2021CleanDataset

March 19, 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
```

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

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

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

```
[68]:        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  …  Fax TollFree EMail  WebAddress  EmplRange  \
      46689     Bramalea Rd     Yes  …  Yes      Yes   Yes         Yes          1
      46690  City Centre Dr      No  …   No       No    No         Yes          2
      46691     Tranmere Dr      No  …  Yes      Yes   Yes         Yes          3
      46692  City Centre Dr      No  …   No       No    No         Yes          2
```

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

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

[5 rows x 28 columns]
```

[69]:

```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 31343 entries, 46689 to 78031
Data columns (total 28 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  isnew       31343 non-null  object
 27  Closed      31343 non-null  object
dtypes: float64(4), int64(8), object(16)
```

```
memory usage: 6.9+ MB
```

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

```
[70]: No     28629
      Yes     2714
      Name: Closed, dtype: int64
```

```
[71]: data.shape
```

```
[71]: (31343, 28)
```

```
[72]: 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
```

```
[73]: #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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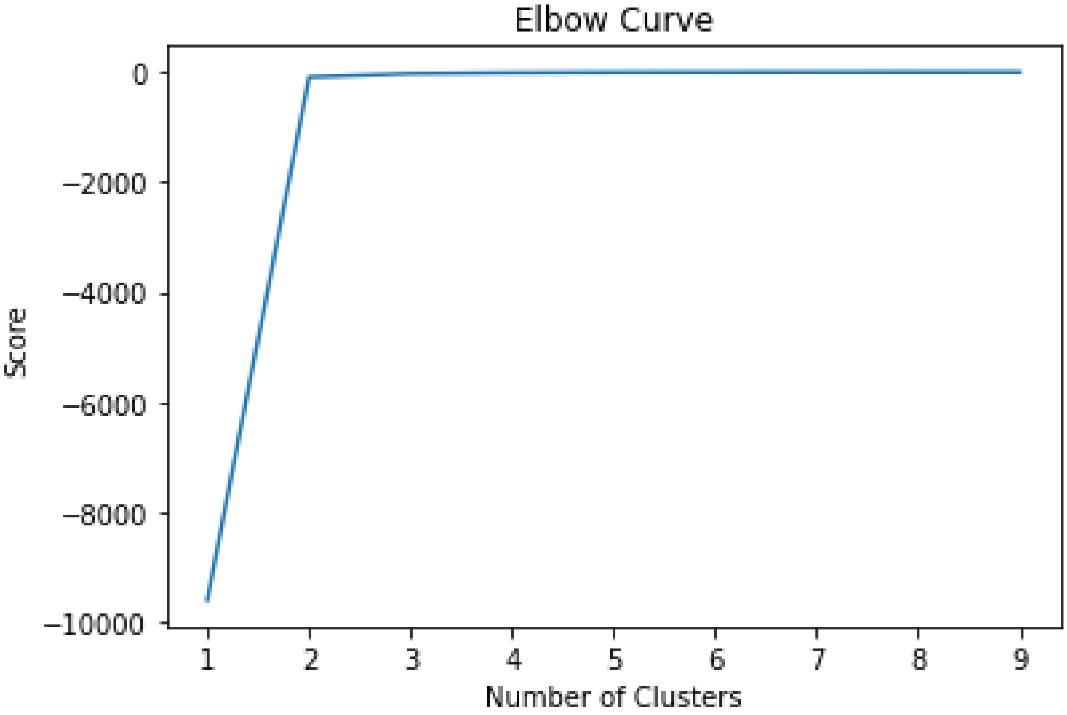
```



[74]:
```
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)
```

```
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[74]:
```
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           StreetName BldgNo  … TollFree EMail WebAddress  EmplRange  \
46689     Bramalea Rd    Yes  …      Yes   Yes        Yes          1
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46693  City Centre Dr     No  …       No    No         No          4

           CENT_X        CENT_Y  Year isnew Closed cluster_label
46689  607567.2334  4.837723e+06  2019    No     No             0
46690  609556.5032  4.827621e+06  2019   Yes     No             0
46691  607415.6044  4.837500e+06  2019    No     No             0
46692  610454.8654  4.839347e+06  2019   Yes     No             0
46693  610454.8654  4.839347e+06  2019   Yes     No             0

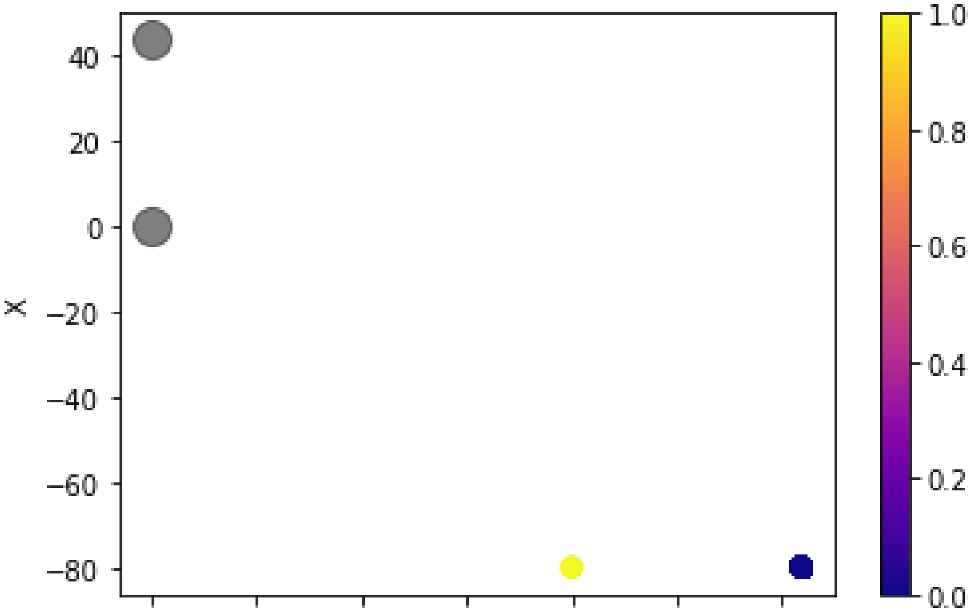
[5 rows x 29 columns]
```

[75]:

```
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)
```

[75]:

```
<matplotlib.collections.PathCollection at 0x7f55dc553580>
```



[76]:

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

```
         Year  Size  NAICS                                          Industry
46689    2019     1     44                                      Retail Trade
46690    2019     2     72                   Accommodation and Food Services
46691    2019     3     81                                    Other Services
46692    2019     2     44                                      Retail Trade
46693    2019     4     44                                      Retail Trade
…         …     …      …                                                 …
78027    2021     3     56  Administrative and Support, Waste Management a…
78028    2021     1     56  Administrative and Support, Waste Management a…
78029    2021     1     72                   Accommodation and Food Services
78030    2021     1     41                                   Wholesale Trade
78031    2021     1     41                                   Wholesale Trade

[31343 rows x 4 columns]
```

[77]:

```
#clustering of inustries and size of business.  All in Mississauga so only 2␣
 ↪clusters
```

```python
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:
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```

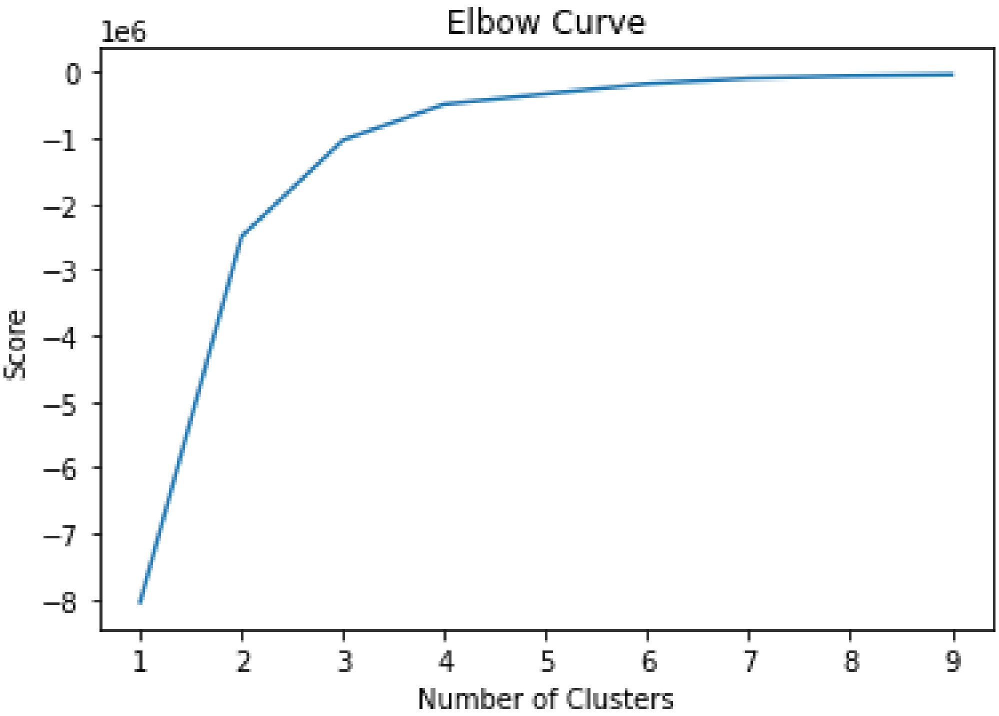

[78]:
```
kmeans = KMeans(n_clusters = 7, init ='k-means++')
kmeans.fit(df2[df2.columns[1:3]]) # Compute k-means clustering.
df2['cluster_label'] = kmeans.fit_predict(df2[df2.columns[1:3]])
centers = kmeans.cluster_centers_ # Coordinates of cluster centers.
labels = kmeans.predict(df2[df2.columns[1:3]]) # Labels of each point
df2.head(5)
```

