Achievement_First_Exercise

January 2, 2020

1 Achievement First Data Analyst Technical Exercise

```
In [589]: import pandas as pd
          import numpy as np
          import seaborn as sns
          import matplotlib.pyplot as plt

          %matplotlib inline
```

```
In [590]: # read in the data
          data = pd.read_excel('F&P Sample Data Set.xlsx')
```

2 Pre-Processing

```
In [591]: data.head()
```

```
Out[591]:    Student ID                  School Name Grade Level  BOY F&P Score  \
          0    10000001       Bushwick Middle School           5           11.0
          1    10000002       Bushwick Middle School           5           11.0
          2    10000003  Crown Heights Middle School           5           11.0
          3    10000004       Bushwick Middle School           5           11.0
          4    10000005       Bushwick Middle School           5           11.0

             EOY F&P Score
          0           16.0
          1           16.0
          2           16.0
          3           16.0
          4           14.0
```

```
In [592]: # check dimensions of data
          print('Data Features: ', data.shape[1])
          print('Data Instances: ', data.shape[0])
```

```
Data Features:  5
Data Instances:  376
```

```
In [593]: # check datatypes of features
          data.dtypes

Out[593]: Student ID          int64
          School Name        object
          Grade Level        object
          BOY F&P Score     float64
          EOY F&P Score     float64
          dtype: object

In [594]: # data columns
          data.columns

Out[594]: Index(['Student ID', 'School Name', 'Grade Level', 'BOY F&P Score',
                 'EOY F&P Score'],
                dtype='object')

In [595]: # check for null (missing) values
          data.isnull().sum()

Out[595]: Student ID        0
          School Name       0
          Grade Level       0
          BOY F&P Score    97
          EOY F&P Score    10
          dtype: int64

In [596]: data.loc[data['BOY F&P Score'].isnull(), 'School Name'].value_counts()

Out[596]: Crown Heights Middle School    80
          Bushwick Middle School         14
          Crown Hghts Middle School       2
          Bushwick MS                     1
          Name: School Name, dtype: int64
```

2.0.1 Grade Level Feature

```
In [597]: # check unique 'Grade Level' feature
          # --> data may have been manually inputted
          data['Grade Level'].value_counts()

Out[597]: 6      197
          5      172
          5th      5
          6th      2
          Name: Grade Level, dtype: int64

In [598]: # Grade Level  == 5
          print(type(data['Grade Level'][0]))

          # Grade Level == 6th
          print(type(data['Grade Level'][374]))
```

```
<class 'int'>
<class 'str'>
```

```
In [599]: # convert '5th -> 5' and '6th -> 6' to maintain consistency
          data['Grade Level'].replace(to_replace=['5th','6th'], value=[5,6], inplace=True)

In [600]: # ensure feature 'Grade Level' is correct
          data['Grade Level'].value_counts()

Out[600]: 6    199
          5    177
          Name: Grade Level, dtype: int64
```

2.0.2 School Name Feature

```
In [601]: # check unique 'School Name' feature
          # --> data may have been manually inputted
          data['School Name'].value_counts()

Out[601]: Bushwick Middle School         198
          Crown Heights Middle School    171
          Bushwick MS                      4
          Crown Hghts Middle School        3
          Name: School Name, dtype: int64

In [602]: # convert 'Brushwick MS -> Bushwick Middle School'
          # convert 'Crown Hghts Middle School -> Crown Heights Middle School'

          replace_lst = ['Bushwick MS', 'Crown Hghts Middle School']
          value_lst = ['Bushwick Middle School', 'Crown Heights Middle School']

          data['School Name'].replace(to_replace=replace_lst, value=value_lst, inplace=True)

In [603]: # ensure feature 'School Name' is correct
          data['School Name'].value_counts()

Out[603]: Bushwick Middle School         202
          Crown Heights Middle School    174
          Name: School Name, dtype: int64
```

2.0.3 BOY/EOY F&P Feature

```
In [604]: # percent of missing values in 'BOY F&P Score'
          # percent of 'BOY F&P Score' data is too large to drop (about 25%)

          print('Percentage of missing values (BOY F&P Score): ',
                (data['BOY F&P Score'].isnull().sum() / data.shape[0])*100)
```

