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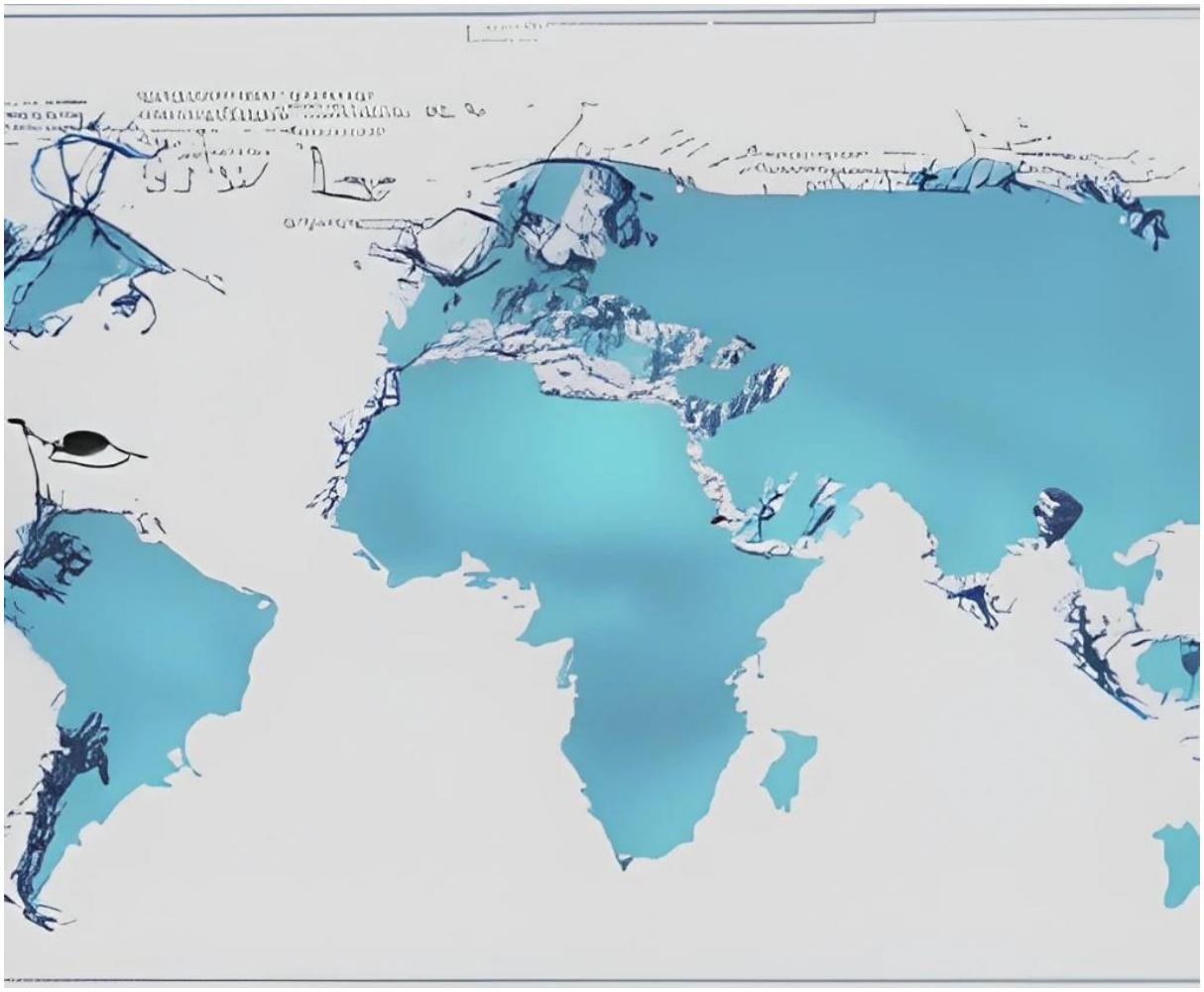

PROJECT PROCESS BOOKLET

LAW & ORDER THROUGH THE EYES OF MIGRATION

https://github.com/RubieStannard/Data-Visualisation-Project.git

COS30045 - DATA VISUALISATION

4 JUNE, 2023

Table of Contents

1. Introduction

1.1. Background and Motivation

The presented visualization displays data through the use of charts to convey the connection between law and order and migration over the past five years. Additionally, the visualization explains how situations may cause individuals to become displaced from their country of residence. Furthermore, the visualization provides insight for interested users into how many illegal and legal migrants enter certain countries.

Users who would be interested in our visualization could include individuals with direct authority over immigration policies, such as border patrol officers, immigration officers, and international lawmakers, who can utilize the data displayed in our visualization to form decisions about possible updates or creation of laws and regulations. Additionally, interested individuals may include human rights activists, who could use the data as evidence to help aid their advocacy efforts. Furthermore, members of the United Nations may be interested in utilizing the visualization for reporting migration statistics. However, the visualization is designed to align with the marking rubric, meaning the most interested user would be the Data Visualisation tutor Shalmoly Mondal. Shalmoly would be interested in viewing the visualization to evaluate how the data is interpreted and displayed.

A more detailed examination of the applications that interested users may undertake with this visualization that displays data related to migration and immigration over the past five years includes understanding the background of refugees around the world, providing a link between major issues an individual may face in their country of origin and their decision to leave their home, and determining the number of legal and illegal immigrants that make up a country's population.

The goal of this project is to identify the different aspects of law and order in relation to immigration and migration and the key aspects of this relationship which we'll accomplish by creating a visualization that displays the diversity of reasons immigrants and/or migrants seek refuge in other countries, and the proportion of legal and illegal immigrants in multiple countries. Our visualization will let users examine the reasons immigrants and/or migrants seek refuge in other countries through the use of multiple radar charts and understand the proportion of legal and illegal immigrants in multiple countries by looking at a choropleth map, with both charts providing users with a more detailed view of the data when hovering over the data points.

1.2. Project Objectives

The benefit of completing this visualization is that it becomes a resource for understanding the trend migration and immigration has had over the past five years. This visualization could help the users mentioned above answer the following questions:

1. What reasons cause people to migrate to other countries?
2. Due to conflict and violence, natural disasters, and human trafficking, what country experiences the most migrants?
3. How many legal and illegal immigrants entered specified countries in the last five years?

Anyone looking for what factors lead to the most displacement in countries and anyone interested in seeing the number of legal and illegal immigrants in multiple countries will be able to easily access and interpret data provided via the multiple radar charts and the choropleth map. Therefore, the visualization itself presents an easy interpretation of this for users to view and understand the data.

1.3. Project Schedule

WEEK 1	• Create the code of conduct • Write the schedule • Discuss the topic and project scope • Start researching
WEEK 2	• Start the project process booklet title and table of contents • Complete the project process booklet title
WEEK 3	• Finalise the project topic and questions to link to the topic • Start selecting and aggregating the data into tables
WEEK 4	• Project stand up 1 • Start the project process booklet requirements • Select graph types to display data
WEEK 5	• Start the first iteration of the low fidelity wireframe graphs
WEEK 6	• Start the project process booklet visualisation design • Complete the first iteration of the low fidelity wireframe graphs • Start the second iteration of the low fidelity wireframe graphs
WEEK 7	• Complete project process booklet requirements • Start the project process booklet data • Start a wireframe website design
WEEK 8	• Start coding the website • Start the project process booklet introduction
WEEK 9	• Get GitHub ready
WEEK 10	• Project stand up 2 • Project consultation • Finish selecting and aggregating the data into tables • Complete the project process booklet table of contents • Complete the project process booklet introduction
WEEK 11	• Project stand up 3 • Project consultation • Complete the project process booklet references
WEEK 12	• Project stand up 4 • Project presentation • Start and complete the project process booklet conclusion • Complete the project process booklet data • Complete the project process booklet visualisation design • Start and complete the project process booklet appendix • Submit the project process booklet • Submit the peer assessment • Complete the website
WEEK 13	• Submit the individual project and group reflection

2. Data

The data used in this visualization was collected from multiple sources, with links provided on page 24, the 'References' page. We manually collected the data by looking through websites, articles, and reports to find data related to the topic we were researching. After gathering the data, it was manually organized into an Excel spreadsheet. All of the data in our datasets will be included in the visualization since we only collected the data needed to answer the questions identified in the 1.2 Visualization Purpose part of the booklet.

