ANALYZING POLICE ACTIVITY WITH PANDAS

Exploring the weather dataset

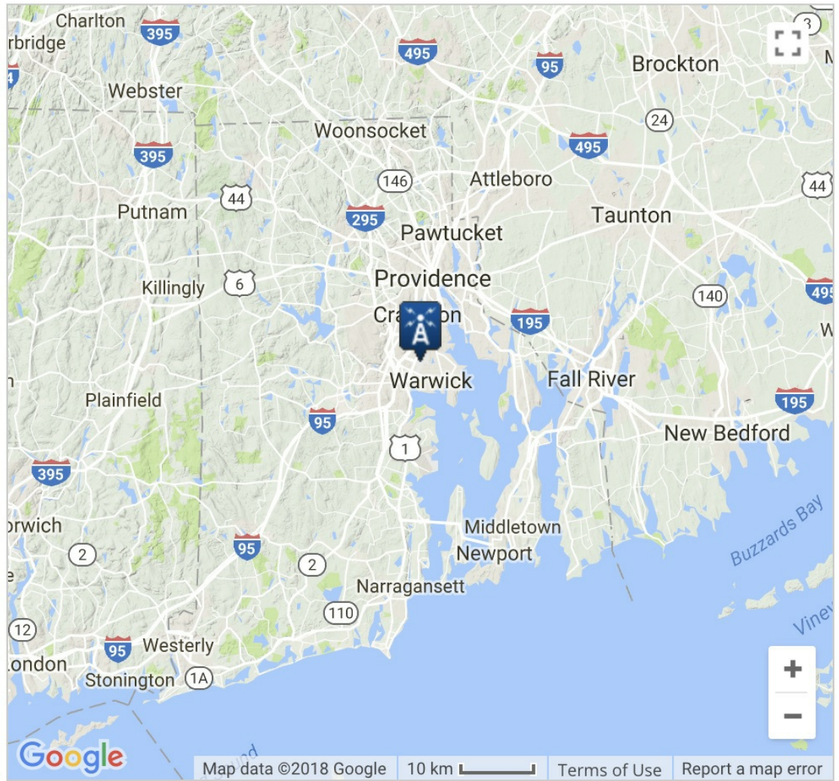
Kevin Markham
Founder, Data School

Introduction to the dataset

NOAA NATIONAL CENTERS FOR ENVIRONMENTAL INFORMATION
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

STATION DETAILS	
Name	PROVIDENCE, RI US
Network:ID	GHCND:USW00014765
Latitude/Longitude	41.7225°, -71.4325°
Elevation	16.8 m

PERIOD OF RECORD	
Start Date[1]	1942-08-01
End Date[1]	2018-04-21
Data Coverage[2]	93%



Examining the columns

```
weather = pd.read_csv('weather.csv')

weather.head()
```

```
       STATION        DATE  TAVG  TMIN  TMAX  AWND  WSF2  WT01  WT02  WT03
0  USW00014765  2005-01-01  44.0    35    53  8.95  25.1   1.0   NaN   NaN
1  USW00014765  2005-01-02  36.0    28    44  9.40  14.1   NaN   NaN   NaN
2  USW00014765  2005-01-03  49.0    44    53  6.93  17.0   1.0   NaN   NaN
3  USW00014765  2005-01-04  42.0    39    45  6.93  16.1   1.0   NaN   NaN
4  USW00014765  2005-01-05  36.0    28    43  7.83  17.0   1.0   NaN   NaN

   ...   WT11  WT13  WT14  WT15  WT16  WT17  WT18  WT19  WT21  WT22
0  ...    NaN   1.0   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN
1  ...    NaN   NaN   NaN   NaN   1.0   NaN   1.0   NaN   NaN   NaN
2  ...    NaN   1.0   NaN   NaN   1.0   NaN   NaN   NaN   NaN   NaN
3  ...    NaN   1.0   1.0   NaN   1.0   NaN   NaN   NaN   NaN   NaN
4  ...    NaN   1.0   NaN   NaN   1.0   NaN   1.0   NaN   NaN   NaN
```

