Project Process Book

MIGRATION OF INDIA DATA VISUALISATION

https://cos30045-group8.netlify.app/

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1. Introduction

1.1 Background and Motivation

The intended audience for our six data visualisations encompasses a diverse group, including individuals, policymakers, researchers, and organizations with a keen interest in comprehending the intricacies and ramifications of migration in India. This user base holds various roles and exhibits different interests, ranging from government officials and policymakers, researchers and analysts, and organisations to the general public.

For government officials and policymakers, our choropleth map and heatmap data visualisations, which delve into the unemployment rates of 2023 in different states of India and the wages disparities between India and other countries, hold immense significance. These visualisations are crucial for making well-informed decisions and addressing socio-economic challenges. They provide a valuable tool for formulating and evaluating policies related to immigration and economic development.

Similarly, researchers and analysts, tasked with studying migration trends and their impact on socio-economic factors, find our sunburst chart data visualisation particularly useful. This visualisation, which represents the population of India each year, contributes to academic research, informs studies on population dynamics, and supports social analysis.

Furthermore, organizations such as Non-Governmental Organizations (NGOs) can harness the insights from our stacked bar chart, which focuses on the relationship between diseases and migration. This data visualisation helps organizations understand migration patterns, enabling targeted interventions and assistance programs and contribute to designing initiatives that address the specific needs of migrant populations and contribute to the promotion of social welfare.

For the general public, our Doughnut Chart data visualisation provides accessible insights into the causes, consequences, and trends of migration in India. It serves as an informative tool for understanding the reasons behind Indian migration.

The importance of our data visualisations spans various critical aspects of socio-economic dynamics in India. Firstly, the unemployment rate visualisation, empowers policymakers to make informed decisions about employment strategies and interventions, crucial for addressing socioeconomic disparities. Also, by addressing unemployment through targeted strategies informed by the unemployment rate visualisation, individuals are more likely to find stable employment opportunities within their home country. Secondly, the reason for migration visualisation, encompassing gender-specific data, aids in crafting policies tailored to the diverse needs of migrant populations, fostering social inclusion and integration. Additionally, understanding the specific reasons for migration enables policymakers to implement measures that directly address the root causes, creating a more conducive environment for people to stay. Thirdly,

wages disparities across countries, presented in our visualisations, offer insights into global economic trends, enabling policymakers to make informed decisions on labour-related policies for sustainable development. Also, the economic planning facilitated by wages disparities and demographic insights further aids in creating opportunities, improving living standards, and reducing the allure of seeking employment abroad. Moreover, our visualisations on international migration from India and the impact on metropolitan areas provide essential data for understanding the scale and implications of global diaspora, guiding diplomatic and urban planning decisions. Additionally, the age-group analysis from the population visualisation aids in demographic planning, influencing policies related to education, healthcare, and workforce development. The visualisation of disease prevalence affecting migration provides invaluable information for public health planning, allowing targeted healthcare strategies to address the unique health needs of migrants, thus enhancing overall well-being. In summary, our data visualisations play a pivotal role in fostering informed decision-making, socio-economic inclusivity, and sustainable development in India thereby reducing the chances of people emigrating.

1.2 Visualisation Purpose

The visualisations empower users to explore and comprehend various facets of migration in India, offering valuable insights and answers to a multitude of questions.

Through the Unemployment Rate of 2023 in India visualisation, users can discern the state-wise distribution of unemployment in 2023, identifying regions with higher or lower rates and understanding the national landscape. This realization underscores the impact of high unemployment as a motivating factor for Indian people to immigrate. By exploring the Indian Migration Reason visualisation, users can acquire insights into the primary reasons for migration concerning a specific gender. This analysis enables the identification of differences in migration patterns between genders and highlights factors that exert a significant impact on migration decisions.

Wages of Various Countries visualisation assists users in grasping the average salary comparison across different countries. It facilitates an understanding of how India's monthly and hourly wage structures compare with those of other nations. Additionally, it helps identify specific countries with higher or lower monthly and hourly wage levels. This visualisation facilitates a comparative analysis of global wage structures, aiding in understanding India's economic competitiveness. The Disease Leads to Migration visualisation allows users to comprehend the prevalence of diseases among immigrants in India. Additionally, it provides insights into which specific diseases contribute to the highest number of immigrants.

Migration from India to Other Countries visualisation offers users insights into the specific metro area of the country to which most Indians immigrate and the total number of Indian immigrants in the specific metro area of the country. Additionally, users can determine the percentage of Indian migration relative to the population of each country's metro area. Furthermore, Population of India visualisation enables users to observe the distribution of India's population across different age groups and track how the population has evolved over time.

The benefits of the completed visualizations are multifold, providing users with a comprehensive understanding of various aspects of migration in India. These insights empower users to make informed decisions, implement targeted interventions, contribute to academic research, and raise public awareness. For instance, policymakers can leverage the Unemployment Rate of 2023 in India visualization to make informed decisions about regional employment strategies, addressing socio-economic disparities effectively. This data-driven approach aids in tailoring interventions based on state-wise unemployment patterns. Next, Non-Governmental Organizations (NGOs) and other organizations can use visualizations like Disease Leads to Migration to design targeted health interventions and assistance programs. Understanding prevalent diseases among migrants is crucial for enhancing overall well-being and planning effective healthcare strategies. Furthermore, researchers can utilize visualizations across the Population of India charts for academic research on population dynamics, socio-economic factors, and migration trends. The detailed data provided by the visualizations contributes valuable insights for in-depth analysis and scholarly exploration. Lastly, the visualizations raise public awareness about the complex interplay between unemployment, migration, and health. By presenting data in a visually accessible format, these visualizations foster a more informed and engaged society, encouraging dialogue and understanding of critical issues.

In summary, the completed visualizations serve as powerful tools for decision-makers, researchers, organizations, and the public, offering diverse benefits that extend to policy formulation, targeted interventions, academic exploration, and societal awareness.

1.3 Project Schedule

Week 3

Activity

1. Conducted research on migration information.
2. Filtered out several suitable countries for our project and discussed with team members to decide which one was more suitable.
3. Read the Project Process Book instructions.

Deadline for this week: 9 September 2023

Week 4

Activity:

1. Discuss and finalize the project title.
2. Identify and retrieve datasets from online sources.
3. Determining the titles for the charts.
4. Search for suitable charts corresponding to each dataset.
5. Participated in and contributed to Stand-Up 1 meeting in class.

Deadline for this week: 16 September 2023

Week 5

Activity:

1. Research on Indian migration details to gain further insights and a deeper understanding of the various aspects of migration in India.
2. Research datasets that related to India.
3. Trying different research methods and sources to uncover diverse and valuable information that could contribute to the project's dataset collection.

Deadline for this week: 23 September 2023

Week 6

Activity:

1. Presented the datasets collected by each team member and discuss the which datasets are suitable for the project.
2. Identify the 6 datasets required for the project.
3. Renamed the dataset titles to enhance clarity and compatibility with the charts.

Deadline for this week: 30 September 2023

Week 7

Activity:

1. Determine and assign the types of charts for each dataset.
2. Generate 6 CSV files by extracting the essential data from the datasets we found.
3. Assign development responsibilities for each chart to every team member.

Deadline for this week: 7 October 2023

Week 8

Activity:

1. Research on the chart templates as references for development.
2. Create a new project in Figma to sketch the chart prototype: here is the protype link [1]
3. Conduct research and commence the development of the charts.

Deadline for this week: 14 October 2023

Week 9

Activity:

1. Should filter out all necessary data and organize it into relevant CSV files.
2. Completed the development of at least one chart.
3. Should finish sketching the chart prototype in Figma.

Deadline for this week: 21 October 2023

Week 10

Activity:

1. Completed the development of at least one chart.
2. Identified and selected the cover page for the Project Process Book.
3. Participated in and contributed to Stand-Up 2 meeting in class.
4. Compiled a comprehensive list of all required features for each chart in point form within the Project Process Book.

Deadline for this week: 28 October 2023

Week 11

Activity:

1. Continued development on the remaining charts.
2. Completed the development of the landing page for the charts.
3. Progressed on the Project Process Book of the data source.

Deadline for this week: 4 November 2023

Week 12

Activity:

1. Completed the development of at least two charts.
2. Accomplished the task of finishing the design sketches through hand drawings.
3. Participated in and contributed to Stand-Up 3 meeting in class.

Deadline for this week: 11 November 2023

Week 13

Activity:

1. Should complete the development of the last two charts.
2. Should complete the addition of explanatory paragraphs to at least three charts, enhancing the understanding and context of the visualized data.
3. Complete the Project Process Book.

Deadline for this week: 18 November 2023

Week 14

Activity:

1. Check the Project Process Book to ensure accuracy and completeness.
2. Sumit the Project Process Book including all the necessary files.
3. Participated in and contributed to Stand-Up 4 meeting in class.

Deadline for this week: 20 November 2023

2. Data

2.1 Data Source

2.1.1. Unemployment Rate of 2023 in India:

We obtained the unemployment rate in India dataset from an article, and the data source is from [2]. The dataset is presented in tabular form within the article. So, we can input all the data into our CSV file by following the tabular form.

There are 2 attributes in the original dataset, and they are "State" and "% of Unemployment Rate in India". Both attributes are being utilized in our data visualisation. Also, to enhance clarity, we have renamed "% of Unemployment Rate in India" to "Unemployment_Percentage_in_2023" and the “State” remains the same.

Our “State” cannot be measured in numerical terms, and it can be divided into categories, so it is qualitative data. Also, it is categorical data because it belongs to a specific category, and there is no inherent order or numeric significance to the states. Then, "Unemployment_Percentage_in_2023" is quantitative because it involves numerical values that can be measured and compared. Moreover, it specifically ratio data, because it represents a percentage, and ratios in this context, have a clear definition of zero. For instance, a value of 0% indicates the complete absence of unemployment, making it a quantitative indicator with meaningful ratios for analysis and comparison.

2.1.2. Indian Migration Reasons

We obtained the Indian migration reason dataset from an article, and the data source is from [3]. The dataset is presented in tabular form within the article. So, we can input all the data into our CSV file by following the tabular form.

There are 4 attributes in the original dataset, and they are "reason of migration", "female", "male" and "person". The selected attributes are “reason of migration", "female" and "male". The decision to exclude "person" is based on its lack of meaningful explanation in the articles under consideration.

“reason_for_migration” does not involve numerical measurements so it is qualitative data. Then, “reason_for_migration” is categorical data also because it represents different categories or reasons for migration. Moreover, both "male" and "female" are quantitative and ratio data due to their incorporation of numerical measurements expressed in percentages and the presence of a meaningful zero point further emphasizes their quantitative nature.

2.1.3. Wages of Various Countries

We obtained the wages of various countries' dataset from a working paper website, and the data source is from [4]. The dataset is presented in a CSV file within the working paper website. So, we can download the CSV file then collect and filter the required data.

The original dataset comprises 63 attributes, and for data visualization, the selected attributes include "year," "country_code," "country_name," "hw3wl_us," and "mw3wl_us." For improved clarity, we have renamed "hw3wl_us" to "hour_wages" and "mw3wl_us" to "monthly_wages." The rationale for not selecting the other attributes is that they exhibit similarity and adhere to a different standard. For instance, attributes like "hw1wl_current" represent the mean wages of hourly workers in standard data without calibration, specifically denoted in Lex, LCU (reported), while "hw2wl_current" represents the mean hourly wages with country-specific calibration, also in Lex, LCU (reported).

The “year” is ordinal data because it indicates a chronological order. Next, "country_code" and "country_name" are categorical data because they are used to represent categories and labels without inherent numerical significance. Moreover, "monthly_wages" and "hourly_wages" are quantitative data and under the category of ratio data because they are numerical and can be measured.

2.1.4. Disease leads to migration

We obtained the disease leads to migration dataset from an article, and the data source is from [5]. The dataset is presented in an image-tabulated form within the article. So, we can input all the data into our CSV file by following the image-tabulated form.

