

# Canada's Immigration Trends and Patterns

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**Abstract**— Canada is one of the leading destinations for international migrants globally, typically allowing one per cent of its population yearly the right to live in Canada permanently. In 2011, Canada had a foreign-born population of approximately 6.8 million, accounting for 21%. This paper uses visual analytics approaches to derive trends and patterns in Canadian immigration from 1980 to 2010. Tools such as Python Libraries and Tableau were used to create Spatio-temporal and temporal visualisations of the evolution of immigration and the demographics of those arriving.

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## 1 PROBLEM STATEMENT

Canada, among many of its stereotypes and aphorisms, has one that rings true- Canada is a nation of immigrants. What initially started with the First Nations people crossing the Bering Strait, followed by British and French settlement, to modern arrival of diverse peoples from around the globe, Canada, as we know today, was built on continuous waves of immigration. In 2011, 21% of the Canadian population were foreign-born- the highest proportion among the G8 nations[1].

Canada is experiencing a population decline due to low fertility rates and an ageing population [2]. Immigration is a means to solve that, by "...support[ing] population, economic, and cultural growth in Canada" [3]. This has led Canada to have some of the highest immigration rates in the western world, admitting approximately 1% of its population annually[4].

The Canadian immigration system has evolved drastically as driven by several primarily economic goals, thus resulting in modifying the point-based system pioneered in the mid-1960s, arising in the *Immigration and Refugee Protection Act* of 2002.

This report will examine the effect of new immigration policy on the demographics of Canadian Immigrants, explicitly addressing the following questions:

- What regions are people emigrating from? Does the policy exhibit racial discrimination?
- Has acceptance rates of specific admission categories and applicants changed?
- Has policy shifted to selecting "designer immigrants" based on "human capital" and their economic potential?

Pertinent data to answer these questions was sourced from Statistics Canada *Immigration and Ethnocultural diversity* datasets [5] from the 2016 census, and the United Nation's *International Migration Flows from Selected Countries* dataset [6].

## 2 STATE OF THE ART

There are various reasons people leave their birth country, whether to seek economic opportunities, or asylum from war, persecution, or natural disaster. Migration is a global phenomenon and a lived experience of many. In 2019, the number of international migrants globally was 272 million, accounting for 3.5% of the world's population [7]. Despite this, finding research applying visual analytics in this

domain was challenging to locate, especially in the setting of a single country.

Similar methodologies and suggested approaches to visual analytics were used among researchers in migration and immigration policy. Chun et al. [8] used tableau to create several interactive visualisations for use on a web platform to present topics including current policy and migration support services, and migrant demographics and motivations for presentation to organisations working with global migrants. This was developed to incorporate data analytics products on the web server, along with background information, surveys, and other pertinent information. They visualised migration to aid policy discovery through geographical mapping, bar graphs, and line graphs with various uses of colours and intensities to distinguish regions and points of interest. This information visualisation methodology via line and bar charts were also seen by Edmonson [9], and Beach et al. [10] while studying Canadian immigration trends and policy. Although, neither pursuing their work through the lens of visual analytics.

While neither Edmonson nor Beach et al.'s research is in the context of visual analytics, their findings are still relevant to the task at hand. Edmonson's work was concerned with similar immigrant demographics, such as country of origin, and educational background asked in this. Similarly, Beach et al. focused on how immigration policy changes- particularly the points-based system-affect economic-class immigration's skill characteristics through regression analysis. Neither implored more advanced information visualisation as a means for analytical reasoning.

Aigner et al. [11] discuss the diversity of temporal visualisation techniques and the difficulties faced when considering all dimensions involved in time-oriented data. Since time is viewed as a quantitative dimension, generic approaches such as parallel coordinates, unsophisticated diagrams and charts, are frequently superior. Specifically, "for simple data and basic analysis tasks, these approaches outperform specialised techniques, because they are easy to learn and understand" [11]. However, not without the caveat of being limited in the number of variables presented.

Andrienko et al. [12] suggest visualisation-based tools to support spatial, temporal, spatial-temporal, and attribute exploration in various spatial development settings. They state that in the environment of processes developing in space, choropleth maps among other classification-based maps are

the most suitable for investigating spatial patterns as they allow for a comprehensive view over an entire area of investigation. Animations are recommended to provide an interactive interface for visualisation. Although, inaccessible in some contexts, simultaneous displays of maps at different time instants are just alternatives for intuitive communication and comparison. For multi-attribute visualisation, a single map can be used with overlaid bar charts. Similar communication of results can be implemented through colour gradient wedges, slices, and rings within regions [13].

Verbert [14] visualised migration flow data via tree diagrams since they believed that traditional cartographic maps lacked clarity, complexity, historical borders, and aesthetic appeal.

### 3 PROPERTIES OF THE DATA

A total of 4 datasets were used. Three datasets were taken from Statistics Canada's *immigration and Ethnocultural Diversity* datasets [5] derived from the 2016 census describing various immigrant<sup>1</sup> demographics from 1980 to 2016:

- Table 98-400-X2016202<sup>2</sup>
- Table 98-400-X2016203<sup>3</sup>
- Table 98-400-X2016204<sup>4</sup>

These datasets each had upwards of 25 million instances across 22, 26, and 33 attributes, respectively. Features included categorical variables such as countries, regions, and continents of origin, educational background, and admission categories<sup>5</sup> presented textually and with numerical identifiers/keys. Temporal data was present as the period of immigration<sup>6</sup> into Canada by selected demographics for 10-year intervals between 1980 to 2010, and 5-year intervals between 2000 to 2016.

The fourth dataset was sourced from the United Nations Department of Economic and Social Affairs *International Migration Flows from Selected Countries*. This dataset contained the yearly immigration into Canada from selected countries, regions, and continents from 1980 to 2013 over ~52 thousand instances.

Datasets were linked via the immigrant-origin and/or admission category with one or both being present in all datasets. Datasets were of high quality and did not appear to have erroneous values or missing data in attributes being considered. Missing values were present in "notes" columns of census data, which was expected. Those columns were dropped since they were not significant to analysis. Similarly, the UN dataset had several empty or insignificant columns which were also dropped.

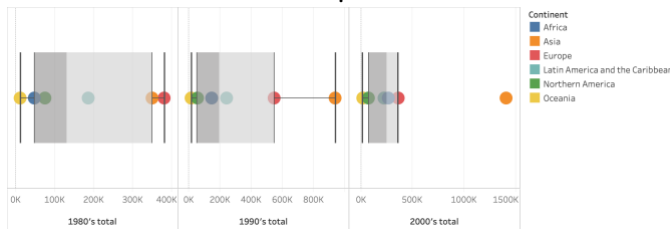


Figure 1 Box plot of UN data of immigration into Canada by continent

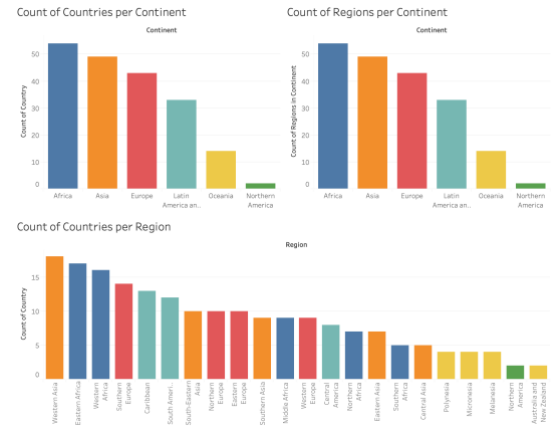


Figure 2 Histogram of Countries and Regions Present in UN dataset

The data distribution of the UN data was evaluated through box plots (figure 1) and histograms (figure 2). The box plot indicated vast differences and outliers in the representation of different migrant backgrounds to Canada. Outliers could be of concern if not filtering or clustering based on demographic profiles or countries or regions of origin. Due to the nature of the outliers, they were not removed from the data as they were still significant in understanding the data. The presence of more data of a particular type (i.e. African countries outnumbering other continents) seen in figure 2 was not of concern since it was still relevant to investigating immigration trends and patterns. Since data and countries were linked between UN and Canadian datasets, the country and regional representation distribution were assumed to be the same. Therefore, they did not warrant a separate distribution analysis. Non-uniformity was present in temporal distributions as Statistics Canada datasets used both five and 10-year intervals, whilst the UN dataset used 1-year intervals.

