ETH
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Distributed Computing

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Resilient Backbone Deployment under Cooperative Adversaries

In emergency, military, or disaster environments, fixed communication infrastructure (e.g., cellular) is often unavailable. To restore connectivity among end users, a fleet of mobile base stations (e.g., UAVs) can self-deploy to form a temporary communication backbone. However, these systems are subject to intelligent jamming attacks by cooperative adversarial teams that can coordinate to disrupt network connectivity. This calls for resilient deployment and coordination strategies that can adapt to adversarial and dynamic conditions.

This project aims to design autonomous coordination mechanisms for two competing teams: (i) cooperative UAV base stations aiming to maximize end-to-end user communication quality, and (ii) cooperative jammers seeking to minimize it. Both teams operate under uncertainty, partial observability, and constrained communication. The challenge is to enable scalable, resilient, and adaptive decision-making under mutual competition.

Research Questions

- How can multiple UAVs coordinate and plan their deployment trajectories to optimize global network performance and resilience under adversarial interference?
- How can teams of jammers learn and exploit cooperative strategies to maximally degrade network performance?
- How to optimally represent system state, including user spatial distribution, environmental features, and opponent intent?
- How can limited inter-agent communication be leveraged for decentralized yet coordinated behavior in both cooperative and adversarial teams?

Methodology

The work will model the problem as a multi-agent partially observable stochastic game (POSG). Cooperative learning within each team and adversarial interaction across teams will be captured through multi-agent reinforcement learning (MARL). The UAV team will optimize a reward based on network connectivity metrics (e.g., throughput, coverage, SINR), while the jammer team will optimize disruption efficiency. State representation learning (e.g., graph neural networks or transformer-based encoders) will be explored to capture spatial-temporal dependencies and facilitate generalization to unseen scenarios.

Interested? Contact us for more information

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