Downloaded from UvA-DARE, the institutional repository of the University of Amsterdam (UvA)
http://dare.uva.nl/document/172165

File ID	172165
Filename	Summary in English

SOURCE (OR PART OF THE FOLLOWING SOURCE):

Type	Dissertation
Title	Dynamic delay management at railways: a Semi-Markovian Decision approach
Author	A. Al-Ibrahim
Faculty	Faculty of Economics and Business
Year	2010
Pages	xii, 233
ISBN	978 90 3610174 5

FULL BIBLIOGRAPHIC DETAILS:
http://dare.uva.nl/record/338751

Copyright

It is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), other than for strictly personal, individual use.

UvA-DARE is a service provided by the library of the University of Amsterdam (http://dare.uva.nl)

English summary

Dynamic Delay Management at Railways
A Semi-Markovian Decision Approach

The topic of this research is dynamic delay management at railways. ProRail, the Dutch railway infrastructure manager, is interested in finding new methods in order to improve train service through optimisation of the usage of the railway network. This optimisation step is needed, since the railway capacity is scarce while the demand is growing in terms of both passenger and freight traffic. With this growing demand, the current way of railway operation will become unsustainable and needs to be reviewed. The Dutch government is aware of this and has expressed its ambitions to gradually increase the number of trains in the most dense part of The Netherlands and gradually move to a system which can be described best as a metro system. In such a system, a high number of trains operate and run close to each other. This way a higher demand can be met. The drawback of such a system is that it is more vulnerable to delays. Due to less buffer space, small delays will more often lead to train conflicts. This change in railway operation will lead to a more dynamic railway service which increases the need for new techniques that can solve train conflicts dynamically.

Train conflicts occur also in the present day situation where timetables are a common practice. Although, timetables are designed to separate trains from each other, some trains get delayed which leads to train conflicts. Currently ProRail relies on the so-called TAD conflict resolution rules which are strongly related to the timetable. Train dispatchers use these rules to resolve train conflicts. The rules are the result of the negotiation process between different operators and prescribe a certain train order per conflict situation. On a number of locations within the Dutch railway network, these rules are however not satisfactory. ProRail is interested in alternative conflict resolution strategies which may have a better performance.

The main goals of the thesis are thus to explore a new technique which is designed to resolve train conflicts within the metro-like system of the future. But also to examine whether such a technique can serve as an alternative for the TAD rules used nowadays by ProRail and by this improve the punctuality of the current railway system. The

theory that we use in this thesis is that of the Semi-Markovian Decision processes. This approach has never been tried before. The idea behind this approach is to be able to construct rules off-line but solve the conflicts on-line pretty much the same way TAD rules are used nowadays. The train dispatchers have an overview of the rules. When a conflict arises, the conflict resolution rule is found and applied.

Due to interdependencies in the railway network, the large part of the delays are knock-on delays which are transmitted from one train to another. Most of these delays are transmitted either at the junctions where trains from different directions come together, or at the track sections when a fast train catches up with a slower one. The goal of our research is to optimize the situation at junctions and taking into consideration the track behind it. Moreover, the rules of the SMD strategy will be local rules designed to resolve the conflicts locally.

In the first chapters we develop the so-called SMD model and show how the conflict resolution problem can be modelled as such. We start with a simple model where trains from different directions come together and need to share the same infrastructure from then onwards. In later chapters this model is extended. The performance of the SMD strategy is compared to a number of heuristics through an extensive simulation study. In all of the cases, the SMD strategy outperforms other strategies, however, in some situations some heuristics turn out to be almost optimal.

Next we apply the SMD model to some fictive networks to study the performance of the SMD model within a network environment. The idea is to solve train conflicts locally but study their effects globally. In the studied network environments the difference in performance between the SMD strategy and the heuristics was substantial. The three networks we have studied had a growing complexity. The last network had a number of complicated aspects which are comparable to characteristics found in the real-life situations. The SMD strategy proved to perform very well, outperforming all other strategies.

The results of the SMD strategy within the fictive cases we studied, encouraged us to apply the model to a real-life situation. In cooperation with ProRail a study area has been chosen involving the line segment Utrecht - Gouda. This line segment is being heavily utilised by both passenger and freight traffic. The line includes Utrecht Central Station which is the largest station in The Netherlands and the main hub where trains from different parts of The Netherlands come together. Moreover, the freight traffic running to and from the Rotterdam harbour makes use of this line segment too. The trains entering this line segment are often delayed which leads to a large number of conflicts which need to be resolved. The TAD rules do solve these conflicts but the train punctuality within the area can still be improved.

The line segment Utrecht - Gouda has been decomposed into a number of areas where local SMD rules have been applied. We have explained how the line segment is divided into areas and how the situation in each area can be translated into the SMD model. By means of a simulation study, the performance of the SMD strategy is compared to that of the TAD rules and to a number of heuristics. The SMD strategy turns out to perform very well, even though it does not hold any information of the timetable and falsely assumes that the train arrivals are Poisson. Within the simulated environment the SMD strategy, when compared to the TAD strategy, has substantially improved the overall train punctuality. Again, some heuristics performed very well and have even in a number of cases outperformed the SMD strategy. A major drawback of the heuristics is however that these strongly depend on a conflict situation. A heuristic which performs well for one conflict situation does not necessarily have to perform well in other cases. The SMD model does not have these drawbacks since it produces strategies which are optimised for each individual case.

The SMD strategy defines a rule for every possible situation. By grouping the situations together, for which the same rule applies, we can construct compact SMD tables which present the SMD strategy on a comprehensive sheet. These tables can be used by train dispatchers pretty much in the same manner they use the TAD rules today. This similarity between the two can contribute to a fast adaptation and acceptance of the SMD strategy by the train dispatchers.

The goal of this thesis has been to examine the possibility of using the theory of the Semi-Markovian decision processes to resolve train conflicts dynamically. The presented results not only show that this is possible but that this approach has a potential to improve the current train conflict handling procedures and hereby improve the train punctuality. Due to the complete independence from the timetables, the approach is also ready for the metro-like situation which is likely to be implemented in The Netherlands in the near future. Moreover, we believe that the model can be easily extended to cover specific railway situations that can be found in practice.