AttributeGraphsAndExtraKNNStuff

December 17, 2020

```
In [1]: import pandas as pd # Pandas library
        import numpy as np # Numpy library
        import matplotlib.pyplot as plt # Matplotlib library
        import numpy.linalg as la # Linear algebra functions
        import math # Math library
        import random # Random library
        import seaborn as sns # Seaborn library
```

```
In [3]: crime_data = pd.read_csv('./SanFranciscoCrimeDataset/crime.csv',
                                 header=1,
                                 skipinitialspace=False,
                                 names=['IncidntNum', 'Category', 'Descript', 'DayOfWeek', 'Da
                                       'PdDistrict', 'Resolution', 'Address', 'X', 'Y', 'Loca
        crime_data = crime_data[ ~crime_data['PdDistrict'].isna() ]
        crime_data.head()
```

```
Out[3]:    IncidntNum      Category                                   Descript  \
        0   120058272   WEAPON LAWS  FIREARM, LOADED, IN VEHICLE, POSSESSION OR USE
        1   141059263      WARRANTS                              WARRANT ARREST
        2   160013662  NON-CRIMINAL                               LOST PROPERTY
        3   160002740  NON-CRIMINAL                               LOST PROPERTY
        4   160002869       ASSAULT                                     BATTERY

          DayOfWeek                     Date   Time  PdDistrict      Resolution  \
        0    Friday  01/29/2016 12:00:00 AM  11:00    SOUTHERN  ARREST, BOOKED
        1    Monday  04/25/2016 12:00:00 AM  14:59     BAYVIEW  ARREST, BOOKED
        2   Tuesday  01/05/2016 12:00:00 AM  23:50  TENDERLOIN            NONE
        3    Friday  01/01/2016 12:00:00 AM  00:30     MISSION            NONE
        4    Friday  01/01/2016 12:00:00 AM  21:35    NORTHERN            NONE

                          Address           X          Y  \
        0  800 Block of BRYANT ST -122.403405  37.775421
        1   KEITH ST / SHAFTER AV -122.388856  37.729981
        2  JONES ST / OFARRELL ST -122.412971  37.785788
        3    16TH ST / MISSION ST -122.419672  37.765050
        4   1700 Block of BUSH ST -122.426077  37.788019
```

```
                              Location            PdId
0   (37.775420706711, -122.403404791479)  12005827212168
1  (37.7299809672996, -122.388856204292)  14105926363010
2  (37.7857883766888, -122.412970537591)  16001366271000
3  (37.7650501214668, -122.419671780296)  16000274071000
4   (37.788018555829, -122.426077177375)  16000286904134
```

