11-PandaDataframes

August 11, 2020

1 Pandas Dataframes

[1]:
```
%matplotlib inline
%config InlineBackend.figure_format = 'retina'
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt

pd.set_option("display.max_rows", 8)
plt.rcParams['figure.figsize'] = (9, 6)
```

1.1 Create a DataFrame

[2]:
```
dates = pd.date_range('20130101', periods=6)
pd.DataFrame(np.random.randn(6,4), index=dates, columns=list('ABCD'))
```

[2]:

	A	B	C	D
2013-01-01	1.660599	0.175701	1.066349	-0.747557
2013-01-02	-0.092833	1.137038	-0.186423	-0.155672
2013-01-03	-0.806344	-0.565339	0.448610	-1.046974
2013-01-04	0.243302	0.378401	0.211149	0.451231
2013-01-05	-0.971364	1.123546	-0.710483	2.440515
2013-01-06	1.091346	0.328460	-0.396649	-0.893437

[3]:
```
pd.DataFrame({'A' : 1.,
              'B' : pd.Timestamp('20130102'),
              'C' : pd.Series(1,index=list(range(4)),dtype='float32'),
              'D' : np.arange(4,dtype='int32'),
              'E' : pd.Categorical(["test","train","test","train"]),
              'F' : 'foo' })
```

[3]:

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

1.2 Load Data from CSV File

[4]:
```
url = "https://www.fun-mooc.fr/c4x/agrocampusouest/40001S03/asset/
↪AnaDo_JeuDonnees_TemperatFrance.csv"
french_cities = pd.read_csv(url, delimiter=";", encoding="latin1", index_col=0)
french_cities
```

[4]:
```
             Janv  Févr  Mars  Avri   Mai  Juin  juil  Août  Sept  Octo  Nove  \
Bordeaux      5.6   6.6  10.3  12.8  15.8  19.3  20.9  21.0  18.6  13.8   9.1
Brest         6.1   5.8   7.8   9.2  11.6  14.4  15.6  16.0  14.7  12.0   9.0
Clermont      2.6   3.7   7.5  10.3  13.8  17.3  19.4  19.1  16.2  11.2   6.6
Grenoble      1.5   3.2   7.7  10.6  14.5  17.8  20.1  19.5  16.7  11.4   6.5
…             …     …     …    …     …     …     …     …     …     …
Rennes        4.8   5.3   7.9  10.1  13.1  16.2  17.9  17.8  15.7  11.6   7.8
Strasbourg    0.4   1.5   5.6   9.8  14.0  17.2  19.0  18.3  15.1   9.5   4.9
Toulouse      4.7   5.6   9.2  11.6  14.9  18.7  20.9  20.9  18.3  13.3   8.6
Vichy         2.4   3.4   7.1   9.9  13.6  17.1  19.3  18.8  16.0  11.0   6.6

             Déce   Lati  Long   Moye  Ampl Région
Bordeaux      6.2  44.50 -0.34  13.33  15.4     SO
Brest         7.0  48.24 -4.29  10.77  10.2     NO
Clermont      3.6  45.47  3.05  10.94  16.8     SE
Grenoble      2.3  45.10  5.43  10.98  18.6     SE
…             …    …     …     …     …     …
Rennes        5.4  48.05 -1.41  11.13  13.1     NO
Strasbourg    1.3  48.35  7.45   9.72  18.6     NE
Toulouse      5.5  43.36  1.26  12.68  16.2     SO
Vichy         3.4  46.08  3.26  10.72  16.9     SE

[15 rows x 17 columns]
```

1.3 Viewing Data

[5]:
```
french_cities.head()
```

[5]:
```
           Janv  Févr  Mars  Avri   Mai  Juin  juil  Août  Sept  Octo  Nove  \
Bordeaux    5.6   6.6  10.3  12.8  15.8  19.3  20.9  21.0  18.6  13.8   9.1
Brest       6.1   5.8   7.8   9.2  11.6  14.4  15.6  16.0  14.7  12.0   9.0
Clermont    2.6   3.7   7.5  10.3  13.8  17.3  19.4  19.1  16.2  11.2   6.6
Grenoble    1.5   3.2   7.7  10.6  14.5  17.8  20.1  19.5  16.7  11.4   6.5
Lille       2.4   2.9   6.0   8.9  12.4  15.3  17.1  17.1  14.7  10.4   6.1

           Déce   Lati  Long   Moye  Ampl Région
Bordeaux    6.2  44.50 -0.34  13.33  15.4     SO
Brest       7.0  48.24 -4.29  10.77  10.2     NO
Clermont    3.6  45.47  3.05  10.94  16.8     SE
```

```
Grenoble   2.3  45.10  5.43  10.98  18.6     SE
Lille      3.5  50.38  3.04   9.73  14.7     NE
```

[6]:
```
french_cities.tail()
```

[6]:
```
            Janv  Févr  Mars  Avri   Mai  Juin  juil  Août  Sept  Octo  Nove  \
Paris        3.4   4.1   7.6  10.7  14.3  17.5  19.1  18.7  16.0  11.4   7.1
Rennes       4.8   5.3   7.9  10.1  13.1  16.2  17.9  17.8  15.7  11.6   7.8
Strasbourg   0.4   1.5   5.6   9.8  14.0  17.2  19.0  18.3  15.1   9.5   4.9
Toulouse     4.7   5.6   9.2  11.6  14.9  18.7  20.9  20.9  18.3  13.3   8.6
Vichy        2.4   3.4   7.1   9.9  13.6  17.1  19.3  18.8  16.0  11.0   6.6

            Déce   Lati  Long   Moye  Ampl Région
Paris        4.3  48.52  2.20  11.18  15.7     NE
Rennes       5.4  48.05 -1.41  11.13  13.1     NO
Strasbourg   1.3  48.35  7.45   9.72  18.6     NE
Toulouse     5.5  43.36  1.26  12.68  16.2     SO
Vichy        3.4  46.08  3.26  10.72  16.9     SE
```

1.4 Index

[7]:
```
french_cities.index
```

[7]:
```
Index(['Bordeaux', 'Brest', 'Clermont', 'Grenoble', 'Lille', 'Lyon',
       'Marseille', 'Montpellier', 'Nantes', 'Nice', 'Paris', 'Rennes',
       'Strasbourg', 'Toulouse', 'Vichy'],
      dtype='object')
```

We can rename an index by setting its name.

