



Swinburne University of Technology

On The Move: Understanding Human Migration Through Visualization in Australia

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[\[https://mercury.swin.edu.au/cos30045/s104071453/Project/index.html\]](https://mercury.swin.edu.au/cos30045/s104071453/Project/index.html)

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1 Introduction

1.1 Background and motivation

This data visualization showing human migration to Australia would attract the interest of a variety of groups, including academics, policymakers, journalists, and individuals with an interest in understanding migration patterns in Australia. The users would want to explore the data to gain information on the factors that cause migration to Australia, such as employment opportunities, family, or political issues in migrants' home countries. This visualization is important because it helps to show the complex and dynamic nature of human migration to Australia, which has significant social, economic, and political implications for the country and its people. By providing a clear and compelling picture of migration patterns, this visualization can inform policy decisions, promote public awareness, and allow a greater understanding of the diverse experiences and contributions of migrants to Australian society.

1.2 Visualization purpose

After viewing the data visualization of human migration to Australia, users will be able to answer a variety of questions, such as:

- What are the overall trends in migration to Australia over time?
- What are the top countries of origin for migrants coming to Australia?
- What is the demographic makeup of migrants to Australia?
- Is there a pattern between migrating countries and states in Australia?

The potential benefits of the completed visualization include:

- Providing a more accessible and engaging way of presenting complex migration data.
- Allowing users to gain a better understanding of the factors driving migration to Australia.
- Highlighting the diversity and richness of Australia's migrant communities.
- Informing policymakers and stakeholders about the impact of migration on Australian society and the economy.
- Identifying gaps and opportunities for further research and analysis in the field of migration studies.

1.3 Project schedule

- **Week 1-2:** Start working on the project, gather information regarding the topic and start deciding which one to use and which visualization are we using.
- **Week 3-4: Start Preparing on how the website would look like**
 - Prepare some images on how we want it to look like
 - Start on designing the home page or give a presentation how it would look like
 - Figure out which chart are we going to use.
- **Week 5-7: Focusing on determining which data are we using and start coding the website.**
 - Gather as much information as we can and start implementing them towards our charts using D3.
- **Week 8: Finish the website.**
 - Fix the websites and add more CSS or JavaScript to make it nice.
 - Figure out what to do if there's an error or something is not working properly (finishing touches)
- **Week 9: Finish the Data Visualization Process Book**
 - Complete the Process book.
- **Week 10-12: Finalize the project.**
 - Check with tutor if everything is working properly.
 - Submit everything.

2 Data

2.1 Data Source

All the data in the project comes from the official Australian Bureau of Statistics' page titled Migration, Australia [Migration, Australia, 2019-20 financial year | Australian Bureau of Statistics](#)

The first dataset contains Australia's migration statistics, specifically highlighting the top 20 countries of birth for migrants across different states and territories in 2016. Values will be adjusted for better readability, as the table has values such as 250 that are actually 250,000. Table 1 offers a glimpse of the table structure, but it only showcases a portion of the complete dataset. As part of the cleanup process, redundant rows labeled

"Australia" and "Overseas-born" will be removed since they do not contribute to the analysis. This ensures that the table focuses solely on the relevant information regarding the top 20 countries of birth. Additionally, changing the state names to a consistent name to go with other tables and files.

	NSW	Vic.	Qld	SA	WA	Tas.	NT	ACT	Aust.(c)
	'000	'000	'000	'000	'000	'000	'000	'000	'000
Australia	5,406.4	4,280.6	3,705.1	1,294.0	1,660.6	449.7	190.3	289.6	17,278.8
Overseas-born									
England	250.7	192.7	200.4	103.7	213.9	20.5	6.7	13.3	1,002.1
New Zealand	127.9	102.7	219.9	13.8	87.4	5.4	5.6	5.0	568.2
China(d)	256.1	176.6	51.6	26.8	30.0	3.3	1.4	11.9	557.7
India	153.8	182.8	53.1	29.0	53.4	2.1	4.2	10.9	489.4
Philippines	94.1	56.0	43.1	13.3	33.4	1.8	7.0	4.0	252.7
Vietnam	92.9	89.9	21.8	15.7	17.6	0.5	1.2	3.6	243.2

