A long-term travel time prediction algorithm using historical data

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A long-term travel time prediction algorithm using historical data

Based on research by TNO and Delft University of Technology a long term travel time prediction algorithm using historical data is developed. In a case study, the effect of different factors influencing the travel time are studied, as well as the suitability of this prediction method for large scale travel time predictions.
The algorithm is implemented as web service for one of the most used route planners of the Netherlands of the ANWB, a Dutch motorist association. The outline of the algorithm, results of the case study and the performance of the algorithm for the total motorway network of The Netherlands are presented. Also, future plans are revealed in short.

Introduction

- Long-term travel time predictors predict the travel time for a start time of several hours in the future, useful for e.g. logistic planners, in navigation systems and route planners
- The variability and unreliability of travel times will increase by increasing congestion
- People accept congestion, but desire less unreliability in estimating their travel times
- Long-term travel time predictors are hardly used at this time. This is expected to change in the coming years

What we have done

- Research to long-term travel time prediction methods
- Case-study with detailed weather data on a corridor
- Development of long-term travel time prediction algorithm for the ANWB

Outline of the algorithm

- A number of different algorrithms and approaches for travel time prediction were investigated
- K-nearest neighbour approach is selected as good method for long-term travel time prediction
- Database with historical travel times and extra conditions has been composed (time, day of the week, date, etc.)
- The kNN method searches the *k* situations in the database which resemble the situation to be predicted most.
- To determine the degree of resemblance, distance functions are defined (e.g. logarithmic, linear, exponential, relative distance)
- In the calibration process, the best distance function was determined

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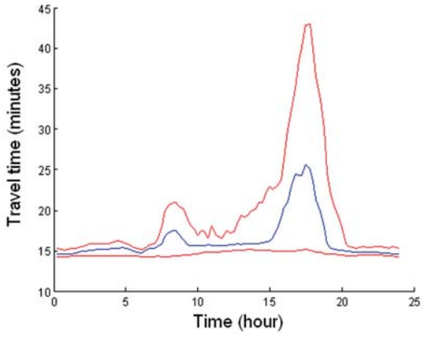
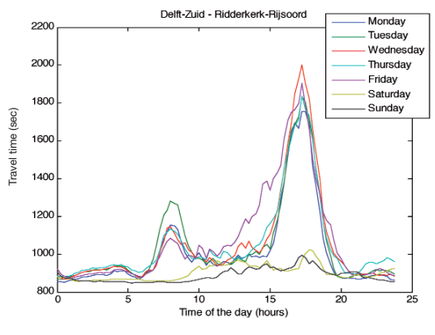
Travel time prediction case-study

Case-study Delft-Zuid-Zwijndrecht

- Long-term travel time predictor applied in case-study on a single route of three successive motorways (A13, A20, A16) in the Netherlands of 25 km long
- This route represents a frequently used route for freight transport. On this route, there is a large variability in travel times
- Historical data-base:
  - dates and travel times for every 15 minutes of 2004, based on measurements from loop-detectors
  - very accurate and detailed precipitation data per 15 minutes, calibrated for every 2.5 square kilometre
  - school holidays, large events, and special days

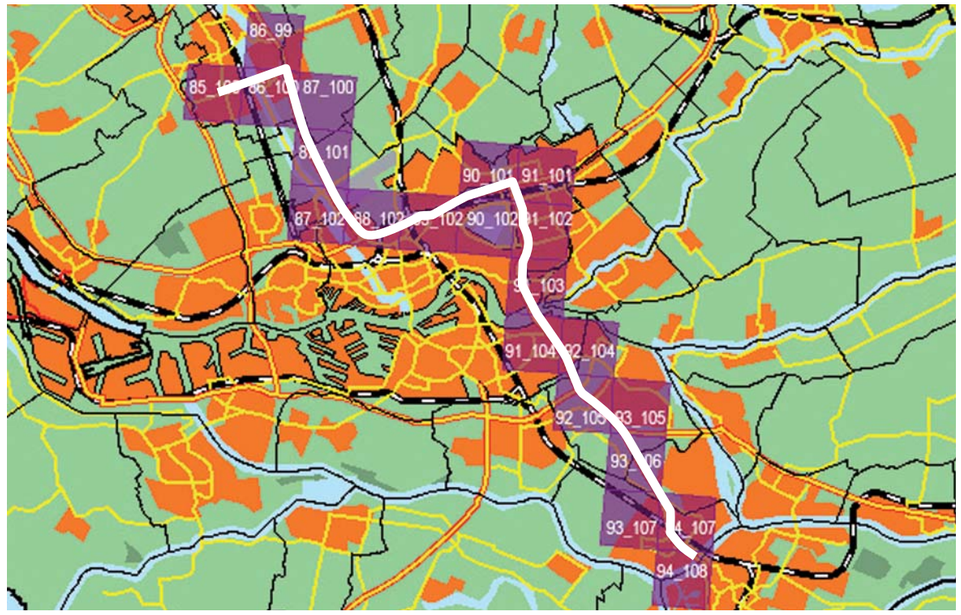


The blue line is the median. The red lines show the 10% and 90% percentile.



