THE ANNALS of MATHEMATICAL STATISTICS

FOUNDED AND EDITED BY H. C. CARVER, 1930–1938
EDITED BY S. S. WILKS 1938–1949

THE OFFICIAL JOURNAL OF THE INSTITUTE OF MATHEMATICAL STATISTICS

VOLUME 28

Institute of Mathematical Statistics is collaborating with JSTOR to digitize, preserve, and extend access to *The Annals of Mathematical Statistics.*
www.jstor.org

CONTENTS OF VOLUME 28

ARTICLES

AGNEW, RALPH PALMER. Estimates for Global Central Limit Theorems 26–42

ANIS, A. A. AND M. E. SOLARI. Sums of a Finite Number of Independent Normal Variates 706–716

ANDERSON, T. W. AND LEO A. GOODMAN. Statistical Inference About Markov Chains 89–110

AUSTIN, T., R. FAGEN, T. LEHRER, AND W. PENNEY. The Distribution of the Number of Locally Maximal Elements in a Random Sample 786–790

BANKIER, J. A. AND R. E. WALPOLE. Components of Variance Analysis for Proportional Frequencies 742–753

BENEŠ, V. E. On Queues with Poisson Arrivals 670–677

BINET, F. E. AND G. SZEKERES. On Borel Fields Over Finite Sets 494–498

BIRNBAUM, Z. W. AND ORVAL M. KLOSE. Bounds for the Variance of the Mann-Whitney Statistic 933–945

BLACKWELL, DAVID. On Discrete Variables Whose Sum is Absolutely Continuous 520–521

BLACKWELL, DAVID AND J. L. HODGES, JR. Design for the Control of Selection Bias 449–460

BLACKWELL, DAVID AND LAMBERT KOOPMANS. On the Identifiability Problem for Functions of Finite Markov Chains 1011–1015

BLASBALG, H. Transformation of the Fundamental Relationships in Sequential Analysis 1024–1028

BLOCK, H. D. Estimates of Error for Two Modifications of the Robbins-Monro Stochastic Approximation Process 1003–1010

BLUM, J. R. AND LIONEL WEISS. Consistency of Certain Two-Sample Tests 242–246

BOX, G. E. P. AND J. S. HUNTER. Multi-Factor Experimental Designs for Exploring Response Surfaces 195–241

BRADLEY, RALPH ALLAN AND CLYDE YOUNG KRAMER. Intra-Block Analysis for Factorials in Two-Associate Class Group Divisible Designs 349–361

BRADLEY, R. A. AND D. E. W. SCHUMANN. The Comparison of the Sensitivities of Similar Experiments: Theory 902–920

BREIMAN, LEO. On Transient Markov Chains with Application to the Uniqueness Problem for Markov Processes 499–503

BREIMAN, LEO. The Individual Ergodic Theorem of Information Theory 809–811

BREIMAN, LEO. A Counterexample to a Theorem of Kolmogorov 811–814

BURTON, R. C. AND W. S. CONNOR. On the Identity Relationship for Fractional Replicates of the 2^n Series 762–767

CHU, J. T. Some Uses of Quasi-Ranges 173–180
CLARKE, BRUCE A. Maximum Likelihood Estimates in a Simple Queue 1036–1040
COHEN, A. CLIFFORD, JR. Restriction and Selection in Multinormal Distributions 731–741
CONNOR, W. S. AND R. C. BURTON. On the Identity Relationship for Fractional Replicates of the 2^n Series 762–767
DARLING, D. A. The Kolmogorov-Smirnov, Cramér-von Mises Tests 823–838
DAWSON, REED AND I. J. GOOD. Exact Markov Probabilities from Oriented Linear Graphs 946–956
DERMAN, CYRUS. Non-Parametric Up-and-Down Experimentation .. 795–798
DERMAN, C., S. LITTAUER, AND H. SOLOMON. Tightened Multi-Level Continuous Sampling Plans 395–404
DIXON, W. J. Estimates of the Mean and Standard Deviation of a Normal Population 806–809
DURAND, DAVID AND J. ARTHUR GREENWOOD. Random Unit Vectors II: Usefulness of Gram-Charlier and Related Series in Approximating Distributions 978–986
DWASS, MEYER. Modified Randomization Tests for Nonparametric Hypotheses 181–187
DWASS, MEYER. On the Distribution of Ranks and of Certain Rank Order Statistics 424–431
DWASS, MEYER AND HENRY TEICHER. On Infinitely Divisible Random Vectors 461–470
FAGEN, R., T. AUSTIN, T. LEHRER, AND W. PENNEY. The Distribution of the Number of Locally Maximal Elements in a Random Sample 786–790
FAXÉR, P. AND H. WOLD. On the Specification Error in Regression Analysis 265–267
FRASER, D. A. S. A Regression Analysis Using the Invariance Method 517–520
FRASER, D. A. S. On the Combining of Interblock and Intrablock Estimates 814–816
Fraser, D. A. S. Most Powerful Rank-Type Tests 1040–1043
FREEMAN, G. H. Some Further Methods of Constructing Regular Group Divisible Incomplete Block Designs 479–487
FREUND, JOHN E. AND R. L. WINE. On the Enumeration of Decision Patterns Involving n Means 256–259
GAUTSCHI, WERNER. Some Remarks on Systematic Sampling 385–394
GEISSER, SEYMOUR. The Distribution of the Ratios of Certain Quadratic Forms in Time Series 724–730
GIRSCHICK, M. A., S. KARLIN, AND H. L. ROYDEN. Multistage Statistical Decision Procedures 111–125
GOOD, I. J. On the Serial Test for Random Sequences 262–264

