
UNIVERSITÀ DEGLI STUDI DI NAPOLI FEDERICO II

**DOTTORATO DI RICERCA / PhD PROGRAM IN
INFORMATION TECHNOLOGY AND ELECTRICAL ENGINEERING**

Activities and Publications Report

PhD Student: **Nicola Albarella**

Student ID: DR993892

PhD Cycle: XXXV

PhD Cycle Chairman: Prof. Stefano Russo

PhD program student's start date: 01/11/2019

PhD program student's end date: 31/10/2022

Supervisor: Prof. Stefania Santini

e-mail: stefania.santini@unina.it

Co-supervisor:

e-mail:

PhD scholarship funding entity: Kineton S.r.l.

General information

Nicola Albarella received in year 2019 the Master Science degree in Automation Engineering from the University of Napoli Federico II. He attended a curriculum in Automation Engineering within the PhD program in Information Technology and Electrical Engineering. He received a grant from Kineton S.r.l.

Study activities

Attended Courses

Year	Course Title	Type	Credits	Lecturer	Organization
1	Intelligenza Artificiale ed Etica: La ricerca in IA alla prova delle sfide etiche	Ad hoc course	1.6	Profs. Roberto Prevete, Francesco Isgrò	ITEE
2	Safety Critical Systems for Railway Traffic Management	Ad hoc course	3.6	Dr. Mario Barbareschi	ITEE
3	Machine Learning	Ad hoc course	2.4	Profs. Marco Aiello, Anna Corazza, Diego Gagnaniello, Francesco Isgrò, Roberto Prevete, Francesco Raimondi, Carlo Sansone	ITEE
4	Innovation management, entrepreneurship and intellectual property	Ad hoc course	5	Prof. Pierluigi Ripa	ITEE
5	Metodi Formali	MSc course	3	Prof. Valeria Vittorini	University of Napoli Federico II, Italy
6	Big Data Analytics and Business Intelligence	MSc course	6	Prof. Antonio Picariello	University of Napoli Federico II, Italy
7	Sistemi Embedded	MSc course	6	Prof. Antonino Mazzeo	University of Napoli Federico II, Italy
8	Control Systems for Autonomous Ground Vehicles	MSc course	6	Prof. Stefania Santini	University of Napoli Federico II, Italy
9	Strategic Orientation for STEM Research & Writing	Ad hoc course	4	Dr. Chie Shin Fraser	ITEE

Attended PhD Schools

Year	School title	Location	Credits	Dates	Organization
1 st	Scuola Nazionale Dottorandi di Elettronica Ferdinando Gasparini	Napoli, Italy	9	14/10-18/10/2019	University of Campania Luigi Vanvitelli - University of Napoli Federico II, Italy

Attended Seminars

Year	Seminar Title	Credits	Lecturer	Lecturer affiliation	Organization
1 st	Deep learning onramp	0.4	Prof. Carlo Sansone	University of Napoli Federico II	DIETI
2 nd	Lo spazio cibernetico come dominio bellico	0.4	Prof. Guglielmo Tamburrini	University of Napoli Federico II	DIETI
3 rd	Computational Biology: Large scale data analysis to understand the molecular bases of human diseases	0.2	Prof. Michele Ceccarelli	University of Napoli Federico II	DIETI
4 th	Elettromagnetismo e salute	0.2			DIETI
5 th	How to get published with the IEEE?	0.4	Dr. Alessandra Scippa	University of Napoli Federico II	ITEE
6 th	Large Scale training of Deep neural Networks	0.4	Dr. Giuseppe Fiameni	University of Napoli Federico II	DIETI
7 th	La programmazione europea e la ricerca. Nuovi scenari della programmazione europea dopo il 2020 – La gestione di un progetto di ricerca	0.4	Filippo Ammirati	Innovation Village 2020	DIETI
8 th	SAS Analytics	0.4	Dr. Cinzia Gianfiori	SAS Academic Program Manager	ITEE
9 th	Planning 5G under EMF constraints: challenges and opportunities	0.4	Prof. Luca Chiaraviglio	University of Tor Vergata	ITEE
10 th	Exploring Autonomy in robotic Flexible Endoscopy	0.4	Prof. Fanny Ficuciello	University of Napoli Federico II	ITEE
11 th	L'esperienza del progetto di tele-riabilitazione NEUROREAB	0.6	Ing. D. Furno Ing. L. Romanelli	University of Napoli Federico II	ITEE
12 th	Patent searching best practices with IEEE Xplore	0.2	Dr. Eszter Lukacs	IEEE - Client Service Manager	ITEE
13 th	GDPR basics for computer scientists	0.3	Prof. P. Bonatti	University of Napoli Federico II	ITEE

