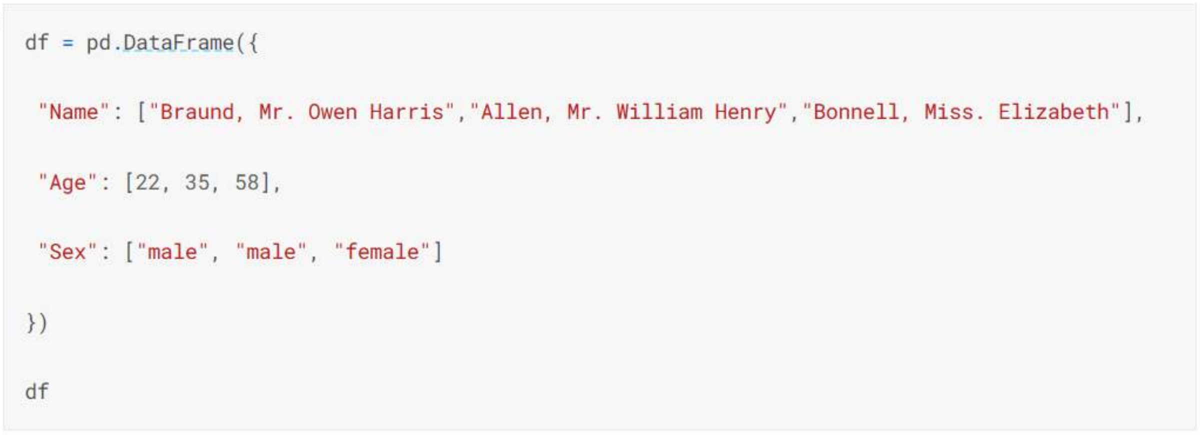
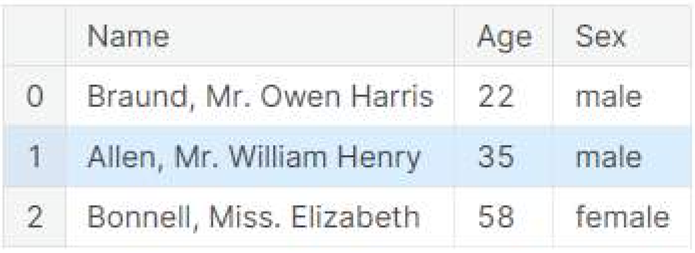
Python Pandas from Basics to Advance



```
df = pd.DataFrame({

 "Name": ["Braund, Mr. Owen Harris","Allen, Mr. William Henry","Bonnell, Miss. Elizabeth"],

 "Age": [22, 35, 58],

 "Sex": ["male", "male", "female"]

})

df
```



	Name	Age	Sex
0	Braund, Mr. Owen Harris	22	male
1	Allen, Mr. William Henry	35	male
2	Bonnell, Miss. Elizabeth	58	female

Syed Afroz Ali
Data Scientist (Kaggle Grandmaster)
https://www.kaggle.com/pythonafroz
https://www.linkedin.com/in/syed-afroz-70939914/

Pandas toolkit Part 1

Syed Afroz Ali

In [1]:
```
import pandas as pd
import matplotlib.pyplot as plt
```

In [2]:
```
df = pd.DataFrame({

 "Name": ["Braund, Mr. Owen Harris","Allen, Mr. William Henry","Bonnell, Miss.

 "Age": [22, 35, 58],

 "Sex": ["male", "male", "female"]

})

df
```

Out[2]:

	Name	Age	Sex
0	Braund, Mr. Owen Harris	22	male
1	Allen, Mr. William Henry	35	male
2	Bonnell, Miss. Elizabeth	58	female

In [3]:
```
df["Age"]
```

Out[3]:
```
0    22
1    35
2    58
Name: Age, dtype: int64
```

In [4]:
```
ages = pd.Series([22, 35, 58], name="Age")
ages
```

Out[4]:
```
0    22
1    35
2    58
Name: Age, dtype: int64
```

In [5]:
```
df["Age"].max()
```

Out[5]:
```
58
```

In [6]:
```
ages.max()
```

Out[6]:
```
58
```

In [7]:
```
df.describe()
```
Out[7]:

	Age
count	3.000000
mean	38.333333
std	18.230012
min	22.000000
25%	28.500000
50%	35.000000
75%	46.500000
max	58.000000

In [8]:
```
titanic = pd.read_csv("train_titanic.csv")
titanic.head()
```
Out[8]:

	PassengerId	Survived	Pclass	Name	Sex	Age	SibSp	Parch	Ticket	Fare	Cal
0	1	0	3	Braund, Mr. Owen Harris	male	22.0	1	0	A/5 21171	7.2500	N
1	2	1	1	Cumings, Mrs. John Bradley (Florence Briggs Th...	female	38.0	1	0	PC 17599	71.2833	C
2	3	1	3	Heikkinen, Miss. Laina	female	26.0	0	0	STON/O2. 3101282	7.9250	N
3	4	1	1	Futrelle, Mrs. Jacques Heath (Lily May Peel)	female	35.0	1	0	113803	53.1000	C1
4	5	0	3	Allen, Mr. William Henry	male	35.0	0	0	373450	8.0500	N

In [9]:
```
titanic.dtypes
```

Out[9]:
```
PassengerId      int64
Survived         int64
Pclass           int64
Name            object
Sex             object
Age            float64
SibSp            int64
Parch            int64
Ticket          object
Fare           float64
Cabin           object
Embarked        object
dtype: object
```

In [10]:
```
titanic.to_excel("titanic.xlsx", sheet_name="passengers", index=False)
```

In [11]:
```
titanic = pd.read_excel("titanic.xlsx", sheet_name="passengers")
```

In [12]:
```
titanic.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 891 entries, 0 to 890
Data columns (total 12 columns):
 #   Column       Non-Null Count  Dtype  
---  ------       --------------  -----  
 0   PassengerId  891 non-null    int64  
 1   Survived     891 non-null    int64  
 2   Pclass       891 non-null    int64  
 3   Name         891 non-null    object 
 4   Sex          891 non-null    object 
 5   Age          714 non-null    float64
 6   SibSp        891 non-null    int64  
 7   Parch        891 non-null    int64  
 8   Ticket       891 non-null    object 
 9   Fare         891 non-null    float64
 10  Cabin        204 non-null    object 
 11  Embarked     889 non-null    object 
dtypes: float64(2), int64(5), object(5)
memory usage: 83.7+ KB
```

In [13]:
```
ages = titanic["Age"]
ages.head()
```

Out[13]:
```
0    22.0
1    38.0
2    26.0
3    35.0
4    35.0
Name: Age, dtype: float64
```

In [14]:
```python
type(titanic["Age"])
```
Out[14]:
```
pandas.core.series.Series
```

In [15]:
```python
titanic["Age"].shape
```
Out[15]:
```
(891,)
```

In [16]:
```python
titanic["Age"].shape
```
Out[16]:
```
(891,)
```

In [17]:
```python
age_sex = titanic[["Age", "Sex"]]
age_sex.head()
```
Out[17]:

	Age	Sex
0	22.0	male
1	38.0	female
2	26.0	female
3	35.0	female
4	35.0	male

In [18]:
```python
titanic[["Age", "Sex"]].shape
```
Out[18]:
```
(891, 2)
```

In [19]:
```python
above_35 = titanic[titanic["Age"] > 35]
above_35.head()
```
Out[19]:

	PassengerId	Survived	Pclass	Name	Sex	Age	SibSp	Parch	Ticket	Fare	Cab
1	2	1	1	Cumings, Mrs. John Bradley (Florence Briggs Th...	female	38.0	1	0	PC 17599	71.2833	C8
6	7	0	1	McCarthy, Mr. Timothy J	male	54.0	0	0	17463	51.8625	E4
11	12	1	1	Bonnell, Miss. Elizabeth	female	58.0	0	0	113783	26.5500	C1
13	14	0	3	Andersson, Mr. Anders Johan	male	39.0	1	5	347082	31.2750	Na
15	16	1	2	Hewlett, Mrs. (Mary D Kingcome)	female	55.0	0	0	248706	16.0000	Na

```
In [20]: class_23 = titanic[titanic["Pclass"].isin([2, 3])]
         class_23.head()
```

Out[20]:

	PassengerId	Survived	Pclass	Name	Sex	Age	SibSp	Parch	Ticket	Fare	Cal
0	1	0	3	Braund, Mr. Owen Harris	male	22.0	1	0	A/5 21171	7.2500	N
2	3	1	3	Heikkinen, Miss. Laina	female	26.0	0	0	STON/O2. 3101282	7.9250	N
4	5	0	3	Allen, Mr. William Henry	male	35.0	0	0	373450	8.0500	N
5	6	0	3	Moran, Mr. James	male	NaN	0	0	330877	8.4583	N
7	8	0	3	Palsson, Master. Gosta Leonard	male	2.0	3	1	349909	21.0750	N

```
In [21]: class_23 = titanic[(titanic["Pclass"] == 2) | (titanic["Pclass"] == 3)]
         class_23.head()
```

Out[21]:

	PassengerId	Survived	Pclass	Name	Sex	Age	SibSp	Parch	Ticket	Fare	Cal
0	1	0	3	Braund, Mr. Owen Harris	male	22.0	1	0	A/5 21171	7.2500	N
2	3	1	3	Heikkinen, Miss. Laina	female	26.0	0	0	STON/O2. 3101282	7.9250	N
4	5	0	3	Allen, Mr. William Henry	male	35.0	0	0	373450	8.0500	N
5	6	0	3	Moran, Mr. James	male	NaN	0	0	330877	8.4583	N
7	8	0	3	Palsson, Master. Gosta Leonard	male	2.0	3	1	349909	21.0750	N

In [22]:
```python
age_no_na = titanic[titanic["Age"].notna()]
age_no_na.head()
```

Out[22]:

	PassengerId	Survived	Pclass	Name	Sex	Age	SibSp	Parch	Ticket	Fare	Cal
0	1	0	3	Braund, Mr. Owen Harris	male	22.0	1	0	A/5 21171	7.2500	N
1	2	1	1	Cumings, Mrs. John Bradley (Florence Briggs Th...	female	38.0	1	0	PC 17599	71.2833	C
2	3	1	3	Heikkinen, Miss. Laina	female	26.0	0	0	STON/O2. 3101282	7.9250	N
3	4	1	1	Futrelle, Mrs. Jacques Heath (Lily May Peel)	female	35.0	1	0	113803	53.1000	C1
4	5	0	3	Allen, Mr. William Henry	male	35.0	0	0	373450	8.0500	N

In [23]:
```python
adult_names = titanic.loc[titanic["Age"] > 35]
adult_names.head()
```

Out[23]:

	PassengerId	Survived	Pclass	Name	Sex	Age	SibSp	Parch	Ticket	Fare	Cab
1	2	1	1	Cumings, Mrs. John Bradley (Florence Briggs Th...	female	38.0	1	0	PC 17599	71.2833	C8
6	7	0	1	McCarthy, Mr. Timothy J	male	54.0	0	0	17463	51.8625	E4
11	12	1	1	Bonnell, Miss. Elizabeth	female	58.0	0	0	113783	26.5500	C10
13	14	0	3	Andersson, Mr. Anders Johan	male	39.0	1	5	347082	31.2750	Na
15	16	1	2	Hewlett, Mrs. (Mary D Kingcome)	female	55.0	0	0	248706	16.0000	Na

In [24]:
```
adult_names = titanic.loc[titanic["Age"] > 35, "Name"]
adult_names.head()
```

Out[24]:
```
1     Cumings, Mrs. John Bradley (Florence Briggs Th...
6                                 McCarthy, Mr. Timothy J
11                               Bonnell, Miss. Elizabeth
13                            Andersson, Mr. Anders Johan
15                       Hewlett, Mrs. (Mary D Kingcome)
Name: Name, dtype: object
```

In [25]:
```
titanic.iloc[9:25, 2:5]
```

Out[25]:

	Pclass	Name	Sex
9	2	Nasser, Mrs. Nicholas (Adele Achem)	female
10	3	Sandstrom, Miss. Marguerite Rut	female
11	1	Bonnell, Miss. Elizabeth	female
12	3	Saundercock, Mr. William Henry	male
13	3	Andersson, Mr. Anders Johan	male
14	3	Vestrom, Miss. Hulda Amanda Adolfina	female
15	2	Hewlett, Mrs. (Mary D Kingcome)	female
16	3	Rice, Master. Eugene	male
17	2	Williams, Mr. Charles Eugene	male
18	3	Vander Planke, Mrs. Julius (Emelia Maria Vande...	female
19	3	Masselmani, Mrs. Fatima	female
20	2	Fynney, Mr. Joseph J	male
21	2	Beesley, Mr. Lawrence	male
22	3	McGowan, Miss. Anna "Annie"	female
23	1	Sloper, Mr. William Thompson	male
24	3	Palsson, Miss. Torborg Danira	female

In [26]:
```
anon = titanic.iloc[0:3, 3] = "anonymous"
anon
```

Out[26]:
```
'anonymous'
```

In [27]:
```python
titanic.head()
```

Out[27]:

	PassengerId	Survived	Pclass	Name	Sex	Age	SibSp	Parch	Ticket	Fare	Ca
0	1	0	3	anonymous	male	22.0	1	0	A/5 21171	7.2500	I
1	2	1	1	anonymous	female	38.0	1	0	PC 17599	71.2833	
2	3	1	3	anonymous	female	26.0	0	0	STON/O2. 3101282	7.9250	I
3	4	1	1	Futrelle, Mrs. Jacques Heath (Lily May Peel)	female	35.0	1	0	113803	53.1000	C
4	5	0	3	Allen, Mr. William Henry	male	35.0	0	0	373450	8.0500	I

In [28]:
```python
titanic["Age"].mean()
```

Out[28]:
```
29.69911764705882
```

In [29]:
```python
titanic[["Age", "Fare"]].median()
```

Out[29]:
```
Age      28.0000
Fare     14.4542
dtype: float64
```

In [30]:
```python
titanic[["Age", "Fare"]].describe()
```

Out[30]:

	Age	Fare
count	714.000000	891.000000
mean	29.699118	32.204208
std	14.526497	49.693429
min	0.420000	0.000000
25%	20.125000	7.910400
50%	28.000000	14.454200
75%	38.000000	31.000000
max	80.000000	512.329200

```
In [31]: titanic.agg({

         "Age": ["min", "max", "median", "skew"],
         "Fare": ["min", "max", "median", "mean"]

         })
```

```
Out[31]:
                Age        Fare
         min     0.420000    0.000000
         max    80.000000  512.329200
         median 28.000000   14.454200
         skew    0.389108         NaN
         mean         NaN   32.204208
```

```
In [32]: titanic[["Sex", "Age"]].groupby("Sex").mean()
```

```
Out[32]:
                 Age
         Sex
         female  27.915709
         male    30.726645
```

```
In [33]: titanic[["Sex", "Age"]].groupby("Sex").max()
```

```
Out[33]:
                 Age
         Sex
         female  63.0
         male    80.0
```

```
In [34]: titanic[["Sex", "Age"]].groupby("Sex").first()
```

```
Out[34]:
                 Age
         Sex
         female  38.0
         male    22.0
```

```
In [35]: titanic.head(2)
```

```
Out[35]:
            PassengerId  Survived  Pclass       Name     Sex   Age  SibSp  Parch  Ticket     Fare  Cabin
         0            1         0       3  anonymous    male  22.0      1      0     A/5   7.2500    NaN
                                                                                   21171
         1            2         1       1  anonymous  female  38.0      1      0      PC  71.2833    C85
                                                                                   17599
```

In [37]:
```python
titanic.groupby("Sex")["Age"].mean()
```

Out[37]:
```
Sex
female    27.915709
male      30.726645
Name: Age, dtype: float64
```

In [38]:
```python
titanic.groupby(["Sex", "Pclass"])["Fare"].mean()
```

Out[38]:
```
Sex     Pclass
female  1         106.125798
        2          21.970121
        3          16.118810
male    1          67.226127
        2          19.741782
        3          12.661633
Name: Fare, dtype: float64
```

In [39]:
```python
titanic["Pclass"].value_counts()
```

Out[39]:
```
3    491
1    216
2    184
Name: Pclass, dtype: int64
```

In [40]:
```python
titanic.groupby("Pclass")["Pclass"].count()
```

Out[40]:
```
Pclass
1    216
2    184
3    491
Name: Pclass, dtype: int64
```

In [41]:
```python
titanic.sort_values(by="Age",ascending=False).head()
```

Out[41]:

	PassengerId	Survived	Pclass	Name	Sex	Age	SibSp	Parch	Ticket	Fare	Ca
630	631	1	1	Barkworth, Mr. Algernon Henry Wilson	male	80.0	0	0	27042	30.0000	A
851	852	0	3	Svensson, Mr. Johan	male	74.0	0	0	347060	7.7750	N
493	494	0	1	Artagaveytia, Mr. Ramon	male	71.0	0	0	PC 17609	49.5042	N
96	97	0	1	Goldschmidt, Mr. George B	male	71.0	0	0	PC 17754	34.6542	
116	117	0	3	Connors, Mr. Patrick	male	70.5	0	0	370369	7.7500	N

In [42]:
```python
titanic.sort_values(by=['Pclass', 'Age'], ascending=False).head()
```

Out[42]:

	PassengerId	Survived	Pclass	Name	Sex	Age	SibSp	Parch	Ticket	Fare	Cabi
851	852	0	3	Svensson, Mr. Johan	male	74.0	0	0	347060	7.7750	Nal
116	117	0	3	Connors, Mr. Patrick	male	70.5	0	0	370369	7.7500	Nal
280	281	0	3	Duane, Mr. Frank	male	65.0	0	0	336439	7.7500	Nal
483	484	1	3	Turkula, Mrs. (Hedwig)	female	63.0	0	0	4134	9.5875	Nal
326	327	0	3	Nysveen, Mr. Johan Hansen	male	61.0	0	0	345364	6.2375	Nal

In [43]:
```python
titanic.dtypes
```

Out[43]:
```
PassengerId      int64
Survived         int64
Pclass           int64
Name            object
Sex             object
Age            float64
SibSp            int64
Parch            int64
Ticket          object
Fare           float64
Cabin           object
Embarked        object
dtype: object
```

In [44]:
```python
titanic["Name"].str.lower()
```

Out[44]:
```
0                                               anonymous
1                                               anonymous
2                                               anonymous
3             futrelle, mrs. jacques heath (lily may peel)
4                                allen, mr. william henry
                              ...
886                                 montvila, rev. juozas
887                          graham, miss. margaret edith
888              johnston, miss. catherine helen "carrie"
889                                 behr, mr. karl howell
890                                   dooley, mr. patrick
Name: Name, Length: 891, dtype: object
```

In [45]:
```
titanic["Name"].str.split(",")
```

Out[45]:
```
0                                           [anonymous]
1                                           [anonymous]
2                                           [anonymous]
3      [Futrelle,  Mrs. Jacques Heath (Lily May Peel)]
4                           [Allen,  Mr. William Henry]
                             ...
886                            [Montvila,  Rev. Juozas]
887                     [Graham,  Miss. Margaret Edith]
888        [Johnston,  Miss. Catherine Helen "Carrie"]
889                            [Behr,  Mr. Karl Howell]
890                              [Dooley,  Mr. Patrick]
Name: Name, Length: 891, dtype: object
```

In [46]:
```
titanic["Surname"] = titanic["Name"].str.split(",").str.get(0)
titanic["Surname"]
```

Out[46]:
```
0      anonymous
1      anonymous
2      anonymous
3       Futrelle
4          Allen
         ...
886     Montvila
887       Graham
888     Johnston
889         Behr
890       Dooley
Name: Surname, Length: 891, dtype: object
```

In [47]:
```
titanic["Name_main"] = titanic["Name"].str.split(",").str.get(1)
titanic["Name_main"]
```

Out[47]:
```
0                                     NaN
1                                     NaN
2                                     NaN
3       Mrs. Jacques Heath (Lily May Peel)
4                        Mr. William Henry
                      ...
886                            Rev. Juozas
887                    Miss. Margaret Edith
888        Miss. Catherine Helen "Carrie"
889                         Mr. Karl Howell
890                             Mr. Patrick
Name: Name_main, Length: 891, dtype: object
```

In [48]:
```
titanic["Name"].str.split(",")
```

Out[48]:
```
0                                        [anonymous]
1                                        [anonymous]
2                                        [anonymous]
3       [Futrelle,  Mrs. Jacques Heath (Lily May Peel)]
4                          [Allen,  Mr. William Henry]
                              ...
886                           [Montvila,  Rev. Juozas]
887                    [Graham,  Miss. Margaret Edith]
888        [Johnston,  Miss. Catherine Helen "Carrie"]
889                           [Behr,  Mr. Karl Howell]
890                             [Dooley,  Mr. Patrick]
Name: Name, Length: 891, dtype: object
```

In [49]:
```
titanic['Real_Name'] = titanic["Name"].str.split(",").str.get(0)
titanic.head()
```

Out[49]:

	PassengerId	Survived	Pclass	Name	Sex	Age	SibSp	Parch	Ticket	Fare	Ca
0	1	0	3	anonymous	male	22.0	1	0	A/5 21171	7.2500	I
1	2	1	1	anonymous	female	38.0	1	0	PC 17599	71.2833	
2	3	1	3	anonymous	female	26.0	0	0	STON/O2. 3101282	7.9250	I
3	4	1	1	Futrelle, Mrs. Jacques Heath (Lily May Peel)	female	35.0	1	0	113803	53.1000	C
4	5	0	3	Allen, Mr. William Henry	male	35.0	0	0	373450	8.0500	I

In [50]:
```
titanic['Surname'] = titanic["Name"].str.split(",").str.get(1)
titanic.head()
```

Out[50]:

	PassengerId	Survived	Pclass	Name	Sex	Age	SibSp	Parch	Ticket	Fare	Ca
0	1	0	3	anonymous	male	22.0	1	0	A/5 21171	7.2500	I
1	2	1	1	anonymous	female	38.0	1	0	PC 17599	71.2833	
2	3	1	3	anonymous	female	26.0	0	0	STON/O2. 3101282	7.9250	I
3	4	1	1	Futrelle, Mrs. Jacques Heath (Lily May Peel)	female	35.0	1	0	113803	53.1000	C
4	5	0	3	Allen, Mr. William Henry	male	35.0	0	0	373450	8.0500	I

In [51]:
```
titanic['Salutation'] = titanic['Surname'].str.split(".").str.get(0)
titanic.head()
```

Out[51]:

	PassengerId	Survived	Pclass	Name	Sex	Age	SibSp	Parch	Ticket	Fare	Ca
0	1	0	3	anonymous	male	22.0	1	0	A/5 21171	7.2500	I
1	2	1	1	anonymous	female	38.0	1	0	PC 17599	71.2833	
2	3	1	3	anonymous	female	26.0	0	0	STON/O2. 3101282	7.9250	I
3	4	1	1	Futrelle, Mrs. Jacques Heath (Lily May Peel)	female	35.0	1	0	113803	53.1000	C
4	5	0	3	Allen, Mr. William Henry	male	35.0	0	0	373450	8.0500	I

In [52]:
```
titanic["Name"].str.contains("Mr")
```

Out[52]:
```
0      False
1      False
2      False
3       True
4       True
       ...  
886    False
887    False
888    False
889     True
890     True
Name: Name, Length: 891, dtype: bool
```

In [53]:
```
titanic[titanic["Name"].str.contains("Countess")]
```

Out[53]:

	PassengerId	Survived	Pclass	Name	Sex	Age	SibSp	Parch	Ticket	Fare	Cabin
759	760	1	1	Rothes, the Countess. of (Lucy Noel Martha Dye...	female	33.0	0	0	110152	86.5	B77

```
In [54]: titanic["Name"].str.len()
```

```
Out[54]: 0       9
         1       9
         2       9
         3      44
         4      24
                ..
         886    21
         887    28
         888    40
         889    21
         890    19
         Name: Name, Length: 891, dtype: int64
```

```
In [55]: titanic["Name"].str.len().idxmax()
```

```
Out[55]: 307
```

```
In [56]: titanic.loc[titanic["Name"].str.len().idxmax(), "Name"]
```

```
Out[56]: 'Penasco y Castellana, Mrs. Victor de Satode (Maria Josefa Perez de Soto y Va
         llejo)'
```

```
In [57]: titanic.loc[titanic["Name"].str.len().idxmin(), "Name"]
```

```
Out[57]: 'anonymous'
```

```
In [58]: titanic["Sex_short"] = titanic["Sex"].replace({"male": "M", "female": "F"})
         titanic["Sex_short"]
```

```
Out[58]: 0      M
         1      F
         2      F
         3      F
         4      M
               ..
         886    M
         887    F
         888    F
         889    M
         890    M
         Name: Sex_short, Length: 891, dtype: object
```

```
In [59]: titanic["Sex_short"] = titanic["Sex"].str.replace("female", "F")
         titanic["Sex_short"] = titanic["Sex_short"].str.replace("male", "M")
```

In [170]:
```
import numpy as np
df = pd.DataFrame(np.random.randn(10, 3), columns=list("abc"))
df[["a", "c","b"]]
```

Out[170]:

	a	c	b
0	0.971377	-0.762178	-0.305884
1	0.412251	0.588495	0.096369
2	1.801618	-0.597973	1.489147
3	-0.359858	-0.878680	-1.461579
4	-0.455795	0.681250	0.973445
5	0.852787	-0.544525	-0.295961
6	-1.098355	-1.421945	-0.417816
7	-0.133820	-0.183852	1.228257
8	-0.495825	-1.226723	-0.318924
9	-0.064218	-0.306832	-0.345931

In [171]:
```
df.loc[:, ["a", "c"]]
```

Out[171]:

	a	c
0	0.971377	-0.762178
1	0.412251	0.588495
2	1.801618	-0.597973
3	-0.359858	-0.878680
4	-0.455795	0.681250
5	0.852787	-0.544525
6	-1.098355	-1.421945
7	-0.133820	-0.183852
8	-0.495825	-1.226723
9	-0.064218	-0.306832

Good Code

In [ ]:
```
named = list("abcdefg")
n = 30
columns = named + np.arange(len(named), n).tolist()
df = pd.DataFrame(np.random.randn(n, n), columns=columns)
df.iloc[:, np.r_[:10, 24:30]]
```

```
In [ ]: df = pd.DataFrame({

        "v1": [1, 3, 5, 7, 8, 3, 5, np.nan, 4, 5, 7, 9],
        "v2": [11, 33, 55, 77, 88, 33, 55, np.nan, 44, 55, 77, 99],
        "by1": ["red", "blue", 1, 2, np.nan, "big", 1, 2, "red", 1, np.nan, 12],
        "by2": ["wet","dry",99,95,np.nan,"damp",95,99,"red",99,np.nan,np.nan,]

        })

        df
```

```
In [ ]: g = df.groupby(["by1", "by2"])
        g[["v1", "v2"]].mean()
```

```
In [63]: import numpy as np
         s = pd.Series(np.arange(5), dtype=np.float32)
         s
```

```
Out[63]: 0    0.0
         1    1.0
         2    2.0
         3    3.0
         4    4.0
         dtype: float32
```

```
In [64]: s.isin([2, 4])
```

```
Out[64]: 0    False
         1    False
         2     True
         3    False
         4     True
         dtype: bool
```

Data genetarion code

In [65]:
```
# Data genetarion code

import random
import string

baseball = pd.DataFrame({
"team": ["team %d" % (x + 1) for x in range(5)] * 5,
"player": random.sample(list(string.ascii_lowercase), 25),
"batting avg": np.random.uniform(0.200, 0.400, 25),
    }
)

baseball
```

Out[65]:

	team	player	batting avg
0	team 1	b	0.311944
1	team 2	w	0.300678
2	team 3	c	0.271453
3	team 4	p	0.301531
4	team 5	a	0.257927
5	team 1	q	0.384259
6	team 2	d	0.279827
7	team 3	s	0.200344
8	team 4	f	0.269042
9	team 5	k	0.363716
10	team 1	u	0.355087
11	team 2	v	0.276580
12	team 3	z	0.381452
13	team 4	g	0.264230
14	team 5	e	0.397186
15	team 1	n	0.249416
16	team 2	i	0.245684
17	team 3	y	0.316917
18	team 4	o	0.206810
19	team 5	m	0.272293
20	team 1	h	0.328023
21	team 2	r	0.352936
22	team 3	t	0.350134
23	team 4	x	0.368002
24	team 5	j	0.282423

In [66]:
```
baseball.pivot_table(values="batting avg", columns="team", aggfunc=np.max)
```
Out[66]:

team	**team 1**	**team 2**	**team 3**	**team 4**	**team 5**
batting avg	0.384259	0.352936	0.381452	0.368002	0.397186

In [67]:
```
df = pd.DataFrame({"a": np.random.randn(10), "b": np.random.randn(10)})
df.head()
```
Out[67]:

	a	**b**
0	0.848214	1.528596
1	-1.363807	-1.321466
2	-0.525568	1.252385
3	-0.351879	-0.315065
4	-0.700257	0.328759

In [68]:
```
df.query("a <= b")
```
Out[68]:

	a	**b**
0	0.848214	1.528596
1	-1.363807	-1.321466
2	-0.525568	1.252385
3	-0.351879	-0.315065
4	-0.700257	0.328759
5	-0.927895	-0.516451
6	-1.526683	-0.259954
7	-2.127308	0.531293
8	-0.206562	0.237485
9	0.413750	0.770686

In [69]:
```
df[df["a"] <= df["b"]]
```

Out[69]:

	a	b
0	0.848214	1.528596
1	-1.363807	-1.321466
2	-0.525568	1.252385
3	-0.351879	-0.315065
4	-0.700257	0.328759
5	-0.927895	-0.516451
6	-1.526683	-0.259954
7	-2.127308	0.531293
8	-0.206562	0.237485
9	0.413750	0.770686

In [70]:
```
df.loc[df["a"] <= df["b"]]
```

Out[70]:

	a	b
0	0.848214	1.528596
1	-1.363807	-1.321466
2	-0.525568	1.252385
3	-0.351879	-0.315065
4	-0.700257	0.328759
5	-0.927895	-0.516451
6	-1.526683	-0.259954
7	-2.127308	0.531293
8	-0.206562	0.237485
9	0.413750	0.770686

In [71]:
```
df[df["a"] >= df["b"]]
```

Out[71]:

a	b

```
In [72]: df = pd.DataFrame({"a": np.random.randn(10), "b": np.random.randn(10)})
         df.head()
```

Out[72]:

	a	b
0	0.057788	-0.548498
1	-0.150495	-1.303927
2	0.391174	-0.383887
3	-0.486376	0.660384
4	-0.149571	0.048288

```
In [73]: df.eval("a + b")
```

```
Out[73]: 0   -0.490711
         1   -1.454421
         2    0.007287
         3    0.174008
         4   -0.101283
         5   -0.636180
         6    0.540169
         7   -0.429076
         8    0.185766
         9   -1.048530
         dtype: float64
```

```
In [74]: df["a"] + df["b"]
```

```
Out[74]: 0   -0.490711
         1   -1.454421
         2    0.007287
         3    0.174008
         4   -0.101283
         5   -0.636180
         6    0.540169
         7   -0.429076
         8    0.185766
         9   -1.048530
         dtype: float64
```

In [75]:
```
df = pd.DataFrame({

"x": np.random.uniform(1.0, 168.0, 120),
"y": np.random.uniform(7.0, 334.0, 120),
"z": np.random.uniform(1.7, 20.7, 120),
"month": [5, 6, 7, 8] * 30,
"week": np.random.randint(1, 4, 120)

})

df.head()
```

Out[75]:

	x	y	z	month	week
0	41.516759	33.530167	18.106587	5	1
1	35.505487	252.682232	14.136898	6	3
2	91.041404	170.303748	7.498431	7	2
3	26.488195	332.594130	5.038641	8	3
4	105.767124	107.686286	15.308504	5	2

In [76]:
```
grouped = df.groupby(["month", "week"])
grouped["x"].agg([np.mean, np.std])
```

Out[76]:

		mean	std
month	**week**		
5	**1**	87.949769	52.340418
	2	80.472147	51.547185
	3	83.919926	38.707154
6	**1**	62.640842	45.863364
	2	76.669235	49.722219
	3	74.546488	45.781976
7	**1**	83.765432	35.884936
	2	120.548997	36.888050
	3	90.085512	49.915038
8	**1**	85.325932	60.874941
	2	50.293565	37.083210
	3	59.143017	41.149256

```
In [77]: a = np.array(list(range(1, 24)) + [np.NAN]).reshape(2, 3, 4)
         a
```

```
Out[77]: array([[[ 1.,  2.,  3.,  4.],
                 [ 5.,  6.,  7.,  8.],
                 [ 9., 10., 11., 12.]],

                [[13., 14., 15., 16.],
                 [17., 18., 19., 20.],
                 [21., 22., 23., nan]]])
```

```
In [78]: pd.DataFrame([tuple(list(x) + [val]) for x, val in np.ndenumerate(a)])
```

Out[78]:

	0	1	2	3
0	0	0	0	1.0
1	0	0	1	2.0
2	0	0	2	3.0
3	0	0	3	4.0
4	0	1	0	5.0
5	0	1	1	6.0
6	0	1	2	7.0
7	0	1	3	8.0
8	0	2	0	9.0
9	0	2	1	10.0
10	0	2	2	11.0
11	0	2	3	12.0
12	1	0	0	13.0
13	1	0	1	14.0
14	1	0	2	15.0
15	1	0	3	16.0
16	1	1	0	17.0
17	1	1	1	18.0
18	1	1	2	19.0
19	1	1	3	20.0
20	1	2	0	21.0
21	1	2	1	22.0
22	1	2	2	23.0
23	1	2	3	NaN

In [79]:
```
a = list(enumerate(list(range(1, 5)) + [np.NAN]))
a
```

Out[79]:
```
[(0, 1), (1, 2), (2, 3), (3, 4), (4, nan)]
```

In [80]:
```
pd.DataFrame(a)
```

Out[80]:

	0	1
0	0	1.0
1	1	2.0
2	2	3.0
3	3	4.0
4	4	NaN

In [81]:
```
cheese = pd.DataFrame({

"first": ["John", "Mary"],
"last": ["Doe", "Bo"],
"height": [5.5, 6.0],
"weight": [130, 150]

})

cheese
```

Out[81]:

	first	last	height	weight
0	John	Doe	5.5	130
1	Mary	Bo	6.0	150

In [82]:
```
pd.melt(cheese, id_vars=["first", "last"])
```

Out[82]:

	first	last	variable	value
0	John	Doe	height	5.5
1	Mary	Bo	height	6.0
2	John	Doe	weight	130.0
3	Mary	Bo	weight	150.0

In [83]:
```
cheese.set_index(["first", "last"]).stack() # alternative
```

Out[83]:
```
first  last
John   Doe   height      5.5
             weight    130.0
Mary   Bo    height      6.0
             weight    150.0
dtype: float64
```

In [84]:
```
df = pd.DataFrame({

"x": np.random.uniform(1.0, 168.0, 12),
"y": np.random.uniform(7.0, 334.0, 12),
"z": np.random.uniform(1.7, 20.7, 12),
"month": [5, 6, 7] * 4,
"week": [1, 2] * 6

})

mdf = pd.melt(df, id_vars=["month", "week"])

pd.pivot_table(mdf,values="value",index=["variable", "week"],columns=["month"],
```

Out[84]:

	month	5	6	7
variable	week			
x	1	69.688604	58.926280	50.639441
	2	67.470350	117.676001	118.517232
y	1	160.009684	21.384183	177.609046
	2	203.316298	197.839213	184.583499
z	1	10.060922	4.185807	8.656566
	2	8.009302	11.105621	11.506984

In [85]:
```
df = pd.DataFrame({

"Animal": ["Animal1","Animal2","Animal3","Animal2","Animal1","Animal2","Animal3
"FeedType": ["A", "B", "A", "A", "B", "B", "A"],
"Amount": [10, 7, 4, 2, 5, 6, 2]

})

df.pivot_table(values="Amount", index="Animal", columns="FeedType", aggfunc="su
```

Out[85]:

FeedType	A	B
Animal		
Animal1	10.0	5.0
Animal2	2.0	13.0
Animal3	6.0	NaN

In [86]:
```
df.groupby(["Animal", "FeedType"])["Amount"].sum()
```

Out[86]:
```
Animal   FeedType
Animal1  A           10
         B            5
Animal2  A            2
         B           13
Animal3  A            6
Name: Amount, dtype: int64
```

In [87]:
```
pd.cut(pd.Series([1, 2, 3, 4, 5, 6]), 3)
```

Out[87]:
```
0    (0.995, 2.667]
1    (0.995, 2.667]
2    (2.667, 4.333]
3    (2.667, 4.333]
4      (4.333, 6.0]
5      (4.333, 6.0]
dtype: category
Categories (3, interval[float64, right]): [(0.995, 2.667] < (2.667, 4.333] <
(4.333, 6.0]]
```

In [88]:
```
pd.Series([1, 2, 3, 2, 2, 3]).astype("category")
```

Out[88]:
```
0    1
1    2
2    3
3    2
4    2
5    3
dtype: category
Categories (3, int64): [1, 2, 3]
```

In [89]:
```
frame = pd.DataFrame({"col1": ["A", "B", np.NaN, "C", "D"], "col2": ["F", np.Na

frame
```

Out[89]:

	col1	col2
0	A	F
1	B	NaN
2	NaN	G
3	C	H
4	D	I

In [90]:
```
frame[frame["col2"].isna()]
```

Out[90]:

	col1	col2
1	B	NaN

In [91]:
```
frame[frame["col1"].notna()]
```

Out[91]:

	col1	col2
0	A	F
1	B	NaN
3	C	H
4	D	I

```
In [92]: df1 = pd.DataFrame({"key": ["A", "B", "C", "D"], "value": np.random.randn(4)})
         df2 = pd.DataFrame({"key": ["B", "D", "D", "E"], "value": np.random.randn(4)})
```

```
In [93]: pd.merge(df1, df2, on="key")
```

```
Out[93]:
     key    value_x   value_y
  0    B  -0.335446  1.794026
  1    D   1.224740  1.418379
  2    D   1.224740  0.425891
```

```
In [94]: indexed_df2 = df2.set_index("key")
         pd.merge(df1, indexed_df2, left_on="key", right_index=True)
```

```
Out[94]:
     key    value_x   value_y
  1    B  -0.335446  1.794026
  3    D   1.224740  1.418379
  3    D   1.224740  0.425891
```

```
In [95]: pd.merge(df1, df2, on="key", how="left")
```

```
Out[95]:
     key    value_x   value_y
  0    A   0.429288       NaN
  1    B  -0.335446  1.794026
  2    C  -0.685751       NaN
  3    D   1.224740  1.418379
  4    D   1.224740  0.425891
```

```
In [96]: pd.merge(df1, df2, on="key", how="right")
```

```
Out[96]:
     key    value_x   value_y
  0    B  -0.335446  1.794026
  1    D   1.224740  1.418379
  2    D   1.224740  0.425891
  3    E        NaN  0.828731
```

In [97]:
```
pd.merge(df1, df2, on="key", how="outer")
```
Out[97]:

	key	value_x	value_y
0	A	0.429288	NaN
1	B	-0.335446	1.794026
2	C	-0.685751	NaN
3	D	1.224740	1.418379
4	D	1.224740	0.425891
5	E	NaN	0.828731

In [98]:
```
df1 = pd.DataFrame({"city": ["Chicago", "San Francisco", "New York City"], "ra

df2 = pd.DataFrame({"city": ["Chicago", "Boston", "Los Angeles"], "rank": [1,


pd.concat([df1, df2])
```
Out[98]:

	city	rank
0	Chicago	1
1	San Francisco	2
2	New York City	3
0	Chicago	1
1	Boston	4
2	Los Angeles	5

In [99]:
```
pd.concat([df1, df2]).drop_duplicates()
```
Out[99]:

	city	rank
0	Chicago	1
1	San Francisco	2
2	New York City	3
1	Boston	4
2	Los Angeles	5

In [100]:
```
df = pd.DataFrame({"x": [1, 3, 5], "y": [2, 4, 6]})
df
```
Out[100]:

	x	y
0	1	2
1	3	4
2	5	6

In [101]:
```
firstlast = pd.DataFrame({"String": ["John Smith", "Jane Cook"]})
firstlast["First_Name"] = firstlast["String"].str.split(" ", expand=True)[0]
firstlast["Last_Name"] = firstlast["String"].str.rsplit(" ", expand=True)[1]
firstlast
```

Out[101]:

	String	First_Name	Last_Name
0	John Smith	John	Smith
1	Jane Cook	Jane	Cook

In [102]:
```
firstlast = pd.DataFrame({"string": ["John Smith", "Jane Cook"]})
firstlast["upper"] = firstlast["string"].str.upper()
firstlast["lower"] = firstlast["string"].str.lower()
firstlast["title"] = firstlast["string"].str.title()
firstlast
```

Out[102]:

	string	upper	lower	title
0	John Smith	JOHN SMITH	john smith	John Smith
1	Jane Cook	JANE COOK	jane cook	Jane Cook

In [103]:
```
df1 = pd.DataFrame({"key": ["A", "B", "C", "D"], "value": np.random.randn(4)})
df1
```

Out[103]:

	key	value
0	A	2.710180
1	B	-0.184712
2	C	-0.268376
3	D	1.136070

In [104]:
```
df2 = pd.DataFrame({"key": ["B", "D", "D", "E"], "value": np.random.randn(4)})
df2
```

Out[104]:

	key	value
0	B	-1.961649
1	D	0.885771
2	D	0.695118
3	E	-0.265280

In [105]:
```
inner_join = df1.merge(df2, on=["key"], how="inner")
inner_join
```

Out[105]:

	key	value_x	value_y
0	B	-0.184712	-1.961649
1	D	1.136070	0.885771
2	D	1.136070	0.695118

```
In [106]: left_join = df1.merge(df2, on=["key"], how="left")
          left_join
```

```
Out[106]:
     key   value_x    value_y
  0    A   2.710180        NaN
  1    B  -0.184712  -1.961649
  2    C  -0.268376        NaN
  3    D   1.136070   0.885771
  4    D   1.136070   0.695118
```

```
In [107]: right_join = df1.merge(df2, on=["key"], how="right")
          right_join
```

```
Out[107]:
     key   value_x    value_y
  0    B  -0.184712  -1.961649
  1    D   1.136070   0.885771
  2    D   1.136070   0.695118
  3    E        NaN  -0.265280
```

```
In [108]: outer_join = df1.merge(df2, on=["key"], how="outer")
          outer_join
```

```
Out[108]:
     key   value_x    value_y
  0    A   2.710180        NaN
  1    B  -0.184712  -1.961649
  2    C  -0.268376        NaN
  3    D   1.136070   0.885771
  4    D   1.136070   0.695118
  5    E        NaN  -0.265280
```

```
In [109]: df = pd.DataFrame({"AAA": [1] * 8, "BBB": list(range(0, 8))})
          df
```

Out[109]:

	AAA	BBB
0	1	0
1	1	1
2	1	2
3	1	3
4	1	4
5	1	5
6	1	6
7	1	7

```
In [110]: series = list(range(1, 5))
          series

Out[110]: [1, 2, 3, 4]
```

```
In [111]: df.loc[2:5, "AAA"] = series
          df
```

Out[111]:

	AAA	BBB
0	1	0
1	1	1
2	1	2
3	2	3
4	3	4
5	4	5
6	1	6
7	1	7

In [112]:
```
df = pd.DataFrame({

"class": ["A", "A", "A", "B", "C", "D"],
"student_count": [42, 35, 42, 50, 47, 45],
"all_pass": ["Yes", "Yes", "Yes", "No", "No", "Yes"]

})

df.drop_duplicates()
```

Out[112]:

	class	student_count	all_pass
0	A	42	Yes
1	A	35	Yes
3	B	50	No
4	C	47	No
5	D	45	Yes

In [113]:
```
df.drop_duplicates(["class", "student_count"])
```

Out[113]:

	class	student_count	all_pass
0	A	42	Yes
1	A	35	Yes
3	B	50	No
4	C	47	No
5	D	45	Yes

In [114]:
```
new_row = pd.DataFrame([["E", 51, True]],columns=["class", "student_count", "al
pd.concat([df, new_row])
```

Out[114]:

	class	student_count	all_pass
0	A	42	Yes
1	A	35	Yes
2	A	42	Yes
3	B	50	No
4	C	47	No
5	D	45	Yes
0	E	51	True

In [115]:
```
df = pd.DataFrame({"x": [1, 3, 5], "y": [2, 4, 6]})
df
```

Out[115]:
```
   x  y
0  1  2
1  3  4
2  5  6
```

In [116]:
```
df1 = pd.DataFrame({"key": ["A", "B", "C", "D"], "value": np.random.randn(4)})
df1
```

Out[116]:
```
  key     value
0   A -1.402688
1   B -0.545334
2   C -1.455278
3   D  0.697387
```

In [117]:
```
df2 = pd.DataFrame({"key": ["B", "D", "D", "E"], "value": np.random.randn(4)})
df2
```

Out[117]:
```
  key     value
0   B -0.665418
1   D  0.008734
2   D -0.719310
3   E -0.507211
```

In [118]:
```
inner_join = df1.merge(df2, on=["key"], how="inner")
inner_join
```

Out[118]:
```
  key   value_x   value_y
0   B -0.545334 -0.665418
1   D  0.697387  0.008734
2   D  0.697387 -0.719310
```

In [119]:
```
left_join = df1.merge(df2, on=["key"], how="left")
left_join
```

Out[119]:

	key	value_x	value_y
0	A	-1.402688	NaN
1	B	-0.545334	-0.665418
2	C	-1.455278	NaN
3	D	0.697387	0.008734
4	D	0.697387	-0.719310

In [120]:
```
right_join = df1.merge(df2, on=["key"], how="right")
right_join
```

Out[120]:

	key	value_x	value_y
0	B	-0.545334	-0.665418
1	D	0.697387	0.008734
2	D	0.697387	-0.719310
3	E	NaN	-0.507211

In [121]:
```
outer_join = df1.merge(df2, on=["key"], how="outer")
outer_join
```

Out[121]:

	key	value_x	value_y
0	A	-1.402688	NaN
1	B	-0.545334	-0.665418
2	C	-1.455278	NaN
3	D	0.697387	0.008734
4	D	0.697387	-0.719310
5	E	NaN	-0.507211

In [122]:
```
outer_join["value_x"] + outer_join["value_y"]
```

Out[122]:
```
0          NaN
1    -1.210752
2          NaN
3     0.706121
4    -0.021924
5          NaN
dtype: float64
```

In [123]:
```
outer_join["value_x"].sum()
```

Out[123]:
```
-2.008526169978958
```

```
In [124]: outer_join[outer_join["value_x"].isna()]
```

Out[124]:

	key	value_x	value_y
5	E	NaN	-0.507211

```
In [125]: outer_join[outer_join["value_x"].notna()]
```

Out[125]:

	key	value_x	value_y
0	A	-1.402688	NaN
1	B	-0.545334	-0.665418
2	C	-1.455278	NaN
3	D	0.697387	0.008734
4	D	0.697387	-0.719310

```
In [126]: outer_join.dropna()
```

Out[126]:

	key	value_x	value_y
1	B	-0.545334	-0.665418
3	D	0.697387	0.008734
4	D	0.697387	-0.719310

```
In [127]: outer_join.fillna(method="ffill")
```

Out[127]:

	key	value_x	value_y
0	A	-1.402688	NaN
1	B	-0.545334	-0.665418
2	C	-1.455278	-0.665418
3	D	0.697387	0.008734
4	D	0.697387	-0.719310
5	E	0.697387	-0.507211

```
In [128]: outer_join["value_x"].fillna(outer_join["value_x"].mean())
```

```
Out[128]: 0   -1.402688
          1   -0.545334
          2   -1.455278
          3    0.697387
          4    0.697387
          5   -0.401705
          Name: value_x, dtype: float64
```

In [129]:
```
s = pd.Series([1, 3, 5, np.nan, 6, 8])
s
```

Out[129]:
```
0    1.0
1    3.0
2    5.0
3    NaN
4    6.0
5    8.0
dtype: float64
```

In [130]:
```
dates = pd.date_range("20130101", periods=6)
dates
```

Out[130]:
```
DatetimeIndex(['2013-01-01', '2013-01-02', '2013-01-03', '2013-01-04',
               '2013-01-05', '2013-01-06'],
              dtype='datetime64[ns]', freq='D')
```

In [131]:
```
df = pd.DataFrame(np.random.randn(6, 4), index=dates, columns=list("ABCD"))
df
```

Out[131]:

	A	B	C	D
2013-01-01	-0.591099	-1.749225	1.031762	0.972904
2013-01-02	0.437900	-0.154981	0.621125	0.812640
2013-01-03	-0.277972	0.613546	-1.647452	0.395107
2013-01-04	-0.232215	1.631459	0.539724	-0.872221
2013-01-05	0.427207	-0.571715	1.176223	0.509280
2013-01-06	-0.876173	1.281415	0.015445	-2.132941

In [132]:
```
df2 = pd.DataFrame({

"A": 1.0,
"B": pd.Timestamp("20130102"),
"C": pd.Series(1, index=list(range(4)), dtype="float32"),
"D": np.array([3] * 4, dtype="int32"),
"E": pd.Categorical(["test", "train", "test", "train"]),
"F": "foo"

})

df2
```

Out[132]:

	A	B	C	D	E	F
0	1.0	2013-01-02	1.0	3	test	foo
1	1.0	2013-01-02	1.0	3	train	foo
2	1.0	2013-01-02	1.0	3	test	foo
3	1.0	2013-01-02	1.0	3	train	foo

In [133]:
```
df2.index
```
Out[133]:
```
Int64Index([0, 1, 2, 3], dtype='int64')
```
In [134]:
```
df.to_numpy()
```
Out[134]:
```
array([[-0.59109898, -1.749225  ,  1.03176168,  0.97290379],
       [ 0.43790005, -0.15498061,  0.62112534,  0.81264041],
       [-0.27797154,  0.6135462 , -1.64745161,  0.39510719],
       [-0.23221497,  1.63145916,  0.53972385, -0.87222052],
       [ 0.42720723, -0.57171521,  1.17622299,  0.50928032],
       [-0.87617273,  1.28141542,  0.01544495, -2.13294079]])
```
In [135]:
```
df2.to_numpy()
```
Out[135]:
```
array([[1.0, Timestamp('2013-01-02 00:00:00'), 1.0, 3, 'test', 'foo'],
       [1.0, Timestamp('2013-01-02 00:00:00'), 1.0, 3, 'train', 'foo'],
       [1.0, Timestamp('2013-01-02 00:00:00'), 1.0, 3, 'test', 'foo'],
       [1.0, Timestamp('2013-01-02 00:00:00'), 1.0, 3, 'train', 'foo']],
      dtype=object)
```
In [136]:
```
df.sort_index(axis=1, ascending=False)
```
Out[136]:

	D	C	B	A
2013-01-01	0.972904	1.031762	-1.749225	-0.591099
2013-01-02	0.812640	0.621125	-0.154981	0.437900
2013-01-03	0.395107	-1.647452	0.613546	-0.277972
2013-01-04	-0.872221	0.539724	1.631459	-0.232215
2013-01-05	0.509280	1.176223	-0.571715	0.427207
2013-01-06	-2.132941	0.015445	1.281415	-0.876173

In [137]:
```
df.sort_values(by="B")
```
Out[137]:

	A	B	C	D
2013-01-01	-0.591099	-1.749225	1.031762	0.972904
2013-01-05	0.427207	-0.571715	1.176223	0.509280
2013-01-02	0.437900	-0.154981	0.621125	0.812640
2013-01-03	-0.277972	0.613546	-1.647452	0.395107
2013-01-06	-0.876173	1.281415	0.015445	-2.132941
2013-01-04	-0.232215	1.631459	0.539724	-0.872221

In [138]:
```
df[0:3]
```

Out[138]:

	A	B	C	D
2013-01-01	-0.591099	-1.749225	1.031762	0.972904
2013-01-02	0.437900	-0.154981	0.621125	0.812640
2013-01-03	-0.277972	0.613546	-1.647452	0.395107

In [139]:
```
df["20130102":"20130104"]
```

Out[139]:

	A	B	C	D
2013-01-02	0.437900	-0.154981	0.621125	0.812640
2013-01-03	-0.277972	0.613546	-1.647452	0.395107
2013-01-04	-0.232215	1.631459	0.539724	-0.872221

In [140]:
```
df.loc[dates[0]]
```

Out[140]:
```
A   -0.591099
B   -1.749225
C    1.031762
D    0.972904
Name: 2013-01-01 00:00:00, dtype: float64
```

In [141]:
```
df.loc[:, ["A", "B"]]
```

Out[141]:

	A	B
2013-01-01	-0.591099	-1.749225
2013-01-02	0.437900	-0.154981
2013-01-03	-0.277972	0.613546
2013-01-04	-0.232215	1.631459
2013-01-05	0.427207	-0.571715
2013-01-06	-0.876173	1.281415

In [142]:
```
df.loc["20130102":"20130104", ["A", "B"]]
```

Out[142]:

	A	B
2013-01-02	0.437900	-0.154981
2013-01-03	-0.277972	0.613546
2013-01-04	-0.232215	1.631459

In [143]:
```
df.loc["20130102", ["A", "B"]]
```

Out[143]:
```
A    0.437900
B   -0.154981
Name: 2013-01-02 00:00:00, dtype: float64
```

```
In [144]: df.at[dates[0], "A"]
```

```
Out[144]: -0.5910989777117921
```

```
In [145]: df.iloc[3]
```

```
Out[145]: A   -0.232215
          B    1.631459
          C    0.539724
          D   -0.872221
          Name: 2013-01-04 00:00:00, dtype: float64
```

```
In [146]: df.iloc[3:5, 0:2]
```

Out[146]:

	A	B
2013-01-04	-0.232215	1.631459
2013-01-05	0.427207	-0.571715

```
In [147]: df.iloc[[1, 2, 4], [0, 2]]
```

Out[147]:

	A	C
2013-01-02	0.437900	0.621125
2013-01-03	-0.277972	-1.647452
2013-01-05	0.427207	1.176223

```
In [148]: df.iloc[1:3, :]
```

Out[148]:

	A	B	C	D
2013-01-02	0.437900	-0.154981	0.621125	0.812640
2013-01-03	-0.277972	0.613546	-1.647452	0.395107

```
In [149]: df.iloc[:, 1:3]
```

Out[149]:

	B	C
2013-01-01	-1.749225	1.031762
2013-01-02	-0.154981	0.621125
2013-01-03	0.613546	-1.647452
2013-01-04	1.631459	0.539724
2013-01-05	-0.571715	1.176223
2013-01-06	1.281415	0.015445

```
In [150]: df.iloc[1, 1]
```

```
Out[150]: -0.15498061171987595
```

In [151]:
```
df[df["A"] > 0]
```
Out[151]:

	A	B	C	D
2013-01-02	0.437900	-0.154981	0.621125	0.81264
2013-01-05	0.427207	-0.571715	1.176223	0.50928

In [152]:
```
df[df > 0]
```
Out[152]:

	A	B	C	D
2013-01-01	NaN	NaN	1.031762	0.972904
2013-01-02	0.437900	NaN	0.621125	0.812640
2013-01-03	NaN	0.613546	NaN	0.395107
2013-01-04	NaN	1.631459	0.539724	NaN
2013-01-05	0.427207	NaN	1.176223	0.509280
2013-01-06	NaN	1.281415	0.015445	NaN

In [153]:
```
df2 = df.copy()
df2["E"] = ["one", "one", "two", "three", "four", "three"]
df2
```
Out[153]:

	A	B	C	D	E
2013-01-01	-0.591099	-1.749225	1.031762	0.972904	one
2013-01-02	0.437900	-0.154981	0.621125	0.812640	one
2013-01-03	-0.277972	0.613546	-1.647452	0.395107	two
2013-01-04	-0.232215	1.631459	0.539724	-0.872221	three
2013-01-05	0.427207	-0.571715	1.176223	0.509280	four
2013-01-06	-0.876173	1.281415	0.015445	-2.132941	three

In [154]:
```
df2[df2["E"].isin(["two", "four"])]
```
Out[154]:

	A	B	C	D	E
2013-01-03	-0.277972	0.613546	-1.647452	0.395107	two
2013-01-05	0.427207	-0.571715	1.176223	0.509280	four

In [155]:
```
s1 = pd.Series([1, 2, 3, 4, 5, 6], index=pd.date_range("20130102", periods=6))
s1
```

Out[155]:
```
2013-01-02    1
2013-01-03    2
2013-01-04    3
2013-01-05    4
2013-01-06    5
2013-01-07    6
Freq: D, dtype: int64
```

In [156]:
```
df.at[dates[0], "A"] = 0
```

In [157]:
```
df.iat[0, 1] = 0
```

In [158]:
```
df.loc[:, "D"] = np.array([5] * len(df))
df
```

```
C:\Users\pytho\AppData\Local\Temp\ipykernel_8580\568071402.py:1: DeprecationW
arning: In a future version, `df.iloc[:, i] = newvals` will attempt to set th
e values inplace instead of always setting a new array. To retain the old beh
avior, use either `df[df.columns[i]] = newvals` or, if columns are non-uniqu
e, `df.isetitem(i, newvals)`
  df.loc[:, "D"] = np.array([5] * len(df))
```

Out[158]:

	A	B	C	D
2013-01-01	0.000000	0.000000	1.031762	5
2013-01-02	0.437900	-0.154981	0.621125	5
2013-01-03	-0.277972	0.613546	-1.647452	5
2013-01-04	-0.232215	1.631459	0.539724	5
2013-01-05	0.427207	-0.571715	1.176223	5
2013-01-06	-0.876173	1.281415	0.015445	5

In [159]:
```
df2 = df.copy()
df2[df2 > 0] = -df2
df2
```

Out[159]:

	A	B	C	D
2013-01-01	0.000000	0.000000	-1.031762	-5
2013-01-02	-0.437900	-0.154981	-0.621125	-5
2013-01-03	-0.277972	-0.613546	-1.647452	-5
2013-01-04	-0.232215	-1.631459	-0.539724	-5
2013-01-05	-0.427207	-0.571715	-1.176223	-5
2013-01-06	-0.876173	-1.281415	-0.015445	-5

In [160]:
```
df1 = df.reindex(index=dates[0:4], columns=list(df.columns) + ["E"])
df1.loc[dates[0] : dates[1], "E"] = 1
df1
```

Out[160]:

	A	B	C	D	E
2013-01-01	0.000000	0.000000	1.031762	5	1.0
2013-01-02	0.437900	-0.154981	0.621125	5	1.0
2013-01-03	-0.277972	0.613546	-1.647452	5	NaN
2013-01-04	-0.232215	1.631459	0.539724	5	NaN

In [161]:
```
df1.dropna(how="any")
```

Out[161]:

	A	B	C	D	E
2013-01-01	0.0000	0.000000	1.031762	5	1.0
2013-01-02	0.4379	-0.154981	0.621125	5	1.0

In [162]:
```
df1.fillna(value=5)
```

Out[162]:

	A	B	C	D	E
2013-01-01	0.000000	0.000000	1.031762	5	1.0
2013-01-02	0.437900	-0.154981	0.621125	5	1.0
2013-01-03	-0.277972	0.613546	-1.647452	5	5.0
2013-01-04	-0.232215	1.631459	0.539724	5	5.0

In [163]:
```
pd.isna(df1)
```

Out[163]:

	A	B	C	D	E
2013-01-01	False	False	False	False	False
2013-01-02	False	False	False	False	False
2013-01-03	False	False	False	False	True
2013-01-04	False	False	False	False	True

In [164]:
```
df.mean()
```

Out[164]:
```
A   -0.086875
B    0.466621
C    0.289471
D    5.000000
dtype: float64
```

In [165]:
```
df.mean(1)
```

Out[165]:
```
2013-01-01    1.507940
2013-01-02    1.476011
2013-01-03    0.922031
2013-01-04    1.734742
2013-01-05    1.507929
2013-01-06    1.355172
Freq: D, dtype: float64
```

In [166]:
```
s = pd.Series([1, 3, 5, np.nan, 6, 8], index=dates).shift(2)
s
```

Out[166]:
```
2013-01-01    NaN
2013-01-02    NaN
2013-01-03    1.0
2013-01-04    3.0
2013-01-05    5.0
2013-01-06    NaN
Freq: D, dtype: float64
```

In [167]:
```
df.sub(s, axis="index")
```

Out[167]:

	A	B	C	D
2013-01-01	NaN	NaN	NaN	NaN
2013-01-02	NaN	NaN	NaN	NaN
2013-01-03	-1.277972	-0.386454	-2.647452	4.0
2013-01-04	-3.232215	-1.368541	-2.460276	2.0
2013-01-05	-4.572793	-5.571715	-3.823777	0.0
2013-01-06	NaN	NaN	NaN	NaN

In [168]:
```
df.apply(np.cumsum)
```

Out[168]:

	A	B	C	D
2013-01-01	0.000000	0.000000	1.031762	5
2013-01-02	0.437900	-0.154981	1.652887	10
2013-01-03	0.159929	0.458566	0.005435	15
2013-01-04	-0.072286	2.090025	0.545159	20
2013-01-05	0.354921	1.518310	1.721382	25
2013-01-06	-0.521252	2.799725	1.736827	30

```
In [169]: df.apply(lambda x: x.max() - x.min())
```

```
Out[169]: A    1.314073
          B    2.203174
          C    2.823675
          D    0.000000
          dtype: float64
```

Syed Afroz Ali

```
In [ ]:
```

Pandas toolkit Part 2

Syed Afroz Ali

```
In [1]: import pandas as pd
        import numpy as np
```

```
In [2]: s = pd.Series(np.random.randint(0, 7, size=10))
        s
```

```
Out[2]: 0    0
        1    6
        2    5
        3    6
        4    5
        5    5
        6    2
        7    2
        8    4
        9    2
        dtype: int32
```

```
In [3]: s.value_counts()
```

```
Out[3]: 5    3
        2    3
        6    2
        0    1
        4    1
        dtype: int64
```

```
In [4]: s = pd.Series(["A", "B", "C", "Aaba", "Baca", np.nan, "CABA", "dog", "cat"])
        s.str.lower()
```

```
Out[4]: 0       a
        1       b
        2       c
        3    aaba
        4    baca
        5     NaN
        6    caba
        7     dog
        8     cat
        dtype: object
```

In [5]:
```python
df = pd.DataFrame(np.random.randn(10, 4))
df
```

Out[5]:

	0	1	2	3
0	0.423742	0.285896	-1.319679	0.106474
1	-0.917753	-0.612802	0.510887	-0.192883
2	-0.398895	1.744283	0.392814	1.252180
3	1.275378	-2.030125	1.377954	0.047816
4	0.541705	0.955300	-0.510238	0.690620
5	-0.968414	-0.495862	1.229128	0.968220
6	-1.478773	0.418985	1.010736	-1.494321
7	0.743932	-0.563562	0.986714	0.625697
8	-0.407228	-1.016760	0.617824	-0.370512
9	-0.129449	0.430960	0.192333	0.270365

In [6]:
```python
pieces = [df[:3], df[3:7], df[7:]]
pd.concat(pieces)
```

Out[6]:

	0	1	2	3
0	0.423742	0.285896	-1.319679	0.106474
1	-0.917753	-0.612802	0.510887	-0.192883
2	-0.398895	1.744283	0.392814	1.252180
3	1.275378	-2.030125	1.377954	0.047816
4	0.541705	0.955300	-0.510238	0.690620
5	-0.968414	-0.495862	1.229128	0.968220
6	-1.478773	0.418985	1.010736	-1.494321
7	0.743932	-0.563562	0.986714	0.625697
8	-0.407228	-1.016760	0.617824	-0.370512
9	-0.129449	0.430960	0.192333	0.270365

In [9]:
```python
left = pd.DataFrame({"key": ["foo", "foo"], "lval": [1, 2]})
right = pd.DataFrame({"key": ["foo", "foo"], "rval": [4, 5]})
left
```

Out[9]:

	key	lval
0	foo	1
1	foo	2

In [10]:
```
pd.merge(left, right, on="key")
```

Out[10]:

	key	lval	rval
0	foo	1	4
1	foo	1	5
2	foo	2	4
3	foo	2	5

In [11]:
```
left = pd.DataFrame({"key": ["foo", "bar"], "lval": [1, 2]})
right = pd.DataFrame({"key": ["foo", "bar"], "rval": [4, 5]})
left
```

Out[11]:

	key	lval
0	foo	1
1	bar	2

In [12]:
```
pd.merge(left, right, on="key")
```

Out[12]:

	key	lval	rval
0	foo	1	4
1	bar	2	5

In [13]:
```
df = pd.DataFrame({

"A": ["foo", "bar", "foo", "bar", "foo", "bar", "foo", "foo"],
"B": ["one", "one", "two", "three", "two", "two", "one", "three"],
"C": np.random.randn(8),
"D": np.random.randn(8)

     })
df
```

Out[13]:

	A	B	C	D
0	foo	one	-0.663656	-0.382136
1	bar	one	-1.314220	-1.048106
2	foo	two	0.391064	-0.693546
3	bar	three	-0.778172	0.695501
4	foo	two	1.171063	-0.340544
5	bar	two	-0.688497	0.840714
6	foo	one	-0.762570	-0.991745
7	foo	three	-1.449696	0.397626

In [14]:
```
df.groupby("A").sum()
```

Out[14]:

A	C	D
bar	-2.780889	0.488108
foo	-1.313795	-2.010344

In [15]:
```
df.groupby(["A", "B"]).sum()
```

Out[15]:

A	B	C	D
bar	one	-1.314220	-1.048106
	three	-0.778172	0.695501
	two	-0.688497	0.840714
foo	one	-1.426226	-1.373881
	three	-1.449696	0.397626
	two	1.562128	-1.034089

In [16]:
```
tuples = list(zip(*[
["bar", "bar", "baz", "baz", "foo", "foo", "qux", "qux"],
["one", "two", "one", "two", "one", "two", "one", "two"]
]))

index = pd.MultiIndex.from_tuples(tuples, names=["first", "second"])
df = pd.DataFrame(np.random.randn(8, 2), index=index, columns=["A", "B"])
df2 = df[:4]
df2
```

Out[16]:

first	second	A	B
bar	one	-2.314275	-0.404936
	two	0.370079	-0.128071
baz	one	1.472769	-1.160009
	two	-1.060644	-1.309345

In [17]:
```
stacked = df2.stack()
stacked
```

Out[17]:
```
first  second
bar    one     A   -2.314275
               B   -0.404936
       two     A    0.370079
               B   -0.128071
baz    one     A    1.472769
               B   -1.160009
       two     A   -1.060644
               B   -1.309345
dtype: float64
```

In [18]:
```
stacked.unstack()
```

Out[18]:

		A	**B**
first	**second**		
bar	**one**	-2.314275	-0.404936
	two	0.370079	-0.128071
baz	**one**	1.472769	-1.160009
	two	-1.060644	-1.309345

In [19]:
```
stacked.unstack(1)
```

Out[19]:

	second	**one**	**two**
first			
bar	**A**	-2.314275	0.370079
	B	-0.404936	-0.128071
baz	**A**	1.472769	-1.060644
	B	-1.160009	-1.309345

In [20]:
```python
df = pd.DataFrame({

"A": ["one", "one", "two", "three"] * 3,
"B": ["A", "B", "C"] * 4,
"C": ["foo", "foo", "foo", "bar", "bar", "bar"] * 2,
"D": np.random.randn(12),
"E": np.random.randn(12)

})
df
```

Out[20]:

	A	B	C	D	E
0	one	A	foo	-1.156964	1.545813
1	one	B	foo	-1.975856	-0.172538
2	two	C	foo	-1.677984	-1.310321
3	three	A	bar	-1.159864	-0.761936
4	one	B	bar	0.408105	1.079825
5	one	C	bar	-0.717914	-1.394031
6	two	A	foo	0.620242	-0.099728
7	three	B	foo	0.315321	-0.546775
8	one	C	foo	-0.243819	1.283591
9	one	A	bar	0.718317	-0.877277
10	two	B	bar	0.747791	-0.748307
11	three	C	bar	-0.147173	0.632441

In [21]:
```python
pd.pivot_table(df, values="D", index=["A", "B"], columns=["C"])
```

Out[21]:

	C	**bar**	**foo**
A	**B**		
	A	0.718317	-1.156964
one	**B**	0.408105	-1.975856
	C	-0.717914	-0.243819
	A	-1.159864	NaN
three	**B**	NaN	0.315321
	C	-0.147173	NaN
	A	NaN	0.620242
two	**B**	0.747791	NaN
	C	NaN	-1.677984

```
In [22]: rng = pd.date_range("1/1/2012", periods=100, freq="S")
         ts = pd.Series(np.random.randint(0, 500, len(rng)), index=rng)
         ts.resample("5Min").sum()
```

```
Out[22]: 2012-01-01    26075
         Freq: 5T, dtype: int32
```

```
In [23]: rng = pd.date_range("3/6/2012 00:00", periods=5, freq="D")
         ts = pd.Series(np.random.randn(len(rng)), rng)
         ts
```

```
Out[23]: 2012-03-06    0.023926
         2012-03-07   -0.602996
         2012-03-08    0.686197
         2012-03-09    0.535357
         2012-03-10   -1.408127
         Freq: D, dtype: float64
```

```
In [24]: ts_utc = ts.tz_localize("UTC")
         ts_utc
```

```
Out[24]: 2012-03-06 00:00:00+00:00    0.023926
         2012-03-07 00:00:00+00:00   -0.602996
         2012-03-08 00:00:00+00:00    0.686197
         2012-03-09 00:00:00+00:00    0.535357
         2012-03-10 00:00:00+00:00   -1.408127
         Freq: D, dtype: float64
```

```
In [25]: rng = pd.date_range("1/1/2012", periods=5, freq="M")
         ts = pd.Series(np.random.randn(len(rng)), index=rng)
         ts
```

```
Out[25]: 2012-01-31   -1.062234
         2012-02-29    0.942182
         2012-03-31   -0.908925
         2012-04-30    0.171292
         2012-05-31   -2.773022
         Freq: M, dtype: float64
```

```
In [26]: ps = ts.to_period()
         ps
```

```
Out[26]: 2012-01   -1.062234
         2012-02    0.942182
         2012-03   -0.908925
         2012-04    0.171292
         2012-05   -2.773022
         Freq: M, dtype: float64
```

In [27]:
```
ps.to_timestamp()
```

Out[27]:
```
2012-01-01   -1.062234
2012-02-01    0.942182
2012-03-01   -0.908925
2012-04-01    0.171292
2012-05-01   -2.773022
Freq: MS, dtype: float64
```

In [28]:
```
prng = pd.period_range("1990Q1", "2000Q4", freq="Q-NOV")
ts = pd.Series(np.random.randn(len(prng)), prng)
ts.index = (prng.asfreq("M", "e") + 1).asfreq("H", "s") + 9
ts.head()
```

Out[28]:
```
1990-03-01 09:00   -0.745830
1990-06-01 09:00   -0.117445
1990-09-01 09:00   -0.189264
1990-12-01 09:00    0.541704
1991-03-01 09:00   -0.280971
Freq: H, dtype: float64
```

In [29]:
```
df = pd.DataFrame({"id": [1, 2, 3, 4, 5, 6], "raw_grade": ["a", "b", "b", "a",
df.head()
```

Out[29]:

	id	raw_grade
0	1	a
1	2	b
2	3	b
3	4	a
4	5	a

In [30]:
```
df["grade"] = df["raw_grade"].astype("category")
In [125]: df["grade"]
```

Out[30]:
```
0    a
1    b
2    b
3    a
4    a
5    e
Name: grade, dtype: category
Categories (3, object): ['a', 'b', 'e']
```

In [31]:
```
df["grade"].cat.categories = ["very good", "good", "very bad"]
```

```
In [32]: df["grade"] = df["grade"].cat.set_categories(["very bad", "bad", "medium", "go

         df["grade"]
```

```
Out[32]: 0    very good
         1         good
         2         good
         3    very good
         4    very good
         5     very bad
         Name: grade, dtype: category
         Categories (5, object): ['very bad', 'bad', 'medium', 'good', 'very good']
```

```
In [33]: df.sort_values(by="grade")
```

Out[33]:

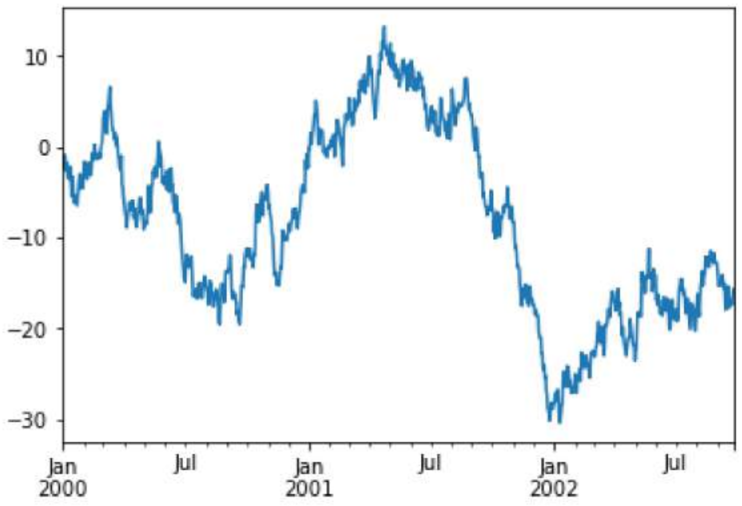
	id	raw_grade	grade
5	6	e	very bad
1	2	b	good
2	3	b	good
0	1	a	very good
3	4	a	very good
4	5	a	very good

```
In [34]: df.groupby("grade").size()
```

```
Out[34]: grade
         very bad     1
         bad          0
         medium       0
         good         2
         very good    3
         dtype: int64
```

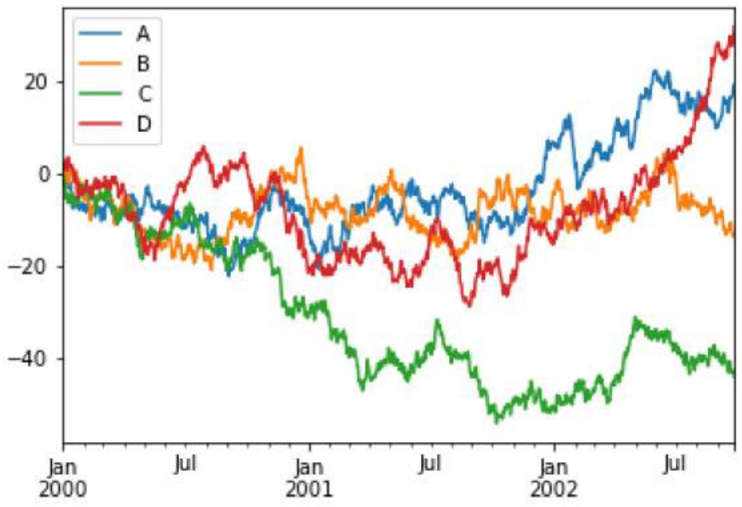
```
In [35]: import matplotlib.pyplot as plt
         plt.close("all")
```

In [36]:
```
ts = pd.Series(np.random.randn(1000), index=pd.date_range("1/1/2000",periods=1(
ts = ts.cumsum()
ts.plot();
```



In [37]:
```
df = pd.DataFrame(np.random.randn(1000, 4), index=ts.index, columns=["A", "B",
df = df.cumsum()
plt.figure();
df.plot();
plt.legend(loc='best');
```

```
<Figure size 432x288 with 0 Axes>
```



In [40]:
```
df.to_csv("foo.csv")
pd.read_csv("foo.csv")
```

Out[40]:

	Unnamed: 0	A	B	C	D
0	2000-01-01	0.070171	-0.384287	-0.333774	1.929496
1	2000-01-02	0.366578	-0.826180	0.025036	1.947304
2	2000-01-03	0.031841	-2.156061	-0.295405	3.846140
3	2000-01-04	-1.453527	-1.720770	0.681525	4.016645
4	2000-01-05	-0.506616	-1.748306	-0.953566	4.466979
...	...	...	...	...	...
995	2002-09-22	-8.952960	12.174642	-44.968475	21.234458
996	2002-09-23	-9.990733	13.157426	-43.955102	22.196782
997	2002-09-24	-10.370856	13.446153	-44.753827	23.111634
998	2002-09-25	-10.254712	13.043342	-44.844481	22.830099
999	2002-09-26	-9.240218	13.054899	-44.254345	22.267607

1000 rows × 5 columns

In [41]:
```
df.to_hdf("foo.h5", "df")
pd.read_hdf("foo.h5", "df")
```

Out[41]:

	A	B	C	D
2000-01-01	0.070171	-0.384287	-0.333774	1.929496
2000-01-02	0.366578	-0.826180	0.025036	1.947304
2000-01-03	0.031841	-2.156061	-0.295405	3.846140
2000-01-04	-1.453527	-1.720770	0.681525	4.016645
2000-01-05	-0.506616	-1.748306	-0.953566	4.466979
...	...	...	...	...
2002-09-22	-8.952960	12.174642	-44.968475	21.234458
2002-09-23	-9.990733	13.157426	-43.955102	22.196782
2002-09-24	-10.370856	13.446153	-44.753827	23.111634
2002-09-25	-10.254712	13.043342	-44.844481	22.830099
2002-09-26	-9.240218	13.054899	-44.254345	22.267607

1000 rows × 4 columns

In [42]:
```
df.to_excel("foo.xlsx", sheet_name="Sheet1")
pd.read_excel("foo.xlsx", "Sheet1", index_col=None, na_values=["NA"])
```

Out[42]:

	Unnamed: 0	A	B	C	D
0	2000-01-01	0.070171	-0.384287	-0.333774	1.929496
1	2000-01-02	0.366578	-0.826180	0.025036	1.947304
2	2000-01-03	0.031841	-2.156061	-0.295405	3.846140
3	2000-01-04	-1.453527	-1.720770	0.681525	4.016645
4	2000-01-05	-0.506616	-1.748306	-0.953566	4.466979
...	...	...	...	...	...
995	2002-09-22	-8.952960	12.174642	-44.968475	21.234458
996	2002-09-23	-9.990733	13.157426	-43.955102	22.196782
997	2002-09-24	-10.370856	13.446153	-44.753827	23.111634
998	2002-09-25	-10.254712	13.043342	-44.844481	22.830099
999	2002-09-26	-9.240218	13.054899	-44.254345	22.267607

1000 rows × 5 columns

In [43]:
```
s = pd.Series(np.random.randn(5), index=["a", "b", "c", "d", "e"])
s
```

Out[43]:
```
a   -0.168186
b   -2.300513
c   -1.303243
d    1.538910
e   -1.602989
dtype: float64
```

In [44]:
```
d = {"b": 1, "a": 0, "c": 2}
pd.Series(d)
```

Out[44]:
```
b    1
a    0
c    2
dtype: int64
```

In [45]:
```
d = {"a": 0.0, "b": 1.0, "c": 2.0}
pd.Series(d)
```

Out[45]:
```
a    0.0
b    1.0
c    2.0
dtype: float64
```

```
In [46]: pd.Series(d, index=["b", "c", "d", "a"])

Out[46]: b    1.0
         c    2.0
         d    NaN
         a    0.0
         dtype: float64

In [47]: pd.Series(5.0, index=["a", "b", "c", "d", "e"])

Out[47]: a    5.0
         b    5.0
         c    5.0
         d    5.0
         e    5.0
         dtype: float64

In [48]: s[0]

Out[48]: -0.1681860503643496

In [49]: s[:3]

Out[49]: a   -0.168186
         b   -2.300513
         c   -1.303243
         dtype: float64

In [50]: s[s > s.median()]

Out[50]: a   -0.168186
         d    1.538910
         dtype: float64

In [51]: s[[4, 3, 1]]

Out[51]: e   -1.602989
         d    1.538910
         b   -2.300513
         dtype: float64

In [52]: np.exp(s)

Out[52]: a    0.845197
         b    0.100207
         c    0.271649
         d    4.659509
         e    0.201294
         dtype: float64
```

```
In [53]: s.array
```

```
Out[53]: <PandasArray>
         [-0.1681860503643496, -2.3005130449484565, -1.3032428199311967,
           1.5389100807195653, -1.6029891733694224]
         Length: 5, dtype: float64
```

```
In [54]: s.to_numpy()
```

```
Out[54]: array([-0.16818605, -2.30051304, -1.30324282,  1.53891008, -1.60298917])
```

```
In [55]: s["a"]
```

```
Out[55]: -0.1681860503643496
```

```
In [56]: s["e"] = 12.0
         s
```

```
Out[56]: a    -0.168186
         b    -2.300513
         c    -1.303243
         d     1.538910
         e    12.000000
         dtype: float64
```

```
In [57]: np.exp(s)
```

```
Out[57]: a         0.845197
         b         0.100207
         c         0.271649
         d         4.659509
         e    162754.791419
         dtype: float64
```

```
In [58]: s[1:] + s[:-1]
```

```
Out[58]: a         NaN
         b   -4.601026
         c   -2.606486
         d    3.077820
         e         NaN
         dtype: float64
```

```
In [59]: s = pd.Series(np.random.randn(5), name="something")
         s
```

```
Out[59]: 0   -0.522842
         1    0.741873
         2   -1.460176
         3   -0.526032
         4   -0.180085
         Name: something, dtype: float64
```

In [60]:
```
s2 = s.rename("different")
s2.name
```

Out[60]:
```
'different'
```

In [61]:
```
d = {
"one": pd.Series([1.0, 2.0, 3.0], index=["a", "b", "c"]),
"two": pd.Series([1.0, 2.0, 3.0, 4.0], index=["a", "b", "c", "d"]),
}

df = pd.DataFrame(d)
df
```

Out[61]:

	one	two
a	1.0	1.0
b	2.0	2.0
c	3.0	3.0
d	NaN	4.0

In [62]:
```
pd.DataFrame(d, index=["d", "b", "a"])
```

Out[62]:

	one	two
d	NaN	4.0
b	2.0	2.0
a	1.0	1.0

In [63]:
```
pd.DataFrame(d, index=["d", "b", "a"], columns=["two", "three"])
```

Out[63]:

	two	three
d	4.0	NaN
b	2.0	NaN
a	1.0	NaN

In [64]:
```
df.index
```

Out[64]:
```
Index(['a', 'b', 'c', 'd'], dtype='object')
```

In [65]:
```
df.columns
```

Out[65]:
```
Index(['one', 'two'], dtype='object')
```

In [66]:
```
d = {"one": [1.0, 2.0, 3.0, 4.0], "two": [4.0, 3.0, 2.0, 1.0]}
pd.DataFrame(d)
```

Out[66]:

	one	two
0	1.0	4.0
1	2.0	3.0
2	3.0	2.0
3	4.0	1.0

In [67]:
```
pd.DataFrame(d, index=["a", "b", "c", "d"])
```

Out[67]:

	one	two
a	1.0	4.0
b	2.0	3.0
c	3.0	2.0
d	4.0	1.0

In [68]:
```
data = np.zeros((2,), dtype=[("A", "i4"), ("B", "f4"), ("C", "a10")])
data[:] = [(1, 2.0, "Hello"), (2, 3.0, "World")]
pd.DataFrame(data)
```

Out[68]:

	A	B	C
0	1	2.0	b'Hello'
1	2	3.0	b'World'

In [69]:
```
pd.DataFrame(data, index=["first", "second"])
```

Out[69]:

	A	B	C
first	1	2.0	b'Hello'
second	2	3.0	b'World'

In [70]:
```
pd.DataFrame(data, columns=["C", "A", "B"])
```

Out[70]:

	C	A	B
0	b'Hello'	1	2.0
1	b'World'	2	3.0

In [71]:
```
data2 = [{"a": 1, "b": 2}, {"a": 5, "b": 10, "c": 20}]
pd.DataFrame(data2)
```

Out[71]:

	a	b	c
0	1	2	NaN
1	5	10	20.0

In [72]:
```
pd.DataFrame(data2, index=["first", "second"])
```

Out[72]:

	a	b	c
first	1	2	NaN
second	5	10	20.0

In [73]:
```
pd.DataFrame(data2, columns=["a", "b"])
```

Out[73]:

	a	b
0	1	2
1	5	10

In [74]:
```
pd.DataFrame({

("a", "b"): {("A", "B"): 1, ("A", "C"): 2},
("a", "a"): {("A", "C"): 3, ("A", "B"): 4},
("a", "c"): {("A", "B"): 5, ("A", "C"): 6},
("b", "a"): {("A", "C"): 7, ("A", "B"): 8},
("b", "b"): {("A", "D"): 9, ("A", "B"): 10}

})
```

Out[74]:

		a			b	
		b	**a**	**c**	**a**	**b**
	B	1.0	4.0	5.0	8.0	10.0
A	**C**	2.0	3.0	6.0	7.0	NaN
	D	NaN	NaN	NaN	NaN	9.0

In [75]:
```
from collections import namedtuple
Point = namedtuple("Point", "x y")
pd.DataFrame([Point(0, 0), Point(0, 3), (2, 3)])
```

Out[75]:

	x	y
0	0	0
1	0	3
2	2	3

In [76]:
```
Point3D = namedtuple("Point3D", "x y z")
```

In [77]:
```
pd.DataFrame([Point3D(0, 0, 0), Point3D(0, 3, 5), Point(2, 3)])
```

Out[77]:

	x	y	z
0	0	0	0.0
1	0	3	5.0
2	2	3	NaN

In [78]:
```
from dataclasses import make_dataclass
Point = make_dataclass("Point", [("x", int), ("y", int)])
pd.DataFrame([Point(0, 0), Point(0, 3), Point(2, 3)])
```

Out[78]:

	x	y
0	0	0
1	0	3
2	2	3

In [79]:
```
pd.DataFrame.from_dict(dict([("A", [1, 2, 3]), ("B", [4, 5, 6])]))
```

Out[79]:

	A	B
0	1	4
1	2	5
2	3	6

In [80]:
```
pd.DataFrame.from_dict(
dict([("A", [1, 2, 3]), ("B", [4, 5, 6])]),
orient="index",
columns=["one", "two", "three"],
)
```

Out[80]:

	one	two	three
A	1	2	3
B	4	5	6

In [81]:
```
pd.DataFrame.from_records(data, index="C")
```

Out[81]:

	A	B
C		
b'Hello'	1	2.0
b'World'	2	3.0

In [82]:
```
df["three"] = df["one"] * df["two"]
df["flag"] = df["one"] > 2
df
```

Out[82]:

	one	two	three	flag
a	1.0	1.0	1.0	False
b	2.0	2.0	4.0	False
c	3.0	3.0	9.0	True
d	NaN	4.0	NaN	False

In [83]:
```
del df["two"]
three = df.pop("three")
df
```

Out[83]:

	one	flag
a	1.0	False
b	2.0	False
c	3.0	True
d	NaN	False

In [84]:
```
df["foo"] = "bar"
df
```

Out[84]:

	one	flag	foo
a	1.0	False	bar
b	2.0	False	bar
c	3.0	True	bar
d	NaN	False	bar

In [85]:
```
df["one_trunc"] = df["one"][:2]
df
```

Out[85]:

	one	flag	foo	one_trunc
a	1.0	False	bar	1.0
b	2.0	False	bar	2.0
c	3.0	True	bar	NaN
d	NaN	False	bar	NaN

In [86]:
```
df.insert(1, "bar", df["one"])
df
```

Out[86]:

	one	bar	flag	foo	one_trunc
a	1.0	1.0	False	bar	1.0
b	2.0	2.0	False	bar	2.0
c	3.0	3.0	True	bar	NaN
d	NaN	NaN	False	bar	NaN

In [87]:
```
iris = pd.read_csv("Iris.csv")
iris.head()
```

Out[87]:

	Id	SepalLengthCm	SepalWidthCm	PetalLengthCm	PetalWidthCm	Species
0	1	5.1	3.5	1.4	0.2	Iris-setosa
1	2	4.9	3.0	1.4	0.2	Iris-setosa
2	3	4.7	3.2	1.3	0.2	Iris-setosa
3	4	4.6	3.1	1.5	0.2	Iris-setosa
4	5	5.0	3.6	1.4	0.2	Iris-setosa

In [88]:
```
iris.assign(sepal_ratio=iris["SepalWidthCm"] / iris["SepalLengthCm"]).head()
```