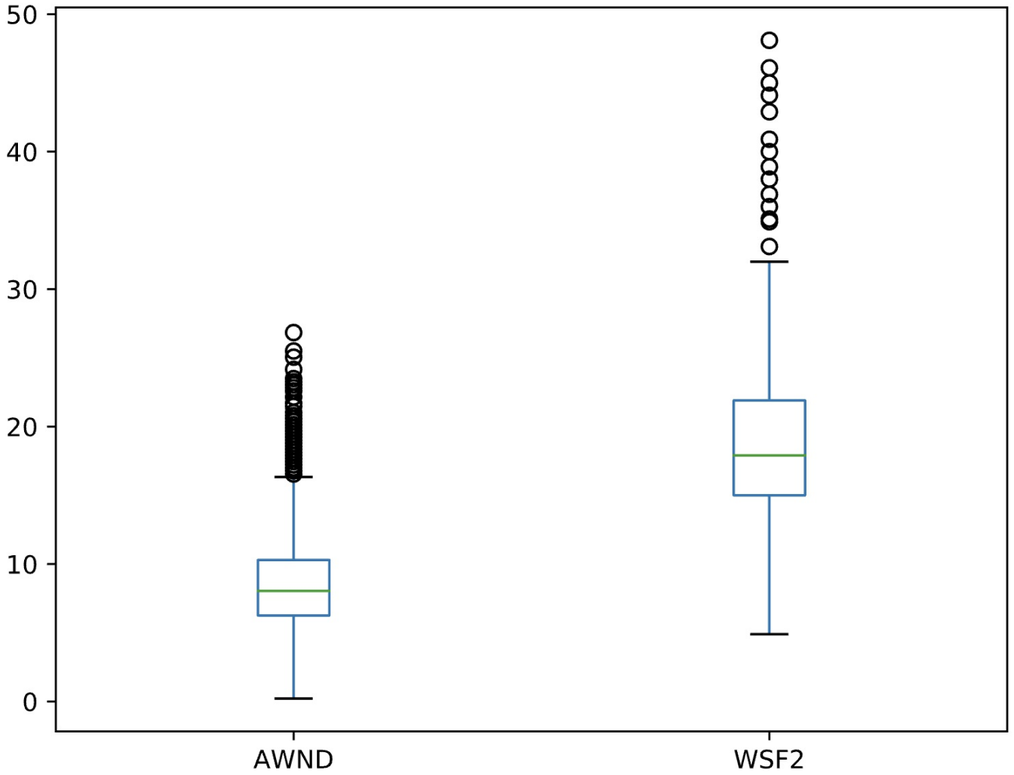
- TAVG, TMIN, TMAX: Temperature
- AWND, WSF2: Wind speed
- WT01 ... WT22: Bad weather conditions

Examining wind speed

```
weather[['AWND', 'WSF2']].head()

   AWND  WSF2
0  8.95  25.1
1  9.40  14.1
2  6.93  17.0
3  6.93  16.1
4  7.83  17.0

weather[['AWND', 'WSF2']].describe()

              AWND         WSF2
count  4017.000000  4017.000000
mean      8.593707    19.274782
std       3.364601     5.623866
min       0.220000     4.900000
25%       6.260000    15.000000
50%       8.050000    17.900000
75%      10.290000    21.900000
max      26.840000    48.100000
```

