Solving the Traveling Salesman Problem with Drone: From Optimization to Machine Learning to Their Integrations

BIOGRAPHY

Changhyun Kwon is an Associate Professor in Industrial and Systems Engineering at KAIST, specializing in computational optimization for transportation and logistics systems. His research integrates machine learning to enhance algorithms for large-scale vehicle routing and mobility service operations. He earned his Ph.D. from Penn State in 2008 and B.S. from KAIST in 2000. His work is published in top journals like Operations Research and Transportation Science. Previously, he was a faculty member at the University at Buffalo and the University of South Florida. He serves on editorial boards and committees, authored Julia Programming for Operations Research, and is part of the JuMP steering committee. Dr. Kwon's research has been funded by various organizations including NSF, USDOT, NRF Korea, Toyota Material Handling, and Samsung Electronics.

ABSTRACT

In this talk, we explore computational methods for solving an NP-hard combinatorial optimization problem, the Traveling Salesman Problem with Drone (TSP-D). We will examine four approaches: (1) dynamic-programming-based search, (2) end-to-end deep reinforcement learning, (3) hybrid genetic search, and (4) an iterative chainlet partitioning method with neural acceleration. The dynamic-programming-based search method provides a powerful computational framework but lacks scalability. The end-to-end learning model employs an attention encoder and an LSTM decoder, while the hybrid genetic search method uses type-aware chromosomes with various local search strategies. The novel iterative chainlet partitioning method achieves state-of-the-art performance, further accelerated by neural-network-based guidance. Throughout this journey, we observe how optimization-based and learning-based methods differ, complement one another, and collaborate effectively.