tutor	Period	Activities
2nd	AKKA Italia s.r.l., Torino	Emanuele De Filippis, Co-Supervisor	November 1, 2023 – May 1, 2024	Study on Natural Language Processing and Anomaly Detection for software testing, focusing on clustering, unsupervised deep learning models, graph-based techniques, and generative AI to detect software failures and address data challenges
2nd / 3rd	Massachusetts Institute of Technology, USA (ALFALab@CSAIL)	Una-May O'Reilly, P.I.	September 9, 2024 - February 28, 2025	Study and laboratory activities on AI Planning and Exploit Chain Generation with the aid of LLMs

PhD Thesis

Natural Language Processing (NLP) has transitioned from a specialized field within computational linguistics to an integral aspect of Artificial Intelligence (AI), facilitating progress in various sectors, including biomedicine, software engineering, and cybersecurity. Despite its rapid progress, NLP still faces challenges related to data scarcity, computational cost, interpretability, and privacy, especially in specialized or high-risk domains where large-scale annotation and adaptation are difficult.

Andrea Vignali's thesis develops along two main research threads that ultimately converge in cybersecurity. The first thread focuses on NLP and its domain-specific adaptations, addressing the limitations of data scarcity and imbalance in biomedical text processing and exploring the use of NLP models for software engineering tasks such as code translation and test case prioritization. The second thread investigates anomaly detection in complex Cyber-Physical Systems (CPSs) through multimodal deep learning models that integrate sensor and network data to improve the identification of system faults and attacks.

These two directions merge in the final part of the thesis, where NLP and anomaly detection converge in cybersecurity applications. Specifically, a novel method is proposed that combines large language models (LLMs) and AI planning to extract structured knowledge from unstructured security data and automatically identify exploit chains, enabling proactive cyber defense. Overall, the thesis demonstrates how the reasoning capabilities of NLP and deep learning can enhance the detection, interpretation, and prevention of anomalies and threats in modern intelligent systems.

Research products

Research results appear in *8* papers published in international journals, *3* contributions to international conferences, *1* contributions to national conferences.

List of scientific publications

International journal papers

Ilaria Bartolini, Vincenzo Moscato, Marco Postiglione, Giancarlo Sperlì, Andrea Vignali,
Data augmentation via context similarity: An application to biomedical Named Entity Recognition,
Information Systems,
vol. 119, pp. 102291, 2023, DOI: 10.1016/j.is.2023.102291

Simon Pietro Romano, Giancarlo Sperli, Andrea Vignali,
An NLP-based approach to assessing a company's maturity level in the digital era,
Expert Systems with Applications,
vol. 252, pp. 124292, 2024, DOI: 10.1016/j.eswa.2024.124292

Vincenzo Moscato, Marco Postiglione, Giancarlo Sperli, Andrea Vignali,
ALDANER: active learning based data augmentation for named entity recognition,
Knowledge-Based Systems,
vol. 305, pp. 112682, 2024, DOI: 10.1016/j.knosys.2024.112682.

Roberto Canonico, Giovanni Esposito, Annalisa Navarro, Simon Pietro Romano, Giancarlo Sperli, Andrea Vignali,
An anomaly-based approach for cyber–physical threat detection using network and sensor data,
Computer Communications,
vol. 234, pp. 108087, 2025, DOI: 10.1016/j.comcom.2025.108087.

Roberto Canonico, Giovanni Esposito, Annalisa Navarro, Simon Pietro Romano, Giancarlo Sperlì, Andrea Vignali,
Empowered Cyber–Physical Systems security using both network and physical data,
Computers & Security,
vol. 152, pp. 104382, 2025, DOI: 10.1016/j.cose.2025.104382.

Roberto Canonico, Francesco Lista, Annalisa Navarro, Giancarlo Sperlí, Andrea Vignali,
Threat detection in reconfigurable Cyber-Physical Systems through Spatio-Temporal Anomaly Detection using graph attention network,
Computers & Security,
vol. 156, pp. 104509, 2025, DOI: 10.1016/j.cose.2025.104509.

Gabriele Dario De Siano, Anna Rita Fasolino, Giancarlo Sperlí, Andrea Vignali,
Translating code with Large Language Models and human-in-the-loop feedback,
Information and Software Technology,
vol. 186, pp. 107785, 2025, DOI: 10.1016/j.infsof.2025.107785.

Pasquale De Falco, Giancarlo Sperlí, Marcello Vestri, Andrea Vignali,
Smart home Demand-Side Management Based on rooftop deep learning photovoltaic power forecasting,
Sustainable Computing: Informatics and Systems,
vol. 186, pp. 101162, 2025, DOI: 10.1016/j.suscom.2025.101162.

International conference papers

Vincenzo Moscato, Marco Postiglione, Guido Secondulfo, Giancarlo Sperlí, Andrea Vignali,
Learning How To Augment Data: An Application To Biomedical NER,
Knowledge Discovery in Healthcare Data (KDH)@International Joint Conferences on Artificial Intelligence (IJCAI),
Macao, China, August 19-25, 2023.
Published

Giancarlo Sperlì, Andrea Vignali,
Anomaly Detection in Cyber-Physical Systems: A Case Study on Pump Health Monitoring,
2024 IEEE International Conference on Acoustics, Speech, and Signal Processing Workshops (ICASSPW),
Jeju, South Korea, April 14-19, 2024, pp. 361-364.
Published (presenting speaker).

Andrea Vignali, Giancarlo Sperlì, Simon Pietro Romano,
Harnessing NLP for test case prioritization: unsupervised approaches,
International Joint Conference on Neural Networks,
Rome, Italy, June 30 - July 5, 2025.
Accepted and Presented (presenting speaker).

National conference papers

Ilaria Bartolini, Angelo Chianese, Vincenzo Moscato, Marco Postiglione, Giancarlo Sperlí, Andrea Vignali, Named Entity Recognition using context similarity data augmentation,
32nd Symposium on Advanced Database Systems (SEBD 2024)
Villasimius, Italy, June 23-26, 2024, vol. 3741, pp. 331-338, CEUR WORKSHOP PROCEEDINGS.

Patents and/or spin offs

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Awards and Prizes

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Date 24 October 2025

PhD student signature Andrea Vignali

Supervisor signature Giancarlo Sperlì

Simon Pietro Romano