报 告 摘 要

Balanced Incomplete Latin Square Designs

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Abstract: Latin squares have been widely used to design an experiment where the blocking factors and treatment factors are of the same levels. For some experiments, the size of blocks may be less than the number of treatments. Since not all of the treatments can be compared within each block, a new class of designs called balanced incomplete Latin squares (BILS) is proposed to deal with such experiments. A general method for constructing BILS is proposed by an intelligent selection of certain cells from a complete Latin square via orthogonal Latin squares. The optimality of the proposed BILS designs is investigated. It is shown that the proposed transversal BILS designs are asymptotically optimal for all the row, column and treatment effects. The relative efficiencies of a delete-one-transversal BILS design with respect to the optimal designs for both cases are also derived; it is shown to be close to 100%, as the order becomes large.

Nested Latin hypercube designs with sliced structures

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Abstract: In computer experiments, designs with a sliced structure are useful for experiments with both qualitative and quantitative factors, and nested designs are preferred when the experiments have multiple levels of accuracy. Space-filling designs with a sliced structure or nested structure have been studied independently. However, it is likely that designs with these two structures are needed simultaneously in some situations, for example, when both the low-accuracy experiment (LE) and high-accuracy experiment (HE) both have quantitative and qualitative factors in a multiple computer experiment. But there are no designs so far to accommodate for such situations. In this paper, based on the permutation method proposed by Qian (2009), we construct a special class of nested Latin hypercube designs (NLHDs) with sliced structures, that is, small sliced Latin hypercube designs (SLHDs) are nested within large SLHDs. In another view, the designs can also be considered as SLHDs with with a nested structure. The construction method is easy to implement and the number of factors is flexible. Numerical simulations show the usefulness of the newly proposed designs.

Minimum squared alias criterion and its application

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Abstract: Nonregular fractional factorial designs such as Plackett-Burman designs and other orthogonal arrays are widely used in various screening experiments for their run size economy and flexibility. In this paper, we present a new method for distinguishing nonregular designs with complex alias structure, which works for all symmetrical and asymmetrical, regular and nonregular orthogonal arrays. Connection between the proposed method and strength of a design are studied. Ranking and classification for nonregular PB designs of 12, 16 runs and asymmetrical designs $OA(18, 2^1 3^7)$ are studied comparing with other criterions. Simulation were studied to demonstrate the suggested criterion.

Nested orthogonal array-based Latin hypercube designs

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Abstract: We propose two methods for constructing a new type of design, called a nested orthogonal array-based Latin hypercube design, intended for multi-fidelity computer experiments. Such designs are two nested space-filling designs in which the large design achieves stratification in both bivariate and univariate margins and the small design achieves stratification in univariate margins. These designs have better space-filling properties than nested Latin hypercube designs in which the large design possesses uniformity in univariate margins only. The first method expands an ordinary Latin hypercube design to a larger design that achieves uniformity in any one- or two-dimensional projection. The second method uses an orthogonal array with strength two to simultaneously construct a pair of nested orthogonal array-based Latin hypercube designs. Examples are given to illustrate the proposed methods. Sampling properties of the proposed designs are derived.

Construction of sliced (nearly) orthogonal Latin hypercube designs

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Abstract: Sliced Latin hypercube designs are very useful for computer experiments with qualitative and quantitative factors, multiple experiments, data pooling and cross-validation. However, the presence of highly correlated columns makes it difficult to identify the most important input factors. In this paper, we develop a constructive method for sliced (nearly) orthogonal Latin hypercube designs through cascading Latin hypercube designs. The resulting design preserves zero or low correlations among columns and can be divided into slices of smaller (nearly) orthogonal Latin hypercube designs. Examples are given for illustrating the proposed method.

The hybrid information criterion and its applications in model selection

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Abstract: There are two type of model selection methods. One method is the best subset procedure. The other one selects variables via various shrinkage methods. We propose a hybrid information criterion, with the well known minimax concave penalty as a special case. The hybrid

information criterion combines the concave penalty criterion and best subset procedure. It essentially screens variables by the minimax concave penalty and selects the correct variables by the best subset procedure simultaneously. This new criterion connects the above two type of criteria. On the one hand, we can select variables via shrinkage method. On the other hand, we can select the correct tuning parameter by the best subset procedure. In addition, if we set the hybrid information criterion as a reference for model selection, we can show that $\gamma_M = 2.7$ for the minimax concave penalty is a robust choice. Thus, the essential connection between the minimax concave penalty and some best subset procedures is revealed.

OPTIMAL DESIGN FOR LINEAR MODEL BASED ON CONFIDENCE RECTANGLE

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Abstract: This paper proposes an alternative criteria of the I_L^r-optimal criteria for the linear regression model with r responses based on the volume of the confidence rectangle. This is referred to as R_L^r-optimality. The R_L^r-optimality criterion is invariant with respect to different parameterizations of the model, and reduces to I_L-optimality as proposed by Dette and O'brien (1999) in single response situations. A generalization of Elfving's theorem is proved for the R_L^r-optimal designs to describe the geometrical characterization of R_L^r-optimality. An equivalence theorem for R_L^r-optimality is given and used to verify R_L^r-optimality of designs, and this is illustrated by two examples.

A variant of the parallel model for sample surveys with sensitive characteristics

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Abstract: In this paper, we propose a new *non-randomized response* (NRR) model, called a variant of the parallel model. A survey design and corresponding statistical inferences including likelihood-based methods, Bayesian methods and bootstrap methods are provided. Theoretical and numerical comparisons showed that the proposed variant of the parallel model over-performs two existing NRR crosswise and triangular models for most of the possible parameter ranges. A real dateset from a survey on 'sexual practices' in San Francisco, Las Vegas and Portland is used to illustrate the proposed methods.

Partially Replicated Two-Level Fractional Factorial Designs via Semifoldover

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Abstract: Most fractional factorial designs have no replicated points and thus do not provide a reliable estimate for experimental error. The objective of this paper is to study the issue of partially replicated two-level fractional factorial (FF) designs, thereby allowing for the unbiased estimation of the experimental error while maintaining the orthogonality of the main effects. Through the tool of indicator function and the idea of semifoldover, we propose two simple and effective techniques to produce designs with partially replicated points in general two-level FF designs, whether they are regular or not. The related properties of the constructed partially replicated designs are investigated. Our results indicate that partially replicated FF are competitive in practice.

大口径机枪加速寿命试验技术研究

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摘要: 多年来，大口径机枪寿命试验均采用全寿命射弹方式，存在着试验周期长、弹药用量过大、试验费用过高等问题，结合试验研究及试验经验，以大口径机枪枪管为主要研究对象，对机枪枪管寿命影响因素及其影响进行了综合分析，初步确定了进行加速寿命试验研究所需的试验条件和初步试验设计方案；通过大量、系统的大口径机枪加速寿命试验研究、数据分析与建模分析，找出了各试验应力对大口径机枪枪管寿命的影响趋势及规律，提出了可大幅度减少试验用弹消耗的大口径机枪加速寿命试验设计方案及相应的数学模型表达形式，为机枪加速寿命试验技术与应用研究奠定了基础。

Designs for Quantitative Factors

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Abstract: In order to construct efficient designs with quantitative factors, we consider permuting factor levels for regular fractional factorial designs and develop some general theory. We show that under a simple condition there is a unique linear permutation that leads to the most efficient design. The theory is then applied to construct generalized minimum aberration designs with 27 and 81 runs. These new designs are more efficient than existing designs for studying quantitative factors. We illustrate practical benefits of using these new designs with an experiment.

Experimental Design and Analysis for Drug Combination Studies

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Abstract: Motivated by experimental designs for drug combination studies, in this paper, we propose a novel approach for generating a uniform distribution on an arbitrary tetragon in two-dimensional Euclidean space $\mathbb{R}^2$. The key idea is to construct a one-to-one transformation between an arbitrary tetragon and the unit square $[0,1]^2$. This transformation then provides a stochastic representation for the random vector uniformly distributed on the tetragon. An algorithm is proposed for generating a uniform distribution in an arbitrary triangular prism in $\mathbb{R}^3$. In addition, we develop methods for generating uniform distributions in a class of convex polyhedrons in n-dimensional Euclidean space $\mathbb{R}^n$. In particular, stochastic representations for uniform distributions in regions with order restrictions are presented. We apply the proposed method to the experimental design for a drug combination study.

正交平衡区组设计统计模型中的方差分析

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摘要: 正交平衡区组设计(或广义正交表)的数据分析类似于正交拉丁方(或正交表)的数据分析. 本文利用类似于正交表数据分析中的投影矩阵的正交分解，研究正交平衡区组设计的统计分析模型，给出了方差分析中的二次型以及各因子的二次型的分布性质，从而给出交平衡区组设计统计模型中的方差分析方法.

An optimal stochastic approximation for estimating the effective window of a control factor

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Abstract: For control processes with a control factor and ternary response, it is important to find the effective settings of the control factor. Especially, finding the window of the control factor necessary to cause the probability of normal response larger than specified p is of scientific and practical interest. We derived the optimal Robbins-Monro procedure and proposed an optimal stochastic approximation to estimate the window of interest. Simulations study shows that the proposed method gives an efficient estimation with small sample sizes and with great accuracy.

正交平衡区组设计正交性的等价条件

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摘要: 正交平衡区组设计(或者广义正交表)是一种类似于正交拉丁方(或者正交表)的新设计,但试验次数大幅减少. 正交性是正交平衡区组设计必须满足的基本要求，本文给出了正交性的一个等价条件。

Design and Analysis for Computer Experiments With Qualitative and Quantitative Variables

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Abstract: Computer experiments have attracted a broad attention in many fields of science and technology. The premises in most literature assume that all the input variables are quantitative. However, researchers often encounter computer experiments involving mixed input variables: both quantitative and qualitative variables. In this paper, we first propose a new type of design, called clustered-sliced Latin hypercube design, which is a special sliced Latin hypercube design with points clustered in the design region. Using such designs for computer experiments with qualitative and quantitative variables helps to capture the correlations between responses corresponding to different level-combinations of the qualitative variables. Further, associated with newly proposed designs, we develop an adaptive analysis strategy for computer experiments with qualitative and quantitative variables, which automatically selects useful information from all auxiliary responses to increase the prediction accuracy of the target response. This strategy is shown to be effective through several numerical examples including a real example from the food engineering literature.

均匀实验设计与广义线性模型数据分析在半导体可靠性实验中的应用初探

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摘要: 半导体集成电路新产品的研发中常常依靠多次实验来优化相关器件的性能及其可靠性。实验的影响因素多，成本高而且周期长，相应的可靠性数据复杂而且变异性大。本文采用高效率的超饱和响应曲面均匀设计法，使用均匀设计学会的均匀设计软件（5.0版）来设计实验。由于对业界常规的单一特定寿命指标的建模误差很大，本文对收集到的含有早期失效、非单一模式的可靠性数据进行深入分析，决定从可靠性机理出发将将本征失效与早期失效分开，因而将常规的单一特定寿命指标修改为反映本征模式的本征寿命指标并新增加反映早期失效的一个比例指标，从而全面反映可靠性数据。这两个指标一起用作可靠性的响应对实验数据进行分析与建模。本文借助于JMP统计软件用逐步回归法对修改的特定寿命的对数与新增的比例指标进行变量筛选，之后又使用广义线性模型对比例指标重新进行建模与精准的预告，并结合本征寿命的对数的建模一起作联合优化。实验与优化预告帮助找到了比过去使用传统试错法得到的最佳结果还要优良许多的新的条件，同时节省了很高的成本而起大大缩短了实验周期。

Construction of Minimal-point Mixed-level Screening Designs Using Conference Matrices

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Abstract: Screening designs are frequently used to identify active effects from a large number of factors. Small size designs are preferred when the experiments are costly. Two-level or 3-level screening designs have been well studied in the litera- ture. However, mixed-level screening designs have not been thoroughly explored. In this paper, a new class of mixed-level screening designs with minimal-point is constructed using conference matrices. The constructed designs can be used to estimate the main effects and quadratic effects with a good performance of D-efficiency and variance of estimates.

An Application of Factor Aliased Effect Number Pattern in Two-level Regular Designs

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Abstract: Varied designs have disparate constructions and different confounding situations. Most models focus on the description of the whole confounding situation of a design. However, actually different columns have different confounding situations. Aware of the situation, practitioners can arrange factors more wisely. Zhou, Balakrishnan and Zhang (2012) proposed a new pattern called factor aliased effect number pattern (F-AENP for short) to depict confounding situation of every column in a GMC design and rank the columns. Using this new pattern, we have calculated F-AENP of all the regular designs of 2n-m with 16 runs and 32 runs. By F-AENP, all the columns in a design can be ranked into a new order. Further more, we obtain the compromise designs applying to the condition that one or two very important factors and two factor interaction involving them should be estimated, and simultaneously experimenters hope them for having confounding situation as clear as possible.

运用基因表达式编程预测消防水管爆破力

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摘要: 根据国家规定，消防水管的爆破力必须达到一定的要求。根据企业的生产经验，消防水管的爆破力和水带口径、经线股数、经线根数、纬线股数、纬线密度等5个工艺参数有关，本研究的目的是探究工艺参数和爆破力之间的关系。传统的方法是建立两者之间的回归方程，但由于工艺参数和爆破力之间的关系非常复杂，无论是多元线性回归还是多项式回归，所得到的预测的误差都比较大。

本研究采用基因表达式编程（GEP）的方法来建立工艺参数和爆破力之间关系的模型。GEP是在遗传算法和遗传编程基础上发展起来的全新的优化算法，自从2001年提出该算法以来，它已经在许多领域得到了广泛的应用。GEP遗传操作的基本单位是染色体，它由若干个基因组成，GEP的特点是把每个基因都分为头部和尾部，头部既可以含有函数符号，也可以包含终结符，而尾部则只能含有终结符。GEP在运行过程中，要有多个参数需要设置。

为了找到GEP合理的参数设置，本研究采用了均匀设计的方法，在设计中考虑了5个因素，每个因素取9个水平，它们分别是A：头部长度，取4、6、8、10、12、14、16、18、20；B：基因数目：取3、4、5、6、7、8、9、10、11；C：适应度函数：取RESR、AESR、R-square、MSE、RMSE、MAE、RSE、RRSE、RA；D：染色体个数：取20、30、40、50、60、70、80、90、100；E：变异概率Pm：取0.04、0.08、0.12、0.16、0.20、0.24、0.28、0.32、0.36。我们采用了U9（96）均匀设计表，该表最多可以安排6个因素，我们将本研究的5个因素放在表的前面5列。根据该设计方案，进行了9组试验，每组做10次试验，保留其中适应度最高的3个试验结果，由此而得到27个较好的试验结果，并得到相应的表达树，并将其转化为数学函数式。然后将工艺参数代入该函数式，并将计算结果和实际的爆破力相比较，从而找出预测误差最小的数学函数式作为工艺参数和爆破力之间关系的模型，结果表明其预测误差显著小于回归方法的预测误差。

自助回归的正交试验数据分析

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摘要: 正交试验当因子数等于或接近正交表列数时,用传统方法不能分析交互作用实为憾事. 本文介绍的自助回归方法,可以破解此难题,适合实际应用.具体作法是:利用EXCEL的回归模块,直接分析试验数据, 如拟合不佳,就辨析趋势图并在电子表格中尝试插入交互作用项和/或多次项,以获取适用的拟合方程. 继而用规划求解模块求得最优解.本文以我国企业质量改进中涌现出的L8(27)和L9(34)两个实例,介绍了此法的成功应用.

利用正交表构造正交平衡区组正交表

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摘要:在正交表的基础上，借助于平衡区组正交表，基于正交表的区组表示列替换为平衡区组每一列且进行列重叠构造技术. 分析显示，新构造地区组具有相遇性、完全性、组内和组间平衡性. 算例表明，利用正交表构造平衡区组设计，可明显减少实验次数.

边际结构模型（MSM）在分析有时序混杂因素的大型临床试验中事件原因的应用

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摘要: 边际结构模型(Marginal Structural Models), '边际'是指所关心的是总体平均效应, '结构'是指要探讨是具有因果的效应(causal)而不是关联的(associational)效应.

该模型的关键概念是"补实"(Counterfactuals,有人译为'反设事实'):在试验过程中, 在某一时刻,某一个体只能有一种处理,可能作为对照,有另一性质相同(似)的个体接受不同处理. 该模型充分应用时序中数据,给出人为设定的完全相同两处理的结果,即补实结果,进行分析,用以消除通常COX模型的偏性, 对随时间变化的协变量进行了矫正,使事件原因的分析更合理,更可靠.

目前所见，有三种现成计算机软件可实现MSM分析。

Blocked Two-Level Regular Factorial Designs With Weak Minimum Aberration

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Abstract: This paper considers the construction of $2^{n-k} : 2^p$ designs with weak minimum aberration, where a $2^{n-k} : 2^p$ design denotes a blocked two-level design with n treatment factors, 2^p blocks, and $N = 2^{n-k}$ runs. We first obtain the minimum value of $A_{2,1}$, the number of two-factor interactions which are aliased with the block effects. We next propose a method to construct the blocked two-level designs such that $A_{3,0}$ and $A_{2,1}$ are minimized simultaneously when $n \leq N/2 - 2^{p-1}$, where $A_{3,0}$ is the number of defining words of length 3 involving only the treatment factors. When $N/2 - 2^{p-1} < n \leq N/2$, $A_{3,0}$ and $A_{2,1}$ can not be minimized simultaneously. Another construction method is then suggested to minimize $A_{3,0}$ and $A_{2,1}$ sequentially. The designs constructed by both methods are weak minimum aberrations with respect to some existing combined wordlength patterns. The constructed designs with 128 runs and more than 128 runs are new and supplement the existing tables in the literature.

Factor aliased effect number pattern and experimental planning

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Abstract: Zhang, Li, Zhao and Ai (2008) introduced a new pattern, called aliased effect number pattern (AENP), for classifying regular factorial designs. Based on the AENP, they proposed a general minimum lower order confounding (GMC) criterion for the selection of designs, and the optimal design selected by the GMC criterion is called a GMC design. Subsequently, all the GMC 2^{n-m} designs with $N/4+1 \leq n \leq N-1$ have been obtained (Li, Zhao and Zhang (2010), Zhang and Cheng (2010), and Cheng and Zhang (2010)), where $N = 2^{n-m}$ is the number of runs and n is the number of factors. Aiming for an efficient implementation of GMC designs in practice, we introduce here a new notion, called Factor-AENP (F-AENP), for ranking the columns of a regular design. We then find all the best F-AENP columns for any GMC 2^{n-m} design with $5N/16 \leq n \leq N-1$. The relationship between the F-AENP and AENP of a design is also given. In order to facilitate practical use of the established results, the F-AENPs of the GMC 2^{n-m} designs for $5N/16+1 \leq n \leq N-1$ with $N = 16, 32$ and 64 are tabulated.