2.1. Choropleth Map

2.1.1. Data Source

The data used for the choropleth maps have been sourced from multiple sources. These maps will contain data about the number of illegal and legal immigrants to the researched countries over the last five years. The datasets are table types where each table row represents an item of data, and each table column is an attribute of the dataset. The dataset attributes and types include:

Attribute	Description	Type
Country name	This attribute contains the name of each country for the immigration data.	Categorical data
Country code	This attribute indicates each country by using a unique 3 letter identifier.	Categorical data
Total	This attribute contains the number of immigrants for each country.	Discrete quantitative data
Longitude (in the GeoJSON code)	This attribute measures the different countries' x-coordinates between -180 and +180.	Continuous quantitative data
Latitude (in the GeoJSON code)	This attribute measures the counties' y-coordinates between -90 and +90.	Continuous quantitative data

The total attribute is only found in my CSV dataset, whereas the longitude and latitude attributes are only in the GeoJSON dataset. The country name and country code are attributes that are in both datasets.

2.1.2. Data Processing

For the data I collected for the choropleth maps, I expect minor clean-up. By manually collecting the data I found necessary, even though the data collection took longer, I reduced the amount of data clean-up and the time spent cleaning up the dataset.

The quantities I plan to obtain from my data are numeric values that represent the total number of immigrants entering the corresponding countries over the last five years. I will not be deriving any variable data from my dataset. The data processing will be manually implemented by validating that the data is correct, aggregating the data from each year into a combined total, and sorting the data into the final spreadsheet.

My clean-up process started with removing the relevant data from my Word table. This included countries that had no data, or only had data for two or less years. After this, I copied the data into Excel and started to replace some values. Countries that had a '-' for years that had no data were replaced with '0' so the AutoSum function would work. Once the symbols was replaced, and the AutoSum function calculated the total for each country,

The information required to create a working CSV included the country codes, so I made a new spreadsheet and copied the list of countries and their codes from Excel E-Maps. I manually copied the country total from my first sheet to the corresponding country on the new sheet. When this was finished, I changed the order of the column from country code, country name and total to have the country name first, code second, and total in the third column. I went through the spreadsheet one last time to delete the countries that had no data. In the end, the spreadsheet only had complete data.

2.1.3. Data Transformation

The choropleth map datasets will only need to be slightly transformed for the visualization to display the data correctly. The transformation process will involve the Excel AutoSum function. The Excel spreadsheets will need to have fields containing the correct information, such as the country name, code, and the total value gathered from using the AutoSum function. Below are the steps taken to transform the data into a CSV file.

1. Using Word to create a table for the data collection.

Country	2018	2019	2020	2021	2022	Total
Albania	14162	13507	-	9195	-	36864
Australia	237200	239600	165999	179000	303700	1125499
Austria	35404	82000	63000	20314	31338	232056
Azerbaijan	1583	2042	392	1084	1313	6414
Belarus	9360	13870	13589	12961	24009	73789
Belgium	109000	113000	92000	52356	56954	423310
Benin	3365	3357	3344	3325	-	13391
Botswana	3819	2933	1816	-	4504	13072
Brazil	67934	69186	56880	20376	4314	218690
Bulgaria	29559	37929	37364	39641	-	144493
Canada	303325	341000	284157	226309	492984	1647775
Chile	237358	230162	98439	113709	44719	724387
Costa Rica	4198	4154	2084	-	4356	14792
Croatia	26092	37726	33414	35912	16415	149559
Cyprus	23442	26170	25861	24001	7585	107059
Czechia	58148	65571	55661	69201	57126	305707
Denmark	64669	61384	57230	63489	20117	266889
Estonia	17547	18259	16209	19524	42022	113561

Figure 1: Data collection table.

I used Word to create a table that had a column for every country and the years 2018 to 2022 for my initial data collection. As I did research and found data, I was putting it into the corresponding table cell. After I collected all the data I could, I deleted countries that had no data and two years or less worth of data.

2. Copying the Word table into Excel.

	A	B	C	D	E	F	G
1	Country	2018	2019	2020	2021	2022	Total
2	Albania	14162	13507	0	9195	0	
3	Australia	237200	239600	165999	179000	303700	
4	Austria	35404	82000	63000	20314	31338	
5	Azerbaijan	1583	2042	392	1084	1313	
6	Belarus	9360	13870	13589	12961	24009	
7	Belgium	109000	113000	92000	52356	56954	
8	Benin	3365	3357	3344	3325	0	
9	Botswana	3819	2933	1816	0	4504	
10	Brazil	67934	69186	56880	20376	4314	
11	Bulgaria	29559	37929	37364	39641	0	
12	Canada	303325	341000	284157	226309	492984	
13	Chile	237358	230162	98439	113709	44719	
14	Costa Rica	4198	4154	2084	0	4356	
15	Croatia	26092	37726	33414	35912	16415	
16	Cyprus	23442	26170	25861	24001	7585	

Figure 2: Organised Excel spreadsheet.

Once I had the necessary data, I copied the Word table into Excel and replaced the cells that had '-' with the value 0 so the AutoSum function would work.

3. Using AutoSum to add each year into a total value.

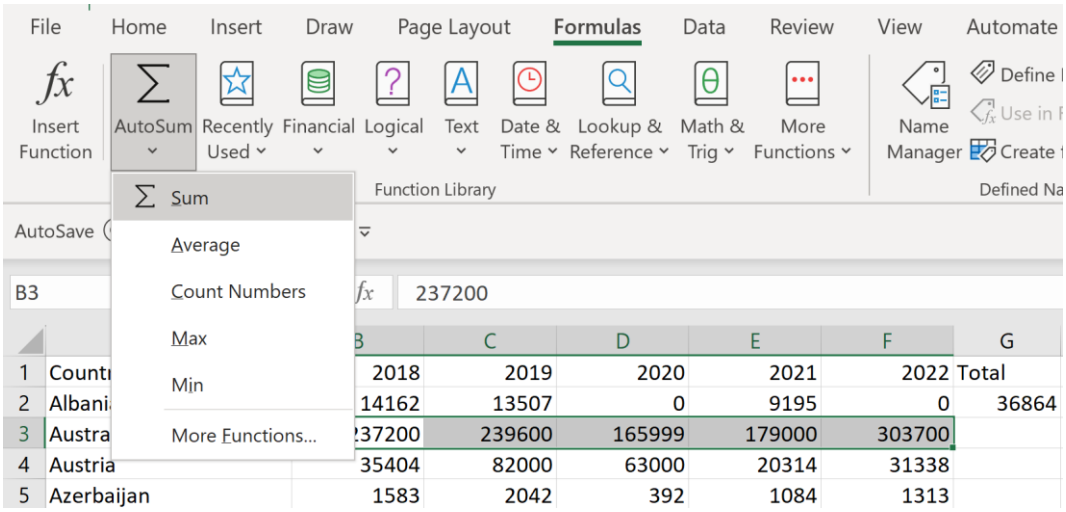

Figure 3: Using AutoSum to add each year's value.

After the data was organized, I used Excel's AutoSum function to sum the data for each year into the total number. I did this by highlighting a row, going to the FORMULAS tab, selecting AUTOSUM, then selecting SUM, which would place the number of the added values into the TOTAL column.

4. Creating a spreadsheet for the CSV.

	A	B	C
1	country	code	total
2			
3			

Figure 4: Creating a CSV spreadsheet.

I created a new spreadsheet that would contain the data for the CSV. To start, I created a column for each piece of information I needed, such as the country name, country code, and total.

5. Filling out the CSV spreadsheet.

	A	B	C
1	country	code	total
2	Albania	ALB	36864
3	Australia	AUS	1125499
4	Austria	AUT	232056
5	Azerbaijan	AZE	6414
6	Belgium	BEL	423310
7	Benin	BEN	13391
8	Bulgaria	BGR	144493
9	Belarus	BLR	73789
10	Brazil	BRA	218690

Figure 5: Filling out the CSV spreadsheet fields.

Each column in the CSV spreadsheet was manually filled out with the required data. The COUNTRY column had the names of each of the countries that I found data for. The TOTAL column is where the AutoSummed values went, and the CODE column contained each country's three letter Alpha-3 code.