[8]:
```
french_cities.index.name = "City"
french_cities.head()
```

[8]:
```
          Janv  Févr  Mars  Avri   Mai  Juin  juil  Août  Sept  Octo  Nove  \
City
Bordeaux   5.6   6.6  10.3  12.8  15.8  19.3  20.9  21.0  18.6  13.8   9.1
Brest      6.1   5.8   7.8   9.2  11.6  14.4  15.6  16.0  14.7  12.0   9.0
Clermont   2.6   3.7   7.5  10.3  13.8  17.3  19.4  19.1  16.2  11.2   6.6
Grenoble   1.5   3.2   7.7  10.6  14.5  17.8  20.1  19.5  16.7  11.4   6.5
Lille      2.4   2.9   6.0   8.9  12.4  15.3  17.1  17.1  14.7  10.4   6.1

          Déce   Lati  Long   Moye  Ampl Région
City
Bordeaux   6.2  44.50 -0.34  13.33  15.4     SO
Brest      7.0  48.24 -4.29  10.77  10.2     NO
Clermont   3.6  45.47  3.05  10.94  16.8     SE
```

```
Grenoble   2.3  45.10  5.43  10.98  18.6     SE
Lille      3.5  50.38  3.04   9.73  14.7     NE
```

1.4.1 Exercise: Rename DataFrame Months in English

[9]:
```
import locale
import calendar

locale.setlocale(locale.LC_ALL,'en_US')

months = calendar.month_abbr
print(*months)
```

```
␣
↪---------------------------------------------------------------------------

Error                                     Traceback (most recent call␣
↪last)

<ipython-input-9-e38d847f0b53> in <module>
  2 import calendar
  3
----> 4 locale.setlocale(locale.LC_ALL,'en_US')
  5
  6 months = calendar.month_abbr


/usr/share/miniconda3/envs/big-data/lib/python3.8/locale.py in␣
↪setlocale(category, locale)
606         # convert to string
607         locale = normalize(_build_localename(locale))
--> 608     return _setlocale(category, locale)
609
610 def resetlocale(category=LC_ALL):


Error: unsupported locale setting
```

[10]:
```
french_cities.rename(
  columns={ old : new
            for old, new in zip(french_cities.columns[:12], months[1:])
           if old != new },
  inplace=True)
french_cities.columns
```

```
␣
↪---------------------------------------------------------------------------

NameError                                 Traceback (most recent call␣
↪last)

<ipython-input-10-39c4d54b672b> in <module>
  1 french_cities.rename(
  2   columns={ old : new
----> 3            for old, new in zip(french_cities.columns[:12], months[1:
↪])
  4           if old != new },
  5   inplace=True)


NameError: name 'months' is not defined
```

[11]:
```
french_cities.rename(columns={'Moye':'Mean'}, inplace=True)
```

[12]:
```
french_cities
```

[12]:

City	Janv	Févr	Mars	Avri	Mai	Juin	juil	Août	Sept	Octo	Nove	Déce	Lati	Long	Mean	Ampl	Région
Bordeaux	5.6	6.6	10.3	12.8	15.8	19.3	20.9	21.0	18.6	13.8	9.1	6.2	44.50	-0.34	13.33	15.4	SO
Brest	6.1	5.8	7.8	9.2	11.6	14.4	15.6	16.0	14.7	12.0	9.0	7.0	48.24	-4.29	10.77	10.2	NO
Clermont	2.6	3.7	7.5	10.3	13.8	17.3	19.4	19.1	16.2	11.2	6.6	3.6	45.47	3.05	10.94	16.8	SE
Grenoble	1.5	3.2	7.7	10.6	14.5	17.8	20.1	19.5	16.7	11.4	6.5	2.3	45.10	5.43	10.98	18.6	SE
…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
Rennes	4.8	5.3	7.9	10.1	13.1	16.2	17.9	17.8	15.7	11.6	7.8	5.4	48.05	-1.41	11.13	13.1	NO
Strasbourg	0.4	1.5	5.6	9.8	14.0	17.2	19.0	18.3	15.1	9.5	4.9	1.3	48.35	7.45	9.72	18.6	NE
Toulouse	4.7	5.6	9.2	11.6	14.9	18.7	20.9	20.9	18.3	13.3	8.6	5.5	43.36	1.26	12.68	16.2	SO
Vichy	2.4	3.4	7.1	9.9	13.6	17.1	19.3	18.8	16.0	11.0	6.6	3.4	46.08	3.26	10.72	16.9	SE

```
[15 rows x 17 columns]
```

1.5 From a local or remote HTML file

We can download and extract data about mean sea level stations around the world from the PSMSL website.

[13]:
```
# Needs `lxml`, `beautifulSoup4` and `html5lib` python packages
table_list = pd.read_html("http://www.psmsl.org/data/obtaining/")
```

[14]:
```
# there is 1 table on that page which contains metadata about the stations␣
↪where
# sea levels are recorded
local_sea_level_stations = table_list[0]
local_sea_level_stations
```

[14]:
```
              Station Name    ID    Lat.     Lon.  GLOSS ID Country  \
0                    BREST     1  48.383   -4.495     242.0     FRA
1               SWINOUJSCIE     2  53.917   14.233       NaN     POL
2                 SHEERNESS     3  51.446    0.743       NaN     GBR
3                  HOLYHEAD     5  53.314   -4.620       NaN     GBR
…                        …   …     …       …       …     …
1544                 SUVA-B  2356 -18.133  178.428       NaN     FJI
1545  SYDNEY PORT JACKSON  2358 -33.826  151.259       NaN     AUS
1546                  ARKO  2359  58.484   16.961       NaN     SWE
1547             UDDEVALLA  2360  58.348   11.895       NaN     SWE

            Date  Coastline  Station
0     07/08/2019        190       91
1     19/10/2001        110       92
2     06/06/2019        170      101
3     06/06/2019        170      191
…            …        …       …
1544  28/01/2020        742       14
1545  13/06/2019        680      138
1546  12/09/2019         50      112
1547  12/09/2019         50       22

[1548 rows x 9 columns]
```

1.6 Indexing on DataFrames

[15]:
```
french_cities['Lati']  # DF [] accesses columns (Series)
```

[15]:
```
City
Bordeaux      44.50
Brest         48.24
Clermont      45.47
Grenoble      45.10
              …
Rennes        48.05
Strasbourg    48.35
Toulouse      43.36
Vichy         46.08
Name: Lati, Length: 15, dtype: float64
```

