Winter Workshop on Mathematical Statistics Bratislava 2008

dedicated to
Andrej Pázman's 70th Birthday

PROGRAM and ABSTACTS

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Winter Workshop on Mathematical Statistics Bratislava 2008

December 15 - 16, 2008, Bratislava, Slovak Republic

Winter Workshop on Mathematical Statistics Bratislava 2008
MKC VEDA, Bratislava, Slovak Republic, December 15-16, 2008

Organized by

- Institute of Measurement Science, Slovak Academy of Sciences, Bratislava

in co-operation with

- Faculty of Mathematics, Physics and Informatics, Comenius University, Bratislava
- Mathematical Institute, Slovak Academy of Sciences, Bratislava

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Scientific Program

MONDAY, December 15, 2008

9:00 - 9:50	*Coffee*
9:50 - 10:00	*Opening*
10:00 - 10:30	**Jiří Anděl** (Prague): How to choose a wrong model
10:30 - 11:00	**Barbara Bogacka** (London): Adaptive experimental designs for dose-selection studies in Phase I clinical trials
11:00 - 11:30	*Coffee*
11:30 - 12:00	**Radoslav Harman** (Bratislava): On universal optimality of experimental designs
12:00 - 12:30	**Luc Pronzato** (Sophia Antipolis): Penalized and response-adaptive optimal designs, with application to dose-finding
13:00 - 14:00	*Lunch*
14:00 - 14:15	*Coffee*
14:15 - 14:45	**Ben Torsney** (Glasgow): Fitting latent variable models for paired comparisons and ranking studies – an application of optimal design theory
14:45 - 15:15	**Anatoly Zhigljavsky** (Cardiff): Optimal designs for correlated observations and characterization of probability distributions
15:15 - 15:45	**Jesús Lopéz-Fidalgo** (Ciudad Real): Experimental designs for a model with mixture of distributions
15:45 - 16:15	*Coffee*
16:15 - 16:45	**Werner G. Müller** (Linz): Measures of spatial dependence and corresponding designs
16:45 - 17:15	**Andrej Pázman** (Bratislava): What can be discovered in a formula for the variance of the BLUE
17:15 - 18:00	*Coffee*
18:00 - 22:00	*Conference Reception*

Scientific Program

TUESDAY, December 16, 2008

9:00 - 9:30	*Coffee*
9:30 - 10:00	**Lubomír Kubáček** (Olomouc): A measure of nonlinearity in singular nonlinear regression models
10:00 - 10:30	**Marie Hušková** (Prague): Testing stability in regression relationship
10:30 - 11:00	**Júlia Volaufová** (New Orleans): Accuracy of p-values of approximate tests in testing for equality of means under unequal variances
11:00 - 11:30	*Coffee*
11:30 - 12:00	**Lynn Roy LaMotte** (New Orleans): Illustrations of Neyman-Pearson tests when simple null and simple alternative are mixtures
12:00 - 12:30	**Igor Vajda** (Prague): Maximum likelihood in the context of more general minimum distance methods
13:00 - 14:00	*Lunch*
14:00 - 14:30	**František Štulajter** (Bratislava): Optimal predicition designs in finite discrete spectrum linear regression models
14:30 - 15:00	**Jana Jurečková** (Prague): Rank tests in measurement errors models
15:00 - 15:15	*Coffee*
15:15 - 15:45	**Jan Hannig** (Chapel Hill): Generalized fiducial inference for wavelet regression
15:45 - 16:15	**Ivan Mizera** (Edmonton): Quantile tomography: Using quantiles with multivariate data
16:15 - 16:30	*Closing*

How to choose a wrong model

Jiří Anděl
Charles University in Prague, Czech Republic
E-mail: jiri.andel@mff.cuni.cz

One can find in statistical books and papers many recommendations how to choose a good model for given data. Moreover, the final model can be checked using diagnostic tools. In the present talk we present a small set of data such that their origin is completely known. We do not reveal the information about the origin of the data and try to find the corresponding model by help of recommended methods. The procedure finally leads to a completely wrong model and so we analyze which step in our considerations was misleading. We are afraid that such error appears in applied statistics quite frequently. Finally, we present another set of data and we try to calculate a reasonable extrapolation. Since no model for these famous data can be found in statistical papers, we use a formal regression model. The forecast is made some 40 years ahead a so we believe that nobody will complain if this extrapolation is not precise enough.

Adaptive experimental designs for dose-selection studies in Phase I clinical trials

Barbara Bogacka
School of Mathematical Sciences, Queen Mary, University of London, UK
E-mail: B.Bogacka@qmw.ac.uk

Phase I clinical trials are the first studies to test new drug candidates in humans. The main objectives of these trials are to estimate pharmacokinetic (PK) parameters and to determine an optimal dose for further exploration in Phase II. The maximum tolerable dose, most commonly used in Phase I clinical trials, may not only carry too much unnecessary risk for patients but may also not be the most efficacious level. This occurs when the efficacy of the drug is unimodal rather than increasing, while the toxicity will be an increasing function of the dose. It may be more beneficial to design a trial so that doses around the so-called Biologically Optimum Dose are used more than other dose levels.

Various criteria of optimality have been applied to find the best dose and it is not clear which one should be recommended to use. In this presentation I compare to approaches: one based on an ethical criterion and one on an efficiency of estimation criterion. I also suggest a new approach combining the dose-selection problem with the estimation of PK parameters.

This is my joint work with A.C. Atkinson, M. Patan and D. Uciński.

On universal optimality of experimental designs

Radoslav Harman
Comenius University, Bratislava, Slovakia
E-mail: harman@fmph.uniba.sk

An optimal experimental design is said to be Schur optimal, if it is at least as good as any other design with respect to all reasonable criteria that depend only on the eigenvalues of the information matrix, which includes the criteria of *D*-, *A*-, *E*-optimality and many others. It turns out that for the linear regression models with uncorrelated errors it is relatively simple to verify Schur optimality of a given design. Of course, not all models admit a Schur optimal design. Nevertheless, it is possible to show that any linear regression model can be linearly reparametrized in a way that the *D*-optimal design, common to all reparametrizations, is a Schur optimal design in the new model. This provides a new support for the use of *D*-optimal designs, especially in the models without natural interpretation of parameters.

An even stronger type of optimality is the so-called Loewner universal optimality. An experimental design is Loewner universally optimal, if it is at least as good as any other design with respect to completely all reasonable criteria. However, it is well known that there is no Loewner universally optimal design for any linear regression model of dimension two or more with uncorrelated errors. Is the same true also for models with correlated errors?

Penalized and response-adaptive optimal designs, with application to dose-finding

Luc Pronzato
Nice Sophia Antipolis University - CNRS, Sophia Antipolis, France
E-mail: pronzato@i3s.unice.fr

Adaptive optimal design with a cost constraint is considered, both for least squares estimation in non-linear regression and for maximum likelihood estimation in Bernoulli type experiments, with application in clinical trials. When the design variables belong to a finite space, one can prove the strong consistency and asymptotic normality of the estimators, both when the cost level is fixed, and the adaptive design converges to an optimum constrained design, and when the objective is to minimize the cost. An example with a bivariate binary model will be presented.

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Fitting latent variable models for paired comparisons and ranking studies – an application of optimal design theory

Ben Torsney
University of Glasgow, UK
E-mail: bent@stats.gla.ac.uk

In a paired comparisons experiment a subject has to indicate which of two 'treatments' T_i, T_j is preferred. We observe O_{ij}, the frequency with which T_i is preferred to T_j in n_{ij} comparisons. Under a class of models for such data, which include the Bradley Terry and Thurstone models, $P(T_i$ is preferred to $T_j) = F(\lambda_i - \lambda_j)$, where $F(\cdot)$ is a symmetric distribu-tion function and (λ_i) is a treatment index. For identifiability purposes constraints must be imposed on parameters. One is to assume that $\sum_i p_i = 1$, where $p_i = \ln(\lambda_i)$; an alternative is $\prod_i p_i = 1$. Thus theorems identifying optimal design weights and algorithms for determining them carry over to the maximum likelihood estimation of these parameters.

Of course these tools can also be used to determine locally optimal designs for such models.

We will explore this fusion of topics, taking the opportunity to expand on the class of models, both for simple paired comparisons data and also for data consisting of orderings or rankings. In particular we will exploit multiplicative algorithms for maximum likelihood estimation.

Optimal designs for correlated observations and characterization of probability distributions

Anatoly Zhigljavsky
Cardiff University, UK
E-mail: ZhigljavskyAA@cardiff.ac.uk

I will start with the optimal design problem for estimating mean (by the unweighted average) in a sequence of correlated observations. In this case, the variance of the estimator is proportional to

$$D(\xi) = \int \int \varrho(x,y)\xi(dx)\xi(dy),$$

where ξ is the design and ϱ is the autocorrelation function. I will discuss behaviour of optimal designs (these designs minimize $D(\xi)$ with respect to ξ) for some autocorrelation functions ϱ.

Then I will use the same functional $D(\xi)$ but relax the condition $\varrho(0) < \infty$. I will argue that the related optimization problem is interesting and may even be useful. For a certain class of functions ϱ with $\varrho(0) = \infty$, I will derive analytic expressions for optimal designs (which are continuous probability measures).

At the end of the talk, I will move to the Bickel-Herzberg approach and its generalization to the case of long-range dependence in the error process.

Experimental designs for a model with mixture of distributions

Jesús López-Fidalgo
Universidad de Castilla-La Mancha, Ciudad Real, Spain
E-mail: jesus.lopezfidalgo@uclm.es

Typically a combustion engine produces emissions of several types of particles. The diameters of the particles are measured and used as the response variable. There is interest in estimating the proportion of particles of each kind, as well as the parameters of the distribution of each population of particles. In this work the information matrix of the MLE's, the information matrix of the estimates computed using the EM algorithm an the empirical covariance matrix are compared. Normal distributions are assumed for two kind of particles and the means are modeled through an independent variable assuming constant variances. Designs are generated and compared using simulations.
This is a joint work with M.M. Rodríguez-Hernández.

Measures of spatial dependence and corresponding designs

Werner G. Müller
Johannes Kepler University, Linz, Austria
E-mail: Werner.Mueller@jku.at

The APLE statistics has recently been proposed as a competitor to the well-established Moran's I as a measure for spatial dependence. We discuss distributional properties and simulation results on their relative performances. Furthermore it is shown, how to utilize such measures in proposing spatial designs that are useful for detecting global and local spatial dependencies.

What can be discovered in a formula for the variance of the BLUE

Andrej Pázman
Comenius University, Bratislava, Slovakia
E-mail: pazman@fmph.uniba.sk

Starting with a commonly known formula for the variance of the BLUE, the *c*-optimality criterion is extended to the parameter-free (infinite-dimensional) model and also to a nonstandard criterion in nonlinear model, which reflects simultaneously the asymptotic *c*-optimality and the necessity of statistical identifiability of parameters. The convexity (concavity) is proved, the directional derivatives are discussed, however, no numerical procedure is proposed until now.

A measure of nonlinearity in singular nonlinear regression models

Lubomír Kubáček
Palacký University, Olomouc, Czech Republic
E-mail: kubacekl@inf.upol.cz

The nonlinear least squares method is sometimes the only way how to find an estimator. If the nonlinearity of the model is not too strong, it is possible to linearize the model and to use the linear statistical theory. A problem is to decide, under which conditions this can be done. If the linearized model is regular such criteria were found. To find a solution for singular models is the aim of the paper.

Testing stability in regression relationship

Marie Hušková
Charles University in Prague, Czech Republic
E-mail: huskova@karlin.mff.cuni.cz

The talk will concern tests for stability of the regression models over time. Typically one has a sequence of observations $Y_1, \ldots, Y_n$ obtained at the ordered time points $t_1 < \cdots < t_n$ such that the first m observations follow a certain statistical (regression) model and after the m-th observation the model changes and the remaining $n - m$ observations follow another regression model. The point m is unknown.

The problem is to decide whether the (regression) model remains the same during the observational period or whether it changes. Another task is to estimate when the model is changing.

The above formulated problem has many variants. It has attracted many researchers both from theoretical and practical point of view. Applications can be found in meteorology, climatology, hydrology or environmental studies, econometric time series, statistical quality control among others.

Accuracy of *p*-values of approximate tests in testing for equality of means under unequal variances

Júlia Volaufová
Louisiana State University Health Sciences Center, New Orleans, USA
E-mail: jvolau@lsuhsc.edu

The generalization of the Behrens-Fisher problem to comparing $k > 2$ means from nonhomogenous populations has attracted the attention of statisticians for many decades. Several approaches offer different approximations to the distribution of the test statistic. The question of statistical properties of these approximations is still alive. One is the Fai-Cornelius generalization of Satterthwaite's approximation of degrees of freedom. As it turns out, this approximation is dependent on the choice of the hypothesis contrast matrix. Here we present a brief overview of several approaches suggested in the literature. We illustrate by simulation the behavior of *p*-values focusing on accuracy. In addition to

the Satterthwaite-Fai-Cornelius test, the Kenward-Roger test, the simple ANOVA F-test, the parametric bootstrap test, and the generalized F-test will be briefly discussed.

Illustrations of Neyman-Pearson tests when simple null and simple alternative are mixtures

Lynn Roy LaMotte
Louisiana State University Health Sciences Center, New Orleans, USA
E-mail: llamot@lsuhsc.edu

The Neyman-Pearson Lemma describes the construction of a most-powerful size-α test of a null distribution L_0 versus an alternative distribution L_1. In most settings, the hypotheses of interest comprise many different distributions. In some cases, the N-P test of L_0 vs. L_1 can be shown to be uniformly most powerful over broader null and alternatives, such as when the likelihood ratio is monotone. When nuisance parameters are involved, or when considering two-sided alternative hypotheses, the customary approach has been to restrict attention to unbiased tests or similar-region tests.

The approach considered here is to construct simple null and simple alternative distributions as convex combinations (mixtures) of distributions in the desired composite null and alternative hypotheses, and then to apply the N-P Lemma to them to construct tests. It can be shown that all such tests are admissible among size-α tests. Properties of such tests are illustrated in terms of several examples in terms of the family of bivariate standard normal distributions.

Maximum likelihood in the context of more general minimum distance methods

Igor Vajda
Institute of Information Theory and Automation
Academy of Sciences of the Czech Republic, Prague
E-mail: vajda@utia.cas.cz

1. Minimum distance statistical methods for the distances completely invariant with respect to sufficient transformations.
2. The information-theoretic measures of inadequacy of statistical models and the maximum likelihood estimation.
3. Information divergence as a deficit of inaccuracy.
4. Relative inaccuracy deficit as an information subdivergence.
5. Information divergence and superdivergence as maxima of information subdivergences.
6. Maximum likelihood estimates as minimizers of information divergences, subdivergences and superdivergences.
7. Extensions to the power divergences, subdivergences and superdivergences. Efficiency and robustness.

General decomposable distances. Relations to the L_1-estimators and L_2-estimators.

Optimal predicition designs in finite discrete spectrum linear regression models

František Štulajter
Comenius University, Bratislava, Slovakia
E-mail: stulajter@fmph.uniba.sk

The *n*-point exact optimal prediction design problem for the simplest nontrivial finite discrete spectrum linear regression models with correlated observation is solved. For all the models in consideration it is shown that the optimal prediction designs belong to a special class of designs supported on at least three distinct points. This permits rapid numerical calculation of the optimal design even in the cases where the explicit solution is not available.

This is a joint work with Radoslav Harman.

Generalized fiducial inference for wavelet regression

Jan Hannig
University of North Carolina at Chapel Hill, USA
E-mail: jan.hannig@unc.edu

We apply Fisher's fiducial idea to conduct statistical inference for wavelet regression. We first develop a general methodology for handling model selection problems within the fiducial framework. With this new methodology we then propose fiduical based methods for performing wavelet curve estimation, as well as constructing both pointwise and curvewise confidence intervals. It is shown that, under some mild regularity conditions, both the new fiducial based pointwise and curvewise confidence intervals have asymptotically correct coverage. Furthermore, simulation results show that these new fiducial based methods, especially for constructing pointwise confidence intervals, also possess promising empirical properties. To the best of our knowledge, this is the first time that the fiducial idea has been applied to a nonparametric estimation problem.

Rank tests in measurement errors models

Jana Jurečková
Charles University in Prague, Czech Republic
E-mail: jurecko@mff.cuni.cz

We consider the rank tests of an hypothesis on $\boldsymbol{\beta}$ or on its components in the linear regression model $Y_i = \beta_0 + \mathbf{x}_{ni}^{\top}\boldsymbol{\beta} + e_i,\ i = 1, \ldots, n$, and ask what happens if we ignore the measurement errors, which eventually affect either the Y_i or the regressors $\mathbf{x}_i,\ i = 1, \ldots, n$. We show that in some cases the rank tests still keep the significance level and are distribution-free, the errors can only reduce their efficiencies. However, to ignore the possible errors in some other cases can lead to wrong conclusions, and the tests should be modified. This mostly concerns the situation when the hypothesis is only on some components of $\boldsymbol{\beta}$ while the other components are nuisance parameters. We illustrate the behavior of the tests on simulated data.

Some results are joint with J. Picek and A. K. Md. E. Saleh.

Quantile tomography: Using quantiles with multivariate data

Ivan Mizera
University of Alberta, Edmonton, Canada
E-mail: mizera@math.ualberta.ca

Directional quantile envelopes—essentially, depth contours—are a possible way to condense the directional quantile information, the information carried by the quantiles of projections. In typical circumstances, they allow for relatively faithful and straightforward retrieval of the directional quantiles, offering a straightforward probabilistic interpretation in terms of the tangent mass at smooth boundary points. They can be viewed as a natural, nonparametric extension of "multivariate quantiles" yielded by fitted multivariate normal distribution, and, as illustrated on data examples, their construction can be adapted to elaborate frameworks—like estimation of extreme quantiles, and directional quantile regression—that require more sophisticated estimation methods than simply evaluating quantiles for empirical distributions. Their estimates are affine equivariant whenever the estimators of directional quantiles are translation and scale equivariant; mathematically, they express the dual aspect of directional quantiles.

Joint work with Linglong Kong.

Professor Andrej Pázman

Professor Andrej Pázman was born on December 6, 1938 in Prague. He got his masters degree in physics at the Faculty of Sciences of Comenius University Bratislava in 1961 and three years later, in 1964, he earned his Ph.D. from the Institute of Measurement Theory of the Slovak Academy of Sciences (SAS) in Bratislava and partly from the Institute of Information Theory and Automation in Prague, under a supervision of J. Bolf and J. Nedoma. During his Ph.D. studies he became interested in statistics and eventually he changed his research orientation entirely from physics to statistics. From 1964 to 1981 Andrej was employed at the Institute of Measurement Science of the Slovak Academy of Sciences, where he pursued research in statistics. Here, jointly with L. Kubáček, he published his first book (in Slovak) "Statistical Methods in Measurement". During the years 1966-69, he worked as a researcher at the International Joint Institutes of Nuclear Research in Dubna, Russia. He has not abandoned physics entirely - while focusing on statistical problems of physics and being motivated by real life problems in physics, it was at that time that he started to be interested in the area of optimal design of experiments.However, he felt that he needed to broaden his knowledge in probability, and hence in 1976 he enrolled at the Laboratory of Probability, University of Paris VI, where he spent five months studying probability. In 1980, Andrej was awarded a scientific degree of Dr.Sc. (Doctor of Sciences) based on a dissertation "On mathematical background of optimum experimental design". His book on the same topic appeared in the same year in Slovak and later in English translation (Foundations of Optimum Experimental Design, Reidel (Kluwer group, 1986). During years 1981-1991 he worked at the Mathematical Institute of the Slovak Academy of Sciences. Here he became the Slovak national delegate at the board of the International Banach Center in Warsaw (1986-1990). After being an adjunct professor at the Faculty of Mathematics and Physics of the Comenius University for 21 years, he left the Mathematical Institute and joined the University in 1991, where he became a full professor in 1992. In years 1992-1998 he served as the Head of the Department of Probability and Statistics, later, 1999-2002 as Head of the Section of Mathematics of the Faculty of Mathematics and Physics. In 1992-2006 he was the head of the National Committee for Dr.Sc. Dissertation Defense in probability and statistics.

Andrej continued to pursue his work in optimal experimental design. In 1986, jointly with J. Mikulecká, V. Raffaj, and M. Tokošová, he published the book "Solved Situations in Experimental Design", in Slovak. In the meantime, Andrej became very interested in nonlinear regression, which became his main research interest. Particularly, small sample properties of estimators in nonlinear regression kept him busy. The results on the uniqueness of MLE, on formulas for the density of estimators in different situations, etc., were summarized later in his book "Nonlinear statistical models" (Kluwer 1993). During this period he was invited to a number of statistical meetings and as a visiting professor at many European universities, such as Imperial College of Science and Technology in London, University of Glasgow, Berlin (east),University of Augsburg, Wirtshaft Universität Wien, Technische Universität Wien, Odense, just to name a few. His most frequent visits were to France, particularly to CNRS laboratories (cooperation with L.Pronzato), then to universities in Grenoble, Bordeaux, and INRA in Versailles. He was asked to join the editorial board of Statistics. For twenty five years (1976-2001), he served on the editorial board of Applications of Mathematics, published in Prague. During recent years Andrej became a member of the editorial board of AMUC (at Comenius University) and of Metrika (Germany 2000 – 2007).

Andrej's research in the recent years focused mainly on nonlinear models with constraints, on nonstandard properties of experimental design in nonlinear models, and on algorithms for optimum design of experiments with correlated observations.

Professor Pázman is an author or coauthor of six books and more than 90 papers published in scientific journals, such as Annals of Statistics, JSPI, Probability & Statistics Letters, Metrika,

Kybernetika, Biometrika, Computational Statistics, Tatra Mountains Mathematical Publications, and many others.

Andrej's activities extend also to other areas, such as being a member of the program committee of the periodic international conference MODA. The second long-term periodic activity is his contribution to the organization of the Probastat conferences; from the very beginning in 1974 on the national level, with some interruptions in the eighties, and again fromthe start on the international level with the most recent one in 2006.

In addition to research, Andrej devoted his time and effort also to teaching and supervising graduate Ph.D. students. Among his students are Anatolij Dvurečenskij, Peter Čerňanský, Jarka Mikulecká, Emil Horvát, Helena Koutková, Rado Harman, Milan Stehlík, and Klára Hornišová.

Professor Andrej Pázman is a leading personality in Slovak mathematical statistics. He is a member of the Learned Society of the Slovak Academy of Sciences, a member of Royal Statistical Society in UK, of the Institute of Mathematical Statistics in the USA, of the International Statistical Institute, and an honorary member of the Union of Slovak Mathematicians and Physicists. He obtained the Gold Medal of the Faculty of Mathematics and Physics of Comenius University, both, the Silver and the Gold Juraj Hronec Medals of the Slovak Academy of Sciences for Contributions to Mathematical Sciences, the Award and also the Premium of the Slovak Literary Found, and the WU Best Paper Award of the city of Vienna.

Publications of Andrej Pázman

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