MODELLING SMART GRIDS 2015

A NEW CHALLENGE FOR STOCHASTICS AND OPTIMIZATION

ENBIS ENERGY DAY 2015
ROUND TABLE DISCUSSION 2015
COST WORKSHOP 2015

BOOK OF ABSTRACTS

Prague
September 10 – 11, 2015

BOOK OF ABSTRACTS

Jaromír Antoch

Electricity Consumption Prediction with Functional Linear Regression

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A functional linear regression model linking observations of a functional response variable with measurements of an explanatory functional variable is considered. This model serves to analyze a real data set describing electricity consumption in Sardinia. The interest lies in predicting either oncoming weekends or oncoming weekdays consumption, provided actual weekdays consumption is known.

Marek Brabec

Modeling Dynamics and Short Term Prediction of Complex Processes

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Modern semiparametric statistical modeling is a powerful tool useful for description of complex and nonlinear systems like those arising in energy-related fields. The approach has been successfully applied in study of many dynamic and spatio-temporal phenomena, both for theoretical and practical reasons. In particular, structured models derived e.g. as GAM (generalized additive models) have been used for short-term predictors that have to respect given "physical" constraints (common in energy production and transport). Part of the GAM development has strong ties to the Bayesian viewpoint. Hence, it can serve as a natural bridge toward models for "information fusion" (pooling data varying in quality and structure).

Eliška Cézová

Analysis of pollution in the neighborhood of opencast coal mines

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Czech power plants substantially rely on the brown coal coming from opencast coal mines in West Bohemia. Despite considerable effort, these mines are still source of polution. This contribution will concentrate on the analysis of measurements of polution and accompanying meteorological measurements collected during the years 2012 – 2014 near Kadaň.

Claudia D'Ambrosio

Optimization Based on Mixed Integer Nonlinear Programming (MINLP) Method

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Mixed integer non linear programming (MINLP) is a discipline that aims at finding solutions to optimization problems with continuous and integer variables subject to non linear constraints. This kind of problems can be found in several practical context like chemical, reservoir, and electrical engineering, just to mention a few. In this talk we will survey the main classes of MINLP problems and the state of the art methods to solve them. To conclude, an application in the smart grid context will be presented.

Alessandro Di Bucchianico

Towards an Effective Collaboration between Industry and Academia

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In order to provide our society now and in the future with electrical power and gas poses complex challenges to energy providers. These complex challenges can only be met successfully if up-to-date optimization and prediction techniques are applied. This requires an intensive collaboration between industry and academia. More and more such collaborations need to be at an international level. We will discuss key elements to establish effective collaborations, including the role of international societies like ENBIS (European Network for Business and Industrial Statistics) and the opportunities that European programmes like Horizon 2020 provide with respect to funding.

Gejza Dohnal

Successive Events and Energy Networks

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A model of successive events will be presented. The contribution deals with a type of events which can be denoted as disastrous. It means fatal events which are highly dependent to each other, they are unrepeatable and their consequences are non reversible in a short time. Moreover, the events propagation forms a branching process, which means that at any time there are several possibilities for spreading. Such events are observed in energy network, where one failure can start a series of another consequences – successive events.

We describe some models of the disastrous events spreading. This is a very important part of risk analysis. Despite the strong dependency of successive events, after some arrangements we can use Markov models for the description. It allows us to compute several characteristics of such system. When we consider a system of objects among them a disastrous event could spread, we can compute a probability distribution of absorbing states, first passage times for any of the objects and many others. This modeling can help us to make some preventive decision or to prepare disaster recovery plans.

Zdeněk Fabián

Distance of observations

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A natural distance between two observations of a random variable is the absolute value of the difference of estimated values of certain score function of these observations. We present a score function suitable for skewed heavy-tailed models, often encountered in energy consumption considerations.

Milan Garbiar

Tackling mathematical challenges of energy forecasting for smart grid

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Modelling of phenomena typical for utility sector poses several challenges. Today we can state that most of the companies with the current state of technologies can overcame challenges related to data

acquisition, data quality, data preprocessing for modelling and understanding of data. Amount of models which needs to be build and maintained is however significantly increasing.

Constructing a single model with a good accuracy is already a challenging task because considering even a relatively few predictor candidates (e.g. calendar information, meteorological forecast data, past consumption), their possible time-delays and/or interactions introduces a large search space for an optimal subset of the predictors.

TIM engine offers automatic building of non-parametric non-linear models from data. Model building is driven by an information criteria that optimizes directly generalization rather than model fit to the data, and thus, the constructed models are parsimonious, transparent and have an excellent generalization ability. Moreover, the generated model structures are transparent and parsimonious what naturally elucidates knowledge concerning the underlying dynamics in data; i.e. the constructed structures reflect the patterns hidden in data.

TIM engine is capable of automatic building of a large amount of models for many (thousands of) datasets within an optimal time.

Daniel Georgiev

Tractable Interval Methods for Secure and Flexible Power System Operation

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Existing flow based tools used in many power system operations evaluate power adequacy and security of individual decision scenarios but fail to consider nearby regions in the operating space. Such tools may lead to market transactions, preventive actions, energy management decision or corrective actions that are nominally efficient but poor in general. Herein a tractable formulation of an interval method is introduced. The presented results include an algorithm defined within a tractable optimisation framework that computes maximal power injection sets containing power injection profiles that are necessarily secure. Applications including inter-operator coordination and reserve market support are discussed.

Ivan Kasanický

Data assimilation using spectral approximation of covariance in EnKF

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Outputs of numerical weather prediction models are crucial data source in many forecast task problems in energy industry, such as prediction of energy produced from renewable sources. The state of these models has to be periodically improved using the information from available measurement. While the dimension of typical weather model is few million or even billion, the number of available measurements is usually less then ten thousand. Therefore advanced techniques to incorporate information obtained in measurement in to the modeled state have been developed. This process is known as data assimilation.

One of the possible approaches to this problem is an ensemble Kalman filter (EnKF), which use multiple samples (ensemble) to represent the distribution of the modeled state. Since the originally proposed technique suffers from many disadvantages, such as low rank approximation of covariance matrix, we have improved the method by using special spectral representation of covariance matrix. Our proposed algorithm is usable in any situation, where hidden second-order stationary state must be updated using given observations.

Ondřej Konár

Forecasting Number of Natural Gas Consumers and their Total Consumption with R

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Revenues of natural gas providers and distributors naturally strongly depend on the amount of delivered natural gas and its price. The retail prices could be different for different customers. Typically the price depends on the volume of consumed gas. In that case it would be useful to forecast the total amount of consumed gas within each tariff class, i.e., for each price level. If the tariff classes didn't depend on the consumption, then it could be solved by standard forecasting methods. Otherwise, customers can change tariff classes over time. This generates a dependency structure between classes.

We have developped an R package for Czech gas distributor RWE GasNet, s.r.o., which implements a prediction model taking into account the described dependency structure. The package is also able to create the explanatory variables for the model from regular invoicing data. The whole process of estimating model parameters and forecasting the number of customers and their total consumption for each tariff class can therefore be done within this R package with no need of extra data preprocessing. In the presentation I will briefly introduce the design of the prediction model and the main features of the package.

Tomáš Masák

Binary Decision Diagrams in Reliability Theory

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Reliability theory and particularly one of its classic modeling tools, fault trees, are concerned with assessing large complex systems such as nuclear power plants, whose failures can cause extremely disastrous consequences. Originally introduced for boolean function manipulation, binary decision diagrams (BDDs) represents an alternative approach to fault tree modeling. Provided monotonicity of studied functions (a.k.a. coherency of studied systems), BDDs can be used to obtain minimal cut sets more effectively. Minimal cut sets is one of the main objects of system analysis, because it improves the understanding of the system modeled by exploring all possible failure mechanisms. Unfortunately, obtaining a minimal cut set of a given boolean function is a NP-hard problem. Combined with the fact that assessed systems are usually very large, this leads to a necessity for competent algorithms. In the paper, a construction of BDDs is explained and efficient algorithms for obtaining minimal cut sets are described in detail. Finally, a comparison of these algorithms against classic fault tree methods is provided. This comparison is based on both theoretical properties and practical application of the algorithms on evaluating fault trees from the Temelín Nuclear Power Station.

Emil Pelikán

Informatics for Modern Energy Management

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The main objective of the round table is to bring together researchers and energy providers, traders and operators. We set three thematic round tables devoted to the governmental and private financing of research (Topics I: Energy is money), academic research and industrial needs (Topics II: Face to face networking) and informatics research targets and horizons required by energy industry (Topic III: Real data - A challenge for decision making). The main output of the round table is to formulate some substantive issues of cooperation between informatics and power industry and up-to-date knowledge transfer between them.

Václav Šmídl

Statistical Calibration of Dynamic Ampacity Model

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Ampere capacity of a conductor (ampacity) is an important parameter in power transmission systems since it limits the amount of energy that can be transmitted. This parameter is heavily dependent on weather conditions. Prediction and even measurement of weather conditions is subject to severe uncertainty. The goal of this research is creation of a statistical model that predicts ampacity and reliably quantifies uncertainty of the prediction. We propose a simple model and illustrate its performance on data from a real transmission line.

Zdeněk Wagner and Pavel Kovanic

Advanced Data Analysis for Industrial Applications

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One of the principal tasks of nowaday's industry is process intensification. The methodology for finding reliable results is highly demanded. While marketing is concentrated on analysis big data that are available in eShops as well as other internet media, the situation in the industry is different because solution must be found in real time based on limited amount of data. The algorithms of data analysis must therefore be fast and robust. In the last few decades statistical methods have advanced considerably but a new, nonstatistical approach to uncertainty, called mathematical gnostics, have also be developed. This new approach is based upon the fundamental laws of nature and robustness is its inherent property. The contribution will present several applications with the emphasis laid upon description of the main features of mathematical gnostics. Previous applications in energetics that can be enhanced by use of the modern algorithms of data analysis will also be mentioned.

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