

**BRADLEY EFRON**  
Professor of Statistics and Biostatistics

---

**University Address**      Department of Statistics      **Born:** May 24, 1938, St. Paul, Minnesota  
390 Serra Mall  
Stanford University  
Stanford, CA 94305-4065      **Citizenship:** U.S. Citizen  
Phone: (650) 723-2206  
Fax: (650) 725-8977  
Email: `brad@stat.stanford.edu`

---

**Education**

1960      California Institute of Technology, B.S., Mathematics  
1962      Stanford University, M.S., Statistics  
1964      Stanford University, Ph.D., Statistics

---

**Professional Experience**

1964–1967      Assistant Professor, Department of Statistics, Stanford University, and Department of Community, Family and Preventive Medicine, Stanford School of Medicine  
1967–1968      Visiting Lecturer, Department of Statistics, Harvard University  
1968–1972      Associate Professor, Department of Statistics, Stanford University, and Department of Community, Family and Preventive Medicine, Stanford School of Medicine  
1971–1972      Visiting Scholar, Department of Mathematics, Imperial College, London  
1972–2015      Professor, Department of Community, Family and Preventive Medicine (renamed Health Research and Policy), Stanford School of Medicine  
1972–      Professor, Department of Statistics, Stanford University  
1980–      Co-director, Mathematical and Computational Science Program, Stanford University  
1987–1990      Associate Dean, School of Humanities and Sciences, Stanford University  
1988–      Max H. Stein Professor of Humanities and Sciences, Stanford University  
April–June 1991      Visiting Professor, Department of Statistics, Harvard University  
1976–1979,      Chairman, Department of Statistics, Stanford University  
1991–1994,      Chairman, Department of Statistics, Stanford University  
1993–1994,      Chairman, Department of Statistics, Stanford University  
1998–1999      Chairman, Department of Statistics, Stanford University  
1996–1997      Chairman, Stanford University Advisory Board  
1998–1999      Chairman, Stanford University Faculty Senate  
1962–      Consultant, Rand Corporation, Santa Monica, CA  
2008–2010      Consultant, Roche Palo Alto LLC, Palo Alto, CA  
2012      Consultant, Google Analytics Group, Mountain View, CA  
2015–      Professor, Department of Biomedical Data Science, Stanford School of Medicine

---

**Professional Activities**

1968–1969      Associate Editor, *Journal of the American Statistical Association*  
1969–1972      Theory and Methods Editor, *Journal of the American Statistical Association*  
1969–1972      Fellow of the University, Stanford University  
1976–1979      Executive Committee, Assembly of Mathematical and Physical Sciences  
1985      Chairman, External Advisory Committee on Statistics for University of Maryland  
1985–1986      Chairman, Overseers Committee, Department of Statistics, Harvard University

1984, Member of the Committee on Resources for the Mathematical Sciences  
 1985–1988  
 1987–1988 President, Institute of Mathematical Statistics  
 1992–1998 Member, Advisory Board, Stanford University  
 1993–1999 Elector, Chair in Statistics, Cambridge University  
 1998 Member, Review Committee, Department of Statistics, University of Washington  
 2004 President, American Statistical Association  
 2006–2012 Founding Editor, *Annals of Applied Statistics*

---

### Memberships

Fellow, Royal Statistical Society	Fellow, American Academy of Arts and Sciences
Fellow, American Statistical Association	Fellow, Institute of Mathematical Statistics
Member, National Academy of Sciences	Fellow, International Statistical Institute

---

### Honors and Awards

1977 Rietz Lecturer, Annual Meeting of the Institute of Mathematical Statistics  
 1978 Ford Prize, Mathematical Association of America  
 1981 Wald Lecturer, Annual Meeting of the Institute of Mathematical Statistics  
 1981 “Outstanding Statistician of The Year”, American Statistical Association Chicago Chapter  
 1983 MacArthur Prize Fellow  
 1983 American Academy of Arts and Sciences Fellow  
 1985 National Academy of Sciences Fellow  
 1987 Endowed Chair, Max H. Stein Professor of Statistics and Biostatistics  
 1990 Wilks Medal, American Statistical Association  
 1995 Honorary Doctor of Science Degree, University of Chicago  
 1996 Ronald A. Fisher Prize, Committee of Presidents of Statistical Societies (COPSS)  
 1998 Doctor Honoris Causa, Universidad Carlos III de Madrid, Spain  
 1998 Parzen Prize for Statistical Innovation, Texas A&M University  
 2002 Doctor Honoris Causa, University of Oslo, Norway  
 2003 C.R. and Bhargarvi Rao Prize, The Pennsylvania State University  
 2006 Gottfried E. Noether Prize, American Statistical Association  
 2005 National Medal of Science (awarded 2007)  
 2010 Distinguished Alumni Award, California Institute of Technology  
 2014 Guy Medal in Gold, Royal Statistical Society  
 2016 Frontiers of Knowledge Award, BBVA Foundation & Spanish National Research Council  
 2018 International Prize in Statistics, International Prize in Statistics Foundation

