A Two-Stage Stochastic Mixed Integer Optimisation Model for High-Speed Passenger Rail Line Planning Problem

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Due to the tremendous size and complexity of the rail network system, a hierarchical planning process [1] is implemented for the passenger transportation planning. The passenger rail line planning problem, which is the strategic-level decision-making problem of passenger transportation planning, play an important role to meet the passenger demand. The line planning problem determine a set of service lines, which specifies a route between an origin and a destination station and stopping plan, combined with the operated frequency in time period in railway system. The line planning problem aims to determine an optimal service line plan to reduce the passenger travel time in an economic way.

It has attracts many researches [2, 3]. As we know that, the passenger demands is an uncertain factor in real-world, it could be different from day to day. Then, different passenger demands scenario are collected according to the data of transportation cards or tickets. Hence, we propose a two-stage stochastic mixed integer optimisation model, including the frequency setting problem and the passenger assignment problem, to design service line plan under uncertain passenger demands. To efficiently solve the model, an improved Benders decomposition algorithm, in which the service frequency is acquired at the first stage and the second-stage passenger assignment problem, which is a large-scale multi-commodity network flow problem to meet the variety passenger demands, is solved by a column generation method. The Benders decomposition algorithm is solved iteratively until convergent condition is reached. A real-world case study is conducted to validate that the proposed approach is promising for solving the high-speed rail line planning problem in China.

Keywords: High-speed rail; line planning problem; stochastic optimisation; benders decomposition algorithm; column generation

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