02417: Time Series Analysis
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Assignment 3: ARIMA model atmospheric CO2

In this assignment you will ARIMA models for the development of atmospheric CO_2 over the past 60 years. Monthly observations from Mauna Loa, Hawaii, are provided by NOAA and the goal is to predict the concentration in the comming years.
The data (same as in assignment 1) is provided in `A3_co2.txt` and includes four columns: year, month within year, time as decimal year and atmospheric CO2 in ppm. The data is provided by NOAA/ESRL: `www.esrl.noaa.gov/gmd/ccgg/trends/`
You should not use the observations for years 2018 and 2019 (Last 20 observations) for estimations/training - only for comparisons/testing.

Question 3.1: Plotting

Plot the data as a function of time. Indicate the test data in the plot. (It is OK to reuse from assignment 1)

Question 3.2: Correlation structure

Plot the autocorrelation function and the partial autocorrelation function of the CO2 concentration.

If relevant you should also plot for transformations of the CO2 concentration.

Comment on the plot(s) including what can you say about a potential model structure at this stage?

Question 3.3: Procedure for identifying ARIMA model

State the approach/algorithm that you will use for identifying the best model. Include your stopping criteria.

Question 3.4: ARIMA model

Finding a suitable ARIMA model for the atmospheric CO2 concentration.

Try to find a suitable ARIMA model for the atmospheric CO2 concentration. Develop the model using graphical and numerical indicators (Including tests) as you described in Q3.3.

In case the residuals of your final are not satisfactory, describe what you have tried and argue why it is not possible to find a better model.

You don't have to present a full residual analysis for every single model that you have looked at. However, you should present some intermittent models in order to argue for the choices that you have made.

Question 3.5: Predictions

Use the model you have developed for predicting the CO2 concentration 4 years ahead and include prediction limits. Compare with the data that was left out.

Make a table presenting the predictions 1, 2, 6, 12 and 20 months ahead.

Comment on your results.

Question 3.6: Attaining 460 ppm

It has often been stated that the CO2 concentration should be attained below 460 ppm. E.g. "Politically Feasible Emissions Targets to Attain 460 ppm CO2 Concentrations" (https://doi.org/10.1093/reep/rer022)

Use your model to predict when the concentration will exceed 460 ppm if the process continues according to your model.