rental_analysis

February 13, 2022

1 Toronto Dwellings Analysis

In this assignment, you will perform fundamental analysis for the Toronto dwellings market to allow potential real estate investors to choose rental investment properties.

[48]:
```
# imports
import panel as pn
pn.extension('plotly')
import plotly.express as px
import pandas as pd
import hvplot.pandas
import matplotlib.pyplot as plt
import os
from pathlib import Path
from dotenv import load_dotenv
from holoviews import opts
```

[2]:
```
# Read the Mapbox API key
load_dotenv()
map_box_api = os.getenv("mapbox_api_key")
```

1.1 Load Data

[3]:
```
# Read the census data into a Pandas DataFrame
file_path = Path("Data/toronto_neighbourhoods_census_data.csv")
to_data = pd.read_csv(file_path, index_col="year")
to_data.head()
```

[3]:
```
                    neighbourhood  single_detached_house  \
year
2001                Agincourt North                   3715
2001  Agincourt South-Malvern West                   3250
2001                     Alderwood                   3175
2001                         Annex                   1060
2001             Banbury-Don Mills                   3615

      apartment_five_storeys_plus  movable_dwelling  semi_detached_house  \
year
```

```
2001                        1480                   0                   1055
2001                        1835                   0                    545
2001                         315                   0                    470
2001                        6090                   5                   1980
2001                        4465                   0                    240

      row_house  duplex  apartment_five_storeys_less  other_house  \
year
2001       1295     195                          185            5
2001        455     105                          425            0
2001         50     185                          370            0
2001        605     275                         3710          165
2001        380      15                         1360            0

      average_house_value  shelter_costs_owned  shelter_costs_rented
year
2001               200388                  810                   870
2001               203047                  806                   892
2001               259998                  817                   924
2001               453850                 1027                  1378
2001               371864                 1007                  1163
```

1.2 Dwelling Types Per Year

In this section, you will calculate the number of dwelling types per year. Visualize the results using bar charts and the Pandas plot function.

Hint: Use the Pandas `groupby` function.

Optional challenge: Plot each bar chart in a different color.

[4]:
```
# Calculate the sum number of dwelling types units per year (hint: use groupby)
# YOUR CODE HERE!

sum_dwelling = to_data.groupby(by=['year']).sum()
sum_dwelling.head()
```

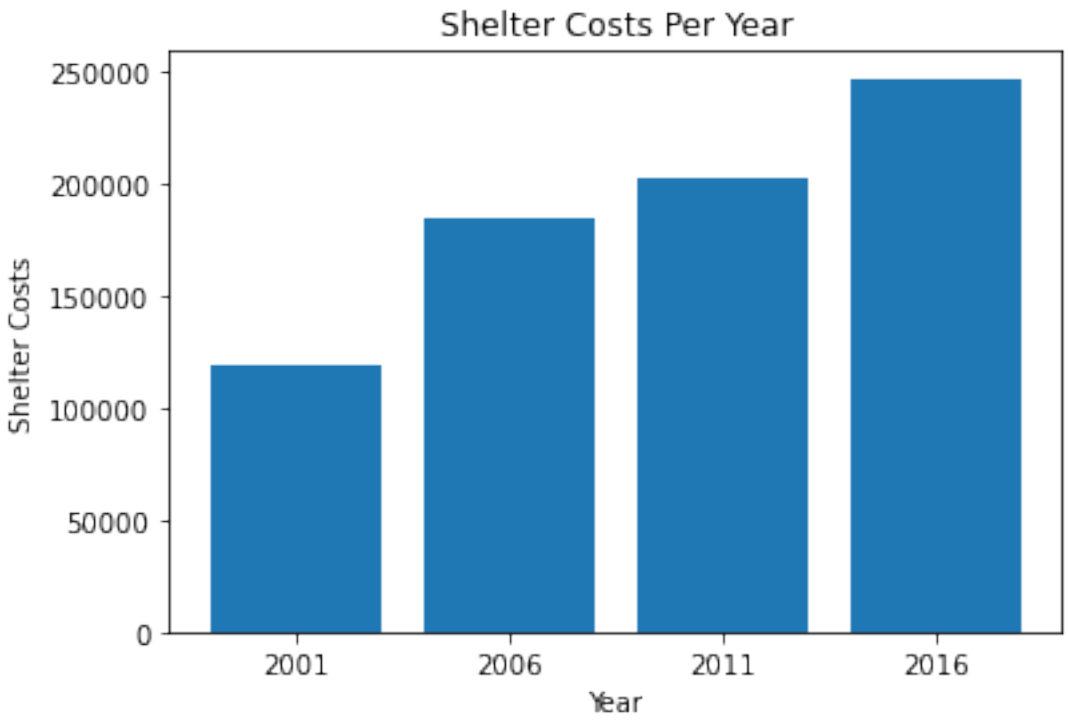
[4]:
```
      single_detached_house  apartment_five_storeys_plus  movable_dwelling  \
year
2001                 300930                       355015                75
2006                 266860                       379400               165
2011                 274940                       429220               100
2016                 269680                       493270                95

      semi_detached_house  row_house  duplex  apartment_five_storeys_less  \
year
2001                90995      52355   23785                       116900
```

```
2006                69430      54690   44095                      162850
2011                72480      60355   44750                      163895
2016                71200      61565   48585                      165575

      other_house  average_house_value  shelter_costs_owned  \
year
2001         3040             40583604               118563
2006         1335             59368353               184352
2011         2165             74259461               202750
2016         2845             92969566               246584

      shelter_costs_rented
year
2001                152031
2006                129558
2011                142771
2016                175885
```

[5]:
```
# Save the dataframe as a csv file
# YOUR CODE HERE!

sum_dwelling.to_csv('sum_dwelling.csv')
```

[6]:
```
## Sliced Data for Shelter Costs of Owned Properties
year = ['2001', '2006', '2011', '2016']
shelter_costs_owned = [118563, 184352, 202750, 246584]
```

[7]:
```
## SHELTER COST GRAPTH
plt.bar(year, shelter_costs_owned)
plt.title('Shelter Costs Per Year')
plt.xlabel('Year')
plt.ylabel('Shelter Costs')
plt.show()
```



[8]:
```
# Create a bar chart per year to show the number of dwelling types
""" New Data Frame to plot individual year data """

data_types = sum_dwelling[
    ['single_detached_house',␣
 ↪'apartment_five_storeys_plus','movable_dwelling','semi_detached_house','row_house',
    'duplex', 'apartment_five_storeys_less', 'other_house']
]
data_types.head()
```

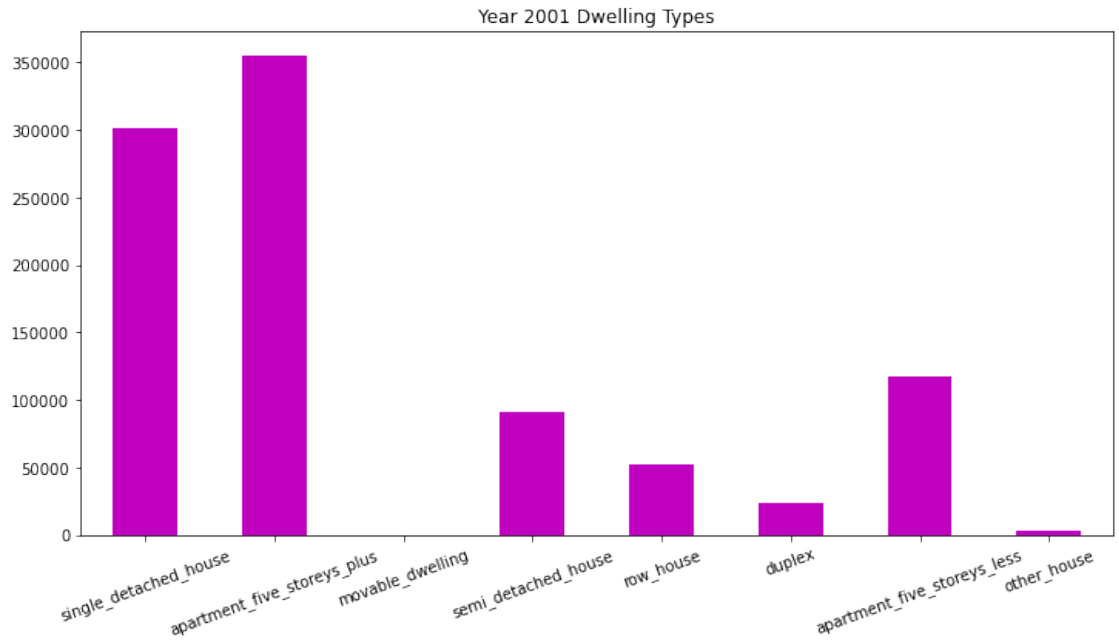
[8]:

