

# Process Book

# WORLDWIDE MIGRATION PATTERN

CS573-DATA VISUALIZATION *Spring 2017*

CONGYANG WANG, XIAOQUN WANG, YIMIN LIN

# Table of Content

- Overview and Motivation
- Related Work
- Questions
- Data
- Design Evolution
- Implementation
- Evaluation

# Table of Content

- **Overview and Motivation**
- Related Work
- Questions
- Data
- Design Evolution
- Implementation
- Evaluation

# Overview and Motivation

## Overview

The vast world of the past has yielded to the global village of today. The world has become more diversity and open to immigrants from different country. Our goal is to find the global migration pattern among each country and the migration trend during five decades (1960~2000), and explore the reason behind the migration phenomenon. Three visualization are presented in the webpage.

The first visualization is a world map, which provide a general idea for our topic. The overall detail of immigration flow can be found using mouseover. The second visualization is a chord diagram, which demonstrate the spread direction of immigrant for some popular countries. Using interactive linked multiple diagrams, users can explore the trend of spreading among five decades, the detailed number of inflow/outflow among each country, and the trend of diversity among time period. The third visualization is a multi-parallel diagram. The countries have been divided based on their developing level. The relation between developing level and the trend of migration netflow can be explored here.

## Motivation

We are all international students who decided to move to another country to study. Therefore, we are curious about what stimulates people to live in another country. The war? The population density? Alternatively, any other reasons.

# Table of Content

- Overview and Motivation
- **Related Work**
- Questions
- Data
- Design Evolution
- Implementation
- Evaluation

# Related Work

## Background

Inspired by Xiaoqun's week 2 reflection about a video named 'Humanity's cultural history captured in 5-minute film'. Which demonstrate 120,000 individuals who were notable enough in their lifetimes that the dates and locations of their births and deaths were recorded.

The other website: <http://peoplemov.in/> shows the global immigration flow at 2010. We want to further visualize the trend of immigration based on different attributes like a year, GDP, a war zone. Our goal is to explore the reason behind the immigration flow. The connection between viz and reader, considered.

# Related Work

peoplemovin  
migration flows across the world.

Pin it Tweet Like 26K

World Population: 6,853,328,460  
Migrants in the world: 215,738,321

Almost 216 million people, or 3.15% of the world population, live outside their countries.

Click on a country box to know more about migration flow to/from that country.

AFGHANISTAN  
ALBANIA  
AMERICAN SAMOA  
ANDORRA  
ANGOLA  
ANTIGUA AND BARBUDA  
ARGENTINA  
ARMENIA  
ARUBA

AUSTRALIA  
AZERBAIJAN  
BAHAMAS

## Top migrant destination

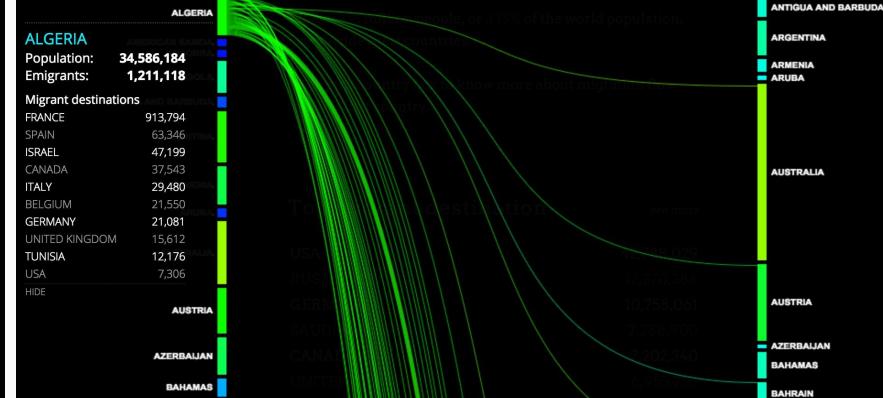
see more

USA	42,788,029
RUSSIAN FED.	12,270,388
GERMANY	10,758,061
SAUDI ARABIA	7,288,900
CANADA	7,202,340

peoplemovin  
migration flows across the world.

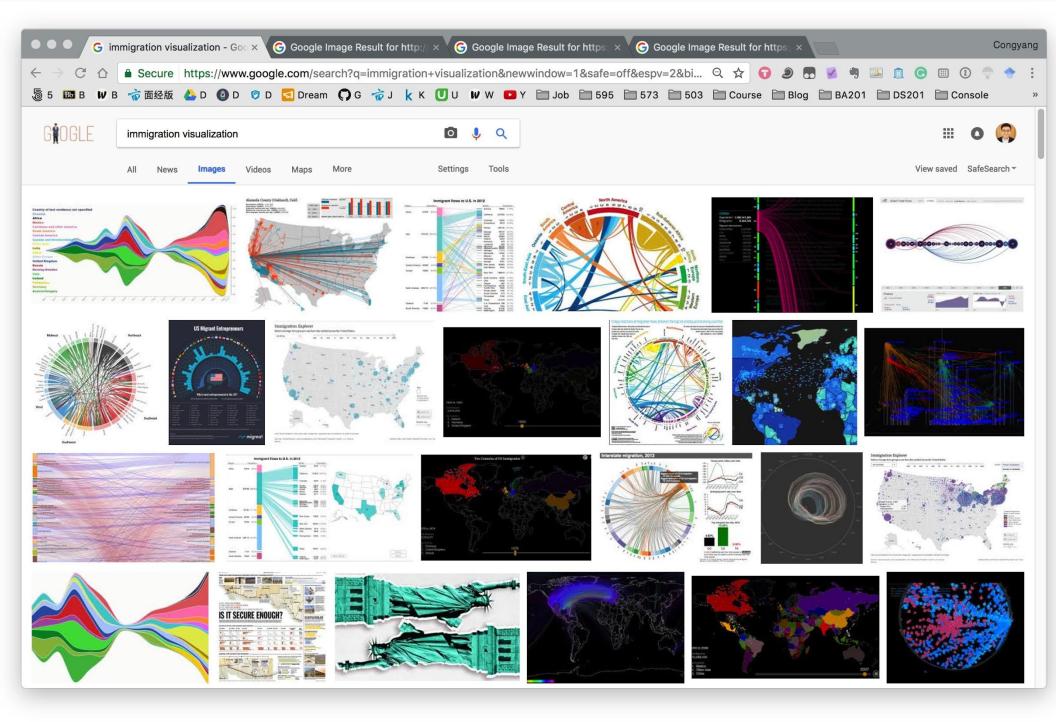
Pin it Tweet Like 28K

World Population: 6,853,328,460  
Migrants in the world: 215,738,321



This website: <http://peoplemov.in/> shows the global immigration flow at 2010.

# Related Work



This website shows the google search results with the keywords: “immigration visualization”.

# Table of Content

- Overview and Motivation
- Related Work
- **Questions**
- Data
- Design Evolution
- Implementation
- Evaluation

# Questions

## 1. Questions to be Solved

In our meeting, we found two categories of the question to be solved by visualization.

**The first one** is to figure out the global/general migration pattern;

**the second one** is to explore the migration pattern for one specific country. Not only the migration volume and migration direction but also the situation for those countries will be presented in our attempts.

## 2. Things to Learn and to Accomplish

In this project, we could learn how to design a web page and how to organize and present the dataset in a way that consumers are willing to take a look. What's more, we will learn how to combine different charts with various visualization idioms to achieve our goal. What we will accomplish is a web page contains well-organized visualizations and descriptions to tell a story.

## 3. Benefits.

Capitalizing the powerful D3 library in this project, we can enhance our proficiency in JavaScript as well as front-end design technics. Our goal is to build a user-friendly interface, which provides us a great opportunity to get exposure in human interaction design field. Finally, the most important thing is that, by aggregating multiple attributes data set, we can learn how to convey the information concisely to the users, which is the key to implement a great visualization.

# Table of Content

- Overview and Motivation
- Related Work
- Questions
- **Data**
- Design Evolution
- Implementation
- Evaluation

# Data

## About Data

For the dataset, the first problem is where to collect the migration data. For the migration data, we found two data sources that have different durations and a different country(which might take a lot of time to clean the data). In the further discussion, We decided to add more features in our visualization, that is the reason why we introduced world population data by country in our dataset. When we are making the parallel coordinates, we thought that the developing country and developed country might have different migration pattern. So we also add the develop country types in the later data processing.

