Artificial curiosity to discover large repertoires of skills for humanoid robots

**Keywords:** machine learning – artificial curiosity – deep reinforcement learning

**Hosting Institution:**
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**Description:** As infants, we have learned large repertoires of skills by curiously exploring our environments. By experimenting with our own bodies and the objects around us while setting ourselves ever more complex learning goals, we have become competent in interacting with the world. How can we emulate such curiosity-driven learning in computers and robots, so that they can learn large repertoires of skills autonomously? In this internship, we will explore new techniques for curiosity-driven learning in the context of simulated humanoid robots. The robot will define new learning goals based on „interesting“ events as perceived via different modalities (vision, touch, hearing, proprioception). For example, the robot may consider it interesting that a certain movement leads to a novel touch sensation while also producing an interesting sound and try to reproduce this effect. While doing so, the robot will acquire an understanding of how it can achieve various effects through its behavior, e.g. learning how to bang its hand on the table to make a sound or how to grasp an object. By focusing learning on goals where rapid learning progress is being made and by using previously learned skills to bootstrap the learning of new skills, the robot should be able to learn large skill repertoires efficiently. The specific objectives of the internship are:

- Review literature on artificial curiosity and deep reinforcement learning.
- Design and conduct experiments to test the ability of different curiosity mechanisms and neural network architectures to allow efficient learning of large skill repertoires.
- Analyse the data and document the results.

**Requirements:** You are expected to have excellent programming skills, preferably in Python. Prior experience with machine learning, in particular reinforcement learning and neural networks is highly desired. An interest in Cognitive Science, e.g. intrinsic motivation is a plus.

**Figure 1:** A simulated humanoid robot learning a sequence of skills. Left: Fixating objects with both cameras (binocular coordination). Learning to look at and track the own gripper with the cameras (eye-hand coordination). Touching an object and estimating if it is within reach. Figure taken from: „Within Reach? Learning to touch objects without prior models“, F. De La Bourdonnaye, C. Teulière, T. Chateau, J. Triesch, IEEE Int. Conf. on Development and Learning and Epigenetic Robotis (2019).