SF2943 Time Series Analysis

TS 6

KTH Royal Institute of Technology

titing@kth.se

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Overview

1. Introduction to the Data
2. Preprocessing
3. Model Analysis and Evaluation
4. Forecast
5. Conclusion

Original Data

The dataset contains the measurements for CO_2-concentration in the atmosphere of Mauna Loa, Hawaii from 1965 to 1980.

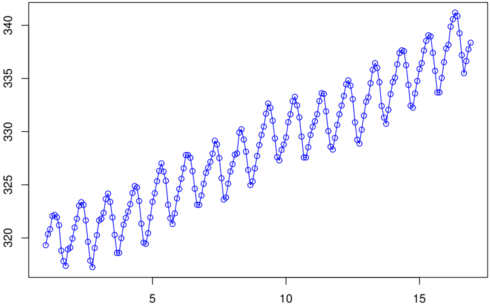


Figure: CO_2 (ppm) mauna loa, 1965-1980

Model Assumption

We assume the ts follows the classical additive model:

$$Y_t = T_t + S_t + X_t$$

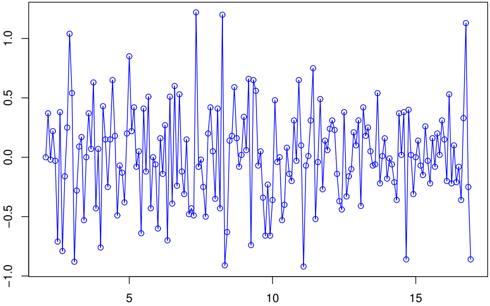
where T_t is the trend , S_t is the seasonality , and X_t is the stationary component.

By applying a differencing operator with lag d $= 12$, because S_t has a period d $= 12$, we can obtain:

$$Y_t - Y_{t-d} = (1 - B^d)Y_t = T_t - T_{t-d} + X_t - X_{t-d}$$

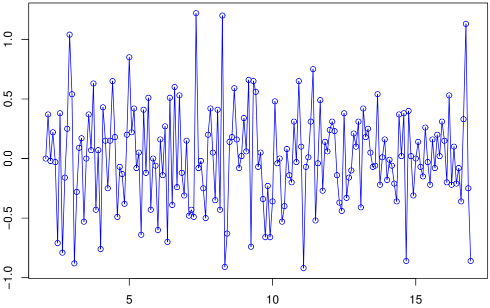
Now the polynomial trend term $T_t - T_{t-d}$ can be eliminated by applying a power of the differencing operator.

Preprocessed Time Series



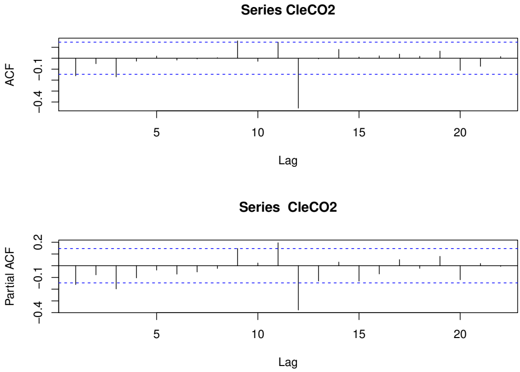
After the differencing, we get the preprocessed time series $\hat{x}_t$. Then we use the Augmented Dickey-Fuller test to check the stationarity of the series.

Preprocessed Time Series (function *adf.test*)



The result of the ADF test can sufficiently reject the null hypothesis of a unit root at level 0.05.

Model Analysis



The ACF value is signicant when lag = 12, which implies a seasonal ARMA model may be suitable.

Final Model

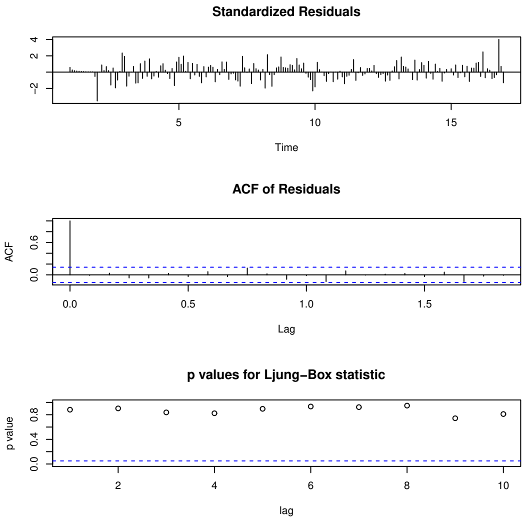
Function auto.arima(): $(1,0,1) \times (0,0,1)_{12}$ (Smallest AICC Value)

Combining the pre-differencing procedure $(1-B)(1-B^{12})Y_t$, our final model is SARIMA model with parameters $(1,1,1) \times (0,1,1)_{12}$.

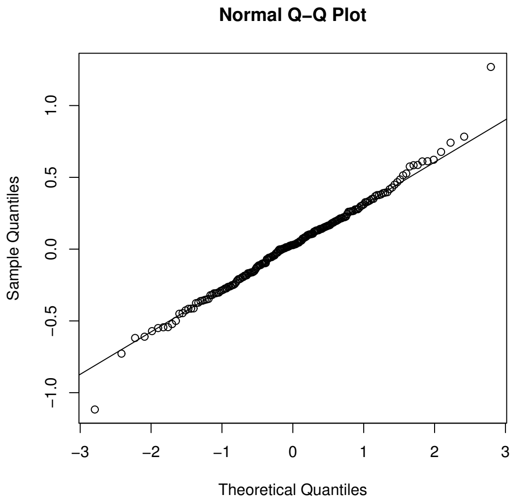
With maximum likelihood method, the coefficients for the final model are estimated as:

Coefficients	Estimate	Standard error
ar_1	0.3714	0.1746
ma_1	-0.6709	0.1378
sma_1	-0.8293	0.0871

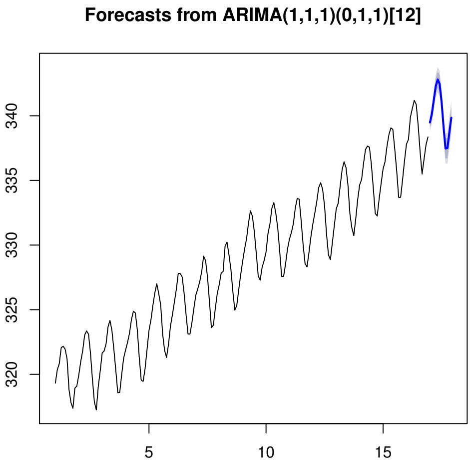
Model Evaluation (function *tsdiag*)



Model Evaluation



Forecast



Conclusion

From the graph of the original CO_2 data, we can see that the additive model seems applicable.

We eliminate the trend and seasonality of the original data with differencing method.

We use a SARIMA model to characterize the stationary component with the help of *auto.arima()* .

The tests (*tsdiag*) of the residuals show that our model has achieved preferable results.