2021CleanDataset

March 26, 2023

```
[1]: import numpy as np
     import pandas as pd
     import matplotlib.pyplot as plt
     import seaborn as sns
     %matplotlib inline
     from sklearn.model_selection import train_test_split
     from sklearn.feature_selection import mutual_info_regression,␣
      ↪mutual_info_classif
```

```
[2]: #read dataset
     data = pd.read_csv("/content/drive/MyDrive/CIND 820 Capstone Project/
      ↪merged_completedata.csv")
```

```
[3]: # filter dataframe
     data = data[data['Year'] >= 2019]
```

```
[4]: data.head()
```

```
[4]:        RecordID          X          Y  FID  BusinessID  \
     46689     46690 -79.665386  43.684736    1           7
     46690     46691 -79.642760  43.593515    2        4246
     46691     46692 -79.667311  43.682752    3          10
     46692     46693 -79.629235  43.698932    4        4247
     46693     46694 -79.629235  43.698932    5        4250

                                Name             Address  StreetNo  \
     46689     Peel Car & Truck Rentals    7050 Bramalea Rd      7050
     46690        Real Fruit Bubble Tea  100 City Centre Dr       100
     46691                  Unifor 2002    7015 Tranmere Dr      7015
     46692  Laura with Plus and Petites  100 City Centre Dr       100
     46693                   Footlocker  100 City Centre Dr       100

               StreetName BldgNo  … TollFree EMail WebAddress  EmplRange  \
     46689     Bramalea Rd    Yes  …      Yes   Yes        Yes          1
     46690  City Centre Dr     No  …       No    No        Yes          2
     46691     Tranmere Dr     No  …      Yes   Yes        Yes          3
     46692  City Centre Dr     No  …       No    No        Yes          2
```

```
46693  City Centre Dr     No  …       No    No         No          4

             CENT_X        CENT_Y  Year Age isnew Closed
46689  607567.2334  4.837723e+06  2019   4    No     No
46690  609556.5032  4.827621e+06  2019   2   Yes     No
46691  607415.6044  4.837500e+06  2019   4    No     No
46692  610454.8654  4.839347e+06  2019   1   Yes     No
46693  610454.8654  4.839347e+06  2019   1   Yes     No

[5 rows x 29 columns]
```

[5]:
```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 31343 entries, 46689 to 78031
Data columns (total 29 columns):
 #   Column      Non-Null Count  Dtype
---  ------      --------------  -----
 0   RecordID    31343 non-null  int64
 1   X           31343 non-null  float64
 2   Y           31343 non-null  float64
 3   FID         31343 non-null  int64
 4   BusinessID  31343 non-null  int64
 5   Name        31343 non-null  object
 6   Address     31343 non-null  object
 7   StreetNo    31343 non-null  int64
 8   StreetName  31343 non-null  object
 9   BldgNo      31343 non-null  object
 10  UnitNo      31343 non-null  object
 11  PostalCode  31343 non-null  object
 12  Location    31343 non-null  object
 13  Ward        31343 non-null  int64
 14  NAICSCode   31343 non-null  int64
 15  NAICSCat    31343 non-null  object
 16  NAICSDescr  31343 non-null  object
 17  Phone       31343 non-null  object
 18  Fax         31343 non-null  object
 19  TollFree    31343 non-null  object
 20  EMail       31343 non-null  object
 21  WebAddress  31343 non-null  object
 22  EmplRange   31343 non-null  int64
 23  CENT_X      31343 non-null  float64
 24  CENT_Y      31343 non-null  float64
 25  Year        31343 non-null  int64
 26  Age         31343 non-null  int64
 27  isnew       31343 non-null  object
 28  Closed      31343 non-null  object
```

```
dtypes: float64(4), int64(9), object(16)
memory usage: 7.2+ MB
```

[6]:

```
data['Closed'].value_counts()
```

[6]:

```
No     28629
Yes     2714
Name: Closed, dtype: int64
```

[7]:

```
data.shape
```

[7]:

```
(31343, 29)
```

[8]:

```
ClosedBy2021 = data['Closed'].value_counts()[1]/data.shape[0]
print("Closed accuracy : ", ClosedBy2021 )
ClosedPercent = ClosedBy2021*100
print("Percent of businesses closed : ", ClosedPercent)
```

```
Closed accuracy :  0.08659030724563699
Percent of businesses closed :  8.6590307245637
```