### 4 ANALYSIS

#### 4.1 Approach

To gain relevant insights to answer the questions proposed in this report, analytical reasoning supported by information visualisation and representation. Keim et al. state that visual analytics aims to visualise data and processes by allowing analytic discourse, communication, evaluation, and decision-making [16]. As such, a visual analytics framework, as outlined in figure 3, was used.

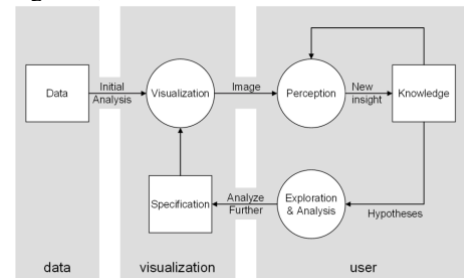


Figure 3 Visual analytics approach from Keim et al. [16]

This framework consists of data, visualisation, and user stages, iterating through visualisations, gained insights, exploration and analysis, and specification.

In the initial data preparation stage, pre-processing techniques were used to clean the data. Since the datasets were extensive, only data of interest was collected. The tables supplied by Statistics Canada provided data pertaining to the whole of Canada in addition to provinces, regions, and major cities. As such, data unrelated to Canada as a whole was removed. Feature engineering was also used to derive the percentage of admission for given immigration categories from individual continents, regions, and educational background for specific periods. Using percentage makeup of demographic values and attributes witnessed normalised the data, therefore, aiding in combating unequally spaced periods seen in between datasets.

The first step is to investigate how immigration numbers have evolved, followed by the trends of demographic traits of interest of those migrating during those periods. Specifically, the change in acceptance of admission categories, and immigrants of each admission category's ethnic and educational background. This was done through temporal visualisation methods such as line graphs and bar charts which are easy to interpret. Colour was used to group demographic indicators mentioned for visual precision. To understand significant countries of origin for Canadian immigrants and other Spatio-temporal insights, choropleth world maps, tree diagrams of continents and regions, and polar coordinate diagrams considering multiple dimensions with time were considered.

These visualisation methods were built upon and iterated as new questions and insights appeared from initially prepared visualisations. As new knowledge was drawn from each visualisation, further exploration of the data and possible interesting immigration patterns ensued, allowing supplementary specification and thus iteration of methods.

## 4.2 Process

The steps outlined in the preceding approach section were completed to answer the three research questions presented:

1. What regions are people emigrating from? Does the policy exhibit racial discrimination?
2. Has acceptance rates of specific admission categories and applicants changed?
3. Has policy shifted to selecting "designer immigrants" based on "human capital" and their economic potential?

Firstly, data preparation and feature creation were done to later facilitate human analytical reasoning and visuals interpretation. Countries were grouped by continent and region so that immigration of each area, as well as total immigration, could be evaluated in a time series (figure 4). From the diagram, it is seen that immigration is steadily increasing over time, with Asia being the main contributor of immigrants into Canada since 1990. This upward trend of immigration flow through time incites further exploration and analysis of immigrant demographics, and reasons driving the increase in immigration over time.

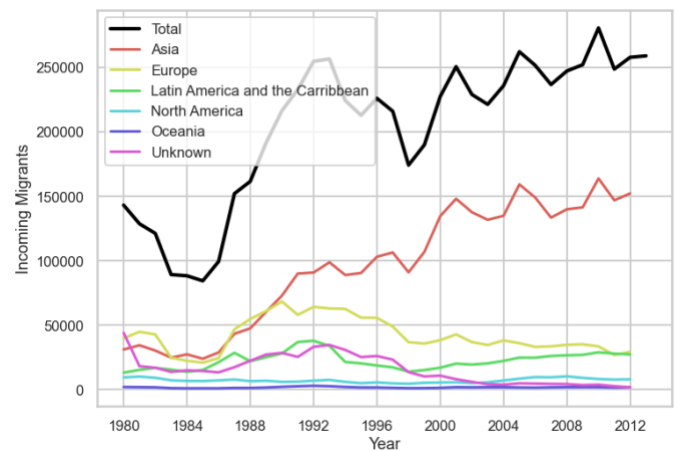


Figure 4 Migrant flow into Canada by year

### Question 1

To evaluate the primary countries of origin for migrants flow into Canada over time, simultaneous choropleth maps were used. Through varying colour intensity countries and regions where significant amounts of migration occur can be highlighted and identified. As seen in figure 5, a considerable amount of immigration from China and India for the total period of 1980 to 2013 appears. It is also observed that European immigration is overtaken by Asian immigration between the 80s and 90s.

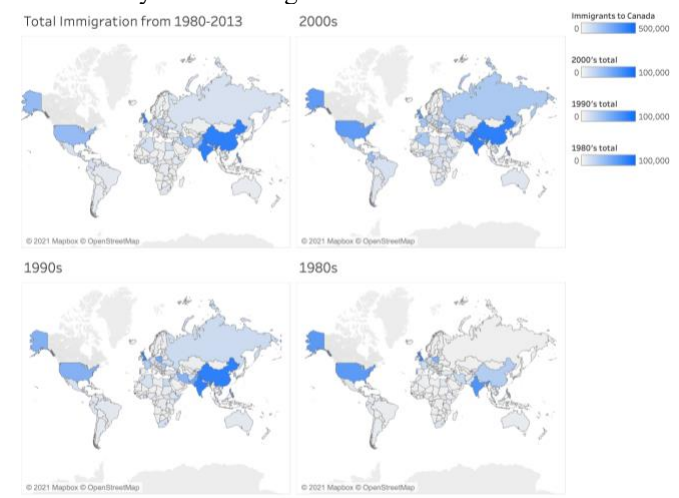


Figure 5 global immigration to Canada

Regions of origin were also considered through tree diagrams grouped by continent (figure 6). It is noticeable that Asian regions overtook European regions as the primary source of immigration during the 1990s and 2000s. The Government of Canada defines a visible minority as "persons, other than Aboriginal peoples, who are non-Caucasian in race or non-white in colour" [17]. Due to the majority of immigrants originating from Asian countries, it can be determined that there is no racial bias towards visible minorities in the immigration policy of the 1990s and 2000s. There is an unexplained switch from majority European immigration flow to that of Asian.

To find possible reasons behind that observation changes in policy, or changes in country profiles needs to be understood through human reasoning. In 1967 Canada

abandoned racially discriminate national preference policies that favoured those arriving from European countries [9]. In its place, a points system was created that evaluated applicants based on factors such as age, French and English language skills, and higher education and occupation skills [9]. This system removed nationality bias from the admission process allowing all nationalities to have equal preference. A further decline in racially discriminate attitudes resulted in multicultural immigration policies implemented in 1971 and 1988 to attract those emigrating from non-European countries [2]. Initially, what could be seen as discriminatory policy-intentionally or not in the point system, which at the time of implementation attracted skilled and educated immigrants from Europe whilst filtering out those from less industrialised countries would become self-contradictory in later years. The immigration flow to Canada would become lead by those emigrating from increasingly industrialised Asian countries [18]. This change in predominant migrant origins is demonstrated in figures 5 and 6.