GOOD, I. J. Saddle-Point Methods for the Multinomial Distribution. 861–881
GOOD, I. J. Correction to "The Surprise Index for the Multivariate Normal Distribution" 1055
GOOD, I. J. AND REED DAWSON. Exact Markov Probabilities From Oriented Linear Graphs 838–946
GOODMAN, LEO A. AND T. W. ANDERSON. Statistical Inference About Markov Chains 89–110
GRAYBILL, FRANKLIN A. AND GEORGE MARSAGLIA. Idempotent Matrices and Quadratic Forms in the General Linear Hypothesis 678–686
GREENWOOD, J. ARTHUR AND DAVID DURAND. Random Unit Vectors II: Usefulness of Gram-Charlier and Related Series in Approximating Distributions 978–986
GUPTA, SHANTI S. AND MILTON SOBEL. On a Statistic Which Arises in Selection and Ranking Problems 957–967
GUTTMAN, IRWIN. On the Power of Optimum Tolerance Regions when Sampling From Normal Distributions 773–778
HAMMERSLEY, J. M. Percolation Processes: Lower Bounds for the Critical Probability 790–795
HODGES, J. L., JR. AND DAVID BLACKWELL. Design for the Control of Selection Bias 449–460
HUNTER, J. S. AND G. E. P. BOX. Multi-Factor Experimental Designs for Exploring Response Surfaces 195–241
JAMES, A. T. The Relationship Algebra of an Experimental Design 993–1002
JOHN, PETER W. M. Divergent Time Homogeneous Birth and Death Processes 514–517
JOHNS, M. V., JR. Non-Parametric Empirical Bayes Procedures 649–669
KARLIN, SAMUEL. Pólya Type Distributions, II 281–308
KARLIN, SAMUEL. Pólya-Type Distributions, III: Admissibility of Multi-Action Problems 839–860
KARLIN, S., M. A. GIRSCHICK, AND H. L. ROYDEN. Multistage Statistical Decision Procedures 111–125
KATZ, LEO AND JAMES H. POWELL. Probability Distributions of Random Variables Associated with a Structure of the Sample Space of Sociometric Investigations 442–448
KHATRI, C. G. AND K. V. RAMACHANDRAN. On a Decision Procedure Based on the Tukey Statistic 802–806
KIEFER, J. Invariance, Minimax Sequential Estimation and Continuous Time Processes 573–601
KIEFER*, J. AND LIONEL WEISS. Some Properties of Generalized Sequential Probability Ratio Tests 57–74
KIMURA, MOTOO. Some Problems of Stochastic Processes in Genetics. 882–901
KLOSE, ORVAL M. AND Z. W. BIRNBAUM. Bounds for the Variance of the Mann-Whitney Statistic 933–945

* See note at the end of this table of contents.

