Simulation environment and ecologically-valid interaction scenarios for multi-agent reinforcement learning

Topic: Multi-agent simulation - Behavioral ecology - Deep reinforcement learning

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The aim of the internship is to design and implement a rich simulation environment reproducing ecologically-valid conditions supposed to have driven some of the major cognitive transitions of the human species (e.g. [1, 2]). In the context of this internship, we will focus on 2D multi-agent environments with complex dynamics, either on the form of a grid-world (as in [3]) or relying on a 2D physics engine (as in [4]). This environment will be used to run preliminary experiments using Multi-Agent Reinforcement Learning algorithms (MARL, see e.g. [3, 5, 6]): a powerful computational tool for studying emergent behavior in populations of learning agents able to sense and act in a simulated environment.

The objectives of the internship are the following:
- Designing and implementing a multi-agent simulation environment
  - Reviewing the literature in simulation environments for multi-agent reinforcement learning (e.g. [3, 4, 5, 6]).
  - Software architecture design and API specification
  - Implementation of the simulation engine (possibly using existing Python libraries, e.g. [5]) and of the visualization interface (possibly using web technologies)
- Designing ecologically-valid interaction scenarios
  - Reviewing the literature in major cognitive transitions in human evolution (e.g. [1, 2])
  - Proposing interaction scenarios based on this literature review
  - Implementing these scenarios in the simulation environment
- Running preliminary experiments using MARL
  - Implementing a simple MARL algorithms (e.g. [3])
  - Running learning experiments on the defined scenarios
  - Data analysis


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.