1 Testing Training Difference for KNN Over Time

```
In [54]: # KNN Class
         class KNN:
             def __init__(self, k):
                 self.k = k
                 self.trainarr = []
                 self.classifier_list = []
                 self.predicted_points = []

             def distance(self, point):
                 """
                 Finds the distance of every training set value from point, and then returns th
                 by distance values paired with the corresponding "classifier"
                 """
         #         distance_pairs_list = [(0,0) for _ in range(len(self.trainarr))]
         #         for ind,i in enumerate(self.trainarr):
         #             distance_pairs_list[ind] = (la.norm(np.array(point) - np.array(i[0])), i
                 distance_pairs_list = [(la.norm(np.array(point) - np.array(i[0])), i[1]) for i
                 distance_pairs_list.sort(key= lambda x: x[0])
                 return distance_pairs_list

             def train(self, tlist):
                 """
                 Takes a list of training data => tuple containing a samples X ndims list and
                 that will be stored for later
                 """
                 self.trainarr = tlist[:]
                 self.classifier_list = list(set([i[1] for i in self.trainarr]))

             def predict(self, point, graphing=False):
                 """
                 Point must be a list, same dimension as the training set
                 graphing is default False (for efficiency), otherwise True adds point to list
                 """
                 classifier_counts = {i[1]: 0 for i in self.trainarr}
                 distance_list = self.distance(point)
                 key_select = ''
                 for index,item in enumerate(distance_list):
                     if index < self.k:
```

```
                classifier_counts[item[1]] += 1
            else:
                #max_dict_val = max([value for key,value in classifier_counts.items()
                max_dict_val = max(classifier_counts.values())
                #max_dict_val = max(classifier_counts, key=classifier_counts.get)
                if list(classifier_counts.values()).count(max_dict_val) > 1:
                    classifier_counts[item[1]] += 1
                else:
                    for key, value in classifier_counts.items():
                        if value == max_dict_val:
                            key_select = key
                            break
                    break
        #print(f'I am predicting that the classifier for point {point} is... {key_sel
        if graphing:
            self.predicted_points.append((point, key_select))
        return key_select

    def plot_train(self):
        """
        Can only plot for 2d data
        """
        colors = ['Green', 'Red', 'Blue', 'Black', 'Yellow', 'Pink', 'Brown', 'Purple
        for ind, item in enumerate(self.classifier_list):
            plotx = [j[0][0] for j in self.trainarr if j[1] == item]
            ploty = [j[0][1] for j in self.trainarr if j[1] == item]
            plt.scatter(x=plotx, y=ploty, c=colors[ind], label=item)
        plt.title('Plot of sample training data')
        plt.legend()
        plt.xlabel('X axis')
        plt.ylabel('Y axis')
        plt.show()

    def plot_train_and_predictions(self):
        """
        Can only plot for 2d data, plots the point that was predicted
        """
        colors = ['Green', 'Red', 'Blue', 'Black', 'Yellow', 'Pink', 'Brown', 'Purple
        for ind, item in enumerate(self.classifier_list):
            plotxtrain = [j[0][0] for j in self.trainarr if j[1] == item]
            plotytrain = [j[0][1] for j in self.trainarr if j[1] == item]
            plotxpredict = [j[0][0] for j in self.predicted_points if j[1] == item]
            plotypredict = [j[0][1] for j in self.predicted_points if j[1] == item]
            plt.scatter(x=plotxtrain, y=plotytrain, c=colors[ind], label=f'Trained: {
            plt.scatter(x=plotxpredict, y=plotypredict, c=colors[ind], label=f'Predic
        plt.title(f'Plot of sample training data and predicted points (k = {self.k})'
        plt.legend()
        plt.xlabel('X axis')
```

```
                 plt.ylabel('Y axis')
                 plt.show()
```

```
In [55]: # split_sets Function
         def split_sets(dataframe, train_p):
             """
             Returns 2 lists of the form needed to use the KNN class using the San Francisco C
             -- The function uses x and y coordinate data for graphing and the type of crime a
             **The dataframe passed can be subset to go by location to see how KNN works on ea
             """
             assert(train_p < 1) # Make sure that p is a percentage
             assert(train_p > 0) # Make sure that p is non-negative

             # Split dataframe into training and test/prediction sets
             train_count = int(dataframe.shape[0] * train_p)
             predict_count = int(dataframe.shape[0] * (1 - train_p))

             #tmp_list = dataframe.values

             tmp_list = dataframe.values[:]
             np.random.shuffle(tmp_list) # Shuffle the rows
             train_list = tmp_list[0:train_count] # Take the first train_p percentage for the
             predict_list = tmp_list[train_count:] # The rest go to predict data

             rtn_train = [([i[1], i[2]], i[0]) for i in train_list]
             rtn_predict = [([i[1], i[2]], i[0]) for i in predict_list]



             #train_list = [ dataframe.values[random.randint(0,train_count-1)][0:4] for i in r
             #predict_list = [ dataframe.values[random.randint(0,train_count-1)][0:4] for i in
         #     train_list = [(0,0) for _ in range(train_count)]
         #     for i in range(0, train_count):
         #         rand_row = train_list[random.randint(0, len(train_list) - 1)]
         #         train_list[i] = ([rand_row[1], rand_row[2]], rand_row[0])


         #     predict_list = [(0,0) for _ in range(predict_count)]
         #     for i in range(0, predict_count):
         #         rand_row = predict_list[random.randint(0, len(predict_list) - 1)]
         #         predict_list[i] = ([rand_row[0], rand_row[1]], rand_row[2])

             # Some test runs
             #print(rtn_train)
             #print(rtn_predict)
             #print(len(dataframe))
             #print(len(train_list), len(predict_list))
             return rtn_train, rtn_predict
```

