Distributed Multi-Agent RL for Routing Optimization

**Description**

In Computer Networks, Routing Optimization (RO) is about finding optimal (and often shortest) routing paths between nodes. Our most recent work trains an RO policy via Swarm Reinforcement Learning (RL) [2] that uses not only the computer network’s topology, but also its current load and performance statistics. However, so far we utilize global network states and rewards, and calculate actions for each routing node in a centralized manner. In this project, we want to find out whether we can achieve comparable performance with a distributed setup, where each routing node assembles its own local view of the network state from its own monitoring as well as information communicated by neighboring nodes.

![Figure 1: Situation-aware RO adjusts packet routes based on the network topology and current utilization/load to avoid congestion, delay and packet drops.](image)

We build upon our existing framework for RL experiments on RO in the network simulator ns-3 [1] and extend it to support distributed RL algorithms. While popular multi-agent algorithms like MAPPO [3] offer decentralized execution using a shared policy, we will also need to respect communication delays caused by the networked nature of our system [4].

**Tasks**

- **Literature Research:** Acquiring a comprehensive understanding of Multi-Agent RL, RL in networked systems and routing optimization; Specifying the research gap we aim to fill; Selecting an algorithm to continue with.
- **Implementation of Distributed RL algorithm into our framework:** Adjusting components like the observation function or the policy network to handle localized information of varying age.
- **Evaluation of the distributed approach in our framework, comparing against centralized RL and heuristic approaches.**

**References**


