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Editorial

Special issue on Integrated optimization models and algorithms in rail planning and control☆

1. Introduction

Railway systems and urban rail transit serve as transportation backbones in many countries. Optimized train operation plans and control decisions are vital for providing better freight and passenger train services, which can further help rail systems maintain and improve their competitiveness on the intermodal transportation marketplace. One of the strongest benefit of rail services is its economy of scales, in terms of vehicle load, and infrastructure scope. This brings directly the central issue of having multiple stakeholders in a joint production and interconnected/integrated environment.

We focus on the rail planning and control perspective, i.e., determining operational plans providing the best service, given the limited resources available. Due to the extremely high complexity of the whole system, most of existing studies focus on investigating quantitatively one single specific issue in this perspective.

Recent rapid development of advanced communication and computation technologies enabled a wide range of possibilities for a systematic integration of different railway planning and control aspects across decision layers. Specifically, the multiple components, stakeholders, and interconnected layers of a railway system define lot of challenges, ranging from train timetabling, railway traffic management, to rolling stock and crew scheduling and train control, including extra aspects which are also vital for a good business, such as passenger satisfaction or maintenance. This trend of integration is very present in the transportation world (Speranza, 2016); but railway systems have their own peculiarities (see e.g. Hansen and Pachl, 2014). A bibliometric search shows the impressive increase in indexed items pertaining the keywords “integrated”, “optimization” and “railways”, in the last years (see Fig. 1).

This special issue, which would not have been possible without the strong support of Prof. Yafeng Yin, all the authors and the referees, investigates the inherent relationships among different planning and operational elements and obtain better system performance. The focus is on a literature update on the hottest topics featuring integration of multiple problems, solution approaches, time scopes. In this sense it is an ideal complement as well as a follow up of review papers which specifically address integration of multiple problems in railway planning and rescheduling (Cacchiani et al., 2014; Corman and Meng, 2015; Turner et al., 2016). The papers submitted describe innovative mathematical formulations, efficient solution algorithms and new system deployments for integrating railway planning and control, which are briefly categorized and described in what follows. As most authors conclude in their papers we wish those approaches to become even more integrated, addressing larger challenges in the mobility world, and moreover be applied for the improvement of existing transport systems.

2. Contributions

2.1. Integrated offline traffic optimization within one planning stage

The paper *A bi-level model for single-line rail timetable design with consideration of demand and capacity* by Yuting Zhu, Baohua Mao, Yun Bai and Shaokuan Chen proposed a bi-level model for designing a train timetable on a urban rail line. Passenger demand and carrying capacity of rolling stocks are jointly considered in the train timetabling stage (Zhu et al., 2017).

The paper *Hybrid cyclicity Combining the benefits of cyclic and non-cyclic timetables* by Tomáš Robenek, Shadi Sharif Azadeh, Yousef Maknoon and Michel Bierlaire examined the benefits of combining the regularity of cyclic timetables and the flexibility of the non-

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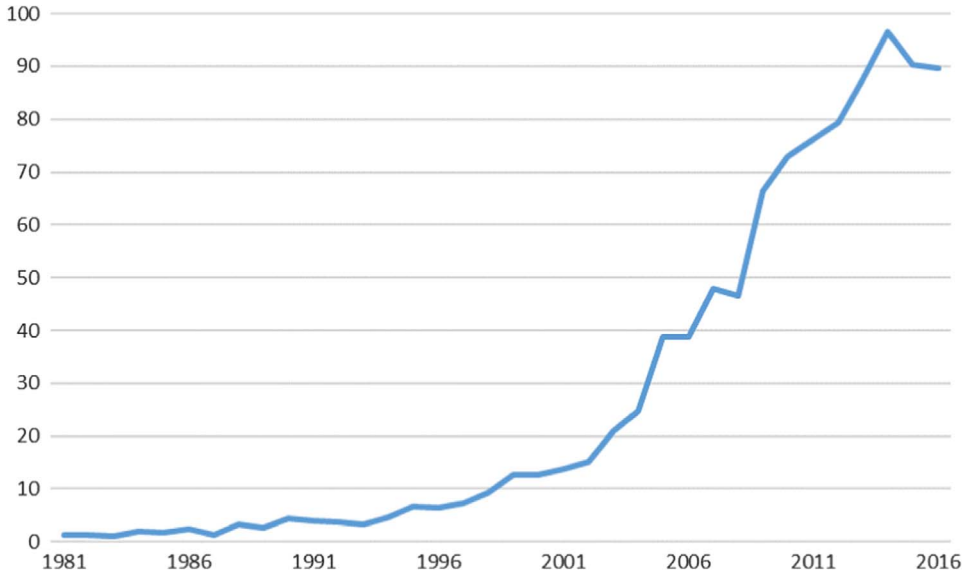

Fig. 1. Trend of indexed items, pertaining integrated optimization in railways (Scopus, 2017).

cyclic ones (Robenek et al., 2017).

The paper *A delay root cause discovery and timetable adjustment model for enhancing the punctuality of railway services* by Wei-Hsun Lee, Li-Hsien Yen and Chien-Ming Chou proposed a delay root cause discovery model which integrates heterogeneous railway operation data sources to reconstruct the details of the railway operations. The model was validated by experiments that it can predict the delay reason with 83%, or even 90% accuracy (Lee et al., 2016).

2.2. Integrated online or real time traffic optimization within one planning stage

The paper *The multi-objective railway timetable rescheduling problem* by Stefan Binder, Yousef Maknoon and Michel Bierlaire generated an integer linear model for optimizing train disposition timetable under large disruptions with integrating three objectives: passenger satisfaction, operational costs and deviation from the original timetable (Binder et al., 2017).

The paper *Improving recovery-to-optimality robustness through efficiency-balanced design of timetable structure* by Chao Lu, Jinjin Tang, Leishan Zhou, Yixiang Yue and Zhitong Huang developed a two-stage approach which integrated recovery-to-optimality robustness to the timetable design process (Lu et al., 2017).

The paper *Rescheduling through stop-skipping in dense railway systems* by Estelle Altazin, Stéphane Dauzère-Pérès, François Ramond and Sabine Tréfond proposed a train rescheduling model whose objective integrates passengers' recovery time and waiting time and the total weighted number of skipped stops (Altazin et al., 2017).

The paper *Real-time automatic rescheduling strategy for an urban rail line by integrating the information of fault handling* by Yuan Gao, Lixing Yang and Ziyou Gao integrated dynamic the information of fault handling into real-time train rescheduling problem and developed a mathematical model for automatically adjusting train timetable (Gao et al., 2017).

2.3. Integrated crew & passenger service management optimization within one planning stage

The paper *Optimization of periodic crew schedules with application of column generation method* by Jaroslav Janacek, Michal Kohani, Matyas Koniorczyk and Peter Marton presented an approach to the problem of periodic crew scheduling in which locomotive drivers and conductors are considered. Column generation techniques and Dantzig-Wolfe type decomposition were employed for modelling and solving the problem (Janacek et al., 2017).

The paper *Designing an integrated distribution system for catering services for high-speed railways: A three-echelon location routing model with tight time windows and time deadlines* by Xin Wu, Lei Nie and Meng Xu developed a three-echelon location routing model for designing catering service network with integrated consideration of passenger demand in a high-speed railway network (Wu et al., 2017).

The paper *Railroad caller districting with reliability, contiguity, balance, and compactness considerations* by Siyang Xie and Yanfeng Ouyang formulated a reliable caller districting problem with joint consideration of district contiguity and compactness, workload balance, and caller desk service reliability (Xie and Ouyang, 2016).

2.4. Integrated optimization across different planning stages

The paper *An eigenmodel for iterative line planning, timetabling and vehicle scheduling in public transportation* by Anita Schöbel

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