

# GLOBAL MIGRATION DYNAMICS: VISUALIZING PATTERNS AND CONTEXTS

[mercury.swin.edu.au/cos30045/s104221423/WorldMigrationProject/](http://mercury.swin.edu.au/cos30045/s104221423/WorldMigrationProject/)

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## 1. Introduction

### 1.1. Background and Motivation

One of the key characteristics of human history has been migration, which has shaped civilizations, economies, and cultures on many continents and during many eras (Siddiqui, T., 2012). People have moved about throughout history as a necessary component of human existence, from the ancient nomadic tribes to the contemporary diasporas fueled by globalization. The topic of global migration has become increasingly important and well-known in the modern era due to a variety of causes, including political unrest, economic inequality, environmental damage, and climate change (Hammar, T., Brochmann, G., Tamas, K., & Faist, T., 2021).

In a time of growing globalization and interconnection, the dynamics of human mobility are more intricate and nuanced than in the past. There are many different reasons why people move, such as to pursue better job prospects, further their education, be with family, or seek safety from persecution or violence (Castles, 2010). Furthermore, population movements are driven by environmental causes including natural catastrophes, environmental degradation, and climate change, which exacerbate already-existing vulnerabilities and inequities.

It is impossible to exaggerate the importance of the global migration issue in the modern world. As the number of individuals living in forced displacement reaches previously unheard-of heights, migration has become a significant humanitarian, social, political, and economic concern. It has significant ramifications for host communities, transit nations, and international geopolitics and has a significant impact on the rights and well-being of migrants (Faist, 2013). Furthermore, a wide range of other urgent challenges, including urbanization, sustainable development, labor markets, social cohesion, and human rights, are intertwined with migration (Castles, 2010).

### 1.2. Visualization Purpose

It is becoming more and more necessary to visualize migration patterns and contexts due to the complexity and difficulties involved in global migration (Zambotti, G., Guan, W., & Gest, J. D. 2015) . A potent tool for deciphering the complex dynamics of migratory flows, exposing temporal and spatial trends, finding patterns and correlations, and locating underlying causes and effects is data visualization (Bertin, 2011). Visualization helps stakeholders, policymakers, scholars, and the public better understand the scope and complexity of migration phenomena by converting complex statistics into understandable and visually appealing representations (van Biljon, J., & Osei-Bryson, K. M. 2020).

Furthermore, migration data visualization acts as a catalyst for comprehending and resolving the underlying reasons and effects of migration (Sander, N., Abel, G. J., Bauer, R., & Schmidt, J. 2014). It offers insightful information about the geographic distribution of migrants, their travel routes and corridors, the demographics of migrant communities, and the social, economic, and environmental settings in which migration takes place. Equipped with such discernments, policymakers can devise

empirically grounded tactics and measures to tackle the obstacles presented by migration, alleviate its adverse effects, and capitalize on its prospective advantages for both migrant populations and receiving communities.

To summarize, the visualization of migration patterns and contexts serves two purposes: first, it improves comprehension of the intricate dynamics of global migration; second, it provides guidance and information for policy and decision-making processes that aim to address the obstacles and maximize the benefits associated with human mobility. Through the effective use of visualization, we can shed light on the paths and histories of migration, give voice to the opinions and experiences of migrants, and help create more just inclusive, and sustainable societies in a global community that is becoming more interconnected by the day.

### 1.3. Project Schedule

#### **Week 2-4: Project Kickoff and Data Collection**

- Define project objectives and scope.
- Assign roles and responsibilities within the team.
- Identify and gather relevant data sources on global migration.
- Begin initial exploration and assessment of the collected data.

#### **Week 5-6: Data Cleaning and Processing**

- Conduct thorough data cleaning to address missing values, inconsistencies, and outliers.
- Standardize data formats and ensure data compatibility.
- Perform any necessary data transformations or aggregations to prepare the data for visualization.

#### **Week 7-8: Design and Prototyping**

- Brainstorm visualization ideas and design concepts.
- Develop initial prototypes of visualization layouts and elements.
- Gather feedback from team members and stakeholders to refine the design.

#### **Week 9-10: Implementation**

- Translate finalized design concepts into code using chosen visualization tools or libraries.
- Integrate cleaned and processed data into the visualization.
- Conduct iterative testing and debugging to ensure functionality and usability.

#### **Week 11: Refinement and Evaluation**

- Fine-tune visual elements, layouts, and interactions based on user feedback.

- Conduct thorough testing of the completed visualization across different devices and browsers.
- Evaluate the effectiveness and usability of visualization in conveying migration patterns and contexts.

### Week 11-12: Documentation and Presentation

- Compile comprehensive documentation of the project process, including data sources, cleaning and processing methods, design decisions, and implementation details.
- Prepare a final presentation summarizing key findings, insights, and implications of the visualization.
- Submit the completed project process book and present the visualization to the instructor and class.

## 2. Data

### 2.1. Data Source

The primary sources for raw data in this project are the World Bank ([worldbank.org](http://worldbank.org)) and the United Nations ([un.org](http://un.org)). These reputable organizations provide comprehensive datasets related to global migration, offering insights into migration trends, demographic characteristics, and socio-economic contexts across countries and regions worldwide.

- **The World Bank ([www.worldbank.org](http://www.worldbank.org)):**

- The World Bank offers a wealth of demographic and socio-economic data, including information on international migration patterns, immigrant populations, and migration-related variables such as country of birth, citizenship status, and migration flows. Data from the World Bank's Migration and Remittances dataset and other sources provide valuable insights into migration trends within countries and globally.
- **Data Set 1:** Life Expectancy data from the World Bank's World Development Indicators dataset.

1. **Data Type:** The data set includes the following variables:

- i. Country Name (Categorical)
- ii. Life Expectancy (Quantitative)

- **Data Set 2:** GDP per Capita data from the World Bank's World Development Indicators dataset.

1. **Data Type:** The data set includes the following variables:

- i. Country Name (Categorical)
- ii. GDP per Capita (Quantitative)
- **Data Set 3:** Population data from the World Bank's World Development Indicators dataset.
  1. **Data Type:** The data set includes the following variables:
    - i. Country Name (Categorical)
    - ii. Population (Quantitative)
  - **File Type:** Raw data obtained in .csv format.
- **United Nations ( [www.un.org](http://www.un.org) ):**
  - The United Nations is a leading source of data and research on global migration, providing comprehensive statistics and analyses on international migration trends, refugee movements, asylum seekers, internally displaced persons (IDPs), and other migration-related topics. Datasets from UN agencies such as the International Organization for Migration (IOM), the United Nations High Commissioner for Refugees (UNHCR), and the United Nations Department of Economic and Social Affairs (UN DESA) offer valuable insights into the scale, dynamics, and impacts of migration worldwide.
  - **Data Set:** Global Migration Statistics from the United Nations
  - **Data Type:** The data set includes the following variables:
    1. Country Name (Categorical)
    2. Number of Immigration People (Quantitative)
  - **File Type:** Raw data obtained in .xlsx format, converted to .csv format using [www.cloudconvert.com/xlsx-to-csv](http://www.cloudconvert.com/xlsx-to-csv) website.

These two main data sources serve as foundational pillars for this project, providing reliable and authoritative data that underpins the visualization of global migration patterns and contexts. Additional supplementary data sources may be explored to enrich the analysis and address specific research questions or objectives identified during the project's development.

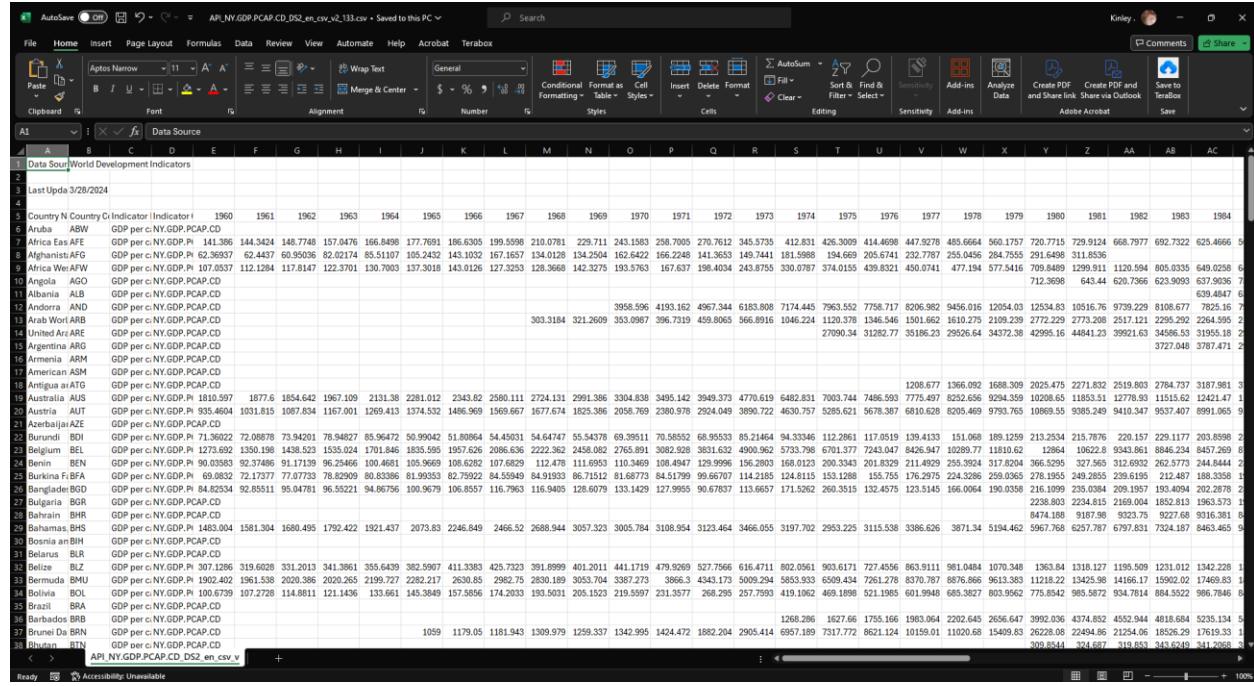
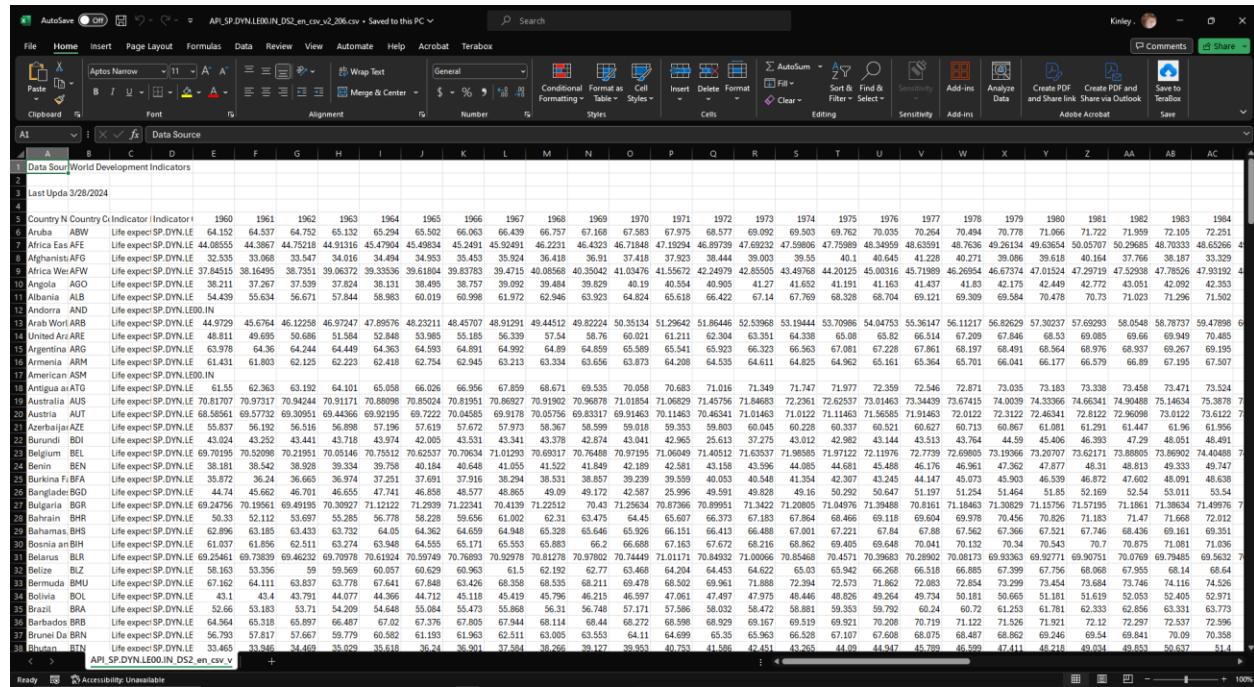
## 2.2. Data Processing

### Hand Processing:

Although the datasets obtained from the organizations guarantee high integrity and timeliness, data cleaning and reorganization are essential to achieve the desired level of "conformity" necessary for visualization in D3.js. The data processing procedure involves distinct steps for each of the retrieved datasets, as each one necessitates pruning, pivoting, and aggregating to a certain degree. Once the design selection is finalized, the dataset will be further filtered to align with the specifications of the data visualization design, marking the milestone of "conformity" and indicating that the data is prepared for visualization.

### World Bank( [www.worldbank.org](http://www.worldbank.org) ):

The original data is structured as a CSV (Comma-Separated Values) file, with the first dataset for **Life Expectancy** containing rows representing different countries or regions and columns representing attributes such as the name of the country, country code, indicator (in this case, life expectancy at birth), and numerical values indicating life expectancy for each year. The second dataset was for **GDP per capita (Current US\$)**, in which each row represents a country, and the columns include the country name, country code, indicator name (GDP per capita), indicator code, and GDP per capita values for different years. The years range from at least 1960 to 2022, with missing data represented by empty fields. The final dataset from the World Bank is for the **Total Population** data. Each row represents a country or region, with columns indicating the name of the country or region, the country code, the type of data (in this case, total population), and population values for different years. The years from 1960 to a more recent year, likely reflect the most up-to-date available data. The population values are in numeric format. Additionally, there are rows representing aggregates such as "World" and "Upper middle income.". The following three figures depict the three original datasets downloaded from the World Bank.



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3	Country	Country	Indicator	Indicator	Indicator	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984																																																																																																																																																																																																																																																																																
4	Aruba	ABW	Populatio	Pop. TPC	Pop. TPC	51068	55811	56682	57475	5878	58782	5921	5922	5942	5933	5910	58816	58855	59065	60028	60715	6133	61465	61738	62006	62267	62624	63116	63683	64174																																																																																																																																																																																																																																																																																
5	Africa Eas	AFR	Populatio	Pop. TPC	Pop. TPC	1,311,08	1,344,08	1,376,08	1,426,08	1,465,08	1,515,08	1,564,08	1,615,08	1,661,08	1,727,08	1,781,08	1,831,08	1,886,08	1,941,08	1,991,08	2,045,08	2,111,08	2,174,08	2,241,08	2,311,08	2,381,08	2,451,08	2,530,08	2,611,08	2,691,08																																																																																																																																																																																																																																																																																
6	Afghanistan	AFG	Populatio	Pop. TPC	Pop. TPC	862,246	879,040	896,040	917,545	93,551,4	95,651,47	97,314,7	101,103,20	102,207,48	104,844,9	107,297,1	110,158,7	112,673,5	115,703,0	116,987,9	121,736,8	124,236,2	129,092,2	129,693,2	149,265,1	151,155,9	159,028,9	195,144,0	192,246,6	196,119,0																																																																																																																																																																																																																																																																																
7	Africa We	AFW	Populatio	Pop. TPC	Pop. TPC	7,972,569	9,931,428	11,014,08	11,048,08	11,081,08	11,116,08	11,136,08	11,166,08	11,196,08	11,226,08	11,256,08	11,286,08	11,316,08	11,346,08	11,376,08	11,406,08	11,436,08	11,466,08	11,496,08	11,526,08	11,556,08	11,586,08	11,616,08	11,646,08	11,676,08	11,706,08																																																																																																																																																																																																																																																																															
8	Angola	AGO	Populatio	Pop. TPC	Pop. TPC	53,771,95	54,413,33	55,214,00	55,998,27	56,739,52	57,589,27	58,420,53	59,262,03	60,297,07	61,774,99	62,804,99	63,847,99	64,873,99	65,903,99	66,933,99	67,963,99	68,993,99	69,023,99	69,053,99	69,083,99	69,113,99	69,143,99	69,173,99	69,203,99	69,233,99	69,263,99	69,293,99	69,323,99																																																																																																																																																																																																																																																																													
9	Anguilla	ALB	Populatio	Pop. TPC	Pop. TPC	16,088,00	16,221,00	17,113	17,629	18,141,33	18,647,91	19,145,73	19,655,99	20,222,72	20,816,99	21,409,75	21,878,99	22,412,03	23,045,62	23,676,99	24,312,03	24,945,62	25,579,44	26,211,99	26,845,62	27,479,44	28,111,99	28,743,62	29,375,44	29,997,62	29,629,44	29,261,99	28,893,62	28,521,44																																																																																																																																																																																																																																																																												
10	Andorra	AND	Populatio	Pop. TPC	Pop. TPC	9443	10,216	11,189	12,693	13,564	14,546	15,745	17,077	18,449	19,860	21,232	22,282	23,493	24,399	25,394	26,374	27,640	29,294	31,414	32,574	34,165	35,886	37,506	39,402	41,218																																																																																																																																																																																																																																																																																
11	Arab Worl	ARB	Populatio	Pop. TPC	Pop. TPC	933,9407	957,6048	982,6686	1,014,08	1,048,08	1,086,08	1,126,08	1,168,08	1,198,08	1,227,08	1,264,08	1,284,08	1,314,08	1,347,08	1,376,08	1,407,08	1,437,08	1,467,08	1,507,08	1,547,08	1,587,08	1,626,08	1,668,08	1,718,08	1,768,08	1,818,08	1,868,08	1,918,08																																																																																																																																																																																																																																																																													
12	United Arz	ARE	Populatio	Pop. TPC	Pop. TPC	13,324	14,094	14,867	15,706	16,535	17,379	18,209	19,140	20,132	21,352	25,326	28,908	34,451	39,236	44,154	49,195	54,539	61,417	70,686	80,523	90,845	101,404	110,189	119,758	123,757	130,331																																																																																																																																																																																																																																																																															
13	Argentina	ARG	Populatio	Pop. TPC	Pop. TPC	203,4974	206,8063	210,2030	213,6017	217,0487	205,366	24,0311	27,757,08	28,020,43	28,422,03	28,812,03	29,202,03	29,592,03	29,982,03	27,671,08	27,912,03	28,151,03	28,391,03	28,631,03	28,871,03	29,111,03	29,351,03	29,591,03	29,831,03	29,971,03	29,713,03	29,281,03																																																																																																																																																																																																																																																																														
14	Armenia	ARM	Populatio	Pop. TPC	Pop. TPC	19,04148	19,715,30	20,393,04	21,064,2	21,720,42	22,340,4	22,954,9	23,559,7	24,164,61	24,763	25,347,7	25,992,53	26,480,4	27,068,52	27,676,46	28,207,99	28,863,11	29,509,22	30,220,11	30,921,21	31,621,32	32,321,42	33,021,52	33,721,62	34,421,72	35,121,82	35,821,92																																																																																																																																																																																																																																																																														
15	American	ASM	Populatio	Pop. TPC	Pop. TPC	20,686	20,626	21,272	21,949	22,656	23,336	24,122	24,848	25,608	26,356	27,075	27,953	28,606	28,529	29,573	30,198	31,324	32,388	34,059	35,367	36,735	38,165																																																																																																																																																																																																																																																																																			
16	Antigua	ATG	Populatio	Pop. TPC	Pop. TPC	53,524	56,708	57,778	58,654	59,632	60,615	61,517	62,437	63,451	64,769	64,649	64,646	64,216	64,235	64,688	65,507	65,231	65,974	66,740	67,509	68,278	69,047	69,814	70,583	71,352	72,121																																																																																																																																																																																																																																																																															
17	Australia	AUS	Populatio	Pop. TPC	Pop. TPC	54,043,48	54,076,48	54,109,48	54,142,48	54,175,48	54,208,48	54,241,48	54,274,48	54,307,48	54,340,48	54,373,48	54,406,48	54,439,48	54,472,48	54,505,48	54,538,48	54,571,48	54,604,48	54,637,48	54,669,48	54,701,48	54,733,48	54,765,48	54,797,48	54,829,48	54,861,48	54,893,48	54,925,48																																																																																																																																																																																																																																																																													
18	Austria	AUT	Populatio	Pop. TPC	Pop. TPC	70,473,59	70,925,99	71,456,04	71,981,43	72,513,99	73,045,04	73,576,04	74,108,04	74,641,04	75,173,04	75,705,04	76,237,04	76,769,04	77,301,04	77,833,04	78,365,04	78,897,04	79,429,04	79,961,04	80,503,04	81,035,04	81,567,04	82,109,04	82,641,04	83,173,04	83,705,04	84,237,04	84,769,04	85,301,04	85,833,04	86,365,04	86,897,04	87,430,04	87,961,04	88,493,04	89,025,04	89,557,04	90,089,04	90,621,04	91,253,04	91,885,04	92,517,04	93,149,04	93,781,04	94,411,04	95,043,04	95,675,04	96,307,04	96,939,04	97,571,04	98,203,04	98,835,04	99,467,04	99,100,04																																																																																																																																																																																																																																																			
19	Azerbaijan	AZE	Populatio	Pop. TPC	Pop. TPC	38,940,45	40,457,80	41,869,50	43,285,99	44,932,99	47,474,99	49,015,99	50,553,99	52,093,99	53,632,99	55,172,99	56,712,99	58,252,99	59,792,99	61,332,99	62,872,99	64,412,99	65,952,99	67,502,99	69,052,99	70,602,99	72,152,99	73,702,99	75,252,99	76,802,99	78,352,99	79,902,99	81,452,99	82,992,99	84,542,99	86,092,99	87,642,99	90,192,99	91,742,99	93,292,99	94,842,99	96,392,99	97,942,99	99,492,99	101,042,99	102,592,99	104,142,99	105,692,99	107,242,99	108,792,99	110,342,99	111,892,99	113,442,99	115,002,99	116,562,99	118,112,99	119,662,99	121,212,99	122,762,99	124,312,99	125,862,99	127,412,99	128,962,99	130,512,99	132,062,99	133,612,99	135,162,99	136,712,99	138,262,99	139,812,99	141,362,99	142,912,99	144,462,99	145,012,99	146,562,99	148,112,99	149,662,99	151,212,99	152,762,99	154,312,99	155,862,99	157,412,99	158,962,99	160,512,99	162,062,99	163,612,99	165,162,99	166,712,99	168,262,99	169,812,99	171,362,99	172,912,99	174,462,99	175,012,99	176,562,99	178,112,99	179,662,99	181,212,99	182,762,99	184,312,99	185,862,99	187,412,99	188,962,99	190,512,99	192,062,99	193,612,99	195,162,99	196,712,99	198,262,99	199,812,99	201,362,99	202,912,99	204,462,99	205,012,99	206,562,99	208,112,99	209,662,99	211,212,99	212,762,99	214,312,99	215,862,99	217,412,99	218,962,99	220,512,99	222,062,99	223,612,99	225,162,99	226,712,99	228,262,99	229,812,99	231,362,99	232,912,99	234,462,99	235,012,99	236,562,99	238,112,99	239,662,99	241,212,99	242,762,99	244,312,99	245,862,99	247,412,99	248,962,99	250,512,99	252,062,99	253,612,99	255,162,99	256,712,99	258,262,99	259,812,99	261,362,99	262,912,99	264,462,99	265,012,99	266,562,99	268,112,99	269,662,99	271,212,99	272,762,99	274,312,99	275,862,99	277,412,99	278,962,99	280,512,99	282,062,99	283,612,99	285,162,99	286,712,99	288,262,99	289,812,99	291,362,99	292,912,99	294,462,99	295,012,99	296,562,99	298,112,99	299,662,99	301,212,99	302,762,99	304,312,99	305,862,99	307,412,99	308,962,99	309,512,99	311,062,99	312,612,99	314,162,99	315,712,99	317,262,99	318,812,99	320,362,99	321,912,99	323,462,99	324,012,99	325,562,99	327,112,99	328,662,99	329,212,99	330,762,99	331,312,99	332,862,99	333,412,99	334,962,99	335,512,99	336,062,99	337,612,99	338,162,99	339,712,99	340,262,99	341,812,99	342,362,99	343,912,99	344,462,99	345,012,99	346,562,99	347,112,99	348,662,99	349,212,99	350,762,99	351,312,99	352,862,99	353,412,99	354,962,99	355,512,99	356,062,99	357,612,99	358,162,99	359,712,99	360,262,99	361,812,99	362,362,99	363,912,99	364,462,99	365,012,99	366,562,99	367,112,99	368,662,99	369,212,99	370,762,99	371,312,99	372,862,99	373,412,99	374,962,99	375,512,99	376,062,99	377,612,99	378,162,99	379,712,99	380,262,99	381,812,99	382,362,99	383,912,99	384,462,99	385,012,99	386,562,99	387,112,99	388,662,99	389,212,99	390,762,99	391,312,99	392,862,99	393,412,99	394,962,99	395,512,99	396,062,99	397,612,99	398,162,99	399,712,99	400,262,99	401,812,99	402,362,99	403,912,99	404,462,99	405,012,99	406,562,99	407,112,99	408,662,99	409,212,99	410,762,99	411,312,99	412,862,99	413,412,99	414,962,99	415,512,99	416,062,99	417,612,99	418,162,99	419,712,99	420,262,99	421,812,99	422,362,99	423,912,99	424,462,99	425,012,99	426,562,99	427,112,99	428,662,99	429,212,99	430,762,99	431,312,99	432,862,99	

**FIGURE 3: POPULATION, TOTAL FROM WORLDBANK.ORG**

The first step of cleaning is to remove unnecessary rows and columns that do not contain important information needed for the visualization. This process was done by hand since all three files only contain a single table, and by cleaning and renaming the file to *WB\_LifeExpect.csv*, *GDP.csv*, and *Population.csv* respectively, we can better handle the file here on out. Figures 3, 4, and 5 depict the aforementioned.

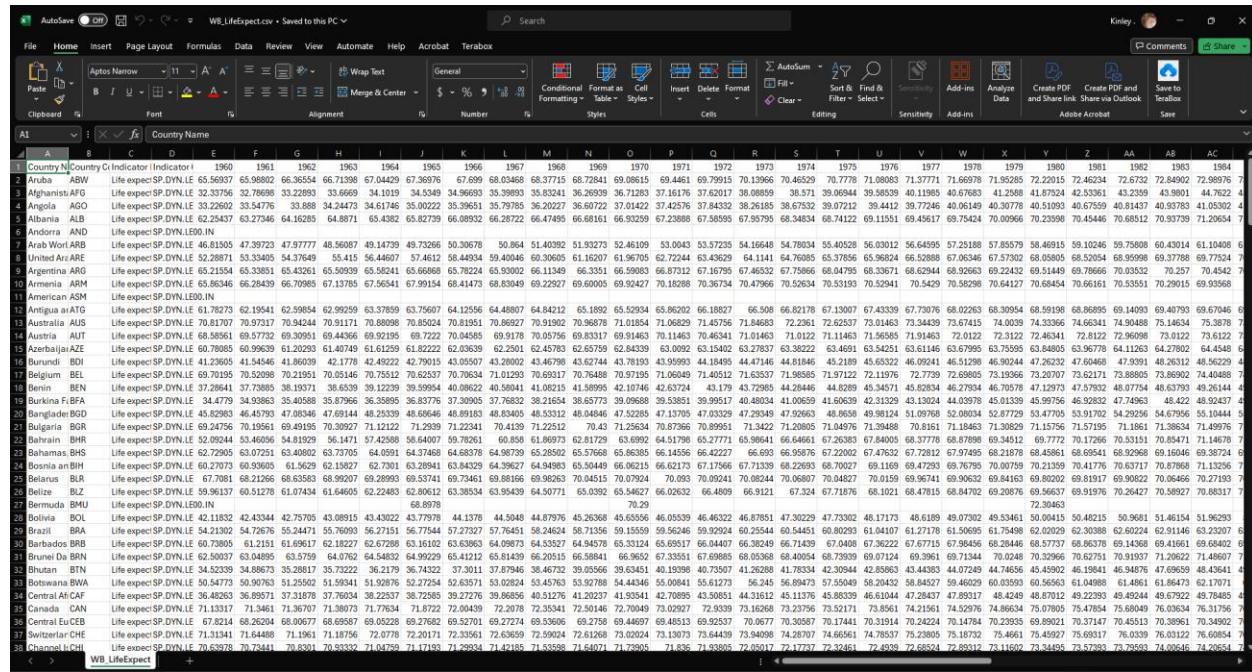


FIGURE 4: LIFE EXPECTANCY DATA AFTER CLEANING BY HAND

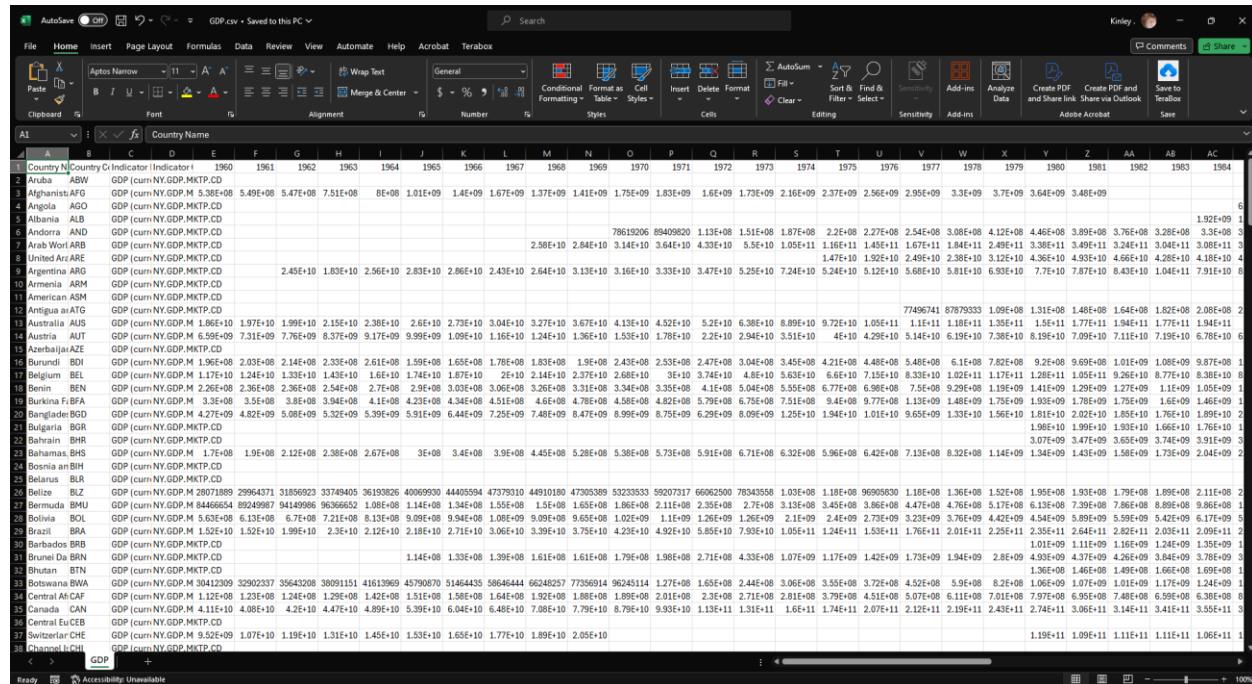
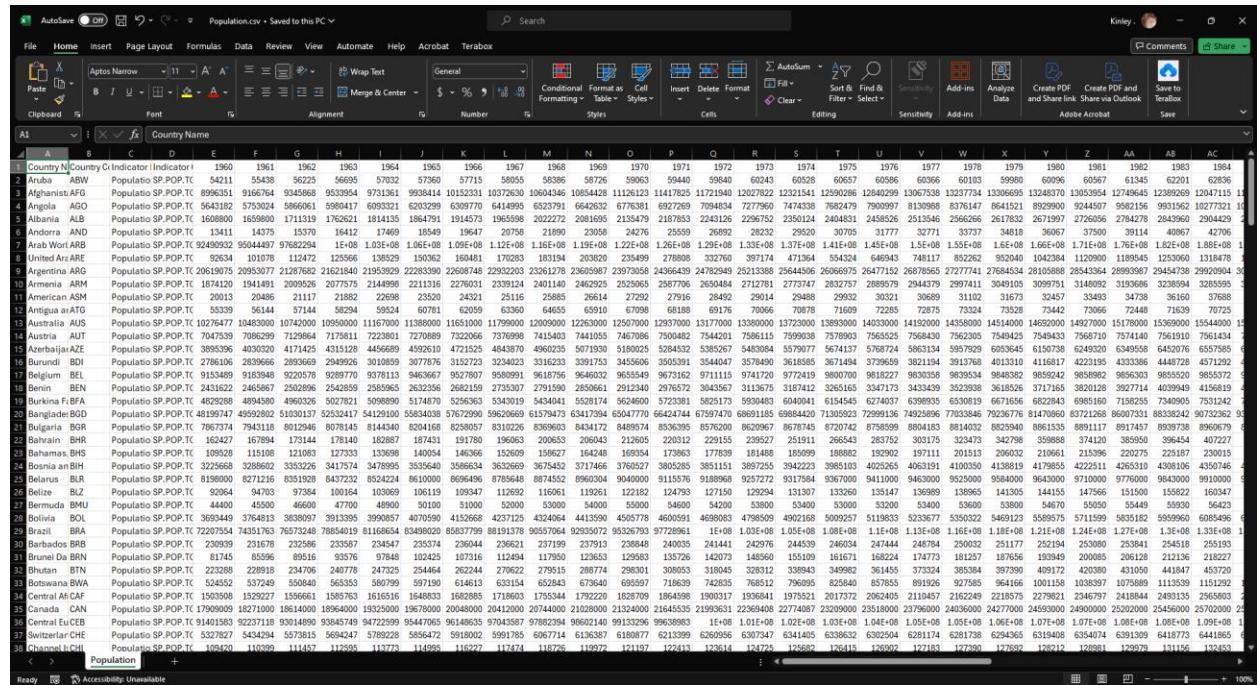


FIGURE 5: GDP PER CAPITA DATA AFTER CLEANING BY HAND



Country	Country Name	N	G	P	F	Y	M	O	Q	R	S	T	U	V	W	X	Y	Z															
Aruba	ABW	Population	SP	POP	TC	54211	55438	56025	56695	57032	57590	57715	58955	58395	58726	59083	59480	60245	60528														
Afghanistan	AFG	Population	SP	POP	TC	8996263	9166784	9345868	9533954	973161	9934414	1015231	1037260	1060449	1085428	1112612	11417940	1207222	1232154	1289208	12840299												
Angola	AGO	Population	SP	POP	TC	5643182	5753024	5866061	5980417	6093321	6203299	6307970	6414995	6523791	6640532	6776381	6944634	717860	7447438	7589097	8113088												
Albania	ALB	Population	SP	POP	TC	1608890	1713193	1814153	1914577	1945598	2016958	2135479	2187853	2243126	2296752	2350124	2404381	2458526	2513546	2566266	2617832												
Andorra	AND	Population	SP	POP	TC	13411	14375	15370	16412	17469	18549	19647	20750	21890	24276	25559	26892	28232	29820	30705	31777	33773											
Arab World	ARB	Population	SP	POP	TC	9249952	9544467	9768229	1005608	1126108	1161608	1196108	1221608	1256108	1281608	1317108	1352108	1387108	1422108	1457108	1492108	1527108											
United Arab Emirates	ARE	Population	SP	POP	TC	92625	101078	112472	125566	138256	150362	160481	170285	181514	203826	235499	278808	332760	397174	471364	534524	646943	748117	852262	952040	1042384	1120984	118954	125306	1318478			
Argentina	ARG	Population	SP	POP	TC	20619075	2095307	2128762	21621840	2195392	2228339	22608748	2293203	23261278	23605987	23973058	24366439	24782949	25213388	25644506	26066075	26477152	2687855	27277741	27684534	28105888	2854336	2893987	29454738	29920950			
Armenia	ARM	Population	SP	POP	TC	187412	1941481	211313	2276031	2393124	2401140	2462929	252065	2587607	2650484	2712781	2773747	2832757	288997	2944379	2974111	3049192	3099751	3140892	315366	323859	325855						
American Samoa	ASM	Population	SP	POP	TC	20013	20486	21117	2186	2198	23520	24231	25116	25885	26614	27292	27916	28492	29014	29488	29932	30321	30684	31102	31673	32457	33493	34738	36169	37688			
Antigua and Barbuda	ATG	Population	SP	POP	TC	53359	56144	57144	58295	59525	60781	62056	63360	64655	66045	67334	68618	69176	70566	70878	71698	72240	72868	73324	73828	7442	75086	76139	70725				
Australia	AUS	Population	SP	POP	TC	1022777	1046000	1060000	1080000	1100000	1120000	1140000	1160000	1180000	1200000	1220000	1240000	1260000	1280000	1300000	1320000	1340000	1360000	1380000	1400000	1420000	1440000	1460000	1480000	1500000			
Austria	AUT	Population	SP	POP	TC	784753	7923801	7971889	7982206	7993866	8010859	8077876	8124022	8162190	8211263	8261346	8310391	8354047	8374766	8417468	8456155	8495433	8533085	8571823	8615707	8653045	8693534	8734140	8774140	8814140	8854140	8894140	
Azerbaijan	AZE	Population	SP	POP	TC	3896396	4002020	4171425	4311126	4456699	4592610	4721525	484870	4962238	5071839	5180025	5284527	5385067	5480984	5579777	5647137	5767074	5863134	5957209	6023645	61507736	6249320	634958	6402765	6457129			
Burundi	BDI	Population	SP	POP	TC	286106	288366	288369	2894906	3010859	3077876	3124022	3162323	3210756	3456506	3503391	3544047	3578490	3617468	3717468	3769527	3805285	3851151	3897255	3921184	3931768	4013320	4116817	4221935	4233386	4448728		
Belgium	BEL	Population	SP	POP	TC	9153493	919398	9220578	9286770	9378113	9453667	9527807	9580991	9631676	9646032	9655549	9671562	9711155	9741720	9772149	9800700	9818227	983058	9853522	9855532								
Benin	BEN	Population	SP	POP	TC	2431622	2458295	2502896	2542895	2585965	2622356	2682159	2735307	2791590	2850661	2912340	2976572	3043567	313675	3187412	323956	3285226	3317165	3371240	3420212	3472210	3522711	4029949	4156189				