`.loc` and `.iloc` allow to access individual values, slices or masked selections:

[16]:
```
french_cities.loc['Rennes', "Sep"]
```

```
␣
↪---------------------------------------------------------------------------

KeyError                                  Traceback (most recent call␣
↪last)

/usr/share/miniconda3/envs/big-data/lib/python3.8/site-packages/pandas/
↪core/indexes/base.py in get_loc(self, key, method, tolerance)
   2888             try:
-> 2889                 return self._engine.get_loc(casted_key)
   2890             except KeyError as err:


pandas/_libs/index.pyx in pandas._libs.index.IndexEngine.get_loc()


pandas/_libs/index.pyx in pandas._libs.index.IndexEngine.get_loc()


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


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


KeyError: 'Sep'
```

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


       KeyError                                  Traceback (most recent call␣
↪last)

       <ipython-input-16-766b5d3b5de4> in <module>
   ----> 1 french_cities.loc['Rennes', "Sep"]


       /usr/share/miniconda3/envs/big-data/lib/python3.8/site-packages/pandas/
↪core/indexing.py in __getitem__(self, key)
       871                     # AttributeError for IntervalTree get_value
       872                     pass
   --> 873             return self._getitem_tuple(key)
       874         else:
       875             # we by definition only have the 0th axis


       /usr/share/miniconda3/envs/big-data/lib/python3.8/site-packages/pandas/
↪core/indexing.py in _getitem_tuple(self, tup)
      1042     def _getitem_tuple(self, tup: Tuple):
      1043         try:
   -> 1044             return self._getitem_lowerdim(tup)
      1045         except IndexingError:
      1046             pass


       /usr/share/miniconda3/envs/big-data/lib/python3.8/site-packages/pandas/
↪core/indexing.py in _getitem_lowerdim(self, tup)
       808                     return section
       809                 # This is an elided recursive call to iloc/loc
   --> 810                 return getattr(section, self.name)[new_key]
       811
       812         raise IndexingError("not applicable")


       /usr/share/miniconda3/envs/big-data/lib/python3.8/site-packages/pandas/
↪core/indexing.py in __getitem__(self, key)
       877
       878             maybe_callable = com.apply_if_callable(key, self.obj)
   --> 879             return self._getitem_axis(maybe_callable, axis=axis)
       880
       881     def _is_scalar_access(self, key: Tuple):
```

```
      /usr/share/miniconda3/envs/big-data/lib/python3.8/site-packages/pandas/
↪core/indexing.py in _getitem_axis(self, key, axis)
     1108         # fall thru to straight lookup
     1109         self._validate_key(key, axis)
  -> 1110         return self._get_label(key, axis=axis)
     1111
     1112     def _get_slice_axis(self, slice_obj: slice, axis: int):


      /usr/share/miniconda3/envs/big-data/lib/python3.8/site-packages/pandas/
↪core/indexing.py in _get_label(self, label, axis)
     1057     def _get_label(self, label, axis: int):
     1058         # GH#5667 this will fail if the label is not present in the␣
↪axis.
  -> 1059         return self.obj.xs(label, axis=axis)
     1060
     1061     def _handle_lowerdim_multi_index_axis0(self, tup: Tuple):


      /usr/share/miniconda3/envs/big-data/lib/python3.8/site-packages/pandas/
↪core/generic.py in xs(self, key, axis, level, drop_level)
     3480             loc, new_index = self.index.get_loc_level(key,␣
↪drop_level=drop_level)
     3481         else:
  -> 3482             loc = self.index.get_loc(key)
     3483
     3484             if isinstance(loc, np.ndarray):


      /usr/share/miniconda3/envs/big-data/lib/python3.8/site-packages/pandas/
↪core/indexes/base.py in get_loc(self, key, method, tolerance)
     2889                 return self._engine.get_loc(casted_key)
     2890             except KeyError as err:
  -> 2891                 raise KeyError(key) from err
     2892
     2893         if tolerance is not None:


      KeyError: 'Sep'
```

[17]:
```
french_cities.loc['Rennes', ["Sep", "Dec"]]
```

```
     ␣
↪---------------------------------------------------------------------------
```

```
KeyError                                  Traceback (most recent call␣
↪last)

<ipython-input-17-988685453654> in <module>
----> 1 french_cities.loc['Rennes', ["Sep", "Dec"]]


/usr/share/miniconda3/envs/big-data/lib/python3.8/site-packages/pandas/
↪core/indexing.py in __getitem__(self, key)
      871                     # AttributeError for IntervalTree get_value
      872                     pass
--> 873             return self._getitem_tuple(key)
      874         else:
      875             # we by definition only have the 0th axis


/usr/share/miniconda3/envs/big-data/lib/python3.8/site-packages/pandas/
↪core/indexing.py in _getitem_tuple(self, tup)
     1042     def _getitem_tuple(self, tup: Tuple):
     1043         try:
-> 1044             return self._getitem_lowerdim(tup)
     1045         except IndexingError:
     1046             pass


/usr/share/miniconda3/envs/big-data/lib/python3.8/site-packages/pandas/
↪core/indexing.py in _getitem_lowerdim(self, tup)
      808                     return section
      809                 # This is an elided recursive call to iloc/loc
--> 810                 return getattr(section, self.name)[new_key]
      811
      812         raise IndexingError("not applicable")


/usr/share/miniconda3/envs/big-data/lib/python3.8/site-packages/pandas/
↪core/indexing.py in __getitem__(self, key)
      877
      878             maybe_callable = com.apply_if_callable(key, self.obj)
--> 879             return self._getitem_axis(maybe_callable, axis=axis)
      880
      881     def _is_scalar_access(self, key: Tuple):


/usr/share/miniconda3/envs/big-data/lib/python3.8/site-packages/pandas/
↪core/indexing.py in _getitem_axis(self, key, axis)
     1097                     raise ValueError("Cannot index with␣
↪multidimensional key")
```

```
      1098
   -> 1099                 return self._getitem_iterable(key, axis=axis)
      1100
      1101             # nested tuple slicing


       /usr/share/miniconda3/envs/big-data/lib/python3.8/site-packages/pandas/
↪core/indexing.py in _getitem_iterable(self, key, axis)
      1035
      1036         # A collection of keys
   -> 1037         keyarr, indexer = self._get_listlike_indexer(key, axis,␣
↪raise_missing=False)
      1038         return self.obj._reindex_with_indexers(
      1039             {axis: [keyarr, indexer]}, copy=True, allow_dups=True