Table 1: Country vs Australian State Migration

The second dataset focuses on the arrivals, departures, and net number of overseas migrations specific to Australian states. Unlike the previous table, this dataset uses raw numbers instead of shortened values. All three tables within this dataset maintain the same structure as depicted in Table 2. During the cleanup process, the rows representing months and the combined years will be excluded. This decision is made to simplify the data analysis and avoid unnecessary data. By removing the monthly breakdown and focusing solely on individual years, we can obtain a clearer and more manageable representation of migration trends.

Period	New South Wales	Victoria	Queensland	South Australia	Western Australia	Tasmania	Northern Territory	Australian Capital Territory	Australia
OVERSEAS MIGRATION ARRIVALS									
2016-17	198,296	159,626	87,821	23,819	48,641	4,703	6,904	10,328	540,152
2017-18	191,451	161,166	85,440	24,104	44,193	5,107	5,024	10,973	527,524
2018-19	194,266	168,314	91,664	26,649	48,078	5,876	5,554	9,945	550,401
2019-20	172,446	150,633	85,581	27,741	50,404	6,507	4,122	9,378	506,859
2020-21	70,615	27,112	23,420	6,009	12,943	1,609	1,445	2,808	146,002
2021-22	149,099	123,769	61,586	21,687	32,242	5,084	4,950	8,721	407,223
2016	186,747	150,754	86,130	23,993	50,616	4,606	6,794	10,001	519,653
2017	194,414	159,713	86,413	23,700	45,733	4,906	5,884	10,559	531,372
2018	192,485	163,517	87,540	24,909	44,698	5,490	5,184	10,528	534,397
2019	208,820	185,728	102,075	30,817	56,850	7,230	5,595	10,700	607,872
2020	91,440	59,713	37,873	12,905	23,710	2,725	2,174	4,777	235,361
2021	88,089	58,033	31,784	9,128	16,127	3,161	2,932	4,733	214,024
2020									
September	10,630	2,471	2,718	815	2,074	157	273	469	19,627
December	21,723	6,006	5,324	1,396	3,058	445	384	787	39,127
2021									
March	18,433	8,848	6,819	1,685	3,600	615	426	894	41,329
June	19,829	9,787	8,559	2,113	4,211	392	362	658	45,919
September	12,541	9,327	6,731	1,477	3,699	537	1,070	728	36,113
December	37,286	30,071	9,675	3,853	4,617	1,617	1,074	2,453	90,663
2022									
March	55,111	49,453	23,567	9,726	10,860	1,646	1,565	3,530	155,490
June	44,161	34,918	21,613	6,631	13,066	1,284	1,241	2,010	124,957
September	58,951	47,240	26,718	8,784	17,434	1,261	1,614	3,708	165,740

Table 2: Overseas Migration by States

2.2 Data processing

The cleanup process for the tables is essential to remove redundant information and align the data with the project's requirements. This ensures that the tables are optimized for efficient coding and data analysis. One crucial aspect of the cleanup involves standardizing state names across all tables, which allows for easier and more consistent coding. The tables are simplified to extract the original values, ensuring the accuracy of the data. The corresponding year, state, and country information is kept to provide context and make analysis easier. This approach helps us fully understand the dataset while keeping its original format intact.

Cleaning up the first table had a few essential steps to ensure data consistency and accuracy, which are shown in Table 3. Firstly, we had to remove the first two rows, which contained irrelevant information and didn't add to the overall dataset. Another task was standardizing the state names across tables. Inconsistencies in the naming conventions could lead to confusion and make it harder to code. Additionally, we recognized the importance of aligning the country names with the world JSON file we were using. Consistency in country names enabled us to accurately match and merge data from both files so that it would be easier to code. Furthermore, we made a significant adjustment by switching from shortened values to absolute values, allowing for better analysis. By

presenting the data in its raw form, we eliminated any potential biases or calculations that could skew the results, ensuring a more accurate representation of the information.