Activities and Publications – Final Report

UNINA PhD in Information Technology and Electrical Engineering – XXXV Cycle

PhD candidate: Nicola Albarella

14 th	At the Nexus of Big Data, Machine Intelligence, and Human Cognition	0.2	Prof. Amato Prof. Longo	University of Napoli Federico II	ITEE
15 th	Exploiting Deep Learning and Probabilistic Modeling for Behavior Analytics	0.2	Prof. Amato Prof. Longo	University of Napoli Federico II	ITEE
16 th	Data Driven Transformation in WINDTRE through Managers voice	0.4	Prof. Amato Prof. Longo	University of Napoli Federico II	ITEE
17 th	From Photometric Redshifts to Improved Weather Forecast an interdisciplinary view on machine learning	0.2	Prof. Amato Prof. Longo	University of Napoli Federico II	ITEE
18 th	Cybercrime and electronic evidence, The international legal framework for an effective criminal justice response	0.4	Prof. Amato Prof. Longo	University of Napoli Federico II	ITEE
19 th	Artificial Intelligence for notary's sector - a case study	0.2	Prof. Amato Prof. Longo	University of Napoli Federico II	ITEE
20 th	The era of Industry 4.0: new frontiers in business model innovation	0.2	Prof. Amato Prof. Longo	University of Napoli Federico II	ITEE
21 st	Machine Learning: causality lost in translation	0.3	Prof. Amato Prof. Longo	University of Napoli Federico II	ITEE
22 nd	Approaches to Graph Machine Learning	0.2	Prof. Amato Prof. Longo	University of Napoli Federico II	ITEE
23 rd	Dissecting human gliomas and their microenvironment by single-cell genomics	0.3	Prof. Michele Ceccarelli	University of Napoli Federico II	ITEE
24 th	Classification and precision therapy of glioblastoma	0.2	Prof. Michele Ceccarelli	University of Napoli Federico II	ITEE
25 th	Finding Drivers in Cancer: from Primary Cancers to Resistance	0.4	Prof. Michele Ceccarelli	University of Napoli Federico II	ITEE
26 th	Supporting machine	0.4	Prof.	University of Napoli	ITEE

Activities and Publications – Final Report

UNINA PhD in Information Technology and Electrical Engineering – XXXV Cycle

PhD candidate: Nicola Albarella

	learning with biological knowledge to extract insight from omics data”,		Michele Ceccarelli	Federico II	
27 th	Visual Interaction and Communication in Data Science	0.4	Prof. Amato Prof. Longo	University of Napoli Federico II	ITEE
28 th	Big Data and Computational Linguistics	0.4	Prof. Amato Prof. Longo	University of Napoli Federico II	ITEE
29 th	Emotions in Reinforcement Learning Agents	0.2	Prof. Silvia Rossi	University of Napoli Federico II	ITEE
30 th	The coming revolution of Data driven Discovery	0.3	Prof. Amato Prof. Longo	University of Napoli Federico II	ITEE
31 st	Parameter Sensitivity in Time Delay System	0.2	Prof. Gabor Stepan	Hungarian Academy of Sciences and the Academy of Europe	ITEE
32 nd	Elucidating and Targeting Mechanisms of Single Cell State Maintenance	0.3	Prof. Michele Ceccarelli	University of Napoli Federico II	ITEE
33 rd	Why do we cooperate? Understanding and Modelling Societies using Reinforcement Learning	0.2	Dr. Marco Coraggio	Scuola Superiore Meridionale	Scuola Superiore Meridionale
34 th	DoveAndiamoDomani - Deep Tech	0.3	Prof. Amato Prof. Longo	University of Napoli Federico II	ITEE
35 th	L'avvincente storia degli acceleratori	0.3	Prof. R. Massa	University of Napoli Federico II	ITEE
36 th	Risk assessment in real life: experiences from the railway domain	0.3	Prof. V.Vittorini	University of Napoli Federico II	ITEE
37 th	Artificial Intelligence and 5G combined with holographic technology: a new perspective for remote health monitoring	0.4	Prof. Amato Prof. Longo	University of Napoli Federico II	ITEE
38 th	Synchronization in complex networks, hypergraphs and simplicial complexes	0.2	Dr. Marco Coraggio	Scuola Superiore Meridionale	Scuola Superiore Meridionale
39 th	5G: l'architettura le applicazioni e la rete di	0.4	N. Pascuino	University of Napoli Federico II	ITEE

accesso radio				
---------------	--	--	--	--

Research activities

Nicola Albarella participated in the research activities:

- **Development and testing of a camera based Forward Collision Warning (FCW) for low-end electric vehicle.** The aim of this activity is to design a low cost scalable FCW system such that it can be employed on low-end vehicles
- **Research on the vehicle nonlinear dynamics with attention to road-tire interactions and their influence on ADAS applications.** The aim of this activity is to improve the longitudinal ADAS state-of-the-art by endowing it with the knowledge of the road friction conditions, e.g. water, snow, ice etc.
- **Bi-Level Optimization Augmented with Conditional Variational AutoEncoders for Autonomous Driving in Dense Traffic.** The aim of this activity is to design a DNN based multi-modal behaviour planner using an CVAE and an optimization based trajectory planner using NMPC, for dense traffic scenarios. The complete planner module can achieve 0% collision thanks to this decoupling, while still resulting in effective policies. The educated guesses obtained from the CVAE allows for faster convergence time for the NMPC.
- **Safe and scalable reinforcement learning for highway driving.** The aim of this activity is to design a safe and scalable driving policy. The scalability property is ensured by using Reinforcement Learning, thus eliminating the need of enumerating driving scenarios. On the other hand, safety is ensured by using the Responsibility Sensitive Safety (RSS) which acts as constraints on RL. The complete decoupling of Machine Learning and safety allows us to use any learning algorithm to learn the driving-policy.

Tutoring and supplementary teaching activities

Credits summary

PhD Year	Courses	Seminars	Research	Tutoring / Supplementary Teaching
1 st				

Research periods in institutions abroad and/or in companies

PhD Year	Institution / Company	Hosting tutor	Period	Activities
1 st	University of Tartu, Tartu, Estonia	Prof. Arun Kumar Singh	10/01/2022-10/09/2022	Research on combining machine learning and optimal control for autonomous driving Joint scientific paper preparation title “Bi-Level Optimization Augmented with Conditional Variational AutoEncoders for Autonomous Driving in Dense Traffic”
2 nd	Kineton	Dr. Manuela Tufo, R&D director	1/06/2021-30/08/2021	On-field experiments on Vehicle In the Loop testing of a camera-based Forward Collision System for an electric vehicle

PhD Thesis

Title: Control Architectures for Advanced Driver Assistance Systems

In the PhD Thesis, Nicola Albarella dealt with the problem of increasing the overall safety of the Advanced Driving Assistance Systems (ADAS) and bridging the gap between assisted driving and autonomous driving.

The rapid economic growth has led to an increasing number of vehicles on the road, thus increasing the number of road accidents as well. This issue is a serious dilemma, laying economic burdens on governments, as well as, safety problems on people. Advanced Driving Assistance Systems (ADAS) are software modules assisting the driver, as the name suggest, in monitoring the environment and controlling the vehicle itself. These modules have been demonstrated to be effective in reducing the rate of collisions, and are the main focus of this thesis.

Increasing the level of safety, thus bridging the gap between driving assistance and autonomous driving is a challenging task. While in the former, a safety driver is always there, and ready to intervene, in the latter the driver could even not be on board at all. Therefore, the vehicle must be capable of driving itself, in any scenarios, despite the adversity of the environment (e.g. road asphalt condition, weather, etc.), the uncertainty in sensor measurements and the complex interactions with other road users.

This thesis tackles this problem from multiple points of view. First, it is shown how, by properly design state of the art ADAS, e.g. by endowing these with additional environment information, it is possible to enhance the overall safety.

Moreover, a new motion planning control architecture it is presented. By properly combining the latest advancements in Machine Learning and Optimal Control, safe and scalable driving policies can be learned from data. It will be shown how, by making safety formally explicit, constraints can be put on Machine Learning techniques, thus increasing both performances and safety.

Publications

Research results appear in 2 papers published in international journals, 1 contribution to international conferences. 1 paper is currently under submission.

List of scientific publications

International journal papers

1. S. Santini, N. Albarella, V. M. Arricale, R. Brancati, A. Sakhnevych, On-board road friction estimation technique for autonomous driving vehicle-following maneuvers, *Applied Sciences* 11(5), 2197, 2021, DOI: <https://doi.org/10.3390/app11052197>
2. N. Albarella, F. Masuccio, L. Novella, M. Tufo, G. Fiengo, A Forward-Collision Warning System for Electric Vehicles: Experimental Validation in Virtual and Real Environment, *Energies*, 14(16), 4872, 2021, DOI: <https://doi.org/10.3390/en14164872>
3. Albarella N, et al, Bi-Level Optimization Augmented with Conditional Variational AutoEncoders for Autonomous Driving in Dense Traffic, Submitted at *Robotics Automation and Letters* (RAL)

International conference papers

1. V.M. Arricale, A. Maiorano, L. Mosconi, G. Napolitano Dell'Annunziata, E. Rocca, N. Albarella. Improved Anti-Lock Braking System With Real-Time Friction Detection to Maximize Vehicle Performance, International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, August 2021, Vol. 85369, p. V001T01A002,. American Society of Mechanical Engineers, DOI: <https://doi.org/10.1115/DETC2021-68431>

Patents and/or spin offs

Awards and Prizes

Date 20/10/2022

PhD student signature



Supervisor signature