[9]:

```
#clustering of locations.  All in Mississauga so only 2 clusters

from sklearn.cluster import KMeans

K_clusters = range(1,10)
kmeans = [KMeans(n_clusters=i) for i in K_clusters]
Y_axis = data[['Y']]
X_axis = data[['X']]
score = [kmeans[i].fit(Y_axis).score(Y_axis) for i in range(len(kmeans))]
# Visualize
plt.plot(K_clusters, score)
plt.xlabel('Number of Clusters')
plt.ylabel('Score')
plt.title('Elbow Curve')
plt.show()
```

```
/usr/local/lib/python3.9/dist-packages/sklearn/cluster/_kmeans.py:870:
FutureWarning: The default value of `n_init` will change from 10 to 'auto' in
1.4. Set the value of `n_init` explicitly to suppress the warning
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```

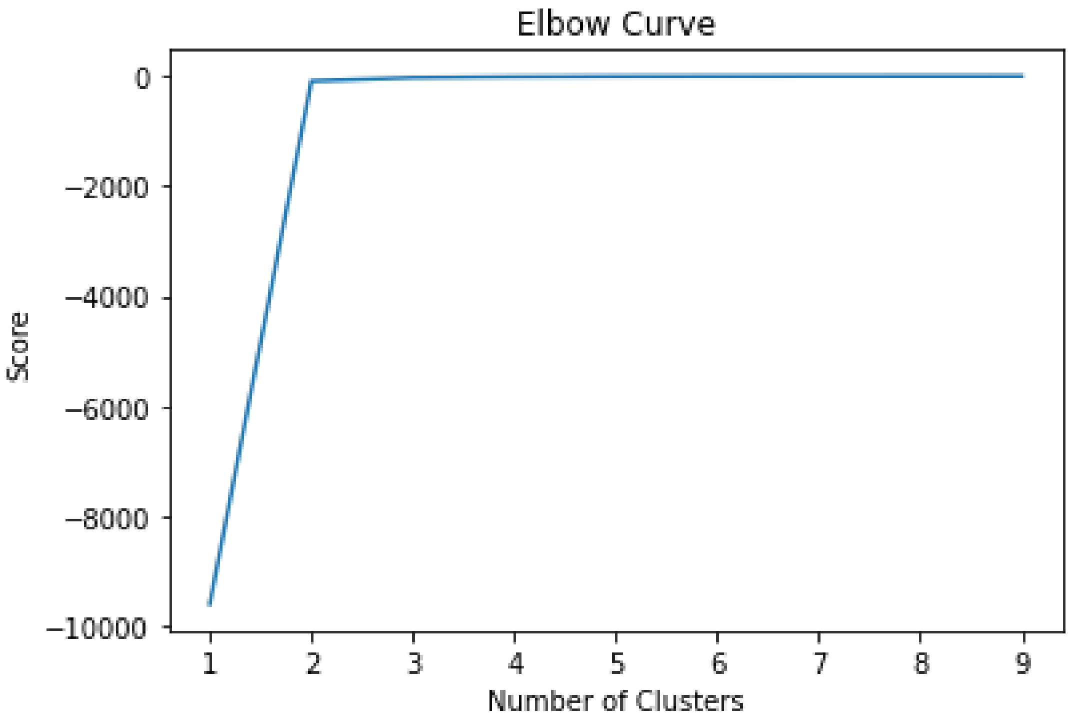

[10]:

```
kmeans = KMeans(n_clusters = 2, init ='k-means++')
kmeans.fit(data[data.columns[1:3]]) # Compute k-means clustering.
data['cluster_label'] = kmeans.fit_predict(data[data.columns[1:3]])
centers = kmeans.cluster_centers_ # Coordinates of cluster centers.
labels = kmeans.predict(data[data.columns[1:3]]) # Labels of each point
data.head(5)
```

```
/usr/local/lib/python3.9/dist-packages/sklearn/cluster/_kmeans.py:870:
FutureWarning: The default value of `n_init` will change from 10 to 'auto' in
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  warnings.warn(
```

[10]:

```
       RecordID          X          Y  FID  BusinessID  \
46689     46690 -79.665386  43.684736    1           7
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46692     46693 -79.629235  43.698932    4        4247
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                              Name             Address  StreetNo  \
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46690        Real Fruit Bubble Tea  100 City Centre Dr       100
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46692  Laura with Plus and Petites  100 City Centre Dr       100
46693                   Footlocker  100 City Centre Dr       100

           StreetName BldgNo  … EMail WebAddress EmplRange        CENT_X  \
46689     Bramalea Rd    Yes  …   Yes        Yes         1   607567.2334
46690  City Centre Dr     No  …    No        Yes         2   609556.5032
46691     Tranmere Dr     No  …   Yes        Yes         3   607415.6044
46692  City Centre Dr     No  …    No        Yes         2   610454.8654
46693  City Centre Dr     No  …    No         No         4   610454.8654

             CENT_Y  Year  Age isnew Closed cluster_label
46689  4.837723e+06  2019    4    No     No             0
46690  4.827621e+06  2019    2   Yes     No             0
46691  4.837500e+06  2019    4    No     No             0
46692  4.839347e+06  2019    1   Yes     No             0
46693  4.839347e+06  2019    1   Yes     No             0

[5 rows x 30 columns]
```
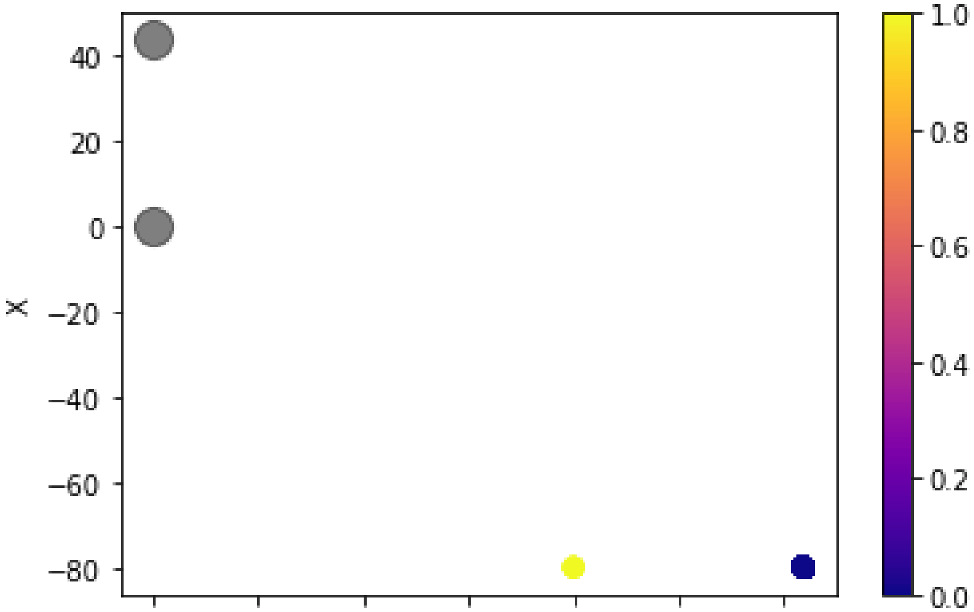

```
[11]: data.plot.scatter(x = 'Y', y = 'X', c=labels, s=50, cmap='plasma')
      plt.scatter(centers[:, 0], centers[:, 1], c='black', s=200, alpha=0.5)
```