Out[88]:

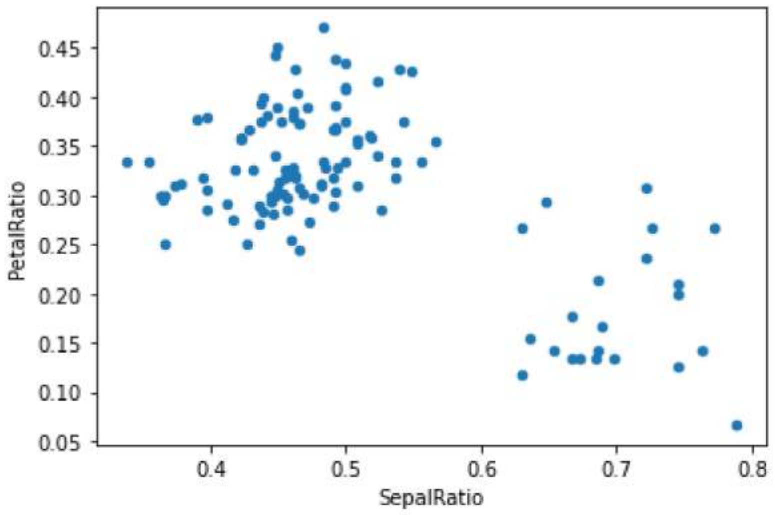
	Id	SepalLengthCm	SepalWidthCm	PetalLengthCm	PetalWidthCm	Species	sepal_ratio
0	1	5.1	3.5	1.4	0.2	Iris-setosa	0.686275
1	2	4.9	3.0	1.4	0.2	Iris-setosa	0.612245
2	3	4.7	3.2	1.3	0.2	Iris-setosa	0.680851
3	4	4.6	3.1	1.5	0.2	Iris-setosa	0.673913
4	5	5.0	3.6	1.4	0.2	Iris-setosa	0.720000

In [89]:
```
iris.assign(sepal_ratio=lambda x: (x["SepalWidthCm"] / x["SepalLengthCm"])).hea
```

Out[89]:

	Id	SepalLengthCm	SepalWidthCm	PetalLengthCm	PetalWidthCm	Species	sepal_ratio
0	1	5.1	3.5	1.4	0.2	Iris-setosa	0.686275
1	2	4.9	3.0	1.4	0.2	Iris-setosa	0.612245
2	3	4.7	3.2	1.3	0.2	Iris-setosa	0.680851
3	4	4.6	3.1	1.5	0.2	Iris-setosa	0.673913
4	5	5.0	3.6	1.4	0.2	Iris-setosa	0.720000

In [90]:
```
(iris.query("SepalLengthCm > 5").assign(
SepalRatio=lambda x: x.SepalWidthCm / x.SepalLengthCm,
PetalRatio=lambda x: x.PetalWidthCm / x.PetalLengthCm,
).plot(kind="scatter", x="SepalRatio", y="PetalRatio"));
```



In [91]:
```
dfa = pd.DataFrame({"A": [1, 2, 3], "B": [4, 5, 6]})
dfa.assign(C=lambda x: x["A"] + x["B"], D=lambda x: x["A"] + x["C"])
```

Out[91]:

	A	B	C	D
0	1	4	5	6
1	2	5	7	9
2	3	6	9	12

In [92]:
```
df = pd.DataFrame(np.random.randn(10, 4), columns=["A", "B", "C", "D"])
df2 = pd.DataFrame(np.random.randn(7, 3), columns=["A", "B", "C"])
df + df2
```

Out[92]:

	A	B	C	D
0	2.420866	1.658919	-0.004957	NaN
1	0.230904	-1.496995	0.531114	NaN
2	0.387801	-2.293522	-0.940368	NaN
3	0.198035	-1.598423	0.608666	NaN
4	-0.750591	1.431920	-1.540342	NaN
5	0.144717	-2.595985	0.175171	NaN
6	0.396199	0.681542	3.810757	NaN
7	NaN	NaN	NaN	NaN
8	NaN	NaN	NaN	NaN
9	NaN	NaN	NaN	NaN

In [93]:
```
df1 = pd.DataFrame({"a": [1, 0, 1], "b": [0, 1, 1]}, dtype=bool)
df2 = pd.DataFrame({"a": [0, 1, 1], "b": [1, 1, 0]}, dtype=bool)
df1 & df2
```

Out[93]:

	a	b
0	False	False
1	False	True
2	True	False

In [94]:
```
df1 | df2
```

Out[94]:

	a	b
0	True	True
1	True	True
2	True	True

In [95]:
```
df1 ^ df2
```

Out[95]:

	a	b
0	True	True
1	True	False
2	False	True

In [96]:
```
-df1
```

Out[96]:

	a	b
0	False	True
1	True	False
2	False	False

In [97]:
```python
np.exp(df)
```

Out[97]:

	A	B	C	D
0	4.850797	7.643395	1.172958	1.574652
1	4.009842	0.933421	7.619213	0.661011
2	1.349996	0.193248	0.811424	1.976038
3	0.941819	0.520655	0.461768	2.772299
4	0.894556	1.922714	0.224244	3.327236
5	1.056101	0.233735	0.556385	0.303122
6	2.077379	0.660008	7.266333	3.149107
7	0.800964	1.414727	0.712628	0.400347
8	1.998324	2.184248	3.783204	0.802994
9	0.723489	8.619131	0.100072	2.146063

In [98]:
```python
ser = pd.Series([1, 2, 3, 4])
np.exp(ser)
```

Out[98]:
```
0     2.718282
1     7.389056
2    20.085537
3    54.598150
dtype: float64
```

In [99]:
```python
ser1 = pd.Series([1, 2, 3], index=["a", "b", "c"])
ser2 = pd.Series([1, 3, 5], index=["b", "a", "c"])
ser1
```

Out[99]:
```
a    1
b    2
c    3
dtype: int64
```

In [100]:
```python
np.remainder(ser1, ser2)
```

Out[100]:
```
a    1
b    0
c    3
dtype: int64
```

In [101]:
```python
ser3 = pd.Series([2, 4, 6], index=["b", "c", "d"])
np.remainder(ser1, ser3)
```

Out[101]:
```
a    NaN
b    0.0
c    3.0
d    NaN
dtype: float64
```

In [102]:
```
ser = pd.Series([1, 2, 3])
idx = pd.Index([4, 5, 6])
np.maximum(ser, idx)
```

Out[102]:
```
0    4
1    5
2    6
dtype: int64
```

In [104]:
```
pd.DataFrame(np.random.randn(3, 12))
```

Out[104]:

	0	1	2	3	4	5	6	7	8
0	-0.501245	0.571128	-0.508366	-0.326784	0.636010	1.006448	-0.910515	-0.502634	1.30684
1	-0.555579	0.528680	0.244514	-0.921669	-0.942707	-1.253826	-1.811112	-0.900820	0.61678
2	-0.576731	-0.872153	2.207928	-0.505467	-0.130966	1.685892	-1.459214	-0.262680	-0.22943

In [105]:
```
pd.set_option("display.width", 40) # default is 80
pd.DataFrame(np.random.randn(3, 12))
```

Out[105]:

	0	1	2	3	4	5	6	7	8
0	0.022773	-1.401868	-0.970989	2.171251	0.414099	0.151816	-1.110283	-0.449167	1.714537
1	-0.789318	-0.265809	-0.678194	-2.483981	0.364979	-0.704912	-0.847870	-1.562679	1.817926
2	-0.841586	-1.769016	1.341991	-0.463400	1.139975	0.237341	-0.223064	-0.146064	0.253593

In [106]:
```
datafile = {
"filename": ["filename_01", "filename_02"],
"path": [
"media/user_name/storage/folder_01/filename_01",
"media/user_name/storage/folder_02/filename_02",]
}

pd.set_option("display.max_colwidth", 30)
pd.DataFrame(datafile)
```

Out[106]:

	filename	path
0	filename_01	media/user_name/storage/fo...
1	filename_02	media/user_name/storage/fo...

In [107]:
```
pd.set_option("display.max_colwidth", 100)
pd.DataFrame(datafile)
```

Out[107]:

	filename	path
0	filename_01	media/user_name/storage/folder_01/filename_01
1	filename_02	media/user_name/storage/folder_02/filename_02

In [ ]:
```
df = pd.DataFrame({"foo1": np.random.randn(5), "foo2": np.random.randn(5)})
df
```

In [108]:
```
index = pd.date_range("1/1/2000", periods=8)
s = pd.Series(np.random.randn(5), index=["a", "b", "c", "d", "e"])
df = pd.DataFrame(np.random.randn(8, 3), index=index, columns=["A", "B", "C"])
```

In [109]:
```
long_series = pd.Series(np.random.randn(1000))
long_series.head()
```

Out[109]:
```
0   -0.026014
1   -1.002232
2    0.435552
3   -0.516468
4    0.919732
dtype: float64
```

In [110]:
```
df[:2]
```

Out[110]:

	A	B	C
2000-01-01	-0.896867	0.519293	0.574513
2000-01-02	1.499996	0.210594	0.004202

In [111]:
```
df.columns = [x.lower() for x in df.columns]
df
```

Out[111]:

	a	b	c
2000-01-01	-0.896867	0.519293	0.574513
2000-01-02	1.499996	0.210594	0.004202
2000-01-03	0.670616	0.012021	-1.118078
2000-01-04	-0.708142	-0.351169	-0.596160
2000-01-05	0.571710	-1.264462	-0.999771
2000-01-06	-0.355902	-0.458909	1.478698
2000-01-07	0.242235	0.194339	-0.864089
2000-01-08	0.073826	0.314112	1.816110

In [112]:
```
s.array
```

Out[112]:
```
<PandasArray>
[-0.9915161162074533,
   0.816408648335188,
  1.1267915421666856,
 0.48624698933925486,
 0.26060288152211175]
Length: 5, dtype: float64
```

```
In [113]: s.index.array
```

```
Out[113]: <PandasArray>
          ['a', 'b', 'c', 'd', 'e']
          Length: 5, dtype: object
```

```
In [114]: s.to_numpy()
```

```
Out[114]: array([-0.99151612,  0.81640865,  1.12679154,  0.48624699,  0.26060288])
```

```
In [115]: np.asarray(s)
```

```
Out[115]: array([-0.99151612,  0.81640865,  1.12679154,  0.48624699,  0.26060288])
```

```
In [116]: ser = pd.Series(pd.date_range("2000", periods=2, tz="CET"))
          ser.to_numpy(dtype=object)
```

```
Out[116]: array([Timestamp('2000-01-01 00:00:00+0100', tz='CET'),
                 Timestamp('2000-01-02 00:00:00+0100', tz='CET')], dtype=object)
```

```
In [117]: pd.set_option("compute.use_bottleneck", False)
          pd.set_option("compute.use_numexpr", False)
```

```
In [118]: df = pd.DataFrame({
          "one": pd.Series(np.random.randn(3), index=["a", "b", "c"]),
          "two": pd.Series(np.random.randn(4), index=["a", "b", "c", "d"]),
          "three": pd.Series(np.random.randn(3), index=["b", "c", "d"]),
          })

          df
```

Out[118]:

	one	two	three
a	-1.171896	-1.181811	NaN
b	0.758395	-0.897135	-1.107687
c	-0.844188	0.018352	2.354688
d	NaN	1.613328	-0.269916

```
In [119]: row = df.iloc[1]
          column = df["two"]
          df.sub(row, axis="columns")
```

Out[119]:

	one	two	three
a	-1.930291	-0.284676	NaN
b	0.000000	0.000000	0.000000
c	-1.602583	0.915488	3.462375
d	NaN	2.510464	0.837772

```
In [120]: df.sub(row, axis=1)
```

Out[120]:

	one	two	three
a	-1.930291	-0.284676	NaN
b	0.000000	0.000000	0.000000
c	-1.602583	0.915488	3.462375
d	NaN	2.510464	0.837772

```
In [121]: df.sub(column, axis="index")
```

Out[121]:

	one	two	three
a	0.009915	0.0	NaN
b	1.655531	0.0	-0.210552
c	-0.862540	0.0	2.336335
d	NaN	0.0	-1.883244

```
In [122]: df.sub(column, axis=0)
```

Out[122]:

	one	two	three
a	0.009915	0.0	NaN
b	1.655531	0.0	-0.210552
c	-0.862540	0.0	2.336335
d	NaN	0.0	-1.883244

```
In [123]: dfmi = df.copy()
          In [27]: dfmi.index = pd.MultiIndex.from_tuples(
          [(1, "a"), (1, "b"), (1, "c"), (2, "a")], names=["first", "second"]
          )

          dfmi.sub(column, axis=0, level="second")
```

Out[123]:

		one	two	three
first	**second**			
	a	0.009915	0.000000	NaN
1	**b**	1.655531	0.000000	-0.210552
	c	-0.862540	0.000000	2.336335
2	**a**	NaN	2.795139	0.911896

In [124]:
```
pd.Series(np.arange(10))
```
Out[124]:
```
0    0
1    1
2    2
3    3
4    4
5    5
6    6
7    7
8    8
9    9
dtype: int32
```
In [125]:
```
div, rem = divmod(df,3)
div
```
Out[125]:

	one	two	three
a	-1.0	-1.0	NaN
b	0.0	-1.0	-1.0
c	-1.0	0.0	0.0
d	NaN	0.0	-1.0

In [126]:
```
idx = pd.Index(np.arange(10))
idx
```
Out[126]:
```
Int64Index([0, 1, 2, 3, 4, 5, 6, 7, 8,
            9],
           dtype='int64')
```
In [127]:
```
div, rem = divmod(idx, 3)
div
```
Out[127]:
```
Int64Index([0, 0, 0, 1, 1, 1, 2, 2, 2,
            3],
           dtype='int64')
```
In [128]:
```
df.gt(df)
```
Out[128]:

	one	two	three
a	False	False	False
b	False	False	False
c	False	False	False
d	False	False	False

```
In [129]: (df > 0).all()

Out[129]: one      False
          two      False
          three    False
          dtype: bool

In [130]: (df > 0).any()

Out[130]: one      True
          two      True
          three    True
          dtype: bool

In [131]: (df > 0).any().any()

Out[131]: True

In [132]: pd.DataFrame(columns=list("ABC")).empty

Out[132]: True

In [133]: (df + df == df * 2).all()

Out[133]: one      False
          two       True
          three    False
          dtype: bool

In [134]: (df + df).equals(df * 2)

Out[134]: True

In [135]: df1 = pd.DataFrame({"col": ["foo", 0, np.nan]})
          df2 = pd.DataFrame({"col": [np.nan, 0, "foo"]}, index=[2, 1, 0])
          df1.equals(df2)

Out[135]: False

In [136]: pd.Series(["foo", "bar", "baz"]) == "foo"

Out[136]: 0     True
          1    False
          2    False
          dtype: bool

In [137]: pd.Index(["foo", "bar", "baz"]) == "foo"

Out[137]: array([ True, False, False])
```

```
In [138]: pd.Series(["foo", "bar", "baz"]) == pd.Index(["foo", "bar", "qux"])

Out[138]: 0     True
          1     True
          2    False
          dtype: bool
```

```
In [139]: pd.Series(["foo", "bar", "baz"]) == np.array(["foo", "bar", "qux"])

Out[139]: 0     True
          1     True
          2    False
          dtype: bool
```

```
In [140]: np.array([1, 2, 3]) == np.array([2])

Out[140]: array([False,  True, False])
```

```
In [141]: df1 = pd.DataFrame(
          {"A": [1.0, np.nan, 3.0, 5.0, np.nan], "B": [np.nan, 2.0, 3.0, np.nan, 6.0]}
          )

          df2 = pd.DataFrame({
          "A": [5.0, 2.0, 4.0, np.nan, 3.0, 7.0],
          "B": [np.nan, np.nan, 3.0, 4.0, 6.0, 8.0],
          })

          df1
```

Out[141]:

	A	B
0	1.0	NaN
1	NaN	2.0
2	3.0	3.0
3	5.0	NaN
4	NaN	6.0

```
In [142]: df1.combine_first(df2)
```

Out[142]:

	A	B
0	1.0	NaN
1	2.0	2.0
2	3.0	3.0
3	5.0	4.0
4	3.0	6.0
5	7.0	8.0

In [143]:
```
def combiner(x, y):
    return np.where(pd.isna(x), y, x)
df1.combine(df2, combiner)
```

Out[143]:

	A	B
0	1.0	NaN
1	2.0	2.0
2	3.0	3.0
3	5.0	4.0
4	3.0	6.0
5	7.0	8.0

In [144]:
```
df.sum(0, skipna=False)
```

Out[144]:
```
one            NaN
two      -0.447266
three          NaN
dtype: float64
```

In [145]:
```
df.sum(axis=1, skipna=True)
```

Out[145]:
```
a   -2.353707
b   -1.246427
c    1.528852
d    1.343413
dtype: float64
```

In [146]:
```
ts_stand = (df - df.mean()) / df.std()
ts_stand.std()
```

Out[146]:
```
one      1.0
two      1.0
three    1.0
dtype: float64
```

In [147]:
```
xs_stand = df.sub(df.mean(1), axis=0).div(df.std(1), axis=0)
xs_stand.std(1)
```

Out[147]:
```
a    1.0
b    1.0
c    1.0
d    1.0
dtype: float64
```

In [148]:
```
np.mean(df["one"])
```

Out[148]:
```
-0.41922927314676367
```

In [149]:
```
np.mean(df["one"].to_numpy())
```
Out[149]:
```
nan
```
In [150]:
```
series = pd.Series(np.random.randn(500))
series[20:500] = np.nan
series[10:20] = 5
series.nunique()
```
Out[150]:
```
11
```
In [151]:
```
series = pd.Series(np.random.randn(1000))
series[::2] = np.nan
series.describe()
```
Out[151]:
```
count    500.000000
mean      -0.007995
std        0.963051
min       -4.036894
25%       -0.617967
50%        0.044174
75%        0.671260
max        2.694971
dtype: float64
```
In [152]:
```
frame = pd.DataFrame(np.random.randn(1000, 5), columns=["a", "b", "c", "d", "e'
frame.iloc[::2] = np.nan
frame.describe()
```
Out[152]:

	a	b	c	d	e
count	500.000000	500.000000	500.000000	500.000000	500.000000
mean	-0.033536	-0.000459	0.063157	0.059826	0.043546
std	0.973013	0.936975	1.046047	1.024661	0.978513
min	-3.491812	-2.591516	-2.787851	-2.796227	-3.234868
25%	-0.637533	-0.607886	-0.712782	-0.616478	-0.564365
50%	-0.022158	0.024663	0.037883	0.044762	-0.024644
75%	0.666086	0.639350	0.758282	0.721884	0.685598
max	2.566799	3.027822	2.766063	3.472135	3.077083

```
In [153]: series.describe(percentiles=[0.05, 0.25, 0.75, 0.95])
```

```
Out[153]: count    500.000000
          mean      -0.007995
          std        0.963051
          min       -4.036894
          5%        -1.707012
          25%       -0.617967
          50%        0.044174
          75%        0.671260
          95%        1.444216
          max        2.694971
          dtype: float64
```

```
In [154]: s = pd.Series(["a", "a", "b", "b", "a", "a", np.nan, "c", "d", "a"])
          s.describe()
```

```
Out[154]: count     9
          unique    4
          top       a
          freq      5
          dtype: object
```

Syed Afroz Ali

Pandas toolkit Part 3

Syed Afroz Ali

In [1]:
```
import pandas as pd
import numpy as np
```

In [2]:
```
frame = pd.DataFrame({"a": ["Yes", "Yes", "No", "No"], "b": range(4)})
frame.describe()
```

Out[2]:

	b
count	4.000000
mean	1.500000
std	1.290994
min	0.000000
25%	0.750000
50%	1.500000
75%	2.250000
max	3.000000

In [3]:
```
frame.describe(include=["object"])
```

Out[3]:

	a
count	4
unique	2
top	Yes
freq	2

In [6]:
```
frame.describe(include=["number"])
```

Out[6]:

	b
count	4.000000
mean	1.500000
std	1.290994
min	0.000000
25%	0.750000
50%	1.500000
75%	2.250000
max	3.000000

In [7]:
```
s1 = pd.Series(np.random.randn(5))
s1
```

Out[7]:
```
0   -0.121086
1    0.060713
2    1.259896
3   -0.161383
4   -2.168469
dtype: float64
```

In [8]:
```
s1.idxmin(), s1.idxmax()
```

Out[8]:
```
(4, 2)
```

In [9]:
```
df1 = pd.DataFrame(np.random.randn(5, 3), columns=["A", "B", "C"])
df1
```

Out[9]:

	A	B	C
0	-1.029309	1.362440	-0.959433
1	0.862846	-0.221771	-1.559672
2	0.735617	0.847179	-0.020883
3	-1.213478	0.416975	1.226910
4	0.020545	-0.211762	-1.391545

In [10]:
```
df1.idxmin(axis=0)
```

Out[10]:
```
A    3
B    1
C    1
dtype: int64
```

In [11]:
```
df1.idxmax(axis=1)
```

Out[11]:
```
0    B
1    A
2    B
3    C
4    A
dtype: object
```

In [12]:
```
df3 = pd.DataFrame([2, 1, 1, 3, np.nan], columns=["A"], index=list("edcba"))
df3
```

Out[12]:

	A
e	2.0
d	1.0
c	1.0
b	3.0
a	NaN

In [13]:
```
data = np.random.randint(0, 7, size=50)
data
```

Out[13]:
```
array([6, 5, 6, 2, 6, 2, 3, 5, 1, 3, 1, 3, 1, 5, 2, 6, 6, 4, 4, 6, 0, 5,
       0, 3, 5, 4, 1, 2, 2, 6, 1, 6, 1, 0, 4, 4, 0, 4, 3, 5, 6, 0, 6, 4,
       5, 5, 1, 1, 2, 5])
```

In [14]:
```
s = pd.Series(data)
s.value_counts()
```

Out[14]:
```
6    10
5     9
1     8
4     7
2     6
3     5
0     5
dtype: int64
```

In [15]:
```
data = {"a": [1, 2, 3, 4], "b": ["x", "x", "y", "y"]}
frame = pd.DataFrame(data)
frame.value_counts()
```

Out[15]:
```
a  b
1  x    1
2  x    1
3  y    1
4  y    1
dtype: int64
```

```
In [16]: s5 = pd.Series([1, 1, 3, 3, 3, 5, 5, 7, 7, 7])
         s5.mode()
```

```
Out[16]: 0    3
         1    7
         dtype: int64
```

```
In [17]: df5 = pd.DataFrame({
         "A": np.random.randint(0, 7, size=50),
         "B": np.random.randint(-10, 15, size=50),
         })
         df5.mode()
```

Out[17]:

	A	B
0	0.0	-9
1	NaN	-3

```
In [18]: arr = np.random.randn(20)
         factor = pd.cut(arr, 4)
         factor
```

```
Out[18]: [(-0.245, 0.809], (0.809, 1.863], (-1.303, -0.245], (-0.245, 0.809], (-0.245,
         0.809], ..., (-0.245, 0.809], (-0.245, 0.809], (1.863, 2.917], (-0.245, 0.80
         9], (-0.245, 0.809]]
         Length: 20
         Categories (4, interval[float64, right]): [(-1.303, -0.245] < (-0.245, 0.809]
         < (0.809, 1.863] < (1.863, 2.917]]
```

```
In [19]: factor = pd.cut(arr, [-5, -1, 0, 1, 5])
         factor
```

```
Out[19]: [(0, 1], (1, 5], (-1, 0], (-1, 0], (0, 1], ..., (0, 1], (0, 1], (1, 5], (-1,
         0], (-1, 0]]
         Length: 20
         Categories (4, interval[int64, right]): [(-5, -1] < (-1, 0] < (0, 1] < (1,
         5]]
```

```
In [20]: arr = np.random.randn(30)
         factor = pd.qcut(arr, [0, 0.25, 0.5, 0.75, 1])
         factor
```

```
Out[20]: [(-0.204, 0.428], (-0.75, -0.204], (-3.0669999999999997, -0.75], (-0.75, -0.2
         04], (-0.75, -0.204], ..., (-3.0669999999999997, -0.75], (-0.204, 0.428], (-
         3.0669999999999997, -0.75], (-0.204, 0.428], (-0.75, -0.204]]
         Length: 30
         Categories (4, interval[float64, right]): [(-3.0669999999999997, -0.75] < (-
         0.75, -0.204] < (-0.204, 0.428] < (0.428, 2.156]]
In [21]: arr = np.random.randn(20)
         factor = pd.cut(arr, [-np.inf, 0, np.inf])
         factor
```

```
Out[21]: [(-inf, 0.0], (-inf, 0.0], (0.0, inf], (0.0, inf], (0.0, inf], ..., (-inf, 0.
         0], (0.0, inf], (0.0, inf], (-inf, 0.0], (-inf, 0.0]]
         Length: 20
         Categories (2, interval[float64, right]): [(-inf, 0.0] < (0.0, inf]]
```

```
In [23]: def extract_city_name(df):
             df["city_name"] = df["city_and_code"].str.split(",").str.get(0)
             return df
         def add_country_name(df, country_name=None):
             col = "city_name"
             df["city_and_country"] = df[col] + country_name
             return df
         df_p = pd.DataFrame({"city_and_code": ["Chicago, IL"]})


         add_country_name(extract_city_name(df_p), country_name="US")
```

Out[23]:

	city_and_code	city_name	city_and_country
0	Chicago, IL	Chicago	ChicagoUS

```
In [24]: df_p.pipe(extract_city_name).pipe(add_country_name, country_name="US")
```

Out[24]:

	city_and_code	city_name	city_and_country
0	Chicago, IL	Chicago	ChicagoUS

In [25]:
```
import statsmodels.formula.api as sm
bb = pd.read_csv("baseball.csv", index_col="id")
(
bb.query("h > 0")
.assign(ln_h=lambda df: np.log(df.h))
.pipe((sm.ols, "data"), "hr ~ ln_h + year + g + C(lg)")
.fit()
.summary()
)
```

Out[25]:
```
OLS Regression Results

     Dep. Variable:                 hr         R-squared:      0.685
             Model:                OLS     Adj. R-squared:      0.665
            Method:      Least Squares        F-statistic:      34.28
              Date:   Thu, 22 Sep 2022  Prob (F-statistic):  3.48e-15
              Time:           18:53:34     Log-Likelihood:    -205.92
 No. Observations:                  68                AIC:      421.8
      Df Residuals:                 63                BIC:      432.9
          Df Model:                  4
  Covariance Type:           nonrobust

                    coef    std err       t   P>|t|     [0.025    0.975]
    Intercept  -8484.7720  4664.146  -1.819  0.074  -1.78e+04  835.780
  C(lg)[T.NL]     -2.2736     1.325  -1.716  0.091     -4.922    0.375
         ln_h     -1.3542     0.875  -1.547  0.127     -3.103    0.395
         year      4.2277     2.324   1.819  0.074     -0.417    8.872
            g      0.1841     0.029   6.258  0.000      0.125    0.243

       Omnibus:  10.875      Durbin-Watson:     1.999
 Prob(Omnibus):   0.004   Jarque-Bera (JB):    17.298
          Skew:   0.537           Prob(JB):  0.000175
      Kurtosis:   5.225           Cond. No.  1.49e+07


Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
[2] The condition number is large, 1.49e+07. This might indicate that there are
strong multicollinearity or other numerical problems.
```

In [27]:
```
df5.apply(np.mean)
```

Out[27]:
```
A    2.96
B    2.06
dtype: float64
```

```
In [28]: df5.apply(np.mean, axis=1)
```

```
Out[28]: 0      3.0
         1      4.5
         2      6.0
         3      1.0
         4      3.0
         5      6.5
         6     -2.5
         7     -4.5
         8      5.0
         9      8.5
         10     2.0
         11     0.0
         12     3.0
         13     2.0
         14    -1.5
         15     5.5
         16     6.5
         17    -3.5
         18     2.5
         19     0.5
         20     1.0
         21     6.5
         22    -1.5
         23     3.0
         24    -3.5
         25     7.5
         26     5.0
         27    -2.5
         28     2.0
         29     3.0
         30     8.5
         31     4.5
         32     0.0
         33     9.0
         34     6.5
         35     8.0
         36    -2.5
         37     0.0
         38     1.5
         39     0.5
         40    -4.0
         41     0.5
         42     7.5
         43    -0.5
         44     0.0
         45     7.0
         46     4.0
         47     5.0
         48     1.0
         49     1.0
         dtype: float64
```

```
In [29]: df5.apply(lambda x: x.max() - x.min())

Out[29]: A     6
         B    23
         dtype: int64
```

```
In [30]: df5.apply(np.cumsum)
```

Out[30]:

	A	B
0	0	6
1	2	13
2	2	25
3	7	22
4	7	28
5	12	36
6	15	28
7	15	19
8	17	27
9	21	40
10	22	43
11	22	43
12	25	46
13	31	44
14	37	35
15	39	44
16	41	55
17	44	45
18	50	44
19	51	44
20	51	46
21	56	54
22	61	46
23	62	51
24	64	42
25	70	51
26	73	58
27	78	48
28	83	47
29	87	49
30	93	60
31	93	69
32	97	65
33	103	77
34	104	89
35	110	99

