

# Python Data Analysis Library - Pandas

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TEAMLAB  
director

최성철

**WARNING:** 본 교육 콘텐츠의 지식재산권은 재단법인 네이버커넥트에 귀속됩니다. **본 콘텐츠를 어떠한 경로로든 외부로 유출 및 수정하는 행위를 엄격히 금합니다.**  
다만, 비영리적 교육 및 연구활동에 한정되어 사용할 수 있으나 재단의 허락을 받아야 합니다. 이를 위반하는 경우, 관련 법률에 따라 책임을 질 수 있습니다.

# pandas

구조화된 데이터의 처리를 지원하는 Python 라이브러리  
Python계의 엑셀 !



# pandas

- 구조화된 데이터의 처리를 지원하는 Python 라이브러리
- panel data → pandas
- 고성능 array 계산 라이브러리인 NumPy와 통합하여,  
강력한 “스프레드시트” 처리 기능을 제공
- 인덱싱, 연산용 함수, 전처리 함수 등을 제공함
- 데이터 처리 및 통계 분석을 위해 사용

## Data table, Sample

## attribute, field, feature, column

CRIM	ZN	INDUS	CHAS	NOX	RM	AGE	DIS	RAD	TAX	PTRATIO	B	LSTAT	MEDV	CAT. MEDV
0.00632	18	2.31	0	0.538	6.575	65.2	4.09	1	296	15.3	396.9	4.98	24	0
0.02731	0	7.07	0	0.469	6.421	78.9	4.9671	2	242	17.8	396.9	9.14	21.6	0
0.02729	0	7.07	0	0.469	7.185	61.1	4.9671	2	242	17.8	392.83	4.03	34.7	1
0.03237	0	2.18	0	0.458	6.998	45.8	6.0622	3	222	18.7	394.63	2.94	33.4	1
0.06905	0	2.18	0	0.458	7.147	54.2	6.0622	3	222	18.7	396.9	5.33	36.2	1
0.02985	0	2.18	0	0.458	6.43	58.7	6.0622	3	222	18.7	394.12	5.21	28.7	0
0.08829	12.5	7.87	0	0.524	6.012	66.6	5.5605	5	311	15.2	395.6	12.43	22.9	0
0.14455	12.5	7.87	0	0.524	6.172	96.1	5.9505	5	311	15.2	396.9	19.15	27.1	0
0.21124	12.5	7.87	0	0.524	5.631	100	6.0821	5	311	15.2	386.63	29.93	16.5	0
0.17004	12.5	7.87	0	0.524	6.004	85.9	6.5921	5	311	15.2	386.71	17.1	18.9	0
0.22489	12.5	7.87	0	0.524	6.377	94.3	6.3467	5	311	15.2	392.52	20.45	15	0
0.11747	12.5	7.87	0	0.524	6.009	82.9	6.2267	5	311	15.2	396.9	13.27	18.9	0
0.09378	12.5	7.87	0	0.524	5.889	39	5.4509	5	311	15.2	390.5	15.71	21.7	0
0.62976	0	8.14	0	0.538	5.949	61.8	4.7075	4	307	21	396.9	8.26	20.4	0
0.63796	0	8.14	0	0.538	6.096	84.5	4.4619	4	307	21	380.02	10.26	18.2	0

instance, tuple, row

Feature vector

data

```
conda create -n ml python=3.8 # 가상환경생성  
activate ml      # 가상환경실행  
conda install pandas    # pandas 설치
```

```
jupyter notebook # 주피터 실행하기
```

```
In [1]: import pandas as pd #라이브러리 호출
```

```
In [2]: data_url = 'https://archive.ics.uci.edu/ml/machine-learning-databases/housing/housing.data' #Data URL  
df_data = pd.read_csv(data_url, sep='\\s+', header = None) #csv 파일 데이터 로드, sep은 빈공간으로 지정하고, header는 없음
```

```
In [3]: df_data.head() #처음 다섯줄 출력
```

Out[3]:

	0	1	2	3	4	5	6	7	8	9	10	11	12	13
0	0.00632	18.0	2.31	0	0.538	6.575	65.2	4.0900	1	296.0	15.3	396.90	4.98	24.0
1	0.02731	0.0	7.07	0	0.469	6.421	78.9	4.9671	2	242.0	17.8	396.90	9.14	21.6
2	0.02729	0.0	7.07	0	0.469	7.185	61.1	4.9671	2	242.0	17.8	392.83	4.03	34.7
3	0.03237	0.0	2.18	0	0.458	6.998	45.8	6.0622	3	222.0	18.7	394.63	2.94	33.4
4	0.06905	0.0	2.18	0	0.458	7.147	54.2	6.0622	3	222.0	18.7	396.90	5.33	36.2

