

## **Train timetabling problem for railway complex topologies**

### **Abstract:**

The train scheduling problem has been solved mainly by three different approaches developed in several papers in the literature. The first approach represents the rail transportation system as a network whose nodes represent yards of stations and whose arcs represent lines of track on which trains carry passengers or freight. The second approach formulates the timetable problem as a resource-constrained project scheduling problem. The third approach consists on developing a specific model for solving specific problems.

To solve the train scheduling problem a new model is developed to consider general complex railway topologies such as: single-multiple-track lines, complex terminal stations, etc. In order to model that, a classification of railway line elements is defined. The mathematical model also deals with general operation policies: different train services sharing some parts of the rail line, heterogeneity in the characteristics of the trains (length, speed, etc.), etc. This model overcomes some of the limitations of previous models found in the literature, such as the difficulties of dealing with stations with a determinate number of tracks or with train services accomplishing different routes, and the difficulties of designing completely new timetables for those cases when no initial timetable is given. This approach yields in large-scale combinatorial problems that are directly solved as integer programming problems.

Finally, the model is applied to design a new schedule for six suburb train services of FGC (Ferrocarrils de la Generalitat). This services shares one big terminal station (Plaza de Cataluña) and some other stations of a double-track line.

**Keywords:** Train timetabling problem, optimization-problem solution methods, Railway complex topologies

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