ORE SEMINAR
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OCEAN AND RESOURCES ENGINEERING
IN THE SCHOOL OF OCEAN AND EARTH SCIENCE AND TECHNOLOGY AT THE UNIVERSITY OF HAWAI'I AT MĀNOA

Frugal Data-Driven Planning on Resource-Constrained Maritime Missions

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Wednesday, April 2, 2025
3:30 pm - 4:30 pm
Zoom only
Meeting ID: 963 5962 3640
Passcode: OREseminar
https://hawaii.zoom.us/j/96359623640

Abstract

Fast, successful, and efficient planning is a core challenge of high-level autonomy in complex environments. The obstacles are seemingly insurmountable. Individual agents often face challenges in terms of resource and compute constraints, limited sensing and communication capabilities, and lack of a priori knowledge about the operating environment. Planning for large teams is burdened by either curse of dimensionality or complex organizational patterns of decentralization. As a result, standard learning or AI methods are largely infeasible – for instance, due to lack of training data or the size of the state space – while human-driven solutions or simple heuristics often produce vastly suboptimal plans. The purpose of this talk is to propose a middle road. We will consider three broad problems in planning: resource-constrained teaming, task-aware data collection, and time-optimal target search and interception. Focusing on their applications in the highly constraining maritime domain, we show that understanding the structure of agent interactions and the interplay between environment and mission progress is key in developing meaningful, computationally tractable policies. Consequently, our strategies combine machine learning reasoning with high-level structure-driven abstraction and mission decomposition. Early empirical work with autonomous surface and underwater vehicles demonstrates that such an approach greatly outperforms existing benchmarks while retaining the capability to operate at impressively large scales.