Time Series

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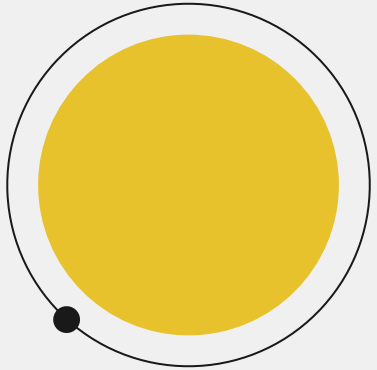
01

Basic concepts in Time Series

White noise and Random walk

- White noise is a series with a mean that is constant with time, a variance that is also constant with time, and zero autocorrelation at all lags.
- Random walk is a mathematical concept that describes a path consisting of a sequence of random steps.



Autocorrelation function (ACF) & Partial Autocorrelation function (PACF)

- ACF measures correlation with past values and is used to identify the order of an autoregressive process.
- PACF measures correlation between the time series and its own past values and is used to identify the order of a moving average process.

Autoregressive Moving Average (ARMA) models

$$X_t = c + \phi_1 X_{t-1} + \phi_2 X_{t-2} + \ldots + \phi_p X_{t-p} + \varepsilon_t + \theta_1 \varepsilon_{t-1} + \theta_2 \varepsilon_{t-2} + \ldots + \theta_q \varepsilon_{t-q}$$

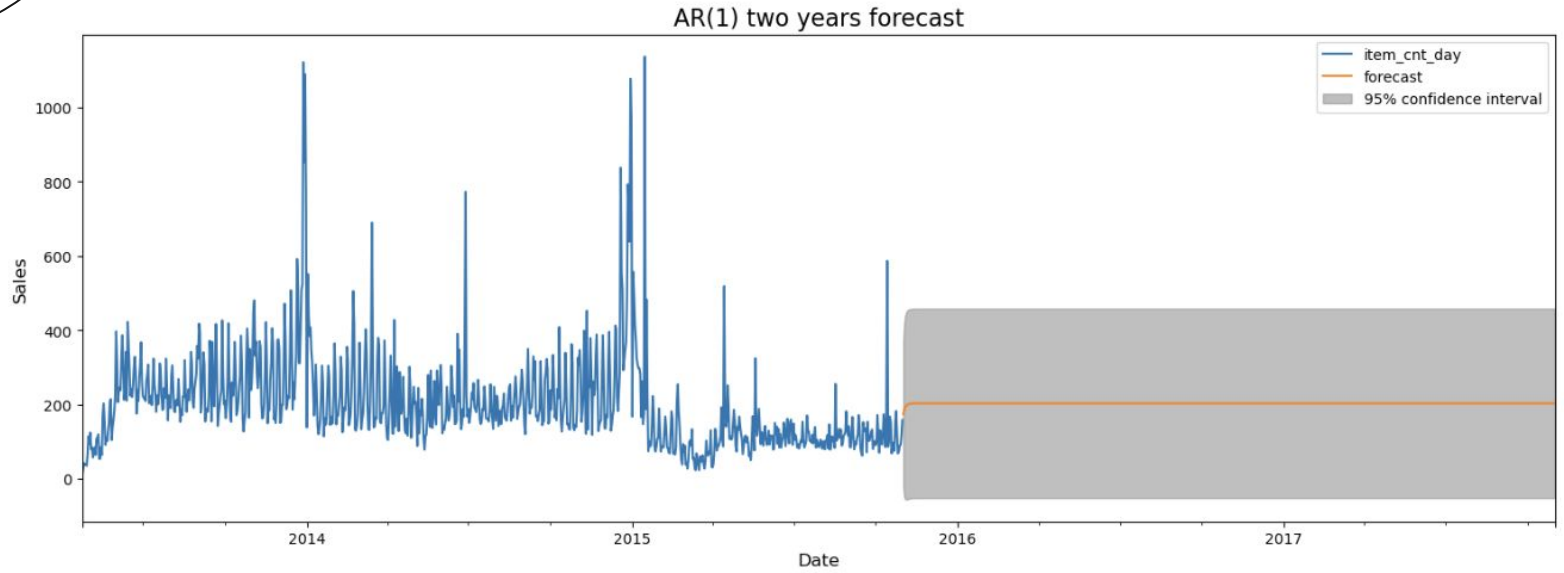
- AR models describe the dependence between an observation and a number of lagged observations
- MA models describe the dependence between an observation and a residual error from a moving average process
- An ARMA model combines the concepts of autoregression (AR) and moving average (MA) to model the temporal dependencies in a time series.