KOOPMANS, LAMBERT AND DAVID BLACKWELL. On the Identifiability Problem for Functions of Finite Markov Chains 1011–1015
KRAMER, CLYDE YOUNG AND RALPH ALLAN BRADLEY. Intra-Block Analysis for Factorials in Two-Associate Class Group Divisible Designs 349–361
LAHA, R. G. On a Characterization of the Normal Distribution from Properties of Suitable Linear Statistics 126–139
LAHA, R. G. On Some Characterization Problems Connected with Linear Structural Relations 405–414
LAHA, R. G. AND J. ROY. On Partially Balanced Linked Block Designs 488–493
LEHMANN*, E. L. A Theory of Some Multiple Decision Problems, I. .. 1–25
LEHMANN, E. L. A Theory of Some Multiple Decision Problems, II .. 547–572
LEHRER, T., T. AUSTIN, R. FAGAN, AND W. PENNEY. The Distribution of the Number of Locally Maximal Elements in a Random Sample 786–790
LITTAUER, S., C. DERMAN, AND H. SOLOMON. Tightened Multi-Level Continuous Sampling Plans 395–404
LOMNICKI, Z. A. AND S. K. ZAREMBA. On the Estimation of Autocorrelation in Time Series 140–158
LUKACS, EUGENE. Remarks Concerning Characteristic Functions .. 717–723
MARSAGLIA, GEORGE AND FRANKLIN A. GRAYBILL. Idempotent Matrices and Quadratic Forms in the General Linear Hypothesis . 678–686
MCMILLAN, B. AND J. RIORDAN. A Moving Single Server Problem . 471–478
PARZEN, EMANUEL. A Central Limit Theorem for Multilinear Stochastic Processes 252–256
PARZEN, EMANUEL. On Consistent Estimates of the Spectrum of a Stationary Time Series 329–348
PARZEN, EMANUEL. On Choosing an Estimate of the Spectral Density Function of a Stationary Time Series 921–932
PENNEY, W., T. AUSTIN, R. FAGEN, AND T. LEHRER. The Distribution of the Number of Locally Maximal Elements in a Random Sample 786–790
PITCHER, T. S. Sets of Measures Not Admitting Necessary and Sufficient Statistics or Subfields 267–268
POWELL, JAMES H. AND LEO KATZ. Probability Distributions of Random Variables Associated with a Structure of the Sample Space of Sociometric Investigations 442–448
RAMACHANDRAN, K. V. AND C. G. KHATRI. On a Decision Procedure Based on the Tukey Statistic 802–806
RAY, W. D. A Proof that the Sequential Probability Ratio Test (S.P.R.T.) of the General Linear Hypothesis Terminates with Probability Unity 521–523

* See note at the end of this table of contents.

REICH, EDGAR. Waiting Times when Queues are in Tandem 768–773
RIORDAN, J. AND B. MCMILLAN. A Moving Single Server Problem .. 471–478
ROY, J. AND R. G. LAHA. On Partially Balanced Linked Block Designs 488–493
ROYDEN, H. L., M. A. GIRSHICK, AND S. KARLIN. Multistage Statistical Decision Procedures 111–125
RUSTAGI, JAGDISH SHARAN. On Minimizing and Maximizing a Certain Integral with Statistical Applications 309–328
SARKADI, K. On the Distribution of the Number of Exceedances 1021–1023
SAVAGE, LEONARD J. When Different Pairs of Hypotheses Have the Same Family of Likelihood-Ratio Test Regions 1028–1032
SAVAGE, I. RICHARD. Contributions to the Theory of Rank Order Statistics—The "Trend" Case 968–977
SCHUMANN, D. E. W. AND R. A. BRADLEY. The Comparison of the Sensitivities of Similar Experiments: Theory 902–920
SEVERO, NORMAN C. Asymptotic Behavior of Tests on the Mean of a Logarithmico-Normal Distribution With Known Variance 1044–1046
SHAPIRO, J. M. Sums of Independent Truncated Random Variables. 754–761
SHERMAN, B. Percentiles of the ω_n Statistic 259–261
SMITH, WALTER L. A Note on Truncation and Sufficient Statistics ... 247–252
SOBEL, MILTON AND SHANTI S. GUPTA. On a Statistic Which Arises in Selection and Ranking Problems 957–967
SOLARI, M. E. AND A. A. ANIS. Sums of a Finite Number of Independent Normal Variates 706–716
SOLOMON, H., C. DERMAN, AND S. LITTAUER. Tightened Multi-Level Continuous Sampling Plans 395–404
SPROTT, D. A. Correction to "A Note on Combined Interblock and Intrablock Estimation in Incomplete Block Designs" 269
STANTON, RALPH G. A note on BIBDS 1054–1055
STEINHAUS, H. The Problem of Estimation 633–648
STERRETT, ANDREW. On the Detection of Defective Members of LARGE POPULATIONS 1033–1036
SUKHATME, BALKRISHNA V. On Certain Two-sample Non-parametric Tests for Variances 188–194
SZEKERES, G. AND F. E. BINET. On Borel Fields Over Finite Sets ... 494–498
TEICHER, HENRY AND MEYER DWASS. On Infinitely Divisible Random Vectors 461–470
TEICHROEW, D. The Mixture of Normal Distributions with Different Variances 510–512
THOMASIAN, A. J. Metrics and Norms on Spaces of Random Variables 512–514
TSAO, CHIA KUEI. Approximations to the Power of Rank Tests 159–172
TUKEY, JOHN W. Variances of Variance Components: II. The Unbalanced Single Classification 43–56

