PhD in Information Technology and Electrical Engineering

Università degli Studi di Napoli Federico II

PhD Student: Saeed Javnmardi

XXXIV Cycle

Training and Research Activities Report – First Year

Tutor: Prof. Antonio Pescapè

Information

I am **Saeed Javanmardi**, and I received a M.Sc. degree in Computer systems architecture engineering from Dezful Azad University in Iran in July 2012. Before I became a PhD student, I published 8 research papers which got 269 citations so far. Currently, I am a PhD Student attending the XXXIV Cycle of the Information Technology and Electrical Engineering (ITEE) PhD program at the Department of Electrical Engineering and Information Technology (DIETI) of the University of Napoli Federico II. My fellowship is financed by university ITEE grant. My respected tutor is prof. **Antonio Pescapè**, and currently I am working on Fog task scheduling approaches for IOT devices. I prepared a research paper, and I am about to submit it.

Study and Training activities

Because I am an international student, I came to Napoli about 3 months later (getting visa took time). During the first year of PhD program, I attended the courses and seminars reported in the following. Moreover, from 15 July 2019 till 19 July 2019 I attended in a summer school for learning Italian cultures and traditions (It had no credit for me).

Courses

1. *Strategic organization for stem research and writting*, Professor Chie Shin Fraster, 15-18-22-23/2019; 1-8/04/2019, 6 Credits.
2. *Internet censorship, enforcement, detection and circumvention*, Dr Giuseppe Aceto, May 7, 8, and 9 2019, 2 Credits.
3. *Machine Learning*, Professor Anna Corazza, 6-20 May, 3.8 Credits
4. Methods for explainable machine learning, Professor Roberto Prevete, 21.05.2019- 31.05.2019, 2.4 Credits.
5. *Computer networks II, Professor Giorgio Ventre, October 2019, 1.2* Credits.

Seminars

1. *On reinforcement learning for computing channel capacity with feedback, Professor Haim Permuter, Organizer Professor Antonia M. Tulino, 21 October 2019, 0.2 credit.*
2. *Innovation in medical robotics and the human cantered paradigm, Dr George Mylonas, September 5 2019, 0.2 credit.*
3. *Applying semi supervised learning to app store analysis, Professor Daniel Rodriguez, Organizer Roberto Pietrantuono, 12/07/2019, credit: 0.2*.
4. *IEEE training and authorship workshop, Dr Eszter Lukacs, organizer Dr Alessandra Scippa 04.04.2019, credit 0.5*.
5. *In network machine learning for networks, Dr Roberto Bifulco, Organizer Professor Simon Pietro Romano, 14, 06, 2019 credit: 0.4*.
6. *Mathematically modelling for science and engineering, Professor Santolo Meo, September 13 2019, credit 0.8*.
7. *Mathematically modelling for science and engineering, Professor Santolo Meo, September 12 2019, 1.4 credit*.
8. *Groups of autonomous micro aerial vehicles cooperating in a real world conditions, Professor Martin Sasua, October 15 2019, Credit 0.4*
9. *Dottorati industria ed enti di ricerca quale dottorato per quale ricerca, Professor Ermanno Eardelli, October 16 2019, credit 0.6*.

10. *Ethics, science and society in brain computer interface. Professor Pim Haselager, Professor Pasquale Arpaia, 18 October 2019, credit 0.6*.
11. *Summer school for learning Italian culture and tradition, 15-19 July 2019, without any credits*.

Credits Summary

Finally, I provide a table reporting a summary of the credits obtained attending modules and seminars and doing research activities.

	Credits year 1							
		1	2	3	4	5	6	
	Estimated	bimonth	bimonth	bimonth	bimonth	bimonth	bimonth	Summary
Modules	18		6	2	3.8	2.4	1.2	**15**
Seminars	13		0.5	0.4	0.9	0.9	2.6	**5.3**
Research	34		7	7	7	9	9	**39**
	65	0	14	9.4	12	12	13	**60**

Research Activity

Fog Task Scheduling Approaches for IOT Devices

In my PhD, I am working in the context of resource management in fog computing, with specific focus on task scheduling. This research activity aims at shed light on fog task scheduling approaches for IOT devices whose deep usage in everyday life is growing more and more. Indeed, as different Internet of Things applications, such as connected security systems, thermostats, cars, electronic appliances, lights in household and commercial environments, base their functions on fog distributed platform, they benefit from using a proper task scheduling approach.

I studied the internet of Things and its applications and limitations and also its popularity. Besides, I found out that fog paradigms provide solutions to IOT issues, and I underestood that Cloud introduces new problems that are mitigated by fog computing. The goal of my reserach is devising a peoper fog task scheduler which should adopt a proper strategy so as to reduce network utilization and delay.

Specifically, I am currently working on bio inspired hybrid task scheduling techniques considering both the computing features of resources and tasks so as to assign the most suitable resources to the tasks. In 2015 I devised a novel approach [1,2] which used the computing features of resources and tasks in cloud task scheduling which got around 147 citation till now in total, and I am currently studying the effects of considering the same idea in bio-inspired hybrid fog task scheduling.

Research Description

Most recently, mobile IOT devices have become an inseparable part of users' everyday life activities [3]. Fog computing is the leading edge technology, which consists of some near-user edge devices (i.e., fog nodes). These nodes work together to carry out the requested services such as running applications or storing important amounts of data. Also, fog is considered as a cloud server operating at the edge of the network [4].

