



PhD in INGEGNERIA DELL'INFORMAZIONE / INFORMATION TECHNOLOGY - 40th cycle

Research Area n. 1 - Computer Science and Engineering

**PNRR 630 Research Field: CONTINUOUS MULTIMODAL DATA AND KNOWLEDGE FUSION
FOR THE OPTIMIZATION OF THE AEROSPACE INDUSTRIAL PROCESSES**

Monthly net income of PhDscholarship (max 36 months)

€ 1500.0

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. In the current scenario, 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 industrial production processes 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, either directed to institutional or business organizations, IIoT analytics solutions are still lacking due to low production volumes and extremely high variability of products, which includes many different



	<p>requirements and innovative technologies. In the frame of future Constellation Programs, Interplanetary Missions and 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, IIoTtelemetry, 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 techniques for continuous multimodal data fusion, using several types of streaming images, from hyperspectral to multispectral to cloud of points using 3d depth mapping technologies. - Develop incremental object detection neural networks with Streaming Machine Learning algorithms (SML) for processing and analyzing streaming IIoT images for fault detection, process optimization, and reducing time spent fortuning and inspection activities. - Investigate knowledge-infused techniques for merging knowledge-graph with the multimodal data fusion approaches developed. - Evaluate the performance of the developed algorithms in Thales Alenia Space production settings.
<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 AleniaSpace, 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.</p> <p>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, with a particular emphasis on multimodal datafusion techniques and continuous embedding techniques derived from Deep Learning and



	<p>Streaming Machine Learning fields.</p> <ul style="list-style-type: none"> - To design and develop novel streaming approaches capable to continuously learn from multimodal images and other form of data, such as knowledge graphs, and adapting to unpredictable changes. These approaches will be evaluated in controlled sandbox scenarios within laboratory settings. - To evaluate and validate the effectiveness of the developed approaches in enhancing the production processes at Thales Alenia Space, focusing on specific real-world use cases.
<p>Educational objectives</p>	<p>The main educational objectives are:</p> <ul style="list-style-type: none"> - Consolidate foundational understanding of machine learning algorithms pertinent to processing streaming data, fusing multimodal data, and object detection and classification. - Develop theoretical expertise in machine learning algorithms specifically designed for processing streaming multimodal data and implementing incremental embedding techniques. - Acquire practical expertise in Deep Learning techniques for embedding images and Streaming Machine Learning methodologies for learning from streaming data. - Achieve multidisciplinary skills relevant to space applications. - Attain soft skills necessary for effective collaboration with stakeholders across various 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>



Composition of the research group	1 Full Professors 1 Associated Professors 1 Assistant Professors 4 PhD Students
Name of the research directors	Emanuele Della Valle

Contacts	
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Additional support - Financial aid per PhD student per year (gross amount)	
Housing - Foreign Students	--
Housing - Out-of-town residents (more than 80Km out of Milano)	--

Scholarship Increase for a period abroad	
Amount monthly	750.0 €
By number of months	6

National Operational Program for Research and Innovation	
Company where the candidate will attend the stage (name and brief description)	Thales Alenia Space Italia
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 France
By number of months abroad	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
<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: 1st year: Yes 2nd year: Yes 3rd year: Yes</p>