# Data

## Source:

### 1. Migration flow till 2009.

<http://www.un.org/en/development/desa/population/migration/data/empirical2/migrationflows.shtml> (Contains

Migration data from 2000 to 2009, divided by Country(region, developed or developing country) or by citizenship)

### 2. Migration bilateral matrix data at 2010,2013.

<https://www.worldbank.org/en/topic/migrationremittancesdiasporaissues/brief/migration-remittances-data>

### 3. World population data(by country)

<http://data.worldbank.org/indicator/SP.POP.TOTL>

### 4. Developed country list

[https://en.wikipedia.org/wiki/The\\_World\\_Factbook\\_list\\_of\\_developed\\_countries](https://en.wikipedia.org/wiki/The_World_Factbook_list_of_developed_countries)

Country C	Country O	Migration	Migration	Country D	Country D	1960 [YR1]	1970 [YR1]	1970 [YR1]	1980 [YR1]	1980 [YR1]	1990 [YR1]	1990 [YR1]	2000 [YR2]	2000 [YR2]					
Afghanist: AFG	Total	TOT	Afghanist: AFG			0	0	0	0	0	0	0	0	0					
Afghanist: AFG	Total	TOT	Albania ALB			0	0	0	0	0	0	0	0	0					
Afghanist: AFG	Total	TOT	Algeria DZA			41	16	13	10	8	8	8	8	8					
Afghanist: AFG	Total	TOT	American ASM			0	0	0	0	0	0	0	0	0					
Afghanist: AFG	Total	TOT	Andorra AND			0	0	2	5	6	6	6	6	6					
Afghanist: AFG	Total	TOT	Angola AGO			0	0	0	0	0	0	0	0	0					
Series Nai Series Coc Country N Country C 1960 [YR1] 1970 [YR1] 1980 [YR1] 1990 [YR1] 2000 [YR2] 2010 [YR2]																			
Populatio SP.POP.TC	Afghanist: AFG			Populatio SP.POP.TC	Albania ALB	1608800	2135479	2671997	3286542	3089027	2913021	Populatio SP.POP.TC	Algeria DZA	11124892	14550033	19337723	25912364	31183658	36036159
Populatio SP.POP.TC	American ASM			Populatio SP.POP.TC	American ASM	20012	27292	32456	47044	57522	55636	Populatio SP.POP.TC	American ASM	20012	27292	32456	47044	57522	55636

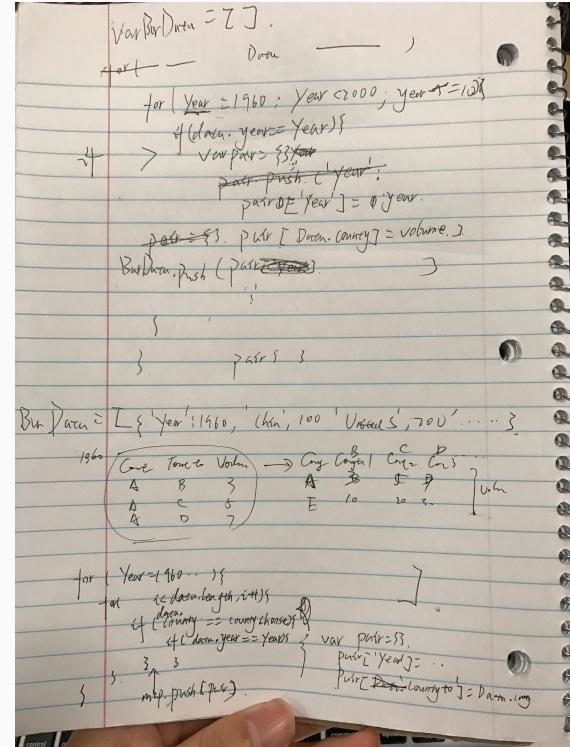
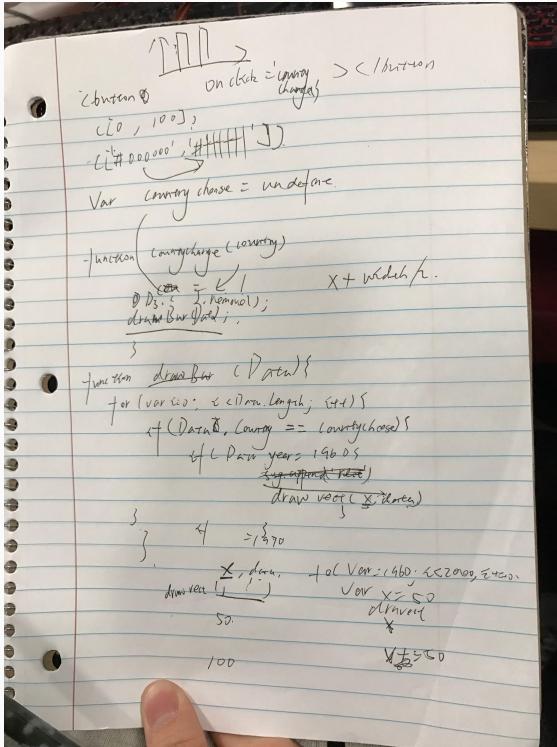
	Andorra		Faroe Islands		Ireland		Monaco		Spain
	Australia		Finland		Israel		Netherlands		Sweden
	Austria		France		Italy		New Zealand		Switzerland
	Belgium		Germany		Japan		Norway		Turkey
	Bermuda		Greece		Liechtenstein		Portugal		United Kingdom
	Canada		Holy See		Luxembourg		San Marino		United States
	Denmark		Iceland		Malta				

# Data

## Data Processing

### 1

The data for each country are stored in different files, and since we have three data sources including migration data, population data. Substantial data processing are needed in our project because we need to integrate all the data source in one file.



# Data

## Data Processing

### 2

To create the data we want, at first, we want to create a json file that can be processed by all of our visualizations. But then we found that it takes to long for JavaScript to process our data. So in our viz we creates different data file for different vizs. The last two images are the data format used to present parallel coordinates and world map.

```
[['Afghanistan', 'AFG', 'Total', 'TOT', 'Afghanistan', 'AFG', 1960, 0],  
['Afghanistan', 'AFG', 'Total', 'TOT', 'Albania', 'ALB', 1960, 0],  
['Afghanistan', 'AFG', 'Total', 'TOT', 'Algeria', 'DZA', 1960, 41],  
['Afghanistan', 'AFG', 'Total', 'TOT', 'American Samoa', 'ASM', 1960, 0],  
['Afghanistan', 'AFG', 'Total', 'TOT', 'Andorra', 'AND', 1960, 0],  
['Afghanistan', 'AFG', 'Total', 'TOT', 'Angola', 'AGO', 1960, 0],  
['Afghanistan', 'AFG', 'Total', 'TOT', 'Anguilla', 'AIA', 1960, 0],  
['Afghanistan', 'AFG', 'Total', 'TOT', 'Antigua and Barbuda', 'ATG', 1960, 0],  
  
[['Country', 'InorOut', 'Develop', 1960, 1970, 1980, 1990, 2000],  
928, 1054163, 1179584], ['Albania', 'Moveout', 'Developing', 74508,  
eveloping', 853881, 1694625, 1602981, 1563318, 1335560], ['America  
5, 19484], ['Angola', 'Moveout', 'Developing', 98851, 132902, 2079.  
veloping', 10999, 5343, 13726, 26499, 41360], ['Argentina', 'Moveo  
  
[['Country', 'Develop', 1960, 1970, 1980, 1990, 2000, 'Total'],  
['Afghanistan',  
'Developing',  
-37534,  
-78052,  
  
[{'Country': 'Afghanistan',  
'CountryCode': 'AFG',  
'Countryto': 'Afghanistan',  
'CountrytoCode': 'AFG',  
'Population': 8994793,  
'Volume': 0,  
'Year': 1960},
```

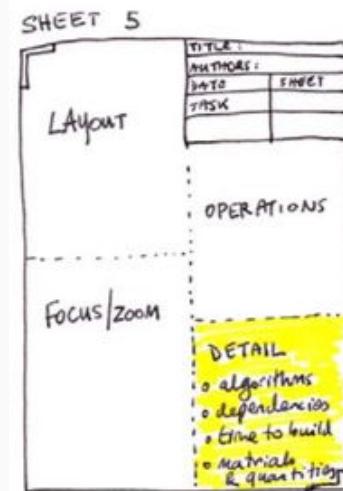
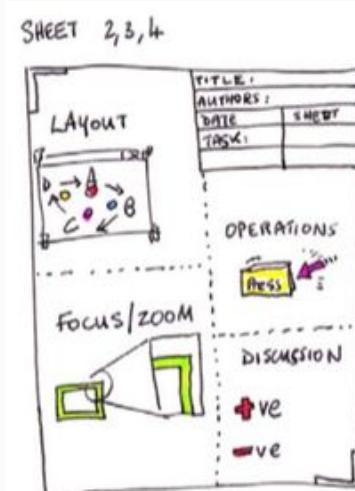
# Table of Content

- Overview and Motivation
- Related Work
- Questions
- Data
- **Design Evolution**
- Implementation
- Evaluation

# Design Evolution

## Design 5 steps

In our first step, we tried to utilize the five step design method to help us find the direction. Exploratory Data Analysis: What visualizations did you use to initially look at your data? What insights did you gain? How did these insights inform your design?



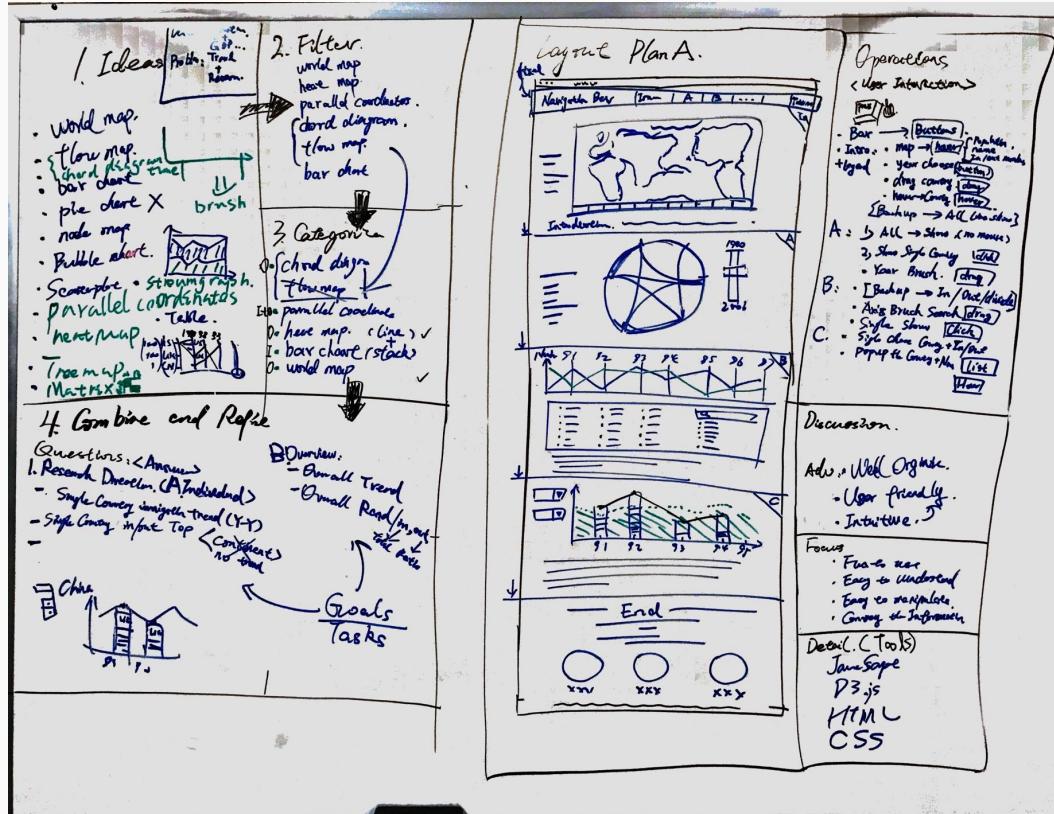
Reference: <http://fds.design/>

# Design Evolution

## Design 5 steps

We combine it to 3

This is the visualization design brainstorm whiteboard sketch; we use the five design sheet inspired from (<http://fds.design/>).



