# pandas resample

November 26, 2018

ww# Examples of the use of *pandas.resample()* to calculate sum and average in different periods

## 0.1 The input file has measurements of air temperature, relative humidity and radiation, as well as a timestamp field for each measurement. It includes one complete day of measurements, taken every 5 minutes, approximately. The measurements are *not* exactly equidistant in time (isochronal).

## 0.2 The function *pandas.resample()* will be used to help aggregate the measurements of temperature and radiation in two different ways:

```
* The temperature will be averaged into hourly temperature
* The radiation will be integrated (added up)
```

```
#
*
```

## 0.3 Import needed libraries

```
In [1]: %matplotlib inline
        import pandas as pd
        import matplotlib.pyplot as plt
        plt.ioff()
```

## 0.4 Read data

```
In [2]: df = pd.read_csv( '../../../data/sensors_to_resample.csv', sep=';' )
```

### 0.4.1 First lines of the table, just to check

```
In [3]: df.head()
```

```
Out[3]:             Timestamp  Temperature  Rel_Humidity  PAR_Radiation
        0  2018-09-16 00:05:00       22.640        34.649          0.032
        1  2018-09-16 00:10:00       22.699        35.280          0.024
        2  2018-09-16 00:15:00       22.700        35.237          0.051
        3  2018-09-16 00:20:00       22.700        34.618          0.013
        4  2018-09-16 00:25:00       22.603        34.133          0.000
```

### 0.4.2 And the last lines

```
In [4]: df.tail()
```

```
Out[4]:                Timestamp  Temperature  Rel_Humidity  PAR_Radiation
        282  2018-09-16 23:37:25       22.492        35.027          0.051
        283  2018-09-16 23:42:25       22.386        34.442          0.051
        284  2018-09-16 23:47:25       22.198        33.610          0.025
        285  2018-09-16 23:52:26       22.172        35.041          0.025
        286  2018-09-16 23:57:27       22.200        35.314          0.025
```

## 0.5 We define the index of the table (previously a consecutive number) to be the data column *Timestamp*

```
In [5]: df.index = pd.DatetimeIndex( df['Timestamp'] )
        df.index
```

```
Out[5]: DatetimeIndex(['2018-09-16 00:05:00', '2018-09-16 00:10:00',
                       '2018-09-16 00:15:00', '2018-09-16 00:20:00',
                       '2018-09-16 00:25:00', '2018-09-16 00:30:00',
                       '2018-09-16 00:35:01', '2018-09-16 00:40:02',
                       '2018-09-16 00:45:03', '2018-09-16 00:50:04',
                       ...
                       '2018-09-16 23:12:23', '2018-09-16 23:17:24',
                       '2018-09-16 23:22:25', '2018-09-16 23:27:25',
                       '2018-09-16 23:32:25', '2018-09-16 23:37:25',
                       '2018-09-16 23:42:25', '2018-09-16 23:47:25',
                       '2018-09-16 23:52:26', '2018-09-16 23:57:27'],
                      dtype='datetime64[ns]', name='Timestamp', length=287, freq=None)
```

## 0.6 Notice that the data type of the column was from "whatever" (*object,* in this case) into *DatetimeIndex* (datetime64 bits)

## 0.7 This is the crucial step!

```
In [6]: print( df.index.dtype)
        print( df['Timestamp'].dtype )
```

```
datetime64[ns]
object
```

### 0.7.1 First lines of the table (you never check too much)

```
In [7]: df.head()
```

```
Out[7]:                                Timestamp  Temperature  Rel_Humidity  \
        Timestamp
        2018-09-16 00:05:00  2018-09-16 00:05:00       22.640        34.649
        2018-09-16 00:10:00  2018-09-16 00:10:00       22.699        35.280
```

```
2018-09-16 00:15:00  2018-09-16 00:15:00       22.700        35.237
2018-09-16 00:20:00  2018-09-16 00:20:00       22.700        34.618
2018-09-16 00:25:00  2018-09-16 00:25:00       22.603        34.133

                     PAR_Radiation
Timestamp
2018-09-16 00:05:00          0.032
2018-09-16 00:10:00          0.024
2018-09-16 00:15:00          0.051
2018-09-16 00:20:00          0.013
2018-09-16 00:25:00          0.000
```

