5-data-operations

February 2, 2024

1 Python Programming (Basic-Intermediate)

1.1 Module 5 - Data Operation

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2 Part 1 - Pandas

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

```python
[2]: import requests
     resp = requests.get('https://api.coingecko.com/api/v3/coins/markets/?
     ↪vs_currency=usd')
     crypto_data = resp.json()
     print(crypto_data)
```

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'roi': None, 'last_updated': '2024-01-31T20:56:02.139Z'}]

```python
coin_id = pd.Series([coin['id'] for coin in crypto_data])
coin_id
```

```
[3]: 0        bitcoin
     1       ethereum
     2         tether
     3     binancecoin
```

```
4          solana
           …
95      frax-share
96           usdd
97           gala
98      frax-ether
99    oasis-network
Length: 100, dtype: object
```

[4]: `coin_id.str.match('usd')`

```
[4]: 0     False
     1     False
     2     False
     3     False
     4     False
           …
     95    False
     96     True
     97    False
     98    False
     99    False
     Length: 100, dtype: bool
```

[5]: `c1  = coin_id.sample(10)`

[6]: `c1`

```
[6]: 92              neo
     54      elrond-erd-2
     13        chainlink
     20              dai
     76           chiliz
     57         algorand
     68           fantom
     93             iota
     95       frax-share
     74    kucoin-shares
     dtype: object
```

[7]: `c1[5:6]`

```
[7]: 57    algorand
     dtype: object
```

2.1 1. Series - create series from numpy ndarray

```
[8]: s = pd.Series(np.random.randn(5), index = ['a','b','c','d','e'])
     print(s)
```

```
a   -0.615484
b   -0.436774
c    0.332703
d   -2.118236
e    0.700739
dtype: float64
```

2.2 2. access series values

```
[9]: s[0] # use numerical index
```

```
[9]: -0.6154839509419447
```

```
[10]: s['a'] # use named index
```

```
[10]: -0.6154839509419447
```

```
[11]: s[['b','c','b']]
```

```
[11]: b   -0.436774
      c    0.332703
      b   -0.436774
      dtype: float64
```

```
[12]: s[:2]
```

```
[12]: a   -0.615484
      b   -0.436774
      dtype: float64
```

```
[13]: s.index
```

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

```
[14]: s.values
```

```
[14]: array([-0.61548395, -0.43677444,  0.33270278, -2.11823598,  0.70073868])
```

2.3 3. Series operations

```
[15]: s
```

```
[15]: a   -0.615484
      b   -0.436774
      c    0.332703
      d   -2.118236
      e    0.700739
      dtype: float64
```

```
[16]: s.sort_values()
```

```
[16]: d   -2.118236
      a   -0.615484
      b   -0.436774
      c    0.332703
      e    0.700739
      dtype: float64
```

```
[17]: s.sort_index(ascending=False)
```

```
[17]: e    0.700739
      d   -2.118236
      c    0.332703
      b   -0.436774
      a   -0.615484
      dtype: float64
```

```
[18]: s.astype('str')
```

```
[18]: a    -0.6154839509419447
      b    -0.4367744406274495
      c    0.33270278289902644
      d    -2.118235979957245
      e     0.7007386755336193
      dtype: object
```

```
[19]: s.loc['b']
```

```
[19]: -0.4367744406274495
```

```
[20]: s['b']
```

```
[20]: -0.4367744406274495
```

```
[21]: s.iloc[0]
```

```
[21]: -0.6154839509419447
```

```
[22]: s[0]
```

```
[22]: -0.6154839509419447
```

```
[23]: c1
```

```
[23]: 92              neo
      54    elrond-erd-2
      13       chainlink
      20             dai
      76          chiliz
      57        algorand
      68          fantom
      93            iota
      95      frax-share
      74    kucoin-shares
      dtype: object
```

```
[24]: c1.loc[5]
```

```
---------------------------------------------------------------------------
KeyError                                  Traceback (most recent call last)
/usr/local/lib/python3.10/dist-packages/pandas/core/indexes/base.py in␣
 ↪get_loc(self, key, method, tolerance)
   3801            try:
-> 3802                return self._engine.get_loc(casted_key)
   3803            except KeyError as err:

/usr/local/lib/python3.10/dist-packages/pandas/_libs/index.pyx in pandas._libs.
 ↪index.IndexEngine.get_loc()

/usr/local/lib/python3.10/dist-packages/pandas/_libs/index.pyx in pandas._libs.
 ↪index.IndexEngine.get_loc()

pandas/_libs/hashtable_class_helper.pxi in pandas._libs.hashtable.Int64HashTabl .
 ↪get_item()

pandas/_libs/hashtable_class_helper.pxi in pandas._libs.hashtable.Int64HashTabl .
 ↪get_item()

KeyError: 5

The above exception was the direct cause of the following exception:

KeyError                                  Traceback (most recent call last)
<ipython-input-24-a28e00456487> in <cell line: 1>()
----> 1 c1.loc[5]
```

```
/usr/local/lib/python3.10/dist-packages/pandas/core/indexing.py in
 ↪__getitem__(self, key)
   1071
   1072                 maybe_callable = com.apply_if_callable(key, self.obj)
-> 1073                 return self._getitem_axis(maybe_callable, axis=axis)
   1074
   1075         def _is_scalar_access(self, key: tuple):

/usr/local/lib/python3.10/dist-packages/pandas/core/indexing.py in
 ↪_getitem_axis(self, key, axis)
   1310             # fall thru to straight lookup
   1311             self._validate_key(key, axis)
-> 1312             return self._get_label(key, axis=axis)
   1313
   1314         def _get_slice_axis(self, slice_obj: slice, axis: int):

/usr/local/lib/python3.10/dist-packages/pandas/core/indexing.py in
 ↪_get_label(self, label, axis)
   1258         def _get_label(self, label, axis: int):
   1259             # GH#5567 this will fail if the label is not present in the axis.
-> 1260             return self.obj.xs(label, axis=axis)
   1261
   1262         def _handle_lowerdim_multi_index_axis0(self, tup: tuple):

/usr/local/lib/python3.10/dist-packages/pandas/core/generic.py in xs(self, key,
 ↪axis, level, drop_level)
   4054                     new_index = index[loc]
   4055             else:
-> 4056                 loc = index.get_loc(key)
   4057
   4058                 if isinstance(loc, np.ndarray):

/usr/local/lib/python3.10/dist-packages/pandas/core/indexes/base.py in
 ↪get_loc(self, key, method, tolerance)
   3802                 return self._engine.get_loc(casted_key)
   3803             except KeyError as err:
-> 3804                 raise KeyError(key) from err
   3805             except TypeError:
   3806                 # If we have a listlike key, _check_indexing_error will
 ↪raise

KeyError: 5
```

```
[25]: c1.iloc[5]
```

```
[25]: 'algorand'
```

```
[26]: s_max = max(abs(s))
      s_max
```

```
[26]: 2.118235979957245
```

```
[27]: s.abs().max()
```

```
[27]: 2.118235979957245
```

```
[28]: s
```

```
[28]: a   -0.615484
      b   -0.436774
      c    0.332703
      d   -2.118236
      e    0.700739
      dtype: float64
```

```
[29]: s.apply(lambda x: x/s_max)
```

```
[29]: a   -0.290564
      b   -0.206197
      c    0.157066
      d   -1.000000
      e    0.330812
      dtype: float64
```

```
[30]: s/s_max
```

```
[30]: a   -0.290564
      b   -0.206197
      c    0.157066
      d   -1.000000
      e    0.330812
      dtype: float64
```

```
[31]: s.clip(lower=-.1, upper = .5)
```

```
[31]: a   -0.100000
      b   -0.100000
      c    0.332703
      d   -0.100000
      e    0.500000
      dtype: float64
```

```
[32]: s.append(pd.Series([-1,1], index=['f','g']))
```

```
<ipython-input-32-f2bfcf76504e>:1: FutureWarning: The series.append method is
deprecated and will be removed from pandas in a future version. Use
pandas.concat instead.
  s.append(pd.Series([-1,1], index=['f','g']))
```

```
[32]: a   -0.615484
      b   -0.436774
      c    0.332703
      d   -2.118236
      e    0.700739
      f   -1.000000
      g    1.000000
      dtype: float64
```

2.4   4. Time series related

We will revisit this topic again once we finished the introduction of data frame.

2.5   5. DataFrame

```python
[33]: d = {'one': [1,2,3,4],
           'two': [4,3,2,1]}
      df = pd.DataFrame(d)
      print(df)
```

```
   one  two
0    1    4
1    2    3
2    3    2
3    4    1
```

```python
[34]: df['one']
```

```
[34]: 0    1
      1    2
      2    3
      3    4
      Name: one, dtype: int64
```

```python
[35]: df[0:1]
```

```
[35]:    one  two
      0    1    4
```

```python
[36]: df['two'].shift(1)
```

```
[36]: 0    NaN
      1    4.0
```

```
2    3.0
3    2.0
Name: two, dtype: float64
```

[37]: `df.values`

[37]:
```
array([[1, 4],
       [2, 3],
       [3, 2],
       [4, 1]])
```

[38]: `df.columns`

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

[39]: `df.index`

[39]: `RangeIndex(start=0, stop=4, step=1)`

2.6 6. Create DataFrame from numpy array

[40]:
```python
d = np.array([['','Col1','Col2'],
              ['Row1',1,2],
              ['Row2',3,4]])
df = pd.DataFrame(data=d[1:,1:],
                  index=['Row1','Row2'],
                  columns=['Col1','Col2'])
print(df)
```

```
      Col1 Col2
Row1    1    2
Row2    3    4
```

[41]: `df`

[41]:
```
      Col1 Col2
Row1    1    2
Row2    3    4
```

2.7 7. Create DataFrame from files

[48]:
```python
from google.colab import drive
drive.mount('/content/drive')
```

```
Mounted at /content/drive
```

```
[49]:  df = pd.read_excel('/content/drive/MyDrive/AIS_DG/Superstore.xlsx',
                           sheet_name='Order',
                           index_col='Row ID')
       df
```

```
[49]:           Order ID Order Date  Ship Date       Ship Mode Customer ID  \
       Row ID
       1     CA-2013-152156 2014-11-09 2014-11-12    Second Class    CG-12520
       2     CA-2013-152156 2014-11-09 2014-11-12    Second Class    CG-12520
       3     CA-2013-138688 2014-06-13 2014-06-17    Second Class    DV-13045
       4     US-2012-108966 2013-10-11 2013-10-18  Standard Class    SO-20335
       5     US-2012-108966 2013-10-11 2013-10-18  Standard Class    SO-20335
       ...              ...        ...        ...             ...         ...
       9990  CA-2011-110422 2012-01-22 2012-01-24    Second Class    TB-21400
       9991  CA-2014-121258 2015-02-27 2015-03-04  Standard Class    DB-13060
       9992  CA-2014-121258 2015-02-27 2015-03-04  Standard Class    DB-13060
       9993  CA-2014-121258 2015-02-27 2015-03-04  Standard Class    DB-13060
       9994  CA-2014-119914 2015-05-05 2015-05-10    Second Class    CC-12220

                Customer Name    Segment        Country             City  \
       Row ID
       1          Claire Gute   Consumer  United States        Henderson
       2          Claire Gute   Consumer  United States        Henderson
       3      Darrin Van Huff  Corporate  United States      Los Angeles
       4        Sean O'Donnell   Consumer  United States  Fort Lauderdale
       5        Sean O'Donnell   Consumer  United States  Fort Lauderdale
       ...                ...        ...            ...              ...
       9990  Tom Boeckenhauer   Consumer  United States            Miami
       9991        Dave Brooks   Consumer  United States       Costa Mesa
       9992        Dave Brooks   Consumer  United States       Costa Mesa
       9993        Dave Brooks   Consumer  United States       Costa Mesa
       9994       Chris Cortes   Consumer  United States      Westminster

                   State  Postal Code Region      Product ID         Category  \
       Row ID
       1        Kentucky        42420  South  FUR-BO-10001798        Furniture
       2        Kentucky        42420  South  FUR-CH-10000454        Furniture
       3      California        90036   West  OFF-LA-10000240  Office Supplies
       4         Florida        33311  South  FUR-TA-10000577        Furniture
       5         Florida        33311  South  OFF-ST-10000760  Office Supplies
       ...           ...          ...    ...              ...              ...
       9990      Florida        33180  South  FUR-FU-10001889        Furniture
       9991   California        92627   West  FUR-FU-10000747        Furniture
       9992   California        92627   West  TEC-PH-10003645       Technology
       9993   California        92627   West  OFF-PA-10004041  Office Supplies
       9994   California        92683   West  OFF-AP-10002684  Office Supplies
```

```
            Sub-Category                                    Product Name  \
Row ID
1              Bookcases               Bush Somerset Collection Bookcase
2                 Chairs  Hon Deluxe Fabric Upholstered Stacking Chairs,…
3                 Labels  Self-Adhesive Address Labels for Typewriters b…
4                 Tables       Bretford CR4500 Series Slim Rectangular Table
5                Storage                    Eldon Fold 'N Roll Cart System
…                    …                                                 …
9990        Furnishings                         Ultra Door Pull Handle
9991        Furnishings  Tenex B1-RE Series Chair Mats for Low Pile Car…
9992             Phones                            Aastra 57i VoIP phone
9993              Paper  It's Hot Message Books with Stickers, 2 3/4" x 5"
9994         Appliances  Acco 7-Outlet Masterpiece Power Center, Wihtou…

           Sales  Quantity  Discount     Profit
Row ID
1        261.9600         2      0.00    41.9136
2        731.9400         3      0.00   219.5820
3         14.6200         2      0.00     6.8714
4        957.5775         5      0.45  -383.0310
5         22.3680         2      0.20     2.5164
…             …        …         …          …
9990      25.2480         3      0.20     4.1028
9991      91.9600         2      0.00    15.6332
9992     258.5760         2      0.20    19.3932
9993      29.6000         4      0.00    13.3200
9994     243.1600         2      0.00    72.9480

[9994 rows x 20 columns]
```

[43]:
```python
pd.set_option('display.max_columns', 500)
```

[44]:
```python
df
```

[44]:
```
      Col1 Col2
Row1     1    2
Row2     3    4
```

2.8 8. DataFrame dimension

[45]:
```python
df.shape
```

[45]:
```
(2, 2)
```

[46]:
```python
df.memory_usage()
```

```
[46]: Index    16
      Col1     16
      Col2     16
      dtype: int64
```

```
[47]: df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Index: 2 entries, Row1 to Row2
Data columns (total 2 columns):
 #   Column  Non-Null Count  Dtype
---  ------  --------------  -----
 0   Col1    2 non-null      object
 1   Col2    2 non-null      object
dtypes: object(2)
memory usage: 48.0+ bytes
```

```
[50]: df.columns
```

```
[50]: Index(['Order ID', 'Order Date', 'Ship Date', 'Ship Mode', 'Customer ID',
             'Customer Name', 'Segment', 'Country', 'City', 'State', 'Postal Code',
             'Region', 'Product ID', 'Category', 'Sub-Category', 'Product Name',
             'Sales', 'Quantity', 'Discount', 'Profit'],
            dtype='object')
```

2.9 9. DataFrame Viewing: head()

```
[51]: df.head()
```

```
[51]:               Order ID Order Date  Ship Date       Ship Mode Customer ID  \
      Row ID
      1       CA-2013-152156 2014-11-09 2014-11-12    Second Class    CG-12520
      2       CA-2013-152156 2014-11-09 2014-11-12    Second Class    CG-12520
      3       CA-2013-138688 2014-06-13 2014-06-17    Second Class    DV-13045
      4       US-2012-108966 2013-10-11 2013-10-18  Standard Class    SO-20335
      5       US-2012-108966 2013-10-11 2013-10-18  Standard Class    SO-20335

                Customer Name     Segment        Country             City  \
      Row ID
      1           Claire Gute    Consumer  United States        Henderson
      2           Claire Gute    Consumer  United States        Henderson
      3       Darrin Van Huff   Corporate  United States      Los Angeles
      4        Sean O'Donnell    Consumer  United States  Fort Lauderdale
      5        Sean O'Donnell    Consumer  United States  Fort Lauderdale

                  State  Postal Code Region       Product ID        Category  \
      Row ID
```

```
1        Kentucky      42420  South  FUR-BO-10001798         Furniture
2        Kentucky      42420  South  FUR-CH-10000454         Furniture
3      California      90036   West  OFF-LA-10000240  Office Supplies
4         Florida      33311  South  FUR-TA-10000577         Furniture
5         Florida      33311  South  OFF-ST-10000760  Office Supplies

       Sub-Category                                    Product Name  \
Row ID
1         Bookcases                  Bush Somerset Collection Bookcase
2            Chairs  Hon Deluxe Fabric Upholstered Stacking Chairs,…
3            Labels  Self-Adhesive Address Labels for Typewriters b…
4            Tables       Bretford CR4500 Series Slim Rectangular Table
5           Storage                    Eldon Fold 'N Roll Cart System

          Sales  Quantity  Discount     Profit
Row ID
1       261.9600         2      0.00    41.9136
2       731.9400         3      0.00   219.5820
3        14.6200         2      0.00     6.8714
4       957.5775         5      0.45  -383.0310
5        22.3680         2      0.20     2.5164
```

[52]: `df[:5]`

[52]:
```
              Order ID Order Date  Ship Date      Ship Mode Customer ID  \
Row ID
1      CA-2013-152156 2014-11-09 2014-11-12   Second Class   CG-12520
2      CA-2013-152156 2014-11-09 2014-11-12   Second Class   CG-12520
3      CA-2013-138688 2014-06-13 2014-06-17   Second Class   DV-13045
4      US-2012-108966 2013-10-11 2013-10-18  Standard Class   SO-20335
5      US-2012-108966 2013-10-11 2013-10-18  Standard Class   SO-20335

         Customer Name     Segment        Country            City  \
Row ID
1          Claire Gute    Consumer  United States       Henderson
2          Claire Gute    Consumer  United States       Henderson
3       Darrin Van Huff   Corporate  United States     Los Angeles
4       Sean O'Donnell    Consumer  United States  Fort Lauderdale
5       Sean O'Donnell    Consumer  United States  Fort Lauderdale

            State  Postal Code Region       Product ID        Category  \
Row ID
1        Kentucky      42420  South  FUR-BO-10001798         Furniture
2        Kentucky      42420  South  FUR-CH-10000454         Furniture
3      California      90036   West  OFF-LA-10000240  Office Supplies
4         Florida      33311  South  FUR-TA-10000577         Furniture
5         Florida      33311  South  OFF-ST-10000760  Office Supplies
```

```
       Sub-Category                                       Product Name  \
Row ID
1        Bookcases                      Bush Somerset Collection Bookcase
2           Chairs   Hon Deluxe Fabric Upholstered Stacking Chairs,…
3           Labels   Self-Adhesive Address Labels for Typewriters b…
4           Tables        Bretford CR4500 Series Slim Rectangular Table
5          Storage                      Eldon Fold 'N Roll Cart System


          Sales  Quantity  Discount      Profit
Row ID
1       261.9600         2      0.00     41.9136
2       731.9400         3      0.00    219.5820
3        14.6200         2      0.00      6.8714
4       957.5775         5      0.45   -383.0310
5        22.3680         2      0.20      2.5164
```

2.10   10. DataFrame Viewing: tail()

```
[53]: df.tail()
```

```
[53]:                 Order ID Order Date  Ship Date       Ship Mode Customer ID  \
      Row ID
      9990    CA-2011-110422 2012-01-22 2012-01-24    Second Class    TB-21400
      9991    CA-2014-121258 2015-02-27 2015-03-04  Standard Class    DB-13060
      9992    CA-2014-121258 2015-02-27 2015-03-04  Standard Class    DB-13060
      9993    CA-2014-121258 2015-02-27 2015-03-04  Standard Class    DB-13060
      9994    CA-2014-119914 2015-05-05 2015-05-10    Second Class    CC-12220


              Customer Name   Segment        Country        City       State  \
      Row ID
      9990    Tom Boeckenhauer  Consumer  United States       Miami      Florida
      9991        Dave Brooks  Consumer  United States  Costa Mesa  California
      9992        Dave Brooks  Consumer  United States  Costa Mesa  California
      9993        Dave Brooks  Consumer  United States  Costa Mesa  California
      9994       Chris Cortes  Consumer  United States  Westminster  California


              Postal Code Region      Product ID        Category Sub-Category  \
      Row ID
      9990          33180  South  FUR-FU-10001889        Furniture  Furnishings
      9991          92627   West  FUR-FU-10000747        Furniture  Furnishings
      9992          92627   West  TEC-PH-10003645       Technology       Phones
      9993          92627   West  OFF-PA-10004041  Office Supplies        Paper
      9994          92683   West  OFF-AP-10002684  Office Supplies   Appliances


                                          Product Name    Sales  Quantity  \
      Row ID
```

```
9990                             Ultra Door Pull Handle   25.248         3
9991    Tenex B1-RE Series Chair Mats for Low Pile Car…   91.960         2
9992                               Aastra 57i VoIP phone  258.576         2
9993    It's Hot Message Books with Stickers, 2 3/4" x 5"  29.600         4
9994    Acco 7-Outlet Masterpiece Power Center, Wihtou…  243.160         2

        Discount    Profit
Row ID
9990         0.2    4.1028
9991         0.0   15.6332
9992         0.2   19.3932
9993         0.0   13.3200
9994         0.0   72.9480
```

2.11 11. Viewing DataFrame: columns

[54]: `df.columns`

[54]:
```
Index(['Order ID', 'Order Date', 'Ship Date', 'Ship Mode', 'Customer ID',
       'Customer Name', 'Segment', 'Country', 'City', 'State', 'Postal Code',
       'Region', 'Product ID', 'Category', 'Sub-Category', 'Product Name',
       'Sales', 'Quantity', 'Discount', 'Profit'],
      dtype='object')
```

[55]: `df.index`

[55]:
```
Int64Index([   1,    2,    3,    4,    5,    6,    7,    8,    9,   10,
            …
            9985, 9986, 9987, 9988, 9989, 9990, 9991, 9992, 9993, 9994],
           dtype='int64', name='Row ID', length=9994)
```

[56]: `df.values`

[56]:
```
array([['CA-2013-152156', Timestamp('2014-11-09 00:00:00'),
        Timestamp('2014-11-12 00:00:00'), …, 2, 0.0, 41.9136],
       ['CA-2013-152156', Timestamp('2014-11-09 00:00:00'),
        Timestamp('2014-11-12 00:00:00'), …, 3, 0.0,
        219.58199999999997],
       ['CA-2013-138688', Timestamp('2014-06-13 00:00:00'),
        Timestamp('2014-06-17 00:00:00'), …, 2, 0.0,
        6.8713999999999995],
       …,
       ['CA-2014-121258', Timestamp('2015-02-27 00:00:00'),
        Timestamp('2015-03-04 00:00:00'), …, 2, 0.2,
        19.393200000000007],
       ['CA-2014-121258', Timestamp('2015-02-27 00:00:00'),
        Timestamp('2015-03-04 00:00:00'), …, 4, 0.0, 13.32],
```

```
        ['CA-2014-119914', Timestamp('2015-05-05 00:00:00'),
          Timestamp('2015-05-10 00:00:00'), …, 2, 0.0, 72.94799999999998]],
        dtype=object)
```