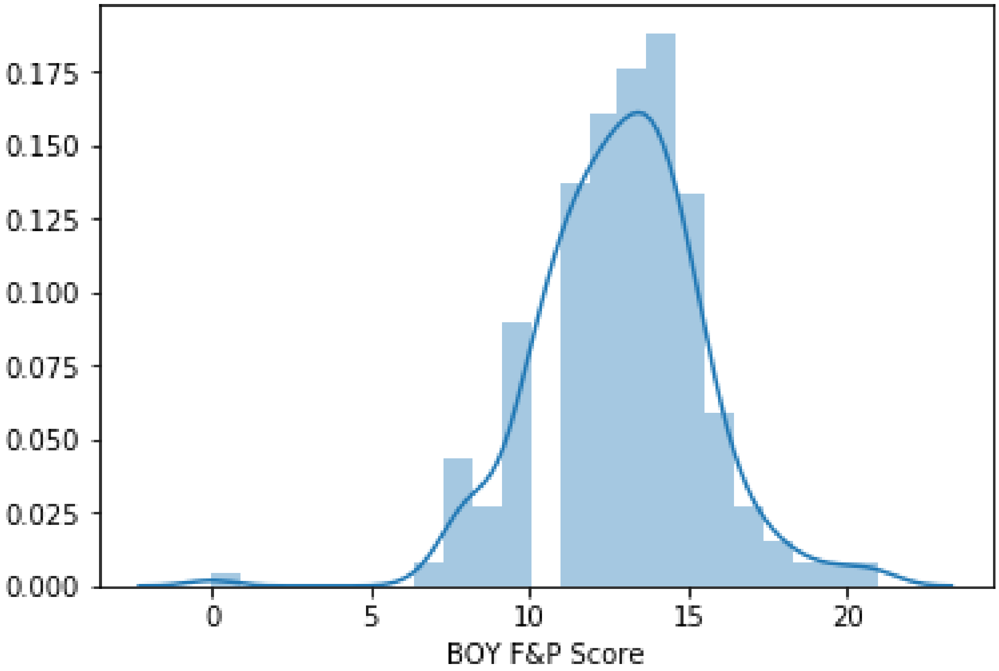
```
Percentage of missing values (BOY F&P Score):  25.79787234042553
```

```
In [605]: # percent of missing values in 'BOY F&P Score'
          # percent of 'EOY F&P Score' data is too large to drop (about 2%)

          print('Percentage of missing values (EOY F&P Score): ',
                (data['EOY F&P Score'].isnull().sum() / data.shape[0])*100)
```

```
Percentage of missing values (EOY F&P Score):  2.6595744680851063
```

