Time Series Aggregation

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Overview

- Download the PM2.5 dataset
- Convert EAV formatted data to time series dataframe and parse data
- Aggregate data by timestamp and attribute
- Upsample data to regular time intervals
- Interpoloate missing data points

Downloading the Data Set

Pulling information from the web:

```
import pandas as pd

pm2_file =
pd.read_csv("https://library.startlearninglabs.uw
.edu/DATASCI400/Datasets/BeijingPM2_IOT.csv")
print(pm2_file.head())
```

Create pandas time stamp object

- Built in functions to bin by timeframe
- Bin data by time intervals:
  - Minute
  - Month
- Pull out useful information such as weekday name

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Converting CSV to a Pandas Time Series

```
import pandas as pd

# you can have pandas convert the date directly
pm2_file = pd.read_csv(file_path,
    parse_dates=['TimeStamp'],
    infer_datetime_format=True)

print(pm2_file.head())
```

	TimeStamp	Attribute	Value
0	2009-12-31 22:17:00	Iws	1.79
1	2009-12-31 22:43:00	precipitation	0
2	2009-12-31 23:19:00	Iws	4.92
3	2009-12-31 23:22:00	HUMI	43
4	2010-01-01 00:02:00	PRES	1019

Explore the Data Set

UCI PM2.5 dataset:

- Hourly meteorological sensor readings for five different cities in China
- Each sensor contains approximate timestamp and an attribute in EAV format
- Time stamps are approximate

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Steps to Parsing the Data Set

- Subset the Data
  - Pull out temperature, precipitation and humidity readings
- Index the data by time stamp
- Coerce column data types
- Replace missing values

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Why Subset the data?

- Work with just the data we need
  - Smaller
  - Faster

Name	Type	Size	Value
pm2_df	DataFrame	(21905, 3)	Column names: TimeStamp, Attribute, Value
pm2_file	DataFrame	(65143, 3)	Column names: TimeStamp, Attribute, Value

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Subsetting the data

```
pm2_df = pm2_file[(pm2_file['Attribute'] == 'precipitation') |
      (pm2_file['Attribute'] == 'TEMP') |
      (pm2_file['Attribute'] == 'HUMI')].copy()

print(pm2_df.head())
```

	TimeStamp	Attribute	Value
1	2009-12-31 22:43:00	precipitation	0
3	2009-12-31 23:22:00	HUMI	43
7	2010-01-01 01:01:00	TEMP	-14
8	2010-01-01 01:04:00	TEMP	-12
10	2010-01-01 01:11:00	TEMP	-11

Setting an Index

`Set_index()`

- Set index on column of interest
- Allows for easy aggregation, resampling and interpolation of data
- Built-in methods for working with time intervals

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Setting an Index

```
import pandas as pd
pm2_file =
pd.read_csv("https://library.startlearninglabs.uw.edu/DATASCI400/Datasets/BeijingPM2_IOT.csv",
                        parse_dates=['TimeStamp'],
                        infer_datetime_format=True)

pm2_df = pm2_df.set_index(['TimeStamp'])
```

To call a function on an object: **object.function(parameters)**

Set_index([column_name])

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Using the Index

```
pm2_df = pm2_df.set_index(['TimeStamp'])
```

Call out year, year & Month

```
print(pm2_df['2010'])
print(pm2_df['2010-12'])
```

Call out month & year on the index

```
print(pm2_df.index.year)
print(pm2_df.index.month)
```

Count the number of observations per year

```
print(pm2_df.groupby(pm2_df.index.year).count())
```

TimeStamp	Attribute	Value
2009	2	2
2010	21322	21322
2011	581	581

TimeStamp	Attribute	Value
2009-12-31 22:43:00	precipitation	0
2009-12-31 23:22:00	HUMI	43
2010-01-01 01:01:00	TEMP	-14
2010-01-01 01:04:00	TEMP	-12
2010-01-01 01:11:00	TEMP	-11

Coercing Data Types

`astype()`

- Specify a data type
- Avoid programming errors
- Ensure accurate calculations

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Coercing Data Types

```
pm2_df['Value'] =
pm2_df['Value'].astype(float)
```

Before

TimeStamp	Attribute	Value
2009-12-31 22:43:00	precipitation	0
2009-12-31 23:22:00	HUMI	43
2010-01-01 01:01:00	TEMP	-14
2010-01-01 01:04:00	TEMP	-12
2010-01-01 01:11:00	TEMP	-11

After

TimeStamp	Attribute	Value
2009-12-31 22:43:00	precipitation	0.0
2009-12-31 23:22:00	HUMI	43.0
2010-01-01 01:01:00	TEMP	-14.0
2010-01-01 01:04:00	TEMP	-12.0
2010-01-01 01:11:00	TEMP	-11.0

