



TEMA E ABSTRACT DI LAVORO RESEARCH FELLOWS JUNIOR (R1) DIEE

RESEARCH FELLOWS

-Start of activities :2025

Bitti Cecilia

Research Topic:

Data Analysis for the Evaluation of the Metbiotel Project.

Abstract:

The research fellowship activity involves the evaluation of the METBIOTEL project through data collection and analysis. The objective is to assess the performance of solutions integrating artificial intelligence and telemedicine for remote monitoring.

Cillara Cristian

Research Topic:

Data and Analytical Characterization of Outcomes in the METBIOTEL Project.

Abstract:

The fellowship activity focuses on the evaluation of the METBIOTEL project through the analysis of collected and processed data. It includes the gathering of information and its assessment to examine the effectiveness of artificial intelligence and telemedicine-based solutions in health monitoring.



Corona Giovanni Battista

Research Topic:

Support for the Activities of the Artificial Intelligence Laboratory of the Cagliari Digital Lab.

Abstract:

The research activity is carried out within the framework of the "Cagliari Digital Lab" (CDL) project, funded by MIMIT (Development and Cohesion Plan of the Ministry of Economic Development – PSC MISE 2014–2020). The objective is to study search and path optimization algorithms on graphs to support efforts in combating fare evasion in urban public transportation, in collaboration with one of the partner companies of the CDL Artificial Intelligence Laboratory.

Filia Alberto

Research Topic:

Development and Implementation of Image Analysis Algorithms for Monitoring Food Production Processes.

Abstract:

The research activity is carried out within the framework of the project "ICT and Industry 4.0 Technologies for the Analysis and Engineering of Complex Food Systems for the Production of High-Value Local Artisan Breads" (AISAC), funded by MIMIT (Research and Development Program "Agreements for Innovation," part of the National Plan for Complementary Investments to the NRRP). The objective is to contribute to the development and implementation of image analysis algorithms, including those based on machine learning techniques, for assessing the quality of baked food products during the production process.





Lai Matteo

Research Topic:

Training Machine Learning Models on Edge Devices

Abstract:

Continuous learning and adaptation of artificial intelligence models is essential to ensure high accuracy in customizable application scenarios, such as speech recognition. As part of the MYRTUS project (Multi-layer 360° dYnamic orchestrion and interopeRable design environmenT for compute-continUum Systems), the research fellowship focuses on the development of a library for the continuous training of AI models on low-resource computing devices. The selected targets are devices based on the RISC-V architecture, which offer low energy consumption—an essential feature for edge computing applications. The training library will support direct feedback alignment algorithms to ensure high performance.

Laus Bartemes Brian

Research Topic:

AI at the Edge on FPGA: Processing Biosignals from Wearable Biosensors.

Abstract:

Within the METBIOTEL project, this work focuses on the development and training of spiking neural networks (SNNs) for integration into a low-power wearable sensor node. The SNN model processes event-encoded data from 96 neural channels to reconstruct cursor movement, enabling real-time decoding of neural activity. Implemented in PyTorch and optimized for TinyML deployment, the network allows efficient on-device data analysis under limited computational resources. Local inference reduces data transmission requirements, contributing to the overall energy efficiency of the sensor node.





Matticola Andrea

Research Topic:

Study of Online Learning Techniques on FPGA for AI in Wearable Health Monitoring Devices.

Abstract:

The study focuses on the research and development of spiking neural networks (SNNs), with particular attention to the application of online-learning techniques to pre-trained networks. The primary objective is anomaly detection in biological signals. Within this context, the focus is on two well-known techniques in the literature: Short Term Plasticity (STP) and Spike Timing Dependent Plasticity (STDP). The case study involved the recognition of epileptic seizures using the MIT EEG dataset. Additionally, various network topologies were explored to maximize performance and develop an effective model suitable for implementation on at-the-edge FPGA-based systems.

Orrù Mauro

Research Topic:

Optimization and FPGA Implementation of a Hardware Accelerator for Real-Time Biomarker Analysis.

