Will we arrive on time?
Forecasting train delays by using data rather than assumptions.

Talk Proposal: submission for the SDS 2018 conference
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Extended Abstract

Punctuality is one of the key success factors of public transport. In Switzerland, with its excellent railway system, punctuality is usually very high. Nevertheless, delays may happen. And whenever they happen, it is in the interest of both railway staff and customers to be informed as soon and as precise as possible: Traffic controllers can take measures to either prevent a looming delay or weaken its consequences, whereas passengers could adjust their travel plans or at least spend waiting time in a more pleasing way.

Traditionally, railway delay forecasts are based on theoretical models: operation schedules contain assumptions on minimum running times between two stations as well as minimum dwelling times at each station. Whenever a train falls behind schedule, these values are used to figure out how fast it can catch up. More elaborate models also consider dependencies between different trains – once again introducing various assumptions on headways, reversals, connection times and other parameters. These models stem back to an era when empirical data was hard to obtain. They have been embodied in almost all IT systems for traffic management and customer information – and have generally proven to be robust and adequate.

However, with far better availability of operational data, these models and their assumptions can be challenged by alternative approaches: shall we still base our forecasts on established, but hypothetical correlations rather than empirical evidence?

www.puenktlichkeit.ch has recently started an experiment to encourage the debate: every minute, it captures the operational situation in Swiss railways and compares it to empirical data of the last 400 days. By looking for similarities, an algorithm derives delay forecasts for all trains scheduled to arrive in Bern within the next hour. All results are instantly published – they can be tracked on the web site and its mobile companion. And they can be compared to the official forecasts of the railway operators, stemming from their traditional models.

The method exclusively uses data that is available on the open data platform of Swiss public transport (www.opentransportdata.ch). As a consequence, several limitations apply: Real time information is only available with an accuracy of one minute, thus restricting the precision of the forecasts. Also, updates are only published on train stops – between two stops, www.puenktlichkeit.ch receives no information and hence cannot revision its forecasts based on the actual position of a running train. Furthermore, there is no data obtainable on cargo trains (which can interfere with passenger traffic), track restrictions, rolling stock, re-routings and many other parameters that affect punctuality. Can reasonable forecasts be achieved despite these limitations?

To find out, every forecast is recorded and later compared to the actual arrival times as they are published by the railway companies. Comparing over 900 000 forecasts of both methods yields interesting results:

- Until 5 minutes before the actual arrival, the empirical approach is clearly superior. For example, 10 minutes prior to arrival, peunktlichkeit.ch correctly predicts the arrival time of more than 16% of all delayed trains – the hit rate of the railway companies being only 2.5%.
- On the contrary, the railway systems are far better in the very short run (1 to 3 minutes before arrival). This is probably due to differences in information supply: in that time span, the train is already approaching Bern station. While the railway systems are able to track its exact position, they do not publish open data on this – and hence, puenktlichkeit.ch cannot revision its forecasts.
- Both methods have a very low rate of false positives, i.e. they rarely estimate a delay to be larger than it occurs. This is important, because otherwise, passengers might miss a train whose actual delay was less than predicted.

The current implementation is restricted and premature in various regards and there are many ideas for improvements and extensions. At the current stage, it is still an experiment. Its aim is to proof the general feasibility of the approach – and the results so far provide strong support.

Of course, usage of theoretical models and empirical data are not at all in contradiction. On the contrary, a synthesis seems to be promising, combining the strengths of both approaches: while theoretical models grant robustness and universal applicability, their precision could be further improved by empirical data in cases where this is sufficiently available.

Target audience

The presentation is targeted at practitioners, researchers and students with an interest in innovative applications of machine learning and open data. An affinity to public transport as well as a basic understanding of predictive models will be useful but not necessary to follow the talk.

Outline of the talk

1) Point of departure: predicting train delays
2) Means of travel: Data at hand and methodology used
3) Getting on board: Setup of the experiment
4) Arriving at results and conclusions
5) Continuing the journey: next stops and directions

Biography

Andreas Gutweniger is currently employed as Senior IT Consultant at Detecon (Switzerland). He has studied at Münster and Turku and earned a master's degree in information systems as well as a PhD in economics. Since 2005, Andreas has been working as business analyst, solution architect and project manager in various IT projects of the Swiss transport industry. He had a key role in designing the current timetabling applications of SBB. In 2016, he enrolled for a postgraduate education in data science at Bern University of Applied Sciences. For his study projects, he started using open data on train punctuality, leading to the development of www.puenktlichkeit.ch, which he privately maintains as a non-profit web site. The site provides detailed statistics on Swiss public transport and is the only public source to compare punctuality across companies. It is regularly used by many experts from the industry.