

## ROBERT J. SERFLING

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### Personal

Married, with five children, the 14-year-old still at home

### Research Interests

*General:* Statistics, Probability, Applied Stochastic Processes, Asymptotic Theory

*Major Current Topics:*

Nonparametric and Robust Multivariate Analysis and Outlier Detection via Quantile Methods

Robust Inference for Multivariate Distributions and Time Series with Very Heavy Tails

Probabilistic Modeling and Statistical Methods in Prostate Cancer Detection and Diagnosis

### Education

Ph.D. (Mathematical Statistics, minor in Public Health), University of North Carolina at Chapel Hill, 1967

B.S. (Mathematics), Georgia Institute of Technology, 1963

### Positions

Professor (1993-present) (*Head*, February 1994 – December 1995), Department of Mathematical Sciences, University of Texas at Dallas

Professor (1979–93) (*Chairman-Elect*, 1980–81, *Chairman*, 1981–85, 1986–88), Department of Mathematical Sciences, Johns Hopkins University

Professor (1975–79), Associate Professor (1970–75), Assistant Professor (1967–70), Department of Statistics, Florida State University

Research Statistician (1966–67), Research Triangle Institute, Research Triangle Park, North Carolina

Mathematician (summers of 1963, 1964), Lockheed Aircraft Corporation, Marietta, Georgia

Statistical Research Assistant (1960-62), Biostatistics Unit, Georgia Department of Public Health, Atlanta, Georgia

### Selected Honors

*Fellow*, American Statistical Association, 1973

*Fellow*, Institute of Mathematical Statistics, 1976

*Elected Member*, International Statistical Institute, 1977

*Recipient of Humboldt-Preis*, awarded by the Alexander von Humboldt Stiftung, Germany, “in recognition of accomplishments in research and teaching,” 1985

*Award for Best Contributed Paper in Nonparametric Statistics at 2002 Joint Statistical Meetings* (in a tie with Ron Randles), awarded by Section on Nonparametric Statistics, American Statistical Association, 2003

*Elected to offices of 2007 Program Chair-Elect and 2008 Program Chair*, Section on Nonparametric Statistics, American Statistical Association, 2006

*R. L. Anderson Lecturer*, Department of Statistics, University of Kentucky, 2007

*Main Guest Lecturer* (4 lectures), *Annual Conference of Finnish Statisticians*, 2007

*Lead Plenary Talk*, *International Symposium on New Directions in Asymptotic Statistics*, University of Georgia, May 2009

## **Selected Visits**

Statistical Advisor (1977–78), Division of Science Resources Studies, National Science Foundation  
Served as specially appointed one-year Statistical Advisor during planning of the ten-year cycle of surveys conducted by the Division and the Census Bureau, commencing with the 1980 Census, for purpose of developing accurate estimates of scientific and engineering manpower in areas critical to government policy and planning. Formulated quantitatively the general goals of the Division and the criteria to be met. Developed recommendations on optimal allocation of the budget across the various surveys to obtain desired accuracy for each of many composite estimates at various levels of aggregation. Articulated recommendations to the staffs of the Division and the Census Bureau.

Visiting Scholar (May–June 1982), Limburgs Universitair Centrum, Belgium, under support of the Belgian NSF

Humboldt Awardee and Visiting Professor (January–July 1986), Institut für Mathematische Stochastik der Albert–Ludwigs–Universität, Freiburg i. Br., Germany

Program Officer (September 2004–November 2005), Probability and Statistics Programs, Division of Mathematical Sciences, National Science Foundation

## **Grants and Contracts**

Co-Investigator, *A Probabilistic Approach to Traffic Problems: Phase I*, Federal Highway Administration, U. S. Department of Transportation (Contract No. FH-11-6680), 1967–69

Co-Investigator, *A Probabilistic Approach to Traffic Problems: Phase II*, Federal Highway Administration, U. S. Department of Transportation (Contract No. FH-11-6890), 1969–70

Co-Investigator, *A Probabilistic Approach to Traffic Problems: Phase III*, Federal Highway Administration, U. S. Department of Transportation (Contract No. DOT-FH-11-7661), 1970–71

Administrator, NSF grant for CBMS Conference, *Limit Theorems in Statistics*, Florida State University, 1969

Principal Investigator, *Sequential Sampling of Finite Populations*, Florida State University (competitive award, Contract No. 011204-014), 1971–72

Principal Investigator, *Testing for Normality of Data*, Florida State University (competitive award, Contract No. 011205-043), 1972–73

Co-Investigator, *Quality and Reliability Evaluation and Naval Probabilistic Applications*, Office of Naval Research, Department of the Navy (Contract No. N00014-67-A-0235-0006), 1972–75

Co-Investigator, *Development of Statistical Methodology for the Design and Analysis of Weather Modification Experiments*, Office of Naval Research, Department of the Navy (Contract No. N00014-76-C-0394), 1976–77

Principal Investigator, *Probability and Statistics for Naval Experimentation, Evaluation, and*

*Operations*, Office of Naval Research, Department of the Navy (Contract No. N00014-76-C-0608), 1976–79

Principal Investigator, *Statistical Evaluation*, Office of Naval Research, Department of the Navy (Contract No. N00014-79-C-0801), 1979–82

Principal Investigator, *Ship Design Reliability Evaluation*, Naval Sea Systems Command, Department of the Navy (Contract No. N00024-82-C-5342), 1982–84

Principal Investigator, *Statistical Evaluation*, Office of Naval Research, Department of the Navy (Contract No. N00014-79-C-0801), 1982–85

Co-Administrator, ONR grant for Mathematical Sciences Lecture Series, *Efficient and Adaptive Nonparametric Statistical Inference*, Johns Hopkins University, June 1983

Co-Administrator, ONR grant for Mathematical Sciences Lecture Series, *Inference for Stochastic Processes of Semimartingale Type*, Johns Hopkins University, July 1984

Principal Investigator, *Statistical Evaluation*, Office of Naval Research, Department of the Navy (Contract No. N00014-79-C-0801), 1985–88

Co-Administrator. ONR grant for Mathematical Sciences Lecture Series, *Probabilistic Analysis of Combinatorial Optimization Problems*, Johns Hopkins University, June 1987