# 데이터 로딩

pandas overview

```
In [4]: df_data.columns = ['CRIM', 'ZN', 'INDUS', 'CHAS', 'NOX', 'RM', 'AGE', 'DIS', 'RAD', 'TAX', 'PTRATIO', 'B', 'LSTAT', 'MEDV']  
# Column Header 이름 지정  
df_data.head()
```

Out [4]:

	CRIM	ZN	INDUS	CHAS	NOX	RM	AGE	DIS	RAD	TAX	PTRATIO	B	LSTAT	MEDV
0	0.00632	18.0	2.31	0	0.538	6.575	65.2	4.0900	1	296.0	15.3	396.90	4.98	24.0
1	0.02731	0.0	7.07	0	0.469	6.421	78.9	4.9671	2	242.0	17.8	396.90	9.14	21.6
2	0.02729	0.0	7.07	0	0.469	7.185	61.1	4.9671	2	242.0	17.8	392.83	4.03	34.7
3	0.03237	0.0	2.18	0	0.458	6.998	45.8	6.0622	3	222.0	18.7	394.63	2.94	33.4
4	0.06905	0.0	2.18	0	0.458	7.147	54.2	6.0622	3	222.0	18.7	396.90	5.33	36.2

# 기본적인 것부터 해보자

# series

# pandas의 구성

series

	CRIM	ZN	INDUS	CHAS	NOX	RM	AGE	DIS	RAD	TAX	PTRATIO	B	LSTAT	weight_0
0	0.00632	18.0	2.31	0	0.538	6.575	65.2	4.0900	1	296.0	15.3	396.90	4.98	1
1	0.02731	0.0	7.07	0	0.469	6.421	78.9	4.9671	2	242.0	17.8	396.90	9.14	1
2	0.02729	0.0	7.07	0	0.469	7.185	61.1	4.9671	2	242.0	17.8	392.83	4.03	1
3	0.03237	0.0	2.18	0	0.458	6.998	45.8	6.0622	3	222.0	18.7	394.63	2.94	1
4	0.06905	0.0	2.18	0	0.458	7.147	54.2	6.0622	3	222.0	18.7	396.90	5.33	1

Series

DataFrame 중 하나의 Column에 해당하는  
데이터의 모음 Object

DataFrame

DataTable 전체를 포함하는 Object

# 일반적인 pandas의 활용

series

```
In [1]: import pandas as pd #라이브러리 호출
```

```
In [2]: data_url = 'https://archive.ics.uci.edu/ml/machine-learning-databases/housing/housing.data' #Data URL  
df_data = pd.read_csv(data_url, sep='\\s+', header = None) #csv 파일 데이터 로드, separate는 빈공간으로 지정하고, column은 없음
```

```
In [3]: df_data.head() #처음 다섯줄 출력
```

Out [3]:

	0	1	2	3	4	5	6	7	8	9	10	11	12	13
0	0.00632	18.0	2.31	0	0.538	6.575	65.2	4.0900	1	296.0	15.3	396.90	4.98	24.0
1	0.02731	0.0	7.07	0	0.469	6.421	78.9	4.9671	2	242.0	17.8	396.90	9.14	21.6
2	0.02729	0.0	7.07	0	0.469	7.185	61.1	4.9671	2	242.0	17.8	392.83	4.03	34.7
3	0.03237	0.0	2.18	0	0.458	6.998	45.8	6.0622	3	222.0	18.7	394.63	2.94	33.4
4	0.06905	0.0	2.18	0	0.458	7.147	54.2	6.0622	3	222.0	18.7	396.90	5.33	36.2

기존데이터를 불러와서  
DataFrame을 생성

## - column vector를 표현하는 object

```
In [1]: from pandas import Series, DataFrame  
        import pandas as pd
```

```
In [ ]: example_obj = Series()
```

Init signature: Series(data=None, index=None, dtype=None, name=None, copy=False, fastpath=False)

Docstring:

One-dimensional ndarray with axis labels (including time series).

Shift + TAB

# Series

series

```
In [2]: list_data = [1,2,3,4,5]
example_obj = Series(data = list_data)
example_obj
```

```
Out [2]: 0    1
          1    2
          2    3
          3    4
          4    5
          dtype: int64
```

**Index**

**data**

**Data type**

index	values
A	5
B	6
C	12
D	-5
E	6.7

- Subclass of `numpy.ndarray`
- Data: any type
- Index labels need not be ordered
- Duplicates are possible (but result in reduced functionality)

<https://www.slideshare.net/wesm/pandas-powerful-data-analysis-tools-for-python>

# Series

series

```
In [3]: list_data = [1,2,3,4,5]
list_name = ["a","b","c","d","e"]
example_obj = Series(data = list_data, index=list_name)
example_obj
```

index 이름을 지정

```
Out [3]: a    1
          b    2
          c    3
          d    4
          e    5
          dtype: int64
```