02

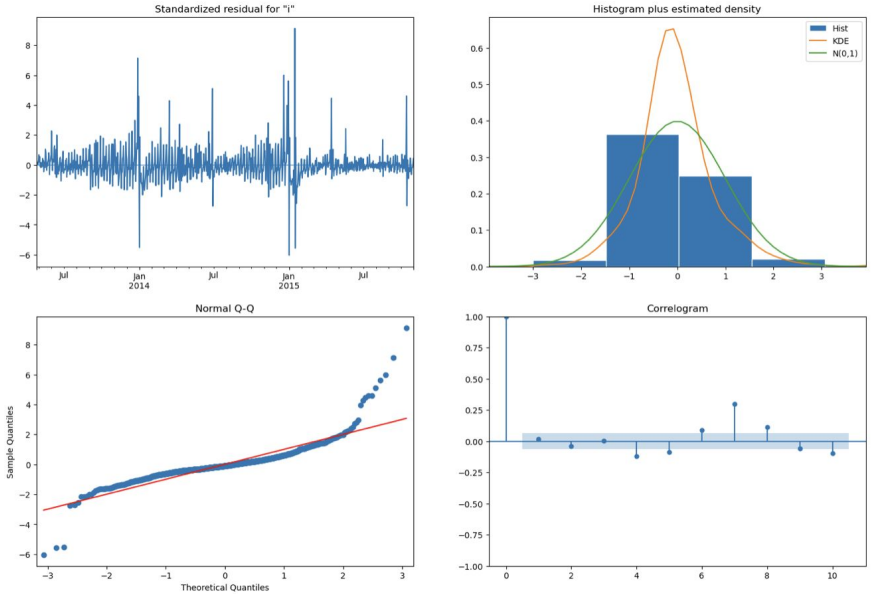
Forecasting competition on Kaggle

About the task

- The data set is daily historical sales data of a company.
- Forecast the sale for you years after ending date of the training data with different models


AR(1) two years forecast
item_cnt_day
forecast
95% confidence interval
Sales
1000
800
600
400
200
0
2014
2015
2016
2017
Date