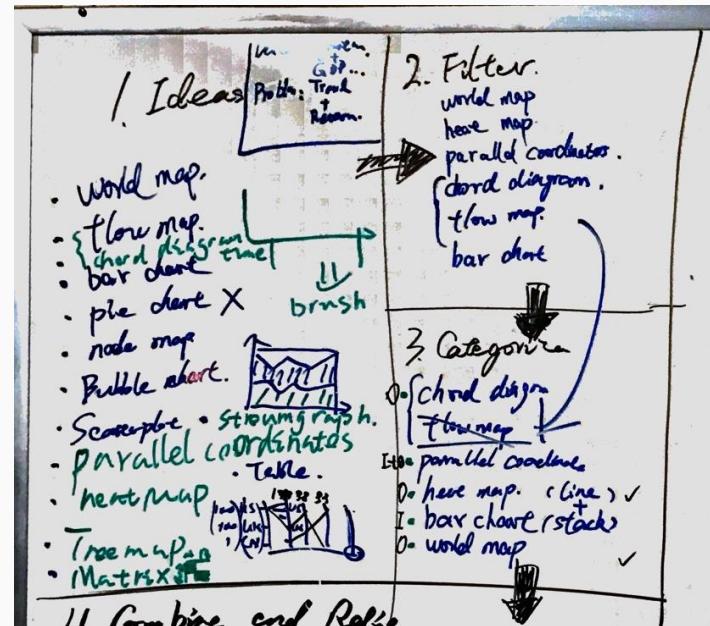
# Design Evolution

## Step-1

We brainstormed the visualization ideas, then filter and categories them.

In our first step, we explored all the visualization formats that might be used in our projects and tried to explore what kind of goals can such format achieve.

We listed world map, flow map(chord diagram), bar chart, pie chart, node network, bubble chart, scatter plot, streamgraph, parallel coordinates, heatmap, tree map and Matrix.



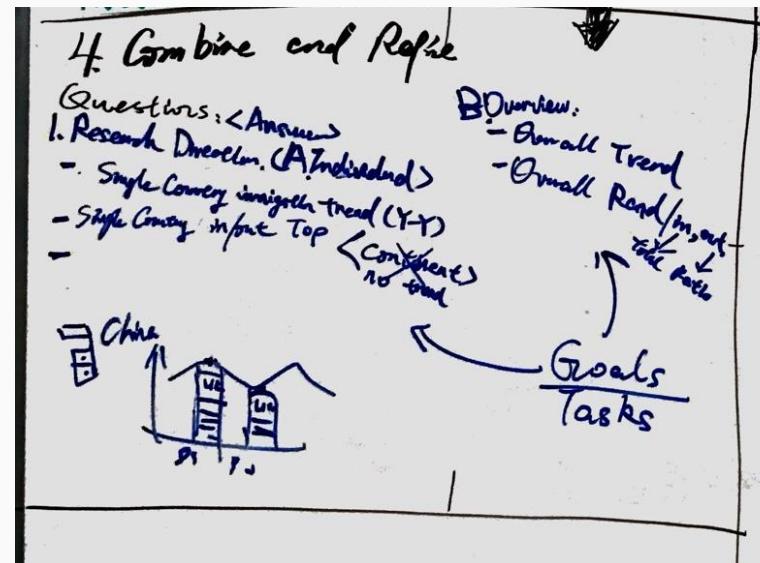
# Design Evolution

## Step-2

We start to think about the detail of our visualization, the goals and the tasks and which visualization should be choose to reach the goals.

In this part, we divided our tasks into two parts. The first one is the overview for this topic. This task, we hope users could get a general idea for our project. Including the overall trend and overall information across countries. The second take is to give users more detailed informations.

In this part, we aim to convey the information for one single country to users in a easy-to-understand way. In this task, users can explore one single country's migration pattern over five decades and explore the exact migration volume for this single country.



# Design Evolution

## Must-Have Features

1. World map with links to show migration and combined with heat map to show the population density
2. The navigation bar on the top to guide users to different visualizations.
3. A chord diagram to show the migration flow among different countries with selection idioms to choose the years.
4. A parallel coordinates chart to show the migration volume pattern for different countries with the brush and search function to reduce and select the specific countries
5. Team members introduction.

## Optional Features

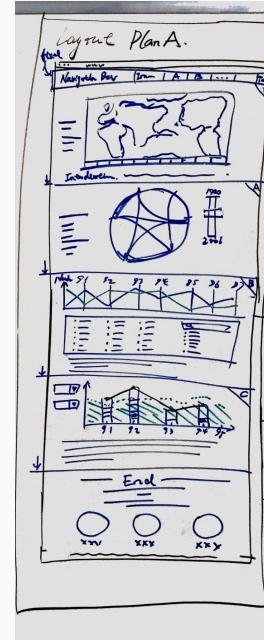
1. Animation to the world map links.
2. Animation to the chord diagram.
3. Other data selection or reduction tools in parallel coordinates. Brush or a zoom to choose the year range.
4. The stacked bar chart for the migration flows with a line.
5. Embed idiom for those visualizations which provided more texted or detailed. information like top countries flow from or flow to, population and GDP.

# Design Evolution

## Step-3

*First, we explored the design space and decided to choose four visualizations to build this visualization project, they are:*

- **Overview Solution:**
  - World Map Visualization
  - Heat Map Visualization
  - Chord Visualization
- **Individual Solution:**
  - Parallel Coordinates Visualization
  - Bar / Stack / Line Visualization



# Design Evolution

## Step-4

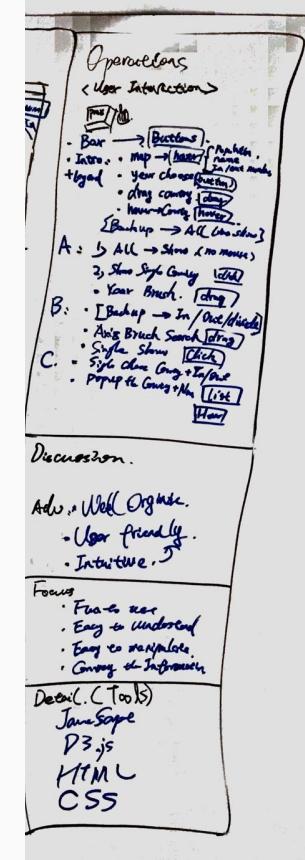
### Visualization Interaction

**1. For the bar chart**, we want to add buttons to select the countries

**2. For the world map**, we want to add a hover effect to show all the details. Year choose button to show the pattern change, drag effect to show the relationship between two countries. Legend and some description are also needed in our world map visualization.

**3. For the parallel coordinates**, we want it to show all the lines at first, but then users could use some data-reduce idioms to reduce the data. A brush to select the specific range, a search function to help users to find the country they are interested in and a hover effect and output to show the detailed values.

**4. For the chord diagram**, we want it to show the top countries flow pattern first. But then when user use the mouse we could present only one countries flow over five decades in the same time. A data list is also needed to help user to choose the exact country they want to explore.

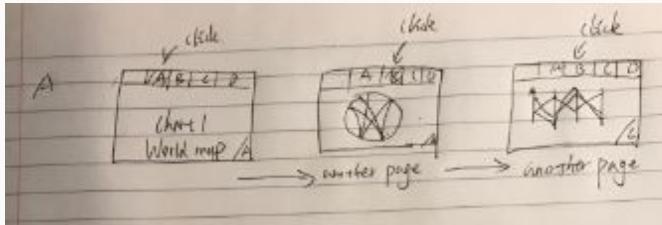


# Design Evolution

## Step-5

### *Web Layout Design*

#### Design A



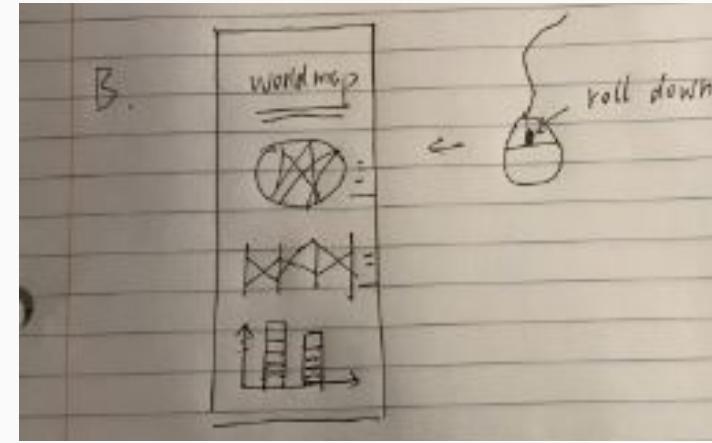
#### Pros:

For one page it only contains one visualization. Easier for users to focus on this chart.

