# Python For Data Science Cheat Sheet
## Pandas Basics

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## Pandas

The Pandas library is built on NumPy and provides easy-to-use data structures and data analysis tools for the Python programming language.

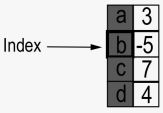

Use the following import convention:

```
>>> Import pandas as pd
```

## Pandas Data Structures

### Series

A one-dimensional labeled array capable of holding any data type




```
>>> s = pd.Series([3, -5, 7, 4], index=['a', 'b', 'c', 'd'])
```

### DataFrame

A two-dimensional labeled data structure with columns of potentially different types

Columns / Index

| | Country | Capital | Population |
|---|---|---|---|
| 0 | Belgium | Brussels | 11190846 |
| 1 | India | New Delhi | 1303171035 |
| 2 | Brazil | Brasília | 207847528 |

```
>>> data = {'Country': ['Belgium', 'India', 'Brazil'],
     'Capital': ['Brussels', 'New Delhi', 'Brasília'],
     'Population': [11190846, 1303171035, 207847528]}

>>> df = pd.DataFrame(data,
         columns=['Country', 'Capital', 'Population'])
```

## I/O

### Read and Write to CSV

```
>>> pd.read_csv('file.csv', header=None, nrows=5)
>>> df.to_csv('myDataFrame.csv')
```

### Read and Write to Excel

```
>>> pd.read_excel('file.xlsx')
>>> pd.to_excel('dir/myDataFrame.xlsx', sheet_name='Sheet1')
Read multiple sheets from the same file
>>> xlsx = pd.ExcelFile('file.xls')
>>> df = pd.read_excel(xlsx, 'Sheet1')
```

### Read and Write to SQL Query or Database Table

```
>>> from sqlalchemy import create_engine
>>> engine = create_engine('sqlite:///:memory:')
>>> pd.read_sql("SELECT * FROM my_table;", engine)
>>> pd.read_sql_table('my_table', engine)
>>> pd.read_sql_query("SELECT * FROM my_table;", engine)
```

read_sql()is a convenience wrapper around read_sql_table() and read_sql_query()

```
>>> pd.to_sql('myDf', engine)
```

## Asking For Help

```
>>> help(pd.Series.loc)
```

## Selection

Also see NumPy Arrays

### Getting

```
>>> s['b']
    -5
>>> df[1:]
    Country  Capital    Population
    1 India  New Delhi  1303171035
    2 Brazil Brasília   207847528
```

Get one element

Get subset of a DataFrame

### Selecting, Boolean Indexing & Setting

**By Position**

```
>>> df.iloc[[0],[0]]
   'Belgium'
>>> df.iat([0],[0])
   'Belgium'
```

Select single value by row & column

**By Label**

```
>>> df.loc[[0], ['Country']]
   'Belgium'
>>> df.at([0], ['Country'])
   'Belgium'
```

Select single value by row & column labels

**By Label/Position**

```
>>> df.ix[2]
    Country    Brazil
    Capital    Brasília
    Population 207847528
>>> df.ix[:,'Capital']
    0 Brussels
    1 New Delhi
    2 Brasília
>>> df.ix[1,'Capital']
   'New Delhi'
```

Select single row of subset of rows

Select a single column of subset of columns

Select rows and columns

**Boolean Indexing**

```
>>> s[~(s > 1)]
>>> s[(s < -1) | (s > 2)]
>>> df[df['Population']
    >1200000000]
```

Series s where value is not >1
s where value is <-1 or >2

Use filter to adjust DataFrame

**Setting**

```
>>> s['a'] = 6
```

Set index a of Series s to 6

## Dropping

```
>>> s.drop(['a', 'c'])
>>> df.drop('Country', axis=1)
```

Drop values from rows (axis=0)
Drop values from columns(axis=1)

## Sort & Rank

```
>>> df.sort_index()
>>> df.sort_values(by='Country')
>>> df.rank()
```

Sort by labels along an axis
Sort by the values along an axis
Assign ranks to entries

## Retrieving Series/DataFrame Information

### Basic Information

```
>>> df.shape
>>> df.index
>>> df.columns
>>> df.info()
>>> df.count()
```

(rows,columns)
Describe index
Describe DataFrame columns
Info on DataFrame
Number of non-NA values

### Summary

```
>>> df.sum()
>>> df.cumsum()
>>> df.min()/df.max()
>>> df.idxmin()/df.idxmax()
>>> df.describe()
>>> df.mean()
>>> df.median()
```

Sum of values
Cummulative sum of values
Minimum/maximum values
Minimum/Maximum index value
Summary statistics
Mean of values
Median of values

## Applying Functions

```
>>> f = lambda x: x*2
>>> df.apply(f)
>>> df.applymap(f)
```

Apply function
Apply function element-wise

## Data Alignment

### Internal Data Alignment

NA values are introduced in the indices that don't overlap:

```
>>> s3 = pd.Series([7, -2, 3], index=['a', 'c', 'd'])
>>> s + s3
    a 10.0
    b NaN
    c 5.0
    d 7.0
    Arithmetic Operations
```

## Arithmetic Operations with Fill Methods

You can also do the internal data alignment yourself with the help of the fill methods:

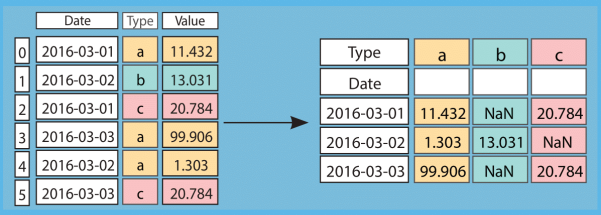
```
>>> s.add(s3, fill_value=0)
    a 10.0
    b -5.0
    c 5.0
    d 7.0
>>> s.sub(s3, fill_value=2)
>>> s.div(s3, fill_value=4)
>>> s.mul(s3, fill_value=3)
```

# Reshaping Data

## Pivot

```
>>> df3= df2.pivot(index='Date',
                   columns='Type',
                   values='Value')
```

Spread rows into columns



| | Date | Type | Value |
|---|---|---|---|
| 0 | 2016-03-01 | a | 11.432 |
| 1 | 2016-03-02 | b | 13.031 |
| 2 | 2016-03-01 | c | 20.784 |
| 3 | 2016-03-03 | a | 99.906 |
| 4 | 2016-03-02 | a | 1.303 |
| 5 | 2016-03-03 | c | 20.784 |

| Type | a | b | c |
|---|---|---|---|
| Date | | | |
| 2016-03-01 | 11.432 | NaN | 20.784 |
| 2016-03-02 | 1.303 | 13.031 | NaN |
| 2016-03-03 | 99.906 | NaN | 20.784 |

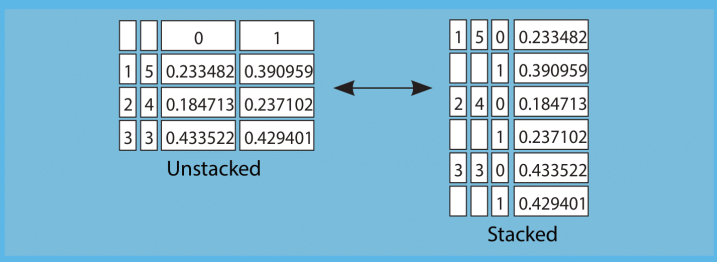
```
>>> df4 = pd.pivot_table(df2,
                         values='Value',
                         index='Date',
                         columns='Type'])
```

Spread rows into columns

## Stack / Unstack

```
>>> stacked = df5.stack()
>>> stacked.unstack()
```

Pivot a level of column labels
Pivot a level of index labels



| | | 0 | 1 |
|---|---|---|---|
| 1 | 5 | 0.233482 | 0.390959 |
| 2 | 4 | 0.184713 | 0.237102 |
| 3 | 3 | 0.433522 | 0.429401 |

