One of the most ambitious goal in Artificial Intelligence (AI) is the realization of a so-called\textit{artificial general intelligence} (AGI), i.e., an AI that is not limited to the realization of a predefined set of tasks but is able to generalize its capabilities to any cognitive task that can be solved by human intelligence. Recent advances in AI have revived research in this field, with the vast majority of contributions focusing on (1) new cognitive architectures and learning algorithms; (2) new cost functions to be optimized and (3) new databases to learn from. However, although AGI is fundamentally related to the characteristics of human intelligence, research in this field rarely considers the processes that may have guided the emergence of complex cognitive capacities during the evolution of the species. Research in Human Behavioral Ecology (HBE, [2]) seeks to understand how the behaviors characterizing human nature can be conceived as adaptive responses to major changes in the structure of our ecological niche. However, very little work in AI proposes to study how this long-term environmental dynamics can potentially guide and improve the acquisition of complex behaviors in artificial systems (see however recent contributions [2], including from our research group [3]). Moreover, to our knowledge, modern AI methods for learning behaviors in sequential environments (e.g. [4]) have not yet been applied to test hypotheses in HBE (although it has recently been proposed [5]).

\section*{Contexte et atouts du poste}

One of the most ambitious goal in Artificial Intelligence (AI) is the realization of a so-called\textit{artificial general intelligence} (AGI), i.e., an AI that is not limited to the realization of a predefined set of tasks but is able to generalize its capabilities to any cognitive task that can be solved by human intelligence. Recent advances in AI have revived research in this field, with the vast majority of contributions focusing on (1) new cognitive architectures and learning algorithms; (2) new cost functions to be optimized and (3) new databases to learn from. However, although AGI is fundamentally related to the characteristics of human intelligence, research in this field rarely considers the processes that may have guided the emergence of complex cognitive capacities during the evolution of the species. Research in Human Behavioral Ecology (HBE, [2]) seeks to understand how the behaviors characterizing human nature can be conceived as adaptive responses to major changes in the structure of our ecological niche. However, very little work in AI proposes to study how this long-term environmental dynamics can potentially guide and improve the acquisition of complex behaviors in artificial systems (see however recent contributions [2], including from our research group [3]). Moreover, to our knowledge, modern AI methods for learning behaviors in sequential environments (e.g. [4]) have not yet been applied to test hypotheses in HBE (although it has recently been proposed [5]).

\section*{Realization}

The first phase of the project will consist of extracting hypotheses and principles from the HBE literature regarding the ecological conditions that may have played a role in the evolution of complex behavior in the human species. In parallel, we will review existing computational methods for the integration of adaptive processes at the evolutionary and developmental scale (e.g. [7], [11]).

In a second phase, we will study the influence of environmental variability in the emergence of learning abilities. We will perform experiments in simulation environments such as MuJoCo [9], in which a complex humanoid agent can control its movements to collect resources in various terrains. We will focus more specifically on the case of bipedal walking by analyzing which environmental changes may favor its emergence.

Finally, in a third phase, we will extend the approach to the emergence of social behaviors in multi-agent environments. In particular, we will focus on the formation of cooperative groups, the management of shared resources, complex tool use, as well as the emergence of communication and culture. We will conduct experiments in multi-agent simulation environments (e.g. [10], [11]).

\section*{References}


This project will address the following research question: Can the acquisition of complex behaviors in artificial agents be improved by modelling ecological conditions that may have played a role in human evolution? We will address it from the perspective of computer simulation using state-of-the-art methods in machine learning. In particular, Deep Reinforcement Learning algorithms (DRL) [4] allow agents with perception and action capabilities to learn complex behaviors from experience in order to maximize long-term rewards. We will make such DRL agents interact in simulated environments that seek to reproduce certain ecological conditions that may have played a role in human evolution. We will study how such agent-environment systems can improve the acquisition of complex skills, considering several hypotheses from the HBE literature related to the emergence of bipedalism, complex tool use, shared resources management as well as cooperation, communication and culture (see e.g. [6] for existing hypotheses on these topics).