       /usr/share/miniconda3/envs/big-data/lib/python3.8/site-packages/pandas/
↪core/indexing.py in _get_listlike_indexer(self, key, axis, raise_missing)
      1252             keyarr, indexer, new_indexer = ax.
↪_reindex_non_unique(keyarr)
      1253
   -> 1254         self._validate_read_indexer(keyarr, indexer, axis,␣
↪raise_missing=raise_missing)
      1255         return keyarr, indexer
      1256


       /usr/share/miniconda3/envs/big-data/lib/python3.8/site-packages/pandas/
↪core/indexing.py in _validate_read_indexer(self, key, indexer, axis,␣
↪raise_missing)
      1296             if missing == len(indexer):
      1297                 axis_name = self.obj._get_axis_name(axis)
   -> 1298                 raise KeyError(f"None of [{key}] are in the␣
↪[{axis_name}]")
      1299
      1300             # We (temporarily) allow for some missing keys with .
↪loc, except in


       KeyError: "None of [Index(['Sep', 'Dec'], dtype='object')] are in the␣
↪[index]"
```

[18]:
```
french_cities.loc['Rennes', "Sep":"Dec"]
```

```
      ␣
↪---------------------------------------------------------------------------

      KeyError                                  Traceback (most recent call␣
↪last)

      /usr/share/miniconda3/envs/big-data/lib/python3.8/site-packages/pandas/
↪core/indexes/base.py in get_loc(self, key, method, tolerance)
      2888             try:
   -> 2889                 return self._engine.get_loc(casted_key)
      2890             except KeyError as err:


      pandas/_libs/index.pyx in pandas._libs.index.IndexEngine.get_loc()


      pandas/_libs/index.pyx in pandas._libs.index.IndexEngine.get_loc()


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


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


      KeyError: 'Sep'


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


      KeyError                                  Traceback (most recent call␣
↪last)

      <ipython-input-18-9347c35b6c44> in <module>
   ----> 1 french_cities.loc['Rennes', "Sep":"Dec"]


      /usr/share/miniconda3/envs/big-data/lib/python3.8/site-packages/pandas/
↪core/indexing.py in __getitem__(self, key)
      871                     # AttributeError for IntervalTree get_value
      872                     pass
   --> 873             return self._getitem_tuple(key)
      874         else:
      875             # we by definition only have the 0th axis
```

```
      /usr/share/miniconda3/envs/big-data/lib/python3.8/site-packages/pandas/
↪core/indexing.py in _getitem_tuple(self, tup)
      1042     def _getitem_tuple(self, tup: Tuple):
      1043         try:
   -> 1044             return self._getitem_lowerdim(tup)
      1045         except IndexingError:
      1046             pass


      /usr/share/miniconda3/envs/big-data/lib/python3.8/site-packages/pandas/
↪core/indexing.py in _getitem_lowerdim(self, tup)
       808                     return section
       809                 # This is an elided recursive call to iloc/loc
   --> 810                 return getattr(section, self.name)[new_key]
       811
       812         raise IndexingError("not applicable")


      /usr/share/miniconda3/envs/big-data/lib/python3.8/site-packages/pandas/
↪core/indexing.py in __getitem__(self, key)
       877
       878             maybe_callable = com.apply_if_callable(key, self.obj)
   --> 879             return self._getitem_axis(maybe_callable, axis=axis)
       880
       881     def _is_scalar_access(self, key: Tuple):


      /usr/share/miniconda3/envs/big-data/lib/python3.8/site-packages/pandas/
↪core/indexing.py in _getitem_axis(self, key, axis)
      1086         if isinstance(key, slice):
      1087             self._validate_key(key, axis)
   -> 1088             return self._get_slice_axis(key, axis=axis)
      1089         elif com.is_bool_indexer(key):
      1090             return self._getbool_axis(key, axis=axis)


      /usr/share/miniconda3/envs/big-data/lib/python3.8/site-packages/pandas/
↪core/indexing.py in _get_slice_axis(self, slice_obj, axis)
      1120
      1121         labels = obj._get_axis(axis)
   -> 1122         indexer = labels.slice_indexer(
      1123             slice_obj.start, slice_obj.stop, slice_obj.step,␣
↪kind="loc"
      1124         )
```

```
       /usr/share/miniconda3/envs/big-data/lib/python3.8/site-packages/pandas/
↪core/indexes/base.py in slice_indexer(self, start, end, step, kind)
      4958         slice(1, 3, None)
      4959         """
   -> 4960         start_slice, end_slice = self.slice_locs(start, end,␣
↪step=step, kind=kind)
      4961
      4962         # return a slice


       /usr/share/miniconda3/envs/big-data/lib/python3.8/site-packages/pandas/
↪core/indexes/base.py in slice_locs(self, start, end, step, kind)
      5159         start_slice = None
      5160         if start is not None:
   -> 5161             start_slice = self.get_slice_bound(start, "left", kind)
      5162         if start_slice is None:
      5163             start_slice = 0


       /usr/share/miniconda3/envs/big-data/lib/python3.8/site-packages/pandas/
↪core/indexes/base.py in get_slice_bound(self, label, side, kind)
      5081             except ValueError:
      5082                 # raise the original KeyError
   -> 5083                 raise err
      5084
      5085         if isinstance(slc, np.ndarray):


       /usr/share/miniconda3/envs/big-data/lib/python3.8/site-packages/pandas/
↪core/indexes/base.py in get_slice_bound(self, label, side, kind)
      5075         # we need to look up the label
      5076         try:
   -> 5077             slc = self.get_loc(label)
      5078         except KeyError as err:
      5079             try:


       /usr/share/miniconda3/envs/big-data/lib/python3.8/site-packages/pandas/
↪core/indexes/base.py in get_loc(self, key, method, tolerance)
      2889                 return self._engine.get_loc(casted_key)
      2890             except KeyError as err:
   -> 2891                 raise KeyError(key) from err
      2892
      2893         if tolerance is not None:
```

```
KeyError: 'Sep'
```

1.7 Masking

[19]:
```
mask = [True, False] * 6 + 5 * [False]
print(french_cities.iloc[:, mask])
```