#### Cons:

Need users to move the mouse and need them to find where to go next

#### Design B



#### Pros:

Easy for users to find where to go next.

#### Cons:

When rich information presented, it is very hard for users to find the position of vizzes.

# Design Evolution

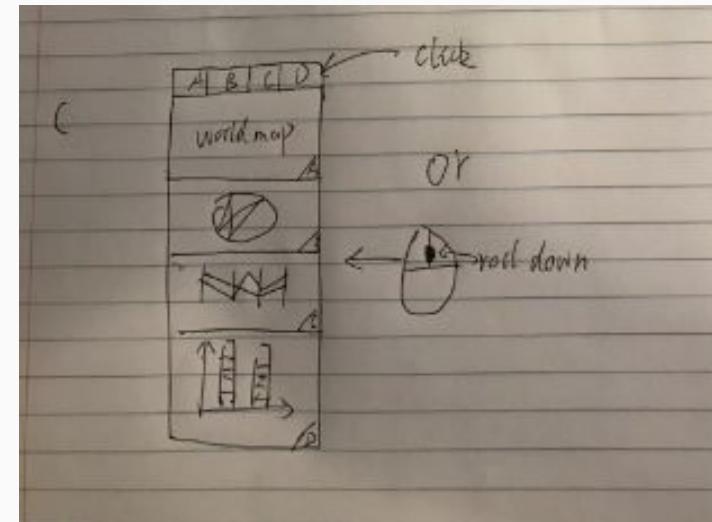
## Step-5

### *Web Layout Design*

*New Solution: We combine the two layouts.*

In our meeting, after watched many visualization pages; we proposed three prototypes for our website layout. After careful consideration, we choose the Design C which contains the characteristics both in Design A and Design B. For design C; further descriptions are listed as follows.

- We choose the One page view instead of the more navigate button to other pages.
- Users can both use the navigation bar and mouse to locate the visualization.



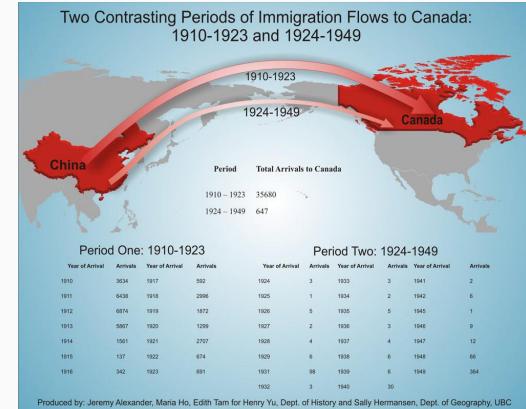
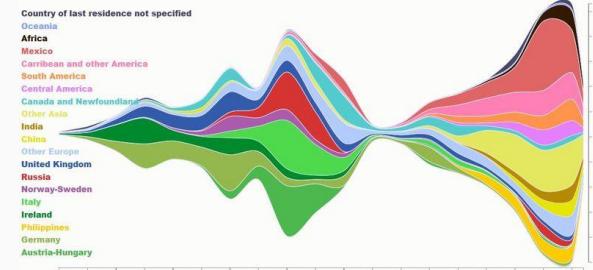
# Design Evolution

## Tools



# Design Evolution

## Design Process



At first, we got inspiration from the visualizations we can find from the web, they all did very fancy job, some of them have the good interaction, some of them have the beautiful design and layout.

But we also found something else. The beautiful design vis don't have the interactive feature, the good interaction vis can not answer the question we were thinking, so we decided to combine the advantages of them to answer our questions.

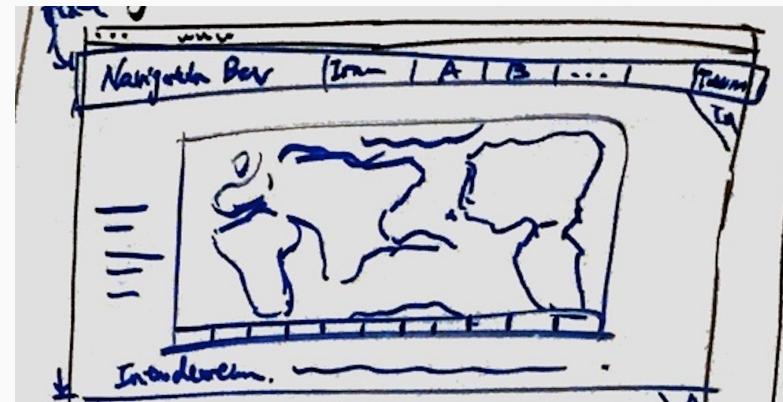
# Design Evolution

## Prototype

For *Map Vis Design*

Through the global map visualization, we hope we can give users a general/ global idea about migration before exploring into any further details. In our design, each country in the world map may have multiple links that link to other countries to demonstrate the direction of migration.

We will represent the density of population and the number of immigration by using deeper color. There will have two modes, inflow and outflow, that allows user to switch between them by click on a bottom. A brush to choose the year. We think it would be very helpful for users to get a general idea.

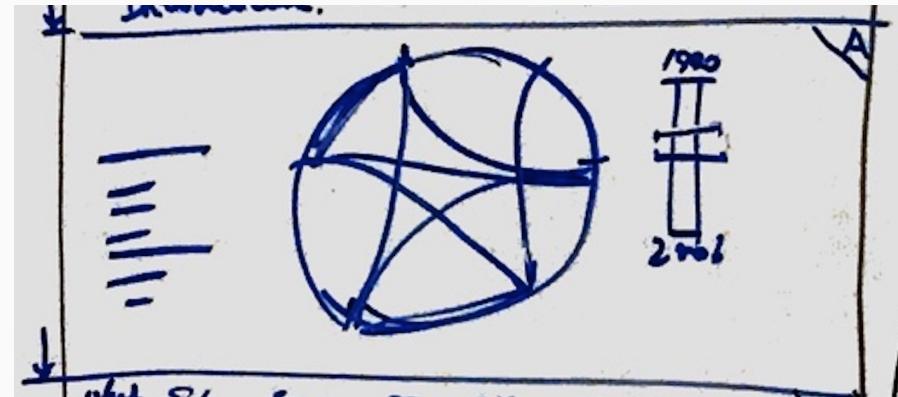


# Design Evolution

## Prototype

For *Chord Vis Design*

Through chord visualization, we believe that users can have a general migration flow idea among different countries before further exploration. In this chord diagram, there will have tooltips that show detailed information about the immigration flow.



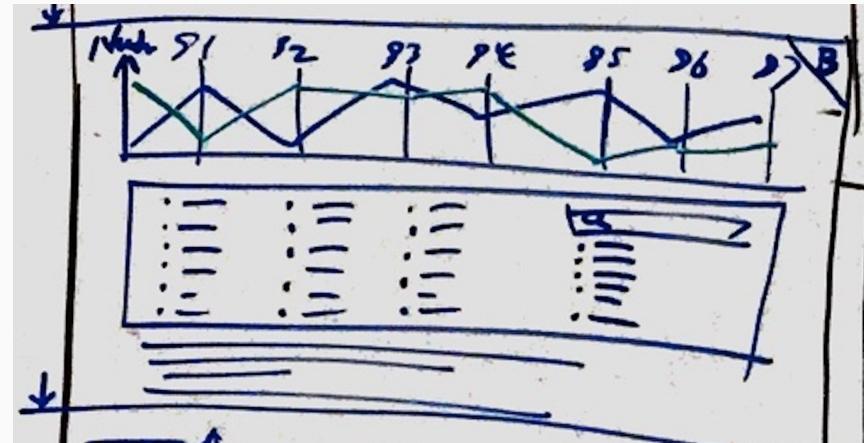
# Design Evolution

## Prototype

### *For Parallel Coordinate Vis Design*

From this visualization, we wish we could provide users with very detailed information for the migration, and that's why we choose parallel coordinates. Multiple attributes of data will be displayed in the same diagram, such as years, number of immigration, name of countries. The trend of immigration among years and countries will be explored by this visualization.

Users could choose to see one specific countries' migration pattern by the search function. Also, they could choose to explore a set of countries' migration pattern by the brush interactivity. Additionally, a choice for inflow, outflow and net flow volume will be provided in this visualization.



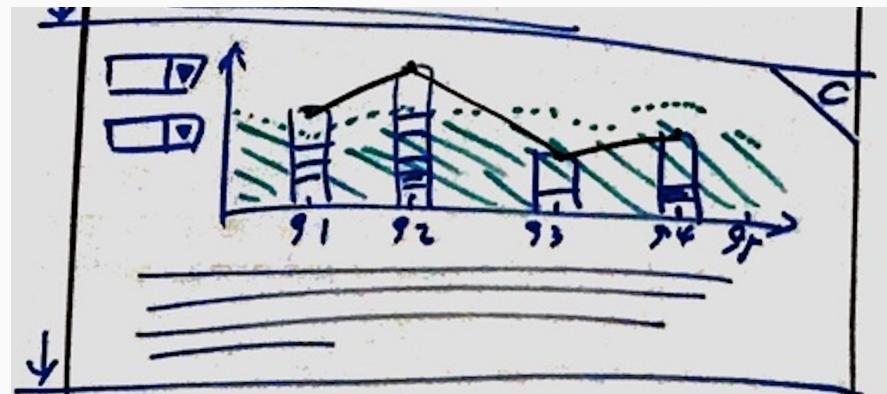
# Design Evolution

## Prototype

For Bar/Line Mix Vis Design

This visualization can combine multiple information together, which helps us convey information more concisely. For each specific country that selected by users, the number of immigration of different years will displayed. The trend of immigration among years can be tracked in the line that connect the top of each bar.

