

Deep Learning–Accelerated Multi-Start Large Neighborhood Search For Real-Time Freight Bundling

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Online Freight Exchange Systems (OFEX) increasingly rely on algorithmic decision support to bundle and allocate transportation jobs under strict real-time constraints. This talk addresses the resulting combinatorial optimization challenge by formulating freight bundling as a selective pickup-and-delivery traveling salesperson problem and proposing a learning–accelerated hybrid search algorithm. The approach combines a Transformer-based neural constructor, which rapidly generates high-quality feasible bundles, with a multi-start large neighborhood search that refines these solutions within sub-second time budgets. Empirical results show that learned initializations systematically improve the effectiveness of neighborhood search, yielding superior quality–time tradeoffs compared to classical metaheuristics and standalone learning-based methods. Beyond freight applications, the findings highlight a broader algorithmic principle: high-quality learned seeds can substantially enhance improvement heuristics for selective routing problems under tight latency constraints.