In [59]:

```
subset_crime = crime_data[['Category', 'X', 'Y']]
train1, predict1 = split_sets(subset_crime, .1)
test1 = KNN(11)
test1.train(train1)
subset_predict = predict1[:200]
# Creates a list of tuples, (what the algorithm guessed, what is correct)
sub_cf_1 = [(test1.predict(tupl[0]), tupl[1]) for tupl in subset_predict]
```

In [60]:

```
# INITIALIZE CURVE HERE
learning_curve = []

# Append to the learning curve
summed = 0
for tupl in sub_cf_1:
    if tupl[0] == tupl[1]:
        summed += 1
learning_curve.append(summed / crime_data.shape[0])
```

In [62]:

```
train2, predict2 = split_sets(subset_crime, .2)
test2 = KNN(11)
test2.train(train2)
subset_predict = predict2[:200]
# Creates a list of tuples, (what the algorithm guessed, what is correct)
sub_cf_2 = [(test2.predict(tupl[0]), tupl[1]) for tupl in subset_predict]
```

In [63]:

```
# Append to the learning curve
summed = 0
for tupl in sub_cf_2:
    if tupl[0] == tupl[1]:
        summed += 1
learning_curve.append(summed / crime_data.shape[0])
```

In [64]:

```
train3, predict3 = split_sets(subset_crime, .3)
test3 = KNN(11)
test3.train(train3)
subset_predict = predict3[:200]
# Creates a list of tuples, (what the algorithm guessed, what is correct)
sub_cf_3 = [(test3.predict(tupl[0]), tupl[1]) for tupl in subset_predict]
```

In [65]:

```
# Append to the learning curve
summed = 0
for tupl in sub_cf_3:
    if tupl[0] == tupl[1]:
        summed += 1
learning_curve.append(summed / crime_data.shape[0])
```

In [66]:

```
train4, predict4 = split_sets(subset_crime, .4)
test4 = KNN(11)
test4.train(train4)
```

```
         subset_predict = predict4[:200]
         # Creates a list of tuples, (what the algorithm guessed, what is correct)
         sub_cf_4 = [(test4.predict(tupl[0]), tupl[1]) for tupl in subset_predict]
```

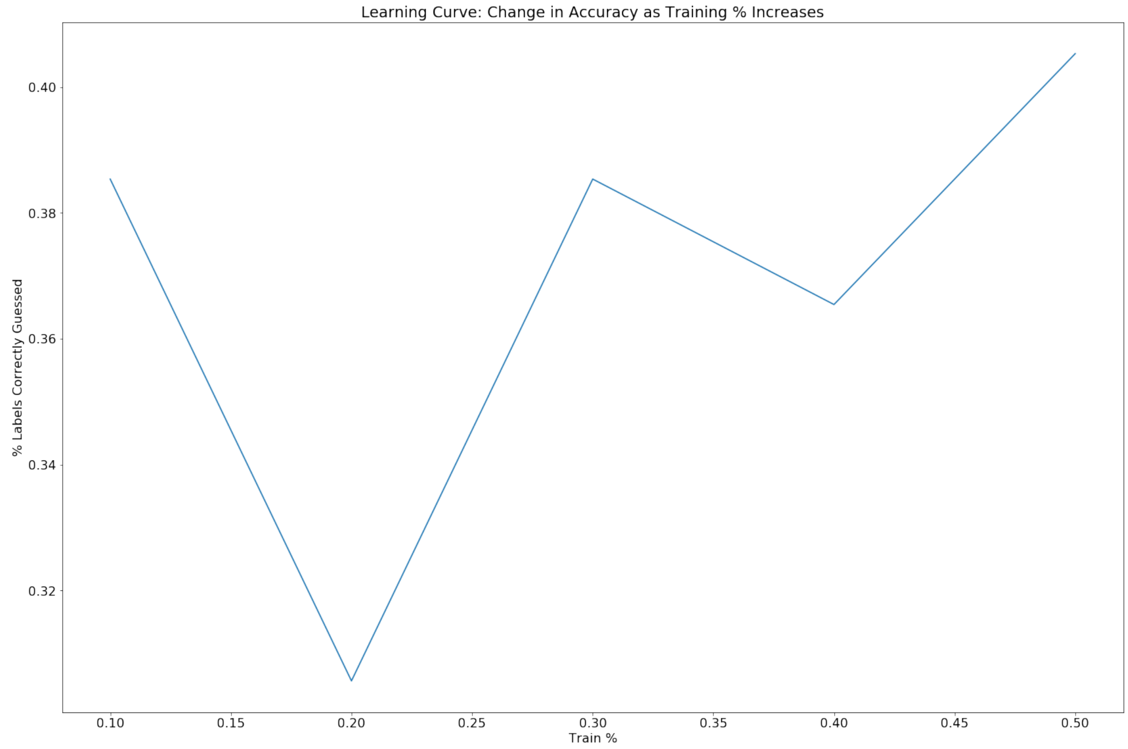
```
In [67]: # Append to the learning curve
         summed = 0
         for tupl in sub_cf_4:
             if tupl[0] == tupl[1]:
                 summed += 1
         learning_curve.append(summed / crime_data.shape[0])
```

```
In [68]: train5, predict5 = split_sets(subset_crime, .5)
         test5 = KNN(11)
         test5.train(train5)
         subset_predict = predict5[:200]
         # Creates a list of tuples, (what the algorithm guessed, what is correct)
         sub_cf_5 = [(test5.predict(tupl[0]), tupl[1]) for tupl in subset_predict]
```

```
In [69]: # Append to the learning curve
         summed = 0
         for tupl in sub_cf_5:
             if tupl[0] == tupl[1]:
                 summed += 1
         learning_curve.append(summed / crime_data.shape[0])
```

```
In [79]: # Print the learning curve
         print([i*100 for i in learning_curve])
         plt.plot([i for i in np.arange(.1, .6, .1)], [i*1000 for i in learning_curve])
         plt.title('Learning Curve: Change in Accuracy as Training % Increases')
         plt.xlabel('Train %')
         plt.ylabel('% Labels Correctly Guessed')
         plt.show()
```

