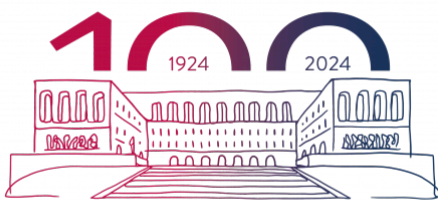


# University of Trieste

*Species Scholarship 2024 host candidate*



**UNIVERSITÀ  
DEGLI STUDI  
DI TRIESTE**

## PIs at the host institution

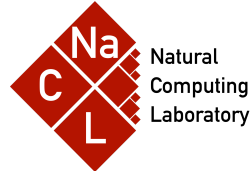
**Eric Medvet** (<https://medvet.inginf.units.it/>) is an Associate Professor in Computer Engineering at the Department of Engineering and Architecture of University of Trieste, Italy. He founded and leads the **Evolutionary Robotics and Artificial Life lab** (ERAllab, <https://erallab.inginf.units.it/>); he is the co-founder and co-head of the Machine Learning Lab. His research activities include evolutionary computation, artificial life, embodied artificial intelligence, and the application of machine learning techniques to engineering problems. He serves as reviewers for many international journals closely related to his research interests; he is a member of the scientific/program committee of the most important conferences on evolutionary computation. He authored and co-authored more than 160 peer-reviewed articles on international journals or conferences, with more than 60 coauthors. He has been a recipient of the Google Faculty Research Award 2020 and has received the best paper award at the EuroGP conference (in 2024 and 2018), at the GECCO conference (in 2021), and the GECCO Humies Silver Award (in 2016).

**Luca Manzoni** (<https://naturalcomputinglab.github.io/people/lmanzoni>) is an Associate Professor in Computer Science at the Department of Mathematics and Geosciences of the University of Trieste and an affiliate member of the National Institute of Oceanography and Applied Geophysics (OGS). He is currently the head of the **Natural Computing Laboratory** (NaCL, <https://naturalcomputinglab.github.io/>). He works in the areas of Evolutionary Computation, Artificial Intelligence, and Natural Computing. He published more than 150 articles in international conferences and journals with more than 80 co-authors. He received multiple awards for his research work, among them two best paper awards at the Conference on Membrane Computing (in 2018 and 2014), the best paper award at the EuroGP 2013 conference, and he was among the recipients of the 2022 SIGEVO Impact Award.

# Research group

The research group is based on three highly interacting labs:

- Evolutionary Robotics and Artificial Life lab (ERALLab, <https://erallab.inginf.units.it/>)
- Natural Computing Laboratory (NaCL, <https://naturalcomputinglab.github.io/>)
- Machine Learning lab (MaLeLab, <https://machinelearning.inginf.units.it/>)



Jointly, the group is currently composed of academic staff:

- Eric Medvet (associate professor, head of ERALLab, **main proponent**)
- Luca Manzoni (associate professor, head of NaCL, **main proponent**)
- Sylvio Barbon Junior (associate professor, head of MaLeLab)
- Alberto Bartoli (full professor)
- Andrea De Lorenzo (assistant professor)
- Laura Nenzi (assistant professor)
- Martino Trevisan (assistant professor)

PostDocs:

- Gloria Pietropolli, NaCL

PhD students (only ERALLab and NaCL listed):

- Giorgia Nadizar, PhD student ERALLab
- Francesco Rusin, PhD student ERALLab
- Giuliamaria Menara, PhD student NaCL
- Rocco Ascone, PhD student NaCL
- Umberto di Laudo, PhD student NaCL
- Kenza Benjelloun, PhD student NaCL
- Michele Rispoli, PhD student NaCL
- Teresa Tonelli, PhD student NaCL

And many master students.

Students and staff interact **daily**, with the goal of mutual enrichment resulting eventually, when possible, in research output.

## Work to be carried out by the student

We propose five research topics in two labs. The visiting student will be able to select the topic based on her/his personal expertise and knowledge about evolutionary computation. She/he will exploit the advisors' and other students' (both PhD and master) experience on the topic; she/he will be able to use software tools ready to be used for the research and will hence have the opportunity to focus on algorithms and experiment design rather than in software development.

### Research projects @ ERALLab

One of the main research topics of interest of the ERALLab staff is **simulated evolutionary robotics**, i.e., the application of evolutionary optimization techniques for designing the shape or the behavior of (often simulated) robotic agents. The assessment of the quality of candidate solutions in evolutionary robotics (simulated or not) is often computationally expensive. In order to address this issue, we propose as a research project the design and development of a general purpose **adaptive mechanism for a fitness surrogate**. During the evolutionary optimization and depending on its current outcome, the fitness surrogate increases or decreases its fidelity (i.e., the quality of approximation of the real fitness). We remark that the evolution of (simulated) robotic agents may be a case study, but the technique could be much more general.

