I-RIM

PhD Course in ROBOTICS AND INTELLIGENT MACHINES

Curriculum: Industry 4.0

Research Themes

For larger companies, robotics has been a key productivity factor for many years. Today, thanks to the development of new enabling technologies from Industry 4.0—such as collaborative robotics and artificial intelligence—robotics is also becoming increasingly relevant for smaller industries, which are crucial to Italy's production and employment capacity.

Several drivers are accelerating the adoption of robotic technologies in industry, including the need for product customization, the demand for increased competitiveness in the global market, and the progressive integration of collaborative robots (cobots) into human-centered manufacturing environments. The introduction and spread of the Industry 4.0 production paradigm has further accelerated the use of robots, which now function as interconnected, highly digitized autonomous agents equipped with digital twins. These systems continuously improve their performance through data analysis from production processes.

The transition to Industry 5.0 will be marked by a shift from simple coexistence to full physical and social cooperation between machines and humans.

All these topics are addressed through an integrated and multidisciplinary approach in the projects proposed within this curriculum. They represent cutting-edge technological challenges that can be effectively tackled thanks to the scientific and technological expertise of the proposing institutions and the experience of the participating researchers.

The main goals of the Industry 4.0 curriculum are to:

- Promote technology transfer from research to industry, particularly in industrial sectors that can most benefit from robotics.
- Provide industry with the opportunity to help shape the research conducted by PhD students, as demonstrated by the high number of scholarships in this curriculum that are funded or co-funded by companies.
- Offer PhD students the opportunity to spend time working within the companies participating in the training program.

The research theme offered by the University of Genoa, the Italian Institute of Technology (IIT), the University of Catania, Leonardo S.p.A., CNR STIIMA, RINA Sp.A. will be awarded to the top applicants selected for this theme.

Ideal candidates are students with a Master's degree (or equivalent/higher qualification) in a STEM field; a background in Robotics or Mechatronics will be particularly valued.

Students will conduct their research project at the hosting institution (as described in the research project sheet). Interested students are encouraged to contact the tutors and/or the Unit's Principal Investigators for further information prior to submitting their application.

International applications are welcome, and participants will receive logistical support for visa issues, relocation, and related matters.

1. Dual Arm Manipulation for human-robot cooperative operations – University of Genoa

Curriculum:

Industry 4.0

Hosting Institution:

University of Genoa (Università degli Studi di Genova)

Department:

DIBRIS, Department of Informatics, Bioengineering, Robotics and Systems Engineering (https://dibris.unige.it/)

Tutor(s):

Prof. Giorgio Cannata

Description:

Collaborative robots (COBOTS) are used in industrial and service applications to accomplish tasks where human-robot cooperation (i.e. sharing a common space) or collaboration (i.e. physically interacting to complete a common action) is required. Between the different approaches to perform Human-Robot Cooperation, Bi-manual or multi-arm manipulation becomes the predominant technique for this type of applications.

The advantages of implementing Bi-manual or Dual arm manipulation (DAM) refers to the ability of transfer the skill of the human entity-operator to the robot in a more intuitive way, and in dual arm coordinated tasks, the use of dual arm manipulation allows to combine the task flexibility and dexterity of serial links, with the stiffness and strength of parallel manipulation while holding objects. (closed chain mechanism)

The PhD project has the goal to implement a dual arm/Bi manual control approach for coordinated tasks, while overcoming the principal issues when performing dual-arm manipulation, such as generating feasible configurations connected through each other (motion planning), internal forces acting while arms are holding objects, manipulators breaking and reinitializing contact with a common object(regrasping), among others.

The experimental scenario is based on a dual-arm robot (sensorized using cameras, tactile and proximity sensors) mounted on a mobile platform for assistive or domestic applications, sharing the space with a human operator to complete a series of operations involving contact of the robot with the environment.

Requirements:

Applicants must have a good knowledge of robotics fundamentals and robot programming. Applicants are also expected to have good programming skills (possibly including Python, C/C++, Matlab/Simulink), confidence with electronic hardware and be capable to conduct experiments, and a strong attitude to problem solving.

References:

1. Zhang, J., Xu, X., Liu, X., & Zhang, M. (2018, December). Relative dynamic modeling of dual-arm coordination robot. In *2018 IEEE International Conference on Robotics and Biomimetics (ROBIO)* (pp. 2045-2050). IEEE.
2. Wang, J., Liu, S., Zhang, B., & Yu, C. (2019). Inverse kinematics-based motion planning for dual-arm robot with orientation constraints. *International Journal of Advanced Robotic Systems*, *16*(2), 1729881419836858.
3. Xian, Z., Lertkultanon, P., & Pham, Q. C. (2017). Closed-chain manipulation of large objects by multi-arm robotic systems. *IEEE Robotics and Automation Letters*, *2*(4), 1832-1839.

Number of positions available:

1

Main Research Site

MacLab, DIBRIS Department, University di Genoa, Via All'Opera Pia,13 - 16145 Genova, Italy.

