Semi-parametric Efficiency, Projection and the Scott-Wild Estimator model

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In situations where data are expensive to collect, it is important to get the "biggest bang for the buck" and use statistical methods that make maximum use of the information in the data. In this talk, we discuss how this idea is made precise in statistical theory by the concept of efficiency. We deal with efficient estimation in parametric and semi-parametric models for both single and multiple samples, and describe the notion of the information bound, using the geometric notion of projection. Our results are applied to regression models for data collected under case-control and two-stage sampling. In particular, we show that the methods proposed by Alastair Scott and Chris Wild for the analysis of generalized case-control data have full semi-parametric efficiency, and hence are the best possible.

Model for students expected performance level through varying control limits in relation to power of valuation

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To date no attempt has been made to understand and measure the performance of student in the view of student's logics. This paper first of its kind in technical education based on basic statistical tools which defines a continuously varying upper and lower limits of performance assuming mid point of the limits as ideal score. Variability is more means more chances of errors. Lower the performance level of students leads to bigger range for scores obtained. Highest level of performance will lead the variability to zero. Valuation of any answer scripts involves human factor. Here we have defined a new parameter termed as "Power of Valuation" which gives an insight in to the whole process of valuation which is tangible and every valuer is identified with his power of valuation in terms of numerical value.

Statistical proofs of matrix theorems

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Matrix algebra is extensively used in the study of linear models, multivariate analysis and optimization problems. It is interesting to note that the matrix results needed to prove statistical propositions can themselves be deduced using some statistical results which can be derived without using matrix algebra. The results are based on Fisher information and its properties which can be established without using matrix results.

Anti-eigen and anti-singular values of a matrix and applications to problems in statistics

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Let A be $p \times p$ positive definite matrix. A p-vector x such that $Ax = \lambda x$ is called an eigenvector with the associated with eigenvalue λ. Equivalent characterizations are:

(i) $\cos \theta = 1$, where θ is the angle between x and Ax.

(ii) $(x' Ax)^{-1} = x A^{-1} x$.

(iii) $\cos \Phi = 1$, where Φ is the angle between $A^{1/2}x$ and $A^{-1/2}x$.

We ask the question what is x such that $\cos\theta$ as defined in (i) is a minimum or the angle of separation between x and Ax is a maximum. Such a vector is called an anti-eigenvector and $\cos \theta$ an anti-eigenvalue of A. This is the basis of operator trigonometry developed by K. Gustafson and P.D.K.M. Rao (1997), *Numerical Range: The Field of Values of Linear Operators and Matrices*, Springer. We may define a measure of departure from condition (ii) as $\min[(x' Ax)(x' A^{-1}x)]^{-1}$ which gives the same anti-eigenvalue. The same result holds if the maximum of the angle Φ between $A^{1/2}x$ and $A^{-1/2}x$ as in condition (iii) is sought. We define a hierarchical series of anti-eigenvalues, and also consider optimization problems associated with measures of separation between an r ($< p$) dimensional subspace S and its transform AS.

Similar problems are considered for a general matrix A and its singular values leading to anti-singular values.

Other possible definitions of anti-eigen and anti-singular values, and applications to problems in statistics will be presented.

Diagnosing non-linear regression structure with power additive smoothing splines

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The additive model and its extended versions have been popular and are included in some statistical softwares (Hastie and Tibshirani, 1990). However, its tight assumptions such as additivity may often give unsatisfactory fit. A power-additive smoothing spline (PASS) model, in which the power transformation (Box and Cox, 1964) is applied to response variables in the additive model, is proposed to diagnose additivity on explanatory variables. It is a nonparametric extension of the linear models with the power-additive transformation considered by Draper and Hunter (1969) and Goto (1995). The power and smoothing parameters are selected by maximizing the marginal log-likelihood in the context of an empirical Bayes approach. The marginal log-likelihood, which involves multi-dimensional integrals, is approximated by using the second-order Taylor expansion of the penalized log-likelihood around its maximum point. The approximated marginal log-likelihood is represented using the determinant of the coefficient matrix in the BLUP equations for a mixed model. A simulation experiment shows that the PASS model suggests an appropriate transformation which aims the additivity.