Travel time per day of the week

This case-study is made possible with support of Transumo ATMO. Transumo (TRANsition SUstainable MObility) is a Dutch platform for companies, governments and knowledge institutes that cooperate in the development of knowledge with regard to sustainable mobility.



Corridor Delft-Zuid – Zwijndrecht in the region of Rotterdam with precipitation pixels

Results case-study

- The median performs better than the average
- The largest benefit is reached by taking into account the day of the week
- Our prediction method extended with accurate precipitation data has improved this a little further, especially during peak hours

Mean absolute relative error of the predicted travel times

Direction	North-South				South-North			
time	08:00	12:00	17:30	22:00	08:00	12:00	17:30	22:00
average	15.7%	7.3%	37.2%	3.8%	36.5%	10.8%	19.0%	9.4%
median	15.0%	5.1%	34.4%	2.7%	26.1%	5.4%	15.3%	4.8%
median per day of the week	8.4%	4.0%	20.6%	2.7%	17.7%	4.9%	12.6%	4.8%
Median of kNN-method with extended weather data	7.7%	4.5%	19.8%	3.4%	15.7%	5.3%	12.7%	5.9%
Median of kNN-method with accurate precipitation data	7.6%	4.6%	19.4%	3.3%	15.5%	5.3%	12.6%	5.9%

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Travel time prediction algorithm for the ANWB route planner

ANWB route planner

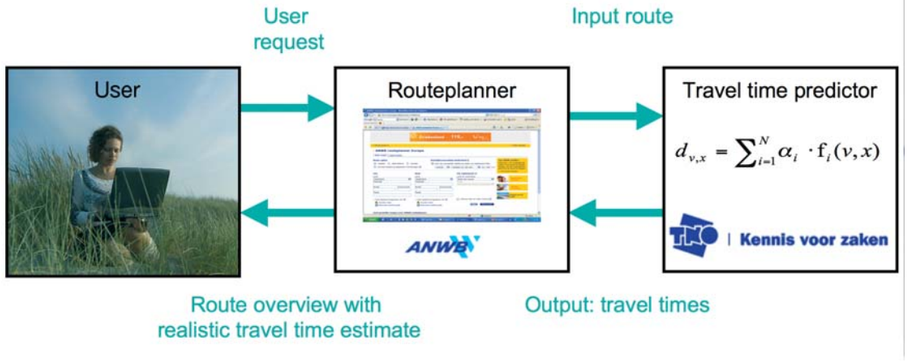
- ANWB: Dutch motorist association with 4 million members
- The ANWB presents at her website a route planner for the total road network of the Netherlands, which is one of the most used route planners in the Netherlands and has about 75 million requests per year.
- kNN-method applied to develop a new travel time predictor for the ANWB wich gives more realistic travel times
- The long-term travel time predictor is operational since September 2007 (*http://route.anwb.nl*)

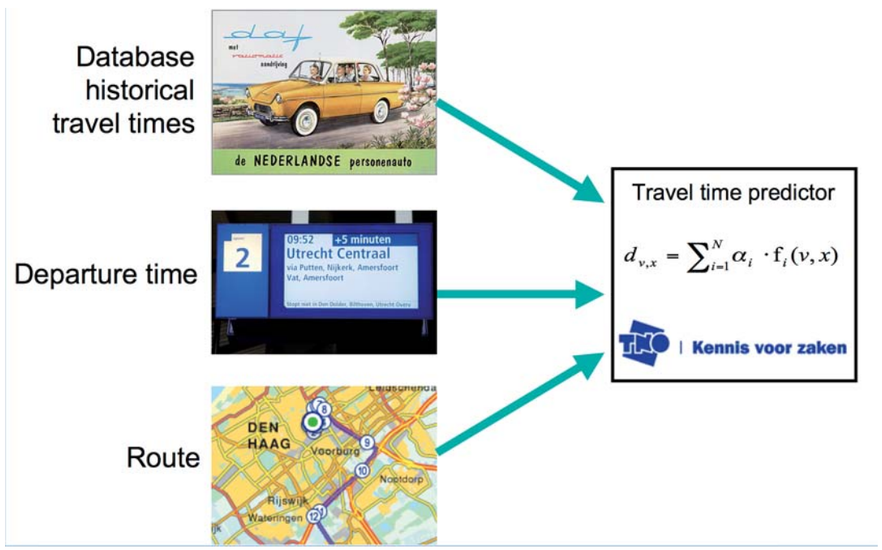
Development of long-term travel time predictor for ANWB