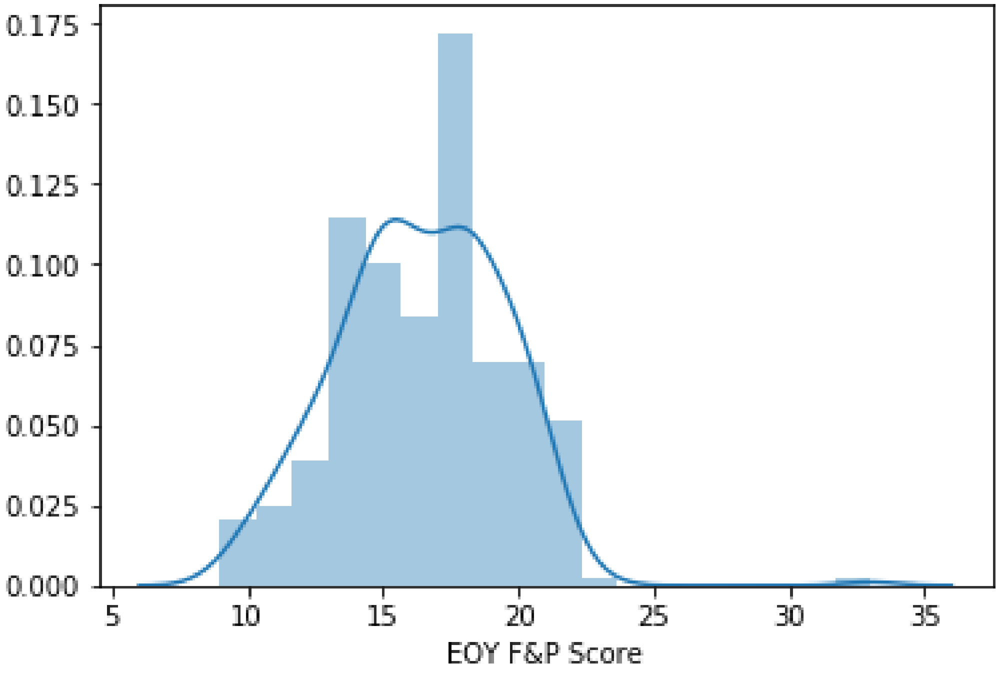
```
In [606]: # Distribution plot of 'BOY F&P Score'
          # the distribution appears to be fairly normal (no drastic outliers),
          # as a result we can use the mean to replace null values

          df = data.loc[data['BOY F&P Score'].notnull(), :]
          sns.distplot(df['BOY F&P Score'])
```

```
Out[606]: <matplotlib.axes._subplots.AxesSubplot at 0x1a1b3a5e10>
```



```
In [607]: # Distribution plot of 'EOY F&P Score'
          # the distribution appears to be fairly normal (no drastic outliers),
          # as a result we can use the mean to replace null values

          df = data.loc[data['EOY F&P Score'].notnull(), :]
          sns.distplot(df['EOY F&P Score'])
```

```
Out[607]: <matplotlib.axes._subplots.AxesSubplot at 0x1a1b6c1710>
```



```
In [608]: # Obtaining the mean 'BOY F&P Score' per 'Grade Level' feature
          data.groupby(['Grade Level', 'School Name'])['BOY F&P Score'].mean()

Out[608]: Grade Level  School Name
          5            Bushwick Middle School         10.868132
                       Crown Heights Middle School    13.155844
          6            Bushwick Middle School         13.718750
                       Crown Heights Middle School    18.066667
          Name: BOY F&P Score, dtype: float64

In [609]: # Obtaining the median 'BOY F&P Score' per 'Grade Level' feature
          data.groupby(['Grade Level', 'School Name'])['BOY F&P Score'].median()

Out[609]: Grade Level  School Name
          5            Bushwick Middle School         11.0
                       Crown Heights Middle School    13.0
          6            Bushwick Middle School         14.0
                       Crown Heights Middle School    18.0
          Name: BOY F&P Score, dtype: float64

In [610]: # Obtaining the mean 'EOY F&P Score' per 'Grade Level' feature
          data.groupby(['Grade Level', 'School Name'])['EOY F&P Score'].mean()
```

```
Out[610]: Grade Level  School Name
          5            Bushwick Middle School         13.580645
                       Crown Heights Middle School    14.828947
          6            Bushwick Middle School         17.854369
                       Crown Heights Middle School    18.829787
          Name: EOY F&P Score, dtype: float64
```

```
In [611]: # Obtaining the median 'EOY F&P Score' per 'Grade Level' feature
          data.groupby(['Grade Level', 'School Name'])['EOY F&P Score'].median()
```

```
Out[611]: Grade Level  School Name
          5            Bushwick Middle School         14.0
                       Crown Heights Middle School    15.0
          6            Bushwick Middle School         18.0
                       Crown Heights Middle School    19.0
          Name: EOY F&P Score, dtype: float64
```

```
In [612]: # Since there is not a significant difference in value
          # for the mean and median for both the 'BOY F&P Score'
          # and the 'EOY F&P Score', I will use the median as the
          # replacement test statistic.  Additionally, I chose the
          # median because the values are in the format of
          # XX.0 float type for both columns.
```

```
In [613]: # replace 'BOY F&P Score' and 'EOY F&P Score' null values
          # with their respective median value by 'Grade Level' and 'School Name'
```

```
In [614]: gl5_BMS_median_BOY = data.loc[(data['Grade Level']==5)&(data['School Name']=='Bushwi
                                    'BOY F&P Score'].median()
          # gl5_BMS_median_BOY -- > 11.0

          data.loc[(data['Grade Level']==5)&(data['School Name']=='Bushwick Middle School')
                   &(data['BOY F&P Score'].isnull()), 'BOY F&P Score'] = gl5_BMS_median_BOY
```

```
In [615]: gl5_BMS_median_EOY = data.loc[(data['Grade Level']==5)&(data['School Name']=='Bushwi
                                    'EOY F&P Score'].median()
          # gl5_BMS_median_EOY -- > 14.0

          data.loc[(data['Grade Level']==5)&(data['School Name']=='Bushwick Middle School')
                   &(data['EOY F&P Score'].isnull()), 'EOY F&P Score'] = gl5_BMS_median_EOY
```

```
In [616]: gl5_CHMS_median_BOY = data.loc[(data['Grade Level']==5)&(data['School Name']=='Crown
                                    'BOY F&P Score'].median()
          # gl5_CHMS_median_BOY -- > 13.0

          data.loc[(data['Grade Level']==5)&(data['School Name']=='Crown Heights Middle School
                   &(data['BOY F&P Score'].isnull()), 'BOY F&P Score'] = gl5_CHMS_median_BOY
```

```
In [617]: gl5_CHMS_median_EOY = data.loc[(data['Grade Level']==5)&(data['School Name']=='Crown
                                    'EOY F&P Score'].median()
```

```
          # gl5_CHMS_median_EOY -- > 13.0

          data.loc[(data['Grade Level']==5)&(data['School Name']=='Crown Heights Middle School
                   &(data['EOY F&P Score'].isnull()), 'EOY F&P Score'] = gl5_CHMS_median_EOY
```

```
In [618]: gl6_BMS_median_BOY = data.loc[(data['Grade Level']==6)&(data['School Name']=='Bushwi
                                    'BOY F&P Score'].median()
          # gl6_BMS_median_BOY -- > 14.0

          data.loc[(data['Grade Level']==6)&(data['School Name']=='Bushwick Middle School')
                   &(data['BOY F&P Score'].isnull()), 'BOY F&P Score'] = gl6_BMS_median_BOY
```

```
In [619]: gl6_BMS_median_EOY = data.loc[(data['Grade Level']==6)&(data['School Name']=='Bushwi
                                    'EOY F&P Score'].median()
          # gl6_BMS_median_EOY -- > 18.0

          data.loc[(data['Grade Level']==6)&(data['School Name']=='Bushwick Middle School')
                   &(data['EOY F&P Score'].isnull()), 'EOY F&P Score'] = gl6_BMS_median_EOY
```

```
In [620]: gl6_CHMS_median_BOY = data.loc[(data['Grade Level']==6)&(data['School Name']=='Crown
                                    'BOY F&P Score'].median()
          # gl6_CHMS_median_BOY -- > 14.0

          data.loc[(data['Grade Level']==6)&(data['School Name']=='Crown Heights Middle School
                   &(data['BOY F&P Score'].isnull()), 'BOY F&P Score'] = gl6_CHMS_median_BOY
```

```
In [621]: gl6_CHMS_median_EOY = data.loc[(data['Grade Level']==6)&(data['School Name']=='Crown
                                    'EOY F&P Score'].median()
          # gl6_CHMS_median_EOY -- > 19.0

          data.loc[(data['Grade Level']==6)&(data['School Name']=='Crown Heights Middle School
                   &(data['EOY F&P Score'].isnull()), 'EOY F&P Score'] = gl6_CHMS_median_EOY
```

```
In [622]: data.isnull().sum()
```

```
Out[622]: Student ID       0
          School Name      0
          Grade Level      0
          BOY F&P Score    0
          EOY F&P Score    0
          dtype: int64
```

