From the Battlefield to the Border: Decision Analytics for Expeditionary Logistics and Security Operations

Abstract

Modern military and security operations must sustain mobility and protect critical assets amid uncertainty and threat. This seminar presents two complementary models that address these challenges through optimization and game theory.

The first study introduces a new formulation for operational-level logistics planning in expeditionary environments. In this model, a military logistics planner coordinates a multimodal fleet of vehicles to transport commodities across an expeditionary theater while maximizing demand fulfillment. We develop a dynamic discretization discovery algorithm that iteratively refines consolidation plans on partially time-expanded networks, accelerating convergence through a flow-based heuristic and a vehicle-cycle elimination procedure. A case study with the U.S. Marine Corps shows that our method doubles demand fulfillment and reduces solve times by nearly 30% compared to benchmark approaches.

The second study examines an incomplete-information inspection game, in which an inspector deploys heterogeneous detection resources across capacitated locations (e.g., seaports) to intercept illegal items smuggled by an adversary. Each player faces uncertainty about the other's available resources. We develop an approach to compute Nash equilibria in polynomial time by characterizing equilibrium detection probabilities and expected damages, and by designing combinatorial algorithms that efficiently coordinate the players' heterogeneous resources. A case study on drug interdiction at U.S. seaports shows that reducing uncertainty about illicit shipments can increase the value of interdicted goods by over $20 million annually, highlighting the value of intelligence.

Together, these studies demonstrate how optimization and game theory can inform resilient planning and security decisions in complex, adversarial environments.