UNIVERSITÀ DEGLI STUDI DI NAPOLI FEDERICO II

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

Activities and Publications Report

PhD Student: Alessandro Di Bernardo

Student DR number: DR995867

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:
No scholarship

General information

Alessandro Di Bernardo received in year 2021 the Master Science degree in Biomedical Engineering from the University of Napoli Federico II. He attended a curriculum in Biomedical Engineering within the PhD program in Information Technology and Electrical Engineering and he didn't receive a grant.

Study activities

Attended Courses

Year	Course Title	Type	Credits	Lecturer	Organization
1st	Virtualization technologies and their applications	Ad hoc course	5	Prof Luigi De Simone	ITEE
1st	Statistical data analysis for science and engineering research	Ad hoc course	4	Prof. Roberto Pietrantuono	ITEE
1st	Data science for patient records analysis	Ad hoc course	3	Prof. Marcello Cinque	ITEE
1st	Neural Network and deep learning	Ah hoc course	6	Prof. Roberto Prevete	ITEE
1st	Metrology and Machine Learning for Brain Computer Interfaces	Ah hoc course	3	Prof. Pasquale Arpaia	ICTH
2nd	Muscle-based Human-Machine Interfaces	Ad hoc course	2.6	Prof. Daniele Esposito	ITEE
2nd	Using Deep Learning Properly	Ad hoc course	4	Prof. Andrea Apicella	ITEE
2nd	Big Data Architecture and Analysis	Ad hoc course	5	Prof. Giancarlo Sperli	ITEE

Attended PhD Schools

Year	School title	Location	Credits	Dates	Organization
1st	N/A				
1st	N/A				
2nd	N/A				

Attended Seminars

Year	Seminar Title	Credits	Lecturer	Lecturer affiliation	Organization
1st	Designing quantum algorithms	0.4	Michele Amoretti		University of Napoli Federico II
1st	The spatial structure of bi-photon states	0.2	Alessio D'Errico		University of Napoli Federico II

1st	The learning landscape in deep neural networks and its exploitation by learning algorithms	0.2	Riccardo Zecchina		University of Napoli Federico II
1st	Systems biology as a compass to understand tumor-immune interactions in humans	0.2	Davide Bedognetti		University of Napoli Federico II
1st	Computational analysis of cancer genomes	0.3	Nùria Lòpez-Bigas		University of Napoli Federico II
1st	Seeqc: the digital quantum computing company	0.2	Marco Arzeo		University of Napoli Federico II
1st	'Project v? C: can a text-to-speech engine generate human sentiments'	0.2	Simon Pietro Romano		University of Napoli Federico II
1st	Bench to bytes to bedside: converting genomic data into healthcare tools	0.2	Serena Nik-Zainal		University of Napoli Federico II
1st	Dissecting glioblastoma by single cell rna-seq	0.2	Itay Tirosh		University of Napoli Federico II
1st	Quantum measurement and control of mechanical motion at room temperature	0.2	Lorenzo Magrini		University of Napoli Federico II
1st	Ethics and politcs of A.I.	0.2	Lorenzo De Stefano		University of Napoli Federico II
1st	An introduction to deep learning for natural language processing	0.2	Marco Valentino		University of Napoli Federico II
1st	Explainable natural language inference	0.2	Marco Valentino		University of Napoli Federico II
1st	Service and companion robots in healthcare	0.3	Andrea Ruggiero		University of Napoli Federico II
1st	Towards AI-Driven Cancer Precision Medicine	0.2	Oliver Elemento		University of Napoli Federico II
1st	Population and medical genomics applications to human traits and diseases	0.2	Nicole Sorazo		University of Napoli Federico II
1st	Designing synthetic circuits with sensing with sensing properties and robust expression in mammalian cells	0.3	Velia Siciliano		University of Napoli Federico II
1st	Reference standards for next generation sequencing assay	0.3	Pasquale Pisapia		University of Napoli Federico II