year	single_detached_house	apartment_five_storeys_plus	movable_dwelling	semi_detached_house	row_house	duplex	apartment_five_storeys_less	other_house
2001	300930	355015	75	90995	52355	23785	116900	1
2006	266860	379400	165	69430	54690	44095	162850	0
2011	274940	429220	100	72480	60355	44750	163895	0
2016	269680	493270	95	71200	61565	48585	165575	0

year	other_house
2001	3040
2006	1335
2011	2165
2016	2845

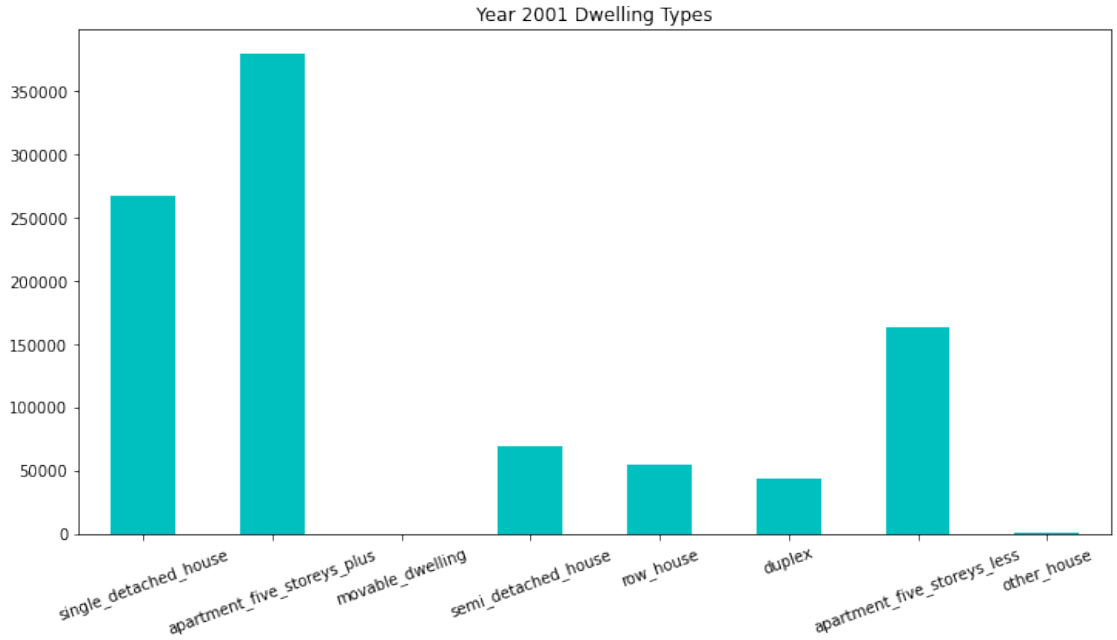
[9]:
```
# Bar chart for 2001
# YOUR CODE HERE!

row = data_types.iloc[0]
row.plot(kind='bar',title='Year 2001 Dwelling Types',figsize=(12,6),␣
 ↪color='m',rot=20)
```

[9]: <AxesSubplot:title={'center':'Year 2001 Dwelling Types'}>



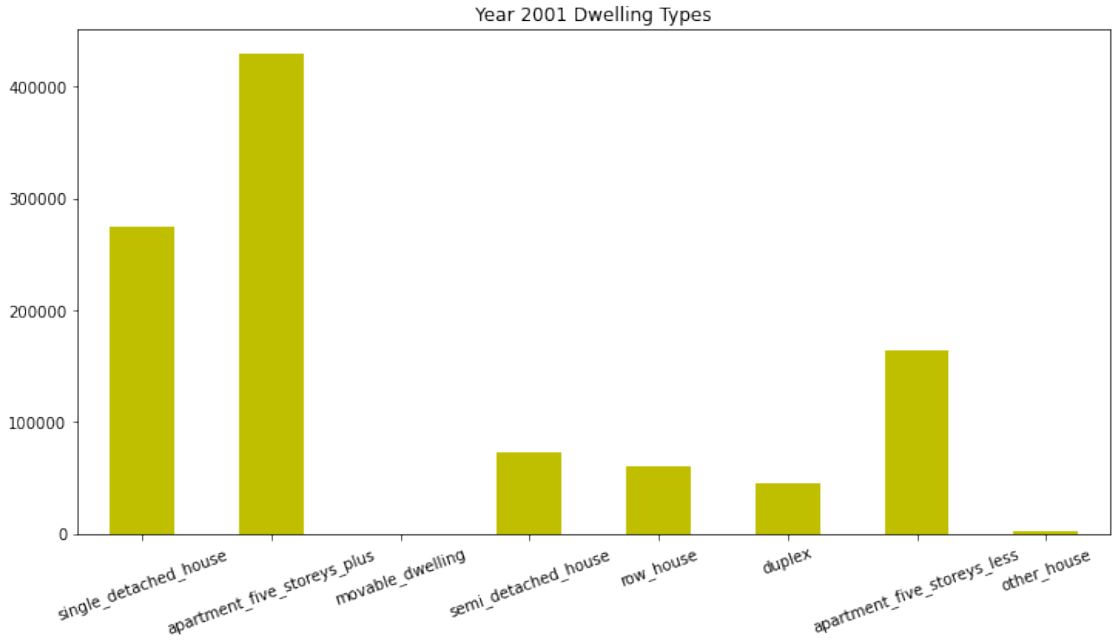
[10]:
```
# Bar chart for 2006
# YOUR CODE HERE!

row2 = data_types.iloc[1]
row2.plot(kind='bar',title='Year 2001 Dwelling Types',figsize=(12,6),␣
 ↪color='c',rot=20)
```