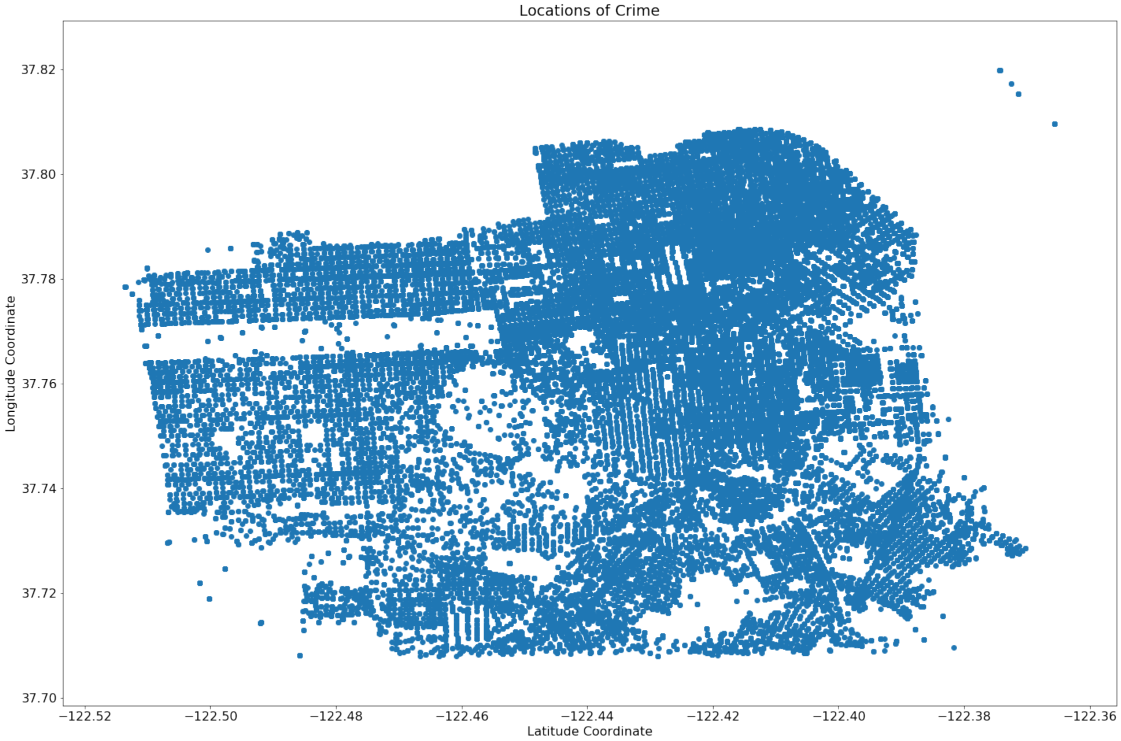
```
[0.03853871812249997, 0.030565190235086182, 0.03853871812249997, 0.03654533615064652, 0.040532
```



