3rd Workshop on Quality Improvement Methods
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Abstracts

Part 1: Dynamic Systems

Probabilistic predictions for observed stochastic processes with approximate Markov property

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Even if the underlying process is Markovian, observed time series data are typically not. However, a Markov approximation is very often reasonable. We show that making such an assumption the transition probabilities of a continuous state Markov chain model can be easily extracted from the recorded data. Using these empirical transition probabilities, we can makevarious types of forecasts. We demonstrate the method for surface wind recordings, making predictions of turbulent gusts arriving at a wind turbine 2 seconds ahead.

Optimizing the BTA deep hole drilling process: a dynamical systems approach

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We use a dynamical systems approach to model and predict the occurence of dynamic disturbances, in this case chatter, during the BTA deep hole drilling process. The model consists of a set of coupled nonlinear differential equations, each of which describes a single, characteristic torsional mode of the boring bar, torsional vibrations having been identified as being responsible for chatter. Our approach mirrors the fact that the spectrum is dominated by a few frequency components, each of which coincides roughly with an eigenmode of the free boring bar. Transitions between different states (e.g. no chatter→chatter, or between different chatter states) are represented by bifurcations of the model solutions, which are obtained numerically. The model is constrained by the properties of the transitions observed in experiments, by the results of bifurcation theory which states that locally, there exist only a few generic types of bifurcations and by the requirement to globaly reproduce the observed time series. To meet the last requirement, model coefficients are adapted by an evolutionary optimization algorithm (covariance matrix adaptation).
The models we have found in this way reproduce observed data and can account for key properties of observed time series. One the one hand, the model is used to predict disturbances sufficiently early before their onset and on the other hand, we intend to use it to devise control strategies to prevent a disturbance from actually occurring after detection.

Part 2: Multivariate Optimisation

Uncertainty of the Optimum Influence Factor Levels in Multicriteria Optimization Using the Concept of Desirability

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The Desirability Index is a widely used method for multicriteria optimization in industrial quality control, by which optimal levels of the process influencing factors are determined in order to achieve maximum process quality. In practice however situations may occur in which slight changes of these factor levels lead to lower production costs or to a facilitation of the production process and therefore would be preferred. An innovative approach for measuring the effect of these changes on the Desirability Index based on its distribution is introduced.

Using QSAR models for lead optimisation: the impact of prediction error.

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Benoît Beck, BrunoBoulanger
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The use of models to predict the Quantitative Structure Activity Relationship has revolutionised the drug discovery process. In the last decades, a lot of drug candidates were failing in the clinical stages just because of poor ADME properties (Absorption, Distribution, Metabolism, and Excretion). Now it's a common practice to test in laboratory only compounds that revealed to be promising according to the predictions of such *in silico* models.
It's the role of the statistician to develop models that can predict the properties of interest as a function of chemical descriptors such as multiple regression, trees, neural networks,… The different properties to optimize are summarised in one objective function using desirability index, a concept introduced by Harrington in 1965. But what is often forgotten in practice is that those models are only a simplification of the reality and the predictions are sullied with error.
We are interested in the impact of those prediction errors when using QSAR models in lead optimisation, more particularly when using algorithms such as genetic algorithms or simulated annealing to select compounds in a combinatorial library.

Part 3: Experimental Design

ROBUST DESIGN FROM COMPUTER SIMULATORS

David M. Steinberg
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Reducing time to market is an increasing challenge to organizations in almost all areas. Reaching the market fast with a robust product is an even greater challenge. Statisticians have been working with product development teams on these problems for the last 20 years with varying levels of success. The use of computer simulators rather than physical experiments can be very helpful in reducing development time. We consider the problem of how to achieve robust design from a process that is studied via a computer simulation. Many case studies of this nature have been published using the same methods for robust parameter design experiments that are applied to actual physical experiments. However, other methods may be better suited for use with computer experiments. We provide in this work a perspective on various approaches and compare them on a case study using simulated performance of a piston. We point out new and promising directions that complement the growing trend of designing products using simulation tools.
This is joint work with Ron Bates (London School of Economics) and Ron Kenett (KPA Ltd., Israel) and grew out of the TITOSIM project, funded by the European Union's Fifth Framework.

Experimental design and analysis in situations with uncontrolled raw material variation

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Kjetil Jøgensen
Tine, Voll

To be able to control an industrial process it is necessary to know the relationship between raw materials, process settings and end product results. In many situations the raw materials are highly complex and difficult to vary in a systematic way. This makes the use of standard experimental design techniques with a systematic variation in the variables difficult. To solve this problem one can measure the raw materials at hand and use these measurements in the modeling. The problem, however, is that it is often not obvious what to measure. In this paper we present a possible approach for such situations based on an experimental design in the factors that are possible to control, the different batches of raw materials organized in blocks in combination with multivariate spectroscopic measurements (using FT-IR) of the raw materials. To analyze the results we include these measurements as principal components or PLS components of the spectra. The usefulness of the approach is demonstrated with an example from cheese production. It is shown that it is possible to obtain a model for the amount of “cheese fines” (a yield loss parameter) based on this approach. The final model contains easily measured information about the raw materials, but is obtained without any prior hypothesis about their contribution.

Part 4: Longitudinal Data

Modelling factorial effects and longitudinal data by Semiparametric Models

Jan Engel
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In the presentation we compare five models from literature for semiparametric modelling where treatments are applied in a blocked factorial design with subjects as blocks, and where the data are longitudinal response data. The five models are fitted to the data and the estimation and testing results are compared. A simulation study investigates the power of testing main effect of treatment and its interaction with time. Conclusions are drawn on the usability of the models for industrial experimentation and suggestions for further research are given.

Analysing experimental design results when the response is a curve : a case study in polymers R&D.

Bernadette Govaerts,
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In many industrial applications, the response of an experiment is a curve as, for example, when a rheometer is used to analyse the hardness of a product as an function of its temperature. In such context, when a set of (designed) experiments are performed, the polynomial regression approach to predict the response as a function of the experimental factors usually used to analyse experimental designs results should be adapted.
This talk will review several methods available to analyse the results of a designed experiment when the response is a curve and compare them on a case study coming from the polymer industry. The different approaches proposed are parametric, semi- or non-parametric and are inspired from the functional analysis literature in statistics and PLS one in chemometrics. They all aim to predict the functional response as a function of the design factor settings. A bootstrap procedure is also investigated to build prediction intervals around the predicted curve and test the significance of model parameters.

Part 5: Applications in Industry

Application of DoE in Automotive Industry

Ulrike Grömping
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This contribution gives three DoE applications from Ford Motor Company and its suppliers. Two experiments are based on 2-level (fractional) factorial designs, while the third application uses a computer experiment with an orthogonal column latin hypercube design. The factorial examples exemplify the scope of experimentation and some typical practical problems when applying fractional factorial plans. Furthermore, the latin hypercube example illustrates some specific chances of computer experimentation.

Bridging the gap between theory and practice - Lean Six Sigma, a new quality approach at Xerox

Jutta Jessenberger
XEROX, Neuss

In the past few years a range of quality programs have been introduced in companies of all types of industry with varying degrees of success. The outcomes of these quality programs were very different - some of them were short-lived, just an expense to get the necessary certification or plainly ignored in daily work.
However, for some of the companies the program "quality" worked with astounding success - most notably for GE whose success in expansion in a large degree was driven by the common language of quality throughout the enterprises associated over the continents.
So what is the recipe for success through quality and how can a company make quality sustainable, efficient and effective to get the desired results - sound savings & growth?
Starting first with a short summary of the quality programs through history, we will then present the solution Xerox started to implement world-wide in 2003. We will discuss the role of Xerox Lean Six Sigma as a significant contributor to the bottom-line results. Furthermore, we will show in how far Lean Six Sigma at Xerox is more than just a new quality initiative.

Inflator Control Plan Project – A 6-Sigma Approach for Airbag Development Programs

Anja Schleppe
Autoliv GmbH, Dachau

This Inflator Control Plan project was started to understand how to tune inflators for Inflatable Curtain performance. The project was started with more than 15 engineers from 3 companies, 2 of them located in the USA and the 3rd one located in Germany. Inflators are main components of airbag modules. This means, inflator outputs become module inputs, and variability of inflator outputs propagates into module outputs. The interdisciplinary team had the task to understand this link between inflator outputs and final product outputs to reduce the number of development tests in future airbag development programs.