[10]: <AxesSubplot:title={'center':'Year 2001 Dwelling Types'}>



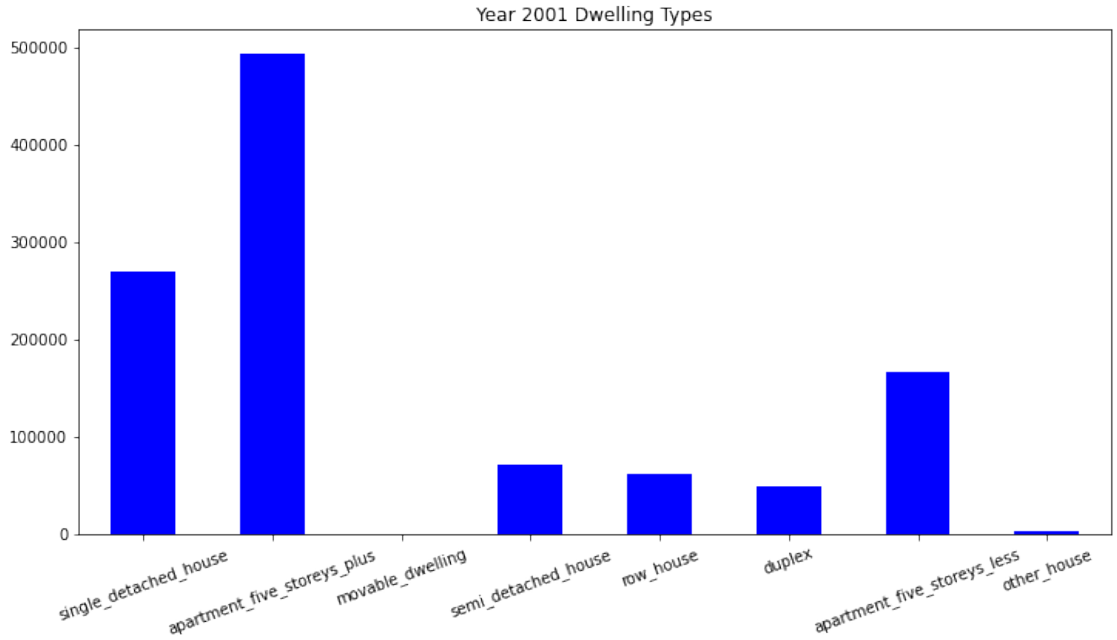
[11]:
```
# Bar chart for 2011
# YOUR CODE HERE!

row3 = data_types.iloc[2]
row3.plot(kind='bar',title='Year 2001 Dwelling Types',figsize=(12,6),␣
 ↪color='y',rot=20)
```

[11]: <AxesSubplot:title={'center':'Year 2001 Dwelling Types'}>



[12]:
```
# Bar chart for 2016
# YOUR CODE HERE!

row4 = data_types.iloc[3]
row4.plot(kind='bar',title='Year 2001 Dwelling Types',figsize=(12,6),␣
 ↪color='blue', rot=20)
```

[12]: <AxesSubplot:title={'center':'Year 2001 Dwelling Types'}>



1.3 Average Monthly Shelter Costs in Toronto Per Year

In this section, you will calculate the average monthly shelter costs for owned and rented dwellings and the average house value for each year. Plot the results as a line chart.

Optional challenge: Plot each line chart in a different color.

[42]:
```
to_data
```

[42]:
```
                    neighbourhood  single_detached_house  \
year
2001                Agincourt North                   3715
2001  Agincourt South-Malvern West                   3250
2001                     Alderwood                   3175
2001                         Annex                   1060
2001             Banbury-Don Mills                   3615
…                              …                      …
2016                     Wychwood                    920
2016                Yonge-Eglinton                   1400
2016                Yonge-St.Clair                    520
2016       York University Heights                   1235
2016            Yorkdale-Glen Park                   2165

      apartment_five_storeys_plus  movable_dwelling  semi_detached_house  \
year
```

```
2001                    1480                 0                 1055
2001                    1835                 0                  545
2001                     315                 0                  470
2001                    6090                 5                 1980
2001                    4465                 0                  240
…                        …                   …                  …
2016                    1295                 0                  880
2016                    1995                 0                  465
2016                    4315                 0                  450
2016                    5505                 0                 1360
2016                    1185                 0                   80

      row_house  duplex  apartment_five_storeys_less  other_house  \
year
2001       1295     195                          185            5
2001        455     105                          425            0
2001         50     185                          370            0
2001        605     275                         3710          165
2001        380      15                         1360            0
…           …      …                            …             …
2016        290     395                         2080           35
2016         60     310                         1445            0
2016        220     130                         1370            0
2016        775     280                          995            0
2016        600     465                          830            5

      average_house_value  shelter_costs_owned  shelter_costs_rented
year
2001               200388                  810                   870
2001               203047                  806                   892
2001               259998                  817                   924
2001               453850                 1027                  1378
2001               371864                 1007                  1163
…                   …                     …                     …
2016               787760                 1864                  1146
2016              1127052                 2398                  1535
2016              1131888                 2192                  1619
2016               425769                 1444                  1122
2016               599698                 1451                  1128

[560 rows x 12 columns]
```

[46]:
```
# Calculate the average monthly shelter costs for owned and rented dwellings
# YOUR CODE HERE!

average_shelter_costs_owned_2001 = to_data.loc['2001', 'shelter_costs_owned'].
↪mean()
```

```
average_shelter_costs_owned_2006 = to_data.loc['2006', 'shelter_costs_owned'].
 ↪mean()
average_shelter_costs_owned_2011 = to_data.loc['2011', 'shelter_costs_owned'].
 ↪mean()
average_shelter_costs_owned_2016 = to_data.loc['2016', 'shelter_costs_owned'].
 ↪mean()

print(f"The Average Owned Shelter Costs in the Year 2001 is:")
print(f"${average_shelter_costs_owned_2001}")
print(f"The Average Owned Shelter Costs in the Year 2006 is:")
print(f"${average_shelter_costs_owned_2006}")
print(f"The Average Owned Shelter Costs in the Year 2011 is:")
print(f"${average_shelter_costs_owned_2011}")
print(f"The Average Owned Shelter Costs in the Year 2016 is:")
print(f"${average_shelter_costs_owned_2016}")
```

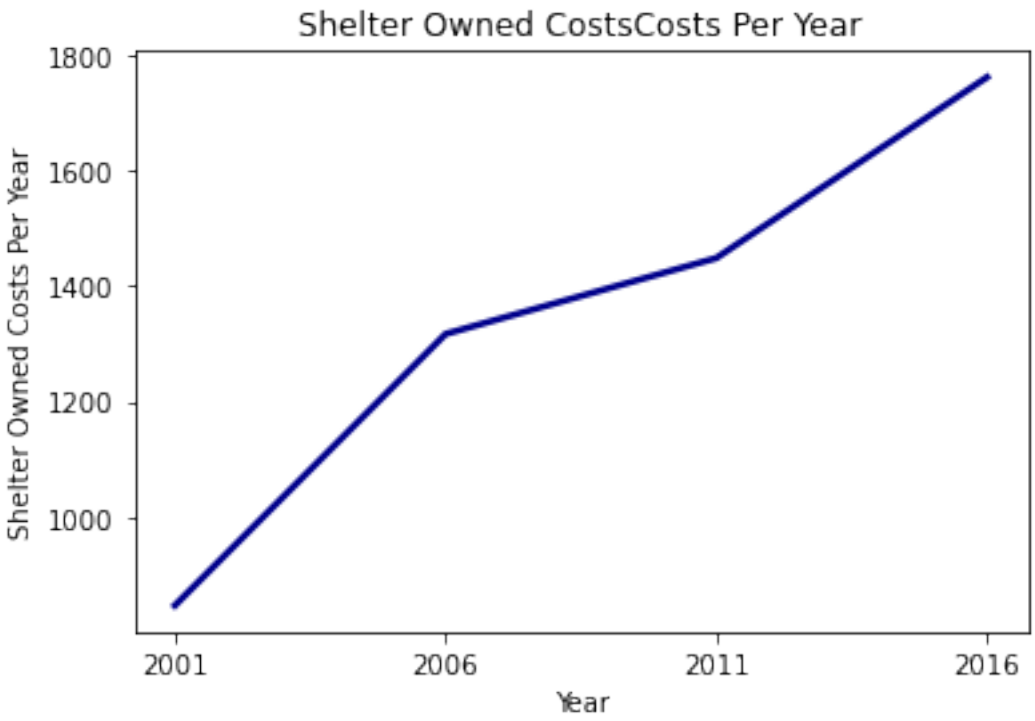
```
The Average Owned Shelter Costs in the Year 2001 is:
$846.8785714285714
The Average Owned Shelter Costs in the Year 2006 is:
$1316.8
The Average Owned Shelter Costs in the Year 2011 is:
$1448.2142857142858
The Average Owned Shelter Costs in the Year 2016 is:
$1761.3142857142857
```

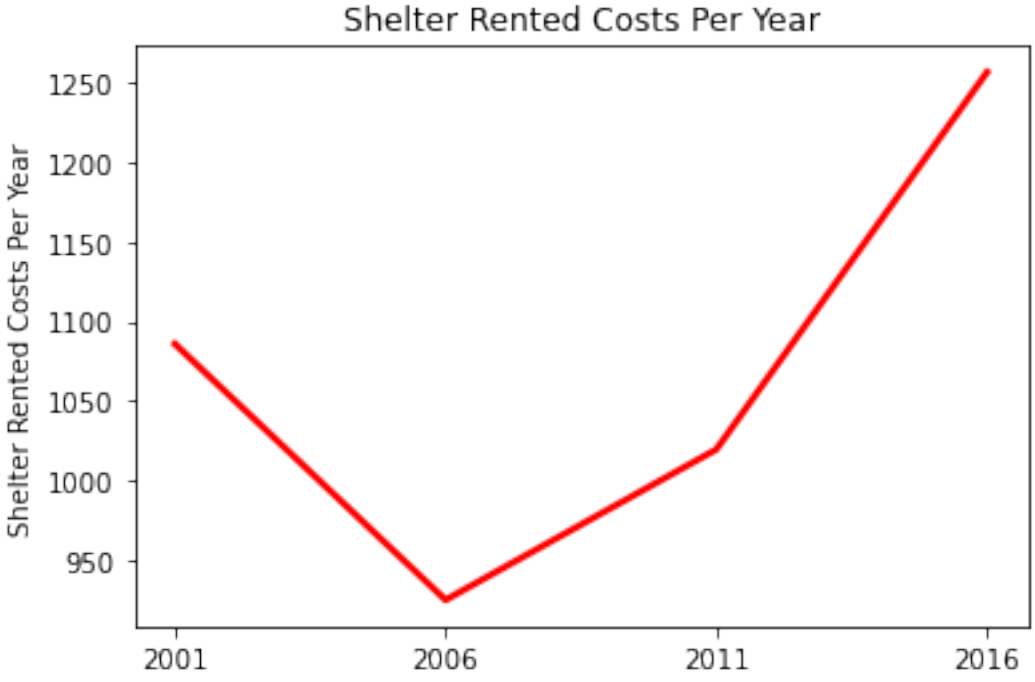
[47]:
```
average_shelter_costs_rented_2001 = to_data.loc['2001', 'shelter_costs_rented'].
 ↪mean()
average_shelter_costs_rented_2006 = to_data.loc['2006', 'shelter_costs_rented'].
 ↪mean()
average_shelter_costs_rented_2011 = to_data.loc['2011', 'shelter_costs_rented'].
 ↪mean()
average_shelter_costs_rented_2016 = to_data.loc['2016', 'shelter_costs_rented'].
 ↪mean()

print(f"The Average Rented Shelter Costs in the Year 2001 is:")
print(f"${average_shelter_costs_rented_2001}")
print(f"The Average Rented Shelter Costs in the Year 2006 is:")
print(f"${average_shelter_costs_rented_2006}")
print(f"The Average Rented Shelter Costs in the Year 2011 is:")
print(f"${average_shelter_costs_rented_2011}")
print(f"The Average Rented Shelter Costs in the Year 2001 is:")
print(f"${average_shelter_costs_rented_2016}")
```

```
The Average Rented Shelter Costs in the Year 2001 is:
$1085.9357142857143
The Average Rented Shelter Costs in the Year 2006 is:
$925.4142857142857
The Average Rented Shelter Costs in the Year 2011 is:
```

```
$1019.7928571428571
The Average Rented Shelter Costs in the Year 2001 is:
$1256.3214285714287
```

[18]:
```
# Create two line charts, one to plot the monthly shelter costs for owned␣
 ↪dwelleing and other for rented dwellings per year

average_shelter_costs_owned_all_plot = [846.8785714285714, 1316.8, 1448.
 ↪2142857142858, 1761.3142857142857]
average_shelter_costs_rented_all_plot = [1085.9357142857143, 925.4142857142857,␣
 ↪1019.7928571428571, 1256.3214285714287]

# Line chart for owned dwellings
# YOUR CODE HERE!
plt.plot(year, average_shelter_costs_owned_all_plot, color='darkblue',␣
 ↪linewidth=2.5)
plt.title('Shelter Owned CostsCosts Per Year')
plt.xlabel('Year')
plt.ylabel('Shelter Owned Costs Per Year')
plt.show()
# Line chart for rented dwellings
# YOUR CODE HERE!
plt.plot(year, average_shelter_costs_rented_all_plot, color='red', linewidth=2.
 ↪5)
plt.title('Shelter Rented Costs Per Year')
plt.ylabel('Shelter Rented Costs Per Year')
plt.show()
```


Shelter Owned CostsCosts Per Year
Shelter Owned Costs Per Year
1800
1600
1400
1200
1000
2001
2006
2011
2016
Year


Shelter Rented Costs Per Year
Shelter Rented Costs Per Year
1250
1200
1150
1100
1050
1000
950
2001
2006
2011
2016

1.4 Average House Value per Year

In this section, you want to determine the average house value per year. An investor may want to understand better the sales price of the rental property over time. For example, a customer will want to know if they should expect an increase or decrease in the property value over time so they can determine how long to hold the rental property. You will visualize the `average_house_value` per year as a bar chart.

[19]:
```
# Calculate the average house value per year
# YOUR CODE HERE!
to_data.tail()
```

[19]:

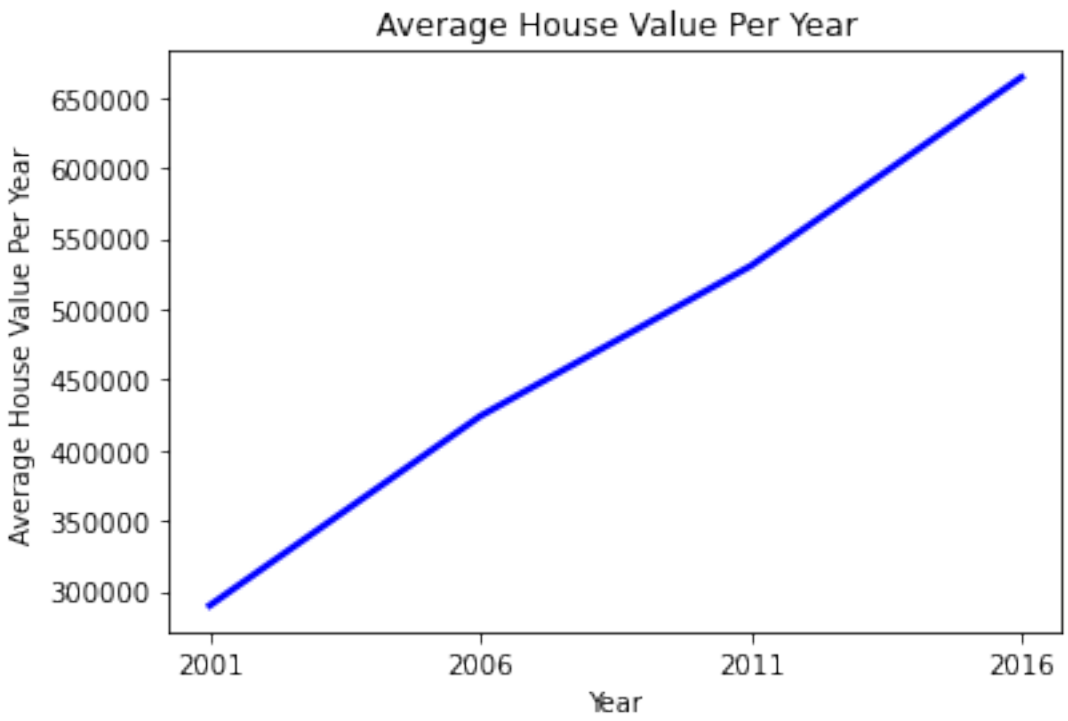
year	neighbourhood	single_detached_house	apartment_five_storeys_plus	movable_dwelling	semi_detached_house	row_house	duplex	apartment_five_storeys_less	other_house	average_house_value	shelter_costs_owned	shelter_costs_rented
2016	Wychwood	920	1295	0	880	290	395	2080	35	787760	1864	1146
2016	Yonge-Eglinton	1400	1995	0	465	60	310	1445	0	1127052	2398	1535
2016	Yonge-St.Clair	520	4315	0	450	220	130	1370	0	1131888	2192	1619
2016	York University Heights	1235	5505	0	1360	775	280	995	0	425769	1444	1122
2016	Yorkdale-Glen Park	2165	1185	0	80	600	465	830	5	599698	1451	1128

