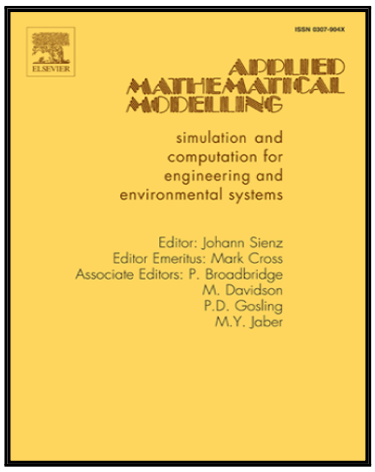

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Uncertain Models on Railway Transportation Planning Problem

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Abstract

This paper investigates the frequency service network design problem in a railway freight transportation system, in which the fixed charge and transportation costs are both nondeterministic. In order to deal with nondeterministic system, uncertain variables are introduced. Here we propose two uncertain programming models, namely, budget-constrained model and possibility-constrained model, to design the fright transportation system. It is proved that the possibility-constrained model can be transformed to an equivalent deterministic transportation model using inverse uncertainty distribution. Based on this equivalence relation, the possibility-constrained optimal transportation plan can be obtained and then the solution of the budget-constrained model can be approximated. Finally, the idea of uncertain models is illustrated by a numerical experiment.

Keywords: Railway freight transportation; Service network design; Uncertain programming; Mixed integer linear programming

1 Introduction

In modern society, freight transportation is a vital component of the economy. A well-performed freight transportation system can ensure a low-cost and fast flow of products, which improves the economy efficiency. Due to the safety and capacity, the railway freight transportation always occupies an important place in the entire transportation system, especially for the long-distance or large-scale freight transportation. Thus, the research on how to make the railway freight transportation more efficient has lasted for decades ([1, 2, 17]).

Essentially, the railway freight transportation problem belongs to service network design problems, which aim to ensure an optimal designation and utilization of resources on networks. Crainic *et al.*[4] pointed out that service strategies can be divided into three planning levels, namely, strategic (long term), tactical (medium term) and operational (short term) planning level. Moreover, Crainic [5] mathematically summarized service network design problems into two categories, that is, frequency and dynamic service network design problems. In the frequency service network design problem, service frequencies are explicit integer decision variables or derived outputs in the model. Typically, frequency service network design models address issues in the strategic/tactical planning level. Dynamic service network design models, however, are closer to the operational planning level, where a time dimension is introduced into the formulation and a space-time network is used to represent the operations over time periods.

The railway freight transportation problem investigated in this paper, according to the categories mentioned above, is a special case of frequency service network design problems. In details, it focuses on a railway freight transportation problem with multiple product and multiple origins/destinations, and aims to find an optimal plan such that the total cost will be minimum. In past decades, most research

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