Mapping Travel Times in Europe

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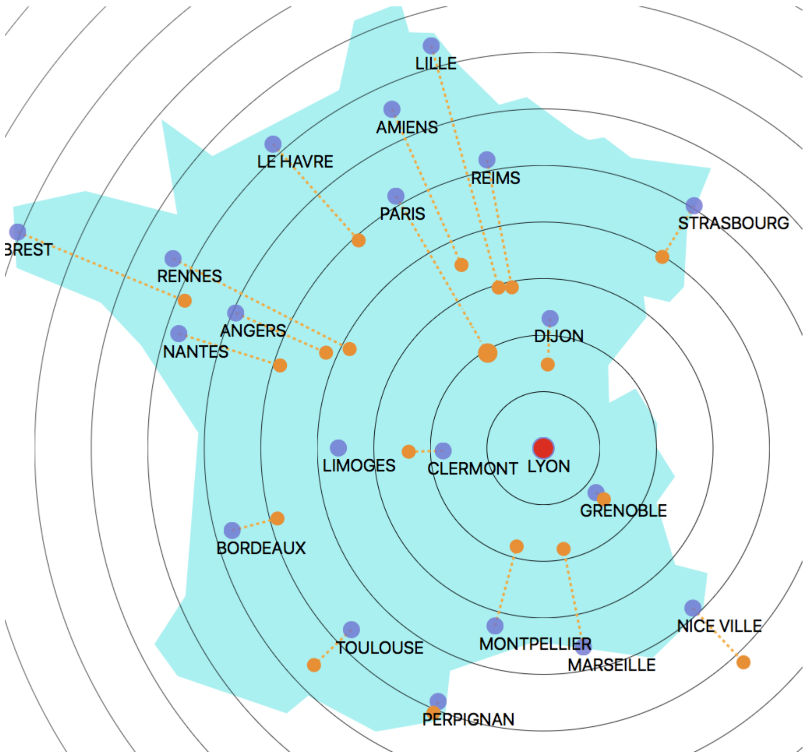

Figure 1: In the Clouds

Abstract

Travel times between two geographical points are rarely proportional to the geographic distances one can see on a standard map. As a result, the visualization of temporal relationships between objects on a map could be invaluable, to *e.g.* a tourist wanting to visit another city without travelling too long. We hereby propose some designs suggestions for such a map. We conceive two different tempographic maps, of France and Europe respectively, in which distances between main cities can be distorted to represent the duration by train that separate them. Those visualizations are a strong tool for the user because he now see his potentials trips according to the actual time he will spend in transportation. Note that this concept can easily be adapted to map any kind of non-geographical distance relationship (price of the journey, 0_2 consumption, *etc.*) between any kind of geographical item.

Index Terms: Tempographic maps—time-space maps—DataViz, —rail network;

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1 Introduction

Since the first so-called bullet train in 1964 in Japan, high-speed trains spread throughout the world and deeply changed the conception we have of space. Destinations that were virtually inaccessible previously stand now reachable in a couple of hours. The world, and within it Europe, is said to be shrinking as trips' duration shorten. But it is common knowledge that trip times are not always, if not never, proportional to the distance travelled. This is due to an uneven rail network in term of speed and frequency, and to various geographical constraints (a lake to circumvent for instance). As a result, one can observe that it is hard with common static maps to really evaluate how fast a city can be accessed from another one. A map where the time component of train trips is visualized could thus be invaluable. As the speed of means of transport is subject to great variability, the "temporal distance" (i.e. duration) is way more informative to the traveller than the standard geographic distance. A use case could be: a Canadian globe-trotter wants to establish for one year in a major European capital city, and search for a place from which many other important cities could be accessible easily. This tourist do not care about the distance he will travel, he just want to know how long it will take.

2 Related works

The concept of visualizing time on a two-dimensional map is quite old, but most works that can be found deal with the representation of event that occurs through time(*e.g.* [1]), instead of the representation of time relationships between objects with a geometric position. The term tempographic map appears to have been coined by van

Schaick , an urbanism teacher [2]. A tempographic map consist of the distortion of geographic distances on a map to fit a notion of time.

