



RESEARCH MASTER INTERNSHIP

Department of Complex Systems Engineering
 Supervisor : Dennis WILSON, Emmanuel RACHELSON

Location : ISAE-SUPAERO, Toulouse
 Tel. : +33 5 61 33 81 27
 E-mail : dennis.wilson@isae.fr

INTERNSHIP DESCRIPTION

Domain : Artificial Intelligence, Evolutionary Computation, Reinforcement Learning
 Title : **EVOLUTIONARY REINFORCEMENT LEARNING**

Evolutionary algorithms have recently demonstrated impressive capabilities as optimization methods for finding policies in reinforcement learning (RL). As opposed to gradient-based methods, these approaches simulate natural selection on a population of competing policies to optimize an agent's behavior. This can be performed with various policy representations, such as function graphs [1] and deep neural networks [2]. The results from evolutionary methods are competitive with state-of-the-art RL methods such as Deep Q-Networks [3] and outperform these methods on many benchmark tasks.

There are many open questions for evolutionary RL methods. While gradient-based methods are required to optimize differentiable functions, evolutionary methods can optimize over any function, or multiple functions, and the development of optimal objective functions for evolutionary RL is an open question. Evolutionary methods also maintain a population of different policies and optimal population management strategies, such as island-based models or diversity metrics, are also open for exploration in the context of RL. Finally, many ideas from traditional reinforcement learning, such as exploration-exploitation trade-off, have yet to be fully considered in the evolutionary context. These could greatly improve sample efficiency, one of the main drawbacks of current evolutionary RL.

The goal of this project is to improve the state-of-the-art of evolutionary reinforcement learning. As there are many possible directions to explore in improving evolutionary RL, the precise topic definition will be determined in discussion with the candidate. The ideal candidate would have experience with evolutionary computation and/or RL and would be motivated to advance this topic; experience with the Julia programming language is a bonus.

References :

- [1] Wilson, Dennis G., et al. "Evolving simple programs for playing Atari games." *Proceedings of the Genetic and Evolutionary Computation Conference*. ACM, 2018.
- [2] Such, Felipe Petroski, et al. "Deep neuroevolution: Genetic algorithms are a competitive alternative for training deep neural networks for reinforcement learning." arXiv preprint arXiv:1712.06567 (2017).
- [3] Mnih, Volodymyr, et al. "Human-level control through deep reinforcement learning." *Nature* 518.7540 (2015): 529.

Methods: genetic algorithms, evolutionary strategies, genetic programming, reinforcement learning

40 % Theoretical Research	0 % Applied Research	60 % Experimental Research
---------------------------	----------------------	----------------------------

Possibility to go on a Ph.D.: Yes No

APPLICANT PROFILE

Knowledge and required level:

Evolutionary Computation, Reinforcement Learning, Machine Learning
 Languages/Systems : Julia, Python, Linux

Applications should be sent by e-mail to the supervisor.