TUKEY, JOHN W. Variances of Variance Components: III. Third Moments in a Balanced Single Classification 378–384
TUKEY, JOHN W. Some Examples with Fiducial Relevance 697–695
TUKEY, J. W. On the Comparative Anatomy of Transformations .. 602–632
TUKEY, JOHN W. Sums of Random Partitions of Ranks 987–992
TWEEDIE, M. C. K. Statistical Properties of Inverse Gaussian Distributions. I 362–377
TWEEDIE, M. C. K. Statistical Properties of Inverse Gaussian Distributions. II 696–705
WALPOLE, R. E. AND J. D. BANKIER. Components of Variance Analysis for Proportional Frequencies 742–753
WALSH, JOHN E. Estimating Future from Past in Life Testing 432–441
WEINGARTEN, HARRY. Tables for Type A Critical Regions 1052–1053
WEISS, LIONEL. The Convergence of Certain Functions of Sample Spacings 778–782
WEISS, LIONEL. The Asymptotic Power of Certain Tests of Fit Based on Sample Spacings 782–786
WEISS, LIONEL. Tests of Fit in the Presence of Nuisance Location and Scale Parameters 1016–1020
WEISS, LIONEL AND J. R. BLUM. Consistency of Certain Two-sample Tests 242–246
WEISS*, LIONEL AND J. KIEFER. Some Properties of Generalized Sequential Probability Ratio Tests 57–74
WENDEL, J. G. Groups and Conditional Monte Carlo 1048–1052
WHITE, JOHN S. Approximate Moments for the Serial Correlation Coefficient 798–802
WHITE, JOHN S. A *t*- test for the Serial Correlation Coefficient 1046–1048
WIJSMAN, ROBERT A. Random Orthogonal Transformations and Their Use in Some Classical Distribution Problems in Multivariate Analysis 415–423
WINE, R. L. AND JOHN E. FREUND. On the Enumeration of Decision Patterns Involving *n* Means 256–259
WISHART, JOHN. An Approximate Formula for the Cumulative *z*-Distribution 504–510
WOLD, H. AND P. FAXÉR. On the Specification Error in Regression Analysis 265–267
WOLFOWITZ, J. The Minimum Distance Method 75–88
ZAREMBA, S. K. AND Z. A. LOMNICKI. On the Estimation of Autocorrelation in Time Series 140–158

MISCELLANEOUS

Abstracts of Papers 523–533, 816–818, 1056–1075
Institutional Members 1098

* See note at the end of this table of contents.

New and Notices.....269, 533–545, 818–822, 1076–1096
Publications Received.....279, 545, 822, 1097–1098
Minutes of the Annual Business Meeting..... 1096–1097
Report of the Washington Meeting, March 7–9..... 542–545
Report of the Atlantic City Meeting, September 10–13..... 1085–1092
Report of the President of the Institute..... 1093–1094
Report of the Secretary of the Institute..... 1096–1097
Report of the Editor of the *Annals*..... 279

Note the following correction to Volume 28. Page 14, formula (4.12) through page 17, line 23 should be exchanged with page 70, line 8, through page 72, next-to-last line.