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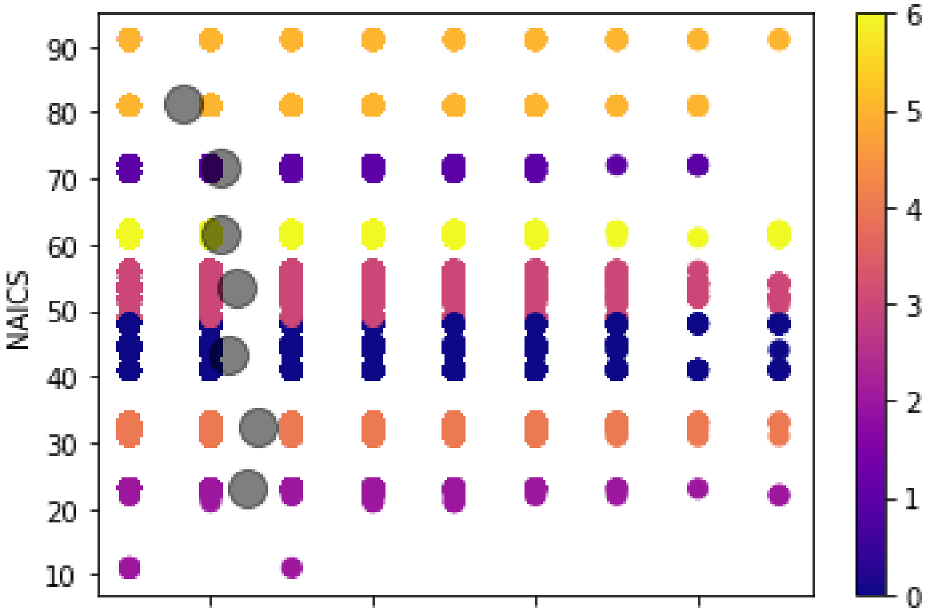

[78]:
```
       Year  Size  NAICS                         Industry  cluster_label
46689  2019     1     44                     Retail Trade              0
46690  2019     2     72  Accommodation and Food Services              1
```

```
46691  2019     3     81                      Other Services              5
46692  2019     2     44                        Retail Trade              0
46693  2019     4     44                        Retail Trade              0
```

[79]:
```
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)
```

[79]:
```
<matplotlib.collections.PathCollection at 0x7f55dc379880>
```



[80]:
```
#see which NAICS codes equal what industries
dfNAICs = df2.groupby(['Industry','NAICS']).count()
dfNAICs
```

[80]:
```
                                                          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

                                                            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
```

[81]:
```
dfIndustryCount = df2.groupby(['Year','Industry'])['Year'].count()
dfIndustryCount
```

[81]:
```
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
```

[82]:
```
dfIndustryCount = df2.groupby(['Industry','Year'])['Industry'].count()
dfIndustryCount
```

[82]:
```
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
```

[83]:

```
# 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
```

[84]:

```
# 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
```

[55]:

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

[55]:

```
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
```

[56]:

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

[56]:

```
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
```

[57]:

```
# 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
```

[58]:

```
# 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
```

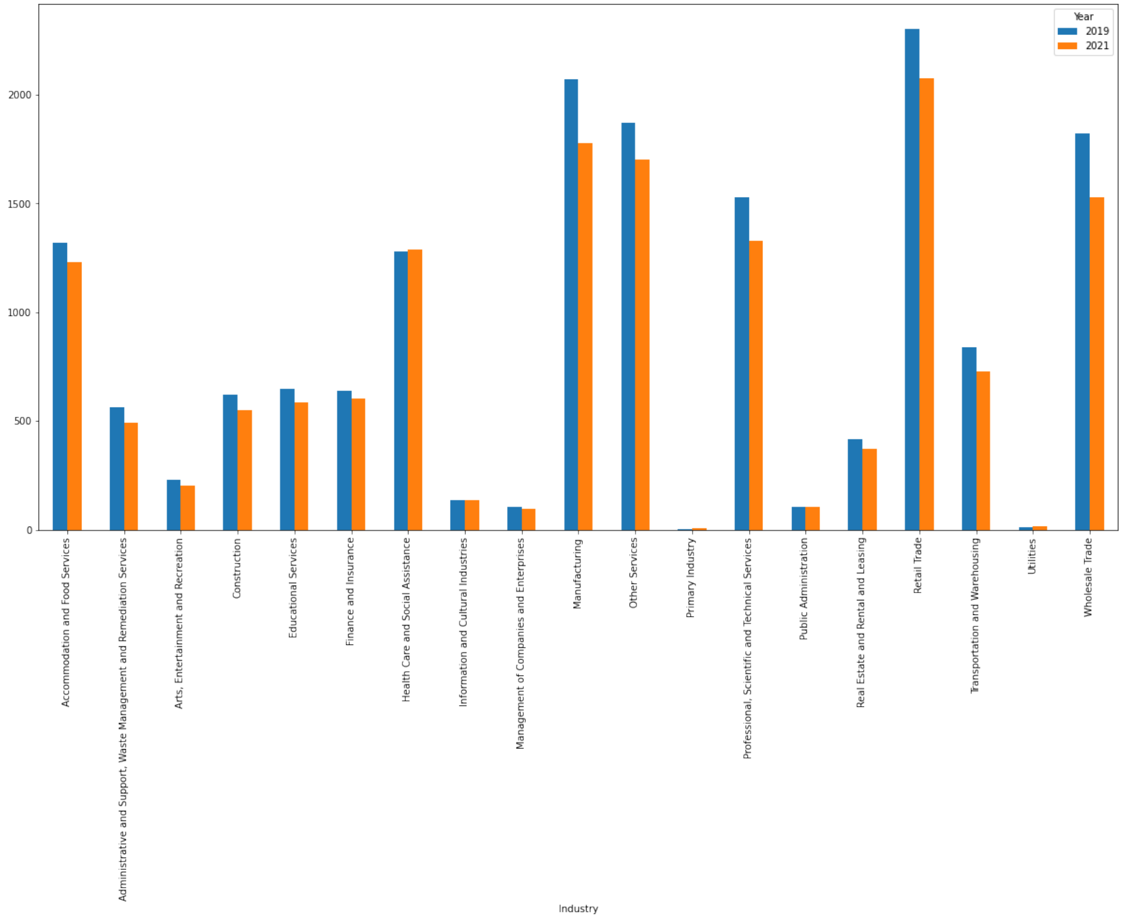
```
3    2019         NaN
     2021  -10.017271
4    2019         NaN
     2021   -9.394454
5    2019         NaN
     2021   -2.057613
6    2019         NaN
     2021   -7.740586
7    2019         NaN
     2021    1.333333
8    2019         NaN
     2021    0.000000
9    2019         NaN
     2021   20.000000
```

[59]:

```
(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.
```

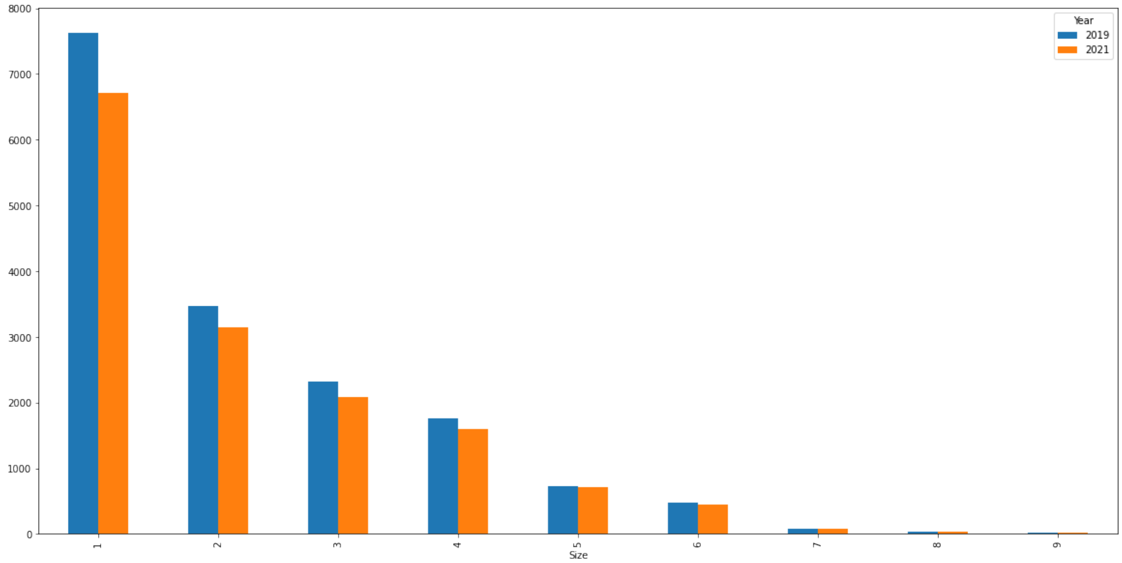
[59]:

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



[60]:
```
(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?
```

[60]:
```
<Axes: xlabel='Size'>
```


8000
7000
6000
5000
4000
3000
2000
1000
0
Year
2019
2021
1
2
3
4
5
6
7
8
9
Size