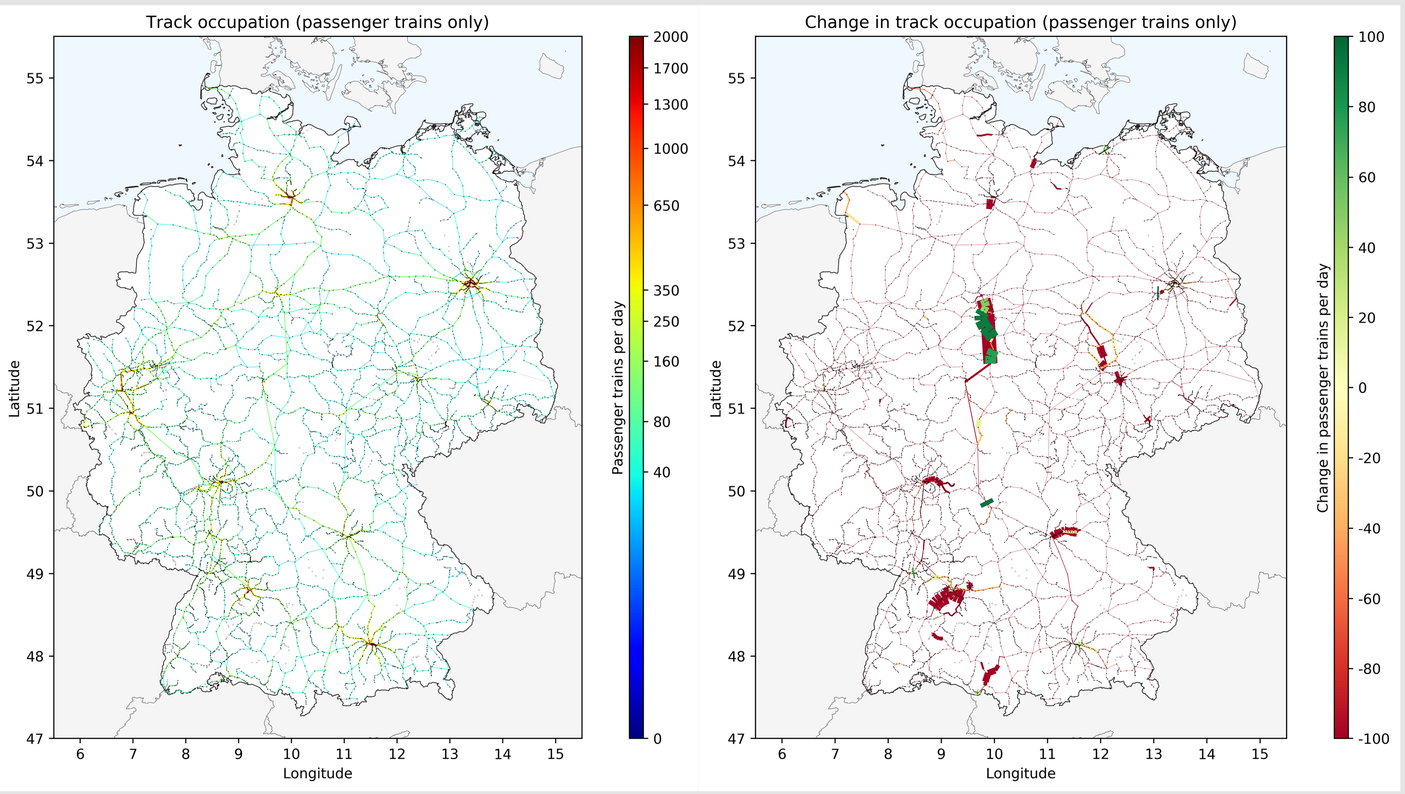
# Automated Analysis of Spatial Accessibility in Railway Networks through Open Timetable Data




**Passenger trains per day on the German railway network. On the left data from 2019-03-21 in total numbers, on the right the difference between 2019-06-13 and the numbers from March.**

## Motivation

Construction works in railway networks often have implications on the overall performance of operations, both in capacity and operational quality. In case of time consuming works, compensating measures for sometimes several months have to be developed and evaluated. When dealing with large effects spanning great parts of a railway network, manual comparisons of changed timetables become tedious or impossible.

Additionally, simple indicators are needed to measure the effects for all affected connections equally. Spatial accessibility, defined as the average time to reach all other points of interest (in our case all German stations), can be one of these indicators for assessing the impact on the passengers' side.

Further, intuitive visualisations can help in understanding the impact of different measures. This is true especially in the communication with affected communities, but in internal communication as well.

## Methodology

As example for the mentioned time consuming works, the renewal of the high speed track between Hannover and Göttingen in Central Germany was chosen. The works are lasting for several months and are reducing the capacity of one of the country's main lines significantly.

The data for the analysis of the impacts on spatial accessibility was gathered from an open data interface of Deutsche Bahn AG.

Open data enables external institutions and even private persons to create additional information and applications for both the transportation companies and passengers as well, accelerating the innovation in IT services drastically.

