



Multi-Agent Reinforcement Learning to understand Cooperation in Animals

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Social interactions are an important yet complex behavior for animals to learn. When learning behavioral policies for social settings, they must take into account the dynamics of the environment and the actions of other agents. The effects of other agents' actions can be difficult to separate from environmental dynamics and other agents' policies might be non-stationary. In cooperative social experiments, these challenges are compounded as animals receive reward only when they coordinate their actions with others. In past cooperative experiments, conditions such as obscured visual access and familiarity were shown to modulate cooperative success (1).

To better understand the strategies animals use to solve cooperative tasks and how experimental conditions affect these strategies, we used multi-agent deep reinforcement learning to model animal behavior during cooperative social tasks (2). Models were trained in a goal-driven manner in a virtual environment that mimicked the experimental paradigm of a rat cooperative social behavior task. In this task, both rats had to press a lever within a certain time window to receive a reward.

As visual occlusion experimentally modulated cooperative success, the restriction of partial observability was imposed on the virtual environment. In the partially observable setting, agents would receive information about other agents only when a gaze action was taken. To model familiarity in our multi-agent setting, we included a 'social model': an internal predictive model that learns the policy of the other agent. When training agents independently (3) and in partially observable conditions, an internal predictive model of the other agent was necessary to achieve high reward on the cooperative task. Modeling cooperative behavior with deep reinforcement learning also provides a hypothesis for neural computations underlying social behavior.

reinforcement learning, social behavior, deep learning, social cooperation