6. Exporting the final manipulated Excel spreadsheet into a CSV file.

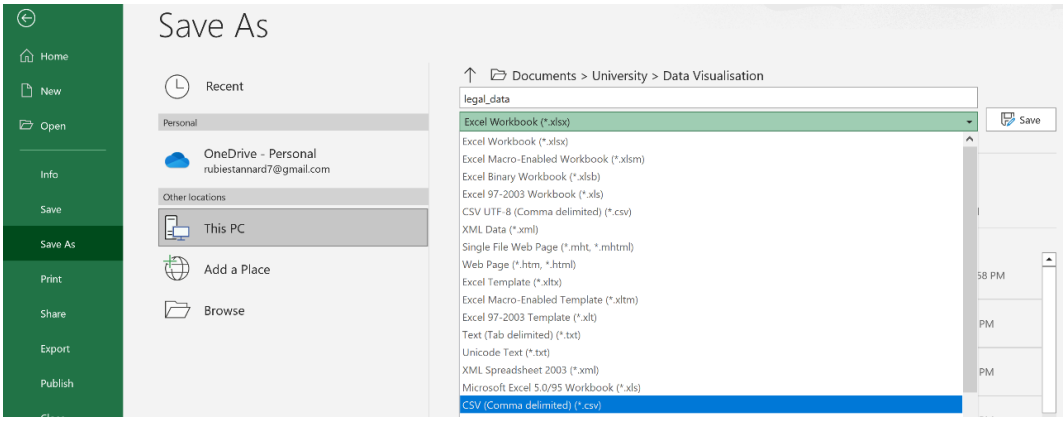

Figure 6: Exporting the Excel spreadsheet as a CSV.

To export the Excel spreadsheet as a CSV file, I went to the FILE tab, then I went to SAVE AS, and went to the dropdown menu to select CSV. This transformation process was done twice, once for the legal data, and another for the illegal data.

7. Downloading a GeoJSON for the country information.

Figure 7: GeoJSON code download.

In order to create the choropleth, the interactive tooltip for the map, and have the data I collected displayed in the tooltip, I downloaded a GeoJSON that had every country needed, the country codes and the longitude and latitude. I downloaded the Country Polygons as GeoJSON from DataHub.

2.2. Radar Chart

2.2.1. Data Source

The data used for the radar charts has been manually sourced from multiple sources, including online articles and databases. All of the raw data that was collected from multiple sources have standard variables, attributes, dataset types and data types. This can be aggregated into a final dataset of three tables separated by a country that has valid data points for the reasons of human trafficking, natural disasters and conflict and violence. Ultimately, there are three dataset tables that represent the reasons of displacement, which can be broken down into the following instances:

Attribute	Description	Type
Year	This attribute represents the years, 2018 to 2021, data has been collected for, separated into 4 columns.	Interval quantitative data
Country name	This attribute represents the name of the country of displacement.	Nominal categorical data
Conflict and violence	This item is made up of 4 values and gives a discrete entity of the number of people displaced from a country for this reason.	Text
Natural disaster	This item is made up of 4 values and gives a discrete entity of the number of people displaced from a country for this reason.	Text

Human trafficking	This item is made up of 4 values and gives a discrete entity of the number of people displaced from a country for this reason.	Text

This data will later be processed and transformed into CSV files that will be imported into the radar chart code.

2.2.2. Data Processing

In the radar chart dataset, there will be substantial data collecting, clean-up, processing, transforming, aggregating, and formatting, mainly due to data availability. The purpose of the radar chart is meant to cover the five-year range, hence causing country data to not have any data for a particular reason or a particular year.

After collecting the data, it had to be reduced, which is demonstrated by the initial 12 countries worth of data being reduced to 6 countries, and 5 years being changed to 4 after removing 2022, due to data not being available. This causes the radar chart data to choose the conflict and violence, natural disasters, and human trafficking for the reasons of displacement for the year range of 2018 to 2021.

Before the data was ready to be finalized, it had to be transformed and aggregated. Data was aggregated by reorganizing the tables into smaller tables for each country. These tables had a column for each reason, and a row for each year with the number for that year matching the reason. The data from the data sources were whole numbers, with values ranging from thousands to millions, which when plotted on a graph using Excel, gave a very skewed and compressed view of it. To be able to properly transform the data into the radar charts, normalization calculations had to be used to change the appearance of the data so it could appear more scaled.

During the process stage, existing variables were categorized, with no new variables being derived. The final datasets were arranged differently to the data sources, with the attributes and variables being reorganized and formatted into different columns and rows.

2.2.3. Data Transformation

As stated above, there are multiple transformations that occurred since the manual collection and arrangement of the initial raw data, to the final transformation through normalizing and scaling to be more easily encoded into a radar chart.

1. Collecting raw data and putting it into tables.

Natural disaster: Displaced people

Country	2022	2021	2020	2019	2018
Afghanistan	150000	29000	109000	306000	79000
Pakistan	7900000	70000	829000	100000	2100
Ukraine	–	2000	2000	–	–
South Sudan	–	506000	443000	294000	6600
DR Congo	209000	888000	279000	233000	81000
Ethiopia	5582000	240000	664000	504000	296000
Syrian Arab Republic	–	79000	25000	17000	27000
Colombia	–	32000	64000	35000	67000
Yemen	–	84,000	223000	31000	18000
Iran	–	41000	52000	520000	74000
Venezuela	–	33,000	2400	320	32000

Figure 8: Initial data collection tables.

To start the transformation process, data was collected by viewing websites, articles, reports, and other online databases. The collected data was then arranged into a raw data table by placing the variables in the corresponding column and row.

2. Repositioning and removing data.

Country	2022	2021	2020	2019	2018
Afghanistan	150000	29000	109000	306000	79000
DR Congo	209000	888000	279000	233000	81000
Ethiopia	5582000	240000	664000	504000	296000
Ukraine	–	2000	2000	–	–
Pakistan	7900000	70000	829000	100000	2100
South Sudan	–	506000	443000	294000	6600
Syrian Arab Republic	–	79000	25000	17000	27000
Colombia	–	32000	64000	35000	67000
Yemen	–	84,000	223000	31000	18000
Iran	–	41000	52000	520000	74000
Venezuela	–	33,000	2400	320	32000

Figure 9: Cleaned and reorganised data tables.

After the researching and data collecting, the clean-up needed to be done. This started with removing the Syrian Arab Republic, Colombia, Yemen, Iran and Venezuela, countries that lacked data related to conflict and violence reasons. Even though these countries had data for human trafficking and natural disasters, they had to be removed in order to have consistent data. Next was removing the year 2022 for the dataset since this year lacked data about the chosen displacement reasons.

3. Scaling the human trafficking data by the number of countries.

Human Trafficking: Displaced people

Country	2022	2021	2020	2019	2018
Afghanistan	–	19213	22530	14464	12272
Pakistan	–	19213	22530	14465	12272
Ukraine	–	21347	18173	17383	16838
South Sudan	–	3816	9512	14172	8135
DR Congo	–	3816	9512	14172	8135
Ethiopia	–	3816	9512	14172	8135

Figure 10: Unscaled and scaled human trafficking data.

After finding country data for conflict and violence and natural disasters, data for human trafficking was only found by region. To resolve this issue, each region number was dived by the number of countries in the radar chart dataset that were in the region. The South and Central Asia region had Afghanistan and Pakistan as the two countries, so the value for the region was divided by 2, with half being given to Afghanistan, and half being given to Pakistan. The African region contained South Sudan, DR Congo, and Ethiopia, so the total was divided by 3, with the three countries each being given a third. The last region was Europe, which only had Ukraine, so all the data for that region was used as Ukraine's human trafficking data.

4. Organising the data into Excel Spreadsheets.

	A	B	C	D
1		Conflict and violence	Natural disasters	Human trafficking
2	2021	4300000	29000	19213
3	2020	3500000	109000	22530
4	2019	3000000	306000	14464
5	2018	2600000	79000	12272

Figure 11: Organised Excel spreadsheet.

Now the data was organized into six Excel spreadsheets, one for each country. The variables in the final tables consisted of a column for the years 2021 to 1028, and a column for each reason with the corresponding value in the corresponding row.

5. Normalising the data to get scaled, easily encoded values.

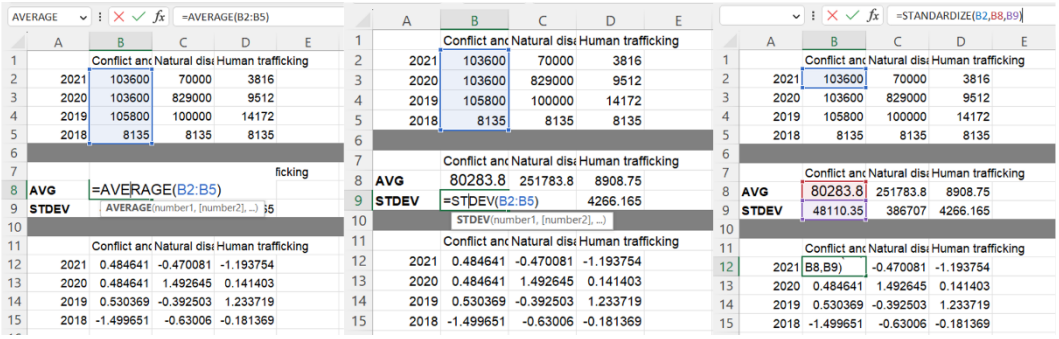

Figure 12: Excel calculations.

An attempt to make a radar chart using the Excel graph feature was made, however, due to some values being larger than others, the chart tried to encode all the data to match each other. To stop this compression, the values were normalized, getting a clearer and more enhanced quality of data for encoding.

Firstly, the data was averaged using the = AVERAGE (range of values) function. Secondly, the standard deviation was found for each of the motivations, done by using the = STDEV (range of values) function. Lastly, to get the normalized value, Excel had to take each value and find the standard deviation by using the = STANDARDIZE (x, mean, standard_dev) function. Generating a chart using the normalized data points gave a clear display of the data compared to the whole number data set radar chart.

6. Save the spreadsheet as a CSV file.

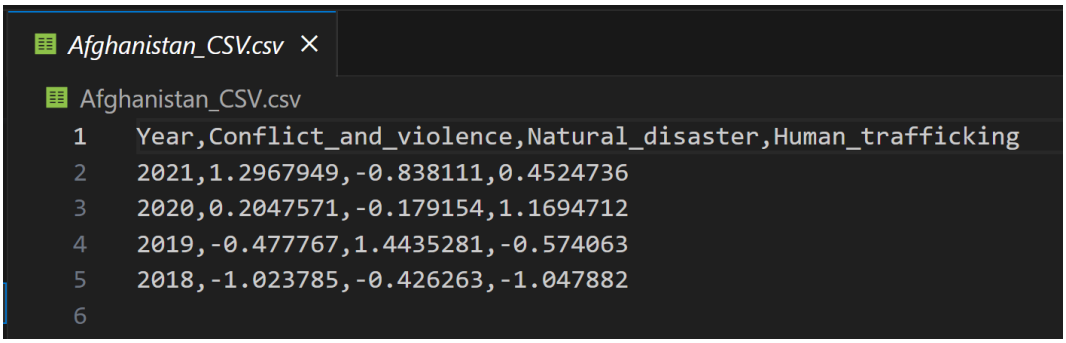

Figure 13: CSV file of the final data.

Once all of the data had been normalized, all that was left was to turn the Excel spreadsheet into a CSV. This was done by saving the file through the save as option and choosing CSV (Comma delimited)(*.csv). This is the final outcome in Visual Studio Code.

3. Requirements

3.1. Must-Have Features

The following requirements must be demonstrated to ensure that the visualization has fulfilled its goals and objectives. Failure to meet these requirements results in incomplete project objectives and goals. The requirements include:

- Tufte's data-ink ratio: Our visualizations need to follow the concepts of the data-ink ratio, so our chart elements are relevant to the immigration and migration data.
- Cohesion: We must have cohesive visualizations, so each graph shows the difference in data, instead of the difference in design.
- Title: Each visualization must have a title that describes what the graph is about.
- Axis labels: The charts axis labels must be appropriately labelled with correct data points to accurately represent our data.
- Explanation: Below each visualization, there must be a summary to provide the viewer with a brief overview of the meaning of our data.
- Legend: The charts will need to have a legend in order to describe each part of the data on the visualizations.
- Mouseover text: Visualizations must have mouseover text to display specific data when the viewer hovers over a specific part of a visualization.
- Scaling: The visualization must have axis values to represent the distance between the units on the charts.

These must-have features were all delivered in our visualization since they are needed for the visualization to work. Not including these features would render the visualization useless since these features are all essential to understand the data in the visualization.

3.2. Optional Features

The following requirements would be nice to demonstrate in the visualization. Failure to meet these requirements will not affect our project, as these requirements aren't critical. The requirements include:

- Transitions: Transitions would be used to animate the data changing when the user interacts with the visualization by hovering over parts of the chart.
- Outlier colour: Data points that are abnormally different from other values should be shown in an outstanding colour to demonstrate that it's an outlier value.

These optional features were not delivered in our visualization since they aren't needed for the visualization to work. The outlier colour doesn't necessarily apply to our data since we're working with a range of values, and the transitions aren't needed for our visualization.

4. Visualisation Design

4.1. Choropleth Map

4.1.1. Visualization Design Proposal

These choropleth maps will be effective for showing the data collected for the number of illegal and legal immigrants entering each country by using colours to represent the data changing between each country. This will be achieved by using a legend that will be displayed on the left side of the maps. There will be a button to change between the two maps and the years of data.

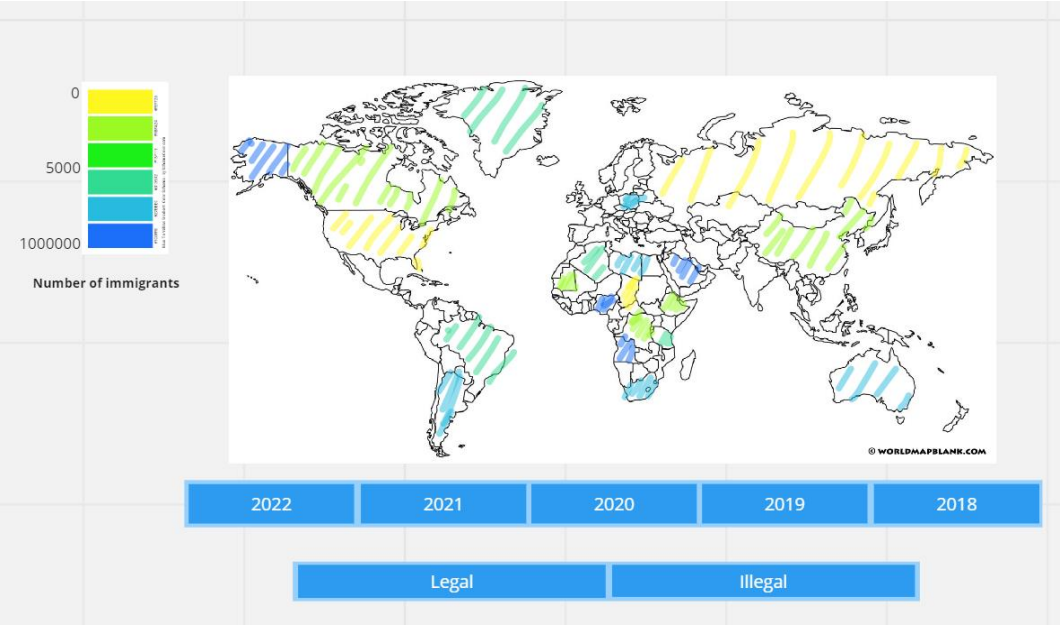

Figure 14: First iteration of the choropleth maps.

Since the legal and illegal data will be answering the question of where these immigrants are migrating to, this dataset is geospatial. The choropleth map was chosen to visually encode this geospatial data because they allow users to answer the question of where the immigrants are going and compare the value of each geographic location.

The colour pallet chosen for this iteration contains seven colours that will represent the number of immigrants for each country. The colour corresponds to a value, which will be shown on the legend, with grey being used for countries that have no data.

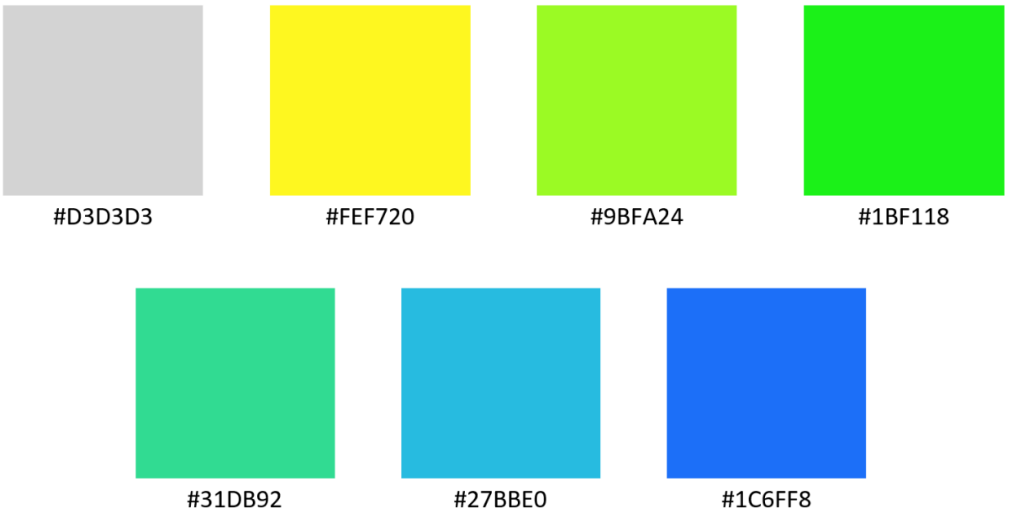

Figure 15: First iteration colour pallet for the choropleth maps.

After talking about having colours that could look similar as well as different, these colours were chosen. We decided this would be the colour scheme for the whole visualization.

4.1.2. Visualization Design Progress

The second iteration of the choropleth maps keeps the buttons that change between the legal and illegal immigration datasets but removes the buttons that show the data for each year. Instead, the maps will use a tooltip to enable users to see the countries data for each year by hovering over the country. The legend has been moved from the left side of the visualization to above it, with the legend keys being squares that represent a value range instead of a single value.

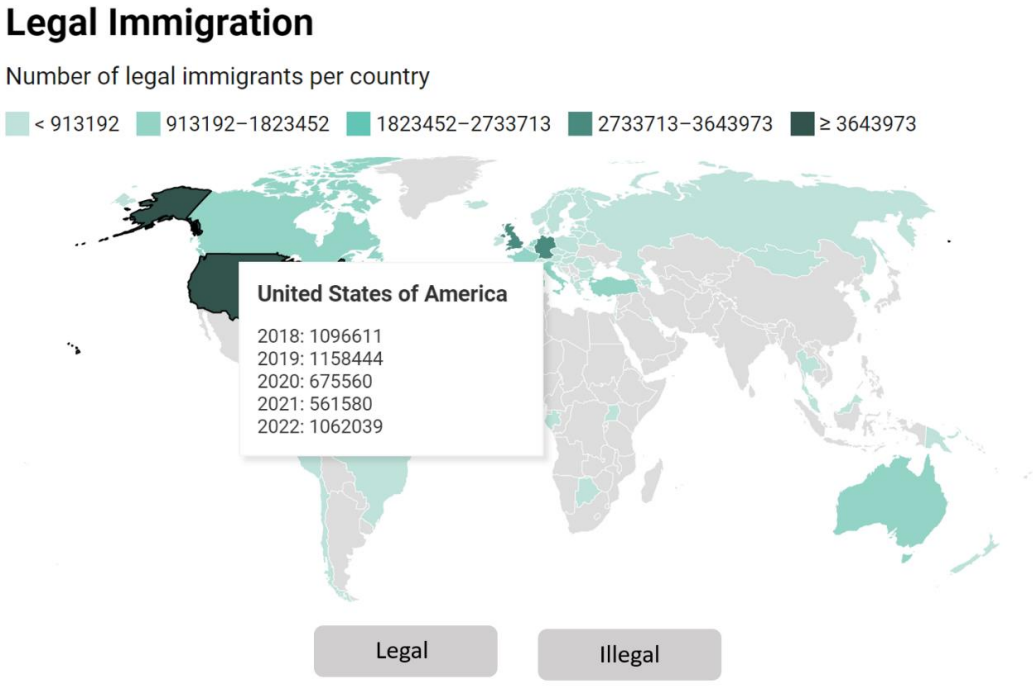

Figure 16: Second iteration of the choropleth maps.

The colour palette chosen for this iteration includes eight colours that still correspond to a value that's displayed through the use of the legend, with grey representing countries that have no data.

Figure 17: Second iteration colour pallet for the choropleth maps.

These colours were chosen from the Greater London Authority City Intelligence Data Design Guidelines PDF. The gradient chosen was turquoise because I like the colour. I decided to use a gradient colour because a gradient can show a pattern of the values increasing from low to high, which is represented in the colours changing from light to dark.

4.1.3. Visualization Design Final

As mentioned at the beginning, the choropleth maps have been chosen to encode the geospatial immigrant data in order to answer the question of where legal and illegal immigrants migrate to. This visualization is effective for showing the data since choropleth maps allow users to see and compare the values between each geographical location. I got the code for the choropleth maps from VizHub.

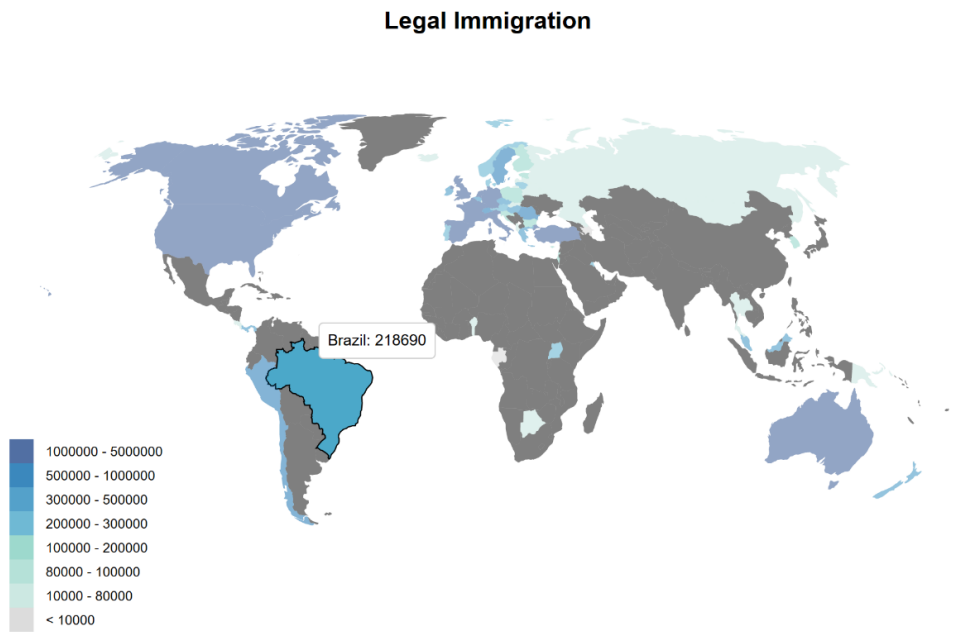

Figure 18: Final iteration of the choropleth maps.

This final iteration removes the buttons that change between the legal and illegal data and instead puts them on different website pages. The tooltip has been changed from showing the data for each year to showing the total value over the five years. The legend is now to the left side of the map, still having squares for the values. The values have also been changed so the number is a visually pleasing whole number.

The colour palette chosen for the final iteration now includes nine colours with the eight colours below corresponding to a value on the legend, with the ninth colour being black which represents countries with no data.

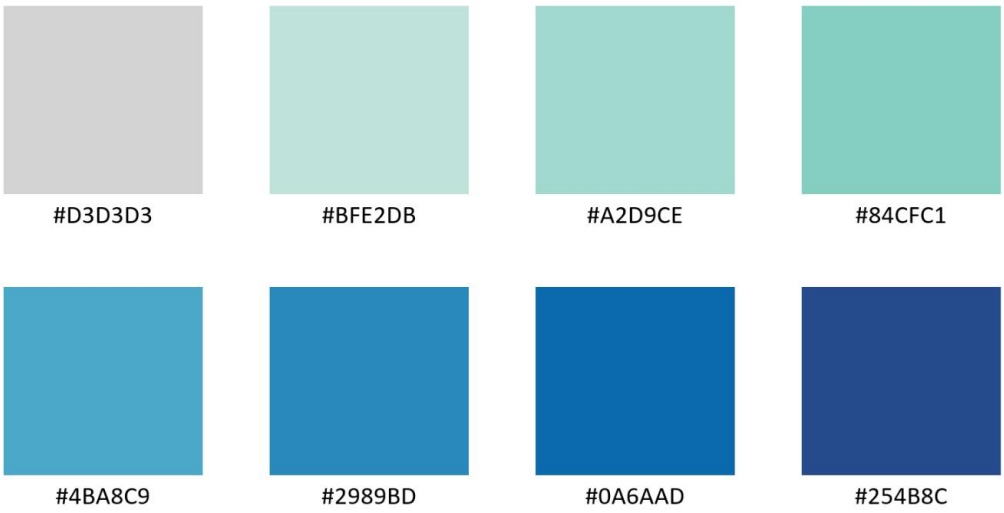

Figure 19: Final iteration colour pallet for the choropleth maps.

