

The estimation of the role of system and statistical thinking in decision making

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Abstract. The goal of this paper is to suggest very simple quantitative estimates of probabilities of wrong decisions being made by managers who don't use system and statistical thinking. The model of decision making discussed by us follows the well-known Shainin rule of green-yellow-red. It is shown that under some conditions (normal distribution of critical characteristics) the probability of wrong decisions can reach up to 50%. The analysis is based on the system archetypes suggested in our previous paper at ENBIS 2006.

Automating model selection for predictive modeling using SAS Enterprise Miner

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Abstract. Predictive modeling, as used in the context of analytic customer relationship management or credit scoring requires building stable models that not only fit the training and validation data, but generalize well when presented with new data that were not used during the modeling stage. Statisticians usually employ techniques like cross-validation or jack-knifing to ensure that no over-fitting occurs. However, finding the best model by trial and error is still a time-consuming challenge, as many statistical methods and data mining algorithms require fine-tuning certain parameters.

Using an example from database marketing, this presentation will demonstrate how SAS Enterprise Miner can be used to run various models with differing parameter settings and automatically select the best performing model for the final scoring task. Model selection can be based on statistical criteria such as misclassification, error or profit/loss (if a profit/loss function is supplied). SAS Enterprise Miner offers a convenient graphical user interface that supports the statistician with all necessary tasks during a data mining project, from sampling and initial data exploration via variable transformation and modeling to model assessment and scoring. Thus, using SAS Enterprise Miner can help statisticians save time during the model building process.

Analysis of repeated measures data that are autocorrelated at lag(k)

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Abstract. Several measurements are taken on the same experimental unit in repeated measures analysis. The subjects are assumed to be drawn as a random sample from a homogeneous population and observations of a variable which are repeated, usually over time. When data are taken in sequence, such data tend to be serially correlated that is, current measurements are correlated with past measurements. Within-subject measurements are likely to be correlated, whereas between-subject measurements are likely to be independent in repeated measures design. Suppose that Y_1, Y_2, \dots, Y_t are random variables taken from t successive time points. The Serial dependency can occur between Y_t and Y_{t-1} . The corresponding correlation coefficients are called autocorrelation coefficients. The distance between the observations that are so correlated is referred as the lag. The covariance structure of repeated measures involves both the between subject and within subject. Usually, the between subject errors are assumed independent and the within subject error assumed correlated. After performing the analysis of variance when there are significant differences between the factors, multiple comparisons tests are used. In these procedures the standard error of the mean is estimated by dividing the MSwithin from the entire Anova by the number of observations in the group, then taking the square root of that quantity but the standard error of the mean needs an autocorrelation correction when the data are autocorrelated. In this study, a simulation study was performed to illustrate the behavior of the post hoc procedures when data is lag(k) autocorrelated and results were compared to the usual procedures.

On using bootstrap methods for understanding empirical loss data and dynamic financial analysis

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Abstract. Computer-Intensive methods for estimation assessment provide valuable information concerning the adequacy of applied probabilistic models. The bootstrap method is an extensive computational approach for understanding empirical data and is based on re-sampling and statistical estimation. It is a powerful tool, especially when only a small data set is used to predict the behaviour of systems or processes. This paper describes some case studies based on the Efron type bootstrap approaches [1] for modelling loss distributions [2] and for general dynamic financial analysis [3]. The case studies are inspired from risk management field. The research is based on theoretical previous developments in accuracy assessment [4], reliability estimation [5] and risk exchange modelling [6].

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Industrial data mining: a real life example of simulation and optimizing an entire semiconductor fab with heavy duty 6 sigma data mining tools

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Abstract. Production of wafers is a real headache in semiconductor industry. Despite accurate planning and controlling there are still systematic and random effects, which influence the production yield. Considering the life cycle of semiconductor designs, it is key to commercial success to shorten the production ramp up and then have a maximum yield. Sometimes it is more productive to have simple and actionable engineering rules than deep understanding of the root causes.

Traditional tools like wafer maps suffer from just representing the status quo, when actually the damage is already done. Therefore the production was optimized, using additional data mining techniques:

- Visualization of response and influencing variables to understand the characteristics.
- Feature selection to find the relevant ones among 1.400 equipments (each with 10 to 300 tools).
- Prediction models like CaRT, CHAID, gradient boosting trees, MARSplines and neural networks were used to show interactions between the equipments and between the tools and to find good and bad combinations. Learning from this, brand new equipment can be classified, whether it raises the yield or tends to produce scrap.
- STATISTICA QC Miner was the software behind the scenes.
- Simple and actionable rules were derived from the analysis and yield was significantly boosted.

Efficient experimental designs in the presence of more than one hard-to-change variable

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Abstract. In “real-life” experiments, especially in an industrial environment, experimental factors are often not independently reset for each run. This is often due to time and/or cost restrictions in the production process. A lot of research has been done for the situation in which there is only one hard-to-change variable in the experiment, the so called “split-plot” experimental design. In industrial settings however there are often more factors that are “hard-to-change” and therefore it is also interesting to search for optimal designs that involve several hard-to-change variables. Some published research deals with this topic but under the restriction that all the hard-to-change variables are reset at the same time which reduces this problem to a split-plot experiment. In our research, we relax this constraint and look for D-optimal designs allowing the various hard-to-change variables to be reset at different points in time.

Phase I statistical control of key indicators in health care

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Abstract. A current challenge health care providers are facing all over the world is the definition of adequate metrics to constantly measure, monitor and control the quality of their services and related costs. The identification of quantitative indicators for the key processes is a first necessary step. In a preceding work, the authors presented an approach to define a set of indicators and its successful implementation at “IRCCS Oasi Maria SS”, a no-profit organization for care and research on mental retardation and brain ageing.

In this article the first results of the statistical analysis of indicators data is presented. Collected data concern two-years of activity. They were analyzed by the perspective of statistical process control. Particularly, since they were the first analyzed data, they were used to set up the statistical control framework (phase I).

The main output is a restricted set of control charts, giving top management the possibility to monitor on a continuous basis the vital processes of the organization, having effect on the quality of provided care, related services and customer (patient/family) satisfaction.

Greedy learning algorithms and their applications to decision trees

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Abstract. In this paper we considered the problem of classification by decision trees. In order to better address the inherent tradeoff between optimality and complexity we implement a revised version of the LRTA*, a known artificial intelligence algorithm. We show that such implementation leads to appealing properties of the classification tree.

A control chart for high quality processes with a FIR property based on the run length of conforming products

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Abstract. The control chart based on the geometric distribution which is in general known as the geometric control chart has been shown to be competitive with the classic p-chart (or with the np-chart) for monitoring the proportion of nonconforming items, especially for applications in high quality manufacturing environments. In this paper we present a new type of geometric chart for controlling attribute data which is based on the run length of conforming items. Specifically, we present the basic principles for designing and implementing the new control chart, after reviewing the control charting procedures using the length of conforming units between two consecutive non-conforming units. This new control chart has an appealing performance.

Selecting explanatory variables with the modified version of Bayesian Information Criterion

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Abstract. Business or science data are often stored in large data bases. Looking for relationships between variables represented in such data bases is one of the most important aspects of data mining. In this talk we consider the problem of identifying factors related to a given continuous characteristic. The common approach to this problem relies on fitting the multiple regression model. The usual goal is to choose the simplest model which would include most of important factors related to the response variable. We will demonstrate that in the situation when the number of variables in the data base is much larger than the number of cases the standard model selection criteria like Akaike Information Criterion or Bayesian Information Criterion (BIC) have a tendency to include many spurious variables. This phenomenon is related to the well known problem of multiple testing. We will present the modified version of BIC which adjusts for this problem and its rank extension designed for the situation when the distribution of the response variable is strongly different from normal. We will illustrate the performance of our method by computer simulations and real data applications.

A note on Smart Alarming Methods

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Abstract. Methods of Smart Alarming aim at timely novelty or anomaly detection in Data Streams. A review is proposed to highlight the key points of using them. In case of univariate data, the more suitable method is not the same of stationary variable or non-stationary variable. Multivariate data set are often dealt with unsupervised learning based methods, using either factor analysis (mostly PCA) or clustering algorithms. Each of these methods must be applied in a specific situation: the possible anomalies can be prior perfectly known or not, learning data set can be large sized or not, and so on. Some examples are outlined. Discussion underlines the importance to have a prior knowledge of variable behaviour, and to consider the global flow chart, including eventually a data preprocessing.

Software reliability growth models: systematic descriptions and implementations

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Abstract. We present a systematic approach to software reliability models based on best practices from statistics. Basic steps in a statistical analysis of software reliability data should include data collection, trend tests, model selection, model estimation, model validation and model interpretation. Several problems arise when we try to meet these standards. Normally, assumptions of independent and identically distributed observations are broken by software reliability models. Therefore, standard results from statistics cannot be used although this is often done. Imprecise mathematical descriptions of the models are usually found in the literature. Even if the model description is correct, we often find a lack of attention for numerical instabilities in parameter estimation.

We also report on the status of a new tool that we are developing to support our systematic approach. Existing tools for software reliability analysis like Casre and Smerfs3 do not make full use of state-of-the-art statistical methodology or do not conform to best practices in statistics. Our tool uses well-documented state-of-the-art algorithms and encourages applying best practices from statistics. Moreover, it can easily be extended to incorporate new models. We decided to use Java for the interface (platform independent) and the statistical programming language R (see www.r-project.org) for the statistical computations. We pay special attention to convergence issues and apply specific algorithms that avoid standard numerical problems.

Supermarkets sales and retail area: a mixture regression model for segmentation

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Abstract. Sales in supermarkets, located across a country, can be explained by a wide range of factors as average price, store area for selling, service quality, regional purchasing power, population and competition.

We intend to construct segments of stores (hypermarkets and supermarkets), identifying characteristics based on different responsiveness of sales to the different explanatory variables.

We use mixture regression models with a constant elasticity model (power function), estimating simultaneously the regression model and the assignment of each store to each segment. The number of segments is accessed by statistical indicators, as information and classification based criteria.

Due to the high importance attributed by managers to the retail area elasticity, this variable has a special role in this analysis, named on the profiling of group members. Data were collected for all 106 stores belonging to national retail group, which sells three own retail brands. Some managerial implications were drawn.

Measuring service quality in higher education sector

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Abstract. The purpose of this work is to examine the performance of five alternative measures of service quality in high education sector – SERVQUAL (Service Quality), Weighted SERVQUAL, SERVPERF (Service Preferences), Weighted SERVPERF and HEDPERF (Higher Education performance). We aim at determining which instrument had the superior measurement capability. Data were collected by means of a structured questionnaire containing perceptions items enhanced from the SERVPERF and HEDPERF scales and expectation items from the SERVQUAL scale, both modified to fit into the higher education sector.

The first draft of the questionnaire was subject to a pilot testing through a focus group and an expert evaluation. Data were gathered from a 300 student's sample of a Portuguese university in Lisbon. Scales were compared in terms of unidimensionality, reliability and validity (convergent, discriminant and predictive). Managerial conclusions were also drawn.

