Autocorrelation and Partial autocorrelation

VISUALIZING TIME SERIES DATA IN PYTHON

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Autocorrelation in time series data

- Autocorrelation is measured as the correlation between a time series and a delayed copy of itself
- For example, an autocorrelation of order 3 returns the correlation between a time series at points (`t_1` , `t_2` , `t_3` , ...) and its own values lagged by 3 time points, i.e. (`t_4` , `t_5` , `t_6` , ...)
- It is used to find repetitive patterns or periodic signal in time series

Statsmodels

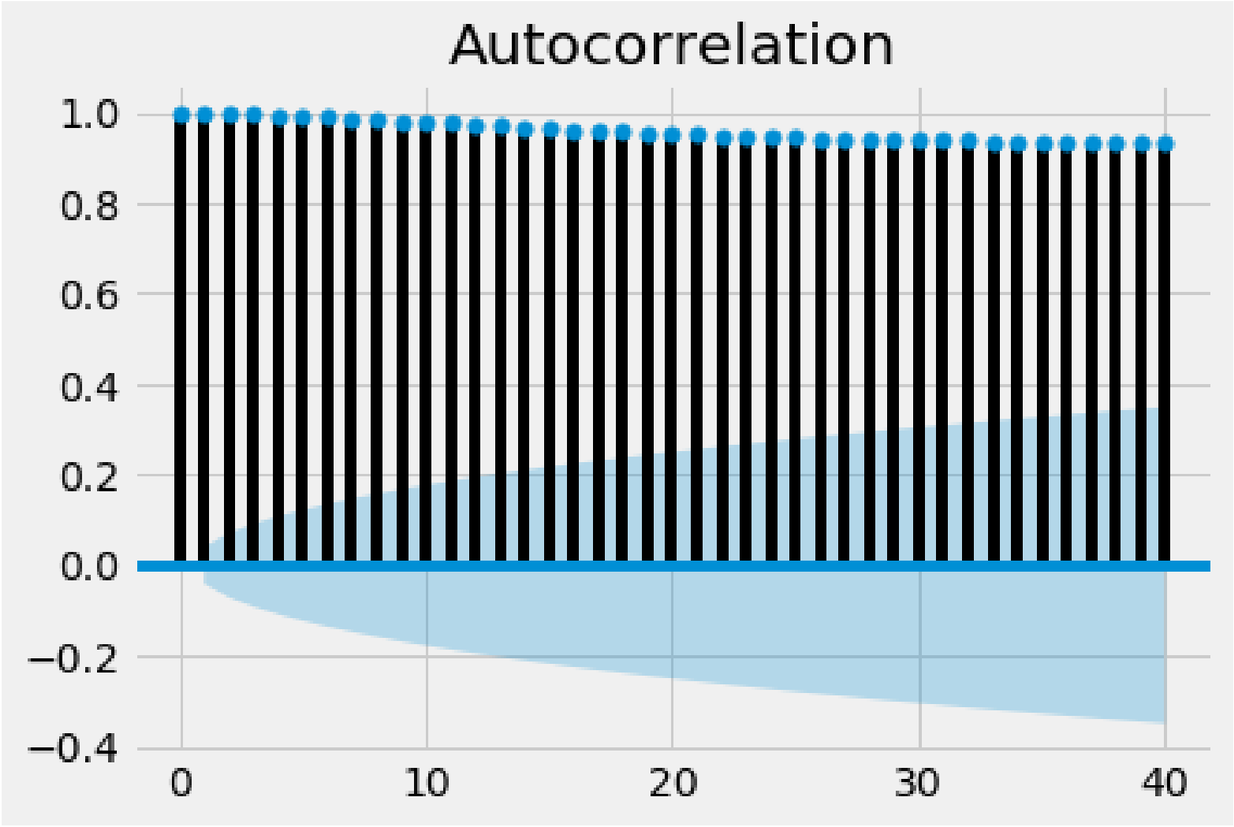
> `statsmodels` is a Python module that provides classes and functions for the estimation of many different statistical models, as well as for conducting statistical tests, and statistical data exploration.