Unstacked

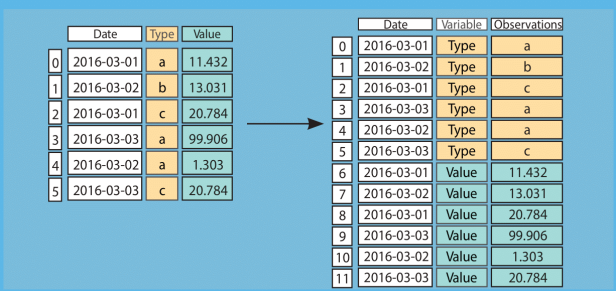
| | | | |
|---|---|---|---|
| 1 | 5 | 0 | 0.233482 |
| | | 1 | 0.390959 |
| 2 | 4 | 0 | 0.184713 |
| | | 1 | 0.237102 |
| 3 | 3 | 0 | 0.433522 |
| | | 1 | 0.429401 |

Stacked

## Melt

```
>>> pd.melt(df2,
            id_vars=["Date"],
            value_vars=["Type", "Value"],
            value_name="Observations")
```

Gather columns into rows



| | Date | Type | Value |
|---|---|---|---|
| 0 | 2016-03-01 | a | 11.432 |
| 1 | 2016-03-02 | b | 13.031 |
| 2 | 2016-03-01 | c | 20.784 |
| 3 | 2016-03-03 | a | 99.906 |
| 4 | 2016-03-02 | a | 1.303 |
| 5 | 2016-03-03 | c | 20.784 |

| | Date | Variable | Observations |
|---|---|---|---|
| 0 | 2016-03-01 | Type | a |
| 1 | 2016-03-02 | Type | b |
| 2 | 2016-03-01 | Type | c |
| 3 | 2016-03-03 | Type | a |
| 4 | 2016-03-02 | Type | a |
| 5 | 2016-03-03 | Type | c |
| 6 | 2016-03-01 | Value | 11.432 |
| 7 | 2016-03-02 | Value | 13.031 |
| 8 | 2016-03-01 | Value | 20.784 |
| 9 | 2016-03-03 | Value | 99.906 |
| 10 | 2016-03-02 | Value | 1.303 |
| 11 | 2016-03-03 | Value | 20.784 |

## Iteration

```
>>> df.iteritems()
>>> df.iterrows()
```

(Column-index, Series) pairs
(Row-index, Series) pairs

# Advanced Indexing

Also see NumPy Arrays

## Selecting

```
>>> df3.loc[:,(df3>1).any()]
```
Select cols with any vals >1

```
>>> df3.loc[:,(df3>1).all()]
```
Select cols with vals > 1

```
>>> df3.loc[:,df3.isnull().any()]
```
Select cols with NaN

```
>>> df3.loc[:,df3.notnull().all()]
```
Select cols without NaN

## Indexing With isin

```
>>> df[(df.Country.isin(df2.Type))]
```
Find same elements

```
>>> df3.filter(items="a","b"])
```
Filter on values

```
>>> df.select(lambda x: not x%5)
```
Select specific elements

## Where

```
>>> s.where(s > 0)
```
Subset the data

## Query

```
>>> df6.query('second > first')
```
Query DataFrame

# Setting/Resetting Index

```
>>> df.set_index('Country')
```
Set the index

```
>>> df4 = df.reset_index()
```
Reset the index

```
>>> df = df.rename(index=str,
                   columns={"Country":"cntry",
                            "Capital":"cptl",
                            "Population":"ppltn"})
```
Rename DataFrame

# Reindexing

```
>>> s2 = s.reindex(['a','c','d','e','b'])
```

## Forward Filling

```
>>> df.reindex(range(4),
               method='ffill')
  Country Capital   Population
0 Belgium Brussels  11190846
1 India   New Delhi 1303171035
2 Brazil  Brasília  207847528
3 Brazil  Brasília  207847528
```

## Backward Filling

```
>>> s3 = s.reindex(range(5),
                   method='bfill')
0 3
1 3
2 3
3 3
4 3
```

# MultiIndexing

```
>>> arrays = [np.array([1,2,3]),
              np.array([5,4,3])]
>>> df5 = pd.DataFrame(np.random.rand(3, 2), index=arrays)
>>> tuples = list(zip(*arrays))
>>> index = pd.MultiIndex.from_tuples(tuples,
                                      names=['first', 'second'])
>>> df6 = pd.DataFrame(np.random.rand(3, 2), index=index)
>>> df2.set_index(["Date", "Type"])
```

# Duplicate Data

```
>>> s3.unique()
```
Return unique values

```
>>> df2.duplicated('Type')
```
Check duplicates

```
>>> df2.drop_duplicates('Type', keep='last')
```
Drop duplicates

```
>>> df.index.duplicated()
```
Check index duplicates

# Grouping Data

## Aggregation

```
>>> df2.groupby(by=['Date','Type']).mean()
>>> df4.groupby(level=0).sum()
>>> df4.groupby(level=0).agg({'a':lambda x:sum(x)/len(x),
                              'b': np.sum})
```

## Transformation

```
>>> customSum = lambda x: (x+x%2)
>>> df4.groupby(level=0).transform(customSum)
```

# Missing Data

```
>>> df.dropna()
```
Drop NaN values

```
>>> df3.fillna(df3.mean())
```
Fill NaN values with a predetermined value

```
>>> df2.replace("a", "f")
```
Replace values with others

# Combining Data

data1

| X1 | X2 |
|---|---|
| a | 11.432 |
| b | 1.303 |
| c | 99.906 |

data2

| X1 | X3 |
|---|---|
| a | 20.784 |
| b | NaN |
| d | 20.784 |

## Merge

```
>>> pd.merge(data1,
             data2,
             how='left',
             on='X1')
```

| X1 | X2 | X3 |
|---|---|---|
| a | 11.432 | 20.784 |
| b | 1.303 | NaN |
| c | 99.906 | NaN |

```
>>> pd.merge(data1,
             data2,
             how='right',
             on='X1')
```

| X1 | X2 | X3 |
|---|---|---|
| a | 11.432 | 20.784 |
| b | 1.303 | NaN |
| d | NaN | 20.784 |

```
>>> pd.merge(data1,
             data2,
             how='inner',
             on='X1')
```

| X1 | X2 | X3 |
|---|---|---|
| a | 11.432 | 20.784 |
| b | 1.303 | NaN |

```
>>> pd.merge(data1,
             data2,
             how='outer',
             on='X1')
```

| X1 | X2 | X3 |
|---|---|---|
| a | 11.432 | 20.784 |
| b | 1.303 | NaN |
| c | 99.906 | NaN |
| d | NaN | 20.784 |

## Join

```
>>> data1.join(data2, how='right')
```

## Concatenate

### Vertical

```
>>> s.append(s2)
```

### Horizontal/Vertical

```
>>> pd.concat([s,s2],axis=1, keys=['One','Two'])
>>> pd.concat([data1, data2], axis=1, join='inner')
```

## Dates

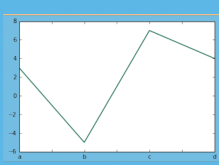
```
>>> df2['Date']= pd.to_datetime(df2['Date'])
>>> df2['Date']= pd.date_range('2000-1-1', periods=6,
                               freq='M')
>>> dates = [datetime(2012,5,1), datetime(2012,5,2)]
>>> index = pd.DatetimeIndex(dates)
>>> index = pd.date_range(datetime(2012,2,1), end, freq='BM')
```

## Visualization

Also see Matplotlib

```
>>> import matplotlib.pyplot as plt
```

```
>>> s.plot()
>>> plt.show()
```



```
>>> df2.plot()
>>> plt.show()
```