## data와 index 이름을 지정

```
In [4]: dict_data = {"a":1, "b":2, "c":3, "d":4, "e":5}  
example_obj = Series(dict_data, dtype=np.float32, name="example_data")  
example_obj
```

data type 설정      series 이름 설정

```
Out[4]: a    1.0  
         b    2.0  
         c    3.0  
         d    4.0  
         e    5.0  
Name: example_data, dtype: float32
```

## data index에 접근하기

```
In [5]: example_obj["a"]
```

```
Out[5]: 1.0
```

## data index에 값 할당하기

```
In [6]: example_obj["a"] = 3.2  
example_obj
```

```
Out[6]: a    3.2  
        b    2.0  
        c    3.0  
        d    4.0  
        e    5.0  
Name: example_data, dtype: float32
```

```
example_obj.values
```

## 값 리스트만

```
array([ 3.20000005,  2.           ,  3.           ,  4.           ,  5.           ],  
      dtype=float32)
```

```
example_obj.index
```

## Index 리스트만

```
Index(['a', 'b', 'c', 'd', 'e'], dtype='object')
```

```
example_obj.name = "number"  
example_obj.index.name = "alphabet"  
example_obj
```

## Data에 대한 정보를 저장

```
alphabet
```

```
a    3.2  
b    2.0  
c    3.0  
d    4.0  
e    5.0
```

```
Name: number, dtype: float32
```

# Series

series

```
dict_data_1 = {"a":1, "b":2, "c":3, "d":4, "e":5}
indexes = ["a","b","c","d","e","f","g","h"]
series_obj_1 = Series(dict_data_1, index=indexes)
series_obj_1      index 값을 기준으로 series 생성
```

```
a    1.0
b    2.0
c    3.0
d    4.0
e    5.0
f    NaN
g    NaN
h    NaN
dtype: float64
```

# dataframe

# pandas의 구성

dataframe

	CRIM	ZN	INDUS	CHAS	NOX	RM	AGE	DIS	RAD	TAX	PTRATIO	B	LSTAT	weight_0
0	0.00632	18.0	2.31	0	0.538	6.575	65.2	4.0900	1	296.0	15.3	396.90	4.98	1
1	0.02731	0.0	7.07	0	0.469	6.421	78.9	4.9671	2	242.0	17.8	396.90	9.14	1
2	0.02729	0.0	7.07	0	0.469	7.185	61.1	4.9671	2	242.0	17.8	392.83	4.03	1
3	0.03237	0.0	2.18	0	0.458	6.998	45.8	6.0622	3	222.0	18.7	394.63	2.94	1
4	0.06905	0.0	2.18	0	0.458	7.147	54.2	6.0622	3	222.0	18.7	396.90	5.33	1

Series

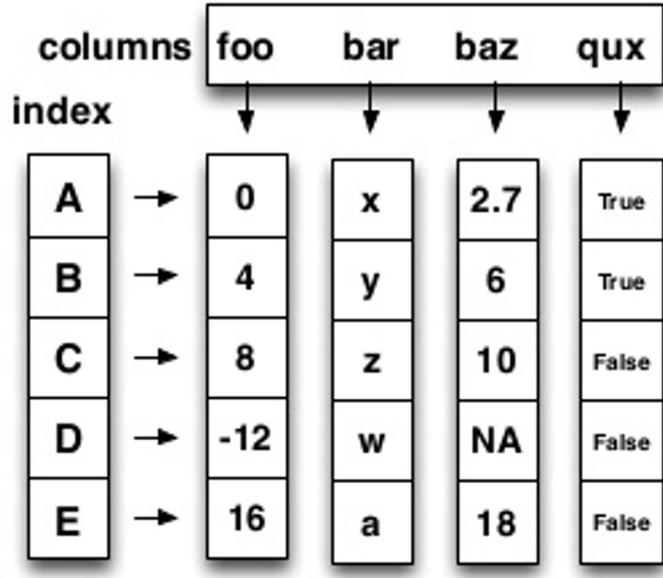
DataFrame 중 하나의 Column에 해당하는  
데이터의 모음 Object

DataFrame

DataTable 전체를 포함하는 Object

# dataframe memory

dataframe



- NumPy array-like
- Each column can have a different type
- Row and column index
- Size mutable: insert and delete columns

<https://www.slideshare.net/wesm/pandas-powerful-data-analysis-tools-for-python>

## Series를 모아서 만든 Data Table = 기본 2차원

```
In [4]: from pandas import Series, DataFrame  
import pandas as pd  
import numpy as np
```

```
In [ ]: DataFrame()
```

Shift + TAB

```
In [3]: Init signature: DataFrame(data=None, index=None, columns=None, dtype=None, copy=False)  
Docstring:  
Two-dimensional size-mutable, potentially heterogeneous tabular data  
structure with labeled axes (rows and columns). Arithmetic operations
```

