

SPECIES Scholarship Host Application

Topic

Evolutionary strategies (ES) have long been applied to continuous optimization problems but have recently found a new application in Artificial Neural Network (ANN) optimization, especially for policy search where the ANN is used in a sequential decision task. While neuroevolution with ES is competitive with deep reinforcement learning (DRL) on modern benchmarks such as Atari games, many open questions remain. In this project, the intern will explore improvements to neuroevolution for policy search.

Recent studies have demonstrated that even simple evolutionary strategies are competitive with contemporary DRL methods on the Atari benchmark [1]. However, there are many existing improvements to evolutionary strategies which are difficult to apply to neuroevolution due to the dimensionality of large ANNs, such as covariance matrix gradient estimates. Indirect encodings such as GENE [2] enable these costly estimates; the full possibilities of these encodings merits further study. In this project, the student will study improvements to recent neuroevolution methods using an in-house codebase and contemporary benchmark tasks. The student will join a team working on DRL, evolution, and specifically neuroevolution.

[1] Chrabaszcz, P., I. Loshchilov, F. Hutter. "Back to basics: benchmarking canonical evolution strategies for playing Atari." IJCAI 2018.

[2] Templier, Paul, Emmanuel Rachelson, and Dennis G. Wilson. "A geometric encoding for neural network evolution." GECCO, 2021.

Research Group and Host Institution

This internship will take place at ISAE-SUPAERO in Toulouse, France, in the SuReLI research team inside the Department of Complex Systems Engineering. The ISAE-SUPAERO Reinforcement Learning Initiative (SuReLI) is a vibrant group of researchers thriving to design next generation AI. We maintain a constructive, lively environment in a human-sized team that range from undergrad students to permanent academic staff, focussed on understanding AI and developing solutions that contribute positive impact on science and society. We work on state of the art algorithms, study their properties mathematically and empirically, and apply them to challenging problems to bridge a gap between theory and real applications. We focus on Reinforcement Learning for sequential decision making problems and its links with other disciplines. Our applications include: autonomous vehicles, control of optimization processes, rehabilitation exoskeleton control, Atari games, aircraft landing scheduling, satellite resources planning, sailboat and UAV planning and control.

ISAE-SUPAERO is one of the top engineering schools in France and a worldwide leader in aerospace engineering. It is a part of the University of Toulouse and there will be a strong link in this internship with other research groups in Toulouse, notably the REVA Artificial Life team at IRIT. ISAE-SUPAERO is also member of the Artificial and Natural Intelligence Toulouse Institute. ANITI has been selected as one of four institutes spearheading research on AI in France and aims to make Toulouse one of the world leaders in Artificial Intelligence in research, education, innovation and economic development. ISAE-SUPAERO has recently advanced its research and educational focuses in Artificial Intelligence with the growth of the Decision Systems research group and Science of Decision and Data Master's program.

Over the course of this internship, the student will be able to profit from the lively environment surrounding AI in Toulouse, attending SuReLI, ANITI, and TidDLe (the Toulouse Interdisciplinary Deep Learning Group) events. The candidate will be surrounded by an international and talented group of students and researchers working on various aspects of evolutionary computation, reinforcement learning, and AI in general.

The student will also be encouraged to explore Toulouse and its surroundings. Once the capital of the Visigoths and now the capital of the air and space industry, Toulouse offers an excellent way to experience France. It is home to and surrounded by UNESCO World Heritage Sites such as the Basilica of St. Sernin, Carcassonne, and Albi. It is frequently ranked as one of the best student cities and best cities for foreigners. For this internship, we can offer housing on the campus of ISAE-SUPAERO, which is along the beautiful Canal du Midi and easily accessible by bike, metro, or bus.

Advisor

Dennis G. Wilson is an Assistant Professor of AI and Data Science at ISAE-SUPAERO in Toulouse, France. He obtained his PhD at the Institut de Recherche en Informatique de Toulouse (IRIT) on the evolution of design principles for artificial neural networks. Prior to that, he worked in the Anyscale Learning For All group in CSAIL, MIT, applying evolutionary strategies and developmental models to the problem of wind farm layout optimization. He is a former chair of the Emergent Researchers in Artificial Life group and is currently co-chair of the Complex Systems track at GECCO.

His research focuses on genetic programming, neural networks, and the evolution of learning. He has published in multiple A rank conferences and has co-authored two book chapters on developmental neural networks. He previously organized a competition on wind farm layout optimization at GECCO, which cumulated in a journal publication on state-of-the-art wind farm optimization methods. He is passionate about environmental applications and is an active member of the Climate Change AI group.