Index of Abstracts for 1957

ASKOVITZ, S. I., 1057
BARGMANN, R. E. and S. N. ROY, 1059
BENEŠ, VÁCLAV EDVARD, 525, 531
BHARUCHA-REID, A. T. and W. MAX WOODS, 1063
BLUMEN, ISADORE, 1066
BOSE, R. C. and R. C. BURTON, 533
BOX, G. E. P., 816
BRADLEY, RALPH A. and CLYDE Y. KRAMER, 816
BÜHLMANN, HANS, 816, 1075
BUCHER, BRADLEY, 530
BURTON, R. C. and R. C. BOSE, 533
CHERNOFF, HERMAN and I. RICHARD SAVAGE, 1068
CHU, J. T., F. C. LEONE and C. W. TOPP, 530
CLARKE, A. BRUCE, 523
CRAIG, ALLEN T., 1057
DERWORT, BERNARD J. and WALDO A. VEZEAU, 1064
DIAMOND, EARL L., 527, 1066, 1067
FERRIS, GEORGE E., 816
GARRATT, A. E., 532
GART, JOHN J., 526
GAUTSCHI, WERNER, 1058
GEISSER, SEYMOUR and SAMUEL W. GREENHOUSE, 818
GNANADESIKAN, R. and S. N. ROY, 527, 1061, 1062
GOODMAN, LEO A., 1065, 1066, 1072
GOODMAN, NATHANIEL ROY, 817
GREENHOUSE, SAMUEL W. and SEYMOUR GEISSER, 818
GUPTA, SHANTI S. and MILTON SOBEL, 531
GURLAND, JOHN, 528, 1056
GUTHRIE, DONALD, JR., 1061, 1069
HALPERIN, MAX, 1069
HARTER, H. LEON, 1062
HARTKEMEIER, HARRY P., 523
HARRIS, BERNARD, 1064
HODGES, J. L., JR., 817
HOEFFDING, W. and J. WOLFOWITZ, 818
HOGG, ROBERT V. and ALLEN T. CRAIG, 1057
HOTELLING, HAROLD, 1056
JOHNS, M. V., JR., 1061, 1069, 1073
KALLIANPUR, GOPINATH, 532
KIEFER, J., 1058, 1058
KRAFT, C. H. and I. OLKIN, 530
KRAMER, CLYDE Y. and RALPH A. BRADLEY, 816
LAURENT, ANDRE G., 1074
LEONE, F. C., J. T. CHU and C. W. TOPP, 530
LLOYD, STUART P., 1059
LUBIN, ARDIE, 524
LUM, MARY D., 1068
MALONEY, CLIFFORD J., 1074
MCFADDEN, J. A., 529
MORRISON, DONALD F. and HAROLD HOTELLING, 1056
MOUSTAFA, M. D., 1073
MOUSTAFA, M. D. and S. N. ROY, 528
MOUSTAFA, M. D., S. N. ROY and J. OGAWA, 1072
NEWMAN, PETER, 1056
NEYMAN, J. and ELIZABETH SCOTT, 1071
NOETHER, GOTTFRIED E., 532
OGAWA, JUNJIRO, 525, 529, 529, 1072
OGAWA, J., M. D. MOUSTAFA, and S. N. ROY, 1072
OLKIN, I. and C. H. KRAFT, 530
PARZEN, EMANUEL, 1056
POTTHOFF, R. F., 1059
PYKE, RONALD, 1064
RAO, M. M., 1062
ROHATGI, MANDAKINI, 1071, 1072
ROSENBERG, LLOYD and JOHN GURLAND, 1056

ROSENBLATT, DAVID, 524, 525, 526, 1060, 1060, 1060, 1061
ROY, S. N., 527
ROY, S. N. and R. E. BARGMANN, 1059
ROY, S. N. and R. GNANADESIKAN, 527, 1062
ROY, S. N., J. OGAWA and M. D. MOUSTAFA, 1072
ROY, S. N. and R. F. POTTHOFF, 1059
SAVAGE, I. RICHARD and HERMAN CHERNOFF, 1068
SCARF, HERBERT, 1066
SCOTT, ELIZABETH L. and J. NEYMAN, 1071
SEAL, K. C., 1075
SIDDIQUI, M. M., 1063, 1063
SKIBINSKY, MORRIS, 529
SOBEL, MILTON and SHANTI S. GUPTA, 531
STECK, GEORGE P., 1065
TOPP, C. W., J. T. CHU and F. C. LEONE, 530
VEZEAU, WALDO A. and BERNARD J. DERWORT, 1064
VAN DER VAART, H. ROBERT, 531, 1069, 1070, 1070, 1070
WALSH, JOHN E., 817
WHITE, JOHN S., 1057
WILLIAMS, EVAN J., 528
WOLFOWITZ, J. and W. HOEFFDING, 818
WOODS, W. MAX, 1063
ZELEN, MARVIN, 526