Abstract:

The research fellowship activity primarily involves the optimization and implementation on FPGA of a hardware accelerator, applicable—among other case studies—to real-time biomarker analysis, with particular attention to low-power requirements. The project focused on adopting a novel architecture based on transformers combined with a pre-existing Spiking Neural Network (Syntzulu) to leverage the intrinsic sparsity of SNNs and reduce energy consumption while maintaining high performance. The accelerator was developed targeting a resource-constrained FPGA (Lattice iCE40UP5k), optimizing the use of various resources including on-chip memory and LUTs, with the goal of maximizing efficiency while maintaining adequate accuracy.





Pau Giovanni

Research Topic:

Design of an Application Utilizing Virtual Reality in Industrial Contexts within the Bakery Supply Chain.

Abstract:

The objective is to create an immersive and interactive environment useful for training, simulation, and operational support during key stages of production. The system recreates production environments in 3D and allows operators to practice dough preparation, shaping, baking, and packaging processes in a safe and realistic way. Interactive content such as tutorials and checklists are also included to standardize practices and increase efficiency. The application is compatible with commercial VR devices, making it accessible even for small companies. Ongoing pilot tests with partner companies will evaluate its training effectiveness.

Pruner Alessandro

Research Topic:

Assistance in the Creation of an Open Dataset via Subjective Quality Testing in Immersive Application Contexts.

Abstract:

The research activity is aimed at supporting the design, organization, and execution of subjective tests to evaluate the perceived quality by users when using immersive applications via a headset. The tests will be conducted in a controlled environment, following specific protocols to ensure reproducible and reliable conditions. Special attention will be given to reproducing test scenarios characterized by specific impact factors, such as visual quality, comfort of use, and interaction fluidity, in order to analyze their influence on the perceived immersive experience. The activity includes defining testing methodologies, selecting parameters to monitor, processing the collected data, and interpreting the results, with the





goal of identifying guidelines for improving the quality of immersive applications and enhancing end-user satisfaction.

Reale Alessandro

Research Topic:

Architecture-Aware Neural Networks for Wearable Biosensors.

Abstract:

The research activity carried out within the fellowship “Architecture-aware Neural Networks for Wearable Biosensors” focuses on the development of a wearable system for recognizing finger gestures, based on a spiking neural network algorithm, using surface electromyographic (sEMG) signals. In the initial phase, an 8-channel acquisition system for sEMG signals was developed, employing a suitably programmed analog-to-digital converter interfaced via SPI communication with a microcontroller. The acquired data were then post-processed and labeled. Subsequently, the gesture recognition algorithm was designed and optimized using the LAVA framework, aiming to achieve high accuracy and low energy consumption in preparation for implementation on on-edge wearable devices.

Saba Sergio

Research Topic:

Implementation of Network Architectures Based on Digital Twin Technology.

Abstract:

The implementation of Digital Twin technology in telecommunications networks has the potential to radically transform infrastructure management and optimization. By virtualizing network elements, Digital Twins enable improved operational efficiency, reduced downtime, and advanced functionality. This research fellowship aims to establish both a theoretical and practical foundation for the integration of Digital Twins into network architectures. The main objectives include resource optimization, support for innovation, reduction of operational and maintenance costs, and enhancement of network resilience and reliability. The study





will focus on the definition and development of a framework that employs a predefined ontology to facilitate the deployment and management of Digital Twins in telecommunications networks.

Scalas Alessio

Research Topic:

Electrical Safety of Wireless Charging Systems for Electric Vehicles.

Abstract:

The research fellowship focuses on the study of various wireless power transfer (WPT) technologies, both static and dynamic. In particular, the initial research activities will involve a literature review on foreign object detection (FOD) and living object detection (LOD). Subsequently, the potential hazards for healthy individuals and those with active implanted electronic devices will be identified, along with an evaluation of sensor technologies that can enhance safety and reduce risk in WPT systems. The ultimate goal of the research is to define guidelines aimed at reducing or eliminating risks for both healthy individuals and those with active implanted devices.





-Start of activities :2024

Alterio Virginia Maria

Research Topic:

Higher-Order Opacity for Discrete Event Systems.

Abstract:

The study of opacity is of fundamental importance in the cybersecurity field, as it is used to verify whether a given system is able to hide sensitive information from an external observer. In this study, systems are modelled as discrete-event systems, and the secret is represented either as a state of the system or as a language. The main goal of the research is to develop and implement MATLAB tools that allow to verify several notions of opacity, such as currentstate opacity, initial-state opacity, language based opacity and state-trajectory opacity. The first step involved developing a function capable of reading a .txt file containing the structure of the automaton, allowing the data to be stored and then analysed in a format compatible with MATLAB. All the algorithms implemented rely on two core functions: the observer of the automaton and on the concurrent composition between two automata. For both of them, a MATLAB function was designed. The observer function takes in input the structure of the automaton; the outputs are a matrix that contains the observer's states, and the transition relation between those states. The concurrent composition function takes in input two transition relation matrices of the two automata and the alphabet. The outputs are the matrix containing the states of the composition and the corresponding transition relation. The current-state opacity function calls the observer function and analyses its states to determine if the automaton is opaque. The initial-state opacity function relies on a modified version of the observer that takes in input automata with more than one initial state. After computing two different observers, the concurrent composition function is recalled, and opacity is verified on its results. The language-based opacity function takes in input two automata, the one in exam and the one that accepts the secret language.





After computing their concurrent composition, opacity verification is performed on the observer of the resulting automaton. The state-trajectory function implements an algorithm based on the diagnosis problem. The tool is able to generate the fault monitor starting from the automaton's structure. After computing the concurrent composition between the two, opacity verification is performed on the observer of the resulting automaton.

Carta Francesco

Research Topic:

Design and Development of a Proof of Concept for a Precision Agriculture System Using Advanced Localization Techniques.

Abstract:

The activities focus on the development of advanced solutions for the management of smart environments through the use of Location-Based Services (LBS), with particular emphasis on precision agriculture supported by drones and advanced localization services that do not rely on GPS technologies. The objective is to improve the sustainability and efficiency of agricultural practices by enabling more precise and targeted use of resources, reducing environmental impact, and maximizing crop yields. The study has explored radio frequency communication technologies (such as RFID, Wi-Fi, Bluetooth, and UWB) and distributed sensor networks to collect data via drones and transmit it to a Digital Twin that manages the crops. This will allow the simulation of various agricultural scenarios, optimization of decision-making processes, and prediction of the impact of different interventions, such as irrigation, pest control treatments, or fertilizer distribution. The interaction between physical drones and their digital twins will make it possible to test and optimize management strategies directly within the virtual model before applying them in the field, reducing the margin of error and improving strategic planning.





Chouquir Azzedine Youssef

Research Topic:

Design of Digital Twins for the Virtualization of Network Elements.

Abstract:

This project falls within the scope of integrating Digital Twin technology with telecommunications networks. The adoption of Digital Twins for the virtualization of network elements can lead to numerous benefits, including: enhanced operational efficiency through reduced downtime and optimized network resource usage; innovation and development by enabling advanced functionalities and supporting technological advancements; reduced operational and maintenance costs through more efficient resource management; and improved network resilience and the overall reliability of telecommunications systems. This specific research activity aims to develop a solid theoretical and practical foundation for the implementation of Digital Twins in the context of telecommunications networks, through the definition of an ontology and the development of a framework based on it.

Contu Maura

Research Topic:

Market Analysis and Sales Procedures of Gluten-Free “Carasau” Bread.

Abstract:

The objective is to enhance a product that combines the Sardinian bread-making tradition with modern needs related to celiac disease and gluten-free diets. The activity is structured in several phases: analysis of national and international demand, study of consumption trends, and comparison with similar products already available on the market. The most effective sales channels—both physical and digital—are also explored, and consumer opinions are collected through questionnaires and interviews. Finally, product valorization





strategies are being defined, focusing on craftsmanship, territorial origin, and nutritional quality. The research aims to develop a sustainable commercialization model capable of promoting an innovative product that remains strongly rooted in local traditions.

