How to use dates & times with pandas

MANIPULATING TIME SERIES DATA IN PYTHON

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Date & time series functionality

- At the root: data types for date & time information
  - Objects for points in time and periods
  - Attributes & methods reflect time-related details
- Sequences of dates & periods:
  - Series or DataFrame columns
  - Index: convert object into Time Series
- Many Series/DataFrame methods rely on time information in the index to provide time-series functionality

Basic building block: pd.Timestamp

```
import pandas as pd  # assumed imported going forward
from datetime import datetime  # To manually create dates
time_stamp = pd.Timestamp(datetime(2017, 1, 1))
pd.Timestamp('2017-01-01') == time_stamp
```

```
True # Understands dates as strings
```

```
time_stamp # type: pandas.tslib.Timestamp
```

```
Timestamp('2017-01-01 00:00:00')
```

Basic building block: pd.Timestamp

- Timestamp object has many attributes to store time-specific information

```
time_stamp.year
```

```
2017
```

```
time_stamp.day_name()
```

```
'Sunday'
```

More building blocks: pd.Period & freq

```
period = pd.Period('2017-01')
period # default: month-end
```

```
Period('2017-01', 'M')
```

```
period.asfreq('D') # convert to daily
```

```
Period('2017-01-31', 'D')
```

```
period.to_timestamp().to_period('M')
```

```
Period('2017-01', 'M')
```

- Period object has freq attribute to store frequency info
- Convert `pd.Period()` to `pd.Timestamp()` and back

More building blocks: pd.Period & freq

```
period + 2
```

```
Period('2017-03', 'M')
```

```
pd.Timestamp('2017-01-31', 'M') + 1
```

```
Timestamp('2017-02-28 00:00:00', freq='M')
```

- Frequency info enables basic date arithmetic

Sequences of dates & times

- `pd.date_range` : `start` , `end` , `periods` , `freq`

```
index = pd.date_range(start='2017-1-1', periods=12, freq='M')
```

```
index
```

```
DatetimeIndex(['2017-01-31', '2017-02-28', '2017-03-31', ...,
               '2017-09-30', '2017-10-31', '2017-11-30', '2017-12-31'],
              dtype='datetime64[ns]', freq='M')
```

- `pd.DateTimeIndex` : sequence of Timestamp objects with frequency info

Sequences of dates & times

```
index[0]
```

```
Timestamp('2017-01-31 00:00:00', freq='M')
```

```
index.to_period()
```

```
PeriodIndex(['2017-01', '2017-02', '2017-03', '2017-04', ...,
             '2017-11', '2017-12'], dtype='period[M]', freq='M')
```

Create a time series: pd.DateTimeIndex

```
pd.DataFrame({'data': index}).info()
```

```
RangeIndex: 12 entries, 0 to 11
Data columns (total 1 columns):
data    12 non-null datetime64[ns]
dtypes: datetime64[ns](1)
```

Create a time series: pd.DateTimeIndex

- `np.random.random` :
  - Random numbers: `[0,1]`
  - 12 rows, 2 columns

```
data = np.random.random((size=12,2))
pd.DataFrame(data=data, index=index).info()
```

```
DatetimeIndex: 12 entries, 2017-01-31 to 2017-12-31
Freq: M
Data columns (total 2 columns):
0    12 non-null float64
1    12 non-null float64
dtypes: float64(2)
```

Frequency aliases & time info

There are many frequency aliases besides ‘M’ and ‘D’:

Period	Alias
Hour	H
Day	D
Week	W
Month	M
Quarter	Q
Year	A

These may be further differentiated by beginning/end of period, or business-specific definition

You can also access these **pd.Timestamp()** attributes:

attribute
.second, .minute, .hour,
.day, .month, .quarter, .year
.weekday
dayofweek
.weekofyear
.dayofyear

Let's practice!

MANIPULATING TIME SERIES DATA IN PYTHON

Indexing & resampling time series

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Time series transformation

Basic time series transformations include:

- Parsing string dates and convert to `datetime64`
- Selecting & slicing for specific subperiods
- Setting & changing `DateTimeIndex` frequency
  - Upsampling vs Downsampling

Getting GOOG stock prices

```
google = pd.read_csv('google.csv')  # import pandas as pd
google.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 504 entries, 0 to 503
Data columns (total 2 columns):
date     504 non-null object
price    504 non-null float64
dtypes: float64(1), object(1)
```

```
google.head()
```

```
         date   price
0  2015-01-02  524.81
1  2015-01-05  513.87
2  2015-01-06  501.96
3  2015-01-07  501.10
4  2015-01-08  502.68
```

Converting string dates to datetime64

- `pd.to_datetime()`:
  - Parse date string
  - Convert to `datetime64`

```
google.date = pd.to_datetime(google.date)
google.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 504 entries, 0 to 503
Data columns (total 2 columns):
date     504 non-null datetime64[ns]
price    504 non-null float64
dtypes: datetime64[ns](1), float64(1)
```