```
            Janv  Mars   Mai  juil  Sept  Nove
City
Bordeaux     5.6  10.3  15.8  20.9  18.6   9.1
Brest        6.1   7.8  11.6  15.6  14.7   9.0
Clermont     2.6   7.5  13.8  19.4  16.2   6.6
Grenoble     1.5   7.7  14.5  20.1  16.7   6.5
…            …     …    …     …     …      …
Rennes       4.8   7.9  13.1  17.9  15.7   7.8
Strasbourg   0.4   5.6  14.0  19.0  15.1   4.9
Toulouse     4.7   9.2  14.9  20.9  18.3   8.6
Vichy        2.4   7.1  13.6  19.3  16.0   6.6

[15 rows x 6 columns]
```

[20]:
```
print(french_cities.loc["Rennes", mask])
```

```
Janv     4.8
Mars     7.9
Mai     13.1
juil    17.9
Sept    15.7
Nove     7.8
Name: Rennes, dtype: object
```

1.8 New column

[21]:
```
french_cities["std"] = french_cities.iloc[:,:12].std(axis=1)
french_cities
```

[21]:
```
            Janv  Févr  Mars  Avri   Mai  Juin  juil  Août  Sept  Octo  Nove  \
City
Bordeaux     5.6   6.6  10.3  12.8  15.8  19.3  20.9  21.0  18.6  13.8   9.1
Brest        6.1   5.8   7.8   9.2  11.6  14.4  15.6  16.0  14.7  12.0   9.0
Clermont     2.6   3.7   7.5  10.3  13.8  17.3  19.4  19.1  16.2  11.2   6.6
Grenoble     1.5   3.2   7.7  10.6  14.5  17.8  20.1  19.5  16.7  11.4   6.5
…            …     …     …    …     …     …     …     …     …     …     …
Rennes       4.8   5.3   7.9  10.1  13.1  16.2  17.9  17.8  15.7  11.6   7.8
Strasbourg   0.4   1.5   5.6   9.8  14.0  17.2  19.0  18.3  15.1   9.5   4.9
```

```
Toulouse     4.7   5.6   9.2  11.6  14.9  18.7  20.9  20.9  18.3  13.3   8.6
Vichy        2.4   3.4   7.1   9.9  13.6  17.1  19.3  18.8  16.0  11.0   6.6

             Déce   Lati  Long   Mean  Ampl Région       std
City
Bordeaux      6.2  44.50 -0.34  13.33  15.4     SO  5.792681
Brest         7.0  48.24 -4.29  10.77  10.2     NO  3.773673
Clermont      3.6  45.47  3.05  10.94  16.8     SE  6.189795
Grenoble      2.3  45.10  5.43  10.98  18.6     SE  6.770771
…           …    …    …    …    …    …       …
Rennes        5.4  48.05 -1.41  11.13  13.1     NO  4.958800
Strasbourg    1.3  48.35  7.45   9.72  18.6     NE  6.931723
Toulouse      5.5  43.36  1.26  12.68  16.2     SO  6.056977
Vichy         3.4  46.08  3.26  10.72  16.9     SE  6.201148

[15 rows x 18 columns]
```

[22]:
```
french_cities = french_cities.drop("std", axis=1) # remove this new column
```

[23]:
```
french_cities
```

[23]:
```
             Janv  Févr  Mars  Avri   Mai  Juin  juil  Août  Sept  Octo  Nove  \
City
Bordeaux      5.6   6.6  10.3  12.8  15.8  19.3  20.9  21.0  18.6  13.8   9.1
Brest         6.1   5.8   7.8   9.2  11.6  14.4  15.6  16.0  14.7  12.0   9.0
Clermont      2.6   3.7   7.5  10.3  13.8  17.3  19.4  19.1  16.2  11.2   6.6
Grenoble      1.5   3.2   7.7  10.6  14.5  17.8  20.1  19.5  16.7  11.4   6.5
…           …    …    …    …    …    …    …    …    …    …    …
Rennes        4.8   5.3   7.9  10.1  13.1  16.2  17.9  17.8  15.7  11.6   7.8
Strasbourg    0.4   1.5   5.6   9.8  14.0  17.2  19.0  18.3  15.1   9.5   4.9
Toulouse      4.7   5.6   9.2  11.6  14.9  18.7  20.9  20.9  18.3  13.3   8.6
Vichy         2.4   3.4   7.1   9.9  13.6  17.1  19.3  18.8  16.0  11.0   6.6

             Déce   Lati  Long   Mean  Ampl Région
City
Bordeaux      6.2  44.50 -0.34  13.33  15.4     SO
Brest         7.0  48.24 -4.29  10.77  10.2     NO
Clermont      3.6  45.47  3.05  10.94  16.8     SE
Grenoble      2.3  45.10  5.43  10.98  18.6     SE
…           …    …    …    …    …
Rennes        5.4  48.05 -1.41  11.13  13.1     NO
Strasbourg    1.3  48.35  7.45   9.72  18.6     NE
Toulouse      5.5  43.36  1.26  12.68  16.2     SO
Vichy         3.4  46.08  3.26  10.72  16.9     SE

[15 rows x 17 columns]
```

1.9 Modifying a dataframe with multiple indexing

[24]:
```
# french_cities['Rennes']['Sep'] = 25 # It does not works and breaks the␣
↪DataFrame
french_cities.loc['Rennes']['Sep'] # = 25 is the right way to do it
```

```
      ␣
↪---------------------------------------------------------------------------

      KeyError                                  Traceback (most recent call␣
↪last)

      /usr/share/miniconda3/envs/big-data/lib/python3.8/site-packages/pandas/
↪core/indexes/base.py in get_loc(self, key, method, tolerance)
      2888             try:
   -> 2889                 return self._engine.get_loc(casted_key)
      2890             except KeyError as err:


      pandas/_libs/index.pyx in pandas._libs.index.IndexEngine.get_loc()


      pandas/_libs/index.pyx in pandas._libs.index.IndexEngine.get_loc()


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


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


      KeyError: 'Sep'


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


      KeyError                                  Traceback (most recent call␣
↪last)

      <ipython-input-24-c68575f89e60> in <module>
        1 # french_cities['Rennes']['Sep'] = 25 # It does not works and breaks␣
↪the DataFrame
   ----> 2 french_cities.loc['Rennes']['Sep'] # = 25 is the right way to do it
```

```
       /usr/share/miniconda3/envs/big-data/lib/python3.8/site-packages/pandas/
↪core/series.py in __getitem__(self, key)
       880
       881         elif key_is_scalar:
   --> 882             return self._get_value(key)
       883
       884         if (


