



Review

of a dissertation thesis with the title
„Train Platforming Problem Solving“
by Emine Akyol

1. Topicality

In my view **the subject of the dissertation work is highly topical**. The work deals with management of train operation in a passenger railway station. The goal is to find an optimal train routing and scheduling within a station yard which is a hard problem especially in large and busy stations. The problem is of high importance since reasonable and far-sighted allocation of trains to platforms improves fluency of the traffic, reduces delays and increases the quality of the transportation service perceived by passengers.

2. Methods

The objective of the work is to propose a new method for solving the train platforming problem. The problem is solved at the tactical level of planning. The goal is to find feasible routes of the trains through the station supposing the network timetable is given, and to adjust arrival and/or departure times so that the total delay of all trains could be as small as possible. Decomposition of the problem and mathematical programming are the main tools to solve the problem. Since the problem is NP-hard, the mathematical model cannot be solved to optimality in a reasonable time. That is why mathematical programming is combined with a heuristic algorithm. Hard decisions about allocation of the trains to the platform tracks are made by the heuristic, the remaining decisions about arrival and departure times are made using the mathematical programming model.

3. Objectives

The objectives of the thesis were twofold. The first goal was to develop a mathematical programming formulation of the problem with regard to safety conditions and technological restrictions of the operation. The second goal was to propose a heuristic algorithm for the problem solution. Basically I think the goals were fulfilled, although there are many doubts in the work.

4. Contributions

A novelty of the approach is in the detailed mathematical programming model and in the proposed heuristic algorithm. This can be regarded as the scientific contribution.

The solution method is of great importance for practice as well, since it enables

- verification of the network timetable with regard to the capacity of the station;
- to reveal bottlenecks in the station that prevent full operation;

- to prepare a track occupation plan that is a decision supporting tool for a dispatcher controlling real-time operation in the station.

5. The extend and quality of the published works related to the dissertation thesis

The student has published one paper closely related to the problem under consideration. Other two papers were accepted for publication. The publication output related to the topic is below-average.

6. Comments

I have doubts about the correctness of the mathematical model and about its validation.

p. 20, Fig. 3.2: Why the combination $j(A,A)$, $q(B,B)$ is omitted in Fig. 3.2 and in the following text?

p. 20, Fig. 3.3: The left side of Fig. 3.3 does not illustrate coupling train j with another train arriving from direction B. The text above the figure does not correspond to the figure.

p. 21, Case 4: The text is not correct. Train j cannot have a couple because it must depart first.

p. 22, Case 7: A similar error as in Case 4: Train q must depart first, that is why it cannot have a couple.

p. 25: Why does the time interval between entry/exit signals and a platform track depend on the train but not on the platform track?

p. 26: I think the explanation in the last paragraph is not correct otherwise the first and last terms in the objective function would be zero. (If originating and transit trains are not allowed to wait in the station, then they must depart on time with no delay. If terminating trains did not have any delay at the departure, then the last term in the objective function would be zero.)

p. 54, Eqs. (4.176) and (4.179): pt should be added to the LHS (time interval after the track was released).

p. 61, Fig. 5.1: The pseudocode of the algorithm is horrible! In the first two lines the symbol j is not defined (from programming point of view). I think both statements should be in a cycle for all j . The second loop (for $lin...$) is useless, a simple assignment $lin = gbb(j)$ would be far more efficient. The same holds for loop for $l...$ - the assignment $l = pref(lin,pr)$ would be sufficient. The same holds for loop for $q...$ in the second part - again the assignment $q = last(l)$ should have been used instead of the loop. Symbols $b(j,l)$, $dt1$, $dt2$ are not explained.

p. 72: The description of the improvement algorithm is confusing. In Step 4, the recovery algorithm is called with parameters tj and tq . However, the recovery algorithm on p. 71 does not have any parameter and performs loops for every train j and every train q . So what is the truth - does the recovery algorithm have parameters or not? Step 5 does not seem very reasonable. It says that the assignment of train tj changes even if the change does not improve the total delay. Moreover, the platform track for train tj is again updated in Step 7. Variable $change$ is set in the recovery algorithm, so I do not understand the statement $change_{ijtq} = 1$ in Step 7. Why does the procedure return to Step 6, when the change proposed by the recovery algorithm does not improve the objective function? I do not understand why the procedure does not stop immediately when there is not delayed train in Step 10. Why does it proceed to Step 12? What does the termination condition $\{tj,tq:w1j>0,w2j>0,change_{ijtq}=0\}=\emptyset$ in Step 12 mean?

- p. 75: Why cannot waiting time of train 6 at the platform track affect the objective function? On the contrary, waiting time of trains 3 and 5 at the platform track should not contribute to the objective function value, since they are terminating trains.
- p. 75, Fig. 6.2: Why does Fig. 6.2 display only 4 out of 7 trains? Why is waiting time of train 2 at the platform track 2 minutes? In my view 1 minute would be enough since according to Eq. (4.89) $z_2 = c_1 + 1$ and according to Eq. (4.90) $c_2 = c_1 + 2$. Why does it take 3 minutes to get train 3 from the entry signal to the platform? The input data say that it should take 1 minute. The description of the testing problem and its results have not convince me that the mathematical model is correct.
- p. 82, Tab. 6.5: The number of trains in each time interval except the first one is 36. However, Table 6.12 presents totally different numbers in most time intervals. Can you explain the discrepancy?
- p. 91, last paragraph: You state that a decision model is solved using Cplex solver. However, on p. 82 you state that the solver could not be run for 3rd and the following intervals. Can you explain the discrepancy in these statements?
- p. 94, 2nd paragraph: What does “simplification of real operation data mean”?
- In addition to the factual objections, the thesis contains a lot of formal errors:
- p. 24: One symbol cannot be used in multiple meanings. Symbol pt states for the number of platform tracks as well as for “the minimum time for arriving of next train after platform track is released”.
- p. 25: The name of the parameter *delay* does not correspond to its meaning.
- p. 26, Fig. 4.1: Arrival time of train j to the home signal should be denoted as rs_j .
- p. 27, Eq. (4.6): The upper limit in the sum should be pt , not s .
- p. 55, last paragraph: Symbol m was not introduced.
- p. 65 and following: All loops miss the upper bound for the control variable, so the number of loops is unknown.

7. Conclusion

The dissertation thesis meets the conditions stated by § 47 Subsection 4 of the Law No. 111/1998. I recommend the thesis to defence.

V Žiline 2.11.2017



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