The accessibility of cities in metropolitan France

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Index Terms: Accessibility—Travel times—Visualization

1 Introduction

There is an undoubted concentration phenomenon of population and activity towards certain nerve centers, that constitute our cities and urban areas. The accessibility of a city has an accelerating effect on this phenomenon, accompanying at a deep level the transformation of the city's demography, activity and culture [5]. In this sense, accessibility has even become of strategical importance in order to drain investments, skills and tourism.

In this work, we aim at proposing a solution to visualize such an accessibility factor for a city. Here the accessibility factor of a city is computed in a rather trivial, yet natural way: It is expressed as the travel time towards this city, averaged out over the territory of metropolitan France. There certainly exist more sophisticated and realistic ways to define such an accessibility factor, and we slightly discuss this as a possible perspective of work in the ending section.

After a brief presentation on existing studies of the socio-economic impact of city accessibility, we shall provide a detailed presentation of our visualization solution. A chart-based presentation will be the main object of this visualization. Indeed, this option provides an instantaneous reading of the relevant information, and also provides a realistic distribution of cities among the territory, thus giving the possibility to easily notice differences between travel times with actual geographical distances.

The visualization should be divided into two parts: A first part should carry in a synthetic way the global information of accessibility of cities across the territory. Then a second part should provide, in an interactive fashion, details on how easily a particular city may be reached, depending on the starting location. We are interested here in two main travel options, namely car and train. The visualization should therefore display accessibility with respect to both of these transportation options.

Another quantity that dramatically impacts the traffic fluidity, and thus the accessibility of a city, it that of the period of time within a year. We therefore aim at developing the possibility for the user to switch between seasons in order to have an demonstration of this effect. The time granularity should obviously be refined to get a better description of the impact of time on real-time accessibility of a city, and we leave this aspect for discussion in the concluding paragraph.

2 Related work

2.1 Socio-economic impact of accessibility

Pour une tude de l'impact de l'efficacit du rseaux intra-urbain sur le march de l'emploi au seins des grandes villes de France on peut consulter [].

In the everyday life accessibility may easily be observed: It indeed is the cause of direct and indirect creation of jobs, a raise in corporation productivity, enforce new partnerships, facilitate exchanges, and reduces transport costs and its environmental impact.

Dans ce travail, on souhaite montrer le degr d'accessibilit des principales villes de France metropolotaine.

Une mauvaise accessibilit peut etre une raison suffisante pour un bachelier de ne pas effectuer ses tudes dans ladite rgion

L'tude des phnomenes de concentration de population (et donc de la puissance economique) en certains poles prend videment en compte l'accessibilit de ces poles comme facteur d'acclration de cette concentration et l'excusivit de ces poles

2.2 Existing visualization methods and case-studies

De nombreuses visualisation de l'tat du traffic grande chelle (et petite chelle) sont disponibles. La figure 1 ci-apres montre une visualisation des temps de trajet vers Paris, suporposant ces temps sur une priode de 200 ans, qui remonte 130 ans en arriere ! pour une discussion ce propos on pourra consulter [6]. Pour une prsentation vulgarise bien plus rcente sur l'volution des temps de trajet en train on pourra voir [2].

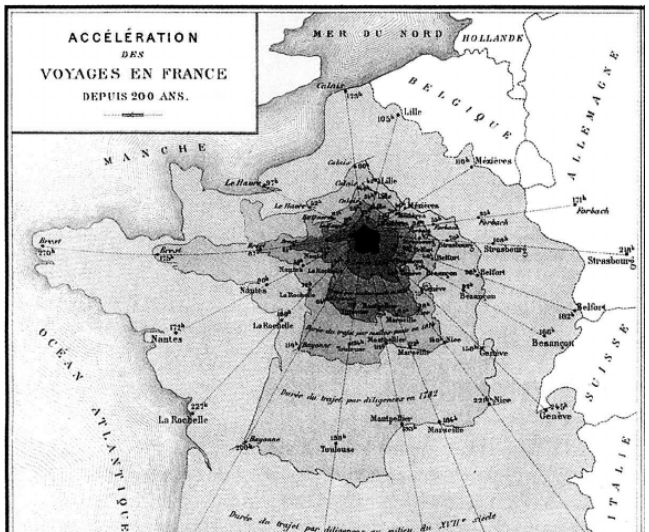

Figure 1: *Accélération des voyages en France depuis 200 ans*, from [4]

La quantit d'articles traitant de l'impact des rseaux de transport sur la socit est immense. Des revues entieres sont ddies ce sujet. Pour une lecture de certains aspects de l'impact de la gomtrie du rseau de chemain de fer on pourra par exemple lire [3] et les references mentionnes.