The original dataset comprises 16 attributes, and for data visualisation, the selected attributes from the original dataset include "Disease Category", "male", "<40 years", ">=40 years" and "Prevalence among migrants". Also, we combine those attributes to become 3 attributes which are “disease_category”, “male_less_than_40_years” and “male_more_than_39_years”. The rationale for not selecting the “Prevalence among non-migrants” attributes is it is not related to our title. Furthermore, the reason for excluding the "female" attribute is the prevalence of numerous instances where the values are consistently 0. To avoid confusion, we have opted to utilize only the data pertaining to males. Also, given that the attribute values are for males and females combined, therefore excluded the “overall prevalence” attribute to simplify and focus our data visualisation.

"disease_category" is categorical data because it represents different categories of diseases, making it a categorical data type. Then, "male_less_than_40_years" and

"male_more_than_39_years" are ratio data because they involve numerical values that can be measured and compared.

2.1.5. Immigration From India to Other Countries

We obtained the immigration from India to other countries dataset from an article, and the data source is from [6]. The dataset is presented in an image-tabulated form within the article. So, we can input all the data into our CSV file by following the image-tabulated form.

There are 3 attributes in the original dataset, and they are "Metropolitan Area", "Immigrant Population from India" and "% of Metro Area Population". Three of the attributes are being utilized in our data visualisation. Also, to enhance clarity, renamed "% of Metro Area Population" to "percentage_of_metro_area_population" and the replaced spaces with underscores and converted to lowercase such as "metropolitan_area" and "immigrant_population_from_india".

"metropolitan_area" is categorical data because it presents different metropolitan areas. Next, for the "immigrant_population_from_india" and "percentage_of_metro_area_population" are ratio data because they involve numerical values, and they can be measured and compared.

2.1.6. Population of India

We obtained the population of India dataset from the United Nations data bank, and the data source is from [7]. The dataset is presented in CSV files within the United Nations data bank. So, we can download the CSV file then collect and filter the required data.

The original dataset includes 12 attributes along with an age range from 0 to 100 attributes. Due to the multitude of attributes, we have consolidated the age range variables into a unified attribute named "age group" for simplification. So, the finalized set of attributes for data visualization comprises 3 attributes which are "Year", "Age_Group" and "Value". The rationale for not selecting the other attributes is they are not related to our title.

"Year" is ordinal data because it represents different years and has a meaningful order but no consistent interval between them. "Age_Group" is categorical data because it represents distinct groups into which classified based on age. "Value" is ratio data because it represents a numerical measure that has a true zero point and allows for meaningful ratios.

2.2 Data Processing

Extensive data cleaning was conducted on the wages of various countries and the population of India due to the substantial volume of data.

For instance, focusing on the population of India, we filtered out non-Indian entries, selected data from the past 5 years, and aggregated 100 single-age population attributes into distinct age ranges, including Age 0-18, Age 19-30, Age 31-40, Age 41-50, Age 51-60, Age 60-70, Age 71-80, Age 81-90, Age 91-99 and Age 100+. Subsequently, we summed up the values within each age range. Additionally, unrelated attributes underwent cleanup for improved dataset clarity. Following these adjustments, the dataset now comprises a total of three attributes and 150 values is a derived result from the data processing steps.

Subsequently, dealing with the wages of various countries, which presented extensive data, even after filtering for the required years, the dataset still comprised 36013 entries and 63 attributes. Furthermore, the dataset contains numerous similar attributes that can be cleaned. For instance, "mw1wl_current" signifies monthly standard data without calibration in Lex, LCU (reported), while "mw3wl_current" represents monthly country-specific calibration with imputation in Lex, LCU (reported), and so forth. To clean up the dataset for relevance to the project, a multi-step process was employed. Initially, numerous unrelated attributes were removed. Then, the dataset was filtered for attribute "y3," denoting industry code, selecting only JC. Subsequently, entries with the number 74 in attribute "y4," signifying occupation code, were filtered out. Lastly, the dataset was refined to include data from seven specific countries, including India. Following these filtering and cleaning steps, the dataset was ultimately condensed to retain only 5 attributes and 245 values.

In the Indian Migration Reason dataset, we eliminated one attribute which is “person” that lacked a meaningful explanation in the articles. To summarize, there are 42 values and 3 attributes.

In the Disease Leads to Migration dataset, we excluded the "female" attribute along with the prevalence among migrants in" <40 years" and ">=40 years" attributes due to the prevalence of numerous zero values, which could render the data incomplete. Additionally, we eliminated one attribute that lacked a meaningful explanation in the articles. Next, we selected 5 specific disease categories for our data visualisation. To summarize, our dataset comprises 3 attributes and a total of 15 values.

There is no data cleaning conducted on the datasets of the Unemployment Rate of 2023 in India and Immigration from India to Other Countries. There are some name replacements for those datasets. For the Unemployment Rate of 2023 in India dataset has 2 attributes and 54 values and for Immigration from India to Other Countries dataset has 3 attributes and 30 values.

3. Requirements

3.1 Must-Have Features

In our endeavour to develop a comprehensive suite of data visualizations, we prioritized user experience by incorporating various essential features across multiple charts. Fundamental to our approach was the integration of mouse-over tooltips, ensuring that users could effortlessly access detailed information by simply hovering over specific data points in all charts. This deliberate inclusion aimed to amplify data visibility and foster user interaction, contributing to an enriched analytical experience. These features will be included in all data visualizations.

Moreover, recognizing the significance of interpretability, we incorporated a color legend in 5 data visualisations which are the Unemployment Rate of 2023 in India, Indian Migration Reasons, Wages of Various Countries, Disease leads to migration and Population of India, strategically designed to illustrate the data ranges. The color-coded representations not only added a visually appealing element to the data but also facilitated a more accessible interpretation for users, promoting a user-friendly environment.

Moreover, our commitment to interactivity led us to introduce filter buttons across the Unemployment Rate of 2023 in India, Wages of Various Countries, and Indian Migration Reasons charts. These buttons empower users to selectively focus on specific data subsets of interest. For instance, in the Heatmap Chart for depicting wages of various countries, the integration of filter buttons enables users to dynamically emphasize a chosen country while rendering others transparent. This interactive feature aims to provide users with a more tailored and focused view of the data, aligning with our dedication to user-centric design. Furthermore, the integration of on-click functions, particularly in the Unemployment Rate of 2023 in India chart, adds an extra layer of user engagement and exploration.

The absence of these crucial features in the charts would be considered a failure in meeting our project objectives. Thus, our commitment remains steadfast in delivering these promised functionalities, ensuring a robust and user-friendly data visualization experience for our audience.

3.2 Optional Features

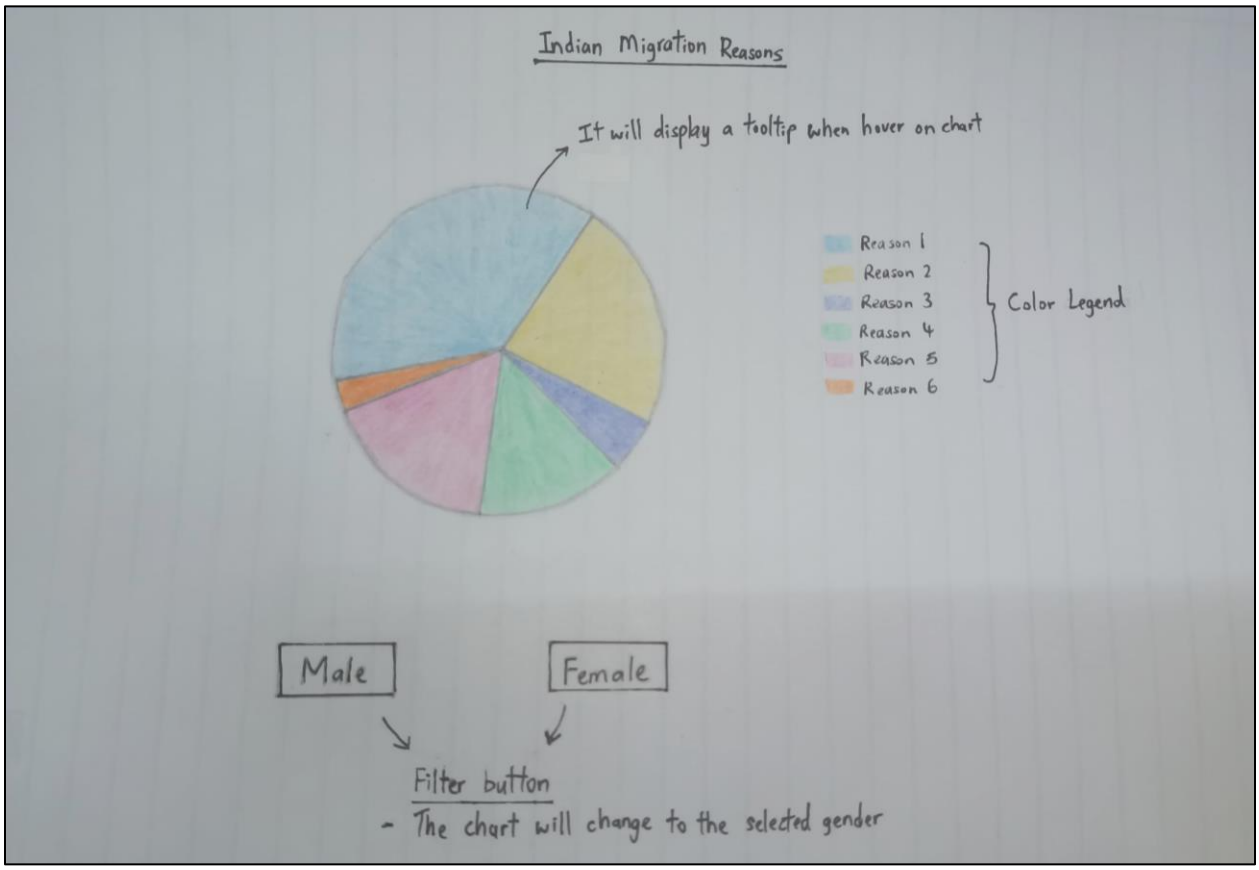
We considered the implementation of three additional features that we believe would be beneficial, they are table form features for displaying more details, a search bar feature, and a zoom-in and zoom-out feature for the choropleth map.

In data visualisations, we have successfully implemented those additional features that, while not deemed critical, significantly enhance the overall functionality and user experience. Specifically, we introduced search bars in charts like unemployment and immigration, facilitating efficient searching for specific data points. Additionally, we implemented a table for details feature, where clicking the filter button not only affects the chart but also dynamically displays the selected data in table form. This feature will be displayed in the charts for the Unemployment Rate of 2023 in India, Wages of Various Countries, and Population of India. This enhancement offers users a comprehensive view of specific details and facilitates a more in-depth analysis.

4. Visualisation Design

To effectively convey diverse datasets related to India, a strategic selection of visualizations has been made. The Unemployment Rate of 2023 in India is aptly represented through a Choropleth Map, allowing for a geographical overview of unemployment distribution across different states. The Indian Migration Reasons are succinctly illustrated using a Doughnut Chart, providing a categorical breakdown that enhances understanding. Wages of Various Countries are compared using a heat map, utilizing color gradients to highlight variations in wage levels comprehensively. The disease that leads to migration is elucidated through a Stacked Bar Chart, offering a visual hierarchy of disease categories contributing to migration patterns. Immigration from India to other countries is visualized dynamically with a Bubble Chart, where each bubble corresponds to a country and its size correlates with the magnitude of immigration. Lastly, the Population of India is presented in a Sunburst Chart, offering a hierarchical view of demographic data. These visualizations, carefully chosen for their appropriateness to the respective datasets, collectively aim to provide a comprehensive and accessible understanding of the intricate facets of Indian data.

4.1. Doughnut Chart: Wages of Various Countries



For the pie chart visualization design, we aim to incorporate several interactive features to enhance user understanding. The chart will show the percentage of Indian males and females migrating for different reasons. Firstly, we plan to implement a tooltip feature, allowing users to hover over individual segments to view detailed information such as the specific reason for migration and the corresponding percentage. Additionally, we intend to include a filter button feature, enabling users to dynamically switch between different gender categories, providing a more comprehensive view of the data. Furthermore, a color legend will be integrated, offering a visual guide to the various reasons for migration, and enhancing overall interpretability.