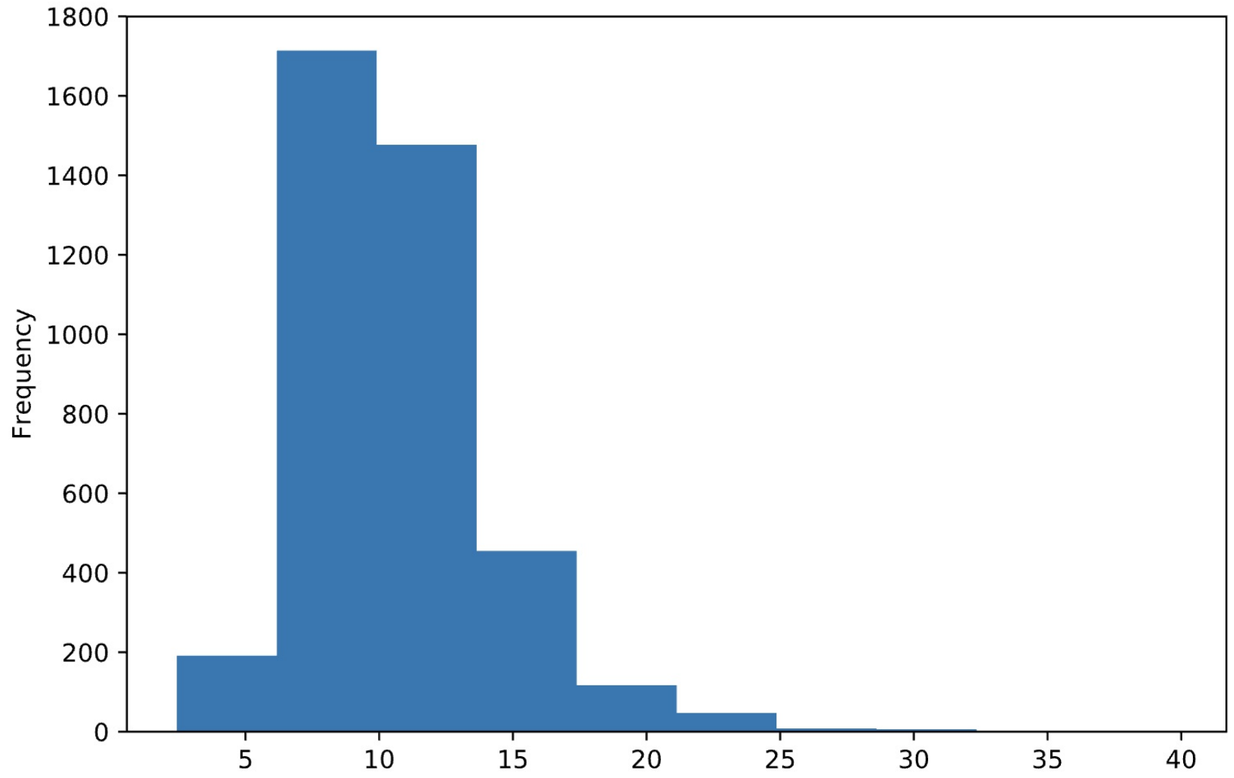
Creating a box plot

```
weather[['AWND', 'WSF2']].plot(kind='box')
plt.show()
```



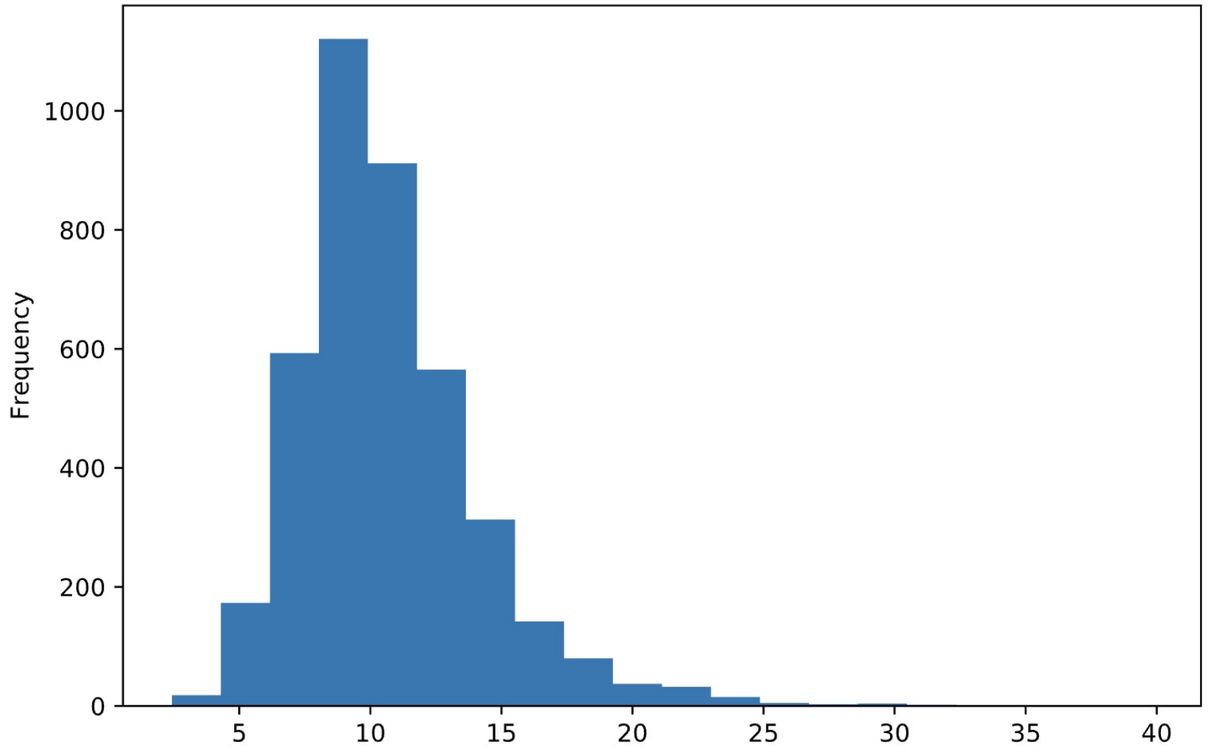
Creating a histogram (1)

```
weather['WDIFF'] = weather.WSF2 - weather.AWND

weather.WDIFF.plot(kind='hist')
plt.show()
```



Creating a histogram (2)

```
weather.WDIFF.plot(kind='hist', bins=20)
plt.show()
```



ANALYZING POLICE ACTIVITY WITH PANDAS

Let's practice!