# dataframe 생성

dataframe

```
In [1]: from pandas import Series, DataFrame  
import pandas as pd  
import numpy as np
```

column\_name : data

```
In [2]: # Example from - https://christianbon.com/python/pandas_map_values_to_values.html/  
raw_data = {'first_name': ['Jason', 'Molly', 'Tina', 'Jake', 'Amy'],  
            'last_name': ['Miller', 'Jacobson', 'Ali', 'Milner', 'Cooze'],  
            'age': [42, 52, 36, 24, 73],  
            'city': ['San Francisco', 'Baltimore', 'Miami', 'Douglas', 'Boston']}  
df = pd.DataFrame(raw_data, columns = ['first_name', 'last_name', 'age', 'city'])  
df
```

Out[2]:

	first_name	last_name	age	city
0	Jason	Miller	42	San Francisco
1	Molly	Jacobson	52	Baltimore
2	Tina	Ali	36	Miami
3	Jake	Milner	24	Douglas
4	Amy	Cooze	73	Boston

# dataframe 생성

dataframe

```
In [3]: DataFrame(raw_data, columns = ["age", "city"])
```

Out[3]:

	age	city
0	42	San Francisco
1	52	Baltimore
2	36	Miami
3	24	Douglas
4	73	Boston

## column 선택

```
In [4]: DataFrame(raw_data, columns = ["first_name", "last_name", "age", "city", "debt"])
```

Out[4]:

	first_name	last_name	age	city	debt
0	Jason	Miller	42	San Francisco	NaN
1	Molly	Jacobson	52	Baltimore	NaN
2	Tina	Ali	36	Miami	NaN
3	Jake	Milner	24	Douglas	NaN
4	Amy	Cooze	73	Boston	NaN

## 새로운 column 추가

```
df = DataFrame(raw_data, columns = ["first_name", "last_name", "age", "city", "debt"])
df.first_name
```

```
0    Jason
1    Molly
2    Tina
3    Jake
4    Amy
Name: first_name, dtype: object
```

## column 선택 - series 추출

```
df["first_name"]
```

```
0    Jason
1    Molly
2    Tina
3    Jake
4    Amy
Name: first_name, dtype: object
```

## column 선택 - series 추출

# dataframe indexing

dataframe

	first_name	last_name	age	city	debt
0	Jason	Miller	42	San Francisco	NaN
1	Molly	Jacobson	52	Baltimore	NaN
2	Tina	Ali	36	Miami	NaN
3	Jake	Milner	24	Douglas	NaN
4	Amy	Cooze	73	Boston	NaN

df.loc[1]

**loc – index location**

```
first_name      Molly
last_name       Jacobson
age             52
city           Baltimore
debt            NaN
Name: 1, dtype: object
```

df["age"].iloc[1:]

**iloc – index position**

```
1    52
2    36
3    24
4    73
Name: age, dtype: int64
```

## loc은 index 이름, iloc은 index number

```
# Example from - https://stackoverflow.com/questions/31593201/pandas-iloc-vs-ix-vs-loc-explanation
s = pd.Series(np.nan, index=[49, 48, 47, 46, 45, 1, 2, 3, 4, 5])
s.loc[:3]
```

```
49    NaN
48    NaN
47    NaN
46    NaN
45    NaN
1     NaN
2     NaN
3     NaN
dtype: float64
```

```
s.iloc[:3]
```

```
49    NaN
48    NaN
47    NaN
dtype: float64
```

## column에 새로운 데이터 할당

```
df.debt = df.age > 40  
df
```

	first_name	last_name	age	city	debt
0	Jason	Miller	42	San Francisco	True
1	Molly	Jacobson	52	Baltimore	True
2	Tina	Ali	36	Miami	False
3	Jake	Milner	24	Douglas	False
4	Amy	Cooze	73	Boston	True

```
df.T
```

# dataframe handling

dataframe

```
In [13]: df.T
```

```
Out[13]:
```

	0	1	2	3	4
first_name	Jason	Molly	Tina	Jake	Amy
last_name	Miller	Jacobson	Ali	Milner	Cooze
age	42	52	36	24	73
city	San Francisco	Baltimore	Miami	Douglas	Boston
debt	True	True	False	False	True

transpose

```
In [14]: df.values
```

```
Out[14]: array([['Jason', 'Miller', 42, 'San Francisco', True],  
                 ['Molly', 'Jacobson', 52, 'Baltimore', True],  
                 ['Tina', 'Ali', 36, 'Miami', False],  
                 ['Jake', 'Milner', 24, 'Douglas', False],  
                 ['Amy', 'Cooze', 73, 'Boston', True]], dtype=object)
```

