ENBIS SESSION: BAYESIAN MODELS FOR ENGINEERING PROBLEMS

ORGANIZER: RAFFAELE ARGIENTO, NATIONAL RESEARCH COUNCIL (CNR), ITALY

TALK 1: PROBABILISTIC SUPPORT VECTOR REGRESSION OF TIME SERIES DATA FOR PROGNOSTICS IN NUCLEAR POWER PLANTS

SPEAKER: VALERIA VITELLI, UNIVERSITY OF OSLO, NORWAY

(JOINT WORK WITH JIE LIU, ENRICO ZIO, REDOUANE SERAOUI)

We propose an innovative Probabilistic Support Vector Regression (PSVR)-based approach to the prediction of the anomalous condition of a Nuclear Power Plant (NPP) component. A Bayesian approach to inference is proposed, to properly account for the expert knowledge. Specific techniques are employed for tuning the model hyperparameters, for model selection and uncertainty analysis. A real case study is considered, concerning condition monitoring of a component of the Reactor Coolant Pump (RCP) of a typical nuclear Pressurized Water Reactor. The model is then further employed for prognostics, in the general context of time series data monitored on components of complex power systems. An ensemble approach based on dynamically weighting different models is proposed to improve prediction power. The novelty of the proposed approach consists in the introduction of a signal reconstruction technique suited for time series data, in the use of a modified radial basis function kernel suited to multiple time series data sets, and in the dynamic calculation of sub-models weights for the ensemble. A novel aggregation method is also proposed for uncertainty analysis. We test the model on a real case study involving 20 failure scenarios from the RCPs of different NPPs. Prediction results are given with the associated uncertainty quantification.

TALK 2: SEMI-MARKOV MODELLING OF ELECTRICITY CO-GENERATION IN RESIDENTIAL APPLICATIONS WITH TIME-DEPENDENT COVARIATES

SPEAKER: RAFFAELE ARGIENTO, NATIONAL RESEARCH COUNCIL (CNR), ITALY

(JOINT WORK WITH ANTONIO PIEVATOLO)

We analyze electrical energy data produced by micro combined heat and power generators (micro-CHP). They are residential machines which produce heat and electricity simultaneously, controlled by heating requirements. We characterize the stochastic process describing the profile of the electricity produced in a typical winter day by a system of micro-CHPs. Firstly we describe the stochastic process used to model the time series of energy produced by a single micro-CHP, obtaining an Accelerated Failure Time (AFT) model with time-varying covariates, over which we make Bayesian inference. Secondly, we devote the main part of this work to the

analysis of the properties of the sum of many realizations of the estimated process, as a means of evaluating the curve of the electricity fed into the grid by a large number of micro-CHPs. Our approach will be computational. We will use a Markov chain to simulate the stationary trajectories of an alternating renewal process with time varying covariates. The method will be applied to a real dataset. The data were collected at the Institute of Construction Technology of the Italian National Research Council where a micro CHP system is installed in an experimental building.

Talk 3: FLEXIBLE CLASSES OF LINEAR DEGRADATION MODELS

SPEAKER: ROSANGELA HELENA LOSCHI, FEDERAL UNIVERSITY OF MINAS GERAIS, BRAZIL

(JOINT WORK WITH RIVERT P. BRAGA OLIVEIRA AND MARTA A. FREITAS)

In this paper we introduce a flexible class of linear degradation model able to accomodate skewness and heavy tailed behavior in the degradation path. That is achieved by assuming that the degradation rate has distributions in both classes of distributions, the families of scale mixture of skew-normal distributions as well as of log-scale mixture of skew-normal distributions. Similar to what is observed in the Weibull case, we prove that the distribution for the failure time belongs to the same family as the degradation rate. This result is useful mainly to infer about the failure time considering the analytical method. We introduce an algorithm to sample from the posterior distributions based on data augmentation technic. We also propose a strategy to infer about the failure time throughout predictive distributions. Results are compared with that obtained using methods traditionaly used in the literature such as the analytical method. The proposed models are assumed to analyse degradation on trains wheels and laser emitters data sets.