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The Rocky Mountain INFORMS Chapter is pleased to host Steven Coutts, a PhD candidate in the Space Resources Program at the Colorado School of Mines. His research is focused on developing adaptive decision algorithms for mineral resource exploration rovers. Steven received a BA in economics from the University of Louisiana, Lafayette, an MBA from Southern Cross University, an MA of Education, and an MA of Public Health from the University of California, Berkeley. Steven has 5 years of work experience as a technical project manager at OffWorld, a mining robotics startup focused on space resource exploration and extraction. His previous projects include developing agent-based simulations for robotic mining operations, developing sensing solutions for underground resource mapping, and developing ConOps solutions for lunar ice extraction under NASA SBIR research grants.

Adaptive Allocation for Best-Arm Identification with Shared Sampling and Switching Costs

Abstract: In resource-constrained exploration campaigns, choosing to travel between locations forfeits sampling opportunities due to time, energy, and distance limitations. Mission planners require deterministic algorithms that are robust to unreliable prior information and can provide explainable decisions for determining which locations to visit, their order, and sampling allocations. We model this as a best-arm identification problem where travel and sampling consume resources from a shared budget. We develop adaptive allocation methods, including SVPA (Smoothed Violation Probability Allocation), which bounds misidentification probability through weighted uncertainty allocation with a learnable smoothing parameter; MSE-based location pruning that iteratively refines plans under relaxed travel constraints; and hybrid path planning that dynamically balances sampling value against travel cost. Validation on real hyperspectral mineral data across 12 mineral groups demonstrates that our machine learning-optimized SVPA agent significantly reduces misidentification errors through adaptive conservatism, providing interpretable decision rules for high-stakes exploration campaigns.