---

### Special Lectures

08.1966 Special Invited Lecturer, Annual Meeting of the IMS  
 1972 Lecturer on General Methodology, Joint Annual Meeting of the IMS and ASA  
 04.1976 Allan Craig Lecturer on Statistics, University of Iowa, Iowa City  
 05.1976 Special Lecturer in Statistics, University of Michigan, Ann Arbor  
 10.1978 Commonwealth Scientific and Industrial Research Organisation (CSIRO) Lecture Series,  
 Clayton South, Victoria, Australia  
 05.1980 Special Lecturer, Massachusetts Institute of Technology, Cambridge  
 06.1980 Principal Lecturer, National Science Foundation Research Conference, Bowling Green, Kentucky  
 03.1981 Keynote Speaker, 13th Conference on the Interface Between Computers and Statistics  
 05.1981 Principal Lecturer, Annual Meeting of Canadian Statistical Association  
 07.1981 Special Lecturer, South African Statistical Association  
 1982 Zyskind Lecturer, Iowa State University, Ames  
 07.1982 Special Invited Lecturer, University of Waterloo, Ontario  
 09.1982 Special Invited Lecturer, European Conference of Statistics, Palermo, Italy

- 10.1982 Keynote Speaker, 28th Conference on the Design of Experiments in Army Research Development and Testing, Monterey, California
- 01.1983 Special Invited Lecturer, American Mathematical Society Annual Meeting, Denver
- 06.1983 Invited Lecturer, Psychometric Society Annual Meeting, University of California, Los Angeles
- 10.1983 Keynote Speaker, Associated Colleges of the Midwest Conference on Computers and the Liberal Arts, Madison, Wisconsin
- 04.1984 Invited Lecturer, Research Workshop on Differential Geometry in Statistics, Imperial College, London
- 07.1984 Keynote Speaker, Conference on Jackknife and Bootstrap Techniques, Edinburgh
- 10.1984 Distinguished Lecturer for the Lecture Series at University of Florida, Gainesville
- 02.1985 Division Speaker, Reed College, Portland, Oregon
- 02.1985 Special Lecturer, Mathematics Association of America
- 04.1985 Special Lecturer, Recent Advances in Mathematics and Statistics, University of New Mexico, Albuquerque
- 05.1985 Special Invited Lecturer for Short Course on Bootstrapping, Norwegian Statistical Association, Oslo
- 08.1985 ASA Short Course on Bootstrap–Jackknife Methods with Robert Tibshirani, Joint Statistical Meetings, Las Vegas, Nevada
- 04.1986 Main Invited Lecturer for Gesellschaft für Angewandte Mathematik und Mechanik (GAMM) Annual Meeting, Dortmund, Germany
- 04.1987 Ferber Lecturer, University of Illinois, Chicago
- 01.1988 Walker–Ames Professor of Biostatistics and of Statistics, University of Washington, Seattle
- 04.1988 Invited Lecturer, Annual Meeting of the Spanish Statistical Association, Benidorm, Spain
- 04.1988 Keynote Speaker, 20th Interface Symposium on Computing Science and Statistics, Reston, Virginia
- 08.1988 Keynote Speaker, COMPSTAT 88, Copenhagen
- 03.1989 Fulkerson Lecturer, Cornell University, New York
- 10.1989 Hotelling Lecturer, University of North Carolina, Chapel Hill
- 02.1990 Keynote Speaker, Symposium on Bootstrapping Methods for Statistical Analysis, Wayne State University, Detroit, Michigan
- 04.1990 Hartley Lecturer, Texas A&M University, College Station
- 07.1990 Keynote Speaker, 10th Australian Statistical Conference, University of New South Wales, Sydney
- 09.1990 Keynote Speaker, 4th Latin American Congress of Probability and Mathematical Statistics (CLAPEM), Mexico City
- 11.1990 Keynote Lecturer, Workshop on The Jackknife, the Bootstrap and Other Resampling Plans, CSI-Piemonte, Torino, Italy
- 03.1991 Pierre Robillard Lecturer, Montreal
- 05.1991 Royal Statistical Reading at Bath, and Invited Lecturer at Oxford University, England
- 03.1992 Charles L. Odoroff Memorial Lecturer, University of Rochester Medical Center, Rochester, New York
- 03.1993 Gentry Lecturer, Wake Forest University, Winston-Salem, North Carolina
- 09.1993 Special Lecturer, University of Padua, Italy
- 10.1993 Spiegelman Award Lecturer, American Public Health Association Meetings, San Francisco
- 05.1994 Invited Special Lecturer, Canadian Statistical Society Annual Meeting, Banff, Alberta
- 09.1994 Invited Plenary Lecturer, Royal Statistical Society Conference, Newcastle, England
- 11.1994 P.R. Krishnaiah Visiting Scholar and Keynote Speaker, Pennsylvania State, University Park
- 06.1995 Special Lecture Speaker, Third Great Lakes Symposium on Statistical Issues in Health Care and Medicine, Kalamazoo, Michigan
- 09.1995 Keynote Speaker, Statistical Symposium on Bootstrap Discrimination and Regression, Paris
- 06.1996 Keynote Speaker, Symposium on Statistics and Astronomy, Pennsylvania State, University Park
- 06.1996 Featured Speaker, Centers for Disease Control, Atlanta
- 06.1996 Bernard G. Greenberg Distinguished Lecturer, University of North Carolina, Chapel Hill
- 08.1996 Distinguished Fisher Lecturer, ASA Annual Meetings, Chicago, Illinois
- 04.1997 Robert Hogg Lecturer, University of Georgia, Athens
- 09.1997 DeGroot Lecturer, Carnegie Mellon University, Pittsburgh, Pennsylvania
- 12.1997 Honorable Visitor, Taiwan National Science Council
- 03.1999 Featured Speaker, 3rd Annual Howard Rowlee Lecture in Mathematics, University of Nebraska, Lincoln
- 04.1999 Featured Speaker, 5th Annual COSM Lecture, University of South Carolina, Columbia
- 10.1999 Buehler–Martin Lecturer, University of Minnesota, Twin Cities
- 12.1999 Clark Cockerham Lecturer, North Carolina State, Raleigh
- 07.2000 Keynote Lecturer, International Classification Society, Namur, Belgium

- 09.2000 Fisher Lecturer, Royal Statistical Society Annual Meeting, University of Reading, England
- 10.2000 Keynote Lecturer, Splus User's Conference, Seattle, Washington
- 04.2001 Lukacs Lecturer, Bowling Green University, Kentucky
- 10.2001 Keynote Lecturer, Austrian Statistical Society 50th Anniversary Meetings, Vienna
- 09.2003 Keynote Lecturer, SLAC Phystat2003, Stanford University, Palo Alto
- 06.2004 Keynote Speaker, International Chinese Statistical Association Applied Statistics Symposium, San Diego
- 10.2004 Keynote Lecturer, XII Annual Congress of the Portuguese Statistical Society, Évora
- 03.2005 Keynote Lecturer, ENAR National Conference, Austin, Texas
- 11.2005 Distinguished Lecturer in Statistical Science, Fields Institute, Toronto, Ontario
- 03.2006 Myra Samuels Lecturer, Purdue University, West Lafayette, Indiana
- 08.2006 Noether Lecturer, Joint Statistical Meetings, Seattle, Washington
- 01.2007 MAA Invited Address, Joint Mathematics Meetings of American Mathematical Society and Mathematics Association of America, New Orleans
- 10.2007 Discovery Series Lecturer, Vanderbilt Medical Center, Nashville
- 07.2008 Special Lecturer, American College of Radiology, Sonoma
- 10.2008 Laurence H. Baker Lectures, Fall Conference on Statistics in Biology, Iowa State University, Ames
- 04.2009 Keynote Speaker, Michigan Student Symposium for Interdisciplinary Statistical Science, University of Michigan, Ann Arbor
- 04.2009 Inaugural Shumway Lecturer, Statistical Science Symposium, University of California, Davis
- 04.2010 Distinguished Lecturer, H. Milton Stewart School of Industrial and Systems Engineering, Georgia Institute of Technology, Atlanta
- 07.2011 Inaugural Tsinghua University Pao-Lu Hsu Distinguished Lecture, Beijing
- 01.2012 AMS Josiah Willard Gibbs Lecturer, Joint Mathematics Meetings, Boston
- 10.2012 Center for Applied Mathematical Sciences Distinguished Lecturer, University of Southern California
- 04.2013 Wilks Memorial Lecture, Princeton University
- 11.2013 Department of Biostatistics & Bioinformatics Distinguished Lecturer, Duke University School of Medicine
- 01.2014 Department of Statistics Invited Lecturer, Texas A&M University
- 02.2014 Inaugural Bill Schucany Scholar Lecture Series, Southern Methodist University
- 03.2014 Department of Statistics Colloquium, Harvard University
- 08.2014 JASA Theory and Methods Session Lecturer, Joint Statistical Meetings, Boston
- 05.2015 Carl Morris Retirement Colloquium Main Speaker, Department of Statistics, Harvard University
- 10.2015 Biostatistics Seminar, University of Michigan School of Public Health, Ann Arbor
- 04.2016 Keynote Speaker, Workshop on Fusion Learning, BFF Inferences and Statistical Foundations, Rutgers University
- 07.2017 Introductory Overview Lecture: *Computer Age Statistical Inference*, Invited Special Presentation, Joint Statistical Meetings, Baltimore

## Abstracts

- A1.** Gaussian distributions for random lines, planes, and hyperplanes (1966). Delivered to the Western Regional Meeting of IMS, June 1965. Abstract appeared *Ann. Math. Statist.*, 769.
- A2.** The problem of the two nearest neighbors (1967). Abstract appeared *Ann. Math. Statist.*, 298.
- A3.** Power approximations in multivariate exponential families (with D. Truax) (1967). Delivered to Western Regional Meeting of IMS, June 1967. Abstract appeared *Ann. Math. Statist.*, 1595.

## Publications

1. Optimum evasion versus systematic search (1964). *SIAM Journal* **12**, 450–457.
2. Increasing properties of Polya frequency functions (1965). *Ann. Math. Statist.* **36**, 272–279.
3. Note on the paper “Decision procedures for finite decision problems under complete ignorance” (1965). *Ann. Math. Statist.* **36**, 691–697.
4. The convex hull of a random set of points (1965). *Biometrika* **52**, 331–343.

5. The two-sample problem with censored data (1966). *Proc. Fifth Berkeley Symp. on Math. Statist. and Prob.*, University of California Press.
6. Geometrical probability and random points on a hypersphere (with T. Cover) (1967). *Ann. Math. Statist.* **38**, 213–220.
7. The power of the likelihood ratio test (1967). *Ann. Math. Statist.* **38**, 802–806.
8. Large deviations theory in exponential families (with D. Truax) (1968). *Ann. Math. Statist.* **39**, 1402–1424.
9. Student’s  $t$ -test under symmetry conditions (1969). *JASA* **64**, 1278–1302.
10. Hotelling’s  $T^2$  test under symmetry conditions (with M.L. Eaton) (1970). *JASA* **65**, 702–711.
11. Some remarks on the inference and decision models of statistics (1970). *Ann. Math. Statist.* **41**, 1034–1058.
12. Studies on toxoplasmosis in El Salvador: Prevalence and incidence of toxoplasmosis as measured by the Sabin–Feldman dye test (1970). J.S. Remington, B. Efron, E. Cavanaugh, H.J. Simon and A. Trejos. *Trans. Roy. Soc. Trop. Med. Hyg.* **64**, 252–267.
13. Does an observed sequence of numbers follow a simple rule? (Another look at Bode’s law) (1971). *JASA* **66**, 552–559.
14. Spurious appearance of mosaicism in three generations in one family with a  $3/B$  translocation. II. Statistical model of the chromosomal abnormality (with R.G. Miller, Jr. and B.Wm. Brown, Jr.) (1971). Department of Statistics Technical Report 27, Stanford University.
15. Forcing a sequential experiment to be balanced (1971). *Biometrika* **58**, 403–417. Also appeared *International Symposium on Hodgkin’s Disease* NCI Monograph **36**, 571–572.
16. Limiting the risk of Bayes and empirical Bayes estimators – Part I: The Bayes case (with C. Morris) (1971). *JASA* **66**, 807–815.
17. Limiting the risk of Bayes and empirical Bayes estimators – Part II: The empirical Bayes case (with C. Morris) (1972). *JASA* **67**, 130–139.
18. Empirical Bayes on vector observations: An extension of Stein’s method (with C. Morris) (1972). *Biometrika* **59**, 335–347.
19. Improving the usual estimator of a normal covariance matrix (with C. Stein and C. Morris) (1972). Department of Statistics Technical Report 37, Stanford University.
20. Stein’s estimation rule and its competitors – An empirical Bayes approach (with C. Morris) (1973). *JASA* **68**, 117–130.
21. Combining possibly related estimation problems (with C. Morris) (1973). *JRSS-B* **35**, 379–421 with discussion.
22. Defining the curvature of a statistical problem (with applications to second order efficiency) (1975). *Ann. Statist.* **3**, 1189–1242 with discussion and Reply.
23. Data analysis using Stein’s estimator and its generalizations (with C. Morris) (1975). *JASA* **70**, 311–319.
24. The efficiency of logistic regression compared to normal discriminant analysis (1975). *JASA* **70**, 892–898.
25. The possible prognostic usefulness of assessing serum proteins and cholesterol in malignancy (with F. Chao and P. Wolf) (1975). *Cancer* **35**, 1223–1229.
26. Biased versus unbiased estimation (1975). *Advan. Math.* **16** 259–277. Reprinted in *Surveys in Applied Mathematics* (1976). Academic Press, New York.
27. Families of minimax estimators of the mean of a multivariate normal distribution (with C. Morris) (1976). *Ann. Statist.* **4**, 11–21.
28. Multivariate empirical Bayes and estimation of covariance matrices (with C. Morris) (1976). *Ann. Statist.* **4**, 22–32.
29. Dealing with many problems simultaneously (with C. Antoniak) (1976). *On the History of Statistics and Probability* (D. Owen, Ed.). Marcel Dekker, New York.
30. Estimating the number of unseen species: How many words did Shakespeare know? (with R. Thisted) (1976). *Biometrika* **63**, 435–447.

31. The efficiency of Cox's likelihood function for censored data (1977). *JASA* **72**, 557–565.
32. Stein's paradox in statistics (with C. Morris) (1977). *Scientific American* **236**, 119–127.
33. The geometry of exponential families (1978). *Ann. Statist.* **6**, 362–376.
34. Regression and ANOVA with zero–one data: Measures of residual variation (1978). *JASA* **73**, 113–121.
35. Controversies in the foundations of statistics (1978). *Amer. Math. Mon.* **85**, 231–246.
36. How broad is the class of normal scale mixtures? (with R. Olshen) (1978). *Ann. Statist.* **6**, 1159–1164.
37. Assessing the accuracy of the MLE: Observed versus expected Fisher information (with D.V. Hinkley) (1978). *Biometrika* **65**, 457–487 with comments and Reply.
38. Bootstrap methods: Another look at the jackknife (1979). *Ann. Statist.* **7**, 1–26.
39. Computers and the theory of statistics: Thinking the unthinkable (1979). *SIAM Review* **21**, 460–480.
40. A distance theorem for exponential families (1980). *Polish J. Prob. Math. Statist.* **1**, 95–98.
41. *Biostatistics Casebook* (with R.G. Miller, Jr., B.Wm. Brown, Jr. and L. Moses) (1980). John Wiley and Sons, New York.
42. Randomizing and balancing a complicated sequential experiment (1980). *Biostatistics Casebook, Part I*, 19–30. John Wiley and Sons, New York.
43. Which of two measurements is better? (1980). *Biostatistics Casebook, Part II*, 153–170. John Wiley and Sons, New York.
44. The jackknife estimate of variance (with C. Stein) (1981). *Ann. Statist.* **9**, 586–596.
45. Censored data and the bootstrap (1981). *JASA* **76**, 312–319.
46. Nonparametric estimates of standard error: The jackknife, the bootstrap, and other methods (1981). *Biometrika* **68**, 589–599.
47. Nonparametric standard errors and confidence intervals (1981). *Canadian J. Statist.* **9**, 139–172 with discussion.
48. Computer and statistical theory (with G. Gong) (1981). Keynote address, *Proc. 13th Conference on the Interface between Computers and Statistics*.
49. *The Jackknife, the Bootstrap, and Other Resampling Plans* (1982). Society for Industrial Mathematics, Philadelphia, PA.
50. Transformation theory: How normal is a family of distributions? (1982). *Ann. Statist.* **10**, 323–339.
51. Maximum likelihood and decision theory (1982). *Ann. Statist.* **10**, 340–356.
52. A leisurely look at the bootstrap, the jackknife, and cross validation (with G. Gong) (1983). *Amer. Statist.* **37**, 36–48.
53. Estimating the error rate of a prediction rule: Improvement on cross-validation (1983). *JASA* **78**, 316–331.
54. Computer intensive methods in statistics (1983). *Lisboa 200th Anniversary Volume*, Lisbon Academy of Sciences, 173–181.
55. Computer intensive methods in statistics (with P. Diaconis) (1983). *Scientific American* **248**, 116–130.
56. Comparing non-nested linear models (1984). *JASA* **79**, 791–803.
57. The art of learning from experience (with Gina Kolata) (1984). *SCIENCE* **225**, 156–158.
58. Testing for independence in a two-way table: New interpretations of the chi-square statistic (with P. Diaconis) (1985). *Ann. Statist.* **13**, 845–913 with discussion and Rejoinder.
59. Bootstrap confidence intervals for a class of parametric problems (1985). *Biometrika* **72**, 45–58.
60. The bootstrap method for assessing statistical accuracy (with R. Tibshirani) (1985). *Behaviormetrika* **17**, 1–35. Also appeared as: Bootstrap methods for standard errors, confidence intervals, and other measures of statistical accuracy (with R. Tibshirani) (1986). *Statist. Sci.* **1**, 54–77 with discussion and Rejoinder.
61. Why isn't everyone a Bayesian? (1986). *Amer. Statist.* **40**, 1–11.
62. How biased is the apparent error rate of a prediction rule? (1986). *JASA* **81**, 461–470.

63. Double exponential families and their use in generalized linear regression (1986). *JASA* **81**, 709–721.
64. Better bootstrap confidence intervals (1987). *JASA* **82**, 171–200 with discussion and Rejoinder.
65. Did Shakespeare write a newly discovered poem? (with R. Thisted) (1987). *Biometrika* **74**, 445–455.
66. Probabilistic–geometric theorems arising from the analysis of contingency tables (with P. Diaconis) (1987). *Contributions to the Theory and Application of Statistics, A Volume in Honor of Herbert Solomon*, 103–125. Academic Press, New York.
67. Computer-intensive methods in statistical regression (1988). *SIAM Review* **30**, 421–449.
68. Logistic regression, survival analysis, and the Kaplan–Meier curve (1988). *JASA* **83**, 414–425.
69. Bootstrap confidence intervals: Good or bad? (1988). *Psychol. Bull.* **104**, 293–296.
70. Three examples of computer-intensive statistical inference (1988). *Sankhya 50th Anniversary Volume* **50**, 338–362. Presented at the *20th Interface Symposium on Computing Science and Statistics* and *COMP-STAT88*.
71. Application of the bootstrap statistical method to the tau-decay-mode problem (with K.G. Hayes and M.L. Perl) (1989). *Physical Review D* **39**, 274–279.
72. Prognostic indicators of laparotomy findings in clinical stage I–II supradiaphragmatic Hodgkin’s disease (1989). M.H. Leibenhaut, R.T. Hoppe, B. Efron, J. Halpern, T. Nelsen and S.A. Rosenberg. *J. Clin. Oncol.* **7**, 81–91.
73. Fisher’s information in terms of the hazard rate (with I. Johnstone) (1990). *Ann. Statist.* **18**, 38–62.
74. More efficient bootstrap computations (1990). *JASA* **85**, 79–89.
75. Regression percentiles using asymmetric squared error loss (1991). *Stat. Sinica* **1**, 93–125.
76. Compliance as an explanatory variable in clinical trials (with D. Feldman) (1991). *JASA* **86**, 9–26 with discussion and Rejoinder.
77. Statistical data analysis in the computer age (with R. Tibshirani) (1991). *SCIENCE* **253**, 390–395.
78. Poisson overdispersion estimates based on the method of asymmetric maximum likelihood (1992). *JASA* **87**, 98–107.
79. Jackknife-after-bootstrap standard errors and influence functions (1992). *JRSS-B* **54**, 83–127 with discussion and Rejoinder.
80. More accurate confidence intervals in exponential families (with T. DiCiccio) (1992). *Biometrika* **79**, 231–245.
81. Six questions raised by the bootstrap (1992). In *Exploring the Limits of Bootstrap* (R. LePage and L. Billard, Eds.). John Wiley and Sons, New York.
82. A simple test of independence for truncated data with applications to redshift surveys (with V. Petrosian) (1992). *Astrophys. J.* **399**, 345–352.
83. Bayes and likelihood calculations from confidence intervals (1993). *Biometrika* **80**, 3–26.
84. *An Introduction to the Bootstrap (Monographs on Statistics and Applied Probability)* (with R. Tibshirani) (1993). Chapman and Hall, New York.
85. Multivariate analysis in the computer age (1993). In *Multivariate Analysis: Future Directions 2* (C.M. Cuadras and C.R. Rao, Eds.). Elsevier Science Publishers, Amsterdam.
86. Survival analysis of the gamma-ray burst data (with V. Petrosian) (1994). *JASA* **89**, 452–462.
87. Missing data, imputation, and the bootstrap (1994). *JASA* **89**, 463–479 with discussion and Rejoinder.
88. On the correlation of angular position with time of occurrence of gamma-ray bursts (with V. Petrosian) (1995). *Astrophys. J. Letters* **441**, L37–L38.
89. Testing isotropy versus clustering of gamma-ray bursts (with V. Petrosian) (1995). *Astrophys. J.* **449**, 216–223.
90. Computer-intensive statistical methods (with R. Tibshirani) (1995). Invited article for *Encyclopedia of Statistical Sciences*, 1–9. Wiley-Interscience, New York.
91. Empirical Bayes methods for combining likelihoods (1996). *JASA* **91**, 538–565 with discussion and Rejoinder.

