

SPECIES Scholarships – Advisor/Host Institution Application

1. Short CV of the advisor

PERSONAL INFORMATION

Family name/surname: Giovanni Iacca

Personal web site: <https://sites.google.com/site/giovanniacca/>

EDUCATION

2022 Italian Habilitation as Full Prof. in Comp. Science
2017 Italian Habilitation as Assoc. Prof. in Comp. Science & Comp. Engineering
2011 PhD in Mathematical Information Technology, University of Jyväskylä, Finland

WORK EXPERIENCE

2018 – Associate Professor, University of Trento
2017 – 2018 Postdoctoral Researcher, RWTH Aachen University, Germany
2013 – 2016 Postdoctoral Researcher, University of Lausanne and EPFL, Switzerland
2012 – 2016 Postdoctoral Researcher, INCAS³, The Netherlands
2006 – 2009 Software Engineer, Sintesi SCpA, Bari, Italy

TEACHING ACTIVITIES

2022 – Lecturer, "Optimization Techniques", Univ. of Trento (MSc)
2019 – Lecturer, "Computer Architectures", Univ. of Trento (BSc)
2018 – Lecturer, "Bio-Inspired Artificial Intelligence", Univ. of Trento (MSc)
2014 – 2016 Teaching assistant, "Bio-Inspired Artificial Intelligence", EPFL (MSc)
2014 – 2016 Teaching assistant, "Mobile Robots", EPFL (MSc)
2009 – 2010 Lecturer, "Protocols & fieldbus", CNR Master's Degree in Industrial Research

AWARDS (SELECTED)

2017 Evostar 2017 Best Paper Award
2012 UKCI AWARENESS Best Paper Award

GRANTS (SELECTED)

2023 – 2024 Co-PI of CISCO project "Toward compressed VTs for domain generalization"
2022 – 2026 Co-PI and WP leader of PATHFINDER-CHALLENGE project "SUSTAIN"
2022 – 2023 Co-PI of AI@TN project "Inference and Training at the Edge"
2015 – 2019 Co-PI and WP leader of FET-OPEN project "PHOENIX"

ORGANIZATION OF SCIENTIFIC MEETINGS (SELECTED)

2017 – Co-organizer of tracks/special sessions for Evostar and GECCO

REVIEWING ACTIVITIES (SELECTED)

- Panel member for scientific conferences, such as: CEC, SSCI, GECCO, PPSN, Evostar, ALIFE, SAC, WIVACE, MSC, WICT, ICCSII, ICA, TIME-E, SEMCCO, SCIS-ISIS, ISDA, etc.
- Reviewer for scientific journals, such as: Scientific Reports, IEEE Trans. on Evolutionary Computation, IEEE Trans. on Cybernetics, Engineering Optimization, Information Sciences, Expert Systems with Applications, Applied Soft Computing, Soft Computing, Information Sciences, Swarm and Evolutionary Computation, PLOS ONE

MEMBERSHIPS OF SCIENTIFIC SOCIETIES (SELECTED)

ELLIS, SPECIES, ACM, IEEE, CIS, CINI, EURO working groups (Metaheuristics, Continuous Optimization, Data Science Meets, Stochastic Optimization, Network Optimization)

2. Description of the research group

The visiting PhD student will be hosted in the Distributed Intelligence and Optimization Lab (DIOL) at the Department of Information Engineering and Computer Science (DISI) of the University of Trento (UNITN), Italy. The group is led by Prof. Giovanni Iacca, and its main research focus is on **computational intelligence, explainable AI, machine learning, distributed systems**, and applications thereof. The PI is also actively involved in dissemination and teaching activities in the field of computational intelligence and optimization. Every year Prof. Iacca gives an elective Master course on "Bio-Inspired Artificial Intelligence" (6 ECTS), which is attended on average by more than 30 students (of which approximately one third are international) with different backgrounds, i.e., Computer Science, Data Science, TLC Engineering, Quantitative & Computational Biology, Mathematics, and Physics. The course is considered by the students one of the most interesting Master courses given at DISI.

The DIOL currently (May 2023) hosts **9 PhD candidates, 2 postdocs, and 10 research interns and master/bachelor students**¹. The ongoing research projects span over a broad range of topics, including interpretable AI, multi-agent systems, federated learning, reinforcement learning, hybrid systems, network pruning, neural architecture search, predictive maintenance, music information retrieval, anomaly detection, evolutionary robotics, and quality-diversity algorithms. We also have active collaborations with companies and other search groups at within and outside the host institution, working at the intersection of multiple fields such as healthcare and Industry 4.0.

Most of the interns/students currently hosted in the group (of which many are international) have previously attended the course "Bio-Inspired Artificial Intelligence" and later only joined the DIOL. These students are working on various topics related to evolutionary computation and machine learning, such as neuro-evolution and adversarial training, evolution of communication and network protocols, influence maximization in social networks, evolutionary robotics and swarm intelligence, quality diversity mechanisms, constrained optimization, very large-scale optimization, agent-based simulations, and their applications.

Overall, the group managed, in a few years, to attract the interest of several students fascinated by bio-inspired computing. One of the main strengths of the group is that it leverages complementary expertise, maintaining a strong focus both on algorithmic and applied research. As mentioned above, the group is also characterized by multiple active collaborations within the department and with well-known researchers from other universities and research institutions.

¹ See <https://sites.google.com/site/giovanniacca/team> for the updated list of the DIOL members.

