



Pandas: The Workhorse of Machine Learning in Python

```
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]: 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]: 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]: 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]:      C      D
```

	A	
bar	-2.780889	0.488108
foo	-1.313795	-2.010344

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

```
Out[15]:      C      D
```

	A	B	
	one	-1.314220	-1.048106
bar	three	-0.778172	0.695501
	two	-0.688497	0.840714
	one	-1.426226	-1.373881
foo	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]:      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 [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]: 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]: 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", "a", "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", "good"])
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")
```

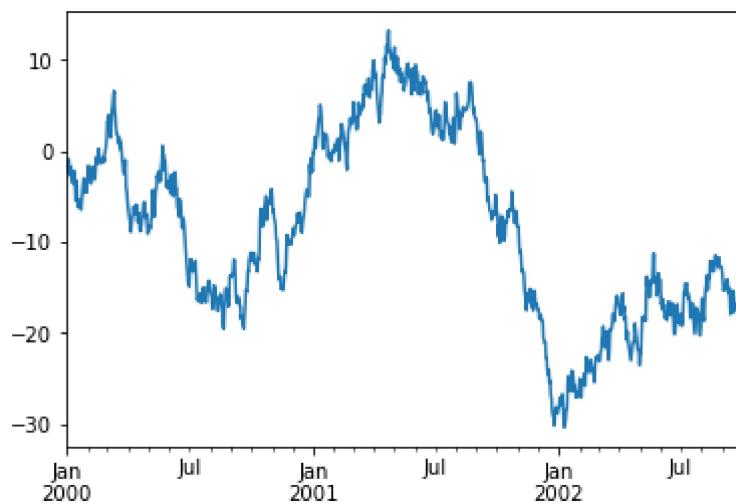
```
Out[33]:   id  raw_grade     grade
      5      6          e  very bad
      1      2          b      good
      2      3          b      good
      0      1          a  very good
      3      4          a  very good
      4      5          a  very good
```

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

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

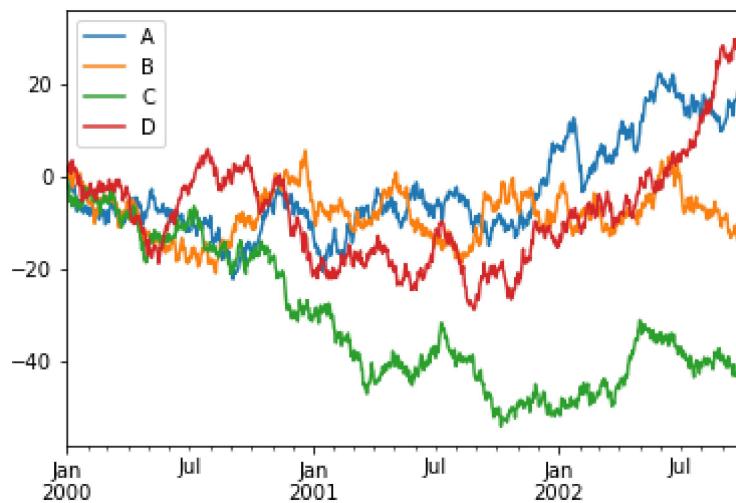
```
In [35]: import matplotlib.pyplot as plt
plt.close("all")
```

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



```
In [37]: df = pd.DataFrame(np.random.randn(1000, 4), index=ts.index, columns=["A", "B", "C", "D"])
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]}
```

```
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  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
```

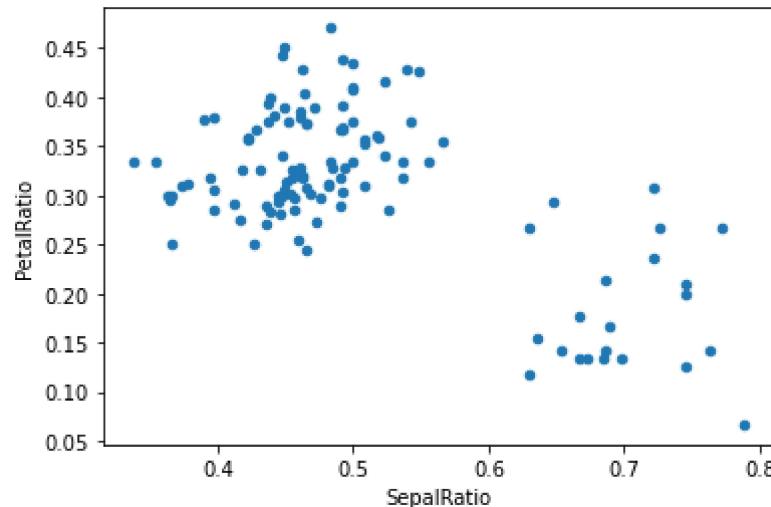
0	1	5.1	3.5	1.4	0.2	Iris-setosa	0.686275
1	2	4.9	3.0	1.4	0.2	Iris-setosa	0.612245
2	3	4.7	3.2	1.3	0.2	Iris-setosa	0.680851
3	4	4.6	3.1	1.5	0.2	Iris-setosa	0.673913
4	5	5.0	3.6	1.4	0.2	Iris-setosa	0.720000

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

```
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]: 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]: 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]: 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]: np.remainder(ser1, ser2)
```

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

```
In [101]: 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  1.306846
1 -0.555579  0.528680  0.244514 -0.921669 -0.942707 -1.253826 -1.811112 -0.900820  0.616784
2 -0.576731 -0.872153  2.207928 -0.505467 -0.130966  1.685892 -1.459214 -0.262680 -0.229437
```



```
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/folder_01/filename_01
1  filename_02  media/user_name/storage/folder_02/filename_02
```

```
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)})
```

```
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]:
```

	first	second	one	two	three
			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.unique()
```

```
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 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", "Bonell, 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	Bonell, 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]: type(titanic["Age"])
```

```
Out[14]: pandas.core.series.Series
```

```
In [15]: titanic["Age"].shape
```

```
Out[15]: (891,)
```

```
In [16]: titanic["Age"].shape
```

```
Out[16]: (891,)
```

```
In [17]: 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

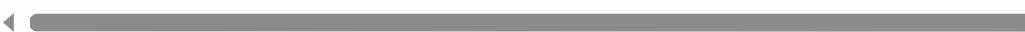
```
In [18]: titanic[["Age", "Sex"]].shape
```

```
Out[18]: (891, 2)
```

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

```
Out[19]:
```

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



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

```
Out[22]:
```

	PassengerId	Survived	Pclass	Name	Sex	Age	SibSp	Parch	Ticket	Fare	Cab
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]: 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	C
6	7	0	1	McCarthy, Mr. Timothy J	male	54.0	0	0	17463	51.8625	E
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	N&
15	16	1	2	Hewlett, Mrs. (Mary D Kingcome)	female	55.0	0	0	248706	16.0000	N&

```
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]: titanic.head()
```

```
Out[27]:
```

	PassengerId	Survived	Pclass	Name	Sex	Age	SibSp	Parch	Ticket	Fare	C
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]: titanic["Age"].mean()
```

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

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

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

```
In [30]: 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 21171	7.2500	Nan
1	2	1	1	anonymous	female	38.0	1	0	PC 17599	71.2833	C85

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

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

```
In [38]: 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]: titanic["Pclass"].value_counts()
```

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

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

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

```
In [41]: 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]: 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]: 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]: 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  C
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      1  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  C
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      1  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	Cabin
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 Vallejo)'
```

```
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 generation code

```
In [65]: # Data generation 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		
1 1	87.949769	52.340418
5 2	80.472147	51.547185
5 3	83.919926	38.707154
1 1	62.640842	45.863364
6 2	76.669235	49.722219
6 3	74.546488	45.781976
1 1	83.765432	35.884936
7 2	120.548997	36.888050
7 3	90.085512	49.915038
1 1	85.325932	60.874941
8 2	50.293565	37.083210
8 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
x	2	67.470350	117.676001	118.517232
y	1	160.009684	21.384183	177.609046
y	2	203.316298	197.839213	184.583499
z	1	10.060922	4.185807	8.656566
z	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	Amount
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.nan, "G", "H", "I"]})
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
```

	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
```

	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
```

	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
```

	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
```

	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"], "rank": [1, 2, 3]})  
df2 = pd.DataFrame({"city": ["Chicago", "Boston", "Los Angeles"], "rank": [1, 4, 5]})  
  
pd.concat([df1, df2])
```

```
Out[98]:    city  rank
```

	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
```

	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
```

	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", "all_pass"])  
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: DeprecationWarning: In a future version, `df.iloc[:, i] = newvals` will attempt to set the values inplace instead of always setting a new array. To retain the old behavior, use either `df[df.columns[i]] = newvals` or, if columns are non-unique, `df.iisetitem(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