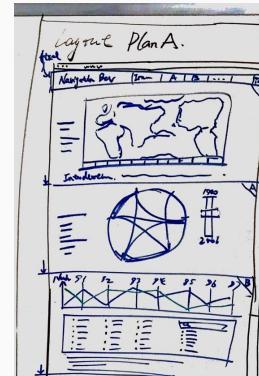
In each bar, migration countries will represented in different color and stack from top to bottom based on the number of migration. To reduce the chaotic, the opacity must be introduced in this visualization. The shadow area shows the population change.



# Design Evolution

## Re-Design

From 4 vis to 3 vis

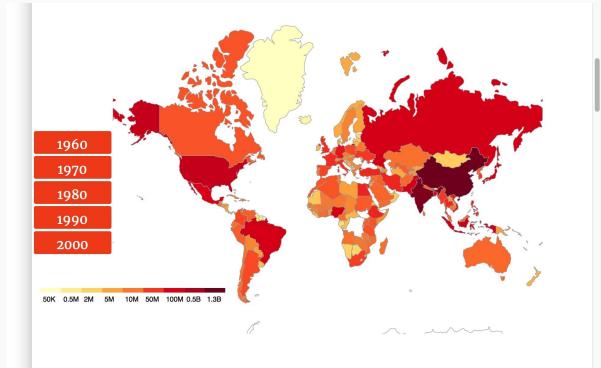
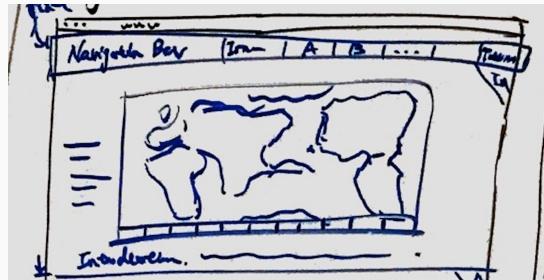


Time is limited. And we found both parallel coordinates and bar chart can help users to explore the details. Therefore, we decided just make the parallel chart and stop work on bar chart.

# Design Evolution

## Design Process

*Overview of the Map Vis evolution*



Prototype

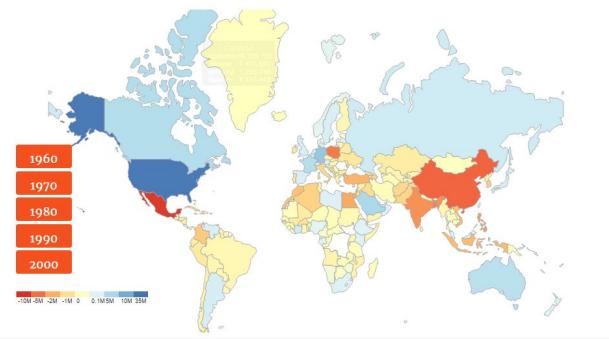


Demo



Stage 1

Stage 2



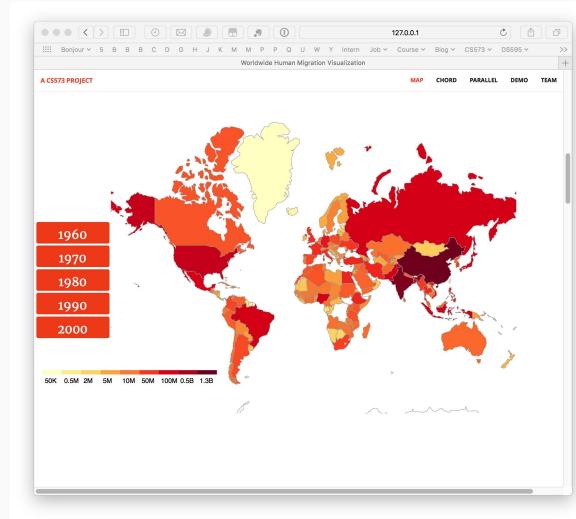
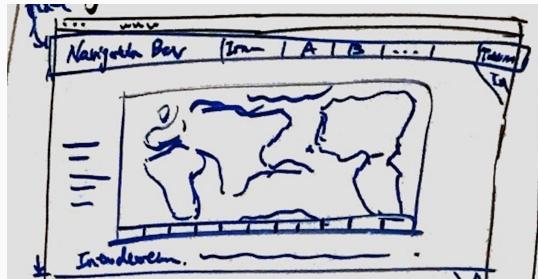
Final

# Design Evolution

## Design Process

*Overview of the Map Vis evolution*

### Stage 1



At first, we want to explore the relation of population and migration. So we also applied population heat map in our first version. Once users mouse over the map, they would see the migration and population details.

# Design Evolution

## Design Process

*Overview of the Map Vis evolution*

### Stage 2



After the prototype presentation. Many audience indicates that the population heat map is very misleading. So we decide to use the gap between people move in and people move out to make the heat map.

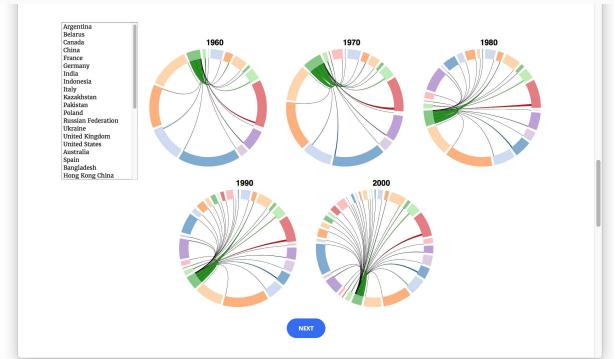
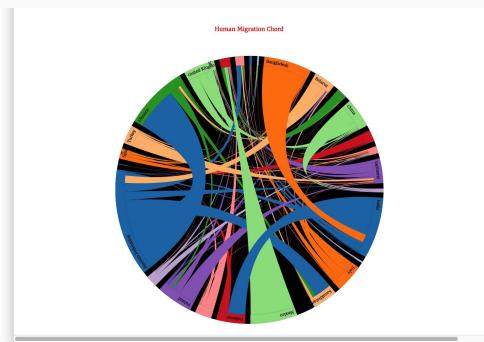
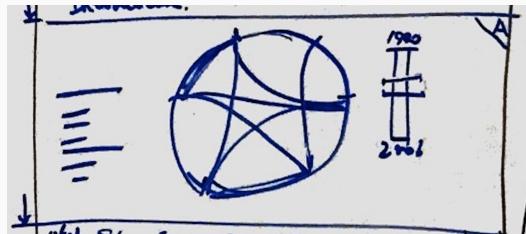
The blue means the move in volume is higher than moveout volume.

The red means the move in volume is lower than moveout volume. The darker color indicates the larger gap between movein and moveout. You can also choose the decades. Use mouse over the country to explore the detail!

# Design Evolution

## Design Process

*Overview of the Chord Vis evolution*



Prototype



Stage 1

Demo



Stage 2

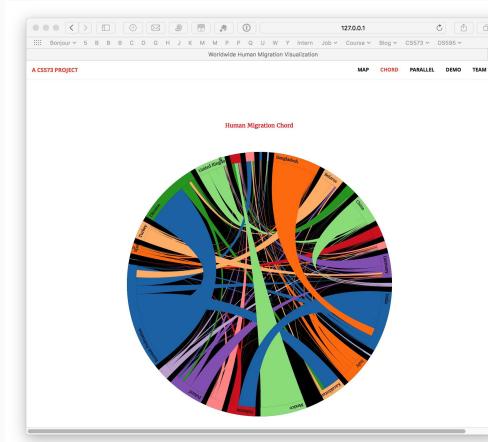
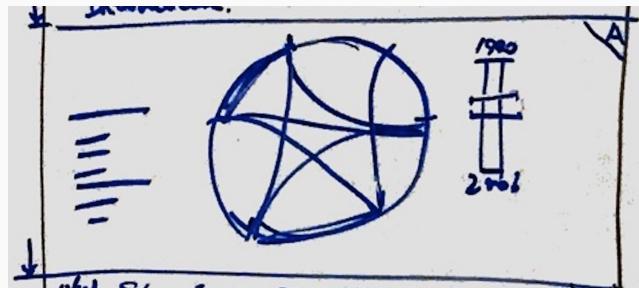
Final

# Design Evolution

## Design Process

*Overview of the Chord Vis evolution*

### Stage 1



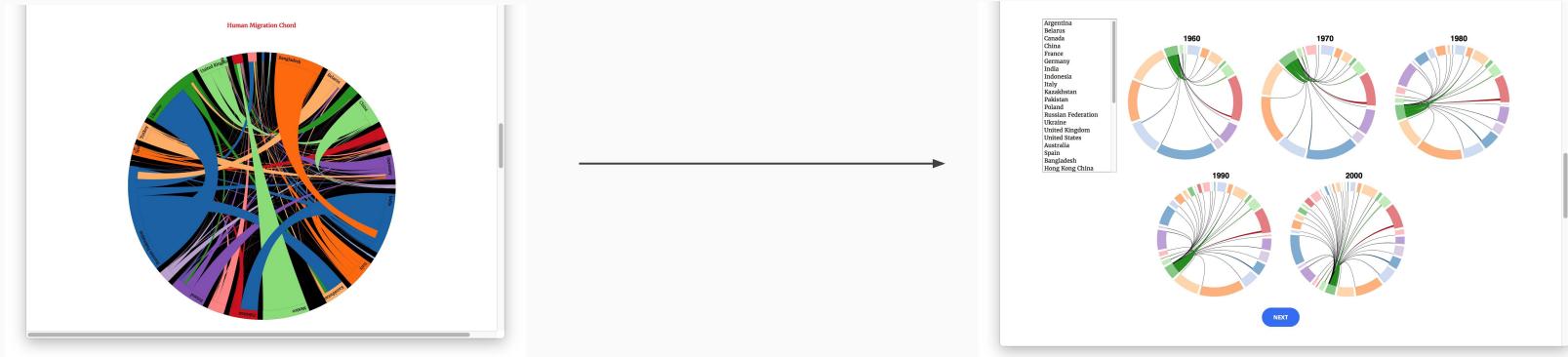
At first we only show one chord for one decade a time, users need to change their selection of year to see the change among decades.

