



PhD in INGEGNERIA DELL'INFORMAZIONE / INFORMATION TECHNOLOGY - 39th cycle

Research Area n. 1 - Computer Science and Engineering

PNRR 117 Research Field: **STREAMING MACHINE LEARNING OF IOT DATA STREAMS FOR PRODUCTION OPTIMIZATION, MACHINE SELF-CARE AND ASSET INTEGRITY**

Monthly net income of PhDscholarship (max 36 months)

€ 1400.0

In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity

Motivation and objectives of the research in this field

The Italian National Plan for Recovery and Resilience emphasizes on the development of new added-value services and business models based on satellite technologies, targeting different industries and a broad set of application domains. In an aerospace market that require innovative product development in a challenging time-to-market, reaching agility to define models and long-term scenarios are mandatory. The Industrial Internet of Things (IIoT) has enabled the collection of large amounts of data from machines and assets in industrial settings. However, the effective use of this data for optimizing production, ensuring asset integrity, and self-care of machines is challenging due to the large volume, velocity, and variety of data streams. The industries in the mass-production markets, manufacturing large quantities of standardized products using assembly lines and automation technology, highlight that the analysis of IIoT telemetry, test reports and ERP information leads to production process optimizations. In the environment of Hardware Engineering for Satellite Industries services, IIoT analytics solutions are still lacking due to low production volumes and extremely high variability of products, which includes many different requirements and innovative technologies. In the frame of future Constellation Programs, Interplanetary Missions and



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| | <p>Planetary Defense Missions, Thales Alenia Space expects analytics to play a key role in manufacturing processes improvement. The activities aim to define a Streaming Data Analytics solution within the electronic equipment production line, that continuously collect, integrate and analyse, IIoT telemetry, Automatic Optical Inspection images, electrical test data and manufacturing/electrical parts traceability data. Correlating the above information, the goals are to:</p> <ul style="list-style-type: none"> - Develop Streaming Machine Learning algorithms (SML) for processing and analyzing streaming IIoT data for predictive maintenance, fault detection, process optimization, and reducing time spent for tuning and inspection activities. - Evaluate the performance of the developed algorithms in Thales Alenia Space production settings. - Investigate techniques for handling data quality issues, missing data, and data drift in streaming data. - Develop techniques for automating the deployment of SML models on edge devices to enable real-time decision making. |
| <p>Methods and techniques that will be developed and used to carry out the research</p> | <p>The research activity aims at developing innovative methods that combine computational and learning approaches to address meaningful problems in industry. The research will be conducted in close collaboration with Thales Alenia Space, who will provide access to real-world data and use cases. The program will follow an iterative approach, where the developed SML algorithms will be continuously evaluated and refined based on feedback from Thales Alenia Space. This Ph.D. program will use a mixed-methods research approach to achieve the research objectives. They comprise:</p> <ul style="list-style-type: none"> • To review and leverage state-of-the-art Machine Learning techniques, such as Deep Learning, Reinforcement Learning, and Streaming Machine Learning. • To design and develop new SML models for improving the Thales Alenia Space asset integrity, evaluating them in its use cases. |



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| | <ul style="list-style-type: none"> To deploy them into IoT edge devices like microcontrollers/microprocessors to analyze data in real-time directly where they are generated. |
| <p>Educational objectives</p> | <p>The main educational objectives are:</p> <ul style="list-style-type: none"> Consolidate background on machine learning algorithms for streaming data, IIoT systems, and edge computing. Develop theoretical expertise in machine learning algorithms tailored for streaming data for resource constraint settings. Develop experimental know-how on Streaming Machine Learning and edge computing. Achieve multidisciplinary skills for space applications. Achieve soft skills related to the collaboration with stakeholders from different disciplines such as engineering, computer science, and business. |
| <p>Job opportunities</p> | <p>This research opens the doors to a wide range of career opportunities in both academia and industry. Some of them includes Research Scientist in academic or industrial research labs, where they can further develop and advance the state-of-the-art in machine learning for streaming IIoT data, or Data Scientist in organizations that deal with large amounts of data such as manufacturing, oil&gas, and technology companies. They can use their expertise in machine learning to analyze and extract insights from data to help organizations make informed decisions.</p> |
| <p>Composition of the research group</p> | <p>1 Full Professors 1 Associated Professors 1 Assistant Professors 2 PhD Students</p> |
| <p>Name of the research directors</p> | <p>Emanuele Della Valle and Marco Brambilla</p> |

| <p style="text-align: center;">Contacts</p> | |
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| Additional support - Financial aid per PhD student per year (gross amount) | |
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| Housing - Foreign Students | -- |
| Housing - Out-of-town residents (more than 80Km out of Milano) | -- |

| Scholarship Increase for a period abroad | |
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| Amount monthly | 700.0 € |
| By number of months | 6 |

| National Operational Program for Research and Innovation | |
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| Company where the candidate will attend the stage (name and brief description) | Thales Alenia Space Italia S.p.A |
| By number of months at the company | 6 |
| Institution or company where the candidate will spend the period abroad (name and brief description) | Thales Alenia Space Italia S.p.A Francia |
| By number of months abroad | 6 |

| Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information |
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| <p>EDUCATIONAL ACTIVITIES (purchase of study books and material, including computers, funding for participation in courses, summer schools, workshops and conferences): financial aid per PhD student.</p> <p>TEACHING ASSISTANTSHIP: availability of funding in recognition of supporting teaching activities by the PhD student There are various forms of financial aid for activities of support to the teaching practice. The PhD student is encouraged to take part in these activities, within the limits allowed by the regulations.</p> <p>COMPUTER AVAILABILITY: individual use.</p> <p>DESK AVAILABILITY: individual use.</p> |