       /usr/share/miniconda3/envs/big-data/lib/python3.8/site-packages/pandas/
↪core/series.py in _get_value(self, label, takeable)
       989
       990         # Similar to Index.get_value, but we do not fall back to␣
↪positional
   --> 991         loc = self.index.get_loc(label)
       992         return self.index._get_values_for_loc(self, loc, label)
       993


       /usr/share/miniconda3/envs/big-data/lib/python3.8/site-packages/pandas/
↪core/indexes/base.py in get_loc(self, key, method, tolerance)
      2889                 return self._engine.get_loc(casted_key)
      2890             except KeyError as err:
   -> 2891                 raise KeyError(key) from err
      2892
      2893         if tolerance is not None:


       KeyError: 'Sep'
```

[25]:
```
french_cities
```

[25]:

City	Janv	Févr	Mars	Avri	Mai	Juin	juil	Août	Sept	Octo	Nove	\
Bordeaux	5.6	6.6	10.3	12.8	15.8	19.3	20.9	21.0	18.6	13.8	9.1	
Brest	6.1	5.8	7.8	9.2	11.6	14.4	15.6	16.0	14.7	12.0	9.0	
Clermont	2.6	3.7	7.5	10.3	13.8	17.3	19.4	19.1	16.2	11.2	6.6	
Grenoble	1.5	3.2	7.7	10.6	14.5	17.8	20.1	19.5	16.7	11.4	6.5	
…	…	…	…	…	…	…	…	…	…	…	…	
Rennes	4.8	5.3	7.9	10.1	13.1	16.2	17.9	17.8	15.7	11.6	7.8	
Strasbourg	0.4	1.5	5.6	9.8	14.0	17.2	19.0	18.3	15.1	9.5	4.9	
Toulouse	4.7	5.6	9.2	11.6	14.9	18.7	20.9	20.9	18.3	13.3	8.6	
Vichy	2.4	3.4	7.1	9.9	13.6	17.1	19.3	18.8	16.0	11.0	6.6	

```
            Déce   Lati  Long   Mean  Ampl Région
City
Bordeaux     6.2  44.50 -0.34  13.33  15.4     SO
Brest        7.0  48.24 -4.29  10.77  10.2     NO
Clermont     3.6  45.47  3.05  10.94  16.8     SE
Grenoble     2.3  45.10  5.43  10.98  18.6     SE
…            …     …     …     …     …     …
Rennes       5.4  48.05 -1.41  11.13  13.1     NO
Strasbourg   1.3  48.35  7.45   9.72  18.6     NE
Toulouse     5.5  43.36  1.26  12.68  16.2     SO
Vichy        3.4  46.08  3.26  10.72  16.9     SE

[15 rows x 17 columns]
```

1.10 Transforming datasets

[26]:
```
french_cities['Mean'].min(), french_cities['Ampl'].max()
```

[26]:
```
(9.72, 18.6)
```

1.11 Apply

Let's convert the temperature mean from Celsius to Fahrenheit degree.

[27]:
```
fahrenheit = lambda T: T*9/5+32
french_cities['Mean'].apply(fahrenheit)
```

[27]:
```
City
Bordeaux      55.994
Brest         51.386
Clermont      51.692
Grenoble      51.764
               …
Rennes        52.034
Strasbourg    49.496
Toulouse      54.824
Vichy         51.296
Name: Mean, Length: 15, dtype: float64
```

1.12 Sort

[28]:
```
french_cities.sort_values(by='Lati')
```

[28]:

City	Janv	Févr	Mars	Avri	Mai	Juin	juil	Août	Sept	Octo	Nove
Marseille	5.5	6.6	10.0	13.0	16.8	20.8	23.3	22.8	19.9	15.0	10.2
Montpellier	5.6	6.7	9.9	12.8	16.2	20.1	22.7	22.3	19.3	14.6	10.0
Toulouse	4.7	5.6	9.2	11.6	14.9	18.7	20.9	20.9	18.3	13.3	8.6
Nice	7.5	8.5	10.8	13.3	16.7	20.1	22.7	22.5	20.3	16.0	11.5
…	…	…	…	…	…	…	…	…	…	…	…
Brest	6.1	5.8	7.8	9.2	11.6	14.4	15.6	16.0	14.7	12.0	9.0
Strasbourg	0.4	1.5	5.6	9.8	14.0	17.2	19.0	18.3	15.1	9.5	4.9
Paris	3.4	4.1	7.6	10.7	14.3	17.5	19.1	18.7	16.0	11.4	7.1
Lille	2.4	2.9	6.0	8.9	12.4	15.3	17.1	17.1	14.7	10.4	6.1

City	Déce	Lati	Long	Mean	Ampl	Région
Marseille	6.9	43.18	5.24	14.23	17.8	SE
Montpellier	6.5	43.36	3.53	13.89	17.1	SE
Toulouse	5.5	43.36	1.26	12.68	16.2	SO
Nice	8.2	43.42	7.15	14.84	15.2	SE
…	…	…	…	…	…	…
Brest	7.0	48.24	-4.29	10.77	10.2	NO
Strasbourg	1.3	48.35	7.45	9.72	18.6	NE
Paris	4.3	48.52	2.20	11.18	15.7	NE
Lille	3.5	50.38	3.04	9.73	14.7	NE

[15 rows x 17 columns]

[29]:
```
french_cities = french_cities.sort_values(by='Lati',ascending=False)
french_cities
```

[29]:

City	Janv	Févr	Mars	Avri	Mai	Juin	juil	Août	Sept	Octo	Nove
Lille	2.4	2.9	6.0	8.9	12.4	15.3	17.1	17.1	14.7	10.4	6.1
Paris	3.4	4.1	7.6	10.7	14.3	17.5	19.1	18.7	16.0	11.4	7.1
Strasbourg	0.4	1.5	5.6	9.8	14.0	17.2	19.0	18.3	15.1	9.5	4.9
Brest	6.1	5.8	7.8	9.2	11.6	14.4	15.6	16.0	14.7	12.0	9.0
…	…	…	…	…	…	…	…	…	…	…	…
Nice	7.5	8.5	10.8	13.3	16.7	20.1	22.7	22.5	20.3	16.0	11.5
Montpellier	5.6	6.7	9.9	12.8	16.2	20.1	22.7	22.3	19.3	14.6	10.0
Toulouse	4.7	5.6	9.2	11.6	14.9	18.7	20.9	20.9	18.3	13.3	8.6
Marseille	5.5	6.6	10.0	13.0	16.8	20.8	23.3	22.8	19.9	15.0	10.2

City	Déce	Lati	Long	Mean	Ampl	Région
Lille	3.5	50.38	3.04	9.73	14.7	NE
Paris	4.3	48.52	2.20	11.18	15.7	NE
Strasbourg	1.3	48.35	7.45	9.72	18.6	NE
Brest	7.0	48.24	-4.29	10.77	10.2	NO