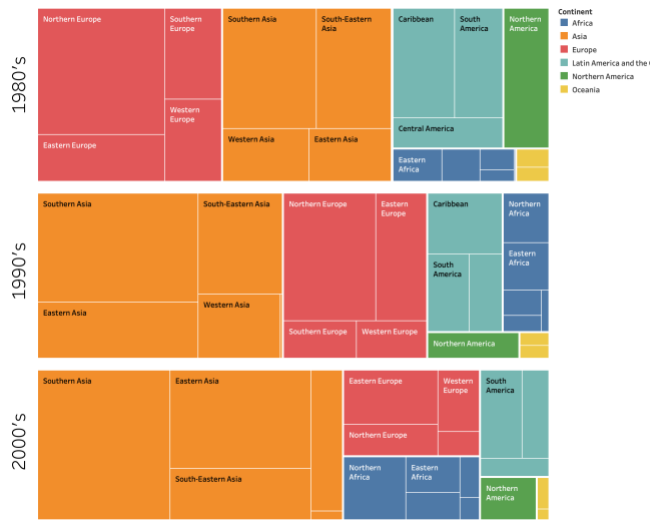


Figure 6 Tree diagram of regions of origin for immigrants from 1980 to 2010

### Question 2

From the exploration and analysis of immigrant ethnic and national origin, further questions arose. Specification of what admission categories immigrants arrive under and their changes over time was required.

Canadian immigrants are classified into four major categories: economic, immigrants sponsored by family, refugees, and others. Development of these categories' admission over time was visualised using bar and line plots (figure 7). The bar plots presented total immigration of 10-year intervals from 1980 to 2010 using colour to visualise the proportion admitted corresponding to each immigration category. A line plot was also used, showing the calculated percentage of each admission category of the total admission represented during a given period. Since the data was normalised into percentage values instead of the number of people admitted, five year periods could also be included without negatively affecting visualisation through the presentation of false trends.

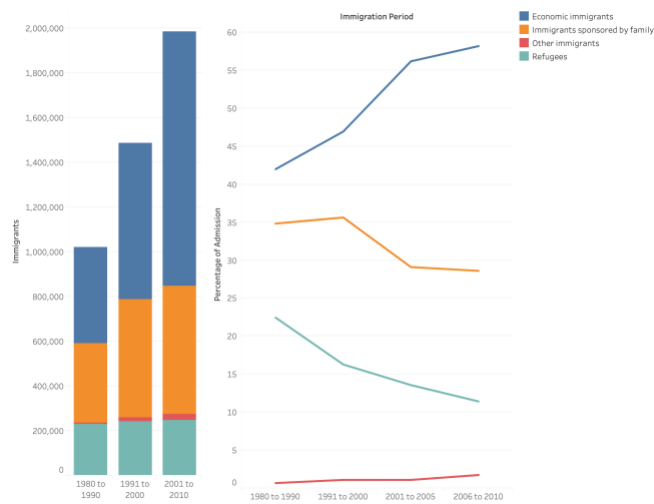


Figure 7 Admission category of immigrants from 1980 to 2010

Figure 7 shows a noticeable increase in economic immigrants. It is observed that the admittance of economic immigrants is inversely proportional to immigrants admitted under refugee and family sponsorship categories which were seen to decrease with time. With this gained knowledge, another iteration of the graph was done to provide insight on which nationalities comprise each admission category. This resulted in the use of a parallel coordinates plot (figure 8).

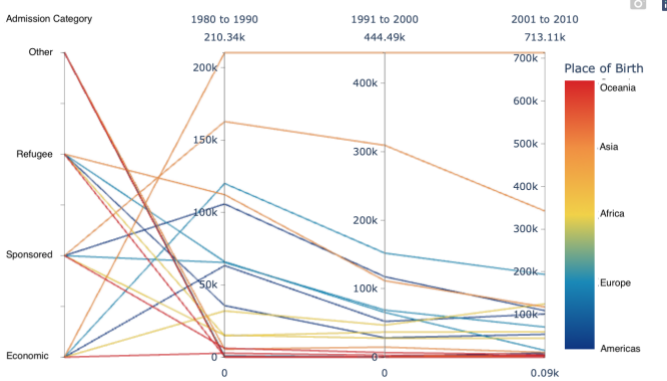


Figure 8 Dominant continental groups represented in each admission category from 1980 to 2010

It can be seen that the vast majority of economic immigrants are arriving from Asian countries, with Asia consistently being the main contributor of economic immigrants from 1980 onwards. The perceived marked rise of economic immigrants instigates further inquiry into how the points-based system policy has effected applicant demographics.