```
[11]: <matplotlib.collections.PathCollection at 0x7fd4fced9bb0>
```



```
[12]: df2 = pd.DataFrame().assign(Year=data['Year'], Size=data['EmplRange'],␣
       ↪NAICS=data['NAICSCode'], BusinessAge=data['Age'], Industry=data['NAICSCat'])
      print(df2)
```

```
        Year  Size  NAICS  BusinessAge  \
46689   2019     1     44            4
46690   2019     2     72            2
46691   2019     3     81            4
46692   2019     2     44            1
46693   2019     4     44            1
…        …     …     …            …
78027   2021     3     56            1
78028   2021     1     56            1
78029   2021     1     72            1
78030   2021     1     41            1
78031   2021     1     41            1


                                    Industry
46689                           Retail Trade
46690        Accommodation and Food Services
46691                         Other Services
```

```
46692                                       Retail Trade
46693                                       Retail Trade
…                                                  …
78027  Administrative and Support, Waste Management a…
78028  Administrative and Support, Waste Management a…
78029                    Accommodation and Food Services
78030                                    Wholesale Trade
78031                                    Wholesale Trade

[31343 rows x 5 columns]
```

[13]:

```python
#clustering of industries and size of business.

from sklearn.cluster import KMeans

K_clusters = range(1,10)
kmeans = [KMeans(n_clusters=i) for i in K_clusters]
Y_axis = df2[['NAICS']]
X_axis = df2[['Size']]
score = [kmeans[i].fit(Y_axis).score(Y_axis) for i in range(len(kmeans))]
# Visualize
plt.plot(K_clusters, score)
plt.xlabel('Number of Clusters')
plt.ylabel('Score')
plt.title('Elbow Curve')
plt.show()
```

```
/usr/local/lib/python3.9/dist-packages/sklearn/cluster/_kmeans.py:870:
FutureWarning: The default value of `n_init` will change from 10 to 'auto' in
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1.4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
/usr/local/lib/python3.9/dist-packages/sklearn/cluster/_kmeans.py:870:
```

```
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  warnings.warn(
```

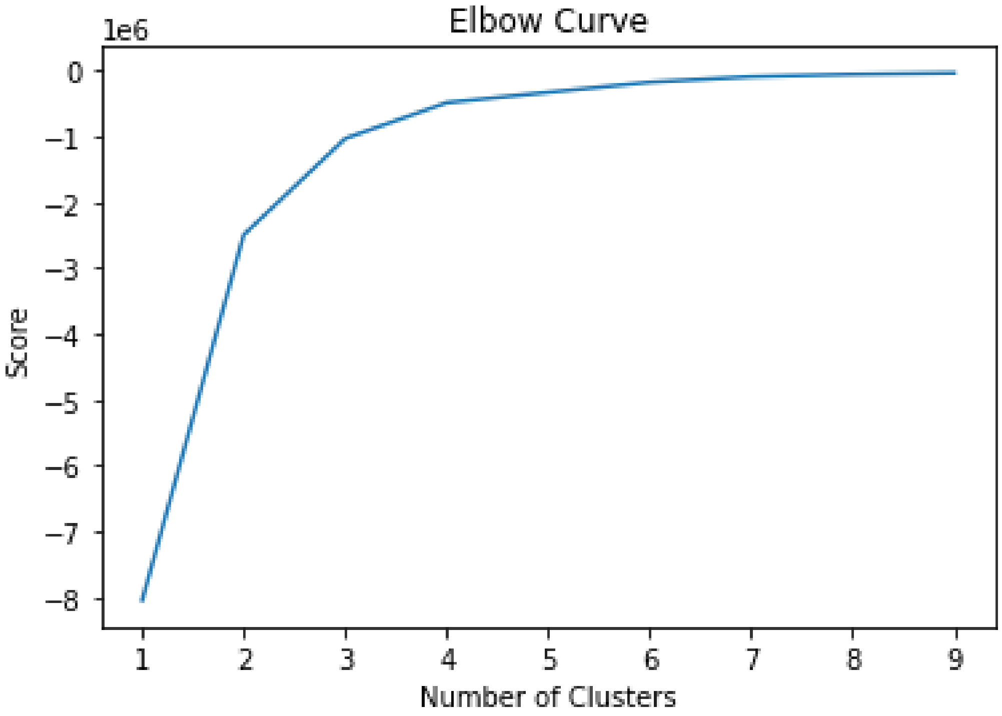

[14]:
```
kmeans = KMeans(n_clusters = 4, init ='k-means++')
kmeans.fit(df2[df2.columns[1:3]]) # Compute k-means clustering.
df2['cluster_label'] = kmeans.fit_predict(df2[df2.columns[1:3]])
centers = kmeans.cluster_centers_ # Coordinates of cluster centers.
labels = kmeans.predict(df2[df2.columns[1:3]]) # Labels of each point
df2.head(5)
```

