



Finanziato
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NextGenerationEU



Università
degli Studi di
Messina



Annex A Short description of the training project

Title of the Training Project:

Algorithms and optimisation techniques aimed at Swarms and Artificial Intelligence Decentralised Systems operating between Cloud and Edge (ASCAID)

Description of the scientific and training objective:

With the emergence of managing the inter-connection of people (Internet of People), processes, data and things (Internet of Things) - the number of connected devices worldwide is expected to grow significantly from billions today to tens of billions in the near future. It is widely believed that the problem that will soon arise is not only how to manage billions of connected objects, but even more, how to manage and use all the data they will generate. Edge computing is gaining increasing interest in all industries and in Smart Cities, thanks to its ability to provide companies with new ways of managing data, which will increasingly become Big Data. The boost that 5G will give to Edge-based applications in terms of connection speed and low latency will determine a completely new evolutionary and innovative domain: there will be the evolution of Edge Computing towards the intelligence and processing of Self-Healing Systems called Swarm. Indeed, many researchers see Edge Computing as the first step towards an even more decentralised model of computing, also known as Swarm Computing, which is expected to be the next revolutionary innovation in digital infrastructures. Swarm Computing requires continuous cooperation between Edge components (e.g. IoT, Intelligent Agents and Objects, Robots, dedicated Edge computing nodes, micro data centres) and multiple federated Cloud platforms, which will enable applications to be self-organising, self-creating, and self-repairing. Ad-hoc intelligent objects will operate distribute and will be deployed on heterogeneous platforms. Cloud, Edge and Swarm Computing offer a broader and different intelligent distribution (more complex distribution of Artificial Intelligence algorithms and at different levels) of applications and computational services, taking into account the individual computational resources of intelligent objects and the data flows coming from them. Indeed, Swarm intelligence tends to treat IoT devices only as innovative data sources, with a lower risk in terms of Security and Privacy of the data itself. In fact, cybersecurity policies consider the distributed technologies (Edge and Cloud-oriented and IoT systems) needed to offer scalable and resilient services. Due to the high interaction of hyper-connected systems together with the integration of different systems, it will be necessary to pay special attention to security issues related to the management of growing volumes of data (Big Data Management), guaranteeing the fundamental principles of the CIA triad (Confidentiality, Integrity and Availability).

The scientific and educational objective therefore revolves around the study of the well-known computational techniques in the field of Machine Learning related to the needs of management and optimisation of Swarms Systems and Decentralised Artificial Intelligence operating between Cloud and Edge aimed at various areas such as Smart Cities, Industry 4.0 and IoT Devices seen as Agent-Automata, taking into account the increasingly stringent security issues (CyberSecurity). Therefore, new algorithms and computing systems capable of providing new answers to challenging systems and scenarios that will arise in the near future in the ICT field. The ICT solutions and Algorithms that will be investigated and developed during the PhD will have to be scalable, efficient and able to manage Big Data and Machine Learning, operating between Cloud and Edge, in a transparent manner

for users and services, providing new solutions not yet fully investigated in the literature. Security solutions will therefore be particularly scalable and efficient and able to manage Big Data in a transparent manner for users and services, providing new solutions not yet investigated in the literature.

Company Supervisor: Dr. Giovanni Lucentini

Conduct of training and research activities:

The integrative training activities for the PhD student will include seminars planned by the PhD Committee, which aim to provide multidisciplinary knowledge in the field of computational mathematics.

In addition to these seminars, there will be study days agreed upon with the company and delivered by the company itself and from the FCRLab group of the MIFT Department at the University of Messina, on the following topics necessary for the doctoral student's knowledge base:

- IoT (Internet of Things), technologies to implement the interaction of the environment and people with technological platforms with the main objective of collecting data;
- Big data management, to learn about technological solutions useful for collecting and storing large amounts of data;
- Cloud and Edge computing, to implement and use distributed computing infrastructures that can also be integrated in decentralised systems;
- Computer Security and Cybersecurity, to learn about approaches and technologies that secure computer communications and access to digital data.
- Optimisation and Decision Support Algorithms based on automatic learning systems (Machine Learning) oriented towards different ICT-related case studies, such as Smart Cities, Industry 4.0 and IoT Devices seen as Agent-Automata supporting human activities.

The doctoral student's training will be complemented by participation in one or two international doctoral schools, in order to enrich the acquired knowledge but also to expand his/her knowledge network internationally. The company will also involve the doctoral student by having him/her participate in meetings with external customers and partners, in order to improve the doctoral student's ability to interact with the world of work and with the different areas of developing business solutions. Even after the internship period conducted within the company's premises, Alma Digit s.r.l.'s contribution will be fundamental to the PhD activities, as the design and testing of the solutions developed will be done in full synergy. In this way, it will be easier to understand, with the University's innovation guidance and Alma Digit s.r.l.'s business experience, whether the activities undertaken are moving in the right direction, or whether they need to be readjusted during the course of the project.

Expected spin-offs and results with particular emphasis on the promotion of economic development and the production system:

Training is an intangible form of investment that creates added value for the human resource and generates profit for the company. It does not provide solutions, but tools for achieving the best solution in terms of costs/benefits possibly applied in any business context. Alma Digit s.r.l. is currently engaged in the development of ICT solutions on different areas such as mobility management in Smart Cities, Industry 4.0 and even Workflow systems with Intelligent Algorithms

capable of interacting with IoT, Cloud and Edge devices. For this reason, the contribution of Alma Digit s.r.l. will be fundamental in launching an applied research activity with a high economic and social impact. The use of Machine Learning technologies, enriched by the deployment of the same at the Edge, allows companies to overcome the traditional limitations of automation processes and increase the efficiency and productivity of their people and assets, acting in support of human activity and ensuring not only faster but better results for the company.

The company ALMA DIGIT S.R.L. will host the PhD student beneficiary of the scholarship financed from the resources of DM 352/2022 for no. 12 months during the PhD.

Period abroad for no. 6 months at the following institution:
Universitätsstr. Klagenfurt am Wörthersee, A-9020, Austria,