UNIVERSITÀ DEGLI STUDI DI NAPOLI FEDERICO II

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

Activities and Publications Report

PhD Student: Marco Vitone

Student ID: DR995147

PhD Cycle: XXXVI
PhD Cycle Chairman: Prof. Stefano Russo

PhD program student's start date: 1/11/2020
PhD program student's end date: 31/10/2023

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PhD scholarship funding entity:
Micron Semiconductor Italia S.R.L

General information

Marco Vitone received in year 2020 the Master Science degree in Electronic Engineering from the University of Napoli Federico II. He attended a curriculum in Electronic Engineering within the PhD program in Information Technology and Electrical Engineering. He received a grant from Micron Semiconductor Italia S.R.L.

Study activities

Attended Courses

Year	Course Title	Type	Credits	Lecturer	Organization
1	Digital Forensics' methods practices and tools	Ad hoc course	3	Dr. D. Cozzolino	ITEE
1	Data Science for Patient Record Analysis	Ad hoc course	2.5	Prof. Marcello Cinque	ITEE
1	Scientific Programming and Visualization with Python	Ad hoc course	2	Prof. Alessio Botta	ITEE
1	Statistical data analysis for science and engineering research	Ad hoc course	4	Prof. Roberto Pietrantuono	ITEE
1	Imprenditorialità Accademica	Ad hoc course	4	Prof. Pierluigi Rippa	ITEE
1	Strategic Orientation for STEM Research & Writing	Ad hoc course	5	Dr. Chie Shin Fraser	ITEE
1	Dispositivi e Sistemi Fotovoltaici	MSc course	9	Prof. Santolo Daliento	DIETI, University of Naples Federico II
2	FPGA per l'elaborazione dei segnali	MSc course	9	Prof. Nicola Petra	DIETI, University of Naples Federico II
2	Cambridge English: Preliminary (PET)	Ad hoc course	6	Dr. Daniele Lombardi	CLA, Centro Linguistico di Ateneo University of Naples Federico II

Attended PhD Schools

Year	School title	Location	Credits	Dates	Organization
1st	Electronics for IoT	Trieste, Italy	3.4	5-7/7/2021	SIE, Associazione Società Italiana di Elettronica

Attended Seminars

Year	Seminar Title	Credits	Lecturer	Lecturer affiliation	Organization
1st	Digital Project Management: practices, processes, techniques, tools and scientific approach	0.2	Prof. Dario Carotenuto	University of Naples Federico II Projcet Management Institute	Dipartimento di Fisica "Ettore Pacini" DIETI University of Napoli Federico II
1st	#andràtuttobene: Images, Texts, Emojis & Geodata in a Sentiment Analysis Pipeline	0.3	Dr. Serena Pelosi	University of Salerno	Dipartimento di Fisica "Ettore Pacini" DIETI University of Napoli Federico II
1st	At the Nexus of Big Data, Machine Intelligence, and Human Cognition	0.2	Prof. George Djorgovski	California Institute of Technology	Dipartimento di Fisica "Ettore Pacini" DIETI University of Napoli Federico II
1st	Exploiting Deep Learning and Probabilistic Modeling for Behavior Analytics	0.2	Prof. Giuseppe Manco	University of Calabria	Dipartimento di Fisica "Ettore Pacini" DIETI University of Napoli Federico II
1st	Data Driven Transformation in WINDTRE through Managers voice	0.4	Eng. Marcello Savarese Eng. Erica Bertone Eng. Amida Kudasheva	WINDTRE	Dipartimento di Fisica "Ettore Pacini" DIETI University of Napoli Federico II
1st	From Photometric Redshifts to Improved Weather Forecast an interdisciplinary view on machine learning	0.2	Dr. Kai Polsterer	Heidelberg Institute of Theorical Studies	Dipartimento di Fisica "Ettore Pacini" DIETI University of Napoli Federico II
1st	Cybercrime and electronic evidence, The international legal framework for an effective criminal justice response	0.2	Eng. Mattero Lucchetti	National Cyber Security Competence Center	Dipartimento di Fisica "Ettore Pacini" DIETI University of Napoli Federico II
1st	Artificial Intelligence for notary's sector - a case study	0.2	Dr. Salvatore Palange	Founder di Fluel Innovation for Business	Dipartimento di Fisica "Ettore Pacini" DIETI University of Napoli Federico II
1st	Machine Learning: causality lost in translation	0.3	Prof. Edwin A. Valentjin	Kapteyn Astronomical Institute, University	Dipartimento di Fisica "Ettore Pacini" DIETI