[57]: `df.info()`

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 9994 entries, 1 to 9994
Data columns (total 20 columns):
 #   Column         Non-Null Count  Dtype
---  ------         --------------  -----
 0   Order ID       9994 non-null   object
 1   Order Date     9994 non-null   datetime64[ns]
 2   Ship Date      9994 non-null   datetime64[ns]
 3   Ship Mode      9994 non-null   object
 4   Customer ID    9994 non-null   object
 5   Customer Name  9994 non-null   object
 6   Segment        9994 non-null   object
 7   Country        9994 non-null   object
 8   City           9994 non-null   object
 9   State          9994 non-null   object
 10  Postal Code    9994 non-null   int64
 11  Region         9994 non-null   object
 12  Product ID     9994 non-null   object
 13  Category       9994 non-null   object
 14  Sub-Category   9994 non-null   object
 15  Product Name   9994 non-null   object
 16  Sales          9994 non-null   float64
 17  Quantity       9994 non-null   int64
 18  Discount       9994 non-null   float64
 19  Profit         9994 non-null   float64
dtypes: datetime64[ns](2), float64(3), int64(2), object(13)
memory usage: 1.6+ MB
```

2.12 12. Viewing DataFrame: describe

[58]: `df.describe(percentiles=[0.9,0.99])`

[58]:

	Postal Code	Sales	Quantity	Discount	Profit
count	9994.000000	9994.000000	9994.000000	9994.000000	9994.000000
mean	55190.379428	229.858001	3.789574	0.156203	28.656896
std	32063.693350	623.245101	2.225110	0.206452	234.260108
min	1040.000000	0.444000	1.000000	0.000000	-6599.978000
50%	56430.500000	54.490000	3.000000	0.200000	8.666500
90%	94122.000000	572.706000	7.000000	0.400000	89.281620
99%	98115.000000	2481.694600	11.000000	0.800000	580.657882
max	99301.000000	22638.480000	14.000000	0.800000	8399.976000

```
[59]: df.describe(include='object')
```

```
[59]:             Order ID      Ship Mode Customer ID   Customer Name   Segment  \
      count           9994           9994        9994            9994      9994
      unique          5009              4         793             793         3
      top     CA-2014-100111  Standard Class   WB-21850   William Brown  Consumer
      freq              14           5968          37              37      5191

                   Country           City        State Region      Product ID  \
      count           9994           9994         9994   9994            9994
      unique             1            531           49      4            1862
      top     United States  New York City   California   West  OFF-PA-10001970
      freq            9994            915         2001   3203              19

                    Category Sub-Category     Product Name
      count             9994         9994             9994
      unique               3           17             1850
      top     Office Supplies      Binders  Staple envelope
      freq              6026         1523               48
```

2.13   13. Sorting data by specific columns

```
[60]: df
```

```
[60]:              Order ID  Order Date   Ship Date       Ship Mode Customer ID  \
      Row ID
      1       CA-2013-152156  2014-11-09  2014-11-12    Second Class    CG-12520
      2       CA-2013-152156  2014-11-09  2014-11-12    Second Class    CG-12520
      3       CA-2013-138688  2014-06-13  2014-06-17    Second Class    DV-13045
      4       US-2012-108966  2013-10-11  2013-10-18  Standard Class    SO-20335
      5       US-2012-108966  2013-10-11  2013-10-18  Standard Class    SO-20335
      ...                ...         ...         ...             ...         ...
      9990    CA-2011-110422  2012-01-22  2012-01-24    Second Class    TB-21400
      9991    CA-2014-121258  2015-02-27  2015-03-04  Standard Class    DB-13060
      9992    CA-2014-121258  2015-02-27  2015-03-04  Standard Class    DB-13060
      9993    CA-2014-121258  2015-02-27  2015-03-04  Standard Class    DB-13060
      9994    CA-2014-119914  2015-05-05  2015-05-10    Second Class    CC-12220

                Customer Name    Segment        Country            City  \
      Row ID
      1           Claire Gute   Consumer  United States        Henderson
      2           Claire Gute   Consumer  United States        Henderson
      3       Darrin Van Huff  Corporate  United States      Los Angeles
      4         Sean O'Donnell   Consumer  United States  Fort Lauderdale
      5         Sean O'Donnell   Consumer  United States  Fort Lauderdale
      ...                 ...        ...            ...              ...
      9990    Tom Boeckenhauer   Consumer  United States            Miami
```

9991	Dave Brooks	Consumer	United States	Costa Mesa
9992	Dave Brooks	Consumer	United States	Costa Mesa
9993	Dave Brooks	Consumer	United States	Costa Mesa
9994	Chris Cortes	Consumer	United States	Westminster

Row ID	State	Postal Code	Region	Product ID	Category \
1	Kentucky	42420	South	FUR-BO-10001798	Furniture
2	Kentucky	42420	South	FUR-CH-10000454	Furniture
3	California	90036	West	OFF-LA-10000240	Office Supplies
4	Florida	33311	South	FUR-TA-10000577	Furniture
5	Florida	33311	South	OFF-ST-10000760	Office Supplies
…	…	…	…	…	…
9990	Florida	33180	South	FUR-FU-10001889	Furniture
9991	California	92627	West	FUR-FU-10000747	Furniture
9992	California	92627	West	TEC-PH-10003645	Technology
9993	California	92627	West	OFF-PA-10004041	Office Supplies
9994	California	92683	West	OFF-AP-10002684	Office Supplies

Row ID	Sub-Category	Product Name \
1	Bookcases	Bush Somerset Collection Bookcase
2	Chairs	Hon Deluxe Fabric Upholstered Stacking Chairs,…
3	Labels	Self-Adhesive Address Labels for Typewriters b…
4	Tables	Bretford CR4500 Series Slim Rectangular Table
5	Storage	Eldon Fold 'N Roll Cart System
…	…	…
9990	Furnishings	Ultra Door Pull Handle
9991	Furnishings	Tenex B1-RE Series Chair Mats for Low Pile Car…
9992	Phones	Aastra 57i VoIP phone
9993	Paper	It's Hot Message Books with Stickers, 2 3/4" x 5"
9994	Appliances	Acco 7-Outlet Masterpiece Power Center, Wihtou…

Row ID	Sales	Quantity	Discount	Profit
1	261.9600	2	0.00	41.9136
2	731.9400	3	0.00	219.5820
3	14.6200	2	0.00	6.8714
4	957.5775	5	0.45	-383.0310
5	22.3680	2	0.20	2.5164
…	…	…	…	…
9990	25.2480	3	0.20	4.1028
9991	91.9600	2	0.00	15.6332
9992	258.5760	2	0.20	19.3932
9993	29.6000	4	0.00	13.3200
9994	243.1600	2	0.00	72.9480

```
[9994 rows x 20 columns]
```

[61]: `df.sort_values(by=['Order Date'])`

[61]:
```
                 Order ID Order Date  Ship Date       Ship Mode Customer ID  \
Row ID
7981    CA-2011-103800 2012-01-04 2012-01-08  Standard Class     DP-13000
740     CA-2011-112326 2012-01-05 2012-01-09  Standard Class     PO-19195
741     CA-2011-112326 2012-01-05 2012-01-09  Standard Class     PO-19195
742     CA-2011-112326 2012-01-05 2012-01-09  Standard Class     PO-19195
1760    CA-2011-141817 2012-01-06 2012-01-13  Standard Class     MB-18085
...                ...        ...        ...             ...          ...
5092    CA-2014-156720 2015-12-31 2016-01-04  Standard Class     JM-15580
909     CA-2014-143259 2015-12-31 2016-01-04  Standard Class     PO-18865
908     CA-2014-143259 2015-12-31 2016-01-04  Standard Class     PO-18865
1297    CA-2014-115427 2015-12-31 2016-01-04  Standard Class     EB-13975
907     CA-2014-143259 2015-12-31 2016-01-04  Standard Class     PO-18865

           Customer Name       Segment        Country           City  \
Row ID
7981       Darren Powers      Consumer  United States        Houston
740        Phillina Ober   Home Office  United States     Naperville
741        Phillina Ober   Home Office  United States     Naperville
742        Phillina Ober   Home Office  United States     Naperville
1760          Mick Brown      Consumer  United States   Philadelphia
...                  ...           ...            ...            ...
5092       Jill Matthias      Consumer  United States       Loveland
909     Patrick O'Donnell      Consumer  United States  New York City
908     Patrick O'Donnell      Consumer  United States  New York City
1297          Erica Bern     Corporate  United States      Fairfield
907     Patrick O'Donnell      Consumer  United States  New York City

              State  Postal Code   Region      Product ID        Category  \
Row ID
7981          Texas        77095  Central  OFF-PA-10000174  Office Supplies
740        Illinois        60540  Central  OFF-LA-10003223  Office Supplies
741        Illinois        60540  Central  OFF-ST-10002743  Office Supplies
742        Illinois        60540  Central  OFF-BI-10004094  Office Supplies
1760   Pennsylvania        19143     East  OFF-AR-10003478  Office Supplies
...             ...          ...      ...             ...             ...
5092       Colorado        80538     West  OFF-FA-10003472  Office Supplies
909        New York        10009     East  OFF-BI-10003684  Office Supplies
908        New York        10009     East  TEC-PH-10004774       Technology
1297     California        94533     West  OFF-BI-10002103  Office Supplies
907        New York        10009     East  FUR-BO-10003441       Furniture

        Sub-Category                               Product Name  \
Row ID
```

```
       Row ID
       7981          Paper  Message Book, Wirebound, Four 5 1/2" X 4" Form…
       740          Labels                                        Avery 508
       741         Storage                      SAFCO Boltless Steel Shelving
       742         Binders          GBC Standard Plastic Binding Systems Combs
       1760            Art  Avery Hi-Liter EverBold Pen Style Fluorescent …
       …               …                                                  …
       5092       Fasteners                             Bagged Rubber Bands
       909         Binders              Wilson Jones Legal Size Ring Binders
       908          Phones                        Gear Head AU3700S Headset
       1297        Binders    Cardinal Slant-D Ring Binder, Heavy Gauge Vinyl
       907        Bookcases  Bush Westfield Collection Bookcases, Fully Ass…

                Sales  Quantity  Discount    Profit
       Row ID
       7981    16.448         2       0.2    5.5512
       740     11.784         3       0.2    4.2717
       741    272.736         3       0.2  -64.7748
       742      3.540         2       0.8   -5.4870
       1760    19.536         3       0.2    4.8840
       …           …         …         …        …
       5092     3.024         3       0.2   -0.6048
       909     52.776         3       0.2   19.7910
       908     90.930         7       0.0    2.7279
       1297    13.904         2       0.2    4.5188
       907    323.136         4       0.2   12.1176

       [9994 rows x 20 columns]
```

[62]:
```python
df\
  .sort_values(by=['Customer ID','Ship Date'],
               ascending=False)
```

[62]:
```
                 Order ID Order Date  Ship Date      Ship Mode Customer ID  \
       Row ID
       8342   CA-2014-141481 2015-06-12 2015-06-15     First Class    ZD-21925
       3815   CA-2013-152471 2014-07-09 2014-07-09        Same Day    ZD-21925
       3816   CA-2013-152471 2014-07-09 2014-07-09        Same Day    ZD-21925
       3041   US-2013-147991 2014-05-06 2014-05-10  Standard Class    ZD-21925
       5898   CA-2013-167682 2014-04-04 2014-04-10  Standard Class    ZD-21925
       …                 …         …          …              …           …
       1300   CA-2012-121391 2013-10-04 2013-10-07     First Class    AA-10315
       7469   CA-2011-138100 2012-09-15 2012-09-20  Standard Class    AA-10315
       7470   CA-2011-138100 2012-09-15 2012-09-20  Standard Class    AA-10315
       2230   CA-2011-128055 2012-03-31 2012-04-05  Standard Class    AA-10315
       2231   CA-2011-128055 2012-03-31 2012-04-05  Standard Class    AA-10315
```

	Customer Name	Segment	Country	City \
Row ID				
8342	Zuschuss Donatelli	Consumer	United States	Los Angeles
3815	Zuschuss Donatelli	Consumer	United States	Jacksonville
3816	Zuschuss Donatelli	Consumer	United States	Jacksonville
3041	Zuschuss Donatelli	Consumer	United States	Chattanooga
5898	Zuschuss Donatelli	Consumer	United States	Richmond
…	…	…	…	…
1300	Alex Avila	Consumer	United States	San Francisco
7469	Alex Avila	Consumer	United States	New York City
7470	Alex Avila	Consumer	United States	New York City
2230	Alex Avila	Consumer	United States	San Francisco
2231	Alex Avila	Consumer	United States	San Francisco

	State	Postal Code	Region	Product ID	Category \
Row ID					
8342	California	90036	West	OFF-AP-10004532	Office Supplies
3815	Florida	32216	South	TEC-PH-10002824	Technology
3816	Florida	32216	South	OFF-PA-10004965	Office Supplies
3041	Tennessee	37421	South	FUR-FU-10004270	Furniture
5898	Indiana	47374	Central	FUR-FU-10003799	Furniture
…	…	…	…	…	…
1300	California	94109	West	OFF-ST-10001590	Office Supplies
7469	New York	10011	East	OFF-PA-10000349	Office Supplies
7470	New York	10011	East	FUR-FU-10002456	Furniture
2230	California	94122	West	OFF-BI-10004390	Office Supplies
2231	California	94122	West	OFF-AP-10002765	Office Supplies

	Sub-Category	Product Name \
Row ID		
8342	Appliances	Kensington 6 Outlet Guardian Standard Surge Pr…
3815	Phones	Jabra SPEAK 410 Multidevice Speakerphone
3816	Paper	Xerox 1921
3041	Furnishings	Eldon Image Series Desk Accessories, Burgundy
5898	Furnishings	Seth Thomas 13 1/2" Wall Clock
…	…	…
1300	Storage	Tenex Personal Project File with Scoop Front D…
7469	Paper	Easy-staple paper
7470	Furnishings	Master Caster Door Stop, Large Neon Orange
2230	Binders	GBC DocuBind 200 Manual Binding Machine
2231	Appliances	Fellowes Advanced Computer Series Surge Protec…

	Sales	Quantity	Discount	Profit
Row ID				
8342	61.440	3	0.0	16.5888
3815	823.960	5	0.2	51.4975
3816	15.984	2	0.2	4.9950

```
3041        16.720           5        0.2      3.3440
5898        71.120           4        0.0     22.0472
...            ...          ...        ...        ...
1300        26.960           2        0.0      7.0096
7469        14.940           3        0.0      7.0218
7470        14.560           2        0.0      6.2608
2230       673.568           2        0.2    252.5880
2231        52.980           2        0.0     14.8344

[9994 rows x 20 columns]
```

2.14 14. Select a column

[63]:
```
df
```

[63]:
```
                Order ID Order Date  Ship Date        Ship Mode Customer ID  \
Row ID
1        CA-2013-152156 2014-11-09 2014-11-12     Second Class    CG-12520
2        CA-2013-152156 2014-11-09 2014-11-12     Second Class    CG-12520
3        CA-2013-138688 2014-06-13 2014-06-17     Second Class    DV-13045
4        US-2012-108966 2013-10-11 2013-10-18  Standard Class    SO-20335
5        US-2012-108966 2013-10-11 2013-10-18  Standard Class    SO-20335
...                 ...        ...        ...              ...         ...
9990     CA-2011-110422 2012-01-22 2012-01-24     Second Class    TB-21400
9991     CA-2014-121258 2015-02-27 2015-03-04  Standard Class    DB-13060
9992     CA-2014-121258 2015-02-27 2015-03-04  Standard Class    DB-13060
9993     CA-2014-121258 2015-02-27 2015-03-04  Standard Class    DB-13060
9994     CA-2014-119914 2015-05-05 2015-05-10     Second Class    CC-12220

            Customer Name     Segment        Country            City  \
Row ID
1             Claire Gute    Consumer  United States       Henderson
2             Claire Gute    Consumer  United States       Henderson
3         Darrin Van Huff   Corporate  United States     Los Angeles
4          Sean O'Donnell    Consumer  United States  Fort Lauderdale
5          Sean O'Donnell    Consumer  United States  Fort Lauderdale
...                   ...         ...            ...             ...
9990     Tom Boeckenhauer    Consumer  United States           Miami
9991          Dave Brooks    Consumer  United States      Costa Mesa
9992          Dave Brooks    Consumer  United States      Costa Mesa
9993          Dave Brooks    Consumer  United States      Costa Mesa
9994         Chris Cortes    Consumer  United States     Westminster

              State  Postal Code Region       Product ID        Category  \
Row ID
1          Kentucky        42420  South  FUR-BO-10001798       Furniture
2          Kentucky        42420  South  FUR-CH-10000454       Furniture
```

```
3        California          90036   West   OFF-LA-10000240   Office Supplies
4          Florida          33311   South  FUR-TA-10000577         Furniture
5          Florida          33311   South  OFF-ST-10000760   Office Supplies
...            ...             ...    ...               ...               ...
9990       Florida          33180   South  FUR-FU-10001889         Furniture
9991     California          92627   West   FUR-FU-10000747         Furniture
9992     California          92627   West   TEC-PH-10003645        Technology
9993     California          92627   West   OFF-PA-10004041   Office Supplies
9994     California          92683   West   OFF-AP-10002684   Office Supplies

           Sub-Category                              Product Name   \
Row ID
1            Bookcases                Bush Somerset Collection Bookcase
2               Chairs  Hon Deluxe Fabric Upholstered Stacking Chairs,…
3               Labels  Self-Adhesive Address Labels for Typewriters b…
4               Tables        Bretford CR4500 Series Slim Rectangular Table
5              Storage                      Eldon Fold 'N Roll Cart System
...                ...                                               …
9990       Furnishings                          Ultra Door Pull Handle
9991       Furnishings  Tenex B1-RE Series Chair Mats for Low Pile Car…
9992            Phones                          Aastra 57i VoIP phone
9993             Paper  It's Hot Message Books with Stickers, 2 3/4" x 5"
9994        Appliances  Acco 7-Outlet Masterpiece Power Center, Wihtou…

           Sales   Quantity  Discount     Profit
Row ID
1        261.9600         2      0.00    41.9136
2        731.9400         3      0.00   219.5820
3         14.6200         2      0.00     6.8714
4        957.5775         5      0.45  -383.0310
5         22.3680         2      0.20     2.5164
...           ...       ...       ...        ...
9990      25.2480         3      0.20     4.1028
9991      91.9600         2      0.00    15.6332
9992     258.5760         2      0.20    19.3932
9993      29.6000         4      0.00    13.3200
9994     243.1600         2      0.00    72.9480

[9994 rows x 20 columns]
```

[64]: `df['Segment']`

[64]:
```
Row ID
1          Consumer
2          Consumer
3         Corporate
4          Consumer
```

```
5        Consumer
            …
9990     Consumer
9991     Consumer
9992     Consumer
9993     Consumer
9994     Consumer
Name: Segment, Length: 9994, dtype: object
```

[65]: `df.Segment`

```
[65]: Row ID
1        Consumer
2        Consumer
3        Corporate
4        Consumer
5        Consumer
            …
9990     Consumer
9991     Consumer
9992     Consumer
9993     Consumer
9994     Consumer
Name: Segment, Length: 9994, dtype: object
```

[66]: `df['Order ID']`

```
[66]: Row ID
1        CA-2013-152156
2        CA-2013-152156
3        CA-2013-138688
4        US-2012-108966
5        US-2012-108966
               …
9990     CA-2011-110422
9991     CA-2014-121258
9992     CA-2014-121258
9993     CA-2014-121258
9994     CA-2014-119914
Name: Order ID, Length: 9994, dtype: object
```

[66]:

[67]: `df[0:2]`

```
[67]:           Order ID Order Date  Ship Date    Ship Mode Customer ID  \
      Row ID
```

```
1          CA-2013-152156 2014-11-09 2014-11-12  Second Class    CG-12520
2          CA-2013-152156 2014-11-09 2014-11-12  Second Class    CG-12520

         Customer Name    Segment        Country      City      State  \
Row ID
1         Claire Gute   Consumer   United States  Henderson   Kentucky
2         Claire Gute   Consumer   United States  Henderson   Kentucky

         Postal Code Region       Product ID   Category Sub-Category  \
Row ID
1              42420   South   FUR-BO-10001798   Furniture      Bookcases
2              42420   South   FUR-CH-10000454   Furniture         Chairs

                                            Product Name   Sales  Quantity  \
Row ID
1                      Bush Somerset Collection Bookcase  261.96         2
2         Hon Deluxe Fabric Upholstered Stacking Chairs,…  731.94         3

         Discount    Profit
Row ID
1             0.0   41.9136
2             0.0  219.5820
```

[68]: `df.loc[:,'Customer ID']`

[68]:
```
Row ID
1        CG-12520
2        CG-12520
3        DV-13045
4        SO-20335
5        SO-20335
          …
9990    TB-21400
9991    DB-13060
9992    DB-13060
9993    DB-13060
9994    CC-12220
Name: Customer ID, Length: 9994, dtype: object
```

[69]: `df.iloc[:,6]`

[69]:
```
Row ID
1         Consumer
2         Consumer
3        Corporate
4         Consumer
5         Consumer
```

```
                  …
9990      Consumer
9991      Consumer
9992      Consumer
9993      Consumer
9994      Consumer
Name: Segment, Length: 9994, dtype: object
```

2.15   15. Select multiple columns

[70]: ```python
df[['Order Date','Sales']]
```

[70]: 
```
          Order Date   Sales
Row ID
1   2014-11-09   261.9600
2   2014-11-09   731.9400
3   2014-06-13   14.6200
4   2013-10-11   957.5775
5   2013-10-11   22.3680
…   …   …
9990   2012-01-22   25.2480
9991   2015-02-27   91.9600
9992   2015-02-27   258.5760
9993   2015-02-27   29.6000
9994   2015-05-05   243.1600

[9994 rows x 2 columns]
```

[71]: ```python
df.loc[:,['Order Date','Sales']]
```

[71]:
```
          Order Date      Sales
Row ID
1         2014-11-09   261.9600
2         2014-11-09   731.9400
3         2014-06-13    14.6200
4         2013-10-11   957.5775
5         2013-10-11    22.3680
…                …          …
9990      2012-01-22    25.2480
9991      2015-02-27    91.9600
9992      2015-02-27   258.5760
9993      2015-02-27    29.6000
9994      2015-05-05   243.1600

[9994 rows x 2 columns]
```

2.15.1 Select custmer-related data

```
[72]: DIM_customer = df[['Customer ID','Customer Name','Segment']]
```

```
[73]: DIM_customer
```

```
[73]:          Customer ID      Customer Name      Segment
      Row ID
      1           CG-12520        Claire Gute     Consumer
      2           CG-12520        Claire Gute     Consumer
      3           DV-13045     Darrin Van Huff    Corporate
      4           SO-20335      Sean O'Donnell     Consumer
      5           SO-20335      Sean O'Donnell     Consumer
      …               …                 …             …
      9990        TB-21400   Tom Boeckenhauer      Consumer
      9991        DB-13060         Dave Brooks      Consumer
      9992        DB-13060         Dave Brooks      Consumer
      9993        DB-13060         Dave Brooks      Consumer
      9994        CC-12220        Chris Cortes      Consumer

      [9994 rows x 3 columns]
```

```
[74]: DIM_customer = DIM_customer.drop_duplicates()
```

```
[75]: DIM_customer.shape
```

```
[75]: (793, 3)
```

2.16   16. More complex selections - .loc and .iloc

```
[76]: df.head(n=6)
```

```
[76]:             Order ID Order Date  Ship Date       Ship Mode Customer ID  \
      Row ID
      1        CA-2013-152156 2014-11-09 2014-11-12    Second Class   CG-12520
      2        CA-2013-152156 2014-11-09 2014-11-12    Second Class   CG-12520
      3        CA-2013-138688 2014-06-13 2014-06-17    Second Class   DV-13045
      4        US-2012-108966 2013-10-11 2013-10-18  Standard Class   SO-20335
      5        US-2012-108966 2013-10-11 2013-10-18  Standard Class   SO-20335
      6        CA-2011-115812 2012-06-09 2012-06-14  Standard Class   BH-11710

                 Customer Name     Segment         Country           City  \
      Row ID
      1           Claire Gute     Consumer   United States        Henderson
      2           Claire Gute     Consumer   United States        Henderson
      3        Darrin Van Huff    Corporate   United States      Los Angeles
      4         Sean O'Donnell     Consumer   United States  Fort Lauderdale
```

```
5          Sean O'Donnell    Consumer   United States   Fort Lauderdale
6          Brosina Hoffman   Consumer   United States      Los Angeles