Dessì Christian

Research Topic:

Preliminary Study and Design of Inductive Charging Systems for the Buoy-Vessel System and Laboratory Testing of the Developed Prototype Solution.

Abstract:

The research activity is aimed at studying aspects related to the design of a wireless energy transfer system. The architecture is conceived for a buoy/autonomous vessel configuration, where the buoy generates and manages the necessary energy, including the inductive charging of the vessel's energy storage. To this end, the average energy requirements have been analyzed, the daily energy balance estimated, and the storage system dimensioned. Additionally, the interface between subsystems has been defined in preparation for validation tests of the inductive charging systems for the buoy/autonomous vessel system at sea, as well as laboratory testing of the developed prototype solution.

Fois Marco

Research Topic:

Edge Acceleration Clusters for Virtual Reality Applications.

Abstract:

The interconnection of multiple computing devices in clusters allows flexible utilization of available computing resources and meets the speed and latency demands imposed by applications. This is particularly true in fields like augmented reality, where low latency is essential to ensure a satisfactory quality of experience. Within the MYRTUS project (Multi-layer 360° dYnamic orchestrion and interopeRable design environmenT for compute-continUum Systems), the research fellowship focuses on defining a distributed and heterogeneous computing architecture capable of integrating FPGA-based devices to provide





hardware acceleration. The computing clusters will leverage the Kubernetes orchestrator and the Docker containerization system to abstract hardware complexity and ensure efficient management of the underlying computing infrastructure.

Mascia Giulia

Research Topic:

Analysis and implementation of different bisimulation approaches

Abstract:

Systems science focuses on the study of complex systems, focussing principally on the problem of analysis, control and verification. In particular, verification makes it possible to check the conformity of the system to a certain specification or to check that the dynamic behaviour of a system is as desired. In this context, the systems analysed are characterised by very high complexity, such as cyber-physical systems, hardware systems or software systems. This complexity is due to the fact that such systems may evolve in different ways depending on their initial state and thus reach different states. To cope with this complexity, the study of reachability is essential, which makes it possible to determine which states of the system can be reached. The bisimulation relation plays a key role in this context, as it makes it possible to analyse the reachability of a system and its correctness by reducing its complexity. The bisimulation relation is an equivalent relation that allows states exhibiting equivalent behaviour to be associated in an equivalent class, thereby constructing a reduced quotient system. In this analysis, the minimum bisimulation, i.e. the finest partition that can be obtained, is of significant importance. In this project, the bisimulation relation between states was analysed and studied. One of the objectives is to develop software that allows the calculation of the minimum bisimulation of a system, trying to improve the efficiency of the process using different approaches. Another goal is to be able to calculate the minimum bisimulation of a system with states characterised by different properties. These objectives allow the bisimulation relationship to be analysed in depth, considering the advantages and disadvantages of different approaches, laying the foundations for the development of new calculation techniques.





Medda Riccardo

Research Topic:

Design of the Energy Harvesting and Storage System for Drone-Vessel and Field Testing of the Developed Solution.

Abstract:

The research activity focused on the design of a self-sufficient power system intended for marine monitoring platforms, with particular attention to the use of renewable energy sources and high-efficiency technologies. Specifically, an energy system based on photovoltaic panels, high-efficiency charge controllers with Maximum Power Point Tracking (MPPT), and rechargeable lithium-ion batteries is being developed. This activity is part of the broader context of developing technological solutions for environmental monitoring in harsh environments and for creating energy-autonomous systems.

Mellino Claudio

Research Topic:

Development of a Demonstrator for Touring Tourist Sites with 3D Content.

Abstract:

The objective of the activity is to acquire digital content using Lidar and photogrammetry, and to develop an application in Unity for virtual tours of tourist sites selected by the Net4U laboratory as part of the CDL (Cagliari Digital Lab) project.