2 Graphs for Attributes

2.1 Scatter Plot of X and Y Coordinates

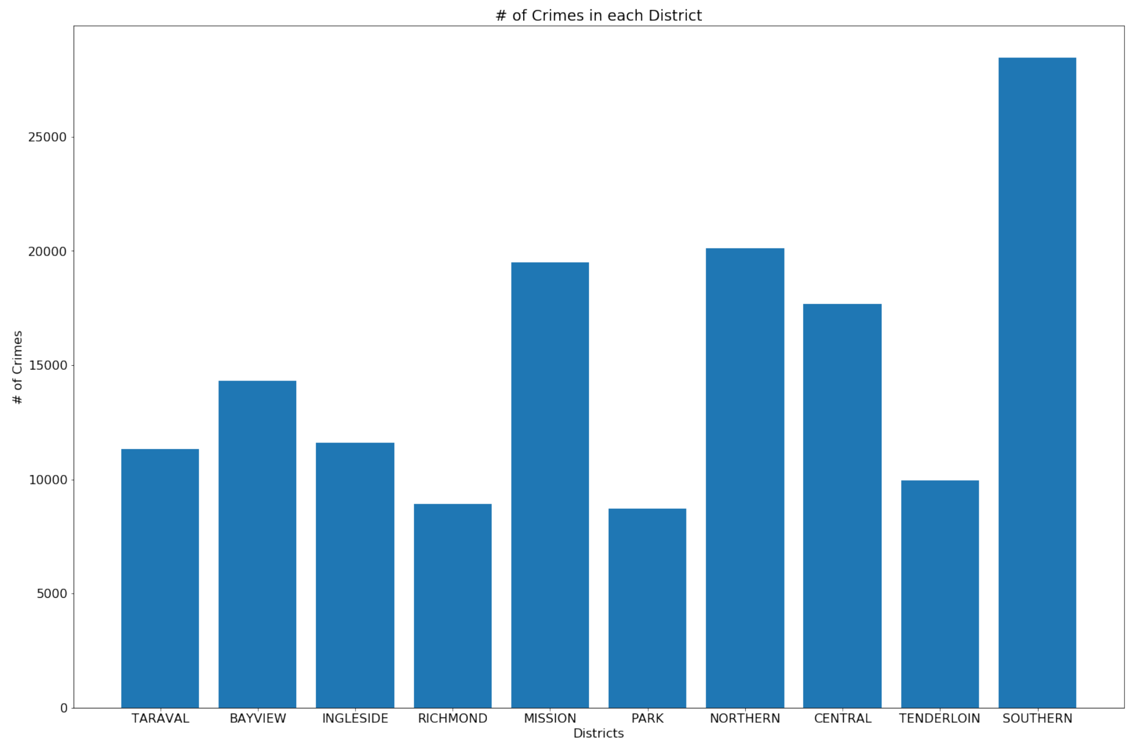
```
In [21]: xy = crime_data[['X', 'Y']].values
         plt.rcParams['figure.figsize'] = (24, 16)
         plt.rcParams['font.size'] = 16
         plt.scatter(x=[i[0] for i in xy], y=[i[1] for i in xy])
         plt.title('Locations of Crime')
         plt.xlabel('Latitude Coordinate')
         plt.ylabel('Longitude Coordinate')
         plt.show()
```