### Question 3

The third point of interest was if or how immigration policy had shifted to selecting "designer immigrants" based on "human capital" and their economic potential. As such, the educational background of incoming immigrants was visualised. The Oxford English Dictionary defines human capital as "the skills, knowledge, and experience possessed by an individual or population, viewed in terms of their value or cost to an organisation or country". In the context of the



Canadian points system, this meant a particular emphasis on educational credentials, age, English and/or French language fluency, work experience, and other skills [10]. The educational background of incoming immigrants of each decade was visualised in figure 9. It can be seen that a majority of economic immigrants have university credentials, and over half have some form of tertiary education. For immigrants of sponsored and refugee class, educational credentials appear to be equally represented in migrant profiles. It seems that the human capital model is not used during the admission of non-economic immigrants. As such further exploration of solely economic immigrants is required.

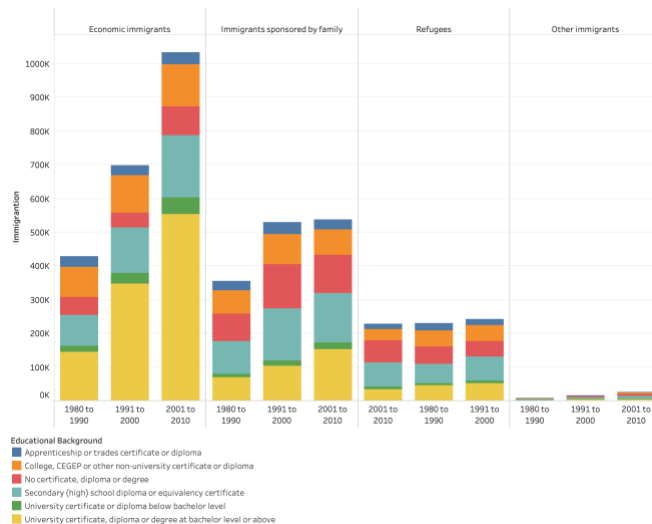


Figure 9 Educational background of immigrants of each admission category

The educational profiles of economic immigrants admitted over time was visualised in figure 10. It can be seen that there is an increase in migrants with university credentials over time, specifically bachelors and masters levels. There is a notable increase between the 1980s and 1990s which is consistent with modification of the points system to place greater weight on human capital, with focus on education credentials in the selection process during this period [4].

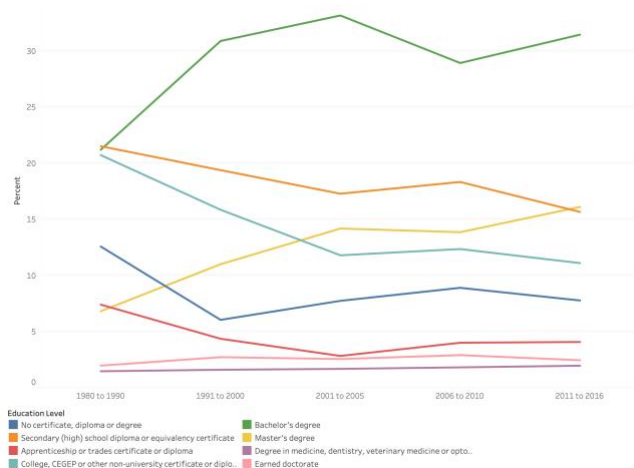


Figure 10 Education Level of Admitted Economic Immigrants

Concurrently, it can be seen that there was a decrease in economic immigrants with non-university education backgrounds, particularly those with college and secondary educational backgrounds. Since policy grew towards supporting a human capital model, education was rewarded with more points than specific occupations [4]. This supports the decline in non-university educated migration as other educational credentials are primarily vocationally focused.

### 4.3 Results

It has been seen that there has been a significant deviation away from primarily European immigration into Canada in the 1980s to that of Asian immigrant flow from the 1990s to present. More recently, African immigration has become measurable to that of European immigration flow into the country. The largest contributing regions of immigrant flow were determined to be Southern and Eastern Asia, with main drivers being Chinese and Indian nationals primarily as economic immigrants. Due to the majority of immigrants being of nationalities that could be classified as visible minorities, racial bias was determined not to be present in current immigration policy.

