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# INVESTIGATION INTO THE DIFFERENCES BETWEEN MONTREAL AND VANCOUVER

## BATTLE OF THE NEIGHBOURHOODS

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# 1 INTRODUCTION

## 1.1 BACKGROUND

Two of the most populated cities in Canada, apart from Toronto, are Montreal and Vancouver. Both cities are very multicultural, have hosted the Olympics, and are both homes to large universities, industry, and world-class attractions. However, located at opposite sides of this vast country they have drastically different cultural identities and local attractions. Montreal is Canada's oldest established city and was originally founded in 1642 and boasts a large francophone community. Vancouver, in contrast, was founded much later in 1867 and hosts a large population of immigrants from eastern Asia. This difference in ethnographic make-up can greatly influence available cuisines and other amenities within a city. Locations of resources within a city can be a huge factor for visitors when selecting which city to visit, and also for locals choosing where in the city to live.

## 1.2 PROBLEM

Given how culturally and historically different Montreal and Vancouver are, it would be interesting to look at the similarities and differences between these two cities based on popular amenities and rental prices. Foursquare data can be helpful in this regard, to look at trending locations within these cities and compare neighbourhoods within each city as well as between Montreal and Vancouver.

## 1.3 INTEREST

This study can potentially help people in determining which city to visit or live in based on their interests.

# 2 DATA ACQUISITION AND CLEANING

## 2.1 DATA SOURCES

Datasets were chosen to represent only the metropolitan boundaries as opposed to the greater Montreal area or the greater Vancouver area which comprise the surrounding cities and towns. The 2016 census was the last available source of population and cost of living values as the long-form national census is only performed every 5 years.

### 2.1.1 Montreal

Montreal is divided into 19 neighbourhoods and the dataset was found here: https://en.wikipedia.org/wiki/Montreal. This dataset included census data from 2016 which reported population, average monthly rent, and area of each neighbourhood. The geojson file for the metropolitan center of Montreal was found here: https://github.com/blackmad/neighborhoods/blob/master/gn-montreal.geojson. A complete set of census data for 2016 was found on Statistics Canada (https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/details/page.cfm?Lang=E&Geo1=CMACA&Code1=462&Geo2=PR&Code2=01&Data=Count&SearchText=Montreal&SearchType=Begins&SearchPR=01&TABID=1&B1=All). The data was downloaded as a .csv file and then imported into a pandas dataframe for cleaning.

### 2.1.2 Vancouver

The data was sourced from a combination of sources. Neighbourhood designations for the 22 districts in Vancouver were taken from: https://en.wikipedia.org/wiki/List_of_neighbourhoods_in_Vancouver. Other data including area, population and average monthly rent were taken from https://vancouver.ca/news-calendar/areas-of-the-city.aspx. Data was manually compiled from individual pdfs corresponding to 2016 census data in new table. The table was saved in .csv format and then converted into a pandas dataframe. The geojson file for the metropolitan center of Vancouver was found on the official Vancouver website: https://opendata.vancouver.ca/explore/dataset/local-area-boundary/information/ . As was done for the Montreal census, a complete set of census data for 2016 was found on Statistics Canada (https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/details/page.cfm?Lang=E&Geo1=CSD&Code1=5915022&Geo2=PR&Code2=01&Data=Count&SearchText=5915022&SearchType=Begins&SearchPR=01&B1=All&Custom=&TABID=3). The data was downloaded as a .csv file and then imported into a pandas dataframe for cleaning.

## 2.2 DATA CLEANING

### 2.2.1 Location data

Geojson files for Montreal and Vancouver were used to obtain Neighbourhood designations and coordinates for further analysis. The Foursquare API was then used to obtain the top nearby venues within a 1500 m radius of the center of each neighbourhood. Venues were then processed by one-hot encoding to quantify the number of venues within each neighbourhood which corresponded to venue categories

as supplied by Foursquare. The ten most common venues in each neighbourhood were aggregated. An unsupervised machine learning algorithm (k-means clustering) on these datasets, with the purpose of clustering neighbourhoods with similar characteristics.

### 2.2.2 Census Data

The census data for Montreal and Vancouver were inputted into pandas dataframes. Data related to age distribution, household income, and total immigration by country were transferred to separate dataframes and plotted by bar graphs.

# 3 RESULTS AND DISCUSSION

## 3.1 LOCATION DATA

The neighbourhood boundary data for Montreal (Table 1) and Vancouver (Table 2) as derived from the geojson files were used to produce folium maps for both cities (Figure 1 and Figure 2). Populations for neighbourhoods were used to overlay a chloropeth layer on both maps to look for highly populated areas within Montreal and Vancouver.