[49]:
```
average_house_value_2001 = to_data.loc['2001', 'average_house_value'].mean()
average_house_value_2006 = to_data.loc['2006', 'average_house_value'].mean()
average_house_value_2011 = to_data.loc['2011', 'average_house_value'].mean()
average_house_value_2016 = to_data.loc['2016', 'average_house_value'].mean()
```

```
print(f"The Average House Value in the Year 2001 is:")
print(f"${average_house_value_2001}")
print(f"The Average House Value in the Year 2006 is:")
print(f"${average_house_value_2006}")
print(f"The Average House Value in the Year 2011 is:")
print(f"${average_house_value_2011}")
print(f"The Average House Value in the Year 2016 is:")
print(f"${average_house_value_2016}")
```

```
The Average House Value in the Year 2001 is:
$289882.8857142857
The Average House Value in the Year 2006 is:
$424059.6642857143
The Average House Value in the Year 2011 is:
$530424.7214285714
The Average House Value in the Year 2016 is:
$664068.3285714285
```

[21]:
```
# Plot the average house value per year as a line chart
# YOUR CODE HERE!

average_house_value_all_plot = [289882.8857142857, 424059.6642857143, 530424.
↪7214285714, 664068.3285714285]

plt.plot(year, average_house_value_all_plot, color='blue', linewidth=2.5)
plt.title('Average House Value Per Year')
plt.xlabel('Year')
plt.ylabel('Average House Value Per Year')
plt.show()
```



1.5 Average House Value by Neighbourhood

In this section, you will use `hvplot` to create an interactive visualization of the average house value with a dropdown selector for the neighbourhood.

Hint: It will be easier to create a new DataFrame from grouping the data and calculating the mean house values for each year and neighbourhood.

[22]:
```
# Create a new DataFrame with the mean house values by neighbourhood per year
# YOUR CODE HERE!

df_mean = to_data[
    ['neighbourhood', 'average_house_value']
]
df_mean
```

[22]:

year	neighbourhood	average_house_value
2001	Agincourt North	200388
2001	Agincourt South-Malvern West	203047
2001	Alderwood	259998
2001	Annex	453850
2001	Banbury-Don Mills	371864

```
…                              …                  …
2016                       Wychwood               787760
2016                  Yonge-Eglinton             1127052
2016                  Yonge-St.Clair             1131888
2016       York University Heights                425769
2016            Yorkdale-Glen Park                599698

[560 rows x 2 columns]
```

[23]:
```
# Use hvplot to create an interactive line chart of the average house value per neighbourhood
# The plot should have a dropdown selector for the neighbourhood
# YOUR CODE HERE!

df_mean.hvplot(x='year', y='average_house_value', width=800, height=500,color='chartreuse',
               line_width= 5, groupby='neighbourhood',
               widget_location='top_left', yformatter='%.0f'
              ,xlabel='Year',ylabel='Average House Value Price')
```

[23]:
```
Column
    [0] Row
        [0] WidgetBox
            [0] Select(margin=(20, 20, 20, 20), name='neighbourhood',
options=['Agincourt North', …], value='Agincourt North', width=250)
        [1] HSpacer()
    [1] HoloViews(DynamicMap, widget_location='top_left')
```

1.6 Number of Dwelling Types per Year

In this section, you will use `hvplot` to create an interactive visualization of the average number of dwelling types per year with a dropdown selector for the neighbourhood.

[24]:
```
# Fetch the data of all dwelling types per year
# YOUR CODE HERE!
to_data_reset = to_data.reset_index()
to_data_reset.head()
```

[24]:
```
   year                neighbourhood  single_detached_house  \
0  2001               Agincourt North                   3715
1  2001  Agincourt South-Malvern West                   3250
2  2001                    Alderwood                   3175
3  2001                        Annex                   1060
4  2001            Banbury-Don Mills                   3615

   apartment_five_storeys_plus  movable_dwelling  semi_detached_house  \
0                         1480                 0                 1055
1                         1835                 0                  545
```

```
2                          315                 0                  470
3                         6090                 5                 1980
4                         4465                 0                  240

   row_house  duplex  apartment_five_storeys_less  other_house  \
0       1295     195                          185            5
1        455     105                          425            0
2         50     185                          370            0
3        605     275                         3710          165
4        380      15                         1360            0

   average_house_value  shelter_costs_owned  shelter_costs_rented
0               200388                  810                   870
1               203047                  806                   892
2               259998                  817                   924
3               453850                 1027                  1378
4               371864                 1007                  1163
```

[25]:
```
# Use hvplot to create an interactive bar chart of the number of dwelling types per neighbourhood
# The plot should have a dropdown selector for the neighbourhood
# YOUR CODE HERE!
```

[26]:
```
to_data_reset_plot = to_data_reset.groupby(['year', 'neighbourhood']).mean()
to_data_reset_plot.head()
```

[26]:
```
                                  single_detached_house  \
year neighbourhood
2001 Agincourt North                             3715.0
     Agincourt South-Malvern West                3250.0
     Alderwood                                   3175.0
     Annex                                       1060.0
     Banbury-Don Mills                           3615.0

                                  apartment_five_storeys_plus  \
year neighbourhood
2001 Agincourt North                                   1480.0
     Agincourt South-Malvern West                      1835.0
     Alderwood                                          315.0
     Annex                                             6090.0
     Banbury-Don Mills                                 4465.0

                                  movable_dwelling  semi_detached_house  \
year neighbourhood
2001 Agincourt North                          0.0                1055.0
     Agincourt South-Malvern West             0.0                 545.0
     Alderwood                                0.0                 470.0
```

```
                                        5.0                1980.0
     Banbury-Don Mills                  0.0                 240.0

                                   row_house  duplex  \
year neighbourhood
2001 Agincourt North                  1295.0   195.0
     Agincourt South-Malvern West      455.0   105.0
     Alderwood                          50.0   185.0
     Annex                             605.0   275.0
     Banbury-Don Mills                 380.0    15.0

                                   apartment_five_storeys_less  other_house  \
year neighbourhood
2001 Agincourt North                                    185.0          5.0
     Agincourt South-Malvern West                       425.0          0.0
     Alderwood                                          370.0          0.0
     Annex                                             3710.0        165.0
     Banbury-Don Mills                                 1360.0          0.0

                                   average_house_value  shelter_costs_owned  \
year neighbourhood
2001 Agincourt North                         200388.0                810.0
     Agincourt South-Malvern West            203047.0                806.0
     Alderwood                               259998.0                817.0
     Annex                                   453850.0               1027.0
     Banbury-Don Mills                       371864.0               1007.0

                                   shelter_costs_rented
year neighbourhood
2001 Agincourt North                             870.0
     Agincourt South-Malvern West                892.0
     Alderwood                                   924.0
     Annex                                      1378.0
     Banbury-Don Mills                          1163.0
```

[27]:
```
to_data_reset_plot.hvplot.bar(x='year',␣
↪y=['single_detached_house','apartment_five_storeys_plus','movable_dwelling',
                                    'semi_detached_house', 'row_house',␣
↪'duplex', 'apartment_five_storeys_less',
                                    'other_house'],stacked=False,␣
↪width=900,height=600, rot=90,groupby='neighbourhood',␣
↪widget_location='top_left'
                                , yformatter='%.0f"', xlabel= 'Year', ylabel =␣
↪'Dwelling Type Units', colormap='rainbow')
```

[27]:
```
Column
    [0] Row
```

```
        [0] WidgetBox
            [0] Select(margin=(20, 20, 20, 20), name='neighbourhood',
options=['Agincourt North', …], value='Agincourt North', width=250)
        [1] HSpacer()
    [1] HoloViews(DynamicMap, widget_location='top_left')
```

1.7 The Top 10 Most Expensive Neighbourhoods

In this section, you will need to calculate the house value for each neighbourhood and then sort the values to obtain the top 10 most expensive neighbourhoods on average. Plot the results as a bar chart.

