Hierarchical RL in StarCraft II with Human Expertise in Subgoals Selection

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Introduction

We leverage hierarchical reinforcement learning (HRL) to integrate human expertise in the decomposition of a complex task and implicitly formulate a curriculum. Experimental results in two SC2 minigames demonstrate the sample efficiency and interpretability of our method.

Background

We follow the MDP formulation, use neural networks to represent the value/policy function, and conduct off-policy learning on collected experiences.

Hierarchy

The figure below illustrates the concept of subgoals and subpolicies with a simple navigation agent navigating to the flag post from $s_0$. Subgoals selected by our method (red nodes) guide the exploration, and contain structural dependence structure (black dashed lines).

Task Decomposition & Curriculum Design

We implement subtasks by customizing SC2 minigames. For BM we implement 3 subtasks for building supply depots, building barracks, and building marines (with already built barracks), respectively. For CMAG, we have 3 subtasks for collecting minerals, building refineries and collecting gas.

Experiments

Average and max rewards achieved and the number of samples used highlight sample efficiency. The reward curves demonstrate interpretability of the agent’s learning and performance.

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Future Research

This initial work invites several exploration directions: developing more efficient and effective ways of introducing human expertise; a more formal and principled state representation to further reduce the complexity of the state space (goal space) with theoretical analysis on its complexity; and a more efficient learning algorithm to pair with the HRL architecture, Experience Replay and Curriculum Learning.

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