Converting string dates to datetime64

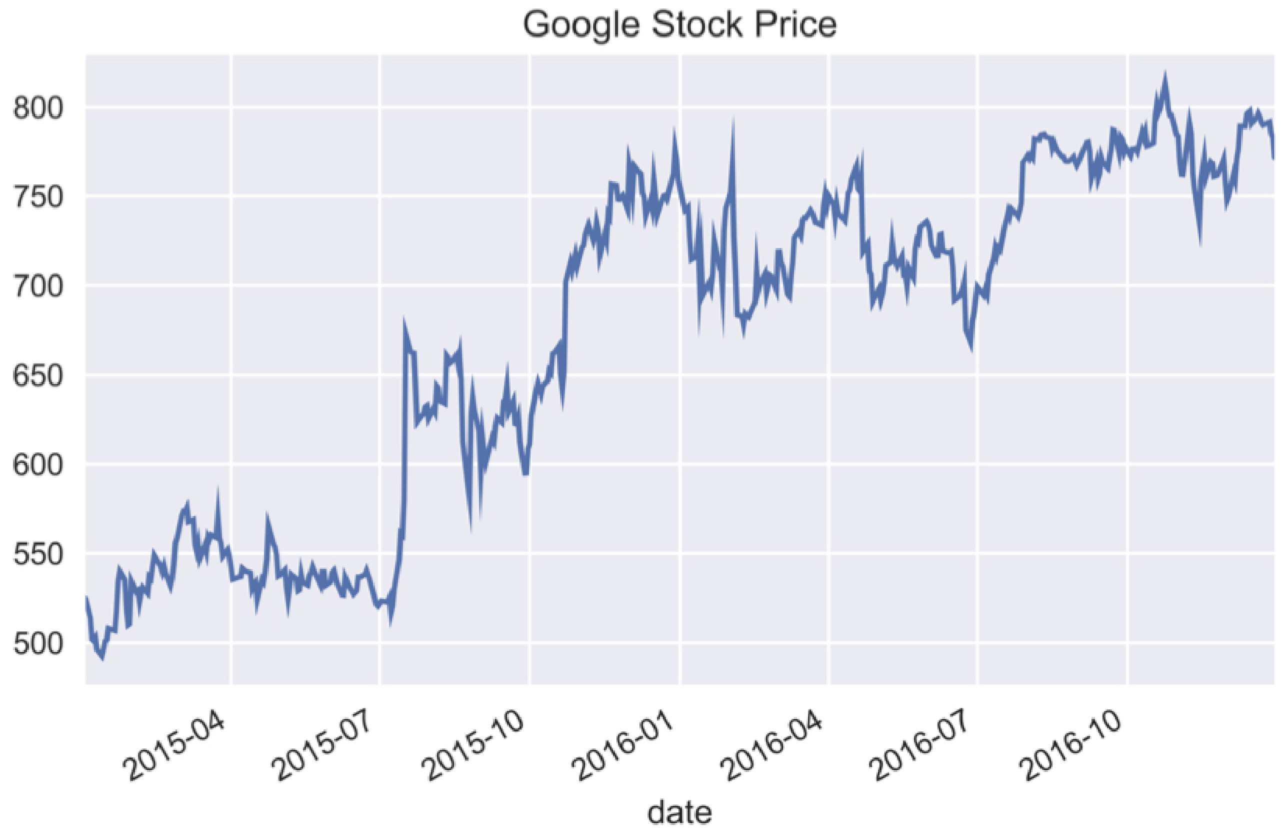
- `.set_index()` :
  - Date into index
  - `inplace` :
    - don't create copy

```
google.set_index('date', inplace=True)
google.info()
```

```
<class 'pandas.core.frame.DataFrame'>
DatetimeIndex: 504 entries, 2015-01-02 to 2016-12-30
Data columns (total 1 columns):
price    504 non-null float64
dtypes: float64(1)
```

Plotting the Google stock time series

```
google.price.plot(title='Google Stock Price')
plt.tight_layout(); plt.show()
```



Partial string indexing

- Selecting/indexing using strings that parse to dates

```
google['2015'].info() # Pass string for part of date
```

```
DatetimeIndex: 252 entries, 2015-01-02 to 2015-12-31
Data columns (total 1 columns):
price    252 non-null float64
dtypes: float64(1)
```

```
google['2015-3': '2016-2'].info() # Slice includes last month
```

```
DatetimeIndex: 252 entries, 2015-03-02 to 2016-02-29
Data columns (total 1 columns):
price    252 non-null float64
dtypes: float64(1)
memory usage: 3.9 KB
```

Partial string indexing

```
google.loc['2016-6-1', 'price'] # Use full date with .loc[]
```

```
734.15
```

