



ANALYZING POLICE ACTIVITY WITH PANDAS

Exploring the weather dataset

Kevin Markham

Founder, Data School



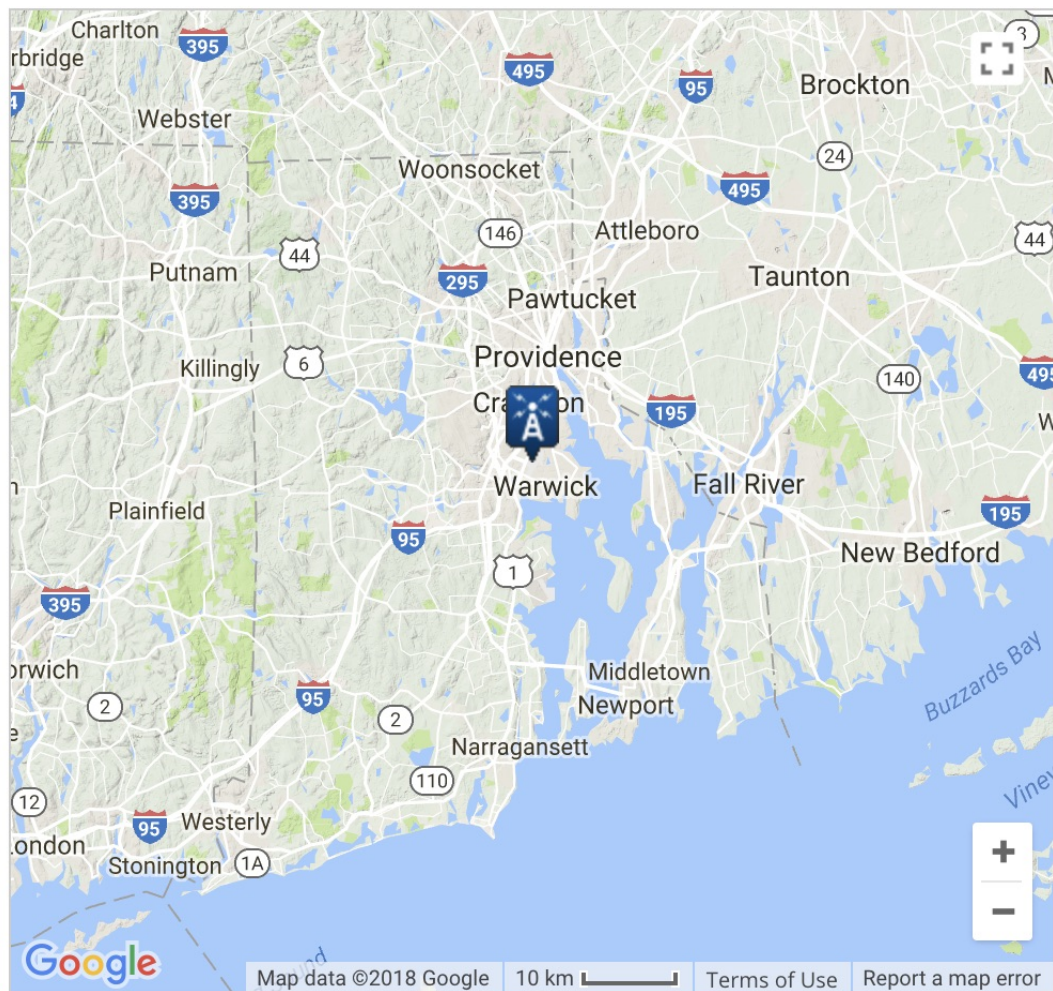
Introduction to the dataset



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

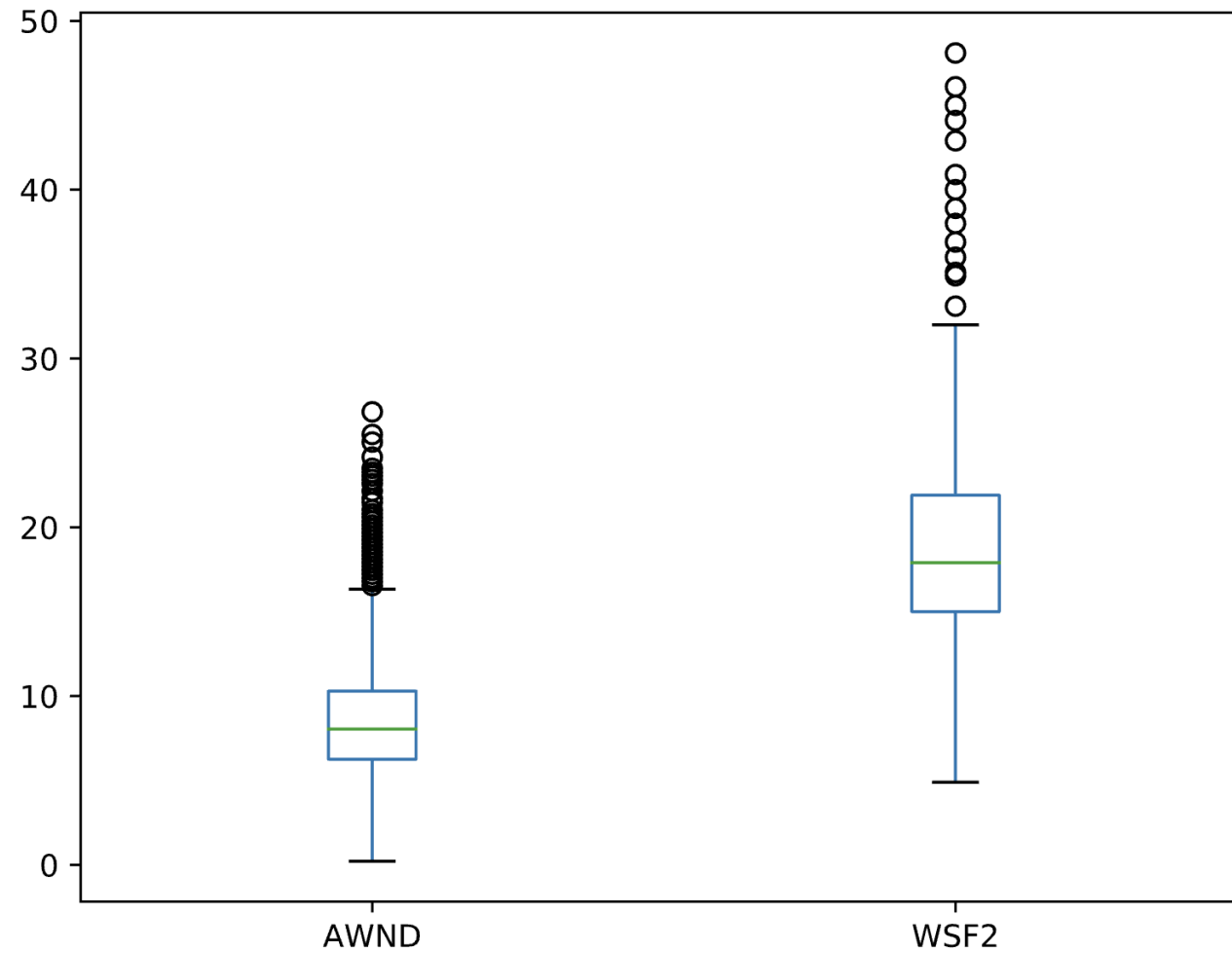
```
weather[['AWND', 'WSF2']].describe()
```