Murralli Floriana

Research Topic:

Artificial Intelligence and Cybersecurity: Towards the Construction of a New Legal Shield.

Abstract:

The project analyzes the legal implications of cybersecurity and personal data protection in the era of emerging technologies, adopting a multidisciplinary approach. At the core of the research is the relationship between law, technology, and ethics, aiming to develop security policies that protect fundamental rights by design and by default. Starting from the study of technologies (big data, AI, IoT, etc.), the work focuses on their impact on cyberspace and





individuals, also reflecting on the ethical and moral significance of technological choices, with a view to regulatory evolution consistent with the protection of human dignity in the digital environment.

Nieddu Nicola

Research Topic:

Study of Potential, Actual, and Planned Economic, Social, and Environmental Impacts Related to the Development of Gluten-Free Products within the AISAC Project.

Abstract:

The research activity is aimed at studying aspects related to the development of gluten-free products from a sustainability perspective, through the assessment of economic, social, and environmental impacts. The work involves analyzing both the potential and actual impacts, as well as those planned during the implementation of the AISAC project, with particular reference to innovation applied to the traditional Sardinian bread, pane carasau. Additionally, the most appropriate criteria will be examined to identify the most effective strategies for technology transfer, in order to enhance the project results in alignment with the sustainability goals of the agri-food sector.

Nurcis Giovanni

Research Topic:

Identification of Jamming Attacks in IoT Localization Services.

Abstract:

Localization applications in Internet of Things (IoT) scenarios are highly vulnerable to data tampering attacks aimed at degrading the quality of the offered service. Among these, jamming attacks are of particular interest, as they introduce radio interference to falsify the power levels of useful signals, resulting in reduced accuracy of position estimates. This research activity aims to define statistical models for the analysis of such signals, capable of real-time recognition of anomalous behavior of network nodes, and methodologies for assessing the reliability of data collected for localization purposes. Starting from radio traffic analysis and targeted simulations, the objectives are to develop lightweight jamming





detection algorithms designed to operate on resource-constrained devices and to pursue two complementary mitigation approaches: (i) isolation of compromised anchors to limit localization errors and improve system reliability; (ii) localization of the attacking device by focusing on the transmitted interference signal. The expected contribution is to provide low-complexity tools and guidelines that enhance the resilience of IoT localization systems, reducing the impact of attacks and ensuring reliable performance in critical scenarios—from Industry 4.0 to smart cities—where continuity of localization services is essential.

Petza Daniel

Research Topic:

Design and Development of a Context Data Simulator for Internet of Things (IoT) Environments.

Abstract:

The management of smart environments requires the use of contextual data, which feed into profiling the behavior of devices and people, as well as generating and updating their corresponding Digital Twins. In this scenario, the use of simulators that allow safe and realistic experimentation with different management policies offers opportunities for studying and optimizing spaces. The objective of this research activity is to develop simulation software that enables the creation of customized virtual environments and interaction with the Digital Twins of objects and people within those environments, simulating their behaviors and reactions to events. The activities will focus on analyzing existing simulators, designing the software architecture, and developing a preliminary version of the simulation software including basic functionalities.





Pili Giulia

Research Topic:

Study and Design of Interactive Virtual Environments for Developing Literacy Skills in Girls with Rett Syndrome.

Abstract:

The project, conducted in collaboration with the Italian Rett Syndrome Association (AIRETT), aims to develop a non-immersive virtual reality system based on eye-tracking technology to support cognitive rehabilitation in Rett syndrome patients. The software's objective is to strengthen the association between the graphical representation of common objects and their written forms through progressively complex exercises embedded in familiar and engaging contexts, thereby encouraging consistent training participation and maintaining patient focus. The work involves designing and creating 3D environments for the game scenarios, integrating eye-tracking technology, developing the mechanics underpinning the rehabilitation protocol, and implementing data logging for usage analysis and outcome assessment.

Pireddu Daniela

Research Topic:

Analysis and Implementation of Computer Vision Algorithms for Detecting Geometric Parameters and Color of Gluten-Free "Carasau" Dough.