Plotting autocorrelations

```
import matplotlib.pyplot as plt
from statsmodels.graphics import tsaplots
fig = tsaplots.plot_acf(co2_levels['co2'], lags=40)

plt.show()
```

Interpreting autocorrelation plots



Partial autocorrelation in time series data

- Contrary to autocorrelation, partial autocorrelation removes the effect of previous time points

- For example, a partial autocorrelation function of `order 3` returns the correlation between our time series (`t1` , `t2` , `t3` , ...) and lagged values of itself by 3 time points (`t4` , `t5` , `t6` , ...), but only after removing all effects attributable to lags 1 and 2

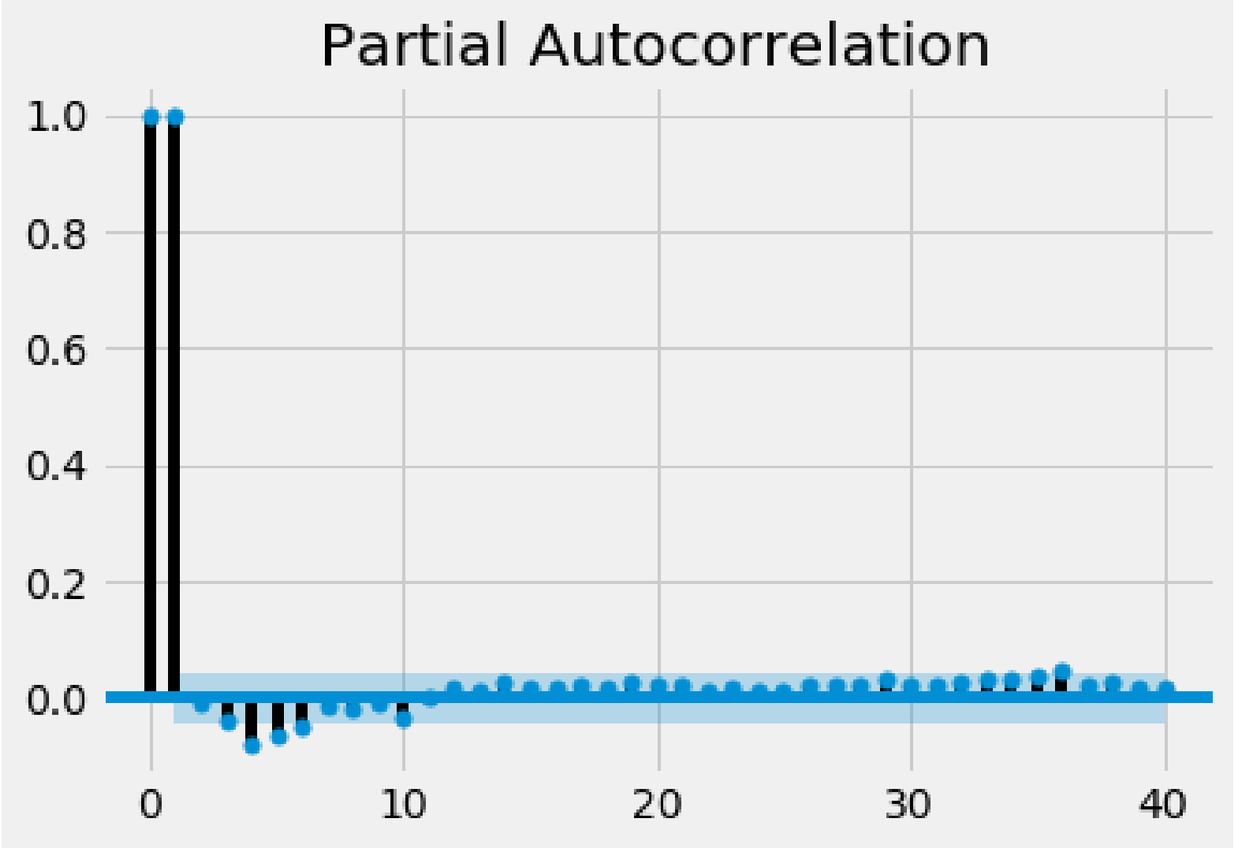
Plotting partial autocorrelations

```
import matplotlib.pyplot as plt

from statsmodels.graphics import tsaplots
fig = tsaplots.plot_pacf(co2_levels['co2'], lags=40)

plt.show()
```