Burkina Faso	BFA	Population	SP	POP	TC	4960324	5027821	5098910	5174870	5256363	5343019	5434041	5528174	5624600	5723381	5825173	5939483	6040401	6134545	6274037	6359893	6530819	6671656	6822843	6985095	7182525	7340905	7515242					
Bangladesh	BGD	Population	SP	POP	TC	48199747	4952802	5053137	5255241	5412910	5583408	5767299	5962069	6157473	63417394	65047770	66242447	6797470	6869185	6988420	7105923	7203676	7417060	75372126	7610760	765205	7749425	7849433	7989710	8071440	8173262		
Bulgaria	BG	Population	SP	POP	TC	7867374	7943118	8012946	8071845	8144340	8204168	828057	8310226	8369603	8431172	8489574	8536395	8576200	8620697	8678745	8720742	8758999	8804183	8814032	88525940	8891117	8917457	8959738	8960679				
Bahrain	BHR	Population	SP	POP	TC	163427	167894	171344	178140	182887	187431	191780	196063	200653	206043	212695	220312	229155	236643	251891	262643	303175	323473	342798	359888	374120	385950	396454	4027227				
Bahamas	BHS	Population	SP	POP	TC	109528	115108	121083	127333	133698	140054	146366	153699	164287	164248	169354	177839	181488	185999	1911576	198968	201153	206032	210661	215396	220275	225187	230015					
Bosnia and Herzegovina	BH	Population	SP	POP	TC	322566	328660	3353226	341574	347899	3535643	3632669	3767452	3769527	3817468	3875625	3942223	3985103	4013891	4178955	4225211	4265310	4308106	4350746									
Belarus	BLR	Population	SP	POP	TC	819800	8271216	8351928	8477232	8610000	869496	8785648	8874224	8960304	9040000	9115576	9188968	9257722	931784	9411000	9463000	9525000	9584000	9710000	9776000	9843000	9910000						
Belize	BZ	Population	SP	POP	TC	22064	9103	9736	10403	10800	11200	11600	12000	12400	12800	13200	13600	14000	14400	14800	15200	15600	16000	16400	16800	17200	17600	18000	18400	18800	19200		
Bolivia	BOL	Population	SP	POP	TC	365349	3838997	3913395	3990857	4070590	4153569	4207129	430494	441359	4505776	4605991	4695202	4785599	4875599	4962057	5052057	514933	523877	535002	5469123	558959	5711599	5855102	5985960	6054596			
Brasil	BRA	Population	SP	POP	TC	7227554	7431763	7677248	7884019	8116864	8387799	8657064	9055704	9293072	9532670	9723691	101308	105018	108018	111018	114018	117018	121018	124018	127018	130018	133018	136018	139018	142018	145018		
Barbados	BRB	Population	SP	POP	TC	230937	231678	233587	235374	236044	237391	238848	240035	241441	242076	244459	246034	247444	248784	251177	252194	253841	254518	255193									
Brunei Darussalam	BRN	Population	SP	POP	TC	81745	85596	89516	93576	97848	10245	107316	112494	117590	125633	13726	142073	148560	151019	161671	168224	174773	181257	187656	193049	200085	206128	212136	218227				
Bhutan	BTN	Population	SP	POP	TC	22329	228198	2347078	242755	254466	262244	276622	279515	286774	298301	308053	318045	328312	339843	34982	361455	373324	385384	397384	409172	420399	431094	441847	455720				
Botswana	BWA	Population	SP	POP	TC	524552	537249	550849	567199	571790	581629	587597	597190	607190	616413	631514	652845	678640	695597	712839	728512	746595	752450	765245	778512	790695	804619	8101158	1038397	107588	113539	115129	
Central African Republic	CAF	Population	SP	POP	TC	150359	152927	155666	158765	161651	164883	168588	170544	172534	174534	176534	178534	1792208	182789	1864598	1900173	1975521	2017372	2062405	2110457	2162249	2218575	227981	2346797	2418844	2489313	2565880	
Canada	CAN	Population	SP	POP	TC	1790909	1827100	18614000	18964000	19325000	19678000	20048000	20421000	20744000	21028000	21324000	21645535	2193531	2236408	22774087	23090000	23518000	23796000	24036000	24277000	24590000	25020000	25456000	25702000				
Central European Union	CEB	Population	SP	POP	TC	91401583	9237118	93014890	9384769	9472359	9544763	97043587	9782394	98602140	99133296	99638983	10148	101618	10218	103018	103818	104018	104518	105018	105418	105818	106018	106418	106818	10708	108018	108618	109018
Switzerland	CHE	Population	SP	POP	TC	3327827	3454294	3573815	3686427	3789228	3856427	3918002	3991790	4067174	4136387	4208877	4231599	4265900	4314045	4361382	4421108	4481738	4621108	478139	493139	518773	534052	5441865	561873	5711599	5855102	5985960	
Chile	CHL	Population	SP	POP	TC	109420	110395	111273	111995	112227	112740	112786																					

**FIGURE 7: RAW DATA FILE DOWNLOADED FROM UN**

With the first step of making the dataset usable for our project, the file needs to be converted to a CSV format. By using a web-based application called “cloudconvert” ([www.cloudconvert.com/csv-to-xlsx](http://www.cloudconvert.com/csv-to-xlsx)), we were able to obtain the required file. Based on the above figure, the file contains multiple tables, each representing an aspect of immigrant and emigrant when being considered for comparison between countries. This was an obstacle for us when trying to process the data. Instead of processing the whole file, we decided to pick out the tables that held information that was crucial to the aim of the visualization. The table we have chosen is Table 1 ( International migrant stock at mid-year by sex and by major area, region, country, or area, 1990 – 2017). With the process of handling the dataset by hand, we have split the said table into different files, with each name containing the format “*Migrate\_XXXX.xlsx*” where “XXXX” corresponds to each respective year. The original Table 1 is as follows:

FIGURE 8: THE ORIGINAL TABLE 1 FROM THE UN DATASET

After the process of hand-cleaning data for table 1, we have the following files:

File	Last Modified	Size
GDP.csv	update	2 days ago
ISO_codes.csv	update	6 minutes ago
LatLong.csv	update	2 days ago
Migrate_1995.xlsx	update	2 days ago
Migrate_2000.xlsx	update	2 days ago
Migrate_2005.xlsx	update	2 days ago
Migrate_2010.xlsx	update	2 days ago
Migrate_2015.xlsx	update	2 days ago
Population.csv	update	2 days ago
WB_LifeExpect.csv	update	2 days ago

**FIGURE 9: SPLIT THE TABLE MENTIONED ABOVE INTO DIFFERENT FILES**

Each of these files has the same format, with the only difference between each one being the year they represent. For example, the following figure is a representation of the format, more specifically the file *“Migrate\_2000.csv”*.

The screenshot shows a Microsoft Excel spreadsheet titled 'Migrate\_2000.xlsx' in Protected View. The table has a header row with columns for 'Destination', 'Numeric', 'Data Type', and various migration statistics. The data includes counts for 'Total', 'Other North', 'Other South', 'Afghanistan', 'Albania', 'Algeria', 'American Samoa', 'Andorra', 'Angola', 'Anguilla', 'Antigua and Barbuda', 'Argentina', 'Armenia', 'Aruba', 'Australia', 'Austria', 'Azerbaijan', and many other countries. The table is very large, spanning multiple pages of data.

FIGURE 10: MIGRATE\_2000.CSV EXAMPLE

All the “Migrate\_XXXX.xlsx” was formatted the same for ease of use and cleaner data representation.

## Code Processing:

With each of the previously hand-processed data files, we put them into the same directory called “raw\_data” for ease of navigation and differentiation. All the previous files were not suitable for generating a visualization, so we had to come up with a Python-based program to help us process the data better and faster. The code can be explained as the following:

1. Data Processing: The program reads and processes various demographic and economic data from different sources, including data related to countries, population, life expectancy, GDP, and migration.
2. Statistical Calculations: The program calculates various statistics related to migration, such as positive and negative stock, net migration, and immigration fraction.
3. Data Output: After processing and analyzing the data, the program outputs the results into structured formats, including JSON and CSV files, which can be used for further analysis, visualization, or integration with other systems.

```

1 # Define constants
2 labels = ['Country Name', 'Country Code']
3 years = [1990, 1995, 2000, 2005, 2010, 2015]
4 used = labels + years
5 not_used = ['Destination', 'Numeric', 'Data Type', 'Total', 'Other North', 'Other South']
6
7 # Read the manually prepared data
8 countries = pd.read_csv('./raw_data/countrieslist.txt', delimiter=' ', index_col='Country Code', engine='python')
9 latlong = pd.read_csv('./raw_data/latlong.csv', index_col='Alpha 3', engine='python', usecols=['Alpha 3', 'lat', 'long'])
10 iso_codes = pd.read_csv('./raw_data/ISO_codes.csv', index_col='Country Code', engine='python')
11 pop = pd.read_csv('./raw_data/population.csv', index_col='Country Code', engine='python', usecols=used)
12 lifeexp = pd.read_csv('./raw_data/lifeexpect.csv', index_col='Country Code', engine='python', usecols=used)
13 gdp = pd.read_csv('./raw_data/gdp.csv', index_col='Country Code', engine='python', usecols=used)
14 migrate_data = pd.read_excel('./raw_data/migrate_1990.xlsx', header=0)
15
16 # Initialization variables to store read data and results
17 countries_dict = countries.to_dict()
18 countries_list = countries.index.tolist()
19 latlong_list = latlong.index.tolist()
20
21 shared_index = countries_list[0] & set(latlong_list)].index
22 shared_index = pop.index.intersection(shared_index)
23
24 pop = pop.reindex(shared_index)
25
26 immigrants = {}
27 emigrants = {}
28 maxs = {}
29
30 in_lines = {}
31 em_lines = {}
32
33 positive_stock = pd.DataFrame(0.0, index=pop.index, columns=years)
34 negative_stock = pd.DataFrame(0.0, index=pop.index, columns=years)
35 net_stock = pd.DataFrame(0.0, index=pop.index, columns=years)
36 total_stock = pd.DataFrame(0.0, index=pop.index, columns=years)
37 in_frac = pd.DataFrame(0.0, index=pop.index, columns=years)
38
39 # Reusable functions
40
41 # Scale values for easier reading
42 def scale(value, max_val):
43     return ((value * (0.2)) / max_val) + 0.2
44
45 # Calculate migration data for each defined year
46 def cat_migration(year):
47     migration = pd.read_excel('./raw_data/Migrate_{}_year.xlsx', header=0)
48
49     migration = migration.query('Numeric < 000 and Numeric > 999')
50     migration['Country Code'] = iso_codes.loc[migration['Numeric'], 'alpha-3'].values
51     migration.set_index('Country Code', inplace=True)
52     migration_shard_index = migration.index.intersection(pop[year].dropna().index)
53     migration = migration.reindex(migration_shard_index)
54     pop[year] = pop[year].reindex(migration_shard_index)
55
56     good_countries = set(migration['Destination'])
57
58     for code in migration.columns[G]:
59         if code not in good_countries:
60             migration.drop(code, axis=1, inplace=True)
61         else:
62             migration.rename(columns={code: migration.index[migration['Destination'] == code][0]}, inplace=True)
63
64     new_not_used = []
65     for not_used_col in not_used:
66         if not_used_col in migration:
67             new_not_used.append(not_used_col)
68
69     return migration.drop(new_not_used, axis=1)
70
71 # Calculate the origin and end of a migration
72 def mig_line(origin, destination, status, value, scaled_value):
73     d = dict()
74     d['origin'] = ('longitude': latlong.loc[origin]['lat'],
75                    'longitude': latlong.loc[origin]['long'])
76     d['destination'] = ('longitude': latlong.loc[destination]['lat'],
77                         'longitude': latlong.loc[destination]['long'])
78     d['value'] = value
79     d['scaled_value'] = scaled_value
80     if status == 'in':
81         d['id'] = origin
82         d['name'] = countries_dict['Country Name'][origin]
83         d['label'] = origin
84         d['id'] = destination
85         d['name'] = countries_dict['Country Name'][destination]
86         return d
87
88 # Process each row in the migration data file
89 def mig_row(row_name, row, status, max_val):
90     if status == 'in':
91         target = destination + migration
92         target += ('longitude': latlong.loc[destination]['lat'],
93                    'longitude': latlong.loc[destination]['long'])
94         target += ('longitude': latlong.loc[origin]['lat'],
95                    'longitude': latlong.loc[origin]['long'])
96     else:
97         target = origin + migration
98         target += ('longitude': latlong.loc[origin]['lat'],
99                    'longitude': latlong.loc[origin]['long'])
100
101     target['value'] = value
102     target['scaled_value'] = scaled_value
103
104     if target in migration:
105         migration.loc[target] = target
106     else:
107         migration = migration.append(target)
108
109     return migration
110
111 # Process the migration data
112 def mig_lines(migration, status, threshold, maximum):
113     assert status in ['in', 'em']
114     d = {}
115     if status == 'in':
116         for code, row in migration.iterrows():
117             if row['value'] > threshold:
118                 d[mig_line(code, row['name'], status, row['value'], scale(row['value'], max_val))] = row
119
120     return d
121
122 # Process data for each defined year
123 for year in years:
124     immigrants[year] = cat_migration(year)
125     immigrants[year] = immigrants[year].transpose()
126     emigrants[year] = immigrants[year].transpose()
127     in_lines[year] = mig_lines(immigrants[year], 'in', 1000, maxs[year])
128     em_lines[year] = mig_lines(emigrants[year], 'em', 1000, maxs[year])
129
130     positive_stock[year] = immigrants[year].fillna(0.0).sum(axis=0)
131     negative_stock[year] = emigrants[year].fillna(0.0).sum(axis=0)
132
133     total_stock[year] = positive_stock[year] + negative_stock[year]
134     net_stock[year] = positive_stock[year] - negative_stock[year]
135
136     in_frac[year] = net_stock[year] / total_stock[year]
137
138     lifeexp = lifeexp.reindex(lifeexp.index.intersection(shared_index))
139     lifeexp.drop('SNP', inplace=True)
140
141     pop = pop.reindex(pop.index.intersection(countries.index))
142     gdp = gdp.reindex(gdp.index.intersection(pop.index))
143
144     gdp_per_cap = gdp.copy()
145     for year in years:
146         gdp_per_cap['gdp_per_cap'][year] = gdp[year] / pop[year]
147
148     gdp_per_cap.rename(columns={'Country Name': 'name'}, inplace=True)
149
150     # Write to processed files for use in analysis
151     with open('./processed_data/immigrant.json', 'w') as out: json.dump(in_lines, out, indent=2)
152     with open('./processed_data/emigrant.json', 'w') as out: json.dump(em_lines, out, indent=2)
153     with open('./processed_data/countries.json', 'w') as out: json.dump(countries_dict['Country Name'], out, indent=2)
154     gdp_per_cap.to_csv('./processed_data/gdp_per_cap.csv', index_label='id')
155     lifeexp.to_csv('./processed_data/lifeTotal.csv', index_label='id')
156     total_stock.to_csv('./processed_data/NetTotalMigrants.csv', index_label='id')
157     in_frac.to_csv('./processed_data/NetTotalRatio.csv', index_label='id')
158
159

```

FIGURE 11: PYTHON-BASED PROGRAM FOR DATA CLEANING

## Additional files:

Apart from all the above dataset files, two more were considered to be crucial during the process of creating the visualizations: *ISO\_codes.csv* and *LatLong.csv*.

# 3. Requirements

## 3.1. Must-have Features:

### Interactive Visualization:

- a. Hover Effect:
  - Implemented the world map to display detailed data and explanations when hovering over specific countries or regions.
  - Added to the map to highlight migration pathways and showcase detailed data.
- b. Drill-Down:
  - Different description box tabs are shown when clicking on specific countries, providing a How-to-read section and a summary/background section. Additionally, a detailed data table is displayed.
- c. Selectors:
  - Implemented the world map, allowing users to select a country and view migration patterns to and from that country.

### Additional Information:

- Providing ample context is crucial for visualization understanding, so we provide additional labeling.

### Clear Data Labeling:

- Ensures users grasp the represented data.

### Color Contrast:

- Different colors represent distinct migration flows, aiding readers' visual clarity.

## 3.2. Optional Features:

### Tooltip Integration:

Tooltips offer instant context, eliminating the need to memorize information. While this functionality couldn't be implemented, an alternative has been provided to serve a similar purpose.

## 4. Visualization Design:

We structure our visualization design process into four stages, each applicable to both initial development and refinement. These stages are as follows:

### 1. Conceptualize:

- Brainstorming & Sketching: Generate rough ideas based on project goals and data. This includes sketching layouts, exploring visual elements (maps, charts, graphs), and storytelling approaches.
- Research & Inspiration: Analyze existing migration visualizations to learn from best practices.
- Target Audience: Consider user needs (policymakers, researchers, public) for effective communication.
- Technical Feasibility: Evaluate visualization techniques considering data complexity, performance, and resources.

### 2. Visualize:

- Refine Sketches: Polish initial sketches based on feedback, using design software or prototyping tools.
- Prototype Layouts: Develop layouts balancing visual appeal and functionality. Experiment with data element arrangement, scales, and annotations.
- Color Palette & Style: Explore color schemes, typography, and graphic styles for a cohesive and engaging presentation. Apply color theory for readability and meaning.

### 3. Materialize:

- Finalize Design: Make final decisions on styling, colors, and additional visual elements. Create a style guide for consistency.
- Iterate on Feedback: Refine based on usability testing and user research, ensuring accessibility for diverse users.
- Interactive Elements: Consider tooltips, filters, and animations to enhance engagement and exploration. Design intuitive navigation to guide users.

### 4. Implementation:

- Coding the Design: Translate final design concepts into code using appropriate libraries (d3.js).
- Data Integration: Integrate cleaned and processed data, ensuring accuracy and relevance. Use data-driven visual encoding techniques (size, color, position).
- Testing & Debugging: Conduct thorough testing to identify and resolve technical issues or compatibility concerns. Test across devices, screen sizes, and browsers.
- Iterative Changes: Propose changes based on usability testing to optimize engagement and comprehension. Document the implementation process for future updates and maintenance.

### 4.1. Conceptualize (Design Iteration) stage:

We want to offer a straightforward, interactive layout in the first early stages of the visualization design process that will work for the public, who is our target audience. We adopt distinct approaches to

various visualizations while working with classified sorted data, all the while maintaining consistency to guarantee a user-friendly experience.

Without thoroughly reviewing the data we have discovered, we created a rough sketch for the first visualization, Migration Pattern, to convey our ideas to the reader. We concentrated on "World Map" style visualizations and carefully considered our options because our goal is to visualize the flow of immigrants and emigrants from different countries to one another.

The figure below is our attempt to implement a "World Map" visualization, which in our opinion, was the go-to way to help users grasp the concept of Immigrant and Emigrant flows relative to countries all over the world.

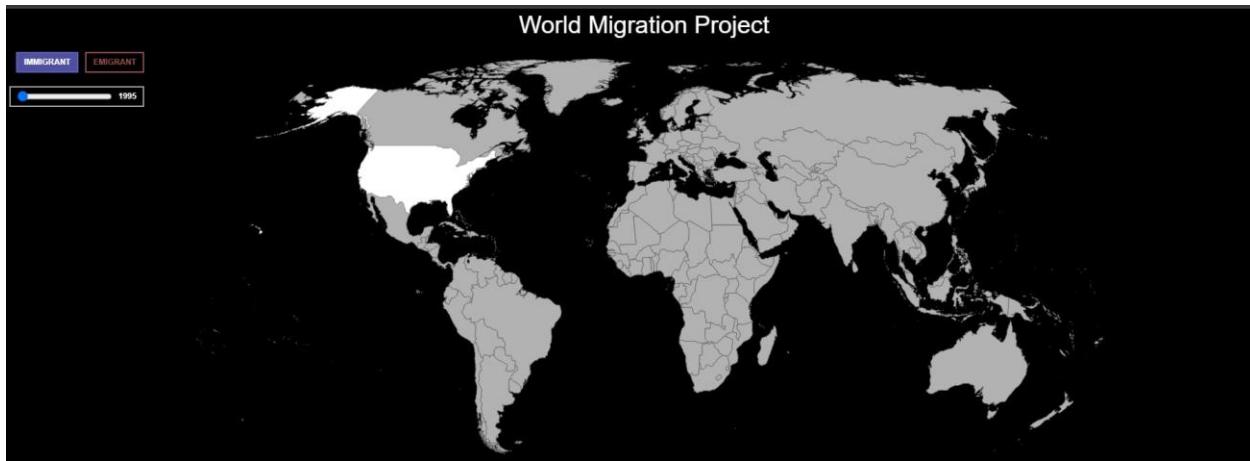


FIGURE 12: AN ATTEMPT AT THE WORLD MAP SKETCH

Throughout our research, we have found other visualization alternatives but mostly aren't suitable for the scope our project is going for. A bar chart is a great implementation of a visualization to describe the flow of immigrations and emigrations over time. Still, sadly that's only applicable for a single country for each country, since implementing for all countries over the world can make a bar chart seem inadequate when the user wants to compare between countries. Instead, we have chosen the Bar Chart as a supporting visualization for the main one, i.e. the World Map above. Another type of supporting visualization we decided to implement was a Pie Chart, for which the goal was to visualize the men and women percentage in immigrating or emigrating between countries.