3 Feature Engineering

```
In [623]: # include the additional feature of 'Proficiency Level'
          # 4th Grade EOY / 5th Grade BOY: Remedial (1-9), Below Proficient (10-11), Proficien
          # 5th Grade EOY / 6th Grade BOY: Remedial (1-11), Below Proficient (12-13), Proficie
          # 6th Grade EOY / 7th Grade BOY: Remedial (1-13), Belwo Proficient (14-15), Proficie
          # Relevant for our dataset:
          # - 5th Grade BOY: Remedial (1-9), Below Proficient (10-11), Proficient (12-13), Adv
          # - 5th Grade EOY: Remedial (1-11), Below Proficient (12-13), Proficient (14-15), Ad
          # - 6th Grade BOY: Remedial (1-11), Below Proficient (12-13), Proficient (14-15), Ad
          # - 6th Grade EOY: Remedial (1-13), Below Proficient (14-15), Proficient (16-17), Ad

In [624]: # Defined two functions:
          # - one for BOY for both 5/6 grade level
          # - one for EOY for both 5/6 grade level

          def BOY_Prof(row):
              if row['Grade Level'] == 5:
                  if (row['BOY F&P Score']>0) & (row['BOY F&P Score']<=9):
                      return 'Remedial'
                  elif (row['BOY F&P Score']>9) & (row['BOY F&P Score']<=11):
                      return 'Below Proficient'
                  elif (row['BOY F&P Score']>11) & (row['BOY F&P Score']<=13):
                      return 'Proficient'
                  else:
                      return 'Advanced'
              elif row['Grade Level'] == 6:
                  if (row['BOY F&P Score']>0) & (row['BOY F&P Score']<=11):
                      return 'Remedial'
                  elif (row['BOY F&P Score']>11) & (row['BOY F&P Score']<=13):
                      return 'Below Proficient'
                  elif (row['BOY F&P Score']>13) & (row['BOY F&P Score']<=15):
                      return 'Proficient'
                  else:
                      return 'Advanced'
              else:
                  return np.NaN

          def EOY_Prof(row):
              if row['Grade Level'] == 5:
                  if (row['EOY F&P Score']>0) & (row['EOY F&P Score']<=11):
                      return 'Remedial'
                  elif (row['EOY F&P Score']>11) & (row['EOY F&P Score']<=13):
                      return 'Below Proficient'
                  elif (row['EOY F&P Score']>13) & (row['EOY F&P Score']<=15):
                      return 'Proficient'
                  else:
                      return 'Advanced'
              elif row['Grade Level'] == 6:
                  if (row['EOY F&P Score']>0) & (row['EOY F&P Score']<=13):
                      return 'Remedial'
                  elif (row['EOY F&P Score']>13) & (row['EOY F&P Score']<=15):
                      return 'Below Proficient'
```

```
                elif (row['EOY F&P Score']>15) & (row['EOY F&P Score']<=17):
                    return 'Proficient'
                else:
                    return 'Advanced'
            else:
                return np.NaN
```

```
In [625]: data['BOY Proficiency'] = data.apply(func=BOY_Prof, axis=1)
          data['EOY Proficiency'] = data.apply(func=EOY_Prof, axis=1)
```

```
In [626]: data.head()
```

```
Out[626]:    Student ID                  School Name  Grade Level  BOY F&P Score  \
          0    10000001       Bushwick Middle School            5           11.0
          1    10000002       Bushwick Middle School            5           11.0
          2    10000003  Crown Heights Middle School            5           11.0
          3    10000004       Bushwick Middle School            5           11.0
          4    10000005       Bushwick Middle School            5           11.0

             EOY F&P Score   BOY Proficiency EOY Proficiency
          0           16.0  Below Proficient        Advanced
          1           16.0  Below Proficient        Advanced
          2           16.0  Below Proficient        Advanced
          3           16.0  Below Proficient        Advanced
          4           14.0  Below Proficient      Proficient
```

```
In [627]: data.isnull().sum()
```

```
Out[627]: Student ID         0
          School Name        0
          Grade Level        0
          BOY F&P Score      0
          EOY F&P Score      0
          BOY Proficiency    0
          EOY Proficiency    0
          dtype: int64
```