값 출력

```
In [20]: df.to_csv()
```

```
Out[20]: ',first_name,last_name,age,city,debt\n0,Jason,Miller,42, San Francisco,True\n1,Molly,Jacobson,52,Baltimore,True\n2,Tina,Ali,36,Miami,False\n3,Jake,Milner,24,Douglas,False\n4,Amy,Cooze,73,Boston,True'
```

CSV 변환

## column을 삭제함

```
del df[ "debt" ]
```

```
df
```

	first_name	last_name	age	city
0	Jason	Miller	42	San Francisco
1	Molly	Jacobson	52	Baltimore
2	Tina	Ali	36	Miami
3	Jake	Milner	24	Douglas
4	Amy	Cooze	73	Boston

# selection & drop

# Selection with column names

selection & drop

```
df[ "account" ].head(3)
```

한개의 column 선택시

```
0    211829  
1    320563  
2    648336
```

```
Name: account, dtype: int64
```

1개 이상의 column 선택

```
df[ [ "account", "street", "state" ] ].head(3)
```

	account	street	state
0	211829	34456 Sean Highway	Texas
1	320563	1311 Alvis Tunnel	NorthCarolina
2	648336	62184 Schamberger Underpass Apt. 231	Iowa

# Selection with index number

selection & drop

df[ :3] column 이름 없이 사용하는 index number는 row 기준 표시

	account	name	street	city	state	postal-code	Jan	Feb	Mar
0	211829	Kerluke, Koepp and Hilpert	34456 Sean Highway	New Jaycob	Texas	28752	10000	62000	35000
1	320563	Walter-Trantow	1311 Alvis Tunnel	Port Khadijah	NorthCarolina	38365	95000	45000	35000
2	648336	Bashirian, Kunde and Price	62184 Schamberger Underpass Apt. 231	New Lilianland	Iowa	76517	91000	120000	35000

df[ "account" ][ :3]

column이름과 함께 row index 사용시, 해당 column만

```
0    211829  
1    320563  
2    648336  
Name: account, dtype: int64
```

# Selection with index number

selection & drop

```
account_serires = df["account"]  
account_serires[:3]
```

```
0    211829  
1    320563  
2    648336  
Name: account, dtype: int64
```

```
account_serires[[0,1,2]]
```

```
0    211829    1개 이상의  
1    320563    index  
2    648336  
Name: account, dtype: int64
```

```
account_serires[account_serires<250000]
```

```
0    211829  
3    109996  
4    121213  
5    132971  
6    145068  
7    205217  
8    209744  
9    212303  
10   214098  
11   231907  
12   242368
```

```
Name: account, dtype: int64
```

Boolean index

# index 변경

selection & drop

```
df.index = df[ "account" ]  
del df[ "account" ]  
df.head()
```

	<b>name</b>	<b>street</b>	<b>city</b>	<b>state</b>	<b>postal-code</b>	<b>Jan</b>	<b>Feb</b>	<b>Mar</b>
<b>account</b>								
<b>211829</b>	Kerluke, Koepp and Hilpert	34456 Sean Highway	New Jaycob	Texas	28752	10000	62000	35000
<b>320563</b>	Walter-Trantow	1311 Alvis Tunnel	Port Khadijah	NorthCarolina	38365	95000	45000	35000
<b>648336</b>	Bashirian, Kunde and Price	62184 Schamberger Underpass Apt. 231	New Lilianland	Iowa	76517	91000	120000	35000
<b>109996</b>	D'Amore, Gleichner and Bode	155 Fadel Crescent Apt. 144	Hyattburgh	Maine	46021	45000	120000	10000
<b>121213</b>	Bauch-Goldner	7274 Marissa Common	Shanahanchester	California	49681	162000	120000	35000

# basic, loc, iloc selection

selection & drop

Column 과 index  
number

```
df[["name", "street"]][:2]
```

	name	street
<b>account</b>		
<b>211829</b>	Kerluke, Koepp and Hilpert	34456 Sean Highway
<b>320563</b>	Walter-Trantow	1311 Alvis Tunnel

Column number와 index number

```
df.iloc[:2,:2]
```

	name	street
<b>account</b>		
<b>211829</b>	Kerluke, Koepp and Hilpert	34456 Sean Highway
<b>320563</b>	Walter-Trantow	1311 Alvis Tunnel

df.loc[[211829,320563],["name", "street"]] Column 과 index

name

	name	street
<b>account</b>		
<b>211829</b>	Kerluke, Koepp and Hilpert	34456 Sean Highway
<b>320563</b>	Walter-Trantow	1311 Alvis Tunnel