## 4.2. Visualize Stage:

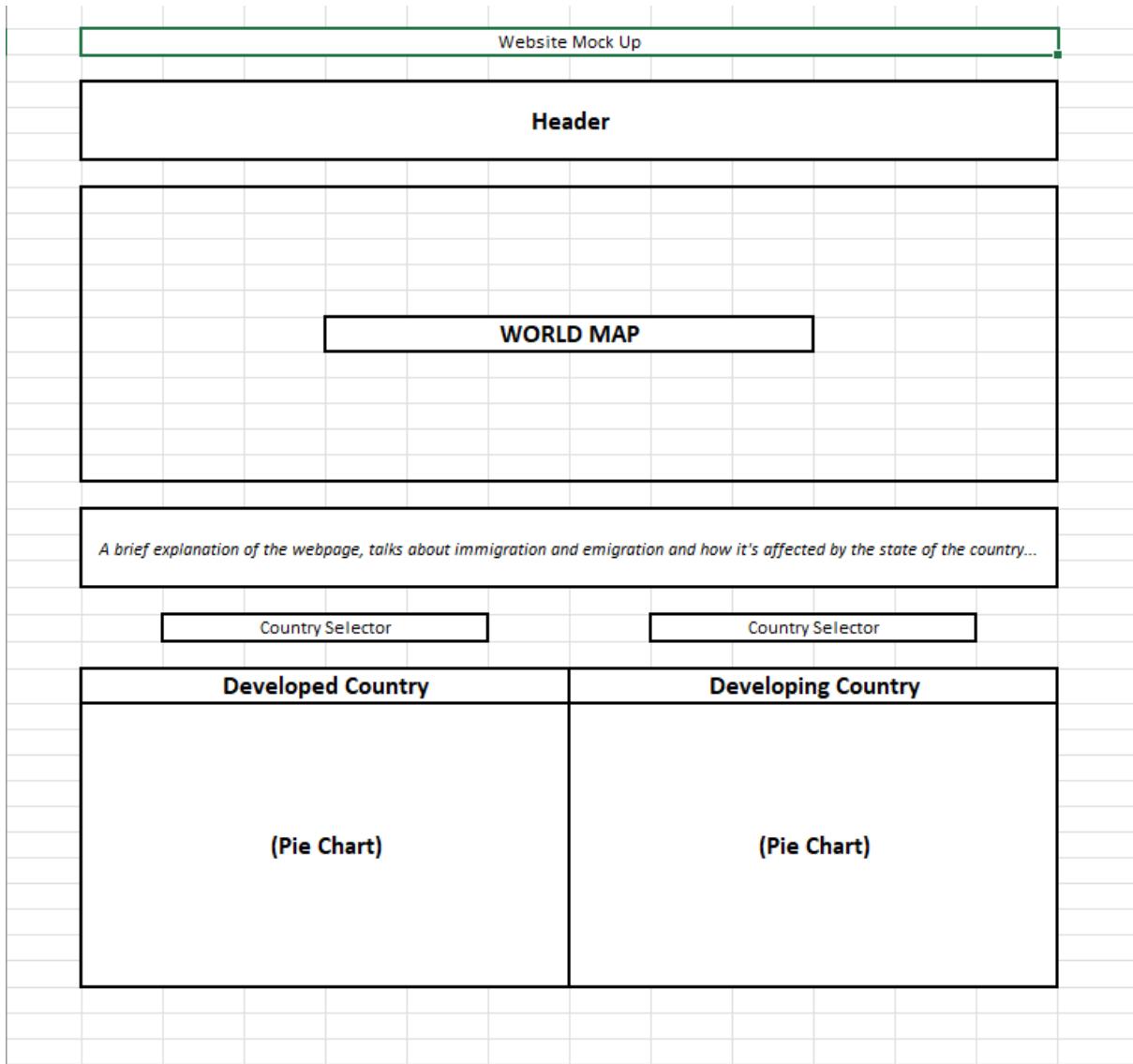
We now produce a set of higher fidelity designs after looking into our design decisions, which aids in contextualizing the idea behind these visualizations. We would like to see a justified, centered look at the Migration Pattern visualization, with different sections representing different rates of immigration and emigration.



**FIGURE 13: FIRST ITERATION OF THE WORLD MAP**

The figure depicts our first iteration of a World Map. The key feature is the clear delineation of countries by black borders. There's no indication of country labels or other details on this specific screenshot, and the scale isn't evident, making it difficult to gauge the relative size of different regions. However, this map serves as a simple yet informative way to visualize the Earth's landmasses divided into individual nations. There is no additional information about the World Migration Project on the screenshot. It is unclear what the purpose of the website is, or what kind of information it provides about migration.

With these ideas in mind, a mockup for the website was made by me in an Excel sheet to gather feedback from the lecturer, Dr Hoang Xuan Tung. We made suggestions on how to implement the GDP per Capita data into the visualization to help users better understand the correlation between the immigration/emigration rate and how the GDP of a country can affect those numbers. We have chosen a side-to-side Pie Chart depicted in the figure below, to help users compare developing and developed countries. It would contain the percentage of men and women when immigrating or emigrating, and the user can specify which country to visualize.



**FIGURE 14: MOCKUP DESIGN OF THE WEBSITE**

After receiving feedback from Dr. Hoang Xuan Tung, we have decided to implement a color system within the World Map to display the GDP per capita, making the two Pie charts below the main visualization redundant. This will be further elaborated in the next section of this report.

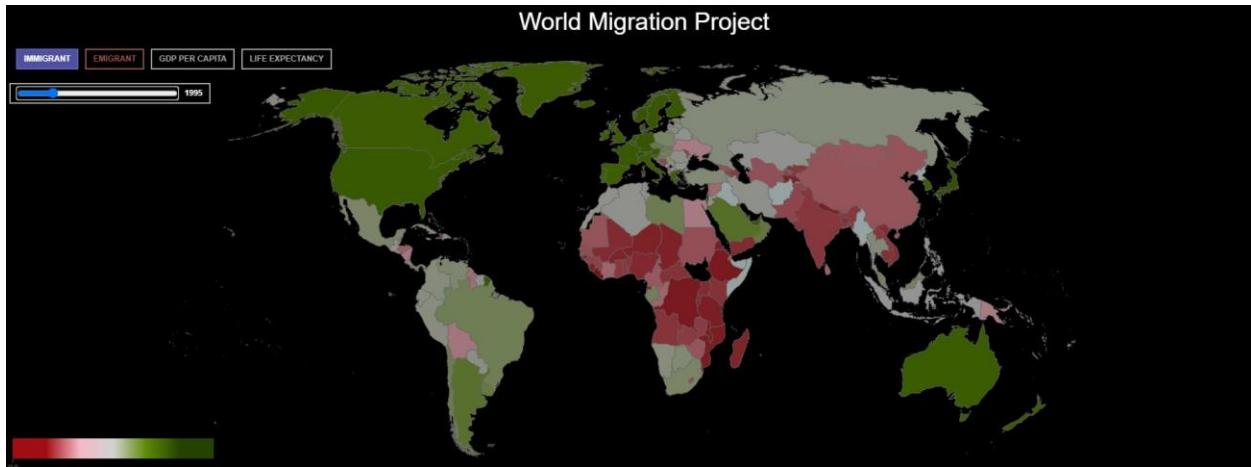


FIGURE 14: SECOND ITERATION OF THE WORLD MAP

With suggestions from Dr. Hoang Xuan Tung, the idea was to use a single World Map to display the flow of immigration and emigration using colored lines, flowing in or out of a selected country. Options are displayed at the top-left of the World Map to prompt the users between viewing the immigrant flow, which would be represented by a curved line flowing in from other countries, with the emigrant being represented in the same way. At this stage, we were still working on a simple way of showing the difference between the in-flow of immigrants and the out-flow of immigrants. A simple color scale between red and green was used to represent the differences in **GDP per capita**, and **Life expectancy**. However, there was a problem as our team felt the lack of supporting charts, as the website lacked basic information about the said World Map, so we were prompted to raise concerns during the next Stand-Up meeting.

#### 4.3. Materialize Stage:

Between the two Stand-Up meetings 2 and 3, our team was able to add additional user controls to help navigate the world map, while changing the color scale to better represent the changes in the data (i.e. GDP per capita and Life expectancy). The result was the following figure.

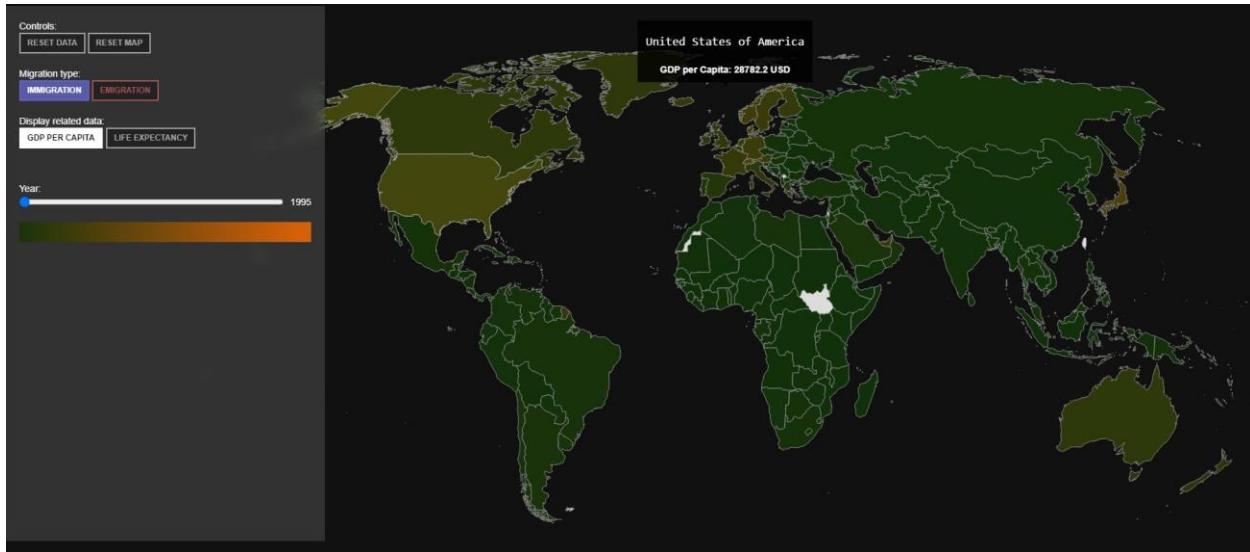


FIGURE 15: THIRD ITERATION OF THE WORLD MAP

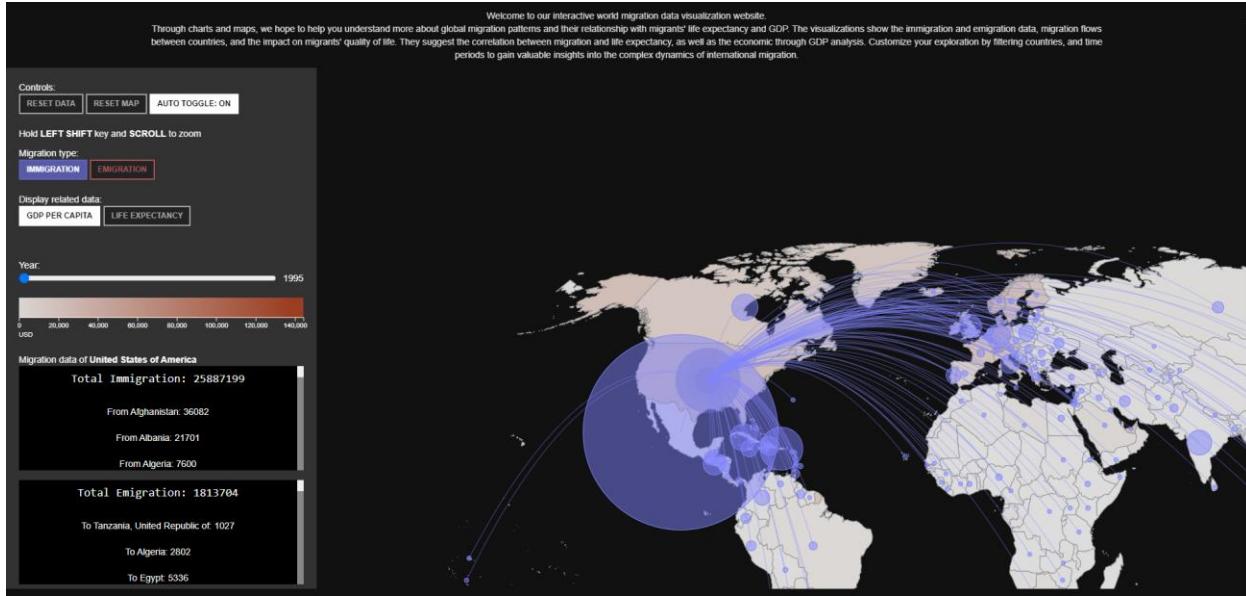
With Stand-Up Meeting 3 coming to an end, we decided to add another supporting visualization, a simple line graph that shows the net immigrant/emigrant rate of a country. With the idea of helping the users grasp the concept of immigrant and emigrant better, we feel that the said supporting visualization would provide ample support, displaying numbers that help users to conceive the flow of immigrants and emigrants better from the World Map alone.