```
…             …    …    …    …    …    …
Nice          8.2  43.42  7.15  14.84  15.2     SE
Montpellier   6.5  43.36  3.53  13.89  17.1     SE
Toulouse      5.5  43.36  1.26  12.68  16.2     SO
Marseille     6.9  43.18  5.24  14.23  17.8     SE

[15 rows x 17 columns]
```

1.13 Stack and unstack

Instead of seeing the months along the axis 1, and the cities along the axis 0, let's try to convert these into an outer and an inner axis along only 1 time dimension.

[30]:
```
pd.set_option("display.max_rows", 20)
unstacked = french_cities.iloc[:,:12].unstack()
unstacked
```

[30]:
```
      City
Janv  Lille          2.4
      Paris          3.4
      Strasbourg     0.4
      Brest          6.1
      Rennes         4.8
                    …
Déce  Bordeaux       6.2
      Nice           8.2
      Montpellier    6.5
      Toulouse       5.5
      Marseille      6.9
Length: 180, dtype: float64
```

[31]:
```
type(unstacked)
```

[31]:
```
pandas.core.series.Series
```

1.14 Transpose

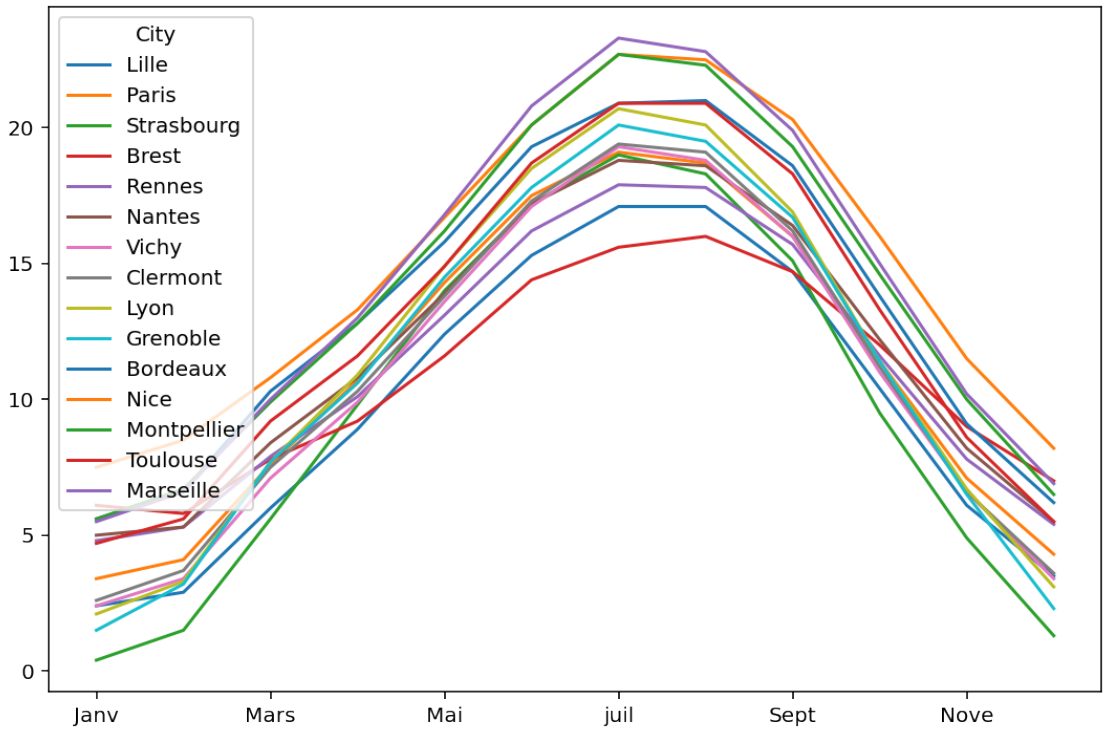
The result is grouped in the wrong order since it sorts first the axis that was unstacked. We need to transpose the dataframe.

[32]:
```
city_temp = french_cities.iloc[:,:12].transpose()
city_temp.plot()
```

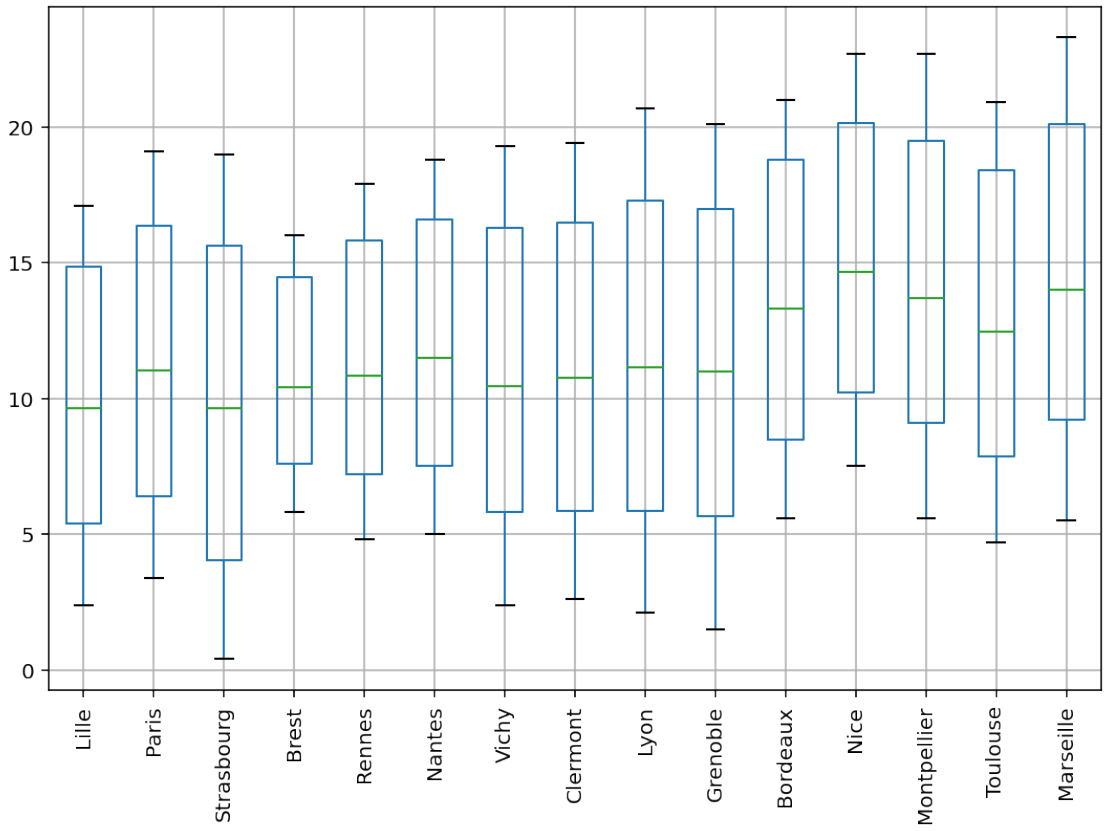
```
/usr/share/miniconda3/envs/big-data/lib/python3.8/site-
packages/pandas/plotting/_matplotlib/core.py:1235: UserWarning: FixedFormatter
```

