02427 Advanced Time Series Analysis

Computer exercise 4a

As for the fourth computer exercise you may choose among two different exercises. This document is a description of the exercise concerning estimation of wind power given weather forecasts.

Estimation of wind power

The power production from wind turbiness is very dependent on the wind. So weather forecasts for the wind direction and speed is of great interest when trying to control the power production. In several countries the production of wind power accounts for an increasing part of the total power production and in order to control the conventional power plants and to trade power on NordPool, the nordic power exchange, a prediction of the power production from wind turbines is needed.

The aim of this exercise is to develop adaptive models for predictions of the power production at different time horisonts given the available weather forecasts.

Description of data

The data in this exercise is from Klim, a wind farm located near Fjerritslev in the Northwest of Jutland. A new weather forecast is made every 6 hours and it consists of estimates of the wind speed, direction, and temperature for every hour in the following 48 hours. Every hour the power production from the wind farm is recorded.

The data is in 2 files both having a header with information on the content. The time format in both files is `yyyymmddhhmm` and missing data is labeled as 'NaN'. The recorded productions are in the file `wind_pow.deb` (1Mb) which contains three columns:

- TimeMeas - Time of the measurement
- ToyMeas - Time of the year (days since new year)
- PowerMeas - Measured power production (kW)

The weather forecasts are in the file `wind_nwp.deb` (20Mb) which contains six columns:

- TimeNWP - Time of predictions
- ToyNWP - Time of the year
- PTimeNWP - Time when forecast was calculated
- WSpdNWP - Predicted wind speed (m/s)
- WDirNWP - Predicted wind direction (deg)
- TempNWP - Predicted temperature (K)

The wind speed and direction and temperature are in HIRLAM level 31 which corresponds to a height of about 70m. It is important to understand the combination of the first and third columns. As mentioned there is a new forecast every 6 hours and every forecast covers $[0;48]$h with a resolution of one hour. Hence, every forecast produces 49 lines in the file with the time of the calculation time in the third column and the time of the predictions in the first column.

In the Gbar at DTU the files are available from:
`/gbar/euler/home1/imm/immlec/02427/`
For those using Matlab the file `wind_read.m` (From the homepage) can be used to read the data from that location (saves diskspace).

Exercise

A nonlinear dependence on wind speed and direction is expected. You are requested to develop adaptive models for the prediction of wind power 1, 2, and 3 hours ahead. You have to specify your own model. An example could be a model with diurnal variations, an autoregressive part, and a dependence on changes in wind speed.

Look at the parameter traces and see what you can identify.

Be aware that the roughness of the surroundings has a seasonal variation, this is partly due to leaves on trees.

Hint: Start with a simple model, e.g. pure autoregressive, and see how improvements of the model results in better predictions.

Suggestion: As a beginning it may be an idea to estimate the power curve, the dependence of the power production on the wind speed, for different wind directions.

General help: If requested further material (Matlab files and comments) can be made available on the homepage.