92. Using specially designed exponential families for density estimation (with R. Tibshirani) (1996). *Ann. Statist.* **24**, 2431–2461.
93. Bootstrap confidence intervals (with T. DiCiccio) (1996). *Statist. Sci.* **11**, 189–212.
94. Bootstrap confidence levels for phylogenetic trees (with E. Halloran and S. Holmes) (1996). *Proc. Nat. Acad. Sci.* **93**, 13429–13434.
95. Improvements on cross-validation: The .632+ bootstrap method (with R. Tibshirani) (1997). *JASA* **92**, 548–560.
96. The length heuristic for simultaneous hypothesis tests (1997). *Biometrika* **84**, 143–157.
97. Risk for retinitis in patients with AIDS can be assessed by quantitation of threshold levels of cytomegalovirus DNA burden in blood (1997). L. Rasmussen, D. Zipeto, R.A. Wolitz, A. Dowling, B. Efron and T.C. Merigan. *J. Infect. Dis.* **176**, 1146–1155.
98. A predictive morphometric model for the obstructive sleep apnea syndrome (1997). C.A. Kushida, B. Efron and C. Guilleminault. *Ann. Intern. Med.* **127**, 581–587.
99. Circadian rhythms and enhanced athletic performance in the National Football League (1997). R.S. Smith, C. Guilleminault and B. Efron. *Sleep* **20**, 362–365.
100. The problem of regions (with R. Tibshirani) (1998). *Ann. Statist.* **26**, 1687–1718.
101. R.A. Fisher in the 21st century (1998). *Statist. Sci.* **13**, 95–122 with discussion and Rejoinder.
102. Nonparametric methods for doubly truncated data (with V. Petrosian) (1999). *JASA* **94**, 824–834.
103. HIV-1 genotypic resistance patterns predict response to saquinavir-ritonavir therapy in patients in whom previous protease inhibitor therapy had failed (1999). B. Efron, A.R. Zolopa, R.W. Shafer, et al. *Ann. Intern. Med.* **131**, 813–821.
104. The bootstrap and modern statistics (2000). *JASA* **95**, 1293–1296.
105. Selection criteria for scatterplot smoothers (2001). *Ann. Statist.* **29**, 470–504.
106. Infectious complications among 620 consecutive heart transplant patients at Stanford University Medical Center (2001). J.G. Montoya, L.F. Giraldo, B. Efron, et al. *CID* **33**, 629–640.
107. Empirical Bayes analysis of a microarray experiment (with R. Tibshirani, J.D. Storey and V. Tusher) (2001). *JASA* **96**, 1151–1160.
108. Microarrays empirical Bayes methods, and false discovery rates (with J.D. Storey and R. Tibshirani) (2001). Department of Statistics Technical Report 217, Stanford University. Available at [statweb.stanford.edu/~brad/papers/](http://statweb.stanford.edu/~brad/papers/).
109. Scales of evidence for model selection: Fisher versus Jeffreys (with A. Gous) (2001). In *IMS Lecture Notes – Monograph Series: Model Selection* **38** (P. Lahiri, Ed.), 208–256 with discussion and Rejoinder.
110. Empirical Bayes methods and false discovery rates for microarrays (with R. Tibshirani) (2002). *Genet. Epidemiol.* **23**, 70–86.
111. The two-way proportional hazards model (2002). *JRSS-B* **64**, 899–909.
112. Smoothers and the  $C_p$ , GML, and EE criteria: A geometric approach (with S.C. Kou) (2002). *JASA* **97**, 766–782.
113. Pre-validation and inference in microarrays (with R. Tibshirani) (2002). *Stat. Appl. Genet. Mol. Biol.* **1**, 1–8.
114. Robbins, empirical Bayes, and microarrays (2003). *Ann. Statist.* **31**, 366–378.
115. Bayesians, frequentists, and physicists (2003). *Proc. PHYSTAT2003*, 17–28.
116. Second thoughts on the bootstrap (2003). *Statist. Sci.* **18**, 135–140.
117. Bradley Efron: A conversation with good friends (with Susan Holmes, Carl Morris and Rob Tibshirani) (2003). *Statist. Sci.* **18**, 268–281.
118. The statistical century (2003). In *Stochastic Musings: Perspectives from the Pioneers of the Late 20th Century* (J. Panaretos, Ed.), 29–44. Lawrence Erlbaum Associates, New Jersey.