1	Country	New South Wales	Victoria	Queensland	South Australia	Western Australia	Tasmania	Northern Territory	Australian Capital Territory
2	United Kingdom	250700	192700	200400	103700	213900	20500	6700	13300
3	New Zealand	127900	102700	219900	13800	87400	5400	5600	5000
4	China	256100	176600	51600	26800	30000	3300	1400	11900
5	India	153800	182800	53100	29000	53400	2100	4200	10900
6	Philippines	94100	56000	43100	13300	33400	1800	7000	4000
7	Vietnam	92900	89900	21800	15700	17600	500	1200	3600
8	Italy	56000	79100	14800	20200	22000	1000	600	2100

Table 3: Reformatted Country vs Australian State Migration

The second group of tables required significant attention and cleaning to optimize their usability. The main idea was to separate these tables into two cohesive tables, which are Table 4 and Table 5, splitting the information so it was easier to use. First, we changed the state values across the tables to ensure consistency, making it easier to code and manipulate the data. In addition to changing the state values, we also removed unwanted years and months from the table by eliminating these unnecessary rows. We refined the arrivals table so we could focus only on the essential data points. Then, we changed the structure of the departures table to make the coding of the graph easier. By splitting the tables, changing state values, and removing unwanted years and months, we created a comprehensive and consolidated dataset that was highly efficient for analysis and coding purposes.

1	Period	New South Wales	Victoria	Queensland	South Australia	Western Australia	Tasmania	Northern Territory	Australian Capital Territory
2	2016	186747	150754	86130	23993	50616	4606	6794	10001
3	2017	194414	159713	86413	23700	45733	4906	5884	10559
4	2018	192485	163517	87540	24909	44698	5490	5184	10528
5	2019	208820	185728	102075	30817	56850	7230	5595	10700
6	2020	91440	59713	37873	12905	23710	2725	2174	4777
7	2021	88089	58033	31784	9128	16127	3161	2932	4733
8	2022	158223	131611	71898	25141	41360	4191	4420	9248

Table 4: Reformatted to Overseas Arrivals by State

1	Category	Year	Value
2	New South Wales	2016	90545
3	New South Wales	2017	99486
4	New South Wales	2018	99599
5	New South Wales	2019	129536
6	New South Wales	2020	84438
7	New South Wales	2021	75715
8	New South Wales	2022	62623
9	Victoria	2016	67846
10	Victoria	2017	72581
11	Victoria	2018	73980
12	Victoria	2019	100665

Table 5: Reformatted to Overseas Departures by State and Year

3 Requirements

3.1 Must-have features

- *Whole Map of Australia with Selected Countries:*
The website successfully incorporated a whole map of Australia, allowing users to interact with it by selecting specific countries. Once a country was selected, users were redirected to a world map that showcased relevant data. This feature was successfully implemented as planned.
- *World Map Data Visualization:*
Unfortunately, we weren't able to deliver the intended features for the world map data visualization. Instead of comprehensive visualizations beyond connections,

the implemented feature focused on showcasing connections between countries using lines. The country's origin color intensity represented the number of migrants, with darker colors indicating a higher number of migrants. While this provided some insights into migration patterns, it fell short of the original goal of offering a comprehensive data visualization experience. The limitations in resources, time constraints, and technical challenges contributed to the inability to deliver the initially promised features.

- *Separate Graphs for Overseas Migration by State:*
The website included separate graphs that specifically focused on overseas migration by state. These graphs provided insights into both arrivals and departures. Users could interact with the graphs, view specific data points, and gain a better understanding of migration patterns. These separate graphs were successfully implemented, allowing users to explore and analyze migration data at the state level.

3.2 Optional features

- *Line Transitions:*
A transition effect was implemented for the line graph. When users select a state, a dot representing the data point first appears, followed by a line forming to connect with the other data points. This transition effect enhances the visual representation of the data and provides a smooth and engaging experience for users.
- *Animations/Transitions for Graphs:*
The graphs representing overseas migration by state include basic transitions when filtering or updating the data. The bars in the graphs smoothly update their positions and sizes when applying filters or changing the selected states. These transitions provide a visually pleasing effect and enhance the user experience when interacting with the graphs.

4 Visualization Design

4.1 Initial Design Ideas

For the visualization design, we considered the following ideas:

1. Choropleth Map:

- The initial idea was to use a choropleth map to display the migration patterns within Australia.
- Each state would be represented by a different color, with the intensity of the color indicating the volume of inbound migration.
- Connection lines would be used to show the origin countries or regions of the migrants.
- Sketch of initial design:

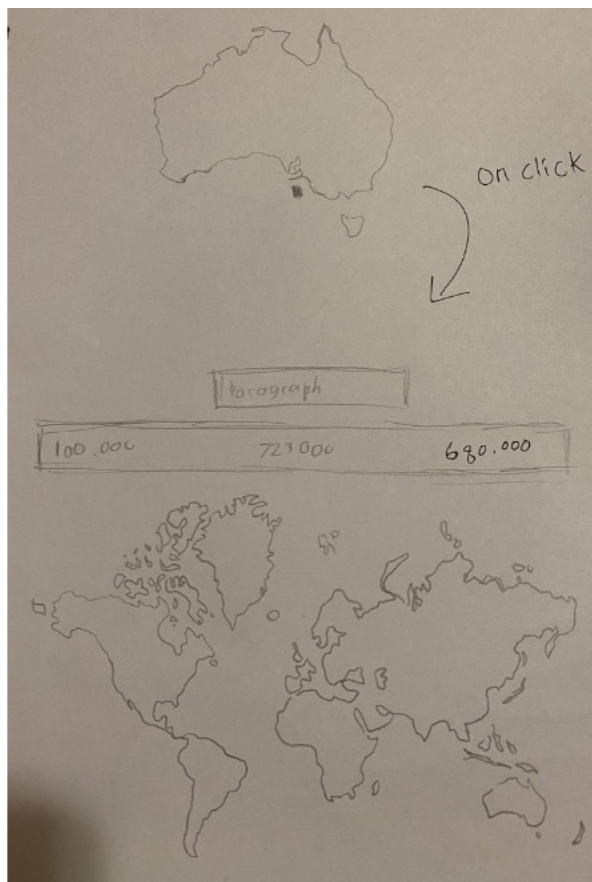


Figure 1: Choropleth map initial sketch.

2. Inbound Migration Pattern Across Australian States (Line Graph):

- The initial idea for the line graph was to depict the inbound migration patterns across Australian states over time.
- Each state would be represented by a line, with the x-axis representing the years and the y-axis representing the number of migrants.
- Dots would be used to indicate the migration volumes for each year, allowing users to observe trends and changes.

Sketch of Initial Design:

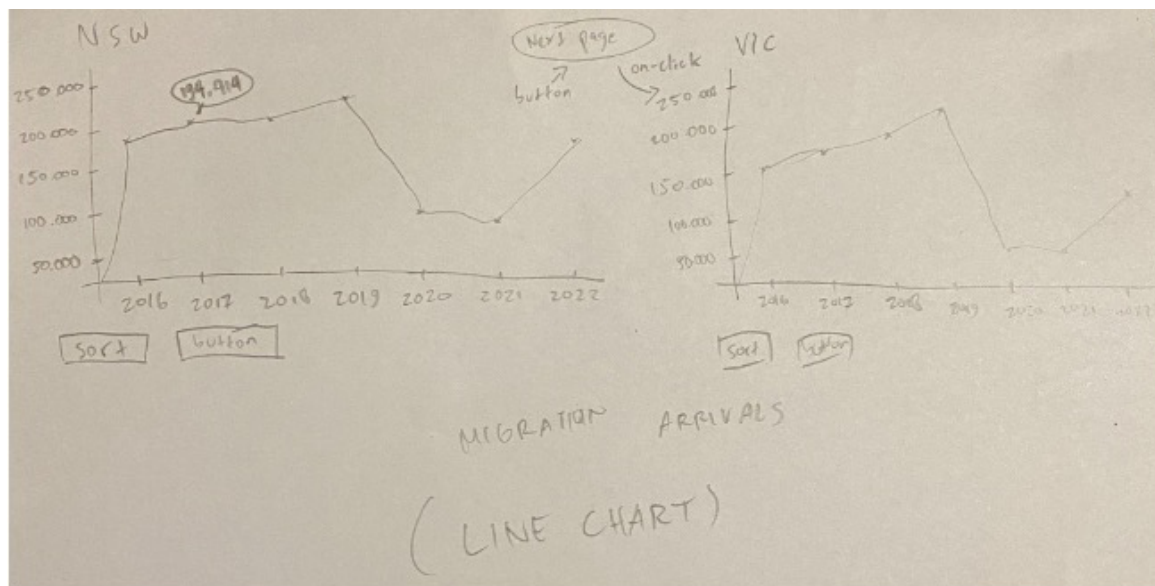


Figure 2: Line Graph Initial Sketch.

3. Outbound Migration Pattern (Stacked Bar Chart):

- The initial design idea for the stacked bar chart was to illustrate outbound migration patterns from Australian states.
- The chart would include checkboxes representing different states, allowing users to select or deselect specific states and observe changes in the displayed data.
- The stacked bars would represent the destination regions or countries for outbound migration, with each segment indicating the migration volume to a particular destination.

Sketch of Initial Design:

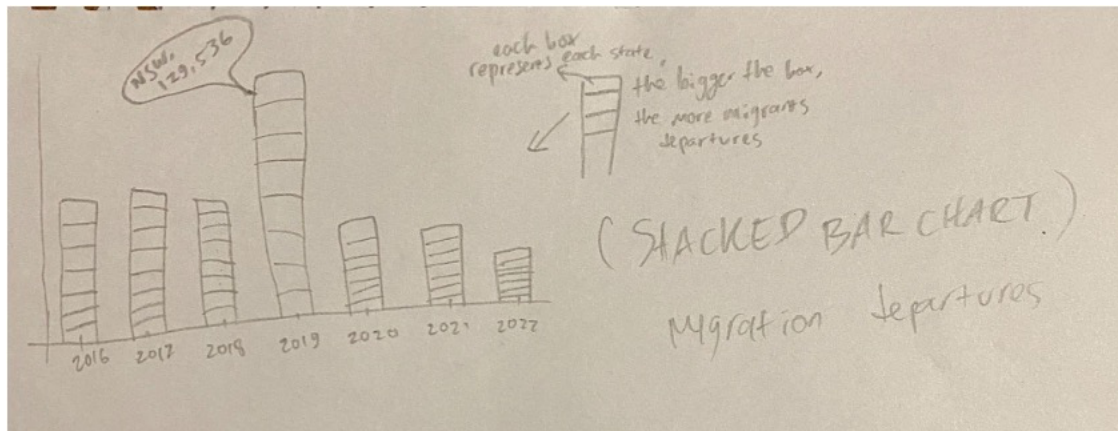


Figure 3: Stacked Bar Chart Initial Sketch.

4.2 Evolution of the Design

During the design process, we iterated on the initial ideas and made improvements based on feedback and usability considerations. The designs evolved as follows:

Choropleth Map:

- The color encoding for the choropleth map was refined to create a smooth gradient that accurately represented the volume of inbound migration.
- The connection lines between countries and states were made more prominent to enhance the visual representation of migration flow.
- The final design incorporated tooltips to provide detailed information about the migration volumes and country origins.

Screenshot of Final Design:

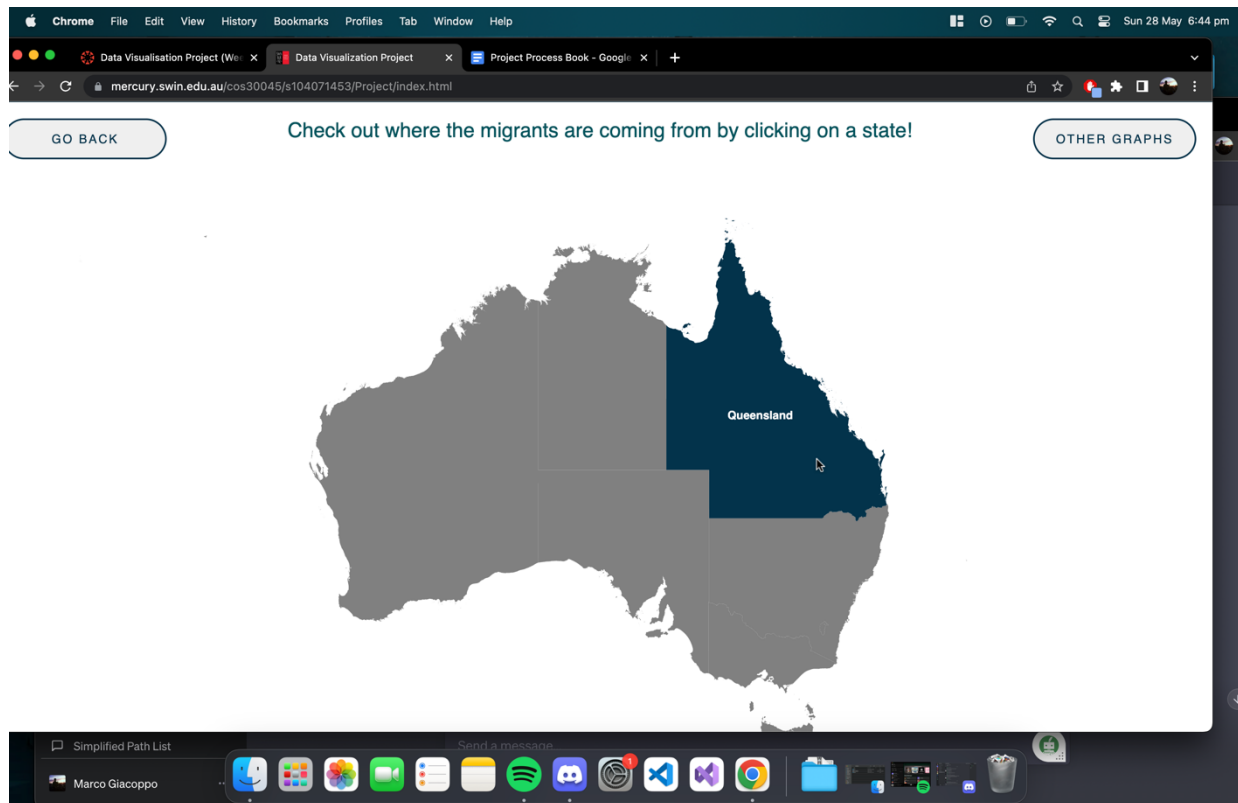


Figure 4: Choropleth Australia Map Final Design.



Figure 5: Choropleth World Map Final Design.

Line Graph:

- The line graph design was enhanced with animated transitions to improve the user experience.
- When users clicked on a specific state button, the dots representing the migration volumes appeared first, followed by the lines forming and connecting them.
- This transition effect made it easier for users to track and understand the migration trends over time.

Screenshot of final Design:

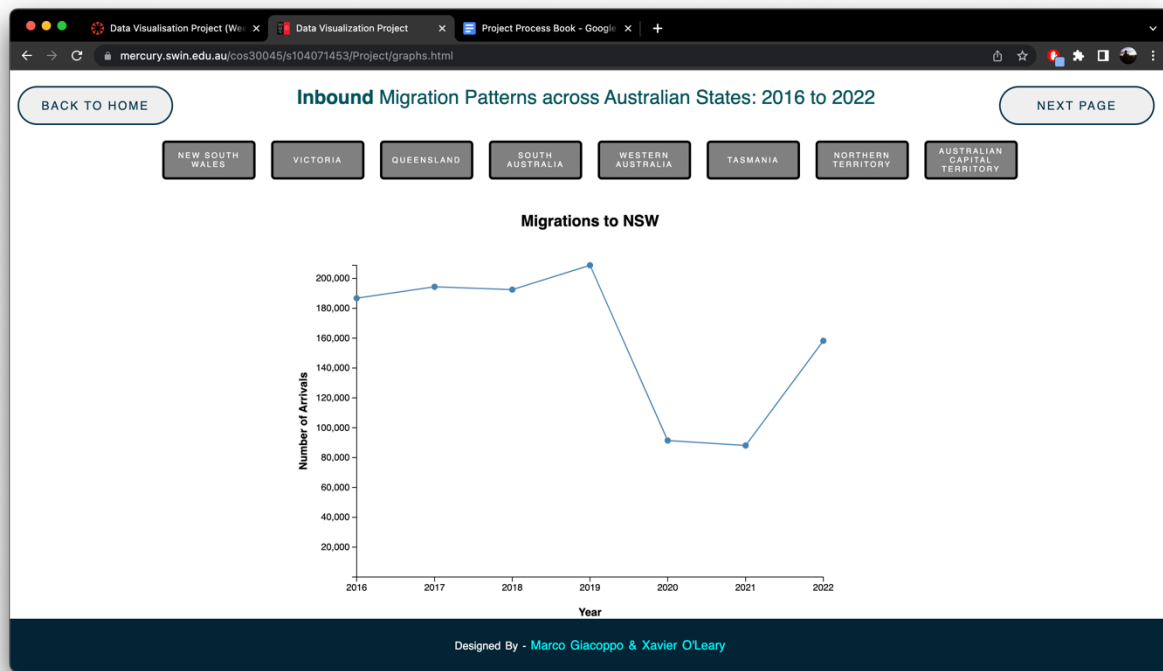


Figure 6: Line Graph Final Design.

Stacked Bar Chart:

- The stacked bar chart design was refined to include tooltips showing the exact volume of migration for each state segment.
- The bar thickness was adjusted to accurately represent the migration volume, with thicker bars indicating larger migration volumes.
- The interactive checkbox feature allowed users to select or deselect specific states and observe changes in the displayed data.

Screenshot of final Design:

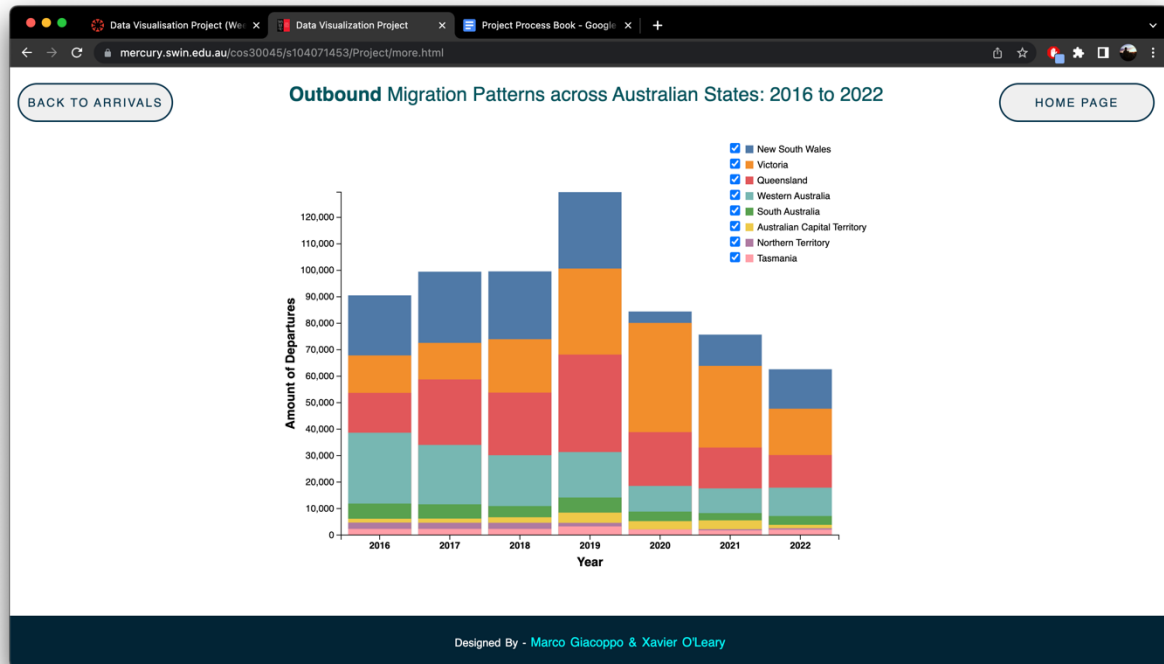


Figure 7: Stacked Bar Chart Final Design.

4.3 Justification of Visual Encoding and Idioms

Choropleth Map:

- The use of color encoding in the choropleth map allows for a clear representation of the volume of inbound migration in each state.
- The color gradient provides a visual hierarchy, enabling users to quickly identify states with higher or lower migration volumes.
- The connection lines between countries and states help users understand the origin of migrants and visualize the migration flow across borders.

Line Graph:

- The line graph is a suitable choice to illustrate migration trends over time for different states.
- Using lines to connect the data points enables users to observe the overall patterns and identify any significant changes.

- The use of dots as markers for each data point helps users pinpoint specific migration volumes and compare them across years and states.

Stacked Bar Chart:

- The stacked bar chart effectively shows the outbound migration patterns from Australian states.
- The tooltips provide precise information about the migration volumes for each state segment, allowing users to gain detailed insights.
- The use of bar thickness helps users understand the relative magnitude of migration volumes between different states.

These visual encoding decisions were made to make the migration data clear, simple to understand, and effectively communicated to users. The designs changed as a result of iterative procedures and feedback, yielding visually appealing and useful data visualizations.

5 Conclusion

In conclusion, the process of creating our website for visualizing human migration has been enlightening and fruitful. We wanted to develop an interactive platform that highlights the patterns and trends of human migrations, with a particular emphasis on Australia, through this project.

A map of Australia that lets users look up where immigrants came from was one of the key features we implemented. Users could quickly switch to a world map that showed the connections between nations and the corresponding migration flows by clicking on regions. This feature gave viewers a thorough understanding of the global nature of human migration while highlighting the various origins of those looking for fresh experiences and opportunities.

We also included a line graph and a stacked bar chart that showed the number of immigrants who arrived and departed in Australia, broken down by state. Users were able to spot trends and changes over time by using this visualization to analyze and compare the migration wave across various regions. We wanted to make the information easier to understand and produce valuable insights about the country's migration trends.

Throughout the project, we encountered challenges and made iterative design decisions to improve the user experience and effectively communicate the data. We implemented features such as tooltips, transitions, and interactive elements to enhance interactivity and engagement. We also incorporated visual encoding techniques, including color gradients, connection lines, and bar thickness, to convey information effectively and facilitate data interpretation.

Overall, this project provided us with hands-on experience in designing and implementing data visualizations. We gained a deeper understanding of data preparation, iterative design processes, visual encoding techniques, user interaction, and the importance of balancing aesthetics and functionality. These lessons will undoubtedly be valuable in future data visualization endeavors, equipping us with the skills necessary to effectively communicate insights and tell compelling data-driven stories.

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