	on cytological samples: A worldwide ring trial study				
1st	Driving precision medicine and drug discovery using systems biology approaches	0.3	Mukesh Bansal		University of Napoli Federico II
1st	Brain Computer Interface: extracting information from EEG signals	0.3	Nicola Moccaldi		University of Napoli Federico II
1st	Orizzonti quantistici per l'industria	1.2	Paolo De Natale, Prof. Francesco Saverio Cataliotti, Daniela Selisca, Tommaso Occhipinti, Alessandro Titta, Tommaso Tessitore		Alessandro Zavatta, QTI
1st	Towards Sustainable IT	0.4	Giorgia Sepe, Linda Santini e Anna Bartnik		University of Napoli Federico II
1st	Vine robots: design challenges and unique opportunities	0.2	Nicholas Naclerio		University of Napoli Federico II
1st	Thermoacoustics for renewable energies	0.2	Elio Di Giulio		University of Napoli Federico II
1st	Switched differential algebraic equations: jumps and impulses	0.3	Stephan Trenn		University of Napoli Federico II
1st	Variable IO latencies in real life	0.4	Luca Porzio, Roberto Izzi, Dionisio Minopoli		University of Napoli Federico II
1st	Wireless collaborative intelligent with goal-oriented communications	0.4	Yulin Shao		University of Napoli Federico II
1st	Accelerating target identification and drug discovery through the power of high scale human genetics	0.3	Giusy Della Gatta		University of Napoli Federico II
1st	Robotic assistance: pros and cons of a new	0.3	Michele Manigrasso		University of Napoli Federico II

	technology				
1st	Lezione 2 corso imprenditorialità accademica	0.4	Nadia Di Paola		University of Napoli Federico II
1st	Introduction to Intellectual Property management	0.4	Alessandro Marroni		University of Napoli Federico II
1st	WHERE DO WE GO FROM HERE? Some useful tips to understand what's around your business idea	0.4	Mara Cordua		University of Napoli Federico II
2nd	Data minning the output of quantum simulators – from critical behavior to algorithmic complexity	0.2	Marcello Dalmonte		University of Napoli Federico II
2nd	Crash course on data excellence – parte 1	0.3	Roberto Maranca		University of Napoli Federico II
2nd	Automated Offensive Security: Intelligence is all you need	0.3	Simon Pietro Romano		University of Napoli Federico II
2nd	Durability of Fuel Cell Systems	0.3	Elodie Pahon		University of Napoli Federico II
2nd	Open digital frameworkcrash course	0.6	Alberto Curcio, Valeria Crimaldi		University of Napoli Federico II
2nd	ITIL-Crash course	0.6	Alberto Curcio, Valeria Crimaldi		University of Napoli Federico II
2nd	Blockchain and 5G in business	0.6	Conforto Luca, Mutarelli Gabriele		University of Napoli Federico II
2nd	Analysis and control of functional brain networks	0.2	Fabio Pasqualetti		University of Napoli Federico II
2nd	The state of the art of AI and Physics-Based Simulations in drug discovery	0.2	Andrea Beccari		University of Napoli Federico II
2nd	Learning gene association networks using single-cell RNAseq data: a graphical approach	0.3	Davide Risso		University of Napoli Federico II
2nd	Crash course on data excellence – part III	0.2	Roberto Maranca		University of Napoli Federico II
2nd	Symbiotic Control of Wearable Soft Suits for human motion assistance and	0.4	Lorenzo Masia		University of Napoli Federico II

	augmentation				
2nd	Quantum communications with continuous variables of light	0.3	Cosmo Lupo		University of Napoli Federico II
2nd	Exploring Advanced Aerial Robotics: A Journey into Cutting-Edge Projects and Neural Control	0.2	Eugenio Cuniato		University of Napoli Federico II
2nd	Fondi Europei e programmazione 2021/2027	0.4	Tommaso Foglia		University of Napoli Federico II
2nd	Panoramica delle opportunità di finanziamento	0.6	Tommaso Foglia		University of Napoli Federico II
2nd	Tecniche e metodi per la redazione dei progetti – 1^ modulo	0.6	Tommaso Foglia		University of Napoli Federico II
3rd	IEEE Metroxraine 2024	4.8	IEEE INTERNATIONAL CONFERENCE	Conference IEEE	IEEE, University of Hertfordshire, University of Bath

Research activities

During his doctoral program, Alessandro Di Bernardo carried out extensive research in the field of Quantum Technology, with a particular focus on Quantum Machine Learning. His work began with a thorough exploration of the state of the art, leading to the formulation of a proposal aimed at developing quantum technologies for real-world systems. Specifically, he focused on creating a quantum algorithm using IBM's Qiskit library, applied to the analysis and classification of electroencephalographic (EEG) signals.

