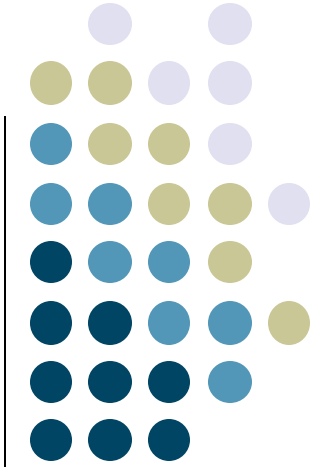
Exploring Data with Pandas I



John Stasko

CS 6452

Prototyping Interactive Systems

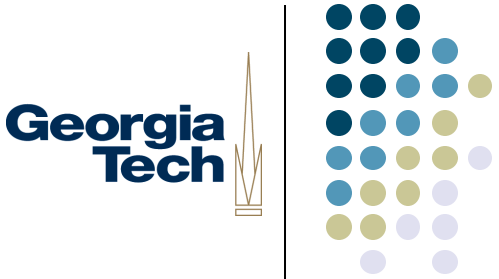
Learning Objectives

- Become familiar with Pandas library
- Learn about Pandas ability to read in and manipulate CSV files

Pandas

- Open source library providing data analysis capabilities for Python
- Designed to be high-performance with easy-to-use data structures
- Connects with other libraries to provide visualization capabilities too

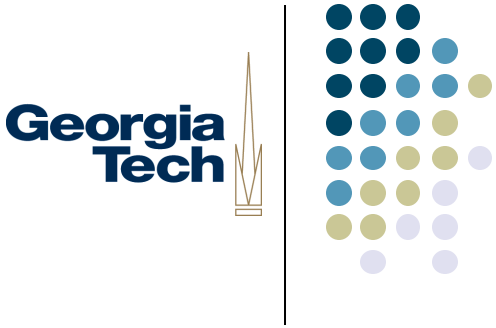
Application



- Tabular data such as that from Excel spreadsheet or SQL table

- Two primary data structures
  - Series: 1-dimensional
  - DataFrame: 2-dimensional

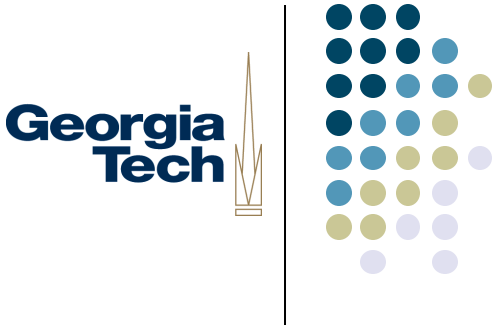
Series



Like an array or list in Python

```
>>> s = pd.Series([12, 'Atlanta', 4.2, 'Jackets'])
>>> s
0        12
1   Atlanta
2       4.2
3   Jackets
dtype: object
```

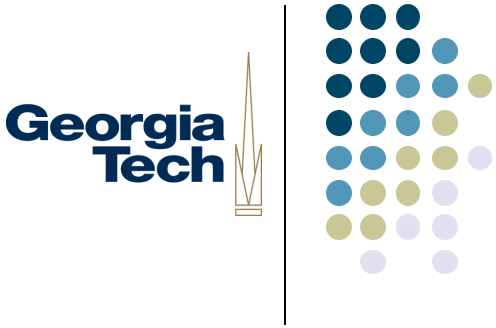
Series



Can specify an index

```
>>> s = pd.Series([12, 'Atlanta', 4.2, 'Jackets'],
                  index=['A', 'B', 'C', 'D']))
>>> s
A        12
B   Atlanta
C       4.2
D   Jackets
dtype: object
```

Series



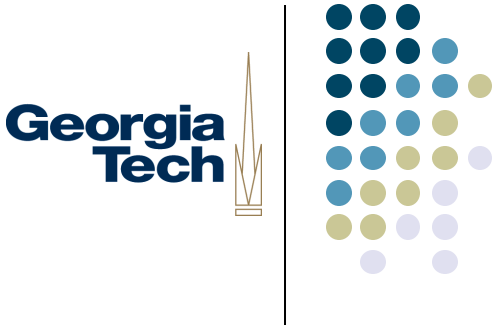
Can read in from a dictionary

```
>>> d = {'Chicago': 1000, 'New York': 1300, 'Portland': 900,
     'San Francisco': 1100, 'Austin': 450, 'Boston': None}
>>> cities = pd.Series(d)
>>> cities
Austin            450
Boston            NaN
Chicago          1000
New York         1300
Portland          900
San Francisco    1100
dtype: float64
```