Contacts:

Email: giorgio.cannata@unige.it

Funding Scheme: This doctorate grant is by the University of Genova.

Scholarship Amount:

- Fascia 4: 19,500 €/year

2. Active, distributed and recursive reasoning models for cognitive robots - University of Genoa

Curriculum:

Industry 4.0

Hosting Institution:

University of Genoa (Università degli Studi di Genova)

Department:

DIBRIS, Department of Informatics, Bioengineering, Robotics and Systems Engineering (https://dibris.unige.it/)

Tutor(s):

Prof. Fulvio Mastrogiovanni

Description:

The ability for an autonomous robot to act proactively in its surrounding and while interacting with humans is vital to be effective. Providing robots with adequate knowledge in a wide range of scenarios and situations is very expensive, both in terms of effort to provide and encode knowledge, and for what concerns the time it takes to do so. At the research level, the current situation is robots able to perform skillfully in very narrow tasks, if provided with Artificial Intelligence (AI) models trained on a huge amount of data.

Novel approaches to design and develop cognitive architectures for robots, and in particular advanced reasoning models, seem to exacerbate this issue. Advanced multi-modal AI models, such as for instance OpenVLA [1], leverage Large Language Models (LLMs) to encode qualitatively different information (such as a linguistic description of tasks, their visual unfolding, and the related robot joint states) to generate task descriptions specifically tailored for the goal to achieve, the robot embodiment, and its (visual) perception. Even when training is successful, the result task is very narrow and specialized, despite showing up impressive capabilities.

Building up on such advanced multi-modal AI models, this PhD thesis aims to design and develop reasoning capabilities for robots inspired by theories about human cognition. In particular, we want to investigate 1) the general structure of a robot cognitive architecture informed by the principles of active sensing and inference, interactive and distributed processing, and recursion, as well as 2) the existence of general-purpose “algorithm” which, operating continuously, can lead to flexible and adaptable robot behavior. To attain these goals, the specific research topics may include one or more of the following:

- active sensing strategies: inspired by the paradigm of Active Inference [2], sensing will be treated as an active process aimed at reducing the uncertainties associated with the robot’s own knowledge; this could lead to planning and execute sensing behavior based on the status of the robot knowledge;
- action-oriented knowledge representation: likewise, robot knowledge must be actionable, that is, being acquired and encoded such that knowledge-based action is facilitated and less computationally effortful; specific metrics to evaluate robot knowledge in terms of uncertainty, accuracy, and actionability will have to be investigated;

- distributed and concurrent AI reasoning models: while current multi-modal AI models are of a “one-size-fits-all” nature, this PhD thesis will investigate how to orchestrate and combine the results of multiple, possibly specialized, (multi-modal) AI models, all of them running concurrently; this will lead to the possibility of investigating matters related to “inner speech”, that is, using integrated linguistic-level descriptions of the data flow emerging from these models;
- hierarchical approaches to sensing, reasoning, and action: it will be posited here that the overall robot behavior will be obtained assuming that such orchestration be of a hierarchical nature, that is, instead of assuming a centralized “algorithm” to schedule how sensing modules, multi-modal AI models, and action models, all of them will be considered as components which can be invoked by each other recursively [3];
- “intrinsic” behavioral models: we will posit that such distributed, hierarchical nature will be driven by normative goals and objectives, which will have to be satisfied by the concurrent behavior of all components.

Key challenges to be addressed may include:

- Identification of key strategies in active sensing, for example to integrate vision and tactile information in active sensing, representation, and action models;
- hybrid, multi-modal, continuous-discrete knowledge representation approaches, possibly informed by strategies implemented in biological beings to efficiently ground actions;
- approaches to integrate the outcome of concurrent AI reasoning models, possibly inspired by such decentralized formalisms as Cellular Automata and alike [4];
- design and formalization of hierarchical approaches to modelling robot behavior, with the aim of a seamless integration of sensing, reasoning, and action modules;
- ways of embedding normative goals and objective such that to be compatible with active, hierarchical and distributed modules.

The developed techniques and methods will be validated through simulations and real-world

Experiments. Scenarios will include humanoid robots able to interact with their environment, for example in in-home or industry settings.

Requirements:

Candidates should have a degree in Robotics Engineering, Computer Engineering, or related study programs. Applicants are expected to be proficient in software design and development (software architectures for robots, C/C++, Python), artificial intelligence techniques for robots, sensing, reasoning, and motion planning and execution. The ideal candidate is proficient computer vision, tactile sensing, knowledge representation, concurrent and recurrent processes.