Task scheduling is the major part of resource management which has a major role for Fog computing performance. For task scheduling in fog, jobs (applications/services) decompress into a set of assigned tasks to the fog devices. If the job is a set of independent tasks, then the tasks can be executed separately on different fog devices [5]. In my research in the first year, I focused on fog task scheduling problem which is a highly distributed platform, for processing distributed and large scale applications. At the end of the day, I found that a hybrid bio inspired algorithm is adequate to solve this problem. The goal of my research is to find the most adequate fog devices to run the application tasks so as to have a proper outcome in terms of delay, network utilization and cost of execution in cloud.

As a first step in this direction, I tried to focus on a three-tiered network architecture (i.e., Cloud-Fog-Thing), and I found that the scheduler can be implemented in a router, gateway, or local server, etc. Due to processing capacity limitation, some fog devices could cooperate or connect to cloud data centres to execute user's requests. In the IOT paradigm, the network state changes continuously. The Fog schedulers have to adapt themselves immediately in such environments by training from the previous states (i.e., experiences). Hence, selecting a proper strategy (i.e., fast converge and reliable) to modify the schedule in a new state is a big challenge. Moreover, based on my former researches before becoming PhD student, I am aware that a fuzzy logic which uses mamdani as the inference engine [6], is a proper approach to perform previous experience or define some assumptions in task scheduling. The task scheduler should assure that it can schedule the user's jobs considering dynamic features of fog environment. Real-time processing is the requirements of IOT applications in which data is processed within a specified deadline [7]. A task scheduler should merge both provider benefits in terms of cost, and users' benefits in terms of delay.

By studying the nature of heuristic and meta-heuristic algorithms, I found that these algorithms have the most usage in resource management in distributed systems, because they can deal with the dynamic changing of the distributed systems. Based on my research I found that among them, the particle swarm optimization (PSO) has the right ability for global searching and as a robust method it can be applied to many use cases [8]. Besides, it has fewer parameters than either genetic algorithm (GA) or Swarm intelligence (SA). A fuzzy optimization is a proper approach for some environments where the settings are not precisely defined or previously unknown. Also, fuzzy optimization has some unique characteristics that

makes it an appropriate choice for several control problems. By using mamdani fuzzy rules, we can make a relationship between some parameters by adding priority to them. Motivated by this consideration, in my research in the first year, I employed fuzzy logic in the fitness function of a PSO-based scheduler to improve PSO's performance in task placement on fog devices. Considering mobility behaviour of the environment, and striking a balance between delay tolerant and delay sensitive applications, and also considering both the users and fog provider benefits are the main characteristics of the topic of my research in the first year. The contributions of my research are as follows: (i) a design of a fog architecture for task scheduling for IoT edge devices; (ii) a structure for Fog computing applications, and a hybrid PSO fuzzy based task scheduling approach; (iii) an IOT based case study which leverages a Fog computing environment, by applying the computing capacities of the fog devices and the users tasks. The main achievements of this work is providing a fog task scheduler which provides low delay, network utilization and cost of execution in cloud.

By studying the literature I found that broker management strategy is a proper approach in application placement [9], and I used the same idea for task scheduling, and I put the scheduler in the broker (fog gateway), But based on different scenarios, it can be located in Cloud/Fog gateway, or super peer of a virtual organization or in a specific fog device. Broker is a node which has the information of the fog devices. It is located between the fog devices and the users, and acts like a portal for users' applications. As most of time Cloud data-centre is far away from the users' devices, so in my research I used fog devices for task scheduling and in case of fog device overloading, it sends tasks to the cloud data centre (Cloud data offloading). Firstly it sends delay tolerant applications to the cloud, and then it sends delay sensitive applications. Cloud data offloading is used to overcome the limitations of fog device computing capacities.

The last but not the least point is that, in my research I tried to put scheduler in the fog gateway instead of cloud gateway, and also I tried to use fog devices in the same fog region from scratch. I tried to use the computing capacities of the fog devices and only in case of computing overloading I used cloud data offloading.

Collaborations
I did not collaborate with any companies in the first year of my PhD.

Products

Journal Papers
I did not publish any journal papers.

Conference Papers
I did not publish any conference papers.

Conferences and Seminars
I only participated in seminars and conferences which are mentioned earlier in seminar part.

Activity Abroad
I have not carried out any long-term activity abroad during my first PhD year.

Tutorship

I did not take participate in any tutorship activities.

References

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[2]- Shojafar, Mohammad, Saeed Javanmardi, Saeid Abolfazli, and Nicola Cordeschi. "FUGE: A joint meta-heuristic approach to cloud job scheduling algorithm using fuzzy theory and a genetic method." *Cluster Computing* 18, no. 2 (2015): 829-844.

[3]- Elazhary, Hanan. "Internet of Things (IoT), mobile cloud, cloudlet, mobile IoT, IoT cloud, fog, mobile edge, and edge emerging computing paradigms: Disambiguation and research directions." *Journal of network and computer applications* (2018).

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[6]- Pourjavad, Ehsan, and Rene V. Mayorga. "A comparative study and measuring performance of manufacturing systems with Mamdani fuzzy inference system." *Journal of Intelligent Manufacturing* 30, no. 3 (2019): 1085-1097.

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[8]- Gill, Sukhpal Singh, Peter Garraghan, and Rajkumar Buyya. "ROUTER: Fog enabled cloud based intelligent resource management approach for smart home IoT devices." *Journal of Systems and Software* (2019).

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