	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()
```

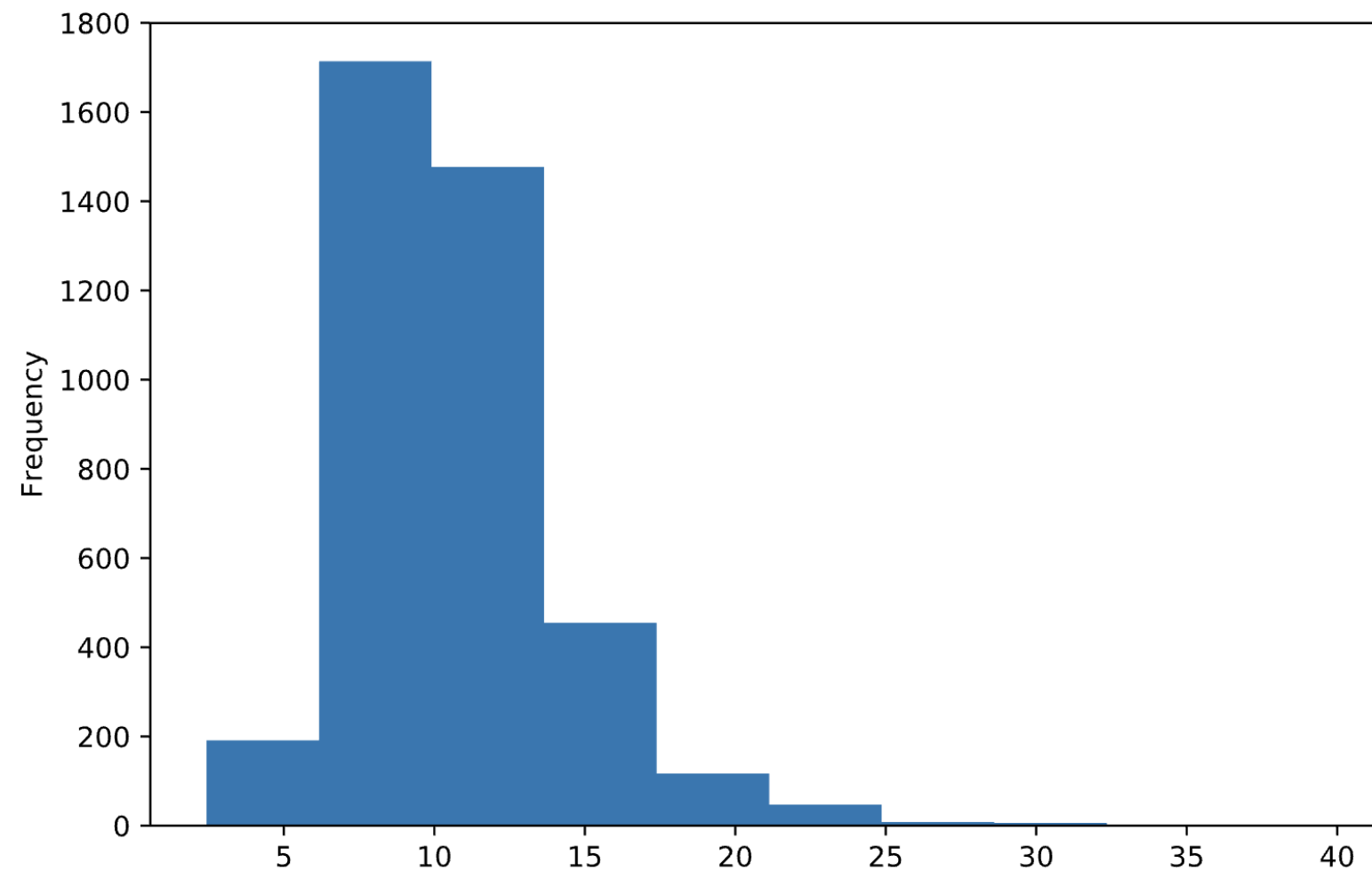




Creating a histogram (1)

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

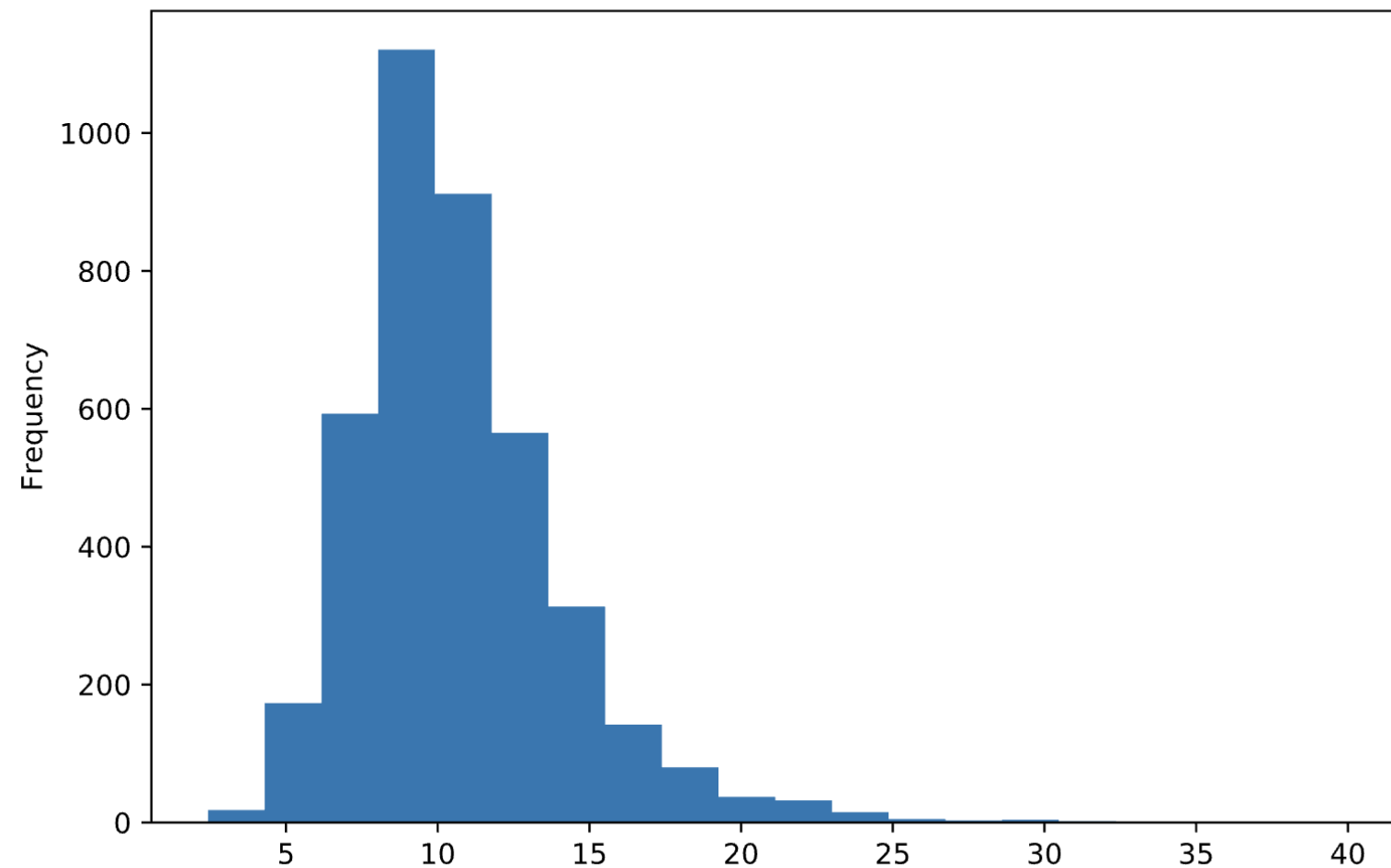
```
weather.WDIFF.plot(kind='hist')  
plt.show()
```





Creating a histogram (2)

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





ANALYZING POLICE ACTIVITY WITH PANDAS

Let's practice!



ANALYZING POLICE ACTIVITY WITH PANDAS

Categorizing the weather

Kevin Markham

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

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

0	132.0
1	108.0
2	146.0
3	126.0
4	107.0



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
```



ANALYZING POLICE ACTIVITY WITH PANDAS

Let's practice!



ANALYZING POLICE ACTIVITY WITH PANDAS

Merging datasets

Kevin Markham

Founder, Data School

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



ANALYZING POLICE ACTIVITY WITH PANDAS

Let's practice!



ANALYZING POLICE ACTIVITY WITH PANDAS

**Does weather affect the
arrest rate?**

Kevin Markham

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
...		



ANALYZING POLICE ACTIVITY WITH PANDAS

Let's practice!



ANALYZING POLICE ACTIVITY WITH PANDAS

Conclusion

Kevin Markham

Founder, Data School



Stanford Open Policing Project



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



ANALYZING POLICE ACTIVITY WITH PANDAS

Thank you!