Studying human migration and factors influencing this migration

Blondelle Thomas* Joymangul Jensen† Moisson Matthieu‡

ABSTRACT

We have designed a new visualisation to understand international migrations and correlate it in an easy way with other factors, such as the economy. Many parameters can be changed such as the time period, the specified country, and the background colors of the map.

In this final report, we discuss first about the importance of the migration phenomenon and the necessity of a clear and concise visualisation. We will then see how it has so far been represented in the literature. A description of the project will follow: it will be explained the development of the concept and the implementation on the website, as well as how the map should be used. The report continues with a discussion about the possible improvements that can be added to the visualisation and the data in itself.

Index Terms: Data Visualization—Human Migration—World map—Factors affecting human migration; Open Data—OECD Stats—GDP—Migration statistics

1 INTRODUCTION

Modern nomadism is complex: it mixes multiple causes, which vary with countries of origin and destinations. It has indeed been the subject of many theories to understand it: in 1889-"Laws of Migration" [10], Ravenstein, the first migration theorist, explained that migration is directed by a balance between unfavorable and more favorable conditions; besides his laws state that migration is mainly the result of economic factors.

It is all the more paramount to understand these migratory phenomena that their consequences are immediate for the migrants and the host country populations but also because it is a good estimator of the changes on a world scale.

Migration phenomena are traditionally distinguished as two movements: immigration and emigration.

Immigration concerns, for a given country, people entering the territory. This is a topical subject and very often a sensitive one because it intimately affects the opinions of both parties. There are indeed varying feelings of the host populations: sometimes welcoming, like Germany with Syrian refugees, but often perceived suspiciously. The immigration movements imply a lasting change of the country, with mixtures of sometimes opposite culture, which are not always homogeneous.

For its part, emigration concerns, always for a given country, the movements of people leaving the country to go elsewhere. For example, French people who leave France to go to Germany. This phenomenon is often a marker of the attractiveness of a country, or, in this case, of its lack of attractiveness. Emigration happens for economic reasons (other countries have better living conditions), for tax reasons (there are more advantageous countries), for political reasons (the country of origin is now hostile (Edward Snowden)), etc.

The phenomenon of migration is ultimately a vital topic to understand the world but remains extremely complex to grasp. This is why we decided to study this subject through a simple, concise and explanatory visualisation.

In concrete terms, we have implemented an interactive map of recent migrations, 2000 to 2015, in and out of OECD countries. It displays not only migration flows over a selected period but also other migration indicators such as the ratio of number of immigrants over the number of emigrants and the reference economic indicator: GDP. Additional information is available by hovering over the countries. The superposition of these three graphic elements greatly facilitates the understanding of the phenomenon.

This visualisation is intended for all audiences, ranging from the youngest who would like to understand the major migratory phenomena to political organizations wishing they had a clear and complete information.

2 RELATED WORK

2.1 Descriptive migration visualisations

Immigration flows are sensitive political data and therefore, it is a fruitful topic abounding in the literature. Many of the associated visualisation are interactive maps and show global or country-specific immigration flows. For instance, [4, 7, 12] print global default data and allow, after a user's click on a country, the display of migration flows by country.

The importance of migratory masses is often represented by more or less saturated colors on the countries of departure or arrival [7] but this is not always the case: [12] represents these flows by a quantity of points around the country in question, when it comes to inflows, and by a quantity of points on the countries of arrival, for the outflows. [4] , shown on figure 1 represents these masses by means of circles of variable diameters.

These flows are sometimes underlined with arrows of constant width [7] or even by flows of points from one country to one another [2]: the quantity of points in these flows of points depends on the importance of the migratory flow.

Other initiatives to represent these population movements use more undisclosed representations. It can be noted the use of chord diagram [11], which is appropriate for the representation of relations between data. This type of representation, however, becomes easily unreadable with the number of nodes needed to be located, explaining a restriction of the diagram to ten large geographical areas.