Abstract:

The objective is to analyze in real time the geometric characteristics (diameter, thickness, regularity) and color features of the dough sheet, to ensure uniformity and qualitative consistency of the finished product. The activity involves the acquisition and processing of inline images, the development of algorithms to detect visual defects and color variations,





and integration with machine learning systems for automated quality control. The algorithms are validated on real samples, in collaboration with industrial partners.

Orrù Elisabetta

Research Topic:

Analysis of the State of the Art of Gluten-Free Flatbread Baking Techniques.

Abstract:

The objective is to study the challenges related to the absence of gluten and to identify innovative technological solutions to improve the quality of the final product. The activity includes the analysis of existing baking technologies, the identification of critical process parameters, and the exploration of new technologies such as smart sensors and radiofrequency systems. In parallel, the impact of different techniques on the sensory and nutritional quality of the product is being evaluated.

Urru Francesco

Research Topic:

Wearable Embedded Solutions and Home Automation Implementation for Biomedical Applications.

Abstract:

Smart and wearable devices are increasingly used in personalized and remote healthcare applications. As part of the STOPme project (Supporting Termination Of stereotyPies in patients with Rett syndrome by advanced ambient intelligence), the research grant aims to develop a wearable system for monitoring and recognizing hand stereotypies. To this end, the BlueCoin device by STMicroelectronics will be used for motion acquisition and local data processing. The complete system will also include a data collection hub and various actuators to stimulate the interruption of stereotypies.





Start activities: 2023

Caboni Renato

Research Topic:

Development and Testing of a Platform for XR Content Authoring.

Abstract:

The research activity is focused on the development of an authoring platform for extended reality (XR) content, aimed at the design and dissemination of immersive and interactive virtual environments, with particular attention to the enhancement of cultural heritage. The research concentrates on the development of tools and methodologies that enable even non-expert users to create realistic, navigable, and customizable XR experiences by integrating heterogeneous multimedia content (texts, images, sounds, videos, 3D models). A key area of the activity involves experimenting with advanced techniques for the digitization of physical spaces of historical, artistic, and architectural interest, using photogrammetry, LiDAR scanning, and specialized software for 3D modeling and interactive environment development. The workflow includes the reconstruction and optimization of geometries, followed by the integration of content into graphic engines, with the goal of delivering high-quality immersive experiences accessible across diverse hardware platforms, including non-professional systems. The overall objective of the research is to create an accessible, interoperable, and scalable platform capable of supporting multiple application scenarios, from education to experiential tourism and virtual museums, contributing to the creation of an open and participatory XR ecosystem. The work is part of the broader framework of the Cagliari Digital Lab, contributing to technological innovation in the service of culture and the promotion of the local territory.





Patta Valentino

Research Topic:

Security-Focused Classification of Network Traffic in IoT Environments.

Abstract:

The project aims to develop a network traffic classification system for IoT networks to detect malicious intrusions by analyzing heterogeneous traffic flows, particularly unencrypted ones. The goal is to create a classifier that delivers high performance in distinguishing between benign and malicious traffic, while maintaining low computational complexity to enable deployment at the network Edge. In this context, statistical methodologies based on a small number (maximum 3) of network/transport layer traffic features have been developed and tested on both publicly available datasets and industrial data collected by project partners.

Satta Gianluca

Research Topic:

Legal Impact of Emerging Technologies Between Cybersecurity and Data Protection.

Abstract:

The research activity, developed within the framework of the project “SERICS – Security and Rights in Cyber Space”, addresses the main legal issues of cybersecurity, cyberspace regulation, and data protection through a multidimensional methodological approach. It focuses in particular on the changing socio-economic context, shaped by the “risk society” and the global dialogue between cultures and legal systems, which relies on information technologies to safeguard individual and collective rights, as well as to enhance security levels. Furthermore, the research extends its exploratory analysis of cyberspace to the latest developments in emerging technologies, with particular attention to the protection of individuals both online and offline.