# Design Evolution

## Design Process

*Overview of the Chord Vis evolution*

Stage 2

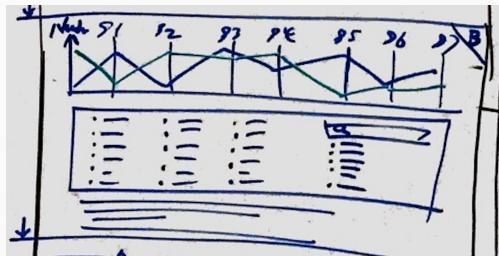


Then we decide to use linked multiple interactive technique, which allow users to observe the spreading direction among decades simultaneously. Which is more intuitive and easy to understand compare to our first version. We also add the list box user selection, which helps users filter out the country they want to explore.

# Design Evolution

## Design Process

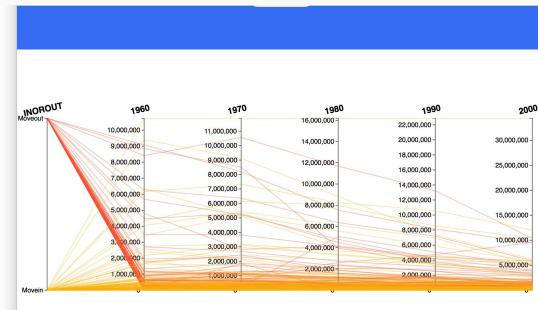
Overview of the *Parallel Coordinate Vis evolution*



Prototype



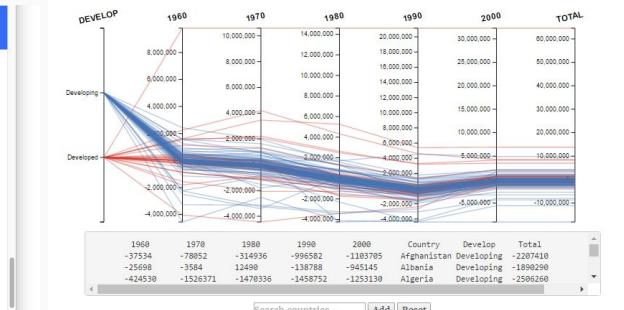
Stage 1



Demo



Stage 2



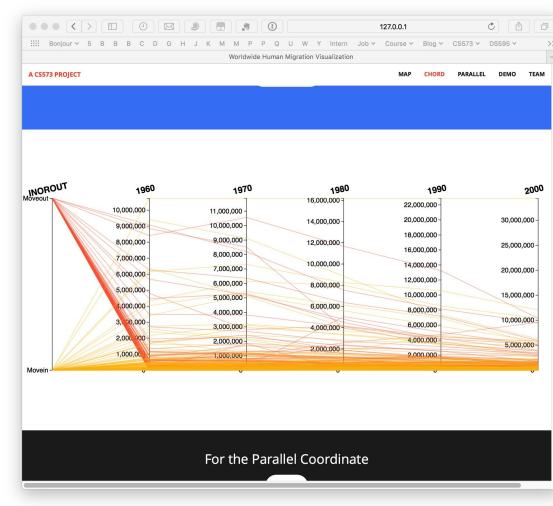
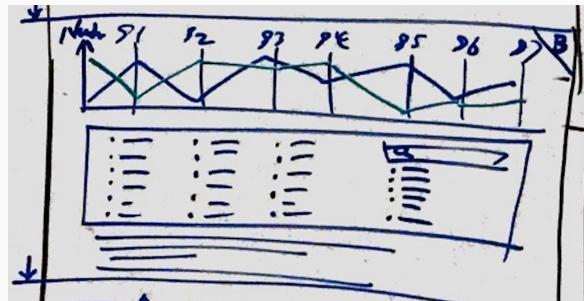
Final

# Design Evolution

## Design Process

Overview of the **Parallel Coordinate Vis** evolution

### Stage 1



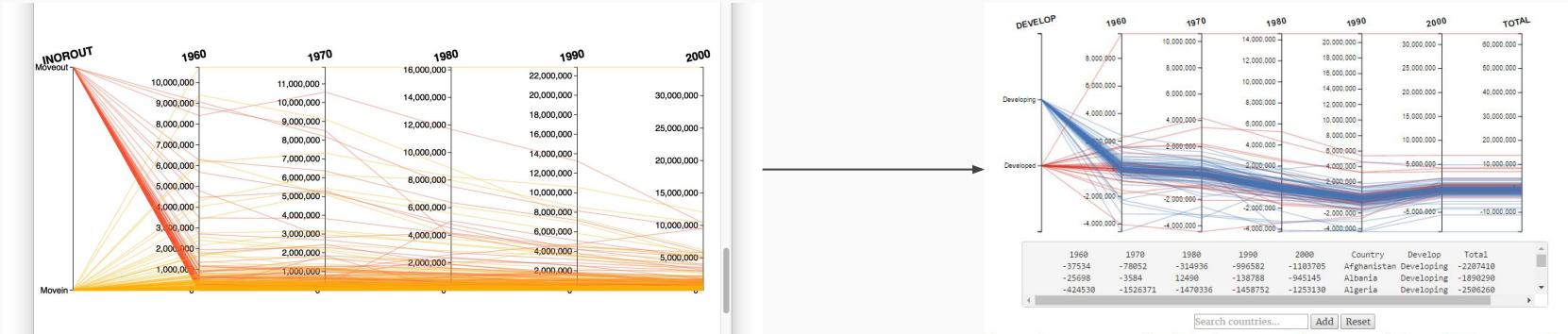
In our first version, we use move in and move out to categorize the data.

# Design Evolution

## Design Process

Overview of the *Parallel Coordinate Vis evolution*

### Stage 2



After the prototype discussion, we found that using the develop type might be more story-telling. And use the balance would be more easier to explore the data.

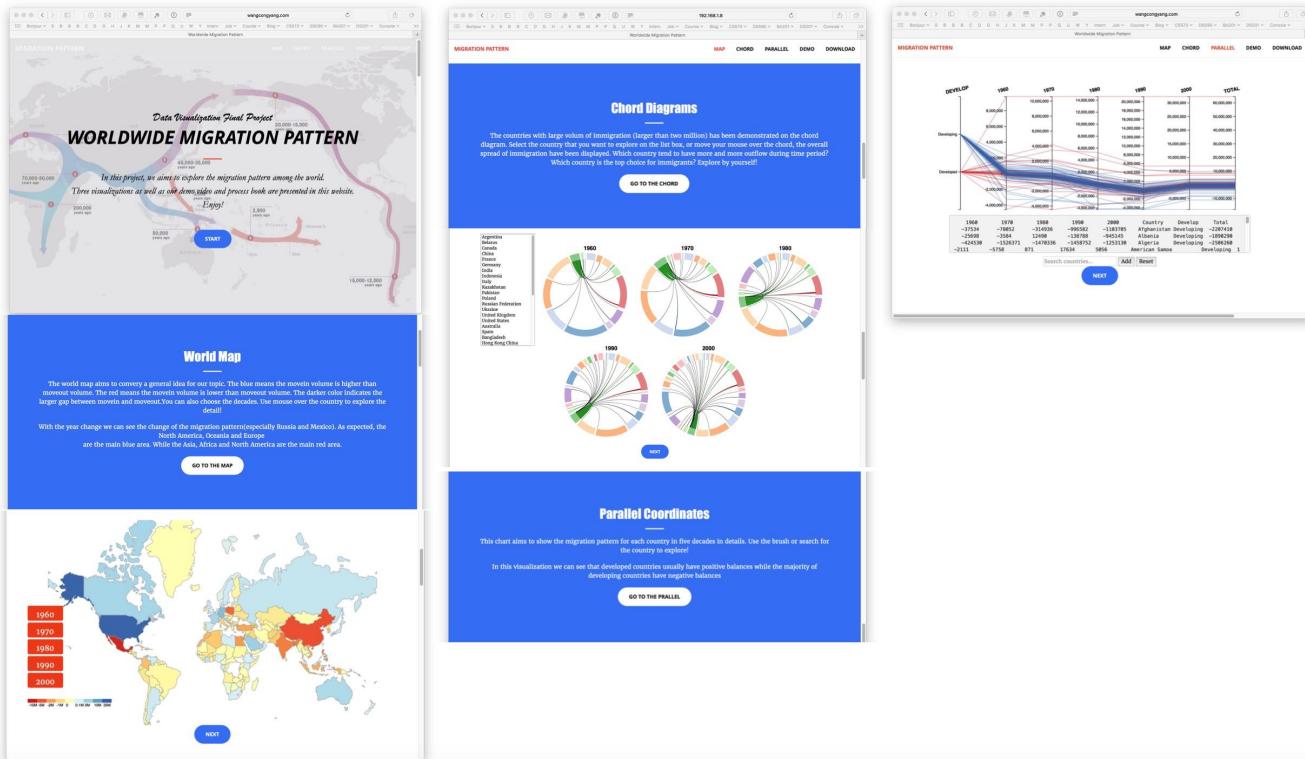
# Table of Content

- Overview and Motivation
- Related Work
- Questions
- Data
- Design Evolution
- **Implementation**
- Evaluation