**Table 1. Neighbourhoods in Montreal.**

| Neighbourhoods | Area (Square kilometer) | Population (2016) | Population Density | Average Monthly Rent |
|---|---|---|---|---|
| Ahuntsic-Cartierville | 242 | 134245 | 5547.3 | 1167.0 |
| Anjou | 137 | 42796 | 3123.8 | 1151.0 |
| Cote-des-Neiges--Notre-Dame-de-Grace | 214 | 166520 | 7781.3 | 1300.0 |
| Lachine | 177 | 44489 | 2513.5 | 1078.0 |
| LaSalle | 163 | 76853 | 4714.9 | 1283.0 |
| Plateau-Mont-Royal | 81 | 104000 | 12839.5 | 1437.0 |
| Sud-Ouest | 157 | 78151 | 4977.8 | 1526.0 |
| L'Ile-Bizard--Sainte-Genevieve | 236 | 18413 | 780.2 | 1639.0 |
| Mercier-Hochelaga-Maisonneuve | 254 | 136024 | 5355.3 | 1164.0 |
| Montreal-Nord | 111 | 84234 | 7588.6 | 1002.0 |
| Outremont | 39 | 23954 | 6142.1 | 1690.0 |
| Pierrefonds--Roxboro | 271 | 69297 | 2557.1 | 1303.0 |
| Pointe-aux-Trembles-Rivieres-des-Prairies | 423 | 106743 | 2523.5 | 1195.0 |
| Rosemont--La-Petite-Patrie | 159 | 139590 | 8779.2 | 1287.0 |
| Saint-Laurent | 428 | 98828 | 2309.1 | 1325.0 |
| St-Leonard | 135 | 78305 | 5800.0 | 1262.0 |
| Verdun--Ile-des-Soeurs | 97 | 69229 | 7137.0 | 1384.0 |
| Ville-Marie | 165 | 89170 | 5404.2 | 1613.0 |
| Villeray-Saint-Michel-Parc-Extension | 165 | 143853 | 8718.4 | 1197.0 |
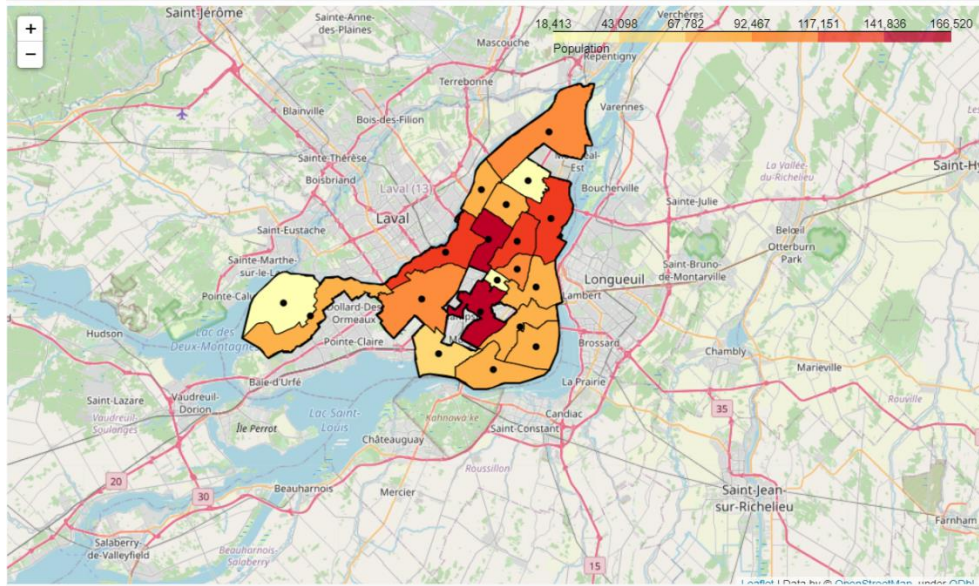
**Figure 1. Neighbourhoods of Montreal coloured according to population in 2016.**

**Table 2. Neighbourhoods in Vancouver.**

| Neighbourhood | Area (Hectares) | Population | Average Monthly Rent |
|---|---|---|---|
| Arbutus Ridge | 370 | 15910 | 1688 |
| Downtown Vancouver | 370 | 62030 | 1589 |
| Dunbar-Southlands | 856 | 21425 | 1824 |
| Fairview | 327 | 33620 | 1341 |
| Grandview-Woodland | 445 | 29175 | 1041 |
| Hastings-Sunrise | 793 | 34575 | 1103 |
| Kensington-Cedar Cottage | 724 | 49325 | 1163 |
| Kerrisdale | 631 | 13975 | 1504 |
| Killarney | 664 | 29325 | 1094 |
| Kitsilano | 546 | 43045 | 1472 |
| Marpole | 559 | 24460 | 1113 |
| Mount Pleasant | 366 | 32955 | 1291 |
| Oakridge | 401 | 13030 | 1494 |
| Renfrew-Collingwood | 805 | 51530 | 1107 |
| Riley Park | 491 | 22555 | 1361 |
| Shaughnessy | 446 | 8430 | 1789 |
| South Cambie | 217 | 7970 | 1500 |
| Strathcona | 388 | 12585 | 699 |
| Sunset | 626 | 36500 | 1112 |
| Victoria-Fraserview | 531 | 31065 | 1064 |
| West End | 198 | 47200 | 1308 |
| West Point Grey | 445 | 13065 | 1524 |

4
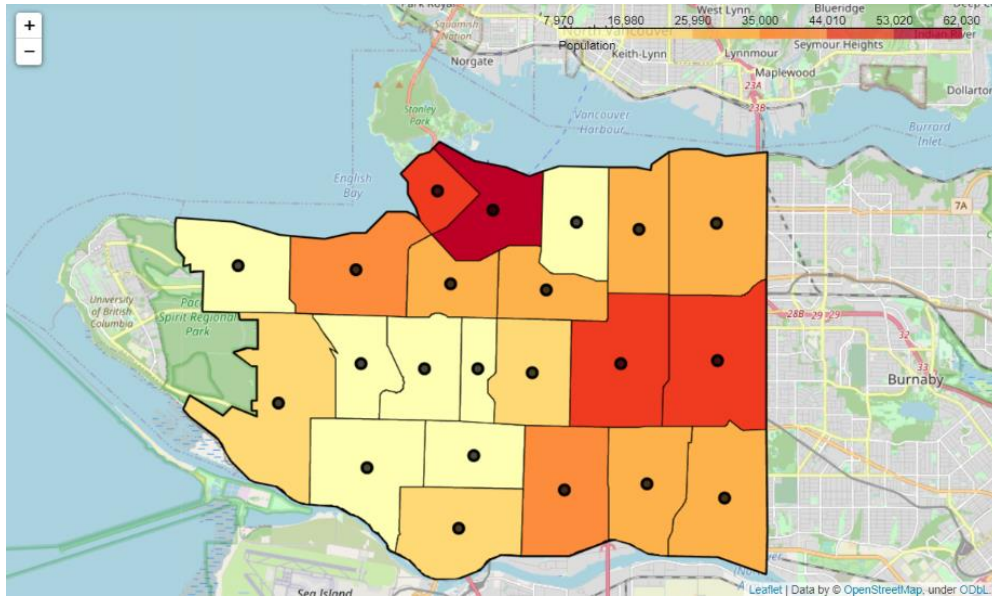
**Figure 2. Neighbourhoods of Vancouver coloured according to population in 2016.**

