Federated Control with Hierarchical Multi-Agent Deep Reinforcement Learning

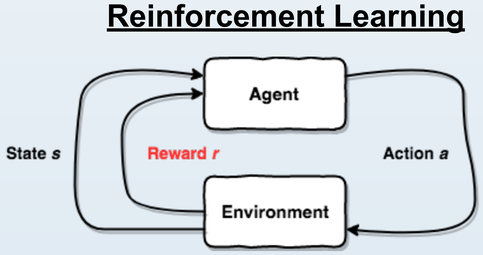
Saurabh Kumar[1*], Pararth Shah[2*], Dilek Hakkani-Tur[2], Larry Heck[2]
Georgia Institute of Technology[1], Google Research[2]
Contact: skumar311@gatech.edu, pararth@google.com
**Denotes equal contribution*

Abstract

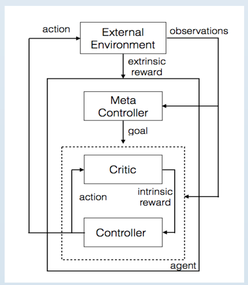
We present a framework combining hierarchical and multi-agent deep reinforcement learning approaches to solve coordination problems among a multitude of agents using a semi-decentralized model. The framework extends the multi-agent learning setup by introducing a meta-controller that guides the communication between agent pairs, enabling agents to focus on communicating with only one other agent at any step. This hierarchical decomposition of the task allows for efficient exploration to learn policies that identify globally optimal solutions even as the number of collaborating agents increases. We show promising initial experimental results on a simulated distributed scheduling problem.

Background

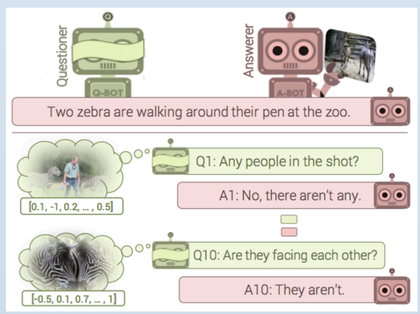
Reinforcement Learning



Hierarchical Reinforcement Learning



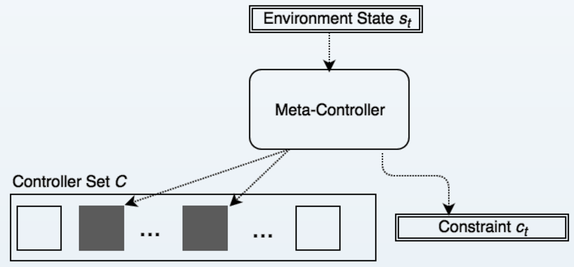
Multi-Agent Reinforcement Learning



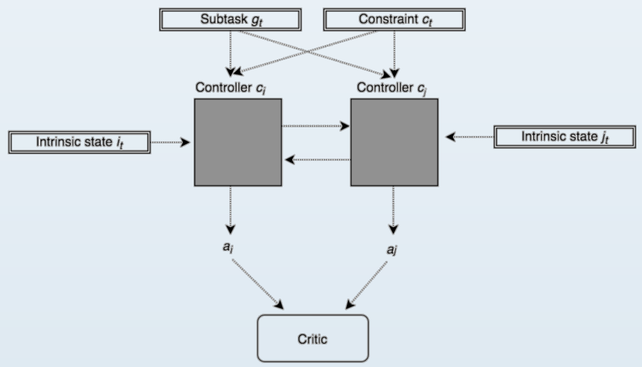
Approach

Federated Control (FCRL) Model
(Hierarchical RL + Multi-Agent RL)