2.2 Bar Graph of Number of Crimes in Each District

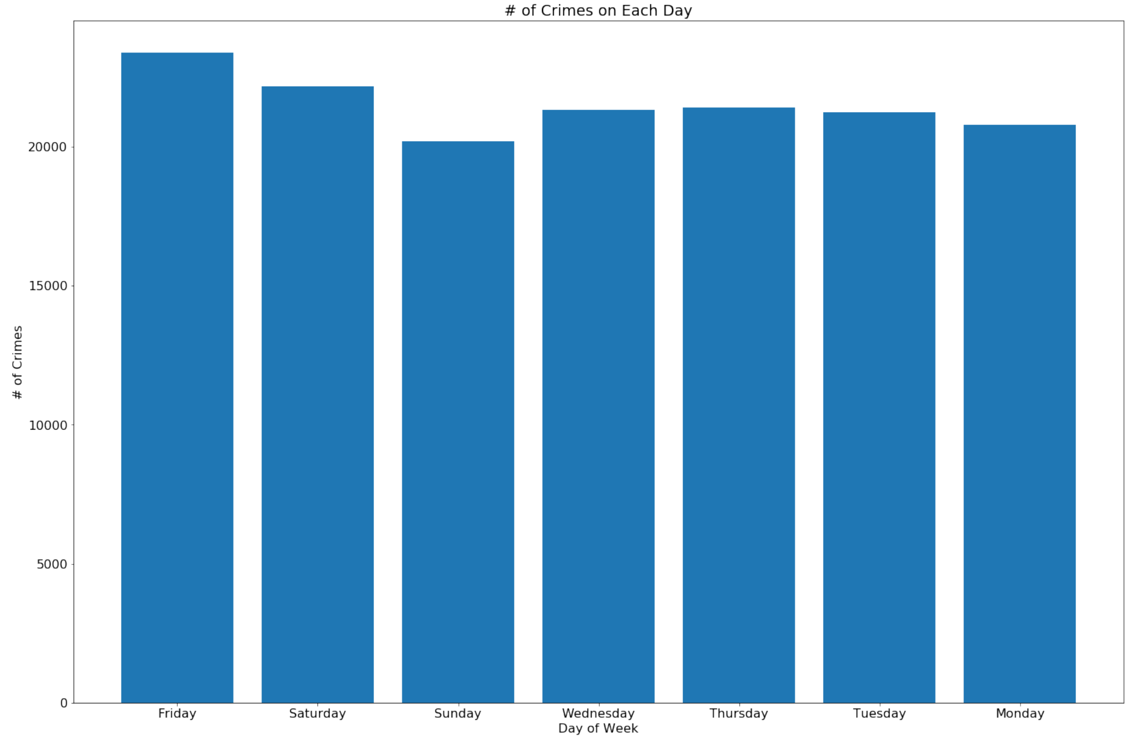
```
In [19]: parse_districts = list(set([i[0] for i in crime_data[['PdDistrict']].values]))
         crime_count = {i: 0 for i in parse_districts}
         for element in crime_data[['PdDistrict']].values:
             crime_count[element[0]] += 1

         x = [i for i in crime_count.keys()]
         height = [i for i in crime_count.values()]
         plt.bar(x, height)
         plt.title('# of Crimes in each District')
         plt.xlabel('Districts')
         plt.ylabel('# of Crimes')
         plt.show()
```



```
In [52]: parse_days = list(set([i[0] for i in crime_data[['DayOfWeek']].values]))
         day_crime_count = {day: 0 for day in parse_days}
         for element in crime_data[['DayOfWeek']].values:
             day_crime_count[element[0]] += 1

         x = [i for i in day_crime_count.keys()]
         height = [i for i in day_crime_count.values()]
         plt.bar(x, height)
         plt.title('# of Crimes on Each Day')
         plt.xlabel('Day of Week')
         plt.ylabel('# of Crimes')
         plt.show()
```



2.3 Description of Attributes

There are only so many meaningful labels within the dataset. The graphs that you see above are a scatter plot of the x and y coordinates and a bar plot of the number of crimes per district in San Francisco. These are some of the only meaningful attributes to plot because when you look at attributes such as the date, incident number, and pdid, these are unique values that make sense to graph. These points are data that are numerical values that have no true numerical meaning in the context of a graph. As for the remaining attributes like some of the description and day of the week categories, this data is nominal making nothing more than a bar graph or table available to graph.