International Statistics Festival Salzburg 2016

Recent Advances and Innovative Applications of
Nonparametric and Multivariate Methods

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Abstracts

Rank-Based Estimation for Single Index Models and Extensions
Ash Abebe, Auburn University, USA

Abstract. We consider the estimation of the regression coefficients and the nonparametric function of the single-index regression model. The asymptotic properties of the proposed estimator are studied. Monte Carlo simulation experiments demonstrate the robustness and efficiency the proposed estimator. A real life example illustrates that the rank regression procedure effectively corrects model nonlinearity even in the presence of outliers in the response space. We will study extensions of this model to the single-index varying-coefficient model.

Permuting Incomplete Paired Data:
A Novel Exact and Asymptotic Correct Permutation Test
Lubna Amro, University of Ulm, Germany

Abstract. Various statistical tests have been developed for testing the equality of means in matched pairs with missing values. However, most existing methods are commonly based on certain distributional assumptions such as normality, 0-symmetry or homoscedasticity of the data. The aim of this paper is to develop a statistical test that is robust against deviations from such assumptions and also leads to valid inference in case of heteroscedasticity or skewed distributions. This is achieved by applying a novel randomization approach. The resulting test procedure is not only shown to be asymptotically correct but is also finitely exact if the distribution of the data is invariant with respect to the considered randomization group. Its small sample performance is further studied in an extensive simulation study and compared to existing methods. Finally, an illustrative data example is analyzed.

Which semi-parametric models can be estimated using profile maximum likelihood techniques?

Eric Beutner, University of Maastricht, Netherlands

Abstract. Inference based on the likelihood function and its variants like the profile likelihood function has a long history. In the semi-parametric context Murphy & van der Vaart (2000) showed that profile likelihood inference for the finite-dimensional parameter behaves like ordinary likelihood inference. Their results apply, for instance, to Cox's proportional hazards model. On the other hand it is known that the same approach fails for accelerated failure time models. We consider a semi-parametric model for recurrent events that incorporates treatment effects via effective age functions. We shall give conditions on the effective age functions under which the profile likelihood function at the parameter z exceeds the profile likelihood function at the parameter z' with probability p. We present examples where p equals 1 regardless of the true probability measure and the sample size. This shows clearly that for this model profile likelihood inference may lead to inconsistent estimators.

Parametric and Nonparametric Interactions - Meaning and Interpretation -

Edgar Brunner, University of Göttingen, Germany

Abstract. This talk discusses some aspects of parametric and nonparametric interactions. First it is demonstrated by means of an example that – even in linear models – the notion of the expression 'interaction' depends on the measurement scale. In nonparametric models, I will restrict the considerations to interactions based on linear combinations of the Mann-Whitney effects

$$p_{ij} = \int F_i \, \mathrm{d}F_j$$

The different meanings of these two types of interactions are discussed by comparing their invariance properties. These differences can be explained by the fact that parametric (linear) interactions are defined by linear combinations of location parameters ignoring the variances and the shapes of the distributions while nonparametric interactions are defined by linear combinations of 'separation measures' (involving variances and the total shapes) of the distributions. Unfortunately, this is often not well understood be researchers in applications when recommending rank tests as robust alternatives to parametric (ANOVA) procedures.

In general, this is not true for investigating interactions – with the exception of a particular ranking procedure in two-way layouts involving different rankings in rows and columns (Gao and Alvo, 2005). The talk closes by a brief discussion of some recently developed software for rank procedures including tests as well as confidence intervals.

Maximum likelihood estimation for circular unitary ensembles

Manfred Denker, Pennsylvania State University, USA

Abstract. We discuss extensions of circular unitary ensembles from random matrix theory, which are based on Dyson's classical work in 1962. These models can be treated using Toeplitz determinants and Szego's determinantal identity for integrable functions on the n- dimensional torus. We show a central limit theorem for the sufficient statistics defining the models and their associated approximate maximum likelihood function. We discuss non-parametric extensions. This is joint work with R. Dakovic and M. Gordin.

A graphical approach to resampling based multiple testing procedures

Livio Finos, University of Padua, Italy

Abstract. Recently multiple test procedures have been developed that reflect the relative importance of different study objectives, such as fixed sequence, fallback, and gatekeeping procedures. In addition, graphical approaches have been proposed that facilitate the visualization and communication of Bonferroni-based closed test procedures for common multiple test problems, such as comparing several treatments with a control, or assessing the benefit of a new drug for more than one endpoint. Being based on the Bonferroni test, these procedures suffer from considerable conservativeness, especially in situations where test statics are correlated. In this talk I will present extended graphical approaches that dissociate the underlying weighting strategy from the employed test procedure. This allows one to first derive suitable weighting strategies that reflect the given study.

Data integration with high dimensionality

Xin Gao, York University, Toronto, Canada

Abstract. We consider a problem of data integration. Consider determining which genes affect a disease. The genes, which we call predictor objects, can be measured in different experiments on the same individual, e.g., microarray, proteomics, etc. We address the question of finding which genes are predictors of disease either by microarray, proteomics or both. Our formulation is more general. In a given data set, there are a fixed number of responses for each individual, which may include a mix of discrete, binary and continuous variables. There is also a class of predictor objects, which may differ within a subject depending on how the predictor object is measured, i.e., depend on the experiment. The goal is to select which predictor objects affect any of the responses, where the number of such informative predictor objects or features tends to infinity as sample size increases. There are marginal likelihoods for each way the predictor object is measured, i.e., for each experiment, We specify a pseudolikelihood combining the marginal likelihoods, and propose a pseudolikelihood information criterion. We establish selection consistency for the pseudolikelihood information criterion with unbounded true model size, which includes a Bayesian information criterion with appropriate penalty term as a special case. Simulations indicate that integrating the data improves upon, sometimes dramatically, using only one of the responses and one of the means of measuring the predictor object.

Some remarks on blinded adaptations of clinical trials

Ekkehard Glimm, Novartis Pharma AG, Basel, Switzerland

Abstract. Planned and unplanned modifications of an ongoing clinical trial are often unavoidable. It is often claimed that such modifications are unproblematic as long as they are done in a "blinded" fashion. This term is ambiguous: Sometimes, it is interpreted as meaning that a trial team has no information whatsoever about the data obtained thus far. In other situations, they are viewed as merely implying that the treatment allocation is unknown to the team, whereas other information, e.g. overall mean response or total variation are available. We will explore the impact of such "semiblinded" interim modifications on an ongoing clinical trial. The focus will be on rejection probabilities of statistical tests (type I errors and power).

It will be seen that some modifications (e.g. blinded sample size reviews) are less problematic than others (e.g. modifications of randomization ratios). Modifications can cause type I error inflations that do not even disappear asymptotically.

A non-parametric Bayesian approach to decompounding from high frequency data

Shota Gugushvili, University of Leiden, Netherlands

Abstract. Given a sample from a discretely observed compound Poisson process, we consider non-parametric estimation of the density f_0 of its jump sizes, as well as of its intensity λ_0. We take a Bayesian approach to the problem and specify the prior on f_0 as the Dirichlet location mixture of normal densities. An independent prior for λ_0 is assumed to be compactly supported and possess a positive density with respect to the Lebesgue measure. We show that under suitable assumptions the posterior contracts around the pair (λ_0, f_0) at essentially (up to a logarithmic factor) the $\sqrt{n\Delta}$-rate, where n is the number of observations and Δ is the mesh size at which the process is sampled. The emphasis is on high frequency data, $\Delta \to 0$, but the obtained results are also valid for fixed Δ. Simulations complement the theory.

High-dimensional inference for repeated measures data

Solomon Harrar, University of Kentucky, USA

Abstract. In this talk, test statistics for repeated measures design are introduced when the dimension is large. Asymptotic distribution of the statistics are derived for the equal as well as unequal covariance cases in the balanced as well as unbalanced cases. Consistent and unbiased estimators of the asymptotic variances will also be presented. Simulation study provides favorable evidence for the accuracy of the asymptotic approximation under the null hypothesis and power simulations show that the new methods possess enormous advantage when the dimension is large. Data from Electroencephalograph (EEG) experiment will be analyzed to illustrate the application of the results.

False discovery proportion estimation by permutations: confidence for SAM

Jesse Hemerik, University of Leiden, Netherlands

Abstract. SAM is a highly popular multiple testing method that estimates the false discovery proportion (FDP), the fraction of false positives among all rejected hypotheses. It does so based on permutations of the data. Perhaps surprisingly, until now this method had no known properties. We extend SAM by providing $(1-\alpha)100\%$ - confidence upper bounds for the FDP,so that exact confidence statements can be made. As a special case, an estimate of the FDP is obtained that underestimates the FDP with probability at most 0.5. Moreover, using a closed testing procedure, we decrease the upper bounds and estimates in such a way that the confidence level is maintained.

A Test Procedure for Uniformity on Stiefel Manifold on the Basis of Random Projections

Toshiya Iwashita, Tokyo University of Applied Sciences, Japan

Abstract. This paper proposes a new procedure to test uniformity on the Stiefel manifold. The procedure is formulated by adopting a nonparametric method on the basis of the Kolmogorov-Smirnov statistic which are composed of random projections of samples. The distribution function of the test statistic is derived by making use of theoretical products concerned with spherical distributions which includes the uniform distribution on the sphere. As well as theoretical inquiry into the test procedure for uniformity on the Stiefel manifold, numerical experiments are conducted to illustrate the usage of the proposed procedure and to verify effectiveness of consistency for uniformity on the sphere through the power under alternative hypotheses.

(joint work in process with Amegaya, M. Hashiguchi, H and Klar, B; Perhaps, Amegaya(student) and Hashiguchi (Associate Prof. would join the conference as co-arthors)

Preferences of goodness-of-fit tests: A survey about the analysis of nonparametric power functions

Arnold Janssen, University of Düsseldorf, Germany

Abstract. Goodness of fit tests are usually constistent for nonparametric models. However, they do not meet the power of oracle tests (Neyman Person tests) for local alternatives when the distributions would be known.The statistician likes to distinguish and to compare the power of different competing tests. It is shown that under certain circumstances every test has a preference for a finite dimensional space of alternatives. Apart from this space, the power function is almost flat on balls of alternatives. There exists no test which pays equal attention to an infinite number of orthogonal alternatives. The results are not surprising. Every statistician knows that it is impossible to separate an infinite sequence of different parameters simultaneously if only a finite number of observations is available. A well-reflected choice of tests requires some knowledge about preferences concerning alternatives which may come from the practical experiment. A guide to the construction of tests is given.

Rank-based methods in linear model with measurement errors

Jana Jurečková, University of Prague, Czech Republic

Abstract. We consider a semiparametric partially linear model where a response is linearly regressed to a set of observable covariates, which may be affected by additive random measurement errors. We shall illustrate advantage of the rank inference on in this situation. Namely the rank tests for regression can be recommended, because their critical region is insensitive to measurement errors under very general conditions; the errors affect only the power of the test. However, the R-estimator of the slope parameter in linear model is biased, because its distribution depends on the power function of the pertaining test. On the other hand, the local asymptotic bias of the R-estimator neither depends on the chosen score-generating function nor on the unknown distribution of the model errors.

The research was partially done jointly with H.L.Koul, R. Navrátil, J. Picek and A.K. Md.E. Saleh.

Randomization and permutation inference in adaptive clinical trials

Florian Klinglmüller, Medical University of Vienna, Austria

Abstract. Adaptive designs use information emerging from an ongoing clinical trial to perform mid-trial design modifications. Most of the available test procedures for adaptive designs rely on restrictive assumptions about the distribution of outcome measures and test statistics. We propose a framework of nonparametric tests for confirmatory adaptive designs that extend the conditional error rate approach - a general statistical principle for confirmatory adaptive designs - to rerandomization and permutation tests. The proposed procedures require less distributional assumptions, while providing similar flexibility as existing adaptive test procedures. The proposed procedures provide conditional and unconditional control of the Type I error rate and are robust in terms of power for a wide variety of outcome distributions.

Robust analyses of over-dispersed counts with varying follow-up in small samples and rare diseases

Frank Konietschke, University of Texas at Dallas, USA

Abstract. In this talk, we consider inference methods for count data, such as the number of relapses and magnetic resonance imaging (MRI) lesion counts in multiple sclerosis (MS), or exacerbations in chronic obstructive pulmonary disease (COPD). In such clinical trials, the number of exacerbations and the follow-up time is recorded for each patient. Due to the heterogeneity of patients, the number of exacerbations cannot be assumed to follow a Poisson distribution, and over-dispersion has to be taken into account for valid statistical inferences. We derive statistical inference methods for testing null hypotheses as well as for constructing confidence intervals for the underlying treatment effects. For small sample sizes, a studentized permutation approach will be investigated. Extensive simulation studies show that the permutation based statistics tend to maintain the nominal type-1 error level or coverage probability very satisfactorily. A real data set illustrates the application of the proposed methods. The project is in cooperation with Professor Tim Friede, University of Göttingen, and Professor Markus Pauly, University of Ulm.

Statistical Fusion Learning: Fusing Inferences from Multiple Sources for More Powerful Findings

Regina Liu, Rutgers University, USA

Abstract. Inferences from multiple databases or studies can often be fused together to yield a more powerful overall inference than individual studies alone. Fusion learning refers to the development of effective approaches for synergizing learnings from different data sources. Effective fusion learning is of vital importance, especially in light of the ubiquitous automated data collection nowadays. Decision-making processes in many domains such as medicine, life science, social studies, etc. often benefit greatly from considering data from different sources, possibly with varying forms of complexity and heterogeneity in their data structure.

This talk presents some new fusion methodologies for extracting and merging useful information. Some methodologies are motivated by challenges arising from massive complex structures from different data sources, while others by specific goal-directed or individual applications, such as in individualized medicine. Underlying those methodologies is the tool of "confidence distribution" (CD), which, simply put, is a versatile distributional inferential scheme (unlike the usual point or interval inferences) without priors. Some simulation studies and real applications are used to illustrate the broad applicability of the proposed approaches.

On the Confidence Distribution Concept

Jochen Mau, University of Düsseldorf, Germany

Abstract. Cox's [1] confidence distribution has attracted considerable attention and formal expansion in recent years, cf. [2,3] for the most visible, perhaps. The vibrant research and wide interest has most recently been documented by a workshop at Rutgers University [4]. I wish to add two remarks, one practical, one theoretical:

1. Confidence intervals are often recommended for presentation of outcomes from, e.g. randomized clinical trials, and they are also the principal tool in any subsequent meta-analyses given that several trials on the same clinical issue have appeared. These intervals calculated from the data, are typically centered at the calculated effect measure, e.g. the sample mean in a parametric context, and then compared with respect to their location and the location of the hypothesized parameter value. However, the distances on the

line do not show the "probabilistic weight" of each. A more informative way is then to give the "observed confidence distribution", and in particular its mass on the interval of "practically irrelevant differences" as it had been used and written into the trial protocol for the purpose of sample size estimation a priori. This may be particularly useful in the reporting of statistical evidence after a non-significant trial outcome [5].

2. The current definition of a confidence distribution [3] sets out from a sample set $\mathcal{X}$ and a parameter set Θ, their product $\mathcal{X} \times \Theta$ and a function $H : \mathcal{X} \times \Theta \to [0,1]$ [3], with $\bigwedge_{x\in\mathcal{X}} H(x;\cdot) : \Theta \to [0,1]$ is a cdf, $\bigwedge_{\theta\in\Theta} H(\cdot;\theta) : \mathcal{X} \to [0,1]$ (no explicit statement), and $\bigvee_{\theta_0\in\Theta} \bigwedge_{x\in\mathcal{X}} H(\cdot;\theta_0) : \mathcal{X} \to [0,1]$ is $U[0,1]$, with θ_0 denoting the "true" value of parameter θ. However, the third statement seems incomplete, as $U[0,1]$ distributions require a finite interval, and the second raises the question what is assumed when $\theta \neq \theta_0$ but the difference is rather small. Apart from this, the construction of the concept does not appear embedded well in probability theory: beyond some measurability and "a.s." statements, an obvious reference to by now well established probabilistic random measure theory [6] is lacking, cf. [7] for an early step.
In fact, the concept of some *confidence distribution (function)* on a parameter set is so appealing that one may wish to have it *per se*, that is already without a sampling context, just have Θ as a set of *models* of some physical stochastic phenomenon, as for example complex adaptive systems models in economic interactions on specific markets, body system dynamics, or much simpler situations. On Θ one will certainly like to distinguish "close" and "distant" models the least, hence introduce also a *topology*. This leads one into a rigorously elaborated theory of $[0,\infty[$-valued random measures for locally compact second countable *Hausdorff spaces*; the odds function may be used for transformation from probability measures.
Leaving aside all technicalities, I will briefly explain the main basic concepts and discuss the issue of defining a "confidence distribution" in this more general context.

References: [1] Cox, D.R. (1958). *Ann. Math. Stat.*, **29**, 357-372. [2] Schweder, T. & Hjort, N.L. (2002). *Scand. J. Stat.*, **29**, 309-332. [3] Xie, M.-G. & Singh, K. (2013). *Int. Stat. Rev.*, **81**, 1, 3-39. [4] Department of Statistics & DIMACS (2016). *Fusion Learning & BFF (Bayesian, Frequentist and Fiducial) Inferences and Statistical Foundations.* Workshop, April 11-13, 2016, Rutgers University, New Jersey. [5] Mau, J., et al. for the Study Group SPPI (2002). *Clin. Oral Impl. Res.*, **13**, 477-487. [6] Kallenberg, O.(1974). *Random Measures.* Akademie-Verlag, Berlin. [7] Mau, J. (1987). In: *Probability and Bayesian Statistics*, R. Viertl (ed.). Plenum Press, New York, pp. 347-356.

An introduction to modern randomization and permutation testing

Markus Pauly, University of Ulm, Germany

Abstract. Permutation and randomization methods are classical tools for statistical inference which are typically developed to test certain invariance hypotheses. For example, a classical permutation test is suitable for testing the null hypothesis of equal distributions in an unpaired two-sample problem. After an introduction to permutation and more general randomization tests we discuss recent advances for generalizing their applicability to broader classes of testing problems which are formulated in certain effects/functionals.
Note: This talk is particularly suited for master and phd-students of mathematics/statistics.

A Parallel Analysis of Union-Intersection and Intersection-Union Tests for Equivalence

Fortunato Pesarin, University of Padua, Italy

Abstract. It is said: "To minimize type II errors, large samples are recommended. In practicae all null hypotheses are claimed to be false for sufficiently large samples so … it is nonsensical to perform an experiment with the sole aim of rejecting the null hypothesis." This remarkable concept suggests considering the null hypothesis as an equivalence interval, where the hypotheses are $H_0 : [-a \leq \delta \leq b]$ and $H_1 : (\delta < -a) \cup (\delta > b)$. To obtain practical solutions, a permutation Union-Intersection (UI) procedure is presented. Testing for equivalence of two treatments is widely used in medical and pharmaco-statistics. It is traditionally approached by a Two One-Sided Test (TOST) within the Intersection-Union principle. According to this, the null hypothesis states that the effects are lying outside and the alternative inside the interval, $H_0 : (\delta \leq a) \cup (\delta \geq b)$ and $H_1 : (-a < \delta < b)$. Our main goal is to go beyond the limitations of likelihood based methods by working within the permutation tests.

On optimality of a single observation confidence interval for the mean of a normal distribution with unknown mean and variance

Steve Portnoy, University of Illinois at Urbana-Champaign, USA

Abstract. In a 1965 Decision Theory course at Stanford University, Charles Stein began a digression with "an amusing problem": Is there a proper confidence interval for the mean based on a single observation from a normal distribution with both mean and variance unknown? Stein introduced the interval $(-c|X|, c|X|)$ and showed that the minimal coverage probability tended to one as c increased to infinity; thus providing a confidence interval with any confidence level. Oddly, Stein omitted any development of optimality. Here we characterize scale and sign invariant rules and discuss minimaxity in the sense of minimizing maximum expected length over all confidence intervals with fixed coverage. The Stein interval is not minimax for smaller confidence levels, as randomized rules can do strictly better in the minimax sense. The Hunt-Stein argument is used to show that there are minimax intervals among randomized invariant ones, and we describe how to find a minimax rule.

Optimal exact tests for multiple binary endpoints

Robin Ristl, Medical University of Vienna, Austria

Abstract. In confirmative clinical trials with limited sample size, challenges arise because the asymptotic theory may lose accuracy to approximate the distribution of test statistics. Often, non-parametric exact tests are applied instead. However, the distribution of the corresponding test statistics is usually discrete and they may be overly conservative. This problem may be further aggravated if multiple endpoints are tested using a standard multiple testing procedure such as the Bonferroni test. To overcome this drawback, we propose an optimal multiple testing procedure for binary endpoints to compare a treatment versus a control. The proposed procedure is based on numeric optimization of the multivariate rejection region for a global null hypothesis using multiple Fisher exact tests. Different optimization objectives are considered. Applying the closed testing principle we obtain an optimized multiple testing procedure with strong control of the family wise error rate.

On Subsampling, Algebraic Confidence Covers and Asymptotics

Milan Stehlík, University of Valparaiso, Chile

Abstract. Hartigan's "typical value theorem" (1969) [3] is the basis for random subsampling, a resampling plan which uses group theory to construct confidence intervals for the center of a symmetric distribution on a real line. Atkins and Sherman [1] derived a group-theoretic condition on a set of subsamples of a random sample from a continuous random variable symmetric about 0 to be sufficient to provide typical values for 0: Nowadays, in the "Big Data" era, subsampling from a complex data can be viewed as a natural solution to the computational issues induced by the immoderate size of databases. Since ignoring the survey scheme can impede estimation by introducing a non-negligible bias, it might be helpful to derive statistics under symmetry (or other group action) constrain. While a plethora of analyzes has already been conducted to provide unbiased and efficient estimation of average quantiles, to our knowledge, such is not the case for phenomenons involving invariance under the action of a finite reflection group, e.g. the hyperoctahedral groups of B_n type. We have addressed this issue in Francis, Stehlík and Wynn [2]. Beside that, surprisingly, generating functions for such structures (e.g. B_n) follow asymptotics of Hájek-Šidák CLT (1967). Structures (e.g. B_n) can naturally introduce invariances, under which statistician can build up covering nets in higher dimensions. Such knowledge provide us omnibus covering nets, which cannot be obtained by inverting of severely directed nonparametric multivariate rank tests (see recent paper Jurečková and Kalina [4].).

References: [1] J.E. Atkins, G.J. Sherman, *Sets of typical subsamples*, Statistics and Prob. Letters 14, 115-117, 1992. [2] A. Francis, M. Stehlík, H. Wynn: *"Building" Exact Confidence Nets"* , Bernoulli, 2016. [3] J.A. Hartigan (1969). *Using Subsample Values as Typical Values.* Journal of the American Statistical Association, Vol. 64, No. 328, 1303-1317, 1969. [4] J. Jurečková, J. Kalina: *Nonparametric multivariate rank tests and their unbiasedness*, Bernoulli 18(1), 229-251, 2012. 1

Logarithmic quantile estimation and its applications to nonparametric factorial designs

Lucia Tabacu, Old Dominion University, USA

Abstract. The logarithmic quantile estimation for rank statistics estimates quantiles based on the almost sure central limit theorem for linear rank statistics for samples with continuous distribution functions. The logarithmic quantile estimation for rank statistics is a procedure that estimates quantiles directly from the data and not using the asymptotic distributions or estimations of unknown variances, covariances or eigenvalues of covariance matrices. In this talk we show how the logarithmic quantile estimation is derived from the almost sure central limit theorem and how it is applied to nonparametric factorial designs. As an application, we consider the c-sample problem, when the samples may be dependent and the asymptotic distribution is unknown. In this case the logarithmic quantile estimation is applicable to the Kruskal-Wallis statistic and we illustrate this using the data set from Boos (1986). Another application is the shoulder tip pain study that appears in Lumley (1996) and that can be analyzed using a combination of logarithmic quantile estimation and an ANOVA type statistic. This is joint work with Manfred Denker.

Confidence distribution as a bridge for Bayesian, frequentist and fiducial (BFF) inferences

Ming-Ge Xie, Rutgers University, USA

Abstract. A confidence distribution (CD) is a sample-dependent distribution function that can serve as a distribution estimate, contrasting with a point or interval estimate, of an unknown parameter. It can represent confidence intervals (regions) of all levels for the parameter. It can provide "simple and interpretable summaries of what can reasonably be learned from data", as well as meaningful answers for all questions in statistical inference. An emerging theme is "Any statistical approach, regardless of being frequentist, fiducial or Bayesian, can potentially be unified under the concept of confidence distributions, as long as it can be used to derive confidence intervals of all levels, exactly or asymptotically." We articulate the logic behind the developments, and show how CD can potentially bridge posterior probabilistic inferences in Bayesian, frequentist and fiducial (BFF) schools in all aspects, including estimation, testing and prediction. We will also present a fusion-learning example to demonstrate that the CD developments can provide an effective combined inference across BFF aisles.

A Bayesian Stochastic Approximation Method

Jin Xu, East China Normal University, Shanghai, China

Abstract. In this article, we propose a Bayesian stochastic approximation method to estimate the root of a regression function. The method features adaptive modelling and nonrecursive iteration. Strong consistency of the Bayes estimator is established. More importantly, the proposed procedure shows superb finite sample performance comparing with Robbins–Monro type procedures. Extensions to searching for extrema and generalized multivariate quantile are presented.

Non-unbiased two-sample nonparametric tests. Numerical example

Xeniya Yermolenko, University of Prague, Czech Republic

Abstract. Many tests on vector or scalar parameters against two-sided alternatives are generally not finite-sample unbiased. They are unbiased only for symmetric distributions or under similar conditions. This was already noticed by Amrhein [1995], Sugiura et al. [2006] and generally analyzed by Jurečková & Kalina [2012], Jurečková & Milhaud [2003] and later by many others. While in univariate models the tests are unbiased against one-sample alternatives, such alternatives are not clearly characterized in the multivariate models. We shall numerically illustrate this important problem on the Wilcoxon test against two-sample alternative of shift in location, applied to a skew logistic distribution and unequal sample sizes.

References: Amrhein, P. (1995). An example of a two-sided Wilcoxon signed rank test which is not unbiased. *Ann. Inst. Statist. Math.* **47** 167-170.

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