             State  Postal Code Region      Product ID        Category  \
Row ID
1          Kentucky       42420  South  FUR-BO-10001798       Furniture
2          Kentucky       42420  South  FUR-CH-10000454       Furniture
3        California       90036   West  OFF-LA-10000240  Office Supplies
4           Florida       33311  South  FUR-TA-10000577       Furniture
5           Florida       33311  South  OFF-ST-10000760  Office Supplies
6        California       90032   West  FUR-FU-10001487       Furniture

        Sub-Category                                   Product Name  \
Row ID
1          Bookcases                  Bush Somerset Collection Bookcase
2             Chairs  Hon Deluxe Fabric Upholstered Stacking Chairs,…
3             Labels  Self-Adhesive Address Labels for Typewriters b…
4             Tables      Bretford CR4500 Series Slim Rectangular Table
5            Storage                  Eldon Fold 'N Roll Cart System
6        Furnishings  Eldon Expressions Wood and Plastic Desk Access…

          Sales  Quantity  Discount      Profit
Row ID
1        261.9600         2      0.00    41.9136
2        731.9400         3      0.00   219.5820
3         14.6200         2      0.00     6.8714
4        957.5775         5      0.45  -383.0310
5         22.3680         2      0.20     2.5164
6         48.8600         7      0.00    14.1694
```

[77]: `df.loc[[2,4,5],['Order Date','Sales']]`

```
[77]:       Order Date      Sales
      Row ID
      2      2014-11-09   731.9400
      4      2013-10-11   957.5775
      5      2013-10-11    22.3680
```

[78]: `df.iloc[[2,4,5],[0,1,2]]`

```
[78]:            Order ID Order Date  Ship Date
      Row ID
      3      CA-2013-138688 2014-06-13 2014-06-17
      5      US-2012-108966 2013-10-11 2013-10-18
      6      CA-2011-115812 2012-06-09 2012-06-14
```

[79]: `df.columns`

```
[79]: Index(['Order ID', 'Order Date', 'Ship Date', 'Ship Mode', 'Customer ID',
             'Customer Name', 'Segment', 'Country', 'City', 'State', 'Postal Code',
             'Region', 'Product ID', 'Category', 'Sub-Category', 'Product Name',
             'Sales', 'Quantity', 'Discount', 'Profit'],
            dtype='object')
```

```
[80]: pd.Series(df.columns)
```

```
[80]: 0            Order ID
      1          Order Date
      2           Ship Date
      3           Ship Mode
      4         Customer ID
      5       Customer Name
      6             Segment
      7             Country
      8                City
      9               State
      10        Postal Code
      11             Region
      12         Product ID
      13           Category
      14       Sub-Category
      15       Product Name
      16              Sales
      17           Quantity
      18           Discount
      19             Profit
      dtype: object
```

```
[81]: pd.Series(df.columns).str.contains('ID')
```

```
[81]: 0      True
      1     False
      2     False
      3     False
      4      True
      5     False
      6     False
      7     False
      8     False
      9     False
      10    False
      11    False
      12     True
      13    False
      14    False
```

```
15     False
16     False
17     False
18     False
19     False
dtype: bool
```

[82]: `df.columns[pd.Series(df.columns).str.contains('ID')]`

[82]: `Index(['Order ID', 'Customer ID', 'Product ID'], dtype='object')`

[83]: `df.columns[pd.Series(df.columns).str.endswith('ID')]`

[83]: `Index(['Order ID', 'Customer ID', 'Product ID'], dtype='object')`

[84]: `df[df.columns[pd.Series(df.columns).str.endswith('ID')]]`

```
[84]:              Order ID Customer ID      Product ID
      Row ID
      1       CA-2013-152156    CG-12520  FUR-BO-10001798
      2       CA-2013-152156    CG-12520  FUR-CH-10000454
      3       CA-2013-138688    DV-13045  OFF-LA-10000240
      4       US-2012-108966    SO-20335  FUR-TA-10000577
      5       US-2012-108966    SO-20335  OFF-ST-10000760
      ...                ...         ...              ...
      9990    CA-2011-110422    TB-21400  FUR-FU-10001889
      9991    CA-2014-121258    DB-13060  FUR-FU-10000747
      9992    CA-2014-121258    DB-13060  TEC-PH-10003645
      9993    CA-2014-121258    DB-13060  OFF-PA-10004041
      9994    CA-2014-119914    CC-12220  OFF-AP-10002684

      [9994 rows x 3 columns]
```

2.17 17. Indexing (aka filtering)

[85]: `df[0:2]`

```
[85]:              Order ID Order Date  Ship Date     Ship Mode Customer ID  \
      Row ID
      1       CA-2013-152156 2014-11-09 2014-11-12  Second Class    CG-12520
      2       CA-2013-152156 2014-11-09 2014-11-12  Second Class    CG-12520

              Customer Name   Segment        Country       City     State  \
      Row ID
      1        Claire Gute  Consumer  United States  Henderson  Kentucky
      2        Claire Gute  Consumer  United States  Henderson  Kentucky
```

```
         Postal Code Region      Product ID  Category Sub-Category  \
Row ID
1               42420  South  FUR-BO-10001798  Furniture     Bookcases
2               42420  South  FUR-CH-10000454  Furniture        Chairs

                                     Product Name   Sales  Quantity  \
Row ID
1               Bush Somerset Collection Bookcase  261.96         2
2       Hon Deluxe Fabric Upholstered Stacking Chairs,…  731.94         3

        Discount    Profit
Row ID
1            0.0   41.9136
2            0.0  219.5820
```

[86]: `df.loc[[2,4],:]`

[86]:
```
             Order ID Order Date  Ship Date       Ship Mode Customer ID  \
Row ID
2       CA-2013-152156 2014-11-09 2014-11-12    Second Class   CG-12520
4       US-2012-108966 2013-10-11 2013-10-18  Standard Class   SO-20335

         Customer Name   Segment       Country            City     State  \
Row ID
2         Claire Gute  Consumer  United States       Henderson  Kentucky
4     Sean O'Donnell  Consumer  United States  Fort Lauderdale   Florida

        Postal Code Region      Product ID  Category Sub-Category  \
Row ID
2               42420  South  FUR-CH-10000454  Furniture        Chairs
4               33311  South  FUR-TA-10000577  Furniture        Tables

                                     Product Name    Sales  Quantity  \
Row ID
2       Hon Deluxe Fabric Upholstered Stacking Chairs,…  731.9400         3
4           Bretford CR4500 Series Slim Rectangular Table  957.5775         5

        Discount    Profit
Row ID
2            0.00  219.582
4            0.45 -383.031
```

2.18 18. Boolean indexing by isin

[87]: `df['Ship Mode'].value_counts()`

```
[87]: Standard Class    5968
      Second Class      1945
      First Class       1538
      Same Day           543
      Name: Ship Mode, dtype: int64
```

```
[88]: df['Ship Mode'].isin(['First Class','Same Day'])
```

```
[88]: Row ID
      1       False
      2       False
      3       False
      4       False
      5       False
              ...
      9990    False
      9991    False
      9992    False
      9993    False
      9994    False
      Name: Ship Mode, Length: 9994, dtype: bool
```

```
[89]: df.loc[df['Ship Mode'].isin(['First Class', 'Same Day']), :]
```

```
[89]:         Order ID Order Date  Ship Date    Ship Mode Customer ID  \
      Row ID
      36    CA-2013-117590 2014-12-09 2014-12-11  First Class   GH-14485
      37    CA-2013-117590 2014-12-09 2014-12-11  First Class   GH-14485
      45    CA-2013-118255 2014-03-12 2014-03-14  First Class   ON-18715
      46    CA-2013-118255 2014-03-12 2014-03-14  First Class   ON-18715
      56    CA-2013-111682 2014-06-18 2014-06-19  First Class   TB-21055
      ...              ...        ...        ...          ...        ...
      9934  CA-2011-166555 2012-07-11 2012-07-14  First Class   JK-15205
      9962  CA-2012-168088 2013-03-19 2013-03-22  First Class   CM-12655
      9963  CA-2012-168088 2013-03-19 2013-03-22  First Class   CM-12655
      9964  CA-2012-143700 2013-07-26 2013-07-26     Same Day   AS-10240
      9982  CA-2014-163566 2015-08-04 2015-08-07  First Class   TB-21055

              Customer Name     Segment        Country         City  \
      Row ID
      36          Gene Hale   Corporate  United States    Richardson
      37          Gene Hale   Corporate  United States    Richardson
      45      Odella Nelson   Corporate  United States         Eagan
      46      Odella Nelson   Corporate  United States         Eagan
      56    Ted Butterfield    Consumer  United States          Troy
      ...               ...         ...            ...           ...
      9934      Jamie Kunitz    Consumer  United States  Niagara Falls
```

```
9962    Corinna Mitchell  Home Office  United States       Houston
9963    Corinna Mitchell  Home Office  United States       Houston
9964      Alan Shonely      Consumer  United States   Philadelphia
9982    Ted Butterfield     Consumer  United States      Fairfield


                State  Postal Code   Region      Product ID        Category  \
Row ID
36              Texas        75080  Central  TEC-PH-10004977      Technology
37              Texas        75080  Central  FUR-FU-10003664       Furniture
45          Minnesota        55122  Central  TEC-AC-10000171      Technology
46          Minnesota        55122  Central  OFF-BI-10003291  Office Supplies
56           New York        12180     East  OFF-ST-10000604  Office Supplies
…                 …            …        …                …               …
9934         New York        14304     East  TEC-PH-10004912      Technology
9962            Texas        77041  Central  OFF-PA-10000675  Office Supplies
9963            Texas        77041  Central  FUR-BO-10004218       Furniture
9964     Pennsylvania        19140     East  OFF-PA-10003072  Office Supplies
9982             Ohio        45014     East  OFF-LA-10004484  Office Supplies


        Sub-Category                                   Product Name  \
Row ID
36           Phones                                     GE 30524EE4
37       Furnishings  Electrix Architect's Clamp-On Swing Arm Lamp, …
45       Accessories  Verbatim 25 GB 6x Blu-ray Single Layer Recorda…
46           Binders  Wilson Jones Leather-Like Binders with DublLoc…
56           Storage               Home/Office Personal File Carts
…               …                                              …
9934         Phones          Cisco SPA112 2 Port Phone Adapter
9962          Paper                                     Xerox 1919
9963       Bookcases  Bush Heritage Pine Collection 5-Shelf Bookcase…
9964          Paper       Eureka Recycled Copy Paper 8 1/2" x 11", Ream
9982         Labels                                       Avery 476


           Sales  Quantity  Discount     Profit
Row ID
36     1097.5440         7      0.20   123.4737
37      190.9200         5      0.60  -147.9630
45       45.9800         2      0.00    19.7714
46       17.4600         2      0.00     8.2062
56      208.5600         6      0.00    52.1400
…            …        …         …          …
9934    164.8500         3      0.00    47.8065
9962     65.5840         2      0.20    23.7742
9963    383.4656         4      0.32   -67.6704
9964     10.3680         2      0.20     3.6288
9982     16.5200         5      0.20     5.3690
```

```
[2081 rows x 20 columns]
```

```
[90]: df[df['Ship Mode'].isin(['First Class'])]
```

```
[90]:                 Order ID Order Date  Ship Date    Ship Mode Customer ID  \
      Row ID
      36      CA-2013-117590 2014-12-09 2014-12-11  First Class    GH-14485
      37      CA-2013-117590 2014-12-09 2014-12-11  First Class    GH-14485
      45      CA-2013-118255 2014-03-12 2014-03-14  First Class    ON-18715
      46      CA-2013-118255 2014-03-12 2014-03-14  First Class    ON-18715
      56      CA-2013-111682 2014-06-18 2014-06-19  First Class    TB-21055
      ...                ...        ...        ...          ...         ...
      9928    CA-2012-159534 2013-03-20 2013-03-23  First Class    DH-13075
      9934    CA-2011-166555 2012-07-11 2012-07-14  First Class    JK-15205
      9962    CA-2012-168088 2013-03-19 2013-03-22  First Class    CM-12655
      9963    CA-2012-168088 2013-03-19 2013-03-22  First Class    CM-12655
      9982    CA-2014-163566 2015-08-04 2015-08-07  First Class    TB-21055

                Customer Name       Segment        Country           City  \
      Row ID
      36           Gene Hale    Corporate  United States      Richardson
      37           Gene Hale    Corporate  United States      Richardson
      45       Odella Nelson    Corporate  United States           Eagan
      46       Odella Nelson    Corporate  United States           Eagan
      56     Ted Butterfield     Consumer  United States            Troy
      ...               ...          ...            ...             ...
      9928     Dave Hallsten    Corporate  United States   New York City
      9934      Jamie Kunitz     Consumer  United States   Niagara Falls
      9962   Corinna Mitchell  Home Office  United States        Houston
      9963   Corinna Mitchell  Home Office  United States        Houston
      9982   Ted Butterfield     Consumer  United States       Fairfield

                 State  Postal Code   Region      Product ID        Category  \
      Row ID
      36         Texas        75080  Central  TEC-PH-10004977      Technology
      37         Texas        75080  Central  FUR-FU-10003664       Furniture
      45     Minnesota        55122  Central  TEC-AC-10000171      Technology
      46     Minnesota        55122  Central  OFF-BI-10003291  Office Supplies
      56      New York        12180     East  OFF-ST-10000604  Office Supplies
      ...          ...          ...      ...              ...             ...
      9928    New York        10035     East  OFF-ST-10001172  Office Supplies
      9934    New York        14304     East  TEC-PH-10004912      Technology
      9962       Texas        77041  Central  OFF-PA-10000675  Office Supplies
      9963       Texas        77041  Central  FUR-BO-10004218       Furniture
      9982        Ohio        45014     East  OFF-LA-10004484  Office Supplies

             Sub-Category                                       Product Name  \
      Row ID
```

```
Row ID
36           Phones                                        GE 30524EE4
37       Furnishings   Electrix Architect's Clamp-On Swing Arm Lamp, …
45       Accessories   Verbatim 25 GB 6x Blu-ray Single Layer Recorda…
46          Binders    Wilson Jones Leather-Like Binders with DublLoc…
56          Storage                        Home/Office Personal File Carts
…              …                                                    …
9928        Storage                            Tennsco Lockers, Sand
9934         Phones                    Cisco SPA112 2 Port Phone Adapter
9962          Paper                                        Xerox 1919
9963       Bookcases   Bush Heritage Pine Collection 5-Shelf Bookcase…
9982         Labels                                        Avery 476

             Sales   Quantity   Discount     Profit
Row ID
36        1097.5440         7       0.20   123.4737
37         190.9200         5       0.60  -147.9630
45          45.9800         2       0.00    19.7714
46          17.4600         2       0.00     8.2062
56         208.5600         6       0.00    52.1400
…              …        …         …         …
9928        83.9200         4       0.00    20.1408
9934       164.8500         3       0.00    47.8065
9962        65.5840         2       0.20    23.7742
9963       383.4656         4       0.32   -67.6704
9982        16.5200         5       0.20     5.3690

[1538 rows x 20 columns]
```

2.19 19. Boolean indexing by conditions

```
[91]: df['Profit']
```

```
[91]: Row ID
1          41.9136
2         219.5820
3           6.8714
4        -383.0310
5           2.5164
              …
9990        4.1028
9991       15.6332
9992       19.3932
9993       13.3200
9994       72.9480
Name: Profit, Length: 9994, dtype: float64
```

```
[92]: df['Profit'] < 0
```

```
[92]: Row ID
      1       False
      2       False
      3       False
      4        True
      5       False
              …
      9990    False
      9991    False
      9992    False
      9993    False
      9994    False
      Name: Profit, Length: 9994, dtype: bool
```

```
[93]: df[df['Profit'] < 0]
```

```
[93]:              Order ID  Order Date   Ship Date       Ship Mode Customer ID  \
      Row ID
      4      US-2012-108966  2013-10-11  2013-10-18  Standard Class    SO-20335
      15     US-2012-118983  2013-11-22  2013-11-26  Standard Class    HP-14815
      16     US-2012-118983  2013-11-22  2013-11-26  Standard Class    HP-14815
      24     US-2014-156909  2015-07-17  2015-07-19    Second Class    SF-20065
      28     US-2012-150630  2013-09-17  2013-09-21  Standard Class    TB-21520
      …                 …           …           …               …           …
      9921   CA-2013-149272  2014-03-16  2014-03-20  Standard Class    MY-18295
      9922   CA-2011-111360  2012-11-24  2012-11-30  Standard Class    AT-10435
      9932   CA-2012-104948  2013-11-13  2013-11-17  Standard Class    KH-16510
      9938   CA-2013-164889  2014-06-04  2014-06-07    Second Class    CP-12340
      9963   CA-2012-168088  2013-03-19  2013-03-22     First Class    CM-12655

               Customer Name       Segment        Country            City  \
      Row ID
      4        Sean O'Donnell      Consumer  United States  Fort Lauderdale
      15        Harold Pawlan   Home Office  United States       Fort Worth
      16        Harold Pawlan   Home Office  United States       Fort Worth
      24      Sandra Flanagan      Consumer  United States     Philadelphia
      28      Tracy Blumstein      Consumer  United States     Philadelphia
      …                  …             …            …               …
      9921   Muhammed Yedwab     Corporate  United States            Bryan
      9922        Alyssa Tate   Home Office  United States            Akron
      9932       Keith Herrera      Consumer  United States  San Bernardino
      9938       Christine Phan     Corporate  United States      Los Angeles
      9963   Corinna Mitchell   Home Office  United States          Houston

               State  Postal Code    Region      Product ID       Category  \
      Row ID
```

```
       Row ID
4           Florida         33311    South  FUR-TA-10000577        Furniture
15          Texas           76106  Central  OFF-AP-10002311  Office Supplies
16          Texas           76106  Central  OFF-BI-10000756  Office Supplies
24          Pennsylvania    19140     East  FUR-CH-10002774        Furniture
28          Pennsylvania    19140     East  FUR-BO-10004834        Furniture
...         ...             ...       ...   ...                    ...
9921        Texas           77803  Central  OFF-BI-10004233  Office Supplies
9922        Ohio            44312     East  OFF-BI-10003350  Office Supplies
9932        California      92404     West  FUR-BO-10004357        Furniture
9938        California      90049     West  FUR-TA-10001676        Furniture
9963        Texas           77041  Central  FUR-BO-10004218        Furniture

        Sub-Category                                     Product Name  \
Row ID
4             Tables      Bretford CR4500 Series Slim Rectangular Table
15        Appliances  Holmes Replacement Filter for HEPA Air Cleaner…
16           Binders    Storex DuraTech Recycled Plastic Frosted Binders
24            Chairs                  Global Deluxe Stacking Chair, Gray
28          Bookcases  Riverside Palais Royal Lawyers Bookcase, Royal…
...            ...                                              ...
9921          Binders  GBC Pre-Punched Binding Paper, Plastic, White,…
9922          Binders                  Acco Expandable Hanging Binders
9932        Bookcases    O'Sullivan Living Dimensions 3-Shelf Bookcases
9938           Tables      Hon 61000 Series Interactive Training Tables
9963        Bookcases  Bush Heritage Pine Collection 5-Shelf Bookcase…

           Sales  Quantity  Discount       Profit
Row ID
4       957.5775         5      0.45   -383.0310
15       68.8100         5      0.80   -123.8580
16        2.5440         3      0.80     -3.8160
24       71.3720         2      0.30     -1.0196
28     3083.4300         7      0.50  -1665.0522
...          ...       ...       ...          ...
9921     22.3860         7      0.80    -35.8176
9922      5.7420         3      0.70     -4.5936
9932    683.3320         4      0.15    -40.1960
9938     71.0880         2      0.20     -1.7772
9963    383.4656         4      0.32    -67.6704

[1871 rows x 20 columns]
```

```python
[94]: cond = (df['Profit'] < 0) & (df['Ship Mode'].isin(['First Class']))
      cond
```

```
[94]: Row ID
      1       False
      2       False
      3       False
      4       False
      5       False
              …
      9990    False
      9991    False
      9992    False
      9993    False
      9994    False
      Length: 9994, dtype: bool
```

```
[95]: df[cond]
```

```
[95]:              Order ID Order Date  Ship Date   Ship Mode Customer ID  \
      Row ID
      37      CA-2013-117590 2014-12-09 2014-12-11  First Class   GH-14485
      76      US-2014-118038 2015-12-10 2015-12-12  First Class   KB-16600
      77      US-2014-118038 2015-12-10 2015-12-12  First Class   KB-16600
      85      US-2014-119662 2015-11-14 2015-11-17  First Class   CS-12400
      131     US-2014-164147 2015-02-03 2015-02-06  First Class   DW-13585
      …                  …          …          …            …          …
      9877    US-2014-166324 2015-04-21 2015-04-22  First Class   BE-11455
      9878    US-2014-166324 2015-04-21 2015-04-22  First Class   BE-11455
      9879    US-2014-166324 2015-04-21 2015-04-22  First Class   BE-11455
      9913    CA-2012-132388 2013-10-10 2013-10-12  First Class   KN-16390
      9963    CA-2012-168088 2013-03-19 2013-03-22  First Class   CM-12655

                 Customer Name       Segment        Country           City  \
      Row ID
      37            Gene Hale      Corporate  United States     Richardson
      76          Ken Brennan      Corporate  United States        Houston
      77          Ken Brennan      Corporate  United States        Houston
      85     Christopher Schild  Home Office  United States        Chicago
      131        Dorothy Wardle     Corporate  United States       Columbus
      …                  …              …              …              …
      9877         Brad Eason  Home Office  United States      Cleveland
      9878         Brad Eason  Home Office  United States      Cleveland
      9879         Brad Eason  Home Office  United States      Cleveland
      9913   Katherine Nockton     Corporate  United States  Santa Barbara
      9963    Corinna Mitchell  Home Office  United States        Houston

                 State  Postal Code   Region       Product ID      Category  \
      Row ID
      37         Texas        75080  Central  FUR-FU-10003664     Furniture
```

```
76          Texas          77041   Central   OFF-BI-10004182   Office Supplies
77          Texas          77041   Central   FUR-FU-10000260        Furniture
85          Illinois       60623   Central   OFF-ST-10003656   Office Supplies
131         Ohio           43229      East   TEC-PH-10002293        Technology
...         ...            ...     ...       ...               ...
9877        Ohio           44105      East   OFF-ST-10000078   Office Supplies
9878        Ohio           44105      East   OFF-BI-10000174   Office Supplies
9879        Ohio           44105      East   TEC-PH-10004080        Technology
9913        California      93101      West   FUR-CH-10001714        Furniture
9963        Texas          77041   Central   FUR-BO-10004218        Furniture

         Sub-Category                               Product Name  \
Row ID
37          Furnishings  Electrix Architect's Clamp-On Swing Arm Lamp, …
76              Binders                                Economy Binders
77          Furnishings                      6" Cubicle Wall Clock, Black
85              Storage                Safco Industrial Wire Shelving
131              Phones  Anker 36W 4-Port USB Wall Charger Travel Power…
...              ...                                          ...
9877            Storage           Tennsco 6- and 18-Compartment Lockers
9878            Binders  Wilson Jones Clip & Carry Folder Binder Tool f…
9879             Phones                      Avaya 5410 Digital phone
9913             Chairs     Global Leather & Oak Executive Chair, Burgundy
9963          Bookcases  Bush Heritage Pine Collection 5-Shelf Bookcase…

          Sales  Quantity  Discount     Profit
Row ID
37      190.9200         5      0.60  -147.9630
76        1.2480         3      0.80    -1.9344
77        9.7080         3      0.60    -5.8248
85      230.3760         3      0.20   -48.9549
131      59.9700         5      0.40   -11.9940
...          ...       ...       ...        ...
9877    848.5440         4      0.20   -21.2136
9878      8.7000         5      0.70    -6.3800
9879    122.3820         3      0.40   -24.4764
9913    362.1360         3      0.20   -54.3204
9963    383.4656         4      0.32   -67.6704

[293 rows x 20 columns]
```

2.20   20. Add column

```
[96]: df['Unit Sales'] = df['Sales']/df['Quantity']
      df[['Product ID','Unit Sales']]
```

```
[96]:            Product ID  Unit Sales
      Row ID
      1        FUR-BO-10001798     130.9800
      2        FUR-CH-10000454     243.9800
      3        OFF-LA-10000240       7.3100
      4        FUR-TA-10000577     191.5155
      5        OFF-ST-10000760      11.1840
      ...                  ...          ...
      9990     FUR-FU-10001889       8.4160
      9991     FUR-FU-10000747      45.9800
      9992     TEC-PH-10003645     129.2880
      9993     OFF-PA-10004041       7.4000
      9994     OFF-AP-10002684     121.5800

      [9994 rows x 2 columns]
```

```
[97]:  df
```

```
[97]:             Order ID Order Date  Ship Date       Ship Mode Customer ID  \
      Row ID
      1        CA-2013-152156 2014-11-09 2014-11-12    Second Class    CG-12520
      2        CA-2013-152156 2014-11-09 2014-11-12    Second Class    CG-12520
      3        CA-2013-138688 2014-06-13 2014-06-17    Second Class    DV-13045
      4        US-2012-108966 2013-10-11 2013-10-18  Standard Class    SO-20335
      5        US-2012-108966 2013-10-11 2013-10-18  Standard Class    SO-20335
      ...                 ...        ...        ...             ...         ...
      9990     CA-2011-110422 2012-01-22 2012-01-24    Second Class    TB-21400
      9991     CA-2014-121258 2015-02-27 2015-03-04  Standard Class    DB-13060
      9992     CA-2014-121258 2015-02-27 2015-03-04  Standard Class    DB-13060
      9993     CA-2014-121258 2015-02-27 2015-03-04  Standard Class    DB-13060
      9994     CA-2014-119914 2015-05-05 2015-05-10    Second Class    CC-12220

                Customer Name     Segment        Country            City  \
      Row ID
      1           Claire Gute    Consumer  United States       Henderson
      2           Claire Gute    Consumer  United States       Henderson
      3        Darrin Van Huff   Corporate  United States     Los Angeles
      4         Sean O'Donnell    Consumer  United States  Fort Lauderdale
      5         Sean O'Donnell    Consumer  United States  Fort Lauderdale
      ...                 ...        ...           ...              ...
      9990    Tom Boeckenhauer    Consumer  United States           Miami
      9991          Dave Brooks    Consumer  United States      Costa Mesa
      9992          Dave Brooks    Consumer  United States      Costa Mesa
      9993          Dave Brooks    Consumer  United States      Costa Mesa
      9994         Chris Cortes    Consumer  United States     Westminster

                 State  Postal Code Region       Product ID        Category  \
```

```
      Row ID
      1            Kentucky        42420   South   FUR-BO-10001798          Furniture
      2            Kentucky        42420   South   FUR-CH-10000454          Furniture
      3          California        90036    West   OFF-LA-10000240   Office Supplies
      4             Florida        33311   South   FUR-TA-10000577          Furniture
      5             Florida        33311   South   OFF-ST-10000760   Office Supplies
      ...               ...          ...     ...               ...              ...
      9990          Florida        33180   South   FUR-FU-10001889          Furniture
      9991       California        92627    West   FUR-FU-10000747          Furniture
      9992       California        92627    West   TEC-PH-10003645         Technology
      9993       California        92627    West   OFF-PA-10004041   Office Supplies
      9994       California        92683    West   OFF-AP-10002684   Office Supplies

              Sub-Category                                    Product Name  \
      Row ID
      1            Bookcases               Bush Somerset Collection Bookcase
      2               Chairs   Hon Deluxe Fabric Upholstered Stacking Chairs,…
      3               Labels   Self-Adhesive Address Labels for Typewriters b…
      4               Tables         Bretford CR4500 Series Slim Rectangular Table
      5              Storage               Eldon Fold 'N Roll Cart System
      ...               ...                                             …
      9990       Furnishings                        Ultra Door Pull Handle
      9991       Furnishings   Tenex B1-RE Series Chair Mats for Low Pile Car…
      9992            Phones                        Aastra 57i VoIP phone
      9993             Paper   It's Hot Message Books with Stickers, 2 3/4" x 5"
      9994        Appliances   Acco 7-Outlet Masterpiece Power Center, Wihtou…

                 Sales   Quantity   Discount      Profit   Unit Sales
      Row ID
      1        261.9600          2       0.00     41.9136     130.9800
      2        731.9400          3       0.00    219.5820     243.9800
      3         14.6200          2       0.00      6.8714       7.3100
      4        957.5775          5       0.45   -383.0310     191.5155
      5         22.3680          2       0.20      2.5164      11.1840
      ...           ...        ...        ...         ...          ...
      9990      25.2480          3       0.20      4.1028       8.4160
      9991      91.9600          2       0.00     15.6332      45.9800
      9992     258.5760          2       0.20     19.3932     129.2880
      9993      29.6000          4       0.00     13.3200       7.4000
      9994     243.1600          2       0.00     72.9480     121.5800

      [9994 rows x 21 columns]
```

[98]:
```python
#df['Ones'] = 1
df = df.assign(Ones = 1)
```

[99]:
```python
df.head()
```

```
[99]:              Order ID Order Date   Ship Date       Ship Mode Customer ID  \
       Row ID
       1       CA-2013-152156 2014-11-09 2014-11-12    Second Class    CG-12520
       2       CA-2013-152156 2014-11-09 2014-11-12    Second Class    CG-12520
       3       CA-2013-138688 2014-06-13 2014-06-17    Second Class    DV-13045
       4       US-2012-108966 2013-10-11 2013-10-18  Standard Class    SO-20335
       5       US-2012-108966 2013-10-11 2013-10-18  Standard Class    SO-20335


                Customer Name    Segment        Country            City  \
       Row ID
       1          Claire Gute   Consumer  United States        Henderson
       2          Claire Gute   Consumer  United States        Henderson
       3       Darrin Van Huff  Corporate  United States      Los Angeles
       4       Sean O'Donnell   Consumer  United States  Fort Lauderdale
       5       Sean O'Donnell   Consumer  United States  Fort Lauderdale


                   State  Postal Code Region      Product ID        Category  \
       Row ID
       1         Kentucky        42420  South  FUR-BO-10001798       Furniture
       2         Kentucky        42420  South  FUR-CH-10000454       Furniture
       3       California        90036   West  OFF-LA-10000240  Office Supplies
       4          Florida        33311  South  FUR-TA-10000577       Furniture
       5          Florida        33311  South  OFF-ST-10000760  Office Supplies


              Sub-Category                                      Product Name  \
       Row ID
       1          Bookcases                    Bush Somerset Collection Bookcase
       2             Chairs  Hon Deluxe Fabric Upholstered Stacking Chairs,…
       3             Labels  Self-Adhesive Address Labels for Typewriters b…
       4             Tables       Bretford CR4500 Series Slim Rectangular Table
       5            Storage                    Eldon Fold 'N Roll Cart System


                  Sales  Quantity  Discount    Profit  Unit Sales  Ones
       Row ID
       1       261.9600         2      0.00   41.9136    130.9800     1
       2       731.9400         3      0.00  219.5820    243.9800     1
       3        14.6200         2      0.00    6.8714      7.3100     1
       4       957.5775         5      0.45 -383.0310    191.5155     1
       5        22.3680         2      0.20    2.5164     11.1840     1
```

[100]: `df1 = df`

[101]: `df1`

```
[101]:              Order ID Order Date   Ship Date       Ship Mode Customer ID  \
       Row ID
       1       CA-2013-152156 2014-11-09 2014-11-12    Second Class    CG-12520
```

```
2        CA-2013-152156 2014-11-09 2014-11-12    Second Class    CG-12520
3        CA-2013-138688 2014-06-13 2014-06-17    Second Class    DV-13045
4        US-2012-108966 2013-10-11 2013-10-18  Standard Class    SO-20335
5        US-2012-108966 2013-10-11 2013-10-18  Standard Class    SO-20335
...                 ...        ...        ...             ...         ...
9990     CA-2011-110422 2012-01-22 2012-01-24    Second Class    TB-21400
9991     CA-2014-121258 2015-02-27 2015-03-04  Standard Class    DB-13060
9992     CA-2014-121258 2015-02-27 2015-03-04  Standard Class    DB-13060
9993     CA-2014-121258 2015-02-27 2015-03-04  Standard Class    DB-13060
9994     CA-2014-119914 2015-05-05 2015-05-10    Second Class    CC-12220


            Customer Name     Segment        Country           City  \
Row ID
1             Claire Gute    Consumer  United States        Henderson
2             Claire Gute    Consumer  United States        Henderson
3          Darrin Van Huff   Corporate  United States     Los Angeles
4           Sean O'Donnell    Consumer  United States  Fort Lauderdale
5           Sean O'Donnell    Consumer  United States  Fort Lauderdale
...                  ...         ...            ...             ...
9990     Tom Boeckenhauer    Consumer  United States           Miami
9991          Dave Brooks    Consumer  United States       Costa Mesa
9992          Dave Brooks    Consumer  United States       Costa Mesa
9993          Dave Brooks    Consumer  United States       Costa Mesa
9994         Chris Cortes    Consumer  United States     Westminster


             State  Postal Code Region       Product ID        Category  \
Row ID
1          Kentucky        42420  South  FUR-BO-10001798       Furniture
2          Kentucky        42420  South  FUR-CH-10000454       Furniture
3        California        90036   West  OFF-LA-10000240  Office Supplies
4           Florida        33311  South  FUR-TA-10000577       Furniture
5           Florida        33311  South  OFF-ST-10000760  Office Supplies
...             ...          ...    ...              ...             ...
9990        Florida        33180  South  FUR-FU-10001889       Furniture
9991     California        92627   West  FUR-FU-10000747       Furniture
9992     California        92627   West  TEC-PH-10003645       Technology
9993     California        92627   West  OFF-PA-10004041  Office Supplies
9994     California        92683   West  OFF-AP-10002684  Office Supplies


        Sub-Category                                       Product Name  \
Row ID
1          Bookcases                  Bush Somerset Collection Bookcase
2             Chairs  Hon Deluxe Fabric Upholstered Stacking Chairs,…
3             Labels  Self-Adhesive Address Labels for Typewriters b…
4             Tables       Bretford CR4500 Series Slim Rectangular Table
5            Storage                    Eldon Fold 'N Roll Cart System
...              ...                                                …
```

```
9990      Furnishings                              Ultra Door Pull Handle
9991      Furnishings  Tenex B1-RE Series Chair Mats for Low Pile Car…
9992           Phones                                  Aastra 57i VoIP phone
9993            Paper  It's Hot Message Books with Stickers, 2 3/4" x 5"
9994       Appliances  Acco 7-Outlet Masterpiece Power Center, Wihtou…


             Sales  Quantity  Discount     Profit  Unit Sales  Ones
Row ID
1          261.9600         2      0.00    41.9136    130.9800     1
2          731.9400         3      0.00   219.5820    243.9800     1
3           14.6200         2      0.00     6.8714      7.3100     1
4          957.5775         5      0.45  -383.0310    191.5155     1
5           22.3680         2      0.20     2.5164     11.1840     1
…               …         …       …          …          …      …
9990        25.2480         3      0.20     4.1028      8.4160     1
9991        91.9600         2      0.00    15.6332     45.9800     1
9992       258.5760         2      0.20    19.3932    129.2880     1
9993        29.6000         4      0.00    13.3200      7.4000     1
9994       243.1600         2      0.00    72.9480    121.5800     1

[9994 rows x 22 columns]
```

[102]: `del df1['Ones']`

[103]: `df`

[103]:
```
               Order ID Order Date   Ship Date       Ship Mode Customer ID  \
Row ID
1      CA-2013-152156 2014-11-09  2014-11-12    Second Class     CG-12520
2      CA-2013-152156 2014-11-09  2014-11-12    Second Class     CG-12520
3      CA-2013-138688 2014-06-13  2014-06-17    Second Class     DV-13045
4      US-2012-108966 2013-10-11  2013-10-18  Standard Class     SO-20335
5      US-2012-108966 2013-10-11  2013-10-18  Standard Class     SO-20335
…                 …         …          …             …          …
9990   CA-2011-110422 2012-01-22  2012-01-24    Second Class     TB-21400
9991   CA-2014-121258 2015-02-27  2015-03-04  Standard Class     DB-13060
9992   CA-2014-121258 2015-02-27  2015-03-04  Standard Class     DB-13060
9993   CA-2014-121258 2015-02-27  2015-03-04  Standard Class     DB-13060
9994   CA-2014-119914 2015-05-05  2015-05-10    Second Class     CC-12220


           Customer Name     Segment        Country            City  \
Row ID
1            Claire Gute    Consumer  United States        Henderson
2            Claire Gute    Consumer  United States        Henderson
3         Darrin Van Huff   Corporate  United States      Los Angeles
4          Sean O'Donnell   Consumer  United States  Fort Lauderdale
5          Sean O'Donnell   Consumer  United States  Fort Lauderdale
```

```
...                           ...       ...            ...                   ...
9990      Tom Boeckenhauer    Consumer  United States            Miami
9991          Dave Brooks     Consumer  United States       Costa Mesa
9992          Dave Brooks     Consumer  United States       Costa Mesa
9993          Dave Brooks     Consumer  United States       Costa Mesa
9994          Chris Cortes    Consumer  United States      Westminster
```

```
             State  Postal Code Region     Product ID         Category  \
Row ID
1          Kentucky       42420  South  FUR-BO-10001798        Furniture
2          Kentucky       42420  South  FUR-CH-10000454        Furniture
3        California       90036   West  OFF-LA-10000240  Office Supplies
4           Florida       33311  South  FUR-TA-10000577        Furniture
5           Florida       33311  South  OFF-ST-10000760  Office Supplies
...             ...         ...    ...              ...              ...
9990        Florida       33180  South  FUR-FU-10001889        Furniture
9991     California       92627   West  FUR-FU-10000747        Furniture
9992     California       92627   West  TEC-PH-10003645       Technology
9993     California       92627   West  OFF-PA-10004041  Office Supplies
9994     California       92683   West  OFF-AP-10002684  Office Supplies
```

```
        Sub-Category                                    Product Name  \
Row ID
1          Bookcases                  Bush Somerset Collection Bookcase
2             Chairs  Hon Deluxe Fabric Upholstered Stacking Chairs,…
3             Labels  Self-Adhesive Address Labels for Typewriters b…
4             Tables       Bretford CR4500 Series Slim Rectangular Table
5            Storage                    Eldon Fold 'N Roll Cart System
...              ...                                              …
9990     Furnishings                           Ultra Door Pull Handle
9991     Furnishings  Tenex B1-RE Series Chair Mats for Low Pile Car…
9992          Phones                             Aastra 57i VoIP phone
9993           Paper  It's Hot Message Books with Stickers, 2 3/4" x 5"
9994      Appliances  Acco 7-Outlet Masterpiece Power Center, Wihtou…
```

```
          Sales  Quantity  Discount     Profit  Unit Sales
Row ID
1       261.9600         2      0.00    41.9136    130.9800
2       731.9400         3      0.00   219.5820    243.9800
3        14.6200         2      0.00     6.8714      7.3100
4       957.5775         5      0.45  -383.0310    191.5155
5        22.3680         2      0.20     2.5164     11.1840
...          ...       ...       ...        ...         ...
9990     25.2480         3      0.20     4.1028      8.4160
9991     91.9600         2      0.00    15.6332     45.9800
9992    258.5760         2      0.20    19.3932    129.2880
9993     29.6000         4      0.00    13.3200      7.4000
```

```
9994     243.1600           2      0.00    72.9480     121.5800

[9994 rows x 21 columns]
```

[104]: `df1 = df.copy()`

[105]: `del df1['Unit Sales']`

[106]: `df`

[106]:
```
              Order ID Order Date  Ship Date       Ship Mode Customer ID  \
Row ID
1       CA-2013-152156 2014-11-09 2014-11-12    Second Class    CG-12520
2       CA-2013-152156 2014-11-09 2014-11-12    Second Class    CG-12520
3       CA-2013-138688 2014-06-13 2014-06-17    Second Class    DV-13045
4       US-2012-108966 2013-10-11 2013-10-18  Standard Class    SO-20335
5       US-2012-108966 2013-10-11 2013-10-18  Standard Class    SO-20335
...                ...        ...        ...             ...         ...
9990    CA-2011-110422 2012-01-22 2012-01-24    Second Class    TB-21400
9991    CA-2014-121258 2015-02-27 2015-03-04  Standard Class    DB-13060
9992    CA-2014-121258 2015-02-27 2015-03-04  Standard Class    DB-13060
9993    CA-2014-121258 2015-02-27 2015-03-04  Standard Class    DB-13060
9994    CA-2014-119914 2015-05-05 2015-05-10    Second Class    CC-12220

           Customer Name    Segment        Country            City  \
Row ID
1            Claire Gute   Consumer  United States       Henderson
2            Claire Gute   Consumer  United States       Henderson
3         Darrin Van Huff  Corporate  United States     Los Angeles
4          Sean O'Donnell   Consumer  United States  Fort Lauderdale
5          Sean O'Donnell   Consumer  United States  Fort Lauderdale
...                   ...        ...            ...             ...
9990    Tom Boeckenhauer   Consumer  United States           Miami
9991         Dave Brooks   Consumer  United States      Costa Mesa
9992         Dave Brooks   Consumer  United States      Costa Mesa
9993         Dave Brooks   Consumer  United States      Costa Mesa
9994         Chris Cortes   Consumer  United States     Westminster

             State  Postal Code Region       Product ID         Category  \
Row ID
1         Kentucky        42420  South  FUR-BO-10001798        Furniture
2         Kentucky        42420  South  FUR-CH-10000454        Furniture
3       California        90036   West  OFF-LA-10000240  Office Supplies
4          Florida        33311  South  FUR-TA-10000577        Furniture
5          Florida        33311  South  OFF-ST-10000760  Office Supplies
...            ...          ...    ...              ...              ...
9990       Florida        33180  South  FUR-FU-10001889        Furniture
```

```
9991   California        92627   West  FUR-FU-10000747        Furniture
9992   California        92627   West  TEC-PH-10003645        Technology
9993   California        92627   West  OFF-PA-10004041  Office Supplies
9994   California        92683   West  OFF-AP-10002684  Office Supplies

          Sub-Category                                Product Name  \
Row ID
1           Bookcases                 Bush Somerset Collection Bookcase
2              Chairs  Hon Deluxe Fabric Upholstered Stacking Chairs,…
3              Labels  Self-Adhesive Address Labels for Typewriters b…
4              Tables        Bretford CR4500 Series Slim Rectangular Table
5             Storage                    Eldon Fold 'N Roll Cart System
…                 …                                             …
9990        Furnishings                         Ultra Door Pull Handle
9991        Furnishings  Tenex B1-RE Series Chair Mats for Low Pile Car…
9992             Phones                           Aastra 57i VoIP phone
9993              Paper  It's Hot Message Books with Stickers, 2 3/4" x 5"
9994         Appliances  Acco 7-Outlet Masterpiece Power Center, Wihtou…

           Sales  Quantity  Discount      Profit   Unit Sales
Row ID
1       261.9600         2      0.00     41.9136     130.9800
2       731.9400         3      0.00    219.5820     243.9800
3        14.6200         2      0.00      6.8714       7.3100
4       957.5775         5      0.45   -383.0310     191.5155
5        22.3680         2      0.20      2.5164      11.1840
…            …         …         …           …            …
9990     25.2480         3      0.20      4.1028       8.4160
9991     91.9600         2      0.00     15.6332      45.9800
9992    258.5760         2      0.20     19.3932     129.2880
9993     29.6000         4      0.00     13.3200       7.4000
9994    243.1600         2      0.00     72.9480     121.5800

[9994 rows x 21 columns]
```

2.21   21. Delete (drop) column (safely)

```
[107]:  df.drop(columns=['Unit Sales'], inplace=True)
        df.columns
```

```
[107]:  Index(['Order ID', 'Order Date', 'Ship Date', 'Ship Mode', 'Customer ID',
               'Customer Name', 'Segment', 'Country', 'City', 'State', 'Postal Code',
               'Region', 'Product ID', 'Category', 'Sub-Category', 'Product Name',
               'Sales', 'Quantity', 'Discount', 'Profit'],
             dtype='object')
```

```
[108]: df1 = df.drop(columns=['Order Date','Ship Date'])
       df1.columns
```

```
[108]: Index(['Order ID', 'Ship Mode', 'Customer ID', 'Customer Name', 'Segment',
              'Country', 'City', 'State', 'Postal Code', 'Region', 'Product ID',
              'Category', 'Sub-Category', 'Product Name', 'Sales', 'Quantity',
              'Discount', 'Profit'],
            dtype='object')
```

```
[109]: df['Ones'] = 0
```

```
[110]: df
```

```
[110]:            Order ID Order Date  Ship Date       Ship Mode Customer ID  \
       Row ID
       1       CA-2013-152156 2014-11-09 2014-11-12    Second Class    CG-12520
       2       CA-2013-152156 2014-11-09 2014-11-12    Second Class    CG-12520
       3       CA-2013-138688 2014-06-13 2014-06-17    Second Class    DV-13045
       4       US-2012-108966 2013-10-11 2013-10-18  Standard Class    SO-20335
       5       US-2012-108966 2013-10-11 2013-10-18  Standard Class    SO-20335
       ...             ...        ...        ...             ...         ...
       9990    CA-2011-110422 2012-01-22 2012-01-24    Second Class    TB-21400
       9991    CA-2014-121258 2015-02-27 2015-03-04  Standard Class    DB-13060
       9992    CA-2014-121258 2015-02-27 2015-03-04  Standard Class    DB-13060
       9993    CA-2014-121258 2015-02-27 2015-03-04  Standard Class    DB-13060
       9994    CA-2014-119914 2015-05-05 2015-05-10    Second Class    CC-12220

                 Customer Name     Segment        Country             City  \
       Row ID
       1           Claire Gute    Consumer  United States        Henderson
       2           Claire Gute    Consumer  United States        Henderson
       3       Darrin Van Huff   Corporate  United States      Los Angeles
       4         Sean O'Donnell    Consumer  United States  Fort Lauderdale
       5         Sean O'Donnell    Consumer  United States  Fort Lauderdale
       ...             ...           ...            ...              ...
       9990    Tom Boeckenhauer    Consumer  United States            Miami
       9991         Dave Brooks    Consumer  United States       Costa Mesa
       9992         Dave Brooks    Consumer  United States       Costa Mesa
       9993         Dave Brooks    Consumer  United States       Costa Mesa
       9994        Chris Cortes    Consumer  United States      Westminster

                   State  Postal Code Region       Product ID         Category  \
       Row ID
       1        Kentucky        42420  South  FUR-BO-10001798        Furniture
       2        Kentucky        42420  South  FUR-CH-10000454        Furniture
       3      California        90036   West  OFF-LA-10000240  Office Supplies
       4         Florida        33311  South  FUR-TA-10000577        Furniture
```

```
5         Florida       33311  South  OFF-ST-10000760  Office Supplies
...           ...          ...    ...              ...              ...
9990      Florida       33180  South  FUR-FU-10001889       Furniture
9991   California       92627   West  FUR-FU-10000747       Furniture
9992   California       92627   West  TEC-PH-10003645      Technology
9993   California       92627   West  OFF-PA-10004041  Office Supplies
9994   California       92683   West  OFF-AP-10002684  Office Supplies


        Sub-Category                                    Product Name  \
Row ID
1         Bookcases              Bush Somerset Collection Bookcase
2            Chairs  Hon Deluxe Fabric Upholstered Stacking Chairs,…
3            Labels  Self-Adhesive Address Labels for Typewriters b…
4            Tables      Bretford CR4500 Series Slim Rectangular Table
5           Storage                  Eldon Fold 'N Roll Cart System
...             ...                                             ...
9990     Furnishings                        Ultra Door Pull Handle
9991     Furnishings  Tenex B1-RE Series Chair Mats for Low Pile Car…
9992          Phones                            Aastra 57i VoIP phone
9993           Paper  It's Hot Message Books with Stickers, 2 3/4" x 5"
9994      Appliances  Acco 7-Outlet Masterpiece Power Center, Wihtou…