## index 재설정

selection & drop

```
df.index = list(range(0,15))  
df.head()
```

	<b>name</b>	<b>street</b>	<b>city</b>	<b>state</b>	<b>postal-code</b>
<b>0</b>	Kerluke, Koepp and Hilpert	34456 Sean Highway	New Jaycob	Texas	28752
<b>1</b>	Walter-Trantow	1311 Alvis Tunnel	Port Khadijah	NorthCarolina	38365
<b>2</b>	Bashirian, Kunde and Price	62184 Schamberger Underpass Apt. 231	New Lilianland	Iowa	76517

```
df.drop(1) index number로 drop
```

	<b>name</b>	<b>street</b>	<b>city</b>	<b>s</b>
0	Kerluke, Koepp and Hilpert	34456 Sean Highway	New Jaycob	T
2	Bashirian, Kunde and Price	62184 Schamberger Underpass Apt. 231	New Lilianland	k

```
df.drop([0,1,2,3]) 한개 이상의 Index number로 drop
```

	account	name	street	city	state
4	121213	Bauch-Goldner	7274 Marissa Common	Shanahanchester	California
5	132971	Williamson, Schumm and Hettinger	89403 Casimer Spring	Jeremieburgh	Arkansas
6	145068	Casper LLC	340 Consuela Bridge Apt. 400	Lake Gabriellaton	Mississipi

axis 지정으로 축을 기준으로 drop → column 중에 “city”

```
df.drop("city", axis=1) # df.drop(["city", "state"], axis=1)
```

	<b>name</b>	<b>street</b>	<b>state</b>	<b>postal-code</b>
0	Kerluke, Koepp and Hilpert	34456 Sean Highway	Texas	28752
1	Walter-Trantow	1311 Alvis Tunnel	NorthCarolina	38365
2	Bashirian, Kunde and Price	62184 Schamberger Underpass Apt. 231	Iowa	76517

# dataframe operations

# series operation

dataframe operations

```
s1 = Series(  
    range(1,6), index=list("abced"))  
s1  
  
a    1  
b    2  
c    3  
e    4  
d    5  
dtype: int64
```

```
s2 = Series(  
    range(5,11), index=list("bcedef"))  
s2  
  
b    5  
c    6  
e    7  
d    8  
e    9  
f    10  
dtype: int64
```

s1.add(s2)

```
a      NaN  
b      7.0  
c      9.0  
d     13.0  
e     11.0  
e     13.0  
f      NaN  
dtype: float64
```

s1 + s2

```
a      NaN  
b      7.0  
c      9.0  
d     13.0  
e     11.0  
e     13.0  
f      NaN  
dtype: float64
```

index 으로 기준으로 연산수행

겹치는 index가 없을 경우  
NaN값으로 반환

# dataframe operation

dataframe operations

```
df1 = DataFrame(  
    np.arange(9).reshape(3,3),  
    columns=list("abc"))  
df1
```

	a	b	c
0	0	1	2
1	3	4	5
2	6	7	8

```
df2 = DataFrame(  
    np.arange(16).reshape(4,4),  
    columns=list("abcd"))  
df2
```

	a	b	c	d
0	0	1	2	3
1	4	5	6	7
2	8	9	10	11
3	12	13	14	15

df1 + df2

	a	b	c	d
0	0.0	2.0	4.0	NaN
1	7.0	9.0	11.0	NaN
2	14.0	16.0	18.0	NaN
3	NaN	NaN	NaN	NaN

df1.add(df2, fill\_value=0)

	a	b	c	d
0	0.0	2.0	4.0	3.0
1	7.0	9.0	11.0	7.0
2	14.0	16.0	18.0	11.0
3	12.0	13.0	14.0	15.0

df는 column과 index를 모두 고려

add operation을 쓰면 NaN값 0으로 변환  
Operation types: add, sub, div, mul

# series + dataframe

dataframe operations

```
df = DataFrame(  
    np.arange(16).reshape(4,4),  
    columns=list("abcd"))  
  
df
```

	a	b	c	d
0	0	1	2	3
1	4	5	6	7
2	8	9	10	11
3	12	13	14	15

```
s2 = Series(np.arange(10,14))  
s2
```

```
0      10  
1      11  
2      12  
3      13  
dtype: int64
```

```
df + s2
```

	a	b	c	d	0	1	2	3
0	NaN							
1	NaN							
2	NaN							
3	NaN							

```
df.add(s2, axis=0)
```

	a	b	c	d
0	10	11	12	13
1	15	16	17	18
2	20	21	22	23
3	25	26	27	28

axis를 기준으로  
row broadcasting 실행

# lambda, map, apply

## map for series

lambda, map, apply

- pandas의 series type의 데이터에도 map 함수 사용 가능
- function 대신 dict, sequence형 자료등으로 대체 가능

```
s1 = Series(np.arange(10))
s1.head(5)
```

```
0    0
1    1
2    2
3    3
4    4
dtype: int64
```

```
s1.map(lambda x: x**2).head(5)
```

```
0    0
1    1
2    4
3    9
4   16
dtype: int64
```