### 0.7.2 And the last lines again

```
In [8]: df.tail()
```

```
Out[8]:                                Timestamp  Temperature  Rel_Humidity  \
        Timestamp
        2018-09-16 23:37:25  2018-09-16 23:37:25       22.492        35.027
        2018-09-16 23:42:25  2018-09-16 23:42:25       22.386        34.442
        2018-09-16 23:47:25  2018-09-16 23:47:25       22.198        33.610
        2018-09-16 23:52:26  2018-09-16 23:52:26       22.172        35.041
        2018-09-16 23:57:27  2018-09-16 23:57:27       22.200        35.314

                             PAR_Radiation
        Timestamp
        2018-09-16 23:37:25          0.051
        2018-09-16 23:42:25          0.051
        2018-09-16 23:47:25          0.025
        2018-09-16 23:52:26          0.025
        2018-09-16 23:57:27          0.025
```

## 0.8 Notice that the timestamps are not exactly isochronal: that is our main problem here

```
In [9]: df['Timestamp'].head()
```

```
Out[9]: Timestamp
        2018-09-16 00:05:00    2018-09-16 00:05:00
        2018-09-16 00:10:00    2018-09-16 00:10:00
        2018-09-16 00:15:00    2018-09-16 00:15:00
        2018-09-16 00:20:00    2018-09-16 00:20:00
        2018-09-16 00:25:00    2018-09-16 00:25:00
        Name: Timestamp, dtype: object
```

```
In [10]: df['Timestamp'].tail()
```

```
Out[10]: Timestamp
         2018-09-16 23:37:25    2018-09-16 23:37:25
```

```
2018-09-16 23:42:25    2018-09-16 23:42:25
2018-09-16 23:47:25    2018-09-16 23:47:25
2018-09-16 23:52:26    2018-09-16 23:52:26
2018-09-16 23:57:27    2018-09-16 23:57:27
Name: Timestamp, dtype: object
```

### 0.9 Just to show it more clearly, we can check the difference (discret derivative, for the sake of precision) between timestamps

```
In [11]: duration_between_timestamps = df.index.to_series().diff()
```

### 0.10 Convert to seconds to compare more easily

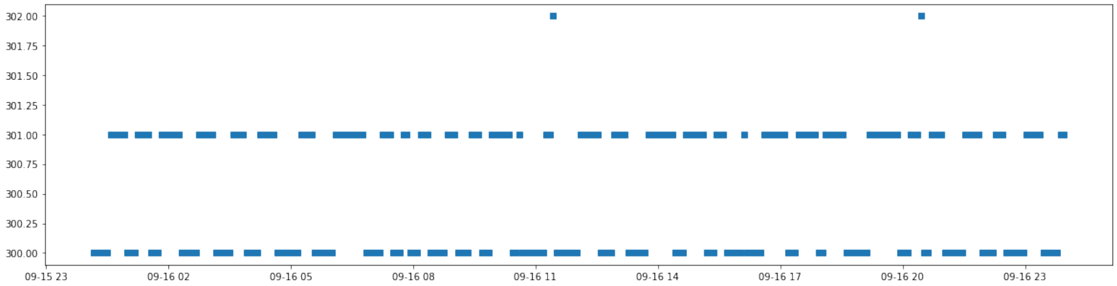
```
In [12]: duration_between_timestamps = duration_between_timestamps.dt.seconds
```

```
In [13]: print( duration_between_timestamps.min() )
         print( duration_between_timestamps.max() )
```

```
300.0
302.0
```

### 0.11 Plot the number of seconds between measurements

```
In [14]: fig, ax = plt.subplots( nrows=1, ncols=1, figsize=(20,5) )
         ax.plot( df.index, duration_between_timestamps, linestyle='', marker='s' )
         plt.show()
```



#### 0.11.1 Doesn't seem like a big deal, a shift of one or two seconds, but towards midnight it adds up to a couple of minutes, we don't have the measurements at the "minute 5" anymore

```
In [15]: df['Timestamp'].tail()
```

```
Out[15]: Timestamp
         2018-09-16 23:37:25    2018-09-16 23:37:25
         2018-09-16 23:42:25    2018-09-16 23:42:25
         2018-09-16 23:47:25    2018-09-16 23:47:25
```

```
2018-09-16 23:52:26    2018-09-16 23:52:26
2018-09-16 23:57:27    2018-09-16 23:57:27
Name: Timestamp, dtype: object
```

## 0.12 This is the problem to solve, and we want to do it with *pandas.resample*

### 0.12.1 For *resample* to work properly, the series must have a time index, as stated in the documentation:

```
Convenience method for frequency conversion and resampling of time series. Object must have a d
```