Diagnose the underlying assumptions of a time series model

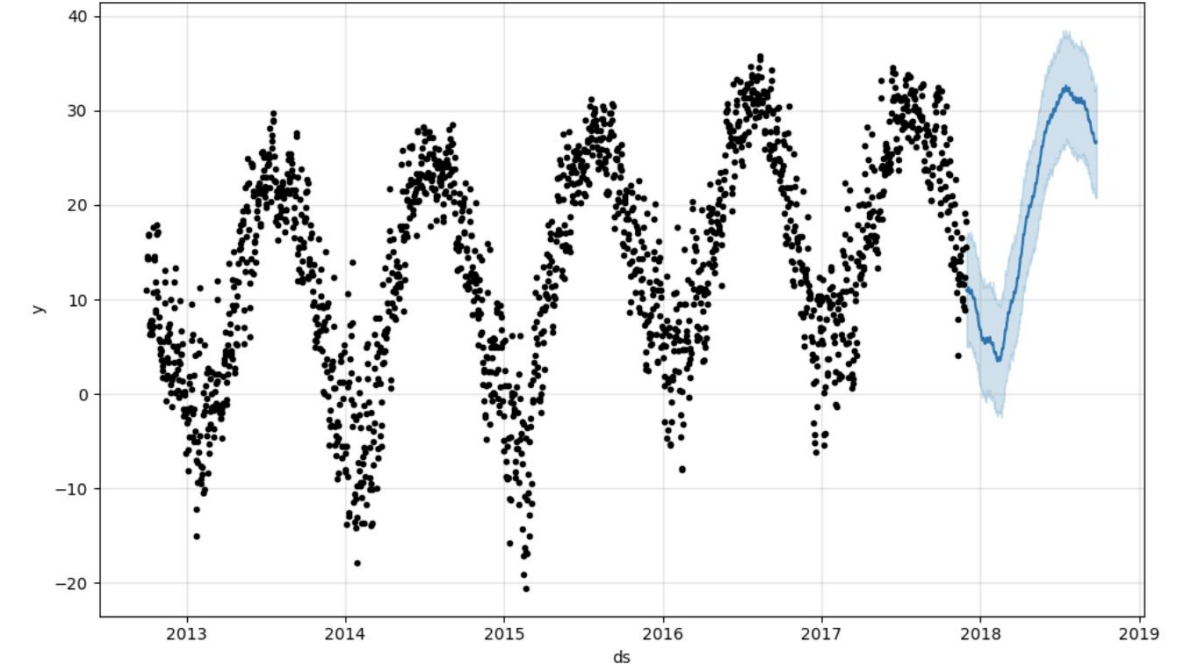


ARIMA (1,1,1)

03

Forecasting with Prophet

Forecasting with Prophet on weather data



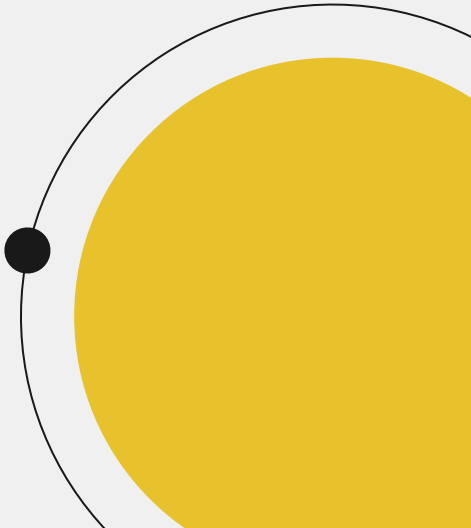
Forecast one year after the data

04

Fourier Transform

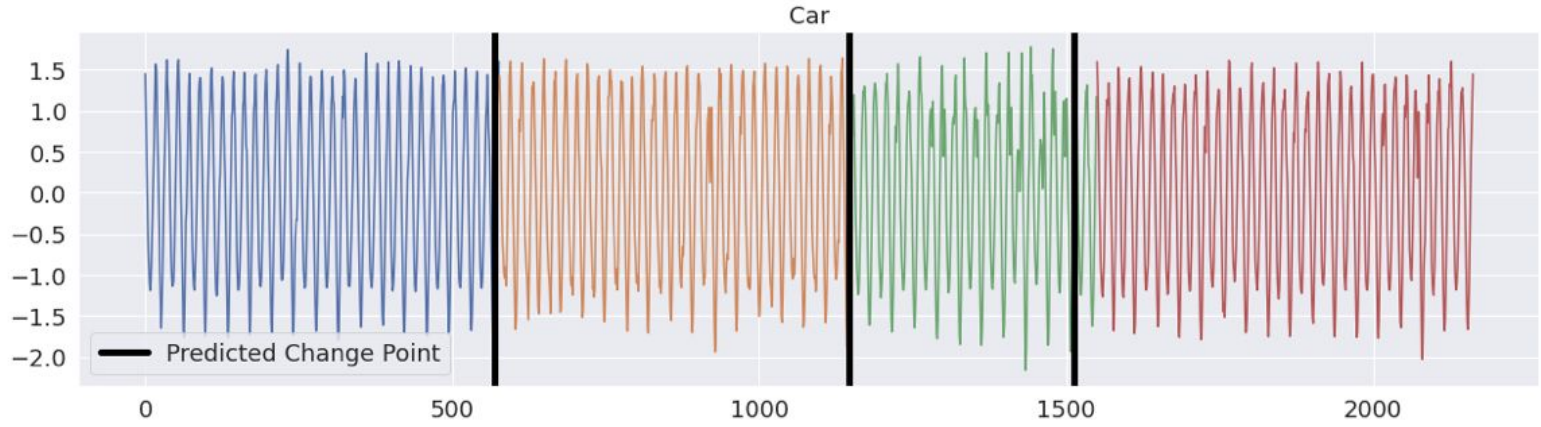
Fourier Transform

- The Fourier transform is a mathematical technique used to decompose a complex signal into its individual frequency components.
- DFT (Discrete Fourier Transform) is a mathematical operation that transforms a discrete signal from the time domain to the frequency domain
- FFT (Fast Fourier Transform) is an efficient algorithm for computing the DFT, which reduces the computation time compared to the basic definition.

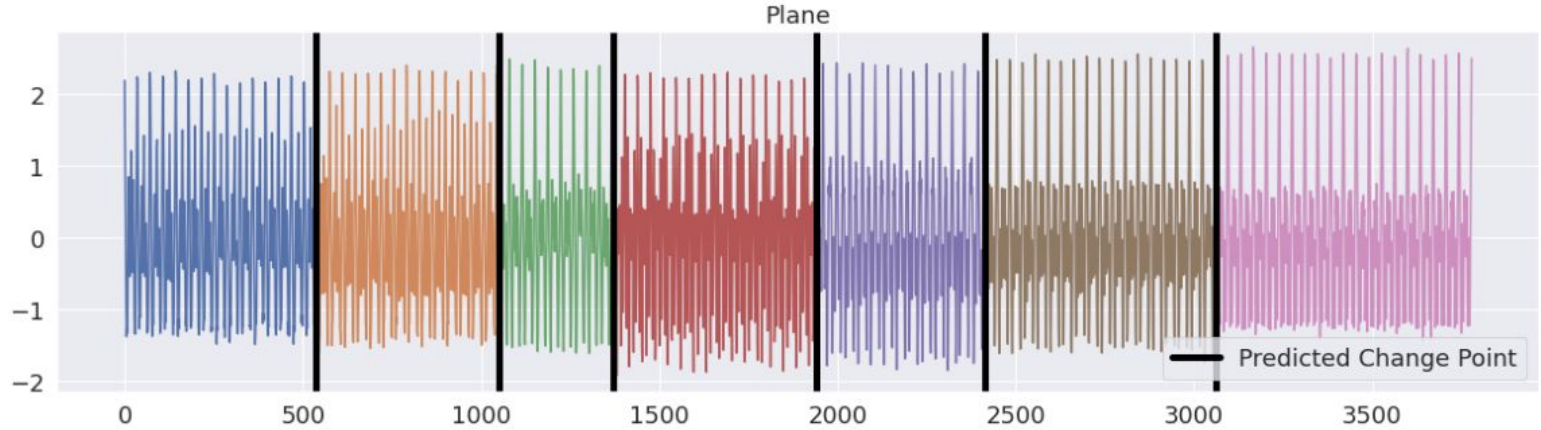


05

From motif to discord detection



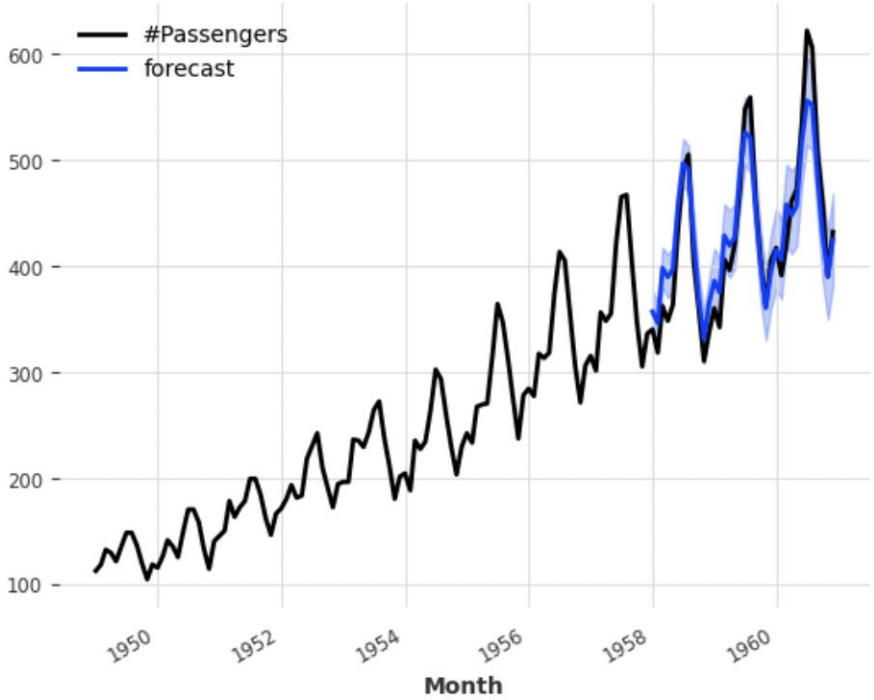
Time Series: Plane: True Change Points: [540 1044 1368 1944 2412 3060], Found Change Points: [2412, 3060, 1371, 1942, 1050, 535], Score: 0.000705



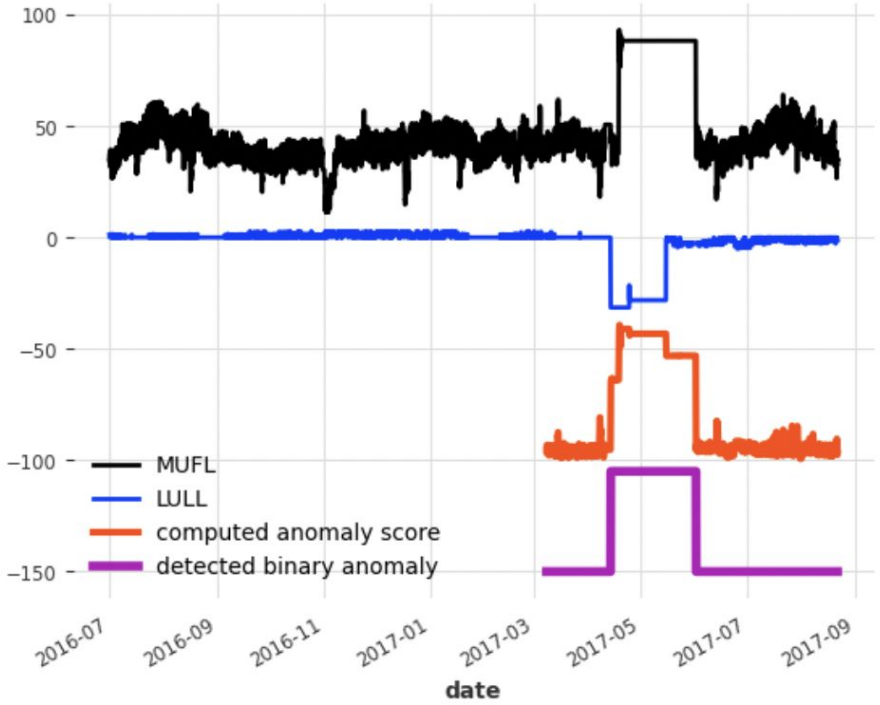
06

Forecasting with Darts

Exponential Smoothing



Shifting and scaling some of the series to make everything appear on the same figure:



Thank you!