The timetable information was processed with python and manually adjusted in case of data errors or missing data. The track network was generated only from the timetabling data, showing a proof of concept for a network generation without infrastructure data. Afterwards, minimal travel times were computed with a specialised routing algorithm searching for all-to-all connections in a very efficient way. This allowed for a fast computation on standard hardware.

## Challenges

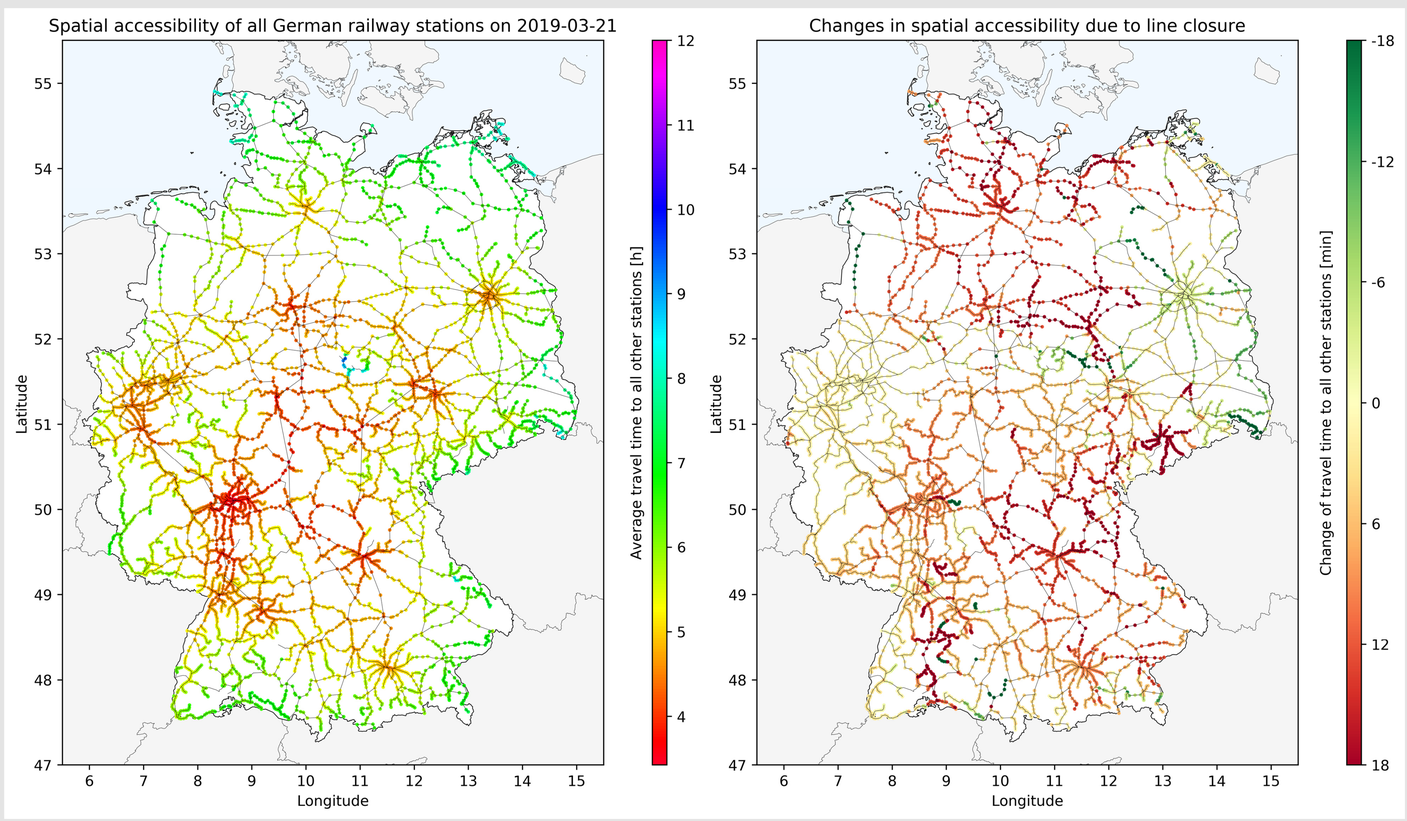
The target of comparing different timetables in different construction states required great flexibility in case of data changes throughout the observed timespan (e.g. changing routes or replacement services in other parts of the network). Also, a high level of automation had to be reached to enable fast comparisons without much manual work.

## Results

On the top, the number of passenger trains per track section is shown. The shift from the high speed main line to the former main line can be seen between Hannover and Göttingen as well as an overall reduction in trains running through the affected section. Near Stuttgart, some routes are closed for construction too, resulting in a large decrease in train numbers.

On the bottom, the differences in spatial accessibility are shown, resulting in travel time losses in nearly the whole network. The spatial accessibility of all German stations was reduced from 5.33 h to 5.40 h or by 1.3%. The impact of the evaluated line closure can be seen in the whole of Northern Germany. In the area around Chemnitz in the east, additional construction works with replacement buses are taking place.

The goal of visualising the impact of large construction works and the calculation of a simple indicator could be achieved successfully. This could be used for evaluating compensating measures for future line closures and for communicating this process with the public.




**Mean travel time in hours from each station to all other German railway stations. On the left data from 2019-03-21 in total numbers, on the right the difference between 2019-06-13 and the numbers from March.**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