Module 2: Exploratory Data Analysis

Part 2: Two Dimensional Data

The Data Frame

Create a Pandas dataframe

```
df = pd.DataFrame( <data>, <index>, <column_names> )
```

Read in a CSV

```
df = pd.read_csv(<file>)

df = pd.read_csv(<url>)
```

Excel

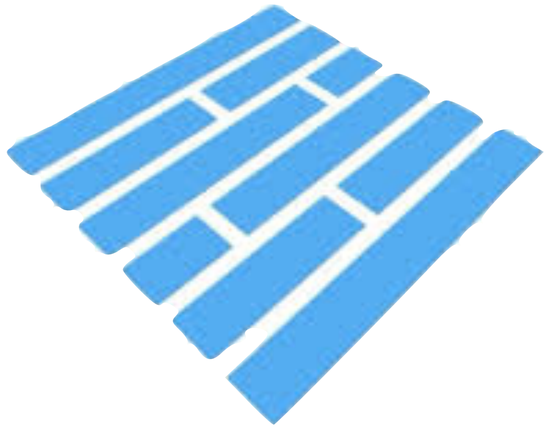
```
df = pd.read_excel(<file>, sheetname=<sheetname>)
```

From a Database

```
df = pd.read_sql(<query>, <connection>)
```

Parquet

```
df = pd.read_parquet(<file>)
```



XML

```
import requests

user_agent_url = 'http://www.user-agents.org/allagents.xml'
xml_data = requests.get(user_agent_url).content
```

http://www.austintaylor.io/lxml/python/pandas/xml/dataframe/2016/07/08/convert-xml-to-pandas-dataframe/

Web Server Logs

Web Server Logs

```
195.154.46.135 - - [25/Oct/2015:04:11:25 +0100] "GET /
linux/doing-pxe-without-dhcp-control HTTP/1.1" 200 24323
"http://howto.basjes.nl/" "Mozilla/5.0 (Windows NT 5.1;
rv:35.0) Gecko/20100101 Firefox/35.0"
```

Web Server Logs

```
195.154.46.135 - - [25/Oct/2015:04:11:25 +0100] "GET /
linux/doing-pxe-without-dhcp-control HTTP/1.1" 200 24323
"http://howto.basjes.nl/" "Mozilla/5.0 (Windows NT 5.1;
rv:35.0) Gecko/20100101 Firefox/35.0"
```

```
from apachelogs import LogParser
line_parser = LogParser("%h %l %u %t \"%r\" %>s %b \"{Referer}
i\" \"%{User-agent}i\"")
```

Web Server Logs

er	request_first_line	request_header_referer	request_header_user_agent	request_http_ver	request_method	request_url
	GET /linux/doing-pxe-without-dhcp-control HTTP...	http://howto.basjes.nl/	Mozilla/5.0 (Windows NT 5.1; rv:35.0) Gecko/20...	1.1	GET	/linux/doing-pxe-v
	GET /join_form HTTP/1.0	http://howto.basjes.nl/	Mozilla/5.0 (Windows NT 5.1; rv:35.0) Gecko/20...	1.0	GET	/join_form
	POST /join_form HTTP/1.1	http://howto.basjes.nl/join_form	Mozilla/5.0 (Windows NT 5.1; rv:35.0) Gecko/20...	1.1	POST	/join_form
	GET /join_form HTTP/1.0	http://howto.basjes.nl/	Mozilla/5.0 (Windows NT 6.3; WOW64; rv:34.0) G...	1.0	GET	/join_form
	POST /join_form HTTP/1.1	http://howto.basjes.nl/join_form	Mozilla/5.0 (Windows NT 6.3; WOW64; rv:34.0) G...	1.1	POST	/join_form
	GET /acl_users/credentials_cookie_auth/require...	http://howto.basjes.nl/join_form	Mozilla/5.0 (Windows NT 6.3; WOW64; rv:34.0) G...	1.1	GET	/acl_users/creden

Nested Data?

Nested Data?


```
{"time": 1084443427.311224,
 "timestamp": "2004-05-13T10:17:07.311224",
"IP": {
   "version": 4,
   "ttl": 128,
   "proto": 6,
   "options": [],
   "len": 48,
   "dst": "65.208.228.223",
   "frag": 0,
   "flags": 2, "src": “145.254.160.237",
   "chksum": 37355
   },
   "Ethernet": {"src": "00:00:01:00:00:00", "type": 2048, "dst": “fe:ff:20:00:01:00"},
   …
```

Nested Data

```
pd.read_json('nested_data.json')
```

```
pd.read_json('nested_data.json')
```

	DNS	Ethernet	IP	TCP	UDP	time	timestamp
0	NaN	{'type': 2048, 'dst': 'fe:ff:20:00:01:00', 'sr...	{'dst': '65.208.228.223', 'len': 48, 'version'...	{'window': 8760, 'chksum': 49932, 'sport': 337...	NaN	1.084443e+09	2004-05-13 10:17:07.311224
1	NaN	{'type': 2048, 'dst': '00:00:01:00:00:00', 'sr...	{'dst': '145.254.160.237', 'len': 48, 'version...	{'window': 5840, 'chksum': 23516, 'sport': 80,...	NaN	1.084443e+09	2004-05-13 10:17:08.222534
2	NaN	{'type': 2048, 'dst': 'fe:ff:20:00:01:00', 'sr...	{'dst': '65.208.228.223', 'len': 40, 'version'...	{'window': 9660, 'chksum': 31076, 'sport': 337...	NaN	1.084443e+09	2004-05-13 10:17:08.222534
3	NaN	{'type': 2048, 'dst': 'fe:ff:20:00:01:00', 'sr...	{'dst': '65.208.228.223', 'len': 519, 'version...	{'window': 9660, 'chksum': 43352, 'sport': 337...	NaN	1.084443e+09	2004-05-13 10:17:08.222534
4	NaN	{'type': 2048, 'dst': '00:00:01:00:00:00', 'sr...	{'dst': '145.254.160.237', 'len': 40, 'version...	{'window': 6432, 'chksum': 33825, 'sport': 80,...	NaN	1.084443e+09	2004-05-13 10:17:08.783340

Nested Data

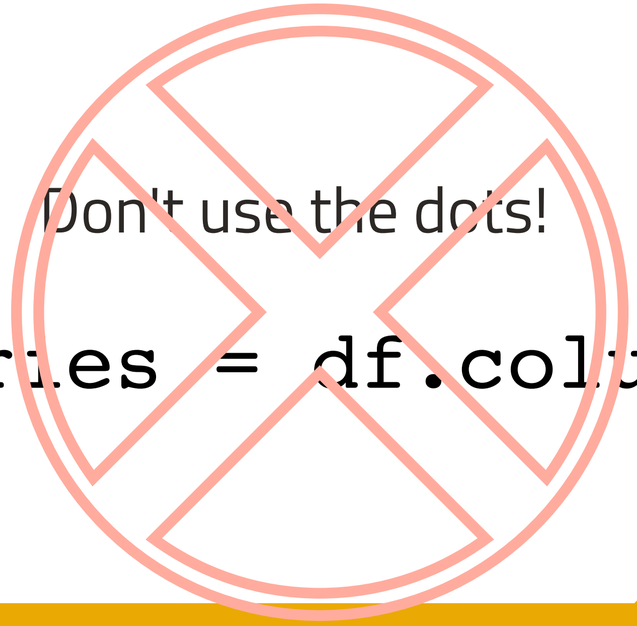
```
from pandas import json_normalize
import json
import pandas as pd

with open('nested.json') as data_file:
    pcap_data = json.load(data_file)

df = pd.DataFrame(json_normalize(pcap_data))
```

```
df = pd.DataFrame(json_normalize(pcap_data))
```

...	TCP.seq	TCP.sport	TCP.urgptr	TCP.window	L
...	951057939.0	3372.0	0.0	8760.0	
...	290218379.0	80.0	0.0	5840.0	
...	951057940.0	3372.0	0.0	9660.0	
...	951057940.0	3372.0	0.0	9660.0	
...	290218380.0	80.0	0.0	6432.0	

Two Ways of Accessing Columns

```
my_series = df.loc[:,'column1']
```



Return a **series**

```
my_series = df.loc[:,'column1']
```

Return a **dataframe**

```
df = df[['column1','column2','column3']]
```

Filtering a DataFrame

```
df[<boolean condition>]
```

```
df[['col1','col2']][df['col3'] > 5]
```

In Class Exercise
Back at xx:xx

Please complete Exercise 5 in Worksheet 2.1: Exploring Two Dimensional Data

Start on Worksheet 2.2

Aggregations can be done over rows or columns

```
data.sum(axis='index')
```

OR

```
data.sum(axis='columns')
```

Common options for Pandas Methods

```
DataFrame.drop(labels,
               axis='columns',
               level=None,
               in_place=False,
               errors='raise')
```

Merging Data Sets

```
combinedSeries = pd.concat(
                     [series1, series2])
```

Joins

```
pd.merge( leftData, rightData,
          how="<join type>" )
```

Option	SQL Equivalent	Description
inner	INNER JOIN	Intersection
left	LEFT OUTER JOIN	Returns items in Set A, but not in Set B
right	RIGHT OUTER JOIN	Returns items in Set B, but not in Set A
outer	FULL OUTER JOIN	Returns the union of both sets

```
pd.merge( leftData, rightData,
          how="<join type>",
          on=<field list> )
```

In-Class Exercise
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Please complete Worksheet 2.2: Exploratory Data Analysis

Grouping and Aggregating Data

Grouping and Aggregating Data

date	src_ip	dst_ip	port
2018-06-21	192.168.20.2	10.10.4.1	80
2018-06-21	192.168.20.1	10.10.4.2	443
2018-06-21	192.168.20.2	10.10.5.1	80
2018-06-22	192.168.20.2	10.10.4.1	80

```
df.groupby(['src_ip')
```

Grouping and Aggregating Data

date	src_ip	dst_ip	port
2018-06-21	192.168.20.2	10.10.4.1	80
2018-06-21	192.168.20.1	10.10.4.2	443
2018-06-21	192.168.20.2	10.10.5.1	80
2018-06-22	192.168.20.2	10.10.4.1	80

```
df.groupby('src_ip')['port'].count()
```

src_ip	count
192.168.20.1	1
192.168.20.2	3

Grouping and Aggregating Data

date	src_ip	dst_ip	port
2018-06-21	192.168.20.2	10.10.4.1	80
2018-06-21	192.168.20.1	10.10.4.2	443
2018-06-21	192.168.20.2	10.10.5.1	80
2018-06-22	192.168.20.2	10.10.4.1	80

```
df.groupby(['date','src_ip'])['port'].count()
```

Multi-Index

```
date          src_ip
2018-06-21    192.168.20.1     1
              192.168.20.2     2
2018-06-22    192.168.20.2     1
```

Grouping and Aggregating Data

date	src_ip	dst_ip	port
2018-06-21	192.168.20.2	10.10.4.1	80
2018-06-21	192.168.20.1	10.10.4.2	443
2018-06-21	192.168.20.2	10.10.5.1	80
2018-06-22	192.168.20.2	10.10.4.1	80

```
df.groupby(['date','src_ip'], as_index=False)['port'].count()
```

	date	src_ip	port
0	2018-06-21	192.168.20.1	1
1	2018-06-21	192.168.20.2	2
2	2018-06-22	192.168.20.2	1

```
my_series.dropna()
my_series.fillna(value="<value to fill with>")
```

In-Class Exercise
Back at xx:xx

Please complete Worksheet 2.2: Exploratory Data Analysis