## 3.2 FOURSQUARE DATA

Foursquare API data was used to located the top 300 venues within 1500 m of the center of each neighbourhood. The venues were plotted in blue on top of the population density chloropath maps (Figure 3). For Montreal there were 197 unique venue categories with the most popular neighbourhoods being: Outremont, Plateau-Mont-Royal, Sud-Ouest, and Ville-Marie (Table 3). The majority of these venues are located within central region of Montreal. For Vancouver, 220 unique venue categories were returned with the most popular neighbourhoods being: Downtown, Fairview, Grandview-Woodland, Hastings, Sunrise, Kensington-Cedar Cottage, Kitsilano, Mount Pleasant, Riley Park, South Cambie, Strathcona, and West End (Table 4). The majority of these venues are located alone major routes across the city and in the downtown core at the north end of the city. In both cases the venue distribution seems to match the population distribution in each city.
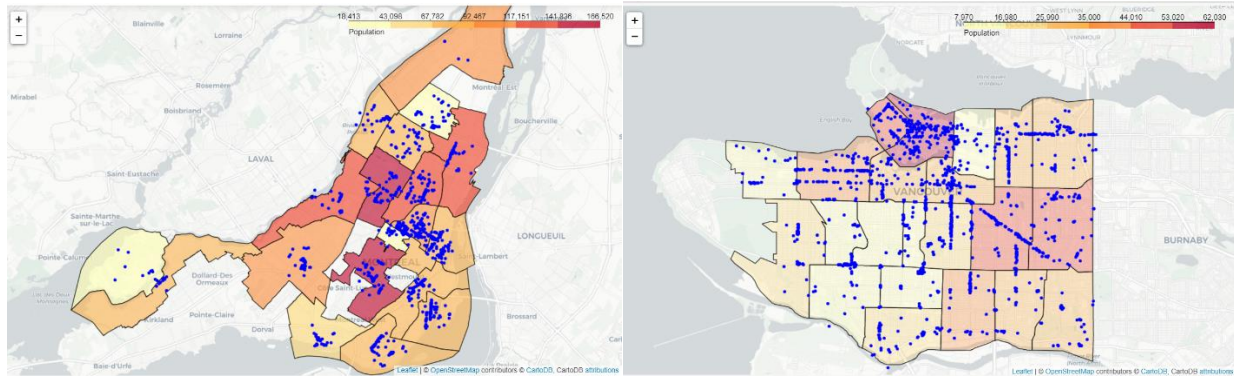
<div align="center">(a)                                    (b)</div>

**Figure 3. Neighbourhoods of (a) Montreal and (b) Vancouver coloured according to population in 2016 overlaid with popular venues as derived from Foursquare API data.**

**Table 3. Neighbourhoods of Montreal with returned number of venues per neighbourhood via Foursquare API.**

| Neighbourhood | Neighbourhood Latitude | Neighbourhood Longitude | Venue | Venue Latitude | Venue Longitude | Venue Category |
|---|---|---|---|---|---|---|
| Ahuntsic-Cartierville | 28 | 28 | 28 | 28 | 28 | 28 |
| Anjou | 48 | 48 | 48 | 48 | 48 | 48 |
| Cote-des-Neiges--Notre-Dame-de-Grace | 80 | 80 | 80 | 80 | 80 | 80 |
| L'Ile-Bizard--Sainte-Genevieve | 4 | 4 | 4 | 4 | 4 | 4 |
| LaSalle | 58 | 58 | 58 | 58 | 58 | 58 |
| Lachine | 30 | 30 | 30 | 30 | 30 | 30 |
| Mercier-Hochelaga-Maisonneuve | 38 | 38 | 38 | 38 | 38 | 38 |
| Montreal-Nord | 30 | 30 | 30 | 30 | 30 | 30 |
| Outremont | 100 | 100 | 100 | 100 | 100 | 100 |
| Pierrefonds--Roxboro | 22 | 22 | 22 | 22 | 22 | 22 |
| Plateau-Mont-Royal | 100 | 100 | 100 | 100 | 100 | 100 |
| Pointe-aux-Trembles-Rivieres-des-Prairies | 4 | 4 | 4 | 4 | 4 | 4 |
| Rosemont--La-Petite-Patrie | 86 | 86 | 86 | 86 | 86 | 86 |
| Saint-Laurent | 42 | 42 | 42 | 42 | 42 | 42 |
| St-Leonard | 38 | 38 | 38 | 38 | 38 | 38 |
| Sud-Ouest | 100 | 100 | 100 | 100 | 100 | 100 |
| Verdun--Ile-des-Soeurs | 62 | 62 | 62 | 62 | 62 | 62 |
| Ville-Marie | 100 | 100 | 100 | 100 | 100 | 100 |
| Villeray-Saint-Michel-Parc-Extension | 70 | 70 | 70 | 70 | 70 | 70 |

**Table 4. Neighbourhoods of Vancouver with returned number of venues per neighbourhood via Foursquare API.**

| Neighbourhood | Neighbourhood Latitude | Neighbourhood Longitude | Venue | Venue Latitude | Venue Longitude | Venue Category |
|---|---|---|---|---|---|---|
| Arbutus-Ridge | 63 | 63 | 63 | 63 | 63 | 63 |
| Downtown | 100 | 100 | 100 | 100 | 100 | 100 |
| Dunbar-Southlands | 39 | 39 | 39 | 39 | 39 | 39 |
| Fairview | 100 | 100 | 100 | 100 | 100 | 100 |
| Grandview-Woodland | 100 | 100 | 100 | 100 | 100 | 100 |
| Hastings-Sunrise | 100 | 100 | 100 | 100 | 100 | 100 |
| Kensington-Cedar Cottage | 100 | 100 | 100 | 100 | 100 | 100 |
| Kerrisdale | 54 | 54 | 54 | 54 | 54 | 54 |
| Killarney | 45 | 45 | 45 | 45 | 45 | 45 |
| Kitsilano | 100 | 100 | 100 | 100 | 100 | 100 |
| Marpole | 68 | 68 | 68 | 68 | 68 | 68 |
| Mount Pleasant | 100 | 100 | 100 | 100 | 100 | 100 |
| Oakridge | 45 | 45 | 45 | 45 | 45 | 45 |
| Renfrew-Collingwood | 90 | 90 | 90 | 90 | 90 | 90 |
| Riley Park | 100 | 100 | 100 | 100 | 100 | 100 |
| Shaughnessy | 41 | 41 | 41 | 41 | 41 | 41 |
| South Cambie | 100 | 100 | 100 | 100 | 100 | 100 |
| Strathcona | 100 | 100 | 100 | 100 | 100 | 100 |
| Sunset | 59 | 59 | 59 | 59 | 59 | 59 |
| Victoria-Fraserview | 44 | 44 | 44 | 44 | 44 | 44 |
| West End | 100 | 100 | 100 | 100 | 100 | 100 |
| West Point Grey | 52 | 52 | 52 | 52 | 52 | 52 |

## 3.3   CLUSTER ANALYSIS

The venues were sorted according to category and the first through tenth most common venue types for each neighbourhood were calculated. The k-means algorithm was then used to cluster neighbourhoods according to similar popular venues. The Silhouetter Score was used to select the number of clusters. For both Montreal and Vancouver, the maximum score was seen at 2 clusters. However, this isn't  very helpful to differentiate between different locations within the city for any interesting conclusions. A similarly high score was seen for 3 clusters with a score of 0.487 for both Montreal and Vancouver. The resultant output for Montreal and Vancouver can be seen in Tables 5 and 6, respectively.

