

Study of carbon emissions, frequency and average prices of high speed trains per month

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1 INTRODUCTION

As the prices of the SNCF trains are very floating, we raise questions about the reasons of these fluctuations. Our work is intended for the more or less regular customers who are keen to understand the SNCF network operation. In this article, we will be interested in two factors which are the frequency and the CO2 emissions of the TVG¹ per month. The goal of this work is to highlight a potential correlation between the price, the CO2 emission and the number of trains per month. Furthermore, if a train pollutes a lot, does the SNCF try to limit the frequency of this line ? What will be the effects on the prices ? Will this line price be lowered to encourage the travellers to foster it and limit damages of the CO2 emission by transiting a greater number of people or will it rise up to discourage the traveller to use this line ?

The purpose is also to distinguish these variations and their causes in time. Indeed, our data extend over a large period of time going from 2011 to 2017. It is thus possible to follow the evolution of the criteria, and to wonder about the factors which induce such variations.

In order to draw the users attention on this study case, we decided to use an interactive and animated map display. This article will first describe the state of the art and then discuss our innovative visual model. The last section will mention the technologies we shall use to achieve our goal.

2 RELATED WORK

This part will depict the state of the art. Several map visualizations can be find, which show transport lines. However, the criteria which are considered are often quite limited. Our study is about monthly carbon emissions, price and frequency of high speed trains.

2.1 CO2 consumption

The SNCF offers a visualization [1] comparing CO2 emission produced during a travel offered by their railway services, and the CO2 emission for that same journey by car or by plane. This visualization is available for three different defined journeys and isn't time-interactive. When searching information regarding a travel, CO2 emission is indicated on the top right corner to inform the traveller. However, no comparison is actually allowed concerning this datum.

2.2 French rail network visualization

Senseable City Laboratory [6] shows many visualizations about the french rail network, according to several approaches:

- Isochronic France: the purpose is to highlight distance between cities, not in terms of kilometers, but in terms of needed time (by train) between the cities. This distance varies through time, so that we can see a dynamic distorted France map, where the distance between cities represents the needed travel time, at a time of day.

- Consumption and train size (in number of passengers): This view [7] is particularly interesting for us, as it shows a similar point of view to what we are willing to show. In particular, we can see the routes of the french rail network on which trains are circulating, pictured as bubbles.

2.3 Analysis of journey prices

The UFC² wrote an article about the SNCF prices depending on the distance covered by the trains [4]. The analysis dates from February 2017 and revolves around 80 TGV lines. The results show that the SNCF has ceased to price the lines by the number of kilometers. Indeed, this factor is not the only one to take into account. This work is very interesting for our project and goes in the same track. Actually, we are parsing other data to understand and explain the prices. However, the CO2 emission is directly related to the distance and the duration of the travel. Thus, even if the travelled distance is not a sufficient criterion to explain the prices applied by the SNCF, it can be interesting to consider and to study the link between CO2 emissions by kilometer in order not to mislead results. In fact, certain routes involve a big distance, therefore a large amount of CO2 emission, however, it would be unimaginable to delete this traffic. It would be an interesting criterion to consider and to highlight in the advanced search view we are offering in our visualization.

3 DESIGN SUGGESTIONS

3.1 Visualization

As our data visualization is intended for the general public without prior knowledge, it has to remain simple and easily understandable. Rail lines are thus represented on the map using colors and sizes to highlight the different criteria (price and number of trains).

At first, when a user launches the simulation, the whole rail network is displayed. However, it is then possible to choose to visualize data about a specific town (all outgoing and incoming trains) or about a specific rail line (two-way flow). A "comparison" mode allows the user to compare either two cities or two rail lines. The aim here is to focus the study on three criteria, which are: the average price depending on how many trains there are, the number of trains according to carbon emissions and last, the price depending on CO2 emissions.

The final view (Fig. 1) is therefore composed of a French map on which trains are moving on rail lines. A side menu allows for the choice of which criteria the user wants to analyze.

We can see that the frequency of the trains is shown by the size of the trains and the prices by the colors. It is already possible to compare different criteria. However, there are many information and that is why we suggest to specify the research by town or line to help with reading the analysis and charts.

By refining a research, it is possible to directly access the second tab of the menu window: the comparison mode (Fig. 2). A user is able to compare two cities or lines with several charts and elements for analyses. Some information are written to help the user identify which problem must be taken into account. We reuse the French map and the same colors of the main view to make the analysis easier.

¹TGV: Trains Grandes Vitesses, high speed trains

²UFC: Union Fédérale des Consommateurs, an organization that advises customers on purchases

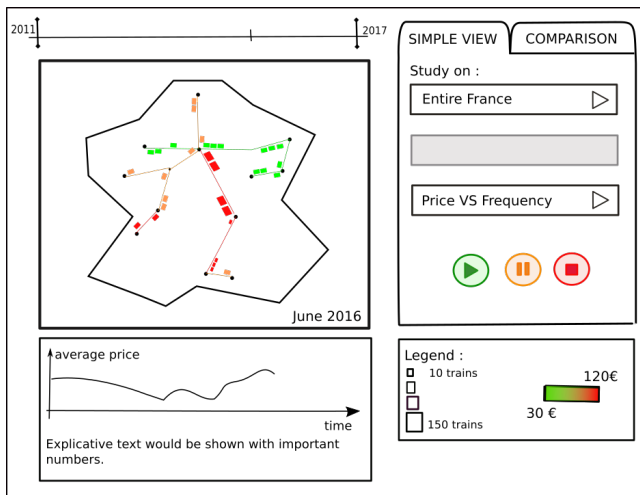


Figure 1: Home view when arriving on the visualization, high speed trains of the entire France depending on price and frequency

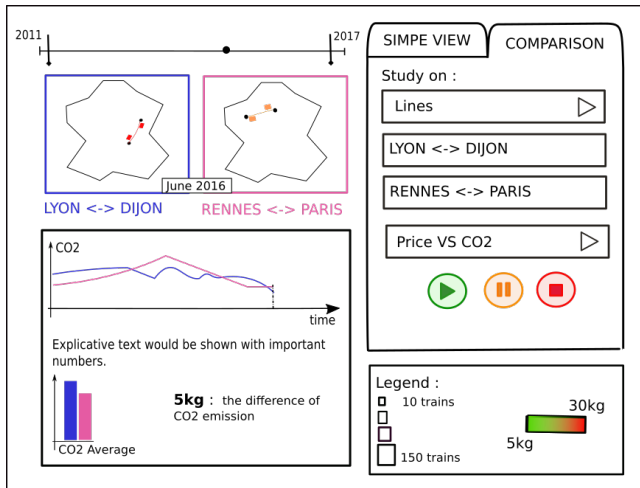


Figure 2: Comparison of Lyon-Dijon and Rennes-Paris lines depending on average prices and CO2 emission

We are willing to insist on the temporal evolution of our model as much as possible. Indeed, our monthly data extend from 2011 to 2017. This can also lead to a reflection on the time it would take to bring a plan into action. Let us say that carbon emissions are high for a given line, the potential variation of the other criteria will not be instant. Thus, we could also consider the concept of delay.

Thanks to this advanced search, the user has a wide choice over the way data are represented. There is a map if he prefers dynamic and playful display. But he can also interpret comparative charts, computed from the selected criteria. A short text description highlights the important facts and figures which may be useful for further analysis, for example an average value or standard deviation. The goal of a text description is to give clear figures and make a short summary as an alternative to graphs for those who would not know how to analyze them clearly.

From a design standpoint, the view can be divided into three sections.

- First, a form allows for the choice of the search criteria, that is to say, a city, a rail line or the whole mainland France. Another field is used to select either the town or the line on which

the user wants to focus on. The last field is to specify the data to compare: number of trains and price, price and carbon emissions or number of trains and carbon emissions.

- The map of the country or region to consider for the study is also displayed. In case it is the whole country, the map uses most of the available space. Indeed, it is hard to give details on data about the entire network without risking excessive information. Given that, only the number of trains and the price will be visible on the default display as they are easier to identify. Only one chart of average values will be added below the map. The graph must not contain information about each rail line otherwise it would not be understandable. On the other hand, for an advanced search in comparison mode, the map size will be reduced as several graphs will be shown to give the same information and even more details.
- An area is dedicated to showing charts and a short description of the data considered. Hence there is a work not only on creating charts but also on analyzing them prior to displaying them. Indeed, the goal is to ease the understanding of the study by giving the most important information that should be noticed without requiring any computation from the observer. This requires that we think about which information are the most important, as they should be the same for each of the three comparison that can be made. Indeed, as the comparisons do not run on the same criterion, the values do not have the same meaning. So the text should just mention important figures but no judgment other these values.

3.2 Open Data-sets

To make our visualization, we must have some basic data to rely on. It is essential for us to have open data. As we want to show SNCF data, we therefore get those data on their website [2]. So we chose three of their proposed data-set : one about CO2 consumption, another about the prices, and the last one gives details about the rail lines, including the number of trains. Each of the tables contains monthly information. For this reason, we have to update data only each month, and not more frequently.

3.3 D3.js and Maps Tool-Kits

Among the technologies available for this project, we have decided to use the famous D3.js framework. It is already full of resources to display simple charts as well as more complex and advanced data visualization. Among other things, we need to show a French map. Hopefully, we can rely on an existing project [3]. Is it composed of an interactive French map with all departments. What remains to be done is placing the cities we need on the map. But this can be done using the towns' coordinates. Then, we will have to create lines to link the cities in order to represent the whole rail network. The hardest thing to do will be to set the trains in motion. We can also follow other tutorial [5]. It explains us how to do some transitions. As for the other charts, we have been studying them for three weeks in class. The main difficulty we seem to have is to create and to animate the map. It is the most important point we have to focus on. Indeed, showing static data is quite easy, but having them moving over time can be much harder.

4 CONCLUSION

In this article, we have defined our future visualization about the high speed trains of the SNCF in France depending on their price, their CO2 emissions and their frequency. The project will be completed by January 2018 and so be available to explore the data through the maps and charts.

REFERENCES

- [1] L'information co2 dcryptée pour vous. <http://www.sncf.com/fr/train-emission-co2>. Online; accessed 25 November 2017.
- [2] Sncf open data. <https://data.sncf.com/explore/>. Online; accessed 25 November 2017.
- [3] D3js - map. <http://www.datavis.fr/index.php?page=map-firststep>, January 2017.
- [4] Tarif sncf au kilometre (2017). <https://ales.ufcquechoisir.fr/2017/02/22/tarif-sncf-au-kilometre-2017/>, February 2017. Online; accessed 25 November 2017.
- [5] M. Bostock. Working with transitions. <https://bost.ocks.org/mike/transition/>, October 2012. Online; accessed 25 November 2017.
- [6] p. l. Kristian Kloeckl, X. Chen, C. Sommer, d. Carlo Ratti, and a. d. Assaf Biderman. Trains of data. <http://senseable.mit.edu/trainsofdata/>. Online; accessed 25 November 2017.
- [7] p. l. Kristian Kloeckl, X. Chen, C. Sommer, d. Carlo Ratti, and a. d. Assaf Biderman. Trains of data. https://www.youtube.com/watch?time_continue=2&v=I17_nuPiJI4, November 2017. Online; accessed 25 November 2017.