



ANALYZING POLICE ACTIVITY WITH PANDAS

Exploring the weather dataset

Kevin Markham

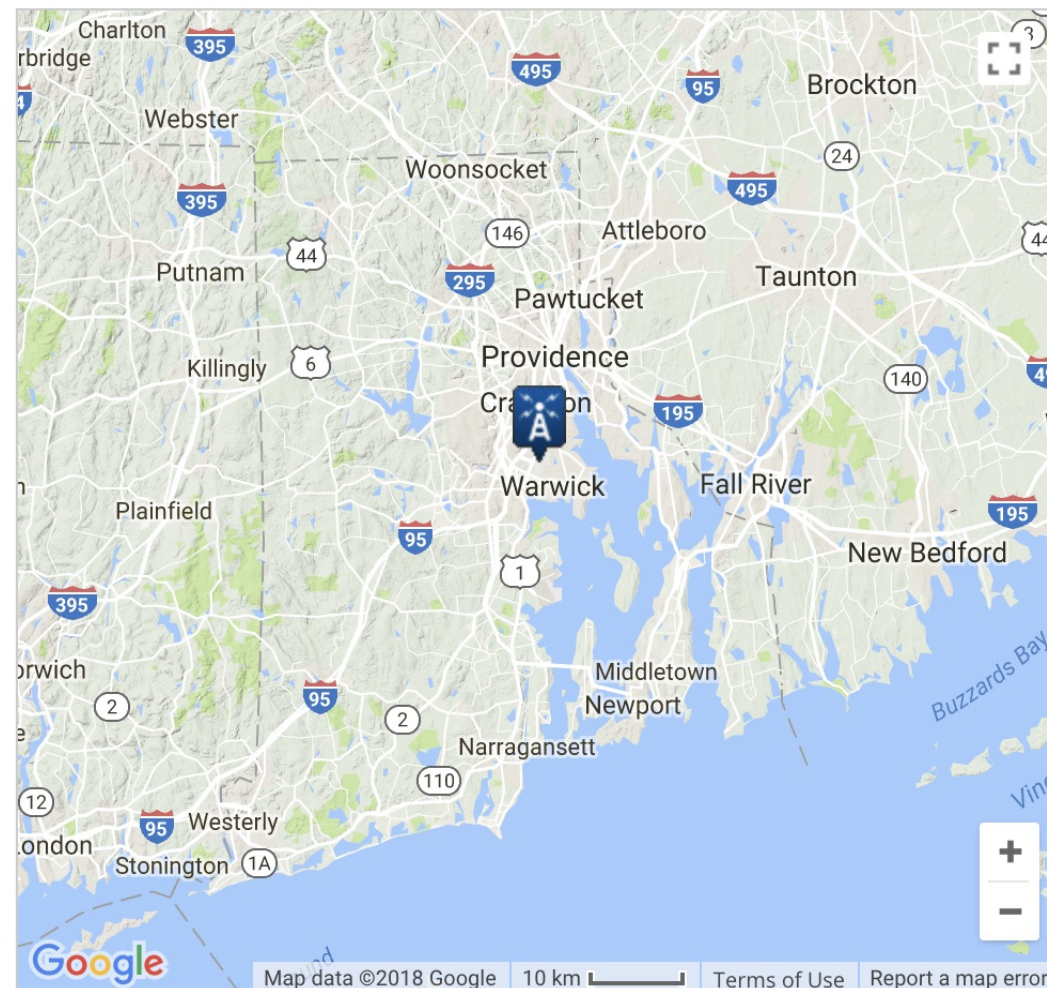
Founder, Data School

