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The mathematics behind the performance of wind turbines

Abstract

We are interested in the performance of a wind turbine for maintenance and power pricing management purposes. For maintenance purposes, we will show how to explore the Supervisory Control and Data Acquisition (SCADA) data, available with every wind turbine, in order to build condition based maintenance (CBM) approaches for the main components of the system. More concretely, in this talk, we will explore concepts from statistics and connect them to stochastic processes. In particular, we will use statistical concepts stemming from Statistical Process Control (SPC) and we will connect them to CBM and first passage times. To this purpose, we will use as a paradigm, mainly for illustration and simplicity purposes, the connection between the Shewhart control chart with the On-Off stochastic process. For the power pricing management purposes it is necessary to develop models that accurately forecast the power output of a wind turbine. As a first step and following the guidelines of the existing literature we used the SCADA data to model the wind turbine power curve (WTPC). We explored various parametric and non-parametric modelling techniques for the modelling of the WTPC. All of these techniques seem to have an intrinsic limitation in terms of accuracy, making the corresponding models inappropriate for short-term forecasting. To avoid this conundrum, we will show that adding a properly scaled autoregressivemoving-average (ARMA) modelling layer increases short term prediction performance while keeping the long term prediction capabilities of WTPC models.

The first part on the maintenance is joint on going work with Alessandro Di Bucchianico (TU/e) and Bert Zwart (CWI) and the second part on the power pricing management is joint on going work with Sndor Kolumbn and Nazanin Noorae (TU/e)