# map for series

lambda, map, apply

```
z = {1: 'A', 2: 'B', 3: 'C'}  
s1.map(z).head(5)
```

```
0      NaN  
1        A  
2        B  
3        C  
4      NaN  
dtype: object
```

dict type으로  
데이터 교체  
없는 값은 NaN

```
s2 = Series(np.arange(10,20))  
s1.map(s2).head(5)
```

```
0      10  
1      11  
2      12  
3      13  
4      14  
dtype: int64
```

같은 위치의 데이터를 s2로  
전환

## example - map for series

lambda, map, apply

```
df = pd.read_csv("wages.csv")
df.head()
```

	earn	height	sex	race	ed	age
0	79571.299011	73.89	male	white	16	49
1	96396.988643	66.23	female	white	16	62
2	48710.666947	63.77	female	white	16	33
3	80478.096153	63.22	female	other	16	95
4	82089.345498	63.08	female	white	17	43

```
df.sex.unique()
```

```
array(['male', 'female'], dtype=object)
```

```
df["sex_code"] = df.sex.map({"male":0, "female":1})
df.head(5)
```

성별 str → 성별 code

	earn	height	sex	race	ed	age	sex_code
0	79571.299011	73.89	male	white	16	49	0
1	96396.988643	66.23	female	white	16	62	1
2	48710.666947	63.77	female	white	16	33	1
3	80478.096153	63.22	female	other	16	95	1
4	82089.345498	63.08	female	white	17	43	1

# replace function

lambda, map, apply

- Map 함수의 기능 중 데이터 변환 기능만 담당
- 데이터 변환시 많이 사용하는 함수

```
df.sex.replace(  
    {"male":0, "female":1}  
).head()
```

0 0      dict type 적용  
1 1  
2 1  
3 1  
4 1  
  
Name: sex, dtype: int64

```
df.sex.replace(  
    ["male", "female"],  
    [0,1], inplace=True)  
df.head(5)
```

	earn	height	sex	race	ed	age	sex_code
0	79571.299011	73.89	0	white	16	49	0
1	96396.988643	66.23	1	white	16	62	1
2	48710.666947	63.77	1	white	16	33	1

Target list  
Conversion list

inplace → 데이터 변환결과를 적용

## apply for dataframe

lambda, map, apply

- map과 달리, series 전체(column)에 해당 함수를 적용
- 입력 값이 series 데이터로 입력 받아 handling 가능

```
df_info = df[["earn", "height", "age"]]
df_info.head()
```

	earn	height	age
0	79571.299011	73.89	49
1	96396.988643	66.23	62
2	48710.666947	63.77	33
3	80478.096153	63.22	95
4	82089.345498	63.08	43

```
f = lambda x : x.max() - x.min()
df_info.apply(f)
```

```
earn      318047.708444
height      19.870000
age      73.000000
dtype: float64
```

각 column 별로 결과값 반환

## apply for dataframe

lambda, map, apply

- 내장 연산 함수를 사용할 때도 똑같은 효과를 거둘 수 있음
- mean, std 등 사용가능

```
df_info.sum()
```

```
earn      4.474344e+07
height    9.183125e+04
age       6.250800e+04
dtype: float64
```

```
df_info.apply(sum)
```

```
earn      4.474344e+07
height    9.183125e+04
age       6.250800e+04
dtype: float64
```

## apply for dataframe

lambda, map, apply

- scalar 값 이외에 series값의 반환도 가능함

```
def f(x):
    return Series([x.min(), x.max()], index=["min", "max"])
df_info.apply(f)
```

	earn	height	age
min	-98.580489	57.34	22
max	317949.127955	77.21	95

# applymap for dataframe

lambda, map, apply

- series 단위가 아닌 element 단위로 함수를 적용함
- series 단위에 apply를 적용시킬 때와 같은 효과

```
f = lambda x : -x  
df_info.applymap(f).head(5)
```

	earn	height	age
0	-79571.299011	-73.89	-49
1	-96396.988643	-66.23	-62
2	-48710.666947	-63.77	-33
3	-80478.096153	-63.22	-95
4	-82089.345498	-63.08	-43

```
f = lambda x : -x  
df_info[ "earn" ].apply(f).head(5)
```

```
0    -79571.299011  
1    -96396.988643  
2    -48710.666947  
3    -80478.096153  
4    -82089.345498  
Name: earn, dtype: float64
```