```
should only be used together with FixedLocator
  ax.set_xticklabels(xticklabels)
```

[32]: <AxesSubplot:>



[33]:
```
city_temp.boxplot(rot=90);
```



1.15 Describing

[34]:
```
french_cities['Région'].describe()
```

[34]:
```
count     15
unique     4
top       SE
freq       7
Name: Région, dtype: object
```

[35]:
```
french_cities['Région'].unique()
```

[35]:
```
array(['NE', 'NO', 'SE', 'SO'], dtype=object)
```

[36]:
```
french_cities['Région'].value_counts()
```

[36]:
```
SE    7
NO    3
NE    3
```

```
SO    2
Name: Région, dtype: int64
```

[37]:
```
# To save memory, we can convert it to a categorical column:
french_cities["Région"] = french_cities["Région"].astype("category")
```

[38]:
```
french_cities.memory_usage()
```

[38]:
```
Index     760
Janv      120
Févr      120
Mars      120
Avri      120
Mai       120
Juin      120
juil      120
Août      120
Sept      120
Octo      120
Nove      120
Déce      120
Lati      120
Long      120
Mean      120
Ampl      120
Région    207
dtype: int64
```

1.16 Data Aggregation/summarization

1.17 groupby

[39]:
```
fc_grouped_region = french_cities.groupby("Région")
type(fc_grouped_region)
```

[39]:
```
pandas.core.groupby.generic.DataFrameGroupBy
```

[40]:
```
for group_name, subdf in fc_grouped_region:
    print(group_name)
    print(subdf)
    print("")
```

```
NE
            Janv  Févr  Mars  Avri   Mai  Juin  juil  Août  Sept  Octo  Nove  \
City
Lille        2.4   2.9   6.0   8.9  12.4  15.3  17.1  17.1  14.7  10.4   6.1
```

```
Paris        3.4   4.1   7.6  10.7  14.3  17.5  19.1  18.7  16.0  11.4   7.1
Strasbourg   0.4   1.5   5.6   9.8  14.0  17.2  19.0  18.3  15.1   9.5   4.9

            Déce   Lati  Long   Mean  Ampl Région
City
Lille        3.5  50.38  3.04   9.73  14.7     NE
Paris        4.3  48.52  2.20  11.18  15.7     NE
Strasbourg   1.3  48.35  7.45   9.72  18.6     NE

NO
        Janv  Févr  Mars  Avri   Mai  Juin  juil  Août  Sept  Octo  Nove  \
City
Brest    6.1   5.8   7.8   9.2  11.6  14.4  15.6  16.0  14.7  12.0   9.0
Rennes   4.8   5.3   7.9  10.1  13.1  16.2  17.9  17.8  15.7  11.6   7.8
Nantes   5.0   5.3   8.4  10.8  13.9  17.2  18.8  18.6  16.4  12.2   8.2

        Déce   Lati  Long   Mean  Ampl Région
City
Brest    7.0  48.24 -4.29  10.77  10.2     NO
Rennes   5.4  48.05 -1.41  11.13  13.1     NO
Nantes   5.5  47.13 -1.33  11.69  13.8     NO

SE
             Janv  Févr  Mars  Avri   Mai  Juin  juil  Août  Sept  Octo  Nove  \
City
Vichy         2.4   3.4   7.1   9.9  13.6  17.1  19.3  18.8  16.0  11.0   6.6
Clermont      2.6   3.7   7.5  10.3  13.8  17.3  19.4  19.1  16.2  11.2   6.6
Lyon          2.1   3.3   7.7  10.9  14.9  18.5  20.7  20.1  16.9  11.4   6.7
Grenoble      1.5   3.2   7.7  10.6  14.5  17.8  20.1  19.5  16.7  11.4   6.5
Nice          7.5   8.5  10.8  13.3  16.7  20.1  22.7  22.5  20.3  16.0  11.5
Montpellier   5.6   6.7   9.9  12.8  16.2  20.1  22.7  22.3  19.3  14.6  10.0
Marseille     5.5   6.6  10.0  13.0  16.8  20.8  23.3  22.8  19.9  15.0  10.2

             Déce   Lati  Long   Mean  Ampl Région
City
Vichy         3.4  46.08  3.26  10.72  16.9     SE
Clermont      3.6  45.47  3.05  10.94  16.8     SE
Lyon          3.1  45.45  4.51  11.36  18.6     SE
Grenoble      2.3  45.10  5.43  10.98  18.6     SE
Nice          8.2  43.42  7.15  14.84  15.2     SE
Montpellier   6.5  43.36  3.53  13.89  17.1     SE
Marseille     6.9  43.18  5.24  14.23  17.8     SE

SO
          Janv  Févr  Mars  Avri   Mai  Juin  juil  Août  Sept  Octo  Nove  \
City
Bordeaux   5.6   6.6  10.3  12.8  15.8  19.3  20.9  21.0  18.6  13.8   9.1
Toulouse   4.7   5.6   9.2  11.6  14.9  18.7  20.9  20.9  18.3  13.3   8.6
```

City	Déce	Lati	Long	Mean	Ampl	Région
Bordeaux	6.2	44.50	-0.34	13.33	15.4	SO
Toulouse	5.5	43.36	1.26	12.68	16.2	SO