2019-01480 - PhD Position F/M (BN19) Grounded language learning and curiosity-driven exploration with deep reinforcement learning

Type de contrat : CDD de la fonction publique
Niveau de diplôme exigé : Bac + 5 ou équivalent
Fonction : Doctorant

A propos du centre ou de la direction fonctionnelle

The Flowers team studies computational mechanisms allowing robots and humans to acquire open-ended repertoires of skills through life-long learning. This includes the processes for progressively discovering their bodies and interaction with objects, tools and others. In particular, we study mechanisms of intrinsically motivated learning (also called curiosity-driven active learning), autonomous unsupervised exploration, imitation and social learning, multimodal statistical inference, embodiment and maturation and self-organization.

The team considers cognitive development as a complex dynamical system which needs to be understood through systemic thinking, leveraging tools and concepts from computational sciences (artificial intelligence, machine learning and robotics), neuroscience and psychology. In this perspective, algorithms and robotics models are powerful scientific languages to express theories of cognitive development in the living.

Of particular interest to the Flowers team is the formation of repertoires of sensorimotor and interaction skills as well as their relation with the acquisition and evolution of languages. The team is also working on applications of this research in three fields: adaptive human-computer interfaces, educational technologies and open-source robotics for art and education.

Contexte et atouts du poste

Scientific context:

A major challenge of artificial intelligence is to understand how can embodied machines learn like children, i.e. autonomously acquire and develop open repertoires of skills in large open-ended environments. Based on more than a decade of work modeling various fundamental processes of infant development, ranging from curiosity-driven exploration of sensorimotor skills to socially guided language acquisition (Oudeyer and Smith, 2016), the Flowers lab has been working on transposing these computational models (initially made to understand better human learning) to machine learning (with the aim to build flexible autonomous lifelong learning machines). In particular, the Flowers lab laid the foundation of the Intrinsically Motivated Goal Exploration (IMGEP) framework, in which machines learn autonomously structured goal representations (Laversanne-Finot et al., 2018), and sample their own goals with self-organized curriculum learning, either using population-based (Baranes and Oudeyer, 2013) or multi-goal deep reinforcement learning (Colas et al., 2018) approaches. Here, the objective is to discover and master a diversity of controllable outcomes, and learn world models, while avoiding to spend too much time trying to learn goals that are too complicated or even impossible. The work on IMGEP algorithms has focused so far on curiosity-driven learning of low-level sensorimotor skills in a single agent.

However, child development is also strongly guided by social peers, and in particular through language guidance. In several computational models in the domain of cognitive science (Kaplan et al., 2008; Oudeyer and Smith, 2016; Forestier and Oudeyer, 2017), we have proposed and studied the hypothesis that grounded language acquisition and sensorimotor development are tightly coupled through the interplay of curiosity-driven exploration and social guidance. For example, in (Forestier and Oudeyer, 2017) we have shown curiosity-driven exploration could lead to the joint discovery of speech communication and tool use. However, these computational models articulating curiosity-driven learning and language acquisition have not been transposed so far in modern deep reinforcement learning contexts. At the same time, there is an emerging literature in Deep RL focusing on algorithms for grounded language acquisition (Bahdanau et al., 2018; Chaplot et al., 2018; Fu et al., 2019; Shah et al., 2018), that has been developing advanced technical tools for the acquisition of natural language processing capabilities, which may be leveraged in the IMGEP framework.

This will be the topic of this PhD thesis, aiming at designing and studying intrinsically motivated multi-goal deep RL architectures that integrate the learning of natural language guidance from a social peer with curiosity-driven acquisition of sensorimotor skills.

Mission confiée

Work description:

The work will begin with familiarization with state-of-the-art concepts and techniques in three domains: 1) computational models of child development focusing on language and curiosity (Oudeyer and Smith, 2016); 2) Deep RL/deep learning based IMGEP algorithms (Colas et al., 2018; Laversanne-Finot et al., 2018); 3) Deep RL based embodied language acquisition algorithms (Bahdanau et al., 2018; Chaplot et al., 2018; Fu et al., 2019; Shah et al., 2018) leveraging advances in natural language processing for learning structured sentence embeddings (Devlin et al., 2018). Then, work will be achieved to design and study algorithms that use such Deep RL natural language processing techniques in the IMGEP framework, enabling agents to learn natural language instructions associated to sensorimotor skills they discover through curiosity, and studying the interactions between these two algorithmic processes. Experimental work will be achieved using virtual environments based on the Unity 3D ML-Agents or Malmo/Minecraft platform, with a simulated social peer. If the sample efficiency of the targeted algorithms permits, one will be able to make experiments with real human-robot interaction using the robotic platforms of the lab (possibly with the design of algorithms leveraging what was learnt in simulation to bootstrap learning in the real world).

Applications should be sent to pierre-yves.oudeyer@inria.fr (with CV and letter of motivation)

References:


Web site of Flowers Lab: https://flowers.inria.fr

**Principales activités**

See above.

**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 (videoteleconferencing, loan of computer equipment, etc.)
- Social, cultural and sports events and activities
- Access to vocational training
- Social security coverage

**Rémunération**

1982€ / month (before taxes) during the first 2 years, 2085€ / month (before taxes) during the third year.

**Informations générales**

- **Thème/Domaine**: Robotique et environnements intelligents
- **Statistiques (Big data)** (BAP E)
- **Ville**: Talence
- **Centre Inria**: CRI Bordeaux - Sud-Ouest
- **Date de prise de fonction souhaitée**: 2019-10-01
- **Durée de contrat**: 2 ans, 1 mois
- **Date limite pour postuler**: 2019-04-14

**Contacts**

- **Équipe Inria**: FLOWERS
- **Directeur de thèse**: Oudeyer Pierre-yves / pierre-yves.oudeyer@inria.fr

**A propos d'Inria**

Inria, l’institut national de recherche dédié aux sciences du numérique, promeut l’excellence scientifique et le transfert pour avoir le plus grand impact. Il emploie 2400 personnes. Ses 200 équipes-projets agiles, en général communes avec des partenaires académiques, impliquent plus de 3000 scientifiques pour relever les défis des sciences informatiques et mathématiques, souvent à l'interface d'autres disciplines. Inria travaille avec de nombreuses entreprises et a accompagné la création de plus de 160 start-up. L'institut s'efforce ainsi de répondre aux enjeux de la transformation numérique de la science, de la société et de l'économie.

**L'essentiel pour réussir**

Candidates should have outstanding competences in at least one of these areas, and ideally have experience in several of them:

- Deep reinforcement learning
- Natural language processing with deep networks
- Models of embodied language acquisition
Other requirements:
- Excellent skills in python, with experience with pyTorch or TensorFlow.
- Motivation to work on a project that combines machine learning techniques and cognitive sciences concepts.

Consignes pour postuler

Thank you to send:
- CV
- Cover letter
- Master marks and ranking
- Support letter(s)

Sécurité défense:
Ce poste est susceptible d’être affecté dans une zone à régime restrictif (ZRR), telle que définie dans le décret n°2011-1425 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.

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

Attention: Les candidatures doivent être déposées en ligne sur le site Inria. Le traitement des candidatures adressées par d'autres canaux n'est pas garanti.