.asfreq(): set frequency

- `.asfreq('D')`:
  - Convert `DateTimeIndex` to calendar day frequency

```
google.asfreq('D').info() # set calendar day frequency
```

```
DatetimeIndex: 729 entries, 2015-01-02 to 2016-12-30
Freq: D
Data columns (total 1 columns):
price    504 non-null float64
dtypes: float64(1)
```

.asfreq(): set frequency

- Upsampling:
  - Higher frequency implies new dates => missing data

```
google.asfreq('D').head()
```

```
             price
date
2015-01-02  524.81
2015-01-03     NaN
2015-01-04     NaN
2015-01-05  513.87
2015-01-06  501.96
```

.asfreq(): reset frequency

- `.asfreq('B')` :
  - Convert `DateTimeIndex` to business day frequency

```
google = google.asfreq('B') # Change to calendar day frequency
google.info()
```

```
DatetimeIndex: 521 entries, 2015-01-02 to 2016-12-30
Freq: B
Data columns (total 1 columns):
price    504 non-null float64
dtypes: float64(1)
```

.asfreq(): reset frequency

```
google[google.price.isnull()] # Select missing 'price' values
```

```
            price
date
2015-01-19    NaN
2015-02-16    NaN
...
2016-11-24    NaN
2016-12-26    NaN
```

- Business days that were not trading days

Let's practice!

MANIPULATING TIME SERIES DATA IN PYTHON

Lags, changes, and returns for stock price series

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Basic time series calculations

- Typical Time Series manipulations include:
  - Shift or lag values back or forward back in time
  - Get the difference in value for a given time period
  - Compute the percent change over any number of periods
- `pandas` built-in methods rely on `pd.DateTimeIndex`

Getting GOOG stock prices

- Let `pd.read_csv()` do the parsing for you!

```
google = pd.read_csv('google.csv', parse_dates=['date'], index_col='date')
```

```
google.info()
```

```
<class 'pandas.core.frame.DataFrame'>
DatetimeIndex: 504 entries, 2015-01-02 to 2016-12-30
Data columns (total 1 columns):
price    504 non-null float64
dtypes: float64(1)
```

Getting GOOG stock prices

```
google.head()
```

```
            price
date
2015-01-02  524.81
2015-01-05  513.87
2015-01-06  501.96
2015-01-07  501.10
2015-01-08  502.68
```

.shift(): Moving data between past & future

- `.shift()`:
  - defaults to `periods=1`
  - 1 period into future

```
google['shifted'] = google.price.shift() # default: periods=1
google.head(3)
```

```
             price  shifted
date
2015-01-02  542.81      NaN
2015-01-05  513.87   542.81
2015-01-06  501.96   513.87
```

.shift(): Moving data between past & future

- `.shift(periods=-1)` :
  - lagged data
  - 1 period back in time

```
google['lagged'] = google.price.shift(periods=-1)
google[['price', 'lagged', 'shifted']].tail(3)
```

```
             price  lagged  shifted
date
2016-12-28  785.05  782.79   791.55
2016-12-29  782.79  771.82   785.05
2016-12-30  771.82     NaN   782.79
```

Calculate one-period percent change

- x_t / x_{t-1}

```
google['change'] = google.price.div(google.shifted)
google[['price', 'shifted', 'change']].head(3)
```

```
             price  shifted    change
Date
2017-01-03  786.14      NaN       NaN
2017-01-04  786.90   786.14  1.000967
2017-01-05  794.02   786.90  1.009048
```

Calculate one-period percent change

```
google['return'] = google.change.sub(1).mul(100)
google[['price', 'shifted', 'change', 'return']].head(3)
```

```
             price  shifted  change  return
date
2015-01-02  524.81      NaN     NaN     NaN
2015-01-05  513.87   524.81    0.98   -2.08
2015-01-06  501.96   513.87    0.98   -2.32
```

.diff(): built-in time-series change

- Difference in value for two adjacent periods
- $x_t - x_{t-1}$

```
google['diff'] = google.price.diff()
google[['price', 'diff']].head(3)
```

```
             price    diff
date
2015-01-02  524.81     NaN
2015-01-05  513.87  -10.94
2015-01-06  501.96  -11.91
```

.pct_change(): built-in time-series % change

- Percent change for two adjacent periods
- $\frac{x_t}{x_{t-1}}$

```
google['pct_change'] = google.price.pct_change().mul(100)
google[['price', 'return', 'pct_change']].head(3)
```

```
             price    return  pct_change
date
2015-01-02  524.81       NaN         NaN
2015-01-05  513.87     -2.08       -2.08
2015-01-06  501.96     -2.32       -2.32
```

Looking ahead: Get multi-period returns

```
google['return_3d'] = google.price.pct_change(periods=3).mul(100)
google[['price', 'return_3d']].head()
```

```
             price  return_3d
date
2015-01-02  524.81        NaN
2015-01-05  513.87        NaN
2015-01-06  501.96        NaN
2015-01-07  501.10  -4.517825
2015-01-08  502.68  -2.177594
```

- Percent change for two periods, 3 trading days apart

Let's practice!

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