Weighted trees have also been used [15] to represent population flows. The width of the branches indicates the proportion of migrants and the different colors allow a quick visual distinction of influential branches. The main limitation of this type of diagram lies in the need for an large display, which limits the overall understanding of the data presented.

2.2 Migration visualisation and causes

Population movements are born under the impulse of many factors.

Economic reasons very often happen to be an important factor of migration as said before. Parameters describing the economy of a country are numerous: the growth of a country, the employment rate, opportunities abroad. Political parameters, such as the type of regime of the country, the rate of corruption, family factors or environmental factors, such as rising water levels in very low-lying countries are also determining ones.

These causes, however, are seldom shown with migration data, even though they would inform greatly the reader. One rare example

*e-mail: thomas.blondelle@ecl15.ec-lyon.fr

†e-mail: jensen.joymangul@etu.univ-lyon1.fr

‡e-mail: matthieu.moisson-franckhauser@etu.univ-lyon1.fr.com

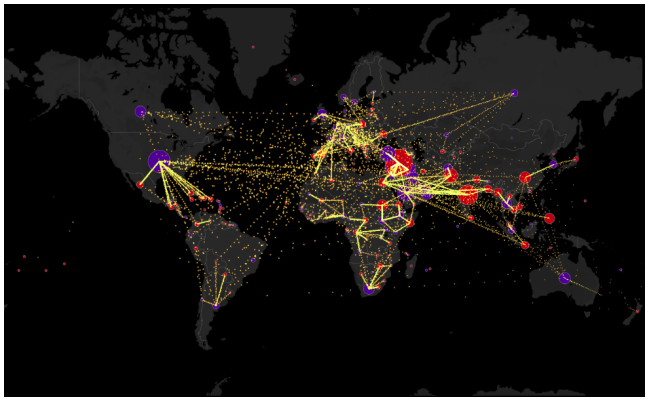

Figure 1: Map of global migration flows between 2010 and 2015 [4]

is [7], which links the main population movements with climate change.

Most maps deal with economic, political, and environmental issues regardless of migration flows, such as [1] for instance.

2.3 Map with panning-zoom

The possibility to zoom and pan on a map natively has its importance for the user: gaining in precision for the borders, selecting a very small country or just moving the map requires this functionality. However, we have not noted many maps developing such a feature for a specific software is needed, such as D3.js[1], and a non-static data format like .png is not sufficient.

2.4 Comprehensive maps of migration flows and migration factors

Our research has led to no satisfactory match for extensive maps about migration and its causes, even though comprehensive reports have written about it [6, 13].

3 Project Description

3.1 Strategy and approach

3.1.1 Group formation

To implement this project, we have decided to do it step by step. We were supervised by our data visualization teacher who asked us to do a different task each week. The first one was to create an effective group. At the start, we were two students in double degree looking for a third student. We then met another student in double degree. This fact is important: because of overlapping courses, we needed to work independently if someone was not present.

3.1.2 Choice of the subject

The second step was to choose a subject we all wanted to work on. The constraint for the project's theme is mobility and transport. After a short brainstorming, we have decided to develop a visualisation about migration, for its originality and the interest it may generate. The choice came naturally in view of the members of our group. Before going further in our reflection, we have made some research about migration, which allowed us to discover that there were plenty of open-data on this topic available on the Internet. We also found that, despite this ocean of data, it was difficult to find a understandable migration map with other relevant information explaining the migration. This led us to define our project more precisely: "Studying human migration and factors influencing this migration".

[1] Data-Driven Documents

3.1.3 First sketches

The idea being selected, we have then all met again to discuss the layout of the visualisation that we want to achieve. We have drawn different possibilities for the visualisation, including a map with several options available on the side. We have also imagined a bubble graph in which each country was represented by a bubble. For example, the size of the bubble represents the ratio and the color represents another information like the GDP. This representation can be a good idea but it exist approximately 180 country in the world so the bubble graph will be very condensed. Furthermore, this visualisation is unusual and may prevent viewers to easily grasp the concept.