Interpreting partial autocorrelations plot



Let's practice!

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Seasonality, trend and noise in time series data

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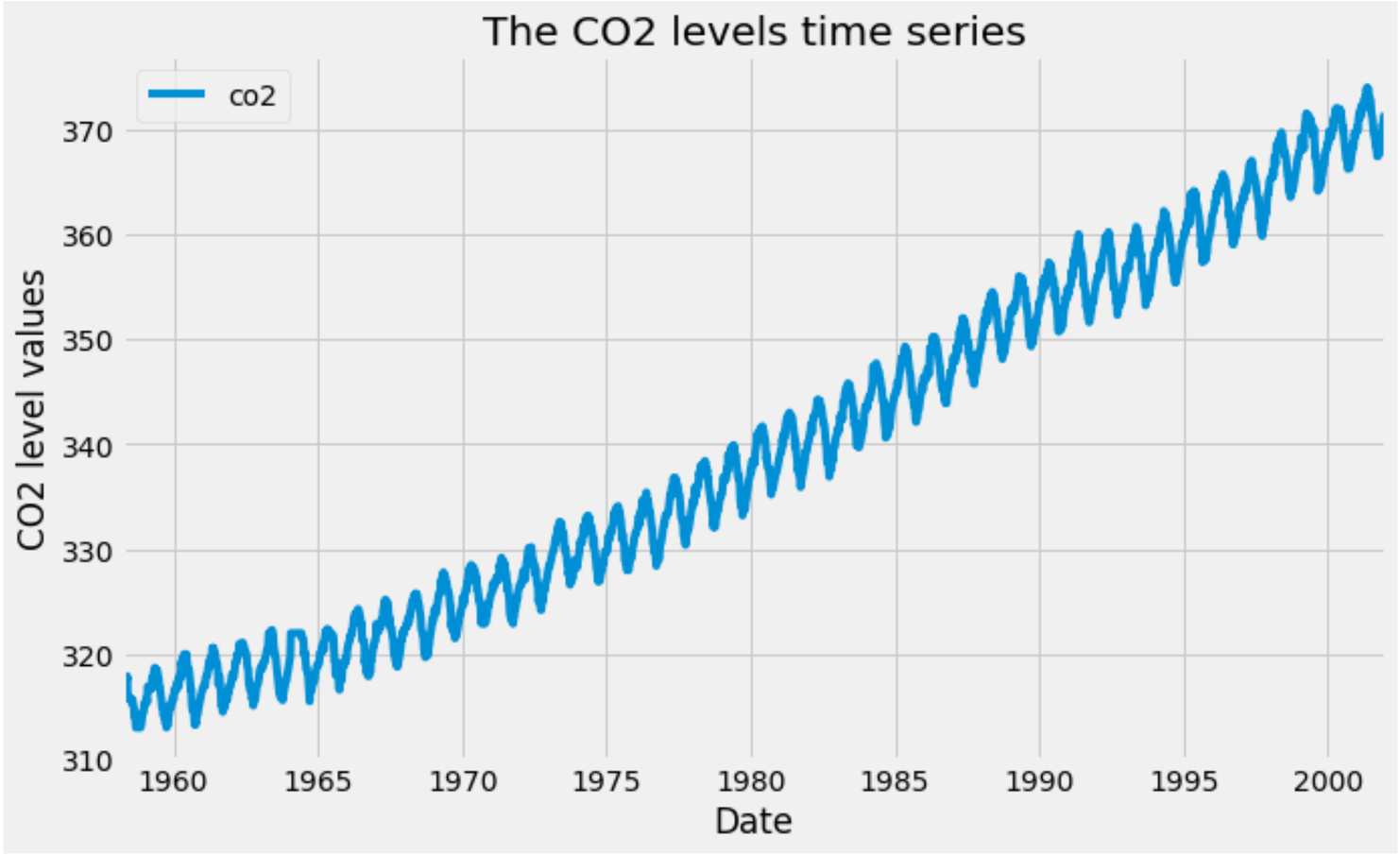
Properties of time series