**Table 5. Neighbourhoods, cluster designation and top 10 venues for Montreal.**

| Neighbourhoods | Average Monthly Rent | Cluster Labels | 1st Most Common Venue | 2nd Most Common Venue | 3rd Most Common Venue | 4th Most Common Venue | 5th Most Common Venue | 6th Most Common Venue | 7th Most Common Venue | 8th Most Common Venue | 9th Most Common Venue | 10th Most Common Venue |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pointe-aux-Trembles-Rivieres-des-Prairies | 1195 | 0 | Bakery | Convenience Store | Restaurant | Auto Dealership | English Restaurant | Flea Market | Fish Market | Fish & Chips Shop | Fast Food Restaurant | Farmers Market |
| Ahuntsic-Cartierville | 1167 | 1 | Park | Pharmacy | Grocery Store | Restaurant | Pizza Place | New American Restaurant | Farmers Market | Fast Food Restaurant | Seafood Restaurant | Breakfast Spot |
| Verdun--Ile-des-Soeurs | 1384 | 1 | Park | Pizza Place | Cafe | Bank | Sandwich Place | Mediterranean Restaurant | Indian Restaurant | Trail | BBQ Joint | Grocery Store |
| St-Leonard | 1262 | 1 | Pharmacy | Gas Station | Italian Restaurant | Sandwich Place | Drugstore | Fast Food Restaurant | Bank | Bakery | Sports Bar | Gastropub |
| Saint-Laurent | 1325 | 1 | Sporting Goods Shop | Hotel | Breakfast Spot | Bank | Restaurant | Sandwich Place | Fast Food Restaurant | Liquor Store | Shipping Store | Shoe Store |
| Rosemont--La-Petite-Patrie | 1287 | 1 | Park | Pharmacy | Bar | Breakfast Spot | Pizza Place | Bakery | Italian Restaurant | Grocery Store | Restaurant | Brewery |
| Pierrefonds--Roxboro | 1303 | 1 | Pizza Place | Restaurant | Convenience Store | Grocery Store | Park | Pharmacy | Skating Rink | Breakfast Spot | Food & Drink Shop | French Restaurant |
| Outremont | 1690 | 1 | Cafe | Bakery | Bar | Mediterranean Restaurant | Restaurant | French Restaurant | Bagel Shop | Supermarket | Breakfast Spot | Park |
| Ville-Marie | 1613 | 1 | Cafe | Hotel | Cocktail Bar | Plaza | Bar | Spa | Restaurant | Tea Room | Coffee Shop | Hostel |
| Montreal-Nord | 1002 | 1 | Pharmacy | Italian Restaurant | Grocery Store | Breakfast Spot | Restaurant | Supermarket | Gas Station | Fast Food Restaurant | Portuguese Restaurant | Video Game Store |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Sud-Ouest* | 1526 | 1 | Bakery | Cafe | Breakfast Spot | Restaurant | French Restaurant | Ice Cream Shop | Pizza Place | Brewery | Bar | Gastropub |
| *Plateau-Mont-Royal* | 1437 | 1 | Cafe | Bakery | Restaurant | Park | Vegetarian / Vegan Restaurant | Portuguese Restaurant | Yoga Studio | Coffee Shop | Deli / Bodega | Middle Eastern Restaurant |
| *LaSalle* | 1283 | 1 | Fast Food Restaurant | Breakfast Spot | Pizza Place | Pharmacy | Restaurant | Coffee Shop | Italian Restaurant | Gym / Fitness Center | Sandwich Place | Pet Store |
| *Lachine* | 1078 | 1 | Park | Italian Restaurant | Pharmacy | Fast Food Restaurant | Ice Cream Shop | Bank | Liquor Store | Lighthouse | Sandwich Place | Restaurant |
| *Cote-des-Neiges--Notre-Dame-de-Grace* | 1300 | 1 | Coffee Shop | Pharmacy | Bakery | Vietnamese Restaurant | Fast Food Restaurant | Restaurant | Bank | Liquor Store | Pizza Place | Grocery Store |
| *Anjou* | 1151 | 1 | Coffee Shop | Clothing Store | Restaurant | Fast Food Restaurant | Gas Station | Pharmacy | Pizza Place | Burger Joint | Convenience Store | Sandwich Place |
| *Mercier-Hochelaga-Maisonneuve* | 1164 | 1 | Coffee Shop | Restaurant | Breakfast Spot | Fast Food Restaurant | Pharmacy | Greek Restaurant | Liquor Store | Thai Restaurant | Italian Restaurant | Paintball Field |
| *Villeray-Saint-Michel-Parc-Extension* | 1197 | 1 | Grocery Store | Vietnamese Restaurant | Bakery | Fast Food Restaurant | Sandwich Place | Portuguese Restaurant | Pharmacy | Sushi Restaurant | Coffee Shop | Breakfast Spot |
| *L'Ile-Bizard--Sainte-Genevieve* | 1639 | 2 | Golf Course | Construction & Landscaping | English Restaurant | Flea Market | Fish Market | Fish & Chips Shop | Fast Food Restaurant | Farmers Market | Falafel Restaurant | Fabric Shop |