Project Coordinator, *Convergence Theory for Generalized Types of Robust and Nonparametric Statistics*, Collaborative Research Grants Programme, Scientific Affairs Division, North Atlantic Treaty Organization (Grant No. 0034/87), 1987–88

Principal Investigator, *Statistical Evaluation*, Office of Naval Research, Department of the Navy (Contract No. N00014-88-K-0090), 1988–1990

Principal Investigator, *Statistical Evaluation*, Office of Naval Research, Department of the Navy (Contract No. N00014-90-J-1671), 1990–1992

Co-Investigator, *Application of Empirical Process Theory to Nonstationary Time Series*, Collaborative Research Grants Programme, Scientific Affairs Division, North Atlantic Treaty Organization, 1996–1998

Principal Investigator, *Robust Methods in Actuarial Science*, Society of Actuaries and Casualty Actuarial Society, 1997–1998

Principal Investigator, *Multidimensional Depth Functions, Multidimensional Generalized L-Statistics, and Related Procedures*, National Science Foundation (Grant No. DMS-9705209), 1997–2001

Principal Investigator, *Robust and Efficient Fitting of Loss Models*, Society of Actuaries, 2000–2002

Principal Investigator, *Nonparametric and Robust Multivariate Analysis via Quantile Functions*, National Science Foundation (Grant No. DMS-0103698), 2001–2008

Principal Investigator, *Supplemental Funding for NSF Grant No. DMS-0103698*, National Science Foundation (Grant No. DMS-0432351), 2004

Principal Investigator, *Mathematical Modeling and Testing of the Relationship of Prostate Gland Volume to Prostate Cancer Detection Rate*, GlaxoSmithKline, 2004–2005

Co-Principal Investigator (with O. Daescu), *Outlier Identification and Handling in Computational Geometry Problems*, National Science Foundation (Grant No. CCF-0430366), 2004–2006

Principal Investigator, *Extended Mathematical Modeling and Testing of the Relationship of Prostate Gland Volume to Prostate Cancer Detection Rate, Fraction of Biopsy Cores, and Volume of Cancer Found*, GlaxoSmithKline, 2006–2008

Principal Investigator, *Multivariate Modeling in Actuarial Science Allowing Heavy Tailed Distributions, via the L-Moments/L-Comoments Approach*, The Actuarial Foundation, 2007–2009

Principal Investigator, *Foundations for Multivariate and Time Series Analysis with Heavy Tailed Data via L-Comoments*, National Security Agency (Grant No. H98230-08-1-0106), 2008-2010  
Principal Investigator, *Nonparametric Outlyingness and Descriptive Measures in Multivariate and General Data Settings*, National Science Foundation (Grant No. DMS-0805786), 2008-2011  
Principal Investigator, *Supplemental Funding for NSF Grant No. DMS-0805786*, National Science Foundation (Grant No. DMS-0940165), 2009

### Publications (excluding books)

- “A note on the covariance of a random variable and its reciprocal,” *American Statistician*, 1967, **21** (4), 33
- “Contributions to central limit theory for dependent variables,” *Annals of Mathematical Statistics*, 1968, **39**, 1158-1175
- “The Wilcoxon two-sample statistic on strongly mixing processes,” *Annals of Mathematical Statistics*, 1968, **39**, 1202-1209
- “Approximately optimal stratification,” *Journal of American Statistical Association*, 1968, **63**, 1298-1309
- “Non-Poisson models for traffic flow,” *Transportation Research*, 1969, **3**, 299-306
- “The variance function of the Erlang process,” *Annals of Institute of Statistical Mathematics*, 1970, **22**, 327-337
- “Moment inequalities for the maximum cumulative sum,” *Annals of Mathematical Statistics*, 1970, **41**, 1226-1234
- “Convergence properties of  $S_n$  under moment restrictions,” *Annals of Mathematical Statistics*, 1970, **41**, 1235-1248
- “On averaging over distinct units in sampling with replacement,” *Annals of Mathematical Statistics*, 1970, **41**, 2132-2134 (with R. M. Korwar)
- “On distribution function-moment relationships in a stationary point process,” *Z. Wahrscheinlichkeitstheorie ver. Gebiete*, 1971, **18**, 1-8 (with Harald Cramér and M. R. Leadbetter)
- “Point processes for traffic flow,” *Proc. 38th Session ISI* (Contributed Papers Volume), 1971, 352-357
- Contribution to discussion of paper by M. Zelen, *Proc. 38th Session ISI*, 1971, 660
- “The law of the iterated logarithm for  $U$ -statistics and related von Mises statistics,” *Annals of Mathematical Statistics*, 1971, **42**, 1974 (Abstract #71 T-49) [The abstract is the paper.]
- Book review of *Brownian Motion and Diffusion*, by David Freedman, *Technometrics*, 1973, **15**, 653-654
- “Convergence rates for  $U$ -statistics and related statistics,” *Annals of Statistics*, 1973, **1**, 153-160 (with William F. Grams)
- “Probability inequalities for the sum in sampling without replacement,” *Annals of Statistics*, 1974, **2**, 39-48
- “Research in point processes, with applications in reliability and biometry,” in *Reliability and Biometry: Statistical Analysis of Lifelength* (F. Proschan and R. J. Serfling, eds.), SIAM, 1974, 109-128
- “A general Poisson approximation theorem,” *Annals of Probability*, 1975, **3**, 726-731
- “The Poisson distribution for the frequency of rare levels of persistent meteorological elements,” in *Proc. 4th Conf. on Probability and Statistics in Atmospheric Sciences*, 1975, 135-138
- “Asymptotic theory of sequential fixed-width confidence intervals,” *Journal of American Statistical Association*, 1976, **71**, 949-955 (with D. D. Wackerly)

