Select a day of the week:

Week

Select a provider:

All

Select train type:

All

Select stations area:

Randstad ×

Non-Randstad ×

Select station type:

Choose an option

Group project - TIL6022

Group 6

(*note: to get an interactive version of this report, open the Report.py file and open it by typing **Streamlit run Report.py** in the terminal, this will open the interactive report on your local server.*)

(Van Lieshout, 2018, Volkskrant)

Members

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1. Research objectives

The main research question of this study is: What are the seat capacities of the train network for different railway companies (NS, Arriva, Keolis and Qbuzz) in the current time schedule? This question will be answered by answering the following sub-questions:

- What is the difference in capacities of trains between the Randstad and outside the Randstad?
- How does the capacity differ between different days of the week?
- To what extend does the capacity differ when looking at train types, i.e. Sprinter vs. Intercity trains?
- How do other railway companies compare to the NS?

2. Introduction

Every day, more than 1 million passengers use the services of the Dutch national railway company, Nederlandse Spoorwegen (NS). The NS has the concession to run the main rail routes in the Netherlands and operates with 4800 train rides and 260.000 seats per day with Sprinters and Intercity's. Every year the train schedule is updated and changes are made. Different tracks in the network have different

frequencies of train service, which leads to different capacity between cities. To understand and map those differences this project is set up. With databases from the NS, an overview is made of the seat capacity between cities on the main rail route. This data is analysed for differences in capacity between cities in- and outside the Randstad, between days of the week and between Sprinters and Intercity's.

To make the python script and visualisations in this report the following steps were taken: First, the found datasets with data about every trajectory driven and the train used from every operator can be loaded. An extra column will be added for the amount of seats, based on the train type and length. Every train has a unique number within the train service (route). The amount of seats will be stored in a DataFrame corresponding to that train service. Different train services serve the same trajectories. That is why seats on trajectories that are the same will be added to one another. Now, there is a DataFrame with the total amount of seats for every trajectory within the network. The next step is to plot them on a map. For this, the NS API will be requested for the lines between the stations. This API has information about the complete Dutch railway network, so also from trajectories only driven on by other operators. Lastly, a color will be assigned for every trajectory, where the one with the most seats is red and the least amount of seats yellow.

The results are visualised in a interactive map (chapter 6), this is the main delivearble of this project and all sub-questions are answered by using this map

Go to 6. Interactive Map

3. Analysis seat capacity in- and outside the Randstad

The Netherlands is a small country, but even it has significant regional differences. The biggest of this differences can be noticed by looking at the Randstad region. This is the main economic and political hub of the country and contains most of the big cities. Therefore it is much more developed than other parts of the Netherlands. The Randstad is also sometimes counted as one big city conglomeration because of the interconectivity between the cities. So, it is expected that the public transport capacity in the Randstad will be significantly higher than in the rest of the country. Looking at the interactive map in chapter 6, this is the case.

Go to 6. Interactive Map

In the interactive map, the stations within the Randstad are displayed with a darker gray color than the non-Randstad stations. The Randstad has both a bigger density of stations and all of the red lines(high seat capacity) can be found in the Randstad. This can be confirmed by the average amout of trips for the trajectories in the Randstad compared by the tranjectories outside of the Randstad.

Randstad = 846768, Non-Randstad = 262787

So, the train services in the Randstad have on average more than three times the capacity than their non-Randstad counterparts. Next up there will be looked at the trajectories with the highest and lowest capacity. These are shown in the tables down below:

Tabe 1: Trajectories with highest capacity

From	To	Seats
Amsterdam Centraal	Amsterdam Sloterdijk	2,804,743
Utrecht Vaartsche Rijn	Utrecht Centraal	1,889,216
Amsterdam Muiderpoort	Amsterdam Centraal	1,696,851
Amsterdam Holendrecht	Amsterdam Bijlmer ArenA	1,659,776
Abcoude	Amsterdam Holendrecht	1,659,776
Breukelen	Abcoude	1,659,776
Schiphol Airport	Hoofddorp	1,633,914
Utrecht Centraal	Utrecht Zuilen	1,567,422
Maarssen	Breukelen	1,566,476
Utrecht Zuilen	Maarssen	1,566,126

Table 2: Trajectories with lowest capacity

From	To	Seats
Daarlerveen	Vriezenveen	24,830
Vroomshoop	Daarleveen	24,830
Marienberg	Vroomshoop	24,830
Vriezenveen	Almelo	24,830
Windschoten	Bad Nieuweschans	26,685
Zuidbroek	Veendam	27,180
Eemshaven	Roodeschool	28,260
Hindeloopen	Workum	36,666
Koudum	Hindeloopen	36,666
Workum	IJlst	36,666

The trajectories from Table 1 are all situated in the Randstad, while the ones in Table 2 are all outside the randstad. This even more accentuates the big differences in these regions

4. Analysis seat capacity for every day of the week

It is obvious that on some days there is a higher transport demand than on other days. Think for example of the difference between a regular workday and a sunday. So it is expected that the capacity of the railway network would reflect that. In the interactive streamlit visual it is possible to look at the capacity for each individual day of the week.

Go to 6. Interactive Map

The interactive map does not show significant differences between Monday up to Friday, however, there is a visable difference between the work week and the weekend. This is indicated by the fact that when the data from Monday to Friday is plotted, the lines show more of a red color than during the weekend. To look at these differences in more detail the graph in figure 1 shows the total capacity for each day of the week:

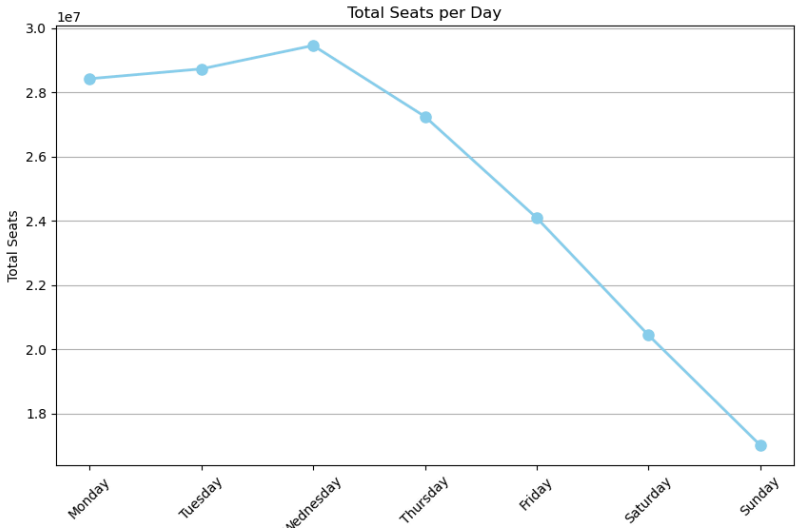


Figure 1: Variation of the total seat capacity during the week

Another interesting statistic is the difference in maximum and minimum seat capacity per route during the week. This indicates to what extent the train schedule varies throughout the week. Table 3 presents the ten largest differences. Important to note is that all these tracks with high flucuations are in the Randstad. This can be explained by the fact that population dense areas usually experience rush hours that demand high capacity, so the difference between peak and regular demand is much broader

Table 3: The trajects with the highest difference between the minimum and maximum seat capacity in a week

From	To	Difference	Maximum seats	Minimum seats
Delft	Rijswijk	160,469	199,069	38,600
Rijswijk	Den Haag Moerwijk	160,469	199,069	38,600
Den Haag Moerwijk	Den Haag HS	160,469	199,069	38,600
Delft Campus	Delft	153,269	199,069	45,800
Utrecht Vaartsche Rijn	Utrecht Centraal	127,834	309,904	182,070
Amsterdam Centraal	Amsterdam Sloterdijk	127,697	444,295	316,598
Rotterdam Centraal	Rotterdam Blaak	121,916	205,024	83,108
Rotterdam Stadion	Rotterdam Lombardijen	117,916	201,024	83,108
Rotterdam Zuid	Rotterdam Stadion	117,916	201,024	83,108
Rotterdam Blaak	Rotterdam Zuid	117,916	201,024	83,108

5. Analysis seat capacity of Sprinters and InterCity's

The NS makes a distinct difference between Sprinters an InterCity trains. Sprinter are meant to travel short distances with quick accereration but stop at every small station, while InterCitys are used to transport people between bigger hubs with high speed but skip a lot of smaller stations. But what type of train has the higher capacity?

Go to 6. Interactive Map

In the interactive map the capacities for either sprinters and intercity's can be selected. However, precise differences are not visible. In figure 2 the seat capacities per day for all Sprinters and InterCities are presented. This figure clearly shows that the total seat capacity of InterCities is significantly higher than of Sprinters.

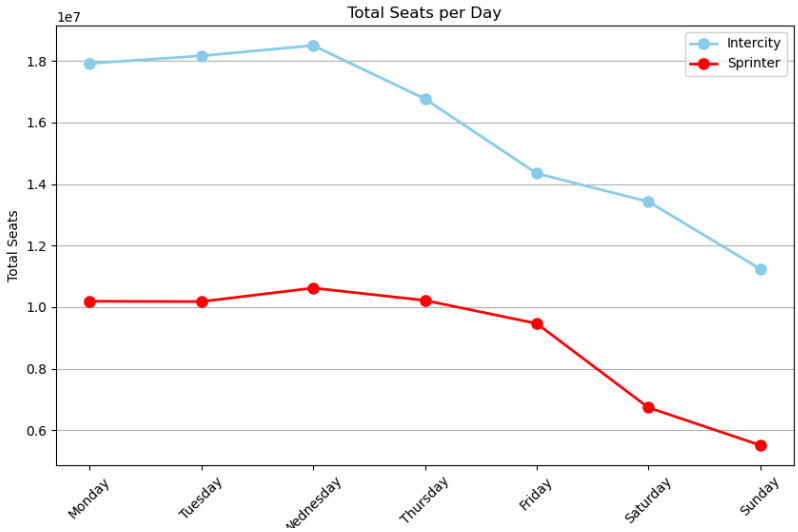


Figure 2: Difference in capacity between intercity's and sprinters

This result is supported by the week total and average of both the sprinters and intercity's, which is presented in table 4.

