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CIRRELT / CORS (Montréal Chapter) joint seminar

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Reinforcement Learning for Cost Estimation in Two-Level Combinatorial Decision Problems

Abstract: Many combinatorial decision problems exhibit a two-level decision structure, where high-level strategic choices influence lower-level operational decisions. Examples include Facility Location, Location Routing, and Outsourcing problems, where second-level decisions determine costs that depend on first-level choices. A key challenge in solving such problems efficiently is accurately and rapidly estimating second-level costs to guide first-level decision-making. In this presentation, we propose leveraging Reinforcement Learning (RL) to obtain fast and accurate approximations of second-level costs, which can then be integrated into traditional (meta)-heuristic frameworks for exploring first-level decisions.

More specifically, we demonstrate this approach on a daily distribution problem, named VRP-DO, where a fixed fleet must serve a set of customers whose demands are stochastic. Each day, the set of customers and their demand distributions are revealed. The decision-maker can outsource a subset of customers at a given cost while committing to serve the remaining ones. The objective is to determine the optimal outsourcing decision and an efficient routing policy for the committed customers to minimize the overall cost.

The VRP-DO follows a natural two-level structure: the first-level decision assigns customers to in-house or outsourced service, while the second-level decision determines an optimal routing policy and its expected cost. We solve this problem using a heuristic algorithm that follows this decomposition. An Iterated Local Search (ILS) explores different outsourcing and commitment partitions, while a Deep Q-Network-based cost approximation (DQNCO) efficiently estimates second-level routing costs. We validate the effectiveness of the proposed approach by comparing its performance against three alternative methods.

Biography: Fausto Errico is an Associate Professor at the École de technologie supérieure (ÉTS) in Montréal, Canada. He is a member of the GERAD and CIRRELT research centers. He obtained his Ph.D. in Mathematical Engineering from Politecnico di Milano, Italy. His research interests include decomposition methods for large-scale linear programs, stochastic programming and reinforcement learning. The main fields of application include public transit, hydropower generation, freight distribution and autonomous vehicles.

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Ouvert à tous / Open to all

Responsable / Organizer :
Nadia Lahrichi

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