[28]:
```
# Getting the data from the top 10 expensive neighbourhoods
# YOUR CODE HERE!

to_data
```

[28]:

year	neighbourhood	single_detached_house	apartment_five_storeys_plus	movable_dwelling	semi_detached_house	row_house	duplex	apartment_five_storeys_less	other_house
2001	Agincourt North	3715	1480	0	1055				
2001	Agincourt South-Malvern West	3250	1835	0	545				
2001	Alderwood	3175	315	0	470				
2001	Annex	1060	6090	5	1980				
2001	Banbury-Don Mills	3615	4465	0	240				
…	…	…	…	…	…				
2016	Wychwood	920	1295	0	880				
2016	Yonge-Eglinton	1400	1995	0	465				
2016	Yonge-St.Clair	520	4315	0	450				
2016	York University Heights	1235	5505	0	1360				
2016	Yorkdale-Glen Park	2165	1185	0	80				

```
year
2001       1295     195                          185            5
2001        455     105                          425            0
2001         50     185                          370            0
2001        605     275                         3710          165
2001        380      15                         1360            0
…           …      …                             …            …
2016        290     395                         2080           35
2016         60     310                         1445            0
2016        220     130                         1370            0
2016        775     280                          995            0
2016        600     465                          830            5

      average_house_value  shelter_costs_owned  shelter_costs_rented
year
2001                200388                  810                   870
2001                203047                  806                   892
2001                259998                  817                   924
2001                453850                 1027                  1378
2001                371864                 1007                  1163
…                      …                    …                     …
2016                787760                 1864                  1146
2016               1127052                 2398                  1535
2016               1131888                 2192                  1619
2016                425769                 1444                  1122
2016                599698                 1451                  1128

[560 rows x 12 columns]
```

[29]:
```
# Plotting the data from the top 10 expensive neighbourhoods
# YOUR CODE HERE

richest_neighbourhoods = to_data.groupby('neighbourhood').mean()
richest_neighbourhoods_sorted = richest_neighbourhoods.
 ↪sort_values('average_house_value', ascending=False)
richest_neighbourhoods_sorted_top_10 = richest_neighbourhoods_sorted[0:10]
richest_neighbourhoods_sorted_top_10_housevalue =␣
 ↪richest_neighbourhoods_sorted_top_10['average_house_value']
richest_neighbourhoods_sorted_top_10_housevalue.hvplot.bar(yformatter="%.0f",␣
 ↪width=750,height=600, rot=90,
                                                            title='Top 10 Most␣
 ↪Expensive Neighbourhoods In Toronto',
                                                            ylabel='Price',
                                                           xlabel='Price')
```

[29]: :Bars [neighbourhood] (average_house_value)

1.8 Neighbourhood Map

In this section, you will read in neighbourhoods location data and build an interactive map with the average house value per neighbourhood. Use a `scatter_mapbox` from Plotly express to create the visualization. Remember, you will need your Mapbox API key for this.

1.8.1 Load Location Data

[30]:
```
# Load neighbourhoods coordinates data
file_path = Path("Data/toronto_neighbourhoods_coordinates.csv")
df_neighbourhood_locations = pd.read_csv(file_path,index_col='neighbourhood')
df_neighbourhood_locations.head()
```

[30]:

neighbourhood	lat	lon
Agincourt North	43.805441	-79.266712
Agincourt South-Malvern West	43.788658	-79.265612
Alderwood	43.604937	-79.541611
Annex	43.671585	-79.404001
Banbury-Don Mills	43.737657	-79.349718

1.8.2 Data Preparation

You will need to join the location data with the mean values per neighbourhood.

1. Calculate the mean values for each neighbourhood.
2. Join the average values with the neighbourhood locations.

[31]:
```
# Calculate the mean values for each neighborhood
# YOUR CODE HERE!

""" Dataframe mean already calucated above in cell [22] so resued here"""

richest_neighbourhoods
```

[31]:

neighbourhood	single_detached_house	\
Agincourt North	3435.00	
Agincourt South-Malvern West	2897.50	
Alderwood	2903.75	
Annex	751.25	
Banbury-Don Mills	3572.50	
…	…	
Wychwood	1056.25	
Yonge-Eglinton	1468.75	
Yonge-St.Clair	565.00	
York University Heights	1355.00	
Yorkdale-Glen Park	2286.25	

neighbourhood	apartment_five_storeys_plus	movable_dwelling	\
Agincourt North	1947.50	2.50	
Agincourt South-Malvern West	2180.00	1.25	
Alderwood	302.50	1.25	
Annex	7235.00	1.25	
Banbury-Don Mills	5388.75	1.25	
…	…	…	
Wychwood	1236.25	0.00	
Yonge-Eglinton	1638.75	0.00	
Yonge-St.Clair	3948.75	0.00	
York University Heights	5165.00	1.25	
Yorkdale-Glen Park	1347.50	0.00	

neighbourhood	semi_detached_house	row_house	duplex	\
Agincourt North	863.75	1406.25	512.50	
Agincourt South-Malvern West	375.00	456.25	523.75	
Alderwood	503.75	76.25	302.50	
Annex	1375.00	613.75	355.00	
Banbury-Don Mills	273.75	626.25	32.50	
…	…	…	…	
Wychwood	992.50	298.75	325.00	
Yonge-Eglinton	470.00	33.75	328.75	
Yonge-St.Clair	425.00	212.50	172.50	
York University Heights	1316.25	662.50	188.75	
Yorkdale-Glen Park	73.75	450.00	377.50	

neighbourhood	apartment_five_storeys_less	other_house	\
Agincourt North	547.50	10.00	
Agincourt South-Malvern West	628.75	32.50	
Alderwood	502.50	1.25	
Annex	4605.00	83.75	
Banbury-Don Mills	1340.00	0.00	
…	…	…	
Wychwood	1878.75	17.50	
Yonge-Eglinton	1385.00	6.25	
Yonge-St.Clair	1308.75	6.25	
York University Heights	1085.00	33.75	
Yorkdale-Glen Park	722.50	7.50	

neighbourhood	average_house_value	shelter_costs_owned	\
Agincourt North	329811.50	1109.00	
Agincourt South-Malvern West	334189.00	1131.25	
Alderwood	427922.50	1166.75	

```
Annex                                746977.00              1692.75
Banbury-Don Mills                    612039.00              1463.50
…                                          …                     …
Wychwood                             565976.50              1390.75
Yonge-Eglinton                       809745.75              1799.50
Yonge-St.Clair                       813220.25              1680.75
York University Heights              305899.50              1116.75
Yorkdale-Glen Park                   430861.25              1122.50

                                shelter_costs_rented
neighbourhood
Agincourt North                              983.50
Agincourt South-Malvern West                 985.00
Alderwood                                   1003.25
Annex                                       1315.25
Banbury-Don Mills                           1242.75
…                                                …
Wychwood                                    1017.25
Yonge-Eglinton                              1347.75
Yonge-St.Clair                              1369.00
York University Heights                      937.50
Yorkdale-Glen Park                           942.50

[140 rows x 11 columns]
```