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Categorizing the weather

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Founder, Data School

Selecting a DataFrame slice

```
weather.shape
(4017, 28)

weather.columns
Index(['STATION', 'DATE', 'TAVG', 'TMIN', 'TMAX', 'AWND', 'WSF2', 'WT01',
       'WT02', 'WT03', 'WT04', 'WT05', 'WT06', 'WT07', 'WT08', 'WT09',
       'WT10', 'WT11', 'WT13', 'WT14', 'WT15', 'WT16', 'WT17', 'WT18',
       'WT19', 'WT21', 'WT22', 'TDIFF'],
      dtype='object')

temp = weather.loc[:, 'TAVG':'TMAX']

temp.shape
(4017, 3)

temp.columns
Index(['TAVG', 'TMIN', 'TMAX'], dtype='object')
```

DataFrame operations

```
temp.head()

   TAVG  TMIN  TMAX
0  44.0    35    53
1  36.0    28    44
2  49.0    44    53
3  42.0    39    45
4  36.0    28    43

temp.sum()

TAVG     63884.0
TMIN    174677.0
TMAX    246116.0
dtype: float64

temp.sum(axis='columns').head()

0    132.0
1    108.0
2    146.0
3    126.0
4    107.0
dtype: float64
```

Mapping one set of values to another

```
ri.stop_duration.unique()
array(['0-15 Min', '16-30 Min', '30+ Min'], dtype=object)

mapping = {'0-15 Min':'short', '16-30 Min':'medium', '30+ Min':'long'}

ri['stop_length'] = ri.stop_duration.map(mapping)

ri.stop_length.dtype
dtype('O')
```

Changing data type from object to category

```
ri.stop_length.unique()
array(['short', 'medium', 'long'], dtype=object)
```

- Category type stores the data more efficiently
- Allows you to specify a logical order for the categories

```
ri.stop_length.memory_usage(deep=True)
8689481

cats = ['short', 'medium', 'long']

ri['stop_length'] = ri.stop_length.astype('category', ordered=True,
                                          categories=cats)

ri.stop_length.memory_usage(deep=True)
3400602
```

Using ordered categories

```
ri.stop_length.head()

stop_datetime
2005-01-04 12:55:00     short
2005-01-23 23:15:00     short
2005-02-17 04:15:00     short
2005-02-20 17:15:00    medium
2005-02-24 01:20:00     short
Name: stop_length, dtype: category
Categories (3, object): [short < medium < long]

ri[ri.stop_length > 'short'].shape
(16959, 16)

ri.groupby('stop_length').is_arrested.mean()

stop_length
short     0.013654
medium    0.093595
long      0.261572
Name: is_arrested, dtype: float64
```

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Merging datasets

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Preparing the first DataFrame

```
apple

                        date   time   price
date_and_time
2018-02-14 09:30:00  2/14/18   9:30  163.04
2018-02-14 16:00:00  2/14/18  16:00  167.37
2018-02-15 09:30:00  2/15/18   9:30  169.79
2018-02-15 16:00:00  2/15/18  16:00  172.99

apple.reset_index(inplace=True)

apple

        date_and_time     date   time   price
0 2018-02-14 09:30:00  2/14/18   9:30  163.04
1 2018-02-14 16:00:00  2/14/18  16:00  167.37
2 2018-02-15 09:30:00  2/15/18   9:30  169.79
3 2018-02-15 16:00:00  2/15/18  16:00  172.99
```

Preparing the second DataFrame

```
high_low

      DATE    HIGH     LOW
0  2/14/18  167.54  162.88
1  2/15/18  173.09  169.00
2  2/16/18  174.82  171.77

high = high_low[['DATE', 'HIGH']]

high

      DATE    HIGH
0  2/14/18  167.54
1  2/15/18  173.09
2  2/16/18  174.82
```

Merging the DataFrames

```
apple_high = pd.merge(left=apple, right=high, left_on='date',
                      right_on='DATE', how='left')
```