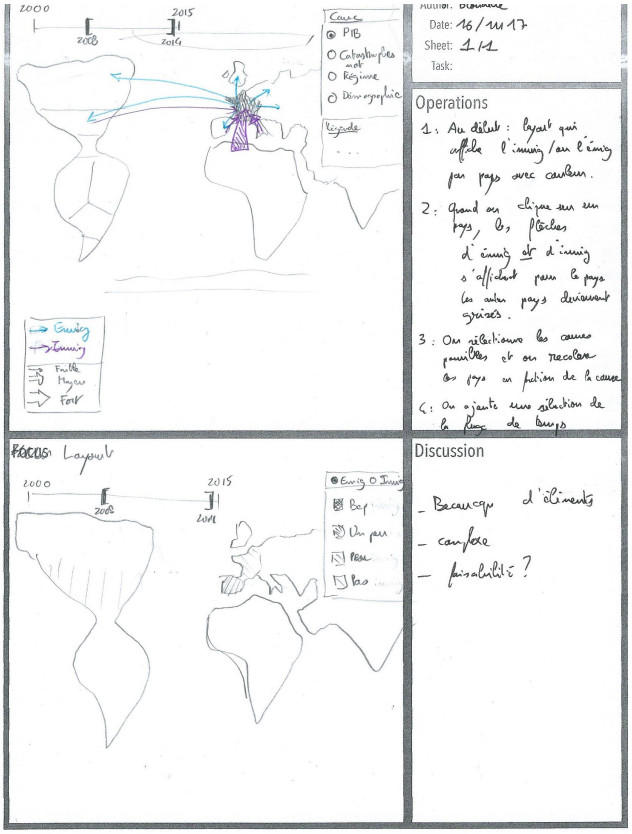

Figure 2: Idea #1 of the visualisation (sketch)

We have rapidly decided to focus on the sketch shown on figure 2. It is indeed much easier to understand this type of visualisation and our goal was to be as clear as possible. Thus we have worked deeper on this concept sketch and we have created a second template of what we want, using notably Tableau, shown on figures 3 and 4.

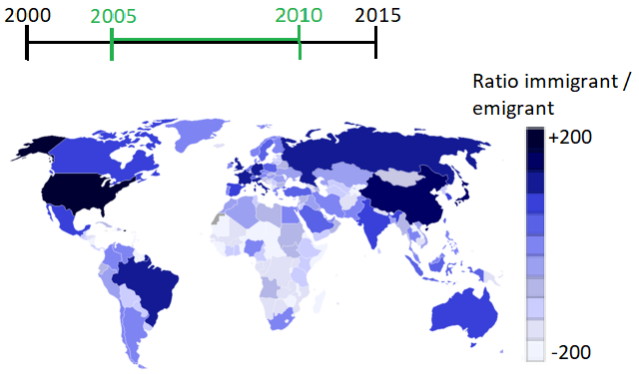

Figure 3: Idea of first view when you arrive on the project

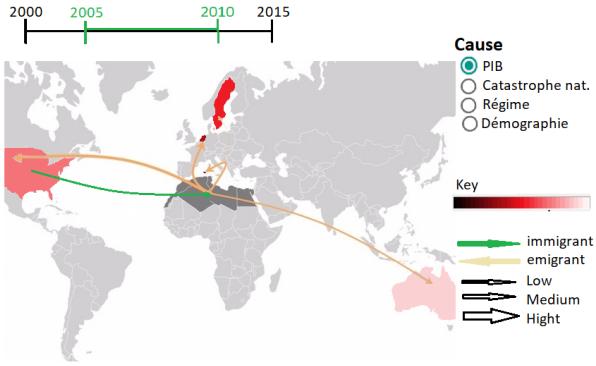

Figure 4: Idea of focus when you click on country

3.1.4 Data

We then had to get the actual data. We have begun by the most important set: the GeoJson map and the migration data. We met our first difficulty that is to correlate the different data. Fortunately, we found that migration data and GeoJson share the same country code which allowed us to easily merge both sets. Quickly afterwards, we found the GDP data with the same country code.