119. Least angle regression (with T. Hastie, I. Johnstone and R. Tibshirani) (2004). *Ann. Statist.* **32**, 407–499 with discussion and Rejoinder. doi:10.1214/009053604000000067
120. Large-scale simultaneous hypothesis testing: The choice of a null hypothesis (2004). *JASA* **99**, 96–104.
121. The estimation of prediction error: Covariance penalties and cross-validation (2004). *JASA* **99**, 619–642 with discussion.
122. Bayesians, frequentists, and scientists (2005). *JASA* **100**, 1–5.
123. Mouse strain-specific differences in vascular wall gene expression and their relationship to vascular disease (with R. Tabibiazar, R.A. Wagner, J.M. Spin, et al.) (2005). *Arterioscler. Thromb. Vasc. Biol.* **25**, 302–308.
124. Selection and estimation for large-scale simultaneous inference (2005). Department of Statistics Technical Report 232, Stanford University. Available at [statweb.stanford.edu/~brad/papers/](http://statweb.stanford.edu/~brad/papers/).
125. Local false discovery rates (2005). Department of Statistics Technical Report 234, Stanford University. Available at [statweb.stanford.edu/~brad/papers/](http://statweb.stanford.edu/~brad/papers/).
126. Impact of HIV-1 Subtype and antiretroviral therapy on protease and reverse transcriptase genotype: Results of a global collaboration (2005). R. Kantor, D.A. Katzenstein, B. Efron, et al. *PLoS Medicine* **2**, 325–337.
127. Signature patterns of gene expression in mouse atherosclerosis and their correlation to human coronary disease (2005). R. Tabibiazar, R.A. Wagner, et al. *Physical Genomics* **22**, 213–226.
128. The ‘miss rate’ for the analysis of gene expression data (2005). J. Taylor, R. Tibshirani and B. Efron. *Biostatistics* **6**, 111–117.
129. Modern science and the Bayesian–frequentist controversy (2005). *Papers of the XII Congress of the Portuguese Statistical Society*, 9–20.
130. Minimum volume confidence regions for a multivariate normal mean vector (2006). *JRSS-B* **68** Part 4, 1–16.
131. On testing the significance of sets of genes (with R. Tibshirani) (2007). *Ann. Appl. Statist.* **1** 107–129.
132. Correlation and large-scale simultaneous significance testing (2007). *JASA* **102**, 93–103.
133. Doing thousands of hypothesis tests at the same time (2007). *METRON* **65**, 3–21.
134. Size, power, and false discovery rates (2007). *Ann. Statist.* **35**, 1351–1377.
135. Discussion: The Dantzig selector: Statistical estimation when  $p$  is much larger than  $n$  (with T. Hastie and R. Tibshirani) (2007). *Ann. Statist.* **35**, 2358–2364.
136. Simultaneous inference: When should hypothesis testing problems be combined? (2008). *Ann. Appl. Statist.* **2**, 197–223.
137. Microarrays, empirical Bayes, and the two-groups model (2008). *Statist. Sci.* **23**, 1–47 with discussion and Rejoinder.
138. False discovery rates and the James–Stein estimator (2008). *Statistica Sinica* **18**, 805–810.
139. Prediction of early progression in recently diagnosed IgA nephropathy (with K.V. Lemley, R.A. Lafayette, G. Derby, K.L. Blouch, L. Anderson and B.D. Myers) (2008). *Nephrol. Dialysis Transplant.* **23**, 213–222.
140. Are a set of microarrays independent of each other? (2009) *Ann. Appl. Statist.* **3**, 922–942. doi:10.1214/09-AOAS236
141. Empirical Bayes estimates for large-scale prediction problems (2009). *J. Amer. Statist. Assoc.* **104**, 1015–1028. doi:10.1198/jasa.2009.tm08523
142. Large-Scale Inference: Empirical Bayes Methods for Estimation, Testing, and Prediction (2010). *Institute of Mathematical Statistics Monographs I*, Cambridge University Press, Cambridge.
143. Correlated  $z$ -values and the accuracy of large-scale statistical estimates (2010). *J. Amer. Statist. Assoc.* **105**, 1042–1069 with discussion and Rejoinder. doi:10.1198/jasa.2010.tm09129
144. Imprecision of creatinine-based GFR estimates in uninephric kidney donors (with J.C. Tan, B. Ho, S. Busque, K. Blouch, G. Derby, and B.D. Myers) (2010). *Clin. J. Amer. Soc. Nephrol.* **5**, 497–502. doi:10.2215/CJN.05280709
145. The future of indirect evidence (2010). *Statist. Sci.* **25**, 145–157. doi:10.1214/09-STS308