Brand loyalty and mixture regression models: segmenting customers in jeans market

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Abstract. Brand value (BV) has been widely studied in recent years. The popularity of this subject is mainly due to its importance concerning strategic decisions as: differentiation, profitability and competitiveness of organizations, namely those evolving in an industrial environment.

We intend to analyse loyalty – a brand-value effect, and test if the intangible value of a brand is (empirically) an effective determinant of BV, or, instead, if the only determinants of BV are tangible variables, as quality or notoriety.

As the fashion industry (jeans) and their customers are very sensible to intangible factors, we use as explanatory variables brand personality and store image, despite the most classical determinants were brand personality and perceived quality.

To evaluate the relevance of the intangible factors in explaining brand loyalty we consider the latent variable personality, which were constructed based on the 15 items, proposed by the seminal article of Aaker.

We intend to construct segments of customers based on brand loyalty and that present different responsiveness to the explanatory variables. As the dependent variable – brand loyalty – is a binary variable, we use a logistic mixture regression model.

We collected information from 500 customers when they were shopping. We study 5 of the main brands of the jeans industry. Scales used in the questionnaire were the first factor analysed before the mixture study. Some managerial implications were drawn.

Statistical consultancy. What's in it for me?

R. Caulcutt

Abstract. Our consultancy clients will usually require advice or guidance on the collection, analysis and interpretation of data. The statistician is well equipped to provide this advice, based on his/her deep understanding of statistical theory and practice. But, what else might the client hope to gain from the consultancy interaction? What does the statistician hope to achieve? How about the other interested parties; what's in it for them?

This presentation will discuss the psychological needs of all the stakeholders in the statistical consultancy interaction. If the statistician does not respond to these needs, he/she may experience disappointment and greatly reduced effectiveness. How, then, should the consultant operate in order to increase the probability of success, in an environment where each participant may be wondering "What's in it for me?"

A two-sided multivariate p control chart

P. Cozzucoli

Abstract. We assume that the operator is interested in monitoring a multinomial process, that is the items are classified into $(k+1)$ ordered distinct and mutually exclusive categories; specifically, the first category is used to classify the conforming items, while the remaining k categories are used to classify the nonconforming items in k defect grades, with increasing degrees of nonconformity. Usually the process is said to be capable if the proportion of nonconforming items is very small and remains low, or declines, over time. In this case, because we have chosen to classify the nonconforming items into k defect grades, the overall proportion of nonconforming items depends on the k categories, which are not necessary independent, and we are interested in evaluating over time the proportion of nonconforming items in each category as well as the overall (across the k categories) proportion of nonconforming items. To achieve this goal, in this paper we propose i) a normalized index that can be used to evaluate the capability of the process and ii) a two sided Shewhart-type multivariate control chart with probabilistic limits to monitor the overall proportion of nonconforming items. In addition, we suggest a solution to the identification problem when an out control signal takes occurs. The same sample statistic is used to define the normalized index and the multivariate p control chart.

Notes on experimental design for statistical calibration

P. Cozzucoli

Abstract. Let's consider for example the problem involving measurements of a specific pollutant in samples taken to monitor the air pollution; suppose that we can use two different instruments and/or methods to do that: one very precise but slow and expensive and another very quick, cheap but less precise. Using measures less precise Y we want to estimate the true value of pollutant X ; this is a typical calibration problem. A statistical calibration problem is usually carried out in two distinct stages. At a first stage, responses are observed corresponding to known regressor values; using these observations the operator obtains useful information about the calibration curve. At a second stage, one or more responses are observed which are corresponding to an unknown value of the regressor; the estimation of this unknown value is of primary importance for prediction. In general, the methodology was developed for point and interval estimation and extensively applied in Chemistry, Biology and Engineering. For a general review and references on the calibration see Osborne (1991). In this paper we consider a specific experimental calibration design for statistical calibration, by assuming a linear model, that improves the estimation of the calibration curve. We investigate this improvement in the estimation considering the corresponding confidence intervals. We are interested to show that the confidence intervals are shorter than those obtained by the standard design.

The use of intelligent experimental designs for optimal automotive engine calibration online at engine test bench

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Abstract. Control-unit calibration for modern internal combustion engines is currently facing a conflict caused by the additional effort needed to calibrate increasingly complex engine data with a growing number of parameters, together with extremely ambitious objectives regarding the period of time and the resources needed for calibration, performance, consumption, and comfort expected by the customer and emissions levels which are more and more stringent.

To reduce costs we look for reducing testing time at test bench and hence use minimal number of measurements. That leads to Optimal Experimental Design approaches. Designing experiments often leads to trade-offs between local and global search: local criteria encompass achieving best calibration i.e. the optimization of a target (for example performance) under many constraints (emissions, consumption), whereas global criteria tend to explore the whole domain or improve model quality.

We present here the context and methods investigated at Siemens VDO Automotive for optimal engine calibration online at the test bench. The approach will be illustrated on a practical industrial engine calibration example.

Design of experiments for mean and variance

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Abstract. The great majority of experimental designs are directed towards estimating the mean of a single response variable under homoscedasticity. However, in many practical applications the variance structure is not known and the variance, as well as the mean, needs to be estimated. Estimating the mean and variance simultaneously is particularly relevant in quality control experiments. The first person to bring attention to the importance of reducing variability in such experiments was Taguchi in the 1980s. Taguchi methods seek to design a product or a process whose performance meets a specified target on average and exhibits little variability. This variability may be a consequence of environmental factors, controllable and uncontrollable factors during the manufacturing process and component deterioration.

More recently, Atkinson & Cook (1995) and Vining & Schaub (1996) developed optimal design theory for estimation of mean and variance functions simultaneously. Both papers assume that the variance function is estimated using the residuals of the regression function for the mean. However, researchers often prefer using sample variances for quantifying and modelling variation. This has the advantage that the responses of the variance function do not depend on the specification of the mean function. If sample variances are utilized, the optimal design approaches of Atkinson & Cook (1995) and Vining & Schaub (1996) are no longer ideal. Therefore, building on the work of Goos, Tack and Vandebroek (2001), we propose a new optimal design criterion for the simultaneous estimation of mean and variance functions, where it is assumed that sample variances are used for estimating the latter function.

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Paired comparisons in visual perception studies using small sample sizes

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Abstract. Paired comparisons is a useful method for experimental design with various applications like perceived crime seriousness and measurement of health status. Industrial applications concern the relative importance of factors before including them into an experiment, consumer tests in the food industry and visual perception research. Visual perception researchers perform experiments on display systems and they ask subjects to compare or rank displays according to a specified criterion, such as brightness or sharpness. In this way, they investigate perceived differences between displays to hopefully understand these from physical specifications. A classical model for such experiments is the Thurstone model of the form $H(p_{AB}) = a - b$, where p_{AB} is the probability that display A is preferred over display B , and a and b are scores for the two displays. It is important to estimate scores, to test differences of scores and to test the effect of factors like image content and gender of subjects. For these purposes, Generalized Linear Models (GLM) appear to be very useful.

We shall firstly embed the Thurstone model into GLM and discuss a multiple testing procedure for differences of scores, controlling the family wise error rate. Further, we present tests for factors on scores. Secondly, in a simulation study we find testing power as a function of the number of subjects. Finally, a case study will be worked out as an example and we end with some discussion points.

Load shedding: a new proposal

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Abstract. During overloads in the mains, the load curtailment applied to interruptible loads is often the only solution to keep the network in operation. Normally, in contingencies, the difference between the power absorbed and the power produced is very low, often less than 1% of the latter. Therefore if all the loads participated in the load shedding program, the discomfort would be minimal, considering its usually short duration. According to this point of view, we present a new approach to the load shedding program to guarantee the correct electrical system operation by increasing the number of participants. This new load control strategy is named Distributed Interruptible Load Shedding (DILS). Indeed, it is possible to split every user's load into interruptible and uninterruptible parts, and to operate on the interruptible part only. The optimal load reduction request is found by minimizing the expected value of an appropriate cost function, thus taking the uncertainty about the power absorbed by each customer into account. Presently, several users such as hospitals, data centres, supermarkets, universities, industries, etc. might be very interested in typical shedding programs as a way to spare money in their electrical account. However, in the future, when the domotic power plants are likely to be used widely, the distributors could interest the end users in participating in DILS programs for either economic or social reasons. By adopting the DILS program, the distributors can resort to the interruptible loads not only in case of emergency conditions but also during normal and alert operations.

The effect of liberalization in the Italian gasoline sector: higher chance of collusion or incomplete liberalization?

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Abstract. This paper aims to investigate, using a statistical approach, the impact of liberalization of the gasoline retail prices in Italy. The industry nowadays is characterized by an oligopoly made of vertically integrated companies holding a share of 98% of the distribution activities. Moreover gasoline can be classified as a good with a strong anelastic demand (at least in the short-run). These conditions are clearly favorable for an agreement between refiners. On the basis of a data set on the individual recommended gasoline daily prices from 1990 to 2005, the paper investigates two main issues. The first is the impact of some macroeconomic variables on the level of gasoline prices. Countless factors are involved in the generation of prices, first of all the crude oil price and the differences in euro/dollar exchange rate. Other factors like inflation, consumptions, production costs and taxation matter in fixing the price level. Moreover, strategic effects may also be important: the refiners may strategically react asymmetrically to oil price shocks, with immediate upward adjustments and delayed downward adjustments. The second one aims is the assessment of two nonexclusive hypotheses: the un-expected increase – after liberalization – in the observed retail price level, is due either to an increase in the degree of collusion among refiners, and/or to some restrictions to effective competition among retailers (e.g. limits in the opening time, and in the possibility to sell non oil goods, etc.). If the second hypothesis is confirmed, it will provide some evidence that the liberalization process in this sector is incomplete in Italy.

On-line diagnostics tools in the Mobile Spatial coordinate Measuring System (MScMS)

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Abstract. Mobile Spatial coordinate Measuring System (MScMS) is a wireless-sensor-network based system developed at the industrial metrology and quality engineering laboratory of DISPEA – Politecnico di Torino. It has been designed to perform simple and rapid indoor dimensional measurements of large-size volumes.

It is made up of three basic parts: a “constellation” of wireless devices (Crickets), liberally distributed around the working area; a mobile probe to register the coordinate points of the measured object (using the constellation as a reference system); a PC to store data sent – via Bluetooth – by the mobile probe and to elaborate them utilising an ad hoc application software, created in Matlab. Crickets and mobile probe utilize ultrasound (US) transceivers in order to communicate and evaluate mutual distances.

The system makes it possible to calculate the position – in terms of spatial coordinates – of the object points “touched” by the probe. Acquired data are then available for different types of elaboration (determination of distances, curves or surfaces of measured objects).