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Deal with Missing Values

- Avoid errors
- Ensure accurate calculations
- `fillna()` – replaces missing values
- `dropna()` – removes missing values

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Deal with Missing Values

```
pm2_df = pm2_df.dropna(axis=0,
how='any')
```

Axis=0 drops the entire row
Axis=1 drops the entire column
How=any drops rows with any NaN value
How=all drops rows that are all NaN

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Aggregating by a single column

- Pandas `groupby()`
- Group data by a column, such as Attribute
- Perform calculations on each group, such as get the mean of all temperature readings (calculate average temperature)

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Aggregating by a single column

```
grouped = pm2_df.groupby('Attribute')

print(grouped)
<pandas.core.groupby.DataFrameGroupBy
object at 0x000001E0A791BE48>
```

HUMI

TimeStamp	Attribute	Value
2009-12-31 23:22:00	HUMI	43.0
2010-01-01 01:36:00	HUMI	55.0
2010-01-01 02:20:00	HUMI	47.0
2010-01-01 02:21:00	HUMI	51.0
2010-01-01 02:59:00	HUMI	43.0

TEMP

TimeStamp	Attribute	Value
2010-01-01 01:01:00	TEMP	-14.0
2010-01-01 01:04:00	TEMP	-12.0
2010-01-01 01:11:00	TEMP	-11.0
2010-01-01 01:43:00	TEMP	-11.0
2010-01-01 04:14:00	TEMP	-12.0

precipitation

TimeStamp	Attribute	Value
2009-12-31 22:43:00	precipitation	0.0
2010-01-01 02:16:00	precipitation	0.0
2010-01-01 03:45:00	precipitation	0.0
2010-01-01 03:53:00	precipitation	0.0
2010-01-01 06:10:00	precipitation	0.0

Aggregating by multiple columns

- Pandas `groupby()`
- List of columns
- Mixed data types use `dataframe_name.column_name` format

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Aggregating by time stamp

```
year_attr_group =
pm2_df.groupby([pm2_df.index.year,
pm2_df.Attribute])
for x,y in year_attr_group:
    print(x)
    print(y)
```

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Resampling a Time Series

- Change the frequency of your time series
- Pandas `resample()`
  - Downsample
  - Upsample

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Resampling a time series

```
downsample = pm2_df.resample('1min')
print(downsample.head(100))
```

Resample()
–Only works on numerical columns

TimeStamp	Value
2009-12-31 22:43:00	0.0
2009-12-31 22:44:00	NaN
2009-12-31 22:45:00	NaN
2009-12-31 22:46:00	NaN
2009-12-31 22:47:00	NaN
2009-12-31 22:48:00	NaN
2009-12-31 22:49:00	NaN
2009-12-31 22:50:00	NaN
2009-12-31 22:51:00	NaN
2009-12-31 22:52:00	NaN
2009-12-31 22:53:00	NaN
2009-12-31 22:54:00	NaN

Upsampling time series

```
upsampled =
pm2_df.groupby('Attribute').resample(
'1S').mean()

for group, x in
upsampled.iteritems():
    print(group)
    print(x)
```

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Interpolating Missing Data Points

Interpolate()

- Estimates missing values
- Lots of calculations using up memory

```
upsampled_interpolated =
upsampled.interpolate(method='linear')
```

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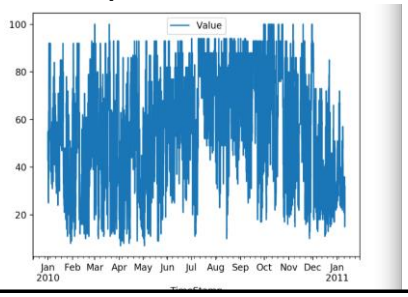
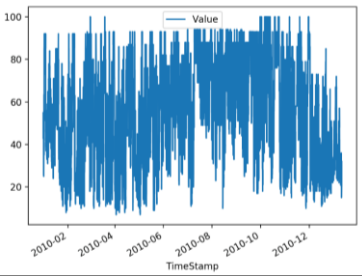
Comparing Plots

Interpolated Data almost identical to original data.

Interpolated



Original



Interpolating Temperature Readings

Your Turn

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Interpolate Missing Temperature Data

1. Upsample the temperature dataset to 1 second intervals
2. Interpolate the temperature data using a polynomial method instead of linear
3. Plot the distributions of the original temperature data and compare with a plot of the upsampled and interpolated data

Summary

>Working with time series data in pandas

>Aggregating time series data

>Resampling and interpreting time series data