# Implementation

## Final Vis Implementation

- 1 Cover
- 3 Description
- 3 Visualization



# Implementation

## Final Vis Deployment

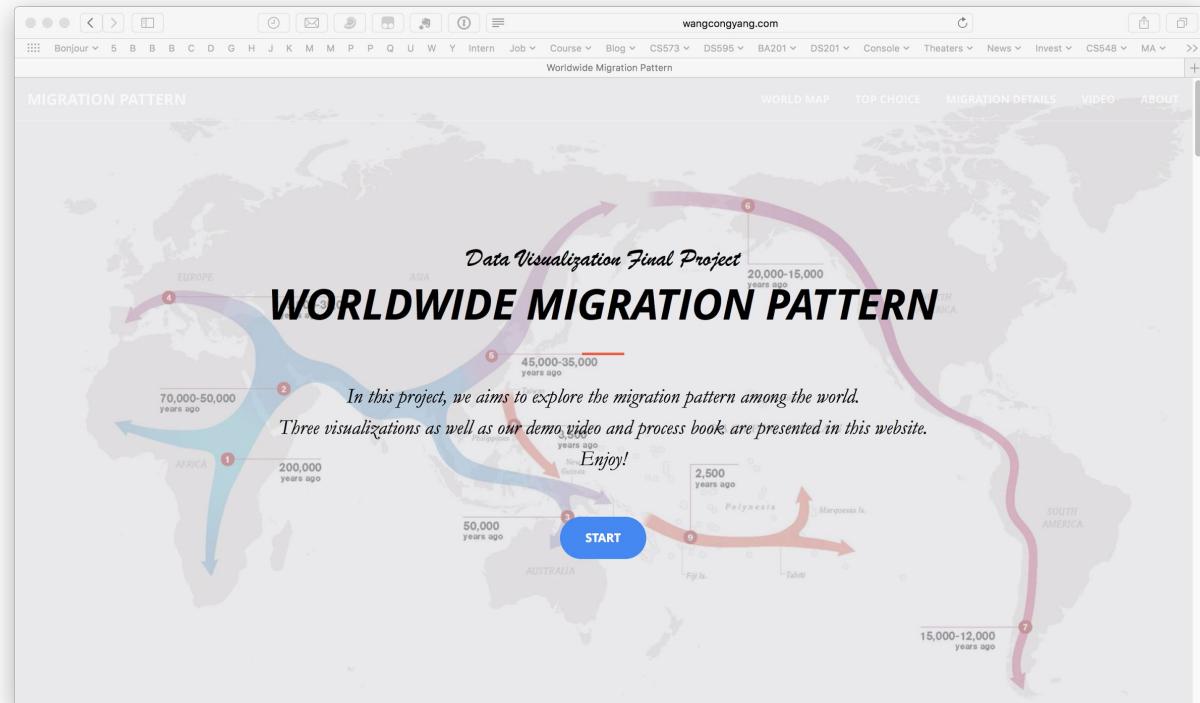
### Cover

The first sight of the audience will see a faded picture which shows the immigration of the human 10,000 years ago.

We use this to give an idea of the human migration history.

There also add the title and the navigation bar at the top of the web.

The navigation bar's color can be changed we you scroll down.



# Implementation

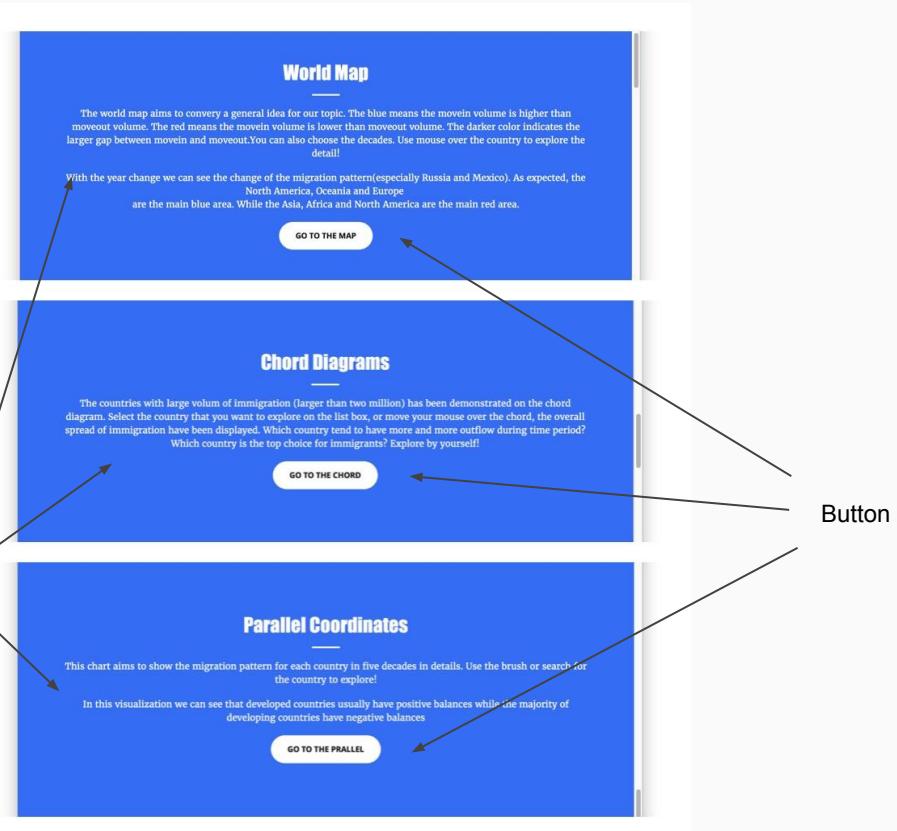
## Final Vis Deployment

### Description Row

In this series section, you can check more information about the vis you will see after you click the button.

We add the description row to help user to understand the vis better to cut the learning cost. We use the same design to tell the user they belong to the same function.

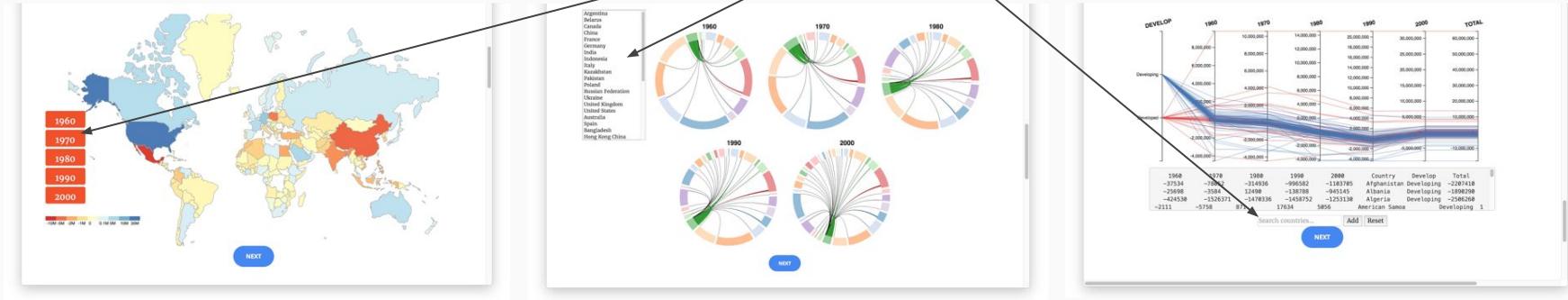
Description



# Implementation

## Final Vis Deployment

3 Visualization Show



In this series section, you can interactive with every vis to check more info you like, after you click the button, you can move on. First, we add interactive feature to every visualization to make you more close to them. Second, we add the button at the end of the each visualization to give you an idea where you can go.

# Implementation

## Final Vis Deployment *Map Visualization*

### FUNCTIONALITY

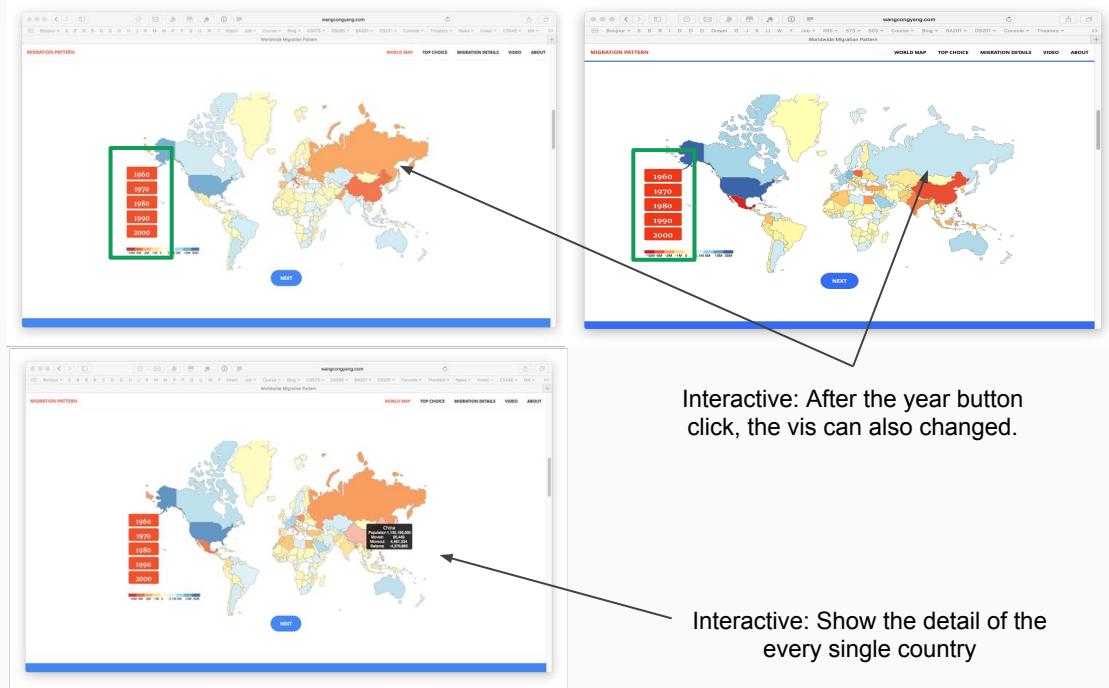
Two colors to present negative or positive. Overview for the world map

### KEY DESIGN

Color scheme legend, numbers separated by comma, heat map for two colors.

