Emergence of group size through multi-agent reinforcement learning in a simulated environment

Topic: Deep reinforcement learning - Multi-agent simulation - Emergent cooperation and communication

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Social animals live in groups of different sizes depending on the constraints imposed by their ecological niches. Regarding primates, it has been proposed that the optimal size of the group emerges from two opposing constraints (e.g. [1]). On the one hand, being part of a large group reduces the risk of being captured by predators. On the other hand, being part of a large group increases competition in foraging, reducing the amount of food resources available to each individual.

The paradigm of Multi-Agent Reinforcement Learning (MARL, see e.g. [2]) provides a powerful tool for studying emergent behavior in populations of learning agents able to sense and act in a simulated environment. We will use this paradigm to study how an optimal group size can emerge from specific ecological constraints in a simulated environment containing resources to be collected as well as predator agents to escape from.

The objectives of the internship are the following:

- To review the literature in two scientific domains: the formation of optimal group sizes in social animals (e.g. [1]) and multi-agent reinforcement learning (e.g. [2]).
- To design and implement a population of reinforcement learning agents interacting together in a simulated environment. Each agent will be equipped with sensors (e.g. for detecting objects and other agents in the environment) and effectors (e.g. for navigating in the environment). The environment will contain three types of entities: resources, prey agents and predator agents.
- To run massively-parallel simulations in a computer cluster.
- To analyse the data resulting from the simulations and show how the parameters of the model influence the emergence of an optimal group size.


Expected ability of the student: Excellent programming skills, preferably in Python. Prior experience with machine learning and/or data analysis. Strong interest in modeling emergent behavior in multi-agent simulations.