The properties of time series

- Seasonality: does the data display a clear periodic pattern?
- Trend: does the data follow a consistent upwards or downwards slope?
- Noise: are there any outlier points or missing values that are not consistent with the rest of the data?

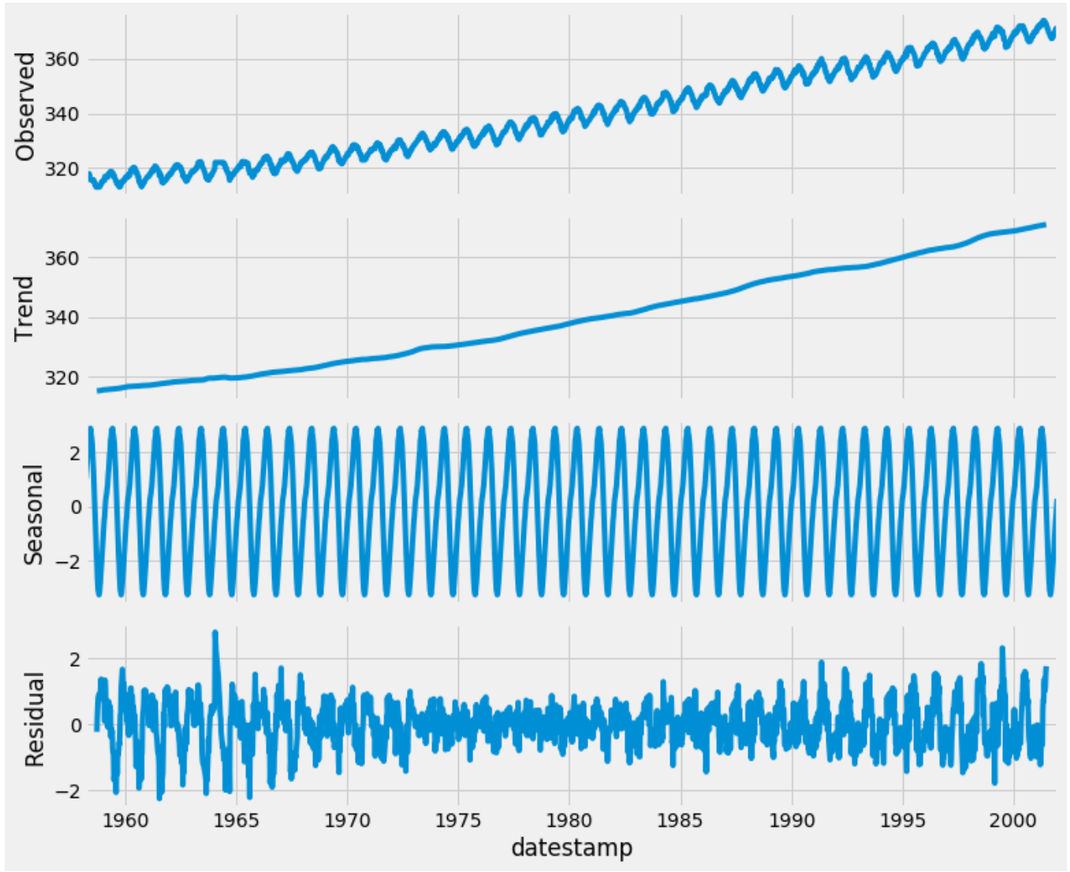
Time series decomposition

```
import statsmodels.api as sm
import matplotlib.pyplot as plt
from pylab import rcParams

rcParams['figure.figsize'] = 11, 9
decomposition = sm.tsa.seasonal_decompose(
                co2_levels['co2'])
fig = decomposition.plot()

plt.show()
```

A plot of time series decomposition on the CO2 data



Extracting components from time series decomposition

```
print(dir(decomposition))
```

```
['__class__', '__delattr__', '__dict__',
 ... 'plot', 'resid', 'seasonal', 'trend']
```

```
print(decomposition.seasonal)
```

```
datestamp
1958-03-29    1.028042
1958-04-05    1.235242
1958-04-12    1.412344
1958-04-19    1.701186
```

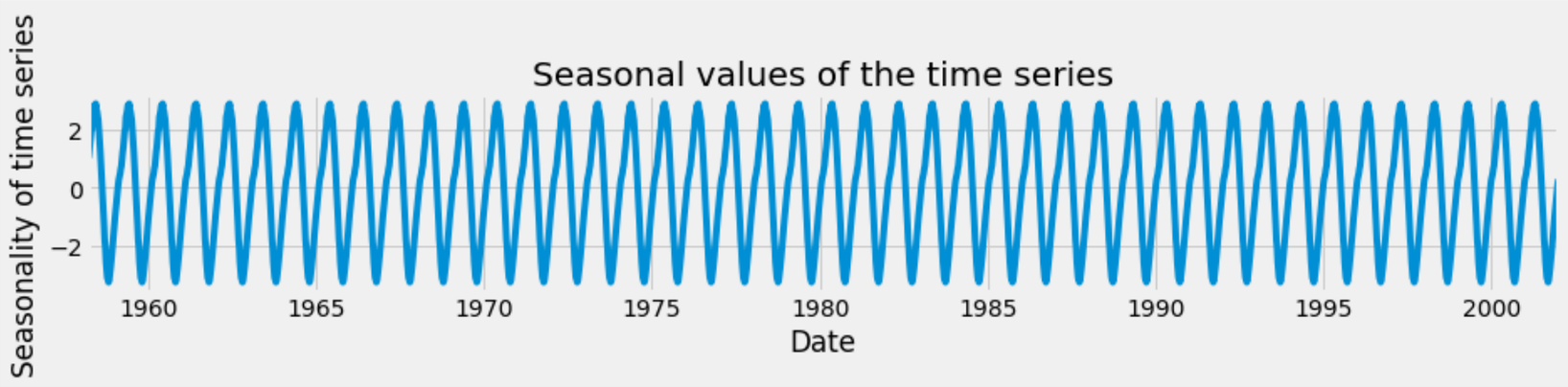
Seasonality component in time series

```
decomp_seasonal = decomposition.seasonal

ax = decomp_seasonal.plot(figsize=(14, 2))
ax.set_xlabel('Date')
ax.set_ylabel('Seasonality of time series')
ax.set_title('Seasonal values of the time series')

plt.show()
```