Agent Hierarchy

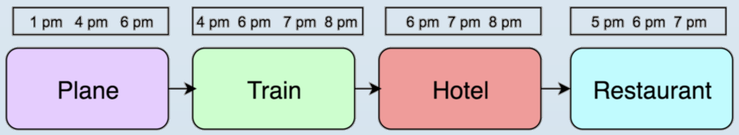


Controller Communication

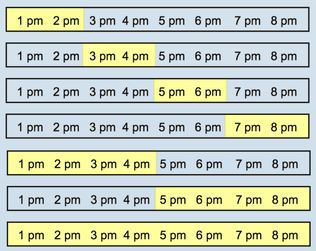


Environment

Subtask Ordering

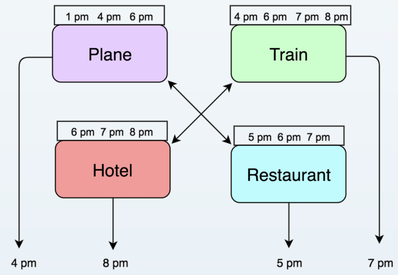


Constraints

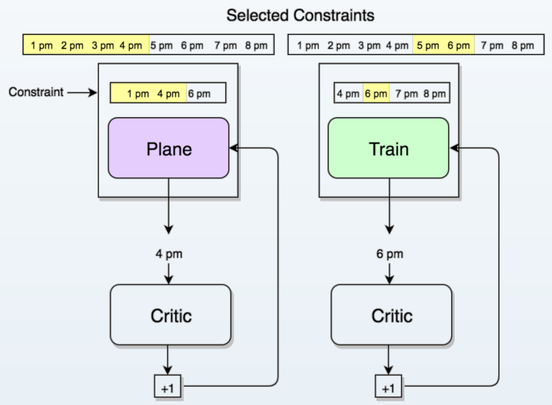


Experiment

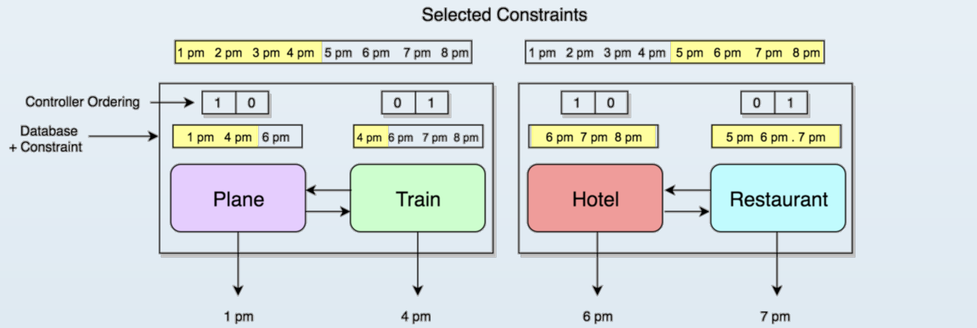
Multi-Agent RL



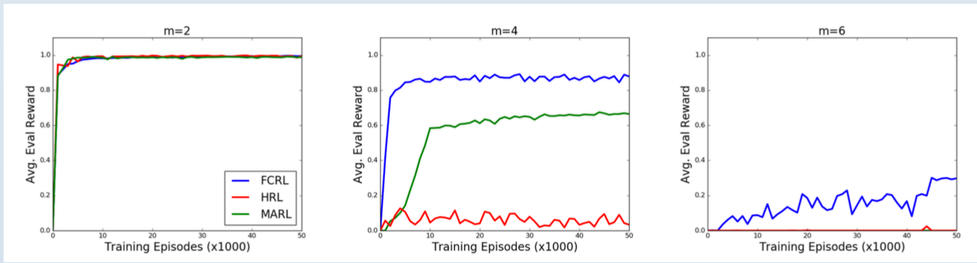
Hierarchical RL



FCRL



Results & Conclusions



- **HRL: Meta-Controller must pick right sequence of constraints + no communication**
- **MARL: Agents communicate preferences and update choices**
- **FCRL: Meta-Controller guides communications by focusing on disjoint database slices**
  - **Controllers communicate with only one other controller**

Future Work

- **Increase database size + number of communication turns**
- **More complex coordination environments, e.g. traffic control**
- **Train controllers using LOLA and/or Counterfactual Policy Gradients**