[32]:
```
# Join the average values with the neighbourhood locations
# YOUR CODE HERE!

df_mean_neighbourhood_locations = pd.concat([richest_neighbourhoods,␣
↪df_neighbourhood_locations], axis=1)
df_mean_neighbourhood_locations
```

[32]:
```
                                single_detached_house  \
neighbourhood
Agincourt North                               3435.00
Agincourt South-Malvern West                  2897.50
Alderwood                                     2903.75
Annex                                          751.25
Banbury-Don Mills                             3572.50
…                                                  …
Wychwood                                      1056.25
Yonge-Eglinton                                1468.75
Yonge-St.Clair                                 565.00
York University Heights                       1355.00
Yorkdale-Glen Park                            2286.25

                                apartment_five_storeys_plus  movable_dwelling  \
```

neighbourhood		
Agincourt North	1947.50	2.50
Agincourt South-Malvern West	2180.00	1.25
Alderwood	302.50	1.25
Annex	7235.00	1.25
Banbury-Don Mills	5388.75	1.25
…	…	…
Wychwood	1236.25	0.00
Yonge-Eglinton	1638.75	0.00
Yonge-St.Clair	3948.75	0.00
York University Heights	5165.00	1.25
Yorkdale-Glen Park	1347.50	0.00

neighbourhood	semi_detached_house	row_house	duplex	\
Agincourt North	863.75	1406.25	512.50	
Agincourt South-Malvern West	375.00	456.25	523.75	
Alderwood	503.75	76.25	302.50	
Annex	1375.00	613.75	355.00	
Banbury-Don Mills	273.75	626.25	32.50	
…	…	…	…	
Wychwood	992.50	298.75	325.00	
Yonge-Eglinton	470.00	33.75	328.75	
Yonge-St.Clair	425.00	212.50	172.50	
York University Heights	1316.25	662.50	188.75	
Yorkdale-Glen Park	73.75	450.00	377.50	

neighbourhood	apartment_five_storeys_less	other_house	\
Agincourt North	547.50	10.00	
Agincourt South-Malvern West	628.75	32.50	
Alderwood	502.50	1.25	
Annex	4605.00	83.75	
Banbury-Don Mills	1340.00	0.00	
…	…	…	
Wychwood	1878.75	17.50	
Yonge-Eglinton	1385.00	6.25	
Yonge-St.Clair	1308.75	6.25	
York University Heights	1085.00	33.75	
Yorkdale-Glen Park	722.50	7.50	

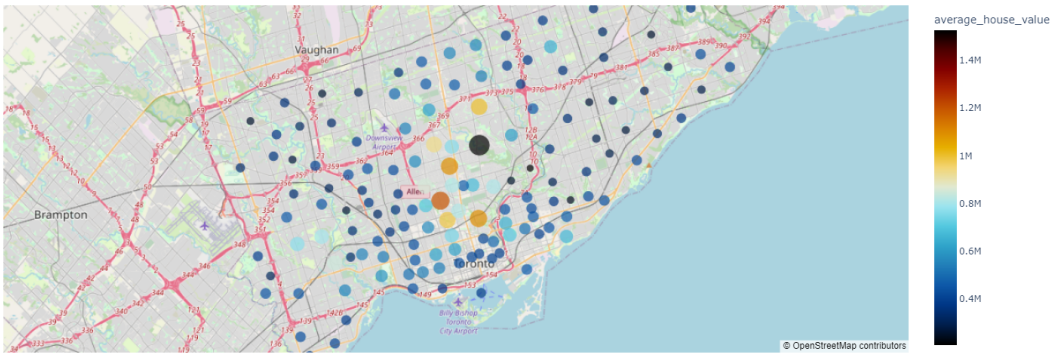
neighbourhood	average_house_value	shelter_costs_owned	\
Agincourt North	329811.50	1109.00	
Agincourt South-Malvern West	334189.00	1131.25	
Alderwood	427922.50	1166.75	
Annex	746977.00	1692.75	

```
Banbury-Don Mills                612039.00              1463.50
…                                      …                     …
Wychwood                         565976.50              1390.75
Yonge-Eglinton                   809745.75              1799.50
Yonge-St.Clair                   813220.25              1680.75
York University Heights          305899.50              1116.75
Yorkdale-Glen Park               430861.25              1122.50

                               shelter_costs_rented        lat        lon
neighbourhood
Agincourt North                              983.50  43.805441 -79.266712
Agincourt South-Malvern West                 985.00  43.788658 -79.265612
Alderwood                                   1003.25  43.604937 -79.541611
Annex                                       1315.25  43.671585 -79.404001
Banbury-Don Mills                           1242.75  43.737657 -79.349718
…                                               …         …         …
Wychwood                                    1017.25  43.676919 -79.425515
Yonge-Eglinton                              1347.75  43.704689 -79.403590
Yonge-St.Clair                              1369.00  43.687859 -79.397871
York University Heights                      937.50  43.765736 -79.488883
Yorkdale-Glen Park                           942.50  43.714672 -79.457108

[140 rows x 13 columns]
```

1.8.3 Mapbox Visualization

Plot the average values per neighbourhood using a Plotly express `scatter_mapbox` visualization.

[33]:
```
# Create a scatter mapbox to analyze neighbourhood info
# YOUR CODE HERE!

fig = px.scatter_mapbox(df_mean_neighbourhood_locations, lat="lat", lon="lon", ␣
 ↪ color="average_house_value",
                  color_continuous_scale=px.colors.cyclical.IceFire,␣
 ↪size='average_house_value', zoom=10,mapbox_style='open-street-map',␣
 ↪height=600)
fig.show()
```

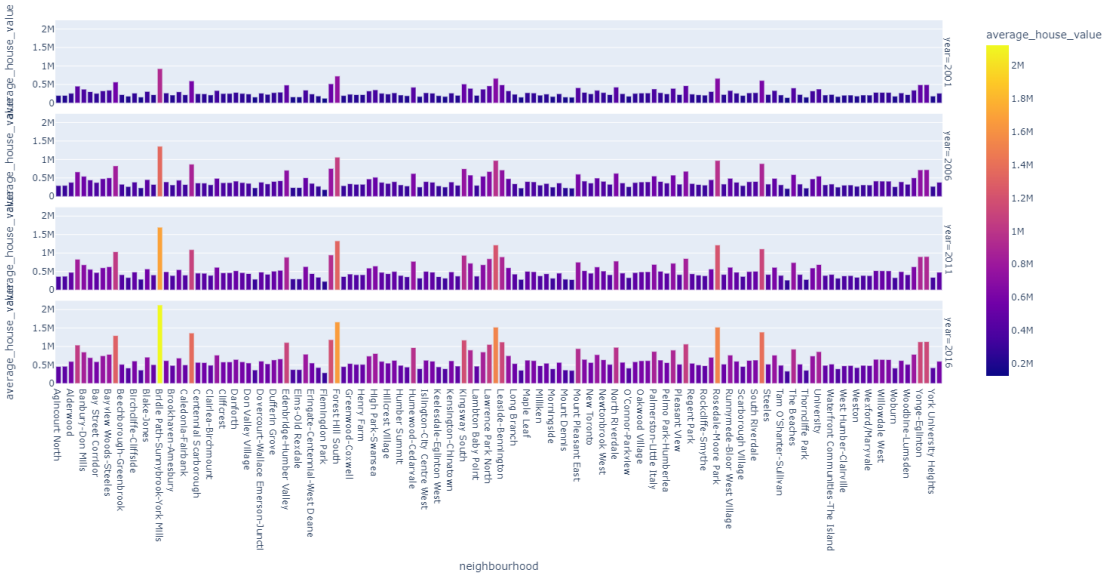


1.9 Cost Analysis - Optional Challenge

In this section, you will use Plotly express to a couple of plots that investors can interactively filter and explore various factors related to the house value of the Toronto's neighbourhoods.