2.1 Europe

Spiekermann and Wegener have in the 90 published a few work papers on this idea, for the German Institute for Country Planning [1]. They pursued the same aim as ours: to visualize the shrinking of space induced by high-speed rail lines. They followed two sub-goals. First, proposing different visualizations of the time context of a city. This translate into different areas centered around one reference city. Marks and colours can then translate a one-to-many temporal relationship. The second is more broadly to give to the reader a snapshot of temporal relationships between any two points of a map. Here, they use an algorithm that iteratively rearrange a grid of points on a map in order to make distances fit best the trail trips' duration. They use interpolation methods to distort every point of the map, even the ones for which no temporal relationship is available. This can be seen as a case of Multidimensional Scaling (MDS). In MDS, a distance matrix is used to position points on a 2D plan. Here, the distance matrix corresponds to travel times between objects, and distances to missing points on the maps (e.g. a point that is not a city) were inferred by interpolation. The result is quite interesting, but is only an approximation. Furthermore, the readability is not at all optimal, as we can see in FIGURE.

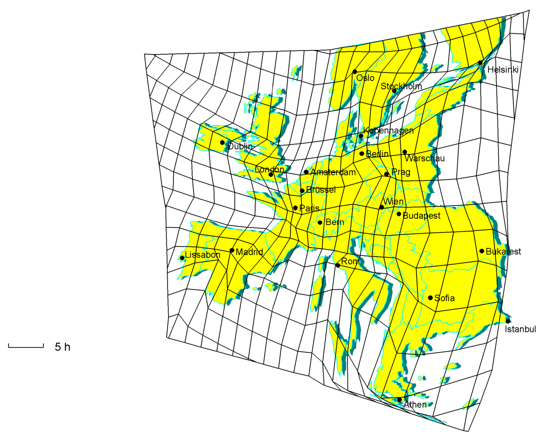

Figure 2: Work of Spiekermann and al

2.2 France

Some maps of travel time in France can be found online [3]. The French high-speed rail network is shaped like a star,whose centre is Paris. Thus, the maps are often centred around Paris,and only the temporal relationship between Paris and another city can be visualized. To our best knowledge there is no existing map that dynamically enables the user to set another city as a reference. In this aspect, our work is an innovation.

3 Project Description

We have achieved to design two maps, one of France and one of Europe, that fulfill our objectives of visualization.

3.1 Layout

We chose simplicity over a high load of information, which translate into a clean, quite minimalist design.

The layout is as in FIGURE 3 : on the left is the map of either France or Europe, with smoothed borders and of a solid color. We made a selection of a few main cities (between 15 and 20). They are represented the usual way, with a small disk overhanging their

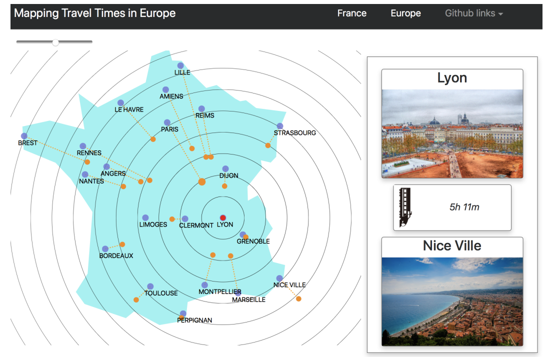

Figure 3: Final work

name, the latter in uppercase for increased readability. On the right is a panel which shall guide the user and display the travel time of the journey he will have selected, as well as images of both origin and destination city. It is itself composed of three elements, corresponding to the origin city, to the travel and to the destination city, respectively. On the top left is a slider, of which we shall talk later. At the top of the screen is a navigation bar which enables to refresh the page, switch visualization (France or Europe), and access the github's pages of the project and of the authors.

3.2 User Experience

The user stumbling upon our website is warmly welcomed by a popup message, which explains to him what it is about, as well as how to interact with it. It is offered to the user to choose between starting with the French or the European map. The user then land on the chosen page, in which the map looks at first like every other map he or she knows.

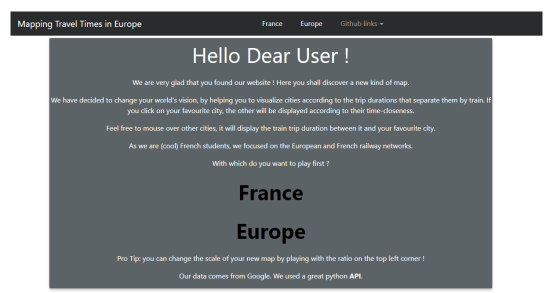

Figure 4: Pop up message

Indeed, at first, the cities' position corresponds to their geographical localization, for the user to build his own mental representation of the geography of the space he or she is studying. As this moment, the distance between the cities is proportional to the actual distance between them. On the right, the first element is sole displayed, in which a message invite the user to "Select a city". Once the user click on a city, the second step takes place. Below the aforementioned message was an illustration of a futuristic city, which transforms into an illustration of the selected "reference" city.