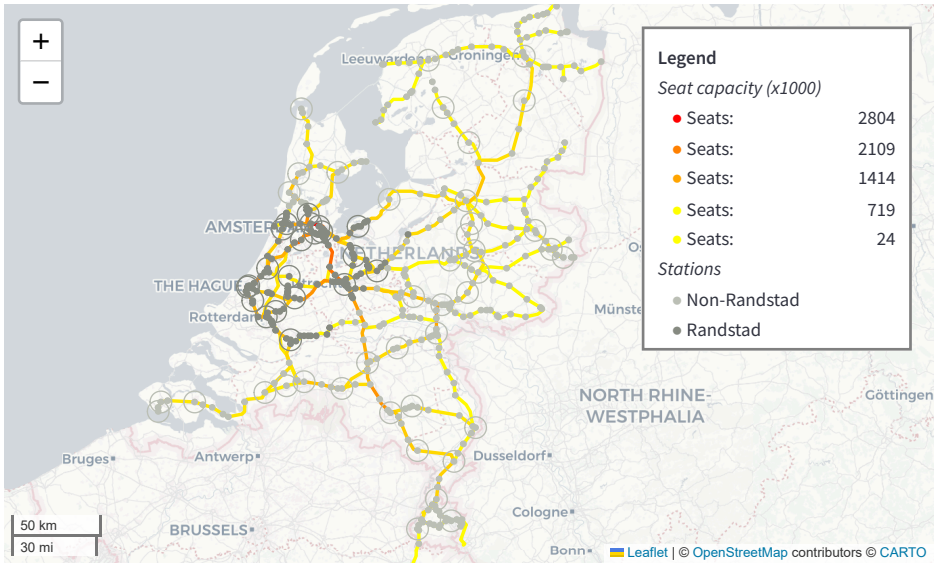
Table 4: Week total and average for sprinters and intercity's

Train type	Total	Average
Sprinters	62,915,436	156,117.7072
Intercity's	110,365,719	402,794.5949

6. Interactive Map

Intensity of Rail Use

The map below shows the intensity of each piece of rail in The Netherlands. The map is adjustable and several different options can be selected in the side bar. Different station types can be selected for both inside as outside of the Randstad area. For the whole week option, different transport providers can be selected. If a particular day of the week is selected, the map is shown for all providers combined. In the legend the meaning of the colors are visible. The range of this colors is determined by the maximum, 3rd quarter (75% of the maximum value), median, 1st quarter (25% of the maximum value) and the minimum value of the capacities. So if, for example, the red color in a particular selection is equal to 2804, the maximum seat capacity in that selection is equal to 2,804,000 seats.



7. Discussion

In this project the following main question is researched:

What are the seat capacities of the train network in the current NS time schedule?

This question was studied by gathering and analyzing data from the NS, Keolis, Qbuzz and Arriva and creating an interactive map of all seat capacities. With this data and the map the subquestions were answered. In conclusion, seat capacities are higher for Randstad stations than for non-Randstad stations, higher for week days than for weekend days and higher for intercity's than for sprinters. This is in line with what was expected before the study was performed.

Now that there is a answer the rest of this deiscussion will deal with points of interest that follow from our research:

Altough it is not shown on the map, there is in reality a RNET train connection between Alphen a/d Rijn and Gouda which is operated by NS, but it was not included in the provided data so it could not be modelled. Similarly, the track from Utrecht centraal to Utrecht Malielaan was also not included in the data.

In the week that the data was derived from (week 41), there were some irregularities due to maintenance activities. These are summed below:

- Monday up to Thursday: no traffic between Nijverdal/Rijssen and Almelo
- Whole week: No traffic between Leeuwarden and Akkrum
- Monday and Tuesday: No traffic between Akkrum and Meppel

- Saturday and Sunday: No traffic between Harlingen Haven/Stavoren and Leeuwarden
- Friday up to Sunday: No traffic between Delft Campus and Rotterdam Central Station

Lastly, some of the lines on the map where different tracks converge the lines are plotted over each other instead of being added up. This might lead to inconveniences, because it can be difficult to directly determine the capacity for these sections

8. Contribution statement

To conclude this report, the main tasks and resonsibilies are stated for each group memeber:

- Alene: Wrote the Randstad notebook, statistics_report and partially the report. Made all the graphs and table in the report
- Mathijs: Set up github repository and corresponding vs-system, worked on streamlit implementation, created the interactive map in streamlit
- Thijs: Main contributer to the HoofdNotebookFinal
- Niels: Made the Trainservices.csv, filtered non-usable data (bus data Arriva/Qbuzz) from the operator DataFrames, worked on the Final notebook, wrote all comments in the Final notebook
- Chris: Partially wrote the report,worked on the storyline, worked on the streamlit implementation, contributed to the interactive map.