Seasonality component in time series



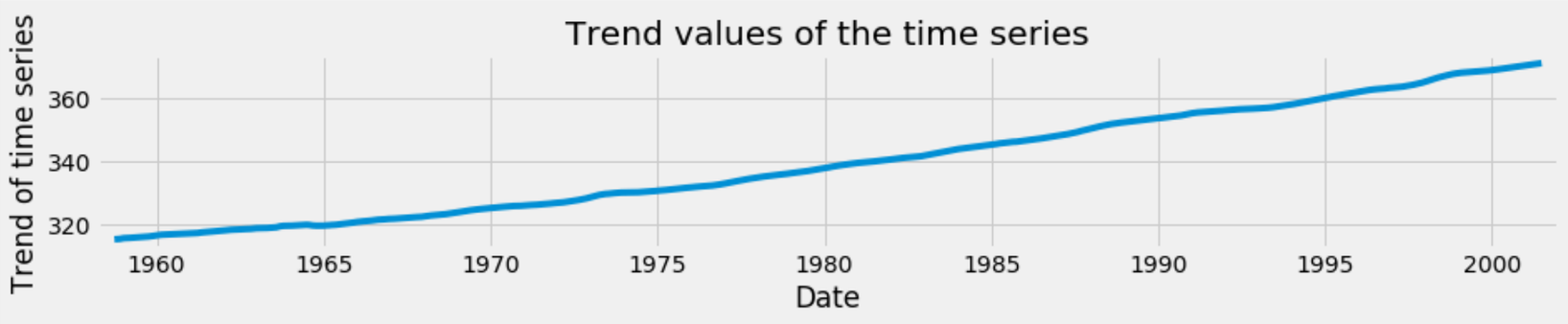
Trend component in time series

```
decomp_trend = decomposition.trend


ax = decomp_trend.plot(figsize=(14, 2))
ax.set_xlabel('Date')
ax.set_ylabel('Trend of time series')
ax.set_title('Trend values of the time series')


plt.show()
```

Trend component in time series



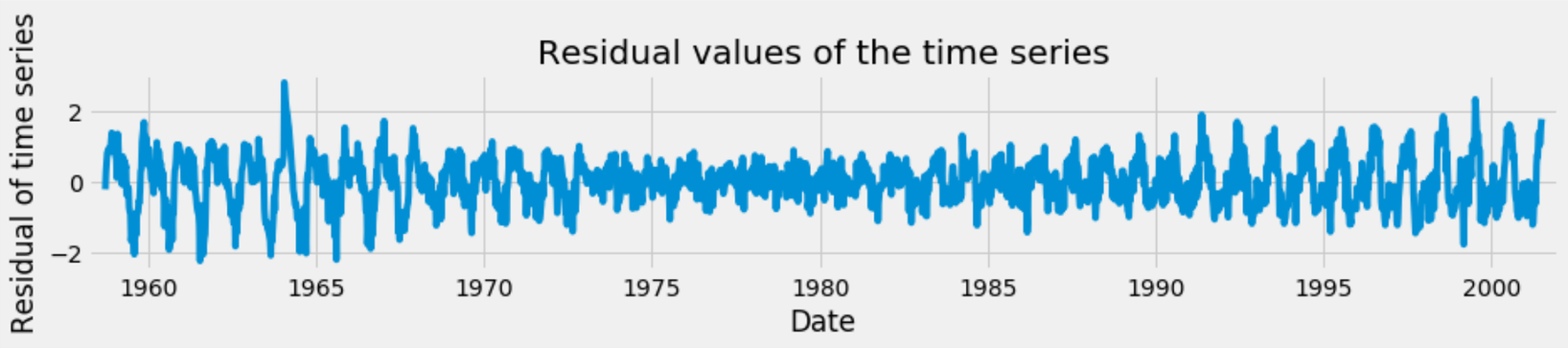
Noise component in time series

```
decomp_resid = decomp.resid


ax = decomp_resid.plot(figsize=(14, 2))
ax.set_xlabel('Date')
ax.set_ylabel('Residual of time series')
ax.set_title('Residual values of the time series')


plt.show()
```

Noise component in time series



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A review on what you have learned so far