The research involved making critical decisions, such as selecting the appropriate development environment, programming language, and quantum framework. Additionally, a significant portion of the work revolved around determining whether to implement a hybrid or full quantum approach for classification tasks, as well as choosing the most effective quantum hyperparameters to optimize algorithm performance.

As his research progressed, a considerable effort was dedicated to coding and refining the algorithm. Toward the end of the program, Di Bernardo not only documented his results but also contributed to the scientific community by preparing a paper for the IEEE Metroxraine conference. He is currently in the process of finalizing a journal paper specifically tailored to his research outcomes, which is expected to be published soon.

Tutoring and supplementary teaching activities

Credits summary

PhD Year	Courses	Seminars	Research	Tutoring / Supplementary Teaching
1st	21	9.7	35	0
2nd	11.6	6.3	45	0
3rd	0	4.8	56	0

Research periods in institutions abroad and/or in companies

PhD Year	Institution / Company	Hosting tutor	Period	Activities
1st	N/A	N/A	N/A	N/A
2nd	N/A	N/A	N/A	N/A
3	N/A	N/A	N/A	N/A

PhD Thesis

In the PhD Thesis, Alessandro Di Bernardo described and collected the main results obtained. The research project aims to demonstrate the potential of quantum computing, with a particular focus on quantum machine learning, in a metrology key.

Specifically, after outlining the main application contexts and their state of the art, he introduced an application proposal on real systems with a measurement imprint. In fact, taking a real system through a quantum approach, data on variations are collected and then pre-processed and classified by a quantum machine learning algorithm. The prototype was developed based on a dataset of EEG signals that the research team had available. The aim was to demonstrate the value of quantum machine learning in terms of its ability to generalise and discriminate correctly between specific signals.

The main effort was for the implementation phase in choosing a number of variables, such as development environment, framework, libraries, so that a classification algorithm could be realised. Several steps were taken to the point that during the course, not only was a comparison made between classical machine learning and quantum machine learning approaches, but also between intermediate steps such as hybrid quantum machine learning or full quantum machine learning.

The results showed that all quantum approaches exhibited overfitting problems and showed worse classification performance for these EEG signals than traditional machine learning. This research aims to demonstrate the limitations and potential advantages of the quantum approach in comparison with traditional machine learning, with a focus on the handling of overfitting in the different quantum variants, proving or updating the state of the art.

Research products

Research results appear in *1* papers published in international journals, *0* papers published in national journals, *1* contributions to international conferences, *1* contributions to national conferences, 0 patents.
In addition, a paper is being prepared for submission to a journal.

List of scientific publications

International journal papers

P. Arpaia, U. Bracale, F. Corcione, E. De Benedetto, A. Di Bernardo, V. Di Capua, L. Duraccio, R. Peltrini, R. Prevete,
Assessment of blood perfusion quality in laparoscopic colorectal surgery by means of Machine Learning,
International Journal of Nature, scientific reports,
Scientific Reports, 2022, 12.1: 14682.

International conference papers

L. Angrisani, E. De Benedetto, A. Di Bernardo, R. Prevete, A. Tedesco,

A Comparative Analysis Between Quantum Machine Learning and Machine Learning on EEG Dataset,
International Conference IEEE on Metrology for eXtended Reality, Artificial Intelligence and Neural Engineering,
St Albans, London, UK, Oct. 2024.

National conference papers

R. De Santis, A. Fresa, P. Calzone, G. Guida, A. Panza, F. Adinolfi, M. Imbò, A. Di Bernardo, R. Sibilia
Blockchain in Healthcare: Building a Secure Foundation for Digital Medicine,
Conference on I-CITIES 2024, ICT for smart cities,
Messina, Italy, Sept. 2024, https://icities24.unime.it/papers/9.pdf.

Patents and/or spin offs

N/A

Awards and Prizes

N/A

Date 10/10/2024

PhD student signature Ing. Alessandro Di Bernardo

Supervisor signature