```
/usr/local/lib/python3.9/dist-packages/sklearn/cluster/_kmeans.py:870:
```

```
FutureWarning: The default value of `n_init` will change from 10 to 'auto' in
1.4. Set the value of `n_init` explicitly to suppress the warning
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1.4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
```
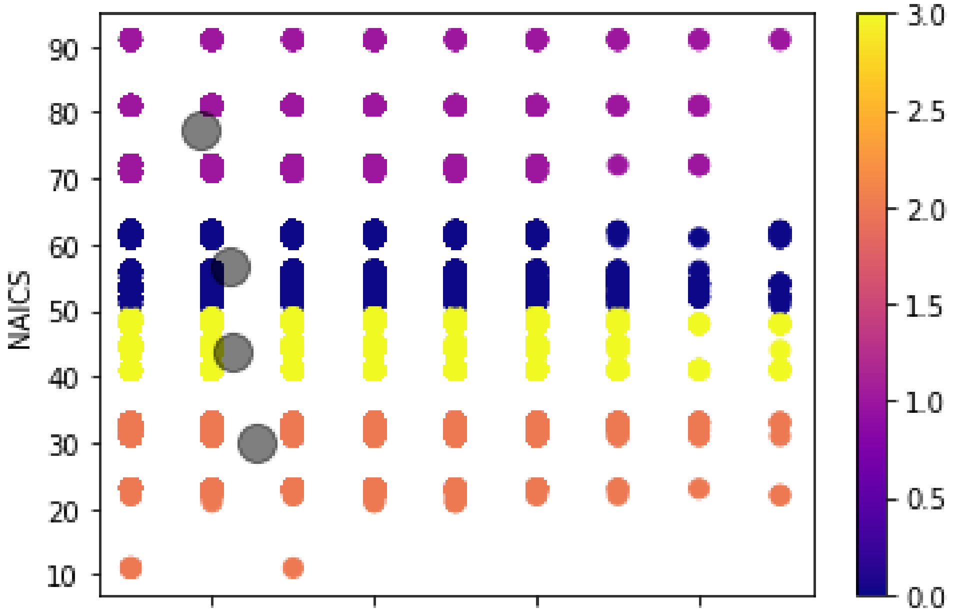

[14]:
```
        Year  Size  NAICS  BusinessAge                          Industry  \
46689   2019     1     44            4                      Retail Trade
46690   2019     2     72            2  Accommodation and Food Services
46691   2019     3     81            4                    Other Services
46692   2019     2     44            1                      Retail Trade
46693   2019     4     44            1                      Retail Trade

       cluster_label
46689              3
46690              1
46691              1
46692              3
46693              3
```

[15]:
```python
df2.plot.scatter(x = 'Size', y = 'NAICS', c=labels, s=50, cmap='plasma')
plt.scatter(centers[:, 0], centers[:, 1], c='black', s=200, alpha=0.5)
```

[15]:
```
<matplotlib.collections.PathCollection at 0x7fd4bdac01f0>
```



[16]:

```
#clustering of industries and age of business.

from sklearn.cluster import KMeans

K_clusters = range(1,10)
kmeans = [KMeans(n_clusters=i) for i in K_clusters]
Y_axis = df2[['NAICS']]
X_axis = df2[['BusinessAge']]
score = [kmeans[i].fit(Y_axis).score(Y_axis) for i in range(len(kmeans))]
# Visualize
plt.plot(K_clusters, score)
plt.xlabel('Number of Clusters')
plt.ylabel('Score')
plt.title('Elbow Curve')
plt.show()
```

```
/usr/local/lib/python3.9/dist-packages/sklearn/cluster/_kmeans.py:870:
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  warnings.warn(
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1.4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
```

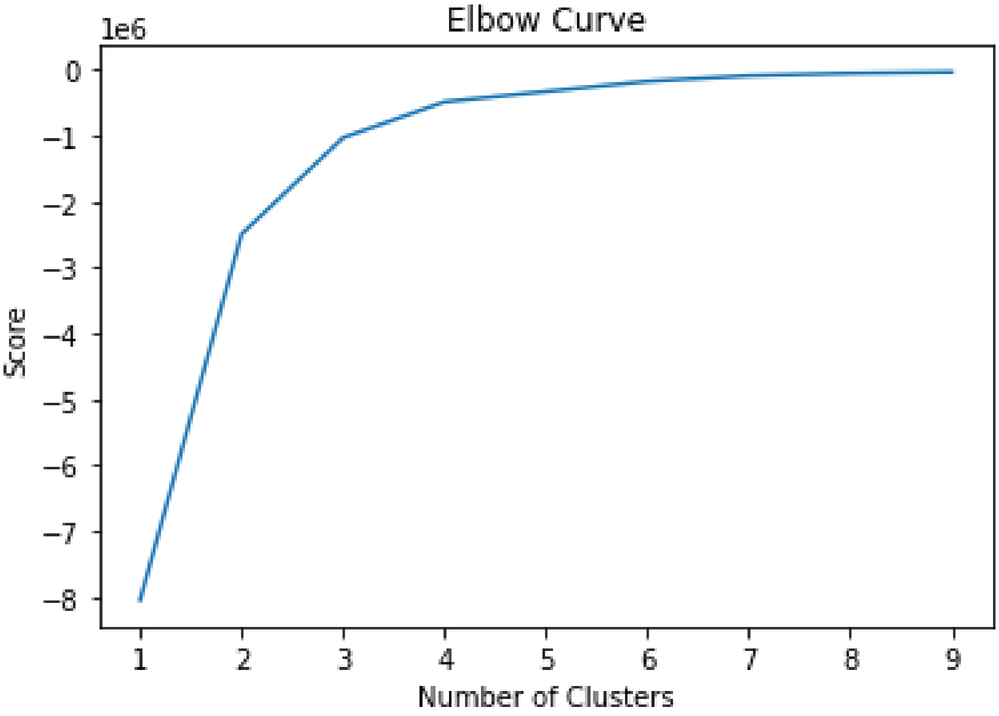

```
[17]: kmeans = KMeans(n_clusters = 4, init ='k-means++')
      kmeans.fit(df2[df2.columns[2:4]]) # Compute k-means clustering.
      df2['cluster_label'] = kmeans.fit_predict(df2[df2.columns[2:4]])
      centers = kmeans.cluster_centers_ # Coordinates of cluster centers.
      labels = kmeans.predict(df2[df2.columns[2:4]]) # Labels of each point
      df2.head(5)
```

```
/usr/local/lib/python3.9/dist-packages/sklearn/cluster/_kmeans.py:870:
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1.4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
```

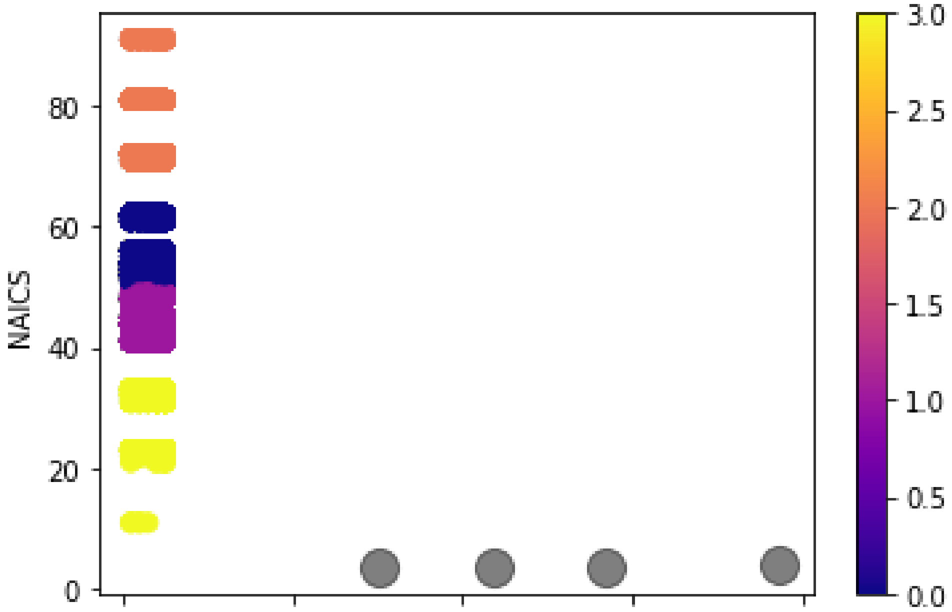
```
[17]:        Year  Size  NAICS  BusinessAge                    Industry  \
      46689  2019     1     44            4                Retail Trade
```

```
46690  2019     2     72             2  Accommodation and Food Services
46691  2019     3     81             4                   Other Services
46692  2019     2     44             1                     Retail Trade
46693  2019     4     44             1                     Retail Trade

       cluster_label
46689              1
46690              2
46691              2
46692              1
46693              1
```

[18]:
```
df2.plot.scatter(x = 'BusinessAge', y = 'NAICS', c=labels, s=50, cmap='plasma')
plt.scatter(centers[:, 0], centers[:, 1], c='black', s=200, alpha=0.5)
```

[18]:
```
<matplotlib.collections.PathCollection at 0x7fd4bd9546d0>
```



[19]:
```
#see which NAICS codes equal what industries
dfNAICs = df2.groupby(['Industry','NAICS']).count()
dfNAICs
```

[19]:
```
                                                           Year  Size  \
Industry                                            NAICS
Accommodation and Food Services                     72     2551  2551
Administrative and Support, Waste Management an… 56      1056  1056
Arts, Entertainment and Recreation                  71      430   430
```

```
Construction                                       23     1169  1169
Educational Services                               61     1234  1234
Finance and Insurance                              52     1242  1242
Health Care and Social Assistance                  62     2568  2568
Information and Cultural Industries                51      273   273
Management of Companies and Enterprises            55      205   205
Manufacturing                                      31      459   459
                                                   32     1102  1102
                                                   33     2289  2289
Other Services                                     81     3576  3576
Primary Industry                                   11        5     5
                                                   21        6     6
Professional, Scientific and Technical Services    54     2857  2857
Public Administration                              91      211   211
Real Estate and Rental and Leasing                 53      785   785
Retail Trade                                       44     3548  3548
                                                   45      829   829
Transportation and Warehousing                     48     1209  1209
                                                   49      357   357
Utilities                                          22       30    30
Wholesale Trade                                    41     3352  3352

                                                          BusinessAge  \
Industry                                           NAICS
Accommodation and Food Services                    72            2551
Administrative and Support, Waste Management an… 56           1056
Arts, Entertainment and Recreation                 71             430
Construction                                       23            1169
Educational Services                               61            1234
Finance and Insurance                              52            1242
Health Care and Social Assistance                  62            2568
Information and Cultural Industries                51             273
Management of Companies and Enterprises            55             205
Manufacturing                                      31             459
                                                   32            1102
                                                   33            2289
Other Services                                     81            3576
Primary Industry                                   11               5
                                                   21               6
Professional, Scientific and Technical Services    54            2857
Public Administration                              91             211
Real Estate and Rental and Leasing                 53             785
Retail Trade                                       44            3548
                                                   45             829
Transportation and Warehousing                     48            1209
                                                   49             357
Utilities                                          22              30
```

```
Wholesale Trade                                    41            3352

                                                          cluster_label
Industry                                           NAICS
Accommodation and Food Services                    72                2551
Administrative and Support, Waste Management an… 56              1056
Arts, Entertainment and Recreation                 71                 430
Construction                                       23                1169
Educational Services                               61                1234
Finance and Insurance                              52                1242
Health Care and Social Assistance                  62                2568
Information and Cultural Industries                51                 273
Management of Companies and Enterprises            55                 205
Manufacturing                                      31                 459
                                                   32                1102
                                                   33                2289
Other Services                                     81                3576
Primary Industry                                   11                   5
                                                   21                   6
Professional, Scientific and Technical Services    54                2857
Public Administration                              91                 211
Real Estate and Rental and Leasing                 53                 785
Retail Trade                                       44                3548
                                                   45                 829
Transportation and Warehousing                     48                1209
                                                   49                 357
Utilities                                          22                  30
Wholesale Trade                                    41                3352
```

[20]:
```
dfIndustryCount = df2.groupby(['Year','Industry'])['Year'].count()
dfIndustryCount
```

[20]:
```
Year  Industry
2019  Accommodation and Food Services
1321
      Administrative and Support, Waste Management and Remediation Services
562
      Arts, Entertainment and Recreation
228
      Construction
621
      Educational Services
647
      Finance and Insurance
638
      Health Care and Social Assistance
1281
```

```
      Information and Cultural Industries
137
      Management of Companies and Enterprises
107
      Manufacturing
2071
      Other Services
1873
      Primary Industry
5
      Professional, Scientific and Technical Services
1527
      Public Administration
107
      Real Estate and Rental and Leasing
415
      Retail Trade
2303
      Transportation and Warehousing
838
      Utilities
14
      Wholesale Trade
1823
2021  Accommodation and Food Services
1230
      Administrative and Support, Waste Management and Remediation Services
494
      Arts, Entertainment and Recreation
202
      Construction
548
      Educational Services
587
      Finance and Insurance
604
      Health Care and Social Assistance
1287
      Information and Cultural Industries
136
      Management of Companies and Enterprises
98
      Manufacturing
1779
      Other Services
1703
      Primary Industry
```