# pandas built-in functions

## - Numeric type 데이터의 요약 정보를 보여줌

```
df = pd.read_csv("wages.csv")
df.head()
```

	earn	height	sex	race	ed	age
0	79571.299011	73.89	male	white	16	49
1	96396.988643	66.23	female	white	16	62
2	48710.666947	63.77	female	white	16	33
3	80478.096153	63.22	female	other	16	95
4	82089.345498	63.08	female	white	17	43

```
df.describe()
```

	earn	height	ed	age
count	1379.000000	1379.000000	1379.000000	1379.000000
mean	32446.292622	66.592640	13.354605	45.328499
std	31257.070006	3.818108	2.438741	15.789715
min	-98.580489	57.340000	3.000000	22.000000
25%	10538.790721	63.720000	12.000000	33.000000
50%	26877.870178	66.050000	13.000000	42.000000
75%	44506.215336	69.315000	15.000000	55.000000
max	317949.127955	77.210000	18.000000	95.000000

- series data의 유일한 값을 list를 반환함

```
df.race.unique()
```

유일한 인종의 값 list

```
array(['white', 'other', 'hispanic', 'black'], dtype=object)
```

```
np.array(dict(enumerate(df["race"].unique())))
```

dict type으로 index

```
array({0: 'white', 1: 'other', 2: 'hispanic', 3: 'black'}, dtype=object)
```

```
value = list(map(int, np.array(list(enumerate(df["race"].unique())))[ :, 0 ].tolist()))
key = np.array(list(enumerate(df["race"].unique())), dtype=str)[ :, 1 ].tolist()
```

```
value, key
```

label index 값과 label 값 각각 추출

```
([0, 1, 2, 3], ['white', 'other', 'hispanic', 'black'])
```

- series data의 유일한 값을 list를 반환함

```
df["race"].replace(to_replace=key, value=value, inplace=True)
```

label str → index 값으로 변환

```
value = list(map(int, np.array(list(enumerate(df["sex"].unique())))[ :, 0].tolist()))
key = np.array(list(enumerate(df["sex"].unique())), dtype=str)[ :, 1].tolist()
```

```
value, key
```

성별에 대해서도 동일하게 적용

```
([0, 1], ['male', 'female'])
```

```
df["sex"].replace(to_replace=key, value=value, inplace=True)
df.head(5)
```

	earn	height	sex	race	ed	age
0	79571.299011	73.89	0	0	16	49
1	96396.988643	66.23	1	0	16	62

“sex”와 “race” column의  
index labelling

- 기본적인 column 또는 row 값의 연산을 지원
- sub, mean, min, max, count, median, mad, var 등

`df.sum(axis=0)` | column 별

```
earn      4.474344e+07  
height    9.183125e+04  
sex       8.590000e+02  
race      5.610000e+02  
ed        1.841600e+04  
age       6.250800e+04  
dtype: float64
```

`df.sum(axis=1)` row 별

```
0          79710.189011  
1          96542.218643  
2          48824.436947  
3          80654.316153  
4          82213.425498  
5          15423.882901  
6          47231.711821
```

- column 또는 row 값의 NaN (null) 값의 index를 반환함

```
df.isnull()
```

	earn	height	sex	race	ed	age
0	False	False	False	False	False	False
1	False	False	False	False	False	False
2	False	False	False	False	False	False

```
df.isnull().sum()
```

```
earn          0   Null인 값의 합  
height        0  
sex           0  
race          0  
ed            0  
age           0  
dtype: int64
```

- column 값을 기준으로 데이터를 sorting

```
df.sort_values(["age", "earn"], ascending=True).head(10)
```

	earn	height	sex	race	ed	age
1038	-56.321979	67.81	0	2	10	22
800	-27.876819	72.29	0	0	12	22
963	-25.655260	68.90	0	0	12	22
1105	988.565070	64.71	1	0	12	22
801	1000.221504	64.09	1	0	12	22

ascending → 오름차순

- 상관계수와 공분산을 구하는 함수
- corr, cov, corrwith

```
: df.age.corr(df.earn)
```

```
: 0.074003491778360575
```

```
: df.age.cov(df.earn)
```

```
: 36523.6992104089
```

```
df.corrwith(df.earn)
```

```
earn      1.000000
height   0.291600
sex     -0.337328
race    -0.063977
ed       0.350374
age      0.074003
dtype: float64
```

# Correlation & Covariance

pandas built-in functions

```
df.corr()
```

	<b>earn</b>	<b>height</b>	<b>sex</b>	<b>race</b>	<b>ed</b>	<b>age</b>
<b>earn</b>	1.000000	0.291600	-0.337328	-0.063977	0.350374	0.074003
<b>height</b>	0.291600	1.000000	-0.703672	-0.045974	0.114047	-0.133727
<b>sex</b>	-0.337328	-0.703672	1.000000	0.000858	-0.061747	0.070036
<b>race</b>	-0.063977	-0.045974	0.000858	1.000000	-0.049487	-0.056879
<b>ed</b>	0.350374	0.114047	-0.061747	-0.049487	1.000000	-0.129802
<b>age</b>	0.074003	-0.133727	0.070036	-0.056879	-0.129802	1.000000

End of  
Document  
Thank You.