#### 4.4. Implementation Stage:



FIGURE 16: FOURTH ITERATION OF THE WORLD MAP

The final design for our Stand-Up Meeting 4 is displayed above, with almost every feature we aim to create, the map contains everything needed for a user to navigate and use the World Map effectively. The newly implemented user interface showcases a Migration Data showcase of selected countries, which would display every country immigrating or emigrating relative to the selected country.



**FIGURE 17: EXAMPLE OF THE NEW USER INTERFACE ( U.S.A. IN 1995 )**

With the previously mentioned supporting visualization, we have found a way to implement it. By selecting a country on the World Map, a second visualization will appear beneath the World Map. This visualization aims to help users understand more about the numbers of immigrants compared to emigrants of a country.

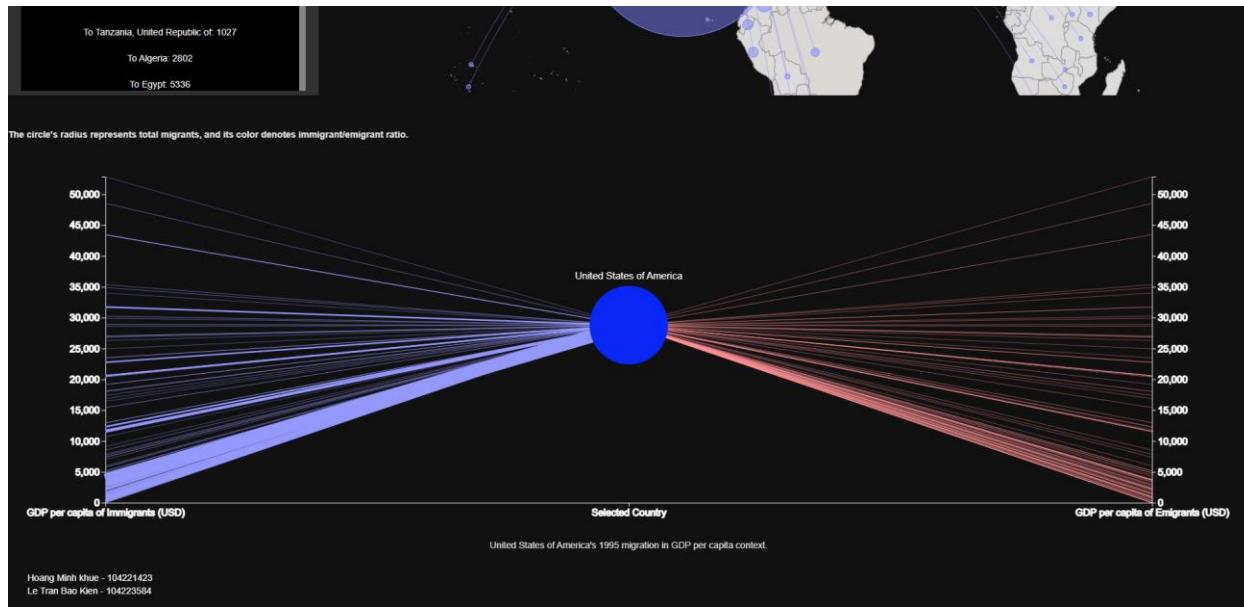


FIGURE 18: EXAMPLE OF THE SUPPORTING VISUALIZATION ( U.S.A. IN 1995)

With the final product completed, we felt the need to help users find countries easier, since for some, locating countries through geographical is not an easy task, so we opted to implement a search bar function, to help users find specific countries.



FIGURE 19: IMPLEMENTATION OF THE SEARCH FUNCTION, FINAL ITERATION OF THE WORLD MAP

## 5. Final Design

The final version of our data visualization set is shown below; you can also view it by clicking the provided Mercury link ([mercury.swin.edu.au/cos30045/s104221423/WorldMigrationProject/](http://mercury.swin.edu.au/cos30045/s104221423/WorldMigrationProject/)).

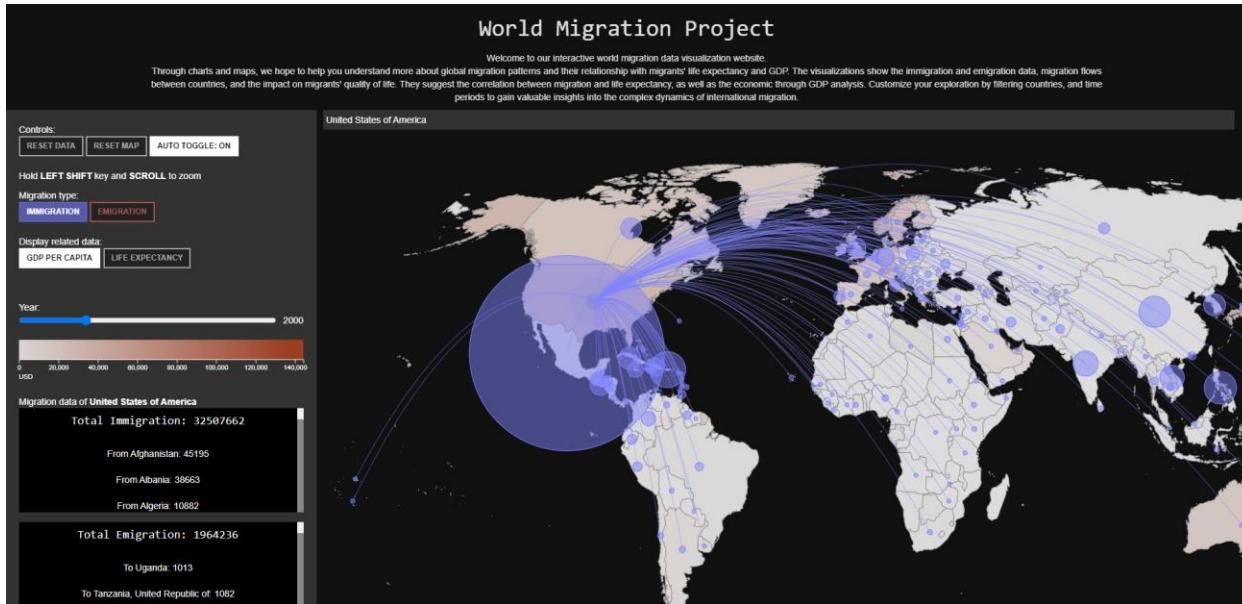


FIGURE 20: FINAL DESIGN OF THE WEBSITE 1

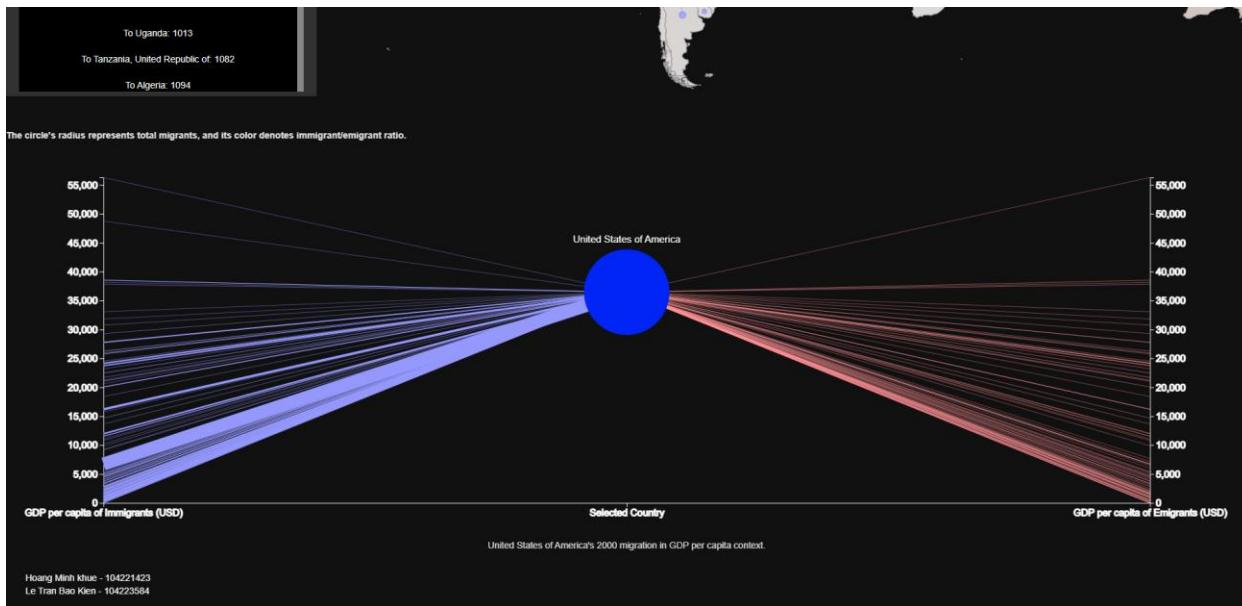


FIGURE 21: FINAL DESIGN OF THE WEBSITE 2

## 6. Conclusion

In today's globalized world, migration—especially cross-country migration—has become extremely common. There are pull and push factors at play in this trend. We extracted, processed, analyzed, and visualized the global migration to highlight the aforementioned phenomena. We selected two distinct kinds of diagrams. A world map is utilized to illustrate and contrast the migration flow, GDP per capita, and life expectancy; a line chart is employed to illustrate the variations in the migration numbers. The JavaScript D3.js library was used to plot the data. The essential features for both visualizations are interactive visualization, extra background information, a distinct data label, and contrasting colors for the various data points. Lastly, usability testing was done to make sure the visualization is easy to use, effectively conveys information, and meets the needs of the intended audience.

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