Keys become the index

NaN – not a number

DataFrame

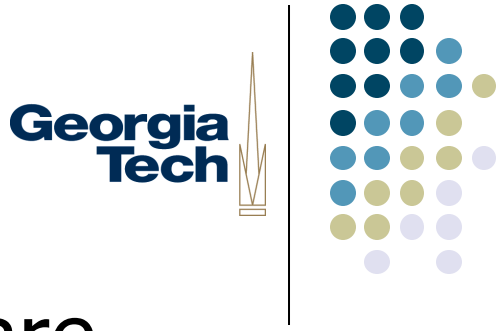


Like a table

```
>>> data = {'year': [2010, 2011, 2012, 2011, 2012, 2010, 2011, 2012],
        'team': ['Bears', 'Bears', 'Bears', 'Packers',
                 'Packers', 'Lions', 'Lions', 'Lions'],
        'wins': [11, 8, 10, 15, 11, 6, 10, 4],
        'losses': [5, 8, 6, 1, 5, 10, 6, 12]}
>>> football = pd.DataFrame(data, columns=['year', 'team', 'wins',
                                           'losses'])
>>> football

# next slide…
```

	year	team	wins	losses
0	2010	Bears	11	5
1	2011	Bears	8	8
2	2012	Bears	10	6
3	2011	Packers	15	1
4	2012	Packers	11	5
5	2010	Lions	6	10
6	2011	Lions	10	6
7	2012	Lions	4	12

Play Along

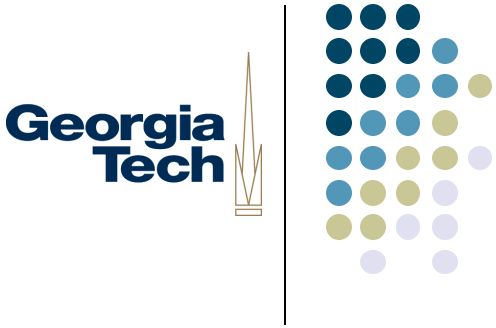


- Grab `whiskeys.csv` from t-square
- Open Python from the folder that contains the file
- Do your `import`s

```
import pandas as pd
import matplotlib
```

Read in CSV

```
>>>import pandas as pd

>>>df = pd.read_csv("whiskeys.csv")
>>>df
```

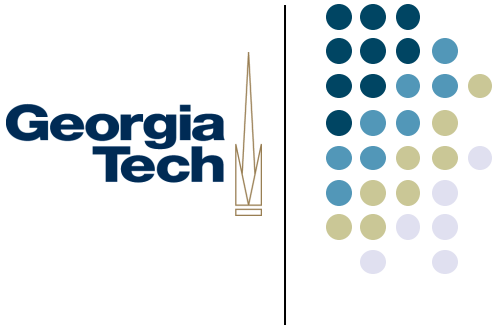


	Name	Rating	Country	\
0	Tyrconnell 10 Year Old Single Malt Madeira Cas...	100	Ireland	
1	Dalmore 18 Year Old Single Highland Malt Scotc...	100	Scotland	
2	Powers 12 Year Old Irish Whiskey	99	Ireland	
3	Suntory The Yamazaki 18 Year Old Single Malt W...	99	Japan	
4	Glenmorangie 10 Year Old Single Malt Scotch Wh...	99	Scotland	
5	Glenmorangie Single Malt Scotch	99	Scotland	
6	Bunnahabhain 18 Year Old Single Malt Scotch	99	Scotland	
7	Laphroaig 18 Year Old Single Malt Scotch	99	Scotland	
8	…			
279	Glengoyne 10 Year Old Single Malt Scotch	*	Scotland	
280	The Tweeddale Blend	*	Scotland	
281	A.H. Hirsch Finest Reserve 20 Bourbon	*	USA	
282	Elijah Craig 18 Year Bourbon	*	USA	
283	Kavalan Solist Vinho Single Malt Whisky	*	Taiwan	

	Category	Price	ABV	Age	Brand
0	Single Malt	72	46	10	Tyrconnell
1	Highlands	165	43	18	Dalmore
2	Blended	35	40	12	Powers
3	…				
277	Speyside	69	57	18	Glenlivet
278	Blended	*	43	*	Bell's
279	Highlands	NaN	*	10	Glengoyne
280	Blended	30	46	12	Tweeddale
281	Bourbon	280	45	16	A.H. Hirsch
282	Bourbon	40	45	18	Elijah Craig
283	Single Malt	100	59.2	*	Kavalan

[284 rows x 8 columns]

Info



What fields?

