

NUTECH SOLUTIONS

# CASE STUDY

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THE DUTCH MINISTRY OF TRAFFIC

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## COMPANY BACKGROUND

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The Dutch Ministry of Traffic ("Ministerie van Verkeer en Waterstaat") is responsible for covering all aspects of traffic engineering, road safety and traffic management of the public traffic systems in the Netherlands.

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## UNDERSTANDING CUSTOMERS NEEDS

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The public road system in the Netherlands is very dense and highly developed, and yet the country is faced with an ever-increasing traffic load on roads that are already at maximum capacity. The traffic problem is compounded by the fact that a lot of traffic light controlled intersections exist, even on highly frequented highways. During times of high traffic volume, these intersections act as bottlenecks that cause considerable traffic jams. Consequently, the optimization of these intersections is a crucial part of improving the overall traffic situation. Moreover, reducing transportation delays has a huge impact on a country's national growth product, and enormous savings can be realized through improved utilization of existing highways instead of developing new ones.

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## SCHEDULING OPTIMIZATION

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For many decades, the optimization of traffic light schedules had been a very popular research topic in traffic engineering. Usually, this task had been performed by hand or, if feasible, with an analytical approach. Both of these approaches implied a static control system that was not able to react to different flow scenarios over time. The Dutch Ministry of Traffic engaged NuTech Solutions to assist them in the development of a new traffic light scheduler capable of dynamically adapting its control strategy to changing traffic situations. This type of traffic controller would vary the green light times at each intersection to optimize the current flow of vehicles. The information about actual traffic density would be delivered to the system by control loops in the street, with the end goal of maximizing traffic flow through these intersections.

The traffic light control problem that the Dutch Ministry of Traffic wanted to solve was a dynamic one, and dynamic optimization problems are best handled through the use of evolutionary algorithms. Evolutionary algorithms, unlike traditional controllers, possess an inherent feature that made them very well suited for this project: *adaptability*. Therefore, NuTech Solutions developed a program based on Evolutionary Strategies, which are well known for their capability of adapting to

dynamic variables. Building the traffic light scheduler on Evolutionary Strategies allowed for fast adaptation to changes in the environment. To evaluate the new controller's performance on real traffic situations, NuTech Solutions made use of the simulation tool FLASH / FLEXYT-II (a package developed by the Dutch Ministry of Traffic). This tool was used for designing and testing control plans for signals offline, but using real-world intersections. The tool was also capable of simulating all sorts of traffic participants from pedestrians to large trucks. Four intersections were used to test the new traffic light control system, all of which reflected typical crossings. The evolutionary controller received detection data from the control loops in the street, and used this information to minimize the delay and the number of stops per vehicle.

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## RESULTS

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Without any fine-tuning of the parameters or the objective function, the traffic light scheduler developed by NuTech Solutions yielded results that were very similar to that of the state-of-the-art controller used by the Dutch Ministry of Traffic. The difference however, lay in the adaptive capabilities of the evolutionary controller. When unexpected bottlenecks occurred, or accidents happened, the system was able to immediately alter the scheduler of green light times on the intersection to optimize throughput. Overtime, the system also analyzed the changes in traffic flow and altered the control pattern accordingly. Additionally, under heavy traffic flow and on complex intersections, the evolutionary controller always outperformed the static controller. Fine-tuning the parameters and the objective function for each particular intersection would allow the evolutionary controller to yield significantly superior results under all operating scenarios than those delivered by static controller. The Dutch Ministry of Traffic will use the new traffic light scheduler developed by NuTech Solutions to meet the following goals:

- Reduction of traffic jams and overall transportation times.
- Reduction of expenditures on the development of new highway systems.