4 Exploratory Data Analysis

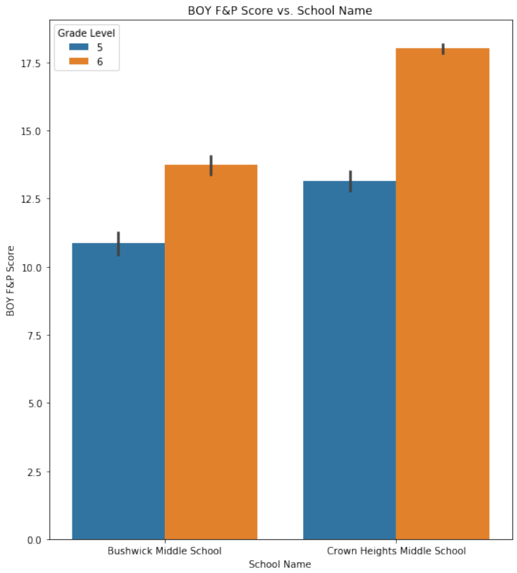
Note: the analysis below included the replacement of null values with the median test statistic for both the 'BOY F&P Score' and 'EOY F&P Score'. The null scores accounted for about 25% of all scores, which was too significant to drop. This could be the reason why for ex) Crown Heights Proficiency levels decrease from BOY to EOY. My assumption is that kids may have joined mid school year and did not receive an initial BOY F&P Score.