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On the optimal choice of the regularization parameter through variance ratio estimation

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A persistent problem in Tykhonov/Phillips regularization for the treatment of ill-conditioned linear problems is the optimal choice of the regularization parameter. Here we propose an efficient algorithm which adopts formulas from variance component estimation to compute a certain variance ratio iteratively that, after convergence, may serve as "optimal" regularization parameter. During each iteration step, the trace of a matrix with the size of the unknowns has to be evaluated.

Recollections from a fifty-year random walk midst matrices, statistics and computing

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A brief and personal overview is given of some developments in matrix algebra, statistics and computing during the years of my participation in these activities from 1945 – 2005.

Things my mother never told me about matrices

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Linear algebra is one of our most useful tools in statistics, and in science generally. The question then is: What should we teach our undergraduate and our graduate students about linear algebra, and how are we going to teach it? Furthermore, what do we need to know if we are going to do research in statistics and what resources do we need? If we are in a statistics or biostatistics department, which has separated or has always been separated from the mathematics department, should we teach our own linear algebra or should we delegate it to the mathematicians? I hope to consider some of these questions in my talk.

As far as research tools are concerned, I am currently writing a book tentatively entitled, "*A matrix handbook for statisticians*". This book is for research people who may want to use the book like a compendium or encyclopaedia to look up a particular result and also obtain some references to applications. In my talk I hope to give an overview of the subject as I currently see it. In my book, proofs will be referenced but omitted to keep down the book size. This work is still in progress so I am very interested in receiving reprints and references to useful material and talking to people about the subject.

Coefficients of ergodicity in a matrix setting

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If A is an $n \times n$ real matrix, with equal row sums a, we shall be concerned with the quantity:

$$\tau_p(A) = \sup \{ \| \delta^T A \|_p : \| \delta^T \|_p = 1, \ \delta^T \mathbf{1} = 1 \},$$

where optimization is over real-valued vectors $\delta = \{ \delta_i \}$, and $\| \delta^T \|_p = \{ \sum_{i=1}^{n} |\delta_i|^p \}^{1/p}$. In the case $p = 1$ it has explicit form $\tau_1(A) = \frac{1}{2} \max_{(i,j)} \sum_{s=1}^{n} |a_{is} - a_{js}|$ and it bounds eigenvalues of A other than a. When A is a stochastic matrix P, so that $a=1$, coefficients such as $\tau_p(P)$, have been used for investigating weak convergence in finite inhomogeneous Markov chains (products of stochastic matrices), because of the submultiplicative property of such coefficients: hence the name "coefficients of ergodicity". $\tau_1(P)$ is the Markov-Dobrushin coefficient of ergodicity. It is the spectral bounding property of this coefficient, however, which is the focus of this presentation. Statistical uses of it to be discussed include (1) its bounding the maximal correlation of a finite bivariate distribution; and (2) its measuring relative sensitivity, under perturbation of the transition matrix P, of the stationary distribution of a finite homogeneous Markov chain.

The historical origin of the Markov-Dobrushin coefficient, and some remarks (needing further development) on its relation to coefficients such as Poincaré's and Cheeger's, were given in Seneta (1996). Other aspects of ergodicity coefficients could well be surveyed. These include work published since the appearance of Seneta (1981), on explicit forms of coefficients in terms of matrix entries, on more general definitions of coefficients, and on application to matrices with structure other than that specified above for A. The author's own list of publications since 1973 on ergodicity coefficients, and publications and books relating to this topic which he has been sent by review journals and colleagues since 1981, will be made available, and will provide further guidance in this respect from their titles. More extensive literature search via MathSciNet will turn up further literature. Additions to the cited bibliography are welcome: please contact the author at the Workshop, or later by email (eseneta@maths.usyd.edu.au).

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Inequalities and equalities associated with the Watson efficiency in orthogonally partitioned full rank linear models

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We consider partitioned linear models where the model matrix $\mathbf{X} = (\mathbf{X}_1 : \mathbf{X}_2)$ has full column rank, and concentrate on the special case where $\mathbf{X}_1'\mathbf{X}_2 = \mathbf{0}$, when we say that the model is *orthogonally partitioned.* We assume that the underlying covariance matrix is positive definite and find conditions for which the total Watson efficiency of ordinary least squares exceeds, equals or is less than the product of the two subset Watson efficiencies, i.e., the product of the Watson efficiencies associated with the two subsets of parameters in the underlying partitioned linear model.

We introduce the notions of *generalized efficiency function*, *efficiency factorization multiplier* and *determinantal covariance ratio*, and obtain several inequalities and equalities. We give special attention to those partitioned linear models for which the total Watson efficiency of ordinary least squares equals the product of the two subset Watson efficiencies. A key characterization involves the relationship between a certain partial correlation coefficient and the associated ordinary correlation coefficient.

We illustrate our findings with two real data sets: Delozier's lathe data [S. Weisberg, *Applied Linear Regression*, 2^{nd} ed., Wiley, 1985] and Worsley's fMRI data [Worsley et al., *NeuroImage*, 15, 1-15, 2002].

[Joint research with Ka Lok Chu (Dawson College, Montréal), Jarkko Isotalo and Simo Puntanen (University of Tampere), following results by Chu (Ph.D. thesis, McGill University, 2004) and by Chu, Isotalo, Puntanen and Styan (*Inequalities and Applications*, Th.M. Rassias, ed., Springer, to appear).]

Eigenvectors of block circulant matrices

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The eigenvectors and eigenvalues of block circulant matrices had been found for real symmetric matrices with symmetric submatrices, and for block circulant matrices with circulant submatrices. The eigenvectors are now found for general block circulant matrices, including the Jordan Canonical Form for defective eigenvectors.

A Matrix with Consecutive Integer Eigenvalues

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A nonsymmetric matrix $\mathbf{A} = diag(\mathbf{1}^T\ \mathbf{C}) + \mathbf{C}$: N×N, where $c_{ij}=p_i(1-p_j) / (p_i-p_j)$, $c_{ii} = 0$, and $0 \leq p \leq 1$ are distinct, is remarkable due to its eigenvalues. They are consecutive integers *0* to *N-1*. The matrix has applications in sampling theory where one is looking for the inclusion probabilities of Conditional Poisson sampling design with fixed sample size *n*, given the inclusion probabilities p_i of Poisson sampling design (Bondesson et al., 2004). The eigenvector of **A** corresponding to the eigenvalue *n-1* gives solution to the problem. The findings of authors are presented in the lecture. The authors feel that similar matrices must have been considered earlier in some other context and hope to get references.

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On the commutativity of orthogonal projectors

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It is well-known that the Moore-Penrose inverse of the product of two orthogonal projectors is idempotent. Moreover, this product is an orthogonal projector if both factors commute. Basing on these facts and a useful representation of idempotent matrices, a number of results concerning the commutativity of orthogonal projectors are achieved. Special attention is paid to the group inverse and the parallel sum.

Leaving useful traces when working with matrices

K. Vehkalahti

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Matrix computations are studied in the context of multivariate statistical analysis. Examples related to measurement and factor analysis are presented, focusing on the way of working. How properly does the working process get documented, and what sort of traces are left behind, are relevant questions in any area of research. Leaving useful traces may save a considerable amount of time by helping the researcher in backtracking and managing multiple projects. It also provides better possibilities for other researchers to comprehend the points of a study. These principles are demonstrated in practice with Survo software.

Estimating the covariance matrix by spectral decomposition approach in linear mixed model

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For balanced linear mixed effects models in which random effects are multi-way classification, the covariance matrix Σ of observation vector can be written as the spectral decomposition form: $\Sigma = \sum_{i=1}^{k} \lambda_i M_i$, where the λ_i's \$ are the distinct eigenvalues of Σ and the M_i's \$ are a known completed orthogonal set of projection matrices determined by the design matrices corresponding to random effects. The λ_i's are all linear combination of unknown variance components. The estimable condition of the λ_i's is given. By using above decomposition and unified theory of the least squares which is so-called spectral decomposition estimate (SDE) approach, we can obtain estimate λ_i^* which have independent χ^2 distribution with the degree freedom $m_i = tr(M_i)$. Thus $\Sigma^* = \sum_{i=1}^{k} \lambda_i^* M_i$ is an estimate of Σ. Under the loss function $L(\Sigma^*\Sigma) = tr(\Sigma^* - \Sigma)^2$, the risk of $R(\Sigma^*) = E\{L(\Sigma^*,\Sigma)\}$ is obtained. For the random effect model, it is proved that three estimates (SDE , ANOVAE and MINQUE) of Σ have the same risk function.

On permutations of matrix products

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It is well-known that *trace*$(AB) \geq 0$ for nonnegative definite A and B. However, *trace*(ABC) can be positive, zero or negative, even when C is nonnegative definite. The genesis of the present investigation is consideration of a product of square matrices $A=A_1A_2, \ldots, A_n$. Permuting the factors of A leads to a different matrix product. We are interested in conditions under which the spectrum remains invariant.

Publication of Papers

The Editors of "Research Letters in Information and Mathematical Sciences" (RLIMS) will publish a special issue of RLIMS of papers delivered at the Workshop which will be made available on the web - see http://iims.massey.ac.nz/research/letters/. A printed version of the special RLIMS issue will be made available to all participants.

Note that RLIMS is a preprint series. After editing, articles are published online and can be referenced. Copyright remains with the authors. All participants will be able to submit their manuscript to a refereed journal for publication.

Manuscripts for this special issue of RLIMS should be submitted, electronically to Dr Paul Cowpertwait <P.S.Cowpertwait@massey.ac.nz> by June 30, 2005 using one of the templates (Word or Latex) available at http://iims.massey.ac.nz/research/letters/instructions.html

"International Statistical Review" (ISR)
The IOC have agreed to an arrangement whereby participants delivering "synthesis and review" type statistical papers will, subject to the usual referring process, be given strong consideration for having their manuscript published in the ISR. This is a review journal, and does not cater for narrowly specialized papers. Publication will be fast once the referees' reports are positive. Participants are recommended to consult the "Statement of Editorial Policy" from the Editors of ISR (below). *Participants presenting narrowly specialized technical papers should consider making a submission to "Linear Algebra and its Applications" or the "Electronic Journal of Linear Algebra".*

INTERNATIONAL STATISTICAL REVIEW

Statement of Editorial Policy

The *International Statistical Review (ISR)* is the flagship journal of the International Statistical Institute and of its constituent sections (the Bernoulli Society for Mathematical Statistics and Probability, the International Association for Official Statistics, the International Association for Statistical Computing, the International Association for Statistical Education and the International Association of Survey Statisticians). The *ISR* is widely circulated and subscribed to by individuals and institutions in all parts of the world.

The main aim of the *ISR* is to publish papers of an expository, review, or tutorial nature that will be of wide interest to readers. Such papers may or may not contain strictly original material. All papers are refereed.

The *ISR* has two Editors, in order to demonstrate its commitment to the whole field of statistics, widely interpreted. Eugene Seneta of the University of Sydney, Australia, is primarily responsible for papers in the broad area of mathematical and theoretical statistics and probability, as well as computational statistics, statistics as applied in the physical, biological, medical and environmental sciences, industry and commerce, history of statistics and the teaching of statistics. Asta Manninen of the City of Helsinki, Urban Facts, Finland, is primarily responsible for the areas of official and government statistics and public policy, demography and population studies, banking and finance, the social sciences, survey statistics, as well as for papers of broad public interest.

Review papers are the main raison d'être of the *ISR*, but the kind of review that the Editors would wish to encourage is *not* purely bibliographic. Readers of the *ISR* will find 'critical reviews' far more useful and these are very strongly encouraged. A critical review is one that provides an introduction to a field, pointers to key original references, and clear and interesting insights and comments both about past work and about future directions for research and applications. A good critical review will be accessible to non-specialists while being stimulating and interesting to experts. It will of necessity be something of a 'personal view' of a subject while of course retaining scientific integrity and giving full credit to original sources of cited work. There is no need for a critical review to attempt exhaustive coverage of the field (provided it does not claim to do so!) and careful direction towards key references is more important than any attempt at an exhaustive bibliography.

Broadly based papers of wide interest that contain original material are very much welcomed. However the Editors do not wish to publish (even really excellent) technically original papers that are accessible or interesting only to a small group of specialists.

Papers on the history of statistics and probability are welcomed provided they are of wide interest and preferably if they convey insights of current relevance.

Authors and referees of all papers should bear in mind that many of the readers of the *ISR* (particularly in the developing world) do not have easy access to libraries or to other journals, and therefore it is hoped that papers will be as self-contained as possible, while of course giving proper bibliographic credit.

Eugene Seneta and Asta Manninen, Joint Editors
September, 2003.

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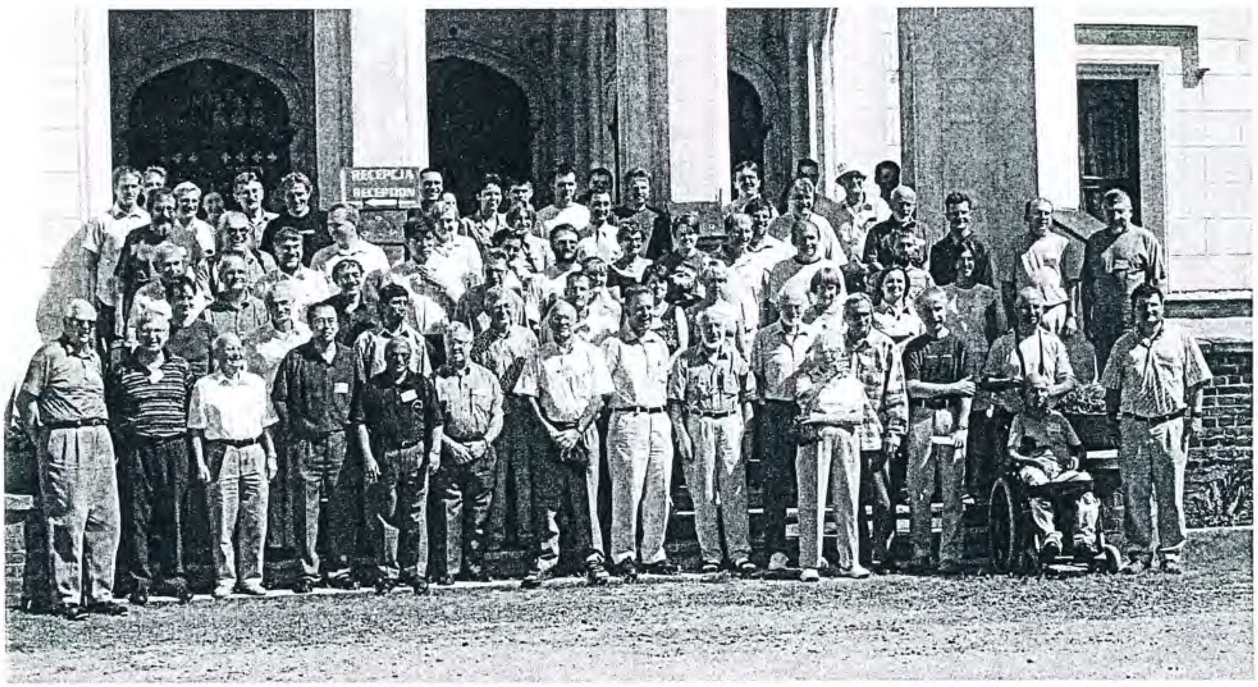
Photograph of Participants from the last IWMS meeting

Participants of the 13th International Workshop in Matrices and Statistics held at Bedlewo, Poland, 18 – 21 August 2004.



Photograph by Hazel Hunter

Some Biographical Material on the Keynote Speakers

The Workshop organizers are grateful to Professors C R Rao, Shayle Searle, George Seber, and Eugene Seneta for their acceptance of the invitations to deliver the keynote talks.

We have included in this booklet the following biographical information

Professor C R Rao
Short biography of C R Rao, F.R.S.
"A Conversation with C R Rao, Interview by Morris DeGroot, in *Statistical Science*, Vol 2, 1987. Reprinted with permission of the Institute of Mathematical Statistics.

Professor Shayle Searle
"Shayle Searle's Contributions to the Evolution of the SAS System" by Robert N. Rodriguez, Russell D. Wolfinger, Randall D. Tobias, SAS Institute Inc., SAS Campus Drive, Cary, NC 27513 USA. Provided by the SAS Institute, Cary, NC, U.S.A.

Professor Eugene Seneta
"Pitman Medal Awarded to E. Seneta." *Australian and New Zealand Journal of Statistics*, 40(4), *pp*385-387, 1998. Reprinted with permission from Blackwell Publishing Ltd.

Professor George Seber
A short biography of George Seber