For the alternative ideas for the pie chart, we consider using a doughnut chart instead of a standard pie chart. The doughnut offers a more visually appealing appearance compared to conventional pie charts. Another alternative idea is to substitute the conventional filter button with a radio button with one update button for a different interaction style.

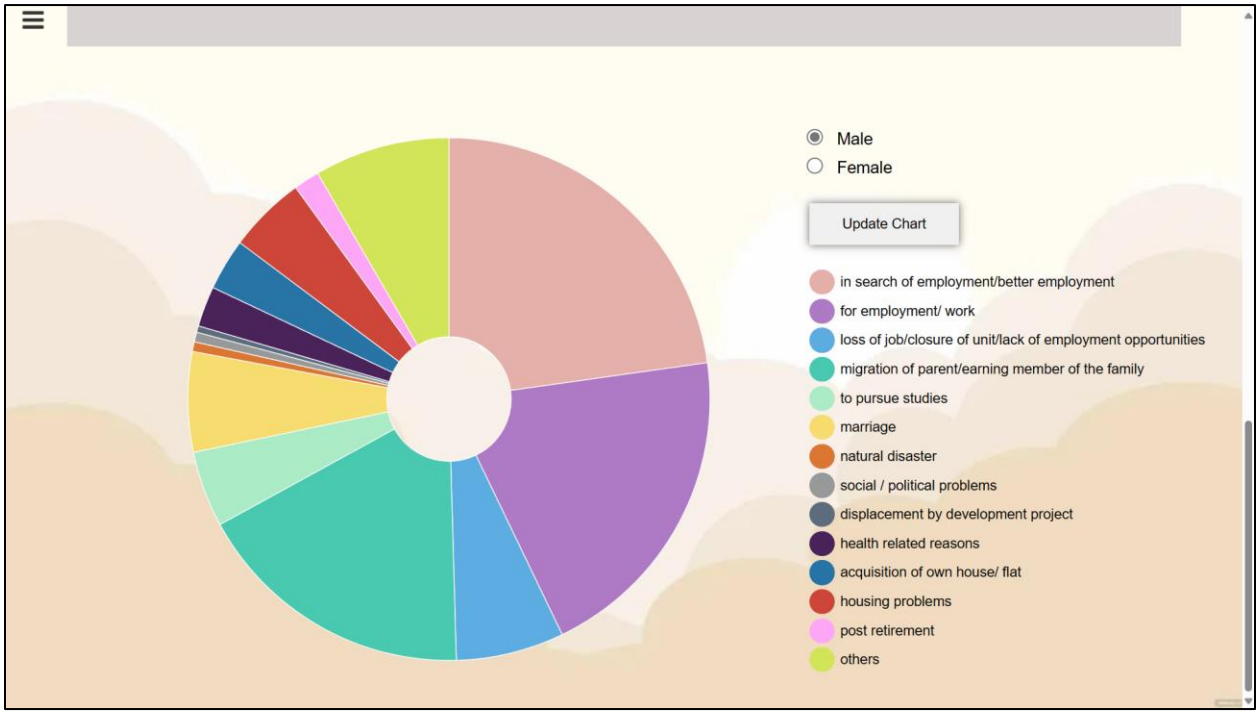
For our pie chart's visual encoding, we utilize the areas as the marks. Then, we utilize channels which are the size which is the area for the percentage value in the pie charts and the color hue is employed to distinguish reason categories, assigning a unique color to each slice. Additionally, the

containment mark is applied, using the entire pie chart to encapsulate information about the overall distribution and proportions of different categories.

The evolution of pie chart design involves iteration and considerations for enhancing user experience. Initially, the focus was on creating a clear and informative representation of the causes of Indian immigration, with the standard pie chart chosen for its simplicity and familiarity. Tone, size and curb markings have been carefully chosen to effectively encode data, providing visual appeal and clarity. As the design evolved, we decided to use alternative ideas which are using the doughnut charts and radio buttons instead of conventional filter buttons, aiming to enhance visual appeal and interactivity. Also, interactive features were introduced to increase user engagement. Tooltip functionality has been incorporated to provide users with on-demand details, making visualizations more user-friendly. The ratio filter button functionality enables users to explore data based on gender, providing a dynamic and customizable experience.

The chosen visualisation idioms for the pie chart design are justified to enhance user understanding and engagement. The inclusion of a tooltip feature allows users to gain detailed insights by hovering over segments, providing clarity on specific reasons for migration and their corresponding percentages. The filter button feature facilitates dynamic exploration across different gender categories, offering a comprehensive view. Alternative ideas, like using a doughnut chart and radio buttons, aim to improve visual appeal and interactivity. The doughnut chart provides a visually appealing alternative, while the radio button introduces a different interaction style for enhanced user experience.

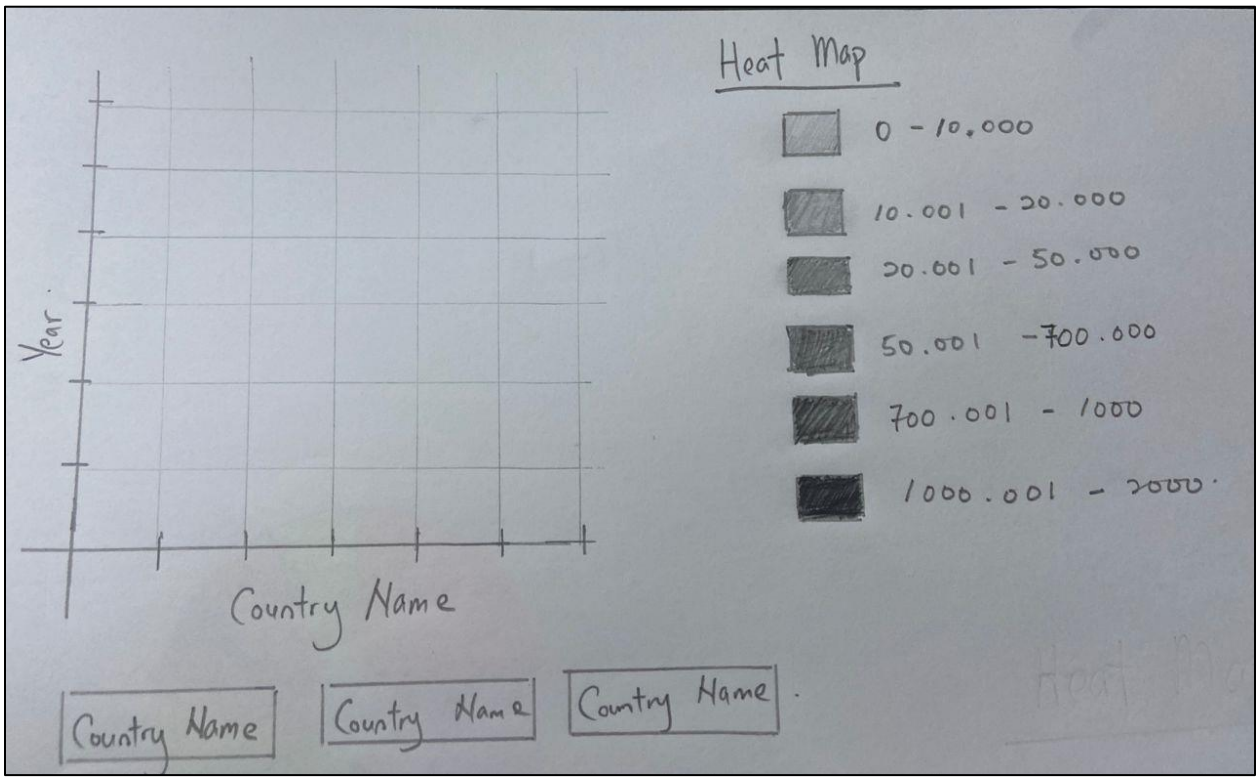
Final design of chart:



In the final design of the chart, we implemented both alternative ideas for the chart from the pie chart to the doughnut chart and the radio button with a filter button. Also, the visualization incorporates a tooltip feature, radio filter buttons feature and a color legend. The color hue is used to distinguish between different reason categories, and the size of each segment represents the percentage value. This final design ensures a user-friendly, interactive, and visually informative representation of migration data.

We are using this reference code [8] as the foundation for our modifications.

4.2. Heatmap Chart: Wages of Various Countries



This visual representation will illustrate monthly salaries across various countries, with a color-gradient scheme facilitating straightforward comparisons. For the heatmap chart depicting wages of various countries, several design considerations aim to enhance data visibility and comprehension. Firstly, a color gradient will be employed, ranging from light blue to dark blue tones, to represent the wage levels. This will allow users to quickly discern low and high-wage regions. Additionally, tooltips will be implemented to provide detailed information when hovering over each country, including specific monthly and hourly wage values. The heatmap will be organized with clear labels and axes, ensuring intuitive navigation. To facilitate interactivity, a legend explaining the color range will be included. Also, the heat map also contains filter buttons

to filter out selected countries, and the chart will dynamically adjust based on the selected criteria. This visualization aims to offer an insightful and accessible representation of various countries' wage disparities.

In terms of refining the color legend, the first alternative idea is to transform the existing rectangular color range into ten square segments, each representing a distinct wage range. Alongside these color squares, clear annotations can be included to indicate the numerical values associated with each color. This modification aims to improve the clarity and precision of the color legend, making it more user-friendly and facilitating a quicker interpretation of wage levels. The visual representation of wage ranges through squares can contribute to a more intuitive and visually appealing design. The second alternative proposes a stacked bar chart to represent hourly and monthly wages, offering a straightforward comparison between countries. Each country is depicted by a vertical bar, and the height of the bar corresponds to its wage level.

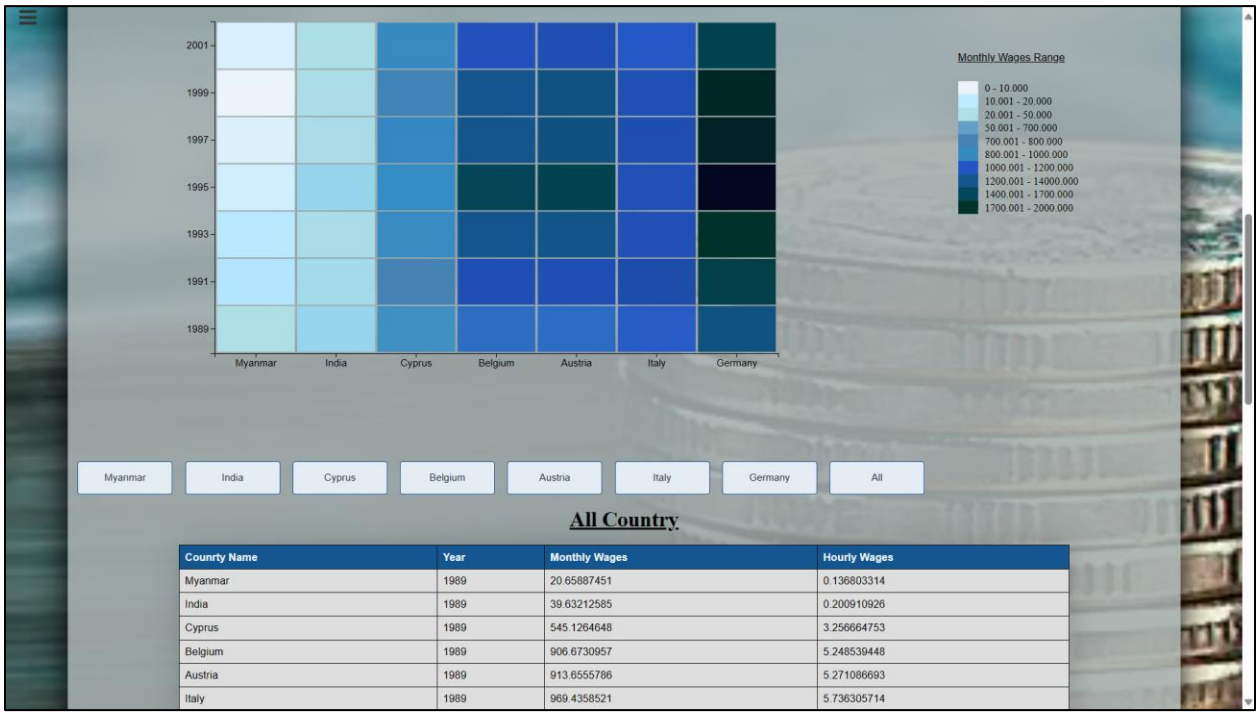
In the visual encoding of heatmaps, the primary idiom involves representing data using rectangular areas. Additionally, it employs channels for horizontal and vertical positions, along with color saturation, to effectively convey a matrix of data values. This approach enhances the viewer's ability to recognize patterns and variations within the dataset. The structured grid layout facilitates the comparison of values across various categories or time points, providing a systematic and organized presentation of information.