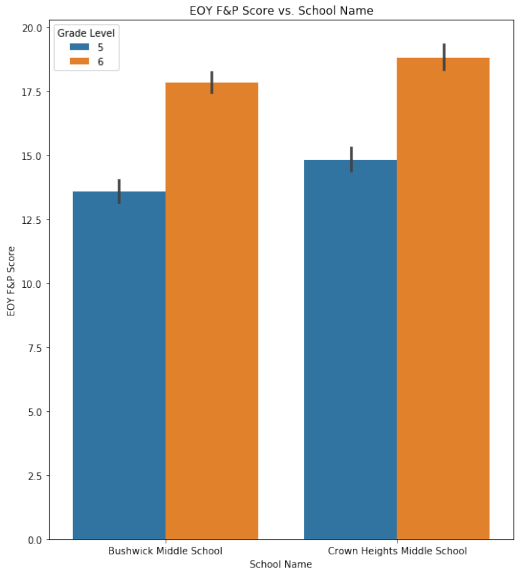
4.0.1 BOY/EOY Analysis

```
In [628]: # barplot displaying the 'BOY F&P Scores' with respect to 'School Name' and 'Grade L
```

```
        # It appears that Bushwick Middle School has a lowered BOY F&P Score for both
        # Grades 5th and 6th when compared to Crown Heights Middle School.

        # Bushwick Middle School

        #                BOY F&P Scores:   EOY F&P Scores:   Increase:
        # 5th Graders:   10.876289         13.597938         2.721649
        # 6th Graders:   13.742857         17.857143         4.114286

        # Crown Heights Middle School

        #                BOY F&P Scores:   EOY F&P Scores:   Increase:
        # 5th Graders:   13.150000         14.837500         1.6875
        # 6th Graders:   18.010638         18.829787         0.826862

        # Interestingly enough, the 5th graders at Crown Heights Middle School
        # are practically at the same reading level as the 6th graders at Bushwick Middle Sc
        # The 6th graders at Bushwick Middle School have a slightly raised BOY F&P Score tha
        # at Crown Heights Middle School. This is to be expected since the grade level is hig
        # the BOY Scores are so close in value with only a difference of 0.592857.

        # What is interesting about this data is that although the Crown Heights Middle Scho
        # off at a higher F&P Score in the BOY, they did not progress as significantly as the
        # Schoolers.  On the other hand, since Bushwick Middle Schoolers did begin the year
        # there was a lot of room for improvement.

        # NOTE: replacement of null values may have affected these results.
```

```
In [629]: plt.figure(figsize=(20,10))
          plt.subplot(1,2,1)
          plt.title('BOY F&P Score vs. School Name')
          sns.barplot(x='School Name', y='BOY F&P Score', hue='Grade Level', data=data)

          plt.subplot(1,2,2)
          plt.title('EOY F&P Score vs. School Name')
          sns.barplot(x='School Name', y='EOY F&P Score', hue='Grade Level', data=data)

          plt.subplots_adjust(wspace = 0.3, hspace = 0.3);
```





```
In [630]: data.groupby(['School Name', 'Grade Level'])['BOY F&P Score'].mean()

Out[630]: School Name                 Grade Level
          Bushwick Middle School      5              10.876289
                                      6              13.742857
          Crown Heights Middle School 5              13.150000
                                      6              18.010638
          Name: BOY F&P Score, dtype: float64
```

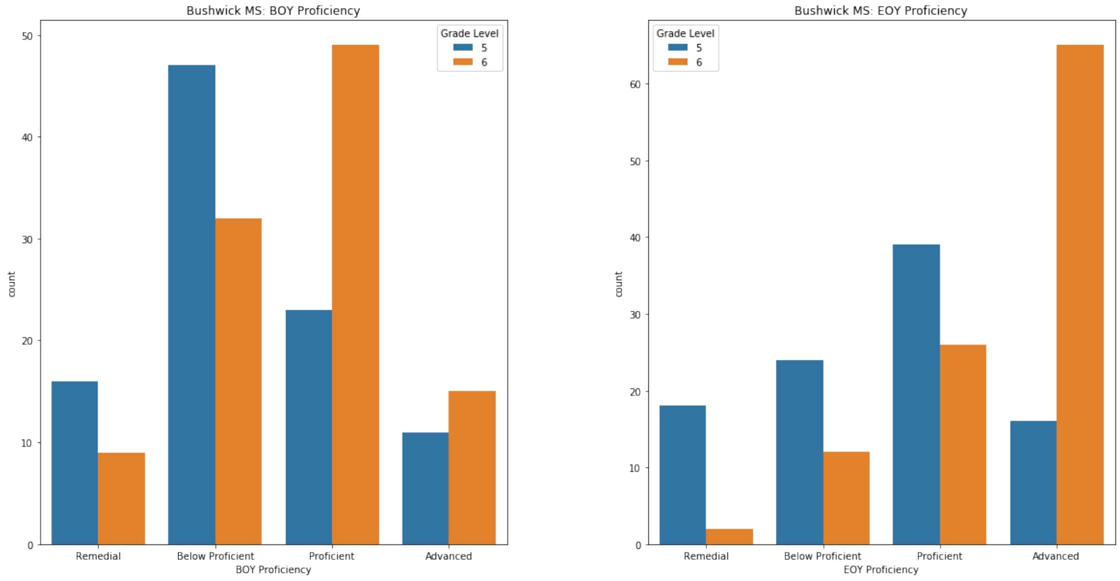
```
In [631]: data.groupby(['School Name', 'Grade Level'])['EOY F&P Score'].mean()

Out[631]: School Name                 Grade Level
          Bushwick Middle School      5              13.597938
                                      6              17.857143
          Crown Heights Middle School 5              14.837500
                                      6              18.829787
          Name: EOY F&P Score, dtype: float64
```