These colours were chosen for the final colour palette because there's still a gradient that can show the pattern of the values being low and high, but adding the blue makes seeing the difference between the colours easier and provides a bit of colour variety without straying too far away from the turquoise gradient. I got these colours from the GnBu Sequential (Multi-Hue) colour found on Color Schemes by Mike Bostock on ObservableHQ.

4.2. Radar Chart

4.2.1. Visualization Design Proposal

Initially, we brainstormed what type of chart would be the best to display data on the reasons for internal displacement and decided to use radar charts as they are a good way to display multiple variables defined using colours. Radar charts outline groups of data which gives an even and easy-to-understand visual representation of the value in each group. We also proposed that there be multiple radar charts, one for each country, with buttons that allow users to select which countries' data they want to view.

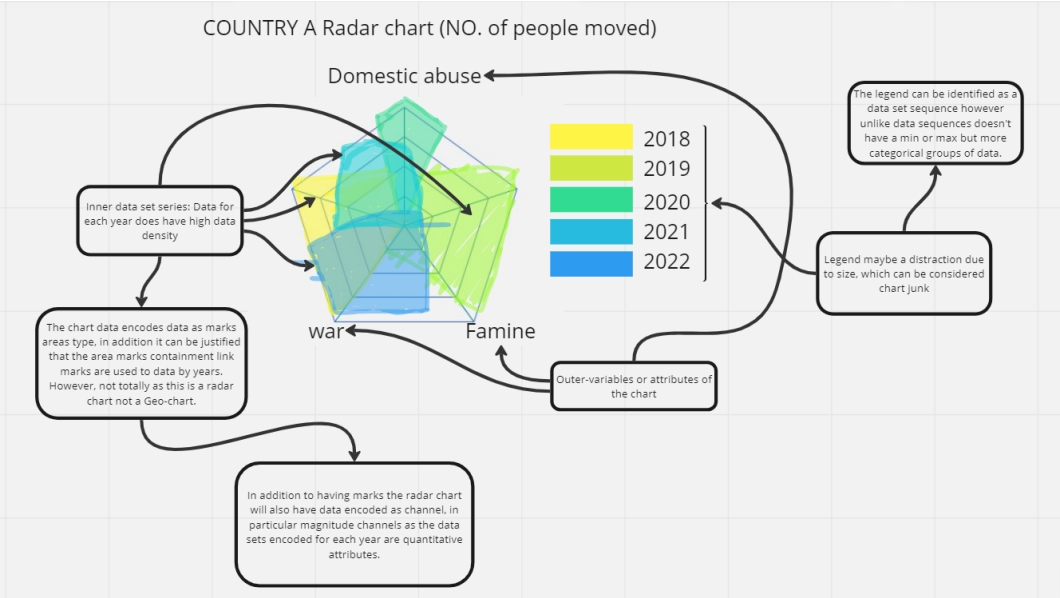

Figure 20: First iteration of the radar charts.

This first iteration is a simple mock-up to demonstrate what outer variables and data series would be displayed. The initial reasons for displacement displayed were going to be domestic violence, war, and famine, as seen in the image above. In addition, the year range of the data that was going to be collected was 2018 to 2022, hence the five colours, which were chosen for being bright and easy-to-see.

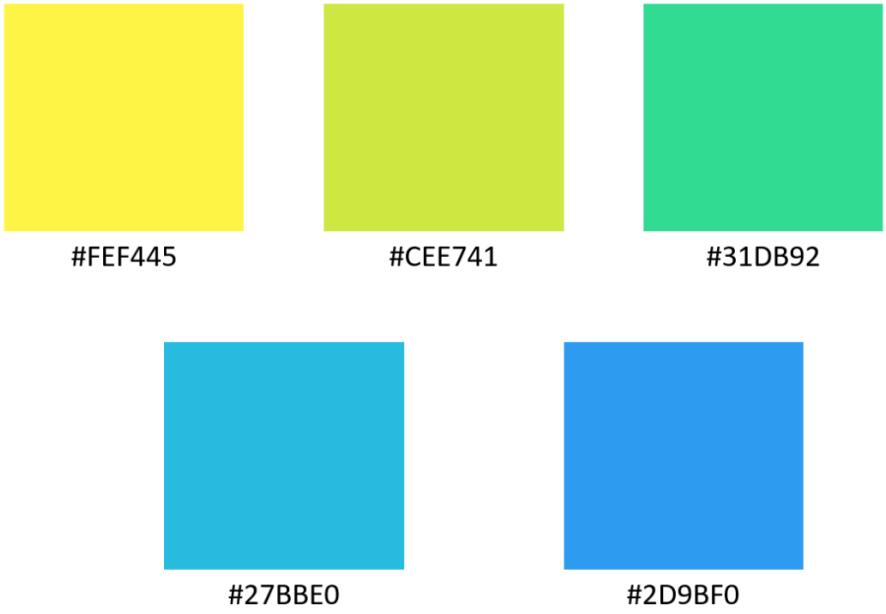

Figure 21: First iteration colour pallet for the radar charts.

Evidently, Tufte's Data-Ink Ratio is somewhat low as a lot of the ink is allocated to be used in the displaying of data, with some for the grid, helping with data clarity. However, this iteration may be using too much ink for the legend. The chart also has a high data density, meaning the data takes up a big portion of the chart. Before designing this chart, we didn't initially decide how each county's data would be visually encoded on a single chart that already had multiple variables.

4.2.2. Visualization Design Progress

Iteration two was created after the data had been collected and finalized, which is why there are a lot of design changes. We chose to generate this in Excel rather than drawing it in Miro like we did with the previous iteration. Generating it through Excel gave us a more accurate look into how the final visualization would look. As seen below, the visualization displays data on the number of people who were displaced due to three motivations. Firstly, the data only is for one country, as it was decided after the first iteration that it would be better to display the data of each country on separate graphs, applying to Tufte's principles of small multiples. Unlike other visualizations or what this particular principle is trying to define, each chart for each country is to be viewed separately.

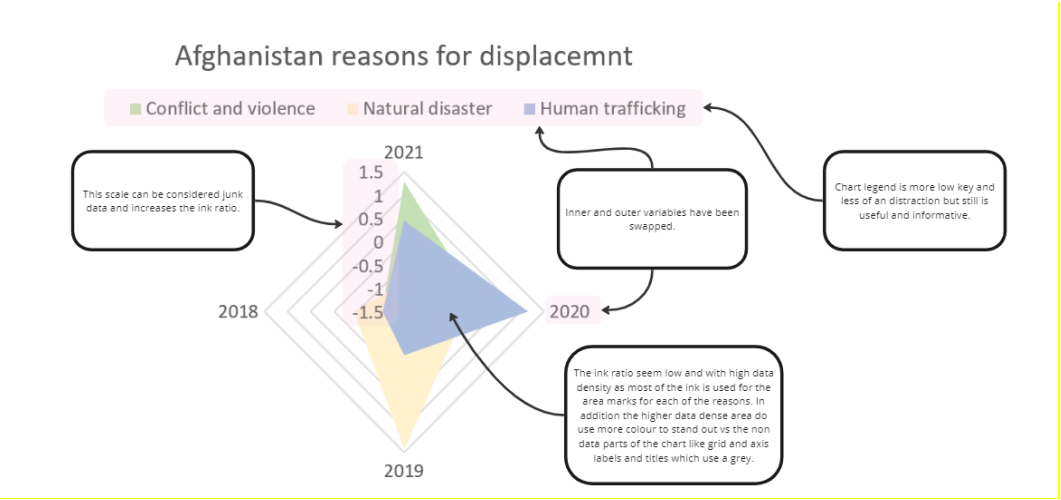

Figure 22: Second iteration of the radar charts.

The first change to this iteration was accurately displaying the data. A variety of chart generating websites were used, but in all of them, the chart grid would change according to the outer variables. If the reasons were used as the outer variables, the grid would be a triangle, whereas if the years were used as the outer variables, the grid would be a diamond. It was decided that a diamond grid would be used to avoid data being compressed.

As mentioned above, many changes to the first iteration were made to get this iteration, with the colour palette being the biggest change. The area that each reason took up on the chart was also addressed. The colour palette was also changed to be less intense and distracting, providing a visually pleasing chart while still using different colours that were randomly chosen.

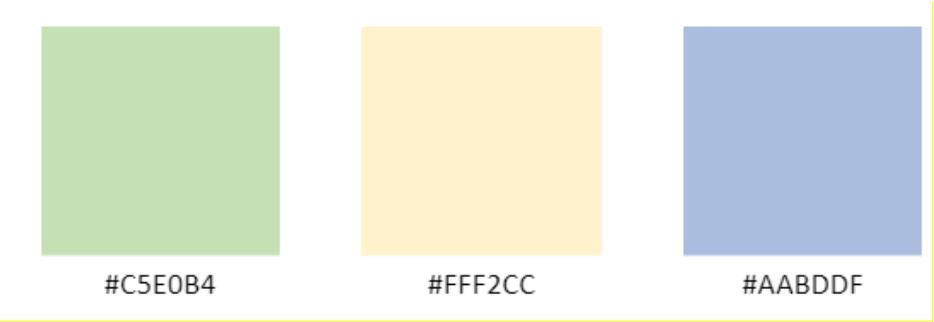

Figure 23: Second iteration colour pallet for the radar charts.

Using Excel to draw up the chart preloaded a legend, solving the ink ratio and junk issues the initial design had. A new legend colour palette, that now consisted of three colours, one for each reason, helped the flow and ease of understanding data.

4.2.3. Visualization Design Final

This is the final visualisation of the radar chart. It doesn't look like the second iteration due to the negative normalised values. After trying to scale the data, the output was still the same, however, the radar chart gride and axis was successfully implemented, as was the opacity changing for the mouse over effect.

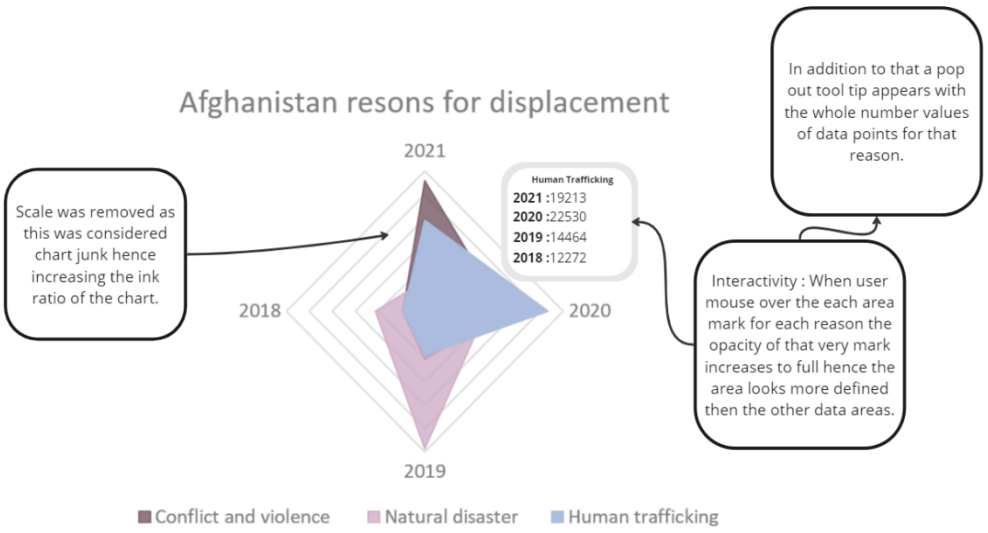

Figure 24: Third iteration of the radar charts.

The legend for the final outcome was different from previous iterations, where instead of squares or lines, they're small circles. The legend has also gone from being placed to the right and above the chart to now being placed underneath it. This was because of coding issues and having minimal time left. These reasons are also why we couldn't implement a tooltip when we planned to. To make up for this, we created tables underneath the chart that displayed the data the tooltip was meant to show. Having trouble connecting the CSV files could also be another reason there was no tooltip.

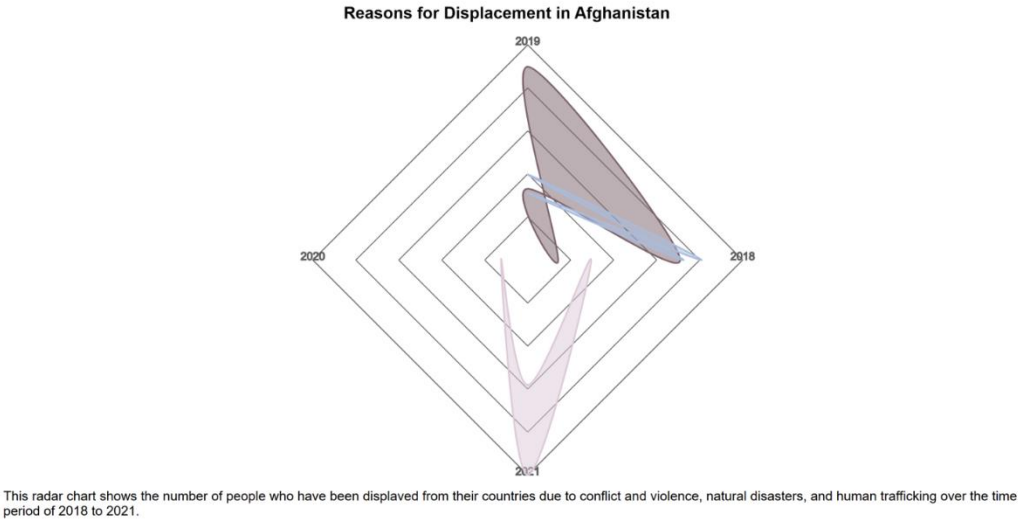

Figure 25: Final iteration of the radar charts.

Once again, this adheres to Tufte's Design Principles as the chart accurately represents the data set of number of displaced people for each reason, which is evident in how the radar chart is encoded with additional interactive popout features, which gives more reference to the values which the encoded data areas are being represented. Unnecessary ink and chart junk was removed to maximise the data-ink ration, giving the radar chart a high data density.

There are small multiples in the visualisation as there are multiple radar charts on separate pages, staying consistent with each design element and principal added. However, there is a lot of data variation as there is a factor of data from multiple sources and each have three types of data for

human trafficking, natural disasters, and conflict and violence. The chart has no out of context data, and has been labelled correctly.

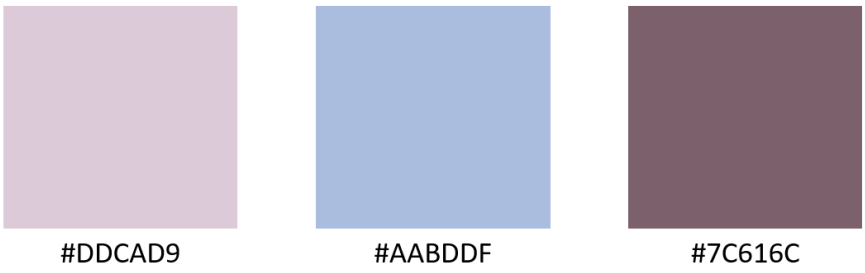

Figure 25: Final iteration colour pallet for the radar charts.

The colour pallet for the final iteration has also changed. To show the data in a clear and visually pleasing way, similar milder colours were picked from Coolors. These colours were also good for the opacity as they didn't obscure one another.

5. Conclusion

Each year across the globe, more and more people are being displaced from their homes due to events happening in the world. Where these people go and what happens to them is a highly political matter in many countries. Throughout the span of the project, we have explored the issues of migration within the last 5 years. In order to help users understand the context and patterns of human migration via a visualization, we had to learn about the fundamental principles of data visualizations and good visualization design practices needed to make our visualization.

Our visualization had to be made using D3, a library import for JavaScript that's used to manipulate CSV documents. In the process of learning about and using D3 and JavaScript, we were able to apply a structured design process to build our interactive migration visualization, presented on a website hosted on GitHub.

We learnt both technical skills and data related skills, as well as gaining more insight to migration topics. Some of the technical skills we learnt were how to use CSV files to make tooltips for interactivity, learning what a GeoJSON is and why t's necessary for a choropleth map, and how to code visualization elements, such as different shaped chart grids, legends, and keys. Our data related skills involved learning the necessary clean up and transformation processes needed to create a working CSV that would correctly display the data, as well as calculations that would normalize the data. Additionally, the insight we gained from completing this project helped us understand that certain countries have different issues that cause certain amounts of people to become displaced.

All of the skills and knowledge we learnt were acquired from completing this project. These will be beneficial for us if we have future projects that involve creating data visualizations or researching data heavy topics.