1.9.1 Create a bar chart row facet to plot the average house values for all Toronto's neighbourhoods per year

[34]:
```
# YOUR CODE HERE!
avg_house_value_year = to_data[
    ['neighbourhood','average_house_value']
].reset_index()

fig = px.bar(avg_house_value_year, x='neighbourhood', y='average_house_value',␣
↪color='average_house_value', facet_row='year', height=800)
fig.show()
```



1.9.2 Create a sunburst chart to conduct a costs analysis of most expensive neighbourhoods in Toronto per year

[35]:
```
# Fetch the data from all expensive neighbourhoods per year.
# YOUR CODE HERE!
df_mean_reset = to_data.reset_index()
df_mean_reset
```

[35]:

	year	neighbourhood	single_detached_house	\
0	2001	Agincourt North	3715	
1	2001	Agincourt South-Malvern West	3250	
2	2001	Alderwood	3175	
3	2001	Annex	1060	
4	2001	Banbury-Don Mills	3615	
..	…	…	…	
555	2016	Wychwood	920	
556	2016	Yonge-Eglinton	1400	
557	2016	Yonge-St.Clair	520	
558	2016	York University Heights	1235	
559	2016	Yorkdale-Glen Park	2165	

	apartment_five_storeys_plus	movable_dwelling	semi_detached_house	\
0	1480	0	1055	
1	1835	0	545	
2	315	0	470	
3	6090	5	1980	
4	4465	0	240	

```
..                          …                 …                    …
555                        1295                 0                  880
556                        1995                 0                  465
557                        4315                 0                  450
558                        5505                 0                 1360
559                        1185                 0                   80

     row_house  duplex  apartment_five_storeys_less  other_house  \
0         1295     195                          185            5
1          455     105                          425            0
2           50     185                          370            0
3          605     275                         3710          165
4          380      15                         1360            0
..         …     …                             …             …
555        290     395                         2080           35
556         60     310                         1445            0
557        220     130                         1370            0
558        775     280                          995            0
559        600     465                          830            5

     average_house_value  shelter_costs_owned  shelter_costs_rented
0                 200388                  810                   870
1                 203047                  806                   892
2                 259998                  817                   924
3                 453850                 1027                  1378
4                 371864                 1007                  1163
..                   …                    …                     …
555               787760                 1864                  1146
556              1127052                 2398                  1535
557              1131888                 2192                  1619
558               425769                 1444                  1122
559               599698                 1451                  1128

[560 rows x 13 columns]
```

[36]:
```
# Create the sunburst chart
# YOUR CODE HERE!

df_mean_reset_2001 = df_mean_reset.loc[df_mean_reset['year'] == 2001].
 ↪sort_values('average_house_value', ascending=False)[0:10]
df_mean_reset_2006 = df_mean_reset.loc[df_mean_reset['year'] == 2006].
 ↪sort_values('average_house_value', ascending=False)[0:10]
df_mean_reset_2011 = df_mean_reset.loc[df_mean_reset['year'] == 2011].
 ↪sort_values('average_house_value', ascending=False)[0:10]
df_mean_reset_2016 = df_mean_reset.loc[df_mean_reset['year'] == 2016].
 ↪sort_values('average_house_value', ascending=False)[0:10]
```

```
top10_richest_neighbourhoods_byyear = pd.concat([df_mean_reset_2001,␣
↪df_mean_reset_2006, df_mean_reset_2011,df_mean_reset_2016])
top10_richest_neighbourhoods_byyear.head()
```

[36]:

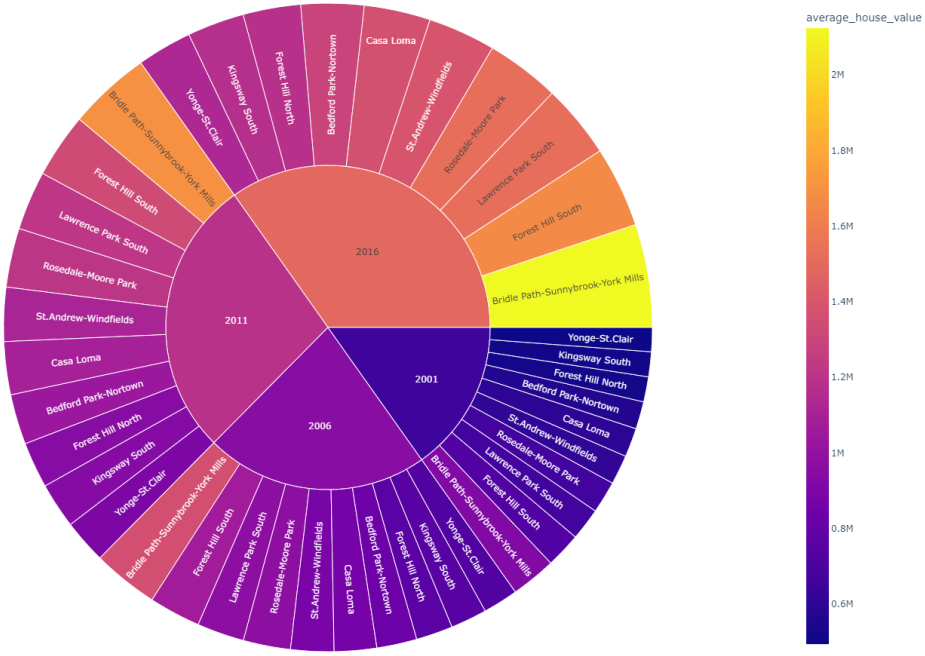
	year	neighbourhood	single_detached_house	\
16	2001	Bridle Path-Sunnybrook-York Mills	2275	
44	2001	Forest Hill South	1815	
69	2001	Lawrence Park South	3590	
104	2001	Rosedale-Moore Park	2610	
111	2001	St.Andrew-Windfields	3275	

	apartment_five_storeys_plus	movable_dwelling	semi_detached_house	\
16	110	0	25	
44	2440	5	65	
69	570	0	170	
104	3880	0	520	
111	1455	0	220	

	row_house	duplex	apartment_five_storeys_less	other_house	\
16	15	10	20	0	
44	45	85	1010	15	
69	70	190	845	40	
104	225	290	1735	0	
111	555	45	525	5	

	average_house_value	shelter_costs_owned	shelter_costs_rented
16	927466	1983	1790
44	726664	1001	1469
69	664712	1021	1630
104	664476	1219	1540
111	607040	1055	1551

[37]:
```
sunburst_chart = px.sunburst(top10_richest_neighbourhoods_byyear,␣
↪path=['year','neighbourhood'], values='average_house_value',
                             color='average_house_value',
                            ␣
↪hover_data=['single_detached_house','apartment_five_storeys_plus','movable_dwelling','semi_
↪'row_house', 'duplex', 'apartment_five_storeys_less',
                                        'other_house',␣
↪'shelter_costs_owned','shelter_costs_rented'],
                             width=1000,height=1000)
sunburst_chart.show()
```


2016
2011
2006
2001
Bridle Path-Sunnybrook-York Mills
Forest Hill South
Lawrence Park South
Rosedale-Moore Park
St.Andrew-Windfields
Casa Loma
Bedford Park-Nortown
Forest Hill North
Kingsway South
Yonge-St.Clair
average_house_value
2M
1.8M
1.6M
1.4M
1.2M
1M
0.8M
0.6M

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