**(that was the reason to use DatetimeIndex previously)**

## 0.13 If we have that index, we can do things like:

```
In [16]: print( df.index.min(), df.index.max() )
```

```
2018-09-16 00:05:00 2018-09-16 23:57:27
```

```
In [17]: print( df.resample( '1H' ).mean().index.min(), df.resample( '1H' ).mean().index.max()
```

```
2018-09-16 00:00:00 2018-09-16 23:00:00
```

```
In [18]: print( df.resample( '5Min' ).mean().index.min(), df.resample( '5Min' ).mean().index.ma
```

```
2018-09-16 00:05:00 2018-09-16 23:55:00
```

**For the record, *5 minutes* can be '5Min' or '5T' ('5M' are 5 months)**

```
In [19]: print( df.resample( '5M' ).mean().index.min(), df.resample( '5M' ).mean().index.max()
         print( df.resample( '5Min' ).mean().index.min(), df.resample( '5Min' ).mean().index.ma
         print( df.resample( '5T' ).mean().index.min(), df.resample( '5T' ).mean().index.max()
```

```
2018-09-30 00:00:00 2018-09-30 00:00:00
2018-09-16 00:05:00 2018-09-16 23:55:00
2018-09-16 00:05:00 2018-09-16 23:55:00
```

## 0.14 What happened?

### 0.14.1 What happened was:

.resample( 'new intevals' ).mean()

### 0.14.2 The index is recalculated to 1 hour or 5 minutes, and the *mean*(!) is taken as the new value for the intervals. This is perhaps easier to see in the hourly example:

```
In [20]: df['Temperature'].head(15)
```

```
Out[20]: Timestamp
         2018-09-16 00:05:00    22.640
         2018-09-16 00:10:00    22.699
         2018-09-16 00:15:00    22.700
         2018-09-16 00:20:00    22.700
         2018-09-16 00:25:00    22.603
         2018-09-16 00:30:00    22.503
         2018-09-16 00:35:01    22.403
         2018-09-16 00:40:02    22.410
         2018-09-16 00:45:03    22.429
         2018-09-16 00:50:04    22.430
         2018-09-16 00:55:05    22.400
         2018-09-16 01:00:05    22.301
         2018-09-16 01:05:05    22.191
         2018-09-16 01:10:05    22.102
         2018-09-16 01:15:06    22.110
         Name: Temperature, dtype: float64
```

```
In [21]: df['Temperature'].resample( '1H' ).mean().head()
```

```
Out[21]: Timestamp
         2018-09-16 00:00:00    22.537909
         2018-09-16 01:00:00    22.256083
         2018-09-16 02:00:00    22.310167
         2018-09-16 03:00:00    22.398333
         2018-09-16 04:00:00    22.500833
         Freq: H, Name: Temperature, dtype: float64
```

### 0.14.3 Other methods for resample are:

```
bfill()    # Backward fill
count()    # Number of values in the interval
ffill()    # Forward fill
first()    # Use the first (valid) data
last()     # Use tha last (valid) data
max()      # Maximum value in the interval
mean()     # Mean of the interval
median()   # Median of values in the interval
min()      # Minimum value in the interval
nunique()  # Number of unique values
std()      # Standard deviation
sum()      # Sum of the values in the interval
var()      # Variance in the interval
```

### 0.14.4 Here a complete list (still need to check it thoroughly, though)

```
In [22]: tmp = df['Temperature'].resample( '1H' )
         methods = [ method_name for method_name in dir(tmp) if callable(getattr(tmp, method_na
         methods = [ method_name for method_name in methods if not '_' in method_name ]
         print( methods )
```

```
['agg', 'aggregate', 'apply', 'asfreq', 'backfill', 'bfill', 'count', 'ffill', 'fillna', 'firs
```

## 0.15 A couple of examples

```
In [23]: df['Temperature'].head(15)
```

```
Out[23]: Timestamp
         2018-09-16 00:05:00    22.640
         2018-09-16 00:10:00    22.699
         2018-09-16 00:15:00    22.700
         2018-09-16 00:20:00    22.700
         2018-09-16 00:25:00    22.603
         2018-09-16 00:30:00    22.503
         2018-09-16 00:35:01    22.403
         2018-09-16 00:40:02    22.410
         2018-09-16 00:45:03    22.429
         2018-09-16 00:50:04    22.430
         2018-09-16 00:55:05    22.400
         2018-09-16 01:00:05    22.301
         2018-09-16 01:05:05    22.191
         2018-09-16 01:10:05    22.102
         2018-09-16 01:15:06    22.110
         Name: Temperature, dtype: float64
```

```
In [24]: df['Temperature'].resample( '1H' ).min().head(2)
```

```
Out[24]: Timestamp
         2018-09-16 00:00:00    22.400
         2018-09-16 01:00:00    22.102
         Freq: H, Name: Temperature, dtype: float64
```

```
In [25]: df['Temperature'].resample( '1H' ).max().head(2)
```

```
Out[25]: Timestamp
         2018-09-16 00:00:00    22.70
         2018-09-16 01:00:00    22.41
         Freq: H, Name: Temperature, dtype: float64
```

```
In [26]: df['Temperature'].resample( '1H' ).sum().head(2)
```

```
Out[26]: Timestamp
         2018-09-16 00:00:00    247.917
         2018-09-16 01:00:00    267.073
         Freq: H, Name: Temperature, dtype: float64
```

```
In [27]: df['Temperature'].resample( '1H' ).first().head(2)

Out[27]: Timestamp
         2018-09-16 00:00:00    22.640
         2018-09-16 01:00:00    22.301
         Freq: H, Name: Temperature, dtype: float64
```