Economic immigration is the primary migrant flow into the country, making up over 50% of those admitted to the country in recent years. Increase in economic immigration was supported by neoliberal policies implemented during coinciding periods of conservative government (1984-1993 and 2005-2015) that emphasised economic immigration and labour-market integration [19].

Finally, there has been a stark increase in the proportion of immigrants with university credentials over time. This can be contributed to point system policy reform in the 1990s which evaluated immigrants arriving under economic class admission. Further changes in 1993 placed greater weight on university education whilst selecting prospective immigrants [10].

## 5 CRITICAL REFLECTION

The chosen approach of iterating through visualising data, perceiving, gaining knowledge, exploration and analysis, and specification was an appropriate methodology for answering the research questions. The process was necessary to gain insights into nations of origin and demographics of incoming migrants, and how it has evolved over the years with the introduction of new policies and updates of current policy.

Temporal data can be challenging to represent intuitively when considering multiple dimensions or attributes in addition to time. Line, bar, and polar coordinate diagrams were chosen for temporal visualisations since frequently unsophisticated methods are superior in their ease of communicating data for knowledge gain. Spacio-temporal data such as countries of origin for migrants were represented on simultaneous choropleth maps. Primary countries of emigration for each decade were easy to ascertain through colour contrast. Tableau lacks the ability to make split choropleth maps which would have been required to make a multidimensional map displaying density through time as slices of a country per decade. This would have allowed for a single visualisation instead of needing to exhibit multiple

maps simultaneously. Tree diagrams were used since it was challenging to visualise smaller countries on a global map. This is where interactive visualisation would have aided tremendously. The tree diagrams gave a concise answer to significant source regions and continents of immigrants.

The iterating process was a crucial factor in successful visualisation and knowledge gain. With each new visual new questions and exploratory ideas emerged, allowing further specification of attributes and feature engineering. Future work could employ modelling techniques to aid the visual analytic process. For future modelling, and even during this study, it would be preferred to have attributes and demographic information for each year opposed to every decade or five years as seen in the Statistics Canada datasets procured. It would be interesting to apply clustering techniques to visualise which regions, cities, or even boroughs immigrants settle in upon arrival in future work. Additionally, modelling of economic applicant profiles would be of relevance as multiple variables-and weights thereof, concerning an applicant's human capital play a significant role in a migrant's admission success within the points-based system. The *immigration and Ethnocultural Diversity* datasets contain vast amounts of demographic attributes, allowing for further insights into the immigrant population.

In 2020 it was estimated that there were 272 migrants globally[7], echoing the universal relevance of understanding migration trends and immigration policy. As time goes on, it has become apparent Canada's visible minorities are increasingly becoming the majority.

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<sup>1</sup> 'Immigrant' refers to a person who is, or who has ever been, a landed immigrant or permanent resident. Such a person has been granted the right to live in Canada permanently by immigration authorities [15].

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<sup>2</sup> Admission Category and Applicant Type (7), Period of Immigration (7), Place of Birth (272), Age (12) and Sex (3) for the Immigrant Population Who Landed Between 1980 and 2016, in Private Households of Canada, Provinces and Territories, Census Metropolitan Areas and Census Agglomerations, 2016 Census - 25% Sample Data

<sup>3</sup> Admission Category and Applicant Type (47), Immigrant Status and Period of Immigration (11B), Age (7A), Sex (3) and Selected Demographic, Cultural, Labour Force and Educational Characteristics (825) for the Population in Private Households

<sup>4</sup> Admission Category and Applicant Type (7), Labour Force Status (8), Period of Immigration (7), Highest Certificate, Diploma or Degree (7), Location of Study (5), Age (13A) and Sex (3) for the Population Aged 15 Years and Over that Immigrated between 1980 and 2016, Living in Private Households

<sup>5</sup> 'Admission category' refers to the name of the immigration program or group of programs under which an immigrant has been granted for the first time the right to live in Canada permanently by immigration authorities [15].

<sup>6</sup> Period of immigration refers to the period in which the immigrant first obtained landed immigrant or permanent resident status [15].