	A	B
36	111	93
37	114	90
38	119	88
39	123	85
40	124	76
41	128	73
42	132	84
43	138	77
44	143	72
45	144	85
46	146	91
47	146	101
48	146	103
49	148	103

```
In [32]: df5.apply(np.exp)
```

```
Out[32]:
              A              B
0      1.000000     403.428793
1      7.389056    1096.633158
2      1.000000  162754.791419
3    148.413159       0.049787
4      1.000000     403.428793
5    148.413159    2980.957987
6     20.085537       0.000335
7      1.000000       0.000123
8      7.389056    2980.957987
9     54.598150  442413.392009
10     2.718282      20.085537
11     1.000000       1.000000
12    20.085537      20.085537
13   403.428793       0.135335
14   403.428793       0.000123
15     7.389056    8103.083928
16     7.389056   59874.141715
17    20.085537       0.000045
18   403.428793       0.367879
19     2.718282       1.000000
20     1.000000       7.389056
21   148.413159    2980.957987
22   148.413159       0.000335
23     2.718282     148.413159
24     7.389056       0.000123
25   403.428793    8103.083928
26    20.085537    1096.633158
27   148.413159       0.000045
28   148.413159       0.367879
29    54.598150       7.389056
30   403.428793   59874.141715
31     1.000000    8103.083928
32    54.598150       0.018316
33   403.428793  162754.791419
34     2.718282  162754.791419
35   403.428793   22026.465795
```

	A	B
36	2.718282	0.002479
37	20.085537	0.049787
38	148.413159	0.135335
39	54.598150	0.049787
40	2.718282	0.000123
41	54.598150	0.049787
42	54.598150	59874.141715
43	403.428793	0.000912
44	148.413159	0.006738
45	2.718282	442413.392009
46	7.389056	403.428793
47	1.000000	22026.465795
48	1.000000	7.389056
49	7.389056	1.000000

```
In [33]: df5.apply("mean")
```

```
Out[33]: A    2.96
         B    2.06
         dtype: float64
```

In [35]:
```
df5.apply("mean", axis=1)
```
Out[35]:
```
0     3.0
1     4.5
2     6.0
3     1.0
4     3.0
5     6.5
6    -2.5
7    -4.5
8     5.0
9     8.5
10    2.0
11    0.0
12    3.0
13    2.0
14   -1.5
15    5.5
16    6.5
17   -3.5
18    2.5
19    0.5
20    1.0
21    6.5
22   -1.5
23    3.0
24   -3.5
25    7.5
26    5.0
27   -2.5
28    2.0
29    3.0
30    8.5
31    4.5
32    0.0
33    9.0
34    6.5
35    8.0
36   -2.5
37    0.0
38    1.5
39    0.5
40   -4.0
41    0.5
42    7.5
43   -0.5
44    0.0
45    7.0
46    4.0
47    5.0
48    1.0
49    1.0
dtype: float64
```

In [36]:
```
def subtract_and_divide(x, sub, divide=1):
    return (x - sub) / divide

df5.apply(subtract_and_divide, args=(5,), divide=3)
```

Out[36]:

	A	B
0	-1.666667	0.333333
1	-1.000000	0.666667
2	-1.666667	2.333333
3	0.000000	-2.666667
4	-1.666667	0.333333
5	0.000000	1.000000
6	-0.666667	-4.333333
7	-1.666667	-4.666667
8	-1.000000	1.000000
9	-0.333333	2.666667
10	-1.333333	-0.666667
11	-1.666667	-1.666667
12	-0.666667	-0.666667
13	0.333333	-2.333333
14	0.333333	-4.666667
15	-1.000000	1.333333
16	-1.000000	2.000000
17	-0.666667	-5.000000
18	0.333333	-2.000000
19	-1.333333	-1.666667
20	-1.666667	-1.000000
21	0.000000	1.000000
22	0.000000	-4.333333
23	-1.333333	0.000000
24	-1.000000	-4.666667
25	0.333333	1.333333
26	-0.666667	0.666667
27	0.000000	-5.000000
28	0.000000	-2.000000
29	-0.333333	-1.000000
30	0.333333	2.000000
31	-1.666667	1.333333
32	-0.333333	-3.000000
33	0.333333	2.333333
34	-1.333333	2.333333
35	0.333333	1.666667

	A	B
36	-1.333333	-3.666667
37	-0.666667	-2.666667
38	0.000000	-2.333333
39	-0.333333	-2.666667
40	-1.333333	-4.666667
41	-0.333333	-2.666667
42	-0.333333	2.000000
43	0.333333	-4.000000
44	0.000000	-3.333333
45	-1.333333	2.666667
46	-1.000000	0.333333
47	-1.666667	1.666667
48	-1.666667	-1.000000
49	-1.000000	-1.666667

In [37]:

```
tsdf = pd.DataFrame(
np.random.randn(10, 3),
columns=["A", "B", "C"],
index=pd.date_range("1/1/2000", periods=10),
)

tsdf.iloc[3:7] = np.nan
tsdf
```

Out[37]:

	A	B	C
2000-01-01	1.100146	-0.594632	-0.486077
2000-01-02	-1.281338	-0.032859	0.675010
2000-01-03	-1.250284	1.207627	-0.363746
2000-01-04	NaN	NaN	NaN
2000-01-05	NaN	NaN	NaN
2000-01-06	NaN	NaN	NaN
2000-01-07	NaN	NaN	NaN
2000-01-08	1.381345	-1.236094	2.241808
2000-01-09	0.209783	0.166198	-0.248163
2000-01-10	2.156381	0.918886	-2.077679

```
In [38]: tsdf.agg(np.sum)
```

```
Out[38]: A    2.316033
         B    0.429125
         C   -0.258846
         dtype: float64
```

```
In [39]: tsdf.agg("sum")
```

```
Out[39]: A    2.316033
         B    0.429125
         C   -0.258846
         dtype: float64
```

```
In [40]: tsdf.sum()
```

```
Out[40]: A    2.316033
         B    0.429125
         C   -0.258846
         dtype: float64
```

```
In [41]: tsdf["A"].agg("sum")
```

```
Out[41]: 2.3160328735804745
```

```
In [42]: tsdf.agg(["sum", "mean"])
```

Out[42]:

	A	B	C
sum	2.316033	0.429125	-0.258846
mean	0.386005	0.071521	-0.043141

```
In [43]: tsdf["A"].agg(["sum", "mean"])
```

```
Out[43]: sum     2.316033
         mean    0.386005
         Name: A, dtype: float64
```

```
In [44]: tsdf["A"].agg(["sum", lambda x: x.mean()])
```

```
Out[44]: sum         2.316033
         <lambda>    0.386005
         Name: A, dtype: float64
```

```
In [45]: def mymean(x):
             return x.mean()

         tsdf["A"].agg(["sum", mymean])
```

```
Out[45]: sum       2.316033
         mymean    0.386005
         Name: A, dtype: float64
```

In [46]:
```
tsdf.agg({"A": "mean", "B": "sum"})
```

Out[46]:
```
A    0.386005
B    0.429125
dtype: float64
```

In [47]:
```
tsdf.agg({"A": ["mean", "min"], "B": "sum"})
```

Out[47]:

	A	B
mean	0.386005	NaN
min	-1.281338	NaN
sum	NaN	0.429125

In [48]:
```
mdf = pd.DataFrame({
"A": [1, 2, 3],
"B": [1.0, 2.0, 3.0],
"C": ["foo", "bar", "baz"],
"D": pd.date_range("20130101", periods=3),
})
```

In [49]:
```
mdf.agg(["min", "sum"])
```

Out[49]:

	A	B	C	D
min	1	1.0	bar	2013-01-01
sum	6	6.0	foobarbaz	NaT

In [50]:
```
# Custom describe

from functools import partial
q_25 = partial(pd.Series.quantile, q=0.25)
q_25.__name__ = "25%"
q_75 = partial(pd.Series.quantile, q=0.75)
q_75.__name__ = "75%"
tsdf.agg(["count", "mean", "std", "min", q_25, "median", q_75, "max"])
```

Out[50]:

	A	B	C
count	6.000000	6.000000	6.000000
mean	0.386005	0.071521	-0.043141
std	1.422916	0.914575	1.429482
min	-1.281338	-1.236094	-2.077679
25%	-0.885267	-0.454189	-0.455494
median	0.654965	0.066669	-0.305954
75%	1.311045	0.730714	0.444217
max	2.156381	1.207627	2.241808

In [52]:
```
tsdf = pd.DataFrame(
np.random.randn(10, 3),
columns=["A", "B", "C"],
index=pd.date_range("1/1/2000", periods=10),
)

tsdf.iloc[3:7] = np.nan
tsdf
```

Out[52]:

	A	B	C
2000-01-01	-0.632673	0.474561	-0.798479
2000-01-02	1.250986	-0.578337	1.065323
2000-01-03	-0.998635	-1.218509	-0.738105
2000-01-04	NaN	NaN	NaN
2000-01-05	NaN	NaN	NaN
2000-01-06	NaN	NaN	NaN
2000-01-07	NaN	NaN	NaN
2000-01-08	-0.683195	1.623150	0.090563
2000-01-09	-0.118824	-0.426729	-1.098490
2000-01-10	-1.150192	0.214560	1.337532

In [53]:
```
tsdf.transform(np.abs)
```

Out[53]:

	A	B	C
2000-01-01	0.632673	0.474561	0.798479
2000-01-02	1.250986	0.578337	1.065323
2000-01-03	0.998635	1.218509	0.738105
2000-01-04	NaN	NaN	NaN
2000-01-05	NaN	NaN	NaN
2000-01-06	NaN	NaN	NaN
2000-01-07	NaN	NaN	NaN
2000-01-08	0.683195	1.623150	0.090563
2000-01-09	0.118824	0.426729	1.098490
2000-01-10	1.150192	0.214560	1.337532

In [54]:
```
tsdf.transform("abs")
```
Out[54]:

	A	B	C
2000-01-01	0.632673	0.474561	0.798479
2000-01-02	1.250986	0.578337	1.065323
2000-01-03	0.998635	1.218509	0.738105
2000-01-04	NaN	NaN	NaN
2000-01-05	NaN	NaN	NaN
2000-01-06	NaN	NaN	NaN
2000-01-07	NaN	NaN	NaN
2000-01-08	0.683195	1.623150	0.090563
2000-01-09	0.118824	0.426729	1.098490
2000-01-10	1.150192	0.214560	1.337532

In [55]:
```
tsdf.transform(lambda x: x.abs())
```
Out[55]:

	A	B	C
2000-01-01	0.632673	0.474561	0.798479
2000-01-02	1.250986	0.578337	1.065323
2000-01-03	0.998635	1.218509	0.738105
2000-01-04	NaN	NaN	NaN
2000-01-05	NaN	NaN	NaN
2000-01-06	NaN	NaN	NaN
2000-01-07	NaN	NaN	NaN
2000-01-08	0.683195	1.623150	0.090563
2000-01-09	0.118824	0.426729	1.098490
2000-01-10	1.150192	0.214560	1.337532

In [56]:
```
np.abs(tsdf)
```

Out[56]:

	A	B	C
2000-01-01	0.632673	0.474561	0.798479
2000-01-02	1.250986	0.578337	1.065323
2000-01-03	0.998635	1.218509	0.738105
2000-01-04	NaN	NaN	NaN
2000-01-05	NaN	NaN	NaN
2000-01-06	NaN	NaN	NaN
2000-01-07	NaN	NaN	NaN
2000-01-08	0.683195	1.623150	0.090563
2000-01-09	0.118824	0.426729	1.098490
2000-01-10	1.150192	0.214560	1.337532

In [57]:
```
tsdf["A"].transform(np.abs)
```

Out[57]:
```
2000-01-01    0.632673
2000-01-02    1.250986
2000-01-03    0.998635
2000-01-04         NaN
2000-01-05         NaN
2000-01-06         NaN
2000-01-07         NaN
2000-01-08    0.683195
2000-01-09    0.118824
2000-01-10    1.150192
Freq: D, Name: A, dtype: float64
```

In [58]:
```
tsdf.transform([np.abs, lambda x: x + 1])
```

Out[58]:

	A		B		C	
	absolute	**<lambda>**	**absolute**	**<lambda>**	**absolute**	**<lambda>**
2000-01-01	0.632673	0.367327	0.474561	1.474561	0.798479	0.201521
2000-01-02	1.250986	2.250986	0.578337	0.421663	1.065323	2.065323
2000-01-03	0.998635	0.001365	1.218509	-0.218509	0.738105	0.261895
2000-01-04	NaN	NaN	NaN	NaN	NaN	NaN
2000-01-05	NaN	NaN	NaN	NaN	NaN	NaN
2000-01-06	NaN	NaN	NaN	NaN	NaN	NaN
2000-01-07	NaN	NaN	NaN	NaN	NaN	NaN
2000-01-08	0.683195	0.316805	1.623150	2.623150	0.090563	1.090563
2000-01-09	0.118824	0.881176	0.426729	0.573271	1.098490	-0.098490
2000-01-10	1.150192	-0.150192	0.214560	1.214560	1.337532	2.337532

In [59]:
```
tsdf["A"].transform([np.abs, lambda x: x + 1])
```

Out[59]:

	absolute	<lambda>
2000-01-01	0.632673	0.367327
2000-01-02	1.250986	2.250986
2000-01-03	0.998635	0.001365
2000-01-04	NaN	NaN
2000-01-05	NaN	NaN
2000-01-06	NaN	NaN
2000-01-07	NaN	NaN
2000-01-08	0.683195	0.316805
2000-01-09	0.118824	0.881176
2000-01-10	1.150192	-0.150192

In [60]:
```
tsdf.transform({"A": np.abs, "B": lambda x: x + 1})
```

Out[60]:

	A	B
2000-01-01	0.632673	1.474561
2000-01-02	1.250986	0.421663
2000-01-03	0.998635	-0.218509
2000-01-04	NaN	NaN
2000-01-05	NaN	NaN
2000-01-06	NaN	NaN
2000-01-07	NaN	NaN
2000-01-08	0.683195	2.623150
2000-01-09	0.118824	0.573271
2000-01-10	1.150192	1.214560

In [68]:
```
df = pd.DataFrame({
"one": pd.Series(np.random.randn(3), index=["a", "b", "c"]),
"two": pd.Series(np.random.randn(4), index=["a", "b", "c", "d"]),
"three": pd.Series(np.random.randn(3), index=["b", "c", "d"]),
})

df
```

Out[68]:

	one	two	three
a	-0.789990	-0.020558	NaN
b	0.572949	-0.778513	-0.450913
c	-0.367262	1.963174	-0.203882
d	NaN	-0.313509	0.001874

```
In [69]: df["three"] = df["one"] * df["two"]
         df["flag"] = df["one"] > 2
         df
```

Out[69]:

	one	two	three	flag
a	-0.789990	-0.020558	0.016241	False
b	0.572949	-0.778513	-0.446048	False
c	-0.367262	1.963174	-0.721000	False
d	NaN	-0.313509	NaN	False

```
In [70]: def f(x):
             return len(str(x))
         df["one"].map(f)
```

```
Out[70]: a    19
         b    18
         c    19
         d     3
         Name: one, dtype: int64
```

```
In [71]: df.applymap(f)
```

Out[71]:

	one	two	three	flag
a	19	21	19	5
b	18	19	19	5
c	19	18	19	5
d	3	19	3	5

```
In [72]: s = pd.Series(
         ["six", "seven", "six", "seven", "six"], index=["a", "b", "c", "d", "e"]
         )

         t = pd.Series({"six": 6.0, "seven": 7.0})
         s
```

```
Out[72]: a      six
         b    seven
         c      six
         d    seven
         e      six
         dtype: object
```

In [73]:
```
s.map(t)
```

Out[73]:
```
a    6.0
b    7.0
c    6.0
d    7.0
e    6.0
dtype: float64
```

In [74]:
```
s = pd.Series(np.random.randn(5), index=["a", "b", "c", "d", "e"])
s
```

Out[74]:
```
a   -0.727970
b    1.102445
c    1.113834
d   -0.195407
e    0.238101
dtype: float64
```

In [75]:
```
s.reindex(["e", "b", "f", "d"])
```

Out[75]:
```
e    0.238101
b    1.102445
f         NaN
d   -0.195407
dtype: float64
```

In [76]:
```
df.reindex(index=["c", "f", "b"], columns=["three", "two", "one"])
```

Out[76]:

	three	two	one
c	-0.721000	1.963174	-0.367262
f	NaN	NaN	NaN
b	-0.446048	-0.778513	0.572949

In [77]:
```
df.reindex(["c", "f", "b"], axis="index")
```

Out[77]:

	one	two	three	flag
c	-0.367262	1.963174	-0.721000	False
f	NaN	NaN	NaN	NaN
b	0.572949	-0.778513	-0.446048	False

In [78]:
```
rs = s.reindex(df.index)
rs
```

Out[78]:
```
a   -0.727970
b    1.102445
c    1.113834
d   -0.195407
dtype: float64
```

In [79]:
```
df.reindex(["c", "f", "b"], axis="index")
```

Out[79]:

	one	two	three	flag
c	-0.367262	1.963174	-0.721000	False
f	NaN	NaN	NaN	NaN
b	0.572949	-0.778513	-0.446048	False

In [80]:
```
df.reindex(["three", "two", "one"], axis="columns")
```

Out[80]:

	three	two	one
a	0.016241	-0.020558	-0.789990
b	-0.446048	-0.778513	0.572949
c	-0.721000	1.963174	-0.367262
d	NaN	-0.313509	NaN

In [82]:
```
df.reindex_like(df)
```

Out[82]:

	one	two	three	flag
a	-0.789990	-0.020558	0.016241	False
b	0.572949	-0.778513	-0.446048	False
c	-0.367262	1.963174	-0.721000	False
d	NaN	-0.313509	NaN	False

In [83]:
```
s = pd.Series(np.random.randn(5), index=["a", "b", "c", "d", "e"])
s1 = s[:4]
s2 = s[1:]
s1.align(s2)
```

Out[83]:
```
(a   -0.511169
 b   -0.185304
 c    0.725502
 d   -1.852033
 e         NaN
 dtype: float64,
 a         NaN
 b   -0.185304
 c    0.725502
 d   -1.852033
 e   -1.251512
 dtype: float64)
```

```
In [84]: s1.align(s2, join="inner")
```

```
Out[84]: (b   -0.185304
          c    0.725502
          d   -1.852033
          dtype: float64,
          b   -0.185304
          c    0.725502
          d   -1.852033
          dtype: float64)
```

```
In [85]: s1.align(s2, join="left")
```

```
Out[85]: (a   -0.511169
          b   -0.185304
          c    0.725502
          d   -1.852033
          dtype: float64,
          a         NaN
          b   -0.185304
          c    0.725502
          d   -1.852033
          dtype: float64)
```

```
In [88]: df.align(df5, join="inner")
```

```
Out[88]: (Empty DataFrame
          Columns: []
          Index: [],
          Empty DataFrame
          Columns: []
          Index: [])
```

```
In [89]: df.align(df5, join="inner", axis=0)
```

```
Out[89]: (Empty DataFrame
          Columns: [one, two, three, flag]
          Index: [],
          Empty DataFrame
          Columns: [A, B]
          Index: [])
```

In [91]:
```
df.align(df5.iloc[0], axis=1)
```

Out[91]:
```
(     A   B   flag       one     three       two
 a NaN NaN  False -0.789990  0.016241 -0.020558
 b NaN NaN  False  0.572949 -0.446048 -0.778513
 c NaN NaN  False -0.367262 -0.721000  1.963174
 d NaN NaN  False       NaN       NaN -0.313509,
 A        0.0
 B        6.0
 flag     NaN
 one      NaN
 three    NaN
 two      NaN
 Name: 0, dtype: float64)
```

In [92]:
```
rng = pd.date_range("1/3/2000", periods=8)
ts = pd.Series(np.random.randn(8), index=rng)
ts2 = ts[[0, 3, 6]]
ts
```

Out[92]:
```
2000-01-03   -1.310621
2000-01-04   -0.992201
2000-01-05   -1.394069
2000-01-06    0.820258
2000-01-07   -1.331111
2000-01-08    0.116894
2000-01-09   -0.452949
2000-01-10    1.596265
Freq: D, dtype: float64
```

In [93]:
```

ts2.reindex(ts.index)
```

Out[93]:
```
2000-01-03   -1.310621
2000-01-04         NaN
2000-01-05         NaN
2000-01-06    0.820258
2000-01-07         NaN
2000-01-08         NaN
2000-01-09   -0.452949
2000-01-10         NaN
Freq: D, dtype: float64
```

In [94]:
```
ts2.reindex(ts.index, method="ffill")
```

Out[94]:
```
2000-01-03   -1.310621
2000-01-04   -1.310621
2000-01-05   -1.310621
2000-01-06    0.820258
2000-01-07    0.820258
2000-01-08    0.820258
2000-01-09   -0.452949
2000-01-10   -0.452949
Freq: D, dtype: float64
```

```
In [95]: ts2.reindex(ts.index, method="bfill")

Out[95]: 2000-01-03   -1.310621
         2000-01-04    0.820258
         2000-01-05    0.820258
         2000-01-06    0.820258
         2000-01-07   -0.452949
         2000-01-08   -0.452949
         2000-01-09   -0.452949
         2000-01-10         NaN
         Freq: D, dtype: float64
```

```
In [96]: ts2.reindex(ts.index, method="nearest")

Out[96]: 2000-01-03   -1.310621
         2000-01-04   -1.310621
         2000-01-05    0.820258
         2000-01-06    0.820258
         2000-01-07    0.820258
         2000-01-08   -0.452949
         2000-01-09   -0.452949
         2000-01-10   -0.452949
         Freq: D, dtype: float64
```

```
In [97]: ts2.reindex(ts.index).fillna(method="ffill")

Out[97]: 2000-01-03   -1.310621
         2000-01-04   -1.310621
         2000-01-05   -1.310621
         2000-01-06    0.820258
         2000-01-07    0.820258
         2000-01-08    0.820258
         2000-01-09   -0.452949
         2000-01-10   -0.452949
         Freq: D, dtype: float64
```

```
In [98]: ts2.reindex(ts.index, method="ffill", limit=1)

Out[98]: 2000-01-03   -1.310621
         2000-01-04   -1.310621
         2000-01-05         NaN
         2000-01-06    0.820258
         2000-01-07    0.820258
         2000-01-08         NaN
         2000-01-09   -0.452949
         2000-01-10   -0.452949
         Freq: D, dtype: float64
```

In [99]:
```
ts2.reindex(ts.index, method="ffill", tolerance="1 day")
```

Out[99]:
```
2000-01-03   -1.310621
2000-01-04   -1.310621
2000-01-05         NaN
2000-01-06    0.820258
2000-01-07    0.820258
2000-01-08         NaN
2000-01-09   -0.452949
2000-01-10   -0.452949
Freq: D, dtype: float64
```

In [100]:
```
df.drop(["a", "d"], axis=0)
```

Out[100]:

	one	two	three	flag
b	0.572949	-0.778513	-0.446048	False
c	-0.367262	1.963174	-0.721000	False

In [101]:
```
df.drop(["one"], axis=1)
```

Out[101]:

	two	three	flag
a	-0.020558	0.016241	False
b	-0.778513	-0.446048	False
c	1.963174	-0.721000	False
d	-0.313509	NaN	False

In [102]:
```
df.reindex(df.index.difference(["a", "d"]))
```

Out[102]:

	one	two	three	flag
b	0.572949	-0.778513	-0.446048	False
c	-0.367262	1.963174	-0.721000	False

In [103]:
```
s.rename(str.upper)
```

Out[103]:
```
A   -0.511169
B   -0.185304
C    0.725502
D   -1.852033
E   -1.251512
dtype: float64
```

In [104]:
```
df.rename(
columns={"one": "foo", "two": "bar"},
index={"a": "apple", "b": "banana", "d": "durian"})
```

Out[104]:

	foo	bar	three	flag
apple	-0.789990	-0.020558	0.016241	False
banana	0.572949	-0.778513	-0.446048	False
c	-0.367262	1.963174	-0.721000	False
durian	NaN	-0.313509	NaN	False

In [105]:
```
df.rename({"one": "foo", "two": "bar"}, axis="columns")
```

Out[105]:

	foo	bar	three	flag
a	-0.789990	-0.020558	0.016241	False
b	0.572949	-0.778513	-0.446048	False
c	-0.367262	1.963174	-0.721000	False
d	NaN	-0.313509	NaN	False

In [106]:
```
df.rename({"a": "apple", "b": "banana", "d": "durian"}, axis="index")
```

Out[106]:

	one	two	three	flag
apple	-0.789990	-0.020558	0.016241	False
banana	0.572949	-0.778513	-0.446048	False
c	-0.367262	1.963174	-0.721000	False
durian	NaN	-0.313509	NaN	False

In [107]:
```
s.rename("scalar-name")
```

Out[107]:
```
a   -0.511169
b   -0.185304
c    0.725502
d   -1.852033
e   -1.251512
Name: scalar-name, dtype: float64
```

```
In [108]: df = pd.DataFrame(
          {"x": [1, 2, 3, 4, 5, 6], "y": [10, 20, 30, 40, 50, 60]},
          index=pd.MultiIndex.from_product(
          [["a", "b", "c"], [1, 2]], names=["let", "num"]
          ))

          df
```

```
Out[108]:
                 x   y
          let num
          a   1  1  10
              2  2  20
          b   1  3  30
              2  4  40
          c   1  5  50
              2  6  60
```

```
In [109]: df.rename_axis(index={"let": "abc"})
```

```
Out[109]:
                 x   y
          abc num
          a   1  1  10
              2  2  20
          b   1  3  30
              2  4  40
          c   1  5  50
              2  6  60
```

```
In [110]: df.rename_axis(index=str.upper)
```

```
Out[110]:
                 x   y
          LET NUM
          a   1  1  10
              2  2  20
          b   1  3  30
              2  4  40
          c   1  5  50
              2  6  60
```

In [111]:
```
df = pd.DataFrame({"col1": np.random.randn(3), "col2": np.random.randn(3)}, inc

for col in df:
    print(col)
```

```
col1
col2
```

In [112]:
```
df = pd.DataFrame({"a": [1, 2, 3], "b": ["a", "b", "c"]})
In [257]: for index, row in df.iterrows():
        row["a"] = 10
df
```

Out[112]:

	a	b
0	1	a
1	2	b
2	3	c

In [113]:
```
for label, ser in df.items():
    print(label)
    print(ser)
```

```
a
0    1
1    2
2    3
Name: a, dtype: int64
b
0    a
1    b
2    c
Name: b, dtype: object
```

In [114]:
```
for row_index, row in df.iterrows():
    print(row_index, row, sep="\n")
```

```
0
a    1
b    a
Name: 0, dtype: object
1
a    2
b    b
Name: 1, dtype: object
2
a    3
b    c
Name: 2, dtype: object
```

```
In [115]: df_orig = pd.DataFrame([[1, 1.5]], columns=["int", "float"])
          df_orig.dtypes

Out[115]: int        int64
          float    float64
          dtype: object

In [116]: row = next(df_orig.iterrows())[1]
          row

Out[116]: int      1.0
          float    1.5
          Name: 0, dtype: float64

In [117]: row["int"].dtype

Out[117]: dtype('float64')

In [118]: df_orig["int"].dtype

Out[118]: dtype('int64')

In [119]: df2 = pd.DataFrame({"x": [1, 2, 3], "y": [4, 5, 6]})
          print(df2)

             x  y
          0  1  4
          1  2  5
          2  3  6

In [120]: df2_t = pd.DataFrame({idx: values for idx, values in df2.iterrows()})
          print(df2_t)

             0  1  2
          x  1  2  3
          y  4  5  6

In [121]: for row in df.itertuples():
              print(row)

          Pandas(Index=0, a=1, b='a')
          Pandas(Index=1, a=2, b='b')
          Pandas(Index=2, a=3, b='c')

In [122]: s = pd.Series(pd.date_range("20130101 09:10:12", periods=4))
          s

Out[122]: 0   2013-01-01 09:10:12
          1   2013-01-02 09:10:12
          2   2013-01-03 09:10:12
          3   2013-01-04 09:10:12
          dtype: datetime64[ns]
```

```
In [123]: s.dt.hour
```

```
Out[123]: 0    9
          1    9
          2    9
          3    9
          dtype: int64
```

```
In [124]: s.dt.second
```

```
Out[124]: 0    12
          1    12
          2    12
          3    12
          dtype: int64
```

```
In [125]: s.dt.day
```

```
Out[125]: 0    1
          1    2
          2    3
          3    4
          dtype: int64
```

```
In [126]: s[s.dt.day == 2]
```

```
Out[126]: 1   2013-01-02 09:10:12
          dtype: datetime64[ns]
```

```
In [127]: stz = s.dt.tz_localize("US/Eastern")
          stz
```

```
Out[127]: 0   2013-01-01 09:10:12-05:00
          1   2013-01-02 09:10:12-05:00
          2   2013-01-03 09:10:12-05:00
          3   2013-01-04 09:10:12-05:00
          dtype: datetime64[ns, US/Eastern]
```

```
In [128]: s.dt.tz_localize("UTC").dt.tz_convert("US/Eastern")
```

```
Out[128]: 0   2013-01-01 04:10:12-05:00
          1   2013-01-02 04:10:12-05:00
          2   2013-01-03 04:10:12-05:00
          3   2013-01-04 04:10:12-05:00
          dtype: datetime64[ns, US/Eastern]
```

```
In [129]: s = pd.Series(pd.date_range("20130101", periods=4))
          s

Out[129]: 0   2013-01-01
          1   2013-01-02
          2   2013-01-03
          3   2013-01-04
          dtype: datetime64[ns]

In [130]: s.dt.strftime("%Y/%m/%d")

Out[130]: 0    2013/01/01
          1    2013/01/02
          2    2013/01/03
          3    2013/01/04
          dtype: object

In [132]: s = pd.Series(pd.period_range("20130101", periods=4))
          s

Out[132]: 0    2013-01-01
          1    2013-01-02
          2    2013-01-03
          3    2013-01-04
          dtype: period[D]

In [133]: s.dt.strftime("%Y/%m/%d")

Out[133]: 0    2013/01/01
          1    2013/01/02
          2    2013/01/03
          3    2013/01/04
          dtype: object

In [134]: s = pd.Series(pd.period_range("20130101", periods=4, freq="D"))
          s

Out[134]: 0    2013-01-01
          1    2013-01-02
          2    2013-01-03
          3    2013-01-04
          dtype: period[D]

In [135]: s.dt.year

Out[135]: 0    2013
          1    2013
          2    2013
          3    2013
          dtype: int64
```

```
In [136]: s.dt.day
```

```
Out[136]: 0    1
          1    2
          2    3
          3    4
          dtype: int64
```

```
In [137]: s = pd.Series(pd.timedelta_range("1 day 00:00:05", periods=4, freq="s"))
          s
```

```
Out[137]: 0   1 days 00:00:05
          1   1 days 00:00:06
          2   1 days 00:00:07
          3   1 days 00:00:08
          dtype: timedelta64[ns]
```

```
In [138]: s.dt.days
```

```
Out[138]: 0    1
          1    1
          2    1
          3    1
          dtype: int64
```

```
In [139]: s.dt.seconds
```

```
Out[139]: 0    5
          1    6
          2    7
          3    8
          dtype: int64
```

```
In [140]: s.dt.components
```