- The travel time predictor has been developed in phases:
  - Phase 1 (finished): the departure time or arrival time, day of the week and the date is used to estimate the expected travel time
  - Phase 2: other factors such as precipitation and school holidays can be added

Historical database

- travel times measured with loop detectors of the total motorway network in the Netherlands over a period of halve a year
- Outliers, such as average speeds larger than 200 km/h, are removed from the database
- Later, a database for a longer period will be used





Calibration of long-term travel time predictor

- The algorithm is calibrated with a large set of representative routes, dates and times
- The weight factor of the variables, the type of distance function and the cluster size k is determined by minimizing the Mean Relative Error and Maximum Relative Error
- Weight factors: most weight on time of day, then on day of the week, and little weight on date

Results long-term travel time predictor

- Mean relative error 10%
- Over 66% of the predictions differ less than 10% from the real travel times
- Over 80% differ less than 20%

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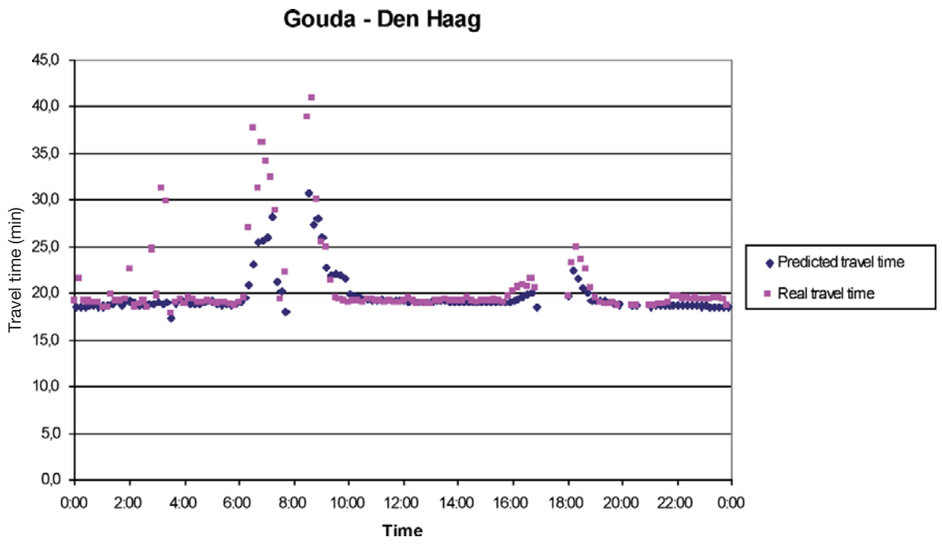
Conclusions and future plans



Conclusions

- The results of the long-term travel time predictor for the ANWB route planner are good (mean error 10%), considering the largest part of the predictions is done for peak hours
- It can be concluded from the case-study on the corridor in the region of Rotterdam and the travel time predictor for the ANWB that the kNN method is a good method for long-term travel time prediction
- With the ANWB travel time predictor, TNO has developed a tool that is a useful extension of the ANWB services. The travel time predictor informs the motorist with a more realistic travel time; especially in the peak hours, when there is a lot of congestion in The Netherlands.

Future plans long term travel time predictor

- The kNN-method is flexible, so it can be easily extended with other variables such as weather conditions, big events, road activities or school holidays.
- Taking into account weather conditions: an online-coupling can be established with the national weather forecast.
- Incorporate the travel time prediction into the shortest path determination to minimize travel times

Future plans short term travel time prediction with Bayesian analysis

With Bayesian analysis, the likelihood of an event for a known piece of evidence can be calculated from a set of data. This can be used to estimate the most probable travel time.
The factors that influence travel time most will be detected automatically. This approach is already applied by Inrix (USA).
A pilot with this prediction method is running on a part of the motorway network in South-Holland, commissioned by the AVV, Transport Research Centre of the Ministry of Transport, Public Works and Water Management of the Netherlands, set-up by a joint effort of TNO and Inrix.
In this pilot, both historical data and actual speed data are used. A prediction is determined up to one hour ahead. TNO is testing the feasibility of this method and also extending the scope of applicability for The Netherlands.