References:

1. M. J. Kim, K. Pertsch, S. Karamcheti, T. Xiao, A. Balakrishna, S. Nair, R. Rafailov, E. Foster, G. Lam, P. Sanketi, Q. Vuong, T. Kollar, B. Burchfiel, R. Tedrake, D. Sadigh, S. Levine, P. Liang, C. Finn. OpenVLA: an open-source vision-language-action model. arXiv:2406.09246, 2024.
2. T. Parr, G. Pezzulo, K. Friston. Active Inference: The free energy principle in mind, brain, and behavior. MIT Press, 2022.
3. H. Karami, A. Thomas, F. Mastrogiovanni. A task and motion planning framework using iteratively deepened AND/OR graph networks. Robotics and Autonomous Systems 189, 104943, 2025.

4. A. Ilachinski. Cellular Automata: A discrete universe. World Scientific, 2001.
Number of positions available: 1
Main Research Site TheEngineRoom Lab (https://theengineroom.dibris.unige.it/), DIBRIS Department, University of Genoa, Viale Francesco Causa, 16145, Genova, Italy.
Contacts: Emails: fulvio.mastrogiovanni@unige.it
Funding Scheme: This doctorate grant is funded by the University of Genova.
Scholarship Amount: • Fascia 4: 19,500 €/year

3. Cooperative models and control in human-robot collaboration scenarios – Università di Genova

Curriculum:

Industry 4.0

Hosting Institution:

University of Genoa (Università degli Studi di Genova)

Department:

DIBRIS, Department of Informatics, Bioengineering, Robotics and Systems Engineering (https://dibris.unige.it/)

Tutor(s):

Prof. Enrico Simetti, Prof. Fulvio Mastrogiovanni

Description:

Effective human-robot collaboration requires the development of sophisticated models that enable robots to understand and predict human behavior, facilitating seamless and safe interaction. While humans utilize adaptable cognitive models to collaborate with each other, replicating such models in robotic systems remains an evolving research challenge. This research proposal focuses on creating integrated cognitive models that merge human behavior analysis, motion perception, and task-priority management. These models will equip robots with the ability to adapt dynamically to the changing conditions of collaboration and different operational contexts.

The research is developed along two main directions. In the first, the aim is to design integrated cognitive models for task recognition and behavior prediction using machine learning techniques, such as convolutional neural networks for processing video data and recurrent neural networks for time-series sensor data. This will allow robots to perceive human actions, infer intentions, and predict potential future states of the collaboration. Additionally, leveraging in-the-loop simulations and digital twin technology will enable real-time assessment of ergonomics and interaction patterns, enhancing the robot's capacity to anticipate complex scenarios and respond with appropriate adjustments. This research will start from previous work [1].

In the second, task-priority-based control will be implemented to manage complex multi-robot scenarios, balancing safety, ergonomic considerations, and task objectives. This involves optimizing the robot's real-time response to concurrent demands, enabling it to maintain a balance between various goals and constraints. In particular, the idea is to work on optimization and reinforcement learning algorithms to tune the gains and priority of such control frameworks [2,3].

Requirements:

Applicants are expected to have strong programming skills (including Python, C/C++), a good background in control, software development and machine learning.

References:

1. Darvish, K., Wanderlingh, F., Bruno, B., Simetti, E., Mastrogiovanni, F., & Casalino, G. (2018). Flexible human–robot cooperation models for assisted shop-floor tasks. Mechatronics, 51, 97-114.
2. Karimi, M., & Ahmadi, M. (2021). A reinforcement learning approach in assignment of task priorities in kinematic control of redundant robots. IEEE Robotics and Automation Letters, 7(2), 850-857.
3. Penco, L., Hoffman, E. M., Modugno, V., Gomes, W., Mouret, J. B., & Ivaldi, S. (2020). Learning robust task priorities and gains for control of redundant robots. IEEE Robotics and Automation Letters, 5(2), 2626-2633.

Number of positions available: 1

Main Research Sites

GRAAL (https://graal.dibris.unige.it/) and TheEngineRoom (https://theengineroom.dibris.unige.it/), DIBRIS Department, University of Genoa, Via all'Opera Pia 13, 16145, Genova, Italy.

Contacts:

Email: enrico.simetti@unige.it, fulvio.mastrogiovanni@unige.it

Funding Scheme: This doctorate grant is funded by the DIBRIS Department (Project PRIN 2022 CONCERTO – A COgNitive arChitecture for sEamless human-Robot inTeractiOn)

Scholarship Amount:

- Fascia 4: 19,500 €/year

4. Adaptive and interactive task planning in robots enhanced by LLMs and VLMs – Italian Institute of Technology (IIT)

Curriculum:

Industry 4.0

Hosting Institution

Italian Institute of Technology (Istituto Italiano di Tecnologia)

Department:

Human-Robot Interfaces and Interaction (https://hri.iit.it/)

Tutor(s):

Dr. Arash Ajoudani

Description:

To support the broader integration of robotics across diverse domains, there is a critical need for programming frameworks that are accessible to non-experts. This dissertation investigates a novel human-in-the-loop approach that leverages both **Vision-Language Models (VLMs)** and **Large Language Models (LLMs)** to enhance robot plan generation from single RGB video demonstrations. While observational learning allows for intuitive transfer of human skills, vision-based approaches alone, particularly from limited demonstrations, can suffer from ambiguity, lack of generalization, and susceptibility to failure. In the proposed PhD theme, VLMs extract task-relevant information from video input, generating an initial robot execution plan. This plan is then interactively refined through natural language dialogue with an LLM, which incorporates user-specified goals, constraints, or safety considerations using its commonsense reasoning capabilities. This iterative refinement process not only mitigates failure risks inherent in vision-only systems but also enables plan adaptation without requiring further demonstrations. By integrating VLMs and LLMs in a synergistic pipeline, this PhD research will contribute a scalable, accessible methodology for robust robot learning from demonstration.

Requirements:

The successful candidate must have an MSc degree with a strong background in Robotics, Machine Learning and/or computer vision.

The successful candidate should have:

- Good skills on C++ and Python
- Experience with ROS
- Confidence with version control tools (specifically git)
- Good communication skills and ability/willingness to integrate within a multidisciplinary international research group
- Good knowledge of written and spoken English.

References:

1. Merlo E, Lagomarsino M, Lamon E, Ajoudani A. Exploiting Information Theory for Intuitive Robot Programming of Manual Activities. IEEE Transactions on Robotics. 2025 Jan 15.

2. Merlo E, Lagomarsino M, Ajoudani A. Information-Theoretic Detection of Bimanual Interactions for Dual-Arm Robot Plan Generation. IEEE Robotics and Automation Letters. 2025 Mar 17.
3. Merlo E, Lagomarsino M, Lamon E, Ajoudani A. Automatic interaction and activity recognition from videos of human manual demonstrations with application to anomaly detection. In2023 32nd IEEE International Conference on Robot and Human Interactive Communication (RO-MAN) 2023 Aug 28 (pp. 1188-1195). IEEE.

Number of positions available:

1

Main Research Site

Center for Robotics and Intelligent Systems (CRIS), Istituto Italiano di Tecnologia, via San Quirico 19D, 16163, Genova, Italy.

Contacts:

Email: arash.ajoudani@iit.it

Funding Scheme: This doctorate grant is funded by the Italian Institute of Technology.

Scholarship Amount:

- Fascia 4: 19,500 €/year

5. Machine Learning for Cross-Modal Sensory Substitution in Robotic Manipulation and Human-Robot Interaction – Italian Institute of Technology (IIT)

Curriculum:

Industry 4.0

Hosting Institution

Italian Institute of Technology (Istituto Italiano di Tecnologia)

Department:

Human-Robot Interfaces and Interaction (https://hri.iit.it/)

Tutor(s):

Dr. Arash Ajoudani

ISTITUTO ITALIANO DI TECNOLOGIA

Description:

Modern robotic systems often rely on specific sensor modalities, such as vision, force, or tactile feedback, for task execution. However, these sensors can fail, degrade, or become unsuitable in dynamic or constrained environments. This dissertation investigates the use of machine learning for cross-modal sensory substitution, enabling robots to perform manipulation tasks by replacing or augmenting a missing or unreliable sensory channel with an alternative modality. Inspired by human sensory plasticity and substitution (e.g., reading Braille by touch or perceiving obstacles through echolocation), the proposed research develops models that allow robots to adaptively remap information from one sensor (e.g., audio, proprioception, or visual input) to substitute another (e.g., tactile or force feedback).

By training deep models on multi-sensor data in diverse manipulation contexts, the system learns to preserve task-relevant features across modalities and generalizes substitution strategies to unseen objects and environments. The research further explores how such substitution frameworks can support resilient human-robot interaction, allowing shared autonomy even when critical sensory pathways are impaired or unavailable. Evaluation is conducted across representative HRI tasks, including collaborative assembly and shared tool use, demonstrating how robots can “feel” through sight or “see” through force, while preserving task accuracy and safety.

Requirements:

The successful candidate must have an MSc degree with a strong background in Robotics, Machine Learning and/or computer vision.

The successful candidate should have:

- Good skills on C++ and Python
- Experience with ROS
- Confidence with version control tools (specifically git)
- Good communication skills and ability/willingness to integrate within a multidisciplinary international research group

- Good knowledge of written and spoken English.

References:

1. Ozdamar I, Sirintuna D, Ajoudani A. A Machine Learning Approach to Sensor Substitution for Non-Prehensile Manipulation. arXiv preprint arXiv:2502.09180. 2025 Feb 13.

Number of positions available:

1

Main Research Site

Center for Robotics and Intelligent Systems (CRIS), Istituto Italiano di Tecnologia, via San Quirico 19D, 16163, Genova, Italy.

Contacts:

Email: arash.ajoudani@iit.it

Funding Scheme: This doctorate grant is funded by the Italian Institute of Technology.

Scholarship Amount:

- Fascia 4: 19,500 €/year

6. Collaborative robotics for the processing of natural and technical surfaces – Università di Catania

Curriculum: Industry 4.0	
Hosting Institution: University of Catania (Università di Catania)	
Department: Dipartimento di Ingegneria Civile e Architettura (https://www.dicar.unict.it/en)	
Tutor(s): Prof. Alessandro Cammarata, Prof. Rosario Sinatra	

Description:

Nerosicilia Group, a leading Italian manufacturer with over twenty years of expertise in natural and technical surface production, seeks to integrate collaborative robotics (cobots) to enhance manufacturing efficiency while supporting workers in repetitive assembly operations. The company's specialization in custom-made solutions requires flexible automation that preserves skilled craftsmanship while improving operational performance.

The primary challenge in surface manufacturing lies in repetitive assembly tasks that subject workers to physical strain and ergonomic stress. Current industrial robots lack the flexibility required for custom production, while traditional automation cannot adapt to varying product specifications. Collaborative robotics presents an innovative solution by combining robotic precision with human adaptability and decision-making capabilities.

This project aims to develop and implement cobot applications specifically designed for surface manufacturing environments. Key research areas include adaptive material handling systems for varying surface dimensions and compositions, precision assembly support mechanisms that maintain quality across diverse custom projects, and intelligent workflow coordination systems that optimize human-robot collaboration. The research will explore specialized end-effectors and sensing systems designed for handling natural stone, engineered surfaces, and technical materials.

Advanced sensing technologies will enable real-time adaptation to different materials and processing requirements. Computer vision systems will support quality inspection, while force feedback mechanisms will ensure delicate material handling. Furthermore, optimization algorithms in virtual environments with digital twins will enhance processes.

Requirements:

The ideal candidate would have a Master Degree in Mechanical Engineering, Management Engineering or Industrial Automation Engineering. Applicants are expected to have a knowledge of mechatronics, software programming, and the most up-to-date industrial automation systems are required. Proficiency in Python and ROS (Robot Operating System) is essential. Strong analytical capabilities and experience with CAD software and simulation tools are preferred

References:

1. Bolton, William. Mechatronics: electronic control systems in mechanical and electrical engineering. Pearson Education, 2018
2. Lyshevski, Sergey Edward. Mechatronics and Control of Electromechanical Systems, CRC Press, 2020.
3. M. Bdiwi, M. Pfeifer, and A. Sterzing, "A new strategy for ensuring human safety during various levels of interaction with industrial robots," CIRP Annals, vol. 66, 2017.
4. A. Ajoudani et al., "Progress and prospects of the human–robot collaboration," Autonomous Robots, vol. 42, 2018.

Company name and link (for industrial projects):

Nerosicilia Group srl (https://nerosicilia.com/)

Number of positions available:

1

Main Research Site

Nerosicilia Group srl, Sp Comiso-Chiaramonte Km 6.800, Chiaramonte Gulfi (RG) 97012 Italy

University of Catania, DICAR, Cittadella universitaria Via Santa Sofia, 64 – 95123, Catania, Italy.

Contacts:

Email: alessandro.cammarata@unict.it; rosario.sinatra@unict.it

Funding Scheme: This doctorate grant is funded by the University of Catania (through external funds of Nerosicilia Group srl).

Scholarship Amount:

- Fascia 4: 19,500 €/year

7. Using AI to detect defects on the composite using optical and acoustic sensors – Leonardo S.p.A., CNR STIIMA

Curriculum: Industry 4.0	
Hosting Institution: Leonardo S.p.A.	
Department: Leonardo Divisione Aerostrutture	
Tutor(s): Dr. Davide Chirico (Leonardo), Dr. Vito Renò (CNR STIIMA)	

Description:

Production processes for aircraft manufacturing, although strictly supervised and inspected, can in some cases create defects in the final product that could impact quality, safety, and performance. Unexpected events could further damage or break some components of the aircraft. Therefore, it is mandatory to research for cutting-edge quality control and support systems for enhancing the aerospace production line support, for example integrating AI-empowered techniques as well as computer vision ones.

As an example, in order to improve sustainability in manufacturing (e.g. reduction of material waste; reduction of energy consumption; increase of quality levels) in combination with business productivity, costs reduction and quality assurance, AI-based models to support the monitoring of drilling operation and visual inspection of fuselage defects can be investigated and developed. Moreover, for increased lifetime of machinery and improved product quality, monitoring of critical machine and product parameters and developing AI-based models to support the monitoring of operations and visual inspection need to be investigated, designed and developed.

The objective of this PhD will span from the requirements definitions and applications for new sensors to the development of AI models. The sensors that will be installed into manufacturing processes, in accordance to the principles of not duplicating information (one variable will be measured by one type of sensor), considering possible redundancies for better accuracy, and will be designed in order to acquire data in the most straightforward possible way. LEONARDO will share its experience with CNR STIIMA to have a standard and cross-sectional work approach. In particular, the evaluation of proper devices for sensing and perception to be integrated to capture 1D, 2D and 3D quality data (microphones, stereo cameras, lidar, etc…) considering possible inputs from the field and the application (e.g. resolution, accuracy, framerate, synchronisation, calibration and context constraints).

Particular attention will be devoted to the design and development of the tools/setups for acquiring data from the manufacturing line from a technological point of view focused on vision hardware and processing algorithms. Among them, both AI/ML techniques will be evaluated, as well as standard computer vision approaches for collecting data and extracting meaningful features.

The development of AI-driven systems acting as serving systems in the real world—e.g., addressing industrial needs—requires following a rigorous strategy and development methodology. Many different aspects such as proper translation of the system requirements to ML requirements, assuring the quality of the data as well as a proper deployment setup, considering adequate measures for addressing data and model drift and finally assuring trustworthiness and handling ethical aspects in relation to processing individuals' data are all to be satisfied and managed decently.

The approach will be highly multidisciplinary as it will span across different disciplines: computer vision, software engineering, data science, AI and machine learning, optimization, simulation and quality control under the common reference application scenario of aerospace production line support.

Requirements:

Applicants are expected to have a background in computer science, computer engineering or information engineering (or equivalent). Applicants are expected to know programming languages (e.g. python) and object-oriented programming. Applicants should preferably have studied and applied machine learning or deep learning models. Applicants should preferably be familiar with popular libraries such as opencv, pytorch, pandas, scikit-image or scikit-learn.

References:

1. Cheng, X., Ma, G., Wu, Z., Zu, H., & Hu, X. (2023). Automatic defect depth estimation for ultrasonic testing in carbon fiber reinforced composites using deep learning. NDT & E International, 135, 102804.
2. Liso, A., Patruno, C., Cardellicchio, A., Ardino, P., Gallo, N., Del Prete, G., ... & Renò, V. (2025). A Deep Learning based Probabilistic Approach for Non-Destructive Testing of Aircraft Components using Laser Ultrasonic Data. IEEE Access.
3. Saeed, N., King, N., Said, Z., & Omar, M. A. (2019). Automatic defects detection in CFRP thermograms, using convolutional neural networks and transfer learning. Infrared Physics & Technology, 102, 103048.

Company name and link (for industrial projects):

Leonardo S.p.A. (https://www.leonardo.com/it/home)

Number of positions available:

1

Main Research Site

Leonardo, Strada Provinciale, 83, 74023 Grottaglie (TA);

CNR Stiima, Via Giovanni Amendola 122/D - 70126 Bari (BA)

Contacts:

Email: Davide Chirico: davide.chirico@leonardo.com, Vito Renò: vito.reno@cnr.it

Funding Scheme: This doctorate grant is funded by Leonardo S.p.a.

Scholarship Amount:

- Fascia 3: 18,500 €/year

8. Large Language Models and Sensor-Enhanced Artificial Intelligence for Talent Discovery and Bias-Aware Recruitment – RINA S.p.A., University of Genoa

Curriculum:

Industry 4.0

Hosting Institution:

RINA S.p.A.

University of Genoa

Department:

RINA S.p.A.: Human Resource Department

University of Genoa: DIBRIS, Department of Informatics, Bioengineering, Robotics and Systems Engineering (https://dibris.unige.it/)

Tutor(s):

Dr. Alessandro Galvani (RINA), Prof. Carmine Tommaso Recchiuto (UNIGE)

Description:

This research addresses two main questions related to the key phases of talent discovery and recruitment: Curriculum Vitae (CV) analysis and interviews.

Q1: Can Large Language Models (LLMs) transform how recruiters explore and interpret large-scale CV corpora—moving beyond rigid keyword searches to enable flexible, contextual, and semantically rich talent discovery?

Q2: May real-time reasoning systems support recruiters in their work by a) integrating multiple sources of information, b) helping interpret key cognitive and personality traits of candidates, and c) limiting the subjectivity of the evaluation process by providing objective, data-driven insights, which, among other benefits, may help reduce discrimination against underrepresented groups and enhance inclusion?

The first research question (Q1) addresses a fundamental limitation in traditional software to manage recruitment: their reliance on keyword-based filtering mechanisms, which often miss candidates with adjacent or analogous experiences. While a recruiter reading CVs "with an open mind" might connect the dots between roles, industries, or competencies, current tools cannot replicate this intuitive reasoning. To address this, the project proposes the development of a semantic CV exploration tool powered by LLMs**.** The tool should support:

- **Professional analogy**: If a person has done X, they might know how to do Y (e.g., stakeholder engagement → recruiting).
- **Sector proximity, cross-role, and adjacent skill discovery:** Identifying candidates from adjacent industries or for roles different from their previous positions — especially in cases where skill transfer is common but not immediately apparent.

Rather than acting as a replacement for recruiters, the system will serve as an **augmentation tool**, surfacing valuable profiles that might otherwise be overlooked.