**Table 6. Neighbourhoods, cluster designation and top 10 venues for Vancouver.**

| Neighbourhood | Average Monthly Rent | Cluster Labels | 1st Most Common Venue | 2nd Most Common Venue | 3rd Most Common Venue | 4th Most Common Venue | 5th Most Common Venue | 6th Most Common Venue | 7th Most Common Venue | 8th Most Common Venue | 9th Most Common Venue | 10th Most Common Venue |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Strathcona | 699 | 0 | Brewery | Cafe | Park | Pizza Place | Ice Cream Shop | Gourmet Shop | Asian Restaurant | Coffee Shop | Italian Restaurant | Breakfast Spot |
| Grandview-Woodland | 1041 | 0 | Brewery | Coffee Shop | Cafe | Pizza Place | Sushi Restaurant | Ice Cream Shop | Italian Restaurant | Indian Restaurant | Bakery | Middle Eastern Restaurant |
| Mount Pleasant | 1291 | 0 | Coffee Shop | Brewery | Bakery | Vietnamese Restaurant | Sushi Restaurant | Yoga Studio | Chinese Restaurant | Pizza Place | Park | Outdoor Supply Store |
| Arbutus-Ridge | 1688 | 1 | Coffee Shop | Chinese Restaurant | Grocery Store | Park | Dessert Shop | Sandwich Place | Italian Restaurant | Bakery | Japanese Restaurant | Tea Room |
| Victoria-Fraserview | 1064 | 1 | Bus Stop | Convenience Store | Asian Restaurant | Chinese Restaurant | Sandwich Place | Coffee Shop | Electronics Store | Park | Japanese Restaurant | Gas Station |
| Sunset | 1112 | 1 | Chinese Restaurant | Sandwich Place | Coffee Shop | Indian Restaurant | Burger Joint | Gas Station | Vietnamese Restaurant | Restaurant | Asian Restaurant | Fast Food Restaurant |
| South Cambie | 1500 | 1 | Coffee Shop | Park | Chinese Restaurant | Japanese Restaurant | Bank | Sushi Restaurant | Garden | Bakery | Cafe | Vietnamese Restaurant |
| Shaughnessy | 1789 | 1 | Coffee Shop | Sandwich Place | Sushi Restaurant | Bubble Tea Shop | Bank | Burger Joint | Garden | Restaurant | Convenience Store | Gourmet Shop |
| Riley Park | 1361 | 1 | Cafe | Coffee Shop | Vietnamese Restaurant | Park | Japanese Restaurant | Chinese Restaurant | Pizza Place | Bakery | Furniture / Home Store | Arts & Crafts Store |
| Renfrew-Collingwood | 1107 | 1 | Chinese Restaurant | Park | Pizza Place | Coffee Shop | Bus Station | Asian Restaurant | Metro Station | Convenience Store | Grocery Store | Pet Store |
| Oakridge | 1494 | 1 | Coffee Shop | Sushi Restaurant | Bus Stop | Park | Tea Room | Restaurant | Fast Food Restaurant | Shopping Mall | Garden | Sporting Goods Shop |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Marpole* | 1113 | 1 | Bank | Vietnamese Restaurant | Pharmacy | Sushi Restaurant | Chinese Restaurant | Coffee Shop | Sandwich Place | Dessert Shop | Furniture / Home Store | Gas Station |
| *Kitsilano* | 1472 | 1 | Coffee Shop | Bakery | Sushi Restaurant | Cafe | Grocery Store | Restaurant | Thai Restaurant | Yoga Studio | Greek Restaurant | Sporting Goods Shop |
| *Killarney* | 1094 | 1 | Bus Stop | Coffee Shop | Shopping Mall | Gas Station | Park | Sushi Restaurant | Farmers Market | Burger Joint | Golf Course | Grocery Store |
| *Kerrisdale* | 1504 | 1 | Bus Stop | Coffee Shop | Chinese Restaurant | Pharmacy | Golf Course | Tea Room | Cafe | Park | Sushi Restaurant | Supermarket |
| *Kensington-Cedar Cottage* | 1163 | 1 | Vietnamese Restaurant | Chinese Restaurant | Vegetarian / Vegan Restaurant | Coffee Shop | Cafe | Japanese Restaurant | Gym / Fitness Center | Grocery Store | Bakery | Pizza Place |
| *Hastings-Sunrise* | 1103 | 1 | Vietnamese Restaurant | Coffee Shop | Park | Theme Park Ride / Attraction | Cafe | Sushi Restaurant | Chinese Restaurant | Bakery | Italian Restaurant | Event Space |
| *Dunbar-Southlands* | 1824 | 1 | Grocery Store | Golf Course | Liquor Store | Bakery | Coffee Shop | Sushi Restaurant | Bank | Park | Gym | Bus Stop |
| *West Point Grey* | 1524 | 1 | Park | Sushi Restaurant | Beach | Coffee Shop | Cafe | Japanese Restaurant | Bank | Vegetarian / Vegan Restaurant | Pub | Fast Food Restaurant |
| *Fairview* | 1341 | 2 | Park | Seafood Restaurant | Restaurant | Cafe | Japanese Restaurant | Indian Restaurant | Coffee Shop | Pizza Place | Bakery | Sushi Restaurant |
| *Downtown* | 1589 | 2 | Hotel | Restaurant | Seafood Restaurant | Japanese Restaurant | Dessert Shop | Sandwich Place | Coffee Shop | Concert Hall | Bakery | Yoga Studio |
| *West End* | 1308 | 2 | Hotel | Japanese Restaurant | Italian Restaurant | Dessert Shop | Coffee Shop | Sandwich Place | Park | Sculpture Garden | Bakery | Ramen Restaurant |

The resultant cluster data for the neighbourhoods were mapped. The clusters were overlaid on a chloropath map showing the average rental cost in each neighbourhood (Figure 4). A bar graph showing the average rental cost per neighbourhood was plotted with respect to their cluster labels (Figure 5 and

