

Integrated optimization of train timetable, rolling stock assignment and short-turning strategy for a metro line

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This presentation is about three different things. What is the problem we are trying to solve?
Trains have

- High demand during peaks
- Long waiting times
- Too many passengers for 1 train
- fixed numbers of trains

As an example he gives the tramline of Utrecht. The suggestions to solve the above problems he gives

- Stop-stop
 - Skip a stop that is not very popular
- Express/local stopping: Have trains that run on parts of the line
- Short turning: Potentially turn the metro around earlier (You can choose any time)

With short turning you can increase a service from 3 to five with the trade of that some stations are visited less often.

Problem characteristics

- Irregular time table
- Rolling stock assignment
- Short-turning

We solve this model with a hybrid model. First we use a genetic model using a standard ILP-solver. This is NP-Hard. Our genetic algorithm consists of:

- Creation
- Cross-over
- Mutation

We first create a random number of down- and upstream services and random headways. We use a sub-model

- Fit chromosomes to constraints
- Gurobi (Tries to connect the services to the headways)
- Minimizes the number of changed headways

Now we have the creation we can do the cross-over:

- Select 2 chromosomes
- Split at random index
- Swap tails

We have n -mutation changes the amount of upstream services and h -mutation changes one of the headways of the solution. We select the best 25 chromosomes and the other 25 will be selected with a tournament.

They tried it in real life at the Beijing line 6. There are two stations in the middle of the line where metro's can change directions and depots at the end and start. At the moment Beijing uses a regular time interval. When comparing it to the model in the paper we see that the line is a lot busier in the middle of the line. The total waiting time in seconds has gone from 86,495,451 to 47,774,308 and the people that had to wait and could not get into the train has been decreased three times. They have also compared the algorithm to the algorithm without short-term and this also shows positive results.

Conclusion

This paper optimizes the train tabling by quite a big amount and even better compared to other algorithms. Which is better than a lot of other papers, because not all compare with other methods.