\section*{Informations générales}

- **Thème/Domaine :** Robotique et environnements intelligents
- **Ville :** Talence
- **Centre Inria :** CRI Bordeaux - Sud-Ouest
- **Date de prise de fonction souhaitée :** 2020-10-01
- **Durée de contrat :** 2 ans
- **Date limite pour postuler :** 2020-08-31

\section*{Contacts}

- **Equipe Inria :** FLOWERS
- **Recruteur :** Moulin-frier Clément / element.moulin-frier@inria.fr

\section*{A propos d’Inria}

Inria est l'institut national de recherche dédié aux sciences et technologies du numérique. Il emploie 2600 personnes. Ses 200 équipes-projets agiles, en général communes avec des partenaires académiques, impliquent plus de 3500 scientifiques pour relever les défis du numérique, souvent à l'interface d'autres disciplines. L'institut a fait appel à de nombreux talents dans plus d'une quarantaine de métiers différents. 500 personnels d'appui à la recherche et à l'innovation contribuent à faire émerger et grandir des projets scientifiques ou entrepreneuriaux qui impactent le monde. Inria travaille avec de nombreuses entreprises et a accompagné la création de plus de 180 start-up. L'institut se sert ainsi de répondre aux enjeux de la transformation numérique de la science, de la société et de l'économie.

\section*{L’essentiel pour réussir}

You have a strong background in both computer science (with expertise in at least one of these topics: deep reinforcement learning, meta-learning, evolutionary computation, game theory) and life science (with expertise in at least one of these topics: behavior ecology, origins of social behaviors, evolutionary biology).

You are fascinated by understanding and modeling emergent processes at multiple time scales. You are excited by building strong connections between recent advances in AI and fundamental research questions in animal behavior.

\section*{Consignes pour postuler}

Thank you to send:
- CV
- Cover letter
- Support letters (mandatory)
- List of publication

\section*{Sécurité défense :}

Ce poste est susceptible d'être affecté dans une zone à régime restrictif (ZRR), telle que définie dans le décret n°2011-425 relatif à la protection du potentiel scientifique et technique de la nation (PPST). L'autorisation d'accès à une zone est délivrée par le chef d'établissement, après avis ministériel favorable, tel que défini dans l'arrêté du 03 juillet 2012, relatif à la PPST. Un avis ministériel défavorable pour un poste affecté dans une ZRR aurait pour conséquence l'annulation du recrutement.

\section*{Politique de recrutement :}

Dans le cadre de sa politique diversité, tous les postes Inria sont accessibles aux personnes en situation de handicap.
Principales activités

- Review the state of the art in machine learning (deep reinforcement learning, meta-learning of neural architectures and learning algorithms, procedural environment generation) and cognitive science (behavioral ecology, origins of social behaviors, evolutionary biology)
- To identify key challenges in the existing literature and to propose interdisciplinary solutions for addressing them
- To design and implement challenging simulation environments and new algorithms based on principles from behavioral ecology
- To run massively-parallel simulations in computer clusters
- To analyze the data resulting from the simulations and to publish the results in relevant conferences and journals

Compétences

- Excellent programming skills, preferably in Python. Experience with Pytorch or Tensorflow.
- Prior experience with deep reinforcement learning and data analysis. Experience with meta-learning, evolutionary computation, game theory or multi-agent systems is a plus.
- Strong interest in modelling emergent behaviour in simulation environments.
- Strong interest in behavioral ecology and evolutionary biology.
- Fluent English.

Avantages

- Subsidized meals
- Partial reimbursement of public transport costs
- Possibility of teleworking (after 6 months of employment) and flexible organization of working hours
- Professional equipment available (videoconferencing, loan of computer equipment, etc.)
- Access to vocational training
- Social security coverage

Rémunération

2653€ / month (before taxs)