Figure 6). This allows one to look at neighbourhoods with similar amenities and compare the cost of living in each neighbourhood. For example, if one lives in Outremont in Montreal, one can consider moving to the similar neighbourhood of Montreal-Nord, which is around $600 per month cheaper to rent in.
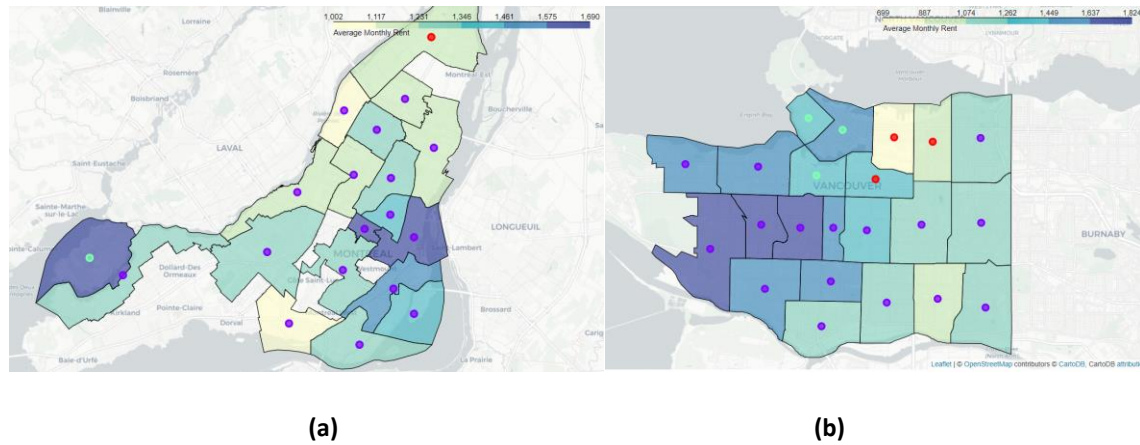


(a)                                                     (b)

**Figure 4. Neighbourhoods of (a) Montreal and (b) Vancouver coloured according to average monthly rental costs in 2016 overlaid with clusters as derived from Foursquare API data.**
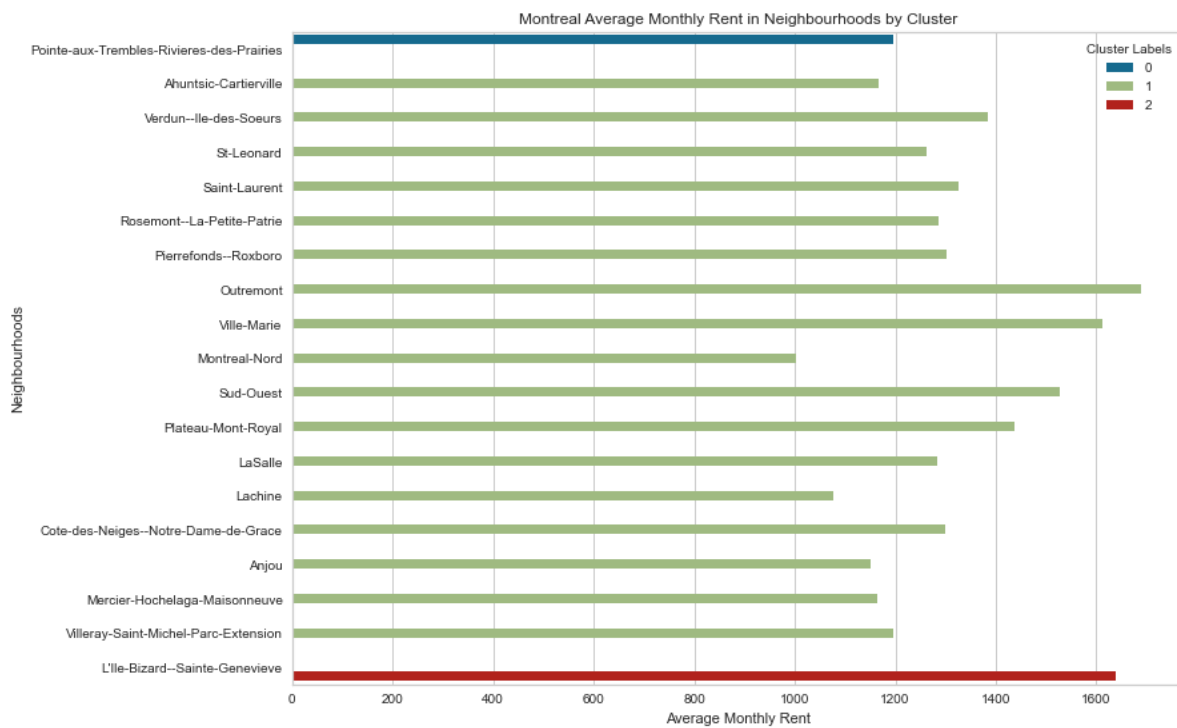


**Figure 5. Average monthly rental cost in Montreal by cluster designation.**
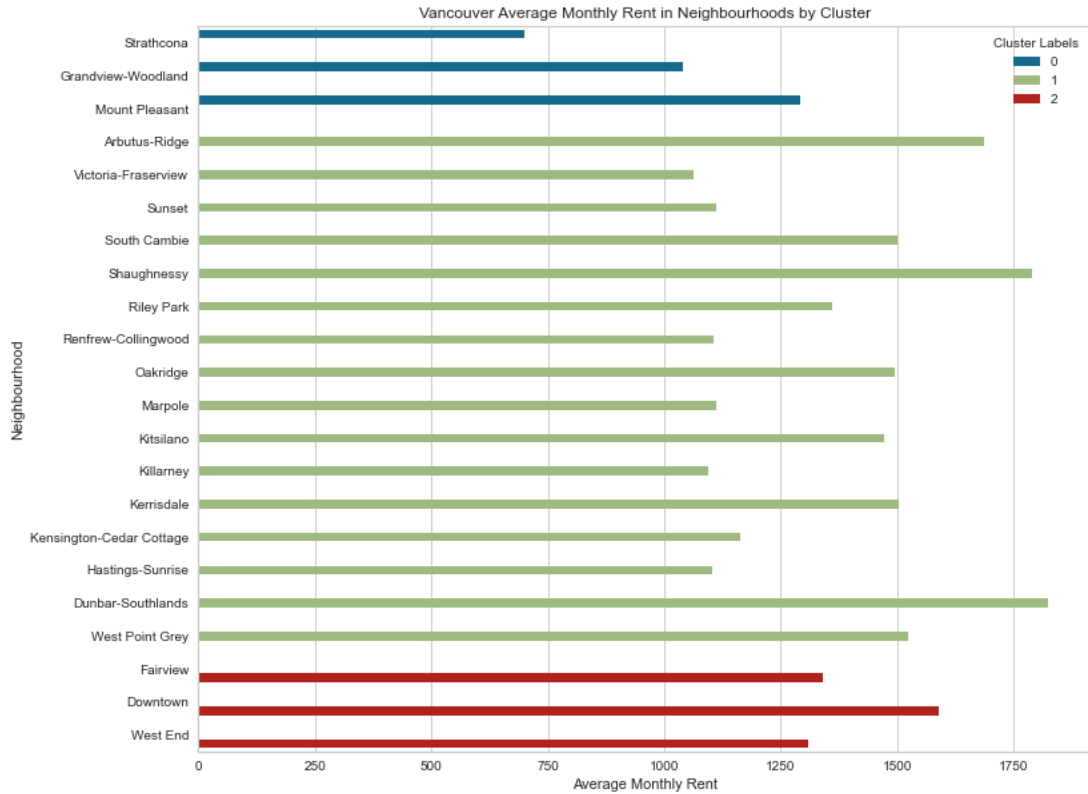
Figure 6. Average monthly rental cost in Vancouver by cluster designation.

