

Call for PhD and postdoc candidates

Topic : Computational models of curiosity-driven exploration in humans and monkeys (PhD)

Laboratory: Flowers team at Inria and Ensta ParisTech

Author of the PhD topic proposal: Pierre-Yves Oudeyer and Manuel Lopes

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

Scientific context:

Curiosity and creativity are among the last unexplored frontiers of higher cognition, and we know very little about their neural and behavioural mechanisms in humans and animals. In the last ten years, the Flowers team has been developing computational/mathematical models of spontaneous exploration and active information seeking, and recently teamed up with Jacqueline Gottlieb's Cognitive Neuroscience Lab (Univ. Columbia, NY, US) and Celeste Kidd's developmental psychology lab (Univ. Rochester, US), to develop theories as well as new experimental paradigms allowing to uncover mechanisms of curiosity (Gottlieb et al., 2013; Kidd and Hayden, 2015). In this context, curiosity can be understood as a family of mechanisms that evolved to allow agents to maximize their knowledge and control of the useful properties of the world - i.e., the regularities that exist in the world - using active, targeted investigations. In other words, we view curiosity as a decision process that maximizes learning and assigns value ("interest") to competing tasks based on their epistemic qualities - i.e., their estimated potential allow discovery and learning about the structure of the world.

Goal: The goal of this project will consist in elaborating and analysing new computational/mathematical models of information-seeking and active exploration in the context of original experimental paradigms. These models will be based on the technical framework of Bayesian reinforcement learning and extend models developed recently in the team (Daddoua et al., 2016; Gottlieb et al., 2013; Oudeyer and Kaplan, 2007), and be compared to the related theoretical framework by Friston (2010) and called the free-energy principle. The goal of these model will be to account for behavioural and neural data observed in three series of experiments that will happen in the project: experiments studying 1) information-seeking behaviour in humans during free exploration; 2) information-seeking behaviour in human children during free play; 3) information-seeking behaviour and neural correlates in monkeys.

During the project, the collaboration with Jacqueline Gottlieb and Celeste Kidd will involve travels to their universities in the US, and joint writing of scientific articles.

Web site of these collaborating labs:

Gottlieb's cognitive neuroscience lab, Univ. Columbia, NY: <http://www.gottlielab.com>

Kidd Lab, Univ. Rochester, US: <http://www.bcs.rochester.edu/people/ckidd/>

Required knowledge and background:

Strong skills in mathematics, statistical inference, information theory. Advanced programming skills in script languages like python/Matlab. Advanced skills in machine learning, and in particular reinforcement learning. Motivation to work in an interdisciplinary project at the frontiers of computer science, neuroscience and psychology. Prior experience with computational modelling of biological processes will be a

Contact: Applications should be sent to pierre-yves.oudeyer@inria.fr and manuel.lopes@inria.fr

References :

Daddaoua N., Lopes M. and Gottlieb J. (2016) Intrinsically motivated oculomotor exploration guided by uncertainty reduction and conditioned reinforcement in non-human primates,. *Nature Scientific Reports*, 6:20202, 2016.

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Gottlieb, J., Oudeyer, P-Y., Lopes, M., Baranes, A. (2013) Information Seeking, Curiosity and Attention: Computational and Neural Mechanisms, *Trends in Cognitive Science*, 17(11), pp. 585-596.

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Keywords: curiosity; exploration; learning; computational model; computational neuroscience; active learning, reinforcement learning; decision making