          Sales  Quantity  Discount    Profit  Ones
Row ID
1      261.9600         2      0.00   41.9136     0
2      731.9400         3      0.00  219.5820     0
3       14.6200         2      0.00    6.8714     0
4      957.5775         5      0.45 -383.0310     0
5       22.3680         2      0.20    2.5164     0
...         ...       ...       ...       ...   ...
9990    25.2480         3      0.20    4.1028     0
9991    91.9600         2      0.00   15.6332     0
9992   258.5760         2      0.20   19.3932     0
9993    29.6000         4      0.00   13.3200     0
9994   243.1600         2      0.00   72.9480     0

[9994 rows x 21 columns]
```

2.22   22. Missing data

```python
[111]: test = pd.read_csv('/content/drive/MyDrive/AIS_DG/Telco-Churn.csv')
```

```python
[112]: test.head()
```

```
[112]:   customerID  gender  SeniorCitizen Partner Dependents  tenure PhoneService  \
     0  7590-VHVEG  Female              0     Yes         No       1           No
     1  5575-GNVDE    Male              0      No         No      34          Yes
```

```
2  3668-QPYBK    Male                 0        No           No        2           Yes
3  7795-CFOCW    Male                 0        No           No       45            No
4  9237-HQITU  Female                 0        No           No        2           Yes


       MultipleLines InternetService OnlineSecurity OnlineBackup  \
0  No phone service             DSL             No          Yes
1                No             DSL            Yes           No
2                No             DSL            Yes          Yes
3  No phone service             DSL            Yes           No
4                No     Fiber optic             No           No


  DeviceProtection TechSupport StreamingTV StreamingMovies        Contract  \
0               No          No          No              No  Month-to-month
1              Yes          No          No              No        One year
2               No          No          No              No  Month-to-month
3              Yes         Yes          No              No        One year
4               No          No          No              No  Month-to-month


  PaperlessBilling             PaymentMethod  MonthlyCharges TotalCharges  \
0              Yes          Electronic check           29.85        29.85
1               No              Mailed check           56.95       1889.5
2              Yes              Mailed check           53.85       108.15
3               No  Bank transfer (automatic)          42.30      1840.75
4              Yes          Electronic check           70.70       151.65


  Churn
0    No
1    No
2   Yes
3    No
4   Yes
```

[113]: `test.info()`

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 7043 entries, 0 to 7042
Data columns (total 21 columns):
 #   Column          Non-Null Count  Dtype
---  ------          --------------  -----
 0   customerID      7043 non-null   object
 1   gender          7043 non-null   object
 2   SeniorCitizen   7043 non-null   int64
 3   Partner         7043 non-null   object
 4   Dependents      7043 non-null   object
 5   tenure          7043 non-null   int64
 6   PhoneService    7043 non-null   object
 7   MultipleLines   7043 non-null   object
```

```
 8   InternetService   7043 non-null    object
 9   OnlineSecurity    7043 non-null    object
10   OnlineBackup      7043 non-null    object
11   DeviceProtection  7043 non-null    object
12   TechSupport       7043 non-null    object
13   StreamingTV       7043 non-null    object
14   StreamingMovies   7043 non-null    object
15   Contract          7043 non-null    object
16   PaperlessBilling  7043 non-null    object
17   PaymentMethod     7043 non-null    object
18   MonthlyCharges    7043 non-null    float64
19   TotalCharges      7043 non-null    object
20   Churn             7043 non-null    object
dtypes: float64(1), int64(2), object(18)
memory usage: 1.1+ MB
```

[114]: `test['TotalCharges'].value_counts().index`

[114]:
```
Index([' ', '20.2', '19.75', '20.05', '19.9', '19.65', '45.3', '19.55',
       '20.15', '20.25',
       …
       '3306.85', '424.75', '6565.85', '2117.2', '203.95', '6849.4', '692.35',
       '130.15', '3211.9', '6844.5'],
      dtype='object', length=6531)
```

[115]: `test.isnull().any()`

[115]:
```
customerID        False
gender            False
SeniorCitizen     False
Partner           False
Dependents        False
tenure            False
PhoneService      False
MultipleLines     False
InternetService   False
OnlineSecurity    False
OnlineBackup      False
DeviceProtection  False
TechSupport       False
StreamingTV       False
StreamingMovies   False
Contract          False
PaperlessBilling  False
PaymentMethod     False
MonthlyCharges    False
TotalCharges      False
```

```
Churn               False
dtype: bool
```

[116]:
```
churnData = pd.read_csv('/content/drive/MyDrive/AIS_DG/Telco-Churn.
↪csv',na_values=' ')
```

[117]:
```
churnData.isna().any()
```

[117]:
```
customerID          False
gender              False
SeniorCitizen       False
Partner             False
Dependents          False
tenure              False
PhoneService        False
MultipleLines       False
InternetService     False
OnlineSecurity      False
OnlineBackup        False
DeviceProtection    False
TechSupport         False
StreamingTV         False
StreamingMovies     False
Contract            False
PaperlessBilling    False
PaymentMethod       False
MonthlyCharges      False
TotalCharges         True
Churn               False
dtype: bool
```

[118]:
```
churnData['TotalCharges'].isna()
```

[118]:
```
0       False
1       False
2       False
3       False
4       False
        ...
7038    False
7039    False
7040    False
7041    False
7042    False
Name: TotalCharges, Length: 7043, dtype: bool
```

[119]:
```
churnData.head()
```

```
[119]:      customerID  gender  SeniorCitizen Partner Dependents  tenure PhoneService  \
      0  7590-VHVEG  Female              0     Yes         No       1           No
      1  5575-GNVDE    Male              0      No         No      34          Yes
      2  3668-QPYBK    Male              0      No         No       2          Yes
      3  7795-CFOCW    Male              0      No         No      45           No
      4  9237-HQITU  Female              0      No         No       2          Yes

           MultipleLines InternetService OnlineSecurity OnlineBackup  \
      0  No phone service             DSL             No          Yes
      1                No             DSL            Yes           No
      2                No             DSL            Yes          Yes
      3  No phone service             DSL            Yes           No
      4                No     Fiber optic             No           No

        DeviceProtection TechSupport StreamingTV StreamingMovies         Contract  \
      0               No          No          No              No  Month-to-month
      1              Yes          No          No              No        One year
      2               No          No          No              No  Month-to-month
      3              Yes         Yes          No              No        One year
      4               No          No          No              No  Month-to-month

        PaperlessBilling              PaymentMethod  MonthlyCharges  TotalCharges  \
      0              Yes           Electronic check           29.85         29.85
      1               No               Mailed check           56.95       1889.50
      2              Yes               Mailed check           53.85        108.15
      3               No  Bank transfer (automatic)           42.30       1840.75
      4              Yes           Electronic check           70.70        151.65

        Churn
      0    No
      1    No
      2   Yes
      3    No
      4   Yes

[120]: churnData[churnData['TotalCharges'].isna()]

[120]:       customerID  gender  SeniorCitizen Partner Dependents  tenure  \
      488   4472-LVYGI  Female              0     Yes        Yes       0
      753   3115-CZMZD    Male              0      No        Yes       0
      936   5709-LVOEQ  Female              0     Yes        Yes       0
      1082  4367-NUYAO    Male              0     Yes        Yes       0
      1340  1371-DWPAZ  Female              0     Yes        Yes       0
      3331  7644-OMVMY    Male              0     Yes        Yes       0
      3826  3213-VVOLG    Male              0     Yes        Yes       0
      4380  2520-SGTTA  Female              0     Yes        Yes       0
      5218  2923-ARZLG    Male              0     Yes        Yes       0
```

```
6670  4075-WKNIU  Female              0    Yes      Yes      0
6754  2775-SEFEE  Male                0    No       Yes      0
```

	PhoneService	MultipleLines	InternetService	OnlineSecurity
488	No	No phone service	DSL	Yes
753	Yes	No	No	No internet service
936	Yes	No	DSL	Yes
1082	Yes	Yes	No	No internet service
1340	No	No phone service	DSL	Yes
3331	Yes	No	No	No internet service
3826	Yes	Yes	No	No internet service
4380	Yes	No	No	No internet service
5218	Yes	No	No	No internet service
6670	Yes	Yes	DSL	No
6754	Yes	Yes	DSL	Yes

	OnlineBackup	DeviceProtection	TechSupport
488	No	Yes	Yes
753	No internet service	No internet service	No internet service
936	Yes	Yes	No
1082	No internet service	No internet service	No internet service
1340	Yes	Yes	Yes
3331	No internet service	No internet service	No internet service
3826	No internet service	No internet service	No internet service
4380	No internet service	No internet service	No internet service
5218	No internet service	No internet service	No internet service
6670	Yes	Yes	Yes
6754	Yes	No	Yes

	StreamingTV	StreamingMovies	Contract	PaperlessBilling
488	Yes	No	Two year	Yes
753	No internet service	No internet service	Two year	No
936	Yes	Yes	Two year	No
1082	No internet service	No internet service	Two year	No
1340	Yes	No	Two year	No
3331	No internet service	No internet service	Two year	No
3826	No internet service	No internet service	Two year	No
4380	No internet service	No internet service	Two year	No
5218	No internet service	No internet service	One year	Yes
6670	Yes	No	Two year	No
6754	No	No	Two year	Yes

	PaymentMethod	MonthlyCharges	TotalCharges	Churn
488	Bank transfer (automatic)	52.55	NaN	No
753	Mailed check	20.25	NaN	No
936	Mailed check	80.85	NaN	No
1082	Mailed check	25.75	NaN	No

```
1340        Credit card (automatic)         56.05            NaN    No
3331                  Mailed check          19.85            NaN    No
3826                  Mailed check          25.35            NaN    No
4380                  Mailed check          20.00            NaN    No
5218                  Mailed check          19.70            NaN    No
6670                  Mailed check          73.35            NaN    No
6754  Bank transfer (automatic)             61.90            NaN    No
```

[121]: `churnData[churnData['tenure'] == 0]`

[121]:
```
        customerID  gender  SeniorCitizen Partner Dependents  tenure  \
488      4472-LVYGI  Female              0     Yes        Yes       0
753      3115-CZMZD    Male              0      No        Yes       0
936      5709-LVOEQ  Female              0     Yes        Yes       0
1082     4367-NUYAO    Male              0     Yes        Yes       0
1340     1371-DWPAZ  Female              0     Yes        Yes       0
3331     7644-OMVMY    Male              0     Yes        Yes       0
3826     3213-VVOLG    Male              0     Yes        Yes       0
4380     2520-SGTTA  Female              0     Yes        Yes       0
5218     2923-ARZLG    Male              0     Yes        Yes       0
6670     4075-WKNIU  Female              0     Yes        Yes       0
6754     2775-SEFEE    Male              0      No        Yes       0

        PhoneService     MultipleLines InternetService     OnlineSecurity  \
488               No  No phone service             DSL                Yes
753              Yes                No              No  No internet service
936              Yes                No             DSL                Yes
1082             Yes               Yes              No  No internet service
1340              No  No phone service             DSL                Yes
3331             Yes                No              No  No internet service
3826             Yes               Yes              No  No internet service
4380             Yes                No              No  No internet service
5218             Yes                No              No  No internet service
6670             Yes               Yes             DSL                 No
6754             Yes               Yes             DSL                Yes

              OnlineBackup      DeviceProtection         TechSupport  \
488                     No                   Yes                 Yes
753   No internet service   No internet service  No internet service
936                    Yes                   Yes                  No
1082  No internet service   No internet service  No internet service
1340                   Yes                   Yes                 Yes
3331  No internet service   No internet service  No internet service
3826  No internet service   No internet service  No internet service
4380  No internet service   No internet service  No internet service
5218  No internet service   No internet service  No internet service
6670                   Yes                   Yes                 Yes
```

```
6754                    Yes                    No                    Yes

              StreamingTV      StreamingMovies  Contract PaperlessBilling  \
488                   Yes                   No  Two year              Yes
753   No internet service  No internet service  Two year               No
936                   Yes                  Yes  Two year               No
1082  No internet service  No internet service  Two year               No
1340                  Yes                   No  Two year               No
3331  No internet service  No internet service  Two year               No
3826  No internet service  No internet service  Two year               No
4380  No internet service  No internet service  Two year               No
5218  No internet service  No internet service  One year              Yes
6670                  Yes                   No  Two year               No
6754                   No                   No  Two year              Yes

                 PaymentMethod  MonthlyCharges  TotalCharges Churn
488   Bank transfer (automatic)           52.55           NaN    No
753               Mailed check           20.25           NaN    No
936               Mailed check           80.85           NaN    No
1082              Mailed check           25.75           NaN    No
1340    Credit card (automatic)           56.05           NaN    No
3331              Mailed check           19.85           NaN    No
3826              Mailed check           25.35           NaN    No
4380              Mailed check           20.00           NaN    No
5218              Mailed check           19.70           NaN    No
6670              Mailed check           73.35           NaN    No
6754  Bank transfer (automatic)           61.90           NaN    No
```

2.23 23. Removing missing data rows

[122]: `churnData.shape`

[122]: (7043, 21)

[123]:
```
churnData_1 = churnData.dropna(how='any')
churnData_1.shape
```

[123]: (7032, 21)

[124]: `churnData_1.isnull().any()`

[124]:
```
customerID        False
gender            False
SeniorCitizen     False
Partner           False
Dependents        False
tenure            False
```

```
PhoneService        False
MultipleLines       False
InternetService     False
OnlineSecurity      False
OnlineBackup        False
DeviceProtection    False
TechSupport         False
StreamingTV         False
StreamingMovies     False
Contract            False
PaperlessBilling    False
PaymentMethod       False
MonthlyCharges      False
TotalCharges        False
Churn               False
dtype: bool
```

2.24 24. Filling missing data: investigate

```
[125]: churnData.isnull()
```

```
[125]:        customerID  gender  SeniorCitizen  Partner  Dependents  tenure  \
       0           False   False          False    False       False   False
       1           False   False          False    False       False   False
       2           False   False          False    False       False   False
       3           False   False          False    False       False   False
       4           False   False          False    False       False   False
       ...           ...     ...            ...      ...         ...     ...
       7038        False   False          False    False       False   False
       7039        False   False          False    False       False   False
       7040        False   False          False    False       False   False
       7041        False   False          False    False       False   False
       7042        False   False          False    False       False   False

              PhoneService  MultipleLines  InternetService  OnlineSecurity  \
       0             False          False            False           False
       1             False          False            False           False
       2             False          False            False           False
       3             False          False            False           False
       4             False          False            False           False
       ...             ...            ...              ...             ...
       7038          False          False            False           False
       7039          False          False            False           False
       7040          False          False            False           False
       7041          False          False            False           False
       7042          False          False            False           False
```

```
       OnlineBackup  DeviceProtection  TechSupport  StreamingTV  \
0             False             False        False        False
1             False             False        False        False
2             False             False        False        False
3             False             False        False        False
4             False             False        False        False
...             ...               ...          ...          ...
7038          False             False        False        False
7039          False             False        False        False
7040          False             False        False        False
7041          False             False        False        False
7042          False             False        False        False

       StreamingMovies  Contract  PaperlessBilling  PaymentMethod  \
0                False     False             False          False
1                False     False             False          False
2                False     False             False          False
3                False     False             False          False
4                False     False             False          False
...                ...       ...               ...            ...
7038             False     False             False          False
7039             False     False             False          False
7040             False     False             False          False
7041             False     False             False          False
7042             False     False             False          False

       MonthlyCharges  TotalCharges  Churn
0               False         False  False
1               False         False  False
2               False         False  False
3               False         False  False
4               False         False  False
...               ...           ...    ...
7038            False         False  False
7039            False         False  False
7040            False         False  False
7041            False         False  False
7042            False         False  False

[7043 rows x 21 columns]
```

[126]: `churnData.isnull().any()`

[126]:
```
customerID        False
gender            False
SeniorCitizen     False
Partner           False
```

```
Dependents          False
tenure              False
PhoneService        False
MultipleLines       False
InternetService     False
OnlineSecurity      False
OnlineBackup        False
DeviceProtection    False
TechSupport         False
StreamingTV         False
StreamingMovies     False
Contract            False
PaperlessBilling    False
PaymentMethod       False
MonthlyCharges      False
TotalCharges         True
Churn               False
dtype: bool
```

[127]: `churnData[churnData['TotalCharges'].isnull()]`

[127]:
```
      customerID  gender  SeniorCitizen Partner Dependents  tenure  \
488   4472-LVYGI  Female              0     Yes        Yes       0
753   3115-CZMZD    Male              0      No        Yes       0
936   5709-LVOEQ  Female              0     Yes        Yes       0
1082  4367-NUYAO    Male              0     Yes        Yes       0
1340  1371-DWPAZ  Female              0     Yes        Yes       0
3331  7644-OMVMY    Male              0     Yes        Yes       0
3826  3213-VVOLG    Male              0     Yes        Yes       0
4380  2520-SGTTA  Female              0     Yes        Yes       0
5218  2923-ARZLG    Male              0     Yes        Yes       0
6670  4075-WKNIU  Female              0     Yes        Yes       0
6754  2775-SEFEE    Male              0      No        Yes       0

     PhoneService       MultipleLines InternetService       OnlineSecurity  \
488            No  No phone service             DSL                  Yes
753           Yes                No              No  No internet service
936           Yes                No             DSL                  Yes
1082          Yes               Yes              No  No internet service
1340           No  No phone service             DSL                  Yes
3331          Yes                No              No  No internet service
3826          Yes               Yes              No  No internet service
4380          Yes                No              No  No internet service
5218          Yes                No              No  No internet service
6670          Yes               Yes             DSL                   No
6754          Yes               Yes             DSL                  Yes
```

```
        OnlineBackup    DeviceProtection       TechSupport  \
488                 No               Yes               Yes
753  No internet service  No internet service  No internet service
936                Yes               Yes                No
1082  No internet service  No internet service  No internet service
1340               Yes               Yes               Yes
3331  No internet service  No internet service  No internet service
3826  No internet service  No internet service  No internet service
4380  No internet service  No internet service  No internet service
5218  No internet service  No internet service  No internet service
6670               Yes               Yes               Yes
6754               Yes                No               Yes

          StreamingTV     StreamingMovies  Contract PaperlessBilling  \
488               Yes                 No  Two year              Yes
753  No internet service  No internet service  Two year               No
936               Yes                Yes  Two year               No
1082  No internet service  No internet service  Two year               No
1340               Yes                 No  Two year               No
3331  No internet service  No internet service  Two year               No
3826  No internet service  No internet service  Two year               No
4380  No internet service  No internet service  Two year               No
5218  No internet service  No internet service  One year              Yes
6670               Yes                 No  Two year               No
6754                No                 No  Two year              Yes

                PaymentMethod  MonthlyCharges  TotalCharges Churn
488   Bank transfer (automatic)           52.55           NaN    No
753                Mailed check           20.25           NaN    No
936                Mailed check           80.85           NaN    No
1082               Mailed check           25.75           NaN    No
1340   Credit card (automatic)           56.05           NaN    No
3331               Mailed check           19.85           NaN    No
3826               Mailed check           25.35           NaN    No
4380               Mailed check           20.00           NaN    No
5218               Mailed check           19.70           NaN    No
6670               Mailed check           73.35           NaN    No
6754  Bank transfer (automatic)           61.90           NaN    No
```

2.25 25. Filling missing data: fillna

```
[128]: churnData.dropna().isna().any()
```

```
[128]: customerID        False
       gender            False
       SeniorCitizen     False
       Partner           False
```

```
Dependents          False
tenure              False
PhoneService        False
MultipleLines       False
InternetService     False
OnlineSecurity      False
OnlineBackup        False
DeviceProtection    False
TechSupport         False
StreamingTV         False
StreamingMovies     False
Contract            False
PaperlessBilling    False
PaymentMethod       False
MonthlyCharges      False
TotalCharges        False
Churn               False
dtype: bool
```

[129]:
```python
churnData_2 = churnData.fillna(value={'TotalCharges':0, 'tenure':0})
churnData_2.isnull().any()
```

[129]:
```
customerID          False
gender              False
SeniorCitizen       False
Partner             False
Dependents          False
tenure              False
PhoneService        False
MultipleLines       False
InternetService     False
OnlineSecurity      False
OnlineBackup        False
DeviceProtection    False
TechSupport         False
StreamingTV         False
StreamingMovies     False
Contract            False
PaperlessBilling    False
PaymentMethod       False
MonthlyCharges      False
TotalCharges        False
Churn               False
dtype: bool
```

2.26 26. Statistical operations

```
[130]: churnData.mean()
```

<ipython-input-130-cccca424e68e>:1: FutureWarning: The default value of
numeric_only in DataFrame.mean is deprecated. In a future version, it will
default to False. In addition, specifying 'numeric_only=None' is deprecated.
Select only valid columns or specify the value of numeric_only to silence this
warning.
  churnData.mean()

```
[130]: SeniorCitizen         0.162147
       tenure               32.371149
       MonthlyCharges       64.761692
       TotalCharges       2283.300441
       dtype: float64
```

```
[131]: churnData.std()
```

<ipython-input-131-efd5c85dfcbf>:1: FutureWarning: The default value of
numeric_only in DataFrame.std is deprecated. In a future version, it will
default to False. In addition, specifying 'numeric_only=None' is deprecated.
Select only valid columns or specify the value of numeric_only to silence this
warning.
  churnData.std()

```
[131]: SeniorCitizen         0.368612
       tenure               24.559481
       MonthlyCharges       30.090047
       TotalCharges       2266.771362
       dtype: float64
```

```
[132]: churnData.median()
```

<ipython-input-132-61ddd473a11a>:1: FutureWarning: The default value of
numeric_only in DataFrame.median is deprecated. In a future version, it will
default to False. In addition, specifying 'numeric_only=None' is deprecated.
Select only valid columns or specify the value of numeric_only to silence this
warning.
  churnData.median()

```
[132]: SeniorCitizen         0.000
       tenure               29.000
       MonthlyCharges       70.350
       TotalCharges       1397.475
       dtype: float64
```

```
[133]: churnData.quantile([0.1,0.9,0.99,1])
```

```
<ipython-input-133-48bfe3edbd92>:1: FutureWarning: The default value of
numeric_only in DataFrame.quantile is deprecated. In a future version, it will
default to False. Select only valid columns or specify the value of numeric_only
to silence this warning.
  churnData.quantile([0.1,0.9,0.99,1])
```

[133]:
	SeniorCitizen	tenure	MonthlyCharges	TotalCharges
0.10	0.0	2.0	20.050	84.600
0.90	1.0	69.0	102.600	5976.640
0.99	1.0	72.0	114.729	8039.883
1.00	1.0	72.0	118.750	8684.800

2.27 27. Apply

[134]:
```
churnData.select_dtypes('object')
```

[134]:
	customerID	gender	Partner	Dependents	PhoneService	MultipleLines	\
0	7590-VHVEG	Female	Yes	No	No	No phone service	
1	5575-GNVDE	Male	No	No	Yes	No	
2	3668-QPYBK	Male	No	No	Yes	No	
3	7795-CFOCW	Male	No	No	No	No phone service	
4	9237-HQITU	Female	No	No	Yes	No	
...	...	...	...	...	...	...	
7038	6840-RESVB	Male	Yes	Yes	Yes	Yes	
7039	2234-XADUH	Female	Yes	Yes	Yes	Yes	
7040	4801-JZAZL	Female	Yes	Yes	No	No phone service	
7041	8361-LTMKD	Male	Yes	No	Yes	Yes	
7042	3186-AJIEK	Male	No	No	Yes	No	

