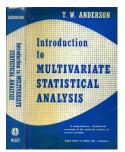
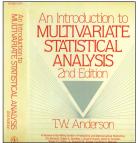
Some comments on T. W. Anderson's publications¹

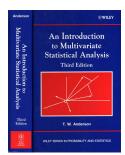


¹By George P. H. Styan: Special invited talk at the 17th International Workshop on Matrices and Statistics in Honour of Prof. T. W. Anderson's 90th Birthday, Tomar, Portugal, 23–26 July 2008. Talk based on the handout = "annotated and illustrated bibliography with hyperlinks for T. W. Anderson in celebration of his 90th birthday" by Simo Puntanen & George P. H. Styan, 12 pp. This file compiled on July 23, 2008.

It was 50 years ago that T. W. Anderson published the first edition of his multivariate book. In 1962 when I first met Professor Anderson at Columbia University, I asked him which book he would be using in teaching multivariate analysis. He said "I think probably it will be my book."





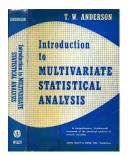


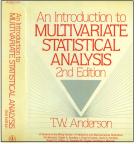
Original version: 1958 (687); 2nd Edition: 1984 (612); 3rd Edition: 2003 (231)²

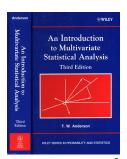
Francis John Anscombe (1918–2001): "Undoubtedly Prof. Anderson's book [1] will long remain the standard extbook and work of reference for multivariate theory based on the normal distribution. If such a beautifully written and beautifully printed book can have any fault—of being ever so slightly too smooth—what a good fault ..."

 $^{^2}$ The numbers in parentheses are the numbers of "libraries worldwide that own item" according to the open-access WorldCat First Search OCLC (Online Computer Library Center), 8 July 2008. Total = 1530.

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It was 60 years ago, however, that T. W. Anderson published what is probably still my favourite paper³ by him.

On the Theory of Testing Serial Correlation. By T. W. Anderson 2 (Stockholm).

1. Introduction

Several different statistics have been proposed for testing the independence between successive observations from a normal population. In order to choose between the various tests a theory of testing this hypothesis in certain populations is needed. In this paper the problem is studied within the framework of the Neyman-Pearson theory. Certain theorems concerning more general problems of quadratic forms are developed and later applied to the question of testing serial

It is shown that +beat+ tests exist for serial correlation in certain populations: for example, in a circular population. In other populations there may not be a best test; for example in certain stationary cases. When the observations have as expected values a linear repression on given sfixed variatess. it is shown that if there is a certain relation between the fixed variates and the quadratic forms involved, best tests exist. In other cases there may exist no best test.

It is shown how a serial correlation coefficient is conatructed when a best test exists. The problem of finding its distribution is reduced to a standard problem. A table of significance levels is given for two such statistics.

2. The Class of Similar Regions,

Many problems concerning serial correlation can be put into the following form: Let the joint density function of

² Inchaded in Combin Commission Paper, New Series No. 30. ² Follow of the John Stmon Guggenheim Memorial Foundation

Research Associate of the Cownes Commission for Research in Economics.

C 1968. Absenter & William's Subtracker! Abliefulation Expensed with pensionator, trobading correction notes on page 89, from Sharehousek Akharietádskyll, 31. (1943). 05-116. lee also the commentary by Jerzy K. Baksalary, Stmo Puntanee, and Goorge P. H. Seye



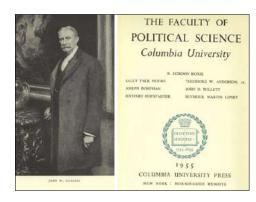




"I went to Sweden in August 1947 and staved until April 1948 ... I wanted to go abroad, I had never been out of the United States and I thought this would be an opportunity ... I had been in touch with Harald Cramér ... he was one reason for going to Sweden, Another reason was that I was interested in the land of my forebears," T. W.Anderson in [37, p. 261].

In 1995 after the 4th IWMS in Montréal, Simo Puntanen had a sore throat (possibly due to the air-conditioning in the Sheraton Centre where the IWMS was held). At a hospital in Tampere, Simo met Dr. Martin Rasmussen, who asked Simo what he did for a living. Simo told him, and Dr. Rasmussen replied that Harald Cramér (1893-1985) was his grandfather. He added that after telling this to statisticians they start kissing his toes. As a result Simo invited Dr. Rasmussen to the 8th IWMS in 1999 in Tampere, where Dr. Rasmussen gave a very nice talk in the reception before the IWMS got going. He was called Dr X in the programme booklet.

³On the theory of testing serial correlation, *Skandinavisk Aktuarietidskrift*, 31, 88–116 (reprinted (with corrections) in The Collected Papers [26, vol. 1, pp. 61-89]). See also the commentary "On T. W. Anderson's contributions to solving the problem of when the ordinary least-squares estimator is best linear unbiased and to characterizing rank additivity of matrices" by Jerzy K. Baksalary, Simo Puntanen & George P. H. Styan, The Collected Papers [26, vol. 2, pp. 1579-1591].









R. Gordon Hoxie, Sally Falk Moore, Richard Hofstadter



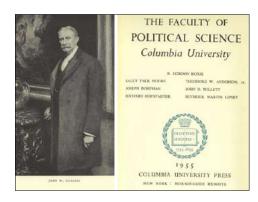


T. W. Anderson, John D. Millett, Seymour Martin Lipset 4

"John William Burgess (1844–1931) is one of the fathers of American political science [and is] likely to be remembered for his work in founding and building up the school of Political Science at Columbia University."

Ralph Gordon Hoxie (1919–2002) and others founded the Center for the Study of the Presidency, under the name of the Library of Presidential Papers, a scholarly forum, which publishes Presidential Studies Quarterly as a resource and archive for historians and other scholars.

⁴We would be pleased to find an image of Joseph Dorfman (1904–1991).









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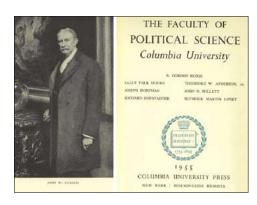


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R. Gordon Hoxie, Sally Falk Moore, Richard Hofstadter





T. W. Anderson, John D. Millett, Seymour Martin Lipset 5

Frederick H. Jackson [in the *Mississippi Valley Historical Review*]: "Founded in 1880, the Faculty of Political Science was the first division of Columbia to offer graduate work, and its founder, John W. Burgess (above left) did more than anybody to forward the university idea. In 1912, the year of Burgess's retirement as dean of the Graduate Faculties, the trustees formally recognized the metamorphosis by redesignating the institution Columbia University."

⁵We would be pleased to find an image of Joseph Dorfman (1904–1991).

SELECTED PAPERS IN STATISTICS AND PROBABILITY BY ABRAHAM WALD

Edited for the Institute of Mathematical Statistics

T. W. Anderson, Committee Chairman

H. Cramér E. L. Lehmann

H. A. Freeman A. M. Mood

J. L. Hodges, Jr. C. M. Stein







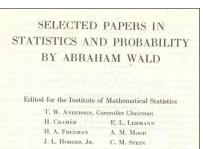






T. W. Anderson, Harald Cramér, Joseph L. Hodges, Jr., Erich L. Lehmann, Charles Stein⁶

 $^{^6}$ We would be pleased to find images of Harold Adolph Freeman (b. 1909; MIT Class of 1931), Alexander McFarlane Mood (PhD, Princeton 1940).





Samuel E. Gluck [in *Philosophy of Science*]: "The Editors have included a 104-item bibliography of Wald's writings, a short biography, and excellent indexes of names and subjects. The book now makes readily available practically all of Wald's work in book form. The current volume is a tribute to Wald's collaborators as well as to him, and a compliment to the editors of this labor of love. Abraham Wald was born in Romania in 1902. Until he entered the university he was home-educated. Living under Nazi tyranny until 1938, he then came to the United States. In 1946 Columbia University created a Department of Mathematical Statistics, with Wald as executive officer.

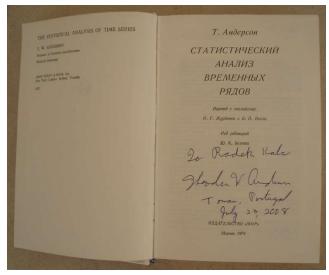
In 1950, while on a lecture tour in India, he and Mrs. Wald were killed in a plane crash."





D. R. Cox [in *Science*]: "The present volume is a fine record of Wilks's work. It begins with a quite detailed biography and critique of his research. In addition to the widely known and commonly referred to papers, which nevertheless it is good to have collected together, there are a number of papers not previously readily accessible."





T. W. Anderson's publications





T. W. Anderson, Somesh Das Gupta, George P. H. Styan, Stanley L. Sclove, Jeremy D. Finn



M. G. Kendall [in the *International Statistical Review*]: "Altogether [5] is a remarkable achievement, requiring endless patience and an encyclopaedic knowledge of the subject. It has taken ten years to complete. Statisticians throughout the world are deeply indebted to the three main authors, a large number of co-workers and, by no means least, the publisher."



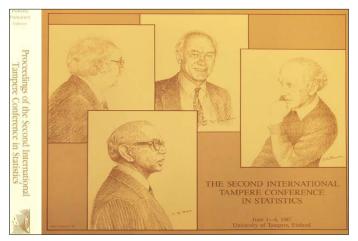
J. Richard Landis [in *Technometrics*]: "The authors of [6] are to be commended for their lucid presentation of statistical methodology within the framework of real data. As a result of the frequent usage of examples, graphs and figures, and illustrative exercises, the reader is presented with the relevance of the statistical techniques to the questions of interest."



M. J. Collop [in *Journal of the Royal Statistical Society Series A (Statistics in Society)*]: "Altogether [15] is an attractive book. The material is well motivated, by appeal to examples of actual research studies, many of which will provoke discussion in themselves.

Political pollsters may be less happy to see their performance in the 1948 Truman–Dewey presidential election still being used against them."

The Second International Tampere Conference in Statistics featured T. W. Anderson (b. 1918), with George E. P. Box (b. 1919), C. R. Rao (b. 1920) & E. J. "Ted" Hannan (1921–1994).



T. W. Anderson's publications







Lawrence R. Klein, Jingji Jiliangxue Jiangyi, T. W. Anderson

Lawrence Robert Klein (b. 1920) was awarded the Nobel memorial prize in economics in 1980 "for the creation of econometric models and the application to the analysis of economic fluctuations and economic policies".

Jingji Jiliangxue Jiangyi = Lecture Notes on Econometrics⁷
Publisher: Hangkong Gongye Chubanshe = Aviation Industry Press

Gregory C. Chow: "An important landmark in the development of modern economics [in China] was a workshop on econometrics in the summer of 1980 sponsored by the Chinese Academy of Social Science, with its Vice-president Xu Dixin as host. Lawrence Klein was the organizer. Six other lecturers were T. W. Anderson, Albert Ando, Gregory Chow, Cheng Hsiao, Lawrence Lau, and Vincent Su."

Book cover page image (and title and copyright page images to follow) courtesy Yongge Tian.







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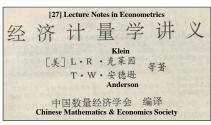
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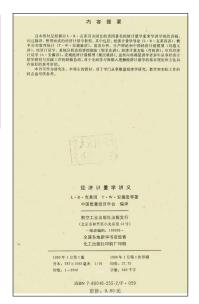
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 $^{^{7}}$ Book cover page image (and title and copyright page images to follow) courtesy Yongge Tian.









T. W. Anderson's publications







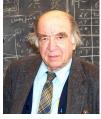
Milton Friedman (1912-2006), Leonid Hurwicz (1917-2008), Lawrence R. Klein (b. 1920)

- Anderson's Nobel number = 1 (Friedman⁸, Hurwicz⁹, Klein)
- Anderson's TIME cover number = 1 (Friedman)
- ullet Anderson's stamp number = 1 (Klein: Guinea-Bissau, Maldives)

⁸T. W. Anderson & Milton Friedman (1960). A limitation of the optimum property of the sequential probability ratio test. In *Contributions to Probability and Statistics; Essays in Honor of Harold Hotelling* (Ingram Olkin, Sudhisl G. Ghurye, Wassily Hoeffding, William G. Madow & Henry B. Mann, eds.), Stanford University Press, pp. 57–69 (reprinted in *The Collected Papers* [26, vol. 1, pp. 513–525]).

⁹T. W. Anderson & Leonid Hurwicz (1946). Statistical models with disturbances in equations and/ordisturbances in variables. Cowles Commission for Research in Economics, unpublished report.







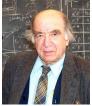
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Rose and Milton Friedman, Leonid Hurwicz, Eric Stark Maskin, Roger Myerson

Milton Friedman (1912–2006) made major contributions to the fields of economics and statistics. In 1976, he was awarded the Nobel Memorial Prize in Economic Sciences for his achievements in the fields of consumption analysis, monetary history and theory, and for his demonstration of the complexity of stabilization policy.

Leonid "Leo" Hurwicz (1917–2008) was among the first economists to recognize the value of game theory and was a pioneer in its application. In 1961 he became chairman of the <u>Statistics</u> Department at the University of Minnesota. The 2007 Nobel Memorial Prize in Economic Sciences was awarded jointly to Hurwicz, Eric Stark Maskin (b. 1950) and Roger Myerson (b. 1951) for their joint work on mechanism design. [Wikipedia]

But Anderson's Erdős number = 2 (via Donald A. Darling¹⁰)



Paul Erdős (1913–1996)





Donald A. Darling (b. 1915)11

Frank Ludvig Spitzer (1926–1992)

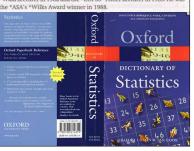
¹⁰ T. W. Anderson & D. A. Darling (1952). Asymptotic theory of certain 'goodness of fit' criteria based on stochastic processes. *The Annals of Mathematical Statistics*, 23, 193–212 (reprinted in *The Collected Papers* [26, vol. 1, pp. 243–262]).

D. A. Darling & P. Erdős (1956). A limit theorem for the maximum of normalized sums of independent random variables. *Duke Mathematical Journal*, 23, 143–155.

 $^{^{11}}$ We would be pleased to find an image of Donald A. Darling.

In the 2nd Edition [40] of the Oxford Dictionary of Statistics (Graham Upton & Ian Cook, eds., OUP 2006), we find:

Anderson, Theodore Ted' Wilbur (1918-; b. Minneapolis, MN)
American mathematical statistician who specialized in the analysis of
"multivariate data. Anderson was a graduate of Northwestern U (1939)
and Princeton U (PhD in 1945). In 1946 he joined the staff at Columbia U,
moving in 1967 to Stanford U. He was Editor of the *Annals of Mathematical
Statistics 1950-2, and President of the *IMS in 1962. He was the IMS's
"Wald Lecturer in 1982 and the *COPSS *Fisher Lecturer in 1985. He was
the *ASA's *Wilks Award winner in 1988.



Anderson-Darling test A general test, published in 1952, that compares the fit of the observed "cumulative distribution function with that expected. It was derived by "Anderson and David A. Darling is a modification of the "Cramér-von Mises test. The test statistic A" is given by

$$A^{2} = -\frac{1}{n} \sum_{j=1}^{n} (2j-1) [\ln\{F(x_{(j)})\} + \ln\{1 - F(x_{(j)})\}] - n,$$

where F is the hypothesized cumulative distribution function, n is the *sample size, and $x_{\{j\}}$ is the jth ordered *observation

 $(x_{(1)} \le x_{(2)} \le \cdots \le x_{(q)})$. The statistic can also be used to test for *normal and *exponential distributions with unknown *parameters estimated by their sample equivalents. In some cases, as shown in the following table, an adjusted test statistic is required.

| | TEST STATISTIC | UPPER TAIL PROBABILITY | | | |
|---|--|------------------------|----------------|----------------|----------------|
| | | 0.10 | 0.05 | 0.025 | 0.01 |
| Specified distribution Normal, estimated | A ² A ² | 1.933 0.894 | 2.492 1.087 | 3.070 1.285 | 3.857 1.551 |
| mean (n > 20) Normal, estimated variance (n > 20) | A^2 | 1.743 | 2.308 | 2.898 | 3.702 |
| Normal, estimated mean and variance | $A^2(1+\frac{3}{4\pi}+\frac{9}{4\pi^2})$ | 0.631 | 0.752 | 0.873 | 1.035 |
| Exponential, estimated mean | $A^2(1+\frac{3}{10n})$ | 1.062 | 1.321 | 1.591 | 1.959 |

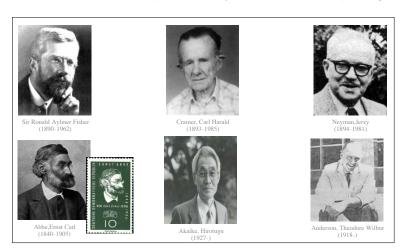
but in Wikipedia it's Donald

Anderson-Darling test

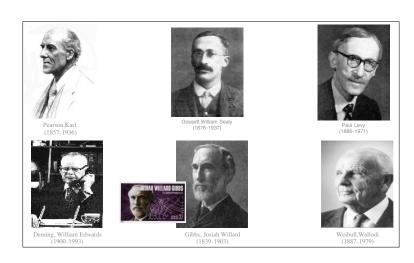
From Wikipedia, the free encyclopedia

The Anderson-Darling test, named after Theodore Wilbur Anderson, Jr. (1918–?) and [Donald A. Darling [1915–?), who invented it in $1952^{[1]}$, is one of the most powerful statistics for detecting most departures from hormality. It may be used with small sample sizes $n \le 25$. Very large sample sizes any reject the assumption of normality with only slight imperfections, but industrial data with sample sizes of 200 and more have passed the Anderson-Darling test.

We were led to the *Oxford Dictionary of Statistics* from the website of the Dept. of Statistics, National Taipei University, where we found a photo gallery 12.



 $^{^{12}}$ Possibly inspired by the photos in Sequoia Hall, see our handout, page 2. We have inserted the stamp images!





Bayes,Reverend Thomas (1701-1761)



Boole,George (1815-1864)



Blackwell, David (Harold) (1919-)



Bonferroni, Carlo Emilio (1892-1960)



Bernoulli, Jacob (Jacques) (1654-1705)



Markov, Andrei Andreevich (1856-1922)



Many thanks to Götz Trenkler for alerting me to the stamp depicting Kolmogorov. This stamp, from Portugal, also depicts Jules Henri Poincaré (1854–1912) & Kurt Gödel (1906–1978).



















T. W. Anderson, Kai-Tai Fang, Ingram Olkin; Tze Leung Lai, Ingram Olkin, Raja Velu



Morris H. DeGroot (1986), Peter C. B. Phillips (1986), Yadolah Dodge (1999)



Wayne A. Fuller, Michael D. Perlman & Harry O. Posten (video: 1995, 2005)

T. W. Anderson's publications

"As young scholars contemplate an academic career of teaching and research they are challenged and inspired by the work of senior scientists who have gone before them. Amongst econometricians, the Cowles Commission¹³ researchers of the 1940s occupy a special position of seniority and significance.

Their contributions are seen by most of us as the mainspring of decades of subsequent research. They opened up new and promising fields of research, they set new standards of mathematical rigor in their work, and they forged new and productive areas of contact with sister disciplines like mathematical statistics.

¹³ The Cowles Commission for Research in Economics is an economic research institute, founded in Colorado Springs in 1932 by Alfred Cowles (1891–1984), a businessman and economist. In 1939, the Cowles Commission moved to the University of Chicago under the directorship of Theodore Otte Yntema (1900–1985). Jacob Marschak (1898–1977) was director from 1943–1948, when it was passed over to Tjalling Charles Koopmans (1910–1985), who was the joint winner, with Leonid Vitaliyevich Kantorovich (1912–1986), of the 1975 Nobel Memorial Prize in Economics.

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"Ted Anderson was a young and energetic member of the Cowles Commission research team in 1945–1946. His individual and joint contributions were a vital element in the Cowles research endeavor during this productive period. His articles now stand as classic works in the history of econometrics, and they have helped to inspire many subsequent generations of econometricians. In mathematical statistics, as well as econometrics, Ted Anderson is a scholar of immense stature.

The scope and diversity of his research in statistical theory is almost a phenomenon in itself. Sometimes it seems that wherever one turns in the subject, Ted's mark and influence are already firmly established. His books on multivariate analysis and time series rapidly became accepted as major treatises and are now integral parts of the bookshelves of every statistician. His articles, like his books, have long established him as one of the best communicators in the statistics profession.

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"His work is nothing short of exemplary, both in rigor and in exposition, and has been the fountainhead of entire fields of subsequent research. Those of us who have had the privilege of knowing Ted as a person see him as a gentleman of humility and much personal charm.

His students, his colleagues and his friends at other institutions have all been fortunate to have intellectual and personal contact with him. It is hoped that the following interview will bring Ted closer to a much wider audience, so that all of us will now have an opportunity to learn from his thinking about matters of research and teaching, his insights into the past, and the possibilities of the future."

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