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Doctoral Programme in Information Engineering and Computer Science

CALL FOR APPLICATIONS
Admission to the Doctoral Programme in
INFORMATION ENGINEERING AND COMPUTER SCIENCE
First call 39th cycle, a.y. 2023/2024

Scholarships on reserved topics

A1 - Cross-modal understanding and generation of visual and textual contents

Funded by DISI Department of Information Engineering and Computer Science (poject PRIN 2020 "CREATIVE", CUP no. E63C22000380001, Prot. no. 2020ZSL9F9)

The convergence of deep learning with Computer Vision and NLP has made it possible to empower not only effective understanding and retrieval, but also - more recently - the generation of textual and visual information. However, in many cases the two communities tend to work independently, missing the benefit of developing innovative approaches which can work cross-modally, i.e. moving from text to visual and vice versa, or even mixing them. This research grant will be investigating and developing innovative cross-modal neural models which can manipulate and transform different types of data seamlessly by enabling: cross-modal processing of textual and visual input to create efficient and reusable representations in a shared space; cross-modal understanding of textual and visual content for retrieval of digital data, and cross-modal generation, e.g. producing text from visual and vice versa, including mixed content. The research will be done within the framework of the PRIN 2020 project CREATIVE (CUP: E63C22000380001) and of the Horizon Europe project ELIAS.

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A2 - Foundation models for fake news analysis

Funded by DISI Department of Information Engineering and Computer Science (project HE RIA AI4TRUST - GA no. 101070190, CUP no. E63C22003900006)

This PhD project will focus on the study and the development of novel approaches for the automatic analysis of news and social media contents in order to spot fake news and malicious contents. In particular, the PhD will investigate the use of state of the art foundation models (e.g. CLIP, ALIGN) for the analysis of these contents, and develop and evaluate novel approaches considering both publicly available benchmarks and datasets collected in the AI4trust project.

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A3 - Multimodal content analysis and synthesis for deep-fakes detection

Funded by DISI Department of Information Engineering and Computer Science (project HE RIA AI4TRUST - GA no. 101070190, CUP no. E63C22003900006)

This research targets the development of novel and generalizable AI-driven approaches for detecting fake/generated/inpainted content in videos and images. Building on emerging multimodal representation learning approaches the project will develop novel deep learning architectures that provide more descriptive cross-modal representations and use these representations for detecting content re-contextualization. Approaches for content generation useful for data augmentation will also be considered. The research will be done within the framework of the Horizon Europe project AI4Trust (CUP: E63C22003900006) and of the PRIN 2020 project CREATIVE (CUP: E63C22000380001).

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A4 - Integrative Machine Translation

Funded by FBK Fondazione Bruno Kessler

The advent of foundation models has introduced unprecedented opportunities in all areas of natural language processing. Automatic translation (be it speech or text translation) is no exception, with a wide variety of language directions, domains and application scenarios whose coverage is no longer a mere utopia. Although conditions today are more favorable than in the past, open challenges still exist in terms of fully exploiting the power of the available models, increasing their flexibility to integrate diverse input types, or constraining the output to meet specific application requirements. Open questions include: how to feed non-symbolic models with symbolic information describing the context of a translation request? How to supply meta-information about target users? How to integrate model capabilities with external information from structured knowledge bases? How to condition the output to specific target applications? This PhD aims to explore state-of-the-art solutions to tackle these challenges, with a special focus on the integration of multimodal information (e.g. contextual information supplied as visual cues), user-specific constraints (e.g. for gender/formality control), and application-specific constraints (e.g. structural requirements as in the case of video subtitling).

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A5 - Planning Specialization via Reinforcement Learning

Funded by FBK Fondazione Bruno Kessler

Planning – devising a strategy to achieve a desired objective – is one of the basic forms of intelligence, with applications in autonomous robotics, logistics, flexible production, and many other fields. Historically, planning research has followed a general-purpose framework: a generic engine searches for the strategy by reasoning on the problem statement. Despite substantial progress in recent years, domain-independent planning still suffers from scalability issues and fails to deal with real-word problems. The alternative is to devise ad-hoc, domain-specific solutions that, although efficient, are costly to develop, rigid to maintain, and often inapplicable in non-nominal situations.
The PhD student will study the foundations of an innovative approach to Planning that will be domain-independent and efficient at the same time. The idea is to adopt a framework based on Reinforcement Learning, where a domain-independent planner is specialized with respect to the domain at hand. This research project will advance the state of the art in planning beyond the “efficiency vs flexibility” dilemma and provide effective techniques to be validated on real-world use-cases.

.Contact: Andrea Micheli amicheli@fbk.eu

A6 - Social and Cooperative AI Systems

Funded by FBK Fondazione Bruno Kessler

Social learning and learning of cause-and-effect relationships are key components of human intelligence. The goal of the current PhD thesis is to model and evaluate notions of social learning, social influence, and counterfactual and causal learning in order to improve the performance of a group of AI agents and their ability to produce explainable decisions in scenarios where they have to interact with humans. Additionally, the thesis may also investigate the properties of empirical social networks (for example, sparsity) to organize the topology of communications, interactions, and cooperation that occur between a multiplicity of AI agents.
The ideal candidate will have research interests on multi-agent deep reinforcement learning, complex networks, causal learning. The candidate will have the possibility of working within the ELLIS network and in collaboration with top international universities and research centers.

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A7 - Strategies for improving Neural Dialogue Models generation
Funded by FBK Fondazione Bruno Kessler

Conversational agents are experiencing a surge in interest given the continuous release of new models and the ever evolving scenario of NLG. Still, the actual focus is mainly on model size, training data size and prompt engineering. The interaction of these elements with related aspects, such as decoding strategies, knowledge guided generation, data quality, knowledge distillation -just to mention a few- can help in improving the models, especially for better factuality, reducing hallucination and increasing coherence among dialogue turns. The goal of this PhD Thesis is to overcome the shortcomings of present large language models by incorporating novel strategies for better generation.

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A8 -TinyML for learning and inference in resource-constrained networked devices
Funded by **FBK** Fondazione Bruno Kessler

Machine learning and deep neural networks have proven to be highly effective in processing multimodal data, such as audio, video, and environmental data, on powerful computing systems. However, a major challenge in artificial intelligence is how to extend these capabilities to resource-constrained devices, such as end nodes, in an IoT system. Fortunately, recent advancements in TinyML approaches are opening up new opportunities to bring AI to the far edge of the edge-to-cloud continuum. Exciting research scenarios are emerging that span from tiny deep learning solutions for inference on resource-constrained platforms, which rely on distillation, quantization, or neural architecture search, up to combining software techniques with innovative hardware that support TinyML. Moreover, the complexity grows when we consider moving learning to the edge to take advantage of the opportunities presented by connected, distributed devices. To address these challenges, this research aims to (i) develop novel hardware and software approaches for optimizing AI on energy-efficient embedded devices, with a particular focus on audio processing and computer vision, but not limited to these areas; (ii) explore the potential of distributing and fusing intelligence from heterogeneous nodes in an IoT; and (iii) demonstrate the benefits of these approaches in real-world application scenarios, such as those found in smart cities. The candidate's profile and interests will be considered when structuring this interdisciplinary research at the intersection of Artificial Intelligence, Embedded Systems, Distributed Computing, and Low power hardware, contributing to the development of innovative solutions for real-world challenges. The candidate will have the opportunity to work on cutting-edge technology, gain experience in interdisciplinary collaboration, and make significant contributions to the field of tiny machine learning.

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A9 - High Performance Artificial Intelligence for climate change research at extreme-scale
Funded by CN1 - National centre for HPC, SPOKE 4, CN0000013 – CUP no. E63C22000970007

The Department of Information Engineering and Computer Science of the University of Trento offers a PhD scholarship for outstanding students who are willing to explore and deliver new cutting-edge technologies regarding High Performance Artificial Intelligence for climate change research at extreme-scale. The activity will contribute to the software stack and infrastructure needed for next generation Earth system models (ESMs) workflows within the “Earth & Climate” Spoke of the recently established ICSC - Italian National Center for High Performance Computing, Big Data and Quantum Computing. The position will target challenges at extreme scale at the intersection between AI and HPC in a climate change research context,

dominated by very large volumes of scientific data. The activity will benefit from and will be strongly integrated with the resources and software platform made available by the ICSC Italian National Center.

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B1 – Low-power wireless networking and localization for the Internet of Things
Funded by DISI Department of Information Engineering and Computer Science

The PhD student will explore research themes at the intersection of networking and localization. These include novel schemes to efficiently coordinate and harmonize the two in a single protocol stack, but also novel techniques that improve the two dimensions separately. Particular emphasis will be given to techniques exploiting concurrent transmissions. The reference radio technology for these research efforts will be ultra-wideband (UWB) but others (e.g., Bluetooth, LoRa, backscatter) are also within scope. The activities carried out can be characterized as "systems research". Novel ideas and contributions are embodied in prototypes concretely demonstrating feasibility and improvements over the state of the art. Ongoing projects include: understanding the behavior of visitors in a museum; understanding social interactions among individuals and groups; sport analytics; industrial control and robotics. Typical performance metrics include energy efficiency, ranging/positioning accuracy, reliability, and scalability w.r.t. users and sample rate. Models are used to characterize the performance of prototypes, which are then evaluated experimentally in realistic setups. In this respect, the research group offers unique assets, including a 130-node (~8000sqm) indoor UWB testbed and two accurate (mm-level) optical facilities.

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B2 - In-Network Computing for System Security
Funded by FBK Fondazione Bruno Kessler

In recent years, there has been a significant increase in demand for secure and efficient systems to process data. In-network computing has emerged as a promising solution for offloading computation tasks, reducing latency, and relieving the workload of connected computing nodes. This technology uses smart network interface cards (smartNICs) to perform computation tasks on the network. However, limited adoption of this technology is due to the maturity of the software stack and related programming models, particularly for security applications.
This PhD scholarship aims to investigate many aspects of enabling in-network computing as a newer paradigm for solving security challenges, including cryptography. After conducting a literature review to identify relevant research and industry efforts in this area, focusing on existing systems such as NVIDIA Bluefield and programming models like DOCA or sPIN, the PhD candidate will identify challenges associated with adopting an in-network computing model for security and propose novel technical solutions. Additionally, the PhD candidate will conduct experimental evaluations to measure the performance and security of the proposed solutions (e.g., cryptographic algorithms implemented on smartNICs) and compare these results with traditional approaches. The findings of this research can guide future research and development in this area and can be applicable to industries that require secure and efficient data processing.

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B3 - On-chip fully digital architectures for real-time data processing in CMOS SPAD array sensors
Funded by FBK Fondazione Bruno Kessler

SPAD arrays in CMOS technology are single photon detectors providing < 100 ps time resolution. They are used in a wide spectrum of time-resolved imaging systems, such as medical and biomedical imaging (e.g., fluorescence lifetime imaging microscopy, Raman spectroscopy, and diffuse optical tomography), depth sensing for industrial, automotive, space and consumer applications, and quantum imaging (super-resolution microscopy, ghost imaging). These systems rely on the high temporal resolution of SPAD

detectors combined with time-to-digital converters to generate precise timestamps of individual photons, which are then processed to extract the required information (lifetime, time-of-flight, etc). In case of large arrays of SPADs, the readout channel becomes the bottleneck of the system, demanding the integration of on chip of power- and area-efficient custom digital signal processors. The objective of this project is to develop hardware friendly algorithms for the specific challenges identified above, test them using existing sensors and then designing custom processors to be integrated on-chip. The student will interact with experts in the fields of single-photon image sensors, and analog/mixed signal integrated circuit design, gaining a unique combination of background knowledge. The expected outcome is the realization of state-of-the-art image sensors and their validation in a real use-case scenario.

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B4 - Provenance and Computational Reproducibility for climate change research at scale

Funded by CN1 - National centre for HPC, SPOKE 4, CN0000013 – CUP no. E63C22000970007

The Department of Information Engineering and Computer Science of the University of Trento offers a PhD scholarship for outstanding students who are willing to explore and develop novel ideas, solutions and technologies regarding provenance and computational reproducibility for climate change research at scale. The activity will contribute to the software infrastructure needed for next generation Earth system models (ESMs) workflows within the “Earth & Climate” Spoke of the recently established ICSC - Italian National Center for High Performance Computing, Big Data and Quantum Computing. The position will target provenance and reproducibility challenges standing at the intersection of big data and cloud computing in a climate change research context dominated by very complex experiments as well as large volumes of scientific data. The activity will benefit from and will be strongly integrated with the resources and software platform made available by the ICSC Italian National Center.

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B5 - Systems, signal processing algorithms, and communication protocols for networking, localization and security in underwater acoustic networks

Funded by iNEST - Interconnected Nord-Est Innovation Ecosystem, SPOKE 8, CUP no. E63C22001030007

The student will design efficient network protocols including, e.g., medium access, routing, and error control, for underwater acoustic networks in support of localization and multi-hop data retrieval. The protocols will include security features that take into account the bandwidth and energy constraints of underwater devices, e.g., through physical layer security techniques.

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C1 -AI-based techniques for personalized and playful education

Funded by FBK Fondazione Bruno Kessler

In modern and heterogeneous learning environments, the one-size-fits-all approach is proven to be fundamentally flawed. Individualization through adaptivity is crucial to nurture individual potential, needs and motivational factors.
The goal of this PhD thesis is to investigate the potential of combining gamification mechanics and adaptive personalized learning, analyzing the impact in terms of students' achievements, participation and motivation. In particular, the PhD candidate will investigate AI-based theories and techniques for the development and validation of an open, content-agnostic, and extensible platform for personalized playful learning. The platform will be validated in different formal and informal educational contexts.
The ideal candidate has a background in Computer Science or Cognitive Science. Game design, educational and cognitive psychology, motivation theories, knowledge on designing and conducting experimental studies, experience with quantitative and qualitative data analysis techniques are a plus for the application and should be acquired during the Phd training.

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C2 - Data Spaces and Data Governance for Agriculture 4.0: Interoperable Platforms for AgriDataSpaces

Funded by FBK Fondazione Bruno Kessler

This research aims to investigate the design of secure and interoperable data spaces and data governance frameworks for the management and sharing of agricultural data in the context of Agriculture 4.0. The study will explore the technical and organizational challenges of establishing and governing data spaces, which are virtual environments for managing, sharing, and analyzing data. The research will examine the potential benefits of data spaces in agriculture, such as improving crop yields, reducing environmental impact, and enhancing the overall efficiency of agricultural operations. The study will explore how data governance frameworks can be designed to ensure data privacy, security, and accountability in the agriculture industry. The research will investigate the technical and economic factors that influence the adoption and implementation of these frameworks, including issues related to data quality, interoperability, and standardization. The study will also explore how emerging technologies, such as blockchain, edge computing, and machine learning, can enhance the security and governance of data spaces in agriculture. The research will identify strategies for optimizing these technologies and frameworks to promote innovation, collaboration, and sustainability in Agriculture 4.0.

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C3 -Formal methods for embedded software

Funded by FBK Fondazione Bruno Kessler

Techniques based on formal methods for the verification and validation of embedded and safety-critical software systems are becoming increasingly important, due to the growing complexity and importance of such systems in every aspect of modern society. Despite the major progress seen in the last twenty years, however, the application of formal methods in embedded software remains a challenge in practice, due to factors such as the interplay between computation and physical aspects and the increasing complexity of the software and its configurations.
This project will investigate novel techniques for the application of formal methods to the design, verification, and validation of embedded software, with particular emphasis on safety-critical application domains such as railways, automotive, avionics, and aerospace. The techniques considered will include a combination of automated and interactive theorem proving, satisfiability modulo theories, model checking, abstract interpretation, and deductive verification. Examples of the problems tackled during the project include the formal verification of functional requirements expressed in temporal logics, automated test-case generation, efficient handling of parametric/multi-configuration software systems and product lines, and the verification of software operating in a physical environment, subject to real-time constraints. Importantly, in addition to researching novel theoretical results, a significant part of the project activities will be devoted to the

implementation of the techniques in state-of-the-art verification tools developed at FBK and their application to real-world problems in collaboration with our industrial partners.

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C4 -Formal methods for hybrid systems
Funded by FBK Fondazione Bruno Kessler

Hybrid systems are formal models combining discrete and continuous-time dynamic behaviors. They can be found in various applications such as robotics, control systems, cyber-physical systems, and transportation systems. Formal methods for hybrid systems provide a powerful set of techniques for designing, analyzing, and verifying the behavior of complex systems that exhibit both continuous and discrete behaviors. These techniques can be used to ensure the correctness and safety of the system and to detect design flaws and bugs early in the development cycle.
This project will investigate new formal methods to prove properties of hybrid systems integrating model checking, automated theorem, and numerical analysis for control theory. Different aspects of hybrid systems will be considered including temporal properties, diagnosability and epistemic properties, reliability and robustness to faults. Compositional reasoning and proof synthesis will be also considered. The new methods will be implemented and evaluated on industrial benchmarks derived by industrial collaboration of FBK in various application domains such as space, avionics, autonomotive, railyways, and energy.

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C5 - Formal methods for industry
Funded by FBK Fondazione Bruno Kessler

Industrial systems are reaching an unprecedented degree of complexity. The process of designing a complex system is expensive, time consuming and error-prone. Moreover, the design process has to guarantee not only the functional correctness of the implemented system, but also its dependability and resilience with respect to run-time faults. Hence, the design process must characterize the likelihood of faults, mitigate possible failures, and assess the effectiveness of the adopted mitigation measures.
Formal methods have been increasingly used over the last decades to deal with the shortcomings of designing a complex system. Formal methods are based on the adoption of a formal, mathematical model of the system, shared between all actors involved in the system design, and on a tool-supported methodology to aid all the steps of the design, from the definition of the architecture down to the final implementation in HW and SW. Formal methods include technologies such as model checking, an automatic technique to symbolically and exhaustively analyze all possible executions of the system in the formal model, in order to detect design flaws as early as possible. Model checking techniques have been recently extended to assess the safety and dependability characteristics of the design, and for system certification.
The objective of this study is to advance the state-of-the-art in system design using formal methods. This includes adapting and extending the system design methodology, investigating improved versions of state-of-the-art routines for verification and safety assessment of complex systems, and developing novel extensions to address open problems. Examples of such extensions include novel techniques for contract-based design and contract-based safety assessment, advanced techniques for formal verification based on compositional reasoning, the analysis of the timing aspects of fault propagation, the characterization of transient and sporadic faults, the analysis of the effectiveness of fault mitigation measures in presence of complex fault patterns, and the modeling of analysis of systems with continuous and hybrid dynamics.
This study will exploit the challenges and benchmarks defined in various industrial projects carried out at FBK.

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C6 - Planning and Scheduling for Applications
Funded by FBK Fondazione Bruno Kessler

Planning and scheduling are techniques to automate and/or optimize decision-making. There is a breadth of applications that can benefit from the application of this kind of technique including (but not limited to)

robotics, flexible manufacturing, logistics and people management.
The aim of this PhD scholarship is to investigate and reinforce the applicability of this kind of technique considering the whole spectrum of domains that recently emerged from the AIPlan4EU (aiplan4eu-project.eu) project. The candidate will research innovative approaches and algorithms to improve the performance, usability and/or relevance of planning and scheduling techniques deployed in diverse scenarios, having the unique possibility to work and experiment with real-world scenarios of planning already deployed by the project.

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C7 -Study of the interplay between semantic and interaction patterns in online social media
Funded by FBK Fondazione Bruno Kessler

The widespread use of social media has transformed the way people interact and communicate with each other. The interactions that occur on social media create a network that facilitates the transmission of information across large groups of people. This network can be used to understand how information flows through society and how it shapes people's beliefs and opinions.
One way to understand the social network that is created through online interactions is to analyze the textual information contained within user profiles and messages. This information can be used to characterize users, identify emerging topics, and extract information about cultural characteristics. By studying the patterns of interactions between users, it is possible to identify their stance on specific topics, communication dynamics and communities sharing the same opinions.
However, understanding the social network alone is not enough to gain a complete understanding of how information is transmitted and how it shapes society. It is also important to consider the physical location of these groups and how it affects their interactions and the diffusion of information across the social network. This is because physical space can play a significant role in shaping social dynamics and the diffusion of information. For example, social movements may arise in response to local events, and these movements may have a different impact in different geographic locations.
The interplay between the structure of the social network and the semantic information that diffuses across it is a complex phenomenon that requires a multidisciplinary approach, and that can be further enriched with geographical information. This PhD thesis will employ various research methods, including data mining, network analysis, Natural Language Processing (NLP), and geographic information systems (GIS), to explore this interplay. By examining the relationship between the social network and semantic information, the research aims to provide insights into how social media shapes society and how it can be used to better understand the dynamics of cultural groups, minorities, and social movements of opinion. Ultimately, the findings of this research may have important implications for fields such as sociology, anthropology, and communication studies, as well as for policymakers and social media companies.

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C8 - Integrated Natural language and computer vision system
Funded by FAIR - Future Artificial Intelligence Research, PE0000013 – CUP no. E63C22002110007

Sensing of behavioral patterns. This project will focus on the collection and interpretation of vision as well as Radio Frequency (RF) data for the comprehension of indoor user behavior.

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D1 - Development of methodologies based on machine learning and artificial intelligence for the automatic analysis of hyperspectral and multispectral satellite remote sensing images

Funded by DISI Department of Information Engineering and Computer Science (CUP no. F33C22000260005)

The automatic analysis of images acquired by Earth Observation satellites is crucial for many different applications (e.g., precision farming, forestry, analysis of urban areas, monitoring of natural disasters). Even if artificial intelligence and machine learning have been widely used in this context, there are still many methodological challenges and application issues that should be addressed in the analysis of satellite data. The research activities of this grant are related to the development of novel methodologies based on deep learning for the automatic analysis of images acquired by Earth Observation satellites. The research will be focused on the problems of the semantic segmentation (classification) and information extraction from optical (multispectral and hyperspectral) images acquired by last generation satellites (e.g., PRISMA, Sentinel 2). The activity will consider methodological research (for the development of novel methods) and the related application to real world scenarios. Research will be developed at the Remote Sensing Laboratory (https://rslab.disi.unitn.it/) and will be linked to the project activities in progress on the aforementioned topics in the laboratory. Part of the activity will be developed in the PRISMA-Learn project of Italian Space Agency, which is focused on the development of deep learning methods for the automatic classification of hyperspectral images acquired by the PRISMA hyperspectral satellite sensor.

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D2 - Machine learnig and artificial intelligence methodologies for the automatic analysis of data acquired by planetary radars

Funded by DISI Department of Information Engineering and Computer Science (CUP no. F65F21000950005)

Space missions for the exploration of planets and celestial bodies in the Solar system are very important for the huge scientific and technological return associated with them. Some of the most challenging science objectives of these missions are related to the analysis of sub-surface processes that are of crucial importance for many different implications. The research activities of this grant are related to planetary radar sounders, which are instruments for the study of the subsurface of the planets of the Solar system. These radars operate from satellite platforms and acquire images related to the subsurface of celestial bodies that can results in groundbreaking science results. The activity will be focused on the development of methodologies for the processing and the automatic analysis of these data. Special emphasis will be given to methodologies that exploit the most recent developments in the framework of machine learning and signal processing.
Research will be developed at the Remote Sensing Laboratory (https://rslab.disi.unitn.it/) and will be related to the Radar for Icy Moon Exploration (RIME) on board of the JUpiter ICy moons Explorer (JUICE) of the European Space Agency (see https://sci.esa.int/web/juice for more details on the mission).

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D3 - Radar sounder for the analysis of the sub-surface of planetary bodies

Funded by DISI Department of Information Engineering and Computer Science (CUP no. F63C22000650005)

The research of this grant are related to planetary radar sounders, which are instruments for the study of the subsurface of the planets of the Solar system. These radars operate from satellite platforms and acquire data related to the subsurface of celestial bodies that can results in groundbreaking science results. This activity will be developed in the framework of the EnVision mission of the European Space Agency (ESA) (for more information refer to https://envisionvenus.eu/envision/). In particular, the attention will be focused on one of the instruments on-board Envision which is a Sub-surface Radar Sounder (SRS). SRS

has the objective to study the shallow Venus sub-surface (up to few hunded meters). The PhD research activity will include the following topics:
- Novel methodologies and techniques for radar signal processing and information extraction from radargrams.
- Simulations for the analysis of the performance of the radar versus the main SRS parameters and the Venus scenarios. This activity will leverage radar simulators and the use of a radar sounder/ground penetrating radar from drone on terrestrial sites considered as analogous of Venus subsurface. Research will be developed at the Remote Sensing Laboratory (https://rslab.disi.unitn.it/)

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D4 - Artificial intelligence for remote sensing time series analysis
Funded by FBK Fondazione Bruno Kessler

Nowadays a huge amount of remote sensing data is available being acquired with a high temporal, spatial and spectral resolution. Those data are coming from several missions, among the others: ESA Copernicus (Sentinels), ASI PRISMA and COSMO-SkyMed, and future IRID constellation. The management and use of such data requires the design of novel solutions being able to handle long time series of dense but irregular data worldwide in the context of high-power computing systems looking both back and forth in time. Candidates will be requested to develop novel methodologies based on machine learning, deep learning, pattern recognition and artificial intelligence for information extraction, classification, target detection and change detection in long and dense time series of remote sensing images.
Besides the requirements established by the rules of the ICT school, preferential characteristics for candidates for this scholarship are:
• master degree in Electrical Engineering, Communication Engineering, Computer Science, Mathematics or equivalents;
• knowledge in pattern recognition, deep learning, image/signal processing, statistic/remote sensing, passive/active sensors..

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D5 - Artificial intelligence methods for radar sounder data processing
Funded by FBK Fondazione Bruno Kessler (project ASI EnVision ph.B1 – CUP no. F63C22000650005**)**

In 2023 there will be the launch of the European Space Agency (ESA) mission JUpiter ICy moons Explorer (JUICE) to the Jovian system, and the development of the ESA EnVision mission to Venus will continue. Both missions carry on board a radar sounder instrument for subsurface sensing of planetary bodies. In the context of these two projects we are looking for candidates willing to design methodologies for sub-surface radar image processing and analysis. The outcome of this activity will contribute in improving the understanding of subsurface structures, and their correlation to planetary body history and climate. The candidate will be requested to design and develop novel methodologies based on machine learning, deep learning, pattern recognition and artificial intelligence for information extraction, classification, target detection, noise reduction and change detection in radar and radar sounder images.
Besides the requirements established by the rules of the ICT school, preferential characteristics for candidates for this scholarship are:
• master degree in Electrical Engineering, Communication Engineering, Computer Science, Mathematics or equivalents;
• knowledge in pattern recognition, deep learning, image/signal processing, statistic/remote sThis grant is funded ensing/radar.
This grant is funded by project ASI EnVision ph.B1 - “Attività scientifiche per il radar sounder di EnVision fase B1” — CUP F63C22000650005.

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D6 - On-device processing for conversational speech recognition in dinner party scenarios

Funded by FBK Fondazione Bruno Kessler

In spite of the recent progress in speech technologies, processing and understanding conversational spontaneous speech is still an open issue, in particular in presence of challenging acoustic conditions as those posed by dinner party scenarios. Although enormous progresses have been made recently in a variety of speech processing tasks (such as speech enhancement, speech separation, speech recognition, spoken language understanding), a unified established solution is still far from being available. In particular, one of the limitations of the current approaches is their computational complexity that makes an actual deployment in low-end or IoT devices not feasible in practice.
The candidate will advance the current state-of-the-art in speech processing (in particular for separation and enhancement) towards developing a unified solution, possibly based on self-supervised or unsupervised approaches, for automatic speech recongition in dinner party scenarions (as those considered in the CHiME challenges).

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D7 - Real-Time Monitoring of Civil Infrastructures using IoT, 3D Metrology and Blockchain Technologies

Funded by FBK Fondazione Bruno Kessler

This research aims to develop an innovative framework that combines 3D metrology, Internet of Things (IoT) and blockchain technologies for secure and trustworthy data management in real-time monitoring of civil infrastructures. The research will investigate the integration of IoT-enabled sensors and advanced 3D surveying techniques (SLAM, LiDAR, etc.) for continuous monitoring of structural health whereas blockchain technology will support secure and decentralized data storage and sharing.
The interdisciplinary Phd will contribute to advancing IoT, 3D metrology and blockchain technologies and their integration, providing a secure and reliable framework for real-time monitoring of civil infrastructure, such as bridges, buildings, dams or monument. The research findings will therefore be applicable to various industries, including transportation, construction, mining, etc. and could have significant implications for public safety and economic development.

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D8 - Robotics and IoT for Intelligent Digital Agriculture: Deep Learning-based IoT Data Analysis

Funded by FBK Fondazione Bruno Kessler

This research aims to investigate the integration of robotics and IoT technologies with deep learning-based IoT Data analysis techniques in the context of digital agriculture. The study will focus on addressing the challenges and opportunities that arise from the combination of these technologies, with a particular emphasis on the use of deep learning algorithms for the mass collection and analysis of agricultural data provided by IoT-distributed sensors. The research will explore how deep learning can improve the efficiency, sustainability, and productivity of agricultural practices by enabling automatic and semi-automatic training of algorithms for classification/analysis. The study will also examine the technical and economic factors that may influence the adoption and implementation of these technologies in the agricultural sector to identify strategies to optimize their use and impact.

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D9 - HPC-enabled large scale image processing and analysis for climate change research

Funded by CN1 - National centre for HPC, SPOKE 4, CN0000013 – CUP no. E63C22000970007

The Department of Information Engineering and Computer Science of the University of Trento offers a PhD scholarship for outstanding students who are willing to advance the software and data infrastructure needed for next generation Earth System Models (ESMs) workflows within the “Earth & Climate” Spoke of the recently established ICSC - Italian National Center for High Performance Computing, Big Data and Quantum Computing.
The activity will target data and computational challenges regarding the development of scalable solutions at the intersection of HPC, Big data and Machine learning to address large scale image processing for cloud detection/removal as well as large scale analysis for image classification on various sources of data (e.g. Earth Observation data, ESM outputs, etc.).
The activity will benefit from and will be strongly integrated with the resources and software platform made available by the ICSC Italian National Center.

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D10 - Quantitative Ultrasound Imaging for tissue characterization

Funded by HLS - Hub Life Science, CUP no. E63C22003780001

The successful candidate will develop and validate quantitative ultrasound imaging techniques for tissue characterization by conducting research on simulated, experimental, pre-clinical, and clinical data. Particular attention will be focused on the characterization of lung tissue alterations by means of quantitative lung ultrasound spectroscopy. Thanks to the availability of simulated, experimental, and clinical data acquired through the deployment of dedicated multispectral imaging methods, the impact of novel spectral features on augmenting lung ultrasound specificity in the differential diagnosis of lung diseases will be investigated.
Research will also be conducted on photoacoustic spectroscopy by means of pre-clinical data in collaboration with the National Research Council.

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