Data-driven Ship Voyage Management

by

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(Conducted in English)

Abstract:

This study proposes an important ship voyage management problem (SVMP) arising from the daily operations of shipping lines. The SVMP aims to minimize the bunker fuel consumption of a ship over a voyage comprising a series of waypoints by adjusting its sailing speeds and trim settings. To address the SVMP, we first develop a tailored method to build two robust artificial neural network (ANN) models using ship voyage report data to quantify the synergetic influence of sailing speed, displacement, trim, and weather/sea conditions on ship fuel efficiency. We proceed to put forward three viable solution countermeasures for the SVMP by means of dynamic programming and simulation-based optimization techniques. Numerical experiments over two 9000-TEU (twenty-foot equivalent unit) containerships show that (a) Countermeasure 1 saves 4.96% and 5.83% of bunker fuel for the two ships, respectively, compared to the real situation; (b) Countermeasure 2 increases bunker fuel savings to 7.63% and 7.57%, respectively; (c) the bunker fuel savings with Countermeasure 3 attain 8.25% on average. These remarkable bunker fuel savings could also translate to significant CO_2 emission mitigation. From the methodological perspective, this study provides a pioneering data-driven optimization solution for the SVMP, which well integrates a highly accurate data analysis model and a combination of dynamic programming models and the state-of-the-art simulation-based optimization approach. Numerical experiments also reveal its superiority to existing alternative approaches.

Bio:

Dr. Yuquan (Bill) Du is a lecturer in the Department of Maritime and Logistics Management, Australian Maritime College. His current research concentrates on scheduling models and algorithms, logistics and supply chain management, especially on the optimisation problems in ports and shipping. Dr. Du has devoted more than 10 years entirely to maritime studies since his first research project on port operations as a master's student in 2006. Some of his studies have gained high academic or industrial reputation, such as INFORMS President's Pick, and Industry Mention of IBM's Optimisation Team on CPLEX. One of his papers also ranks in the MOST CITED ARTICLES since 2011 of Transportation Research Part E. He is also enthusiastic about promoting the applications of optimisation theory and solvers through his blog 'Chinese OR Tea', which has attracted more than 220,000 visits since its opening in 2008.

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All are welcome!