Introduction to the dataset



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

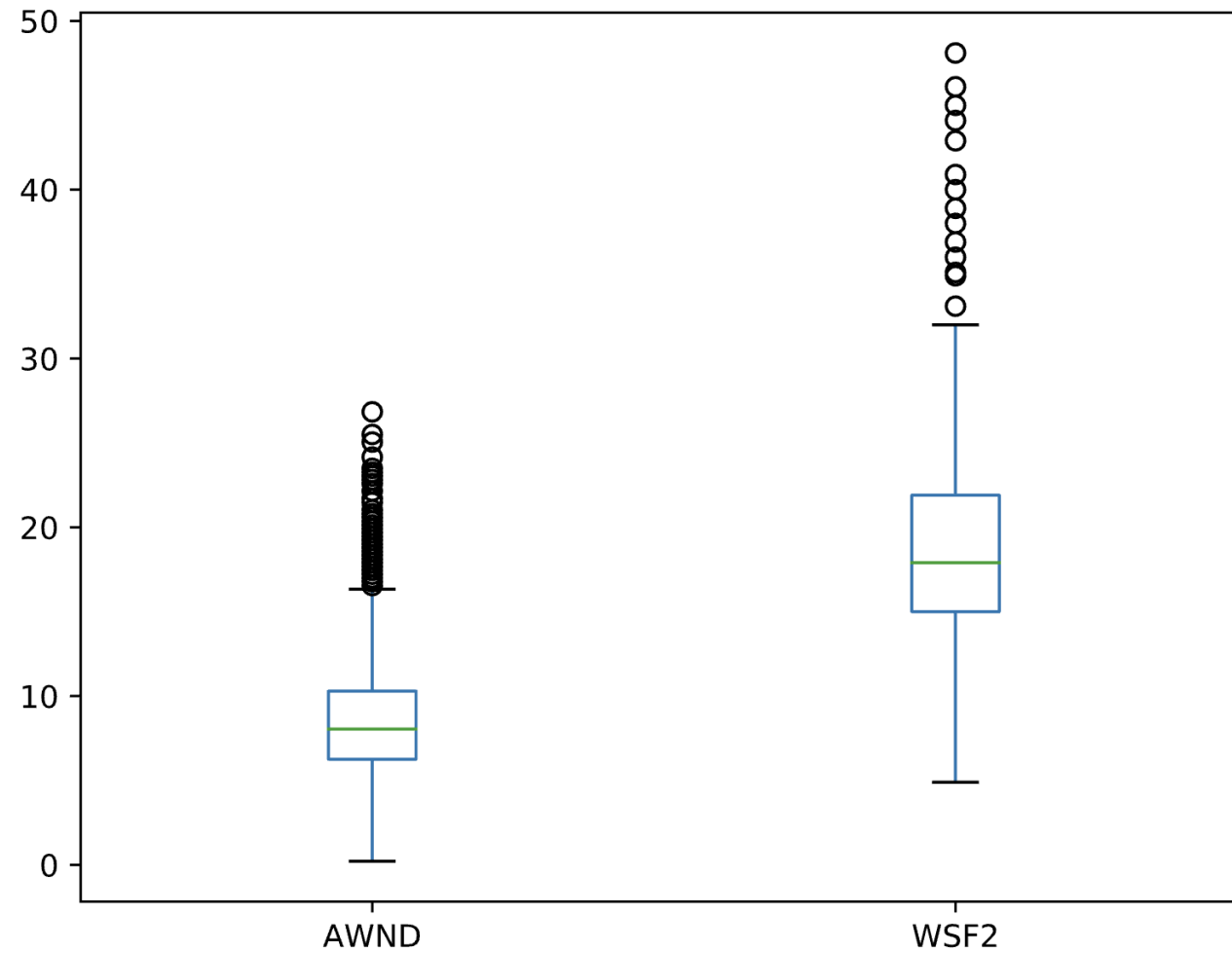
```
weather[['AWND', 'WSF2']].describe()
```

	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()
```

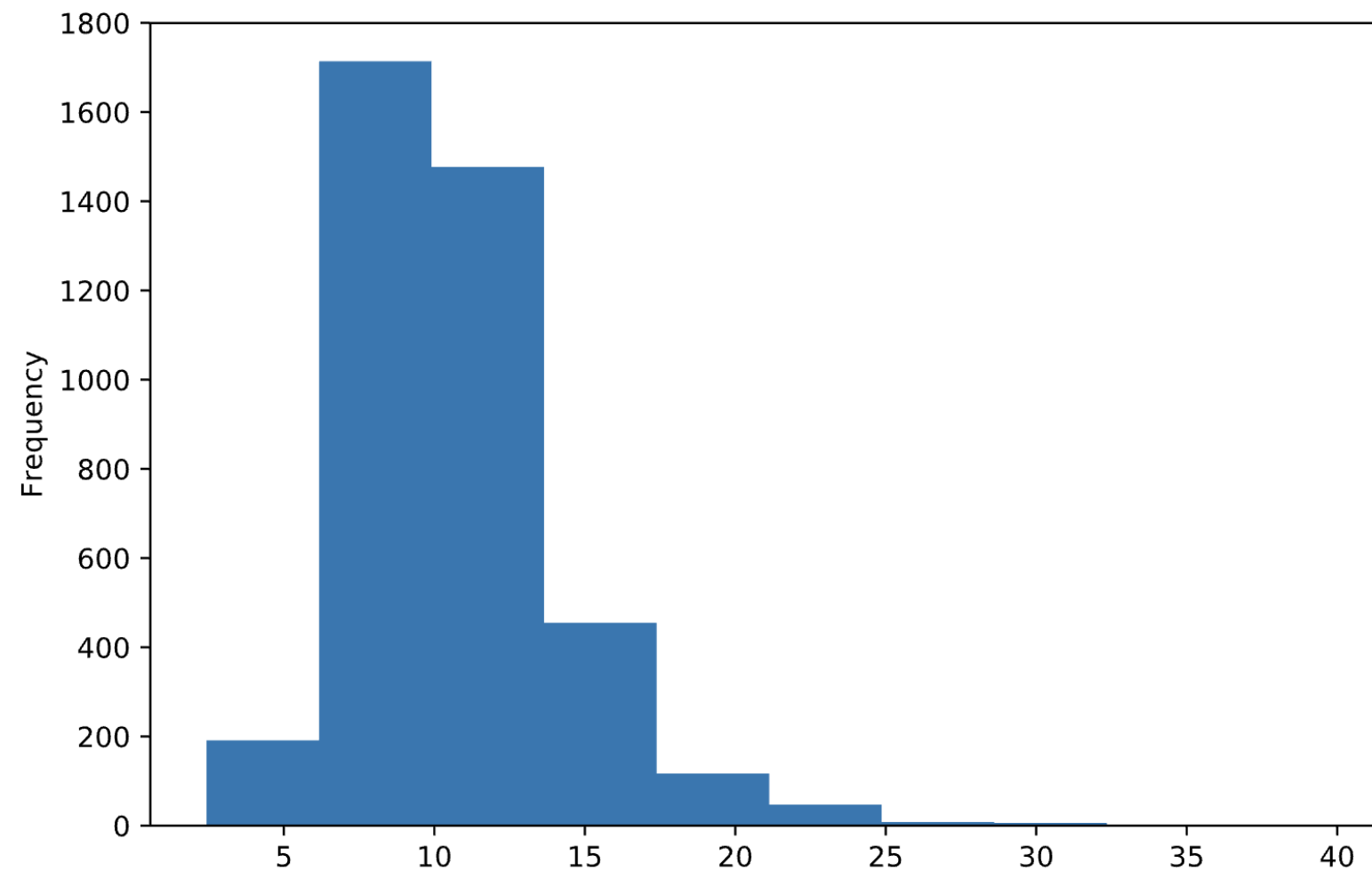




Creating a histogram (1)

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

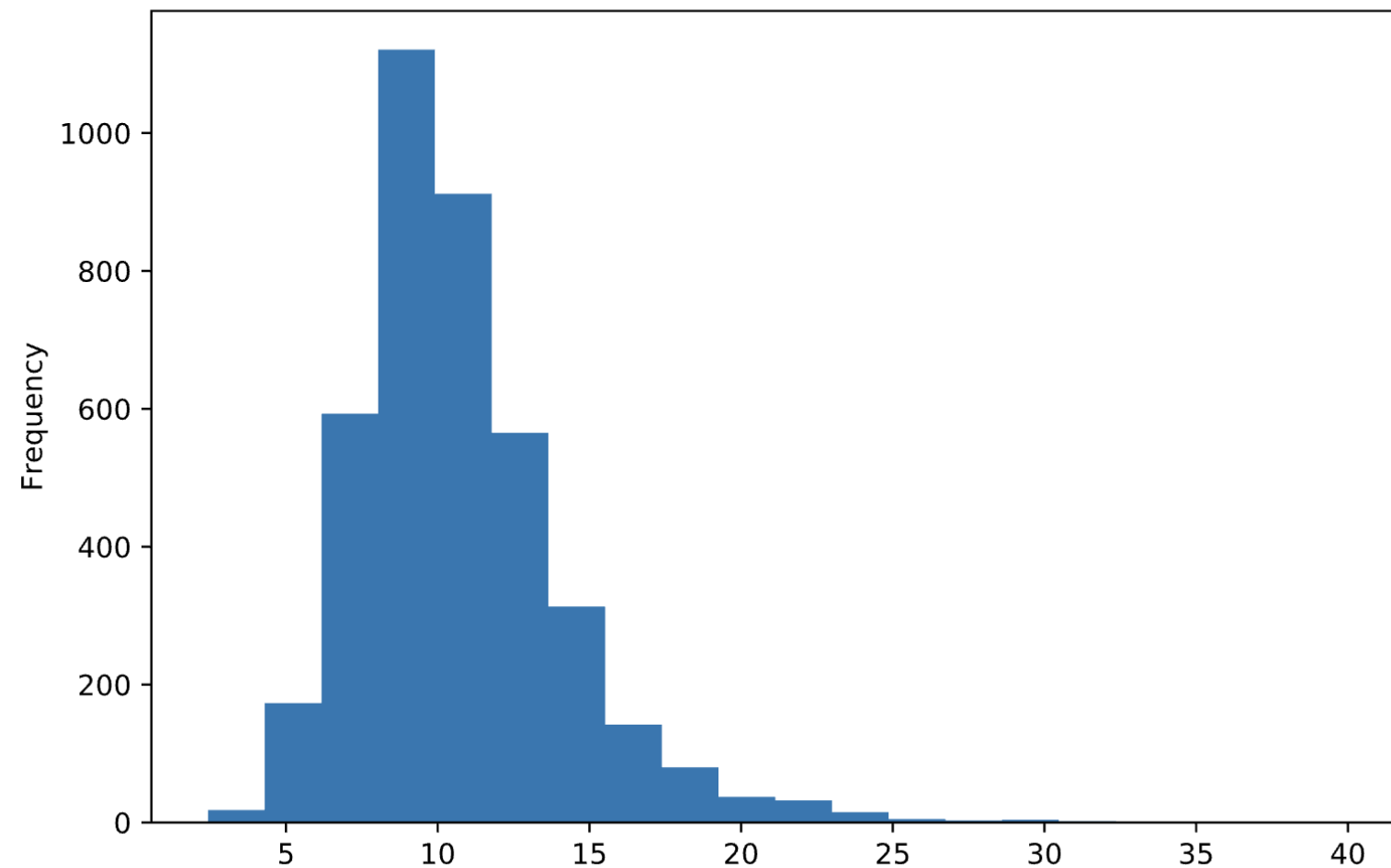
```
weather.WDIFF.plot(kind='hist')  
plt.show()
```





Creating a histogram (2)

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





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Let's practice!



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Categorizing the weather

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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
```



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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
...		



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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!