### INTERACTION ELEMENTS

Mouseover tooltips, hover change, change year button



# Implementation

## Final Vis Deployment *Chord Visualization*

### FUNCTIONALITY

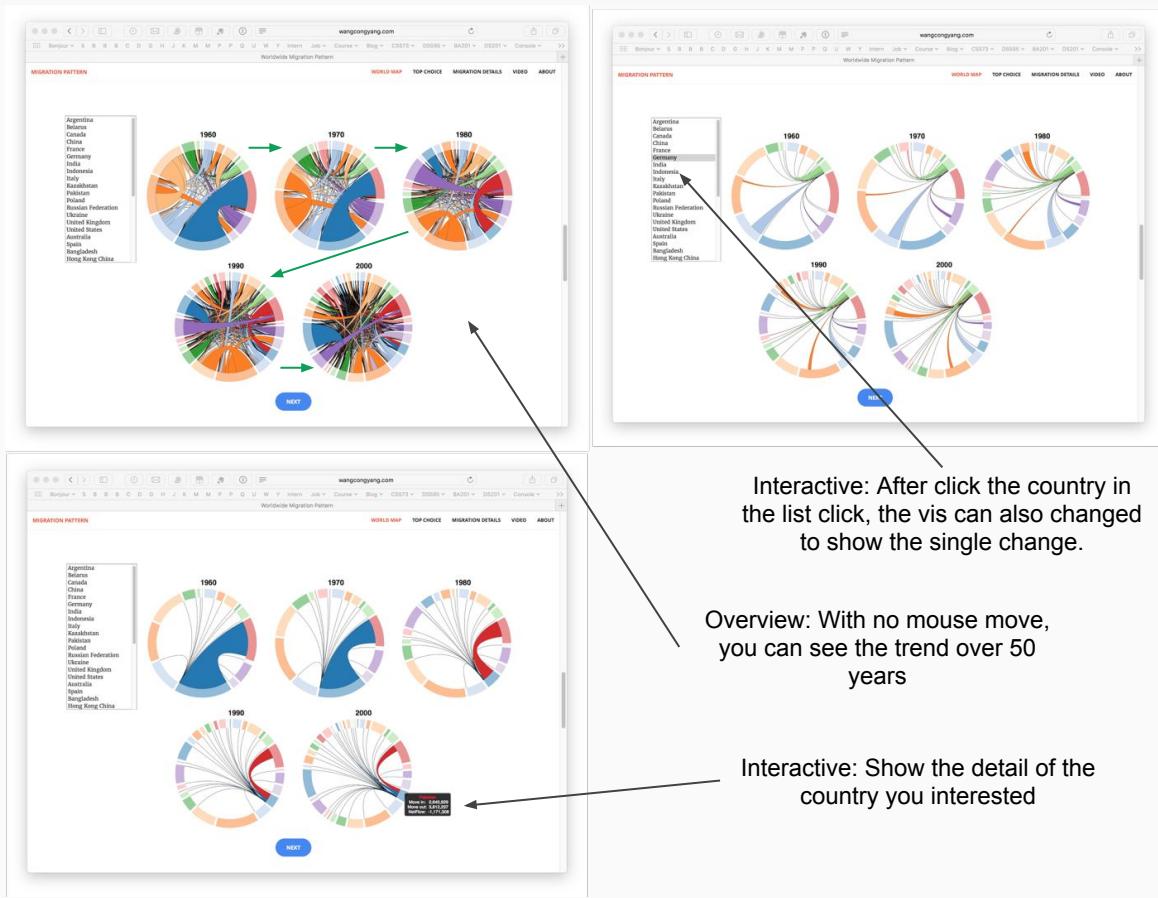
Display the overview spread direction as well as the detailed migration number of some popular countries during five decades period.

### KEY DESIGN

Implemented linked multiple interactive technique, the users can observe the migration spreading among all the decades by either list click or mouse move..

### INTERACTION ELEMENTS

Mouseover tooltips of arc and chord, hover change, click change, linked multiple interactive.



# Implementation

## Final Vis Deployment Parallel Coordinate Visualization

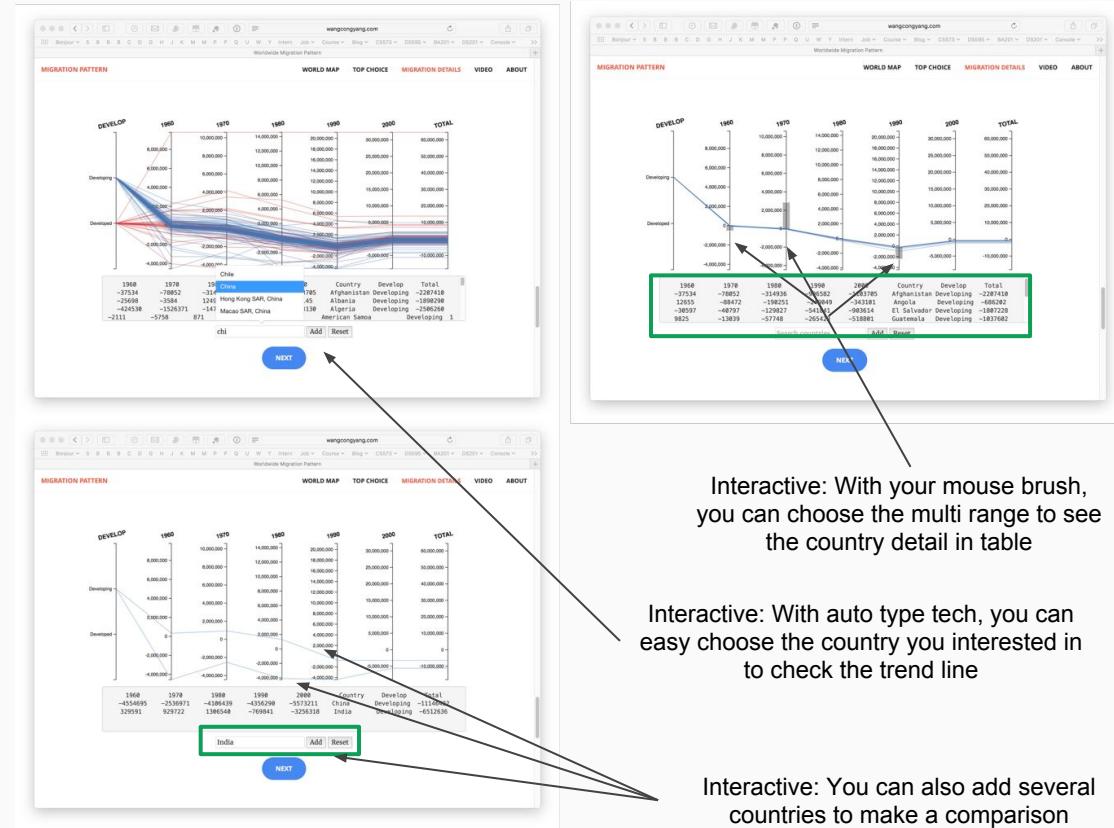
FUNCTIONALITY  
Explore the details.

### KEY DESIGN

Detailed information output, search specific country, compare different countries, select range to view details.

### INTERACTION ELEMENTS

Brush, input box with a datalist, add or reset the chart.



Interactive: With your mouse brush, you can choose the multi range to see the country detail in table

Interactive: With auto type tech, you can easy choose the country you interested in to check the trend line

Interactive: You can also add several countries to make a comparison

# Table of Content

- Overview and Motivation
- Related Work
- Questions
- Data
- Design Evolution
- Implementation
- **Evaluation**

# Evaluation



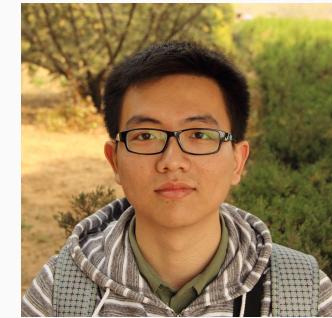
**Congyang Wang**

Evaluation: From this work I understood the whole process of a data visualization on the web, from the three vis we made which wanna tell the story of the immigration, I think we did a good job, but there are more ideas can be deployed to make this work better.



**Xiaoqun Wang**

Evaluation: The migration phenomenon has become more diversity, and it do have relation with developing level or other economic issues. The trend of migration flow for each country can also be discovered in our visualization. I learn the experience about how to make data more presentable and interactive. In the future, we may find more attributes to help us explore global issue behind migration.



**Yimin Lin**

Evaluation: The migration pattern becomes more diverse and mover converged over the five decades. Anyway, people nowadays have a wider range of places to go. In the further study, we hope we could explore more on detailed and find some other attributes such as war location to supplement our visualization.

# Link

<http://coyawa.github.io/DataVisFinal/>

# Video

<https://youtu.be/kskiV5tCm3o>

THE END