3.1.5 D3 Morphing Map Projections

In D3.js there are many ways to display a map. But many of these are not very readable for us. We have found a gist where we can display the different possibilities, like those in figures 5, 6 and 7.

After comparing all the different projection possibilities, we have decided to choose the Mercator projection. This projection have the advantage of displaying all countries in the most universally understood manner. Even if this representation greatly stretches some areas, it is more important for us that everyone recalls a well-known map. The difference with other representations like Bromley is that each country have the same importance.

3.1.6 Implementation of the visualisation

Already accustomed to GitHub tools, it did not take us long to start the repository. We have decided at the moment to share the different tasks. One of us was in charge of beginning the web page and loading the data into this very first web page. Another one had to pre-process the data. The last one was to make some research

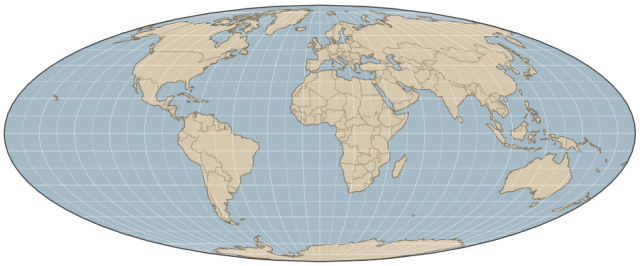

Figure 5: Bromley Projection

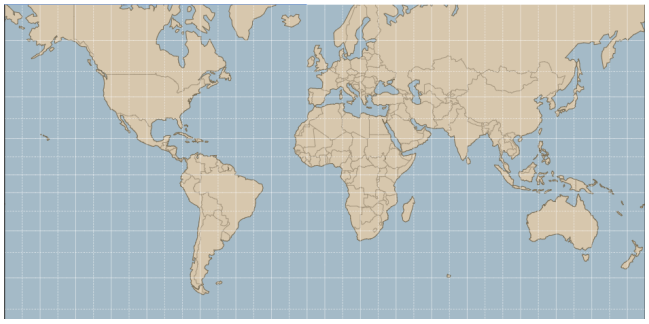

Figure 6: Mercator Projection

Figure 7: Orthographic Projection

about how we can carefully display geoJson with arcs and other information.

During the holidays, we were all focused on the development of the web application. We have somehow intuitively used an Agile approach to do so. First of all, all our progress were made so that each new version is fully functional but has a new feature (creating the map, then the moving tool tip, the coloration, the legend, the zooming, etc). Secondly, we have concentrated our effort on a very short lapse of time: during the two weeks of the Christmas holidays.

We have made great use of the available tools provided by GitHub, notably the remote access to the project repository and the issues section, which display the description of issues: after posting the problem, someone else can then solve it, knowing there is one to solve.

To develop the visualisation, we have used the most recent tools available for web development.

D3.js is a JavaScript library which uses SVG[2] to create highly controlled visualisation. Born around 2011, it is now the most used tool to create graphics in the Internet: it is notably used the New York Times visualisation team since 2013.

We have added Bootstrap, a popular front-end framework, to create the layout of the web page. It let us easily get a responsive and beautiful design.

3.2 Purpose and characteristics

The main focus point is making a graph highly understandable by everyone. In order to do so, we have displayed as much relevant information as possible and highlighted the most useful ones. As a result, the use of color shades is very important as well as the different shapes, sizes and selectors.

First of all, when a user arrives on the webpage, he will see a Mercator map with a well-defined boundary between countries. This map is also colored with the migration ratio per country. This choice lets the user understand at once what we are showing him (a recognizable world map), and the topic of the map: migration.

