2018-00657 - Large-scale automatic learning of autonomous agent behavior with structured deep reinforcement learning [PhD Campaign]

**Contract type:** Public service fixed-term contract  
**Level of qualifications required:** Graduate degree or equivalent  
**Fonction:** PhD Position

### About the research centre or Inria department

Inria, the French national institute for research in computer science and control, is dedicated to fundamental and applied research in information and communication science and technology (ICST). Inria has a workforce of 3,800 people working throughout its eight research centers established in seven regions of France.

Grenoble is the capital city of the French Alpes. Combining the urban life-style of southern France with a unique mountain setting, it is ideally situated for outdoor activities. The Grenoble area is today an important centre of modern industry and science (second largest in France). Dedicated to an ambitious policy in the arts, the city is host to numerous cultural institutions. With 60,000 students (including 6,000 foreign students), Grenoble is the third largest student area in France.

### Context

**Team and its leader:** CHROMA, Pr. Olivier Simonin  
**Research topics:** Machine learning of robot behavior  
**Where:** Lyon  
**Participating researchers:** the advisors will be Olivier Simonin (Pr, HDR), Jilles Dibangoye (MCF) and Christian Wolf (MCF HDR). An important aspect of this project is that it brings together different expertises of the CHROMA team, which is co-located between Lyon and Grenoble. The Ph.D. student, however, will be located in Lyon.

### Assignment

**Context and Strategic Importance of the Project**

Future robots will be trained, rather than programmed, for almost all of their tasks and sub-problems: perception, planning and navigation, behavior and control. However, obtaining gains through learning from massive amounts of data will not be as easy as in vision, speech, language processing, where machine learning was successful in the recent past. In contrast to these problems, which are often solved through supervised learning, teaching robots and agents to act autonomously requires learning from interactions with an environment. Acquiring meaningful experiences with expensive hardware, especially in large-scale setups, is even more difficult and time consuming than labeling static data. Simulation is a promising approach, which has led to well-known successes in game playing (Silver et al., 2017). However, learning agent behavior in complex environments requires considerably more effort in simulations than game playing, and the non observable nature makes the problem inherently more difficult.

This proposal investigates learning of intelligent robot behavior. Possible applications are service robotics, and companion robotics, where robots should be as helpful as possible, for instance recognizing people, activities (Baradel et al, 2018) and propose useful interactions, while at the same time staying as non-intrusive as possible (Matignon et al 2018).


**Matignon, O. Simonin, Multi-Robot Simultaneous Coverage and Mapping of Complex Scene - Comparison of Different Strategies, AAMAS 2018.**

### General Information

- **Theme/Domain:** Robotics and Smart environments  
- **Town/city:** Lyon (Laboratoire CITI)  
- **Inria Center:** CRI Grenoble - Rhône-Alpes  
- **Starting date:** 2018-10-01  
- **Duration of contract:** 3 years  
- **Deadline to apply:** 2018-05-01

### Contacts

- **Inria Team:** CHROMA  
- **Recruiter:** Simonin Olivier / olivier.simonin@inria.fr

### The keys to success

Taste for research, curiosity.

### Conditions for application

The campaign is not open to local students who have not done any significan mobility.

### Defence Security

This position is likely to be situated in a restricted area (ZRR), as defined in Decree No. 2011-1425 relating to the protection of national scientific and technical potential (PPST). Authorization to enter an area is granted by the director of the unit, following a favourable Ministerial decision, as defined in the decree of 3 July 2012 relating to the PPST. An unfavourable Ministerial decision in respect of a position situated in a ZRR would result in the cancellation of the appointment.

### Recruitment Policy

As part of its diversity policy, all Inria positions are accessible to people with disabilities.

---

**Warning:** you must enter your e-mail address in order to save your application to Inria. Applications must be submitted online on the Inria website. Processing of applications sent from other channels is not guaranteed.
Main activities

Scientific and Technological Objectives

In the targeted scenarios, robots need to learn to navigate in the environment in order to solve a specific problem. They need to collect information and to interact with the environment or other actors. In other words, agents need to solve problems with multiple joint action spaces, which involve high level tasks (e.g. a recognition or interaction problem) and low level tasks (e.g. a positioning problem). Deep Learning provides a powerful way to jointly learn prediction models together with hierarchical representations directly from low level data. Key to its success are massive amounts of data and computation. When learning from interactions, in particular in the standard formalisation as (Partially Observable) Markov Decision Process, current research indicates that the bottleneck lies in the combination of the curse of dimensionality inherent in most real-life applications together with the limited amount of entropy used for parameter updates through the reward as single source of information.

In this proposal we plan to address these issues with several strategies:

(i) Hierarchical models, which decompose the main problem into subproblems, some of which can be learned in a fully supervised manner through surrogate losses.

(ii) Structure neural models through strong geometrical, topological or other structural priors.

(iii) Transferring models from large-scale simulations to real life situations involving real robots.

Strong priors are useful to encode knowledge on the structure of the problem, for instance on space and geometry (Parisotto and Salakhutdinov, 2018), (Savinov et al., ICLR 2018). A strong indication for the importance of spatial structure in agents is the fact that, learning agents to localize themselves has indicated the development of neural units which encode this structure (Cueva et al., 2018). In this PhD work, we will focus on learning highly structured representations with the goal of bringing deep reinforcement learning to real world tasks in robotics.


Nikolay Savinov, Alexey Dosovitskiy, Vladlen Koltun, Semi-Parametric Topological Memory for Navigation, ICLR 2018

Christopher J. Cueva, Xue-Xin Wei, Emergence of grid-like representations by training recurrent neural networks to perform spatial localization, ICLR 2018.

Skills

Technical skills and level required:

Computer sciences/AI/Robotics (if possible Deep Learning, Reinforcement learning)

Languages: english.

Benefits package

- Subsidised catering service
- Partially-reimbursed public transport
- Social security
- Paid leave
- Flexible working hours
- Sports facilities

Remuneration


Monthly salary after taxes: around 1596,05€ for 1st and 2nd year. 1678,99€ for 3rd year. (medical insurance included).