3. Description of the work to be carried out by the student(s)

Various research projects are available at the DIOL. In any case, the specific project will be tailored on the applicant's interest. Some of the main research directions that can be potentially explored by the visiting PhD student are the following:

1. Evolutionary learning of interpretable models

While current machine learning models are typically black-box, there is a pressing need for interpretable, transparent models. In previous work^{2,3}, we have proposed the use of evolutionary learning to generate automatically interpretable decision trees coupled with reinforcement learning algorithms. Now we would like to extend this work to account for environments with uncertainties, e.g., those with visual inputs.

2. Hybridization of deep reinforcement learning and metaheuristics

This will be done at two levels: on the one hand, to automatically choose the proper algorithmic operators: on the other hand, to capture the properties of the problem at hand and thus build good solutions to feed to the optimizer. A research project on this topic is currently going on and has several possibilities for extensions.

3. Evolution of network protocols

Building on our previous work⁴, we would like to extend a framework based on Genetic Programming to automatically evolve network protocols at different network layers and for different kinds of networks, possibly extending this approach to co-evolutionary settings where protocols co-evolve against network conditions.

4. Evolution of communication using interpretable agents

The evolution of communication⁵ is a theme that interests many researchers across different research fields, including biology and artificial intelligence. The goal of this project is to evolve a communication system between agents that are inherently understandable by humans, so that the "reasoning" performed by the agents can give insights on the evolution of communication.

5. Problem classification via evolutionary dynamics

One of the main problems in black-box optimization is that very often the optimization process starts from scratch, without using any available knowledge obtained from previous runs. In this project, we will use available data obtained from various evolutionary runs executed on the BBOB and CEC benchmarks to train a machine learning model to classify automatically new problems with respect to their properties such as modality, scalability, etc. Secondly, we will use the trained model to enable automatic adaptation of the evolutionary algorithm.

Other projects, related e.g., to evolutionary robotics⁶, machine learning over distributed systems⁷, predictive maintenance, and neuro-evolution are also available upon request.

² L. L. Custode, G. Iacca, Evolutionary learning of interpretable decision trees, <https://arxiv.org/abs/2012.07723>

³ L. L. Custode, G. Iacca, A co-evolutionary approach to interpretable reinforcement learning in environments with continuous action spaces, IEEE Symposium Series on Computational Intelligence, Orlando, December 2021

⁴ M. Lorandi, L. L. Custode, G. Iacca, Genetic Improvement of Routing Protocols for Delay Tolerant Networks, Transactions on Evolutionary Learning and Optimization, ACM, <https://arxiv.org/abs/2103.07428>

⁵ Q. F. Lotito, L. L. Custode, G. Iacca, A Signal-Centric Perspective on the Evolution of Symbolic Communication, Genetic and Evolutionary Computation Conference, ACM, Lille <https://arxiv.org/abs/2103.16882>

⁶ E. Zardini, D. Zappetti, D. Zambrano, G. Iacca, D. Floreano, Seeking Diversity in Evolutionary Co-design of Soft Tensegrity Modular Robots, Genetic and Evolutionary Computation Conference, ACM, Lille <https://arxiv.org/abs/2104.12175>

⁷ A. Yaman, G. Iacca, Distributed Embodied Evolution over Networks, Applied Soft Computing, Elsevier, Volume 101, Pages 106993, March 2021 <https://arxiv.org/abs/2003.12848>

4. Other information

As for the Host Institution, UNITN is a medium-sized university (with more than 16000 students and almost 700 faculty members), constantly ranked among the best Italian Universities, according to national and international rankings. Notably, UNITN is part of the European Consortium of Innovative Universities (ECIU), which is the leading European consortium of research-intensive universities, with collective emphasis on innovation, creativity, and societal impact, driving the development of a knowledge-based economy.

Within UNITN, the Department of Information Engineering and Computer Science (DISI) is an international environment whose research is focused on artificial intelligence, systems and networks, signal processing, embedded systems, remote and distributed sensing, cybersecurity, and computer vision. DISI has a strong success record on several European competitive funding schemes (such as ERC and FET projects), as well as regional/national funds. DISI has also important existing facilities that will be available to the visiting PhD student, among which an HPC with almost 7000 CPU cores and 50000 GPU CUDA cores⁸, an IoT/WSN testbed including more than 200 nodes, and a laboratory of robotics.

The accommodation and bureaucracy necessary to welcome the visiting PhD student will be handled by the Mobility Office of DISI⁹, which has a consolidated experience in handling the needed paperwork for both EU and non-EU countries and is always available for facilitating the arrival of new researchers and students. If needed, additional funding (to extend the visiting period of up to three additional months, but also for travelling) might be provided to the visiting PhD student, for instance by local funds or by means of the ERASMUS+ program or other international mobility funds. Nevertheless, the SPECIES fellowship allowance would be enough to cover all accommodation and living expenses for three months, considering that the cost of living in Trento is relatively cheap compared to much bigger cities.

Last but not least, the city of Trento is a fascinating old town -with a typical Northern Italy medieval style- surrounded by an amazing mountain landscape. It is constantly ranked among the first three Italian cities for its quality of life. The city is relatively small, with a population of almost 120.000 people, but its center is vibrant and full of restaurants, bars and opportunities for social life. The city also hosts the famous Science Museum (MUSE), which has hosted almost 3 million visitors since 2013. Trento is also well-known for its passion for sports (especially basket, volley, winter sports), and its many sport facilities. Public transportation is extremely efficient and well-organized (and it's basically free for Bachelor, Master and PhD students). For instance, some of the most beautiful locations in the Dolomites (which are part of the UNESCO world heritage) can be reached within just one hour by local bus and trains.

⁸ <https://sites.google.com/unitn.it/hpc/home>

⁹ <https://www.disi.unitn.it/education/international-mobility>