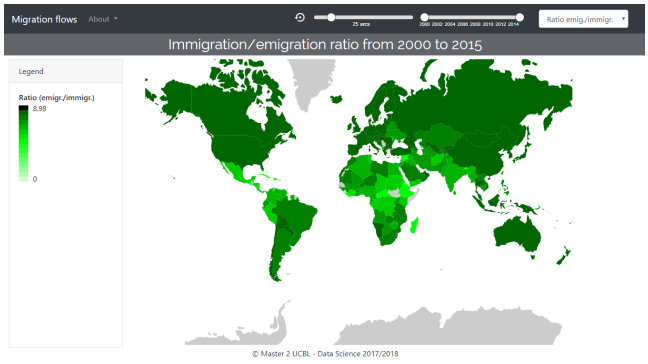

Figure 8: Visualisation displayed at the very start

The user can then play with the different buttons and range selector available on the header. For example, they can select on the top right the coloration they want: GDP per country averaged on the selected period, immigration/emigration ratio, averaged number of immigrants or averaged number of emigrants. Each country will be colored according to the selected coloration. The time period selector can also be used to select the starting year and finishing year during which the information will be calculated. Finally, the left panel includes the legend for the coloration (see Figure 9).

[2]Scalable Vector Graphics

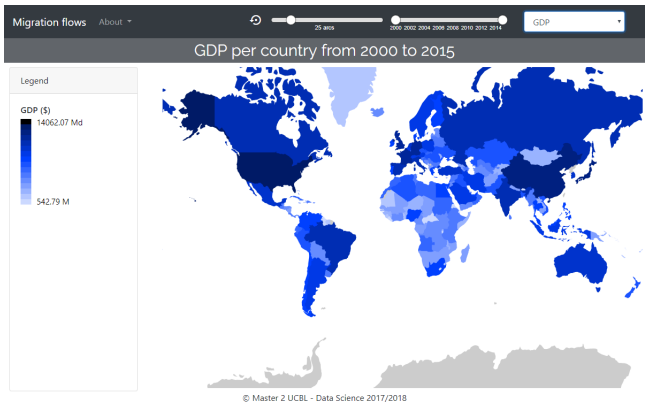

Figure 9: View after selected coloration of GDP

Since we are displaying a world map, in order to add more information, another interaction is possible with this first map. You can click on a given country which makes you change the display as in Figure 10.

This figure still shows the same period selection but arcs appear and the legend is updated. All destinations of emigrants are linked with the selected country with red arcs whose width varies with the importance of the emigration. The arrival of immigrants is shown the same way with green arcs.

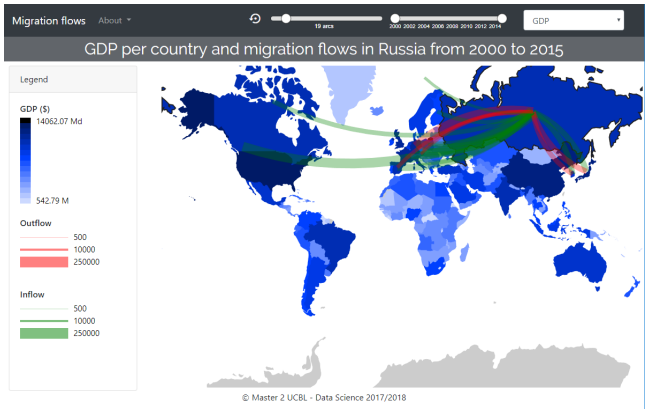

Figure 10: View after click on Russia

We made the choice of separating these two figures not to overload information. Moreover when implementing our visualisation, the user will be able to change different parameters according to the desired information in order to have simple, intuitive and useful graphics.

After developing the main features, we have thought about adding new and yet useful features. In order to represent the most comprehensive map, we have decided to display the main information about a country on a moving tooltip when the user hover on a country. He can see information like the name of the country, average GDP, average incoming, average leaving, and ratio. This information is evaluated each time he changes the period. Figures 11 and 12 illustrate this.

