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Multi-objective optimization for traffic signal control

Gwynne van Kaauwen

Thesis submitted to
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Thesis supervisors:
Prof. dr. ir. C. Tampère
Assessors:
Prof. dr. ir. P. Vansteenwegen
Prof. dr. D. Borremans
Mentors:
M.A. Arman
Ir. D. Bourgeois

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Preface

As I finish this thesis, I look back at what has basically been my life for the last nine months. During the very first thesis meeting in July last year, I would have never guessed this thesis would become what it turns out to be. After hours of discussions and meetings, lots of research and thinking (at times even overthinking) and a tremendous amount of programming, computation time and writing, I am proud of this pile of paper. This work concludes my Master of Engineering: Logistics & Traffic at the KU Leuven.

Before I let the reader dig into this big chunk of text, I would like to thank some people. First of all, my promotor prof. dr. ir. Chris Tampère, who brought the much required nuances to my thesis and pushed me to explore different directions and to be very clear in reporting my findings. Next, supervisor Dries Bourgeois helped me see the practical side of things and guided me through the Flanders guidelines and the use of Vissim. A huge thank you goes to Ali Arman, for meeting with me every week and giving me an enormous amount of advice and feedback on my work. Moreover, Ismail Abuamer explained to me the COM interface in order to execute Vissim simulations through Matlab. Lastly, thanks to the group Mecha(tro)nic system dynamics at the KU Leuven, and specifically dr. Dedoncker, I was able to run the tool with the steepest-descent direct multisearch method. In my personal life, I am grateful for my fellow students, family and friends for supporting me through these months. I will make up for the little time we spent together during the last year! In particular, thanks mom for giving me a ton of advice and for always keeping the faith in me. Moreover, thank you Alex for being there to listen to my rants, doubts and hurrahs regarding this thesis and for reading over multiple chapters. This thesis would not have been the same without these people.

Gwynne van Kaauwen

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Abstract

Signalized intersections have great impact on the performance of the road network. This thesis presents a tool for the multi-objective optimization of traffic signal control. Objective functions have been set up for delay, efficiency and safety. Furthermore, all transport modes are considered. The method consists of five modules; a pre-selection of feasible and valuable combinations of intersection lay-out, signal structure and phase sequence, a derivate-free algorithm called steepest-descent direct multisearch for the optimization of the time durations which results in the Pareto front of optimal solutions, a ranking method implemented on the solution set in order to take into account the decision maker's preferences, a comparison of the remaining solutions based on costs and a non-linear mathematical model quantifying the objectives and constraints for the evaluation of each set of time durations. The mathematical model may be replaced by microscopic traffic simulations or by a mixed approach. Two case studies illustrate the added value of this tool, highlighting its short computation time and ability to find a dense Pareto front. Recommendations for future research include the addition and enhancement of objectives, the consideration of the interaction with nearby road infrastructure and the extension to oversaturated conditions.