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3 PRESENTATION OF OUR VISUALIZATION

3.1 Data acquisition

The data of traveling time between two geographical points on the globe are extremely rich and can be obtained e.g. through the Google *Distance Matrix* API [1], by sending a request in form of a URL, in which information such as city of departure, city of arrival, means of transportation (train or automobile) and traveling date should be specified.

For the reason that, as users of the free version of this service, we are only allowed to initiate requests with a very limited numbers of cities of departure and arrival (10 at a time), it is necessary to automatize the procedure of data acquisition. In order to do this we've written a program in Python which, based on a series of French cities numbered after their population size, takes as parameters a range of departure and arrival cities, the transport means and date that we need, and returns the URL of the corresponding request in the right format. Putting the URL in a web browser returns the desired data, in the form of a .json file, which is then fed to another Python program, the latter returning the traveling time between any two cities included in the request, for the selected transportation means and date.

The number of journeys to be treated dramatically increases as more cities and dates are considered, and storing the entire amount of traveling times between all places that one can name all over the country is simply out of reach. However, we still would like to enable the user to add a desired city upon request: This would consist in providing a field, into which the user may enter a place of his choice in order to obtain its accessibility.

3.2 Visualization structure

The visualization of cities accessibility starts in the first place with a synthetic view: a topographic map of France, where "mountains" represent cities that are easier to access in general and valleys the ones who have a lower mean accessibility.

The main part of the visualization takes the form of a national map as well. However, here, the user is asked to position his cursor over a city. This action will trigger off a coloration of the maps, whether in gradually changing gray or in contour blocks, as being shown in the figure, where the shade of the color represents the travelling time from other places of France to this city (or the other way round from this city to other places). The advantages to use a colored map in our visualization are here very clear: one can not only rapidly grasp the accessiblity of other places in France with respect to this city, but the comparison of the distances in terms of travelling time to the geographical ones is also immediate. It is noteworthy as well that we offer the user two options in the visualization: he could switch between railway and automobile as transportation means and between summer and winter as the season that the journey should take place, for the reason that depending on the month of a year, the SNCF timtable and tha road condition of the highways could also vary. Plus, we give the user the possiblity to select both of the tranportation means. In that case, the map will be displayed with two colors, each of them representing respectively train or car, indicating the quicker way to get to a place. Again, we find such representation with a colored map very attractive, in the way that it could bring immediately the competitivity of both transportations means to light.

La visualisation de l'accessibilit de chaque ville passe d'abord par une vue synthtique: Une seule carte du territoire, couverte par une surface ondulante, dont les pics correspondent aux zones les plus accessibles et les creux aux zones les moins accessibles.

Le corps de la visualisation se prsente galement sous forme d'une carte du territoire, mais ou l'utilisateur est demand de pointer une ville. Cette action dclenche une coloration de la carte, en nuances de gris ou par paliers de couleurs, qui permet de reprsenter le temps de

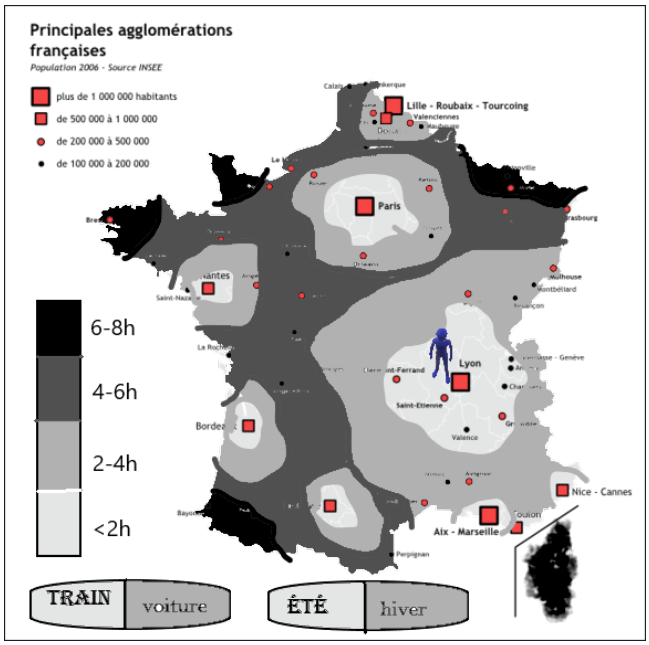

Figure 2: A visualization of traveling times towards the city of Lyon.