### 3.3.1 Montreal Clusters

**Table 7. Average monthly rental prices for Montreal clusters.**

|  | **Average Monthly Rent** |
| --- | --- |
| **Cluster Labels** | |
| **0** | 1195.000000 |
| **1** | 1304.058824 |
| **2** | 1639.000000 |

#### *3.3.1.1 North-East Cluster (Cluster 0)*

This cluster encompasses the Pointe-aux-Trembles-Rivieres-des-Prairies neighbourhood. This district seems to be more focused on shopping, with multiple bakeries and markets (Farmers market and Fish market). The rental price for this area is quite reasonable, likely given the distance from the downtown core.

### 3.3.1.2 South-West Cluster (Cluster 2)

This cluster includes L'Ile-Bizard--Sainte-Genevieve wherein the top venues are related to recreation (Golf course) and commerce (Construction). The average rental price is quite high in this area, as well.

### 3.3.1.3 Central Cluster (Cluster 1)

The remaining neighbourhoods in Montreal can be clustered in near the downtown core. This cluster includes shopping, European style dining, cafes, hotels, and recreational facilities like gyms and spas.

### 3.3.2 Vancouver Clusters

**Table 8. Average monthly rental prices for Vancouver clusters.**

| Cluster Labels | Average Monthly Rent |
|---|---|
| 0 | 1010.333333 |
| 1 | 1369.500000 |
| 2 | 1412.666667 |

### 3.3.2.1 Southern Cluster (Cluster 1)

This cluster comprises the majority of Vancouver, including a wide variety of shops, restaurants, and other amenities like banks, gyms and parks. Shaughnessy and Dunbar-Southlands are the most expensive neighbourhoods in Vancouver, but there are others within the cluster that are quite reasonable and have access to similar amenities.

### 3.3.2.2 Central Cluster (Cluster 0)

Consisting of 3 neighbourhoods (Strathcona, Grandview-Woodland, and Mount Pleasant), this cluster is the location of many breweries, parks, and small eateries. On average, this is the least expensive area in which to rent in Vancouver.

### 3.3.2.3 Downtown-Northern Cluster (Custer 2)

This cluster encompasses the downtown core of Vancouver and it's surrounding neighbourhoods. As such, this cluster included many hotels, attractions and a variety of restaurants. This cluster is also the most expensive in terms of rental prices on average.

## 3.4 Overall Comparisons Between Montreal and Vancouver

### 3.4.1 Household income

The median household income in Vancouver is greater than that seen for Montreal as evidenced by the greater proportion of households which earn over $100,000 a year (Figure 7). Household income is typically proportional to the cost needed to live and work in the city. The most expensive neighbourhood in Vancouver at $1800 per month is almost $200 more expensive than an equivalent residence in Montreal. This is something to be considered when moving or visiting a city, as costs for most goods and services will also reflect the higher cost of living.
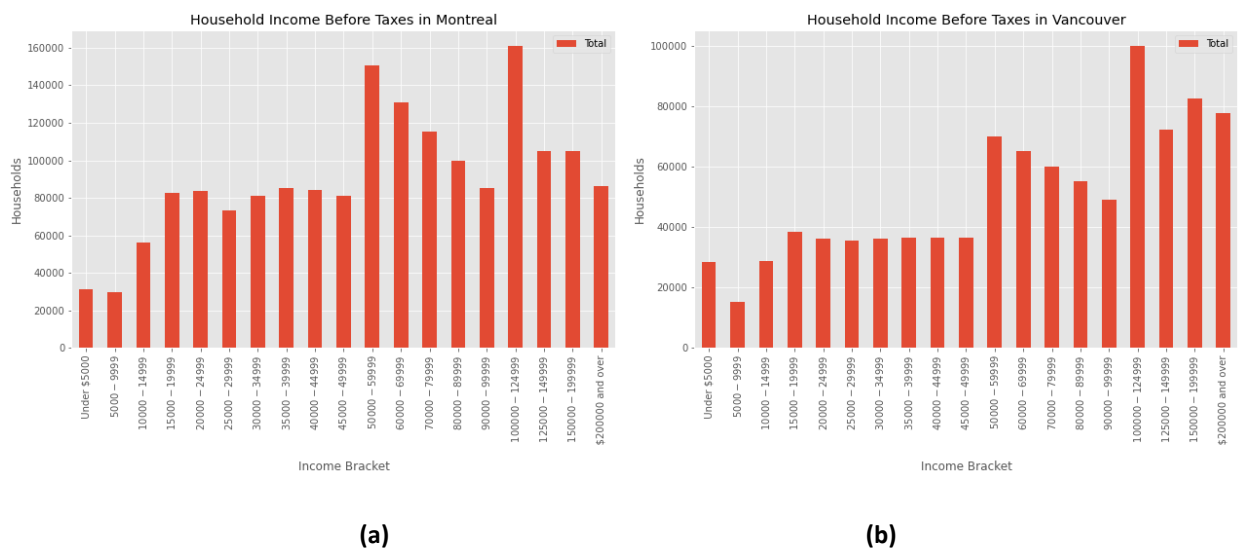


