PhD in Information Technology and Electrical Engineering

Università degli Studi di Napoli Federico II

PhD Student: Vincenzo Norman Vitale

XXXIV Cycle

Training and Research Activities Report – Second Year

Tutor: Prof. Sergio Di Martino

1.Information

PhD Candidate: Vincenzo Norman Vitale – Mat. DR993627

Date of Birth: 30/08/1989

Master Science Title: Master's degree in Computer Science (cum laude) 23/10/2018, Università degli Studi di Napoli "Federico II"

Master Thesis: A protocol for automatic collection of information to generate advanced reports in cultural heritage

Fellowship: "Industry 4.0: Storing, Retrieving and Mining sensor data for Predictive Maintenance" supported by AvioAero a GE Aviation Business

Tutor: Prof. Sergio Di Martino

Year: Second

Cycle: XXXIV

2. Study and Training activities

Lecture/Activity	Type	Hours	Credits	Dates	Organizer	Certificate
Intelligenza artificiale ed etica, la ricercar in IA alla prova delle sfide etiche	Ad hoc Module		1.4	6/12/2019	Università di Napoli Federico II	Yes
:Accelerated Computing with CUDA c/c++; Architecture, Programming and Tools	Ad hoc Module		0.4	25/11/2019	Università di Napoli Federico II And Nvidia	Yes
Virtualization technologies and their applications	Ad hoc Module		4	06-09/04/2020, 15/04/2020, 17/04/2020, 22/04/2020, 24/04/2020, 29-30/04/2020, 15/05/2020	Università di Napoli Federico II	Yes
La programmazione europea e la ricerca. Nuovi scenari della programmazione europea dopo il 2020. La gestione di un progetto di ricerca	Seminar		0.4	13/05/2020	Università di Napoli Federico II And Innovation Village	Yes
Overview of Edge Computing	Seminar		0.3 (CEU/PDH)	28/05/2020	IEEE - Live Training (CEU/PDH)	Yes
Application Scenarios of Edge Computing	Seminar		0.3 (CEU/PDH)	28/05/2020	IEEE - Live Training (CEU/PDH)	Yes

Designing Security Solutions for Edge, Cloud, and IoT	Seminar		0.3 (CEU/PDH)	28/05/2020	IEEE - Live Training (CEU/PDH)	Yes
Human Emotion in Devices and Technology	Seminar		0.3 (CEU/PDH)	28/05/2020	IEEE - Live Training (CEU/PDH)	Yes
Innovation management, entrepreneurship and intellectual property	Ad hoc Module		5	05/05/2020 - 05/06/2020	Università di Napoli Federico II	Yes
Exploring Autonomy in Robotic Flexible Endoscopy	Seminar	2	0.4	12/06/2020	Università di Napoli Federico II	Yes
Design and Implementation of Augmented Reality Software Systems	Ad Hoc Module		4	5,10,11,17-19,25 Giugno 2020	Università di Napoli Federico II	Yes
Machine Learning	Ad Hoc Module		4	06/07/2020 - 17/07/2020	Università di Napoli Federico II	Yes

	YR 1	Credits year 2							YR 3		
			1	2	3	4	5	6			
	Summary	Estimated	bimonth	bimonth	bimonth	bimonth	bimonth	bimonth	Summary	Estimated	Total	Check
Modules	**13,2**	**20**	1,8			13	4		**18,8**	**0**	**32,0**	**30-70**
Seminars	**2,4**	**10**				2			**2**	**6**	**4,4**	**10-30**
Research	**46**	**40**	8	10	9	2	10	10	**49**	**55**	**155,0**	**80-140**
	61,6	**70**	9,8	10	9	17	14	10	**69,8**	**60**	**191,4**	**180**

3.Research Activity

The second year of research activities focused on the study of Time Series management in distributed architectures and forecasting techniques. I focused on data management techniques in Fog-based distributed industrial environments and, unsupervised/semi-supervised techniques for spatio-temporal time-series classification and forecasting.

3.1 Time Series Management in Distributed Environments

The AvioAero's Pomigliano Plant aims to become a smart-factory according to Industry 4.0 principles. In such context my activities are related to Massive Time Series Data management and processing, to enable advanced maintenance tasks. The company has an increasing number of connected industrial machineries (i.e. Industrial IoT assets), producing huge quantity of data, that can be seen in the form of Time Series. The best way to store and analyze this type of data is through the use of Time Series Management Systems (TSMS). These systems can help in daily analysis activities performed on these Time Series by various figures, geographically distributed in all company plants. This context clearly falls in the definition of Industrial Big Data. Therefore, the use of TSMS alone is not enough.

During the second year, my research activities focused on the context in which Time Series are analysed. In fact, it is common for geographically distributed companies to store and process huge data in the Cloud, mainly because of the high availability of resources. However, given the growing amount of data and associated analytics, storage costs and data transfer latencies are bound to increase.

To reduce the impact of such costs and latencies on daily operations, the need of new approaches arises. To identify them, the very first step was to study IoT environments and data management architectures. During this phase, the Fog computing paradigm has emerged as a promising element of the proposed solution. In fact, it has proven to be efficient in reducing latencies for content delivery networks and similar.

So, to efficiently manage massive Time-Series in highly distributed architectures, the most prominent aspects to deal with have been identified. Firstly, we considered characteristics Intrinsically tied to analytic tasks, they may help in the identification of those time-series that needs to be actively monitored. On the other hand, geographical aspects of data requests can identify where time-series are required for analysis and, where may be stored. Lastly, the characteristics related to the temporal execution pattern of analytic queries, helps in the identification of storage needs.

My proposal is a Fog-based storage approach, aimed at reducing the access to slower and costly memories, for analytic tasks on time series data.

3.2 Spatio-Temporal Management and Analytics

In the ITS field, Time Series are smaller than the industrial context, but are almost ever integrated with other data sources, almost ever with spatial data. Such data is often used in the context of Intelligent Vehicles to support the driver and, more in general, in almost every service offered by Smart Cities.

In this context, I focused on spatio-temporal data management and unsupervised/semi-supervised Machine Learning (ML) techniques. If considered alone, the spatial or the temporal dimensions have a plenty of consolidated techniques in any scenario. Anyhow, the combination of both dimensions in a Big Data context (e.g. Smart Cities) leads to a challenging scenario.

Introducing the spatial dimension in consolidated time-series management technique, may influence performances in many ways. We explored how to combine both management techniques in the context of smart cities parking data management.

On the other hand, regarding the parking availability prediction, we studied the influence of geographical information on temporal clustering techniques.

The master student Emanuele Cioffi made his thesis in this context.

4.Products

- Conference Paper "Acoustic Experiences for Cultural Heritage Sites: A Pilot Experiment on Spontaneous Visitors' Interest" in proceedings of "22nd International Conference on Human-Computer Interaction" HCII 2020 Conference.
- Conference Paper "An Haptic Interface for Industrial High-Precision Manufacturing Tasks" in proceedings of "International Conference on Advanced Visual Interfaces" AVI 2020 Conference.
- Conference Paper "Massive Spatio-Temporal Mobility Data: An Empirical Experience on Data Management Techniques" in proceedings of "18th International Symposium on Web and Wireless Geographical Information Systems" W2GIS 2020 conference.
- (Under Review) "Benchmarking Management Techniques for Massive IIoT Time Series in a Fog Architecture" on "International Journal of Grid and Utility Computing".

5. Conferences and Seminars

Conferences

Conferences	Place	Dates	Role
22nd International Conference on Human-Computer Interaction	Copenhagen, Denmark (made remotely)	19-24 July 2020	Author
International Conference on Advanced Visual Interfaces	Island of Ischia, Italy	29 September – 02 October 2020	Author
18th International Symposium on Web and Wireless Geographical Information Systems	Wuhan, China (made remotely)	13-14 November 2020	Author

Presentation made:

- As an author I presented the following conference Papers:
  - Vincenzo Norman Vitale, Marco Olivieri, Antonio Origlia, Niccolò Pretto, Antonio Rodà, Francesco Cutugno "Acoustic Experiences for Cultural Heritage Sites: A Pilot Experiment on Spontaneous Visitors' Interest"
  - Sergio Di Martino, Vincenzo Norman Vitale "An Haptic Interface for Industrial High-Precision Manufacturing Tasks" (Poster presentation)
  - Sergio Di Martino, Vincenzo Norman Vitale "Massive Spatio-Temporal Mobility Data: An Empirical Experience on Data Management Techniques"
- During the master's degree course "Ingegneria del Software II" I made the following presentations:
  - Introduction to Microservices Architectures
  - Introduction to DevOps
  - Microservices In practice with Docker
- During the bachelor's degree course "Tecnologie Web" I made the following presentation:
  - Introduction to Microservices

6. Activity abroad

In March I was starting a period of study abroad in Hannover (Germany), I spent 10 days at L3S research center of the Leibniz University. I had to interrupt this period because of CoViD-19 outbreak.

7.Tutorship

During this second year I have been co-advisor for two master student and two undergraduate students:

- The master student Emanuele Cioffi made his thesis entitled "Una metodologia per migliorare la scalabilità di sistemi di predizione di parcheggi, basata su pattern spazio-temporali ricorrenti". **Graduated**
- The master student Valerio Figliuolo made the studies for his thesis in the field of cost models for data distribution in industrial multilevel architectures.
- The undergraduate student Vincenzo Gallo made his thesis entitled "Visualizzazione di dati spazio-temporali ai fini di analisi predittive in ambito ferroviario".
- The undergraduate student Massimiliano Russo made his thesis entitled "Memorizzazione e recupero di dati spazio-temporali per finalità predittive in ambito ferroviario".

During this second year I have been teaching assistant at:

- Course "Ingegneria del Software I" academic year 2019/20
- Course "Ingegneria del Software II" academic year 2019/20
- Course "Tecnologie Web" academic year 2019/20