Figure 5: Travel illustration

On the map, this selected city is emphasized in size and colour (with a bright red), whilst all the other cities move toward, or away from, it. The new distance that separate them from the reference city then corresponds to the travel time from one to the other by rail. As a consequence, the closest city to the reference is now the one that can be reached the fastest. But to avoid totally destroying the user's mental representation of the cities, circles of another colour replace them at their original spot, linked with them with a dashed line. This link between original position and new position is consolidated by their simultaneous small inflation as a reaction to a mouse hovering over them or over their name. Hence, it is easy to simultaneously keep in mind how far (in geographical distance) used to be a city, and how close it is now temporally speaking.

Below the first image is displayed the second element of the panel, which invite the user to pass his mouse over another city, referred as the "destination" city. When the user does select his destination of interest, the last element of the panel appears, similar to the first one, with a picture and the name of the destination. Passing the mouse over a possible destination is enough to select it, as requiring a click would be straining for the user exploring numerous cities as possibilities. A small vertical train gives the direction of the journey considered in the middle element of the panel.

Both visualization for France and Europe are similar in design and colours, so that the transition from one to the other does not require any strain of the user's mind. We initially had in in mind to display meta-information on cities selected, for instance about their size or cultural landmarks that one could find there, but finally decided that a simple illustration (of course under an open licence) would be enough for the task at hand : providing the user temporal information.

3.3 Redundancy of information

Indeed, we have our traveller in mind, whose questions are : "Does the reference city appears to be well connected to all the others, hence attracting them strongly on the map when selected ?" and then "This city seems to be a good hub. Which are the closest neighboors and how far in time are they ?". An informatio needs to be easely accessed, and we made the choice of redundancy of information. Meaning that the travel time is made clear by several means :

- distance of the shifted cities : this represents the essence of our visualization. The human brain has a natural ability to compare distances (far better than the comparison of areas for instance) , and this is a classic task we achieve when reading a map. For those reason should this representation be quite intuitive;
- isochron circles : those are centered on the reference city, and each new circle correspond to a one hour supplementary hour of travel to the precedent. As a result, the new position of all the other cities, relatively to the reference, can be numerically compared;
- cursor tooltip : while the mouse is hovering over the map, the temporal distance from the reference city to the cursor is displayed, in hours, below the latter. This follows the disposition of the isochron circles, and enables an intuitive legend that dynamically fits the user's interest.
- explicit time on the middle element of the panel : the panel acts as a summary of the travel considered by the user, and a travel time precise to the ten minutes is displayed.

3.4 Personalization

We discovered that the readability of the maps highly depends on the ratio α used to translate travel times into new positions. And that the value of this ratio should be adapted to each reference city selected, for optimal visual appearance and clarity. We hence set a slider on the top left of the map, with which the user can tweak the value of α. It is clear that when the ratio is changed, the radius of the isochronic circles is adapted accordingly.

Here there is a comparison when the ratio is modified.

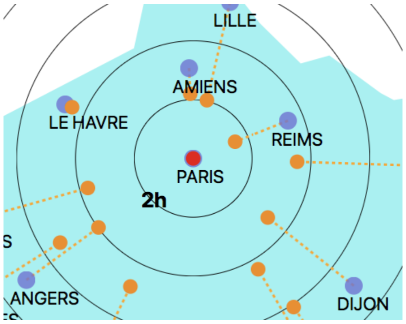

Figure 6: Big ratio

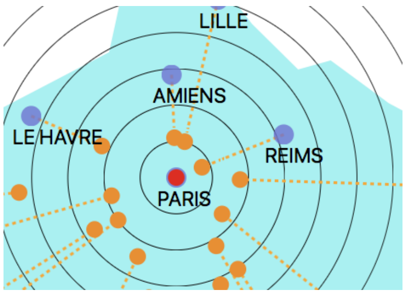

Figure 7: Small ratio

Note that a default value of α could be set for each city, so that the visualization always looks good when a new reference is selected. We did not work on any automation of this process, but it may be a good lead. Another possibility we could have explored is the following : updating α every time another destination city is hovered over, such as the shifted position and the original position coincide. This would enable a quick comparison between the destination and all the other city : if the shifted circle of another city moved away from the reference (compared to the original geographical position), it would mean that the train line liking it to the reference is slower than the one between the destination and the reference. In our implementation, this is possible by manually changing the value of α, but this action is not intuitive for a new user. Continuing this line of reasoning, a color code could indicate if other cities are more or less well connected with the reference than the selected destination. Note that those different improvement are independent, and not mutually exclusive.