				of Groningen The Netherlands	University of Napoli Federico II
1st	Approaches to Graph Machine Learning	0.2	Dr. Miroslav Cepek	ORACLE LABS	Dipartimento di Fisica "Ettore Pacini" DIETI University of Napoli Federico II
1st	Visual Interaction and Communication in Data Science	0.4	Dr. Marco Quartulli	Vicomtech (E)	Dipartimento di Fisica "Ettore Pacini" DIETI University of Napoli Federico II
1st	Big Data and Computational Linguistics	0.4	Prof. Francesco Cutugno	University of Napoli Federico II	Dipartimento di Fisica "Ettore Pacini" DIETI University of Napoli Federico II
1st	Sensoria Health	0.2	Dr. Stefano Rossotti	SENSORIA Health	Dipartimento di Fisica "Ettore Pacini" DIETI University of Napoli Federico II
1st	DoveAndiamoDomani - Deep Tech	0.2	Dr. Francesco Matteucci	University of Napoli Federico II	Dipartimento di Fisica "Ettore Pacini" DIETI University of Napoli Federico II
1st	Robot Manipulation and Control	0.5	Prof. Bruno Siciliano	University of Napoli Federico II	ITEE
1st	Patent Searching Best Practices with IEE Xplore	0.2	Prof. Eszter Lukacs	IEEE	IEEE
1st	How to Get Published with IEEE	0.3	Prof. Paul Henriques	IEEE	IEEE
1st	GDPR basics for computer scientists	0.3	Prof. Rigo Wenning	DIETI	ITEE
1st	Network System, Kuramoto Oscillators and Synchronous Power Flow	0.3	Prof. Francesco Bullo	Department of Mechanical Engineering, University of California Santa Barbara	SSM, Scuola Superiore Meridionale
1st	Measuring the Expansion of	0.3	Prof. Guido	Department of	SSM,

	the Universe with Quasars		Risaliti	Physics and Astronomy, University of Florence	Scuola Superiore Meridionale
1st	Synchronization: A Universal Concept in Non Linear Science	0.3	Dr. Juergen Kurths	Humboldt University Berlin	SSM, Scuola Superiore Meridionale
1st	Probing gravitational field: A fundamental viewpoint	0.3	Prof. Lorenzo Fatibene	Department of Mathemarics, University of Torino	SSM, Scuola Superiore Meridionale
1st	Quantum Simulators	0.3	Prof. Rosario Fazio	Scuola Normale Superiore in the CMI (Condensed Matter and quantum Information)	SSM, Scuola Superiore Meridionale
1st	Engineering the firearm ecosystem: research on media coverage and firearm acquisition in the aftermath of a mass shooting	0.3	Dr. Maurizio Porfiri	New York University Tandon School of Engineering	SSM, Scuola Superiore Meridionale
1st	Measuring the cosmological parameter with SNe-la and Gamma-ray Bursts	0.3	Prof. Massimo Della Valle	INAF	SSM, Scuola Superiore Meridionale
1st	The SHiP project at Cern	0.2	Prof. Andrey Golutvin.	Imperial College London	SSM, Scuola Superiore Meridionale
1st	Astroparticle Physics in the era of Multi-messenger Astronomy	0.3	Prof. Gennaro Miele	Dipartimento di Fisica "Ettore Pacini" University of Napoli Federico II	SSM, Scuola Superiore Meridionale
1st	Hierarchical Seismic Imaging	0.3	Prof. Jean Virieux	University of Grenoble	SSM, Scuola Superiore Meridionale
1st	Additive Manufacturing. A world full of opportunities and challenges!	0.3	Prof. Ferdinando Auricchio	Department of Civil Engineering and Architecture Computational Mechanics and Advanced Materials	SSM, Scuola Superiore Meridionale

				Group University of Pavia	
1st	The coming revolution of Data driven Discovery (a fourth Methodological Paradigm of Science)	0.3	Prof. Giuseppe Longo	University of Napoli Federico II	SSM, Scuola Superiore Meridionale
1st	Why Do We Cooperate? Understanding and Modelling Societies using Reinforcement Learning	0.3	Prof. Mirko Musolesi	University College London, U.K	SSM, Scuola Superiore Meridionale
1st	Rheo-Engineering Microfluidics: How to exploit the rheological properties of fluids to design microfluidic applications	0.3	Prof. Pier Luca Maffettone	University of Napoli Federico II	SSM, Scuola Superiore Meridionale
1st	Classical Cepheids as distance indicators: from the Milky Way to the Hubble constant	0.2	Dr. Marcella Marconi	University of Napoli Federico II	SSM, Scuola Superiore Meridionale
1st	Microgravity Science and Technology: an overview	0.2	Dr. Fabio Peluso	University of Napoli Federico II	SSM, Scuola Superiore Meridionale
1st	Putting more PHYS into PSHA: Advancing Seismic Hazard Analysis with Physics-Based Modelling	0.3	Prof. Thomas H. Jordan	University of Southern California	SSM, Scuola Superiore Meridionale
1st	Modelling the Complexity of Multiagent Activity for Human-AI Interaction using Dynamical Primitives	0.3	Prof. Michael Richardson	Department of Psychology; Centre for Elite performance, Expertise and Training; Faculty of Medical, Health and Human Sciences; Macquarie University – Australia	SSM, Scuola Superiore Meridionale
1st	Dynamics of PDEs and recurrent motions	0.3	Prof. Pietro Baldi	University of Napoli Federico II	SSM, Scuola Superiore Meridionale
2nd	Cyber security in Akka	0.4	Dr. Luigi Villa	Akka Technologies	University of Napoli