4.0.2 Bushwick Proficiency Analysis

```
In [632]: # countplot of Bushwick MS 'BOY Proficiency' with repsect to 'Grade Level'

          # Bushwick Middle School

          # BOY Proficieny   -   Remedial:     Below Proficient:    Proficient:    Advanced:
          # 5th Graders:         16/97 - 16%   47/97 - 48%          23/97 - 23%    11/97 - 11%
          # 6th Graders:         9/105 - 8%    32/105 - 30%         49/105 - 46%   15/105 - 14%

          # EOY Proficiency -  Remedial:       Below Proficient:    Proficient:    Advanced:
```

```
         # 5th Graders:        18/97 - 18%     24/97 - 24%         39/97 - 40%     16/97 - 16%
         # 6th Graders:        2/105 - 2%      12/105 - 11%        26/105 - 24%    65/105 - 61%

         # Difference -       Remedial:      Below Proficient:   Proficient:     Advanced:
         # 5th Graders:        +2%            -24%                +17%            +5%
         # 6th Graders:        -6%            -19%                - 22%           +47%
```

```
In [633]: bushwick = data.loc[data['School Name']=='Bushwick Middle School',:]

          plt.figure(figsize=(20,10))
          plt.subplot(1,2,1)
          plt.title('Bushwick MS: BOY Proficiency')
          sns.countplot(x='BOY Proficiency', hue='Grade Level',
                        order=['Remedial','Below Proficient', 'Proficient', 'Advanced'],
                        data=bushwick)

          plt.subplot(1,2,2)
          plt.title('Bushwick MS: EOY Proficiency')
          sns.countplot(x='EOY Proficiency', hue='Grade Level',
                        order=['Remedial','Below Proficient', 'Proficient', 'Advanced'],
                        data=bushwick);

          plt.subplots_adjust(wspace = 0.3, hspace = 0.3)
```



```
In [634]: bush.groupby('Grade Level')['BOY Proficiency'].value_counts()

Out[634]: Grade Level  BOY Proficiency
          5            Below Proficient    47
```

```
                       Proficient          23
                       Remedial            16
                       Advanced            11
          6            Proficient          49
                       Below Proficient    32
                       Advanced            15
                       Remedial             9
          Name: BOY Proficiency, dtype: int64
```

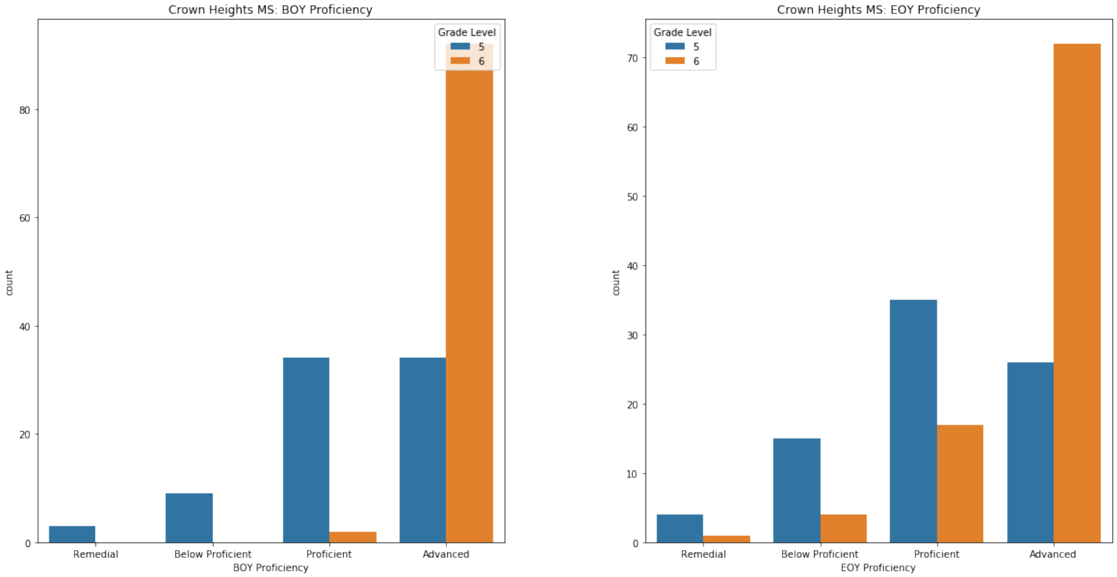
```
In [635]: bush.groupby('Grade Level')['EOY Proficiency'].value_counts()
```

```
Out[635]: Grade Level  EOY Proficiency
          5            Proficient          39
                       Below Proficient    24
                       Remedial            18
                       Advanced            16
          6            Advanced            65
                       Proficient          26
                       Below Proficient    12
                       Remedial             2
          Name: EOY Proficiency, dtype: int64
```