	InternetService	OnlineSecurity	OnlineBackup	DeviceProtection	TechSupport	\
0	DSL	No	Yes	No	No	
1	DSL	Yes	No	Yes	No	
2	DSL	Yes	Yes	No	No	
3	DSL	Yes	No	Yes	Yes	
4	Fiber optic	No	No	No	No	
...	...	...	...	...	...	
7038	DSL	Yes	No	Yes	Yes	
7039	Fiber optic	No	Yes	Yes	No	
7040	DSL	Yes	No	No	No	
7041	Fiber optic	No	No	No	No	
7042	Fiber optic	Yes	No	Yes	Yes	

	StreamingTV	StreamingMovies	Contract	PaperlessBilling	\
0	No	No	Month-to-month	Yes	
1	No	No	One year	No	
2	No	No	Month-to-month	Yes	
3	No	No	One year	No	
```

```
4              No          No  Month-to-month              Yes
...            ...         ...             ...             ...
7038           Yes         Yes        One year             Yes
7039           Yes         Yes        One year             Yes
7040           No          No  Month-to-month              Yes
7041           No          No  Month-to-month              Yes
7042           Yes         Yes        Two year             Yes

                PaymentMethod Churn
0              Electronic check    No
1                  Mailed check    No
2                  Mailed check   Yes
3      Bank transfer (automatic)    No
4              Electronic check   Yes
...                         ...   ...
7038               Mailed check    No
7039     Credit card (automatic)    No
7040           Electronic check    No
7041               Mailed check   Yes
7042   Bank transfer (automatic)    No

[7043 rows x 17 columns]
```

[135]: `churnData._get_numeric_data()`

[135]:
```
      SeniorCitizen  tenure  MonthlyCharges  TotalCharges
0                 0       1           29.85         29.85
1                 0      34           56.95       1889.50
2                 0       2           53.85        108.15
3                 0      45           42.30       1840.75
4                 0       2           70.70        151.65
...             ...     ...             ...           ...
7038              0      24           84.80       1990.50
7039              0      72          103.20       7362.90
7040              0      11           29.60        346.45
7041              1       4           74.40        306.60
7042              0      66          105.65       6844.50

[7043 rows x 4 columns]
```

[136]: `churnData['tenure']/churnData['tenure'].max()`

[136]:
```
0        0.013889
1        0.472222
2        0.027778
3        0.625000
4        0.027778
```

```
        …
7038    0.333333
7039    1.000000
7040    0.152778
7041    0.055556
7042    0.916667
Name: tenure, Length: 7043, dtype: float64
```

[137]: `df.select_dtypes('datetime64[ns]')`

[137]:
```
        Order Date  Ship Date
Row ID
1       2014-11-09 2014-11-12
2       2014-11-09 2014-11-12
3       2014-06-13 2014-06-17
4       2013-10-11 2013-10-18
5       2013-10-11 2013-10-18
…              …          …
9990    2012-01-22 2012-01-24
9991    2015-02-27 2015-03-04
9992    2015-02-27 2015-03-04
9993    2015-02-27 2015-03-04
9994    2015-05-05 2015-05-10

[9994 rows x 2 columns]
```

[138]:
```
churnData_num = churnData._get_numeric_data()
churnData_num.apply(lambda x:x/x.max())
```

[138]:
```
      SeniorCitizen    tenure  MonthlyCharges  TotalCharges
0               0.0  0.013889        0.251368      0.003437
1               0.0  0.472222        0.479579      0.217564
2               0.0  0.027778        0.453474      0.012453
3               0.0  0.625000        0.356211      0.211951
4               0.0  0.027778        0.595368      0.017462
…                 …         …               …             …
7038            0.0  0.333333        0.714105      0.229194
7039            0.0  1.000000        0.869053      0.847792
7040            0.0  0.152778        0.249263      0.039892
7041            1.0  0.055556        0.626526      0.035303
7042            0.0  0.916667        0.889684      0.788101

[7043 rows x 4 columns]
```

2.28 28. Transform

```
[139]: x = churnData.transform({'TotalCharges':[np.log, lambda x: x+1],
                             'PaperlessBilling':lambda x: 1 if x=='Yes' else 0})
       x.columns = ['TotalCharge_Log','PlusOne','PaperLess']
       x
```

```
[139]:       TotalCharge_Log  PlusOne  PaperLess
       0            3.396185    30.85          1
       1            7.544068  1890.50          0
       2            4.683519   109.15          1
       3            7.517928  1841.75          0
       4            5.021575   152.65          1
       ...               ...      ...        ...
       7038         7.596141  1991.50          1
       7039         8.904209  7363.90          1
       7040         5.847739   347.45          1
       7041         5.725544   307.60          1
       7042         8.831201  6845.50          1

       [7043 rows x 3 columns]
```

2.29 29. Concatenate

```
[140]: churnData['customerID']
```

```
[140]: 0          7590-VHVEG
       1          5575-GNVDE
       2          3668-QPYBK
       3          7795-CFOCW
       4          9237-HQITU
                     ...
       7038       6840-RESVB
       7039       2234-XADUH
       7040       4801-JZAZL
       7041       8361-LTMKD
       7042       3186-AJIEK
       Name: customerID, Length: 7043, dtype: object
```

```
[141]: churnData[['TotalCharges', 'MonthlyCharges']]
```

```
[141]:       TotalCharges  MonthlyCharges
       0            29.85           29.85
       1          1889.50           56.95
       2           108.15           53.85
       3          1840.75           42.30
       4           151.65           70.70
```

```
...             ...              ...
7038        1990.50            84.80
7039        7362.90           103.20
7040         346.45            29.60
7041         306.60            74.40
7042        6844.50           105.65

[7043 rows x 2 columns]
```

[142]:
```python
pd.concat([churnData['customerID'][1:7040],
          churnData[['TotalCharges', 'MonthlyCharges']]],
         axis = 1)
```

[142]:
```
      customerID  TotalCharges  MonthlyCharges
1     5575-GNVDE       1889.50           56.95
2     3668-QPYBK        108.15           53.85
3     7795-CFOCW       1840.75           42.30
4     9237-HQITU        151.65           70.70
5     9305-CDSKC        820.50           99.65
...          ...           ...             ...
7039  2234-XADUH       7362.90          103.20
0            NaN         29.85           29.85
7040         NaN        346.45           29.60
7041         NaN        306.60           74.40
7042         NaN       6844.50          105.65

[7043 rows x 3 columns]
```

[143]:
```python
churnData.iloc[0:4,:]
```

[143]:
```
   customerID  gender  SeniorCitizen Partner Dependents  tenure PhoneService  \
0  7590-VHVEG  Female              0     Yes         No       1           No
1  5575-GNVDE    Male              0      No         No      34          Yes
2  3668-QPYBK    Male              0      No         No       2          Yes
3  7795-CFOCW    Male              0      No         No      45           No

      MultipleLines InternetService OnlineSecurity OnlineBackup  \
0  No phone service             DSL             No          Yes
1                No             DSL            Yes           No
2                No             DSL            Yes          Yes
3  No phone service             DSL            Yes           No

  DeviceProtection TechSupport StreamingTV StreamingMovies        Contract  \
0               No          No          No              No  Month-to-month
1              Yes          No          No              No        One year
2               No          No          No              No  Month-to-month
3              Yes         Yes          No              No        One year
```

```
      PaperlessBilling                 PaymentMethod  MonthlyCharges  TotalCharges  \
0                Yes              Electronic check           29.85         29.85
1                 No                 Mailed check           56.95       1889.50
2                Yes                 Mailed check           53.85        108.15
3                 No   Bank transfer (automatic)           42.30       1840.75

     Churn
0      No
1      No
2     Yes
3      No
```

[144]: `pd.concat([churnData.head().drop(columns='customerID'),churnData.tail()],axis=0)`

[144]:
```
        gender  SeniorCitizen Partner Dependents  tenure PhoneService  \
0       Female              0     Yes         No       1           No
1         Male              0      No         No      34          Yes
2         Male              0      No         No       2          Yes
3         Male              0      No         No      45           No
4       Female              0      No         No       2          Yes
7038      Male              0     Yes        Yes      24          Yes
7039    Female              0     Yes        Yes      72          Yes
7040    Female              0     Yes        Yes      11           No
7041      Male              1     Yes         No       4          Yes
7042      Male              0      No         No      66          Yes


         MultipleLines InternetService OnlineSecurity OnlineBackup  \
0     No phone service             DSL             No          Yes
1                   No             DSL            Yes           No
2                   No             DSL            Yes          Yes
3     No phone service             DSL            Yes           No
4                   No     Fiber optic             No           No
7038               Yes             DSL            Yes           No
7039               Yes     Fiber optic             No          Yes
7040  No phone service             DSL            Yes           No
7041               Yes     Fiber optic             No           No
7042                No     Fiber optic            Yes           No


      DeviceProtection TechSupport StreamingTV StreamingMovies         Contract  \
0                   No          No          No              No  Month-to-month
1                  Yes          No          No              No        One year
2                   No          No          No              No  Month-to-month
3                  Yes         Yes          No              No        One year
4                   No          No          No              No  Month-to-month
7038               Yes         Yes         Yes             Yes        One year
7039               Yes          No         Yes             Yes        One year
```

```
7040             No      No      No         No  Month-to-month
7041             No      No      No         No  Month-to-month
7042            Yes     Yes     Yes        Yes        Two year

      PaperlessBilling        PaymentMethod  MonthlyCharges  \
0                 Yes       Electronic check           29.85
1                  No          Mailed check           56.95
2                 Yes          Mailed check           53.85
3                  No  Bank transfer (automatic)       42.30
4                 Yes       Electronic check           70.70
7038              Yes          Mailed check           84.80
7039              Yes  Credit card (automatic)        103.20
7040              Yes       Electronic check           29.60
7041              Yes          Mailed check           74.40
7042              Yes  Bank transfer (automatic)      105.65

      TotalCharges Churn   customerID
0            29.85    No          NaN
1          1889.50    No          NaN
2           108.15   Yes          NaN
3          1840.75    No          NaN
4           151.65   Yes          NaN
7038       1990.50    No   6840-RESVB
7039       7362.90    No   2234-XADUH
7040        346.45    No   4801-JZAZL
7041        306.60   Yes   8361-LTMKD
7042       6844.50    No   3186-AJIEK
```

2.30 30. Join (merge)

```python
import pandas as pd
flights = pd.read_csv('/content/drive/MyDrive/AIS_DG/Flight_flights.csv',
 ↪index_col=0)
airlines = pd.read_csv('/content/drive/MyDrive/AIS_DG/Flight_airlines.csv',
 ↪index_col = 0)
```

```python
flights
```

```
[146]:       year  month  day  dep_time  sched_dep_time  dep_delay  arr_time  \
      1      2013      1    1     517.0             515        2.0     830.0
      2      2013      1    1     533.0             529        4.0     850.0
      3      2013      1    1     542.0             540        2.0     923.0
      4      2013      1    1     544.0             545       -1.0    1004.0
      5      2013      1    1     554.0             600       -6.0     812.0
      ...     ...    ...  ...       ...             ...        ...       ...
      336772 2013      9   30       NaN            1455        NaN       NaN
```

```
336773  2013       9    30       NaN         2200      NaN       NaN
336774  2013       9    30       NaN         1210      NaN       NaN
336775  2013       9    30       NaN         1159      NaN       NaN
336776  2013       9    30       NaN          840      NaN       NaN

        sched_arr_time  arr_delay carrier  flight tailnum origin dest  \
1                  819       11.0      UA    1545  N14228    EWR  IAH
2                  830       20.0      UA    1714  N24211    LGA  IAH
3                  850       33.0      AA    1141  N619AA    JFK  MIA
4                 1022      -18.0      B6     725  N804JB    JFK  BQN
5                  837      -25.0      DL     461  N668DN    LGA  ATL
...                ...        ...     ...     ...     ...    ...  ...
336772            1634        NaN      9E    3393     NaN    JFK  DCA
336773            2312        NaN      9E    3525     NaN    LGA  SYR
336774            1330        NaN      MQ    3461  N535MQ    LGA  BNA
336775            1344        NaN      MQ    3572  N511MQ    LGA  CLE
336776            1020        NaN      MQ    3531  N839MQ    LGA  RDU

        air_time  distance  hour  minute          time_hour
1          227.0      1400     5      15  2013-01-01 05:00:00
2          227.0      1416     5      29  2013-01-01 05:00:00
3          160.0      1089     5      40  2013-01-01 05:00:00
4          183.0      1576     5      45  2013-01-01 05:00:00
5          116.0       762     6       0  2013-01-01 06:00:00
...          ...       ...   ...     ...                  ...
336772       NaN       213    14      55  2013-09-30 14:00:00
336773       NaN       198    22       0  2013-09-30 22:00:00
336774       NaN       764    12      10  2013-09-30 12:00:00
336775       NaN       419    11      59  2013-09-30 11:00:00
336776       NaN       431     8      40  2013-09-30 08:00:00

[336776 rows x 19 columns]
```

[147]: `airlines`

[147]:
```
    carrier                        name
1        9E             Endeavor Air Inc.
2        AA        American Airlines Inc.
3        AS          Alaska Airlines Inc.
4        B6                JetBlue Airways
5        DL           Delta Air Lines Inc.
6        EV      ExpressJet Airlines Inc.
7        F9        Frontier Airlines Inc.
8        FL  AirTran Airways Corporation
9        HA        Hawaiian Airlines Inc.
10       MQ                     Envoy Air
11       OO        SkyWest Airlines Inc.
```

```
12       UA         United Air Lines Inc.
13       US             US Airways Inc.
14       VX             Virgin America
15       WN         Southwest Airlines Co.
16       YV           Mesa Airlines Inc.
```

[148]: `flights[['time_hour','carrier','flight']]`

[148]:
```
                    time_hour carrier  flight
1        2013-01-01 05:00:00      UA    1545
2        2013-01-01 05:00:00      UA    1714
3        2013-01-01 05:00:00      AA    1141
4        2013-01-01 05:00:00      B6     725
5        2013-01-01 06:00:00      DL     461
...                      ...     ...     ...
336772   2013-09-30 14:00:00      9E    3393
336773   2013-09-30 22:00:00      9E    3525
336774   2013-09-30 12:00:00      MQ    3461
336775   2013-09-30 11:00:00      MQ    3572
336776   2013-09-30 08:00:00      MQ    3531

[336776 rows x 3 columns]
```

[149]:
```python
flightData = pd.merge(flights[['time_hour','carrier','flight']],
                      airlines, on='carrier', how='left')
```

[150]: `flightData.head()`

[150]:
```
             time_hour carrier  flight                    name
0  2013-01-01 05:00:00      UA    1545    United Air Lines Inc.
1  2013-01-01 05:00:00      UA    1714    United Air Lines Inc.
2  2013-01-01 05:00:00      AA    1141  American Airlines Inc.
3  2013-01-01 05:00:00      B6     725          JetBlue Airways
4  2013-01-01 06:00:00      DL     461     Delta Air Lines Inc.
```

2.31 31. groupby + agg

[151]: `flights['dep_delay'].count()`

[151]: 328521

[152]: `flights[['carrier','dep_delay']][0:5]`

[152]:
```
   carrier  dep_delay
1       UA        2.0
2       UA        4.0
3       AA        2.0
```

```
4       B6      -1.0
5       DL      -6.0
```

[153]: `flights.count()`

[153]:
```
year              336776
month             336776
day               336776
dep_time          328521
sched_dep_time    336776
dep_delay         328521
arr_time          328063
sched_arr_time    336776
arr_delay         327346
carrier           336776
flight            336776
tailnum           334264
origin            336776
dest              336776
air_time          327346
distance          336776
hour              336776
minute            336776
time_hour         336776
dtype: int64
```

[154]:
```python
import numpy as np
flights.groupby('carrier').agg({'dep_delay':['count',np.max],
                                'arr_delay':[np.mean,np.max]})
```

[154]:
	dep_delay		arr_delay	
	count	amax	mean	amax
carrier				
9E	17416	747.0	7.379669	744.0
AA	32093	1014.0	0.364291	1007.0
AS	712	225.0	-9.930889	198.0
B6	54169	502.0	9.457973	497.0
DL	47761	960.0	1.644341	931.0
EV	51356	548.0	15.796431	577.0
F9	682	853.0	21.920705	834.0
FL	3187	602.0	20.115906	572.0
HA	342	1301.0	-6.915205	1272.0
MQ	25163	1137.0	10.774733	1127.0
OO	29	154.0	11.931034	157.0
UA	57979	483.0	3.558011	455.0
US	19873	500.0	2.129595	492.0
VX	5131	653.0	1.764464	676.0

```
WN              12083    471.0    9.649120    453.0
YV                545    387.0   15.556985    381.0
```

[155]:
```python
flight_groups = flights.groupby('carrier')
```

[156]:
```python
for c,x in flight_groups:
    print(c,x.count())
```

```
9E year              18460
month                18460
day                  18460
dep_time             17416
sched_dep_time       18460
dep_delay            17416
arr_time             17345
sched_arr_time       18460
arr_delay            17294
carrier              18460
flight               18460
tailnum              17416
origin               18460
dest                 18460
air_time             17294
distance             18460
hour                 18460
minute               18460
time_hour            18460
dtype: int64
AA year              32729
month                32729
day                  32729
dep_time             32093
sched_dep_time       32729
dep_delay            32093
arr_time             32059
sched_arr_time       32729
arr_delay            31947
carrier              32729
flight               32729
tailnum              32645
origin               32729
dest                 32729
air_time             31947
distance             32729
hour                 32729
minute               32729
time_hour            32729
```

```
dtype: int64
AS year            714
month        714
day          714
dep_time     712
sched_dep_time   714
dep_delay    712
arr_time     712
sched_arr_time   714
arr_delay    709
carrier      714
flight       714
tailnum      714
origin       714
dest         714
air_time     709
distance     714
hour         714
minute       714
time_hour    714
dtype: int64
B6 year          54635
month        54635
day          54635
dep_time     54169
sched_dep_time   54635
dep_delay    54169
arr_time     54137
sched_arr_time   54635
arr_delay    54049
carrier      54635
flight       54635
tailnum      54635
origin       54635
dest         54635
air_time     54049
distance     54635
hour         54635
minute       54635
time_hour    54635
dtype: int64
DL year          48110
month        48110
day          48110
dep_time     47761
sched_dep_time   48110
dep_delay    47761
arr_time     47746
```

```
sched_arr_time    48110
arr_delay         47658
carrier           48110
flight            48110
tailnum           48110
origin            48110
dest              48110
air_time          47658
distance          48110
hour              48110
minute            48110
time_hour         48110
dtype: int64
EV year              54173
month             54173
day               54173
dep_time          51356
sched_dep_time    54173
dep_delay         51356
arr_time          51251
sched_arr_time    54173
arr_delay         51108
carrier           54173
flight            54173
tailnum           54173
origin            54173
dest              54173
air_time          51108
distance          54173
hour              54173
minute            54173
time_hour         54173
dtype: int64
F9 year              685
month             685
day               685
dep_time          682
sched_dep_time    685
dep_delay         682
arr_time          681
sched_arr_time    685
arr_delay         681
carrier           685
flight            685
tailnum           682
origin            685
dest              685
air_time          681
```

```
distance          685
hour              685
minute            685
time_hour         685
dtype: int64
FL year                3260
month             3260
day               3260
dep_time          3187
sched_dep_time    3260
dep_delay         3187
arr_time          3181
sched_arr_time    3260
arr_delay         3175
carrier           3260
flight            3260
tailnum           3260
origin            3260
dest              3260
air_time          3175
distance          3260
hour              3260
minute            3260
time_hour         3260
dtype: int64
HA year                 342
month             342
day               342
dep_time          342
sched_dep_time    342
dep_delay         342
arr_time          342
sched_arr_time    342
arr_delay         342
carrier           342
flight            342
tailnum           342
origin            342
dest              342
air_time          342
distance          342
hour              342
minute            342
time_hour         342
dtype: int64
MQ year                26397
month             26397
day               26397
```

```
dep_time          25163
sched_dep_time    26397
dep_delay         25163
arr_time          25076
sched_arr_time    26397
arr_delay         25037
carrier           26397
flight            26397
tailnum           26395
origin            26397
dest              26397
air_time          25037
distance          26397
hour              26397
minute            26397
time_hour         26397
dtype: int64
OO year              32
month             32
day               32
dep_time          29
sched_dep_time    32
dep_delay         29
arr_time          29
sched_arr_time    32
arr_delay         29
carrier           32
flight            32
tailnum           32
origin            32
dest              32
air_time          29
distance          32
hour              32
minute            32
time_hour         32
dtype: int64
UA year              58665
month             58665
day               58665
dep_time          57979
sched_dep_time    58665
dep_delay         57979
arr_time          57916
sched_arr_time    58665
arr_delay         57782
carrier           58665
flight            58665
```

```
tailnum           57979
origin            58665
dest              58665
air_time          57782
distance          58665
hour              58665
minute            58665
time_hour         58665
dtype: int64
US year              20536
month             20536
day               20536
dep_time          19873
sched_dep_time    20536
dep_delay         19873
arr_time          19842
sched_arr_time    20536
arr_delay         19831
carrier           20536
flight            20536
tailnum           19873
origin            20536
dest              20536
air_time          19831
distance          20536
hour              20536
minute            20536
time_hour         20536
dtype: int64
VX year               5162
month              5162
day                5162
dep_time           5131
sched_dep_time     5162
dep_delay          5131
arr_time           5127
sched_arr_time     5162
arr_delay          5116
carrier            5162
flight             5162
tailnum            5162
origin             5162
dest               5162
air_time           5116
distance           5162
hour               5162
minute             5162
time_hour          5162
```

```
dtype: int64
WN year              12275
   month              12275
   day                12275
   dep_time           12083
   sched_dep_time     12275
   dep_delay          12083
   arr_time           12075
   sched_arr_time     12275
   arr_delay          12044
   carrier            12275
   flight             12275
   tailnum            12245
   origin             12275
   dest               12275
   air_time           12044
   distance           12275
   hour               12275
   minute             12275
   time_hour          12275
   dtype: int64
YV year                601
   month                601
   day                  601
   dep_time             545
   sched_dep_time       601
   dep_delay            545
   arr_time             544
   sched_arr_time       601
   arr_delay            544
   carrier              601
   flight               601
   tailnum              601
   origin               601
   dest                 601
   air_time             544
   distance             601
   hour                 601
   minute               601
   time_hour            601
   dtype: int64
```

[157]: `flight_groups.apply(lambda x: x.shape)`

[157]:
```
carrier
9E   (18460, 19)
AA   (32729, 19)
```