	Technologies		Dr. Sara Belluccini Dr. Matteo Pracchia		Federico II
2nd	Vehicular Hacking in Akka Technologies	0.4	Dr. Luigi Villa Dr. Luigi Guida	Akka Technologies	University of Napoli Federico II
2nd	All roads leads to WebRTC	0.4	Dr. Lorenzo Miniero	University of Napoli Federico II	University of Napoli Federico II
2nd	Designing Quantum Algorithms	0.4	Prof. Michele Amoretti	University of Parma	University of Napoli Federico II
2nd	Towards a Political Philosophy of AI	0.2	Prof. Mark Coeckelbergh	University of Vienna	Dipartimento di Fisica "Ettore Pacini" DIETI University of Napoli Federico II
2nd	A day in the life of a Chief Data Officer	0.2	Dr. Roberto Maranca	Schneider Electric	Dipartimento di Fisica "Ettore Pacini" DIETI University of Napoli Federico II
2st	Exploring the early Universe through the cosmic microwave	0.3	Prof. Pietro Baldi	University of Napoli Federico II	SSM, Scuola Superiore Meridionale
2st	Evolution by curvature of networks in the plane	0.3	Prof. Carlo Mantegazza	University of Napoli Federico II	SSM, Scuola Superiore Meridionale
2st	Turbolent dynamics in viscous fluids: a complex phenomenon ubiquitous in nature	0.3	Prof. Vincenzo Carbone	Department of Physics, Calabria University	SSM, Scuola Superiore Meridionale
2st	Graphons: A tool for the analysis of systems on large networks	0.3	Prof. Paolo Frasca	Researcher at Centre national de la recherche scientifique – France	SSM, Scuola Superiore Meridionale
2st	Social network dynamics leading to community formation and residential segregation	0.3	Prof. Massimo Franceschetti	University of California	SSM, Scuola Superiore Meridionale
2st	The challenge of gravitational wave detectors of the 3rd generation. Cultural and technological aspects	0.3	Prof. Ettore Majorana	Physics Department, Sapienza University of Rome	SSM, Scuola Superiore

					Meridionale
2st	Space Weather: Science or Application?	0.3	Dr. Lucilla Alfonsi	Istituto Nazionale di Geofisica e Vulcanologia, Rome	SSM, Scuola Superiore Meridionale
2st	The needle in the haystack: the search for rare processes and fundamental laws of Nature	0.3	Prof. Fabio Ambrosino	University of Napoli Federico II	SSM, Scuola Superiore Meridionale
2st	An overview of the transient sky at high-energies	0.3	Prof. Andrea Sanna	University of Cagliari	SSM, Scuola Superiore Meridionale
2st	Global and cluster synchronization in complex networks and beyond	0.3	Prof. Mattia Frasca	University of Catania	SSM, Scuola Superiore Meridionale
2st	High energy X-ray Astrophysics from Space: revealing the backbones of the Universe	0.3	Prof. Maurizio Paolillo	University of Napoli Federico II	SSM, Scuola Superiore Meridionale
2st	From basic principles in spintronics to some recent developments toward spin-orbinics	0.3	Prof. Vincent Cros	University of Paris-Saclay	SSM, Scuola Superiore Meridionale
2st	Capillary Surfaces and a Model of Nanowire Growth	0.3	Prof. Massimiliano Morini	University of Parma	SSM, Scuola Superiore Meridionale
2st	Power-Law Gels, Scott Blair and fractional Calculus of Soft Multi-scale Materials	0.3	Prof. Gareth H. McKinley	Massachusetts Institute of Technology	SSM, Scuola Superiore Meridionale
2st	An informational Discussion around stochastic control and free boundary problems	0.3	Prof. Tiziano De Angelis	University of Torino	SSM, Scuola Superiore Meridionale
2st	Quantum fluids of atoms and of light as analog models of gravity: a fruitful synergy of gravitational physics and quantum optics	0.3	Prof. Iacopo Carusotto	BEC Center of INO-CNR	SSM, Scuola Superiore Meridionale
2st	From resilience assessment to design for resilience: what is missing?	0.3	Prof. Paolo Franchin	University of Rome La Sapienza	SSM, Scuola Superiore Meridionale

Research activities

Marco Vitone participated in the development of innovative techniques for the validation of digital design and the implementation of hardware accelerator for both SoC and ASIC platforms.
Regarding to the first research theme, He collaborated with Micron Semiconductor Italia S.R.L introducing innovation within the industrial verification process of a key product of the company.
More in detail, the aim of this activity is to develop a RTL simulation environment according to the Universal Verification Methodology, the latest verification guideline, accepted by IEEE as a standard. In addition, He worked on a hardware emulation technique which aims to combine the advantages of the UVM with the hardware-in-loop approach in order to overcome the software simulation bottleneck.
As far as the second research theme is concerned, Marco Vitone worked on the implementation of a data path for the hardware acceleration of neural networks. Since the major operation performed in the inner layers is the convolution, these networks require the computation of a huge number of multiplications. To this end, Mr. Vitone worked on a novel FFA algorithm for the mono- a bi- dimensional convolution aiming at reducing the overall number of multiplications required by each convolutional layer. Consequently, he worked on the implementation of a data path on the basis of the algorithm proposed.

Tutoring and supplementary teaching activities

MSc thesis tutorship for Francesco Tarallo, Giuseppe Ferrara (in collaboration with Micron Technology), Mateusz Grzyb and Cezary Radoslaw Karolczak.

Credits summary

PhD Year	Courses	Seminars	Research	Tutoring / Supplementary Teaching
1st	32.9	10.7	23.6	0
2nd	15	7.1	37.9	0
3rd	0	0	60	0

Research periods in institutions abroad and/or in companies

PhD Thesis

System on Chip (SoC) is a complex Integrated Circuit (IC) that includes several components such as CPU, Programmable Logic (FPGA), on-chip memory, storage interfaces, and so on. Over the last decades, the SoC has been widely used in signal processing, communication, networking, and several industrial applications, from the automotive to storage systems management. Although

the SoC platform represents an optimal solution for large-scale industrial product development, the SoC complexity determines a huge effort to validate the entire system. During my PhD program, I collaborated with Micron Technology and I worked on a state-of-the-art SoC device and storage system. One of the crucial steps of the design flow consists of the verification of the entire system and interfaces of the product. To address this issue, my research activity focuses on the development of innovative techniques for the validation of storage systems based on SoC platform. More specifically, a simulation environment has been developed for a custom Micron SoC according to the latest verification methodologies accepted in the Literature as well as in industrial companies. However, the simulations of complex devices, which include a huge number of peripherals, semiconductor intellectual proprieties, and bus interfaces, became a bottleneck in terms of time consumption. To this end, in this work, an innovative hardware emulation technique has been presented which aims to overcome the simulation time bottleneck by integrating the hardware-in-the-loop in the verification flow.

Furthermore, another important issue related to the SoC design consists of the hardware accelerator implementation and system-level integration. My academic research also addresses this aspect of the SoC dealing with the implementation of efficient architectures for hardware acceleration of neural networks. As far as the neural network is concerned, the major operation computed is the convolution, where conventionally several thousands of multiplications are performed by the inner layers. Some applications, such as automotive platforms, multimedia processing, and IoT solutions require the convolution to be implemented through dedicated hardware accelerators. Conventionally, an efficient hardware architecture for neural network acceleration aims to reduce the overall number of the multiplication required by the convolutional layers.

For this reason, a novel FFA algorithm for the mono- and bi-dimensional convolution has been presented in this dissertation. The proposed algorithm explores the partial results reuse aiming at reducing the overall multiplication needed. On the basis of the mentioned algorithm, a hardware data path has been developed for the acceleration of a well-known Convolutional Neural Network as the Alex-Net, which was one of the first deep neural networks presented in Literature.

By developing in hardware the proposed algorithm, the architecture presented in this work is able to reduce the amount of multiplication for each convolutional layer of the Alex-Net.

The data path has been synthesized in 28nm TSMC CMOS technology with a maximum frequency equal to 500 MHz. In addition, a test chip has been fabricated that includes a BIST logic to verify the correctness of the developed data path. A PCB board has been developed to perform experimental analysis and the test chip has been validated by utilizing a pattern generator, logic analyzer, source meters, and oscilloscope.

Publications

Research results appear in 0 papers published in international journals, *0* papers published in national journals, *0* contributions to international conferences, *1* contributions to national conferences, *0* patents.

List of scientific publications

National conference papers

M. Vitone, N. Petra

Reconfigurable Datapath for Hardware Acceleration of Convolutional Neural Network,
52nd Annual Meeting of Associazione Società Italiana di Elettronica (SIE)
Trieste, Italy, July, 2021

Patents and/or spin offs

Awards and Prizes

Date 20/10/2023

PhD student signature Marco Vitone

Supervisor signature Nicola Petra