Exploring the Use of Design of Experiments in Industrial Processes Operating Under Closed-Loop Control: Experimentation in closed-loop systems

Industrial manufacturing processes often operate under closed-loop control, where automation aims to keep important process variables at their set-points. In process industries such as pulp, paper, chemical and steel plants, it is often hard to find production processes operating in open loop. Instead, closed-loop control systems will actively attempt to minimize the impact of process disturbances. However, we argue that an implicit assumption in most experimental investigations is that the studied system is open loop, allowing the experimental factors to freely affect the important system responses. This scenario is typically not found in process industries. The purpose of this article is therefore to explore issues of experimental design and analysis in processes operating under closed-loop control and to illustrate how Design of Experiments can help in improving and optimizing such processes. The Tennessee Eastman challenge process simulator is used as a test-bed to highlight two experimental scenarios. The first scenario explores the impact of experimental factors that may be considered as disturbances in the closed-loop system. The second scenario exemplifies a screening design using the set-points of controllers as experimental factors. We provide examples of how to analyze the two scenarios.
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.75 SJR 1.048 SNIP 1.446
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.34 SNIP 1.632 CiteScore 1.71
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.118 SNIP 1.613 CiteScore 1.5
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.009 SNIP 1.703 CiteScore 1.41
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.739 SNIP 1.017 CiteScore 0.95
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.592 SNIP 1.013 CiteScore 0.94
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.523 SNIP 0.867
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.047 SNIP 1.286
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.81 SNIP 1.145
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.6 SNIP 1.058
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.694 SNIP 1.05
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 0.41 SNIP 0.714
Scopus rating (2004): SJR 0.423 SNIP 1.103
Scopus rating (2003): SJR 0.826 SNIP 0.953
Scopus rating (2002): SJR 0.634 SNIP 0.842
Scopus rating (2001): SJR 0.291 SNIP 0.636
Scopus rating (2000): SJR 0.414 SNIP 0.867
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 0.308 SNIP 0.757

Original language: English
Design of Experiments, Engineering control, Feedback adjustment, Simulation, Tennessee Eastman process
Electronic versions:
Capaci_et_al_2017_Quality_and_Reliability_Engineering_International.pdf
DoIs:
10.1002/qre.2128

Bibliographical note
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Source: FindIt
Source-ID: 2352297727
Publication: Research - peer-review › Journal article – Annual report year: 2017
Managerial implications for improving continuous production processes
Data analytics remains essential for process improvement and optimization. Statistical process control and design of experiments are among the most powerful process and product improvement methods available. However, continuous process environments challenge the application of these methods. In this article we highlight SPC and DoE implementation challenges described in the literature for managers, researchers and practitioners interested in continuous production process improvement. The results may help managers support the implementation of these methods and make researchers and practitioners aware of methodological challenges in continuous process environments.

General information
State: Published
Organisations: Department of Applied Mathematics and Computer Science, Statistics and Data Analysis, Lulea University of Technology
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Number of pages: 11
Publication date: 2017

Host publication information
Title of host publication: Proceedings of The 24th EurOMA conference
Main Research Area: Technical/natural sciences
Conference: The 24th EurOMA conference, Edingburgh, United Kingdom, 01/07/2017 - 01/07/2017
Productivity, Statistical tools, Continuous processes
Electronic versions:
DTU_rsrapport_sammenligning_af_de_sidste_3_rs_tal_publicationtyper_10_11_2017_3_.docx.pdf
Publication: Research - peer-review › Article in proceedings – Annual report year: 2017

On the structure of dynamic principal component analysis used in statistical process monitoring
When principal component analysis (PCA) is used for statistical process monitoring it relies on the assumption that data are time independent. However, industrial data will often exhibit serial correlation. Dynamic PCA (DPCA) has been suggested as a remedy for high-dimensional and time-dependent data. In DPCA the input matrix is augmented by adding time-lagged values of the variables. In building a DPCA model the analyst needs to decide on (1) the number of lags to add, and (2) given a specific lag structure, how many principal components to retain. In this article we propose a new analyst driven method to determine the maximum number of lags in DPCA with a foundation in multivariate time series analysis. The method is based on the behavior of the eigenvalues of the lagged autocorrelation and partial autocorrelation matrices. Given a specific lag structure we also propose a method for determining the number of principal components to retain. The number of retained principal components is determined by visual inspection of the serial correlation in the squared prediction error statistic, Q (SPE), together with the cumulative explained variance of the model. The methods are illustrated using simulated vector autoregressive and moving average data, and tested on Tennessee Eastman process data.

General information
State: Published
Organisations: Department of Applied Mathematics and Computer Science, Statistics and Data Analysis, Lulea University of Technology
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Number of pages: 11
Pages: 1-11
Publication date: 2017
Main Research Area: Technical/natural sciences

Publication information
Journal: Chemometrics and Intelligent Laboratory Systems
Volume: 167
ISSN (Print): 0169-7439
Ratings:
BFI (2018): BFI-level 2
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.6 SJR 0.651 SNIP 1.21
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 0.671 SNIP 1.282 CiteScore 2.68
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 0.878 SNIP 1.763 CiteScore 2.96
Scenario-Neutral Simulation of Flood Risk for Multiple Drivers

General information
State: Published
Organisations: Department of Environmental Engineering, Urban Water Systems, Department of Applied Mathematics and Computer Science, Statistics and Data Analysis, Monash University, Cooperative Research Centre for Water Sensitive Cities
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Number of pages: 2
Publication date: 2017
Event: Abstract from 7th International Conference on Flood Management (ICFM7), Leeds, United Kingdom.
Main Research Area: Technical/natural sciences
Source: PublicationPreSubmission
Source-ID: 137133557
Publication: Research - peer-review » Conference abstract for conference – Annual report year: 2017
Selecting local constraint for alignment of batch process data with dynamic time warping

There are two key reasons for aligning batch process data. The first is to obtain same-length batches so that standard methods of analysis may be applied, whilst the second reason is to synchronise events that take place during each batch so that the same event is associated with the same observation number for every batch. Dynamic time warping has been shown to be an effective method for meeting these objectives. This is based on a dynamic programming algorithm that aligns a batch to a reference batch, by stretching and compressing its local time dimension. The resulting “warping function” may be interpreted as a progress signature of the batch which may be appended to the aligned data for further analysis. For the warping function to be a realistic reflection of the progress of a batch, it is necessary to impose some constraints on the dynamic time warping algorithm, to avoid an alignment which is too aggressive and which contains pathological warping. Previous work has focused on addressing this issue using global constraints. In this work, we investigate the use of local constraints in dynamic time warping and define criteria for evaluating the degree of time distortion and variable synchronisation obtained. A local constraint scheme is extended to include constraints not previously considered, and a novel method for selecting the optimal local constraint with respect to the two criteria is proposed. For illustration, the method is applied to real data from an industrial bacteria fermentation process.

General information
State: Published
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Pages: 161-170
Publication date: 2017
Main Research Area: Technical/natural sciences

Publication information
Journal: Chemometrics and Intelligent Laboratory Systems
Volume: 167
ISSN (Print): 0169-7439
Ratings:
BFI (2018): BFI-level 2
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.6 SJR 0.651 SNIP 1.21
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 0.671 SNIP 1.282 CiteScore 2.68
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 0.878 SNIP 1.763 CiteScore 2.96
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 0.885 SNIP 1.419 CiteScore 2.67
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 0.869 SNIP 1.643 CiteScore 2.68
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 0.76 SNIP 1.342 CiteScore 2.27
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 0.747 SNIP 1.166
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.066 SNIP 1.321
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.962 SNIP 1.272
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.21 SNIP 1.364
Selection of non-zero loadings in sparse principal component analysis
Principal component analysis (PCA) is a widely accepted procedure for summarizing data through dimensional reduction. In PCA, the selection of the appropriate number of components and the interpretation of those components have been the key challenging features. Sparse principal component analysis (SPCA) is a relatively recent technique proposed for producing principal components with sparse loadings via the variance-sparsity trade-off. Although several techniques for deriving sparse loadings have been offered, no detailed guidelines for choosing the penalty parameters to obtain a desired level of sparsity are provided. In this paper, we propose the use of a genetic algorithm (GA) to select the number of non-zero loadings (NNZL) in each principal component while using SPCA. The proposed approach considerably improves the interpretability of principal components and addresses the difficulty in the selection of NNZL in SPCA. Furthermore, we compare the performance of PCA and SPCA in uncovering the underlying latent structure of the data. The key features of the methodology are assessed through a synthetic example, pitprops data and a comparative study of the benchmark Tennessee Eastman process.

General information
State: Published
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Pages: 160-171
Publication date: 2017
Main Research Area: Technical/natural sciences

Publication information
Journal: Chemometrics and Intelligent Laboratory Systems
Volume: 162
ISSN (Print): 0169-7439
Ratings:
BFI (2018): BFI-level 2
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.6 SJR 0.651 SNIP 1.21
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 0.671 SNIP 1.282 CiteScore 2.68
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 0.878 SNIP 1.763 CiteScore 2.96
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 0.885 SNIP 1.419 CiteScore 2.67
Setup for Scenario-free Modelling of Urban Flood Risk in Non-stationary Climate and Urban Development Conditions

An early flood warning system has been developed for urban catchments and is currently running in online operation in Copenhagen. The system is highly dependent on the quality of rainfall forecast inputs. An investigation of precipitation inputs from Radar Nowcast (RN), Numerical Weather Prediction (NWP) with assimilation of radar and cloud data (RA3), and Ensemble NWP with 25 members (S05) is conducted by comparing against rain gauge measurements and flood extent. Despite lower spatial and temporal resolution, the ensemble product seems promising for forecasting extreme events. A combination of the three forecast products is expected to yield the optimal input for flood warning.
Trellis plots as visual aids for analyzing split plot experiments

The analysis of split plot experiments can be challenging due to a complicated error structure resulting from restrictions on complete randomization. Similarly, standard visualization methods do not provide the insight practitioners desire to understand the data, think of explanations, generate hypotheses, build models, or decide on next steps. This article demonstrates the effective use of trellis plots in the preliminary data analysis for split plot experiments to address this problem. Trellis displays help to visualize multivariate data by allowing for conditioning in a general way. They can also be used after the statistical analysis for verification, clarification, and communication.
Monitoring Animal Well-being

In recent years, animal well-being in industrial slaughterhouses has become a significant concern for consumers, farmers, and meat producers. Different groups have different interpretations of animal well-being. For the majority of consumers, animal well-being is highly influenced by their values and experiences. Meat producers are interested in the stress animals endure because it affects meat quality.

Pigs that arrive at slaughterhouses are more sensitive than usual for several reasons. In some cases, pigs are transported for long distances. Not all animals are used to transportation. Upon their arrival, it is common to mix pigs from different farmers in one area. Such mixing can cause fights between pigs, which can lead to additional stress or the animals being harmed. The unfamiliar environment also increases the animals’ stress levels. In some industrial slaughterhouses, up to 62,000 pigs per week are handled. Ensuring the well-being of such large numbers of pigs using only personnel is a complicated task.

Video surveillance of humans has been widely used to ensure safety and order in multiple situations. Methods have been developed to detect individual actions or abnormal behavior in small groups and dense crowds. In recent years, surveillance has also been used to monitor animals. Research has mainly focused on monitoring laboratory animals and farm animals. In both cases, animals are usually in constrained environment and cameras are used to cover all areas where animals are present. To obtain better results, non-intrusive markers or extracted features are used for tracking. Laboratory environments can be highly controlled; thus, no light and shadow noise are present in videos.

In slaughterhouses, the main focus is on monitoring large groups of animals in locations where additional markers cannot be used and pigs can leave or enter the surveilled area. In addition, pigs have a specific walking pattern; thus, motion analysis is not straightforward. The first aim of this thesis is to monitor the movement of pigs without using any additional markers or feature extraction in an unconstrained environment.

In video surveillance, the behavior of humans and animals is monitored based on extremes: event is present/event is not present, objects behave normally/objects behave abnormally, action 1/action 2/action 3, etc. In nature, the motion of humans and animals is continuous with transitions from one action to another. The second aim of this thesis is to propose a method to monitor motion as a continuous process using common classification methods.

General information
State: Published
Organisations: Department of Applied Mathematics and Computer Science, Statistics and Data Analysis
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Number of pages: 160
Publication date: 2016

Publication information
Place of publication: Kgs. Lyngby
Publisher: Technical University of Denmark (DTU)
Original language: English
Series: DTU Compute PHD-2015
Number: 370
ISSN: 0909-3192
Main Research Area: Technical/natural sciences
Electronic versions:
Monitoring pig movement at the slaughterhouse using optical flow and modified angular histograms

We analyse the movement of pig herds through video recordings at a slaughterhouse by using statistical analysis of optical flow (OF) patterns. Unlike the previous attempts to analyse pig movement, no markers, trackers nor identification of individual pigs are needed. Our method handles the analysis of unconstrained areas where pigs are constantly entering and leaving. The goal is to improve animal welfare by real-time prediction of abnormal behaviour through proper interventions. The aim of this study is to identify any stationary pig, which can be an indicator of an injury or an obstacle. In this study, we use the OF vectors to describe points of movement on all pigs and thereby analyse the herd movement. Subsequently, the OF vectors are used to identify abnormal movements of individual pigs. The OF vectors, obtained from the pigs, point in multiple directions rather than in one movement direction. To accommodate the multiple directions of the OF vectors, we propose to quantify OF using a summation of the vectors into bins according to their angles, which we call modified angular histograms. Sequential feature selection is used to select angle ranges, which identify pigs that are moving abnormally in the herd. The vector lengths from the selected angle ranges are compared to the corresponding median, 25th and 75th percentiles from a training set, which contains only normally moving pigs. We show that the method is capable of locating stationary pigs in the recordings regardless of the number of pigs in the frame.
Process Knowledge Discovery Using Sparse Principal Component Analysis

As the goals of ensuring process safety and energy efficiency become ever more challenging, engineers increasingly rely on data collected from such processes for informed decision making. During recent decades, extracting and interpreting valuable process information from large historical data sets has been an active area of research. Among the methods used, principal component analysis (PCA) is a well-established technique that allows for dimensionality reduction for large data sets by finding new uncorrelated variables, namely principal components (PCs). However, it is difficult to interpret the derived PCs, as each PC is a linear combination of all of the original variables and the loadings are typically nonzero. Sparse principal component analysis (SPCA) is a relatively recent technique proposed for producing PCs with sparse loadings via the variance sparsity trade-off. We propose a forward SPCA approach that helps uncover the underlying process knowledge regarding variable relations. This approach systematically determines the optimal sparse loadings for each sparse PC while improving interpretability and minimizing information loss. The salient features of the proposed approach are demonstrated through the Tennessee Eastman process simulation. The results indicate how knowledge and process insight can be discovered through a systematic analysis of sparse loadings.

General information

State: Published
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Pages: 12046-12059
Publication date: 2016
Main Research Area: Technical/natural sciences

Publication information
Journal: Industrial and Engineering Chemistry Research
Volume: 55
Issue number: 46
ISSN (Print): 0888-5885
Ratings:
BFI (2018): BFI-level 2
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.1 SJR 0.945 SNIP 1.139
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Split-plot designs for multistage experimentation

Most of today's complex systems and processes involve several stages through which input or the raw material has to go before the final product is obtained. Also in many cases factors at different stages interact. Therefore, a holistic approach for experimentation that considers all stages at the same time will be more efficient. However, there have been only a few attempts in the literature to provide an adequate and easy-to-use approach for this problem. In this paper, we present a
novel methodology for constructing two-level split-plot and multistage experiments. The methodology is based on the
Kronecker product representation of orthogonal designs and can be used for any number of stages, for various numbers
of subplots and for different number of subplots for each stage. The procedure is demonstrated on both regular and
nonregular designs and provides the maximum number of factors that can be accommodated in each stage. Furthermore,
split-plot designs for multistage experiments with good projective properties are also provided.

General information
State: Published
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Pages: 493-510
Publication date: 2016
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Applied Statistics
Volume: 44
Issue number: 3
ISSN (Print): 0266-4763
Ratings:
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.64 SJR 0.402 SNIP 0.764
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.475 SNIP 0.791 CiteScore 0.61
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.501 SNIP 0.773 CiteScore 0.61
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.542 SNIP 0.91 CiteScore 0.68
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.457 SNIP 0.822 CiteScore 0.58
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.364 SNIP 0.814 CiteScore 0.59
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.306 SNIP 0.481
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.326 SNIP 0.514
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.304 SNIP 0.476
Scopus rating (2007): SJR 0.243 SNIP 0.495
Scopus rating (2006): SJR 0.384 SNIP 0.674
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 0.748 SNIP 0.698
Scopus rating (2004): SJR 0.64 SNIP 0.766
Scopus rating (2003): SJR 0.515 SNIP 0.663
Scopus rating (2002): SJR 0.354 SNIP 0.591
Scopus rating (2001): SJR 0.287 SNIP 0.602
Scopus rating (2000): SJR 0.38 SNIP 0.738
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 0.32 SNIP 0.72
Use of Sparse Principal Component Analysis (SPCA) for Fault Detection

Principal component analysis (PCA) has been widely used for data dimension reduction and process fault detection. However, interpreting the principal components and the outcomes of PCA-based monitoring techniques is a challenging task since each principal component is a linear combination of the original variables which can be numerous in most modern applications. To address this challenge, we first propose the use of sparse principal component analysis (SPCA) where the loadings of some variables in principal components are restricted to zero. This paper then describes a technique to determine the number of non-zero loadings in each principal component. Furthermore, we compare the performance of PCA and SPCA in fault detection. The validity and potential of SPCA are demonstrated through simulated data and a comparative study with the benchmark Tennessee Eastman process.

Design and analysis of biomedical studies

Biomedicine is a field that has great influence on the majority of mankind. The constant development has considerably changed our way of life during the last centuries. This has been achieved through the dedication of biomedical researchers along with the tremendous resources that over time have been allocated this field. It is utterly important to utilize these resources responsibly and efficiently by constantly striving to ensure high-quality biomedical studies. This involves the use of a sound statistical methodology regarding both the design and analysis of biomedical studies. The focus of this project is on statistical aspects that arise within the field of biomedicine.
Two types of errors are frequently accentuated within the framework of statistics, namely type I and type II errors. Type I errors occur when a null hypothesis erroneously is rejected. An acceptable type I error rate is specified prior to conducting the statistical analysis. However, all statistical models make assumptions and if violated the actual type I error rate may deviate from the pre-specified type I error rate. Type II errors occur when we fail to reject a false null hypothesis. On contrary to the type I error rate, the type II error rate is not explicitly specified during the statistical analysis and this entails that assessment of the type II error rate in practice is at risk of being neglected altogether. Concerns regarding type I errors, type II errors and adherence (or lack thereof) to model assumptions for biomedical studies are a recurring theme in this thesis.

Data collected in some biomedical studies are positively skewed; hence methods relying on the normal distribution are not directly applicable. We investigated how data from one of these studies are suitably analyzed. We extracted 23 different summary statistics from data gathered from eleven studies. The degree of adherence to the model assumptions evaluated for each of these summary statistics form basis for our conclusions. Hierarchically structured data are frequently encountered in biomedical studies. For one type of studies entailing such data we have conducted a literature study strongly indicating that this structure commonly is neglected in the statistical analysis. Based on this closed-form expressions for the approximate type I error rate are formulated. The type I error rates are assessed for a number of factor combinations as they appear in practice and in all cases the type I error rates are demonstrated to be severely inflated.

Prior to conducting a study it is important to perform power and sample size determinations to ensure that reliable conclusions can be drawn from the statistical analysis. We have formulated closed-form expressions for the statistical power of studies with a hierarchical structure to guide biomedical researchers designing future studies of this type. Upon model fitting it is important to examine if the model assumptions are met to avoid that spurious conclusions are drawn. While the range of diagnostic methods is extensive for models assuming a normal response it is generally more limited for non-normal models. An R package providing diagnostic tools suitable for examining the validity of binomial regression models have been developed. The binom Tools package is publicly available at the CRAN repository.

General information
State: Published
Organisations: Department of Applied Mathematics and Computer Science, Statistics and Data Analysis
Authors: Hansen, M. K. (Intern), Kulahci, M. (Intern)
Number of pages: 224
Publication date: 2015

Publication information
Place of publication: Kgs. Lyngby
Publisher: Technical University of Denmark (DTU)
Original language: English
Series: DTU Compute PHD-2014
Number: 343
ISSN: 0909-3192
Main Research Area: Technical/natural sciences
Electronic versions:
phd343_Hansen_MK.pdf
Publication: Research > Ph.D. thesis – Annual report year: 2015

Design of Experiments for Food Engineering
This work looks at the application of Design of Experiments (DoE) to Food Engineering (FE) problems in relation to quality. The field of Quality Engineering (QE) is a natural partnering field for FE due to the extensive developments that QE has had in using DoE for quality improvement especially in manufacturing industries. In the thesis the concepts concerning food quality is addressed and in addition how QE proposes to define quality. There is seen a merger in how QE’s definition of quality has been translated for food. At the same time within FE a divergence has been proposed in the literature emphasizing mechanistic modelling over empirical methods. This thesis proposes that this divergence is based on a misunderstanding of what empirical methods entail. The misunderstanding could stem from the issue that the majority of the literature trying to address these issues has focused on analysis procedure almost to the point of excluding the experimental principles and procedures. This thesis has tried to address this as far as possible. The focus has been on supplying practical interpretations of randomization and what blocking entails when designing experiments. These practical interpretations have then been applied in series of actual experiments which are reported and discussed again with the aim of giving practical DoE insight. The diversity of the cases is hopefully broad enough to supply inspiration for others working on their specific issues. The relevance of the fundamental principles is shown by using these directly in the following novel research studies: The promising application of ohmic heating of shrimp. The results showed a promising technology with major potential for addressing quality issues in over cooking and possibly a better control of weight loss. In a second study the application of ASCA for analyzing a designed experiment using image data as the response with the intention of investigation process design choices is presented. Great potential was seen for using image data to elucidate how and where process choices would affect appearances of product. The aim was to show that the fundamental principles of DoE have as much importance and relevance as ever for both the food industry and FE research.
Experiments for Multi-Stage Processes

Multi-stage processes are very common in both process and manufacturing industries. In this article we present a methodology for designing experiments for multi-stage processes. Typically in these situations the design is expected to involve many factors from different stages. To minimize the required number of experimental runs, we suggest using mirror image pairs of experiments at each stage following the first. As the design criterion, we consider their projectivity and mainly focus on projectivity 3 designs. We provide the methodology for generating these designs for processes with any number of stages and also show how to identify and estimate the effects. Both regular and non-regular designs are considered as base designs in generating the overall design.
iCFD: Interpreted Computational Fluid Dynamics – Degeneration of CFD to one-dimensional advection-dispersion models using statistical experimental design – The secondary clarifier

The present study aims at using statistically designed computational fluid dynamics (CFD) simulations as numerical experiments for the identification of one-dimensional (1-D) advection-dispersion models – computationally light tools, used e.g., as sub-models in systems analysis. The objective is to develop a new 1-D framework, referred to as interpreted CFD (iCFD) models, in which statistical meta-models are used to calculate the pseudo-dispersion coefficient (D) as a function of design and flow boundary conditions. The method – presented in a straightforward and transparent way – is illustrated using the example of a circular secondary settling tank (SST). First, the significant design and flow factors are screened out by applying the statistical method of two-level fractional factorial design of experiments. Second, based on the number of significant factors identified through the factor screening study and system understanding, 50 different sets of design and flow conditions are selected using Latin Hypercube Sampling (LHS). The boundary condition sets are imposed on a 2-D axi-symmetrical CFD simulation model of the SST. In the framework, to degenerate the 2-D model structure, CFD model outputs are approximated by the 1-D model through the calibration of three different model structures for D. Correlation equations for the D parameter then are identified as a function of the selected design and flow boundary conditions (meta-models), and their accuracy is evaluated against D values estimated in each numerical experiment. The evaluation and validation of the iCFD model structure is carried out using scenario simulation results obtained with parameters sampled from the corners of the LHS experimental region. For the studied SST, additional iCFD model development was carried out in terms of (i) assessing different density current sub-models; (ii) implementation of a combined flocculation, hindered, transient and compression settling velocity function; and (iii) assessment of modelling the onset of transient and compression settling. Furthermore, the optimal level of model discretization both in 2-D and 1-D was undertaken. Results suggest that the iCFD model developed for the SST through the proposed methodology is able to predict solid distribution with high accuracy – taking a reasonable computational effort – when compared to multi-dimensional numerical experiments, under a wide range of flow and design conditions. iCFD tools could play a crucial role in reliably predicting systems’ performance under normal and shock events.
ICFD modeling of final settlers - developing consistent and effective simulation model structures

Summary of key findings: The concept of interpreted computational fluid dynamic (iCFD) modelling and the development methodology are presented (Fig. 1). The 1-D advection-dispersion model along with the statistically generated, meta-model for pseudo-dispersion constitutes the newly developed iCFD concept. The case of secondary settling tanks (SSTs) is used to demonstrate the methodological steps using the validated CFD model with the hindered-transient compression settling velocity model by (10). Factor screening and Latin hypercube sampling (LSH) are used to degenerate a 2-D axisymmetrical CFD model structure (10) into a one-dimensional (1-D) advection-dispersion model structure. The boundary condition sets, obtained in the LHS, are imposed on the 2-D CFD simulation model of the SST. In the framework, to degenerate the 2-D model structure, CFD model outputs are approximated by the 1-D model through the calibration of three different model structures for D, the pseudo-dispersion coefficient. Correlation equations for the D parameter (meta-models) are then identified as a function of the selected design and flow boundary conditions, and their accuracy is evaluated against the D values estimated in each numerical experiment. The evaluation and validation of the iCFD model structure is carried out using scenario simulation results obtained with parameters sampled from the corners of the LHS.
experimental region. For the studied SST, additional iCFD model development was carried out in terms of (i) assessing different density current sub-models; (ii) implementation of a combined flocculation, hindered, transient and compression settling velocity function; and (iii) assessment of modelling the onset of transient and compression settling. Results suggest that the iCFD model developed for the SST through the proposed methodology is able to predict solid distribution with high accuracy -- taking a reasonable computational effort -- when compared to multi-dimensional numerical experiments, under a wide range of flow and design conditions. The iCFD models developed are intended to comply with the consistent modelling methodology (1). iCFD tools could play an important role in reliably predicting WWTP performance under normal and shock-loading (7). Background and relevance System analysis tools typically comprise numerous sub-models, identified so that the computational effort taken through system analysis exercises is kept to a minimum (4). Consequently, detailed information related to, for instance, design boundaries, may be ignored, and their effects may only be accounted for through calibration of model parameters using pilot tests or catchalls, and by arbitrary amendments of structural uncertainty propagations to outputs (e.g. 1-D SST). The present study aims at using statistically designed CFD simulation scenarios with different design and flow boundary conditions to identify consistent and effective 1-D structures. The attempt of combining CFD simulations and statistical tools is inspired by the work of (6). Further details are shown in (5). Results and discussions Factor screening. Factor screening is carried out by imposing statistically designed moderate (under-loaded) and extreme (under-, critical and over-loaded) operational boundary conditions on the 2-D CFD SST model (8). Results obtained in the statistical analysis of the CFD outputs in the extreme scenario suggest that the loading conditions characterised with feed solid concentration (Xin), SST overflow rate (Qov), recycle ratio (R), and, to a minor extent, the inlet height (Hin), are the four significant factors, impacting the SST performance, in terms of sludge blanket height (SBH), solids concentration in recycle of activated sludge (XRAS) and solids concentration in SST effluent (Xeff). Statistical results obtained in the moderate scenario indicate five factors significantly influencing the SST performance, i.e. Xin, Qov, R, sidewater depth (SWD) and Hin. It should be noted that the baffles installed in the SST inlet and outlet (characterised with 4 parameters), are found to have negligible effect compared to the aforementioned five factors. Internal baffling probably has a positive effect, especially on effluent quality albeit at a lower order of magnitude not visible in our results. LHS. Based on the screening study, the five significant factors used in the subsequent LHS are Xin, Qov, R, SWD and Hin. The LHS yielded 50 CFD simulations, and the outputs, in terms of SBH, XRAS, Xeff, total amount of solids in SST (Mtot) values, are extracted from the steady-state solution, and then used to perform the iCFD model identification, iCFD model identification. We assess the 1-D model structure in terms of setting the feed location (layer) and transient/compression threshold concentration, XTC. Using the CFD outputs from LHS, we assessed nine different model structures based on literature (1; 3; 2; 10; 9) and on more recent considerations (Fig. 2a). Validation tests were done using the CFD outputs from extreme scenarios. The most effective model structure (relative low the sum of square of relative errors, SSRE, and computational time) obtained is that in which the XTC is set at the concentration of the layer just below the feed-layer. The feed-layer location is set to the highest location where X>Xin (solids concentration in SST influent). An effective discretization level (computational time/numerical error) is assessed by approximating the LHS outputs with an iCFD model discretised using 10-200 layers. Solutions obtained show convergence, and the discretisation scheme with 60 layers seems an effective trade-off. Identification and validation of the D-model. To identify a formulation for the pseudo-dispersion coefficient in the iCFD model, we tested three structural scenarios by defining (i) one single pseudo-dispersion coefficient (D0) for all the layers; (ii) one pseudo-dispersion coefficient (D1) above and another pseudodispersion coefficient (D2) below the feed-layer; (iii) one pseudo-dispersion coefficient (Df) just around the feed-layer. These scenarios were inspired by literature (1; 2; 9). As for the D0—iCFD model, values of SSRE are obtained below 1 with an average SSRE=0.206. The simulation model thus can predict the solids distribution inside the tank with a satisfactory accuracy. Averaged relative errors of 8.1 %, 3.1 %, 16.1 % and 11.8 % are observed for SBH, XRAS, Xeff and Mtot, respectively. A statistical analysis of the calibrated D0 compared to the five input factors is performed. In addition to the elementary factors, four interactions are found significant: XinX, Xin*R, Xin*Xin*Qov. A correlation is obtained between the loading and design factors and D0 with an R² of 0.853 (adjusted R²=0.819), i.e. Eq. 1. D0 values predicted with Eq. 1 are compared to the values estimated using 1-D model approximation of the 50 CFD outputs, and results suggest a relatively effective correlation as well (Fig. 2b). The three iCFD models, employing different formulations for D, calibrated using the meta-models (Eq. 1 for D0), are used to approximate the CFD outputs obtained in the extreme scenarios. Using the D0—iCFD model, the solid distribution at the corners of the LHS experimental region can be predicted with the highest accuracy (average SSRE=0.71), thereby validating the simulation model. For D1,2—iCFD, the meta-model is limited in calculating D, and the model fails the validation test using the extreme scenario (SSRE=386). Using the Df—iCFD model, the predictive accuracy obtained is comparable with that obtained with the D0—iCFD (compare 1.73 to 0.71). The computational time required through simulation with Df—iCFD, however, is significantly higher than that obtained with the D0—iCFD (on average 3.5 times longer). Therefore, this study concludes that, considering the capability and usability - in terms of complexity and computational time - the D0—iCFD model is preferred.

General information
State: Published
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Number of pages: 2
Publication date: 2015
Event: Abstract from 9th IWA Symposium on Systems Analysis and Integrated Assessment (Watermatex 2015), Gold Coast, Queensland, Australia.
Main Research Area: Technical/natural sciences
Source: PublicationPreSubmission
Impact of Autocorrelation on Principal Components and Their Use in Statistical Process Control

A basic assumption when using principal component analysis (PCA) for inferential purposes, such as in statistical process control (SPC), is that the data are independent in time. In many industrial processes, frequent sampling and process dynamics make this assumption unrealistic rendering sampled data autocorrelated (serially dependent). PCA can be used to reduce data dimensionality and to simplify multivariate SPC. Although there have been some attempts in the literature to deal with autocorrelated data in PCA, we argue that the impact of autocorrelation on PCA and PCA-based SPC is neither well understood nor properly documented. This article illustrates through simulations the impact of autocorrelation on the descriptive ability of PCA and on the monitoring performance using PCA-based SPC when autocorrelation is ignored. In the simulations, cross-correlated and autocorrelated data are generated using a stationary first-order vector autoregressive model. The results show that the descriptive ability of PCA may be seriously affected by autocorrelation causing a need to incorporate additional principal components to maintain the model's explanatory ability. When all variables have equal coefficients in a diagonal autoregressive coefficient matrix, the descriptive ability is intact, while a significant impact occurs when the variables have different degrees of autocorrelation. We also illustrate that autocorrelation may impact PCA-based SPC and cause lower false alarm rates and delayed shift detection, especially for negative autocorrelation. However, for larger shifts, the impact of autocorrelation seems rather small.
Pig herd monitoring and undesirable tripping and stepping prevention

Humane handling and slaughter of livestock are of major concern in modern societies. Monitoring animal wellbeing in slaughterhouses is critical in preventing unnecessary stress and physical damage to livestock, which can also affect the meat quality. The goal of this study is to monitor pig herds at the slaughterhouse and identify undesirable events such as pigs tripping or stepping on each other. In this paper, we monitor pig behavior in color videos recorded during unloading from transportation trucks. We monitor the movement of a pig herd where the pigs enter and leave a surveyed area. The method is based on optical flow, which is not well explored for monitoring all types of animals, but is the method of choice for human crowd monitoring. We recommend using modified angular histograms to summarize the optical flow vectors. We show that the classification rate based on support vector machines is 93% of all frames. The sensitivity of the model is 93.5% with 90% specificity and 6.5% false alarm rate. The radial lens distortion and camera position required for convenient surveillance make the recordings highly distorted. Therefore, we also propose a new approach to correct lens and foreshortening distortions by using moving reference points. The method can be applied real-time during the actual unloading operations of pigs. In addition, we present a method for identification of the causes leading to undesirable events, which currently only runs off-line. The comparative analysis of three drivers, which performed the unloading of the pigs from the trucks in the available datasets, indicates that the drivers perform significantly differently. Driver 1 has 2.95 times higher odds to have pigs tripping and stepping on each other than the two others, and Driver 2 has 1.11 times higher odds than Driver 3. (C) 2015 Elsevier B.V. All rights reserved.

General information
State: Published
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Pages: 51-60
Publication date: 2015
Main Research Area: Technical/natural sciences

Publication information
Journal: Computers and Electronics in Agriculture
Volume: 119
Issue number: November
ISSN (Print): 0168-1699
Ratings:
Recent Advances and Future Directions for Quality Engineering

The origins of quality engineering are in manufacturing, where quality engineers apply basic statistical methodologies to improve the quality and productivity of products and processes. In the past decade, people have discovered that these methodologies are effective for improving almost any type of system or process, such as financial, health care, and supply chains. This paper begins with a review of key advances and trends within quality engineering over the past decade. The second part uses the first part as a foundation to outline new application areas for the field. It also discusses how quality engineering needs to evolve in order to make significant contributions to these new areas. © 2015 The Authors Quality and Reliability Engineering International Published by John Wiley & Sons Ltd.
Statistical Data Mining for Efficient Quality Control in Manufacturing

Extensive use of machines, flexible/re-configurable manufacturing and transition towards the fully automated factories call for intelligent use of information recorded during the manufacturing process. Modern manufacturing processes produce Terabytes of information during different stages of the process e.g sensor measurements, machine readings etc, and the major contributor of these big data sets are different quality control processes. In this article we will present methodology to extract valuable insight from manufacturing data. The proposed methodology is based on comparison of probabilities and extension of likelihood principles in statistics as a performance function for Genetic Algorithm.

The Effect of Autocorrelation on the Hotelling T-2 Control Chart

One of the basic assumptions for traditional univariate and multivariate control charts is that the data are independent in time. For the latter, in many cases, the data are serially dependent (autocorrelated) and cross-correlated because of, for example, frequent sampling and process dynamics. It is well known that the autocorrelation affects the false alarm rate and the shift-detection ability of the traditional univariate control charts. However, how the false alarm rate and the shift-detection ability of the Hotelling T-2 control chart are affected by various autocorrelation and cross-correlation structures for different magnitudes of shifts in the process mean is not fully explored in the literature. In this article, the performance of the Hotelling T-2 control chart for different shift sizes and various autocorrelation and cross-correlation structures are compared based on the average run length using simulated data. Three different approaches in constructing the Hotelling T-2 chart are studied for two different estimates of the covariance matrix: (i) ignoring the autocorrelation and using the raw data with theoretical upper control limits; (ii) ignoring the autocorrelation and using the raw data with adjusted control limits calculated through Monte Carlo simulations; and (iii) constructing the control chart for the residuals from a multivariate time series model fitted to the raw data. To limit the complexity, we use a first-order vector autoregressive process and focus mainly on bivariate data. (c) 2014 The Authors. Quality and Reliability Engineering International published by John Wiley & Sons Ltd.
Statistical Process Control (SPC), Hotelling T2-chart, Autocorrelation, Multivariate data, Time series modeling, Simulation
The authors start their review with the discussion on the kappa statistic commonly used in agreement studies. The practical appeal of single summary statistics to summarize an entire statistical analysis such as the ubiquitous R² cannot be denied. However, one should always be quite cautious in concluding solely based on these statistics. As indicated by the authors, the kappa statistic is no different. Often defined as a sample statistic, potentially lead to inconsistent results. In his early work in this area, Professor de Mast explored the paradoxical behavior of this statistic. His more recent work on introducing more sophisticated methods in alleviating some of the issues discussed in this article is certainly worth praise. However, considering the widespread use of the kappa statistic, it is also worth looking into some of the authors' comments on the behavior of this statistic.
Bibliographical note
Article presented at the First Stu Hunter Research Conference in Heemskerk, Netherlands, March 2013.
Source: FindIt
Source-ID: 274861668
Publication: Research - peer-review › Review – Annual report year: 2015

Editorial - a Special Issue on Data Mining

General information
State: Published
Organisations: Department of Applied Mathematics and Computer Science, Statistics and Data Analysis, Arizona State University, Lulea University of Technology
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Number of pages: 1
Pages: 813
Publication date: 2014
Main Research Area: Technical/natural sciences

Publication information
Journal: Quality and Reliability Engineering International
Volume: 30
Issue number: 6
ISSN (Print): 0748-8017
Ratings:
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.75 SJR 1.048 SNIP 1.446
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.34 SNIP 1.632 CiteScore 1.71
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.118 SNIP 1.613 CiteScore 1.5
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.009 SNIP 1.703 CiteScore 1.41
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.739 SNIP 1.017 CiteScore 0.95
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.592 SNIP 1.013 CiteScore 0.94
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.523 SNIP 0.867
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.047 SNIP 1.286
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
In vivo Comet assay – statistical analysis and power calculations of mice testicular cells

The in vivo Comet assay is a sensitive method for evaluating DNA damage. A recurrent concern is how to analyze the data appropriately and efficiently. A popular approach is to summarize the raw data into a summary statistic prior to the statistical analysis. However, consensus on which summary statistic to use has yet to be reached. Another important consideration concerns the assessment of proper sample sizes in the design of Comet assay studies. This study aims to identify a statistic suitably summarizing the % tail DNA of mice testicular samples in Comet assay studies. A second aim is to provide curves for this statistic outlining the number of animals and gels to use. The current study was based on 11 compounds administered via oral gavage in three doses to male mice: CAS no. 110-26-9, CAS no. 512-56-1, CAS no. 111873-33-7, CAS no. 79-94-7, CAS no. 115-96-8, CAS no. 598-55-0, CAS no. 636-97-5, CAS no. 85-28-9, CAS no. 13674-87-8, CAS no. 43100-38-5 and CAS no. 60965-26-6. Testicular cells were examined using the alkaline version of the Comet assay and the DNA damage was quantified as % tail DNA using a fully automatic scoring system. From the raw data 23 summary statistics were examined. A linear mixed-effects model was fitted to the summarized data and the estimated variance components were used to generate power curves as a function of sample size. The statistic that most appropriately summarized the within-sample distributions was the median of the log-transformed data, as it most consistently conformed to the assumptions of the statistical model. Power curves for 1.5-, 2-, and 2.5-fold changes of the highest dose group compared to the control group when 50 and 100 cells were scored per gel are provided to aid in the design of future Comet assay studies on testicular cells.

General information
State: Published
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Number of pages: 12
Pages: 29-40
Publication date: 2014
Main Research Area: Technical/natural sciences

Publication information
Journal: Mutation Research - Genetic Toxicology and Environmental Mutagenesis
Volume: 774
ISSN (Print): 1383-5718
Ratings:
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.25 SJR 0.924 SNIP 0.937
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.042 SNIP 1.212 CiteScore 2.7
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.91 SNIP 1.048 CiteScore 2.64
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.832 SNIP 0.985 CiteScore 2.51
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.869 SNIP 1.054 CiteScore 2.6
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.991 SNIP 1.19 CiteScore 2.85
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.043 SNIP 1.221
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.816 SNIP 1.139
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.85 SNIP 1.168
Scopus rating (2007): SJR 0.807 SNIP 1.077
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.859 SNIP 1.219
Scopus rating (2005): SJR 0.692 SNIP 1.089
Scopus rating (2004): SJR 0.713 SNIP 1.046
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 0.631 SNIP 0.934
Scopus rating (2002): SJR 0.596 SNIP 0.971
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 0.577 SNIP 0.898
Scopus rating (2000): SJR 0.641 SNIP 0.889
Scopus rating (1999): SJR 0.412 SNIP 0.952
Original language: English
Single-cell gel electrophoresis, Genotoxicity, DNA damage, Germ cells, Power, Statistical analysis
DOIs:
10.1016/j.mrgentox.2014.08.006
Source: FindIt
Source-ID: 270716284
Publication: Research - peer-review › Journal article – Annual report year: 2014

Study Delay

General information
State: Published
Organisations: Department of Applied Mathematics and Computer Science, Statistics and Data Analysis
Authors: Sliusarenko, T. (Intern), Gronskyte, R. (Intern), Clemmensen, L. K. H. (Intern), Kulahci, M. (Intern), Ersbøll, B. K. (Intern)
Number of pages: 65
Publication date: 2014

Publication information
Place of publication: Kgs. Lyngby
The type I error rate for in vivo Comet assay data when the hierarchical structure is disregarded

The Comet assay is a sensitive technique for detection of DNA strand breaks. The experimental design of in vivo Comet assay studies are often hierarchically structured, which should be reflected in the statistical analysis. However, the hierarchical structure sometimes seems to be disregarded, and this imposes considerable impact on the type I error rate. This study aims to demonstrate the implications that result from disregarding the hierarchical structure. Different combinations of the factor levels as they appear in a literature study give type I error rates up to 0.51 and for all combinations the type I error rate is greater than the nominal _ at 0.05. Closed-form expressions based on scaled F-distributions using the Welch-Satterthwaite approximation are provided to show how the type I error rate is affected. With this study we hope to motivate researchers to be more precise regarding the exposition of the statistical methodology and to suitably account for the hierarchical structure of Comet assay data whenever present.

A New Paradigm in Mortgage Loan Advice

The Danish mortgage market has undergone considerable changes during the last 15 years. New and more complex variations of loan products have been introduced. Nevertheless, mortgage loan advice has remained, by large, unchanged. This paper addresses a study where a number of new refinancing rules are constructed with the help of a stochastic optimization model and the data mining method, CART.
Class 4 Defects

General information
State: Published
Organisations: Department of Applied Mathematics and Computer Science, Statistics and Data Analysis
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Number of pages: 140
Publication date: 2013

Publication information
Place of publication: Kgs. Lyngby
Publisher: Technical University of Denmark (DTU)
Original language: English
Series: DTU Compute-Technical Report-2013
Number: 23
ISSN: 1601-2321
Main Research Area: Technical/natural sciences
Publication: Research › Report – Annual report year: 2013

Data Mining—A Special Issue of Quality and Reliability Engineering International (QREI)

General information
State: Published
Organisations: Department of Applied Mathematics and Computer Science, Statistics and Data Analysis, Arizona State University
Authors: Li, J. (ed.) (Ekstern), Kulahci, M. (ed.) (Intern)
Number of pages: 1
Pages: 437
Publication date: 2013
Main Research Area: Technical/natural sciences

Publication information
Journal: Quality and Reliability Engineering International
Volume: 29
Issue number: 3
ISSN (Print): 0748-8017
Ratings:
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.75 SJR 1.048 SNIP 1.446
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.34 SNIP 1.632 CiteScore 1.71
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.118 SNIP 1.613 CiteScore 1.5
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.009 SNIP 1.703 CiteScore 1.41
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.739 SNIP 1.017 CiteScore 0.95
Improvement of the ΔσH Model

General information
State: Published
Organisations: Department of Applied Mathematics and Computer Science, Statistics and Data Analysis
Authors: Thyregod, C. (Intern), Andersen, E. W. (Intern), Kulahci, M. (Intern), Ersbøll, B. K. (Intern)
Number of pages: 29
Publication date: 2013

Publication information
Place of publication: Kgs. Lyngby
Publisher: Technical University of Denmark (DTU)
Original language: English
Series: DTU Compute-Technical Report-2013
Number: 22
ISSN: 1601-2321
Main Research Area: Technical/natural sciences
Publication: Research › Report – Annual report year: 2013

Monitoring Motion of Pigs in Thermal Videos
We propose a new approach for monitoring animal movement in thermal videos. The method distinguishes movements as walking in the expected direction from walking in the opposite direction, stopping or lying down. The method utilizes blob detection combined with optical flow to segment the pigs and extract features which characterize a pig’s movement (direction and speed). Subsequently a multiway principal component analysis is used to analyze the movement features and monitor their development over time. Results are presented in the form of quality control charts of the principal components. The method works on-line with pre-training.
Optical flow, Blob detection, Multiway principle components, Quality control

Multivariate Statistical Process Control
As sensor and computer technology continues to improve, it becomes a normal occurrence that we confront with high dimensional data sets. As in many areas of industrial statistics, this brings forth various challenges in statistical process control (SPC) and monitoring for which the aim is to identify “out-of-control” state of a process using control charts in order to reduce the excessive variation caused by so-called assignable causes. In practice, the most common method of monitoring multivariate data is through a statistic akin to the Hotelling’s T2. For high dimensional data with excessive amount of cross correlation, practitioners are often recommended to use latent structures methods such as Principal Component Analysis to summarize the data in only a few linear combinations of the original variables that capture most of the variation in the data. Applications of these control charts in conjunction with image data are plagued with various challenges beyond the usual ones encountered in current applications. In this presentation we will introduce the basic ideas of SPC and the multivariate control charts commonly used in industry. We will further discuss the challenges the practitioners are facing with in the implementation of these charts.

A Comparison of Decision Methods for C_{pk} When Data are Autocorrelated
In many industrial applications, autocorrelated data are becoming increasingly common due to, for example, on-line data collection systems with high-frequency sampling. Therefore, the basic assumption of independent observations for process capability analysis is not valid. The purpose of this article is to compare decision methods using the process capability index C_{pk} when data are autocorrelated. This is done through a case study followed by a simulation study. In the simulation study the actual significance level and power of the decision methods are investigated. The outcome of the
article is that two methods appeared to be better than the others.

**General information**

*State:* Published

*Organisations:* Department of Informatics and Mathematical Modeling, DTU Data Analysis, Lulea University of Technology, Umeå University

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*Pages:* 460-472

*Publication date:* 2012

*Main Research Area:* Technical/natural sciences

**Publication information**

*Journal:* Quality Engineering

*Volume:* 24

*Issue number:* 4

*ISSN (Print):* 0898-2112

*Ratings:*

- BFI (2018): BFI-level 1
- BFI (2017): BFI-level 1
- Web of Science (2017): Indexed yes
- BFI (2016): BFI-level 1
- Scopus rating (2016): CiteScore 1.31 SJR 0.986 SNIP 1.116
- BFI (2015): BFI-level 1
- Scopus rating (2015): SJR 0.594 SNIP 1.163 CiteScore 0.83
- BFI (2014): BFI-level 1
- Scopus rating (2014): SJR 0.421 SNIP 0.871 CiteScore 0.61
- Web of Science (2014): Indexed yes
- BFI (2013): BFI-level 1
- Scopus rating (2013): SJR 0.509 SNIP 1.104 CiteScore 0.71
- ISI indexed (2013): ISI indexed yes
- BFI (2012): BFI-level 1
- Scopus rating (2012): SJR 0.44 SNIP 1.113 CiteScore 0.68
- ISI indexed (2012): ISI indexed no
- BFI (2011): BFI-level 1
- Scopus rating (2011): SJR 0.639 SNIP 1.047 CiteScore 0.68
- ISI indexed (2011): ISI indexed no
- BFI (2010): BFI-level 1
- Scopus rating (2010): SJR 0.567 SNIP 0.808
- BFI (2009): BFI-level 1
- Scopus rating (2009): SJR 0.425 SNIP 0.703
- BFI (2008): BFI-level 1
- Scopus rating (2008): SJR 0.539 SNIP 0.855
- Scopus rating (2007): SJR 0.286 SNIP 0.572
- Web of Science (2007): Indexed yes
- Scopus rating (2006): SJR 0.389 SNIP 1.083
- Scopus rating (2005): SJR 0.586 SNIP 1.113
- Scopus rating (2004): SJR 0.25 SNIP 0.574
- Scopus rating (2003): SJR 0.696 SNIP 0.804
- Scopus rating (2002): SJR 0.363 SNIP 0.46
- Scopus rating (2001): SJR 0.346 SNIP 0.661
- Scopus rating (2000): SJR 0.372 SNIP 0.448
- Scopus rating (1999): SJR 0.384 SNIP 0.811

*Original language:* English

Autocorrelation, Cpk capability index, Continuous process, Process industry

**DOIs:**

10.1080/08982112.2012.710165

*Source:* dtu

*Source-ID:* n:oai:DTIC-ART:isi/371560666::24949
A Comparison of Decision Procedures for Cpk when Data are Autocorrelated

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: Lundkvist, P. (Ekstern), Vänmann, K. (Ekstern), Kulahci, M. (Intern)
Publication date: 2011

Host publication information
Title of host publication: European Network for Business and Industrial Statistics Conference
Main Research Area: Technical/natural sciences
Links:
http://www.enbis.org/
Source: orbit
Source-ID: 283254

Designing fractional factorial split-plot experiments using integer programming
Split-plot designs are commonly used in industrial experiments when there are hard-to-change and easy-to-change factors. Due to the number of factors and resource limitations, it is more practical to run a fractional factorial split-plot (FFSP) design. These designs are variations of the fractional factorial (FF) design, with the restricted randomisation structure to account for the whole plots and subplots. We discuss the formulation of FFSP designs using integer programming (IP) to achieve various design criteria. We specifically look at the maximum number of clear two-factor interactions and variations on this criterion.

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Wright-Patterson AFB, Air Force Institute of Technology, Arizona State University
Authors: Capehart, S. R. (Ekstern), Keha, A. (Ekstern), Kulahci, M. (Intern), Montgomery, D. C. (Ekstern)
Pages: 34-57
Publication date: 2011
Main Research Area: Technical/natural sciences

Publication Information
Volume: 2
Issue number: 1
ISSN (Print): 2040-2252
Ratings:
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Original language: English
design criterion, Clear Effects, Fractional Factorial, FF, Tailor-made designs, Hard-to-change factors
DOIs: 10.1504/IJEDPO.2011.038050
Links:
http://www.ingentaconnect.com/content/ind/ijedpo/2011/00000002/00000001/art00003
Source: orbit
Source-ID: 283237
Publication: Research - peer-review › Journal article – Annual report year: 2011

Designing simulation experiments with controllable and uncontrollable factors for applications in healthcare
We propose a new methodology for designing computer experiments that was inspired by the split-plot designs that are often used in physical experimentation. The methodology has been developed for a simulation model of a surgical unit in a Danish hospital. We classify the factors as controllable and uncontrollable on the basis of their characteristics in the physical system. The experiments are designed so that, for a given setting of the controllable factors, the various settings of the uncontrollable factors cover the design space uniformly. Moreover the methodology allows for overall uniform coverage in the combined design when all settings of the uncontrollable factors are considered at once.
Multivariate Process Control with Autocorrelated Data

As sensor and computer technology continues to improve, it becomes a normal occurrence that we confront with high dimensional data sets. As in many areas of industrial statistics, this brings forth various challenges in statistical process control and monitoring. This new high dimensional data often exhibit not only cross-correlation among the quality characteristics of interest but also serial dependence as a consequence of high sampling frequency and system dynamics. In practice, the most common method of monitoring multivariate data is through what is called the Hotelling’s $T^2$ statistic. For high dimensional data with excessive amount of cross correlation, practitioners are often recommended to use latent structures methods such as Principal Component Analysis to summarize the data in only a few linear combinations of the original variables that capture most of the variation in the data. In this paper, we discuss the effect of autocorrelation (when it is ignored) on multivariate control charts based on these methods and provide some practical suggestions and remedies to overcome this problem.
Split-Plot Designs with Mirror Image Pairs as Subplots
In this article we investigate two-level split-plot designs where the sub-plots consist of only two mirror image trials. Assuming third and higher order interactions negligible, we show that these designs divide the estimated effects into two orthogonal sub-spaces, separating sub-plot main effects and sub-plot by whole-plot interactions from the rest. Further we show how to construct split-plot designs of projectivity $P \geq 3$. We also introduce a new class of split-plot designs with mirror image pairs constructed from non-geometric Plackett–Burman designs. The design properties of such designs are very appealing with effects of major interest free from full aliasing assuming that 3rd and higher order interactions are negligible.

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling, Norwegian University of Science and Technology, University of Massachusetts
Authors: Tyssedal, J. (Ekstern), Kulahci, M. (Intern), Bisgaard, S. (Ekstern)
Pages: 3686-3696
Publication date: 2011
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Statistical Planning and Inference
Volume: 141
Issue number: 12
ISSN (Print): 0378-3758
Ratings:
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 1.257 SNIP 1.174 CiteScore 0.87
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.167 SNIP 1.055 CiteScore 0.74
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.105 SNIP 1.115 CiteScore 0.79
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.097 SNIP 1.095 CiteScore 0.82
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.953 SNIP 1.203 CiteScore 0.83
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.965 SNIP 1.161 CiteScore 0.79
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.058 SNIP 1.056
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.011 SNIP 1.047
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.996 SNIP 1.078
Scopus rating (2007): SJR 1.003 SNIP 1.118
Scopus rating (2006): SJR 0.939 SNIP 1.016
Scopus rating (2005): SJR 1.055 SNIP 1.079
Scopus rating (2004): SJR 0.877 SNIP 0.899
Scopus rating (2003): SJR 0.893 SNIP 0.905
Scopus rating (2002): SJR 0.741 SNIP 0.948
Scopus rating (2001): SJR 0.719 SNIP 0.813
Scopus rating (2000): SJR 0.716 SNIP 0.673
Scopus rating (1999): SJR 0.573 SNIP 0.613
Steepest-Ascent Constrained Simultaneous Perturbation for Multiobjective Optimization

The simultaneous optimization of multiple responses in a dynamic system is challenging. When a response has a known gradient, it is often easily improved along the path of steepest ascent. On the contrary, a stochastic approximation technique may be used when the gradient is unknown or costly to obtain. We consider the problem of optimizing multiple responses in which the gradient is known for only one response. We propose a hybrid approach for this problem, called simultaneous perturbation stochastic approximation steepest ascent, SPSA-SA or SP(SA)(2) for short. SP(SA)(2) is an SPSA technique that leverages information about the known gradient to constrain the perturbations used to approximate the others. We apply SP(SA)(2) to the cross-layer optimization of throughput, packet loss, and end-to-end delay in a mobile ad hoc network (MANET), a self-organizing wireless network. The results show that SP(SA)(2) achieves higher throughput and lower packet loss and end-to-end delay than the steepest ascent, SPSA, and the Nelder-Mead stochastic approximation approaches. It also reduces the cost in the number of iterations to perform the optimization.
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.526 SNIP 1.975
Scopus rating (2007): SJR 1.235 SNIP 2.659
Scopus rating (2006): SJR 1.548 SNIP 2.393
Scopus rating (2005): SJR 0.719 SNIP 2.196
Scopus rating (2004): SJR 0.481 SNIP 1.583
Scopus rating (2003): SJR 0.499 SNIP 1.17
Scopus rating (2002): SJR 0.536 SNIP 1.478
Scopus rating (2001): SJR 0.486 SNIP 0.602
Scopus rating (2000): SJR 0.314 SNIP 1.275
Scopus rating (1999): SJR 0.652 SNIP 0.569
Original language: English
DOIs:
10.1145/1870085.1870087
Source: orbit
Source-ID: 257475
Publication: Research - peer-review › Journal article – Annual report year: 2010

Time Series Analysis and Forecasting by Example

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: Bisgaard, S. (Ekstern), Kulahci, M. (Intern)
Number of pages: 392
Publication date: 2011

Publication information
Publisher: Wiley
ISBN (Print): 9780470540640
Original language: English

Series: Wiley Series in Probability and Statistics
ISSN: 1940-6347
Main Research Area: Technical/natural sciences
DOIs:
10.1002/9781118056943
Links:
Source: orbit
Source-ID: 283229
Publication: Research - peer-review › Book – Annual report year: 2011

Design of Computer Experiments
The main topic of this thesis is design and analysis of computer and simulation experiments and is dealt with in six papers and a summary report. Simulation and computer models have in recent years received increasingly more attention due to their increasing complexity and usability. Software packages make the development of rather complicated computer models using predefined building blocks possible. This implies that the range of phenomenas that are analyzed by means of a computer model has expanded significantly. As the complexity grows so does the need for efficient experimental designs and analysis methods, since the complex computer models often are expensive to use in terms of computer time. The choice of performance parameter is an important part of the analysis of computer and simulation models and Paper A introduces a new statistic for waiting times in health care units. The statistic is a measure of the extent of long waiting times, which are known both to be the most bothersome and to have the greatest impact on patient satisfaction. A simulation model for an orthopedic surgical unit at a hospital illustrates the benefits of using the measure. Another important consideration in connection to simulation models is the design of experiments, which is the decision of which of the possible configurations of the simulation model that should be tested. Since the possible configurations are numerous and the time to test a single configuration may take minutes or hours of computer time, the number of configurations that can be tested is limited. Papers B and C introduce a novel experimental plan for simulation models having two types of input factors. The plan differentiates between factors that can be controlled in both the simulation model and the physical system and factors that are only controllable in the simulation model but simply observed in the physical system. Factors that only are controllable in the simulation model are called uncontrollable factors and they correspond to the environmental factors in fluencing the physical system. Applying the experimental framework on the simulation model in
Paper A shows that the effects of changes in the uncontrollable factors are better understood with the proposed design compared to the alternative and commonly used methods. In papers D and E a modeling framework for analyzing simulation models with multiple noise sources is presented. It is shown that the sources of variation of the simulation model can be divided in two components corresponding to changes in the environmental factors (the uncontrollable factor settings) and to random variation. Moreover, the structure of the environmental effects can be estimated, which can be used to put the system in a more robust operating mode. The interpolation technique called Kriging is the topic of Paper F, which is a widely applied technique for building so called models-for-the-model (metamodels). We propose a method that handles both qualitative and quantitative factors, which is not covered by the standard model. Fitting the final Kriging model is done in two stages each based on fitting regular Kriging models. It is shown that this method works well on a realistic example such as a simulation model for a surgical unit.

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: Dehlendorff, C. (Intern), Andersen, K. K. (Intern), Kulahci, M. (Intern)
Publication date: Dec 2010

Publication information
Place of publication: Kgs. Lyngby, Denmark
Publisher: Technical University of Denmark (DTU)
Original language: English
Series: IMM-PHD-2010-237
Main Research Area: Technical/natural sciences
Electronic versions:
phd237_cd.pdf
Source: orbit
Source-ID: 266323
Publication: Research › Ph.D. thesis – Annual report year: 2010

Analysis of Computer Experiments with Multiple Noise Sources
In this paper we present a modeling framework for analyzing computer models with two types of variations. The paper is based on a case study of an orthopedic surgical unit, which has both controllable and uncontrollable factors. Our results show that this structure of variation can be modeled effectively with linear mixed effects models and generalized additive models. Copyright (C) 2009 John Wiley & Sons, Ltd.

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: Dehlendorff, C. (Intern), Kulahci, M. (Intern), Andersen, K. K. (Intern)
Pages: 137-146
Publication date: 2010
Conference: Annual Meeting of the European-Network-for-Business-and-Industrial-Statistics, Athens, GREECE, 01/01/2008
Main Research Area: Technical/natural sciences

Publication information
Journal: Quality and Reliability Engineering International
Volume: 26
Issue number: 2
ISSN (Print): 0748-8017
Ratings:
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.75 SJR 1.048 SNIP 1.446
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.34 SNIP 1.632 CiteScore 1.71
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.118 SNIP 1.613 CiteScore 1.5
Web of Science (2014): Indexed yes
Analysis of Signal-Response Systems Using GLMM

General information
State: Accepted/In press
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: Gupta, S. (Ekstern), Kulahci, M. (Intern), Montgomery, D. (Ekstern), Borror, C. (Ekstern)
Publication date: 2010
Main Research Area: Technical/natural sciences

Publication information
Journal: Quality and Reliability Engineering International
ISSN (Print): 0748-8017
Ratings:
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Conditional Value at Risk as a Measure for Waiting Time in Simulations of Hospital Units

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: Dehlendorff, C. (Intern), Kulahci, M. (Intern), Merser, S. (Ekstern), Andersen, K. K. (Intern)
Pages: 321-336
Publication date: 2010
Main Research Area: Technical/natural sciences

Publication information
Journal: Quality Technology and Quantitative Management
Volume: 7
Kriging in computer experiments

General information
State: Submitted
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: Dehlendorff, C. (Intern), Kulahci, M. (Intern), Andersen, K. K. (Intern)
Publication date: 2010
Main Research Area: Technical/natural sciences

Publication information
Journal: Technometrics
ISSN (Print): 0040-1706
Ratings:
BFI (2018): BFI-level 2
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): SJR 1.214 SNIP 1.573 CiteScore 1.41
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.013 SNIP 1.462 CiteScore 1.22
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.684 SNIP 2.027 CiteScore 1.49
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.763 SNIP 2.128 CiteScore 1.58
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.797 SNIP 2.187 CiteScore 1.83
Profile-driven regression for modeling and runtime optimization of mobile networks

Computer networks often display nonlinear behavior when examined over a wide range of operating conditions. There are few strategies available for modeling such behavior and optimizing such systems as they run. Profile-driven regression is developed and applied to modeling and runtime optimization of throughput in a mobile ad hoc network, a self-organizing collection of mobile wireless nodes without any fixed infrastructure. The intermediate models generated in profile-driven regression are used to fit an overall model of throughput, and are also used to optimize controllable factors at runtime. Unlike others, the throughput model accounts for node speed. The resulting optimization is very effective; locally optimizing the network factors at runtime results in throughput as much as six times higher than that achieved with the factors at their default levels.

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: McClary, D. (Ekstern), Syrotiuk, V. (Ekstern), Kulahci, M. (Intern)
Publication date: 2010
Main Research Area: Technical/natural sciences

Publication information
Journal: ACM Transactions on Modeling and Computer Simulation
Volume: 20
Issue number: 3
ISSN (Print): 1049-3301
Ratings:
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.443 SNIP 0.791 CiteScore 1.27
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.348 SNIP 0.812 CiteScore 1.41
Accelerated Design Space Search for Physical Simulations Using Computer Experiments

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Mathematical Statistics
Authors: Kulahci, M. (Intern)
Publication date: 2009

Publication information
Original language: English
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 257477
Publication: Research › Sound/Visual production (digital) – Annual report year: 2009

Checking the Adequacy of Fit of Models from Split-Plot Designs
One of the main features that distinguish split-plot experiments from other experiments is that they involve two types of experimental errors: the whole-plot (WP) error and the subplot (SP) error. Taking this into consideration is very important when computing measures of adequacy of fit for split-plot models. In this article, we propose the computation of two R-2, R-2-adjusted, prediction error sums of squares (PRESS), and R-2-prediction statistics to measure the adequacy of fit for the WP and the SP submodels in a split-plot design. This is complemented with the graphical analysis of the two types of
errors to check for any violation of the underlying assumptions and the adequacy of fit of split-plot models. Using examples, we show how computing two measures of model adequacy of fit for each split-plot design model is appropriate and useful as they reveal whether the correct WP and SP effects have been included in the model and describe the predictive performance of each group of effects.

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: Almini, A. A. (Ekstern), Kulahci, M. (Intern), Montgomery, D. C. (Ekstern)
Pages: 272-284
Publication date: 2009
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Quality Technology
Volume: 41
Issue number: 3
ISSN (Print): 0022-4065
Ratings:
BFI (2018): BFI-level 2
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 1.06 SJR 1.098 SNIP 1.242
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.869 SNIP 2.09 CiteScore 1.61
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.352 SNIP 1.546 CiteScore 1.33
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.665 SNIP 1.823 CiteScore 1.84
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.524 SNIP 2.047 CiteScore 1.44
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.433 SNIP 1.89 CiteScore 1.67
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.239 SNIP 1.804
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 2.255 SNIP 2.454
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 2.025 SNIP 2.622
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.056 SNIP 2.096
Scopus rating (2006): SJR 1.253 SNIP 1.969
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.461 SNIP 2.586
Scopus rating (2004): SJR 1.193 SNIP 2.258
Scopus rating (2003): SJR 1.853 SNIP 2.124
Scopus rating (2002): SJR 1.467 SNIP 2.008
Scopus rating (2001): SJR 0.995 SNIP 2.127
Scopus rating (2000): SJR 1.485 SNIP 2.393
Scopus rating (1999): SJR 0.916 SNIP 1.833

Original language: English
R-2-Adjusted, R-2, PRESS, Subplot Error, R-2-Prediction, Residual Analysis, Model Adequacy Checking, Whole-Plot Error
Design and Analysis of Simulation Experiments

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: Dehlendorff, C. (Intern), Kulahci, M. (Intern), Andersen, K. K. (Intern)
Publication date: 2009
Event: Abstract from 2009 INFORMS Western Regional Meeting, Tempe, Arizona, .
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 241925
Publication: Research › Conference abstract for conference – Annual report year: 2009

Designing Simulation Experiments with Controllable and Uncontrollable Factors
In this study we propose a new method for designing computer experiments inspired by the split plot designs used in physical experimentation. The basic layout is that each set of controllable factor settings corresponds to a whole plot for which a number of subplots, each corresponding to one combination of settings of the uncontrollable factors, is employed. The caveat is a desire that the subplots within each whole plot cover the design space uniformly. A further desire is that in the combined design, where all experimental runs are considered at once, the uniformity of the design space coverage should be guaranteed. Our proposed method allows for a large number of uncontrollable and controllable settings to be run in a limited number of runs while uniformly covering the design space for the uncontrollable factors.

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Mathematical Statistics
Authors: Dehlendorff, C. (Intern), Kulahci, M. (Intern), Andersen, K. K. (Intern)
Publication date: 2009

Generating Blocked Fractional Factorial Split-Plot Designs Using Integer Programming

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: Capehart, S. (Ekstern), Kulahci, M. (Intern), Montgomery, D. (Ekstern)
Publication date: 2009

Publication information
Original language: English
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 257478
Publication: Research › Sound/Visual production (digital) – Annual report year: 2009

Quality Quandaries- Time Series Model Selection and Parsimony
Some of the issues involved in selecting adequate models for time series data are discussed using an example concerning the number of users of an Internet server. The process of selecting an appropriate model is subjective and requires experience and judgment. The authors believe an important consideration in model selection should be parameter parsimony. They favor the use of parsimonious mixed ARMA models, noting that research has shown that a model building strategy that considers only autoregressive representations will lead to non-parsimonious models and to loss of forecasting accuracy.

General information
Bisgaard, S. (Ekstern), Kulahci, M. (Intern)
A framework for reactive optimization in mobile ad hoc networks

We present a framework to optimize the performance of a mobile ad hoc network over a wide range of operating conditions. It includes screening experiments to quantify the parameters and interactions among parameters influential to throughput. Profile-driven regression is applied to obtain a model of the non-linear behaviour of throughput. The intermediate models obtained in this modelling effort are used to adapt the parameters as the network conditions change, in order to maximize throughput. The improvements in throughput range from 10-26 times the use of the default parameter settings. The predictive accuracy of the model is monitored and used to update the model dynamically. The results indicate the framework may be useful for the optimization of dynamic systems of high dimension.

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: McClary, D. (Ekstern), Syrotiuk, V. (Ekstern), Kulahci, M. (Intern)
Publication date: 2008

Host publication information
Title of host publication: Proceedings of 1st IEEE International Conference on Information Technology
Publisher: IEEE
ISBN (Print): 978-1-4244-2244-9
Main Research Area: Technical/natural sciences
Conference: IEEE International Conference, 01/01/2008
DOI: 10.1109/INFTECH.2008.4621578
Source: orbit
Source-ID: 270916
Publication: Research - peer-review › Article in proceedings – Annual report year: 2008

A model-free approach to eliminate autocorrelation when testing for process capability

There is an increasing use of on-line data acquisition systems in industry. This usually leads to autocorrelated data and implies that the assumption of independent observations has to be re-examined. Most decision procedures for capability analysis assume independent data. In this article we present a new way of performing capability analysis when data are autocorrelated. This method is based on what can be called the 'iterative skipping' strategy. In that, by skipping a pre-determined number of observations, e.g. considering every fifth observation, the data set is divided into subsamples for which the independence assumption may be valid. For each such subsample of the data we estimate a capability index. Then traditional tests, assuming independence, can be performed based on each estimated capability index from the subsamples. By combining the information from each test statistic based on the subsamples in a suitable way, a new and efficient decision procedure is obtained. We discuss different ways of combining the information from these individual tests. A main appeal of our proposed method is that no time-series model is needed. Copyright (C) 2007 John Wiley & Sons, Ltd.

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: Vannann, K. (Ekstern), Kulahci, M. (Intern)
Pages: 213-228
Publication date: 2008
Main Research Area: Technical/natural sciences

Publication information
Journal: Quality and Reliability Engineering International
Volume: 24
Issue number: 2
ISSN (Print): 0748-8017
Ratings:
  BFI (2018): BFI-level 1
  BFI (2017): BFI-level 1
  Web of Science (2017): Indexed Yes
  BFI (2016): BFI-level 1
  Scopus rating (2016): CiteScore 1.75 SJR 1.048 SNIP 1.446
  BFI (2015): BFI-level 1
  Scopus rating (2015): SJR 1.34 SNIP 1.632 CiteScore 1.71
Box-Cox Transformations and Time Series Modeling – Part 1

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: Bisgaard, S. (Ekstern), Kulahci, M. (Intern)
Publication date: 2008
Main Research Area: Technical/natural sciences

Publication information
Journal: Quality Engineering
ISSN (Print): 0898-2112
Ratings:
BFI (2018): BFI-level 1
Box-Cox Transformations and Time Series Modeling – Part 2

**General information**
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: Bisgaard, S. (Ekster), Kulahci, M. (Intern)
Publication date: 2008
Main Research Area: Technical/natural sciences

**Publication information**
Journal: Quality Engineering
ISSN (Print): 0898-2112
Ratings:
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
Demand signal modelling: a short-range panel forecasting algorithm for semiconductor firm device-level demand

A model-based approach to the forecasting of short-range product demand within the semiconductor industry is presented. Device-level forecast models are developed via a novel two-stage stochastic algorithm that permits leading indicators to be optimally blended with smoothed estimates of unit-level demand. Leading indicators include backlog, bookings, delinquencies, inventory positions, and distributor resales. Group level forecasts are easily obtained through upwards aggregation of the device level forecasts. The forecasting algorithm is demonstrated at two major US-based semiconductor manufacturers. The first application involves a product family consisting of 254 individual devices with a 26-month training dataset and eight-month ex situ validation dataset. A subsequent demonstration refines the approach, and is demonstrated across a panel of six high volume devices with a 29-month training dataset and a 13-month ex situ validation dataset. In both implementations, significant improvement is realised versus legacy forecasting systems.

[Received 11 May 2007; Revised 5 September 2007; Accepted 15 October 2007]

General information
State: Published
Organisations: Arizona State University
Authors: Elias, R. J. (Ekstern), Elias, D. C. (Ekstern), Low, S. A. (Ekstern), Kulahci, M. (Intern)
Pages: 253-278
Designing Simulation Experiments with Controllable and Uncontrollable Factors

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Mathematical Statistics
Authors: Dehlendorff, C. (Intern), Kulahci, M. (Intern), Andersen, K. K. (Intern)
Publication date: 2008
Event: Abstract from 2008 Winter Simulation Conference, Miami, FL, United States.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 224161
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2008

Designing Simulation Experiments with Controllable and Uncontrollable Factors

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Mathematical Statistics
Authors: Dehlendorff, C. (Intern), Kulahci, M. (Intern), Andersen, K. K. (Intern)
Publication date: 2008
Event: Abstract from 2008 Winter Simulation Conference, Miami, FL, United States.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 270915
Publication: Research - peer-review › Article in proceedings – Annual report year: 2008
Estimation of Missing Observations in Two-Level Split-Plot Designs
Inserting estimates for the missing observations from split-plot designs restores their balanced or orthogonal structure and alleviates the difficulties in the statistical analysis. In this article, we extend a method due to Draper and Stoneman to estimate the missing observations from unreplicated two-level factorial and fractional factorial split-plot (FSP and FFSP) designs. The missing observations, which can either be from the same whole plot, from different whole plots, or comprise entire whole plots, are estimated by equating to zero a number of specific contrast columns equal to the number of the missing observations. These estimates are inserted into the design table and the estimates for the remaining effects (or alias chains of effects as the case with FFSP designs) are plotted on two half-normal plots: one for the whole-plot effects and the other for the subplot effects. If the smaller effects do not point at the origin, then different contrast columns to some or all of the initial ones should be discarded and the plots re-examined for bias. Using examples, we show how the method provides estimates for the missing observations that are very close to their actual values. Copyright © 2007 John Wiley & Sons, Ltd.

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: Almimi, A. A. (Ekstern), Kulahci, M. (Intern), Montgomery, D. C. (Ekstern)
Pages: 127-152
Publication date: 2008
Main Research Area: Technical/natural sciences

Publication information
Journal: Quality and Reliability Engineering International
Volume: 24
Issue number: 2
ISSN (Print): 0748-8017
Ratings:
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.75 SJR 1.048 SNIP 1.446
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.34 SNIP 1.632 CiteScore 1.71
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.118 SNIP 1.613 CiteScore 1.5
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.009 SNIP 1.703 CiteScore 1.41
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.739 SNIP 1.017 CiteScore 0.95
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.592 SNIP 1.013 CiteScore 0.94
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.523 SNIP 0.867
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.047 SNIP 1.286
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.81 SNIP 1.145
Web of Science (2008): Indexed yes
Follow-up Designs to Resolve Confounding in Split-Plot Experiments

Split-plot designs are effective in industry due to time and/or cost constraints, restriction on randomization of the treatment combinations of the hard-to-change factors, and different sizes of experimental units. Some of the results of fractional factorial split-plot experiments can be ambiguous and a need may arise to conduct follow-up experiments to separate effects of potential interest by breaking their alias links with others. For completely randomized fractional factorial experiments, methods have been developed to construct follow-up experiments. In this article, we extend the foldover technique to break the alias chains of split-plot experiments. Because it is impractical or not economically possible to foldover the whole-plot factors, as their levels are often hard or expensive to change, the focus of this article is on folding over only one or more subplot factors in order to de-alias certain effects. Six rules are provided to develop foldovers for minimum aberration resolution III and resolution IV fractional factorial split-plot designs.

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: Almimi, A. A. (Ekstern), Kulahci, M. (Intern), Montgomery, D. C. (Ekstern)
Pages: 154-166
Publication date: 2008
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of QualityTechnology
Volume: 40
Issue number: 2
ISSN (Print): 0022-4065
Ratings:
BFI (2018): BFI-level 2
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 1.06 SJR 1.098 SNIP 1.242
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.869 SNIP 2.09 CiteScore 1.61
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.352 SNIP 1.546 CiteScore 1.33
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.665 SNIP 1.823 CiteScore 1.84
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.524 SNIP 2.047 CiteScore 1.44
Simulation and Optimization of an Orthopaedic Surgical Unit

**General information**
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Mathematical Statistics, University of Copenhagen
Authors: Dehlendorff, C. (Intern), Merser, S. (Ekstern), Kulahci, M. (Intern), Andersen, K. K. (Intern)
Publication date: 2008
Event: Poster session presented at Danish Orthopedic Society : Spring Meeting, .
Main Research Area: Technical/natural sciences
Source: orbit
Publication: Research › Poster – Annual report year: 2008

Simulation Experimentation in Health Care Applications

**General information**
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: Dehlendorff, C. (Intern), Kulahci, M. (Intern), Andersen, K. K. (Intern)
Publication date: 2008
Event: Abstract from 8th European Network for Business and Industrial Statistics Conference, Athens, Greece.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 224160
Publication: Research › Conference abstract for conference – Annual report year: 2008

Statistical Modeling of On-Time Delivery of Semiconductors Encompassing Variability of Yield and Cycle Time

**General information**
State: Submitted
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: Maass, E. C. (Ekstern), Fowler, J. W. (Ekstern), Kulahci, M. (Intern)
Publication date: 2008
Main Research Area: Technical/natural sciences

**Publication information**
Journal: IEEE Transactions on Semiconductor Manufacturing
ISSN (Print): 0894-6507
Ratings:
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.49 SNIP 0.989 CiteScore 1.47
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.525 SNIP 0.997 CiteScore 1.4
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.439 SNIP 1.144 CiteScore 1.32
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.434 SNIP 1.259 CiteScore 1.48
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.506 SNIP 1.361 CiteScore 1.1
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.547 SNIP 1.193 CiteScore 1.21
Truncated D-optimal Designs for Screening Experiments

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: Hoskins, D. (Ekstern), Colburn, C. (Ekstern), Kulahci, M. (Intern)
Pages: 359-384
Publication date: 2008
Main Research Area: Technical/natural sciences

Publication information
Journal: American Journal of Mathematical and Management Sciences
Volume: 28
Issue number: 3/4
ISSN (Print): 0196-6324
Ratings:
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.462 SNIP 0.833 CiteScore 0.65
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.217 SNIP 1.103 CiteScore 0.47
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.229 SNIP 0.373 CiteScore 0.32
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.16 SNIP 0.361 CiteScore 0.24
ISI indexed (2013): ISI indexed no
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.15 SNIP 0.264 CiteScore 0.14
ISI indexed (2012): ISI indexed no
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.122 SNIP 0.157 CiteScore 0.13
ISI indexed (2011): ISI indexed no
BFI (2010): BFI-level 1
Accelerated Testing for On-Board Diagnostics

Modern products frequently feature monitors designed to detect actual or impending malfunctions. False alarms (Type I errors) or excessive delays in detecting real malfunctions (Type II errors) can seriously reduce monitor utility. Sound engineering practice includes physical evaluation of error rates. Type II error rates are relatively easy to evaluate empirically. However, adequate evaluation of a low Type I error rate is difficult without using accelerated testing concepts, inducing false alarms using artificially low thresholds and then selecting production thresholds by appropriate extrapolation, as outlined here. This acceleration methodology allows for informed determination of detection thresholds and confidence in monitor performance with substantial reductions over current alternatives in time and cost required for monitor development. Copyright © 2006 John Wiley & Sons, Ltd.
Blocking Factorial Experiments

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: Kulahci, M. (Intern)
Pages: 283-289
Publication date: 2007
Main Research Area: Technical/natural sciences

Publication information
Journal: Quality and Reliability Engineering International
Volume: 23
ISSN (Print): 0748-8017
Ratings:
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.75 SJR 1.048 SNIP 1.446
BFI (2015): BFI-level 1
Combining Latin Hypercube Designs and Discrete Event Simulation in a Study of a Surgical Unit

Summary form given only: In this article experiments on a discrete event simulation model for an orthopedic surgery are considered. The model is developed as part of a larger project in co-operation with Copenhagen University Hospital in Gentofte. Experiments on the model are performed by using Latin hypercube designs. The parameter set consists of system settings such as use of preparation room for sedation and the number of operating rooms, as well as management decisions such as staffing, size of the recovery room and the number of simultaneously active operating rooms. Sensitivity analysis and optimization combined with meta-modeling are employed in search for optimal setups. The primary objective in this article is to minimize time spent by the patients in the system. The overall long-term objective for the orthopedic surgery unit is to minimize time lost during the pre- and post operation activities for acute and elective surgery as well as dedicated elective surgery.

General information
State: Published
Meta-Regression: A Framework for Robust Reactive Optimization

Maintaining optimal performance as the conditions of a system change is a challenging problem. To solve this problem, we present meta-regression, a general methodology for alleviating traditional difficulties in nonlinear regression modelling. Meta-regression allows for reactive optimization, in which system components self-organize to changing conditions in a manner that is robust, or affected minimally by other sources of variability. Meta-regression extends profiling, providing a methodology for model-building when there is incomplete knowledge of the mechanisms and interactions of a nonlinear system.

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: McClary, D. (Ekstern), Syrotiuk, V. R. (Ekstern), Kulahci, M. (Intern)
Pages: 375-378
Publication date: 2007
Partial confounding and projective properties of Plackett-Burman designs

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: Kulahci, M. (Intern), Bisgaard, S. (Ekstern)
Pages: 791-800
Publication date: 2007
Main Research Area: Technical/natural sciences

Publication information
Journal: Quality and Reliability Engineering International
Volume: 23
Issue number: 7
ISSN (Print): 0748-8017
Ratings:
- BFI (2018): BFI-level 1
- BFI (2017): BFI-level 1
- Web of Science (2017): Indexed Yes
- BFI (2016): BFI-level 1
- Scopus rating (2016): CiteScore 1.75 SJR 1.048 SNIP 1.446
- BFI (2015): BFI-level 1
- Scopus rating (2015): SJR 1.34 SNIP 1.632 CiteScore 1.71
- Web of Science (2015): Indexed yes
- BFI (2014): BFI-level 1
- Scopus rating (2014): SJR 1.118 SNIP 1.613 CiteScore 1.5
- Web of Science (2014): Indexed yes
- BFI (2013): BFI-level 1
- Scopus rating (2013): SJR 1.009 SNIP 1.703 CiteScore 1.41
- ISI indexed (2013): ISI indexed yes
- Web of Science (2013): Indexed yes
- BFI (2012): BFI-level 1
- Scopus rating (2012): SJR 0.739 SNIP 1.017 CiteScore 0.95
- ISI indexed (2012): ISI indexed yes
- BFI (2011): BFI-level 1
- Scopus rating (2011): SJR 0.592 SNIP 1.013 CiteScore 0.94
- ISI indexed (2011): ISI indexed yes
- BFI (2010): BFI-level 1
- Scopus rating (2010): SJR 0.523 SNIP 0.867
- Web of Science (2010): Indexed yes
- BFI (2009): BFI-level 1
- Scopus rating (2009): SJR 1.047 SNIP 1.286
- Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.81 SNIP 1.145
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.6 SNIP 1.058
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.694 SNIP 1.05
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 0.41 SNIP 0.714
Scopus rating (2004): SJR 0.423 SNIP 1.103
Scopus rating (2003): SJR 0.826 SNIP 0.953
Scopus rating (2002): SJR 0.634 SNIP 0.842
Scopus rating (2001): SJR 0.291 SNIP 0.636
Scopus rating (2000): SJR 0.414 SNIP 0.867
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 0.308 SNIP 0.757
Original language: English
DOIs: 10.1002/qre.839
Source: orbit
Source-ID: 208578
Publication: Research - peer-review › Journal article – Annual report year: 2007

Quality Quandaries: Practical Time Series Modeling I

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: Bisgaard, S. (Ekstern), Kulahci, M. (Intern)
Pages: 253-262
Publication date: 2007
Main Research Area: Technical/natural sciences

Publication information
Journal: Quality Engineering
Volume: 19
Issue number: 3
ISSN (Print): 0898-2112
Ratings:
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.31 SJR 0.986 SNIP 1.116
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.594 SNIP 1.163 CiteScore 0.83
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.421 SNIP 0.871 CiteScore 0.61
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.509 SNIP 1.104 CiteScore 0.71
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.44 SNIP 1.113 CiteScore 0.68
ISI indexed (2012): ISI indexed no
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.639 SNIP 1.047 CiteScore 0.68
ISI indexed (2011): ISI indexed no
Quality Quandaries: Practical Time Series Modeling II

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: Bisgaard, S. (Ekstern), Kulahci, M. (Intern)
Pages: 393-400
Publication date: 2007
Main Research Area: Technical/natural sciences

Publication information
Journal: Quality Engineering
Volume: 19
Issue number: 4
ISSN (Print): 0898-2112
Ratings:
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.31 SJR 0.986 SNIP 1.116
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.594 SNIP 1.163 CiteScore 0.83
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.421 SNIP 0.871 CiteScore 0.61
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.509 SNIP 1.104 CiteScore 0.71
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.44 SNIP 1.113 CiteScore 0.68
ISI indexed (2012): ISI indexed no
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.639 SNIP 1.047 CiteScore 0.68
ISI indexed (2011): ISI indexed no
Quality Quandaries: Beware of the Effect of Autocorrelation in Regression

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: Bisgaard, S. (Ekstern), Kulahci, M. (Intern)
Pages: 143-148
Publication date: 2007
Main Research Area: Technical/natural sciences

Publication information
Journal: Quality Engineering
Volume: 19
Issue number: 2
Original language: English
Source: orbit
Source-ID: 227985
Publication: Research - peer-review › Journal article – Annual report year: 2007

Quality Quandaries: Process Regime Changes

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: Bisgaard, S. (Ekstern), Kulahci, M. (Intern)
Pages: 83-87
Publication date: 2007
Main Research Area: Technical/natural sciences

Publication information
Journal: Quality Engineering
Volume: 19
Issue number: 1
Original language: English
Source: orbit
Source-ID: 208581
Publication: Research - peer-review › Journal article – Annual report year: 2007
Split-plot Experiments with Unusual Numbers of Subplot Runs

In many experimental situations, it may not be feasible or even possible to run experiments in a completely randomized fashion as usually recommended. Under these circumstances, split-plot experiments in which certain factors are changed less frequently than the others are often used. Most of the literature on split-plot designs is based on 2-level factorials. For those designs, the number of subplots is a power of 2. There may however be some situations where for cost purposes or physical constraints, we may need to have unusual number of subplots such as 3, 5, 6, etc. In this article, we explore this issue and provide some examples based on the Plackett and Burman designs. Also algorithmically constructed D-optimal split-plot designs are compared to those based on Plackett and Burman designs.

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: Kulahci, M. (Intern)
Pages: 363-372
Publication date: 2007
Main Research Area: Technical/natural sciences

Publication information
Journal: Quality Engineering
Volume: 19
Issue number: 4
ISSN (Print): 0898-2112
Ratings:
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.31 SJR 0.986 SNIP 1.116
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.594 SNIP 1.163 CiteScore 0.83
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.421 SNIP 0.871 CiteScore 0.61
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.509 SNIP 1.104 CiteScore 0.71
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.44 SNIP 1.113 CiteScore 0.68
ISI indexed (2012): ISI indexed no
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.639 SNIP 1.047 CiteScore 0.68
ISI indexed (2011): ISI indexed no
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.567 SNIP 0.808
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.425 SNIP 0.703
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.539 SNIP 0.855
Scopus rating (2007): SJR 0.286 SNIP 0.572
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.389 SNIP 1.083
Scopus rating (2005): SJR 0.586 SNIP 1.113
Scopus rating (2004): SJR 0.25 SNIP 0.574
Scopus rating (2003): SJR 0.696 SNIP 0.804
Scopus rating (2002): SJR 0.363 SNIP 0.46
Scopus rating (2001): SJR 0.346 SNIP 0.661
Scopus rating (2000): SJR 0.372 SNIP 0.448
Scopus rating (1999): SJR 0.384 SNIP 0.811
A Generalization of the Alias Matrix

The investigation of aliases or biases is important for the interpretation of the results from factorial experiments. For two-level fractional factorials this can be facilitated through their group structure. For more general arrays the alias matrix can be used. This tool is traditionally based on the assumption that the error structure is that associated with ordinary least squares. For situations where that is not the case, we provide in this article a generalization of the alias matrix applicable under the generalized least squares assumptions. We also show that for the special case of split plot error structure, the generalized alias matrix simplifies to the ordinary alias matrix.

General information
State: Published
Organisations: Department of Applied Mathematics and Computer Science, Statistics and Data Analysis
Authors: Kulahci, M. (Intern), Bisgaard, S. (Ekstern)
Pages: 387-395
Publication date: 2006
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Applied Statistics
Volume: 33
Issue number: 4
ISSN (Print): 0266-4763
Ratings:
- BFI (2018): BFI-level 1
- BFI (2017): BFI-level 1
- Web of Science (2017): Indexed Yes
- BFI (2016): BFI-level 1
- Scopus rating (2016): CiteScore 0.64 SJR 0.402 SNIP 0.764
- Web of Science (2016): Indexed yes
- BFI (2015): BFI-level 1
- Scopus rating (2015): SJR 0.475 SNIP 0.791 CiteScore 0.61
- BFI (2014): BFI-level 1
- Scopus rating (2014): SJR 0.501 SNIP 0.773 CiteScore 0.61
- BFI (2013): BFI-level 1
- Scopus rating (2013): SJR 0.542 SNIP 0.91 CiteScore 0.68
- ISI indexed (2013): ISI indexed yes
- BFI (2012): BFI-level 1
- Scopus rating (2012): SJR 0.457 SNIP 0.822 CiteScore 0.58
- ISI indexed (2012): ISI indexed yes
- BFI (2011): BFI-level 1
- Scopus rating (2011): SJR 0.364 SNIP 0.814 CiteScore 0.59
- ISI indexed (2011): ISI indexed yes
- BFI (2010): BFI-level 1
- Scopus rating (2010): SJR 0.306 SNIP 0.481
- BFI (2009): BFI-level 1
- Scopus rating (2009): SJR 0.326 SNIP 0.514
- BFI (2008): BFI-level 1
- Scopus rating (2008): SJR 0.304 SNIP 0.476
- Scopus rating (2007): SJR 0.243 SNIP 0.495
- Scopus rating (2006): SJR 0.384 SNIP 0.674
- Web of Science (2006): Indexed yes
- Scopus rating (2005): SJR 0.748 SNIP 0.698
An Overview of Short-term Statistical Forecasting Methods
An overview of statistical forecasting methodology is given, focusing on techniques appropriate
to short- and medium-term forecasts. Topics include basic definitions and terminology, smoothing methods,
ARIMA models, regression methods, dynamic regression models, and transfer functions. Techniques for
evaluating and monitoring forecast performance are also summarized.

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: Elias, R. J. (Ekstern), Montgomery, D. C. (Ekstern), Kulahci, M. (Intern)
Pages: 17-36
Publication date: 2006
Main Research Area: Technical/natural sciences

Publication information
Volume: 1
Issue number: 1
ISSN (Print): 1750-9653
Ratings:
Scopus rating (2016): CiteScore 0 SJR 0.112
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Scopus rating (2009): SJR 0.239 SNIP 0.112
Scopus rating (2008): SJR 0.112 SNIP 0.025
Scopus rating (2007): SJR 0.11 SNIP 0.397
Original language: English
Source: orbit
Source-ID: 224149
Publication: Research - peer-review › Journal article – Annual report year: 2006

Challenges in Multivariate Control Charts with Autocorrelated Data

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: Kulahci, M. (Intern), Bisgaard, S. (Ekstern)
Publication date: 2006

Host publication information
Title of host publication: Proceedings to the 12th ISSAT International Conference on Reliability and Quality in Design, Chicago-IL
Main Research Area: Technical/natural sciences
Conference: Proceedings to the 12th ISSAT International Conference on Reliability and Quality in Design, Chicago-IL, 01/01/2006
Links:
Split-plot fractional designs: Is minimum aberration enough?

Split-plot experiments are commonly used in industry for product and process improvement. Recent articles on designing split-plot experiments concentrate on minimum aberration as the design criterion. Minimum aberration has been criticized as a design criterion for completely randomized fractional factorial design and alternative criteria, such as the maximum number of clear two-factor interactions, are suggested (Wu and Hamada (2000)). The need for alternatives to minimum aberration is even more acute for split-plot designs. In a standard split-plot design, there are several types of two-factor interactions, not all of them equally interesting. However, minimum aberration is not designed to distinguish among the different types of two-factor interactions. It should be noted that this criticism is valid not only for the minimum aberration but also for any other design criteria originally proposed for completely randomized designs. Consequently, we provide a modified version of the maximum number of clear two-factor interactions design criterion to be used for split-plot designs.
The Partial Confounding and the Projection Properties of Plackett and Burman Designs

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: Kulahci, M. (Intern), Bisgaard, S. (Ekstern)
Pages: 1-10
Publication date: 2006
Main Research Area: Technical/natural sciences

Publication information
Analysis of Split-Plot Designs with Economical Run Sizes
Checking Process Stability with the Variogram

Follow-up Designs to Resolve Confounding in Split-Plot Experiments

How to Handle Autocorrelation in Capability Analysis
The Use of Plackett and Burman Designs to Construct Split-Plot Designs

When some factors are hard to change and others are relatively easier, split-plot experiments are often an economic alternative to fully randomized designs. Split-plot experiments, with their structure of subplot arrays imbedded within whole-plot arrays, have a tendency to become large, particularly in screening situations when many factors are considered. To alleviate this problem, we explore, for the case of two-level designs, various ways to use orthogonal arrays of the Plackett-Burman type to reduce the number of individual tests. General construction principles are outlined, and the resulting alias structure is derived and discussed.

General information
State: Published
Organisations: University of Massachusetts, Arizona State University
Authors: Kulahci, M. (Intern), Bisgaard, S. (Ekstern)
Pages: 495-502
Publication date: 2005
Main Research Area: Technical/natural sciences

Publication information
Journal: Technometrics
Volume: 47
Issue number: 4
ISSN (Print): 0040-1706
Ratings:
Towards Understanding Factor Dynamics

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: Vadde, K. K. (Ekstern), Syrotiuk, V. R. (Ekstern), Kulahci, M. (Intern)
Publication date: 2005

Host publication information
Title of host publication: 2nd IEEE International Workshop on Adaptive Wireless Networks (AWiN), St. Louis, Missouri
Main Research Area: Technical/natural sciences
Conference: 2nd IEEE International Workshop on Adaptive Wireless Networks (AWiN), St. Louis, Missouri, 01/01/2005
Analysis of Split-Plot Designs with Mirror Image Pairs as Subplots

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: Tyssedal, J. (Ekstern), Kulahci, M. (Intern)
Publication date: 2004

Host publication information
Title of host publication: European Network for Business and Industrial Statistics Conference, Copenhagen-Denmark
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 200517
Publication: Research › Article in proceedings – Annual report year: 2004

Modeling Strategy for Multidimensional Non-linear Problems

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: Kulahci, M. (Intern), Graves, S. (Ekstern), Bisgaard, S. (Ekstern)
Publication date: 2004

Host publication information
Title of host publication: INFORMS Conference, Denver
Main Research Area: Technical/natural sciences
Conference: INFORMS Conference, Denver, Denver, 01/01/2004
Source: orbit
Source-ID: 200479
Publication: Research › Article in proceedings – Annual report year: 2004

Sensitivity of Tennis Players to Racquet Characteristics

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: Wiezel, A. (Ekstern), Kulahci, M. (Intern)
Publication date: 2004

Host publication information
Title of host publication: 5th Engineering of Sport Conference, UC-Davis, California-USA
Main Research Area: Technical/natural sciences
Conference: 5th Engineering of Sport Conference, UC-Davis, California-USA, 01/01/2004
Source: orbit
Source-ID: 200430
Publication: Research - peer-review › Article in proceedings – Annual report year: 2004

Catalysis of Discovery and Development in Engineering and Industry

General information
State: Published
Organisations: University of Wisconsin-Madison, Arizona State University
Authors: Kulahci, M. (Intern), Box, G. E. P. (Ekstern)
Pages: 509-513
Publication date: 2003
Main Research Area: Technical/natural sciences

General information
State: Published
Organisations: Unknown
Authors: Box, G. E. P. (Ekstern), Bisgaard, S. (Ekstern), Graves, S. (Ekstern), Kulahci, M. (Intern)
Pages: 183-191
Publication date: 2003
Main Research Area: Technical/natural sciences

Fractionation of Two-level Designs for Multi-Step Processes (Preserving the Split-Plot Structure)

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: Kulahci, M. (Intern), Ramirez, J. (Ekstern), Cotter, M. (Ekstern), Tobias, R. (Ekstern)
Publication date: 2003

Host publication information
Title of host publication: European Network for Business and Industrial Statistics Conference, Barcelona-Spain
Main Research Area: Technical/natural sciences
Conference: European Network for Business and Industrial Statistics Conference, Barcelona-Spain, 01/01/2003
Source: orbit
Source-ID: 200480
Publication: Research › Article in proceedings – Annual report year: 2003


General information
State: Published
Organisations: Unknown
Authors: Box, G. E. P. (Ekstern), Bisgaard, S. (Ekstern), Graves, S. (Ekstern), Kulahci, M. (Intern)
Publication date: 2003
Main Research Area: Technical/natural sciences

Publication information
Journal: Quality Engineering
Original language: English
Source: orbit
Source-ID: 228565
Publication: Research - peer-review › Journal article – Annual report year: 2003

Improving and Controlling Business Processes

General information
The Application of Plackett and Burman Designs to Split Plot Experiments

Understanding Plackett and Burman Designs

Robust Product Design: Saving Trials with Split Plot Confounding
Switching-One-Column Follow-up Experiments for Plackett-Burman Designs

General information
State: Published
Organisations: University of Amsterdam, University of Wisconsin-Madison
Authors: Bisgaard, S. (Ekstern), Kulahci, M. (Intern)
Pages: 943-949
Publication date: 2001
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Applied Statistics
Volume: 28
Issue number: 8
Original language: English
Source: orbit
Source-ID: 228570
Publication: Research - peer-review › Journal article – Annual report year: 2001

A New Approximation for the Average Run Length of a Cusum

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: Graves, S. (Ekstern), Kulahci, M. (Intern), Bisgaard, S. (Ekstern), James, J. (Ekstern), Marko, K. (Ekstern), Ting, T. (Ekstern), Gilder, J. V. (Ekstern), Wu, C. (Ekstern), Zatorski, H. (Ekstern)
Publication date: 2000

Host publication information
Title of host publication: Joint Statistical Meeting, Indianapolis
Main Research Area: Technical/natural sciences
Conference: Joint Statistical Meeting, Indianapolis, 01/01/2000
Source: orbit
Source-ID: 200450
Publication: Research › Article in proceedings – Annual report year: 2000

Finding Assignable Causes

General information
State: Published
Organisations: University of St. Gallen
Authors: Bisgaard, S. (Ekstern), Kulahci, M. (Intern)
Pages: 633-640
Publication date: 2000
Main Research Area: Technical/natural sciences

Publication information
Journal: Quality Engineering
Volume: 12
Issue number: 4
Original language: English
Source: orbit
Source-ID: 228572
Publication: Research - peer-review › Journal article – Annual report year: 2000

Projects:

Data analysis methods for process understanding and improvement in injection moulding production
Department of Applied Mathematics and Computer Science
**Advancing linear and non-linear mixed models in engineering science**

Department of Applied Mathematics and Computer Science  
Period: 01/09/2015 → 31/08/2018  
Number of participants: 4  
PhD Student:  
Jensen, Sofie Pødenphant (Intern)  
Supervisor:  
Kristensen, Kasper (Intern)  
Kulahci, Murat (Intern)  
Main Supervisor:  
Brockhoff, Per B. (Intern)  

**Financing sources**  
Source: Internal funding (public)  
Name of research programme: Institut stipendie (DTU)  
Project: PhD

**Robust biomarkers for detection of cancer**

Department of Applied Mathematics and Computer Science  
Period: 04/08/2015 → 15/08/2015  
Number of participants: 4  
PhD Student:  
Freltoft, Alexandra Rohde O’Sullivan (Intern)  
Supervisor:  
Dehlendorff, Christian (Intern)  
Stenvang, Jan (Ekstern)  
Main Supervisor:  
Kulahci, Murat (Intern)  

**Financing sources**  
Source: Internal funding (public)  
Name of research programme: Institut stipendie (DTU)  
Project: PhD

**Methods and tools for the statistical data analysis for large datasets collected from bio-based manufacturing processes**

Department of Applied Mathematics and Computer Science  
Period: 01/06/2015 → 31/05/2018  
Number of participants: 4  
PhD Student:  
Spooner, Max Peter (Intern)  
Supervisor:  
Clemmensen, Line Katrine Harder (Intern)  
Ersbøll, Bjarne Kjær (Intern)  

**Financing sources**  
Source: Internal funding (public)  
Name of research programme: Institut stipendie (DTU)  
Project: PhD
Main Supervisor:
Kulahci, Murat (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Forskningsrådsfinansiering
Project: PhD

Intelligent Quality Assessment of Railway Switches and Crossings
This project aims at significantly improving the safety, reliability and operational lifetime of the 3500 switches and crossings (S&Cs) in the Danish railway network. The project is a close cooperation between the Technical University of Denmark (DTU), the Danish rail infrastructure provider Rail Net Denmark and four affiliated European partners with significant expertise within this field. An inter-disciplinary scientific effort is employed to obtain enhanced rail transport reliability and regularity simultaneously with significant savings in S&Cs maintenance costs. The project results will make maintenance based on intelligent fault prediction tools, instead of the presently used regular planned inspections, and it will provide sophisticated tools to prevent hidden faults from developing to failure in the future. In a novel approach, the project will install state-of-the-art sensor technology in selected S&Cs and correlate dynamic parameters during train passage with static geometry data from conventional measurement vehicles. Monitoring of the dynamic responses will provide diagnosis of patterns that indicate when components or ballast begin to deviate from fully functional conditions. Modelling of dynamics will identify root causes to signs of degradation. Damage assessment of components identified by anomalous readings will be done by metallurgical examinations. Data and results will be processed by a holistic model that can produce Maintenance Performance Indicators (MPI) for the S&C condition. The correlation of sensor data to measuring vehicle data will allow existing data to be used reliably as input for the MPI model. It is expected that this project will enable optimisation of maintenance procedures, by which appropriate maintenance can be predicted in advance, thus avoiding unscheduled repairs and delays in the railway traffic.

Department of Wind Energy
Materials science and characterization
Department of Electrical Engineering
Automation and Control
Department of Mechanical Engineering
Solid Mechanics
Department of Applied Mathematics and Computer Science
Statistics and Data Analysis
Banedanmark
Period: 01/03/2015 → 28/02/2019
Number of participants: 14
Acronym: INTELLISWITCH
Number of related Ph.D. students: 1
Project participant:
Galeazzi, Roberto (Intern)
Blanke, Mogens (Intern)
Hansen, Søren (Intern)
Barkhordari, Pegah (Intern)
Asadzadeh, Seyed Mohammad (Intern)
Santos, Ilmar (Intern)
Tejada, Alejandro de Miguel (Intern)
Danielsen, Hilmar Kjartansson (Intern)
Dhar, Somrita (Intern)
Ersbøll, Bjarne Kjær (Intern)
Kulahci, Murat (Intern)
Thyregod, Camilla (Intern)
Hovad, Emil (Intern)
Project Manager, academic:
Juul Jensen, Dorte (Intern)

Financing sources
Characterization of absorption enhancers for orally administered therapeutic peptides in tablet formulations - applying statistical learning

Department of Applied Mathematics and Computer Science
Period: 01/05/2013 → 30/09/2016
Number of participants: 9
Phd Student: Welling, Søren Havelund (Intern)
Supervisor: Buckley, Stephen T. (Ekstern)
Clemmensen, Line Katrine Harder (Intern)
Hovgaard, Lars (Ekstern)
Refsgaard, Hanne (Intern)
Main Supervisor: Brockhoff, Per B. (Intern)
Examiner: Kulahci, Murat (Intern)
Arvastson, Lars Johan (Intern)
Genuer, Robin (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: ErhvervsPhD-ordningen VTU

Relations
Publications:
Characterization of absorption enhancers for orally administered therapeutic peptides in tablet formulations - Applying statistical learning
Project: PhD

Engineering Strategies for improving the convenience food production- industry Case

National Food Institute
Period: 15/11/2012 → 21/04/2016
Number of participants: 7
Phd Student: Pedersen, Søren Juhl (Intern)
Supervisor: Kulahci, Murat (Intern)
Vining, G. Geoffrey (Ekstern)
Main Supervisor: Frosch, Stina (Intern)
Examiner: Jørgensen, Bo Munk (Intern)
Christensen, Lars Bager (Intern)
Vanhatalo, Erik (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU) Samf.
Project: PhD
Monitoring Animal Wellbeing

Department of Applied Mathematics and Computer Science
Period: 15/12/2011 → 31/03/2016
Number of participants: 7
Phd Student:
Gronskyte, Ruta (Intern)
Supervisor:
Clemmensen, Line Katrine Harder (Intern)
Hvid, Marchen Sonja (Ekstern)
Main Supervisor:
Kulahci, Murat (Intern)
Examiner:
Ersbøll, Bjarne Kjær (Intern)
Bergquist, Bjarne (Ekstern)
Christensen, Lars Bager (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Institut, samfinansiering

Relations
Publications:
Monitoring Animal Well-being
Project: PhD

Modeling and Forecasting for Optimal Participation of Renewable Energy in Deregulated Energy Markets

Department of Informatics and Mathematical Modeling
Period: 01/11/2008 → 24/08/2012
Number of participants: 7
Phd Student:
Jónsson, Tryggvi (Intern)
Supervisor:
Nielsen, Torben Skov (Intern)
Poulsen, Niels Kjølstad (Intern)
Main Supervisor:
Pinson, Pierre (Intern)
Examiner:
Kulahci, Murat (Intern)
McSharry, Patrick E. (Ekstern)
Meibom, Peter (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: ErhvervsPhD-ordningen VTU
Project: PhD

Statistical design and analysis of animal experiments

Department of Applied Mathematics and Computer Science
Period: 15/09/2008 → 25/09/2014
Number of participants: 5
Phd Student:
Hansen, Merete Kjær (Intern)
Main Supervisor:
Kulahci, Murat (Intern)
Examiner:
Brockhoff, Per B. (Intern)
Dehlendorff, Christian (Intern)
Vining, G. Geoffrey (Ekstern)
Analytical and Modelling of Chain Data

Department of Informatics and Mathematical Modeling
Period: 01/10/2007 → 05/09/2014
Number of participants: 5
PhD Student:
Kotwa, Ewelina Katarzyna (Intern)
Main Supervisor:
Brockhoff, Per B. (Intern)
Examiner:
Kulahci, Murat (Intern)
Rinnan, Åsmund (Ekstern)
Westad, Frank Ove (Ekstern)

Design of computer experiments

Department of Informatics and Mathematical Modeling
Period: 01/03/2007 → 08/12/2010
Number of participants: 6
PhD Student:
Dehlendorff, Christian (Intern)
Supervisor:
Kulahci, Murat (Intern)
Main Supervisor:
Andersen, Klaus Kaae (Intern)
Examiner:
Nielsen, Bo Friis (Intern)
Lophaven, Søren Nymand (Intern)
Tyssedal, John (Ekstern)

Process capability from an industrial perspective

Department of Informatics and Mathematical Modeling
Period: 01/10/2005 → 30/09/2010
Number of participants: 6
PhD Student:
Windfeldt, Gitte Bjørg (Intern)
Supervisor:
Hortvig, Niels Væver (Ekstern)
Main Supervisor:
Rootzén, Helle (Intern)
Examiner:
Kulahci, Murat (Intern)
Castagliola, Philippe (Ekstern)
Thyregod, Peter (Intern)
Financing sources
Source: Internal funding (public)
Name of research programme: ErhvervsPhD-ordningen VTU
Project: PhD

Activities:

Introduction to Applied Statistics with R for PhD Students
Period: 9 Jun 2017 → 30 Jun 2017
Anders Stockmarr (Lecturer)
Bjarne Kjær Ersbøll (Lecturer)
Elisabeth Wreford Andersen (Guest lecturer)
Murat Kulahci (Lecturer)
Andreas Baum (Lecturer)
Camilla Thyregod (Other)
Jesper Fink Andersen (Other)
Department of Applied Mathematics and Computer Science
Statistics and Data Analysis

Related organisation

Introduction to Applied Statistics with R for PhD Students
Stockmarr, A. (Lecturer), Ersbøll, B. K. (Lecturer), Andersen, E. W. (Guest lecturer), Kulahci, M. (Lecturer), Baum, A. (Lecturer), Thyregod, C. (Other), Andersen, J. F. (Other)
9 Jun 2017 → 30 Jun 2017
Activity: Talks and presentations › Guest lectures, external teaching and course activities at other universities