```
AS       (714, 19)
B6     (54635, 19)
DL     (48110, 19)
EV     (54173, 19)
F9       (685, 19)
FL      (3260, 19)
HA       (342, 19)
MQ     (26397, 19)
OO        (32, 19)
UA     (58665, 19)
US     (20536, 19)
VX      (5162, 19)
WN     (12275, 19)
YV       (601, 19)
dtype: object
```

[158]: `flight_groups.apply(lambda x: x.sample(3))`

[158]:

carrier		year	month	day	dep_time	sched_dep_time	dep_delay \
9E	129466	2013	2	21	1548.0	1520	28.0
	130639	2013	2	22	1902.0	1900	2.0
	98116	2013	12	17	845.0	840	5.0
AA	117987	2013	2	8	NaN	1710	NaN
	240219	2013	6	20	816.0	825	-9.0
	85232	2013	12	3	651.0	655	-4.0
AS	335584	2013	9	29	1821.0	1835	-14.0
	196103	2013	5	3	1813.0	1820	-7.0
	232146	2013	6	11	1819.0	1825	-6.0
B6	58033	2013	11	3	1448.0	1455	-7.0
	172900	2013	4	9	922.0	930	-8.0
	257556	2013	7	8	2237.0	2029	128.0
DL	263998	2013	7	15	1537.0	1545	-8.0
	222841	2013	6	1	1829.0	1829	0.0
	265834	2013	7	17	1256.0	1230	26.0
EV	320778	2013	9	13	1553.0	1552	1.0
	127089	2013	2	19	643.0	635	8.0
	137526	2013	3	2	1233.0	1215	18.0
F9	152197	2013	3	18	823.0	830	-7.0
	98578	2013	12	17	1844.0	1729	75.0
	77021	2013	11	23	1730.0	1729	1.0
FL	252964	2013	7	3	1612.0	1430	102.0
	219905	2013	5	29	1628.0	1630	-2.0
	129009	2013	2	21	710.0	720	-10.0
HA	209574	2013	5	18	955.0	1000	-5.0
	238347	2013	6	18	952.0	1000	-8.0
	163654	2013	3	30	958.0	1000	-2.0

		2013					
MQ	48156	2013	10	23	1631.0	1615	16.0
	215752	2013	5	24	2035.0	1845	110.0
	332411	2013	9	26	835.0	840	-5.0
OO	25526	2013	1	30	1222.0	1115	67.0
	318027	2013	9	10	1759.0	1805	-6.0
	64530	2013	11	10	1443.0	1430	13.0
UA	258369	2013	7	9	1809.0	1708	61.0
	248814	2013	6	29	721.0	705	16.0
	59305	2013	11	4	1910.0	1815	55.0
US	50158	2013	10	25	1713.0	1700	13.0
	331362	2013	9	25	751.0	800	-9.0
	194182	2013	5	1	1821.0	1829	-8.0
VX	252104	2013	7	2	1746.0	1655	51.0
	29069	2013	10	3	739.0	740	-1.0
	224117	2013	6	3	921.0	925	-4.0
WN	254711	2013	7	5	1754.0	1800	-6.0
	30685	2013	10	4	1739.0	1730	9.0
	221830	2013	5	31	1558.0	1555	3.0
YV	145050	2013	3	10	1557.0	1600	-3.0
	239752	2013	6	19	1726.0	1735	-9.0
	294051	2013	8	15	1720.0	1735	-15.0

		arr_time	sched_arr_time	arr_delay	carrier	flight	tailnum	\
carrier								
9E	129466	1709.0	1654	15.0	9E	4105	N8390A	
	130639	2123.0	2124	-1.0	9E	3439	N934XJ	
	98116	1058.0	1026	32.0	9E	2926	N913XJ	
AA	117987	NaN	2015	NaN	AA	695	N3EBAA	
	240219	1054.0	1105	-11.0	AA	719	N3CSAA	
	85232	950.0	940	10.0	AA	1263	N3GXAA	
AS	335584	2149.0	2148	1.0	AS	5	N532AS	
	196103	2056.0	2131	-35.0	AS	7	N525AS	
	232146	2145.0	2145	0.0	AS	7	N594AS	
B6	58033	1934.0	1949	-15.0	B6	703	N632JB	
	172900	1235.0	1244	-9.0	B6	1639	N715JB	
	257556	148.0	2359	109.0	B6	915	N658JB	
DL	263998	1759.0	1814	-15.0	DL	1705	N341NB	
	222841	2009.0	2036	-27.0	DL	2019	N985DL	
	265834	1614.0	1558	16.0	DL	2098	N322NB	
EV	320778	1819.0	1736	43.0	EV	5091	N615QX	
	127089	759.0	745	14.0	EV	3832	N16559	
	137526	1503.0	1520	-17.0	EV	5282	N600QX	
F9	152197	1102.0	1106	-4.0	F9	835	N207FR	
	98578	2105.0	2000	65.0	F9	507	N263AV	
	77021	2004.0	1953	11.0	F9	507	N202FR	
FL	252964	1729.0	1558	91.0	FL	721	N989AT	
	219905	1856.0	1853	3.0	FL	716	N919AT	

	129009	843.0	848	-5.0	FL	850	N608AT
HA	209574	1439.0	1500	-21.0	HA	51	N385HA
	238347	1436.0	1435	1.0	HA	51	N390HA
	163654	1502.0	1530	-28.0	HA	51	N384HA
MQ	48156	1923.0	1845	38.0	MQ	3357	N528MQ
	215752	2206.0	2030	96.0	MQ	4517	N723MQ
	332411	1020.0	1020	0.0	MQ	3531	N735MQ
OO	25526	1402.0	1215	107.0	OO	8500	N978SW
	318027	1945.0	1953	-8.0	OO	5568	N705SK
	64530	1701.0	1634	27.0	OO	4483	N813SK
UA	258369	2128.0	1925	123.0	UA	509	N564UA
	248814	950.0	955	-5.0	UA	253	N571UA
	59305	2156.0	2124	32.0	UA	996	N530UA
US	50158	1848.0	1817	31.0	US	2189	N760US
	331362	851.0	908	-17.0	US	2138	N944UW
	194182	2032.0	2031	1.0	US	1973	N105UW
VX	252104	2041.0	2005	36.0	VX	413	N627VA
	29069	1101.0	1055	6.0	VX	11	N853VA
	224117	1233.0	1220	13.0	VX	407	N628VA
WN	254711	1913.0	1920	-7.0	WN	625	N729SW
	30685	1915.0	1915	0.0	WN	19	N227WN
	221830	1810.0	1815	-5.0	WN	3952	N450WN
YV	145050	1711.0	1723	-12.0	YV	3788	N513MJ
	239752	1931.0	1937	-6.0	YV	2751	N912FJ
	294051	1917.0	1937	-20.0	YV	2751	N904FJ

		origin	dest	air_time	distance	hour	minute \
carrier							
9E	129466	JFK	IAD	49.0	228	15	20
	130639	JFK	CVG	112.0	589	19	0
	98116	JFK	ORD	125.0	740	8	40
AA	117987	JFK	AUS	NaN	1521	17	10
	240219	LGA	DFW	189.0	1389	8	25
	85232	JFK	LAS	337.0	2248	6	55
AS	335584	EWR	SEA	345.0	2402	18	35
	196103	EWR	SEA	300.0	2402	18	20
	232146	EWR	SEA	356.0	2402	18	25
B6	58033	JFK	SJU	195.0	1598	14	55
	172900	LGA	RSW	159.0	1080	9	30
	257556	JFK	SFO	334.0	2586	20	29
DL	263998	LGA	MSY	152.0	1183	15	45
	222841	LGA	MSP	136.0	1020	18	29
	265834	LGA	MIA	155.0	1096	12	30
EV	320778	LGA	PIT	59.0	335	15	52
	127089	EWR	DCA	47.0	199	6	35
	137526	LGA	DFW	177.0	1389	12	15
F9	152197	LGA	DEN	235.0	1620	8	30

	98578	LGA	DEN	232.0	1620	17	29
	77021	LGA	DEN	251.0	1620	17	29
FL	252964	LGA	CAK	62.0	397	14	30
	219905	LGA	ATL	117.0	762	16	30
	129009	LGA	MKE	122.0	738	7	20
HA	209574	JFK	HNL	618.0	4983	10	0
	238347	JFK	HNL	626.0	4983	10	0
	163654	JFK	HNL	644.0	4983	10	0
MQ	48156	LGA	ATL	117.0	762	16	15
	215752	LGA	CRW	65.0	444	18	45
	332411	LGA	RDU	70.0	431	8	40
OO	25526	LGA	ORD	132.0	733	11	15
	318027	LGA	CLE	68.0	419	18	5
	64530	EWR	MSP	177.0	1008	14	30
UA	258369	LGA	DEN	217.0	1620	17	8
	248814	EWR	PDX	301.0	2434	7	5
	59305	EWR	SNA	312.0	2434	18	15
US	50158	LGA	DCA	41.0	214	17	0
	331362	LGA	BOS	35.0	184	8	0
	194182	EWR	CLT	79.0	529	18	29
VX	252104	JFK	LAX	303.0	2475	16	55
	29069	JFK	SFO	361.0	2586	7	40
	224117	JFK	LAX	322.0	2475	9	25
WN	254711	EWR	MDW	115.0	711	18	0
	30685	EWR	STL	123.0	872	17	30
	221830	EWR	DEN	207.0	1605	15	55
YV	145050	LGA	IAD	44.0	229	16	0
	239752	LGA	CLT	82.0	544	17	35
	294051	LGA	CLT	90.0	544	17	35

		time_hour
carrier		
9E	129466	2013-02-21 15:00:00
	130639	2013-02-22 19:00:00
	98116	2013-12-17 08:00:00
AA	117987	2013-02-08 17:00:00
	240219	2013-06-20 08:00:00
	85232	2013-12-03 06:00:00
AS	335584	2013-09-29 18:00:00
	196103	2013-05-03 18:00:00
	232146	2013-06-11 18:00:00
B6	58033	2013-11-03 14:00:00
	172900	2013-04-09 09:00:00
	257556	2013-07-08 20:00:00
DL	263998	2013-07-15 15:00:00
	222841	2013-06-01 18:00:00
	265834	2013-07-17 12:00:00

```
EV      320778    2013-09-13 15:00:00
        127089    2013-02-19 06:00:00
        137526    2013-03-02 12:00:00
F9      152197    2013-03-18 08:00:00
        98578     2013-12-17 17:00:00
        77021     2013-11-23 17:00:00
FL      252964    2013-07-03 14:00:00
        219905    2013-05-29 16:00:00
        129009    2013-02-21 07:00:00
HA      209574    2013-05-18 10:00:00
        238347    2013-06-18 10:00:00
        163654    2013-03-30 10:00:00
MQ      48156     2013-10-23 16:00:00
        215752    2013-05-24 18:00:00
        332411    2013-09-26 08:00:00
OO      25526     2013-01-30 11:00:00
        318027    2013-09-10 18:00:00
        64530     2013-11-10 14:00:00
UA      258369    2013-07-09 17:00:00
        248814    2013-06-29 07:00:00
        59305     2013-11-04 18:00:00
US      50158     2013-10-25 17:00:00
        331362    2013-09-25 08:00:00
        194182    2013-05-01 18:00:00
VX      252104    2013-07-02 16:00:00
        29069     2013-10-03 07:00:00
        224117    2013-06-03 09:00:00
WN      254711    2013-07-05 18:00:00
        30685     2013-10-04 17:00:00
        221830    2013-05-31 15:00:00
YV      145050    2013-03-10 16:00:00
        239752    2013-06-19 17:00:00
        294051    2013-08-15 17:00:00
```

2.32 32. Pivot

[159]: `flights`

[159]:

```
        year  month  day  dep_time  sched_dep_time  dep_delay  arr_time  \
1       2013      1    1     517.0             515        2.0     830.0
2       2013      1    1     533.0             529        4.0     850.0
3       2013      1    1     542.0             540        2.0     923.0
4       2013      1    1     544.0             545       -1.0    1004.0
5       2013      1    1     554.0             600       -6.0     812.0
...      ...    ...  ...       ...             ...        ...       ...
336772  2013      9   30       NaN            1455        NaN       NaN
336773  2013      9   30       NaN            2200        NaN       NaN
```

```
336774  2013      9   30      NaN           1210      NaN      NaN
336775  2013      9   30      NaN           1159      NaN      NaN
336776  2013      9   30      NaN            840      NaN      NaN


        sched_arr_time  arr_delay carrier  flight tailnum origin dest  \
1                  819       11.0      UA    1545  N14228    EWR  IAH
2                  830       20.0      UA    1714  N24211    LGA  IAH
3                  850       33.0      AA    1141  N619AA    JFK  MIA
4                 1022      -18.0      B6     725  N804JB    JFK  BQN
5                  837      -25.0      DL     461  N668DN    LGA  ATL
...                ...        ...     ...     ...     ...    ...  ...
336772            1634        NaN      9E    3393     NaN    JFK  DCA
336773            2312        NaN      9E    3525     NaN    LGA  SYR
336774            1330        NaN      MQ    3461  N535MQ    LGA  BNA
336775            1344        NaN      MQ    3572  N511MQ    LGA  CLE
336776            1020        NaN      MQ    3531  N839MQ    LGA  RDU


        air_time  distance  hour  minute            time_hour
1          227.0      1400     5      15  2013-01-01 05:00:00
2          227.0      1416     5      29  2013-01-01 05:00:00
3          160.0      1089     5      40  2013-01-01 05:00:00
4          183.0      1576     5      45  2013-01-01 05:00:00
5          116.0       762     6       0  2013-01-01 06:00:00
...          ...       ...   ...     ...                  ...
336772       NaN       213    14      55  2013-09-30 14:00:00
336773       NaN       198    22       0  2013-09-30 22:00:00
336774       NaN       764    12      10  2013-09-30 12:00:00
336775       NaN       419    11      59  2013-09-30 11:00:00
336776       NaN       431     8      40  2013-09-30 08:00:00

[336776 rows x 19 columns]
```

```
[160]: flights.groupby(['carrier','month'])\
           .dep_delay.mean()\
           .reset_index()
```

```
[160]:     carrier  month   dep_delay
       0        9E      1   16.882510
       1        9E      2   16.486327
       2        9E      3   13.407530
       3        9E      4   13.567164
       4        9E      5   22.672190
       ..      ...    ...         ...
       180      YV      8   19.066667
       181      YV      9    8.880952
       182      YV     10   20.000000
       183      YV     11   10.520833
```

110

```
184      YV      12   13.113636
```

```
[185 rows x 3 columns]
```

```
[161]: flights.groupby(['carrier','month'])\
         .dep_delay.mean()\
         .reset_index()\
         .pivot(index='carrier',columns='month',values='dep_delay')
```

```
[161]: month           1          2          3          4          5          6   \
       carrier
       9E       16.882510  16.486327  13.407530  13.567164  22.672190  28.952978
       AA        6.932358   8.276923   8.700291  11.696207   9.664621  14.627778
       AS        7.354839   0.722222   8.419355  11.316667   6.774194  13.083333
       B6        9.493436  13.772911  14.240690  15.165175   9.778560  20.392170
       DL        3.849768   5.537440   9.933430   8.166544   9.741168  18.735941
       EV       24.228879  21.523328  26.169820  22.767549  20.242477  25.496834
       F9       10.000000  29.770833  16.754386  24.631579  35.948276  29.436364
       FL        1.972222   5.180851  17.252459  13.121311  19.183230  38.806584
       HA       54.387097  17.357143   1.161290  -2.100000  -1.451613   1.466667
       MQ        6.485494   8.092962   7.193262  13.738095  13.925859  20.842342
       OO       67.000000        NaN        NaN        NaN        NaN  61.000000
       UA        8.326167   7.711234  11.689606  13.651643  12.259470  20.265377
       US        1.817363   0.980164   2.722694   4.062574   3.184888  10.404834
       VX        1.063492   6.609195   9.676568  14.643777  17.830645  28.412500
       WN        9.137056  11.751452  15.246073  18.223602  16.939271  30.514735
       YV       15.846154  10.673913  31.888889  27.111111  15.409091  42.794872

       month           7          8          9         10         11         12
       carrier
       9E       31.398827  17.296807   7.754232   9.334348   7.564444  19.781088
       AA       12.112621   7.169965   5.694272   3.002217   3.102033  11.711427
       AS        2.419355   2.870968  -4.516667   0.677419   3.076923  18.018519
       B6       24.902315  15.678593   6.634260   2.963065   3.517266  17.004497
       DL       20.582242   9.846974   5.526071   3.417502   2.853912  10.790236
       EV       26.504722  16.261828   8.237970  13.418050   9.827979  27.887183
       F9       31.810345  22.218182   8.263158   9.701754  13.533333  13.147541
       FL       41.162698  23.410156  16.948819  13.679487  16.866337  26.105769
       HA       -1.709677   1.677419  -5.440000  -5.095238  -5.440000  -3.142857
       MQ       20.745310  10.050277   5.350545   4.478957   3.277971  12.732733
       OO             NaN  64.000000  -4.941176        NaN   0.800000        NaN
       UA       20.105200  12.424403   6.890823   6.645040   6.372261  17.722739
       US        9.443335   4.960942   1.962583   0.141047   0.576139   4.943653
       VX       35.263374   6.607362   6.988962   4.012739   7.803612   6.096154
       WN       24.628169  21.787966  14.166832  12.460055  11.007782  24.894786
       YV       22.434783  19.066667   8.880952  20.000000  10.520833  13.113636
```

```
[162]:  pd.pivot_table(data=flights,
                        values='dep_delay',
                        index='carrier',
                        columns='month',
                        aggfunc='mean')
```

[162]:

month	1	2	3	4	5	6	\
carrier							
9E	16.882510	16.486327	13.407530	13.567164	22.672190	28.952978	
AA	6.932358	8.276923	8.700291	11.696207	9.664621	14.627778	
AS	7.354839	0.722222	8.419355	11.316667	6.774194	13.083333	
B6	9.493436	13.772911	14.240690	15.165175	9.778560	20.392170	
DL	3.849768	5.537440	9.933430	8.166544	9.741168	18.735941	
EV	24.228879	21.523328	26.169820	22.767549	20.242477	25.496834	
F9	10.000000	29.770833	16.754386	24.631579	35.948276	29.436364	
FL	1.972222	5.180851	17.252459	13.121311	19.183230	38.806584	
HA	54.387097	17.357143	1.161290	-2.100000	-1.451613	1.466667	
MQ	6.485494	8.092962	7.193262	13.738095	13.925859	20.842342	
OO	67.000000	NaN	NaN	NaN	NaN	61.000000	
UA	8.326167	7.711234	11.689606	13.651643	12.259470	20.265377	
US	1.817363	0.980164	2.722694	4.062574	3.184888	10.404834	
VX	1.063492	6.609195	9.676568	14.643777	17.830645	28.412500	
WN	9.137056	11.751452	15.246073	18.223602	16.939271	30.514735	
YV	15.846154	10.673913	31.888889	27.111111	15.409091	42.794872	

month	7	8	9	10	11	12
carrier						
9E	31.398827	17.296807	7.754232	9.334348	7.564444	19.781088
AA	12.112621	7.169965	5.694272	3.002217	3.102033	11.711427
AS	2.419355	2.870968	-4.516667	0.677419	3.076923	18.018519
B6	24.902315	15.678593	6.634260	2.963065	3.517266	17.004497
DL	20.582242	9.846974	5.526071	3.417502	2.853912	10.790236
EV	26.504722	16.261828	8.237970	13.418050	9.827979	27.887183
F9	31.810345	22.218182	8.263158	9.701754	13.533333	13.147541
FL	41.162698	23.410156	16.948819	13.679487	16.866337	26.105769
HA	-1.709677	1.677419	-5.440000	-5.095238	-5.440000	-3.142857
MQ	20.745310	10.050277	5.350545	4.478957	3.277971	12.732733
OO	NaN	64.000000	-4.941176	NaN	0.800000	NaN
UA	20.105200	12.424403	6.890823	6.645040	6.372261	17.722739
US	9.443335	4.960942	1.962583	0.141047	0.576139	4.943653
VX	35.263374	6.607362	6.988962	4.012739	7.803612	6.096154
WN	24.628169	21.787966	14.166832	12.460055	11.007782	24.894786
YV	22.434783	19.066667	8.880952	20.000000	10.520833	13.113636

2.33 33. Melt

```
[163]: expenditure = pd.read_excel('/content/drive/MyDrive/AIS_DG/Gov_Expenditure_EDU.
       ↪xls', sheet_name='Data')
```

```
[164]: expenditure
```

```
[164]:         Country Name Country Code  \
       0              Aruba          ABW
       1            Andorra          AND
       2        Afghanistan          AFG
       3             Angola          AGO
       4            Albania          ALB
       ..               …            …
       244     Yemen, Rep.          YEM
       245    South Africa          ZAF
       246  Congo, Dem. Rep.        COD
       247          Zambia          ZMB
       248        Zimbabwe          ZWE


                                          Indicator Name     Indicator Code  \
       0    Government expenditure on education, total (% …  SE.XPD.TOTL.GB.ZS
       1    Government expenditure on education, total (% …  SE.XPD.TOTL.GB.ZS
       2    Government expenditure on education, total (% …  SE.XPD.TOTL.GB.ZS
       3    Government expenditure on education, total (% …  SE.XPD.TOTL.GB.ZS
       4    Government expenditure on education, total (% …  SE.XPD.TOTL.GB.ZS
       ..                                              …                  …
       244  Government expenditure on education, total (% …  SE.XPD.TOTL.GB.ZS
       245  Government expenditure on education, total (% …  SE.XPD.TOTL.GB.ZS
       246  Government expenditure on education, total (% …  SE.XPD.TOTL.GB.ZS
       247  Government expenditure on education, total (% …  SE.XPD.TOTL.GB.ZS
       248  Government expenditure on education, total (% …  SE.XPD.TOTL.GB.ZS


            1960  1961  1962  1963  1964  1965  1966  1967  1968  1969  1970  1971  \
       0     NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN
       1     NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN
       2     NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN
       3     NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN
       4     NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN
       ..      …     …     …     …     …     …     …     …     …     …     …     …
       244   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN
       245   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN
       246   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN
       247   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN
       248   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN


            1972  1973  1974  1975  1976  1977  1978  1979  1980  1981  1982  1983  \
```

0	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
1	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
3	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
4	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
..	…	…	…	…	…	…	…	…	…	…	…	
244	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
245	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
246	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
247	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
248	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	\
0	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	
1	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	
2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	
3	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	
4	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	
..	…	…	…	…	…	…	…	…	…	…	…		
244	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	
245	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	
246	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	
247	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	
248	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	

	1996	1997	1998	1999	2000	2001	2002	\
0	NaN	NaN	22.08239	19.27892	21.82276	21.32039	19.75715	
1	NaN	NaN	NaN	NaN	NaN	NaN	NaN	
2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	
3	NaN	NaN	NaN	NaN	5.25508	NaN	NaN	
4	NaN	11.15339	9.62407	9.68246	10.13703	10.58193	9.88692	
..	…	…	…	…	…	…	…	
244	NaN	NaN	NaN	NaN	30.48928	30.32128	NaN	
245	NaN	NaN	NaN	NaN	NaN	20.47205	20.09570	
246	NaN	NaN	NaN	NaN	NaN	NaN	NaN	
247	NaN	NaN	NaN	NaN	8.35262	NaN	NaN	
248	NaN	NaN	NaN	NaN	NaN	NaN	NaN	

	2003	2004	2005	2006	2007	2008	2009	\
0	NaN	14.89786	18.88828	NaN	20.78880	19.03620	21.56179	
1	NaN	NaN	NaN	NaN	NaN	NaN	NaN	
2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	
3	NaN	NaN	7.99235	7.45479	NaN	NaN	NaN	
4	10.5736	10.70316	11.35797	10.93295	11.17719	NaN	NaN	
..	…	…	…	…	…	…		
244	NaN	NaN	NaN	NaN	NaN	12.48924	NaN	
245	19.5923	19.93463	19.92499	19.68185	18.38215	17.90631	18.30626	

```
246      NaN       NaN       NaN       NaN       NaN       NaN       NaN
247      NaN  10.58499   7.72973       NaN   6.22791   5.65180       NaN
248      NaN       NaN       NaN       NaN       NaN       NaN       NaN

          2010      2011      2012      2013      2014
0      22.17513  21.77598       NaN       NaN       NaN
1           NaN       NaN       NaN       NaN       NaN
2      22.24014  19.10585  12.82317  18.46120  18.06834
3       8.68477       NaN       NaN       NaN       NaN
4           NaN       NaN       NaN       NaN       NaN
..          …         …         …         …         …
244         NaN       NaN       NaN       NaN       NaN
245    18.04437  18.92162  20.62222  19.15525       NaN
246     8.97646       NaN       NaN       NaN       NaN
247         NaN       NaN       NaN       NaN       NaN
248     8.72091       NaN       NaN       NaN       NaN

[249 rows x 59 columns]
```

[165]:
```python
expenditure['Indicator Name'][0]
```

[165]:
```
'Government expenditure on education, total (% of government expenditure)'
```

[166]:
```python
expenditure.melt(id_vars=['Country Name','Country Code'],
                value_vars=np.arange(1960,2015,1).astype('str'),
                var_name='Year',
                value_name='Expenditure')
```

[166]:
```
           Country Name Country Code   Year   Expenditure
0                 Aruba          ABW   1960           NaN
1               Andorra          AND   1960           NaN
2           Afghanistan          AFG   1960           NaN
3                Angola          AGO   1960           NaN
4               Albania          ALB   1960           NaN
…                    …            …     …             …
13690      Yemen, Rep.          YEM   2014           NaN
13691     South Africa          ZAF   2014           NaN
13692  Congo, Dem. Rep.         COD   2014           NaN
13693           Zambia          ZMB   2014           NaN
13694         Zimbabwe          ZWE   2014           NaN