In tracing the evolution of the heatmap design, we initially focused on critical considerations, including the selection of a color scheme. Opting for a gradient from light blue to dark blue, we aimed to clearly convey the variation between minimum and maximum values, ensuring user comprehension that darker hues correspond to higher values. The initial layout adopted a conventional rectangular grid, utilizing color saturation to signify data values. Subsequently, to enhance user engagement, interactive elements like tooltips and filter buttons were introduced. And when the user interacts with the filter button, the chart dynamically adjusts based on the selected criteria, enhancing user engagement by providing detailed information on specific data points and enabling dynamic exploration of the dataset. Throughout these stages, we explored alternative ideas and implemented a change for the color legend. We transformed the existing rectangular color range into ten square segments, each representing a distinct wage range. Alongside these color squares, clear annotations can be included to indicate the numerical values associated with each color.

The visualisation idioms chosen for the heatmap design were justified based on their efficacy in conveying complex data patterns and facilitating user understanding. The use of color saturation as a channel for representing data values allows for a quick and intuitive grasp of variations across the matrix. The progression from light to dark hues provides a perceptible indication of value intensity, aiding users in identifying trends or anomalies in the data. Additionally, the adoption of a rectangular grid layout organizes the information systematically, enabling users to compare values across different categories or time points efficiently. The incorporation of interactive elements, such as tooltips and filter buttons, enhances user engagement and provides a dynamic exploration of the dataset. The iterative inclusion of a table form further caters to detailed

information needs, ensuring a comprehensive and user-friendly visualisation that aligns with the inherent characteristics of heatmap data representation.

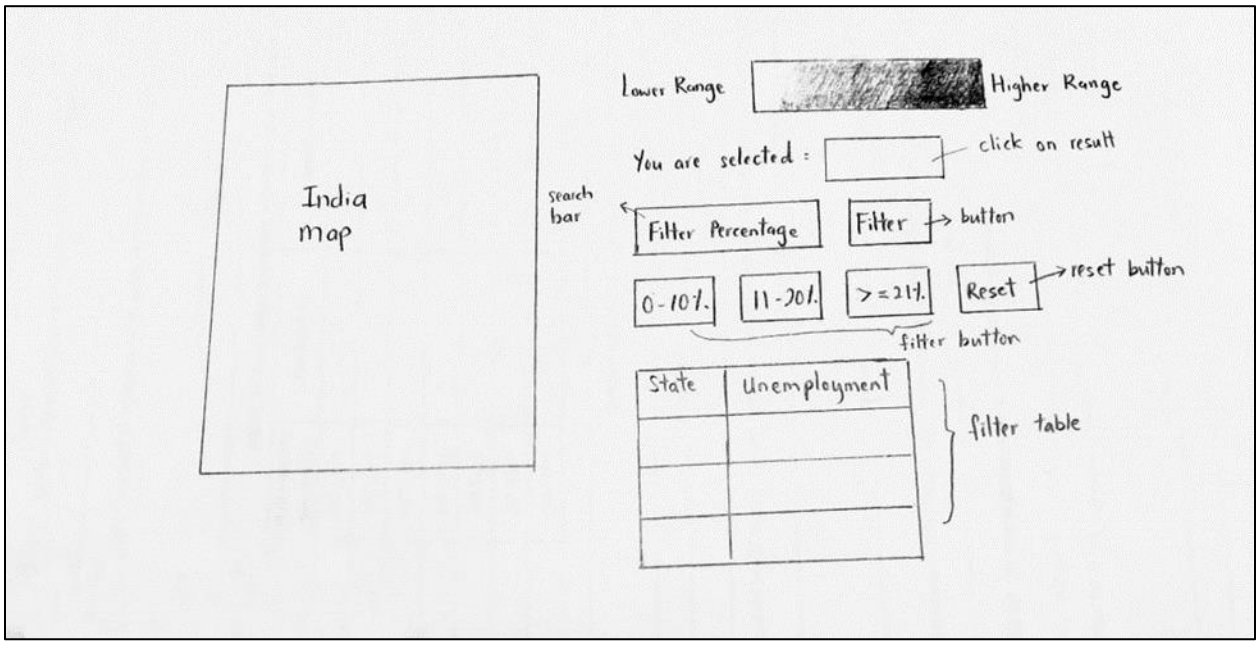
Final design of chart:



In our final heatmap design for visualizing wages of various countries, we implemented the alternative idea for the color legend, and we opted for a color scheme ranging from light blue to dark blue to effectively represent the spectrum of data values. This choice allows users to easily discern differences in wage levels, with darker hues indicating higher wages. The design incorporates interactive elements like tooltips and filter buttons, enhancing user engagement by providing detailed information on specific data points and enabling dynamic exploration of the dataset. Additionally, we iteratively introduced a table form to display more comprehensive information, addressing the need for detailed insights into individual countries. Overall, our final design prioritizes clarity, user interaction, and comprehensive data representation to offer an effective and user-friendly visualization of wages across various countries.

We are using this reference code [9] as the foundation for our modifications.

4.3. Choropleth Map: Unemployment Rate of India for the year 2023



This data visualization which is choropleth map will utilize the map of India to depict the unemployment rate in different states. For the choropleth map visualization design, we plan to employ a color gradient to effectively convey the intensity of data, with darker shades representing higher values. This gradient will provide a visual cue for users to quickly interpret and compare unemployment rates across different regions. To enhance user interaction, we will implement an informative tooltip that appears when hovering over a specific geographic area, offering detailed information about the corresponding unemployment rate. A legend will accompany the map, serving as a reference guide for users to understand the color scale and its associated values. To enhance user flexibility, we have filter buttons, allowing users to concentrate on specific data areas. Additionally, an onclick function will be implemented, dynamically filling the clicked area with a distinct color to indicate selection. Information such as the area name and corresponding unemployment rate will be displayed on the side, providing users with immediate insights upon interaction. Additionally, the visualization includes a search bar for users to filter specific regions based on entered values. Upon confirming the filter or pressing the filter button, a table form will appear below, presenting detailed information related to the selected regions. These design elements collectively aim to deliver a comprehensive and user-friendly choropleth map experience.

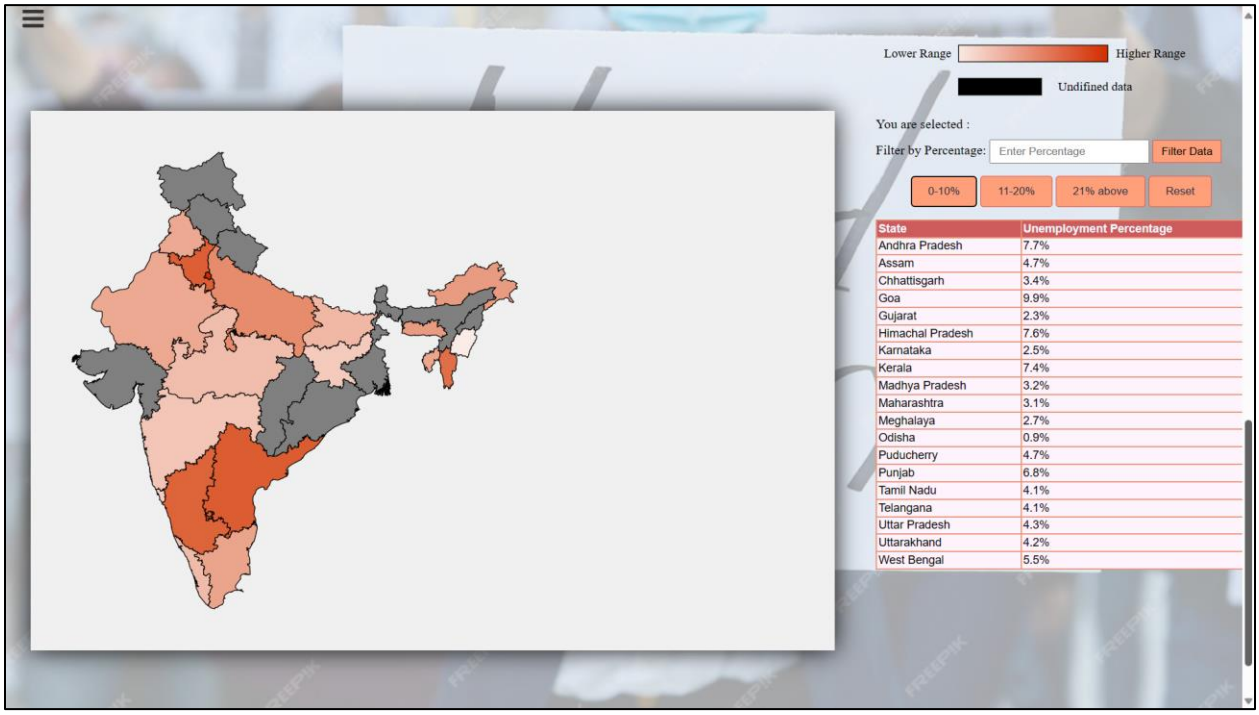
For the first alternative idea, instead of using a choropleth map, we could explore a bubble map where each region is represented by a bubble, and the size of the bubble corresponds to the unemployment rate. This alternative provides a more visual and intuitive representation of the data, allowing users to quickly identify regions with higher or lower unemployment rates. Another alternative is to implement a line chart to illustrate the trend of unemployment rates over time for each region. This alternative adds a temporal dimension to the visualization, allowing users to observe how unemployment rates have changed in different regions over a specified period.

For the choropleth map visual encoding, we utilize the area as the mark, where each geographical region represents a distinct area. The channels employed include color saturation to represent the Unemployment Percentage or the intensity of a particular attribute, providing a visual gradient that indicates variations across regions. The idioms involved in choropleth maps include the use of containment marks for individual geographic areas, employing color gradients to convey information, and often utilizing a legend to aid interpretation by associating colors with specific data ranges. This combination allows for an effective representation of spatial patterns and variations in the chosen dataset.

In the initial design stage of the choropleth chart, we utilized color gradients to communicate data intensity, using darker shades to signify higher values and aiming to distinctly portray variations within the dataset. Subsequently, we introduced interactive features such as hover effects for detailed information and user-friendly filter buttons and onclick functionality to enable more focused exploration of specific areas. As the design evolved, we fine-tuned the details by incorporating a search bar and filter buttons for precise filtering and integrated tabular displays to present comprehensive data beneath the map. These refinements aim to provide users with flexible and information-rich tools that strike a balance between aesthetics and functionality. In the final design, choropleth charts deliver a visually appealing and user-friendly experience, empowering users to interact effectively and derive insights from geographic data.

To justify the visualization idioms chosen for the choropleth map design, the choropleth map design employs a color-based visual encoding idiom to effectively represent geographical variations in the data. The choice of color provides an intuitive and perceptually uniform way to communicate differences in the data values across different regions. We opted for a gradual color gradient of light red to dark red to signify the varying intensity or magnitude of the data, ensuring that users can easily interpret the map and identify regions with higher or lower values. In addition to color encoding, the introduction of interactive features, such as filter buttons and a search bar, adds a layer of user engagement and customization. These features empower users to focus on specific regions of interest or filter the data based on their preferences, contributing to a more personalized and insightful exploration of the choropleth map.

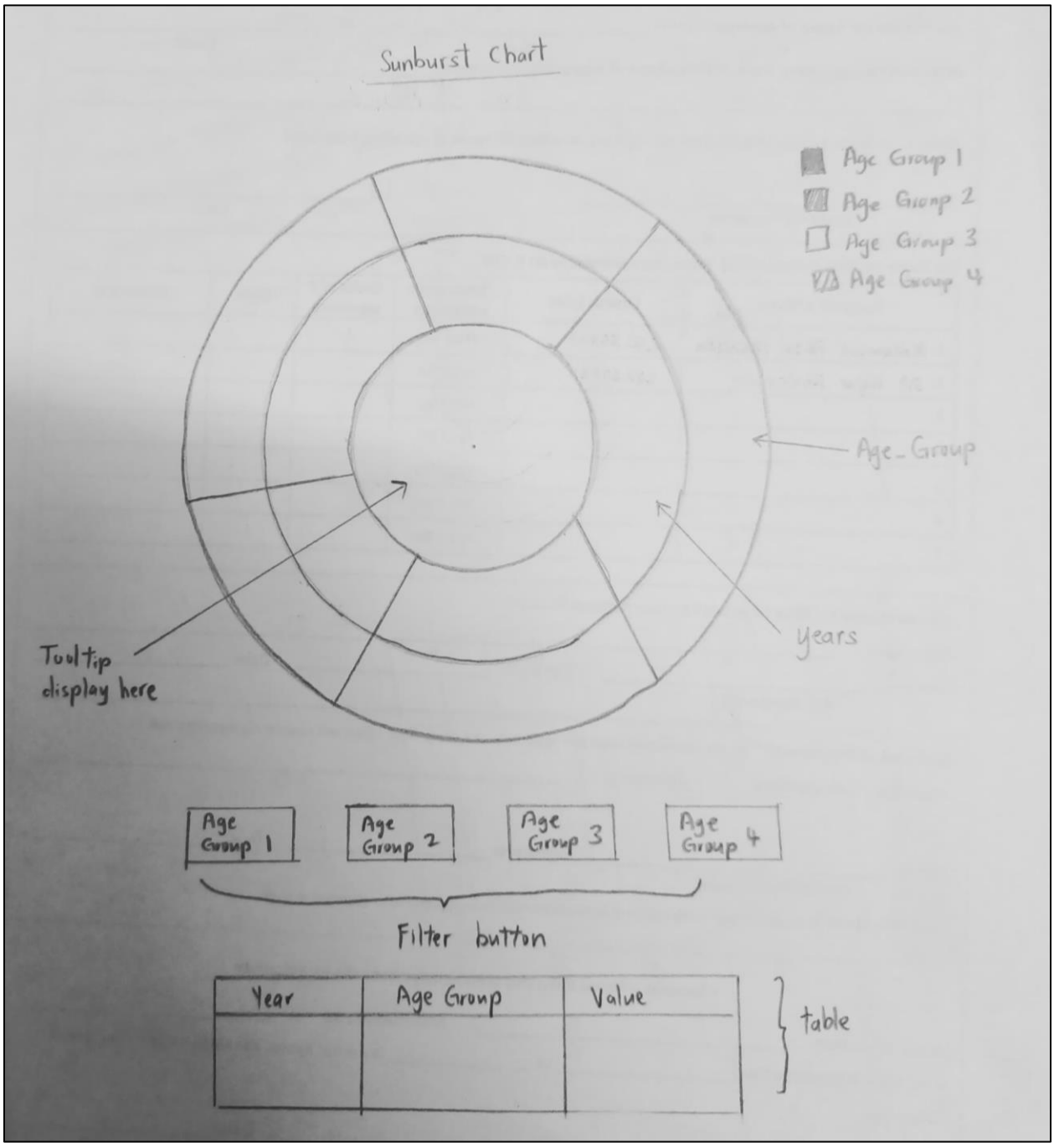
Final design of chart:



In the final design of the choropleth map, we followed the sketch design and our goal was to create an engaging and informative visualization of the data. We opted for a color gradient encoding scheme to represent variations in data values across different geographic regions. The color intensity increases with higher values, providing users with a quick and intuitive understanding of the data distribution. The map is interactive, featuring filter buttons that allow users to focus on specific areas of interest. Additionally, when a region is clicked, it triggers an onclick function that fills the area with another color, providing a visual cue. To enhance user exploration, we incorporated a search bar to filter regions based on user input. Furthermore, detailed information, including the name of the area and relevant data, is displayed on the side, offering a comprehensive view of the selected region. Overall, our final choropleth map design balances aesthetics and functionality, providing users with a powerful tool for data analysis and exploration.

We are using this reference code [10] as the foundation for our modifications.

4.4. Sunburst Chart: Population of India



For the sunburst chart visualization design, our general ideas include incorporating interactive elements to enhance user engagement and understanding. As the sketch shown, our inner circle represents the year, while the surrounding circle depicts the age group. Then, we plan to implement tooltips that provide detailed information when users hover over specific segments, offering insights into the hierarchical structure of the data. Furthermore, distinct colors will be assigned to

represent various age groups and different years, offering visual cues to facilitate users in interpreting the sunburst chart effortlessly. The incorporation of a legend will guide users in comprehending the color-coded categories within the chart. Alongside this, filter buttons will be provided, and upon activation, a table form will be presented, allowing users to access more detailed data. The ultimate design strives to achieve a harmonious blend of aesthetics and functionality, ensuring a smooth and informative user experience.

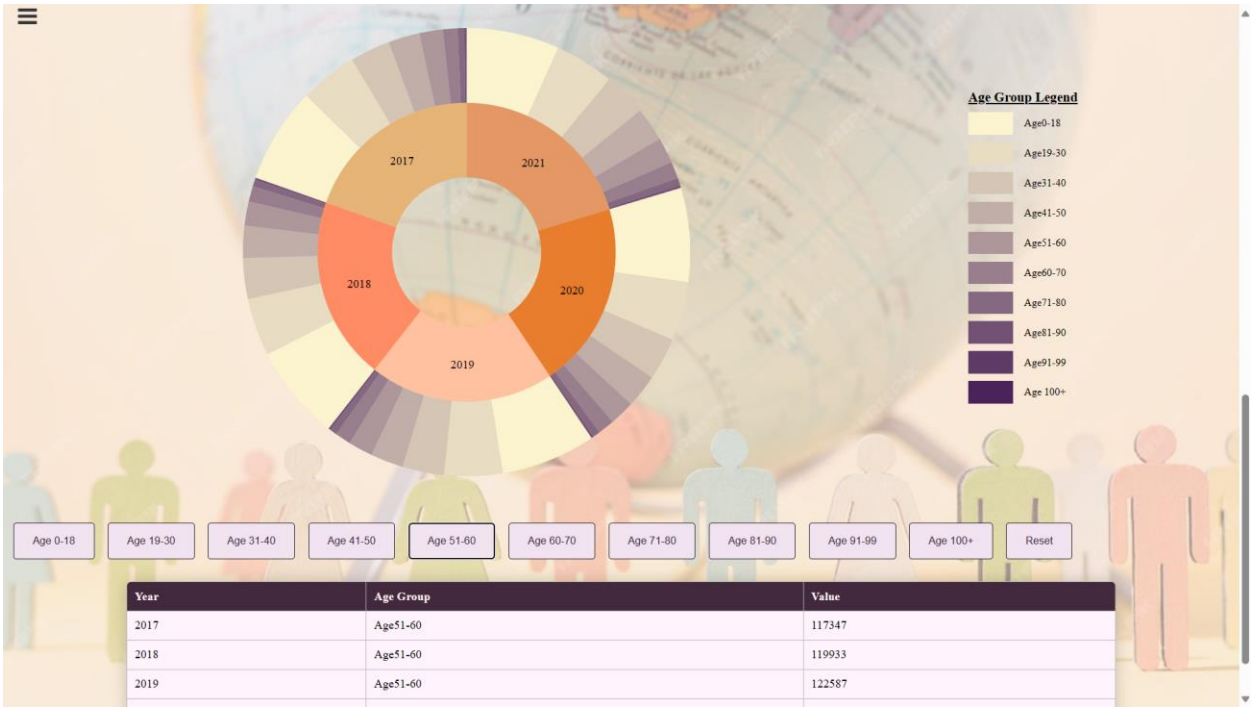
The first alternative idea is to involve adjusting the radial layout of the sunburst chart. Instead of a traditional circular layout, consider a spiral or elliptical arrangement. This alternative design could provide a unique visual representation and potentially improve the user's understanding of hierarchical data. The next alternative idea is transforming the traditional sunburst chart into a zoomable sunburst chart. Allow users to zoom in and out of specific sections of the hierarchy, providing a more detailed view of the data. This zoomable feature could be implemented through user interactions, such as the click features. When zooming in, the chart would reveal more granular information, and when zooming out, it would revert to the broader hierarchical structure. This alternative design aims to offer users flexibility in exploring the data at varying levels of detail, promoting a more dynamic and customizable user experience.

For the sunburst chart visual encoding, we employ the size as the primary mark, where each segment represents a distinct age group. The channels utilized include color hue to represent different age groups and years, providing a clear visual distinction between categories. The angle of each segment corresponds to the proportion of individuals in a specific age group, while the size of the segments can be used to convey an additional attribute, such as population size. The idioms involved in sunburst charts include the use of radial layout to represent hierarchical data, with rings indicating different levels, such as years or age groups. The color hue is used as a categorical channel, allowing users to easily identify and compare age groups. The sunburst chart's hierarchical structure aids in understanding the distribution of age across different categories, offering a visually intuitive representation of age demographics. This sunburst chart primarily utilizes containment marks. The hierarchical structure of a sunburst chart involves nested circles or rings, representing parent and child relationships.

The evolution of the sunburst chart design involved a thoughtful and iterative process to refine both its aesthetic appeal and interactive features. In the initial design phase, our focus was on incorporating interactive elements to enrich user engagement and understanding. We introduced tooltips that would provide detailed information upon hovering over specific segments, revealing insights into the hierarchical structure of the data. As the design progressed, we addressed the need for clear visual cues by assigning distinct colors to represent various age groups and different years within the sunburst chart. This color-coded approach aimed to enhance users' ability to interpret the data effortlessly. To further aid interpretation, a legend was incorporated into the design. The legend served as a guide for users to comprehend the color-coded categories within the chart, providing additional clarity and context. In a subsequent phase, we introduced filter buttons to allow users to interactively explore the data based on specific criteria. Upon activation of these filter buttons, a complementary table form was presented, enabling users to access more detailed data and facilitating a more comprehensive understanding of the information. Throughout these stages, we consider the exploration of alternative ideas, such as considering a radial layout

adjustment. Although this alternative idea was conceptualized, the decision was made to maintain the traditional circular layout for its intuitive representation of hierarchical data.In the final design, the sunburst chart evolved into a well-balanced visualization that harmoniously integrates aesthetics and functionality. The interactive elements, distinct colors, legend, and filter buttons collectively contribute to a seamless and informative user experience.

Final design of chart:

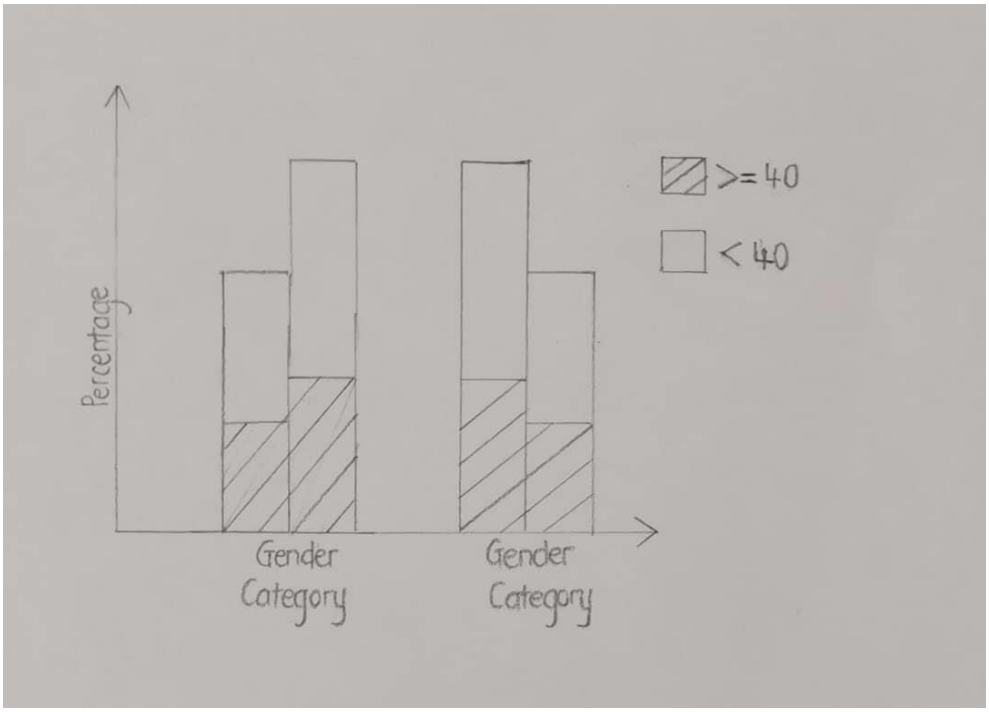


In the final design of the sunburst chart visualization, we followed the sketch design and successfully developed it and we aimed to create a user-friendly and visually appealing experience. The chart incorporates several interactive elements to enhance user engagement and understanding. Tooltips have been implemented, providing detailed information when users hover over specific segments. This feature offers insights into the hierarchical structure of the data, allowing for a deeper exploration of the information. Distinct colors have been carefully assigned to represent various age groups and different years within the sunburst chart. This color-coded approach serves as a visual aid, facilitating users in interpreting the data effortlessly and distinguishing between different categories. To provide additional context and clarity, a legend has been integrated into the design. The legend guides users in comprehending the color-coded categories within the chart, adding a layer of interpretability to the visual representation. The inclusion of filter buttons enhances interactivity, allowing users to explore data based on specific criteria. Upon activation of these filter buttons, a table form is presented, providing users with access to more detailed data in table form. This interactive feature ensures a comprehensive understanding of the information and allows users to customize their exploration. Throughout the design process, user feedback and iterative adjustments played a crucial role in refining the visual elements and interactive features.

The final sunburst chart design achieves a harmonious blend of aesthetics and functionality, providing users with a smooth and informative experience when exploring hierarchical data.

We are using this reference code [11] as the foundation for our modifications.

4.5. Stacked Bar Chart: Disease Lead to Migration



A stacked bar chart is currently used to display the data. Each bar chart shows the disease category of male of different age. The use of colour distinguishes these male range and provide reference to colour legend. In addition, mouseover and tooltip are integrated to enhance interactivity. The reason is to allow the user to get more information by hovering over a particular element.

Moreover, another alternative visualization is grouped bar chart where bar chart is grouped by disease category with each group containing two bar charts representing male of different age. Such a design could provide clearer comparison between disease category while still allowing user to distinguish between male of different age in each group. Another option is to explore the stacked area chart. This will maintain the concept of showing the composition of each disease category in a continuous and flowing manner. This is especially useful if need to emphasize the cumulative nature of data across different dimension.

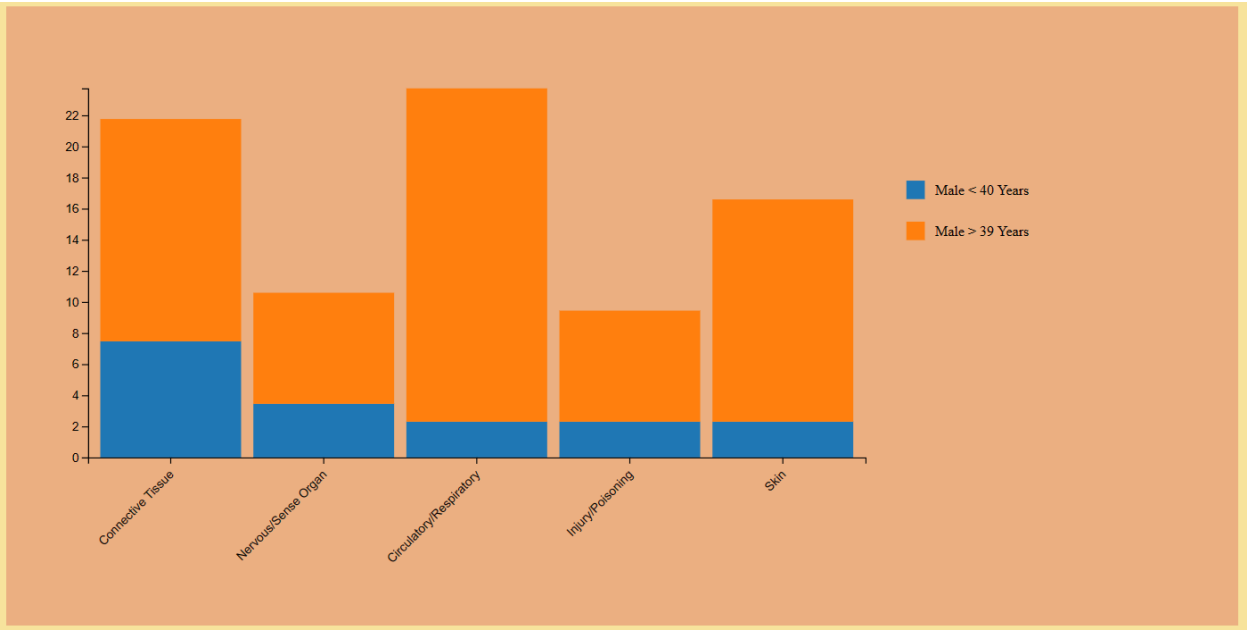
Stacked bar chart is suitable for showing the composition of each disease category and the distribution of male of different age within it. The use of colour helps to easily distinguish between male of different age and ensure the clarity of colour legend. Mouseover and tooltip add a layer of interactivity. The reason for this is to enable the user to explore the detail of a particular element without disrupting the overall view.

In a stacked bar chart, the primary mark employed is the "bar," and the length of each bar serves as a key visual channel representing a quantitative value, such as the count or percentage. The chart utilizes color hue as a categorical channel to differentiate between various segments within each bar, each corresponding to a specific subcategory or group. This color distinction provides a clear visual separation, aiding in the interpretation of individual contributions to the overall composition. The chart's idioms involve the stacked arrangement of bars, emphasizing the cumulative nature of the data. This visual representation is effective for showcasing the distribution of a total value across different subcategories, facilitating easy comparison and analysis.

In the evolution of the design, it started with a basic clustered stacked bar chart. After doing the clustered stacked bar chart, it was found that the female dataset did not fit because it had a lot of unnecessary data that needed to be deleted. Next, colour legend is introduced to solve the clarity problem. The addition of mouseover and tooltip was later enhanced to improve the user experience and provide more detailed information as needed. These iterative changes are guided by a user-centered design approach that aim to make visualisation more intuitive and informative.

The stacked bar chart was chosen because it effectively illustrates the composition of each disease category and the distribution of male of different age. This format is particularly useful when the focus is on comparing the relative range of male of different age in each disease category. Colour coding facilitate quick identification and interactive feature enhance user engagement. Given the nature of the data and the insight sought, stacked bar chart are still a visually effective and user-friendly option.

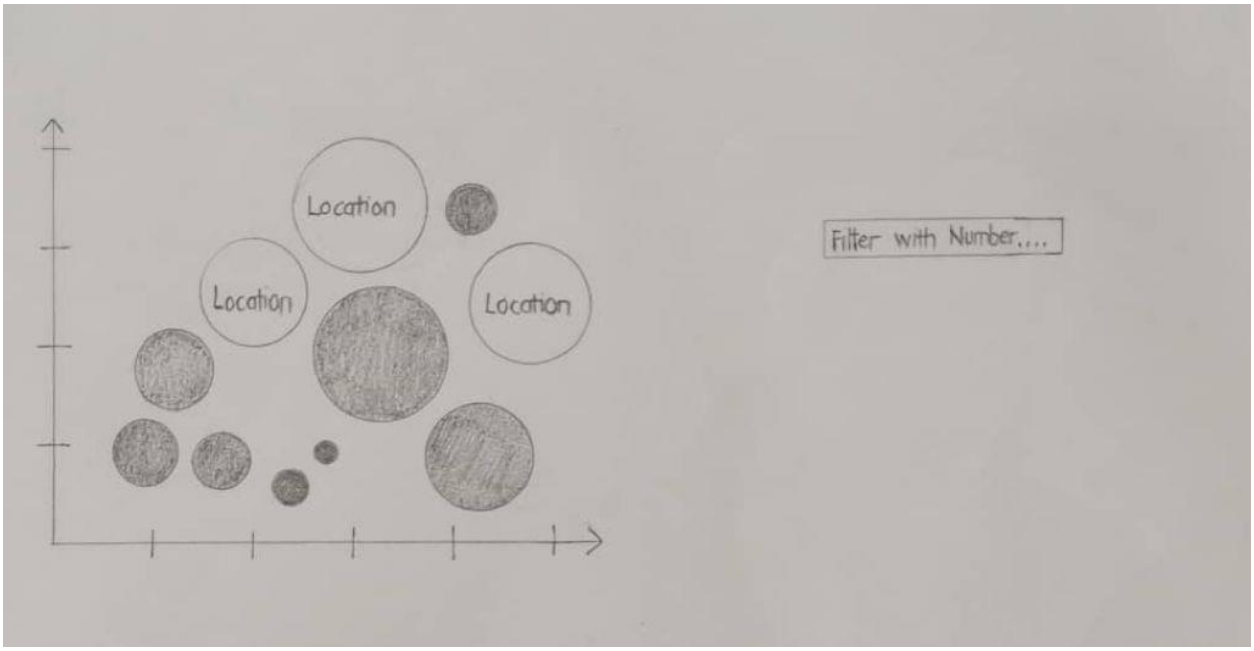
Final Design of Chart:



In the final design iteration, we made improvement to the stacked bar chart to optimize the user experience and enhance data understanding. Combined with colour legend, colour is clearly association with specific male of different age to help user quickly identify. The addition of mouseover and tooltip enrich the interactivity. User can hover over individual bar to reveal additional context and detail to facilitate a more dynamic exploration of the data. In order to increase the focus of the selected bar when hovering, a subtle blur effect is implemented on another bar. The reason is to ensure that user can clearly focus on specific data point of interest. This intentional visual cue helps the user maintain orientation on the chart while highlighting the bar being examined. Together, these thoughtful improvements produce an aesthetically pleasing and user-friendly visualisation that promote ease of data interpretation and engagement.

We are using this reference code [12] as the foundation for our modifications.

4.6. Bubble Chart: Immigration from India to Other Countries



For the visual design of the bubble chart, our goal is to incorporate interactive functions that enhance user understanding. First, we have implemented a tooltip feature allowing users to hover over bubbles to view detailed information, including precise population numbers, percentages, and metro area names. Additionally, we plan to add a search bar filtering functionality, enabling users to filter bubbles by entering the immigration population value. Additionally, upon inputting a value into the search bar, the chart will showcase the bubble that surpasses the entered value. Moreover, our plan includes implementing a color gradient for the bubbles, with lighter hues symbolizing smaller immigration population values and darker shades representing higher immigration population values.

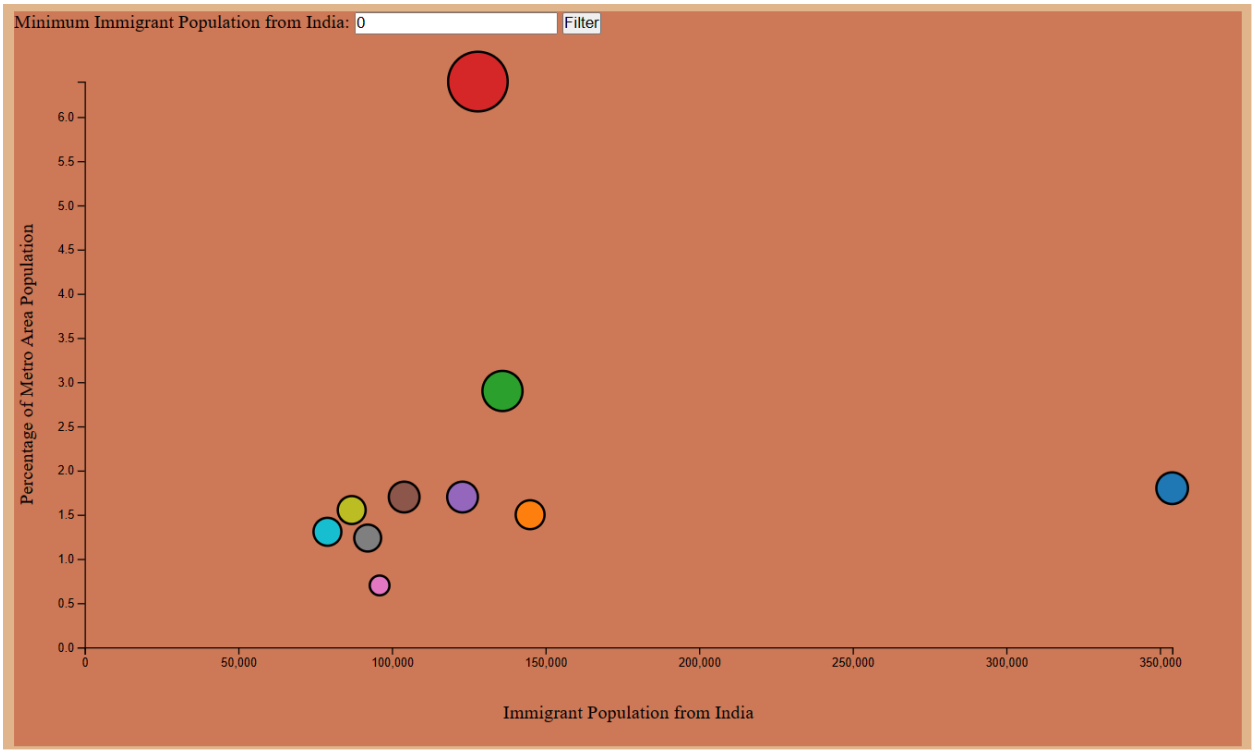
The first alternative idea is to explore a transition to a scatter plot chart for a different visualization approach. In the scatter plot, each data point represents a metro area, and we can use different shapes or colors to distinguish between metro areas. Scatter plots offer a clear representation of individual data points and their relationships, providing users with an alternative perspective on the migration data. The next alternative idea is to employ a categorical color scheme for each metro area. Instead of a gradient that represents the magnitude of the immigration population, assign distinct and easily differentiable colors to each area. This approach enhances visual clarity and allows users to quickly identify and compare immigration populations across different metro areas based on color alone. People can choose colors that are meaningful or representative of each metro area, contributing to a more intuitive and aesthetically pleasing visualization.

For the bubble chart visual encoding, we utilize several key idioms to effectively represent the data. The mark employed is the size of the bubbles, where each bubble corresponds to a specific data point, typically representing a metro area. The channel of color hue is used to convey the

different metro areas, allowing users to distinguish between different groups within the dataset. The placement of bubbles on the x and y-axis can represent two different quantitative variables, providing a clear spatial arrangement of data points. The idioms involved in bubble charts include the use of varying bubble sizes to indicate different magnitudes of the represented variable, creating a visual hierarchy. The color channel aids in categorization, while the spatial arrangement of bubbles helps users discern patterns and trends in the data. Bubble charts, as a whole, are characterized by the use of circular marks to represent data points and are particularly effective in showcasing the relationships between multiple variables in a visually intuitive manner.

The bubble chart design has evolved significantly to enhance both its functionality and visual appeal. Initially, the chart employed bubble size as the primary encoding for the immigration population, complemented by a conventional light-to-dark color gradient representing population magnitudes. Subsequently, an alternative approach was introduced, abandoning the gradient for a categorical color scheme. This alternative idea assigned distinct colors to each metro area, providing a more intuitive representation of geographical differences without relying on a linear color range. Further improvements included the integration of a tooltip feature, allowing users to hover over bubbles and access detailed information. Additionally, a search bar functionality was implemented, enabling users to filter bubbles based on specific immigration population values. This interactive feature dynamically updates the chart to focus on data surpassing the entered value, offering a more user-friendly and visually refined representation of complex immigration data.

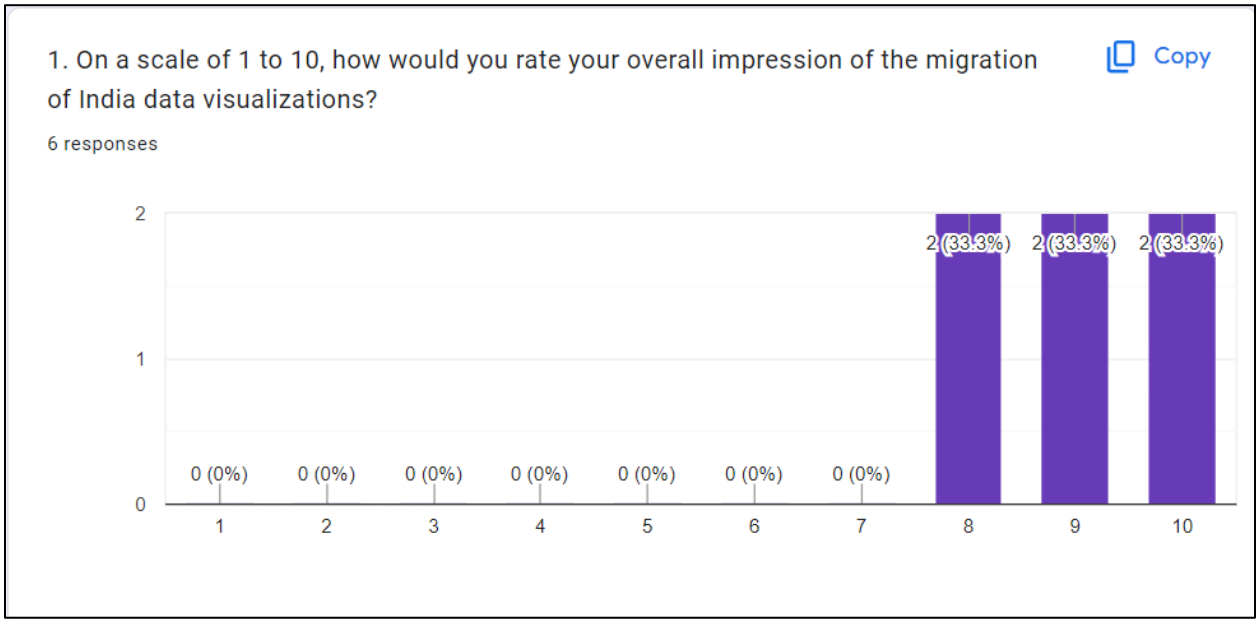
Final design of chart:



In our final bubble chart design for visualizing immigration from India to other countries, we implemented the alternative idea for the color legend, and we opted for a departure from conventional light-to-dark color ranges, the chart adopts a categorical color scheme. Each metro area is assigned a unique color, enhancing visual distinction and easing user interpretation. The chart employs bubble size as the primary encoding, where larger bubbles signify higher immigration populations, enabling users to intuitively grasp the magnitude of each data point. The inclusion of a tooltip feature enriches user engagement by providing detailed information on population numbers, percentages, and metro area names upon hovering over individual bubbles. The integration of a search bar adds filtering functionality, allowing users to dynamically focus on bubbles surpassing a specified immigration population value. This user-friendly interaction, coupled with vibrant aesthetics and strategically placed labels, ensures that the final design strikes a balance between visual appeal and analytical depth, offering a comprehensive and accessible tool for exploring immigration data.

We are using this reference code [13] as the foundation for our modifications.

5. Validation



2. Were you able to easily interpret and understand the data presented in the visualizations?

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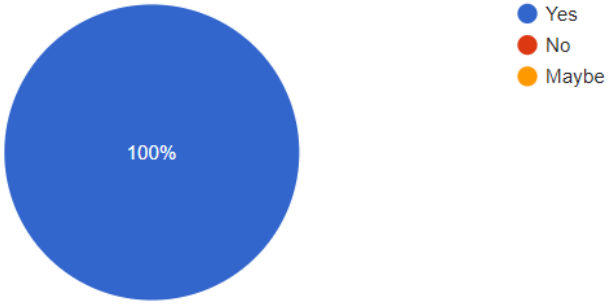
6 responses



3. Were we provided sufficient background information regarding the project?

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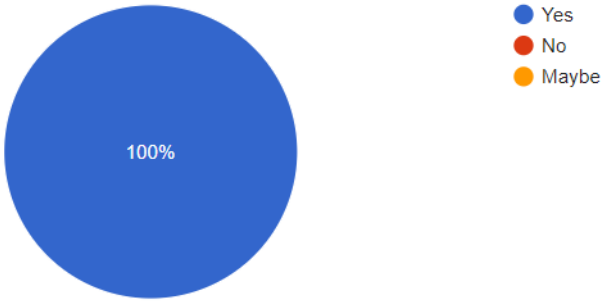

4. How user-friendly did you find the interface of the visualizations?

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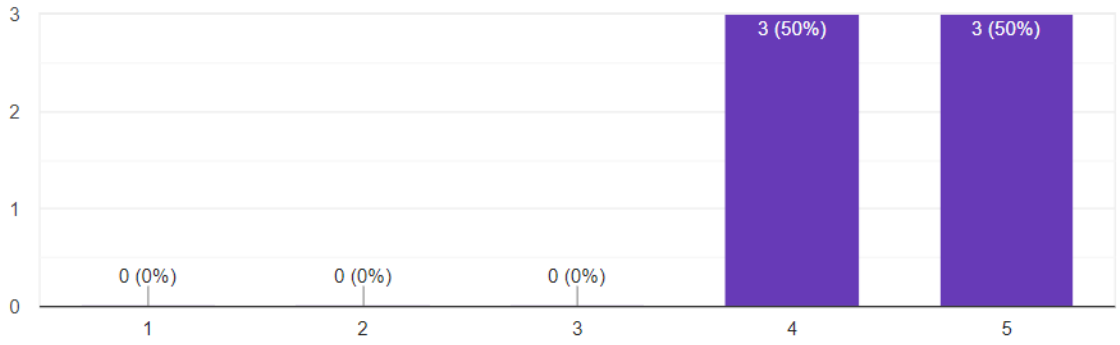
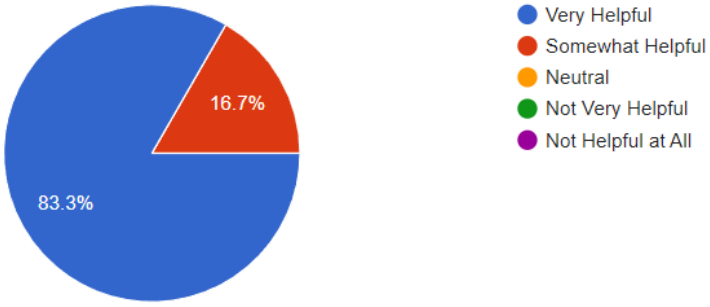


5. How helpful did you find the interactive features, such as tooltips and filter buttons? Copy

6 responses



6. Which specific visualization that you find particularly informative?

6 responses

heatmap

choropleth map

sunburst chart

Doughnut chart

Heat map

Choropleth Map

7. Which specific visualization that you find particularly challenging?

6 responses

no

None

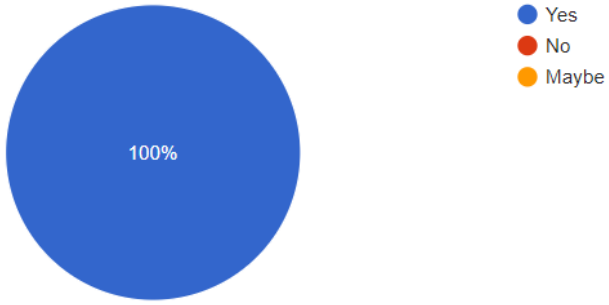
No, all good

No

8. Do you feel that the visualizations increased your awareness of the complexities of migration issues in India?

Copy

6 responses



9. Did the visualizations enhance your awareness and understanding of the challenges related to migration in India?

6 responses

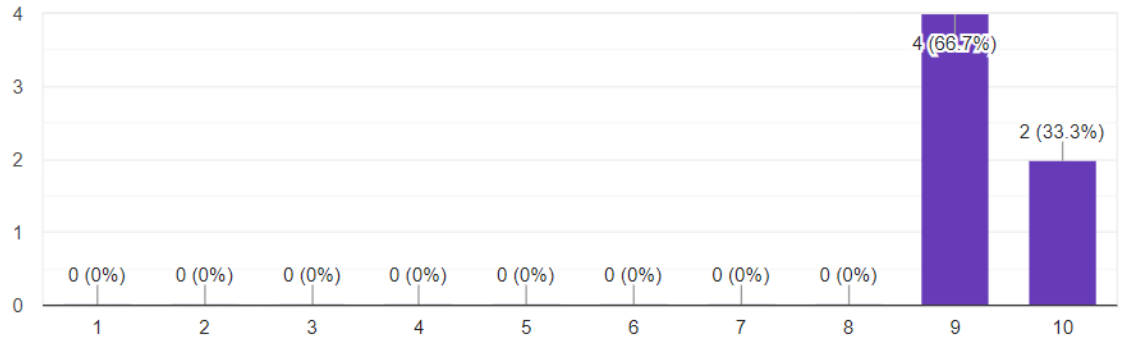
yes

Yes

10. How likely are you to recommend these visualizations to others interested in migration and socio-economic trends?

Copy

6 responses

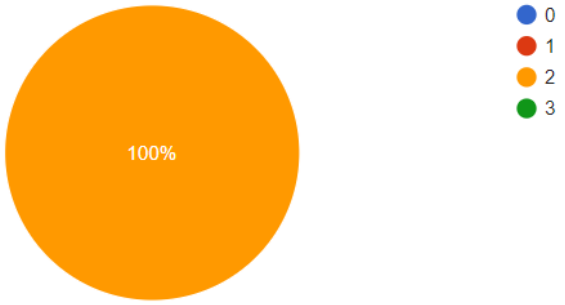


Information Retrieval Assessment:

1. In the visualisation of the 2023 Unemployment Rate in India, how many states show an unemployment rate of 21% or higher?

Copy

6 responses



2. What was the monthly wage of India in 1989?

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6 responses

3. What was the population value for India in the age group 19-30 in 2018?

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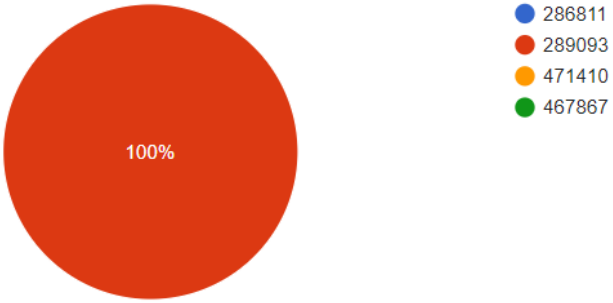
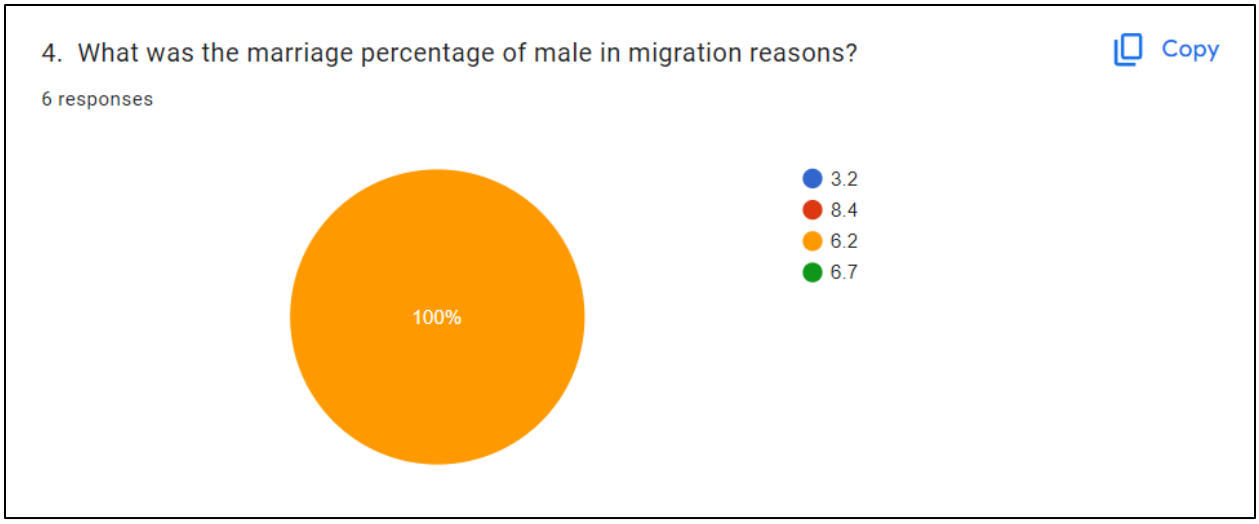
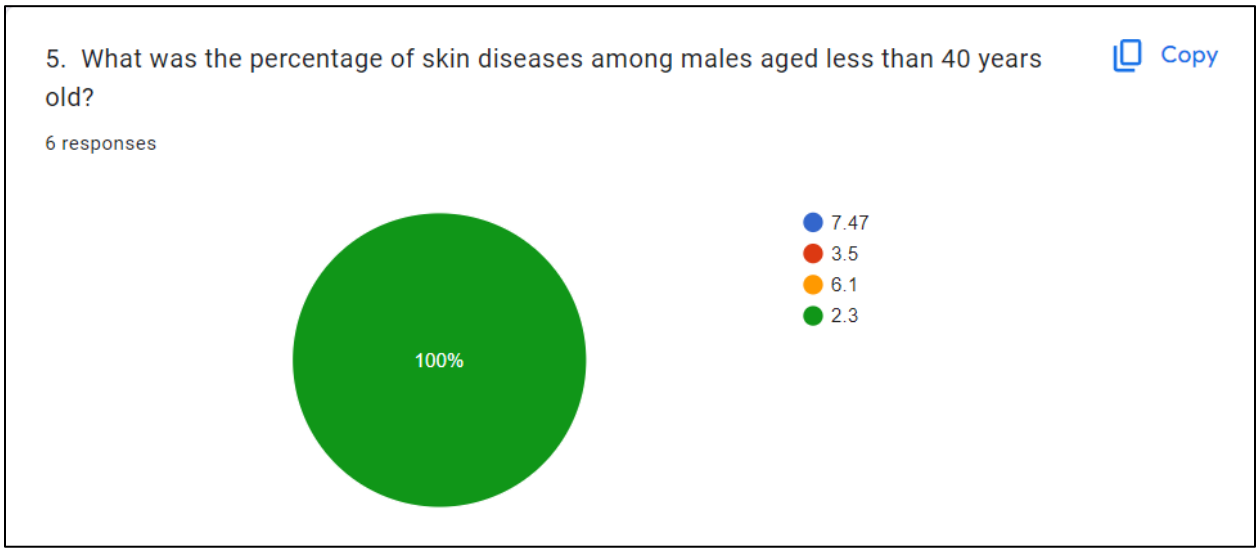
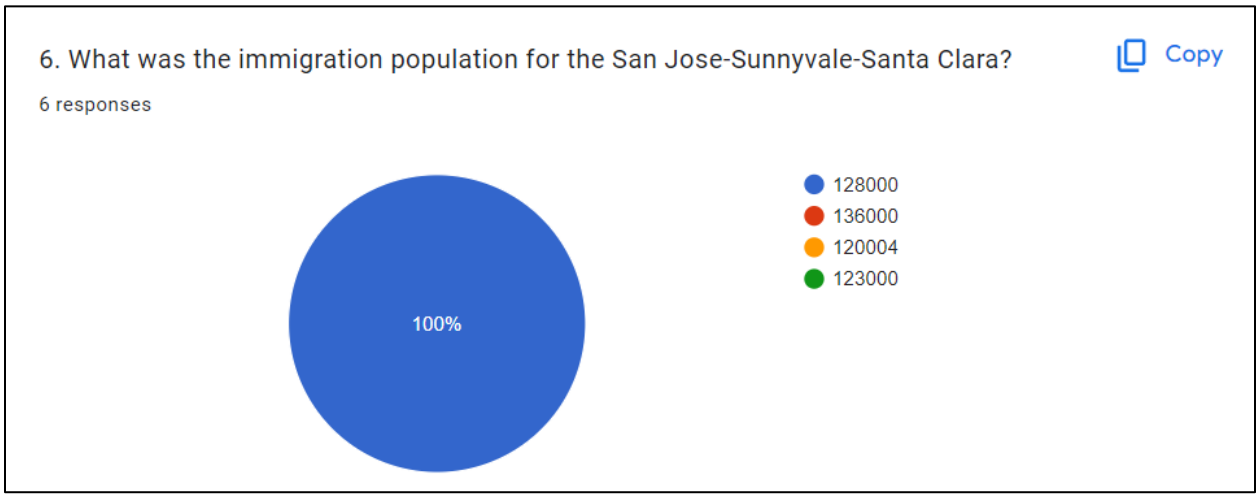
6 responses









There are six respondents participating in our visualisation test. The respondent-submitted survey form has yielded a notably positive response and reflects satisfaction and appreciation for the

effectiveness of the data visualization presented. Respondents expressed their contentment with the clarity and coherence of the data visualization and emphasised how these data visualization aids have enhanced their understanding of complex information.

Additionally, respondents have commended the user-friendly design of the survey form itself as well as citing its intuitiveness and ease of navigation. Moreover, most respondents found the heatmap and choropleth map visualizations to be particularly informative. Furthermore, there were no instances of incorrect answers in the information retrieval evaluation, indicating that our visualizations are highly comprehensible. The positive feedback underscores the success of the data visualization technique employed and indicates that they have not only met but exceeded the user expectation in conveying information in a meaningful and digestible manner. This positive response serves as a testament to the thoughtful implementation of data visualization strategy and demonstrates their impact on the overall user experience and comprehension of the presented data.

6. Conclusion

In the culmination of this project, we have successfully crafted a comprehensive array of data visualizations, delving deep into various facets of migration in India. Key features we have learned and implemented in the project include the introduction of a color legend, zoom functionality, search bar filter, tooltip function, form displaying the detailed feature and onclick feature. Also, by offering insights into unemployment rates, wage disparities, migration reasons, disease correlations, international migration patterns, and population statistics, we have addressed the diverse needs of different user groups, including policymakers, researchers, organizations, and the general public. People can inform decision-making, gain valuable insights for academic research, design targeted intervention measures and access insights into the reasons and trends of migration in India through our visualisations.

The knowledge acquired throughout this project is substantial by us. The emphasis on user-centric design principles has underscored its importance. Iterative feedback and refinement have resulted in visualizations that are not only user-friendly but also highly effective. Striking a balance between aesthetics and functionality has proven crucial, highlighting the need for visualizations to be both informative and engaging.

Interactivity plays a pivotal role in enhancing exploration. The integration of interactive features such as tooltips, filters, and zoom functionalities enhances user engagement, allowing for dynamic exploration of the data. The importance of clear visual encoding, including well-defined color legends and axes, contributes to the clarity and interpretability of visualizations. The exploration of diverse visualization idioms, including choropleth maps, doughnut charts, heatmaps, and sunburst charts, underscores their distinct purposes in serving various data patterns.

In conclusion, through this project, we not only enriched our own understanding and experience but also contributed valuable insights for future endeavours in data exploration and visualization.

7. References

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