```
6
      Professional, Scientific and Technical Services
1330
      Public Administration
104
      Real Estate and Rental and Leasing
370
      Retail Trade
2074
      Transportation and Warehousing
728
      Utilities
16
      Wholesale Trade
1529
Name: Year, dtype: int64
```

[21]:
```
dfIndustryCount = df2.groupby(['Industry','Year'])['Industry'].count()
dfIndustryCount
```

[21]:
```
Industry                                                               Year
Accommodation and Food Services                                        2019
1321
                                                                       2021
1230
Administrative and Support, Waste Management and Remediation Services  2019
562
                                                                       2021
494
Arts, Entertainment and Recreation                                     2019
228
                                                                       2021
202
Construction                                                           2019
621
                                                                       2021
548
Educational Services                                                   2019
647
                                                                       2021
587
Finance and Insurance                                                  2019
638
                                                                       2021
604
Health Care and Social Assistance                                      2019
1281
```

```
                                                                         2021
1287
Information and Cultural Industries                                      2019
137
                                                                         2021
136
Management of Companies and Enterprises                                  2019
107
                                                                         2021
98
Manufacturing                                                            2019
2071
                                                                         2021
1779
Other Services                                                           2019
1873
                                                                         2021
1703
Primary Industry                                                         2019
5
                                                                         2021
6
Professional, Scientific and Technical Services                          2019
1527
                                                                         2021
1330
Public Administration                                                    2019
107
                                                                         2021
104
Real Estate and Rental and Leasing                                       2019
415
                                                                         2021
370
Retail Trade                                                             2019
2303
                                                                         2021
2074
Transportation and Warehousing                                           2019
838
                                                                         2021
728
Utilities                                                                2019
14
                                                                         2021
16
Wholesale Trade                                                          2019
```

```
1823
                                                                       2021
1529
Name: Industry, dtype: int64
```

[22]:

```
# Using DataFrame.agg() Method.
df3 = df2.groupby(['Industry', 'Year']).agg({'Year': 'count'})
print(df3)
```

```
                                                         Year
Industry                                           Year
Accommodation and Food Services                    2019  1321
                                                   2021  1230
Administrative and Support, Waste Management an… 2019   562
                                                   2021   494
Arts, Entertainment and Recreation                 2019   228
                                                   2021   202
Construction                                       2019   621
                                                   2021   548
Educational Services                               2019   647
                                                   2021   587
Finance and Insurance                              2019   638
                                                   2021   604
Health Care and Social Assistance                  2019  1281
                                                   2021  1287
Information and Cultural Industries                2019   137
                                                   2021   136
Management of Companies and Enterprises            2019   107
                                                   2021    98
Manufacturing                                      2019  2071
                                                   2021  1779
Other Services                                     2019  1873
                                                   2021  1703
Primary Industry                                   2019     5
                                                   2021     6
Professional, Scientific and Technical Services    2019  1527
                                                   2021  1330
Public Administration                              2019   107
                                                   2021   104
Real Estate and Rental and Leasing                 2019   415
                                                   2021   370
Retail Trade                                       2019  2303
                                                   2021  2074
Transportation and Warehousing                     2019   838
                                                   2021   728
Utilities                                          2019    14
                                                   2021    16
```

```
Wholesale Trade                                    2019  1823
                                                   2021  1529
```

[23]:

```
# Percentage by pct_change method on groupby.
df4 = df3.groupby(level=0).pct_change()*100
print(df4)
```

```
                                                              Year
Industry                                           Year           
Accommodation and Food Services                    2019        NaN
                                                   2021  -6.888721
Administrative and Support, Waste Management an… 2019        NaN
                                                   2021 -12.099644
Arts, Entertainment and Recreation                 2019        NaN
                                                   2021 -11.403509
Construction                                       2019        NaN
                                                   2021 -11.755233
Educational Services                               2019        NaN
                                                   2021  -9.273570
Finance and Insurance                              2019        NaN
                                                   2021  -5.329154
Health Care and Social Assistance                  2019        NaN
                                                   2021   0.468384
Information and Cultural Industries                2019        NaN
                                                   2021  -0.729927
Management of Companies and Enterprises            2019        NaN
                                                   2021  -8.411215
Manufacturing                                      2019        NaN
                                                   2021 -14.099469
Other Services                                     2019        NaN
                                                   2021  -9.076348
Primary Industry                                   2019        NaN
                                                   2021  20.000000
Professional, Scientific and Technical Services    2019        NaN
                                                   2021 -12.901113
Public Administration                              2019        NaN
                                                   2021  -2.803738
Real Estate and Rental and Leasing                 2019        NaN
                                                   2021 -10.843373
Retail Trade                                       2019        NaN
                                                   2021  -9.943552
Transportation and Warehousing                     2019        NaN
                                                   2021 -13.126492
Utilities                                          2019        NaN
                                                   2021  14.285714
Wholesale Trade                                    2019        NaN
                                                   2021 -16.127263
```

```
[24]: dfSizeCount = df2.groupby(['Year','Size'])['Year'].count()
      dfSizeCount
```

```
[24]: Year  Size
      2019  1       7629
            2       3470
            3       2316
            4       1767
            5        729
            6        478
            7         75
            8         34
            9         20
      2021  1       6712
            2       3139
            3       2084
            4       1601
            5        714
            6        441
            7         76
            8         34
            9         24
      Name: Year, dtype: int64
```

```
[ ]: dfSizeCount = df2.groupby(['Size','Year'])['Size'].count()
     dfSizeCount
```