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Appendix

Home

```
<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="utf-8"/>
    <meta name="description"    content="Data Visualisation Project Website"/>
    <meta name="keywords"         content="HTML, CSS, JavaScript, D3"/>
    <meta name="author"           content="Dilni De Silva & Rubie Stannard"/>
    <link rel="stylesheet" href="style/home.css" type="text/css">
    <title>COS30045 - Data Visualisation</title>
</head>
<body>
<header>
    <section class="header-content">
        <h1 class="header">COS30045 Data Visualisation</h1>
    </section>
</header>
    <div class="navbar">
        <a href="home.html">Home</a>
        <div class="dropdown">
          <button class="dropbtn">Choropleth Maps
            <i class="fa fa-caret-down"></i>
          </button>
          <div class="dropdown-content">
            <a href="legal_choropleth.html">Legal Choropleth</a>
            <a href="illegal_choropleth.html">Illegal Choropleth</a>
          </div>
        </div>
        <div class="dropdown">
            <button class="dropbtn">Radar Charts
              <i class="fa fa-caret-down"></i>
            </button>
            <div class="dropdown-content">
            <a href="afghanistan_radar_chart.html">Afghanistan</a>
            <a href="pakistan_radar_chart.html">Pakistan</a>
            <a href="ukraine_radar_chart.html">Ukraine</a>
            <a href="south_sudan_radar_chart.html">South Sudan</a>
            <a href="dr_congo_radar_chart.html">DR Congo</a>
            <a href="ethiopia_radar_chart.html">Ethiopia</a>
            </div>
          </div>
      </div>
    <h2>Unit Aims and Objectives</h2>
        <p>The COS30045 Data Visualisation unit aims to instruct us on the
fundamental principles of information visualisation, and good design
practices. It will examine and describe in detail main types of information
graphics and visual representations for variety of applications.</p>
```

```
    <hr>
    <h2>Project Summary</h2>
        <p>For this project we will apply a structured iterative design process to research design and build an interactive data visualisation and present it on a website to help users understand the context and patterns of human migration.</p>
        <p>Increasingly more and more people are being displaced from their homes due to world events. Where these people go and what happens to them is a highly politicised issue in many countries. In this project we will explore the issue of migration with a focus on recent events (i.e., the last 5-10 years).</p>
    <hr>
    <h2>Website and Visualisation</h2>
        <p>Our data visualisation website is a major part of the assessment. We have programmed our visualisations in D3.</p>
    <hr>
    <h2>Project Process Booklet</h2>
        <p>The project process booklet is where we have documented the development of our data visualisation design process. This is a major piece of the assessment that demonstrates that we have achieved the unit learning outcomes.</p>
<footer><p><em>2023 Dilni De Silva & Rubie Stannard</em></p></footer>
</body>
</html>
```

Choropleth Maps

```
<!DOCTYPE html>
<html lang="en">
<head>
  <meta charset="utf-8"/>
  <meta name="description"  content="Data Visualisation Project Website"/>
  <meta name="keywords"     content="HTML, CSS, JavaScript, D3"/>
  <meta name="author"       content="Dilni De Silva & Rubie Stannard"/>
  <title>COS30045 - Data Visualisation</title>
  <script src="https://d3js.org/d3.v4.js"></script>
  <script src="javascript/scale.js"></script>
  <script src="javascript/geo_projection.js"></script>
</head>
<body>
<link rel="stylesheet" href="style/choropleth_maps.css">
<header>
  <section class="header-content">
    <h1 class="header">COS30045 - Data Visualisation</h1>
  </section>
</header>
<div class="navbar">
  <a href="home.html">Home</a>
  <div class="dropdown">
```

```
    <button class="dropbtn">Choropleth Maps
    <i class="fa fa-caret-down"></i>
    </button>
    <div class="dropdown-content">
    <a href="legal_choropleth.html">Legal Choropleth</a>
        <a href="illegal_choropleth.html">Illegal Choropleth</a>
    </div>
  </div>
  <div class="dropdown">
    <button class="dropbtn">Radar Charts
      <i class="fa fa-caret-down"></i>
    </button>
    <div class="dropdown-content">
    <a href="afghanistan_radar_chart.html">Afghanistan</a>
    <a href="pakistan_radar_chart.html">Pakistan</a>
    <a href="ukraine_radar_chart.html">Ukraine</a>
    <a href="south_sudan_radar_chart.html">South Sudan</a>
    <a href="dr_congo_radar_chart.html">DR Congo</a>
    <a href="ethiopia_radar_chart.html">Ethiopia</a>
    </div>
    </div>
  </div>
<div class="map">
  <h1>Illegal Immigration</h1>
  <hr>
  <svg id="illegal_choropleth" width="800" height="500"></svg>
</div>
<script src="javascript/illegal_choropleth.js"></script>
  <p>This choropleth map shows the number of illegal immigrants that have
entered the shown countries over the last 5 years.</p>
  <hr>
<footer><p><em>2023 Dilni De Silva & Rubie Stannard</em></p></footer>
</body>
</html>
```

Radar Charts

```
<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="utf-8" />
    <meta name="description" content="Data Visualisation Project Website" />
    <meta name="keywords" content="HTML, CSS, JavaScript, D3" />
    <meta name="author" content="Dilni De Silva & Rubie Stannard" />
    <link rel="stylesheet" href="style/afghanistan_radar.css">
    <script src="https://d3js.org/d3.v7.min.js"></script>
    <title>COS30045 - Data Visualisation</title>
</head>
<body>
```

```
    <header>
        <section class="header-content">
            <h1 class="header">COS30045 - Data Visualisation</h1>
        </section>
    </header>
    <div class="navbar">
        <a href="home.html">Home</a>
        <div class="dropdown">
          <button class="dropbtn">Choropleth Maps
            <i class="fa fa-caret-down"></i>
          </button>
          <div class="dropdown-content">
            <a href="legal_choropleth.html">Legal Choropleth</a>
            <a href="illegal_choropleth.html">Illegal Choropleth</a>
          </div>
        </div>
        <div class="dropdown">
            <button class="dropbtn">Radar Charts
              <i class="fa fa-caret-down"></i>
            </button>
            <div class="dropdown-content">
            <a href="afghanistan_radar_chart.html">Afghanistan</a>
            <a href="pakistan_radar_chart.html">Pakistan</a>
            <a href="ukraine_radar_chart.html">Ukraine</a>
            <a href="south_sudan_radar_chart.html">South Sudan</a>
            <a href="dr_congo_radar_chart.html">DR Congo</a>
            <a href="ethiopia_radar_chart.html">Ethiopia</a>
            </div>
          </div>
      </div>
<hr>
      <h1>Reasons for Displacement in Afghanistan</h1>
      <hr>
    <div id="chart"></div>
    <div id="ledged"></div>
    <div id="Conflict_and_Violence" class="hidden">
        <p><strong>Conflict and Violence</strong></p>
        <p>2021:</p>
        <p>2020:</p>
        <p>2019:</p>
        <p>2018:</p>
    </div>
    <div id="Natural_Disaster" class="hidden">
        <p><strong>Natural Disaster</strong></p>
        <p>2021:</p>
        <p>2020:</p>
        <p>2019:</p>
        <p>2018:</p>
```

```
    </div>
    <div id="Human_Trafficking" class="hidden">
        <p><strong>Human Trafficking</strong></p>
        <p>2021:</p>
        <p>2020:</p>
        <p>2019:</p>
        <p>2018:</p>
    </div>
<hr>
<p>This radar chart shows the number of people who have been displaved from
their countries due to conflict and violence, natural disasters, and human
trafficking over the time period of 2018 to 2021.</p>
<hr>
<table class="center">
        <tr>
          <th>Year</th>
          <th>Conflict and Violence</th>
          <th>Natural Disaters</th>
          <th>Human Trafficking</th>
        </tr>
        <tr>
          <td>2021</td>
          <td>1.2967949</td>
          <td>-0.838111</td>
          <td>0.4524736</td>
        </tr>
        <tr>
          <td>2020</td>
          <td>0.2047571</td>
          <td>-0.179154</td>
          <td>1.1694712</td>
        </tr>
        <tr>
          <td>2019</td>
          <td>-0.477767</td>
          <td>1.4435281</td>
          <td>-0.574063</td>
        </tr>
        <tr>
          <td>2018</td>
          <td>-1.023785</td>
          <td>-0.426263</td>
          <td>-1.047882</td>
        </tr>
      </table>
<p>This table contains the normalised data for Afghanistan. These values are
the values that were supposed to appear on the tooltips.</p>
<hr>
```

```
    <footer><p><em>Dilni De Silva & Rubie Stannard</em></p></footer>
    <script src="javascript/afghanistan_radar.js"></script>
</body>
</html>
```