4.0.3 Crown Heights Proficiency Analysis

```
In [636]: # countplot of Crown Heights MS 'BOY Proficiency' with repsect to 'Grade Level'

          # Crown Heights Middle School

          # BOY Proficieny  -   Remedial:     Below Proficient:   Proficient:    Advanced:
          # 5th Graders:        3/80 - 3%     9/80 - 11%          34/80 - 43%    34/80 - 43%
          # 6th Graders:        0/94 - 0%     0/94 - 0%           2/94 - 2%      92/94 - 97%

          # EOY Proficiency -  Remedial:      Below Proficient:   Proficient:    Advanced:
          # 5th Graders:       4/80 - 5%      15/80 - 19%         35/80 - 44%    26/80 - 32%
          # 6th Graders:       1/94 - 1%      4/94 - 4%           17/94 - 18%    72/94 - 76%

          # Difference -      Remedial:     Below Proficient:   Proficient:    Advanced:
          # 5th Graders:       -2%           +8%                 +1%            -11%
          # 6th Graders:       +1%           +4%                 +12%           -21%

          # NOTE: replacement of null values may have affected these results.
```

```
In [637]: crown = data.loc[data['School Name']=='Crown Heights Middle School',:]

          plt.figure(figsize=(20,10))
          plt.subplot(1,2,1)
          plt.title('Crown Heights MS: BOY Proficiency')
          sns.countplot(x='BOY Proficiency', hue='Grade Level',
                      order=['Remedial','Below Proficient', 'Proficient', 'Advanced'],
                      data=crown)

          plt.subplot(1,2,2)
          plt.title('Crown Heights MS: EOY Proficiency')
          sns.countplot(x='EOY Proficiency', hue='Grade Level',
                      order=['Remedial','Below Proficient', 'Proficient', 'Advanced'],
                      data=crown)

          plt.subplots_adjust(wspace = 0.3, hspace = 0.3);
```



```
In [638]: crown.groupby('Grade Level')['BOY Proficiency'].value_counts()

Out[638]: Grade Level  BOY Proficiency
          5            Advanced            34
                       Proficient          34
                       Below Proficient     9
                       Remedial             3
          6            Advanced            92
                       Proficient           2
          Name: BOY Proficiency, dtype: int64

In [639]: crown.groupby('Grade Level')['EOY Proficiency'].value_counts()

Out[639]: Grade Level  EOY Proficiency
          5            Proficient          35
                       Advanced            26
                       Below Proficient    15
                       Remedial             4
          6            Advanced            72
```

```
                       Proficient          17
                       Below Proficient     4
                       Remedial             1
          Name: EOY Proficiency, dtype: int64
```

```
In [640]: data.head()
```

```
Out[640]:    Student ID                  School Name  Grade Level  BOY F&P Score  \
          0    10000001       Bushwick Middle School            5           11.0
          1    10000002       Bushwick Middle School            5           11.0
          2    10000003  Crown Heights Middle School            5           11.0
          3    10000004       Bushwick Middle School            5           11.0
          4    10000005       Bushwick Middle School            5           11.0

             EOY F&P Score   BOY Proficiency EOY Proficiency
          0           16.0  Below Proficient        Advanced
          1           16.0  Below Proficient        Advanced
          2           16.0  Below Proficient        Advanced
          3           16.0  Below Proficient        Advanced
          4           14.0  Below Proficient      Proficient
```

```
In [ ]:
```