



**PhD in Information Technology and Electrical Engineering**

**Università degli Studi di Napoli Federico II**

**PhD Student: Vida Abdolzadeh**

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**XXXII Cycle**

**Training and Research Activities Report – Third Year**

**Tutor: Nicola Petra**



### 1. Information

I graduated in Computer Engineering; currently, I have finished the third year of PhD in Information Technology and Electrical Engineering - ITEE XXXII Cycle at the University of Naples Federico II, under the supervision of Prof. Nicola Petra. I was winner scholarship for international student .

### 2. Study and Training activities

In this third year I followed courses to improve knowledge in neural networks and digital electronics devices (through PhD Schools), courses to improve research skills (through ad hoc modules of ITEE PhD), course to improve English language and to broaden my knowledge in topic near digital electronics (through M. S. courses and Occasionally provided courses of ITEE PhD).

To be more specific:

#### a. Courses

- (4 CFU) Directions in biomedical engineering research: neuroscience, machine learning and personalised medicine, Prof.Paolo Gargiulo – 16-18 May 2019
- (4CFU) Deep Learning for Image Processing, Prof. Luisa Verdoliva –15/7/2019 - 19/7/2019
- (3 CFU) Morphic Sensing – Prof.Gaetano Gargiulo – 4/7/2019 - 5/7/2019

#### b. Seminars

- (1 CFU) Advanced technology at the service of visitors to cultural heritage sites -Prof. Tsvika Kuflik – 15/03/2019
- (1 CFU) (1 CFU) Groups of autonomous micro aerial vehicles cooperating in real-world conditions: from theory to swarm applications – Prof. MARTIN SASKA - 31/05/2019
- (0.8 CFU) (0.8 CFU) Technology foresight for the armed forces: a structured journey between science-fiction and reality – Prof. Quentin Ladetto -31/05/2019
- (1 CFU) Artificial Intelligence for Energy and Environmental Systems – Prof. Peter P. Groumpos -14/05/2019 –15/05/2019
- (0.8 CFU) Meta-Material Interactions with Light, Radio Waves and Sound – Prof. Andrea Alù -20/06/2019
- (0.8 CFU) In-network Machine Learning for Networks – Prof. Roberto Bifulco - 14/06/2019
- (0.8 CFU) Applying Semi-Supervised Learning to App Store Analysis – Prof. Daniel Rodriguez -12/08/2019

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- (0.8 CFU) On Reinforcement Learning for computing channel capacity with feedback – Prof. Haim Permuter – 21/10/2019
- (0.8 CFU) Ethics, science & society in Brain Computer Interface – Prof. PIM Haselager – 18/10/2019
- (0.8 CFU) Cybernetic space as a war domain – Prof. Gian Piero Siroli – 15/11/2019
- (0.5 CFU) A dynamic and probabilistic orienteering problem – Prof. Claudia Archetti – 08/11/2019
- (0.5 CFU) Flexible two-echelon location-routing for supply networks – Prof. Claudia Archetti – 09/11/2019
- (0.4 CFU) AIS and the national system for maritime traffic monitoring, Prof. Diego Gragnaniello – 07/12/2019

Credits year 3							
	1	2	3	4	5	6	
	Estimated	bimonth	bimonth	bimonth	bimonth	bimonth	Summary
Modules	20	0	4	7	0	0	11
Seminars	5	1	2.8	1.6	0.8	3.4	10
Research	35	9	3.2	1.4	9.2	6.6	39
	60	10	10	10	10	10	60

### 3. Research activity

My research activity is actually focused on Neural network. Neural network is widely used today for image and speech recognition. Speech recognition is used to allow the interaction between human and electronics devices using the voice. This feature is becoming widely used and required. The implementation of a neural network relies on the use of powerful high-end elaboration systems. The usual solution requires the use of several servers running the neural network software, and the interaction between the user and the servers is achieved by means of an internet connection.

There are several applications that do not allow the use of high-end computers nor the use of an internet connection. For instance, using neural networks on a car is problematic because the connection to the internet cannot be guaranteed. Furthermore, the use of speech and image

recognition in the domotics devices (smart television, smart refrigerator, etc.) cannot make use of an external network because of security reasons.

For these reasons there is a strong interest in the implementation of neural networks using low cost, mid power, electronic devices. The most promising technology to be used to that purpose are Systems on Chip, which are integrated circuits that provide, on the same chip, one or more processors and dedicated application specific circuitry. However, the modification to be applied to the neural network algorithms in order to make them implemented with a System on Chip is not trivial.

The purpose of my research activity is to investigate trade-offs and architectures that can be used for the implementation of neural network ready Systems on Chip.

From an algorithmic point of view, a neural network is obtained as the sequence of similar mathematical operations, called layers. The derivation of an efficient circuit for the implementation of the single layer is mandatory for the implementation of the whole network.

My activity for the next months is focused on the development of efficient circuits for the implementation of the so called Long Short Term Memory layer, which is widely used in many speech recognition networks.

### **Publications**

V. Abdolzadeh, N. Petra, " Efficient Implementation of Recurrent Neural Network Accelerators, "Springer Applications in Electronics Pervading Industry, Environment and Society, Published, 02/28/2019.

[https://doi.org/10.1007/978-3-030-11973-7\\_44](https://doi.org/10.1007/978-3-030-11973-7_44)

V. Abdolzadeh and N. Petra, "Efficient Hardware Accelerators for Recurrent neural Network SoC Design," in proc. Societa Italiana di Elettronica conference (SIE), Napoli, IT, 20-22 Jun. 2018. ISBN:978-88-905519-2-5.