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Periodic train timetable expansion: An integrated model of multi-period train service selection and rolling stock circulation with time-varying passenger demand

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The periodic train timetable is one of the most widely used train timetables in passenger railway systems worldwide. However, how to expand well-coordinated daily train services from a single-period timetable pattern is rarely studied. This paper develops a multi-objective mixed integer programming model to solve the periodic train timetable expansion problem, aiming to optimize passenger waiting time and rolling stock operation costs. In our model, the time-varying passenger assignment, train service selection, and rolling stock circulation planning are integrated. Moreover, the rolling stock circulation is considered with a flexible composition mode for efficiency. An ε-constraint method is introduced to explore the Pareto frontier for the multi-objective model and analyze the trade-offs between the service quality and operating cost. The model and analyzing theorem are validated via the real-world case Guangzhou-Shenzhen Intercity Railway transit system.

Keywords
Periodic train timetable, Rolling stock circulation, Flexible train composition, Time-varying passenger demand, Integrated optimization