Out[140]:

	days	hours	minutes	seconds	milliseconds	microseconds	nanoseconds
0	1	0	0	5	0	0	0
1	1	0	0	6	0	0	0
2	1	0	0	7	0	0	0
3	1	0	0	8	0	0	0

Syed Afroz Ali

```
In [ ]:
```

Pandas toolkit Part 4

Syed Afroz Ali

In [1]:
```
import pandas as pd
import numpy as np
```

In [2]:
```
df = pd.DataFrame(
{
"one": pd.Series(np.random.randn(3), index=["a", "b", "c"]),
"two": pd.Series(np.random.randn(4), index=["a", "b", "c", "d"]),
"three": pd.Series(np.random.randn(3), index=["b", "c", "d"]),
}
)
unsorted_df = df.reindex(
index=["a", "d", "c", "b"], columns=["three", "two", "one"]
)

unsorted_df
```

Out[2]:

	three	two	one
a	NaN	-0.326406	-0.078773
d	1.122434	-0.263896	NaN
c	0.745061	-0.700178	2.138660
b	-2.535724	-0.196084	1.556742

In [3]:
```
unsorted_df.sort_index()
```

Out[3]:

	three	two	one
a	NaN	-0.326406	-0.078773
b	-2.535724	-0.196084	1.556742
c	0.745061	-0.700178	2.138660
d	1.122434	-0.263896	NaN

In [4]:
```
unsorted_df.sort_index(ascending=False)
```

Out[4]:

	three	two	one
d	1.122434	-0.263896	NaN
c	0.745061	-0.700178	2.138660
b	-2.535724	-0.196084	1.556742
a	NaN	-0.326406	-0.078773

In [5]:
```
unsorted_df.sort_index(axis=1)
```

Out[5]:

	one	three	two
a	-0.078773	NaN	-0.326406
d	NaN	1.122434	-0.263896
c	2.138660	0.745061	-0.700178
b	1.556742	-2.535724	-0.196084

In [6]:
```
unsorted_df["three"].sort_index()
```

Out[6]:
```
a          NaN
b    -2.535724
c     0.745061
d     1.122434
Name: three, dtype: float64
```

In [7]:
```
s1 = pd.DataFrame({"a": ["B", "a", "C"], "b": [1, 2, 3], "c": [2, 3, 4]}).set_i
s1
```

Out[7]:

		c
a	**b**	
B	**1**	2
a	**2**	3
C	**3**	4

In [8]:
```
s1.sort_index(level="a")
```

Out[8]:

		c
a	**b**	
B	**1**	2
C	**3**	4
a	**2**	3

In [9]:
```
s1.sort_index(level="a", key=lambda idx: idx.str.lower())
```

Out[9]:

		c
a	**b**	
a	**2**	3
B	**1**	2
C	**3**	4

In [10]:
```
df1 = pd.DataFrame({"one": [2, 1, 1, 1], "two": [1, 3, 2, 4], "three": [5, 4, 3

df1.sort_values(by="two")
```

Out[10]:

	one	two	three
0	2	1	5
2	1	2	3
1	1	3	4
3	1	4	2

In [11]:
```
df1[["one", "two", "three"]].sort_values(by=["one", "two"])
```

Out[11]:

	one	two	three
2	1	2	3
1	1	3	4
3	1	4	2
0	2	1	5

In [13]:
```
s = pd.Series(np.random.randn(5), index=["a", "b", "c", "d", "e"])
s
```

Out[13]:
```
a   -0.205803
b    0.766681
c    0.095059
d    1.604067
e    0.372262
dtype: float64
```

In [14]:
```
s[2] = np.nan
s.sort_values()
```

Out[14]:
```
a   -0.205803
e    0.372262
b    0.766681
d    1.604067
c         NaN
dtype: float64
```

In [15]:
```
s.sort_values(na_position="first")
```

Out[15]:
```
c         NaN
a   -0.205803
e    0.372262
b    0.766681
d    1.604067
dtype: float64
```

```
In [16]: s1 = pd.Series(["B", "a", "C"])
         s1.sort_values()
```

```
Out[16]: 0    B
         2    C
         1    a
         dtype: object
```

```
In [17]: df = pd.DataFrame({"a": ["B", "a", "C"], "b": [1, 2, 3]})
         df.sort_values(by="a")
```

Out[17]:

	a	b
0	B	1
2	C	3
1	a	2

```
In [18]: df.sort_values(by="a", key=lambda col: col.str.lower())
```

Out[18]:

	a	b
1	a	2
0	B	1
2	C	3

```
In [19]: idx = pd.MultiIndex.from_tuples([("a", 1), ("a", 2), ("a", 2), ("b", 2), ("b",
         idx.names = ["first", "second"]
         df_multi = pd.DataFrame({"A": np.arange(6, 0, -1)}, index=idx)
         df_multi
```

Out[19]:

		A
first	**second**	
	1	6
a	**2**	5
	2	4
	2	3
b	**1**	2
	1	1

In [21]:
```
df_multi.sort_values(by=["second", "A"])
```

Out[21]:

		A
first	second	
b	1	1
	1	2
a	1	6
b	2	3
a	2	4
	2	5

In [22]:
```
ser = pd.Series([1, 2, 3])
ser.searchsorted([0, 3])
```

Out[22]:
```
array([0, 2], dtype=int64)
```

In [23]:
```
ser.searchsorted([0, 4])
```

Out[23]:
```
array([0, 3], dtype=int64)
```

In [24]:
```
ser.searchsorted([0, 3], sorter=np.argsort(ser))
```

Out[24]:
```
array([0, 2], dtype=int64)
```

In [25]:
```
s = pd.Series(np.random.permutation(10))
s
```

Out[25]:
```
0    4
1    7
2    1
3    2
4    0
5    8
6    5
7    6
8    9
9    3
dtype: int32
```

In [26]:
```
df = pd.DataFrame({
"a": [-2, -1, 1, 10, 8, 11, -1],
"b": list("abdceff"),
"c": [1.0, 2.0, 4.0, 3.2, np.nan, 3.0, 4.0],
})

df.nlargest(3, "a")
```

Out[26]:

	a	b	c
5	11	f	3.0
3	10	c	3.2
4	8	e	NaN

In [27]:
```
df1.columns = pd.MultiIndex.from_tuples([("a", "one"), ("a", "two"), ("b", "thr

df1.sort_values(by=("a", "two"))
```

Out[27]:

	a		b
	one	two	three
0	2	1	5
2	1	2	3
1	1	3	4
3	1	4	2

In [28]:
```
dft = pd.DataFrame({
"A": np.random.rand(3),
"B": 1,
"C": "foo",
"D": pd.Timestamp("20010102"),
"E": pd.Series([1.0] * 3).astype("float32"),
"F": False,
"G": pd.Series([1] * 3, dtype="int8"),
})

dft
```

Out[28]:

	A	B	C	D	E	F	G
0	0.577873	1	foo	2001-01-02	1.0	False	1
1	0.149990	1	foo	2001-01-02	1.0	False	1
2	0.244930	1	foo	2001-01-02	1.0	False	1

In [29]:
```
df1 = pd.DataFrame(np.random.randn(8, 1), columns=["A"], dtype="float32")
df1
```

Out[29]:

	A
0	0.466913
1	1.734496
2	0.416978
3	0.158830
4	0.626867
5	-1.188689
6	-2.190499
7	-0.572933

In [30]:
```
df2 = pd.DataFrame({
"A": pd.Series(np.random.randn(8), dtype="float16"),
"B": pd.Series(np.random.randn(8)),
"C": pd.Series(np.array(np.random.randn(8), dtype="uint8")),
})

df2
```

Out[30]:

	A	B	C
0	0.487549	0.544818	0
1	1.299805	0.228472	0
2	0.007591	0.703416	0
3	0.010628	0.621133	0
4	1.896484	-1.264181	0
5	1.053711	-0.364295	255
6	0.562988	-0.390742	0
7	0.713379	0.547247	0

In [31]:
```
pd.DataFrame([1, 2], columns=["a"]).dtypes
```

Out[31]:
```
a    int64
dtype: object
```

In [32]:
```
pd.DataFrame({"a": [1, 2]}).dtypes
```

Out[32]:
```
a    int64
dtype: object
```

In [33]:
```
pd.DataFrame({"a": 1}, index=list(range(2))).dtypes
```

Out[33]:
```
a    int64
dtype: object
```

In [34]:
```python
df3 = df1.reindex_like(df2).fillna(value=0.0) + df2
df3
```

Out[34]:

	A	B	C
0	0.954462	0.544818	0.0
1	3.034301	0.228472	0.0
2	0.424570	0.703416	0.0
3	0.169458	0.621133	0.0
4	2.523352	-1.264181	0.0
5	-0.134978	-0.364295	255.0
6	-1.627511	-0.390742	0.0
7	0.140446	0.547247	0.0

In [35]:
```python
df3.to_numpy().dtype
```

Out[35]:
```
dtype('float64')
```

In [36]:
```python
df3.astype("float32").dtypes
```

Out[36]:
```
A    float32
B    float32
C    float32
dtype: object
```

In [37]:
```python
dft = pd.DataFrame({"a": [1, 2, 3], "b": [4, 5, 6], "c": [7, 8, 9]})
dft[["a", "b"]] = dft[["a", "b"]].astype(np.uint8)
dft
```

Out[37]:

	a	b	c
0	1	4	7
1	2	5	8
2	3	6	9

In [38]:
```python
dft1 = pd.DataFrame({"a": [1, 0, 1], "b": [4, 5, 6], "c": [7, 8, 9]})
dft1 = dft1.astype({"a": np.bool_, "c": np.float64})
dft1
```

Out[38]:

	a	b	c
0	True	4	7.0
1	False	5	8.0
2	True	6	9.0

```
In [39]: dft = pd.DataFrame({"a": [1, 2, 3], "b": [4, 5, 6], "c": [7, 8, 9]})
         dft.loc[:, ["a", "b"]].astype(np.uint8).dtypes
```

```
Out[39]: a    uint8
         b    uint8
         dtype: object
```

```
In [40]: dft.loc[:, ["a", "b"]] = dft.loc[:, ["a", "b"]].astype(np.uint8)
         dft.dtypes
```

```
Out[40]: a    int64
         b    int64
         c    int64
         dtype: object
```

```
In [41]: import datetime
         df = pd.DataFrame(
         [
         [1, 2],
         ["a", "b"],
         [datetime.datetime(2016, 3, 2), datetime.datetime(2016, 3,2)],
         ]
         )
         df = df.T
         df
```

Out[41]:

	0	1	2
0	1	a	2016-03-02
1	2	b	2016-03-02

```
In [42]: df.infer_objects().dtypes
```

```
Out[42]: 0             int64
         1            object
         2    datetime64[ns]
         dtype: object
```

```
In [ ]: m = ["1.1", 2, 3]
        pd.to_numeric(m)
```

```
In [ ]:
```

```
In [ ]:
```

```
In [ ]:
```

```
In [43]: import datetime
         m = ["2016-07-09", datetime.datetime(2016, 3, 2)]
         pd.to_datetime(m)

Out[43]: DatetimeIndex(['2016-07-09', '2016-03-02'], dtype='datetime64[ns]', freq=Non
         e)
```

```
In [44]: m = ["5us", pd.Timedelta("1day")]
         pd.to_timedelta(m)

Out[44]: TimedeltaIndex(['0 days 00:00:00.000005', '1 days 00:00:00'], dtype='timedelt
         a64[ns]', freq=None)
```

```
In [45]: import datetime
         m = ["apple", datetime.datetime(2016, 3, 2)]
```

```
In [46]: pd.to_datetime(m, errors="coerce")

Out[46]: DatetimeIndex(['NaT', '2016-03-02'], dtype='datetime64[ns]', freq=None)
```

```
In [47]: m = ["apple", 2, 3]
         pd.to_numeric(m, errors="coerce")

Out[47]: array([nan,  2.,  3.])
```

```
In [48]: m = ["apple", pd.Timedelta("1day")]
         pd.to_timedelta(m, errors="coerce")

Out[48]: TimedeltaIndex([NaT, '1 days'], dtype='timedelta64[ns]', freq=None)
```

```
In [49]: import datetime
         m = ["apple", datetime.datetime(2016, 3, 2)]
         pd.to_datetime(m, errors="ignore")

Out[49]: Index(['apple', 2016-03-02 00:00:00], dtype='object')
```

```
In [50]: m = ["apple", 2, 3]
         pd.to_numeric(m, errors="ignore")

Out[50]: array(['apple', 2, 3], dtype=object)
```

```
In [51]: m = ["apple", pd.Timedelta("1day")]
         pd.to_timedelta(m, errors="ignore")

Out[51]: array(['apple', Timedelta('1 days 00:00:00')], dtype=object)
```

In [52]:
```
import datetime
df = pd.DataFrame([["2016-07-09", datetime.datetime(2016, 3, 2)]] * 2, dtype="(
df
```

Out[52]:

	0	1
0	2016-07-09	2016-03-02 00:00:00
1	2016-07-09	2016-03-02 00:00:00

In [54]:
```
df.apply(pd.to_datetime)
```

Out[54]:

	0	1
0	2016-07-09	2016-03-02
1	2016-07-09	2016-03-02

In [55]:
```
df = pd.DataFrame([["1.1", 2, 3]] * 2, dtype="O")
df
```

Out[55]:

	0	1	2
0	1.1	2	3
1	1.1	2	3

In [56]:
```
df.apply(pd.to_numeric)
```

Out[56]:

	0	1	2
0	1.1	2	3
1	1.1	2	3

In [57]:
```
df = pd.DataFrame([["5us", pd.Timedelta("1day")]] * 2, dtype="O")
df
```

Out[57]:

	0	1
0	5us	1 days 00:00:00
1	5us	1 days 00:00:00

In [58]:
```
df.apply(pd.to_timedelta)
```

Out[58]:

	0	1
0	0 days 00:00:00.000005	1 days
1	0 days 00:00:00.000005	1 days

In [59]:
```
dfi = df3.astype("int32")
dfi["E"] = 1
dfi
```

Out[59]:

	A	B	C	E
0	0	0	0	1
1	3	0	0	1
2	0	0	0	1
3	0	0	0	1
4	2	-1	0	1
5	0	0	255	1
6	-1	0	0	1
7	0	0	0	1

In [60]:
```
casted = dfi[dfi > 0]
casted
```

Out[60]:

	A	B	C	E
0	NaN	NaN	NaN	1
1	3.0	NaN	NaN	1
2	NaN	NaN	NaN	1
3	NaN	NaN	NaN	1
4	2.0	NaN	NaN	1
5	NaN	NaN	255.0	1
6	NaN	NaN	NaN	1
7	NaN	NaN	NaN	1

In [61]:
```
df = pd.DataFrame({
"string": list("abc"),
"int64": list(range(1, 4)),
"uint8": np.arange(3, 6).astype("u1"),
"float64": np.arange(4.0, 7.0),
"bool1": [True, False, True],
"bool2": [False, True, False],
"dates": pd.date_range("now", periods=3),
 "category": pd.Series(list("ABC")).astype("category"),
})
```

In [62]:
```
df["tdeltas"] = df.dates.diff()
df["uint64"] = np.arange(3, 6).astype("u8")
df["other_dates"] = pd.date_range("20130101", periods=3)
df["tz_aware_dates"] = pd.date_range("20130101", periods=3, tz="US/Eastern")
df
```

Out[62]:

	string	int64	uint8	float64	bool1	bool2	dates	category	tdeltas	uint64	other_dat
0	a	1	3	4.0	True	False	2022-09-22 19:45:48.623494	A	NaT	3	2013-01-
1	b	2	4	5.0	False	True	2022-09-23 19:45:48.623494	B	1 days	4	2013-01-
2	c	3	5	6.0	True	False	2022-09-24 19:45:48.623494	C	1 days	5	2013-01-

In [63]:
```
df.select_dtypes(include=[bool])
```

Out[63]:

	bool1	bool2
0	True	False
1	False	True
2	True	False

In [65]:
```
df.select_dtypes(include=["bool"])
```

Out[65]:

	bool1	bool2
0	True	False
1	False	True
2	True	False

In [66]:
```
df.select_dtypes(include=["number", "bool"], exclude=["unsignedinteger"])
```

Out[66]:

	int64	float64	bool1	bool2	tdeltas
0	1	4.0	True	False	NaT
1	2	5.0	False	True	1 days
2	3	6.0	True	False	1 days

In [67]:
```
df.select_dtypes(include=["object"])
```

Out[67]:

	string
0	a
1	b
2	c

In [68]:
```
def subdtypes(dtype):
    subs = dtype.__subclasses__()
    if not subs:
        return dtype
    return [dtype, [subdtypes(dt) for dt in subs]]
```

In [69]:
```
subdtypes(np.generic)
```

Out[69]:
```
[numpy.generic,
 [[numpy.number,
   [[numpy.integer,
     [[numpy.signedinteger,
       [numpy.int8,
        numpy.int16,
        numpy.intc,
        numpy.int32,
        numpy.int64,
        numpy.timedelta64]],
      [numpy.unsignedinteger,
       [numpy.uint8, numpy.uint16, numpy.uintc, numpy.uint32, numpy.uint6
4]]]],
    [numpy.inexact,
     [[numpy.floating,
       [numpy.float16, numpy.float32, numpy.float64, numpy.longdouble]],
      [numpy.complexfloating,
       [numpy.complex64, numpy.complex128, numpy.clongdouble]]]]]],
  [numpy.flexible,
   [[numpy.character, [numpy.bytes_, numpy.str_]],
    [numpy.void, [numpy.record]]]],
  numpy.bool_,
  numpy.datetime64,
  numpy.object_]]
```

In [70]:
```
import pandas as pd
from io import StringIO
data = "col1,col2,col3\na,b,1\na,b,2\nc,d,3"
pd.read_csv(StringIO(data))
```

Out[70]:

	col1	col2	col3
0	a	b	1
1	a	b	2
2	c	d	3

In [71]:
```
pd.read_csv(StringIO(data), usecols=lambda x: x.upper() in ["COL1", "COL3"])
```

Out[71]:

	col1	col3
0	a	1
1	a	2
2	c	3

In [72]:
```
data = "col1,col2,col3\na,b,1"
df = pd.read_csv(StringIO(data))
```

In [73]:
```
df.columns = [f"pre_{col}" for col in df.columns]
df
```

Out[73]:

	pre_col1	pre_col2	pre_col3
0	a	b	1

In [74]:
```
data = "col1,col2,col3\na,b,1\na,b,2\nc,d,3"
pd.read_csv(StringIO(data))
```

Out[74]:

	col1	col2	col3
0	a	b	1
1	a	b	2
2	c	d	3

In [75]:
```
pd.read_csv(StringIO(data), skiprows=lambda x: x % 2 != 0)
```

Out[75]:

	col1	col2	col3
0	a	b	2

In [76]:
```
import numpy as np
data = "a,b,c,d\n1,2,3,4\n5,6,7,8\n9,10,11"
print(data)
```

```
a,b,c,d
1,2,3,4
5,6,7,8
9,10,11
```

In [77]:
```
df = pd.read_csv(StringIO(data), dtype=object)
df
```

Out[77]:

	a	b	c	d
0	1	2	3	4
1	5	6	7	8
2	9	10	11	NaN

In [78]:
```
df = pd.read_csv(StringIO(data), dtype={"b": object, "c": np.float64, "d":"Int6
df.dtypes
```

Out[78]:
```
a        int64
b       object
c      float64
d        Int64
dtype: object
```

In [79]:
```
data = "col_1\n1\n2\n'A'\n4.22"
pd.read_csv(StringIO(data), converters={"col_1": str})
df
```

Out[79]:

	a	b	c	d
0	1	2	3.0	4
1	5	6	7.0	8
2	9	10	11.0	<NA>

In [80]:
```
df = pd.read_csv(StringIO(data), dtype="category")
df.dtypes
```

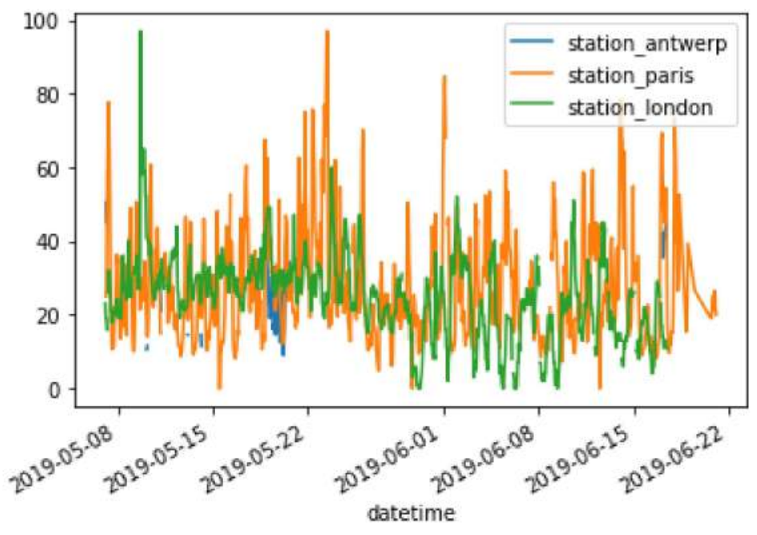
Out[80]:
```
col_1    category
dtype: object
```

In [81]:
```
air_quality = pd.read_csv("air_quality_no2.csv", index_col=0, parse_dates=True)
air_quality.head()
```

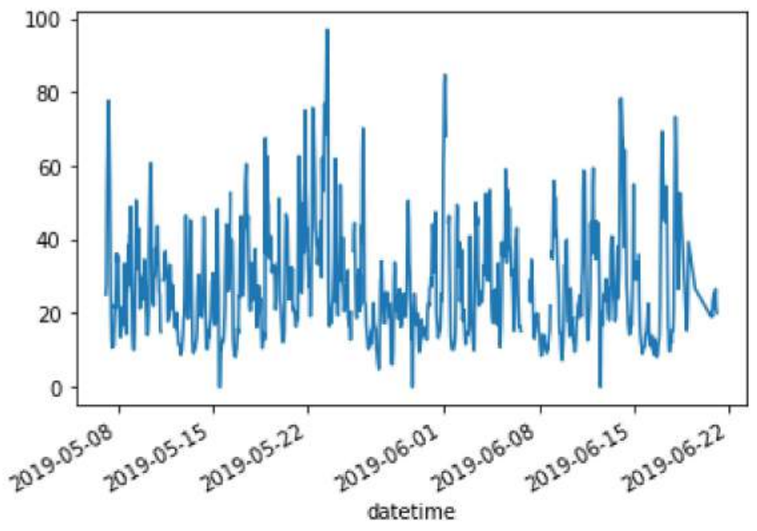
Out[81]:

	station_antwerp	station_paris	station_london
datetime			
2019-05-07 02:00:00	NaN	NaN	23.0
2019-05-07 03:00:00	50.5	25.0	19.0
2019-05-07 04:00:00	45.0	27.7	19.0
2019-05-07 05:00:00	NaN	50.4	16.0
2019-05-07 06:00:00	NaN	61.9	NaN

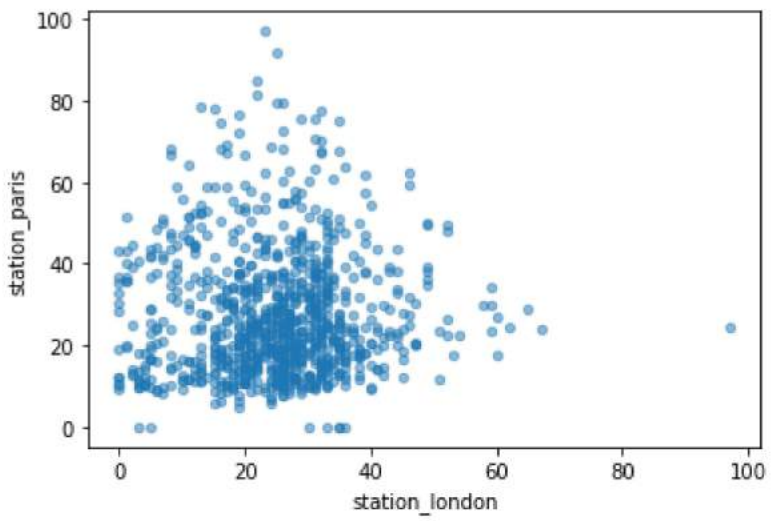
In [82]:
```
air_quality.plot();
```



```
In [83]: air_quality["station_paris"].plot();
```

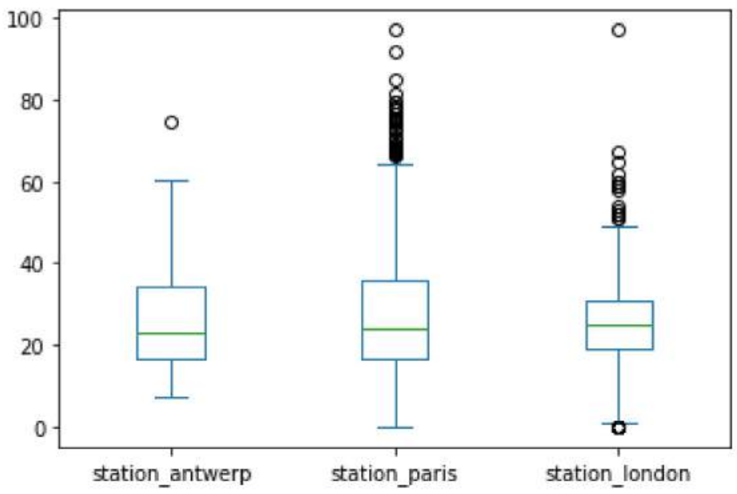


```
In [84]: air_quality.plot.scatter(x="station_london", y="station_paris", alpha=0.5);
```

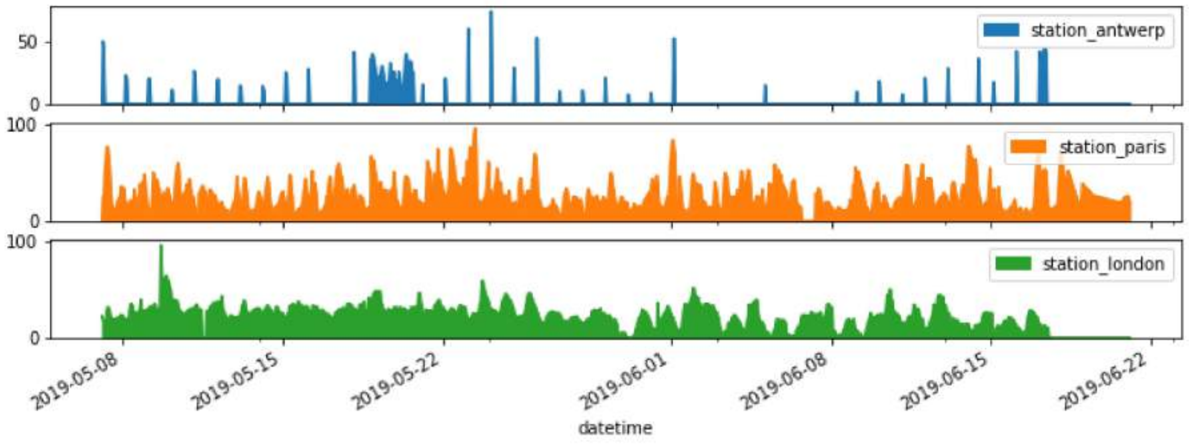


```
In [85]: [
         method_name
         for method_name in dir(air_quality.plot)
         if not method_name.startswith("_")
         ]

Out[85]: ['area',
          'bar',
          'barh',
          'box',
          'density',
          'hexbin',
          'hist',
          'kde',
          'line',
          'pie',
          'scatter']
```

In [86]:
```
air_quality.plot.box();
```

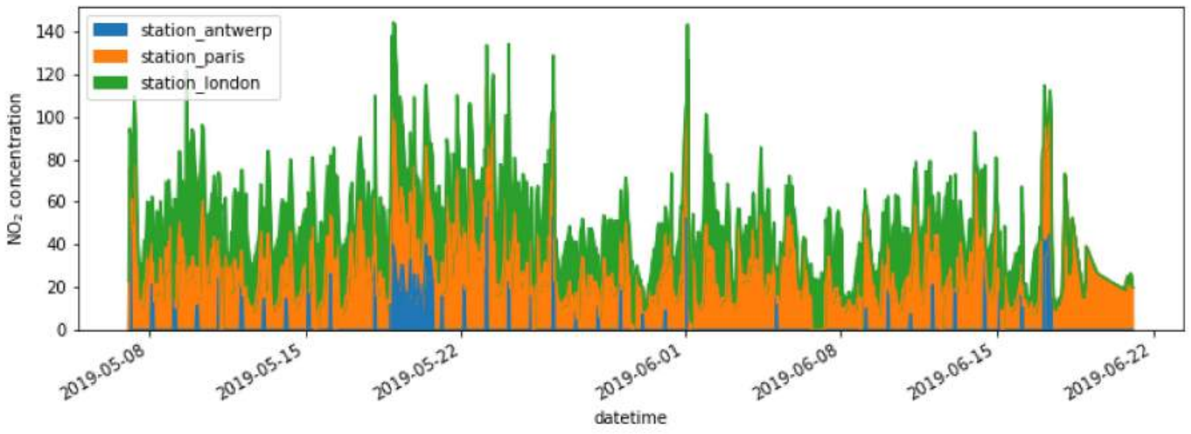


In [87]:
```
axs = air_quality.plot.area(figsize=(12, 4), subplots=True);
axs;
```



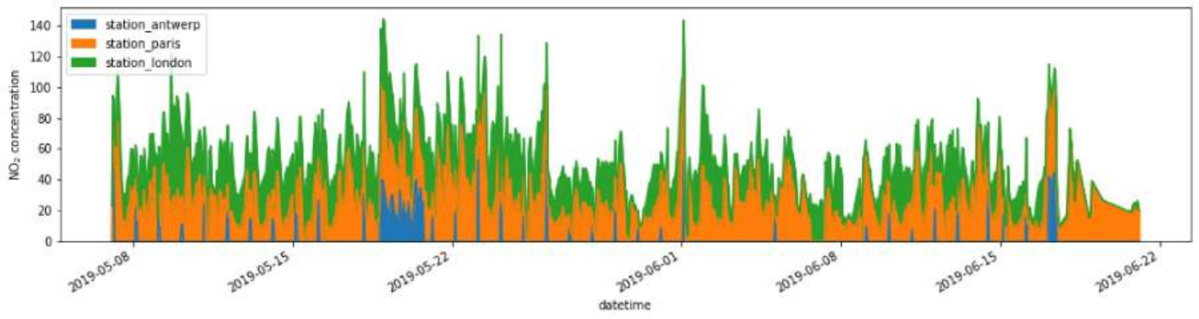
In [88]:
```
fig, axs = plt.subplots(figsize=(12, 4))
air_quality.plot.area(ax=axs)
axs.set_ylabel("NO$_2$ concentration")
fig.savefig("no2_concentrations.png")
```

```
<IPython.core.display.Javascript object>
```



```
In [89]: fig, axs = plt.subplots(figsize=(17, 4))
         air_quality.plot.area(ax=axs)
         axs.set_ylabel("NO$_2$ concentration");
```

```
<IPython.core.display.Javascript object>
```



```
In [90]: air_quality["london_mg_per_cubic"] = air_quality["station_london"] * 1.882
         air_quality.head()
```

Out[90]:

datetime	station_antwerp	station_paris	station_london	london_mg_per_cubic
2019-05-07 02:00:00	NaN	NaN	23.0	43.286
2019-05-07 03:00:00	50.5	25.0	19.0	35.758
2019-05-07 04:00:00	45.0	27.7	19.0	35.758
2019-05-07 05:00:00	NaN	50.4	16.0	30.112
2019-05-07 06:00:00	NaN	61.9	NaN	NaN

```
In [91]: air_quality["ratio_paris_antwerp"] = (air_quality["station_paris"] / air_qualit

         air_quality.head()
```

Out[91]:

datetime	station_antwerp	station_paris	station_london	london_mg_per_cubic	ratio_paris_antwer
2019-05-07 02:00:00	NaN	NaN	23.0	43.286	Nal
2019-05-07 03:00:00	50.5	25.0	19.0	35.758	0.49505
2019-05-07 04:00:00	45.0	27.7	19.0	35.758	0.61555
2019-05-07 05:00:00	NaN	50.4	16.0	30.112	Nal
2019-05-07 06:00:00	NaN	61.9	NaN	NaN	Nal

In [92]:
```
air_quality_renamed = air_quality.rename(
 columns={
 "station_antwerp": "BETR801",
 "station_paris": "FR04014",
 "station_london": "London Westminster",
 }
 )

air_quality_renamed.head()
```

Out[92]:

datetime	BETR801	FR04014	London Westminster	london_mg_per_cubic	ratio_paris_antwerp
2019-05-07 02:00:00	NaN	NaN	23.0	43.286	NaN
2019-05-07 03:00:00	50.5	25.0	19.0	35.758	0.495050
2019-05-07 04:00:00	45.0	27.7	19.0	35.758	0.615556
2019-05-07 05:00:00	NaN	50.4	16.0	30.112	NaN
2019-05-07 06:00:00	NaN	61.9	NaN	NaN	NaN

In [97]:
```
air_quality_renamed = air_quality_renamed.rename(columns=str.lower)
air_quality_renamed.head()
```

Out[97]:

datetime	betr801	fr04014	london westminster	london_mg_per_cubic	ratio_paris_antwerp
2019-05-07 02:00:00	NaN	NaN	23.0	43.286	NaN
2019-05-07 03:00:00	50.5	25.0	19.0	35.758	0.495050
2019-05-07 04:00:00	45.0	27.7	19.0	35.758	0.615556
2019-05-07 05:00:00	NaN	50.4	16.0	30.112	NaN
2019-05-07 06:00:00	NaN	61.9	NaN	NaN	NaN

In [99]:
```
air_quality = pd.read_csv("air_quality_long.csv", index_col="date.utc", parse_

air_quality.head()
```

Out[99]:

	city	country	location	parameter	value	unit
date.utc						
2019-06-18 06:00:00+00:00	Antwerpen	BE	BETR801	pm25	18.0	µg/m³
2019-06-17 08:00:00+00:00	Antwerpen	BE	BETR801	pm25	6.5	µg/m³
2019-06-17 07:00:00+00:00	Antwerpen	BE	BETR801	pm25	18.5	µg/m³
2019-06-17 06:00:00+00:00	Antwerpen	BE	BETR801	pm25	16.0	µg/m³
2019-06-17 05:00:00+00:00	Antwerpen	BE	BETR801	pm25	7.5	µg/m³

In [100]:
```
no2 = air_quality[air_quality["parameter"] == "no2"]
```

In [101]:
```
no2_subset = no2.sort_index().groupby(["location"]).head(2)
no2_subset
```

Out[101]:

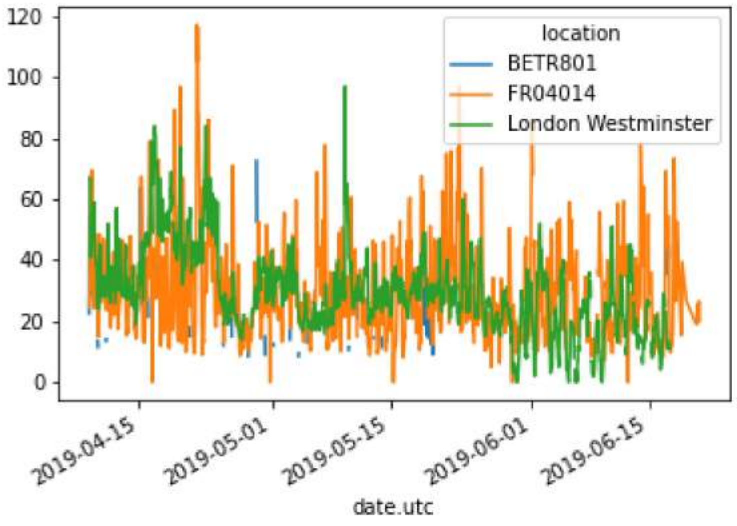
	city	country	location	parameter	value	unit
date.utc						
2019-04-09 01:00:00+00:00	Antwerpen	BE	BETR801	no2	22.5	µg/m³
2019-04-09 01:00:00+00:00	Paris	FR	FR04014	no2	24.4	µg/m³
2019-04-09 02:00:00+00:00	London	GB	London Westminster	no2	67.0	µg/m³
2019-04-09 02:00:00+00:00	Antwerpen	BE	BETR801	no2	53.5	µg/m³
2019-04-09 02:00:00+00:00	Paris	FR	FR04014	no2	27.4	µg/m³
2019-04-09 03:00:00+00:00	London	GB	London Westminster	no2	67.0	µg/m³

In [102]:
```
no2_subset.pivot(columns="location", values="value")
```

Out[102]:

location	BETR801	FR04014	London Westminster
date.utc			
2019-04-09 01:00:00+00:00	22.5	24.4	NaN
2019-04-09 02:00:00+00:00	53.5	27.4	67.0
2019-04-09 03:00:00+00:00	NaN	NaN	67.0

In [103]:
```
no2.pivot(columns="location", values="value").plot();
```



In [104]:
```
air_quality.pivot_table(values="value", index="location", columns="parameter",
```

Out[104]:

parameter	no2	pm25
location		
BETR801	26.950920	23.169492
FR04014	29.374284	NaN
London Westminster	29.740050	13.443568

In [105]:
```
air_quality.pivot_table(
values="value",
index="location",
columns="parameter",
aggfunc="mean",
margins=True,
)
```

Out[105]:

parameter	no2	pm25	All
location			
BETR801	26.950920	23.169492	24.982353
FR04014	29.374284	NaN	29.374284
London Westminster	29.740050	13.443568	21.491708
All	29.430316	14.386849	24.222743

```
In [106]: air_quality.groupby(["parameter", "location"]).mean()
```

```
Out[106]:
                                             value
          parameter             location
                                 BETR801  26.950920
                no2              FR04014  29.374284
                     London Westminster  29.740050
                                 BETR801  23.169492
               pm25
                     London Westminster  13.443568
```

```
In [107]: no2_pivoted = no2.pivot(columns="location", values="value").reset_index()
          no2_pivoted.head()
```

```
Out[107]:
          location                   date.utc  BETR801  FR04014  London Westminster
                 0  2019-04-09 01:00:00+00:00     22.5     24.4                 NaN
                 1  2019-04-09 02:00:00+00:00     53.5     27.4                67.0
                 2  2019-04-09 03:00:00+00:00     54.5     34.2                67.0
                 3  2019-04-09 04:00:00+00:00     34.5     48.5                41.0
                 4  2019-04-09 05:00:00+00:00     46.5     59.5                41.0
```

```
In [108]: no_2 = no2_pivoted.melt(id_vars="date.utc")
          no_2.head()
```

```
Out[108]:
                      date.utc  location  value
          0  2019-04-09 01:00:00+00:00  BETR801   22.5
          1  2019-04-09 02:00:00+00:00  BETR801   53.5
          2  2019-04-09 03:00:00+00:00  BETR801   54.5
          3  2019-04-09 04:00:00+00:00  BETR801   34.5
          4  2019-04-09 05:00:00+00:00  BETR801   46.5
```

In [109]:
```
no_2 = no2_pivoted.melt(
id_vars="date.utc",
value_vars=["BETR801", "FR04014", "London Westminster"],
value_name="NO_2",
var_name="id_location",
)

no_2.head()
```

Out[109]:

	date.utc	id_location	NO_2
0	2019-04-09 01:00:00+00:00	BETR801	22.5
1	2019-04-09 02:00:00+00:00	BETR801	53.5
2	2019-04-09 03:00:00+00:00	BETR801	54.5
3	2019-04-09 04:00:00+00:00	BETR801	34.5
4	2019-04-09 05:00:00+00:00	BETR801	46.5

In [110]:
```
air_quality_no2 = pd.read_csv("air_quality_no2_long.csv",parse_dates=True)
air_quality_no2 = air_quality_no2[["date.utc", "location", "parameter", "value'
air_quality_no2.head()
```

Out[110]:

	date.utc	location	parameter	value
0	2019-06-21 00:00:00+00:00	FR04014	no2	20.0
1	2019-06-20 23:00:00+00:00	FR04014	no2	21.8
2	2019-06-20 22:00:00+00:00	FR04014	no2	26.5
3	2019-06-20 21:00:00+00:00	FR04014	no2	24.9
4	2019-06-20 20:00:00+00:00	FR04014	no2	21.4

In [111]:
```
air_quality_pm25 = pd.read_csv("air_quality_pm25_long.csv",parse_dates=True)

air_quality_pm25 = air_quality_pm25[["date.utc", "location","parameter", "value

air_quality_pm25.head()
```

Out[111]:

	date.utc	location	parameter	value
0	2019-06-18 06:00:00+00:00	BETR801	pm25	18.0
1	2019-06-17 08:00:00+00:00	BETR801	pm25	6.5
2	2019-06-17 07:00:00+00:00	BETR801	pm25	18.5
3	2019-06-17 06:00:00+00:00	BETR801	pm25	16.0
4	2019-06-17 05:00:00+00:00	BETR801	pm25	7.5

In [112]:
```
air_quality = pd.concat([air_quality_pm25, air_quality_no2], axis=0)
air_quality.head()
```

Out[112]:

	date.utc	location	parameter	value
0	2019-06-18 06:00:00+00:00	BETR801	pm25	18.0
1	2019-06-17 08:00:00+00:00	BETR801	pm25	6.5
2	2019-06-17 07:00:00+00:00	BETR801	pm25	18.5
3	2019-06-17 06:00:00+00:00	BETR801	pm25	16.0
4	2019-06-17 05:00:00+00:00	BETR801	pm25	7.5

In [113]:
```
print('Shape of the ``air_quality_pm25`` table: ', air_quality_pm25.shape)
print('Shape of the ``air_quality_no2`` table: ', air_quality_no2.shape)
print('Shape of the resulting ``air_quality`` table: ', air_quality.shape)
```

```
Shape of the ``air_quality_pm25`` table:  (1110, 4)
Shape of the ``air_quality_no2`` table:  (2068, 4)
Shape of the resulting ``air_quality`` table:  (3178, 4)
```

In [114]:
```
air_quality = air_quality.sort_values("date.utc")
air_quality.head()
```

Out[114]:

	date.utc	location	parameter	value
2067	2019-05-07 01:00:00+00:00	London Westminster	no2	23.0
1003	2019-05-07 01:00:00+00:00	FR04014	no2	25.0
100	2019-05-07 01:00:00+00:00	BETR801	pm25	12.5
1098	2019-05-07 01:00:00+00:00	BETR801	no2	50.5
1109	2019-05-07 01:00:00+00:00	London Westminster	pm25	8.0

In [115]:
```
air_quality_ = pd.concat([air_quality_pm25, air_quality_no2], keys=["PM25", "NO
air_quality_.head()
```

Out[115]:

		date.utc	location	parameter	value
	0	2019-06-18 06:00:00+00:00	BETR801	pm25	18.0
	1	2019-06-17 08:00:00+00:00	BETR801	pm25	6.5
PM25	**2**	2019-06-17 07:00:00+00:00	BETR801	pm25	18.5
	3	2019-06-17 06:00:00+00:00	BETR801	pm25	16.0
	4	2019-06-17 05:00:00+00:00	BETR801	pm25	7.5

In [116]:
```
stations_coord = pd.read_csv("air_quality_stations.csv")
stations_coord.head()
```

Out[116]:

	location	coordinates.latitude	coordinates.longitude
0	BELAL01	51.23619	4.38522
1	BELHB23	51.17030	4.34100
2	BELLD01	51.10998	5.00486
3	BELLD02	51.12038	5.02155
4	BELR833	51.32766	4.36226

In [117]:
```
air_quality = pd.merge(air_quality, stations_coord, how="left", on="location")
air_quality.head()
```

Out[117]:

	date.utc	location	parameter	value	coordinates.latitude	coordinates.longitude
0	2019-05-07 01:00:00+00:00	London Westminster	no2	23.0	51.49467	-0.13193
1	2019-05-07 01:00:00+00:00	FR04014	no2	25.0	48.83724	2.39390
2	2019-05-07 01:00:00+00:00	FR04014	no2	25.0	48.83722	2.39390
3	2019-05-07 01:00:00+00:00	BETR801	pm25	12.5	51.20966	4.43182
4	2019-05-07 01:00:00+00:00	BETR801	no2	50.5	51.20966	4.43182

In [118]:
```
air_quality_parameters = pd.read_csv("air_quality_parameters.csv")
air_quality_parameters.head()
```

Out[118]:

	id	description	name
0	bc	Black Carbon	BC
1	co	Carbon Monoxide	CO
2	no2	Nitrogen Dioxide	NO2
3	o3	Ozone	O3
4	pm10	Particulate matter less than 10 micrometers in...	PM10

```
In [119]: air_quality = pd.merge(air_quality, air_quality_parameters,how='left', left_on=
          air_quality.head()
```

Out[119]:

	date.utc	location	parameter	value	coordinates.latitude	coordinates.longitude	id
0	2019-05-07 01:00:00+00:00	London Westminster	no2	23.0	51.49467	-0.13193	no2
1	2019-05-07 01:00:00+00:00	FR04014	no2	25.0	48.83724	2.39390	no2
2	2019-05-07 01:00:00+00:00	FR04014	no2	25.0	48.83722	2.39390	no2
3	2019-05-07 01:00:00+00:00	BETR801	pm25	12.5	51.20966	4.43182	pm25
4	2019-05-07 01:00:00+00:00	BETR801	no2	50.5	51.20966	4.43182	no2

```
In [120]: air_quality = pd.read_csv("air_quality_no2_long.csv")
          air_quality = air_quality.rename(columns={"date.utc": "datetime"})
          air_quality.head()
```

Out[120]:

	city	country	datetime	location	parameter	value	unit
0	Paris	FR	2019-06-21 00:00:00+00:00	FR04014	no2	20.0	µg/m³
1	Paris	FR	2019-06-20 23:00:00+00:00	FR04014	no2	21.8	µg/m³
2	Paris	FR	2019-06-20 22:00:00+00:00	FR04014	no2	26.5	µg/m³
3	Paris	FR	2019-06-20 21:00:00+00:00	FR04014	no2	24.9	µg/m³
4	Paris	FR	2019-06-20 20:00:00+00:00	FR04014	no2	21.4	µg/m³

```
In [121]: air_quality.city.unique()

Out[121]: array(['Paris', 'Antwerpen', 'London'], dtype=object)

In [122]: air_quality["datetime"] = pd.to_datetime(air_quality["datetime"])
          air_quality["datetime"]

Out[122]: 0       2019-06-21 00:00:00+00:00
          1       2019-06-20 23:00:00+00:00
          2       2019-06-20 22:00:00+00:00
          3       2019-06-20 21:00:00+00:00
          4       2019-06-20 20:00:00+00:00
                             ...
          2063    2019-05-07 06:00:00+00:00
          2064    2019-05-07 04:00:00+00:00
          2065    2019-05-07 03:00:00+00:00
          2066    2019-05-07 02:00:00+00:00
          2067    2019-05-07 01:00:00+00:00
          Name: datetime, Length: 2068, dtype: datetime64[ns, UTC]
```

```
In [123]: pd.read_csv("air_quality_no2_long.csv") #parse_dates=["datetime"]
```

Out[123]:

	city	country	date.utc	location	parameter	value	unit
0	Paris	FR	2019-06-21 00:00:00+00:00	FR04014	no2	20.0	µg/m³
1	Paris	FR	2019-06-20 23:00:00+00:00	FR04014	no2	21.8	µg/m³
2	Paris	FR	2019-06-20 22:00:00+00:00	FR04014	no2	26.5	µg/m³
3	Paris	FR	2019-06-20 21:00:00+00:00	FR04014	no2	24.9	µg/m³
4	Paris	FR	2019-06-20 20:00:00+00:00	FR04014	no2	21.4	µg/m³
...	...	...	...	...	...	...	...
2063	London	GB	2019-05-07 06:00:00+00:00	London Westminster	no2	26.0	µg/m³
2064	London	GB	2019-05-07 04:00:00+00:00	London Westminster	no2	16.0	µg/m³
2065	London	GB	2019-05-07 03:00:00+00:00	London Westminster	no2	19.0	µg/m³
2066	London	GB	2019-05-07 02:00:00+00:00	London Westminster	no2	19.0	µg/m³
2067	London	GB	2019-05-07 01:00:00+00:00	London Westminster	no2	23.0	µg/m³

2068 rows × 7 columns

```
In [124]: air_quality["datetime"].min(), air_quality["datetime"].max()
```

```
Out[124]: (Timestamp('2019-05-07 01:00:00+0000', tz='UTC'),
           Timestamp('2019-06-21 00:00:00+0000', tz='UTC'))
```

```
In [125]: air_quality["datetime"].max() - air_quality["datetime"].min()
```

```
Out[125]: Timedelta('44 days 23:00:00')
```

```
In [126]: air_quality["month"] = air_quality["datetime"].dt.month
          air_quality.head()
```

Out[126]:

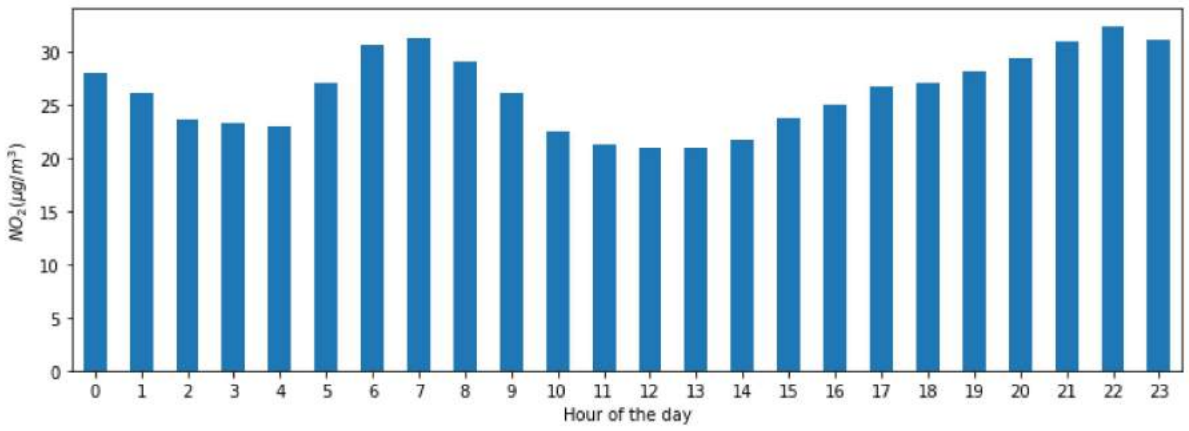
	city	country	datetime	location	parameter	value	unit	month
0	Paris	FR	2019-06-21 00:00:00+00:00	FR04014	no2	20.0	µg/m³	6
1	Paris	FR	2019-06-20 23:00:00+00:00	FR04014	no2	21.8	µg/m³	6
2	Paris	FR	2019-06-20 22:00:00+00:00	FR04014	no2	26.5	µg/m³	6
3	Paris	FR	2019-06-20 21:00:00+00:00	FR04014	no2	24.9	µg/m³	6
4	Paris	FR	2019-06-20 20:00:00+00:00	FR04014	no2	21.4	µg/m³	6

```
In [127]: air_quality.groupby([air_quality["datetime"].dt.weekday, "location"])["value"].
```

```
Out[127]: datetime  location
          0         BETR801               27.875000
                    FR04014               24.856250
                    London Westminster    23.969697
          1         BETR801               22.214286
                    FR04014               30.999359
                    London Westminster    24.885714
          2         BETR801               21.125000
                    FR04014               29.165753
                    London Westminster    23.460432
          3         BETR801               27.500000
                    FR04014               28.600690
                    London Westminster    24.780142
          4         BETR801               28.400000
                    FR04014               31.617986
                    London Westminster    26.446809
          5         BETR801               33.500000
                    FR04014               25.266154
                    London Westminster    24.977612
          6         BETR801               21.896552
                    FR04014               23.274306
                    London Westminster    24.859155
          Name: value, dtype: float64
```

```
In [128]: fig, axs = plt.subplots(figsize=(12, 4))
          air_quality.groupby(air_quality["datetime"].dt.hour)["value"].mean().plot(kind=

          plt.xlabel("Hour of the day"); # custom x label using matplotlib
          plt.ylabel("$NO_2 (µg/m^3)$");
```

```
<IPython.core.display.Javascript object>

<IPython.core.display.Javascript object>

<IPython.core.display.Javascript object>
```



In [129]:
```
no_2 = air_quality.pivot(index="datetime", columns="location", values="value")
no_2.head()
```

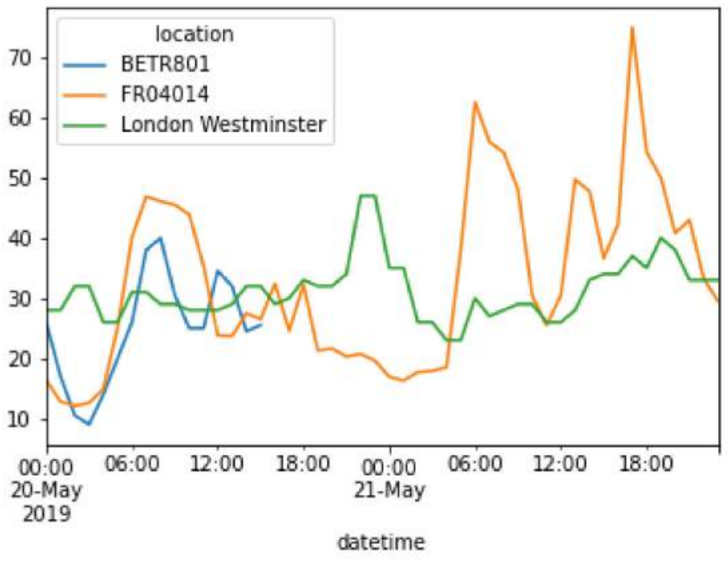
Out[129]:

location	BETR801	FR04014	London Westminster
datetime			
2019-05-07 01:00:00+00:00	50.5	25.0	23.0
2019-05-07 02:00:00+00:00	45.0	27.7	19.0
2019-05-07 03:00:00+00:00	NaN	50.4	19.0
2019-05-07 04:00:00+00:00	NaN	61.9	16.0
2019-05-07 05:00:00+00:00	NaN	72.4	NaN

In [130]:
```
no_2.index.year, no_2.index.weekday
```

Out[130]:
```
(Int64Index([2019, 2019, 2019, 2019, 2019, 2019, 2019, 2019, 2019, 2019,
             ...
             2019, 2019, 2019, 2019, 2019, 2019, 2019, 2019, 2019, 2019],
            dtype='int64', name='datetime', length=1033),
 Int64Index([1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
             ...
             3, 3, 3, 3, 3, 3, 3, 3, 3, 4],
            dtype='int64', name='datetime', length=1033))
```

In [131]:
```
no_2["2019-05-20":"2019-05-21"].plot();
```



In [132]:
```
monthly_max = no_2.resample("M").max()
monthly_max
```

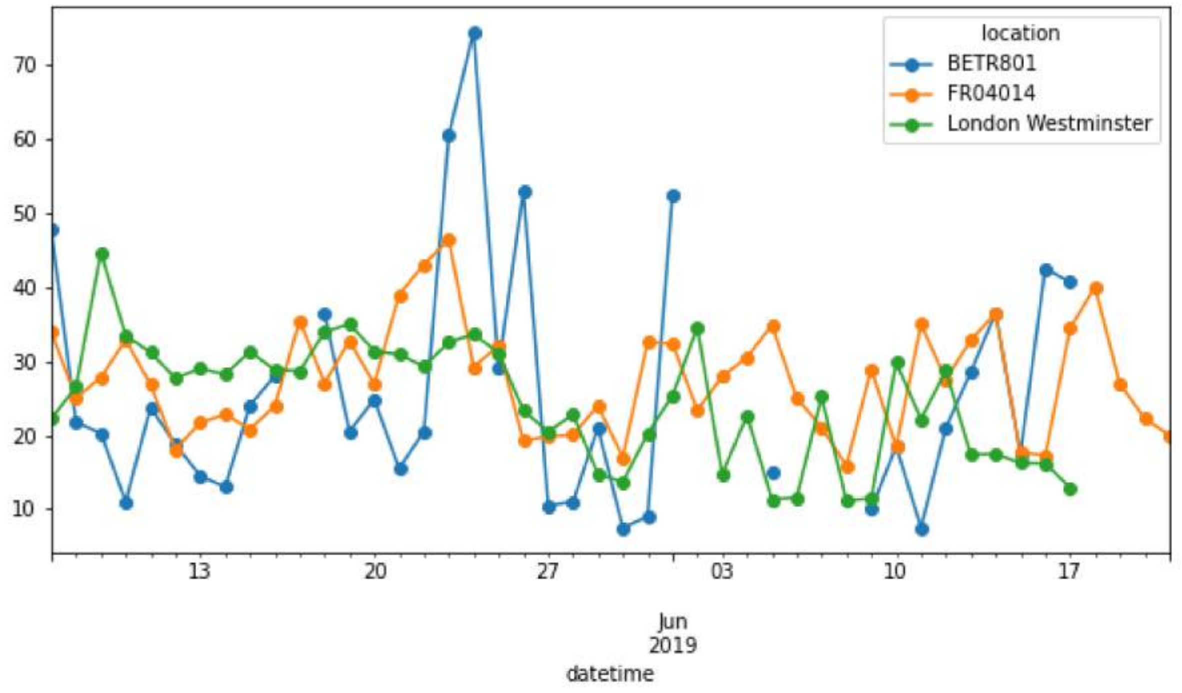
Out[132]:

location	BETR801	FR04014	London Westminster
datetime			
2019-05-31 00:00:00+00:00	74.5	97.0	97.0
2019-06-30 00:00:00+00:00	52.5	84.7	52.0

```
In [133]: monthly_max.index.freq
```

```
Out[133]: <MonthEnd>
```

```
In [134]: no_2.resample("D").mean().plot(style="-o", figsize=(10, 5));
```



Syed Afroz Ali

```
In [ ]:
```

Pandas toolkit Part 5

Syed Afroz Ali

In [1]:
```
import pandas as pd
import numpy as np
```

In [4]:
```
url = ("https://raw.github.com/pandas-dev""/pandas/main/pandas/tests/io/data/cs
tips = pd.read_csv(url)
tips.head()
```

Out[4]:

	total_bill	tip	sex	smoker	day	time	size
0	16.99	1.01	Female	No	Sun	Dinner	2
1	10.34	1.66	Male	No	Sun	Dinner	3
2	21.01	3.50	Male	No	Sun	Dinner	3
3	23.68	3.31	Male	No	Sun	Dinner	2
4	24.59	3.61	Female	No	Sun	Dinner	4

In [3]:
```
tips[["total_bill", "tip", "smoker", "time"]]
```

Out[3]:

	total_bill	tip	smoker	time
0	16.99	1.01	No	Dinner
1	10.34	1.66	No	Dinner
2	21.01	3.50	No	Dinner
3	23.68	3.31	No	Dinner
4	24.59	3.61	No	Dinner
...	...	...	...	...
239	29.03	5.92	No	Dinner
240	27.18	2.00	Yes	Dinner
241	22.67	2.00	Yes	Dinner
242	17.82	1.75	No	Dinner
243	18.78	3.00	No	Dinner

244 rows × 4 columns

```
In [4]: tips.assign(tip_rate=tips["tip"] / tips["total_bill"])
```

Out[4]:

	total_bill	tip	sex	smoker	day	time	size	tip_rate
0	16.99	1.01	Female	No	Sun	Dinner	2	0.059447
1	10.34	1.66	Male	No	Sun	Dinner	3	0.160542
2	21.01	3.50	Male	No	Sun	Dinner	3	0.166587
3	23.68	3.31	Male	No	Sun	Dinner	2	0.139780
4	24.59	3.61	Female	No	Sun	Dinner	4	0.146808
...	...	...	...	...	...	...	...	...
239	29.03	5.92	Male	No	Sat	Dinner	3	0.203927
240	27.18	2.00	Female	Yes	Sat	Dinner	2	0.073584
241	22.67	2.00	Male	Yes	Sat	Dinner	2	0.088222
242	17.82	1.75	Male	No	Sat	Dinner	2	0.098204
243	18.78	3.00	Female	No	Thur	Dinner	2	0.159744

244 rows × 8 columns

```
In [5]: is_dinner = tips["time"] == "Dinner"
        is_dinner
```

```
Out[5]: 0       True
        1       True
        2       True
        3       True
        4       True
                ...
        239     True
        240     True
        241     True
        242     True
        243     True
        Name: time, Length: 244, dtype: bool
```

```
In [6]: is_dinner.value_counts()
```

```
Out[6]: True     176
        False     68
        Name: time, dtype: int64
```

In [7]:
```
tips[is_dinner]
```

Out[7]:

	total_bill	tip	sex	smoker	day	time	size
0	16.99	1.01	Female	No	Sun	Dinner	2
1	10.34	1.66	Male	No	Sun	Dinner	3
2	21.01	3.50	Male	No	Sun	Dinner	3
3	23.68	3.31	Male	No	Sun	Dinner	2
4	24.59	3.61	Female	No	Sun	Dinner	4
...	...	...	...	...	...	...	...
239	29.03	5.92	Male	No	Sat	Dinner	3
240	27.18	2.00	Female	Yes	Sat	Dinner	2
241	22.67	2.00	Male	Yes	Sat	Dinner	2
242	17.82	1.75	Male	No	Sat	Dinner	2
243	18.78	3.00	Female	No	Thur	Dinner	2

176 rows × 7 columns

In [8]:
```
tips[(tips["time"] == "Dinner") & (tips["tip"] > 5.00)]
```

Out[8]:

	total_bill	tip	sex	smoker	day	time	size
23	39.42	7.58	Male	No	Sat	Dinner	4
44	30.40	5.60	Male	No	Sun	Dinner	4
47	32.40	6.00	Male	No	Sun	Dinner	4
52	34.81	5.20	Female	No	Sun	Dinner	4
59	48.27	6.73	Male	No	Sat	Dinner	4
116	29.93	5.07	Male	No	Sun	Dinner	4
155	29.85	5.14	Female	No	Sun	Dinner	5
170	50.81	10.00	Male	Yes	Sat	Dinner	3
172	7.25	5.15	Male	Yes	Sun	Dinner	2
181	23.33	5.65	Male	Yes	Sun	Dinner	2
183	23.17	6.50	Male	Yes	Sun	Dinner	4
211	25.89	5.16	Male	Yes	Sat	Dinner	4
212	48.33	9.00	Male	No	Sat	Dinner	4
214	28.17	6.50	Female	Yes	Sat	Dinner	3
239	29.03	5.92	Male	No	Sat	Dinner	3

```
In [9]: tips[(tips["size"] >= 5) | (tips["total_bill"] > 45)]
```

Out[9]:

	total_bill	tip	sex	smoker	day	time	size
59	48.27	6.73	Male	No	Sat	Dinner	4
125	29.80	4.20	Female	No	Thur	Lunch	6
141	34.30	6.70	Male	No	Thur	Lunch	6
142	41.19	5.00	Male	No	Thur	Lunch	5
143	27.05	5.00	Female	No	Thur	Lunch	6
155	29.85	5.14	Female	No	Sun	Dinner	5
156	48.17	5.00	Male	No	Sun	Dinner	6
170	50.81	10.00	Male	Yes	Sat	Dinner	3
182	45.35	3.50	Male	Yes	Sun	Dinner	3
185	20.69	5.00	Male	No	Sun	Dinner	5
187	30.46	2.00	Male	Yes	Sun	Dinner	5
212	48.33	9.00	Male	No	Sat	Dinner	4
216	28.15	3.00	Male	Yes	Sat	Dinner	5

```
In [10]: tips.groupby("sex").size()
```

```
Out[10]: sex
         Female     87
         Male      157
         dtype: int64
```

```
In [11]: tips.groupby("sex").count()
```

Out[11]:

	total_bill	tip	smoker	day	time	size
sex						
Female	87	87	87	87	87	87
Male	157	157	157	157	157	157

```
In [12]: tips.groupby("sex")["total_bill"].count()
```

```
Out[12]: sex
         Female     87
         Male      157
         Name: total_bill, dtype: int64
```

```
In [13]: tips.groupby("day").agg({"tip": np.mean, "day": np.size})
```

```
Out[13]:
               tip  day
      day
      Fri  2.734737   19
      Sat  2.993103   87
      Sun  3.255132   76
     Thur  2.771452   62
```

```
In [14]: tips.groupby(["smoker", "day"]).agg({"tip": [np.size, np.mean]})
```

```
Out[14]:
                         tip
                   size      mean
 smoker   day
           Fri        4  2.812500
           Sat       45  3.102889
     No
           Sun       57  3.167895
          Thur       45  2.673778
           Fri       15  2.714000
           Sat       42  2.875476
    Yes
           Sun       19  3.516842
          Thur       17  3.030000
```

```
In [15]: tips.nlargest(10 + 5, columns="tip").tail(2)
```

```
Out[15]:
      total_bill   tip     sex  smoker   day    time  size
  85       34.83  5.17  Female      No  Thur   Lunch     4
 211       25.89  5.16    Male     Yes   Sat  Dinner     4
```

In [17]:
```
(
tips.assign(
rn=tips.sort_values(["total_bill"], ascending=False)
.groupby(["day"])
.cumcount()
+ 1
)
.query("rn < 3")
.sort_values(["day", "rn"])
)
```

Out[17]:

	total_bill	tip	sex	smoker	day	time	size	rn
95	40.17	4.73	Male	Yes	Fri	Dinner	4	1
90	28.97	3.00	Male	Yes	Fri	Dinner	2	2
170	50.81	10.00	Male	Yes	Sat	Dinner	3	1
212	48.33	9.00	Male	No	Sat	Dinner	4	2
156	48.17	5.00	Male	No	Sun	Dinner	6	1
182	45.35	3.50	Male	Yes	Sun	Dinner	3	2
197	43.11	5.00	Female	Yes	Thur	Lunch	4	1
142	41.19	5.00	Male	No	Thur	Lunch	5	2

In [18]:
```
(
tips.assign(
rnk=tips.groupby(["day"])["total_bill"].rank(
method="first", ascending=False
)
)
.query("rnk < 3")
.sort_values(["day", "rnk"])
)
```

Out[18]:

	total_bill	tip	sex	smoker	day	time	size	rnk
95	40.17	4.73	Male	Yes	Fri	Dinner	4	1.0
90	28.97	3.00	Male	Yes	Fri	Dinner	2	2.0
170	50.81	10.00	Male	Yes	Sat	Dinner	3	1.0
212	48.33	9.00	Male	No	Sat	Dinner	4	2.0
156	48.17	5.00	Male	No	Sun	Dinner	6	1.0
182	45.35	3.50	Male	Yes	Sun	Dinner	3	2.0
197	43.11	5.00	Female	Yes	Thur	Lunch	4	1.0
142	41.19	5.00	Male	No	Thur	Lunch	5	2.0

In [19]:
```
(
tips[tips["tip"] < 2]
.assign(rnk_min=tips.groupby(["sex"])["tip"].rank(method="min"))
.query("rnk_min < 3")
.sort_values(["sex", "rnk_min"])
)
```

Out[19]:

	total_bill	tip	sex	smoker	day	time	size	rnk_min
67	3.07	1.00	Female	Yes	Sat	Dinner	1	1.0
92	5.75	1.00	Female	Yes	Fri	Dinner	2	1.0
111	7.25	1.00	Female	No	Sat	Dinner	1	1.0
236	12.60	1.00	Male	Yes	Sat	Dinner	2	1.0
237	32.83	1.17	Male	Yes	Sat	Dinner	2	2.0

In [20]:
```
tips.loc[tips["tip"] < 2, "tip"] *= 2
```

In [21]:
```
tips = tips.loc[tips["tip"] <= 9]
```

In [23]:
```
tips = pd.read_csv("tips.csv", sep="\t", header=None)
# alternatively, read_table is an alias to read_csv with tab delimiter
tips = pd.read_table("tips.csv", header=None)
```

In [24]:
```
tips.to_excel("./tips.xlsx")
```

In [25]:
```
tips_df = pd.read_excel("./tips.xlsx", index_col=0)
```

In [26]:
```
tips.head(5)
```

Out[26]:

	0
0	total_bill,tip,sex,smoker,day,time,size
1	16.99,1.01,Female,No,Sun,Dinner,2
2	10.34,1.66,Male,No,Sun,Dinner,3
3	21.01,3.5,Male,No,Sun,Dinner,3
4	23.68,3.31,Male,No,Sun,Dinner,2

In [27]:
```python
tips = pd.read_csv("tips.csv", sep="\t", header=None)
# alternatively, read_table is an alias to read_csv with tab delimiter
tips = pd.read_table("tips.csv", header=None)
tips.head()
```

Out[27]:

	0
0	total_bill,tip,sex,smoker,day,time,size
1	16.99,1.01,Female,No,Sun,Dinner,2
2	10.34,1.66,Male,No,Sun,Dinner,3
3	21.01,3.5,Male,No,Sun,Dinner,3
4	23.68,3.31,Male,No,Sun,Dinner,2

In [28]:
```python
url = ("https://raw.github.com/pandas-dev""/pandas/main/pandas/tests/io/data/cs

tips = pd.read_csv(url)
tips.head()
```

Out[28]:

	total_bill	tip	sex	smoker	day	time	size
0	16.99	1.01	Female	No	Sun	Dinner	2
1	10.34	1.66	Male	No	Sun	Dinner	3
2	21.01	3.50	Male	No	Sun	Dinner	3
3	23.68	3.31	Male	No	Sun	Dinner	2
4	24.59	3.61	Female	No	Sun	Dinner	4

In [29]:
```python
tips["total_bill"] = tips["total_bill"] - 2
tips["new_bill"] = tips["total_bill"] / 2
tips.head()
```

Out[29]:

	total_bill	tip	sex	smoker	day	time	size	new_bill
0	14.99	1.01	Female	No	Sun	Dinner	2	7.495
1	8.34	1.66	Male	No	Sun	Dinner	3	4.170
2	19.01	3.50	Male	No	Sun	Dinner	3	9.505
3	21.68	3.31	Male	No	Sun	Dinner	2	10.840
4	22.59	3.61	Female	No	Sun	Dinner	4	11.295

In [30]:
```python
tips = tips.drop("new_bill", axis=1)
```

In [31]:
```
tips[tips["total_bill"] > 10]
```

Out[31]:

	total_bill	tip	sex	smoker	day	time	size
0	14.99	1.01	Female	No	Sun	Dinner	2
2	19.01	3.50	Male	No	Sun	Dinner	3
3	21.68	3.31	Male	No	Sun	Dinner	2
4	22.59	3.61	Female	No	Sun	Dinner	4
5	23.29	4.71	Male	No	Sun	Dinner	4
...	...	...	...	...	...	...	...
239	27.03	5.92	Male	No	Sat	Dinner	3
240	25.18	2.00	Female	Yes	Sat	Dinner	2
241	20.67	2.00	Male	Yes	Sat	Dinner	2
242	15.82	1.75	Male	No	Sat	Dinner	2
243	16.78	3.00	Female	No	Thur	Dinner	2

204 rows × 7 columns

In [32]:
```
tips["bucket"] = np.where(tips["total_bill"] < 10, "low", "high")
tips
```

Out[32]:

	total_bill	tip	sex	smoker	day	time	size	bucket
0	14.99	1.01	Female	No	Sun	Dinner	2	high
1	8.34	1.66	Male	No	Sun	Dinner	3	low
2	19.01	3.50	Male	No	Sun	Dinner	3	high
3	21.68	3.31	Male	No	Sun	Dinner	2	high
4	22.59	3.61	Female	No	Sun	Dinner	4	high
...	...	...	...	...	...	...	...	...
239	27.03	5.92	Male	No	Sat	Dinner	3	high
240	25.18	2.00	Female	Yes	Sat	Dinner	2	high
241	20.67	2.00	Male	Yes	Sat	Dinner	2	high
242	15.82	1.75	Male	No	Sat	Dinner	2	high
243	16.78	3.00	Female	No	Thur	Dinner	2	high

244 rows × 8 columns

In [33]:
```
tips["date1"] = pd.Timestamp("2013-01-15")
tips["date2"] = pd.Timestamp("2015-02-15")
tips["date1_year"] = tips["date1"].dt.year
tips["date2_month"] = tips["date2"].dt.month
tips["date1_next"] = tips["date1"] + pd.offsets.MonthBegin()
tips["months_between"] = tips["date2"].dt.to_period("M") - tips["date1"].dt.to_

tips[["date1", "date2", "date1_year", "date2_month", "date1_next", "months_betw
```

Out[33]:

	date1	date2	date1_year	date2_month	date1_next	months_between
0	2013-01-15	2015-02-15	2013	2	2013-02-01	<25 * MonthEnds>
1	2013-01-15	2015-02-15	2013	2	2013-02-01	<25 * MonthEnds>
2	2013-01-15	2015-02-15	2013	2	2013-02-01	<25 * MonthEnds>
3	2013-01-15	2015-02-15	2013	2	2013-02-01	<25 * MonthEnds>
4	2013-01-15	2015-02-15	2013	2	2013-02-01	<25 * MonthEnds>
...	...	...	...	...	...	...
239	2013-01-15	2015-02-15	2013	2	2013-02-01	<25 * MonthEnds>
240	2013-01-15	2015-02-15	2013	2	2013-02-01	<25 * MonthEnds>
241	2013-01-15	2015-02-15	2013	2	2013-02-01	<25 * MonthEnds>
242	2013-01-15	2015-02-15	2013	2	2013-02-01	<25 * MonthEnds>
243	2013-01-15	2015-02-15	2013	2	2013-02-01	<25 * MonthEnds>

244 rows × 6 columns

In [34]:
```
tips[["sex", "total_bill", "tip"]]
```

Out[34]:

	sex	total_bill	tip
0	Female	14.99	1.01
1	Male	8.34	1.66
2	Male	19.01	3.50
3	Male	21.68	3.31
4	Female	22.59	3.61
...	...	...	...
239	Male	27.03	5.92
240	Female	25.18	2.00
241	Male	20.67	2.00
242	Male	15.82	1.75
243	Female	16.78	3.00

244 rows × 3 columns

```
In [35]: tips.drop("sex", axis=1)
```

Out[35]:

	total_bill	tip	smoker	day	time	size	bucket	date1	date2	date1_year	date2_month
0	14.99	1.01	No	Sun	Dinner	2	high	2013-01-15	2015-02-15	2013	2
1	8.34	1.66	No	Sun	Dinner	3	low	2013-01-15	2015-02-15	2013	2
2	19.01	3.50	No	Sun	Dinner	3	high	2013-01-15	2015-02-15	2013	2
3	21.68	3.31	No	Sun	Dinner	2	high	2013-01-15	2015-02-15	2013	2
4	22.59	3.61	No	Sun	Dinner	4	high	2013-01-15	2015-02-15	2013	2
...	...	...	...	...	...	...	...	...	...	...	...
239	27.03	5.92	No	Sat	Dinner	3	high	2013-01-15	2015-02-15	2013	2
240	25.18	2.00	Yes	Sat	Dinner	2	high	2013-01-15	2015-02-15	2013	2
241	20.67	2.00	Yes	Sat	Dinner	2	high	2013-01-15	2015-02-15	2013	2
242	15.82	1.75	No	Sat	Dinner	2	high	2013-01-15	2015-02-15	2013	2
243	16.78	3.00	No	Thur	Dinner	2	high	2013-01-15	2015-02-15	2013	2

244 rows × 13 columns

In [40]:
```python
tips.rename(columns={"total_bill": "total_bill_2"})
```

Out[40]:

	total_bill_2	tip	sex	smoker	day	time	size	bucket	date1	date2	date1_year	da
67	1.07	1.00	Female	Yes	Sat	Dinner	1	low	2013-01-15	2015-02-15	2013	
92	3.75	1.00	Female	Yes	Fri	Dinner	2	low	2013-01-15	2015-02-15	2013	
111	5.25	1.00	Female	No	Sat	Dinner	1	low	2013-01-15	2015-02-15	2013	
145	6.35	1.50	Female	No	Thur	Lunch	2	low	2013-01-15	2015-02-15	2013	
135	6.51	1.25	Female	No	Thur	Lunch	2	low	2013-01-15	2015-02-15	2013	
...	...	...	...	...	...	...	...	...	...	...	...	
182	43.35	3.50	Male	Yes	Sun	Dinner	3	high	2013-01-15	2015-02-15	2013	
156	46.17	5.00	Male	No	Sun	Dinner	6	high	2013-01-15	2015-02-15	2013	
59	46.27	6.73	Male	No	Sat	Dinner	4	high	2013-01-15	2015-02-15	2013	
212	46.33	9.00	Male	No	Sat	Dinner	4	high	2013-01-15	2015-02-15	2013	
170	48.81	10.00	Male	Yes	Sat	Dinner	3	high	2013-01-15	2015-02-15	2013	

244 rows × 14 columns

In [38]:
```python
tips = tips.sort_values(["sex", "total_bill"])
tips.head(2)
```

Out[38]:

	total_bill	tip	sex	smoker	day	time	size	bucket	date1	date2	date1_year	date2_m
67	1.07	1.0	Female	Yes	Sat	Dinner	1	low	2013-01-15	2015-02-15	2013	
92	3.75	1.0	Female	Yes	Fri	Dinner	2	low	2013-01-15	2015-02-15	2013	

```
In [41]: tips["time"].str.len()
```

```
Out[41]: 67     6
         92     6
         111    6
         145    5
         135    5
               ..
         182    6
         156    6
         59     6
         212    6
         170    6
         Name: time, Length: 244, dtype: int64
```

```
In [42]: tips["time"].str.rstrip().str.len()
```

```
Out[42]: 67     6
         92     6
         111    6
         145    5
         135    5
               ..
         182    6
         156    6
         59     6
         212    6
         170    6
         Name: time, Length: 244, dtype: int64
```

```
In [43]: tips["sex"].str.find("ale")
```

```
Out[43]: 67     3
         92     3
         111    3
         145    3
         135    3
               ..
         182    1
         156    1
         59     1
         212    1
         170    1
         Name: sex, Length: 244, dtype: int64
```

```
In [44]: tips["sex"].str[0:1]
```

```
Out[44]: 67      F
         92      F
         111     F
         145     F
         135     F
                ..
         182     M
         156     M
         59      M
         212     M
         170     M
         Name: sex, Length: 244, dtype: object
```

```
In [45]: pd.pivot_table(tips, values="tip", index=["size"], columns=["sex"], aggfunc=np.
```

Out[45]:

sex	Female	Male
size		
1	1.276667	1.920000
2	2.528448	2.614184
3	3.250000	3.476667
4	4.021111	4.172143
5	5.140000	3.750000
6	4.600000	5.850000

```
In [54]: tips.iloc[1:2,0:3]
```

Out[54]:

	total_bill	tip	sex
92	3.75	1.0	Female

In [56]:
```
tips == "3.75"
```

Out[56]:

	total_bill	tip	sex	smoker	day	time	size	bucket	date1	date2	date1_year	date2
67	False	False	False	False	False	False	False	False	False	False	False	
92	False	False	False	False	False	False	False	False	False	False	False	
111	False	False	False	False	False	False	False	False	False	False	False	
145	False	False	False	False	False	False	False	False	False	False	False	
135	False	False	False	False	False	False	False	False	False	False	False	
...	...	...	...	...	...	...	...	...	...	...	...	
182	False	False	False	False	False	False	False	False	False	False	False	
156	False	False	False	False	False	False	False	False	False	False	False	
59	False	False	False	False	False	False	False	False	False	False	False	
212	False	False	False	False	False	False	False	False	False	False	False	
170	False	False	False	False	False	False	False	False	False	False	False	

244 rows × 14 columns

In [57]:
```
tips["day"].str.contains("S")
```

Out[57]:
```
67      True
92     False
111     True
145    False
135    False
       ...
182     True
156     True
59      True
212     True
170     True
Name: day, Length: 244, dtype: bool
```

In [58]:
```python
tips.replace("Thu", "Thursday")
```

Out[58]:

	total_bill	tip	sex	smoker	day	time	size	bucket	date1	date2	date1_year	date
67	1.07	1.00	Female	Yes	Sat	Dinner	1	low	2013-01-15	2015-02-15	2013	
92	3.75	1.00	Female	Yes	Fri	Dinner	2	low	2013-01-15	2015-02-15	2013	
111	5.25	1.00	Female	No	Sat	Dinner	1	low	2013-01-15	2015-02-15	2013	
145	6.35	1.50	Female	No	Thur	Lunch	2	low	2013-01-15	2015-02-15	2013	
135	6.51	1.25	Female	No	Thur	Lunch	2	low	2013-01-15	2015-02-15	2013	
...	...	...	...	...	...	...	...	...	...	...	...	
182	43.35	3.50	Male	Yes	Sun	Dinner	3	high	2013-01-15	2015-02-15	2013	
156	46.17	5.00	Male	No	Sun	Dinner	6	high	2013-01-15	2015-02-15	2013	
59	46.27	6.73	Male	No	Sat	Dinner	4	high	2013-01-15	2015-02-15	2013	
212	46.33	9.00	Male	No	Sat	Dinner	4	high	2013-01-15	2015-02-15	2013	
170	48.81	10.00	Male	Yes	Sat	Dinner	3	high	2013-01-15	2015-02-15	2013	

244 rows × 14 columns

In [59]:
```python
tips_summed = tips.groupby(["sex", "smoker"])[["total_bill", "tip"]].sum()
tips_summed
```

Out[59]:

		total_bill	tip
sex	**smoker**		
Female	**No**	869.68	149.77
	Yes	527.27	96.74
Male	**No**	1725.75	302.00
	Yes	1217.07	183.07

In [61]:
```
gb = tips.groupby("smoker")["total_bill"]
tips["adj_total_bill"] = tips["total_bill"] - gb.transform("mean")
tips.head(2)
```

Out[61]:

	total_bill	tip	sex	smoker	day	time	size	bucket	date1	date2	date1_year	date2_m
67	1.07	1.0	Female	Yes	Sat	Dinner	1	low	2013-01-15	2015-02-15	2013	
92	3.75	1.0	Female	Yes	Fri	Dinner	2	low	2013-01-15	2015-02-15	2013	

In [62]:
```
tips.groupby(["sex", "smoker"]).first()
```

Out[62]:

		total_bill	tip	day	time	size	bucket	date1	date2	date1_year	date2_mon
sex	**smoker**										
Female	**No**	5.25	1.00	Sat	Dinner	1	low	2013-01-15	2015-02-15	2013	
	Yes	1.07	1.00	Sat	Dinner	1	low	2013-01-15	2015-02-15	2013	
Male	**No**	5.51	2.00	Thur	Lunch	2	low	2013-01-15	2015-02-15	2013	
	Yes	5.25	5.15	Sun	Dinner	2	low	2013-01-15	2015-02-15	2013	

In [64]:
```
url = ("https://raw.github.com/pandas-dev""/pandas/main/pandas/tests/io/data/cs

tips = pd.read_csv(url)
tips.head(2)
```

Out[64]:

	total_bill	tip	sex	smoker	day	time	size
0	16.99	1.01	Female	No	Sun	Dinner	2
1	10.34	1.66	Male	No	Sun	Dinner	3

In [65]:

```
tips[tips["total_bill"] > 10]
```

Out[65]:

	total_bill	tip	sex	smoker	day	time	size
0	16.99	1.01	Female	No	Sun	Dinner	2
1	10.34	1.66	Male	No	Sun	Dinner	3
2	21.01	3.50	Male	No	Sun	Dinner	3
3	23.68	3.31	Male	No	Sun	Dinner	2
4	24.59	3.61	Female	No	Sun	Dinner	4
...	...	...	...	...	...	...	...
239	29.03	5.92	Male	No	Sat	Dinner	3
240	27.18	2.00	Female	Yes	Sat	Dinner	2
241	22.67	2.00	Male	Yes	Sat	Dinner	2
242	17.82	1.75	Male	No	Sat	Dinner	2
243	18.78	3.00	Female	No	Thur	Dinner	2

227 rows × 7 columns

In [66]:

```
tips[["sex", "total_bill", "tip"]]
```

Out[66]:

	sex	total_bill	tip
0	Female	16.99	1.01
1	Male	10.34	1.66
2	Male	21.01	3.50
3	Male	23.68	3.31
4	Female	24.59	3.61
...	...	...	...
239	Male	29.03	5.92
240	Female	27.18	2.00
241	Male	22.67	2.00
242	Male	17.82	1.75
243	Female	18.78	3.00

244 rows × 3 columns

```
In [67]: tips = tips.sort_values(["sex", "total_bill"])
         tips
```

Out[67]:

	total_bill	tip	sex	smoker	day	time	size
67	3.07	1.00	Female	Yes	Sat	Dinner	1
92	5.75	1.00	Female	Yes	Fri	Dinner	2
111	7.25	1.00	Female	No	Sat	Dinner	1
145	8.35	1.50	Female	No	Thur	Lunch	2
135	8.51	1.25	Female	No	Thur	Lunch	2
...	...	...	...	...	...	...	...
182	45.35	3.50	Male	Yes	Sun	Dinner	3
156	48.17	5.00	Male	No	Sun	Dinner	6
59	48.27	6.73	Male	No	Sat	Dinner	4
212	48.33	9.00	Male	No	Sat	Dinner	4
170	50.81	10.00	Male	Yes	Sat	Dinner	3

244 rows × 7 columns

```
In [5]: print(tips.iloc[-20:, :12].to_string())
```

```
     total_bill  tip     sex smoker   day    time  size
224       13.42  1.58    Male    Yes   Fri   Lunch     2
225       16.27  2.50  Female    Yes   Fri   Lunch     2
226       10.09  2.00  Female    Yes   Fri   Lunch     2
227       20.45  3.00    Male     No   Sat  Dinner     4
228       13.28  2.72    Male     No   Sat  Dinner     2
229       22.12  2.88  Female    Yes   Sat  Dinner     2
230       24.01  2.00    Male    Yes   Sat  Dinner     4
231       15.69  3.00    Male    Yes   Sat  Dinner     3
232       11.61  3.39    Male     No   Sat  Dinner     2
233       10.77  1.47    Male     No   Sat  Dinner     2
234       15.53  3.00    Male    Yes   Sat  Dinner     2
235       10.07  1.25    Male     No   Sat  Dinner     2
236       12.60  1.00    Male    Yes   Sat  Dinner     2
237       32.83  1.17    Male    Yes   Sat  Dinner     2
238       35.83  4.67  Female     No   Sat  Dinner     3
239       29.03  5.92    Male     No   Sat  Dinner     3
240       27.18  2.00  Female    Yes   Sat  Dinner     2
241       22.67  2.00    Male    Yes   Sat  Dinner     2
242       17.82  1.75    Male     No   Sat  Dinner     2
243       18.78  3.00  Female     No  Thur  Dinner     2
```

Syed Afroz Ali

```
In [ ]:
```