The research will explore LLMs as the system's core reasoning engine, which will be responsible for understanding and analyzing the often messy and unstructured text found in CVs. This will enable the platform to retrieve profiles not simply on exact matches, but on semantic proximity—surfacing candidates who may not have identical job titles or employers, but whose career paths suggest they hold relevant or analogous competencies. The solution will **integrate directly with the SAP SuccessFactors platform** for human capital management.

After analyzing the **state-of-the art** in AI-driven recruitment, the research will address:

- **Recruiter-Centered Design**: Conduct focus groups with RINA recruiters to understand strategies of "open-minded" CV reading, and identify key gaps in current technology for CV searching.
- **LLM Tuning**: Extract and preprocess the CV corpus from SAP SuccessFactors. Fine-tune or develop domain-specific prompt for LLMs (e.g., GPT, LLaMA, Claude) using real CVs.
- **Prototype Development and Testing**: Develop a system and user interface that support semantic CV search and natural language queries. Incorporate transparency features to explain why each candidate was retrieved (e.g., following the explainable AI paradigm).
- **Evaluation and Iterative Refinement**: Measure the usefulness, relevance and diversity of the retrieved candidates, also by assessing their job performance over time.

The second research question (Q2) arises from the complexity of recruitment interviews, where human judgment often blends with incomplete or biased information. Specifically, when dealing with junior profiles, technical expertise may be limited, making it essential to **assess candidates' potential**, their ability to manage stress and conflict, and their capacity to connect different elements under pressure. Some of these traits may emerge from standardized assessment tools based on personality, cognitive, deductive, and language skills tests, which place candidates on percentile-based scales. Other essential skills—such as real-world problem-solving—are harder to measure objectively and require custom case studies, which **RINA recruiters develop specifically to assess a candidate's ability** to handle complex problems under pressure.

Despite recruiters being trained to remain as unbiased as possible, candidate evaluation is still influenced by subjective biases stemming from past experiences, values, beliefs, and stereotypes that even trained professional recruiters cannot completely eliminate. Recruiters' impressions ("I like this candidate" / "I don't like this candidate") are often influenced more by how the candidate presents themselves, rather than by the candidate's actual characteristics. This research therefore **aims to minimize, as much as possible, the unavoidable subjectivity of human evaluation**.

To support recruiters in their work, the second phase of the project will develop new sensor-based systems and Artificial Intelligence (AI) tools that combine verbal, vocal, and visual signals to detect elements not identifiable through traditional interviews, including:

- **Text analysis** of the interview using linguistic models.
- **Analysis of prosodic features** such as volume, pauses, and rhythm.
- **Analysis of body and facial movements, gestures, and posture.**
- **Detection of visual cues** such as dress style, earrings, and tattoos.

These elements will serve as inputs to predictive systems designed to **support recruiters in evaluating candidates and understanding factors that may bias their own assessments**. The system is not intended to replace the recruiter's role: **recruiters will remain central to interpretation**, which is crucial for fostering trust in the system and encouraging its adoption.

After analyzing the **state-of-the art** in audio and visual behaviour analysis, the research will follow these phases:

- **Sensor-based systems design** to acquire multimodal behavioral data during interviews.
- **Development and refinement of AI models** inspired by FAIR Machine Learning and explainable AI techniques.
- **Evaluation of the system by collecting data from multiple interviews** across various departments and analyzing them with the developed models to ensure consistency in evaluations by identifying recruiters' biases.

The research will be carried out in collaboration with RINA's Human Resources department, leveraging their expertise and real-case scenarios to guide system design and validation.

Requirements:

Applicants should possess strong programming and data analysis skills (Python preferred), as well as a solid background in Human-Computer Interaction, machine learning, or cognitive science. Experience with natural language processing, affective computing, or behavioral analysis will be considered a plus.

References:

1. Ara A. Human Resource Management in the Age of Generative AI (2025) Human Resource Management in the Age of Generative AI, pp. 1 - 289
2. Chen H., Liu D. Practice of Artificial Intelligence Technology in Enterprise Human Resource Management (2025) Lecture Notes in Electrical Engineering, 1355 LNEE, pp. 188 - 198
3. Ascarza E., Israeli A. Eliminating unintended bias in personalized policies using bias-eliminating adapted trees (BEAT) (2022) Proceedings of the National Academy of Sciences of the United States of America, 119 (11)

Company name and link (for industrial projects):

RINA S.p.A., Registro Italiano navale (https://www.rina.org/en)

Number of positions available:

1

Main Research Site

RINA, Registro Italiano navale, Via Corsica 12, 16128 – Genova, Italy.

Contacts:

Email: Alessandro Galvani (RINA) alessandro.galvani@rina.org, Elisabetta Bottazzi, elisabetta.bottazzi@rina.org Carmine Recchiuto (UNIGE) carmine.recchiuto@dibris.unige.it

Funding Scheme: This doctorate grant is funded by RINA S.p.A.

Scholarship Amount:

- Fascia 2: 17,500 €/year

9. Smart logistics: intelligent SLAM for indoor-outdoor control of mobile robots – Leonardo SpA and University of Genoa

Curriculum: Industry 4.0	 
Hosting Institution: Leonardo S.p.A. University of Genoa (Università degli Studi di Genova)	
Department: Robotics Laboratory, Innovation Hub & Intellectual Property DIBRIS, Department of Informatics, Bioengineering, Robotics and Systems Engineering https://dibris.unige.it/	
Tutor(s): Dr. Navvab Kashiri (Leonardo), Prof. Fulvio Mastrogiovanni (UNIGE)	

Description:

Hybrid, indoor-outdoor localization is vital for smart logistics scenarios, in which mobile robots must move into large, often interconnected facilities spanning both indoor spaces and outdoor loading or staging areas. Ensuring an accurate and robust localization across these environments enables efficient workflow management, automated material handling, and reliable autonomous navigation for tasks such as mapping, exploration, material transport, and patrolling.

Differences between indoor and outdoor environments add complexity to the localization task, as each scenario may require tailored techniques and specific sensors. Transitions between these types of environments are especially challenging, since the robot must maintain a continuous and reliable pose estimation despite the abrupt change in workspace conditions, employed sensors and reliability in data. An example is transitioning from a narrow GNSS-denied aisle to a wide GPS-enabled loading dock.

In indoor scenarios, mobile robots typically rely on visual Simultaneous Localization and Mapping (SLAM), and/or LiDAR-based techniques. Outdoor operations, on the other hand, frequently incorporate GNSS signals for large-scale localization while dealing with varying light, weather, and less-structured surroundings.

This PhD thesis aims to design and develop a robust and adaptable localization and navigation framework that ensures a seamless state estimation for mobile robots operating in highly dynamic logistics environments, thereby supporting reliable autonomous operations across indoor-outdoor transitions. The research topics may include:

- sensor fusion: combining LiDAR, vision, IMU, and GNSS based sensing to ensure a robust navigation despite individual sensor failures, unreliability, or limitations;

- multi-map management: enabling efficient switching or fusion between maps suited for indoor warehouses and outdoor loading areas;
- adaptive parametrization: dynamically adjusting perception, localization, and navigation parameters in response to environmental changes, such as lighting and weather;
- semantic localization: leveraging high-level scene understanding (e.g., detecting aisles, gateways, and/or specific features in the environment) for more context-aware and accurate localization;
- hybrid, topological–metric mapping: integrating a global topological map with detailed metric maps, ensuring both scalability in terms of map size, and local precision;
- learning-based localization: investigating deep learning or reinforcement learning methods that can adaptively predict the robot pose or refine the interpretation of sensor data based on prior operational data.

Key challenges to be addressed include:

- variations in lighting conditions;
- sensor unavailability or temporary outages (e.g., GNSS signal loss);
- uncertainty in robot motion due to partially unstructured environments;
- differences in environmental features and structures.

Special attention will be devoted to integrating these localization strategies with the navigation systems of both wheeled and legged mobile robots now commonly used in logistics settings. The proposed methodologies will be validated through simulations and real-world experiments, ensuring relevance and practical impact in representative test environments that span the indoor-outdoor continuum.

Requirements:

Candidates should have a degree in Robotics Engineering, Computer Engineering, or related study programs. Applicants are expected to be proficient in software design and development (software architectures for robots, C/C++, Python), artificial intelligence techniques for robots, perception, reasoning, and motion planning and execution. The ideal candidate is proficient in SLAM and machine learning.

References:

1. H. Karami, A. Thomas, F. Mastrogiovanni. A task and motion planning framework using iteratively deepened AND/OR graph networks. Robotics and Autonomous Systems 189, 104943, 2025.
2. A. Thomas, G. Ferro, F. Mastrogiovanni, M. Robba. Computational tradeoff in minimum obstacle displacement planning for robot navigation. Proc. 2023 IEEE Int. Conf. on Robotics and Automation (ICRA), 2023.
3. A. Thomas, F. Mastrogiovanni, M. Baglietto. Safe motion planning with environment uncertainty. Robotics and Autonomous Systems 156, 104203.

Company name and link (for industrial projects):

Leonardo S.p.A., https://www.leonardo.com

Number of positions available:

1

Main Research Site

Intelligent Autonomous System, Leonardo Innovation Labs, Via Raffaele Pieragostini, 80, 16151 - Genova, Italy.

TheEngineRoom Lab, DIBRIS Department, University of Genoa, Viale Francesco Causa, 16145, Genova, Italy.

Contacts:

Emails: Fulvio Mastrogiovanni: fulvio.mastrogiovanni@unige.it, Navvab Kashiri: navvab.kashiri@leonardo.com

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Scholarship Amount:

- Fascia 1: 16,500 €/year