3.5 Data

Data were hard to get. The temporal distance matrix that could be built on the data offered by the SNCF, France's national state-owned railway company, was sparse. And to access European, one would have to connect to the API of various European railway companies, which is tedious. As a result, we had to build our own data acquirer, and got our data from Google's Distance Matrix API. To connect to the API, we used a Python library named *Python Client for Google Maps Services* [SOURCE : https://github.com/googlemaps/google-maps-services-python]. Note that there was some missing information, usually linking non major cities. As those information could be found with a manual search on Google Maps, we do not have any explanation of their absence in the data given by Google's Distance Matrix API. Note that if we had chosen to investigate distances by car rather than by train, many open API could have been found easily. We thought to use a Dijkstra algorithm to fulfill our matrix, but the waiting duration between two trains would have been forgot. And this duration might be huge sometimes. This is the reason why we have decided to let those blanks.

A final point : as we were focused on the visualization, we only worked on static data, *i.e.* we run our data acquirer once, on a particular day, and did not update the numbers on a regular basis. An updating, and an averaging of travel times over a longer period (*e.g.* a week) could be done for a mature project.

An other solution would be to actually work with SNCF. Our visualization might be usefull to them. As a consequence a direct access to their data would be powerful for our work.

4 Discussion

4.1 Improvement

At the beginning, we agreed to make a map for time travel in train. But at least, an improvement can be to change the mobility, like an other visualization when you want to travel with your car or a plane. This will change a lot the time travel between two destination, and provide more information for the costumer. By the way, if we change the mobility, we can change the distance where you want to travel too. If you want to take the car, it would be better to travel inside your area. At the opposite, if you take the plane, it would be better to have a world map to choose where you want to go. (Sometimes, the travel between two cities with train in Europe can be very long..)

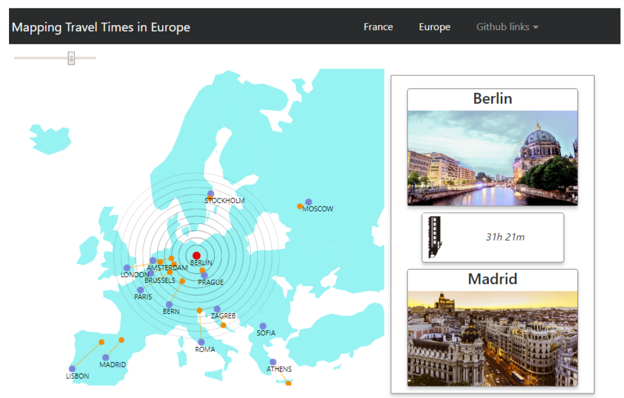

Figure 8: Long travel in train

Another improvement can be the meta-data. Our data for the map are static, we take the data from Google map API at the beginning. It would be great if we take the data in real-time to have the best time travel information.

A dynamic link between France and Europe would have been great. Of course it is not fundamental but it would have smoothed the user experience.

They are many other way to improve this visualization, cause at the beginning we focus on the time travel between cities, but at least, we can have lot of other information for our travel, like the consummation of CO2, more information on the travel (like basic information on the cities)... Indeed the only thing that we need now are the coordinates of the cities and a distance matrix. And the main idea of our work is that a distance matrix does not need to be in meters !

Moreover a great way to link our work with other works would be to gather meta data on the cities and to display them on the right. We only have pictures to enlight the cities. Some information on weather for example would be nice to help the user to plan his trip.

Another possibility would be to let the user choose where he can go. Sometimes we are limited by the time, and it's not possible to loose time. So the user can choose the maximum time the he wanted to travel, and the map will display only the city where he can go. Next, he just have to choose his destination.

5 Conclusion

Lot of people who like to travel choose their destination by the distance of them and sometimes they refuse to travel to some cites because it's too far. But in reality, the distance doesn't mean everything. Some cities are nearly close in kilometres distance, but in time travel are very different, like Lyon-Montpellier is approximately 1h48m but Lyon-Nice is 5h11m for the same distance ! We hope that visualization can help people to realize the difference between the distance and the time. With that new information, this can help them to organize their travel in different way. Moreover we hope that we will change the way people see our hexagon. Indeed as we hope that train, that is one of the most ecologic way to travel, will be more and more used, people will have to re-think the way they perceive their environments. We saw that their are a lot of ways to improve our work, especially by working with other teams who would have other data.

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