In order to protect against causes of error such as, for example, US signal diffraction and reflection, external uncontrolled US sources (key jingling, neon blinking, etc.), or software algorithms non-acceptable solutions, MScMS implements some statistical tests for on-line diagnostics. Three of them are analyzed in this paper: “energy model diagnostics”: based on the “mass-spring system” localization algorithm; “distance model diagnostics”: based on the use of a distance reference standard embedded in the system; “sensor physical/model diagnostics”: based on the redundancy of Crickets’ US transceivers. For each measurement, if all these tests are satisfied at once, the measured result may be considered acceptable with a specific confidence level. Otherwise, the measurement is rejected.

This paper, after a general description of the MScMS, focuses on the description of these three on-line diagnostic tools. Some preliminary results of experimental tests carried out on the system prototype in the industrial metrology and quality engineering laboratory of DISPEA Politecnico di Torino are also presented and discussed.

Model-robust designs for assessing the uncertainty of simulator outputs with linear metamodels

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Abstract. This articles addresses the industrial problem of quantifying the distribution $Y_{sim}(x)$ of the output of a costly simulator when the inputs x are random variables with known distribution μ . Due to the computing time, a Monte Carlo method cannot be applied directly to the simulator but only to an approximate model $Y_{app}(x)$. This *metamodel* is built with few experiments $X = (x^{(1)}, \dots, x^{(n)})$. The question is: how to choose the design of experiments X , so that the distributions of $Y_{app}(x)$ and $Y_{sim}(x)$ are close?

Consider a deterministic simulator. In many situations, it is approached by a linear combination of known basis functions g_0, \dots, g_p

$$Y_{sim}(x) = \sum_{i=0}^p \beta_i g_i(x) + h(x)$$

with β_0, \dots, β_p (unknown) real coefficients, and h an unknown function standing for a model deviation. The corresponding metamodel is:

$$Y_{app}(x) = \sum_{i=0}^p \hat{\beta}_i g_i(x) + \eta(x)$$

where, conditionally to spatial random variables, $(\eta(x))$ is a centered Gaussian process representing the estimation error. The parameters $\hat{\beta}_0, \dots, \hat{\beta}_p, \hat{\sigma}^2$ have to be estimated with the n simulator values calculated for $x \in X$, for instance by ordinary least-squares. In this framework, one can compute the two spreads $|E(Y_{app}(x)) - E(Y_{sim}(x))|$ and $|var(Y_{app}(x)) - var(Y_{sim}(x))|$. We show that with poor conditions on the model deviation h , it is possible to choose X to minimize these quantities. We assume that h belongs to a reproducing kernel Hilbert space H : in usual cases, this only implies regularity conditions to h . Following Yue and Hickernell (1998), both criteria can be bounded by expressions depending only on $\|h\|_H$. Optimal designs are then obtained by minimizing the largest eigenvalue of positive definite matrices. Finally, this methodology is extended to stochastic simulators of the form

$$Y_{sim}(x) = \sum_{i=0}^p \beta_i g_i(x) + h(x) + \varepsilon(x)$$

where $(\varepsilon(x))$ is a Gaussian process modelling the numerical error.

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Mixing krigings for global optimization

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Abstract. Over the last 5-10 years, numerical simulations of stochastic and deterministic systems have become more accurate, but also more time consuming. This makes it impossible to study simulators exhaustively, especially when the number of parameters grows large. Consequently, Computer Experiments is a field of study in expansion; application areas include crash-test studies, reservoir forecasting, nuclear criticality, etc. We focus here on surrogate-based global optimization techniques for this kind of complex models.

Our starting point is the EGO algorithm, which is based on a kriging metamodel. In a first part, we recall in detail how kriging allows building sequential exploration strategies dedicated to global optimization. We point out some problems of kernel selection that are often skipped in the literature of kriging-based optimization.

In a second part, we introduce an extension of the EGO algorithm based on a mixture of kriging models (MKGO). We emphasize on how a mixture of kernel can lower the risk of misspecifying the kernel structure and its hyperparameters, especially when the estimation sample is small. The proposed approach is illustrated with classical deterministic functions (Brainin-Hoo, Goldstein-Price), and compared with existing results.

We also present a study carried out on gaussian processes, and observe the relations between the quality of covariance estimation and the performances obtained in kriging-based optimization. We finally give a bayesian interpretation of MKGO, and discuss the in-and-outs of choosing the prior distribution of the covariance hyperparameters.

This work was conducted within the frame of the DICE (Deep Inside Computer Experiments) Consortium between ARMINES, Renault, EDF, IRSN, ONERA and TOTAL S.A.

Residual analysis in experimental design

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Abstract. Engineers are well aware that standard experimental analyses depend upon various model assumptions about the data to which they relate concerning such key issues as experimental units, factors, blocking and response variable. Violations of model assumptions are usually investigated by plotting and examining least squares and standardised residuals.

Despite the success of these diagnostic procedures, however, it is sometimes difficult to obtain exact tests of critical model assumptions because, unlike the true errors, least squares residuals are correlated and have unequal variances. In this presentation it is shown how to define and use a set of uncorrelated residuals with a common variance to examine these assumptions.

Such techniques are demonstrated to be of particular value in industrial experimentation when the nature of the experimental runs means that observations are indexed by time. It is suggested that the resulting test procedures should complement the usual methods. The construction of this set of uncorrelated residuals is established and shown to be straightforward for practical use when checking for model adequacy.

A hierarchical Bayesian approach to robust parameter design

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Abstract. The goal of robust parameter design experiments is to identify significant location and dispersion factors that can be used to set the mean response at the target level and to decrease the sensitivity of the response to uncontrolled noise factors. This is a very challenging problem in case the design points are not replicated. We present a hierarchical Bayesian model and use data-based priors to find the active factors and to get reliable estimates of the location and dispersion parameters.

Bayesian versus non-Bayesian design of choice experiments in marketing

P. Goos*, R. Kessels, B. Jones and M. Vandebroek

Abstract. In the research marketing and statistics literature, the optimal design of choice-based conjoint studies has received a lot of attention. Roughly speaking, two lines of research can be identified. One line of research focuses on the computationally intensive construction of Bayesian optimal designs for choice experiments. Another line uses combinatorial insights and a simplifying assumption about the parameters of the multinomial logit model to construct optimal designs. The purpose of this presentation is to provide a detailed simulation-based comparison of the two approaches. The comparison will focus on the precision of the estimation and the prediction and provide substantial support in favor of the Bayesian approach. As this approach is computationally intensive, we will also discuss a fast algorithm for computing the Bayesian optimal designs.

Analytical method validation based on the total error concept. Comparison of alternative statistical approaches

B. Govaerts*, M. Maumy, W. Dewé and B. Boulanger

Abstract. In pharmaceutical industries and laboratories, it is crucial to control continuously the validity of analytical methods used to follow the products quality characteristics. It must be assessed at two levels. The “pre-study” validation aims at demonstrating beforehand that the method is able to achieve its objectives. The “in-study” validation is intended to verify, by inserting QC samples in routine runs, that the method remains valid over time. At these two levels, the total error approach considers a method as valid if a sufficient proportion of analytical results are expected to lie in a given interval $[-a, a]$ around the (unknown) nominal value.

This paper presents and compares four approaches, based on this total error concept, of checking the validity of a measurement method at the pre-study level. They can be classified into two categories. For the first, a lower confidence bound for the probability p of a result lying within the acceptance limits is computed and compared to a given acceptance level. Maximum likelihood and delta methods are used to estimate the quality level p and the corresponding estimator variance. Two approaches are then proposed to derive the confidence bound: the asymptotic maximum likelihood approach and a method due to Mee. The second category of approaches checks whether a tolerance interval for hypothetical future measurements lies within the predefined acceptance limits $[-a, a]$. Beta-expectation and beta-gamma-content tolerance intervals are investigated and compared in this context.

Validating clinical trials protocols with simulations

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Abstract. Clinical trials are on the critical path of drug and treatment development. They are expensive in time as well as in money. A clinical trial is essential before any new, and perhaps revolutionary, product can reach the market. The trial protocol is a statement of the design of the clinical trial and how it will be managed, and how a multitude of assumptions will be tested, empirically. The trial will determine if the proposed treatment is actually doing what its sponsors claim it can achieve.

Clinical trials raise complex statistical and ethical issues. A clinical trial that is not properly designed statistically, for example with very low power, can be considered unethical. But an over-designed trial, which lasts a long time and involves too many patients, is also unethical. The former may fail to show that a drug is more effective than its comparator, so patients will have been submitted to a trial with little hope of a useful result. The latter will require some patients to continue receiving the less effective treatment longer than necessary and it will delay the marketing of the more effective drug.

Protocols of clinical trials are traditionally designed by medical experts with the help of statisticians. The main role of a statistician has typically been to determine sample sizes. However, the evaluation of the trial strategy involves many parameters not addressed by simple power calculations based on t-tests or ANOVA.

In this work we describe how, using specially designed simulations, we can evaluate a clinical trial protocol and assess the impact of various assumptions such as drop out rates, patient presentation rates, compliance, treatment effects, end point dependencies, exclusion criteria and distributions of population and response variables. The evaluation will focus on the overall power of the trial to detect clinically significant differences and its cost. We demonstrate the approach with a case study.

Designs for first-order interactions in choice experiments with binary attributes

H. Grossmann*, R. Schwabe and S. G. Gilmour

Abstract. Choice experiments aim at understanding how preferences for goods or services are influenced by the features of competing options and applications in marketing, health economics and other fields abound. In recent years, the efficient design of choice experiments has attracted considerable interest. Typically, these designs have been derived within the framework of the multinomial logit (MNL) model. When it is assumed that the choice probabilities within each choice set are equal, the design problem for the MNL model is equivalent to the corresponding problem for an approximating linear model. By using the correspondence between the design problems, in this talk for choice experiments involving pairs of options described by a common set of two-level factors new exact designs are derived which allow the efficient estimation of main effects and first-order interactions. These designs compare favorably with available alternatives in the literature in that for high efficiencies they usually require the same or a considerably smaller number of choice sets. Similarly, for the same number of choice sets they possess the same or a higher efficiency.

Implementation of a quality plan for the monitoring of blood treatment process for the Belgian Red Cross

A. Guillet*, B. Govaerts and A. Benoit

Abstract. The Belgian Red Cross has to develop quality control procedures to monitor its blood treatment processes in order to be in conformity with the Belgian legislation. This project implies the adaptation of statistical quality control techniques to the particular problematic of blood treatment. Indeed, the non normal distributions and censored data due to the measurement stuff of most of the products made them adapt the classical quality tools.

First, we defined a sampling design for each measurement. Then, we made a brief descriptive analysis of the new data to check the goodness of the plan. After several months, we created some graphs to verify if the specification limit are respected and we computed some statistics on the collected data in order to compare the results between the three sites, to determine if the processes are under control and to evaluate the client-provider risk. Some of the graphs are automatically updated everyday whereas the statistics and the other graphs are monthly created as a report.

To realise it, we had to implement the necessary tools in a statistical software in such a way that every technician can use it. Thus, we chose to make them encode the data directly in worksheets of the statistical software formatted for the different products. Moreover, they followed a small course adapted to their use of the software in order that they can understand how to use it, particularly the use of the macros, and how to read the outputs and detect that there is a problem in the quality of the products.

Genetic algorithms and grid technologies in clustering

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Abstract. In our days quite often very large data sets have to be processed. Data mining is definitely an important and rapidly developing area for such problems. In this presentation we focus on an important part of such work, namely clustering several thousand objects of high dimensionality.

For the clustering, we used a version of the genetic algorithm. Such algorithms imitate the natural selection process by random coupling of pairs of candidates for the best (fittest) clustering and avoid the convergence to a local maximum by rare, random mutations. In clustering applications the objective function is based on the sum of the squared distance between all pairs in the clusters, with a suitable compensation, which prefers the small number of clusters.

For large datasets and algorithms, which can easily be parallelised, the use of a grid of computers is a natural, widely used idea. We compared the performance of the grid-based results of our algorithm to the traditional, single-processor version. Our data base consisted of 10000 images of medium resolution, so the total size was around 0.5GB. Such problems may arise in industrial setup as well, such as in welding processes or in character recognitions for applications such as car manufacturing (see [1]).

The preprocessing constructs a Gaussian Mixture Model (GMM) representation of the images. The GMMs are estimated with an improved Expectation Maximization (EM) algorithm that avoids convergence to the boundary of the parameter space, see [2]. Image clustering is done by matching the representations with a distance-measure, based on the approximation of the Kullback-Leibler divergence.

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Analysis of the efficiency of the new pattern recognition's methods for the control charts

A. Hamrol* and A. Kujawinska

Abstract. The paper concerns the analysis of process stability with the use of process control charts. A new idea of pattern recognition and two original methods of data processing, called OTT and MW are described. The software application CCAUS (Control Charts – Analysis Unnatural Symptoms) supporting process control charts analysis with OTT and MW is presented as well. The paper contains also results of the verification of the proposed methods performed on the basis of data obtained from two machining operations.

Purpose:

Process control charts are used in order to identify occurring of special-causes disturbing a monitored process. When the process is under statistical control, the points on the control chart should follow a random pattern and measurements are to have a normal distribution. There have been many special patterns on the chart indicating that the process lost its stability and a process operator should take a corrective action. As a result the operator has to track the pattern on the control charts and decide whether the process should be corrected or not. He should have a profound knowledge about the process, about the possible sources of special causes and about efficiency of correcting actions. There is always a risk that an experienced worker may resign from his post and the company will thus lose his knowledge.

Design/methodology/approach:

Problems above-mentioned, concerning the analysis of control charts have been removed with substitution for human intelligence with the artificial intelligence tools. It was possible by designing and programming certain methods of pattern's classification on the process control charts, called OTT and MW.

Findings:

Developing the OTT and MW methods provided the author with good results of process stability assessment. The methods proved to be more efficient than the operator – the human. The developed methods let the experts create a set of unconventional patterns of process instability, which significantly widen the range of their application.

Practical Implications (if possible):

The verification of the developed methods was carried out on the basis of data obtained from grinding and superfinish processes. It turned out that both methods are more effective than human process operator. A special software application was developed in order to support data processing.

A corrected likelihood-based confidence area for Weibull distribution parameters and large-scale life time data

N. Haselgruber

Abstract. The Weibull distribution is, in particular for technical applications, a common life time model and data often will be observed in large-scale experiments. Several methods are available to estimate the distribution parameters and confidence areas usually are computed applying the large sample theory for maximum likelihood estimators. Large-scale life time experiments are expensive, consequently samples tend to be small and of short duration which causes right-censored data. The large sample theory loses its applicability.

This presentation suggests a correction of the likelihood-based confidence area which significantly increases its accuracy for small and moderately censored samples.

Scoring – predicting customer behaviour

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Abstract. Facing global markets, for companies the requirement of an efficient customer relationship management (CRM) increases. In analytical CRM, scoring is the most popular tool to predict customers' behaviour and has also become an important tool in finance – especially since the new Basel II regulations are mandatory for all institutes in Europe since the beginning of this year. In this talk a brief introduction to scoring is given, in which fields scoring is employed and what goals can be achieved using it. Furthermore, scorecard development issues are considered which are necessary to guarantee a successful implementation.

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An automotive experience in applying DoE to improve a process

L. Ilzarbe*, M. Tanco, M. J. Alvarez and E. Viles

Abstract. Laser welding is becoming more widely used within the automotive industry because of its reputation for high quality and precision. However, achieving the best set of parameter settings for this process is no trivial task and the industry has encountered many problems in the implementation of laser welding. These problems lead to defects which can be very expensive, so the industry is keen to optimise the process to make it as cost effective as possible. In this paper we present the application of the design of experiments in a car manufacturing company to improve their technical knowledge of the laser welding process and the positive impact that this research already had on the number of defects observed.

Split-plot screening designs with minimal numbers of whole plots

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Abstract. Screening experiments typically have two levels for every factor. In the case where one factor is extremely difficult to change, it is tempting for an operator to sort the randomized design by that factor so that it only changes once. In such a case, there is no way to test the effect of the whole plot factor. Clearly this is undesirable from a statistical point of view. Nevertheless, it is useful to see what can be done both in the design and analysis of such experiments. This talk explores several split-plot designs having only two whole plots and suggests a way to screen for whole plot effects.

Variability of electromagnetic emissions

U. Kappel and J. Kunert*

Abstract. Modern cars' equipment consists of an increasing number of electric and electronic devices. Therefore, the risk of electromagnetic interference increases, too, and thus the importance of assuring electromagnetic compatibility (EMC) grows. Additionally, different cars, even of the same model, are more and more equipped individually. This adds an increasing complexity to EMC management.

The presentation discusses the results of a small study on the relative importance of several factors that might influence the electromagnetic emission of a car's subsystem consisting of a video-, an audio-, and a cell phone component. A fourth factor of interest was the design of the wiring harness connecting these components. All four factors were considered at 4 levels each. For the three components, the levels were chosen in such a way that we would expect increasingly less problems: no grounding of the component's case at all, poor grounding, good grounding and as the fourth level absence of the component. For the harness, we chose the four levels by selecting varying distances between the single wires and circuits. The experiment was done as a fractional factorial design with 16 runs.

The response was the average excess of the measured radiated emissions over the emissions limit, where the average was taken over all frequencies of interest.

Between any two of the 16 runs, the wiring was completely redone, even if the next run had the same level for this factor. This gives a measure of the variability caused by rebuilding the wiring, even if we try to rebuild the system in a completely identical way. To check the size of the pure measurement error, each run was measured 5 times, without any changes between the measurements.

The results seem to indicate that the pure measurement error was relatively small, while the variability caused by rebuilding the wiring was very important. Compared to this "rebuilding error" the effects of the four levels of video, of audio and of the planned variation of the wiring itself were negligible. However, we could show that no grounding or poor grounding of the cell phone component increased the average electromagnetic emissions significantly compared to the other two levels.

These findings could be reproduced in a confirmation experiment.

The Statistical Efficiency Conjecture

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Abstract. In this work we attempt to demonstrate the impact of statistical methods on process and product improvements and the competitive position of organisations. We describe a systematic approach for the evaluation of benefits from process improvement and quality by design and develop and validate the Statistical Efficiency Conjecture that links management maturity with the impact level of problem solving and improvements driven by statistical methods.

The different approaches to the management of industrial organizations can be summarised and classified using a four steps Quality Ladder [Kenett and Zacks, 1998]. The four approaches are 1) Fire Fighting, 2) Inspection, 3) Process Control and 4) Quality by Design and Strategic management. To each management approach, corresponds a particular set of statistical methods and the Quality Ladder maps each management approach to corresponding statistical methods.

Efficient implementation of statistical methods requires a proper match between management approach and statistical tools. We demonstrate, with 21 case studies, the benefits achieved by organisations from process and quality improvements. The underlying theory behind the approach is that organisations that increase the maturity of their management system, moving from fire fighting to quality by design, enjoy increased benefits and significant improvements in their competitive positions.

A practical guide to design conjoint experiments

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Abstract. Understanding the Voice of the Customer (VOC) is a critical first step in developing a successful product or service. If a company can precisely predict customer preferences and needs, it has a competitive advantage to launch innovative products or services that lead to an increase in customer base. A popular way to predict people's choices for prospective goods is the use of conjoint experiments. In a conjoint experiment, respondents usually rate a set of goods on a scale. These goods are presented as profiles or alternatives of combinations of different component attributes. The usefulness of the predictions resulting from the analysis of the experimental data depends on the profiles and the number of test persons used. Also, the assignment of the profiles to the subjects plays a key role. To maximize the information gained you need an efficient experimental design. In this talk, we will show how to properly design conjoint surveys for both main-effects and interaction-effects models.

Accuracy of the end-to-end performance estimation in logistic service environments

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Abstract. An important part of the QoS in logistic services is the ability to distribute items from one point to the other within a defined timeframe. This is called the service standard. Systems that measure the compliance to this standard are often panel based.

The result of the measurement can take for example the following form: “In 2005 95% of all letters sent from sender panellists have been received by receiver panellists on the next day of service”.

All measurement systems are sized according to given accuracy requirements. Basis is an appropriate estimation of the variance of the on-time performance estimator.

CEN, the European standardisation network, has almost finished the development of recommendations on the calculation of this variance. Special difficulties that have to be overcome were:

- All items for any sender, any receiver and any sender–receiver relation may be correlated;
- On-time performance is usually on a level well above 90% where simple normal approximation is weak;
- The sampling design is usually disproportional leading to weighted results.

Statistical modelling of springback simulation

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Abstract. In many engineering applications physical processes can be simulated by complex computer models also called computer experiments. Deep drawing is such an example, where forming and springback can be simulated using finite element analysis.

Such simulations are usually very complex: they are based on many input parameters and calculation of a response can be time-consuming. Hence, even with a simulation at hand we do not entirely understand the input – output relationship at once.

An approach to gain more insight into the input – output relationship is to build a statistical model based on a restricted number of evaluations of the computer code. In this talk we will compare the adequacy of different statistical methods for approximating the springback simulation for a class of workpiece geometries. We discuss the adequacy of the statistical models in terms of their approximation accuracy and interpretability.

Implementation of a Kolmogorov-Smirnov-type test for the partial homogeneity of Markov processes with application to credit ratings

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Abstract. In banking, the default behaviour of the counterpart is not only of interest for the pricing of transactions under credit risk but also for the assessment of a portfolio credit risk. Typically, the estimation of credit rating transitions is based on a homogeneous Markov process, i.e. the assumption that the migrations have constant default intensities. The estimate is only unbiased if the assumption holds. However, the recent release of new regulatory capital requirements for financial intermediaries, named Basel II, requests estimating the probability of default devoid of any (known) bias. We use a test against the hypothesis that default intensities are chronologically constant within a group of similar counterparts, in this case a rating class. The Kolmogorov-Smirnov-type test builds up on the asymptotic normality of counting processes in event history analysis. Right-censoring accommodates for Markov processes with more than one no-absorbing state. A simulation study confirms the consistency as well as the sufficient power of the test in practice. We demonstrate the implementation of the test and show some computational problems and numerical effects while calculating the test statistic. The final test statistic is based on the maximization of statistics. While the maximization must be performed on a discrete grid, we show the effect of using different numbers of grid points. For smaller numbers the maxima are more likely to slip through the grid and the test loses the actual level (and power). Two examples of rating systems show inhomogeneities for few migrations to neighbouring rating classes.

Taut string as an alternative to empirical distribution estimators for system loads in logistics

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Abstract. Large systems or networks are frequently analysed in logistics with the aid of simulation models. Meaningful conclusions can only be derived if the simulation model is a good image of reality. System loads such as arrival times of customers or order quantities are often generated from stochastic distributions. The empirical distribution function is the straightforward choice to derive such a distribution from an observed real-life data set if no information concerning the underlying model structure is given. As an alternative we consider a distribution estimator based on taut string methods. The resulting distribution function generally has fewer knots than the empirical distribution function, leading to a reduced simulation effort. We conduct a simulation study to compare the behaviour of empirical distributions and taut string estimates with estimates of normal distributions and of distributions from the true family. Distribution families relevant for system loads as exponential, normal, uniform and t-distribution are treated. The distance between the estimated and true distribution is measured in terms of Kolmogorov-Smirnov and quantile distances.

Use of experimental design to analyse a Necking-in process

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Abstract. Necking-in is a production process for achieving a diameter reduction in cylindrical bodies. The process depends on many different factors and is - at least at the present state of knowledge - too complex for analytical description of the relevant forming mechanisms. In addition finite element simulation of incremental forming processes like necking-in is very time-consuming. Nevertheless we want to be able to predict the parts' quality, like geometrical accuracy. Therefore, we have to do physical experiments to investigate the main structure of the process. The approach we chose starts with the identification of significant influencing variables using a fractional factorial design. For a process optimisation and robustification we want to apply methods which have already proved their usefulness for another incremental forming process, namely sheet metal spinning. In this talk, we present the methodology with the help of an example. We try to neck-form straight bead welded steel pipes in an inner range to achieve a given geometry.

a diameter reduction in cylindrical bodies. The process depends on many different factors and is - at least at the state of knowledge - too complex for analytical description of the basic forming mechanisms. We have to do physical experiments because simulation of incremental forming processes like Neck Forming is very time-consuming. With these experiments we investigate the main structure of the process. The approach we chose starts with the identification of significant influencing variables using a fractional factorial experiment. For process optimization and robustification we apply methods which have already proved their usefulness for another incremental forming process, namely sheet metal spinning.

In this talk, we present the methodology with the help of an example. In this example we try to neck-form straight bead welded steel pipes in a inner range to achieve one given geometry.

Cost effective screening experiments

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Abstract. Discovery and development in science and industry often involves investigation of many features or factors that could potentially affect the performance of a product or process. In factor screening, designed experiments are used to identify efficiently the few features that influence key properties of the system under study. A brief overview of this broad area will be presented. This will be followed by discussion of a variety of methods with particular emphasis on industrial screening. Ideas will be motivated and illustrated through examples, including a case study from the automotive industry.

Time Series analysis and GARCH modeling in S+ Finmetrics

G. Maggio

Insightful AG

Abstract. S+ is a fine tool for describing, handling, analyzing and modeling Time Series data. S+ Finmetrics is an extended S+ module that contains vast solutions to address such issues. Finmetrics covers large literature on Time Series modeling. As an example, it is considered as a great tool to tackle univariate and multivariate “Generalized Autoregressive Conditional Heteroskedasticity” (GARCH) models developed by Engle (1982), Bollerslev (1986), Nelson (1991), and others. GARCH are capable of modeling time varying volatility and capturing many of the stylized facts of the volatility behavior usually observed in financial time series. An application will be presented in S+ to provide a good understanding of how using an S+ this field can be addressed.

Fitting a model for predicting leaks in pipes for a water supplying company

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Abstract. Aigües de Barcelona is a company that supplies water to Barcelona and other surrounding districts. The company contacted UPC to get help in a project to identify and characterize variables affecting the distribution of leaks in water supply pipes. Although the company already had a model for predicting leaks in pipes, they were not sure about its validity.

The first step was reviewing existing historical data using descriptive statistics and basic graphics. Information from this step was considered valuable by company technicians. The information gathered was used to decide the locations of a nondestructive test to know the current condition of the pipes. The remaining life years was deduced from this data. The information from this study, together with historical data from the leaks database, was used to develop a list of candidate variables for improving the model in the company.

A loglinear model was then fitted. The new model was able to better explain the number of leaks than the previous one. A substantial collateral benefit of the project was revealing how materials and diameters affected the number of leaks in the tubes.

Many important lessons were derived from the project. Among others, the value of having an updated and consistent database for actualizing the model, the falling of some old myths in the company that weren't based on data, and the validation of some other perceptions from technicians.

The presentation will focus not only in the results, but also in the methodology followed and in the relationship with technicians and managers in the company.

Improvement of a manufacturing process by integrated physical and numerical experiments: a case-study in the textile industry

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Abstract. In hi-tech industry, like aerospace and microelectronics, the combined use of simulation and lab tests is a daily practice in the product development phase. It is easy to forecast that it will spread soon also in less knowledge-intensive sectors. However, although Design of Experiments and Computer Experiments provide sound methodologies for running experiments in physical and numerical settings respectively, the integration between the two kinds of investigation is still in its infancy. Yet in that case the sequential experimentation approach, introduced by George Box for physical experiments some fifty years ago, would have an even wider scope.

The work describes the results of a research project which is currently taking place at Technova Srl, a medium size textile firm in Sardinia (Italy). The company produces flocked yarn, a component which, after weaving, becomes a fabric for a wide range of technical applications. Typical end products are coverings for seats and other components in car interiors. The yarn is formed by finely cut fibers (flock) applied to an adhesive coated carrier thread by the electrostatic force. The research focuses on the improvement of the manufacturing process. To this end, we exploit all kind of information sources available, from historical production data to physical experiments on pilot and production machines and experiments on different process simulators. We show that the results obtained by this approach are well beyond the initial expectations of the company in terms of enhanced product quality as well as process economy and flexibility.

The ENBIS papers database

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Abstract. All the details of ENBIS papers such as author, organisation, title, main content, etc. were put together into one spreadsheet on Excel to derive some preliminary results on final take-up on presentation of papers, main authors, main subject headings, etc. These results will be presented with details of the present state of the database and scope for future work.

Prediction of spiralling in BTA deep-hole-drilling

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Abstract. Deep-hole-drilling methods are used for producing holes with high length-to-diameter ratio, good surface finish and straightness. The process is subject to the occurrence of dynamic disturbances called spiralling. It leads to multi lobe-shaped deviation of the cross section of the hole from absolute roundness which constitutes a significant impairment of the workpiece. A common explanation for the occurrence of spiralling is the coincidence of time varying bending eigenfrequencies of the tool with multiples of the spindle rotation frequency. In practice, it is necessary that a process monitoring system is devised to predict the occurrence of spiralling during drilling. This allows the engineers to know when and how to adjust the process. In this work, the application and use of different monitoring strategies are discussed. These strategies are based on control charts in combination with statistical and physical models describing the course of the eigenfrequencies.

A practical experience with Corrugation height production process improvement using an SPC

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Abstract. A product is corrugated into a zigzag. The corrugated profile height is considered to be a critical to quality factor.

The monitoring regime in place was to record corrugation profile height (always in groups of four) at morning startup, and then after any break or after any maintenance. Thus there is always at least one recording a day but typically two to three but could be more. The plan was called “First article inspection”. Originally the plotting unit in the SPC was “day”, thus the control limits would vary with observation number. Also, the control limits were updated each month.

We first advised using each recording (with four measurements) as plotting unit thus avoiding varying control limits. However, we experienced that 1) With this regime the process appeared to be out of control more often, and 2) The variation (estimated sigma) within day was twice the variation within a group-of-four. We fancied that the monitoring regime may not fully monitor the process; perhaps it was monitoring the effect of the interventions more than the running production.

We therefore advised a one month experiment where recordings were taken each hour in addition to the current regime.

The experiment revealed that the current regime had a much smaller variation than the variation of experimental data.

We concluded that we still lack insight into the variation of the process, this should be further investigated. We recommended taking three daily recordings at stated hours in addition to the current regime. We recommended monitoring monthly variation to search for any significant changes of the process.

Standards in control of variability

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Abstract. The text deals with basic schemes of controlling variability.

We show that the main method of controlling variability in man driven systems consists in a use of standards – patterns of systems and processes. Imitation of a pattern is a way to achieve more repeatable course of operation and therefore more repeatable effect thereof.

Scope of standards with regard to their content and domain of application is very wide – some of them are generic, used by broad groups of users and some are personal – used by single persons who are their inventor. Use of some standards may be obligatory (law system) and use of some of them may be optional (science system).

Standards used in organisation reflect a knowledge that belongs to organization. A set of corporate standards includes various know-hows and instructions how to control a variability. Some elements of the knowledge are documented and therefore can be controlled. The rest remains in brains of members of organisation. This knowledge is accessible as long as they are in organisation.

Organisation should take care that corporate standards are being continually improved – improvement of standards is a way to improve organisational performance.

There are several models of standards systems – like ISO 9000 or EFQM Business Excellence Model. There are also schemes used to improve standards used in organization such complex as Six Sigma or such simple as Problem Solving algorithm. The Shewhart-Deming PDCA Cycle is a general algorithm of monitoring standard's improvement.

There is a natural relation between standards and variability: standards used in organization represent corporate knowledge how to operate against factors producing variability.

Variability (a differentiation which has causes not known to observer) represents those phenomena in organisational processes that are not controlled and fall beyond the corporate knowledge.

A comparison of neural network and control charting for monitoring profiles in manufacturing processes

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Abstract. The issue of monitoring profiles has been defined as being one of the most promising areas of research in statistical process control. One immediate difficulty is how to characterize a profile. As a matter of fact, the identification of a statistical model may become more difficult than expected, thus representing an obstacle to the introduction of profile monitoring in actual applications. For example, when a profile represents the physical dimensions of a machined surface, as it results in manufacturing applications, measurements data often exhibit complex spatial correlation.

The aim of this work is to explore a different approach for monitoring profiles, which uses the Adaptive Resonance Theory (ART) neural network. The implementation of this neural network is based on a set of profiles which are representative of the process in its natural, or in-control, state.

Throughout the paper, a real case study related to profiles data obtained by a common machining process is used. With reference to the Phase II of profile monitoring, performance of the proposed approach are compared to those of multivariate control charting of the parameters vector. Although the proposed neural network does not produce always outperforming results, it presents comparable performance in several cases. The main advantage presented by the approach is that the model of profile data is – autonomously – derived by the neural network, without requiring any further intervention by the quality practitioner. This feature may create an important bridge between profile monitoring and quality monitoring of several specifications in actual applications.

Accounting for systematic effects in metrology and testing, namely in comparisons

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Abstract. Replication of measurements and the combination of observations are standard and essential practices in metrology. A metrological – or testing – process of evaluating the uncertainty of the measurement results consists, in each laboratory, of basically three steps, using different methods to fulfil distinct purposes [1]:

- (a) When done on the same standard, to obtain the statistical features of the observations allowing to assess the repeatability of the value of the standard;
- (b) When done on the same standard, to obtain a measure of the effect on the total uncertainty of the variability of the influence parameters affecting the standard, including dependence on time, i.e. to assess the reproducibility of the value of the standard;
- (c) When done on several standards of the laboratory, to check if they have the same value or to establish the differences between their values, and to evaluate the associated uncertainty; i.e. to evaluate the accuracy of the values of the laboratory standards. This exercise can be called intra-laboratory comparison.

When the exercise is performed for purpose (c) by comparing one (or more) standards provided by different laboratories, it is called inter-laboratory comparison. Past experience suggests that one should assume, as an a priori knowledge, that the comparisons are performed to detect bias.

Bias is originating from the influence quantities, whose variability can show a non-zero mean and is also the source of the generally higher uncertainty obtained in “reproducibility conditions” with respect to “repeatability conditions”.

The paper is shortly recalling first the basic terms used in several written standards and international documents that not always are fully consistent each other and also show some evolutions of the concepts in the past decade, with the consequent possible confusion arising from the fact that not everybody is talking of the same things when they are assumed to. Then, is comparing several data models and is discussing their merits in taking (or not) into account the systematic effects, which are the prevailing reason of systematic errors in most metrology and testing measurements.

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Kriging-based sequential inspection plans for Coordinate Measuring Machines

P. Pedone*, D. Romano and G. Vicario

Abstract. In the last two decades kriging models, originally developed for geological applications, have gained increasing popularity in Computer Experiments as a tool for producing accurate predictions of the output of a deterministic computer code. Going against the flow and back to the origins, the paper shows how kriging models may also be effective in a physical experimental setting. Exploiting their recognized prediction capability, we use them to build sequential experiments to be applied to an engineering problem: the construction of inspection plans for checking the compliance of industrial parts to dimensional and geometric specifications on Coordinate Measuring Machines. The inspection plan specifies which points are probed and in which order. Since the economy of the process forces the sample to be small, the engineering objective is to accurately estimate deviations from nominal dimensions and shape by probing a few points only. As best accuracy/cost trade-off is also the objective of sequential designs, the inspection plan will be treated as a sequential experiment to be designed on-line. In the paper we present a number of case-studies, related to the check of form tolerances (straightness, circularity), whose related form error depends heavily on the extreme values of shape deviations. So, in the construction of the sequential design we consider both informative (maximum prediction variance) and problem-specific (search for extreme deviations) criteria. Performance of kriging-based plans is compared with that of the simple non sequential ones massively used in industrial practice (uniform, random, stratified) and with deterministic sequential methods in the engineering literature.

Case-based reasoning and the statistical challenges

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Abstract. Case-based reasoning solves problems using the already stored knowledge, and captures new knowledge, making it immediately available for solving the next problem. Therefore, case-based reasoning can be seen as a method for problem solving, and also as a method to capture new experience and make it immediately available for problem solving. It can be seen as a learning and knowledge-discovery approach, since it can capture from new experience some general knowledge, such as case classes, prototypes and some higher-level concept.

The idea of case-based reasoning originally came from the cognitive science community which discovered that people are rather reasoning on formerly successfully solved cases than on general rules. The case-based reasoning community aims to develop computer models that follow this cognitive process. For many application areas computer models have been successfully developed, which were based on case-based reasoning, such as signal/image processing and interpretation tasks, help-desk applications, medical applications and E-commerce product-selling systems.

In this talk we will explain the case-based reasoning process scheme. We will show what kinds of methods are necessary to provide all the functions for such a computer model. We will develop the bridge between case-based reasoning and statistics. Examples will be given based on signal-interpreting applications. Finally, we will show recent new developments and we will give an outline for further work.

Investigating the impact on product quality of raw material variability for a chemical process: a DoE approach

E. Polwart

Fujifilm Imaging Colorants Ltd

Abstract. Determining the impact on product quality of batch-to-batch variation in raw materials is important in specification setting, establishing critical parameters and for process understanding for chemical and biochemical processes. Where historical data exists on the raw material variability it is possible to consider this to look at the impact on product quality. Where changes in the process and/or product grade occur data-mining may prove infeasible and experimental design may be a more suitable alternative.

This paper will present one possible strategy for carrying out such an experimental design that exploits the inherent correlation within the characteristics of the raw material to give a usefully small number of experiments. Principle component analysis (PCA) was applied to the historical chemical analysis data for the raw material. D-optimal experimental design was applied to the principle component scores to select batches for inclusion in the DoE.

Virtual statistics: exploiting new web-based tools on the company intranet to improve internal discussion and learning within the user community

E. Polwart

Fujifilm Imaging Colorants Ltd

Abstract. Within FFIC we have recently been developing intranet-based tools to facilitate and improve discussion and information sharing. Statistics has been one of the pioneering areas for the use of our new Community Server interface. Both blogs and forums have been used to promote discussion, learning and dissemination of information. This poster will present a background to this approach, detail some examples and share learning from the experience.

Spiralling in BTA deep-hole-drilling: combining statistical and physical models

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Abstract. One serious problem in deep-hole drilling is the formation of a dynamic disturbance called spiralling. Spiralling can be explained by the convergence of bending eigenfrequencies with multiples of the rotational frequency. In former work we therefore proposed a combination of statistical and physical models describing the course of the eigenfrequencies.

In our current work we discuss how this model can be used to predict the occurrence of spiralling. As recent experiments showed the crossing of multiples of the rotational frequency and bending eigenfrequencies yields a resonance effect on the specific multiple. By connecting the amplitude of this resonance to quality measurements of the workpiece this amplitude can be used as a quantification of spiralling. This transforms the binary problem of the decision between 'spiralling' and 'no spiralling' into a continuous problem and opens up the opportunity of a more explicit investigation of spiralling and its impact on the workpiece.

Some thoughts about the use of kriging and smoothing techniques for metamodelling purposes

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Abstract. In this paper we discuss the problem of metamodelling using kriging and smoothing techniques. Both methodologies will be applied on a number of test cases in order to highlight pro's and con's of each approach. The kriging approach will be based on the Gaussian Emulation Machine. The smoothing approach is carried out using non-parametric techniques (state-dependent parameter modelling).

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Integrating data and model uncertainties in paint formulations

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Abstract. Formulations frequently play a key role in rather different industrial applications (adhesives, additives, food, rubber, cosmetics, fertilizers and pesticides, photography, medicines, lubricants, perfumes, plastics, etc.). In spite of their relevance, the usual procedure to address such problems is still based upon extensive trial-and-error processes, usually quite inefficient and with rather limited success rates. Alternatively, in certain fields people have also developed deterministic optimization frameworks that take into account several quality-related product performance criteria, adequately constrained by relationships involving compositions or limits to which some components must comply. Such frameworks however neglect any sources of uncertainty and variability that may be present.

Furthermore, both of the above approaches typically overlook potentially useful information contained in available databases, where data from previous trials is stored, that can (and in fact, should) be used to improve formulation solutions, namely through the estimation of statistical models relating key quality figures to composition variables.

It is also desirable for a final consumer to get involved in the specification of a value hierarchical structure, so that the conceived product meets its desired specifications and unique preference structures.

In this communication, we present a framework to develop and implement a robust approach for addressing and solving formulation problems, which:

- Builds performance/composition relationships from past historical data;
- Explicitly models and takes into account sources of variability and uncertainty characteristics;
- Allows for the proper identification of specific customized optimal formulations for a given customer or specific product usage.

This framework, although generic and easily applicable to other products, was tested within the scope of the paint industry, in order to support the proper identification of optimal waterborne paint formulations.

How engineers learn statistics from motor cycle tires!

J. J. M. Rijpkema

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Abstract. Design Based Learning focuses on an integrated approach to problem solving and engineering design, where students are stimulated to apply concepts and insights gained from mono-disciplinary courses in a multidisciplinary way. Its aim is to expand students' engineering competencies, while working on authentic problems using up-to-date CAE-tools. Design Based Learning offers opportunities to enhance the students' awareness of situations where Engineering Statistics can be relevant, as for example the design of experiments or the modeling and analysis of data may be part of the solution strategy.

In this presentation I will explain the ideas behind Design Based Learning and its implications for our teaching of Engineering Statistics. I will illustrate this with details from a design based project we run for first year's students in Mechanical Engineering at the Eindhoven University of Technology in the Netherlands. In this project tire-characteristics that are crucial for safe road handling of a motor cycle have to be determined experimentally from a full scale experimental setup. I will present experiences from students and lessons learned. Finally, I will discuss ways to enhance engineers' statistical competencies through the use of design based projects in industry.

Metamodels from computer experiments

J. J. M. Rijpkema

Eindhoven University of Technology, The Netherlands

Abstract. In engineering optimization a direct coupling between analysis models and optimization routines may be very inefficient, as during optimization a large number of iterative calls to possibly time-consuming analysis models may be necessary. In those situations it is preferred to uncouple analysis and optimization through the use of so called metamodels or surrogate models: fast to evaluate approximations for objective and constraint functions.

For the construction of metamodels there are a number of approaches available, such as Response Surface Methods (RSM), Kriging, Smoothing Splines and Neural Networks. They all estimate the response for a specific design on the basis of information from the full analysis of a limited number of training designs. However, they differ with respect to their underlying conceptual ideas, the calculation effort needed for training and the applicability to specific situations, such as large-scale optimization problems or analysis models based on numerical simulations.

In this presentation I will focus on two approaches for metamodeling, namely RSM and Kriging. I will review and compare key-concepts and present efficient experimental design strategies to train the models. Furthermore, I will discuss ways to enhance the model building process by taking information on design sensitivities into account.

This may lead to a reduction of the actual number of full model analyses that is necessary for model training and estimation. It may be very effective, especially in those situations where design sensitivities are easily available such as is the case for analysis models based on the Finite Element Method. To illustrate the use of RSM and Kriging results from a numerical model study will be presented. They throw some light on strengths and weaknesses of both approaches in practical applications.

DoE in engine development

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IAV GmbH

Abstract. Stricter legal emission limits and increasing customer expectations lead to a growing number of controllable engine components and thus to a higher engine control complexity. For engine development, however, this means a much higher time and effort to find the optimal combination of all selectable parameters.

This trend can be observed in the field of Gasoline as well as for Diesel engines. At the same time, the development time from the first idea up to the introduction of a new production engine has become even shorter, and the costs have to be reduced.

Since the number of measuring points required for complete operational-test measurements rises exponentially with the number of input variables, it is quite obvious that full factorial measurements are not longer possible. Therefore the method “Design of Experiments” (DoE) is widely accepted as a suitable tool in the automotive sector and its supplying industry. Likewise, this method is broadly applied in the IAV during the advanced development stage up to the production engine applications. An extensive knowledge on the practical every day usage of DoE exists, after this method has successfully passed the test and experimental phase. Whereas DoE is used mainly in the area of steady-state applications recent research work shows a great potential also to optimize transient engine behavior.

This presentation will give an overview about the usage of statistical methods (mainly Design of Experiments) in the production engine calibration. “Engine calibration” is the term for finding the optimal settings of the engine controller unit; optimal in terms of minimal emissions, minimal fuel consumption, good drivability and other brand specific goals.

Robust estimation of the variogram in computer experiments

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Abstract. This article deals with the estimation of the spatial correlation of kriging models in computer experiments. Coming from geostatistics, the kriging model is a Gaussian stochastic process

$$Y(x) = m(x) + Z(x)$$

where x is a d -dimensional vector, $m(x)$ is a deterministic trend, and $Z(x)$ a stationary centered stochastic Gaussian process with spatial correlation function $R(h)$. Both trend and spatial correlation should be estimated from data. However, this is not the case in computer experiments, since a specific parametric form for R is assumed. The most common choice is the anisotropic power-exponential function:

$$R(h) = \exp \left(- \sum_{k=1}^d \theta_k |h_k|^{p_k} \right),$$

with

$$0 < p_k \leq 2, \quad k = 1, \dots, d.$$

This contrasts with geostatistics where the spatial correlation is estimated through the variogram:

$$2\gamma(h) = \text{var}(Z(x+h) - Z(x)).$$

Defined for intrinsic processes, the variogram is equivalent to $R(h)$ for stationary processes. Using the variogram instead of the correlation function is recommended even if the process is stationary, because of possible contaminations by trend estimate residuals. The estimation of $\gamma(h)$ from a given design $x^{(1)}, \dots, x^{(n)}$ is not an easy task since the random variables $(Z(x+h) - Z(x))^2$ are not independent and strongly skewed. In particular, large values may affect the estimation. For this reason, robust estimation is encouraged. Two estimators were proposed by Cressie-Hawkins (1980) and Genton (1998). In this paper, we compare the properties of these estimators with a trimmed mean. Simulations with various amounts of outliers are done, in the same way as Genton's. We observe that both estimators give similar results, and both are outperformed by the trimmed mean. In addition, we extend the study by analyzing the robustness of these estimators to the deviations from normality. To achieve this, a 3-dimensional industrial problem is considered.

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Bayesian Network in Customer Satisfaction Survey

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Abstract. A Bayesian Network is a probabilistic graphical model that represents a set of variables and their probabilistic dependencies. Formally, Bayesian Networks are directed acyclic graphs whose nodes represent variables, and whose arcs encode the conditional dependencies between the variables. Nodes can represent any kind of variable, be it a measured parameter, a latent variable or a hypothesis. They are not restricted to representing random variables, which forms the “Bayesian” aspect of a Bayesian network. Efficient algorithms exist that perform inference and learning in Bayesian Networks. Bayesian Networks that model sequences of variables are called Dynamic Bayesian Networks. Harel et. al (2007) provide a comparison between Markov Chains and Bayesian Networks in the analysis of web usability from e-commerce data. A comparison of regression models, SEMs, and Bayesian Networks is presented by Anderson et. al (2004).

In this paper we apply Bayesian Networks to the analysis of Customer Satisfaction Surveys and we demonstrate the potential of the approach. Bayesian Networks offer advantages in implementing managerially focused models over other statistical techniques designed primarily for evaluating theoretical models. These advantages are providing a causal explanation using observable variables within a single multivariate model and analysis of nonlinear relationships contained in ordinal measurements. Other advantages include the ability to conduct probabilistic inference for prediction and diagnostics with an output metric that can be understood by managers and academics.

Six Sigma implementation in Kraft Foods Europe

A. Schleppe

Kraft Foods, Munich (Germany)

Abstract. This presentation is about Andre Silva who will receive the Best Manager Award 2007 from ENBIS. As Andre cannot attend the conference, he asked Anja Schleppe to present in his name. The audience can expect a presentation from someone who has worked closely with Andre during his time as Manager for the Six Sigma rollout into Kraft Foods Europe. The main steps will be presented that were leading this 32 years old engineer into the Six Sigma world, and his success story will be reported. Andre returned to Brazil in June 2007.

Efficient Design in Conjoint Analysis and alike

R. Schwabe

Abstract. Conjoint analysis is a popular tool in marketing research. Stated choice experiments are performed to evaluate the influence of various options on the consumers' preferences. The quality of the outcome of such experiments heavily depends on its design, i.e. on which questions are asked. The present talk gives an overview of the results of a research project on "Efficient Design in Conjoint Analysis" carried out at the universities of Münster and Magdeburg (joint work with U. Graßhoff [Magdeburg], H. Großmann [London] and H. Holling [Münster]).

Improving alarm systems by classification

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Abstract. False alarms are a problem of many monitoring systems, especially in intensive care. In situations where classical process control methods cannot be applied, existing alarm systems can be improved by classification procedures. This is the case when no “in control state” exists or when the process to be monitored is high dimensional, complex and possibly autocorrelated. Annotations to the existing alarm system that contain an expert’s opinion whether an alarm is considered as “true” or “false” can be used as input for data driven alarm rule generation. We study the use of ensembles of decision trees as classifiers for this problem and at the same time take the unequally severe consequences of misclassifying true as false alarms and false as true alarms into account. A procedure based on the analogy of this classification problem to statistical testing is presented and applied to real data.

The data comes from a standard monitoring system at an intensive care unit. So far, the alarms, mostly based on univariate signals, are triggered when a physiological variable crosses a preset threshold. These standard monitoring systems are known to produce a high number of false alarms that distract and annoy the care givers. With our new procedure, the expected sensitivity of the resulting alarm system can be adjusted to the monitoring environment. This is demonstrated for sensitivities of 95 percent and 98 percent for which a false alarm reduction by 46% and 30% is achieved on average.

Data mining of a mail order customer database for Kansei Engineering

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Abstract. The emotional responses customers have toward a company's products can be revealed using Kansei Engineering (KE). Analysis of these responses yield insight into the importance of design factors and the relationship they share with the emotional responses. KE typically produces 3 dimensional data with customers, products and emotional response via semantic scales as the dimensions. These relationships are the key to the importance of KE in the design process and in providing a broad portfolio of products. As KE is expensive to do properly, data mining can provide an alternative way of assessing which design factors are important to which types of customers. It can also prepare the groundwork for KE. This paper investigates what information can be obtained from data mining sales data as a precursor to KE. The sales data from a mail order catalogue company was data mined in order to detect any differences between customer segments (segments defined by recency of last purchase, frequency of purchases and value of sales) for their geographical region, product choices and product characteristics, including size and colour. Interestingly, the differences between customer segments for the colour and style of products were not very profound. However, customers from the "higher worth" segment purchased more large size items. Product size is apparently an important factor and is related to customer worth. Understanding differences like these within the customer database is critical for informed design choices and for future KE investigations.

Six Sigma, the good, the bad and the very bad

J. Smyth-Renshaw

Abstract. This presentation will examine my personal view of Six Sigma. On my last visit to a ENBIS conference I heard a very negative presentation on Six Sigma. This was a concern. Since, at long last business is starting to wake up to the power of data, the use of statistics, and the data of data management. I wish to present my art gallery of Six Sigma images, the good, the bad and the very bad.

Robust elimination of atypical data points in small samples and high dimensions

F. Sobieczky*, B. Sponer and G. Rappitsch

Abstract. A method of eliminating observations with low statistical depth is proposed, leading to improved affine invariant location estimation. The technique particularly addresses the situation of small samples and high dimensionality of the estimation space, a setting in which the conventional notion of an outlier is not appropriate. Removal of atypical observations is achieved via pruning the longest branches of a spanning tree of the sample. The tree depends on the statistical depth of the observations. If halfspace depth is chosen as the relevant statistical depth function, the algorithm inherits the characteristic robustness and high breakdown properties [see D. Donoho and M. Gasko] while being highly efficient in high dimensions [see P. J. Rousseeuw and A. Struyf]. However, it goes beyond the depth-trimming discussed recently in the literature [see Y. Zuo] and thereby gains the essential feature for successfully processing small samples. The validation of the proposed method is performed by testing a set of multivariate distributions (e.g. multi-normal and t-distribution) and comparing the higher order moments before and after elimination. The impact of the proposed methodology is shown for industrial examples in a production environment where early elimination of atypical observations is important for further statistical post-processing.

In particular, we demonstrate the improvement in the case of correlation estimation for various multivariate distributions. For this application, special attention has to be paid to the influence of atypical observations on the geometry of the estimated contour lines of the underlying density.

Further applications are shown from semiconductor industry to investigate the correlation of electrically measured performance parameters after fabrication (e.g. threshold voltage) and inline measurements of process parameters (e.g. oxide thickness).

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Testing randomness for the gaming industry: tackling the multiple testing issue

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Abstract. In recent years, the gaming industry has experienced considerable growth. In the face of increasing competition, companies have sought to appeal to players by portraying themselves as trustworthy. One way of doing this is to allow the random number generation processes used to be scrutinised by independent bodies. The author has carried out work in this area for organisations including Camelot (operators of the U.K. National Lottery), Gamesys (providers of online gaming) and Active Game Design (providers of “fruit machines”). Whatever the situation, a batch of numbers is obtained from the random number generator, and a battery of statistical tests applied. However, this application of a number of tests causes problems. Assessing each test at the 5% level of significance is problematic because one would expect 5% of tests to be “significant” even if everything is random. For independent tests, adjustments can be made to allow for the fact that multiple tests are being conducted. However, when testing for randomness, it is usually the case that the tests are correlated. Existing approaches to overcoming this problem involve simulating an empirical distribution for the smallest p-value obtained from the tests. However, this discards information provided by the results of the other tests which may also indicate whether or not the random number generator is producing what would be expected from a random process. This paper presents an alternative method for dealing with the multiple testing problem for non-independent tests, where none of the information provided by the tests is discarded.

Statistical issues in Search Engine Marketing

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Abstract. Search Engine Marketing – the paid ads you get when you search on the world wide web – is a rapidly expanding economic sector. Effective use of SEM requires analytical methodologies that will support decision making. We present here methods we have applied and created specifically for this zone of eCommerce, that allow for effective planning of advertising campaigns, based on the results from previous adverts. These methods include modeling the effect of a particular bid on Cost-per-Click, Position, Click-through-rate, Impressions, Conversions and ultimately Profit. Once modeled, these relationships are used to optimize profit at the keyword level. We describe challenges that arise in these efforts, particularly those stemming from the dynamically changing environment of competitor behavior, and the corresponding solutions we have developed. We apply multiple inference techniques to quantify estimated error allowing for accurate decision making per keyword. Finally, we present operations research solutions allowing a particular campaign to be globally optimized.

Use of the Statistical Method in variation reduction projects

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Abstract. Industrial problem solving or variation reduction is best accomplished by following a process improvement system, such as DMAIC (Define, Measure, Analyze, Improve, Control) in Six Sigma. Applying any process improvement system requires a series of empirical investigations where we collect data to learn more about the process. To conduct effective empirical investigations we suggest following another systematic approach we call QPDAC (Question, Plan, Data, Analysis and Conclusion) or the Statistical Method. In this talk we explore the important relationship and synergy between problem solving systems and the Statistical Method. The main ideas are illustrated with examples and a virtual process game.

Local models in data mining

G. Szepannek*, J. Schiffner and C. Weihs

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Abstract. In classification tasks it may sometimes not be meaningful to build single rules on the whole data. This may especially be the case if the classes are composed of several subclasses.

This talk gives an overview of several proposed methods to solve this problem. These methods can be subdivided into methods that either need the subclasses to be specified in advance (see e.g. Weihs et al., 2006) or methods that determine the locality in the data itself in an unsupervised manner (see e.g. Hastie et al., 1996 or Czogiel et al., 2007). Some new issues are also presented. All methods are evaluated and compared on several real-world classification problems.

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Why DoE is not widely used among engineers in Europe?

M. Tanco*, E. Viles, M. J. Alvarez and L. Ilzarbe

Abstract. Engineers perform experiments and analyse data as an integral part of their job. Whether or not engineers have learned statistics, they will do statistics. However, we still have a wide gap between theoretical development of Design of Experiments (DoE) and its effective application in industries. Despite efforts by specialists in quality and statistics, DoE has yet to be applied as widely as it could and should be.

A vast bibliographic study was carried out for detecting the barriers for why DoE is not widely used among engineers in Europe. The barriers detected were firstly grouped and reduced into sixteen groups. Afterwards, a brief survey was carried out to obtain first-hand information about the importance of each barrier. Four different initiatives were carried out in April 2007 for obtaining response from ENBIS members, which allow us not only to access academician but also practitioners interested in DoE. It was mainly an online survey, which is still available on the web at the following direction:

<http://examinador.tecnun.es/mtanco/encuesta.asp>.

We introduce in the following work a deep statistical analysis of the mentioned survey. The most important intended goal of our research is to rank and group the barriers in order to suggest some ideas or solutions to allow DoE become closer to industries. We believe our conclusions will help to identify pitfalls and generate a realm of discussion of the situation in Europe.

Analysis of CUSUM and EWMA control charts for Poisson data under parameter estimation

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Abstract. Cumulative Sum (CUSUM) and Exponentially Weighted Moving Average (EWMA) type control charts are common in industry since they are easy to implement and yet powerful. In order to monitor counts data, such as number of nonconformities in a unit from a repetitive production process, CUSUM and EWMA type control charts were developed under the assumption of Poisson distribution. Although the Poisson distribution may be an appropriate model for such type of processes, in-control process parameters may be unknown in practice and these may be replaced with the estimates from a reference sample. Due to the additional variability introduced by parameter estimation, operational performance of a control chart might differ from the expected performance when the parameters are known. In this research, effect of estimated process mean on the performance of the CUSUM and EWMA type control charts are discussed for Poisson data monitoring.

Fault detection in feedback (closed-loop) controlled systems

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Abstract. Feedback control systems do not remove assignable causes of variation but attempt to compensate variations in the output by adjustments to some controllable process variables. In contrast, statistical process control methods are used with an intention to eliminate assignable causes that are the sources of variation. In the following, characteristics of feedback control systems have been discussed for their integration with statistical process control methods. Optimal controllers, arbitrary controllers and different fault types are considered. Detection of different types of faults by monitoring the deviations from target, control actions, and some other statistics are discussed.

Planning dose response curve experiments with insufficient observations per individual

W. Theis* and H. van der Knaap

Abstract. In food research it is often not feasible or ethically passable to take enough measurements from the subjects under observation. This is especially true for trials where children are involved. Therefore we tried to find an optimal way to spread an insufficient number of observations per individual over time which still enables us to estimate a dose-response profile over time.

Economical aspects of training Six Sigma

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Abstract. Costs of training, length of the training program, benefits from training, number of trained employees and other factors embody economical aspects of training Six Sigma. Mix influence of these factors and their management is the main topic of our paper. We are offering an analysis of a proposed business model of training Six Sigma Green Belts, which argues well-known questions of economical aspects of training programs. We will discuss how to measure the performance of training activities: the efficiency of investments into training of employees (from the financial as well as from qualitative perspective). How our business model propagates the training of Six Sigma Green Belts and finally, how can we solve some antagonistic problems, when designing training programs.

Safety improvement using DMAIC algorithm

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Abstract. With this paper we intend to specify algorithm of realization and evaluation of safety improvement projects. We have used Six Sigma DMAIC methodology to solve the given, safety improvement problem. Individual stages of project realization are described in detail with designed methods, used in selected phases of the DMAIC. At the end of the paper, we present a case study from a realized safety improvement project in a U.S. company operating in metallurgical industry. In project realization, we have used methods like: integrated FMEA, expert opinion, statistical hypothesis testing, and computer simulations. At the end of the paper, we proposed how to evaluate safety improvement projects, using two criterions: technical and economical.

Managing Six Sigma projects – actively

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Abstract. Using real options theory, we had modeled a decision process about quality improvement investments under uncertainty. We have created a generic model adapted to Six Sigma quality improvement methodology, which values the managerial flexibility of running improvement projects. By means of a case study, we have shown how to employ our model and have shown the differences compared to traditional valuation technique, the net present value. At the end of the paper, we have shortly discussed the possible implication of real options theory in regard to cost of quality models.

A control chart for the Desirability Index

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Abstract. The Desirability Index is a multiobjective optimization method in industrial quality control, which includes a-priori preferences of the decision makers regarding the quality criteria and transforms the multiobjective into a univariate problem. Settings of the process influencing factors are selected that lead to the highest possible DI value and therefore to maximum process quality. Until now the DI was solely used for optimization purposes. A straightforward question however is if the maximum DI value can be maintained in the ongoing process. For this purpose a DI control chart is introduced, which proves to be superior compared to existing charts. Additionally an innovative procedure for the analysis of out-of-control signals is presented.

A Bayesian EWMA method to detect jumps at the start-up phase of a process

P. Tsiamyrtzis* and D. M. Hawkins

Abstract. The start-up phase data of a process are the spine of traditional SPC charting and testing methods and are usually assumed to be iid observations from the In Control distribution. In this work a new method is proposed to model Normally distributed start-up phase data where we allow for serial dependence and bidirectional level shifts of the underlying parameter of interest. The theoretic development is based on a Bayesian sequentially updated EWMA model with Normal mixture errors. The new approach makes use of available prior information and provides a framework for drawing decisions and making prediction on line, even with a single observation.

Controlling correlated processes with binomial marginals

C. H. Weiß

Abstract. Few approaches towards the control of autocorrelated attribute data have been proposed in literature. If the marginal process distribution is binomial, then the binomial AR(1) model as a realistic and wellinterpretable process model may be adequate. Based on known and newly derived statistical properties of this model, we will develop possible approaches to control such a process. A case study demonstrates the applicability of the binomial AR(1) model to SPC problems and allows to investigate the performance of the control charts suggested.

Sizing mixture designs

P. Whitcomb* and G. W. Oehlert

Abstract. Newcomers to mixture design find it difficult to choose appropriate designs with adequate precision. Standard power calculations (used for factorial design) are not of much use due the colinearity present in mixture designs. However when using the fitted mixture model for drawing contour maps, 3D surfaces, making predictions, or performing optimization, it is important that the model adequately represent the response behavior over the region of interest. Emphasis is on the ability of the design to support modeling certain types of behavior (linear, quadratic, etc.); we are not generally interested in the individual model coefficients. Therefore, power to detect individual model parameters is not a good measure of what we are designing for. A discussion and pertinent examples will show attendees how the precision of the fitted surface relative to the noise is a critical criterion in design selection. In this presentation, we introduce a process to determine if particular mixture design has adequate precision for DOE needs. Attendees will take away a strategy for determining if a particular mixture design has precision appropriate for their modeling needs.

New adaptive EWMA control charts

S. Yasui* and Y. Ojima

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Abstract. The exponential weighted moving average (EWMA) control charts are more powerful for detecting small shifts than the Shewhart type control charts. Furthermore, the average time to detecting shifts can be shorter, if the sampling interval and/or the sample size is changed depending on the value of statistics is applied to an EWMA control chart. In an EWMA control chart, the plotted statistic is the weighted average of the previous plotted statistic and the current observation, hence, the weight can also be changed depending on the value of plotted statistics. In this study, the adaptive procedure for the weight in an EWMA control chart is proposed. The proposed adaptive EWMA control chart has warning limits and control limits. If the plotted statistic exceeds the warning limit, weighting is changed. We evaluate the performance for detecting several out-of-control situations through Monte Carlo method. The adaptive EWMA control is more powerful for detecting small shift than the traditional EWMA control chart.

Efficient conjoint choice designs in the presence of respondent heterogeneity

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Abstract. The authors propose a fast and efficient algorithm for constructing D -optimal conjoint choice designs for mixed logit models in the presence of respondent heterogeneity. With this new algorithm, the construction of semi-Bayesian D -optimal mixed logit designs with large numbers of attributes and attribute levels becomes practically feasible. The results from the comparison of eight designs (ranging from the simple locally D -optimal design for the multinomial logit model and the nearly orthogonal design generated by Sawtooth (CBC) to the complex semi-Bayesian mixed logit design) across wide ranges of parameter values show that the semi-Bayesian mixed logit approach outperforms the competing designs not only in terms of estimation efficiency but also in terms of prediction accuracy. In particular, it was found that semi-Bayesian mixed logit designs constructed with large heterogeneity parameters are most robust against the misspecification of the values for the mean of the individual-level coefficients for making precise estimations and predictions.

Calibration of instruments using LogVariance models

D. Zappa* and M. Pesaturo

Abstract. Design of experiments are often programmed to estimate the mean response surface. Typically it is often assumed the homoschedasticity hypothesis over the experimental domain. The most recent literature has stressed the importance of evaluation also of the variance response surfaces both to assess the existence of heteroschedasticity and, in the latter case, for a matter of optimization (maximize/minimize the mean, minimizing the expected variance). In this context we exploit the so called Log Linear Variance models (also known as LogVariance models) to assess the calibration of a temperature sensors integrated inside MEMS Chip (Micro Electro Mechanical Systems) which is the core component of Lab-On-Chip (LOC) systems used in DNA clinical analysis. We will show the effectiveness of the procedure using data measured in a real experiment. In addition, because of the computational efforts and the needs of a sw tool easily sharable among researchers, it has been prepared an excel spreadsheet freely available from the authors.

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