[13695 rows x 4 columns]
```

[167]:
```python
expenditureByCountry = expenditure.drop(columns=['Indicator Name','Indicator␣
 ↪Code'])\
                                  .melt(id_vars='Country Name',
```

```
                                     value_vars=np.arange(1960,2015,1).
   ↪astype('str'),

                                     var_name='Year',
                                     value_name='Amount')\
                            .sort_values(by=['Country Name','Year'])
expenditureByCountry
```

[167]:   Country Name Year   Amount
        2   Afghanistan 1960   NaN
        251   Afghanistan 1961   NaN
        500   Afghanistan 1962   NaN
        749   Afghanistan 1963   NaN
        998   Afghanistan 1964   NaN
        ...   .
        12698   Zimbabwe 2010   8.72091
        12947   Zimbabwe 2011   NaN
        13196   Zimbabwe 2012   NaN
        13445   Zimbabwe 2013   NaN
        13694   Zimbabwe 2014   NaN

        [13695 rows x 3 columns]

[168]: `expenditureByCountry[expenditureByCountry['Country Name'].isin(['Thailand'])]`

[168]:   Country Name Year   Amount
        219   Thailand 1960   NaN
        468   Thailand 1961   NaN
        717   Thailand 1962   NaN
        966   Thailand 1963   NaN
        1215   Thailand 1964   NaN
        1464   Thailand 1965   NaN
        1713   Thailand 1966   NaN
        1962   Thailand 1967   NaN
        2211   Thailand 1968   NaN
        2460   Thailand 1969   NaN
        2709   Thailand 1970   NaN
        2958   Thailand 1971   NaN
        3207   Thailand 1972   NaN
        3456   Thailand 1973   NaN
        3705   Thailand 1974   NaN
        3954   Thailand 1975   NaN
        4203   Thailand 1976   NaN
        4452   Thailand 1977   NaN
        4701   Thailand 1978   NaN
        4950   Thailand 1979   NaN
        5199   Thailand 1980   NaN
        5448   Thailand 1981   NaN

```
5697       Thailand  1982         NaN
5946       Thailand  1983         NaN
6195       Thailand  1984         NaN
6444       Thailand  1985         NaN
6693       Thailand  1986         NaN
6942       Thailand  1987         NaN
7191       Thailand  1988         NaN
7440       Thailand  1989         NaN
7689       Thailand  1990         NaN
7938       Thailand  1991         NaN
8187       Thailand  1992         NaN
8436       Thailand  1993         NaN
8685       Thailand  1994         NaN
8934       Thailand  1995         NaN
9183       Thailand  1996         NaN
9432       Thailand  1997         NaN
9681       Thailand  1998    19.48100
9930       Thailand  1999    18.97902
10179      Thailand  2000    28.38860
10428      Thailand  2001    24.24134
10677      Thailand  2002    16.22293
10926      Thailand  2003    20.86635
11175      Thailand  2004    21.45767
11424      Thailand  2005    20.54682
11673      Thailand  2006    22.00279
11922      Thailand  2007    18.48467
12171      Thailand  2008    17.54413
12420      Thailand  2009    17.56252
12669      Thailand  2010    16.46132
12918      Thailand  2011    21.95372
13167      Thailand  2012    20.73911
13416      Thailand  2013         NaN
13665      Thailand  2014         NaN
```

2.34 34. Time series - set time as index

[169]: `flightData`

[169]:
```
                 time_hour carrier  flight                    name
0      2013-01-01 05:00:00      UA    1545    United Air Lines Inc.
1      2013-01-01 05:00:00      UA    1714    United Air Lines Inc.
2      2013-01-01 05:00:00      AA    1141  American Airlines Inc.
3      2013-01-01 05:00:00      B6     725         JetBlue Airways
4      2013-01-01 06:00:00      DL     461    Delta Air Lines Inc.
...                    ...     ...     ...                     ...
336771 2013-09-30 14:00:00      9E    3393       Endeavor Air Inc.
336772 2013-09-30 22:00:00      9E    3525       Endeavor Air Inc.
```

```
336773  2013-09-30 12:00:00       MQ    3461                Envoy Air
336774  2013-09-30 11:00:00       MQ    3572                Envoy Air
336775  2013-09-30 08:00:00       MQ    3531                Envoy Air

[336776 rows x 4 columns]
```

[170]: `flightData.info()`

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 336776 entries, 0 to 336775
Data columns (total 4 columns):
 #   Column     Non-Null Count   Dtype
---  ------     --------------   -----
 0   time_hour  336776 non-null  object
 1   carrier    336776 non-null  object
 2   flight     336776 non-null  int64
 3   name       336776 non-null  object
dtypes: int64(1), object(3)
memory usage: 12.8+ MB
```

[171]: `flightData['time_hour'] = pd.to_datetime(flightData['time_hour'])`

[172]: `flightData.info()`

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 336776 entries, 0 to 336775
Data columns (total 4 columns):
 #   Column     Non-Null Count   Dtype
---  ------     --------------   -----
 0   time_hour  336776 non-null  datetime64[ns]
 1   carrier    336776 non-null  object
 2   flight     336776 non-null  int64
 3   name       336776 non-null  object
dtypes: datetime64[ns](1), int64(1), object(2)
memory usage: 12.8+ MB
```

[173]: `flightData`

```
[173]:                 time_hour carrier  flight                    name
       0      2013-01-01 05:00:00      UA    1545    United Air Lines Inc.
       1      2013-01-01 05:00:00      UA    1714    United Air Lines Inc.
       2      2013-01-01 05:00:00      AA    1141  American Airlines Inc.
       3      2013-01-01 05:00:00      B6     725          JetBlue Airways
       4      2013-01-01 06:00:00      DL     461     Delta Air Lines Inc.
       ...                    ...     ...     ...                      ...
       336771 2013-09-30 14:00:00      9E    3393       Endeavor Air Inc.
       336772 2013-09-30 22:00:00      9E    3525       Endeavor Air Inc.
```

```
336773 2013-09-30 12:00:00       MQ    3461            Envoy Air
336774 2013-09-30 11:00:00       MQ    3572            Envoy Air
336775 2013-09-30 08:00:00       MQ    3531            Envoy Air

[336776 rows x 4 columns]
```

[174]: ```python
flightData.set_index('time_hour',inplace=True)
```

[175]: ```python
flightData.head()
```

[175]:
```
                    carrier flight   name
time_hour
2013-01-01 05:00:00   UA   1545   United Air Lines Inc.
2013-01-01 05:00:00   UA   1714   United Air Lines Inc.
2013-01-01 05:00:00   AA   1141   American Airlines Inc.
2013-01-01 05:00:00   B6   725   JetBlue Airways
2013-01-01 06:00:00   DL   461   Delta Air Lines Inc.
```

## 2.35   35. Time series - aggregate

[176]: ```python
fpw = flightData.resample('W').carrier.count()
fpw
```

[176]:
```
time_hour
2013-01-06    5166
2013-01-13    6114
2013-01-20    6034
2013-01-27    6049
2013-02-03    6063
2013-02-10    6104
2013-02-17    6236
2013-02-24    6381
2013-03-03    6444
2013-03-10    6546
2013-03-17    6555
2013-03-24    6547
2013-03-31    6550
2013-04-07    6592
2013-04-14    6613
2013-04-21    6622
2013-04-28    6560
2013-05-05    6525
2013-05-12    6493
2013-05-19    6523
2013-05-26    6340
2013-06-02    6523
2013-06-09    6550
```

```
2013-06-16     6647
2013-06-23     6680
2013-06-30     6701
2013-07-07     6192
2013-07-14     6759
2013-07-21     6737
2013-07-28     6740
2013-08-04     6734
2013-08-11     6733
2013-08-18     6685
2013-08-25     6628
2013-09-01     6262
2013-09-08     6365
2013-09-15     6473
2013-09-22     6508
2013-09-29     6517
2013-10-06     6527
2013-10-13     6495
2013-10-20     6511
2013-10-27     6506
2013-11-03     6420
2013-11-10     6505
2013-11-17     6515
2013-11-24     6574
2013-12-01     6084
2013-12-08     6440
2013-12-15     6369
2013-12-22     6529
2013-12-29     6066
2014-01-05     1744
Freq: W-SUN, Name: carrier, dtype: int64
```

[177]: `fpw.rolling(2).mean()`

[177]:
```
time_hour
2013-01-06       NaN
2013-01-13    5640.0
2013-01-20    6074.0
2013-01-27    6041.5
2013-02-03    6056.0
2013-02-10    6083.5
2013-02-17    6170.0
2013-02-24    6308.5
2013-03-03    6412.5
2013-03-10    6495.0
2013-03-17    6550.5
2013-03-24    6551.0
```

```
2013-03-31    6548.5
2013-04-07    6571.0
2013-04-14    6602.5
2013-04-21    6617.5
2013-04-28    6591.0
2013-05-05    6542.5
2013-05-12    6509.0
2013-05-19    6508.0
2013-05-26    6431.5
2013-06-02    6431.5
2013-06-09    6536.5
2013-06-16    6598.5
2013-06-23    6663.5
2013-06-30    6690.5
2013-07-07    6446.5
2013-07-14    6475.5
2013-07-21    6748.0
2013-07-28    6738.5
2013-08-04    6737.0
2013-08-11    6733.5
2013-08-18    6709.0
2013-08-25    6656.5
2013-09-01    6445.0
2013-09-08    6313.5
2013-09-15    6419.0
2013-09-22    6490.5
2013-09-29    6512.5
2013-10-06    6522.0
2013-10-13    6511.0
2013-10-20    6503.0
2013-10-27    6508.5
2013-11-03    6463.0
2013-11-10    6462.5
2013-11-17    6510.0
2013-11-24    6544.5
2013-12-01    6329.0
2013-12-08    6262.0
2013-12-15    6404.5
2013-12-22    6449.0
2013-12-29    6297.5
2014-01-05    3905.0
Freq: W-SUN, Name: carrier, dtype: float64
```

2.36 36. Dummies variables

```
[178]: churnData = pd.read_csv('/content/drive/MyDrive/AIS_DG/Telco-Churn.
       ↪csv',na_values=' ')
       churnData['Contract'].head()
```

```
[178]: 0    Month-to-month
       1          One year
       2    Month-to-month
       3          One year
       4    Month-to-month
       Name: Contract, dtype: object
```

```
[179]: churnData['Contract'].unique()
```

```
[179]: array(['Month-to-month', 'One year', 'Two year'], dtype=object)
```

```
[180]: pd.get_dummies(churnData['Contract'],prefix='Contract')
```

```
[180]:       Contract_Month-to-month  Contract_One year  Contract_Two year
       0                           1                  0                  0
       1                           0                  1                  0
       2                           1                  0                  0
       3                           0                  1                  0
       4                           1                  0                  0
       ...                       ...                ...                ...
       7038                        0                  1                  0
       7039                        0                  1                  0
       7040                        1                  0                  0
       7041                        1                  0                  0
       7042                        0                  0                  1

       [7043 rows x 3 columns]
```

```
[181]: pd.get_dummies(churnData['Contract'],
                      prefix='Contract',
                      drop_first=True)
```

```
[181]:       Contract_One year  Contract_Two year
       0                     0                  0
       1                     1                  0
       2                     0                  0
       3                     1                  0
       4                     0                  0
       ...                 ...                ...
       7038                  1                  0
       7039                  1                  0
       7040                  0                  0
```

```
7041                  0                  0
7042                  0                  1

[7043 rows x 2 columns]
```

[182]: `pd.get_dummies(churnData[['Churn','Contract']])`

[182]:
```
      Churn_No  Churn_Yes  Contract_Month-to-month  Contract_One year  \
0            1          0                        1                  0
1            1          0                        0                  1
2            0          1                        1                  0
3            1          0                        0                  1
4            0          1                        1                  0
...        ...        ...                      ...                ...
7038         1          0                        0                  1
7039         1          0                        0                  1
7040         1          0                        1                  0
7041         0          1                        1                  0
7042         1          0                        0                  0

      Contract_Two year
0                     0
1                     0
2                     0
3                     0
4                     0
...                 ...
7038                  0
7039                  0
7040                  0
7041                  0
7042                  1

[7043 rows x 5 columns]
```

2.37 37. Sample data

[183]:
```python
# Simple random sampling
churnData.sample(frac=0.01)
```

[183]:
```
      customerID  gender  SeniorCitizen Partner Dependents  tenure  \
146   6837-BJYDQ    Male              0      No         No       3
4624  0325-XBFAC    Male              0      No         No       8
5023  6653-CBBOM  Female              0      No         No       1
3034  7120-RFMVS    Male              0      No         No       1
1636  1371-OJCEK  Female              0      No         No      48
...          ...     ...            ...     ...        ...     ...
```

```
5873  2122-YWVYA   Female              0      No       No      18
6380  2378-VTKDH    Male               1     Yes       No      65
5643  0231-LXVAP    Male               0      No       No       1
5540  3803-KMQFW   Female              0     Yes      Yes       1
1811  2070-XYMFH   Female              1      No       No      23

      PhoneService MultipleLines InternetService      OnlineSecurity  \
146            Yes            No              No  No internet service
4624           Yes            No     Fiber optic                   No
5023           Yes            No     Fiber optic                   No
3034           Yes           Yes     Fiber optic                   No
1636           Yes           Yes              No  No internet service
…                …             …               …                   …
5873           Yes            No     Fiber optic                  Yes
6380           Yes           Yes     Fiber optic                   No
5643           Yes            No     Fiber optic                   No
5540           Yes            No              No  No internet service
1811           Yes           Yes     Fiber optic                   No

              OnlineBackup      DeviceProtection         TechSupport  \
146    No internet service  No internet service  No internet service
4624                    No                  Yes                   No
5023                    No                   No                   No
3034                    No                   No                   No
1636   No internet service  No internet service  No internet service
…                        …                    …                    …
5873                    No                   No                   No
6380                   Yes                  Yes                   No
5643                    No                   No                  Yes
5540   No internet service  No internet service  No internet service
1811                    No                  Yes                   No

              StreamingTV       StreamingMovies          Contract  \
146    No internet service  No internet service          One year
4624                   Yes                  Yes     Month-to-month
5023                    No                   No     Month-to-month
3034                   Yes                   No     Month-to-month
1636   No internet service  No internet service          One year
…                        …                    …                 …
5873                    No                   No     Month-to-month
6380                   Yes                  Yes     Month-to-month
5643                    No                   No     Month-to-month
5540   No internet service  No internet service     Month-to-month
1811                    No                   No     Month-to-month

      PaperlessBilling          PaymentMethod  MonthlyCharges  \
146                 No          Mailed check           19.60
```

124

```
4624           Yes              Electronic check           94.70
5023           Yes              Electronic check           70.30
3034            No              Electronic check           84.50
1636            No   Bank transfer (automatic)             24.35
...             ...                      ...                 ...
5873           Yes              Electronic check           75.40
6380           Yes              Electronic check          104.35
5643           Yes              Electronic check           75.90
5540            No                  Mailed check           20.55
1811           Yes                  Mailed check           79.35


      TotalCharges Churn
146          61.35    No
4624        740.30   Yes
5023         70.30   Yes
3034         84.50   Yes
1636       1133.70    No
...            ...   ...
5873       1380.40    No
6380       6578.55    No
5643         75.90   Yes
5540         20.55   Yes
1811       1835.30    No

[70 rows x 21 columns]
```

[184]:
```python
#Stratified sampling
churnData.groupby('Churn', group_keys=False).apply(lambda x: x.sample(n=2))
```

[184]:
```
      customerID  gender  SeniorCitizen Partner Dependents  tenure  \
861   9777-IQHWP    Male              0     Yes        Yes      64
1121  3696-XRIEN  Female              0      No         No      50
6169  4847-QNOKA  Female              0      No         No       1
5621  6424-ELEYH  Female              0     Yes         No       3


      PhoneService MultipleLines InternetService OnlineSecurity OnlineBackup  \
861            Yes           Yes     Fiber optic            Yes           No
1121           Yes           Yes             DSL            Yes           No
6169           Yes            No             DSL             No           No
5621           Yes           Yes     Fiber optic             No           No


      DeviceProtection TechSupport StreamingTV StreamingMovies        Contract  \
861                Yes          No          No             Yes        Two year
1121               Yes         Yes         Yes             Yes        One year
6169                No          No          No              No  Month-to-month
5621                No          No          No              No  Month-to-month
```

```
       PaperlessBilling              PaymentMethod  MonthlyCharges  \
861                  No  Bank transfer (automatic)           93.40
1121                Yes     Credit card (automatic)           82.50
6169                Yes  Bank transfer (automatic)           44.90
5621                Yes     Credit card (automatic)           74.75


       TotalCharges Churn
861          5822.3    No
1121         4179.1    No
6169           44.9   Yes
5621          229.5   Yes
```

2.38 38. Variable binning

```
[185]: churnData['TotalCharges']
```

```
[185]: 0          29.85
       1        1889.50
       2         108.15
       3        1840.75
       4         151.65
                 ...
       7038     1990.50
       7039     7362.90
       7040      346.45
       7041      306.60
       7042     6844.50
       Name: TotalCharges, Length: 7043, dtype: float64
```

```
[186]: pd.cut(churnData['TotalCharges'],5).value_counts()
```

```
[186]: (10.134, 1752.0]    3937
       (1752.0, 3485.2]    1179
       (3485.2, 5218.4]     866
       (5218.4, 6951.6]     705
       (6951.6, 8684.8]     345
       Name: TotalCharges, dtype: int64
```

```
[187]: pd.cut(churnData['TotalCharges'],bins=[0, 10, 50, 1000, 5000, 10000])
```

```
[187]: 0            (10, 50]
       1        (1000, 5000]
       2         (50, 1000]
       3        (1000, 5000]
       4         (50, 1000]
                 ...
       7038     (1000, 5000]
```

```
7039      (5000, 10000]
7040        (50, 1000]
7041        (50, 1000]
7042      (5000, 10000]
Name: TotalCharges, Length: 7043, dtype: category
Categories (5, interval[int64, right]): [(0, 10] < (10, 50] < (50, 1000] <
(1000, 5000] <
                                              (5000, 10000]]
```

[188]: `pd.qcut(churnData['TotalCharges'],q=4).value_counts()`

```
[188]: (18.799, 401.45]        1758
       (401.45, 1397.475]      1758
       (1397.475, 3794.738]    1758
       (3794.738, 8684.8]      1758
       Name: TotalCharges, dtype: int64
```

3 Exercise

- From flight data
  - Which flight numbers (carrier + flight) delayed the worst?
  - Obtain the 10 worst flight numbers of each month

[189]:
```
# Work here
flights.sort_values(by='dep_delay', ascending=False)
```

[189]:

	year	month	day	dep_time	sched_dep_time	dep_delay	arr_time
7073	2013	1	9	641.0	900	1301.0	1242.0
235779	2013	6	15	1432.0	1935	1137.0	1607.0
8240	2013	1	10	1121.0	1635	1126.0	1239.0
327044	2013	9	20	1139.0	1845	1014.0	1457.0
270377	2013	7	22	845.0	1600	1005.0	1044.0
...	...	...	...	...	...	...	...
336772	2013	9	30	NaN	1455	NaN	NaN
336773	2013	9	30	NaN	2200	NaN	NaN
336774	2013	9	30	NaN	1210	NaN	NaN
336775	2013	9	30	NaN	1159	NaN	NaN
336776	2013	9	30	NaN	840	NaN	NaN

	sched_arr_time	arr_delay	carrier	flight	tailnum	origin	dest
7073	1530	1272.0	HA	51	N384HA	JFK	HNL
235779	2120	1127.0	MQ	3535	N504MQ	JFK	CMH
8240	1810	1109.0	MQ	3695	N517MQ	EWR	ORD
327044	2210	1007.0	AA	177	N338AA	JFK	SFO
270377	1815	989.0	MQ	3075	N665MQ	JFK	CVG
...	...	...	...	...	...	...	...
336772	1634	NaN	9E	3393	NaN	JFK	DCA

```
336773                2312       NaN      9E    3525       NaN    LGA    SYR
336774                1330       NaN      MQ    3461    N535MQ    LGA    BNA
336775                1344       NaN      MQ    3572    N511MQ    LGA    CLE
336776                1020       NaN      MQ    3531    N839MQ    LGA    RDU

        air_time    distance    hour    minute              time_hour
7073       640.0        4983       9         0    2013-01-09 09:00:00
235779      74.0         483      19        35    2013-06-15 19:00:00
8240       111.0         719      16        35    2013-01-10 16:00:00
327044     354.0        2586      18        45    2013-09-20 18:00:00
270377      96.0         589      16         0    2013-07-22 16:00:00
...          ...         ...     ...       ...                    ...
336772       NaN         213      14        55    2013-09-30 14:00:00
336773       NaN         198      22         0    2013-09-30 22:00:00
336774       NaN         764      12        10    2013-09-30 12:00:00
336775       NaN         419      11        59    2013-09-30 11:00:00
336776       NaN         431       8        40    2013-09-30 08:00:00

[336776 rows x 19 columns]
```

```python
[190]: flights\
           .groupby('month', as_index=False)\
           .apply(lambda x: x.sort_values(by='dep_delay').head(10))
```

```
[190]:           year    month    day    dep_time    sched_dep_time    dep_delay    arr_time  \
0   9620      2013        1     11      1900.0              1930        -30.0      2233.0
    24916     2013        1     29      1703.0              1730        -27.0      1947.0
    18194     2013        1     21      2137.0              2159        -22.0      2232.0
    10124     2013        1     12      1354.0              1416        -22.0      1606.0
    16582     2013        1     20       704.0               725        -21.0      1025.0
...  ...      ...      ...    ...         ...               ...          ...         ...
11  92123     2013       12     10      1841.0              1900        -19.0      2028.0
    109630    2013       12     30       657.0               715        -18.0       927.0
    88214     2013       12      6       811.0               829        -18.0      1119.0
    89870     2013       12      8       853.0               910        -17.0      1105.0
    89677     2013       12      7      2043.0              2100        -17.0      2250.0

          sched_arr_time    arr_delay    carrier    flight    tailnum    origin    dest  \
0   9620              2243        -10.0       DL      1435    N934DL      LGA    TPA
    24916            1957        -10.0       F9       837    N208FR      LGA    DEN
    18194            2316        -44.0       DL      2155    N377NW      LGA    PWM
    10124            1650        -44.0       FL       349    N929AT      LGA    ATL
    16582            1035        -10.0       AS        11    N556AS      EWR    SEA
...                   ...          ...      ...       ...       ...       ...     ...
11  92123            2047        -19.0       9E      2943    N8721B      JFK    RIC
    109630            940        -13.0       MQ      3547    N546MQ      LGA    XNA
    88214            1055         24.0       EV      4419    N12142      EWR    XNA
```

```
89870                 1147       -42.0        EV    5231  N724EV   LGA  CHS
89677                 2315       -25.0        EV    5079  N753EV   LGA  CVG

            air_time  distance  hour  minute           time_hour
0    9620    139.0      1010    19      30  2013-01-11 19:00:00
    24916    250.0      1620    17      30  2013-01-29 17:00:00
    18194     38.0       269    21      59  2013-01-21 21:00:00
    10124    110.0       762    14      16  2013-01-12 14:00:00
    16582    348.0      2402     7      25  2013-01-20 07:00:00
...         ...       ...   ...     ...                 ...
11  92123     62.0       288    19       0  2013-12-10 19:00:00
   109630    186.0      1147     7      15  2013-12-30 07:00:00
    88214    207.0      1131     8      29  2013-12-06 08:00:00
    89870    103.0       641     9      10  2013-12-08 09:00:00
    89677    107.0       585    21       0  2013-12-07 21:00:00

[120 rows x 19 columns]
```

[190]: