POLITECNICO DI MILANO

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

Research Area n. 1 - Computer Science and Engineering

PNRR 117 Research Field: TIME-EVOLVING ANALYTICS AND CONTINUAL LEARNING FOR OPTIMIZATION OF THE SYSTEM INTEGRATION, VERIFICATION, AND VALIDATION PROCESS

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 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 requires innovative product development in a challenging time-to-market, reaching agility to define models and long-term scenarios is mandatory. In the current scenario, modern industries have a large amount of data that often need to be analyzed productively. The commercial industries, which have larger volumes than the aerospace market, highlight that the availability of data and analytics lead to process optimizations.In the environment of Hardware Engineering for Satellite Industries services, either directed to institutional or business organizations, analytics solutions have been traditionally developed through a data collecting software, information systems and business intelligence applications. Despite ensuring traceability and quality requirements, this approach does not allow for catching the opportunity to find correlations quickly and automatically between data and kick off advanced analytics practices. One of the root causes is the extremely high variability of customer products, which includes many different requirements and innovative

	technologies.In future Constellation Programs, Interplanetary Missions and Planetary Defense Missions, Thales Alenia Space expects a Verification and Validation process improvement thanks to new analytics technologies. A Satellite electronic equipment typically comprises several standard modules (like DCDC Converter, Transmitter/receiver modules, etc..) and custom modules specific to the mission (like Digital modules, Processors, and Firmware based payload). The more systems become complex, the more the system Integration, Verification, and Validation (IVV) process becomes essential. The motivation for the proposed industrial PhD program is to address the challenges of the optimization of the IVV process in the aerospace industry by leveraging advanced analytics approaches. The objective is to develop innovative solutions that identify patterns and dependencies among tested components, optimizing the reliability of the IVV process and improving the overall performance and reliability of complex aerospace systems. The ultimate objective of the proposed research is to improve the efficiency and effectiveness of the IVV process, leading to faster and more reliable testing of aerospace systems based on hard automatism in test execution and result organization. This will have significant implications for the aerospace industry, improving the safety and reliability of aerospace systems while reducing costs and improving overall performance. It will also contribute to developing cutting-edge (intrusive testing, test vector) technologies in the field, positioning the industry for continued growth and success in the future.
Methods and techniques that will be developed and used to carry out the research	The proposed Industrial PhD program will focus on applying Time-Evolving Analytics and Continual Learning to optimize the system Integration, Verification, and Validation (IVV) process. The project aims to leverage cutting-edge Machine Learning techniques to develop a comprehensive system for optimizing the IVV process.The first step in the research project will involve collecting and analyzing relevant data from test reports and logs. This data will be used to identify patterns and dependencies among the tested products by applying data mining

	techniques to extract relevant information from the data and identify relationships between different parts.Starting from a comprehensive review of state-of-the-art approaches, Machine Learning algorithms will be developed to predict the behaviour of the tested products based on their dependencies and similarities. These algorithms will be designed to learn and evolve, adapting to system and testing environment changes. Statistical analysis techniques will validate the results and identify potential errors or inconsistencies. These techniques will assess the accuracy of the models and identify any issues that may arise during the IVV testing process.Throughout the project, Continual Learning techniques will ensure that the developed models and algorithms are constantly improving and evolving based on the results of previous IVV tests. This approach will enable the identification of potential issues before they arise, improving the reliability and performance of the IVV process.Finally, optimization algorithms will be employed to find the most efficient testing sequences and configurations in selected industrial use cases. Overall, this approach aims to identify the most efficient way to carry out the IVV testing process while minimizing costs and maximizing system performance.
Educational objectives	The main educational objectives are: • Consolidate background on Integration, Verification, and Validation Process in the aerospace industry. • Develop advanced skills in data analysis and modeling, including the ability to optimize containment dependencies and similarities among tested components, and use this information to build accurate and reliable predictive models. • Achieve multidisciplinary skills for space applications. • Gain experience working in a collaborative industrial research environment, including communication and teamwork skills, and an ability to translate research findings into practical applications. • Develop professional skills, including project management, scientific writing, and presentation skills, in

	management, scientific writing, and presentation skills, in order to effectively communicate research findings to both academic and industrial audiences.
Job opportunities	The PhD candidate will be desirable both in the research environment, where cross-disciplinary skills are increasingly appreciated, and in the expanding field of space applications design, analysis, and management. Knowledge of model-based system engineering applied to the IVV process and practical know-how in machine learning and data analytics to design and optimize complex aerospace systems will be crucial in testing and validation roles within space-related companies.
Composition of the research group	1 Full Professors 1 Associated Professors 1 Assistant Professors 2 PhD Students
Name of the research directors	Emanuele Della Valle and Marco Brambilla

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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	700.0 €
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 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
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. 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. COMPUTER AVAILABILITY: individual use. DESK AVAILABILITY: individual use.