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Review on Transportation Scheduling Problem

1P.Jamuna Devi, 2R.Padmasri, 3D.Bindhu
1,2&3 Assistant Professor, Department of Mathematics
1,2&3 E.G.S.Pillay Engineering College, Nagapattinam-611002, Tamilnadu, South India.

Abstract- Transportation by railroads and airlines contains a rich set of optimization problems with substantial potential savings in transportation costs. In the past few decades, unfortunately, optimization models were not widely used in transportation industries, because of (i) the large size and tremendous complexity of these problems, (ii) the lack of suitable algorithmic approaches for solving them, and (iii) insufficient computing power available. The paper gives an insight to several real-life transportation scheduling problems that are of great importance for railroads and airlines.

Index Terms: locomotives, airways, train scheduling problem review

INTRODUCTION:

Transportation in India needs many research activities to make its process simpler and Mathematics play an important role. The mathematical models support the Indian transportation system along with Engineering and Technology. The transportation industry encompasses numerous decision problems which can be formulated mathematically. One important kind of decision problem is called the scheduling problem, which aims to plan for the movement of passengers and freight. This problem has attracted many researchers in the past due to its interesting nature and economic scale. Some of those researchers are involved in studying the mathematical nature of the problem and in theoretical approaches for solving the problem.

REVIEW ON LOCOMOTIVE SCHEDULING PROBLEMS:

Many railroad transportation problems can be modeled and solved using mathematical optimization techniques. Unfortunately, the related research was not very successful in the past, failing to incorporate the characteristics of real-life applications (Assad [1981] and Haghani [1987]). However, in recent years, with increased profit incentives, strong competition from other freight carriers (especially trucking companies), and better availability of computer systems, railroads have begun to adopt optimization-based decision support for their scheduling problems with some success (Cordeau et al. [1998]). In the last few years, a growing body of advances concerning several aspects of rail freight and passenger transportation has appeared in the operations research literature (see, for example, Jovanovic and Harker [1991], Brannlund et al. [1998], Newton et al. [1998], Cordeau et al. [1998], and Sherali and Suharko [1998]). Locomotive scheduling problems are among the most important problems in railroad scheduling (Florian et al. [1976], Mao and Martland [1981], Smith and Sheffi [1988], Chih et al. [1990], Forbes et al. [1991], Fischetti and Toth [1997], Nou et al. [1997], and Ziarati et al. [1997, 1999]). Locomotive scheduling problems are similar to the airline scheduling problems where one assigns planes of different types to flight legs. The planning version of the locomotive scheduling problem studied in this paper is similar to the well known fleet assignment model (see, for example, Subramanium et al. [1994] and Hane et al. [1995]), and the operational version of the locomotive scheduling problem is similar to the aircraft routing problem (see, for example, Barnhart et al. [1998]). Single locomotive models have been studied by Forbes et al. [1991], and Fischetti and Toth [1997]. Multicommodity flow based models for planning decisions have been studied by Florian et al. [1976], Smith and Sheffi [1988], and Nou et al. [1997]. Multicommodity flow based models for operational decisions have been developed by Chih et al. [1990], and Ziarati et al. [1997, 1999].

RAILROAD BLOCKING PROBLEM:

Railroads carry millions of shipments annually from their origins to their respective destinations. A typical shipment is composed of a set of individual cars that all share a common origin and destination. To reduce the intermediate handling of shipments as they travel over the railroad network, a set of shipments is classified (or grouped) together to create a block. The blocking problem is to identify this classification plan for all shipments in this network, called a blocking plan, so that the total shipment cost is minimum. A blocking plan significantly affects the shipment cost. However, the blocking problem is a very large-scale optimization problem, and its...
complexity and sheer size have not allowed this problem to be solved to optimality or near-optimality satisfying all the practical considerations required for an implementable plan. The two most recent references on blocking problems are by Newton et al. [1998] and Barnhart et al. [2000]. One of the first models for car blocking belongs to Bodin et al. [1980]. This paper formulates the blocking problem as non-linear mixed integer programming problem. The model, which is a multicommodity flow problem with additional side constraints, simultaneously determines the optimal blocking strategies for all the classification yards in a railroad system. Assad [1983] proposes a solution approach for a problem defined on a line network composed of n yards, with traffic flowing from yard 1 to yard n. A dynamic programming formulation with relaxed assumptions led to an efficient solution method. Van Dyke [1986, 1988] describe an interactive heuristic approach that attempts to improve an existing blocking plan by solving a series of shortest-path problems on a network whose arcs represent available blocks. Keaton [1989, 1992] have developed a non-linear MIP for blocking problem, Huntley [1995] has developed a simulated annealing approach, and Gorman [1995] presents a genetic algorithm for constructing operating plans including blocking, train connections, and block-to-train assignments.

Most recent and promising works for blocking problem are by Newton et al. [1998] and Barnhart et al. [2000]. Newton et al. [1998] models the blocking problem as a network design model and formulates the problem as MIP. Their decision variables are to select a block to be made and distribution of traffic among potential paths (consists of blocking arcs). They apply column generation and branch-and-price algorithms to solve the problem. Barnhart et al. [2000] use same formulation as Newton et al. [1998] and propose Lagrangian relaxation technique to decompose the problem in two sub-problems.

**TRAIN ROUTING, TIMETABLING AND DISPATCHING PROBLEM:**

Given a blocking plan and a distribution plan for empty cars, the train routing and time-tabling problem is to identify train routes and their time-tables so as to minimize the cost of carrying cars from their origins to destinations. Real-time operations of trains also require synchronization of train movements on the lines of the physical railway network. Given a train timetable, the train dispatching problem determines a feasible plan of meets and overtakes that satisfies a system of constraints on the operation of trains. Some recent papers on this problem are by Farvolden and Powell [1994], Campbell [1996], Kraft [1998], and Brannlund et al. [1998].

**AIRLINE SCHEDULING PROBLEMS:**

Airline industries now regularly use optimization models in their planning and scheduling tasks and the use of these models has resulted in hundreds of millions of dollars in annual saving for major airlines (Yu [1998], Barnhart and Talluri [1997] and Ahuja et al. [2001c]). Several methods for demand forecasting are in use. Some of them are as follows: (i) stepwise forecasting (first forecast the overall travel demand in a region or zone, then derive the demand for travel for an origin-destination pair, then determine the air-travel demand for that origin-destination), (ii) demand forecasting based on the population of the cities and distance between cities, and (iii) regression analysis.

**FLIGHT SCHEDULE DESIGN PROBLEM:**

The flight schedule design problem consists of deciding when and where flights should be flown. A schedule is fixed for a period of time, usually up to three months, with some minor alternations from month to month. The objective of the schedule design is to develop a schedule defining an origin, a destination, a departure time, and an arrival time for each service to accommodate passenger demands. The schedule should meet resource availability constraints. Constrained resources in airline scheduling include vehicles, crews, maintenance facilities, staff, etc. The schedule design problem can be further divided into two problems: (i) route generation – deciding which candidate flights should be considered; and (ii) route selection – selecting the most profitable flight legs out of all the candidate flight legs.

**CONCLUSION:**

There are numerous transportation scheduling problems that need attentions from the OR community. We have attempted to solve a few of such problems. Our efforts are focused in finding good quality and implementable solutions in reasonable computational time. In this paper we have reviewed the scheduling problems that we have studied and then briefly present the direction for the future research.
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