**(a)**           **(b)**

**Figure 7. Household income before taxes in 2016 for (a) Montreal and (b) Vancouver.**

### 3.4.2 Immigration

The top 15 countries which contributed to immigration to Montreal and Vancouver were plotted according to the number of immigrants (Figure 8). The highest contributors for Montreal immigration were Haiti, France, and Morocco. All of which are French speaking countries. In contrast, Vancouver has a high immigrant population from China, India, and other Asian countries. This cultural difference is reflected in the popular venues which were found via Foursquare. For example in Vancouver, especially in cluster 2, there is a large number of Chinese, Japanese, and Vietnamese restaurants. In contrast, in Montreal, there is a larger proportion of European-style restaurants, like French, Italian and Portuguese. This information is also relevant to those considering immigrating to Canada. Both Montreal and Vancouver are large urban centers of industry, providing ample opportunities for immigrants. The ability

to move into an established community which speaks the same language is invaluable for integrating into a new environment.
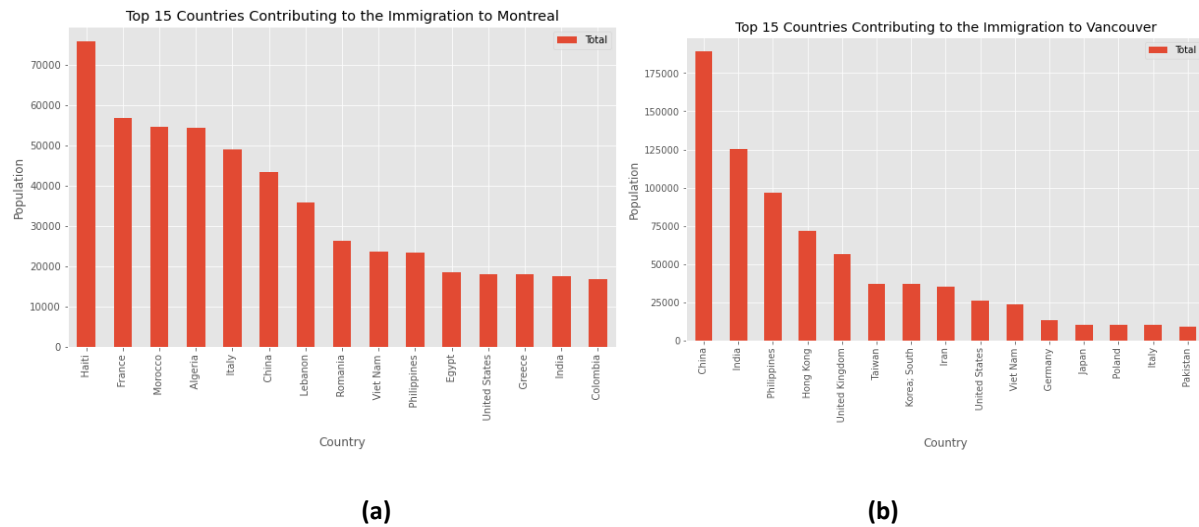


(a)                                                                 (b)

**Figure 8. Top 15 countries which contributed immigration to (a) Montreal and (b) Vancouver.**

### 3.4.3 Population Distribution

Montreal is a younger skewing city, with a greater proportion of young children compared to Vancouver (Figure 9). Given the higher cost associated with living in Vancouver, families with younger children are more able to afford accommodation in Montreal. Gender-wise there's a fairly uniform distribution for both sexes among the population.
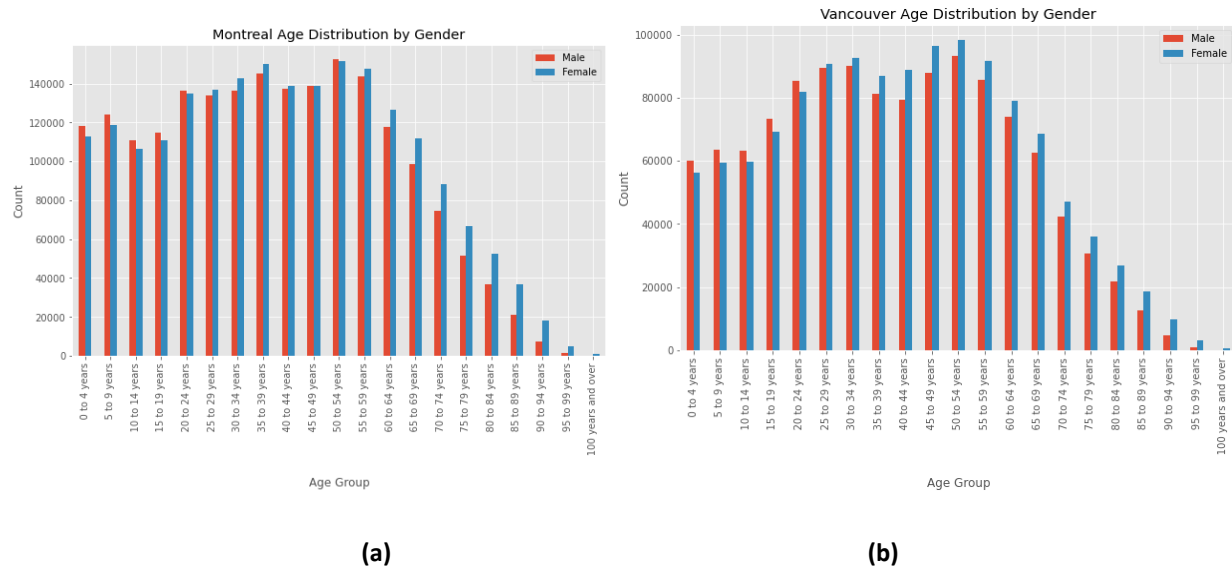
**Figure 9. Age and gender distribution for (a) Montreal and (b) Vancouver.**

# 4 Conclusions

This study sought to provide data to potential visitors to either Montreal or Vancouver to help: identify regions within the city which provide amenities which align with an individuals preferences, the cost associated with living within each city, and the ethnographic make-up of each city to provide immigrants with a built-in community. Both cities provide a large range of amenities throughout the majority of the municipalities, with the exception of small clusters. Thus, the main factor which can affect choosing between these cities is cost. For those considering moving to Vancouver, there is a large Asian community which can help support new immigrants. Similarly, Montreal has a large French population from European countries and Haiti. Overall, the recommendation for individuals with moderate incomes and younger families the best choice is Montreal.

# 5 Future Directions

In continuation of this study, it may be helpful to look at house prices in these areas. The Canadian housing market is currently in an upswing despite the global pandemic. While rental prices, as analysed above, provide helpful information for younger professionals, house prices are more applicable to those with established careers who are looking for a forever home.