```
[ ]: Size  Year
     1     2019    7629
           2021    6712
     2     2019    3470
           2021    3139
     3     2019    2316
           2021    2084
     4     2019    1767
           2021    1601
     5     2019     729
           2021     714
     6     2019     478
           2021     441
     7     2019      75
           2021      76
     8     2019      34
           2021      34
     9     2019      20
           2021      24
     Name: Size, dtype: int64
```

```
[ ]: # Using DataFrame.agg() Method.
     df5 = df2.groupby(['Size', 'Year']).agg({'Year': 'count'})
     print(df5)
```

```
           Year
Size Year
1    2019  7629
     2021  6712
2    2019  3470
     2021  3139
3    2019  2316
     2021  2084
4    2019  1767
     2021  1601
5    2019   729
     2021   714
6    2019   478
     2021   441
7    2019    75
     2021    76
8    2019    34
     2021    34
9    2019    20
     2021    24
```

```
[ ]: # Percentage by pct_change method on groupby.
     df6 = df5.groupby(level=0).pct_change()*100
     print(df6)
```

```
                Year
Size Year
1    2019        NaN
     2021 -12.019924
2    2019        NaN
     2021  -9.538905
3    2019        NaN
     2021 -10.017271
4    2019        NaN
     2021  -9.394454
5    2019        NaN
     2021  -2.057613
6    2019        NaN
     2021  -7.740586
7    2019        NaN
     2021   1.333333
8    2019        NaN
     2021   0.000000
9    2019        NaN
```

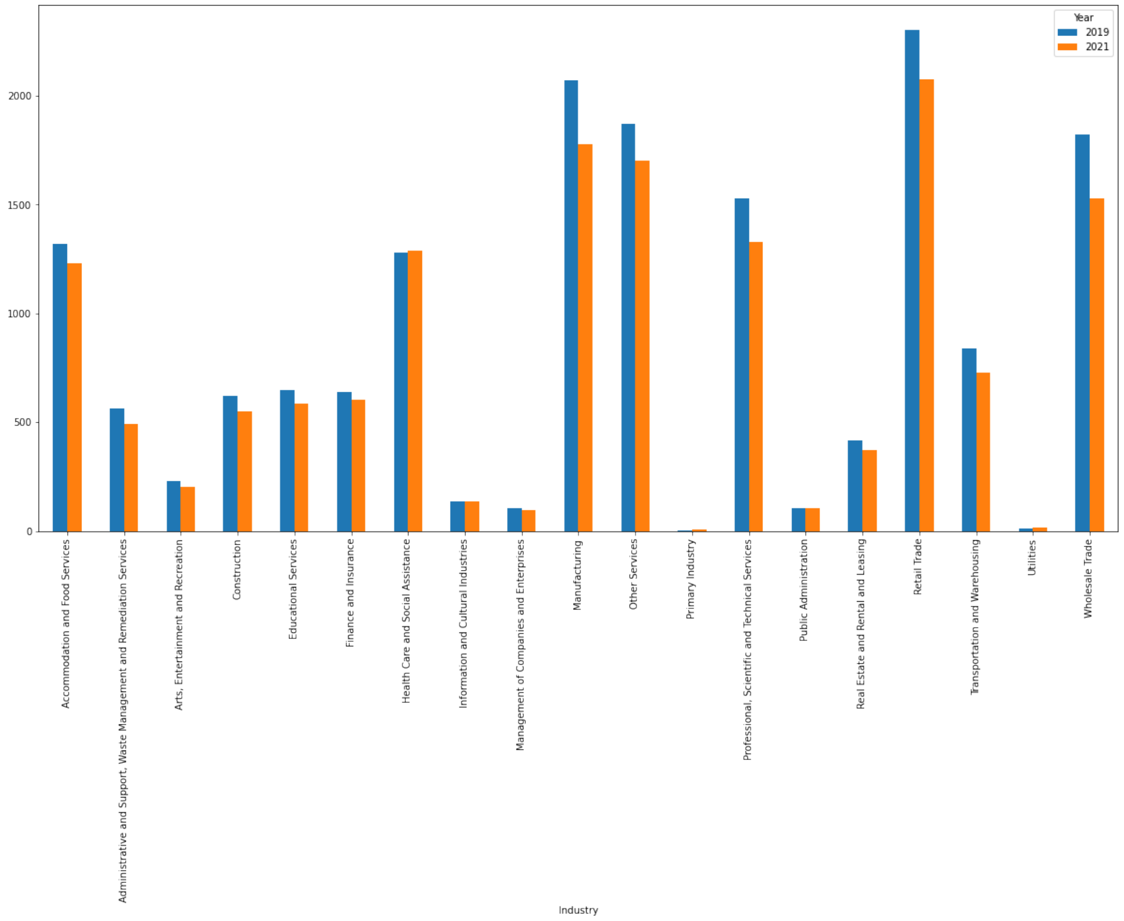
```
2021  20.000000
```

[ ]:

```
(df2.groupby(['Year','Industry'])['Year']
     .count().unstack('Year').plot.bar(figsize=(20, 10)))
#Net loss of businesses by Industry between 2019 and 2021
#Industries where most businesses closed were : Wholesale Trade ; Manufacturing␣
 ↪; Retail Trade
#Some of these industries fall within the industries other studies pointed to␣
 ↪as experiencing and existential threat early in the pandemic and vice versa␣
 ↪least negatively impacted
#example: Retail Trade vs Public Administration
#Industries where least businesss closed were :  Information and Cultural␣
 ↪Industries ; Public Administration
#Industries Health Care and Social Assistance ;  Utlities - Were the only␣
 ↪industries to increase business count
#Some of these fall within the strategic industries Mississauga has identified␣
 ↪for future growth
#So to summarize, there is both agreement and disagreement from the other␣
 ↪studies. Keeping in mind some industries are not in cities eg. Mining or␣
 ↪Fishing.
```

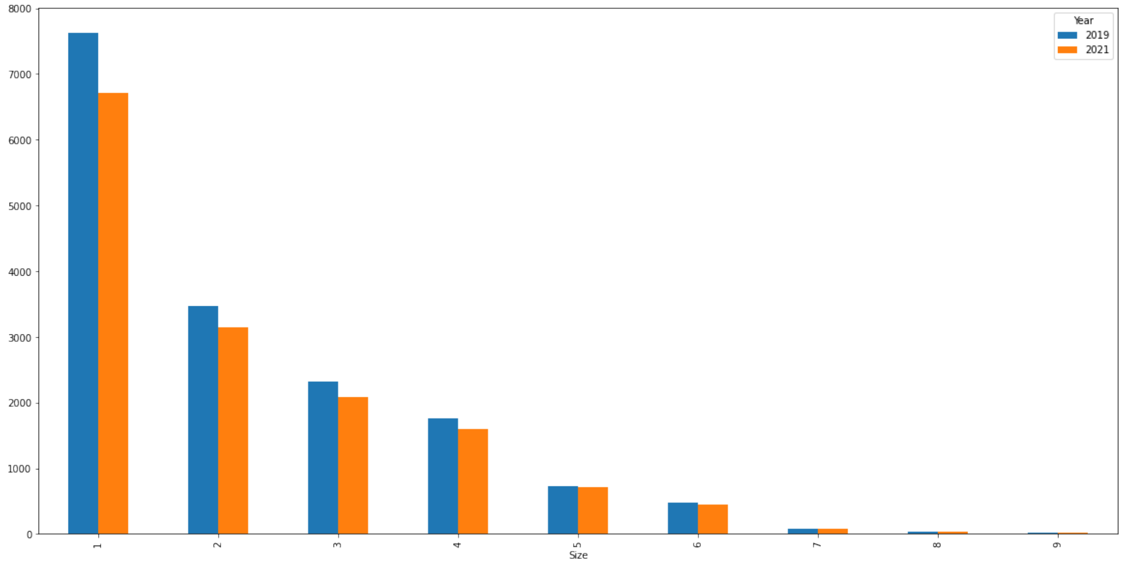
[ ]:

```
<Axes: xlabel='Industry'>
```



```
[ ]: (df2.groupby(['Year','Size'])['Year']
         .count().unstack('Year').plot.bar(figsize=(20, 10)))
     #Net loss of businesses by Size of business between 2019 and 2021
     #The smallest businesses closed the most between 2019 and 2021 - '1 to 4': 1,␣
      ↪'5 to 9': 2, '10 to 19': 3
     #The largest businesses stayed even ['500 to 999': 8]  or even grew ['300 to␣
      ↪499': 7, '1000+': 9 ]
     #The larger the business the more stable
     #This is different from Stats Can ontario survey were 20-99, 5-19 adn 100-249␣
      ↪were hardest hit and 0, 1-4 and 250-499 were least affected
     #I need to factor in the age of the business. Were businesses that were older␣
      ↪less likely to close?
```

```
[ ]: <Axes: xlabel='Size'>
```



[ ]:

```
# Using DataFrame.agg() Method.
df7 = df2.groupby(['BusinessAge', 'Year']).agg({'Year': 'count'})
print(df7)
```

```
                    Year
BusinessAge Year        
1           2019    1668
            2021     937
2           2019    1828
            2021    1343
3           2019    1838
            2021    1465
4           2019   11184
            2021    1577
5           2021    9503
```

[ ]:

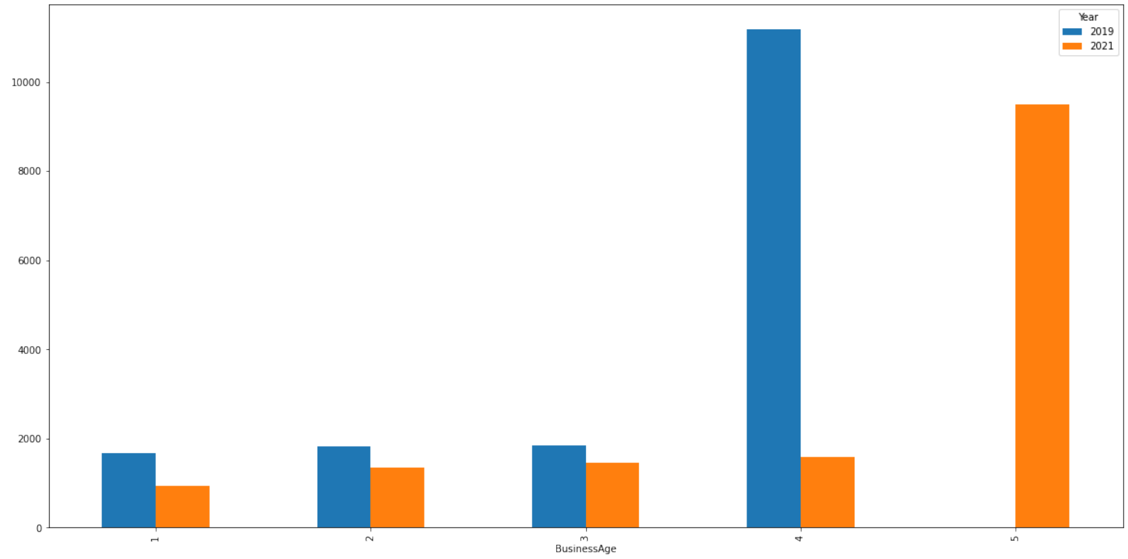
```
# Percentage by pct_change method on groupby.
df8 = df7.groupby(level=0).pct_change()*100
print(df8)
```

```
                        Year
BusinessAge Year            
1           2019         NaN
            2021  -43.824940
2           2019         NaN
            2021  -26.531729
3           2019         NaN
            2021  -20.293798
4           2019         NaN
```

```
            2021 -85.899499
5           2021        NaN
```

[ ]:
```
(df2.groupby(['Year','BusinessAge'])['Year']
    .count().unstack('Year').plot.bar(figsize=(20, 10)))
```

[ ]:
```
<Axes: xlabel='BusinessAge'>
```


Year
🟦 2019
🟧 2021
BusinessAge