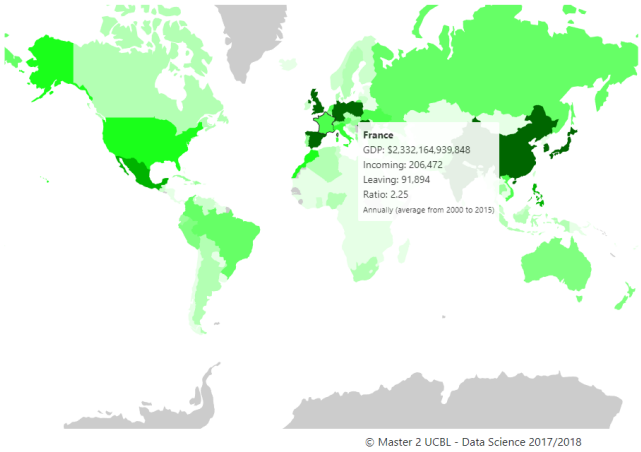

Figure 11: Mouse over a country with none is selected

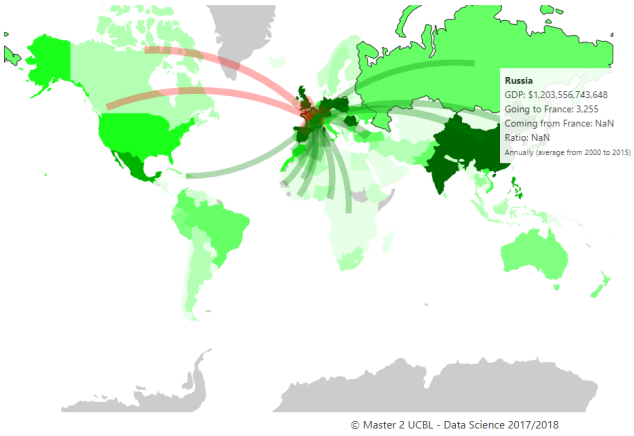

Figure 12: Mouse over country with country selected

4 Discussion

Our visualisation is fully featured for users who want to studying human migration in OCDE country. A first problem was the data migration though. Our migration data is indeed scattered. It depends on the will of the countries to hand over the data. Some country like to show they accept many people. Some others prefer to give no information, for political reasons.

As for the clarity of the visualisation, we considered it sufficient. However some mistakes remain. The first one concerns the centroid of some countries. The arcs for the USA for example finish not in the USA but in Canada. This bug is due to the method of evaluating the centroid (Alaska is moving the centroid upwards). We have used the D3.js v4 method which returns the centroid of a country regardless of the fact that some countries may be multi-polygonal. USA is the most strinking example and Alaska has a vast surface that move greatly the centroid.

We can add some features to improve the visualisation. We have, among other things, thought of display the arcs as arrows to show the direction. Currently the direction of the arcs is indicated by the color of the arc. Adding a ending arrow will make it more readable. The map projector that we have chosen should also be modified to the taste of the user, even if it is only an aesthetic feature.

The last feature we want is the most important from our point of view. To add information we can search data about political, number of people in a country, weather... It is harder but this can add lot of information about why people leave or come to a country. Actually we focus on the GDP but it's not the only thing which can accurately describe a country.

Despite these improvements, we did not find visualisation like ours with so mush information on migration on the web. We could have done this work faster with other softwares but we could not have had great control over fine but important details.

5 Data sources

Many governments do not want to put their migration data as an open data. However, we found that OECD [8][3] allows a free access to all available international migration database. The immediate limit is that it concerns only countries from the OECD.

For the different data to correlate with the migration rate, we used the GDP of the different countries on the World Bank Open Data database [14]. At this point we decided to work with these data already collected in order to get the first visualisation.

6 Conclusion

Understanding the changes of the world as a whole require basic knowledge of migration as it is often a reliable indicator of attractiveness or lack of attractiveness of a country. This can allow us to then look for the reasons behind these movements. We have then created a interactive visualisation of world migration showing the important information such as the GDP and the migration number for every country, the direction of the migration between countries and the relevant information about it, as well as a varying coloration of the countries (GDP, ratio immigrants/emigrant, number of immigrants, or number of emigrants).

An improved visualisation would include another types of data such as the environmental impacts (climate change migration), political regimes (political refugees from tyranny) among others, the visualisation still provides an informative display that may be profitable to a large public.

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