- left=apple: Left DataFrame
- right=high: Right DataFrame
- left_on='date': Key column in left DataFrame
- right_on='DATE': Key column in right DataFrame
- how='left': Type of join

Comparing the DataFrames

```
apple_high

        date_and_time     date   time   price     DATE    HIGH
0 2018-02-14 09:30:00  2/14/18   9:30  163.04  2/14/18  167.54
1 2018-02-14 16:00:00  2/14/18  16:00  167.37  2/14/18  167.54
2 2018-02-15 09:30:00  2/15/18   9:30  169.79  2/15/18  173.09
3 2018-02-15 16:00:00  2/15/18  16:00  172.99  2/15/18  173.09

apple

        date_and_time     date   time   price
0 2018-02-14 09:30:00  2/14/18   9:30  163.04
1 2018-02-14 16:00:00  2/14/18  16:00  167.37
2 2018-02-15 09:30:00  2/15/18   9:30  169.79
3 2018-02-15 16:00:00  2/15/18  16:00  172.99

high

      DATE    HIGH
0  2/14/18  167.54
1  2/15/18  173.09
2  2/16/18  174.82
```

Setting the index

```
apple_high.set_index('date_and_time', inplace=True)

apple_high

                        date   time   price     DATE    HIGH
date_and_time
2018-02-14 09:30:00  2/14/18   9:30  163.04  2/14/18  167.54
2018-02-14 16:00:00  2/14/18  16:00  167.37  2/14/18  167.54
2018-02-15 09:30:00  2/15/18   9:30  169.79  2/15/18  173.09
2018-02-15 16:00:00  2/15/18  16:00  172.99  2/15/18  173.09
```

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Does weather affect the arrest rate?

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Founder, Data School

Driver gender and vehicle searches

```
ri.search_conducted.mean()
0.0382153092354627

ri.groupby('driver_gender').search_conducted.mean()

driver_gender
F    0.019181
M    0.045426

ri.groupby(['violation', 'driver_gender']).search_conducted.mean()

violation            driver_gender
Equipment            F                0.039984
                     M                0.071496
Moving violation     F                0.039257
                     M                0.061524
Other                F                0.041018
                     M                0.046191
Registration/plates  F                0.054924
                     M                0.108802
Seat belt            F                0.017301
                     M                0.035119
Speeding             F                0.008309
                     M                0.027885
```

Examining a multi-indexed Series

```
search_rate = ri.groupby(['violation',
                          'driver_gender']).search_conducted.mean()

search_rate

violation            driver_gender
Equipment            F                0.039984
                     M                0.071496
Moving violation     F                0.039257
                     M                0.061524
Other                F                0.041018
                     M                0.046191
Registration/plates  F                0.054924
                     M                0.108802
Seat belt            F                0.017301
                     M                0.035119
Speeding             F                0.008309
                     M                0.027885

type(search_rate)
pandas.core.series.Series

type(search_rate.index)
pandas.core.indexes.multi.MultiIndex
```

Working with a multi-indexed Series

```
search_rate

violation            driver_gender
Equipment            F                0.039984
                     M                0.071496
Moving violation     F                0.039257
                     M                0.061524
Other                F                0.041018
                     M                0.046191
Registration/plates  F                0.054924
                     M                0.108802
Seat belt            F                0.017301
                     M                0.035119
Speeding             F                0.008309
                     M                0.027885

search_rate.loc['Equipment']

driver_gender
F    0.039984
M    0.071496

search_rate.loc['Equipment', 'M']
0.07149643705463182
```

Converting a multi-indexed Series to a DataFrame

```
search_rate.unstack()

driver_gender                F         M
violation
Equipment                0.039984  0.071496
Moving violation         0.039257  0.061524
Other                    0.041018  0.046191
Registration/plates      0.054924  0.108802
Seat belt                0.017301  0.035119
Speeding                 0.008309  0.027885

type(search_rate.unstack())
pandas.core.frame.DataFrame

ri.pivot_table(index='violation', columns='driver_gender',
               values='search_conducted')

driver_gender                F         M
violation
Equipment                0.039984  0.071496
Moving violation         0.039257  0.061524
Other                    0.041018  0.046191
Registration/plates      0.054924  0.108802
Seat belt                0.017301  0.035119
Speeding                 0.008309  0.027885
```

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Conclusion

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Stanford Open Policing Project

- Download data: https://openpolicing.stanford.edu/

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Thank you!