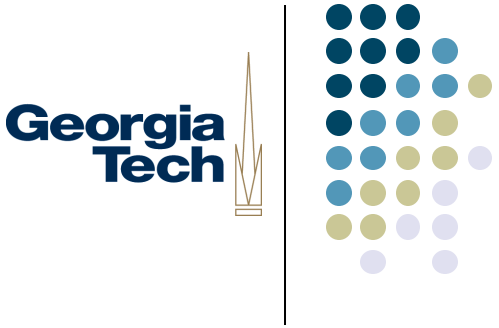
```
>>>df.columns

Index(['Name', 'Rating', 'Country', 'Category', 'Price', 'ABV', 'Age',
       'Brand'],
      dtype='object')
```

How many items?

```
>>>df.index

RangeIndex(start=0, stop=284, step=1)
```

Note: All columns are objects, not ints or numbers

Types



What types are in the file?

```
>>> df.types
Name          object
Rating        object
Country       object
Category      object
Price         object
ABV           object
Age           object
Brand         object
dtype: object

>>> df.ABV.dtype
dtype('O')
```

More Info

```
>>> df.info()

<class 'pandas.core.frame.DataFrame'>
RangeIndex: 284 entries, 0 to 283
Data columns (total 8 columns):
Name         284 non-null object
Rating       284 non-null object
Country      284 non-null object
Category     284 non-null object
Price        281 non-null object
ABV          282 non-null object
Age          284 non-null object
Brand        284 non-null object
dtypes: object(8)
memory usage: 8.9+ KB
```

More Info

```
>>> df.describe(include=['object'])

                                                  Name Rating   Country Category  \
count                                              284    284       284      284
unique                                             284     47         9       15
top     Aberfeldy 12 Year Old Single Malt Scotch     88  Scotland  Blended
freq                                                 1     29       109       73

       Price  ABV  Age     Brand
count    281  282  284       284
unique   107   48   25       153
top       70   40    *  Balvenie
freq      11   99  109         7
```

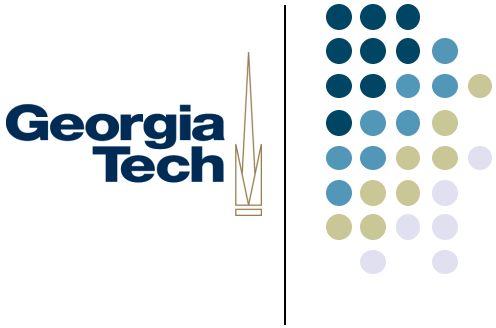
More Info

```
>>> df.describe(include=['int'])

Error
```

Why?

All columns read as strings in this file

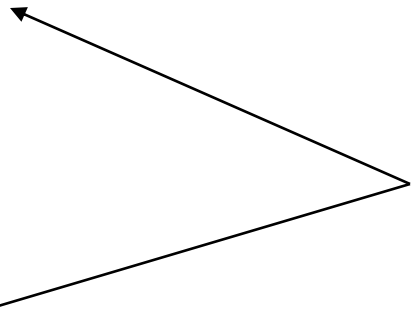
Check First Few



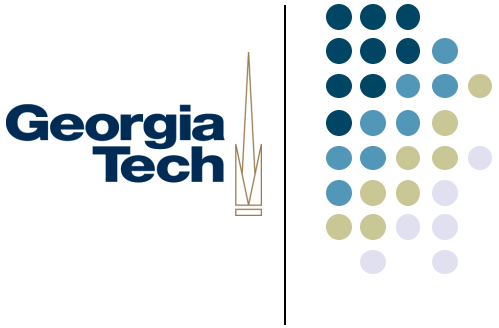
```
>>> df.head()

                                                Name Rating   Country  \
0  Tyrconnell 10 Year Old Single Malt Madeira Cas...    100   Ireland
1  Dalmore 18 Year Old Single Highland Malt Scotc...    100  Scotland
2                  Powers 12 Year Old Irish Whiskey     99   Ireland
3  Suntory The Yamazaki 18 Year Old Single Malt W...     99     Japan
4  Glenmorangie 10 Year Old Single Malt Scotch Wh...     99  Scotland

      Category Price ABV Age         Brand
0  Single Malt    72  46  10    Tyrconnell
1    Highlands   165  43  18       Dalmore
2      Blended    35  40  12        Powers
3  Single Malt   120  43  18       Suntory
4    Highlands    42  40  10  Glenmorangie
```

