On-line distributed learning in swarm robotics: estimating on-the-fly the marginal contributions of robots in a group

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DESCRIPTION

Swarm robotics designates large groups of robots with limited communication and capability, that coordinates on a local basis to achieve tasks that can be evaluated on a larger scale. Typical examples are: collective construction (Werfel et al. 2014), self-assembly into specific patterns (Rubenstein et al., 2014), collective transport and exploration (Bayindir, Sahin, 2007). However, the complex collective dynamics between individuals and the unpredictable nature of real-world environments makes it very difficult to hand-code or optimise swarm behaviours prior to deployment.

A promising class of algorithm to program on-the-fly swarm of robotics is that of embodied evolutionary algorithm (EEA). EEA are on-line distributed learning algorithms that makes it possible to learn collective behaviours on-the-fly while the robots are already deployed in the real world. The benefits of such algorithms is that collective dynamics arises from interaction between robots and with the environments.

One of the major issue is that the global objective, defined at the population level, is difficult to grasp at the individual-level. For example, a group of robots may be asked to gather as many items as possible, which may require some robots to explore part of the environment where there are fewer items that elsewhere. In this case, some robots will under-performed when compared to others, but the global score will be better than that of all robots going only to the area with the highest density of items.

During this internship, we will explore how to estimate synergies and marginal contributions of individuals within a group in an on-line distributed manner. As well known method such as the Shapley value or the Banzhaf power index are computationally and informationally demanding, we will explore how to automatically build individual-based objective function that approximate the local utility from a global utility function and past interactions. In particular, we will explore how a surrogate model of a local utility function can be constructed on-the-fly, to act as a local proxy for the global utility function.

ADMINSTRATIVE INFORMATION

The internship will be done at UPMC, between the ISIR and LIP6 labs, starting Feb. 15th for 6 months (internship gratification is approx. 500 euros per month).

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