

# Distilling Evolutionary Reinforcement Learning via Cooperative Coevolution

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*Abstract*—Recently, evolutionary reinforcement learning (ERL) has obtained much attention in various domains. Maintaining a population of actors, ERL utilises the collected experiences to improve the behaviour policy through efficient exploration. However, the native high-dimensional optimisation of the neural network poses a typical limitation due to the poor scalability of genetic operators. In this paper, we propose a novel cooperative coevolutionary reinforcement learning (CoERL) algorithm to address the scalability problem. Inspired by the cooperative coevolutionary algorithm, CoERL decomposes the policy optimisation problem into multiple subproblems by the divide-and-conquer strategy. Instead of using genetic operators, CoERL partially updates the behaviour policy by searching the gradient in a given area. The partial update based on the subproblem maintains consistency in the parameter space and behaviour space. The collected experiences by the population are then used to facilitate the off-policy gradient, which enhances the sample utility efficiency. Experiments on six locomotion tasks demonstrate the outstanding performance of CoERL, compared with seven state-of-the-art algorithms and baselines. Unique contributions of CoERL’s ingredients are also verified by the ablation.

*Index Terms*—Evolutionary reinforcement learning, cooperative coevolution, reinforcement learning, evolutionary algorithm.