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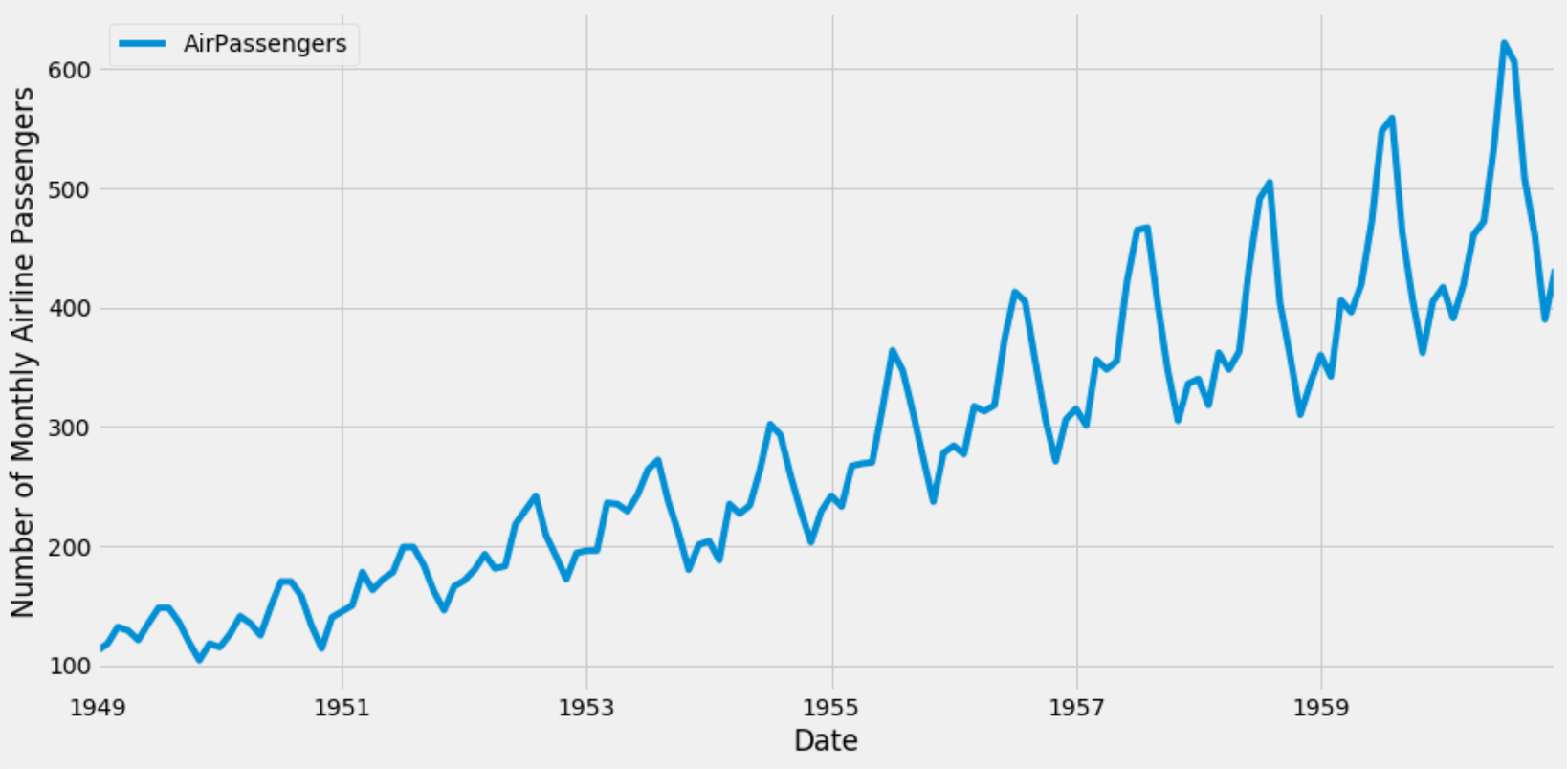
So far ...

- Visualize aggregates of time series data
- Extract statistical summaries
- Autocorrelation and Partial autocorrelation
- Time series decomposition

The airline dataset



Let's analyze this data!

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