- “The role of the Poisson distribution in approximating system reliability of k-out-of-n structures,” *Proc. Conf. on Theory and Applications of Reliability with Emphasis on Bayesian and Non-parametric Methods* (C. P. Tsokos and I. N. Shimi, eds.), Academic Press, 1977, Vol. I, 243–258
- “General moment and probability inequalities for the maximum partial sum,” *Acta Math. Acad. Sci. Hung.*, 1977, **30**, 129–133 (with M. Longnecker)
- “Moment inequalities for  $S_n$  under general dependence restrictions, with applications,” *Z. Wahrscheinlichkeitstheorie ver. Gebiete*, 1978, **43**, 1–21 (with M. Longnecker)
- “Some elementary results on Poisson approximation in a sequence of Bernoulli trials,” *SIAM Review*, 1978, **20**, 567–579
- “A note on differentials and the CLT and LIL for statistical functions, with application to  $M$ -estimates,” *Annals of Statistics*, 1980, **8**, 618–624 (with D. D. Boos)
- Book review of *Stochastic Convergence*, (2nd ed.), by E. Lukacs, *SIAM Review*, 1980, **22**, 243–245
- “On the strong law of large numbers and related results for quasi-stationary sequences,” *Teor. Verajjatnost. i Primenen*, 1980, **25**, 190–194
- “On the Poisson approximation and some applications,” *Trans. 34th Annual Technical Conf. of ASQC*, 1980, 354–360
- “Asymptotic mean integrated squared errors of some nonparametric density estimators,” *IEEE Trans. on Information Theory*, 1981, **IT-27**, 239–242 (with P. E. Cheng)
- “On estimation of a class of efficacy-related parameters,” *Scandinavian Actuarial Journal*, 1981, **8**, 83–92 (with K.-F. Cheng)
- “Asymptotic expansions,” in *Encyclopedia of Statistical Sciences* (N. L. Johnson and S. Kotz, eds.), Vol. 1, Wiley, 1982, 137–139 & Second edition, Vol. 1, (S. Kotz, N. Balakrishnan, C. B. Read, B. Vidakovic and N. L. Johnson, eds.), Wiley, 2006, 259–261
- “Moment and probability bounds with quasi-superadditive structure for the maximum partial sum,” *Annals of Probability*, 1982, **10**, 1032–1040 (with F. A. Móricz and W. F. Stout)
- “Properties and applications of metrics on nonparametric density estimators,” *Proc. International Colloquium on Nonparametric Statistical Inference* (Budapest), North-Holland, 1983, 859–873
- “Error bounds for reconstruction of a function  $f$  from a finite sequence  $\{\text{sgn}(f(t_i) + x_i)\}$ ,” *SIAM Journal on Applied Mathematics*, 1983, **43**, 476–490 (with A. F. Karr)
- “Generalized  $L$ -,  $M$ - and  $R$ -statistics,” *Annals of Statistics*, 1984, **12**, 76–86
- “Asymptotic normality for a general class of statistical functions and applications to measures of spread,” *Annals of Statistics*, 1984, **12**, 1369–1379 (with P. Janssen and N. Veraverbeke)
- “A class of problems in statistical computation: generalized  $L$ - and related statistics,” in *Computer Science and Statistics: 16th Symposium on the Interface*, North-Holland, 1985
- “Asymptotic normality of  $U$ -statistics based on trimmed samples,” *Journal of Statistical Planning and Inference*, 1987, **16**, 63–74 (with P. Janssen and N. Veraverbeke)
- “Generalized order statistics, Bahadur representations, and sequential nonparametric fixed-width confidence intervals” *Journal of Statistical Planning and Inference*, 1988, **19**, 269–282 (with J. Choudhury)
- “Poisson approximations in selected metrics by coupling and semigroup methods, with applications,” *Journal of Statistical Planning and Inference*, 1988, **20**, 1–22 (with P. Deheuvels, A. Karr, and D. Pfeifer)
- “ $U$ -statistics,” in *Encyclopedia of Statistical Sciences* (N. L. Johnson and S. Kotz, eds.), Vol. 9, Wiley, 1988, 436–444

- “Glivenko-Cantelli properties of some generalized empirical df’s and strong convergence of generalized  $L$ -statistics,” *Probability Theory and Related Fields*, 1988, **79**, 75–93 (with R. Helmers and P. Janssen)
- “Strong uniform consistency rates for estimators of conditional functionals,” *Annals of Statistics*, 1988, **16**, 1428–1449 (with W. Härdle and P. Janssen)
- “Maximal inequalities for multidimensionally indexed submartingale arrays,” *Annals of Probability*, 1990, **18**, 630–641 (with T. C. Christofides)
- “Maximal inequalities and convergence results for generalized  $U$ -statistics,” *Journal of Statistical Planning and Inference*, 1990, **24**, 271–286 (with T. C. Christofides)
- “Berry-Esseen rates and bootstrap results for generalized  $L$ -statistics,” *Scandinavian Journal of Statistics*, 1990, **17**, 65–78 (with R. Helmers and P. Janssen)
- “ $U$ -statistics on Winsorized and trimmed samples,” *Statistics and Probability Letters*, 1990, **9**, 439–447 (with P. Janssen and N. Veraverbeke)
- “Nonparametric confidence intervals for generalized quantile parameters in multi-sample contexts,” *Nonparametric Statistics and Related Topics*, (A. K. Md. E. Saleh, ed.), North-Holland, 1992, 121–139
- [In May 1993 a moving van fire destroyed my professional materials and personal belongings. Substantial work on several new research initiatives was completely lost. After reassessing directions and priorities, I started again with new research initiatives. Consequently, there is a publication gap.]
- “ $U$ -statistics on a lattice of i.i.d. random variables,” *Statistics and Probability Letters*, 1998, **40**, 293–303 (with T. C. Christofides)
- “On the performance of some nonparametric location measures relative to a general notion of multivariate symmetry,” *Journal of Statistical Planning and Inference*, 2000, **84**, 55–79 (with Y. Zuo)
- “Robust and nonparametric estimation via generalized  $L$ -statistics: theory, applications, and perspectives,” in *Advances on Methodological and Applied Aspects of Probability and Statistics* (N. Balakrishnan, ed.), Gordon & Breach, 2000, 197–217
- “General notions of statistical depth function,” *Annals of Statistics*, 2000, **28**, 461–482 (with Y. Zuo)
- “Structural properties and convergence results for contours of sample statistical depth functions,” *Annals of Statistics*, 2000, **28**, 483–499 (with Y. Zuo)
- “Nonparametric notions of multivariate ‘scatter measure’ and ‘more scattered’ based on statistical depth functions,” *Journal of Multivariate Analysis*, 2000, **75**, 62–78 (with Y. Zuo)
- “A large deviation theorem for  $U$ -processes,” *Statistics and Probability Letters*, 2000, **49**, 181–193 (with W. Wang)
- “Robust and efficient estimation of the tail index of a one-parameter Pareto distribution,” *North American Actuarial Journal*, 2000, **4**, 12–27 (with V. Brazauskas)
- “Robust estimation of tail parameters for two-parameter Pareto and exponential models via generalized quantile statistics,” *Extremes*, 2000, **3**, 231–249 (with V. Brazauskas)
- “Small sample performance of robust estimators of tail parameters for Pareto and exponential models,” *Journal of Statistical Computation and Simulation*, 2001, **70**, 1–19 (with V. Brazauskas)
- “Shot noise on cluster processes with cluster marks, and studies of long range dependence,” *Advances in Applied Probability*, 2001, **33**, 631–651 (with F. Ramirez-Perez)
- “Quantile functions for multivariate analysis: approaches and applications,” *Statistica Neerlandica*, 2002, **56**, 214–232

- “Generalized quantile processes based on multivariate depth functions, with applications in nonparametric multivariate analysis,” *Journal of Multivariate Analysis*, 2002, **83**, 232–247
- “A depth function and a scale curve based on spatial quantiles,” in *Statistical Data Analysis Based on the  $L_1$ -Norm and Related Methods* (Y. Dodge, ed.), Birkhäuser, 2002, 25–38
- “Efficient and robust fitting of lognormal distributions,” *North American Actuarial Journal*, 2002, **6**, 95–109
- “Asymptotic normality of shot noise on Poisson cluster processes with cluster marks,” *Journal of Probability and Statistical Science*, 2003, **1**, 157–172 (with F. Ramirez-Perez)
- “Favorable estimators for fitting Pareto models: a study using goodness-of-fit measures with actual data,” *ASTIN Bulletin*, 2003, **33**, 365–381 (with V. Brazauskas)
- “Nonparametric multivariate descriptive measures based on spatial quantiles,” *Journal of Statistical Planning and Inference*, 2004, **123**, 259–278
- “Some perspectives on location and scale depth functions,” *Journal of American Statistical Association*, 2004, **99**, 970–973 [Invited and refereed discussion to I. Mizera and C. H. Müller’s “Location-scale depth (with discussion),” *Journal of American Statistical Association*, 2004, **99**, 949–989]
- “Multivariate generalized spatial signed-rank methods,” *Journal of Statistical Research*, 2004, **39**, 25–48 (special issue on Nonparametric Statistics in celebration of A. K. E. Saleh’s tenure as Chief-Editor) (with J. Möttönen and H. Oja)
- “Nonparametric multivariate kurtosis and tailweight measures,” *Journal of Nonparametric Statistics*, 2005, **17**, 441–456 (with J. Wang)
- “Extremal point queries with lines and line segments and related problems,” *Computational Geometry: Theory and Applications*, 2005, **32**, 223–237 (with O. Daescu)
- “Multivariate symmetry and asymmetry,” in *The Encyclopedia of Statistical Sciences, Second Edition*, Vol. 8 (S. Kotz, N. Balakrishnan, C. B. Read, B. Vidakovic and N. L. Johnson, eds.), Wiley, 2006, 5338–5345
- “Influence functions for a general class of depth-based generalized quantile functions,” *Journal of Multivariate Analysis*, 2006, **97**, 810–826 (with J. Wang)
- “Depth functions in nonparametric multivariate inference,” in *Data Depth: Robust Multivariate Analysis, Computational Geometry and Applications* (R. Y. Liu, R. Serfling, and D. L. Souvaine, eds.), 1–16. American Mathematical Society DIMACS Book Series, Volume 72, 2006.
- “On scale curves for nonparametric description of dispersion,” in *Data Depth: Robust Multivariate Analysis, Computational Geometry and Applications* (R. Y. Liu, R. Serfling, and D. L. Souvaine, eds.), 37–48 (with J. Wang). American Mathematical Society DIMACS Book Series, Volume 72, 2006.
- “Modeling prostate cancer detection probability using prostate specific antigen, transition and peripheral zone volumes, and numbers of biopsy cores,” *Journal of Urology*, 2007, **177**, 2352–2356 (1st author, with M. J. Shulman, G. L. Thompson, Z. Xiao, E. A. Benaim, C. G. Roehrborn, and R. Rittmaster)
- “High Grade Prostate Cancer in the Prostate Cancer Prevention Trial: Fact or Artifact?,” Invited and refereed editorial, *Journal of the National Cancer Institute*, 2007, **99**, 1355–1356 (with G. L. Andriole, P. A. Humphrey, and R. L. Grubb)
- “A contribution to multivariate L-moments: L-comoment matrices,” *Journal of Multivariate Analysis*, 2007, **98**, 1765–1781 (with P. Xiao)

- “Multivariate spatial U-quantiles: a Bahadur-Kiefer representation, a Theil-Sen estimator for multiple regression, and a robust dispersion estimator,” *Journal of Statistical Planning and Inference*, 2008, **138**, 1660–1678 (with W. Zhou)
- “Generalized multivariate rank type test statistics via spatial U-quantiles,” *Statistics and Probability Letters*, 2008, **78**, 376–383 (with W. Zhou)
- “Survey on (some) nonparametric and robust multivariate methods”, *Proceedings of 2007 Conference of Finnish Statisticians*, in *The Yearbook of the Finnish Statistical Society 2007*, 2008, 11–41
- “Influence functions of some depth functions, and application to depth-weighted L-statistics,” *Journal of Nonparametric Statistics*, 2009, **21**, 49–66 (with X. Dang and W. Zhou)
- “Inequalities relating addition and replacement type finite sample breakdown points,” *International Journal of Statistical Sciences*, 2009, **9**, 71–83 (Special Issue on Nonparametric Statistics in Honor of Professor A. K. Md. Ehsanes Saleh)
- “Exponential probability inequality and convergence results for the median absolute deviation and its modifications. *Statistics and Probability Letters*, 2009, **79**, 1767–1773 (with S. Mazumder)
- “Bahadur representations for the median absolute deviation and its modifications,” *Statistics and Probability Letters*, 2009, **79**, 1774–1783 (with S. Mazumder)
- “Some perspectives on multivariate quantile and depth functions,” *Annals of Statistics*, 2009, in press (with Y. Zuo) [Invited and refereed discussion to Marc Hallin, Davy Paindaveine, and Miroslav Šiman’s “Multivariate quantiles and multiple-output regression quantiles: from  $L_1$  optimization to halfspace depth (with discussion),” *Annals of Statistics*, 2009, in press]
- “A numerical study of multiple imputation methods using nonparametric outlier identifiers and depth-based performance criteria with clinical laboratory data,” *Journal of Statistical Computation and Simulation*, 2009, in press (with X. Dang)
- “Nonparametric depth-based multivariate outlier identifiers, and masking robustness properties,” *Journal of Statistical Planning and Inference*, 2010, **140**, 198–210 (with X. Dang)
- “Equivariance and invariance properties of multivariate quantile and related functions, and the role of standardization,” *Journal of Nonparametric Statistics*, 2010, in press
- “Asymptotic relative efficiency in estimation,” Invited entry for *International Encyclopedia of Statistical Science* (Miodrag Lovric, Ed.), Springer, 2010, to appear

### Papers Submitted or in Preparation

- “On strong invariant coordinate system (SICS) functionals”, in preparation.
- “Fitting multiple regression and autoregressive models with heavy tail errors, using Gini covariance methods”, in preparation.
- “Robust multivariate outlyingness functions using covariance standardization and projected scaled deviations”, in preparation (with S. Mazumder).

### Working Papers

- “Large deviation results for U- and V-statistics and U- and V-empiricals,” December 1998 (with W. Wang)
- “On a useful connection between samples from one- and two-parameter exponential distributions,” July 1999

## Books

- Author, *Approximation Theorems of Mathematical Statistics*, Wiley, 1980 (paperback edition, 2001)  
(Second edition in preparation)
- Author, *Depth and Quantile Functions in Nonparametric Multivariate Analysis*, Springer, in preparation
- Co-editor, *Reliability and Biometry: Statistical Analysis of Lifelength*, SIAM, 1974 (with F. Proschan)
- Co-author, *Placing Children in Special Education: A Strategy for Equity*, National Academy Press, 1982 (with other members of the National Research Council Panel on Selection and Placement of Students in Programs for the Mentally Retarded)
- Co-editor, *Data Depth: Robust Multivariate Analysis, Computational Geometry and Applications*, American Mathematical Society DIMACS Book Series, Volume 72, 2006 (with R. Y. Liu and D. L. Souvaine)

## Doctoral Students Supervised and Current Affiliations

- William F. Grams, “Rates of Convergence in the Central Limit Theorem for Dependent Variables,” 1972 (Professor, Department of Mathematics, Embry-Riddle Aeronautical University)
- Dennis D. Wackerly, “Asymptotic theory of Sequential Fixed-Width Confidence Intervals for Location Parameters,” 1973 (Professor, Department of Statistics, University of Florida)
- Constance L. Wood, “Weak Convergence of a Modified Empirical Stochastic Process with Applications to Kolmogorov-Smirnov Type Statistics,” 1975 (Professor, Department of Statistics, University of Kentucky)
- Peter F. Thall, “Robust Estimation for the Poisson Process: Models and Procedures,” 1975 (Professor, Department of Biomathematics, M. D. Anderson Cancer Center, University of Texas, Houston)
- Michael T. Longnecker, “Moment Inequalities, Maximal Inequalities, and Their Applications,” 1976 (Professor, Department of Statistics, Texas A&M University)
- Dennis D. Boos, “The Differential Approach in Statistical Theory and Robust Inference,” 1977 (Professor, Department of Statistics, North Carolina State University)
- Kuang-Fu Cheng, “Contributions to the Differential Approach for Statistics as Functionals of the Empirical Density Function,” 1979 (Professor, Graduate Institute of Statistics, Central University, Taipei, Taiwan)
- Philip E. Cheng, “On Nonparametric Estimation of Density and Regression Functions,” 1980 (Professor, Institute of Statistical Science, Academia Sinica, Taipei, Taiwan)
- Japobrata Choudhury, “Sequential Fixed-Width Confidence Intervals Based on Generalized Order Statistics, and a Study of Generalized Hodges-Lehmann Location Estimators,” 1984 (Senior Statistician, Biometrics Unit, U. S. Food and Drug Administration)
- Tasos C. Christofides, “Probability Inequalities and Convergence Theory for Multidimensionally Indexed Semimartingales, with Applications to U-Statistics,” 1987 (Professor, Department of Mathematics, University of Cyprus)
- Wenyang Wang, “Large Deviations of U-Empirical Probability Measures and Statistical Functionals,” 1994 (Senior Statistician, Chase Manhattan Bank, New York)
- Yijun Zuo, “Contributions to Theory and Applications of Statistical Depth Functions,” 1998 (Professor, Department of Statistics and Probability, Michigan State University)

- Vytaras Brazauskas, “Robust and Nonparametric Methods for Pareto Tail Index Estimation, with Actuarial Science Applications,” 1999 (Associate Professor, Department of Mathematics, University of Wisconsin at Milwaukee)
- Filemon Ramirez-Perez, “Contributions to Shot Noise on Cluster Processes with Cluster Marks,” 1999 (Associate Professor, Area de Estadística, Departamento de Fitotecnia, Universidad Autónoma Chapingo, Chapingo, Mexico)
- Zhenwu Chen, “Trimmed and Winzorized M- and Z-Estimators, with Applications to Robust Estimation in Neural Network Models,” 2000 (Senior Statistician, Texas Instruments)
- Jin Wang, “On Nonparametric Multivariate Scale, Kurtosis, and Tailweight Measures,” 2003 (Assistant Professor (tenure-track), Department of Mathematics and Statistics, Northern Arizona University)
- Xin Dang, “Nonparametric Multivariate Outlier Detection Methods, with Applications,” 2005 (Assistant Professor (tenure-track), Department of Mathematics, University of Mississippi)
- Weihua Zhou, “Multivariate Spatial U-Quantiles: Theory and Applications,” 2005 (Assistant Professor (tenure-track), Department of Mathematics and Statistics, University of North Carolina at Charlotte)
- Peng Xiao, “Contributions to Multivariate L-Moments: L-Comoment Matrices,” 2006 (Assistant Professor (tenure-track), Department of Mathematics, East Carolina University)
- Satyaki Mazumder, “Contributions to Robust Nonparametric Multivariate Outlyingness Functions,” graduation Summer 2010

## Teaching

*Regular courses on probability, statistics, stochastic processes, and related subjects:*

- Introductory Statistical Analysis (noncalculus, 2 semester sequence)
- Statistical Decision Making (noncalculus)
- Probability and Statistics for Business and Economics
- Probability and Statistics for Computer Science
- Statistics for Life Sciences
- Introduction to Probability (undergraduate majors)
- Introduction to Statistics (undergraduate majors)
- Introduction to Stochastic Processes (undergraduate majors)
- Sample Surveys (undergraduate and graduate, majors and nonmajors)
- Introduction to Real Analysis (undergraduate majors)
- Probability Theory (graduate majors)
- Statistical Theory (graduate majors)
- Stochastic Processes (graduate majors)
- Large Sample Theory (graduate majors)
- Statistical Methods (graduate majors)
- Advanced Statistical Inference I, II (graduate majors)
- Advanced Probability and Stochastic Processes (graduate majors)
- Multivariate Analysis (graduate majors)
- Nonparametric and Robust Statistical Methods (graduate majors)
- Time Series Modeling and Filtering (graduate majors)

*Graduate level special topics courses:*

Martingales and Related Inequalities  
Stochastic Point Processes  
Weak Convergence of Stochastic Processes  
Convergence Rates  
Stochastic Processes for Statistical Inference  
Advanced Large Sample Theory  
Advanced Sample Survey Topics  
Nonparametric and Robust Inference  
Statistical Inference for Stochastic Processes  
Probabilistic Analysis of Operations Research Algorithms  
Foundations of Statistical Inference  
U-Statistics and Generalized L-Statistics  
Large Deviation Theory  
Multidimensional Quantile Procedures  
Advanced Statistical Methods for Economics and Actuarial Applications  
Survival and Reliability Analysis  
Nonparametric Multivariate Methods using Quantile Methods  
Multivariate Outlier Identification and Handling

**Professional Society Memberships**

Institute of Mathematical Statistics, American Statistical Association, International Statistical Institute, Mathematical Association of America, Bernoulli Society

**Selected Service and Other Professional Activity**

*Service on numerous department and university committees for promotions, recruiting, colloquium, curriculum, advising, departmental development, department review, dean search, university planning, etc., 1967–present. Current UTD assignments include:*

Department Seminar Chairman  
Graduate Advisor for Statistics  
University Advisory Committee on Research  
University Research Integrity Committee

Service as referee for numerous journal submissions, research grant proposals, research institute proposals, external promotion cases, etc., and as international external member on selected dissertation committees, 1968–present

Chairman, Program Committee, IMS Eastern Regional Meeting, 1973

Chairman, Local Arrangements, IMS–ENAR–ASA Joint Eastern Regional Meetings, 1974

Member (*Chairman*, 1974–77), Assessment Administration Review Commission, State of Florida, by appointment of Reubin Askew, Governor, 1973–77

Served as the Statistician on a three-member commission which adjudicated court cases involving disputed sampling studies of property assessment levels in Florida counties.

Member, Editor Selection Committee, IMS, 1976–79 (Chairman, 1978)

Associate Editor, *Annals of Statistics*, 1976–79

Associate Editor, *American Statistician*, 1979–82

Member, National Academy of Science's National Research Council Panel on Selection and Placement of Students in Programs for the Mentally Retarded, 1980–82  
 Provided statistical expertise for analysis and interpretation of relevant data. Co-authored the book reporting the Panel's findings.

Associate Editor, *Communications in Statistics, Part E: Reviews in Statistics*, 1981–88

Member, Nominating Committee, IMS, 1982

Member, Operations Committee, IMS, 1982–85 (Chairman, 1984–85)

Member, Faculty Editorial Board, Johns Hopkins University Press, 1983–86

Member, U. S. Department of Navy's Technical Review Panel for Organotin Environmental Effects, 1984–85  
 Provided statistical expertise for analysis and interpretation of data on environmental effects of the use of ship hull paints containing organotins. Developed recommendations.

Member, National Academy of Science's National Research Council Committee on Applied and Theoretical Statistics, 1984–87  
 Developed recommendations on cutting-edge research directions for the field of statistics.

Associate Editor, *Journal of Statistical Planning and Inference*, 1984–1988

Representative for Johns Hopkins University on Southern Regional Council on Statistics, 1984–93

Treasurer, Bernoulli Society, 1987–1989

Member, special NSF Panel (purpose undisclosed, for confidentiality), 1988

Member, John Hopkins University's Public Interest Investment Advisory Committee, 1990–93  
 Analyzed moral and ethical issues related to financial holdings of the University. Researched activities of relevant companies. Developed recommendations for or against the retention of stocks in the University's portfolio.

Member, special Texas Higher Education Coordinating Board Panel (purpose undisclosed, for confidentiality), 1991

Member, Advisory Committee, Milton S. Eisenhower Library, Johns Hopkins University, 1991–93

IMS Representative, AMS–IMS–SIAM Committee on Joint Summer Research Conferences in the Mathematical Sciences, 1991–93

Editor, *IMS Lecture Notes — Monograph Series*, 1988–93

Organizer, *Workshop on Probabilistic and Statistical Analysis of Algorithms*, University of Texas at Dallas, 1994

Member, special NSF Panel (purpose undisclosed, for confidentiality), June 2001

Member, special NSF Panel (purpose undisclosed, for confidentiality), December 2001

Co-Organizer (with R. Liu, Y. Vardi and D. Souvaine), DIMACS Workshop on *Data Depth: Robust Multivariate Analysis, Computational Geometry, and Applications*, May 2003

Member, NSF Committee of Visitors (COV), for review of the Division of Mathematical Sciences, February 2004

Program Director, Programs in Statistics and Probability, Division of Mathematical Sciences, NSF, 2004–2005

Program Chair-Elect and Program Chair, Section on Nonparametric Statistics, for 2008 Joint Statistical Meetings, American Statistical Association, 2006–2008

Member, special NSF Panel (purpose undisclosed, for confidentiality), September 2008

Member, special NSF Panel (purpose undisclosed, for confidentiality), January 2009

Co-organizer (with Edgar Brunner and Madan Puri), Workshop on *Nonparametric Statistics, Refined, Redefined, and Renewed*, April, 2009

Editorial Advisor, *Journal of Probability and Statistical Science*, 2004–

Associate Editor, *Journal of Multivariate Analysis*, 2007–

Associate Editor, *Journal of Nonparametric Statistics*, 2007–

### **Selected Professional Consulting**

Benjamin K. Phipps, Attorney at Law (Florida)

Provided statistical evaluation of a sales ratio study of property assessments in several Florida counties. Provided expert witness testimony in court cases.

Office of Auditor General, State of Florida

Provided advisory role in the State's setting up its own unit to perform statistical sampling studies of property assessment levels over the counties. Developed sampling plans and methods for implementation by State staff. Worked with legislative committees developing legislation. Provided expert witness testimony in court cases.

Deltona Corporation (Florida)

Designed a sampling plan for a study of land use characteristics.

Westvaco Paper Co. (West Virginia)

Developed probability models for certain characteristics of paper composition.

Office of Public Defender, State of Maryland

Developed a method for probabilistic analysis of polygraph data of a certain form.

Milton S. Eisenhower Library, Johns Hopkins University (without remuneration)

Developed sampling plans for various survey projects conducted by the Library, including (1) evaluation of characteristics of its electronic card file, and (2) determination of the value and types of duplicate volumes in its holdings. Developed design recommendations for an experiment to determine longevity of old books which receive special treatment.

Boyd & Veigel, Attorneys at Law (Texas)

Developed an analysis of percentage pay differentials between grades in the various ranks of the City of Dallas Fire Department. Represented the client as expert witness.

Elizabeth Seton Church (Texas)

Designed a survey questionnaire.

Feedback Plus, Inc. (Texas)

Provided guidance on analysis of survey data.

Audience Research & Design (Texas)

Developed a report on the survey sampling methodology used by the client.

Baylor University Medical Center, Dallas (Texas)

Collaborated with the Director of Neonatology and other staff in design of a clinical trial and analysis of the data, for a study to determine whether the implementation of certain new practices has improved the consistency of neurosonography interpretation across institutions in a network.

UT Southwestern Medical Center, Dallas (Texas)

Collaborated with physicians in the Department of Urology in developing a new model for determining the optimal number of biopsies to take in biopsy sessions for prostate cancer, in designing a prospective clinical trial to test the model, and in analysis of the data.

*Journal of Urology*

Regular compensated reviewer of statistical content of submitted articles, 2007-present.

## Selected Talks

- “Contributions to central limit theory for dependent variables,” IMS Eastern Regional Meeting, 1967
- “Model-building: relaxing the independence assumption of the Poisson process,” SREB Summer Conference on Statistics, 1968
- “Approximately optimal stratification,” ASA Annual Meeting, 1968
- “Moment inequalities for the maximum cumulative sum,” IMS Annual Meeting, 1969
- “Some fundamental relationships for point processes,” IMS Eastern Regional Meeting, 1970
- “Refinements of some probability inequalities of Hoeffding,” IMS Eastern Regional Meeting, 1972
- “Probability inequalities for the sum in sampling without replacement,” IMS Eastern Regional Meeting, 1973
- “Research in point processes, with applications in reliability and biometry,” Conference on Reliability and Biometry, 1973
- “A general Poisson approximation theorem,” IMS Eastern Regional Meeting, 1975
- “The Poisson distribution for the frequency of rare levels of persistent meteorological elements,” Fourth Conference on Probability and Statistics in Atmospheric Sciences, 1975
- “The role of the Poisson distribution in approximating system reliability of k-out-of-n structures,” Conference on Theory and Applications of Reliability, 1975
- “On almost sure convergence of series in quasi-stationary random variables,” IMS Eastern Regional Meeting, 1977
- “A new technique for analyzing robust estimators. I. The general approach. II. Application to M-estimators,” ASA Annual Meeting, 1977
- “Conceptual extensions of the differential, for statistical applications,” IMS Eastern Regional Meeting, 1978
- “Setting levels of desired precision for estimates used both individually and in aggregation,” ASA Annual Meeting, 1978
- “The Berry-Esseen theorem for statistical functions,” IMS Annual Meeting, 1978
- “Probability and moment inequalities for sums, with applications,” IMS Eastern Regional Meeting, 1979
- “A variation on Scheffé’s theorem with application to nonparametric density estimation,” IMS Annual Meeting, 1979
- “The Poisson approximation: new developments with reliability applications,” ASQC Annual Technical Conference, 1980
- “Properties and applications of metrics on nonparametric density estimators,” International Colloquium on Nonparametric Statistical Inference (Budapest), 1980
- “On the almost sure convergence of nonparametric density estimators of kernel type with step function kernels,” IMS Annual Meeting, 1980
- “W-statistics,” IMS Eastern Regional Meeting, 1981
- “Error bounds for estimation of signals from hardlimited noisy data,” ASA Annual Meeting, 1981
- Two lectures, “Generalized L-statistics” and “Nonparametric density estimation,” as *Invited Special Lecturer* in the 10th Annual Lunteren Meeting on Probability and Statistics, Lunteren, Holland, 1981
- “On kernel-type density estimators with kernels having several arguments,” Oberwolfach Conference on Time Series and Density Estimation, Oberwolfach, W. Germany, 1981

- “Generalized L-, M-, and R-statistics,” 2nd International Conference on Limit Theorems in Probability and Statistics, Veszprèm, Hungary, 1982
- “Empirical distribution functions of U-statistic structure,” AMS Annual Meeting, 1984
- “On formulation and comparison of nonparametric measures of spread,” ASA Annual Meeting, 1984
- “Problems in maximal inequalities and their application to the oscillation theory of empirical processes, with applications,” Oberwolfach Conference on Mathematical Statistics, Oberwolfach, W. Germany, 1984
- “A class of problems in statistical computation: generalized L- and related statistics,” Computer Science and Statistics: 16th Symposium on the Interface, 1984
- “Generalized L- and related statistics: some results and open problems,” SREB Summer Conference on Statistics, 1984
- “A strong law of large numbers for generalized L-statistics,” AMS Annual Meeting, 1985
- “On methods of coupling,” Oberwolfach Conference on Dependence in Probability and Statistics, Oberwolfach, W. Germany, 1985
- “Generalized L-statistics,” 4th International Vilnius Conference on Probability Theory and Mathematical Statistics, Vilnius, Lithuania, 1985
- “Theory and applications of generalized U- and L-statistics,” 3rd International Meeting on Statistics in the Basque Country, Bilbao, Spain, 1985
- “Overview of problems and progress in probabilistic analysis of algorithms,” ORSA Annual Meeting, 1985
- “Maximal probability inequalities for multidimensionally indexed arrays of random variables,” Oberwolfach Conference on Mathematical Stochastics, 1986
- “A note on convergence of functions of random elements,” IMS Annual Meeting, 1986
- “U-statistics based on multidimensionally indexed arrays of random variables,” IMS Annual Meeting, 1987
- “A general survey on probabilistic analysis of algorithms,” IMS Annual Meeting, 1987
- “Probabilistic and statistical analysis of algorithms,” SRCOS/ASA Summer Research Conference, 1988
- “Berry-Esseen and bootstrap results for generalized L-statistics,” IMS Annual Meeting, 1989
- “Nonparametric confidence intervals for generalized quantile parameters in multi-sample contexts,” International Symposium on Nonparametric Statistics and Related Topics, Ottawa, Canada, 1991
- “Statistical and computational properties of some notions of multidimensional median,” Computer Science and Statistics: 24th Symposium on the Interface, 1992
- “On criteria for convergence of transformed random elements,” IMS Western Regional Meeting, 1992
- “On properties and roles of some notions of multidimensional median,” IMS Annual Meeting, 1992
- “Robust and nonparametric multiple linear regression via median-based approaches,” International Workshop on Smoothing Techniques in Statistics, Academia Sinica, Taipei, 1993
- Six lectures as *Invited Special Lecturer*, in the *3ème cycle romand de statistique et de probabilités*, sponsored by Swiss Federal Institute of Technology, Crans, Switzerland, March 1993
- “U-statistics on a lattice of random variables,” IMS Annual Meeting, 1997
- “On generalized L-statistics and some applications to Pareto tail index estimation,” as *Keynote Speaker* in the Annual Meeting of Texas Statisticians, 1998

- “On the performance of some nonparametric location measures relative to a general notion of multivariate symmetry,” IMS Annual Meeting, 1998
- “On robust estimation of a Pareto distribution tail index parameter,” ASA Annual Meeting, 1998
- “Robust and nonparametric estimation via generalized L-statistics: theory, applications, and perspectives,” International Indian Statistical Association International Conference, Hamilton, Ontario, Canada, 1998
- “Quantile functions for multivariate analysis: approaches and applications,” International Conference on *Frontier Research in Theoretical Statistics 2000*, sponsored by EURANDOM, Eindhoven, Netherlands, 2000
- “Nonparametric multivariate quantile methods,” Workshop on *Nonparametrics 2001*, Berne, Switzerland, 2001
- “Quantile methods in nonparametric multivariate analysis”, Keynote address, 2002 Robert Bohrer Memorial Workshop for Student Papers in Statistics, University of Illinois at Urbana-Champaign
- “Nonparametric multivariate descriptive measures based on spatial quantiles,” Fourth International Conference on *Statistical Analysis Based on the  $L_1$ -Norm and Related Methods*, Neuchâtel, Switzerland, 2002
- “Volume functionals and skewness measures in nonparametric multivariate analysis,” Joint ASA-IMS-ENAR Statistical Meetings, 2002
- “An overview on outlyingness, depth and quantile functions in nonparametric multivariate analysis,” Keynote address, DIMACS Workshop on *Data Depth: Robust Multivariate Analysis, Computational Geometry, and Applications*, 2003
- “Multivariate generalized spatial signed-rank methods,” Joint ASA-IMS-ENAR Statistical Meetings, 2003
- “Coherent multivariate quantile, depth, rank, and outlyingness methods,” *International Conference on Robust Statistics (ICORS 2004)*, Beijing, 2004
- “The spatial multivariate quantile function: strengths, weaknesses, and competitors”, *International Workshop on Nonparametric Statistical Methods*, Tampere, 2005
- “Cancer detection rate and grade shift in PCPT are reflections of finasteride-induced changes in prostate volume and tumor shrinkage: results of a mathematical modeling study”, Lead co-author on refereed presentation (by R. Rittmaster, M.D.), *Annual Meeting of American Urological Association*, May 2006
- [This presentation was highlighted in a feature article, “Links probed between prostate volume, cancer prediction”, by Cheryl Guttman, in the *Urology Times*, September 1, 2006. Content from the presentation was also incorporated into a Continuing Medical Education supplement to the same issue, “Update on Prostate Health”, prepared with input from the lead author.]
- “Multivariate L-moments: concepts and applications”, WNAR/IMS Joint Meeting, June 2006
- “Nonparametric multivariate outlier detection via depth and quantile functions”, *International Symposium on Nonparametric Statistics and Related Fields*, Ottawa, September 2006
- “Depth and quantile functions in nonparametric multivariate and in shape fitting”, as the *R. L. Anderson Lecturer*, Department of Statistics, University of Kentucky, April 2007
- “Survey on (some) nonparametric and robust multivariate methods” (four lectures), as the *Main Lecturer*, in the *2007 Conference of Finnish Statisticians*, Tampere, May 2007
- “Modeling of prostate cancer detection probability, with applications”, Joint Statistical Meetings, August 2007
- “Multivariate extension of L-moments via L-comoments, and applications” (presented by P. Xiao), Joint Statistical Meetings, August 2008

“Nonparametric multivariate outlier identification in  $\mathbb{R}^d$ ”, Joint Statistical Meetings, August 2008

“Robust nonparametric multivariate outlier identification”, Research Visit on Nonparametric Statistics, Université Libre de Bruxelles, October 2008

“On equivariance and invariance properties of multivariate quantile and related functions, and the role of standardization”, Workshop on *Nonparametric Statistics, Refined, Redefined, and Renewed*, University of Texas at Arlington, April 2009

“Target asymptotic problems arising with multivariate sample quantile functions” (lead plenary talk), *International Symposium on New Directions in Asymptotic Statistics*, University of Georgia, May 2009

Title to be determined, Invited Session on “Data Depth Methods in Data Mining, Clustering, and Beyond”, *International Conference on Nonparametric Statistics and Statistical Learning*, Ohio State University, May 2010

Title to be determined, IMS Invited Session on “Multivariate Ordering and Related Topics”, Joint Statistical Meetings, August 2010

*Updated November '09*