Getting Fields

```
>>> pr_col = df["Price"]
>>> pr_col

# results

>>> ra_col = df.Rating
>>> ra_col

# results
```



Narrowing



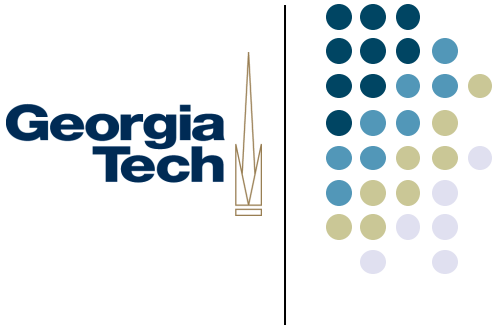
How to get first 5 rows of a column?

```
>>> df["Country"][:5]
```

Getting count of unique values

```
>>> df["Country"].value_counts()
```

Narrowing



How to get all the Corn whiskeys?

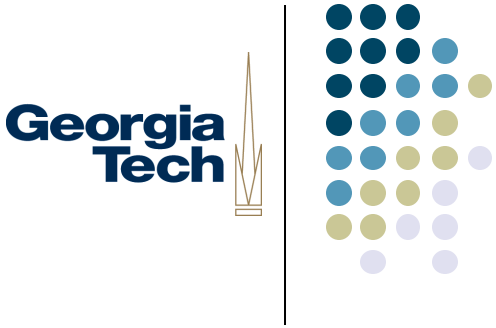
```
>>> corns = df["Category"] == "Corn"
>>> df[corns]
```

Getting count of unique values

```
>>> tops = df["Rating"] > 95
```

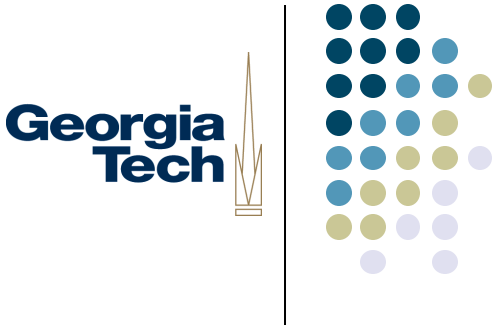
Why won't this work?

Specific Items



```
>>> df.iloc[3]

>>> df.loc[3]

>>> df[3]
# Doesn't work

>>> df[0:3]
```

Accessing Items



What does this produce?

```
>>> df.Name == "Powers 12 Year Old Irish Whiskey"

>>> df[df.Name == "Powers 12 Year Old Irish Whiskey"]
                              Name Rating  Country Category Price ABV  \
2  Powers 12 Year Old Irish Whiskey     99  Ireland  Blended    35  40

   Age   Brand
2   12  Powers
```

Cleaning the Data

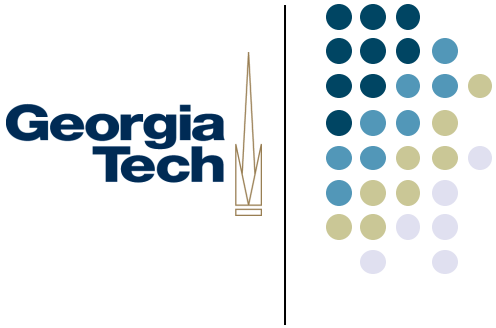
- Frequently there are problems in the data
  - Strange values
  - Missing values
  - …

Info on a Field

```
>>> df.Price.describe()
count      281
unique     107
top         70
freq        11
Name: Price, dtype: object

>>> pr_col.count()
281
```

3 are missing

Conversions



Let's change all the blank entries to *

```
>>> import numpy as np
```

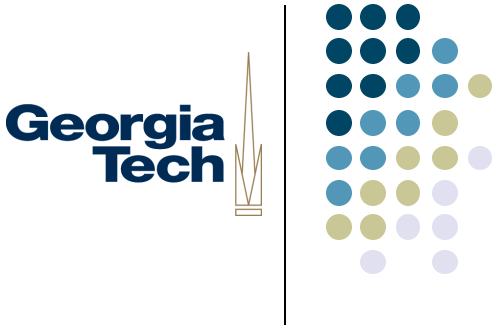
Act on the object being called

```
>>> pr_col.replace(np.nan, '*', inplace=True)
```

```
>>> pr_col.count()
```