trajet depuis n'importe quel point jusqu' cette ville (ou inversement, depuis cette ville jusqu' n'importe quel point de la carte). Les avantages d'une reprsentation par carte par rapport d'autres solutions de visualisation sont multiples: On saisit en un instant la rpartition des zones les plus accessibles depuis cette ville, et la comparaison avec la distance gographique relle est immdiate. Dans cette visualisation deux options seront disponibles: Celle de choisir entre mode de transport (voiture et train), et celle de choisir la saison (t ou hiver).

Nous mettons galement disponibilit la possibilit de slectionner les deux modes de transport: Dans ce cas, tant donne une ville slectionne, la carte prsente alors une partition bicolore du territoire, selon le mode de transport le plus avantageux pour se rendre en ce point. L encore, une reprsentation en carte donne un comparatif immdiat du mode de transport privilgier pour un dplacement.

3.3 Implmentation

La donne disponible dtermine le temps de trajet inter-ville parmis une liste tablie de villes, et il est alors ncessaire d'tendre ceci afin de dfinir un temps de trajet entre deux points quelconques deu territoire. Une approximation de ceci peut etre obtenue en dfinissant un grille Pour La connaissance essentielle dont nous avons besoin est le temps de trajet entre deux villes parmis une collection assez dense sur le territoire. De cette facon, nous pouvons

deux jeux de donnes: un pour la carte, l'autre avec les infos afficher, avec un mapping de l'un vers l'autre.

In this project, the javascript library d3.js will be our top priority as a visualizing tool, not only for its high compatibility with geodata, but also for the wide variety it offers in terms of graphical expressivity of a map. As a result, among all technique details, our first concern will be to select the appropriate d3 template which could be as suitable as possible for our data type. For this reason, our choice could go for a topographic map, which allows us to manipulate the average accessibilities of the cities directly. It could also be a voronoi map, as each cell can represents roughly a French Commune so that it will make it easier to extend the pointwise distances to the whole plane.

The second useful thought which could possibly rend our visualization even more user-friendly is, once a city is selected by the user, if or not we will connnect other main French cities with this one using a arc, just like an airway course map with the travelling time in number in the middle over each arc. Moreover, we could eventually consider to animate them so that an arc joining faster the selected city represents a shorter travelling time etc.

Since we would like to construct a continous color map instead of isolated colorful cities, while on the other hand it is impossible to include every place of France in our culcalation of distances like we explained above, a solution of approximation need to be found for less populated cities and villages. For instance, a treatment using a Voronoi map could be employed just like mentioned previously. But we can also solve this problem more mathematically.

4 Conclusion et perspectives

Dans ce travail on a prsent un facon de visualiser l'accessibilit d'une ville en France metropolitaine. Nous avons choisi une vue en carte, privilgiant ainsi une visualization simple et peu abstraite, mais efficace. Une telle prsentation peut etre complte de nombreuses manires.

Une question naturelle est de pouvoir comparer cette accessibilit l'utilisation globale faite des rseaux de transport: Une ville accessible est-elle effectivement une destination importante ? A l'inverse, l'accessibilit d'une ville avec beaucoup d'affluence possede-t-elle une accessibilit la hauteur des besoins ?

Une perspective serait galement de proposer une pondration du facteur d'accessibilit d'une ville en fonction du temps de trajet: En effet, il est naturel de penser que l'accessibilit d'une ville a un impact beaucoup plus important dans son voisinage que sur des rgions plus distantes, susceptibles d'etre elles-memes attires par un pole d'attractivit plus proche. La calibration d'un tel poids est videmment un probleme dlicat aborder.

Un premier apport envisageable est de voir qui profite le plus de cette accessibilit, et pour quelle raison: ceci ncessite de corrler la prsentation faite avec une tude utilisateurs des rseaux de transport.

Un autre aspect d'intret est de savoir qui voyage: la proportion de voyageurs selon des tranches d'age, de zone d'origine. Enfin il serait intrressant de comparer l'impact socio-conomique du degr de mobilit l'chelle territoriala avec celle d'chelle pri-urbaine.

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