The second research project concerns (synthetic) **data generation** for machine learning (ML). Good ML models make good predictions mostly because they were trained on good data. However, having good data, in quality and quantity, is not always feasible: in some cases, available data is not representative (e.g., it is unbalanced with respect to some cases), is too noisy, or is "simply" not usable due to privacy concerns. Recently, evolutionary computation (EC) has been proven useful to tackle some of these issues, e.g., [A] for unbalanced datasets. In this research project, we will focus on the use of EC for generating synthetic data which is realistic, i.e., useful for training ML models, but privacy-preserving, i.e., it does not disclose the information of the real data it is based on. The few existing approaches for **generating realistic and privacy-preserving synthetic data** are based on deep learning, e.g., [B]. While powerful, these approaches cannot naturally cope with the fact that this is, in essence, a bi-objective optimization problem. On the other hand, EC techniques naturally fit bi-objective problems. This research project builds on the hosting group experience on the assessment of data generation methods (see [B]).

### References

[A] Farinati, Davide, and Leonardo Vanneschi. "GM4OS: An Evolutionary Oversampling Approach for Imbalanced Binary Classification Tasks." International Conference on the Applications of Evolutionary Computation (Part of EvoStar). Cham: Springer Nature Switzerland, 2024.

[B] Panfilo, Daniele, et al. "A deep learning-based pipeline for the generation of synthetic tabular data." IEEE Access (2023).

## Research projects @ NaCL

The NaCL offers projects that cover multiple areas of applications, with a particular focus on three areas: cryptography, oceanography, and improving geometric semantic genetic programming.

The first research project consists of using **genetic programming** (GP) for the evolution of **cryptographic primitives**, in particular vectorial Boolean functions satisfying a series of conditions that are necessary to use them as building blocks for more complex algorithms: balancedness, non-linearity, t-resilience, and so on. The goal is to explore special representations and operators that makes the exploration of the search space less difficult, possibly also considering the use of multi-objective techniques to take into account the multiple conditions that any “strong” function must respect.

The second project has as its main aim the addition of **genetic programming** (GP) in the growing field of **scientific machine learning**, with applications to **oceanography**. In particular, the goal of the visiting student would be to work on oceanographic data with either purely evolutionary or neuroevolutionary techniques to perform tasks of data reconstruction and forecasting, comparing the results to classical deterministic models and techniques both in terms of quality of the results and computation time. Working with this kind of data is challenging due to their real-world nature: data for oceanographic models are readily available for the entire 3D spatial domain, but they are not the reality. Real data are, instead, noisy, limited in spatial availability, and different in nature (sensors in the ocean, satellites, etc.).

The third project is about the implementation and exploration of variants of **geometric semantic genetic programming** (GSGP), a variant of GP introduced in 2012 by Moraglio et al. where the crossover and mutation operators have a clear effect on the semantics of the individuals (namely, they are geometric operators in the semantic space). Recently, a way to obtain small and interpretable individuals for GSGP has been devised via SLIM-GSGP. The goal of the research project is to test the performances of SLIM-GSGP from the computational cost, quality, and interpretability of the results provided. As an additional goal, it will be explored how to improve and enhance the definition and implementation of SLIM-GSGP to compete with state-of-the-art interpretable GP techniques

## Other information

### City of Trieste

Trieste is a mid-sized Italian city placed on the northernmost part of the Mediterranean sea. It is known for its high quality of life (6th in Italy according to Sole 24 Ore ranking) and its lively multiculturalism, deriving from its being a border town. Trieste has for decades been a research and science city: it hosts 2 universities (University of Trieste and SISSA) and many world-level research institutions. It has been the City of Science 2020 and hosted the Euroscience Open Forum (ESOF2020) in early July 2020

(<https://www.esof.eu/en/home.html>)

Trieste is a researcher-friendly city: with its 37 researchers on 1000 inhabitants it is one of the most science-dense regions of the world. As a result, Trieste offers many facilities and accommodations for researchers and students (e.g., Welcome Office:

<http://www.welcomeoffice.fvg.it/>).

**Trieste will host Evostar in 2025!**

### Accommodation

University of Trieste offers many student services, including accommodation and use of the canteen, to its students: see

<http://www.welcomeoffice.fvg.it/practical-info/accommodation/students-and-researchers-hall/>.

Depending on the status of the visiting student, these services may be accessed at a discounted rate.