## 0.16 Some of the methods make more sense for higher frequencies, when the resampling frequency is higher than the original:

```
In [28]: df['Temperature'].resample( '1H' ).ffill().head(2)

Out[28]: Timestamp
         2018-09-16 00:00:00     NaN
         2018-09-16 01:00:00    22.4
         Freq: H, Name: Temperature, dtype: float64
```

```
In [29]: df['Temperature'].resample( '1H' ).bfill().head(2)

Out[29]: Timestamp
         2018-09-16 00:00:00    22.640
         2018-09-16 01:00:00    22.301
         Freq: H, Name: Temperature, dtype: float64
```

### 0.16.1 Now the same with 1 minute as new period:

```
In [30]: df['Temperature'].resample( '1T' ).ffill().head(10)

Out[30]: Timestamp
         2018-09-16 00:05:00    22.640
         2018-09-16 00:06:00    22.640
         2018-09-16 00:07:00    22.640
         2018-09-16 00:08:00    22.640
         2018-09-16 00:09:00    22.640
         2018-09-16 00:10:00    22.699
         2018-09-16 00:11:00    22.699
         2018-09-16 00:12:00    22.699
         2018-09-16 00:13:00    22.699
         2018-09-16 00:14:00    22.699
         Freq: T, Name: Temperature, dtype: float64
```

```
In [31]: df['Temperature'].resample( '1T' ).bfill().head(10)

Out[31]: Timestamp
         2018-09-16 00:05:00    22.640
         2018-09-16 00:06:00    22.699
         2018-09-16 00:07:00    22.699
         2018-09-16 00:08:00    22.699
         2018-09-16 00:09:00    22.699
         2018-09-16 00:10:00    22.699
         2018-09-16 00:11:00    22.700
         2018-09-16 00:12:00    22.700
         2018-09-16 00:13:00    22.700
         2018-09-16 00:14:00    22.700
         Freq: T, Name: Temperature, dtype: float64
```

```
In [32]: df['Temperature'].resample( '1T' ).fillna('nearest').head(10)
```

```
Out[32]: Timestamp
         2018-09-16 00:05:00    22.640
         2018-09-16 00:06:00    22.640
         2018-09-16 00:07:00    22.640
         2018-09-16 00:08:00    22.699
         2018-09-16 00:09:00    22.699
         2018-09-16 00:10:00    22.699
         2018-09-16 00:11:00    22.699
         2018-09-16 00:12:00    22.699
         2018-09-16 00:13:00    22.700
         2018-09-16 00:14:00    22.700
         Freq: T, Name: Temperature, dtype: float64
```

```
In [33]: df['Temperature'].resample( '1T' ).fillna('nearest', limit=1).head(10)
```

```
Out[33]: Timestamp
         2018-09-16 00:05:00    22.640
         2018-09-16 00:06:00    22.640
         2018-09-16 00:07:00       NaN
         2018-09-16 00:08:00       NaN
         2018-09-16 00:09:00    22.699
         2018-09-16 00:10:00    22.699
         2018-09-16 00:11:00    22.699
         2018-09-16 00:12:00       NaN
         2018-09-16 00:13:00       NaN
         2018-09-16 00:14:00    22.700
         Freq: T, Name: Temperature, dtype: float64
```

### 0.17 Lastly, if used on a complete DataFrame, it applies to all columns, so please check to see if that is what you actually want

```
In [34]: df.resample('1H').mean().head()
```

```
Out[34]:                      Temperature  Rel_Humidity  PAR_Radiation
         Timestamp
         2018-09-16 00:00:00    22.537909     34.753909       0.016818
         2018-09-16 01:00:00    22.256083     34.337333       0.060417
         2018-09-16 02:00:00    22.310167     34.318000       0.016000
         2018-09-16 03:00:00    22.398333     34.478500       0.016917
         2018-09-16 04:00:00    22.500833     34.427417       0.067667
```