NumPy's `NaN` (not a number) denotes missing values

Substitutions

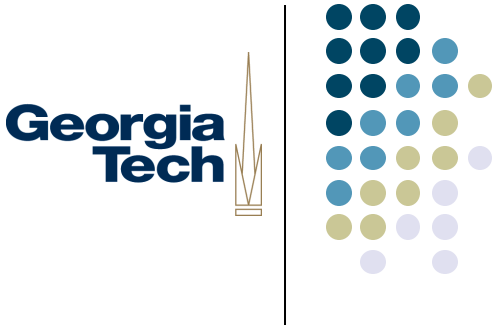


```
>>> df[df.Price.str.contains("\*")]["Name"]
# What are the names of ones with Price '*'?
# replace uses regex so need to escape *
```

Replace * by -1

```
>>> df.Price.replace('*', '-1', inplace=True)
```

Type Conversion



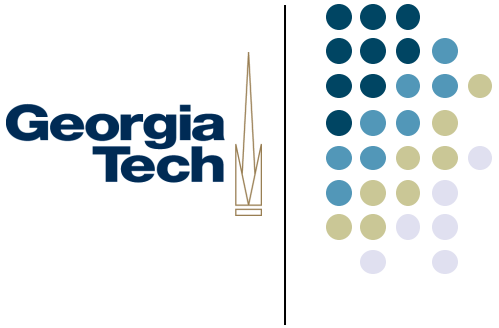
Want to change columns of strings (numbers) to just being numbers

```
>>> df["Price"] = df["Price"].astype("int")
```

Let's now focus on all whiskeys with Price > 100

```
>>> tops = df["Price"] > 100
>>> tops
>>> df[tops]
```

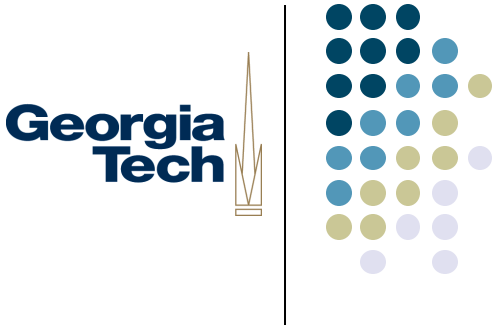
Sorting



Sort by some field

```
>>> df3 = df.sort_values(['Price','Name'],ascending=[0,1])

# First by Price (hi->low), then by Name (low->hi)
```

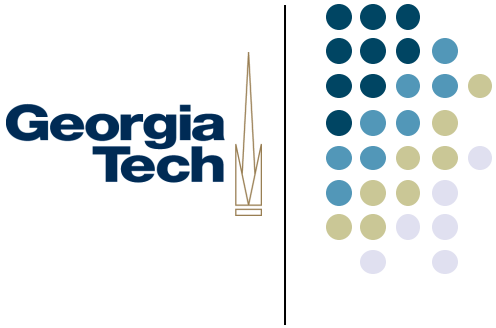
An Alternate Approach



Flexibility on reading in the file

```
>>> df = pd.read_csv("whiskeys.csv")
>>> df['Age'] = pd.to_numeric(df['Age'],errors='coerce')

# Change Age column to numeric
# coerce results in non-numeric becoming NaN

>>> df = df.dropna()

# Remove all the rows with nothing in some column

>>> print(df['Age'].max())
```

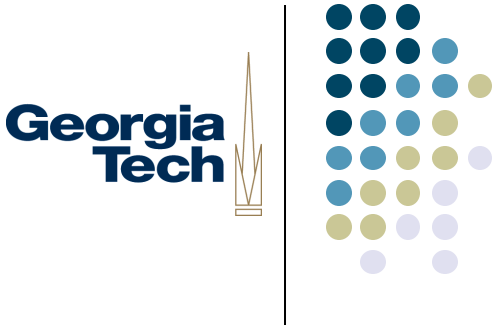
More…



Fix blanks on way in

```
>>> df.fllna(value=5)

# Puts 5 in for all missing values
```

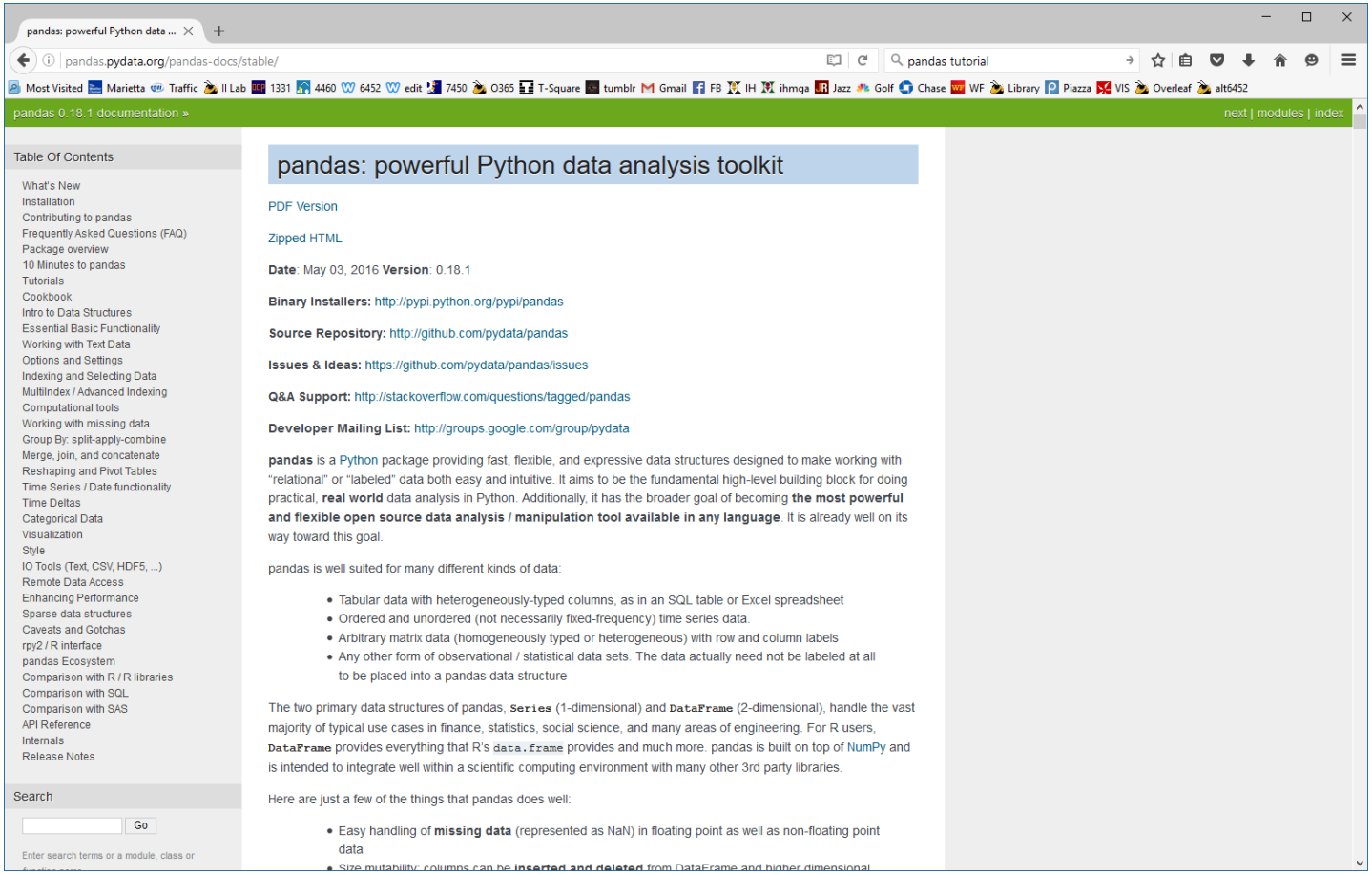
Scripts



- We did this interactively
- But you can save a bunch of commands in a python file and run it like a script against different data sets

Documentation

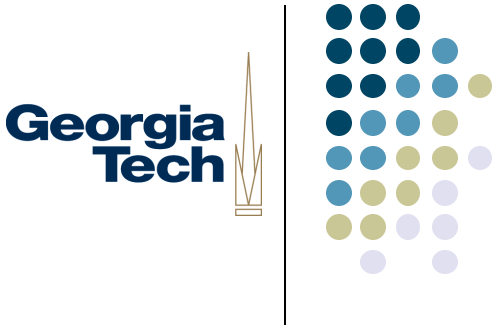
http://pandas.pydata.org/pandas-docs/stable/



Learning Objectives

- Become familiar with Pandas library
- Learn about Pandas ability to read in and manipulate CSV files

Next Time



- Using Pandas to visualize data