

Integrated Neural Forecasting and Ensemble-Inspired Prediction Strategies for Evolutionary Optimization of a Dynamic Multi-Objective Transportation Problem

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Abstract

The study addresses a dynamic multi-objective multi-item solid transportation problem (MOMISTP) within the framework of a real-world fertilizer supply chain with varying cost and time. Unlike traditional static approaches, the problem is formulated dynamically to reflect monthly fluctuations in supply, demand, and conveyance availabilities. A feedforward neural network (FNN) is trained over the real-world historical data of supply, demand and conveyance availabilities to forecast monthly transportation cost and time. These forecasts are utilized as dynamic parameters in the objective functions, resulting in a sequence of dynamic optimization problems. Each monthly instance of the MOMISTP is solved using a dynamic NSGA-II framework. The variability along each time step is quantified using the Frobenius norm, which captures the intensity of environment change between two consecutive time steps. The quantified value is integrated with an ensemble-inspired prediction strategy to produce new solutions based on the changed environment along the time step. The ensembled approach comprises center-based prediction, knee-based prediction, random prediction and boundary population inclusion strategies. These methods are combined in the ratio of 3:3:3:1 to form an initial population for dynamic NSGA-II for further optimization over 12 months. This integrated approach enables effective adaptation to environmental changes and accurate forecasting of transportation parameters over 12 months. The strong correlation between cost and time across months suggests limited trade-offs; thus, a representative solution can be chosen for each time step. Overall, this methodology offers a robust decision-support tool for dynamic and resource-constrained supply chain environments, particularly those requiring time-sensitive logistics planning.

Keywords

Dynamic multi-objective multi-item solid transportation problem, Feedforward neural network, Frobenius norm, Ensemble-inspired prediction and Dynamic NSGA-II.

Biographies

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