Python Tutorial – Part I: Introduction

Mark A. Austin

University of Maryland

austin@umd.edu
ENCE 201, Fall Semester 2023

September 3, 2023

Overview

Part 6

Tabular Data and Dataset Transformation

(Working with Pandas)

Working with Pandas

Introduction to Pandas

Pandas is an open source Python Library that supports working and analysis of tabular data sets.

Benefits:

- Pandas can clean messy data sets, and make them readable and relevant.
- Pandas allows us to analyze large data sets and make conclusions based on statistical theories.
- Three data structures: Series, DataFrame and Panel.

Installation:

```
prompt >> pip3 install pandas
```

What can Pandas do?

Basic Operations:

- Create series and dataframes.
- Read CSV and JSON files.
- Plot data.

Clean Data:

- Clean empty cells.
- Fix wrong format.
- Remove duplicates.

Advanced Operations:

- Combine (concatenate, join, merge) Panda objects.
- Compute correlations.

Panda Series and DataFrames

Panda Series

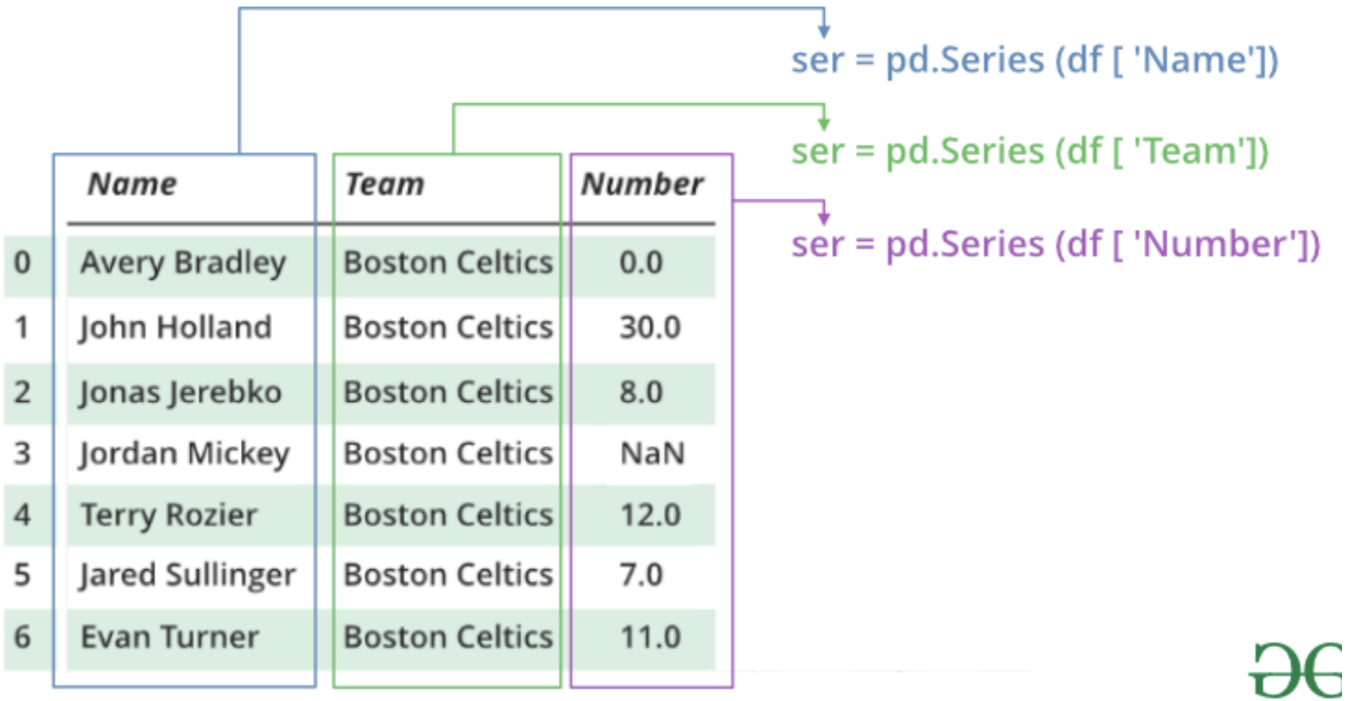
A Panda Series is a one-dimensional ... labeled array capable of holding data of any type (integer, string, float, python objects, etc.).

Panda DataFrame

A Panda DataFrame is a two-dimensional (potentially heterogeneous) tabular data structure with labeled axes for the rows and columns.

Panda Series

Panda Series Elements: columns, data ...



	Name	Team	Number
0	Avery Bradley	Boston Celtics	0.0
1	John Holland	Boston Celtics	30.0
2	Jonas Jerebko	Boston Celtics	8.0
3	Jordan Mickey	Boston Celtics	NaN
4	Terry Rozier	Boston Celtics	12.0
5	Jared Sullinger	Boston Celtics	7.0
6	Evan Turner	Boston Celtics	11.0

Basic Operations:

- Create a series; access elements; index and select data; binary operations; conversion operations.

Panda Series

Example 1: Manually create series from list:

```
# Part 1: Manually create series ...

a = [1, 2, 3, 4, 3, 2, 1 ]
myvar = pd.Series(a)
print(myvar)

# Part 2: Create series from a list with labels ...

myvar = pd.Series(a, index = ["a", "b", "c", "d", "c", "b", "a" ])
print(myvar)
```

Abbreviated Output: Parts 1 and 2 ...

```
Part 01
0    1
1    2
.....
5    2
6    1
dtype: int64
```

```
Part 02
a    1
b    2
.....
b    2
a    1
dtype: int64
```

Panda Series

Example 2: Manually create series from dictionary:

```
calories = {"day1": 420, "day2": 380, "day3": 390}
myvar = pd.Series(calories)
print(myvar)
```

Output:

```
day1    420
day2    380
day3    390
dtype: int64
```

Panda Series

Example 3: Create series from NumPy functions

```
# series01 = pd.Series(np.arange(2,8)) ... ");

series01 = pd.Series(np.arange(2,8))
print(series01)
```

Output:

```
0    2
1    3
2    4
3    5
4    6
5    7
dtype: int64
```

Panda Series

Example 4: Create series from NumPy functions

```
series02 = pd.Series( np.linspace(0,10,5) )
print(series02)

print( series02.size)
print( len(series02) )
print( series02.values )
```

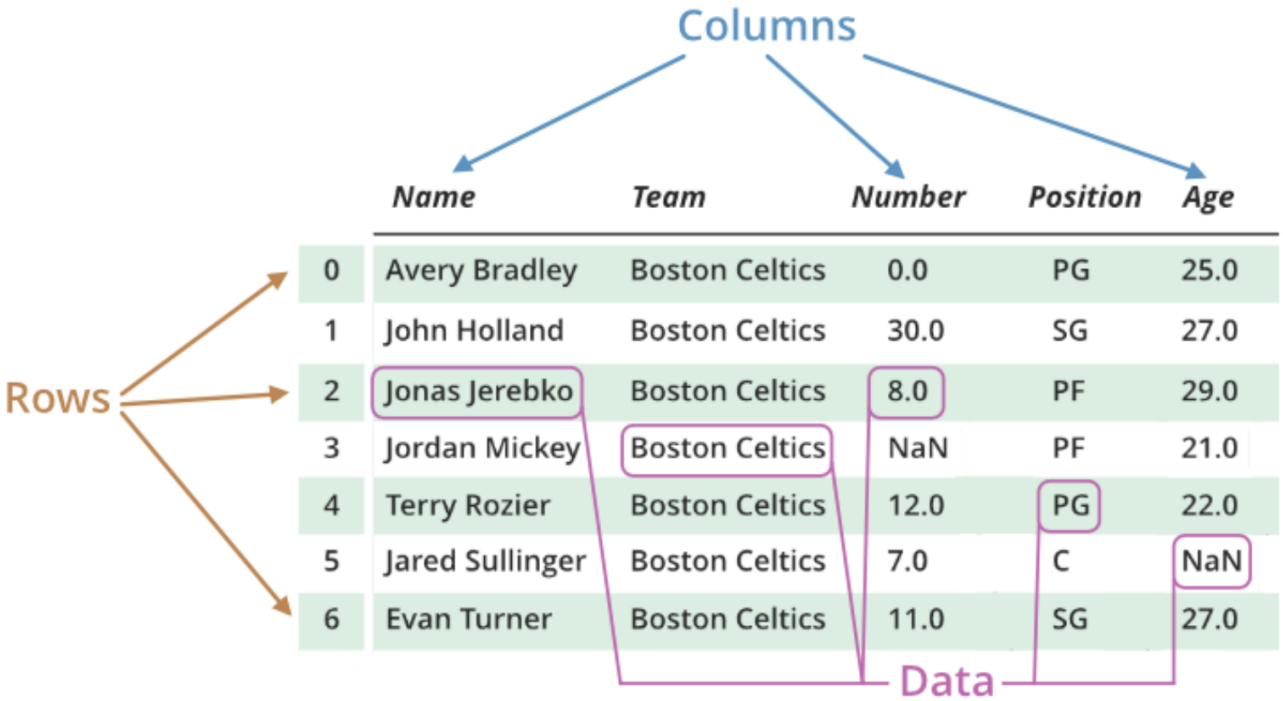
Output:

```
0     0.0
1     2.5
2     5.0
3     7.5
4    10.0
dtype: float64

5                           # <-- series02.size ...
5                           # <-- series02 length ...
[ 0.   2.5  5.   7.5 10. ] # <-- series02 values ...
```

Panda DataFrames

Panda DataFrame Elements: rows, columns, data ...



	Name	Team	Number	Position	Age
0	Avery Bradley	Boston Celtics	0.0	PG	25.0
1	John Holland	Boston Celtics	30.0	SG	27.0
2	Jonas Jerebko	Boston Celtics	8.0	PF	29.0
3	Jordan Mickey	Boston Celtics	NaN	PF	21.0
4	Terry Rozier	Boston Celtics	12.0	PG	22.0
5	Jared Sullinger	Boston Celtics	7.0	C	NaN
6	Evan Turner	Boston Celtics	11.0	SG	27.0

Basic Operations:

- Create dataframe; deal with rows and columns; index and select data; iterate over rows and columns.

Working with Panda DataFrames

Example 1: Manually create small dataset ...

```
mydataset = {
   'cars': [ "BMW", "Honda", "Acura"],
   'year': [ 2013,     2017,    2022]
}

myvar = pd.DataFrame(mydataset)
print(myvar)
```

Output:

```
     cars  year
0     BMW  2013
1   Honda  2017
2   Acura  2022
```

Working with Panda DataFrames

Example 2: Create dataframes from 1-d and 2-d arrays ...

```
myvar = pd.DataFrame( np.arange(1,8) ) # <-- dataframe from 1-d array
print(myvar)

df = pd.DataFrame( [ [1,2],
                     [3,4],
                     [5,6] ] )          # <-- dataframe from 2-d array
print(df)
```

Abbreviated Output:

```
Dataframe from 1-d np array
---------------------------
   0
0  1
1  2
2  3
....
5  6
6  7
```

```
Dataframe from 2-d np array
---------------------------
     0  1
0    1  2
1    3  4
2    5  6
```

Working with Panda DataFrames

Example 3: Create simple dataframe from multiple series ...

```
data = {                              # <-- Create dataframe from
   "calories": [520, 480, 400],       #     multiple series.
   "duration": [ 50,  48,  40]
}

myvar = pd.DataFrame(data)
print(myvar)

index = ["day1", "day2", "day3"]  # <-- give each ros a new name.
myvar = pd.DataFrame(data, index)
print(myvar)
```

Output:

```
Part 1: dataframe from series
   calories  duration
0       520        50
1       480        48
2       400        40
```

```
Part 2: rename rows
      calories  duration
day1       520        50
day2       480        48
day3       400        40
```

Working with Panda DataFrames

Example 4: Create dataframe from JSON object ...

```
# Create JSON object (same format as Python dictionary) ...

data = {
  "Duration":{ "0":60,  "1":60, "2":60,   "3":45,  "4":45,  "5":60 },
  "Pulse":{    "0":110, "1":117, "2":103, "3":109, "4":117, "5":102 },
  "Maxpulse":{ "0":130, "1":145, "2":135, "3":175, "4":148, "5":127 },
  "Calories":{ "0":409, "1":479, "2":340, "3":282, "4":406, "5":300 }
}

df = pd.DataFrame(data)
print(df)
```

Output:

```
   Duration  Pulse  Maxpulse  Calories
0        60    110       130       409
1        60    117       145       479
2        60    103       135       340
3        45    109       175       282
4        45    117       148       406
5        60    102       127       300
```

Working with Panda DataFrames

Example 5: Select rows and columns from dataframe ...

```
# Select columns of a dataframe ...

print( df[ [ 'Duration','Calories'] ].head() )

# Selecting rows of a dataframe ...

print( df.loc['1'].head() )     # <-- extract and print row 1
print( df.loc['2'].head() )     # <-- extract and print row 2
```

Output:

```
Columns of dataframe
--------------------

   Duration  Calories
0        60       409
1        60       479
2        60       340
3        45       282
4        45       406
```

```
Row 1
-----------------

Duration     60
Pulse       117
Maxpulse    145
Calories    479
Name: 1, dtype: int64
```

```
Row 2
-----------------

Duration     60
Pulse       103
Maxpulse    135
Calories    340
Name: 2, dtype: int64
```

Working with Pandas

Example 6: Read and plot CSV data file.

```
df = pd.read_csv('../data/AirPassengers.csv')
print(df.head())

print(df.info())  # <-- print dataframe info and shape ...
print(df.shape)
```

Output:

```
     Month  #Passengers
0  1949-01          112
1  1949-02          118
2  1949-03          132
3  1949-04          129
4  1949-05          121
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 144 entries, 0 to 143
Data columns (total 2 columns):
#   Column       Non-Null Count  Dtype
---  ------       --------------  -----
0   Month        144 non-null    object
1   #Passengers  144 non-null    int64
dtypes: int64(1), object(1)
memory usage: 2.4+ KB
None
(144, 2)
```

Working with Pandas

Example 6: (continued)

```
import matplotlib.pyplot as plt

ax = plt.gca()
df.plot(kind='line',x='Month',y='#Passengers',color='blue',ax=ax)
plt.show()
```

Output: