Learning-Based Matching Algorithm for Smart Freight Platform and Sustainability Assessment in Montreal

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Abstract

Road freight transportation connects producers and consumers, and delivers goods in a timely manner, which is essential for the economy and society. However, traditional freight forwarding faces challenges such as long delays, high labor costs, and empty mileage, which increase the logistics and environmental costs and affect the carriers and shippers negatively. To address these issues, we develop a sustainable smart freight-matching model using Reinforcement Learning (RL). The main components of matching platform include: (i) optimizing real-time carrier-shipper matching using RL, aiming to maximize matches while considering time, location, and capacity (ii) emphasizing designing a dynamic dispatching system to ensure on-time availability, optimize resource allocation, enhance customer satisfaction, and improve operational efficiency in freight fleet management, (iii) stablishing dynamic cargo consolidation to reduce shipping costs, lower CO2 emissions, and enhance vehicle and logistics resource efficiency. To achieve sustainability, this platform maximizes platform profit as economic criterion, minimizing vehicle emissions, as environmental criterion and maximizing service level, as a social criterion. We use the Actor-Critic framework to model the state, action, and reward of the smart freight platform. We use Montreal region as a case study to test our model. We create synthetic data that simulates the real-world characteristics of freight logistics, such as timestamps, player roles, and location coordinates.

Keywords

Frieght road trasportation, Reinforcement learning, Matching, Learning-based algorithms , Smart transportation

Biographies

Ali Shiri is a Ph.D. student in Industrial Engineering at Polytechnique Montréal, where he commenced his studies in September 2022. Holding a master's degree in Electrical Engineering with a focus on Control from the University of Tehran, Throughout his academic and professional journey, Ali has consistently showcased his expertise in areas such as data science, quantitative analysis, and dynamic pricing management, affirming his commitment to sustainable solutions. His research contributions and notable projects underscore his dedication to addressing critical environmental concerns and advancing technological integration, particularly in the realm of transportation, ultimately driving toward a more eco-friendly and sustainable future

Samira Keivanpour is an assistant professor in the Department of Mathematical and Industrial Engineering at Polytechnique Montréal, Canada. She conducts research on sustainable solutions for supply chain and logistics

management, with a focus on end-of-life product treatment, circular manufacturing, and the integration of Industry 4.0 technologies.

Amina Lamghari After receiving a BSc and a Master's in Applied Mathematics, Amina Lamghari obtained a PhD in Operations Research from the University of Montreal, Canada, after which she worked as a post-doctoral fellow and later as a research associate at the COSMO Stochastic Mine Planning Laboratory at McGill University. Amina is currently an associate professor in the Management School at the University of Quebec at Trois-Rivières. Her research interests are centered on various techniques and algorithms —(meta)heuristics, hyper-heuristics, and matheuristics -- for optimization and their integration and application to solve complex scheduling and planning problems in an efficient manner accounting for uncertainty.

Asad Yarahmadi is a PhD candidate in Civil Engineering - Transportation Engineering at Polytechnique Montreal University. He completed his master in GIS and Remote sensing. With his unique blend of expertise in Geographic Information System (GIS) tools, Machine Learning techniques, and Remote Sensing, he excel at integrating technology to address the environmental impact of transportation. Throughout his academic and professional journey, Asad has demonstrated his commitment to sustainable transportation solutions. He also has a proven track record of effectively managing both academic research and industrial projects aimed at tackling crucial environmental issues, such as vehicle emissions. His ultimate goal? Facilitating a greener, more sustainable future.