146. False discovery rates and copy number variation (with N. Zhang) (2011). *Biometrika* **98**, 251–271. doi: 10.1093/biomet/asr018
147. The bootstrap and Markov chain Monte Carlo (2011). *J. Biopharm. Statist.* **21**, 1052–1062. doi:10.1080/10543406.2011.607736
148. Tweedie’s formula and selection bias (2011). *J. Amer. Statist. Assoc.* **106**, 1602–1614. doi:10.1198/jasa.2011.tm1181
149. Bayesian inference and the parametric bootstrap (2012). *Ann. Appl. Statist.* **6**, 1971–1997. doi:10.1214/12-A0AS571
150. Outcomes after non-myeloablative allogeneic hematopoietic cell transplantation with total lymphoid irradiation and anti-thymocyte globulin in lymphoid malignancies after failed autologous transplantation (2013). A.S. Kanate, B. Efron, S. Chhabra, H. Kohrt, J.A. Shizuru, et al. *Biol. Blood Marrow Transplant.* **19**, S154–S155.
151. A 250-year argument: Belief, behavior, and the bootstrap (2013). *Bull. Amer. Math. Soc.* **50**, 129–146. doi:10.1090/S0273-0979-2012-01374-5
152. Perspective: Bayes’ Theorem in the 21st Century (2013). *Science* **340**, 1177–1178. doi:10.1126/science.1236536
153. The impact of circadian misalignment on athletic performance in professional football players (with R.S. Smith, C.D. Mah, and A. Malhotra) (2013). *SLEEP* **36**, 1999–2001. doi:10.5665/sleep.3248
154. Empirical Bayes modeling, computation, and accuracy (2013). Department of Statistics Technical Report 263, Stanford University. Available at [statweb.stanford.edu/~brad/papers/](http://statweb.stanford.edu/~brad/papers/).
155. Outcomes following cardiac catheterization after congenital heart surgery (2014). S.L. Siehr, M.H. Martin, D. Axelrod, B. Efron, L. Peng, S.J. Roth, S. Perry and A.Y. Shin. *Cathet. Cardiovasc. Intervent.* **84**, 622–628. doi:10.1002/ccd.25490
156. Confidence intervals for random forests: The jackknife and the infinitesimal jackknife (with S. Wager and T. Hastie) (2014). *Journal of Machine Learning Research* **15**, 1625–1651 (online). [jmlr.org/papers/v15/wager14a.html](http://jmlr.org/papers/v15/wager14a.html)
157. Two modeling strategies for empirical Bayes estimation (2014). *Statist. Sci.* **29**, 285–301. doi:10.1214/13-STS455
158. Estimation and accuracy after model selection (2014). *J. Amer. Statist. Assoc.* **109**, 991–1007. doi: 10.1080/01621459.2013.823775
159. Frequentist accuracy of Bayesian estimates (2015). *J. Roy. Statist. Soc. Ser. B* **77**, 617–646. doi: 10.1111/rssb.12080
160. Number of lymph nodes removed and survival after gastric cancer resection: An analysis from the US Gastric Cancer Collaborative (2015). S. Gholami, L. Janson, D.J. Worhunsky, T.B. Tran, M.H. Squires III, et al. *J. Amer. Coll. Surg.* **221**, 291–299. doi:10.1016/j.jamcollsurg.2015.04.024
161. Exploring value in congenital heart disease: An evaluation of inpatient admissions (2015). A.Y. Shin, Z. Hu, B. Jin, S. Lal, D.N. Rosenthal, B. Efron, et al. *Congenital Heart Disease* **10**, E278–E287. doi: 10.1111/chd.12290
162. Empirical Bayes deconvolution estimates (2016). *Biometrika* **103**, 1–20. doi:10.1093/biomet/asv068
163. Improvement of abandonment of therapy in pediatric patients with cancer in Guatemala (2016). E. Alvarez, M. Seppa, K. Messacar, J. Kurap, et al. *J. Global Onc.* **2** no. 3-suppl (June 1), 76s–76s. doi: 10.1200/JGO.2016.004648
164. *Computer Age Statistical Inference: Algorithms, Evidence, and Data Science* (2016). Institute of Mathematical Statistics Monographs, Cambridge University Press (with T. Hastie). ISBN-13: 978-1107149892
165. Small volume injections: Evaluation of volume administration deviation from intended injection volumes (2017). M. Muffly, M. Chen, R. Claire, D. Drover, B. Efron, B. Fitch and G. Hammer. *Anesthesia & Analgesia* **125**, 1192–1199. doi: 10.1213/ANE.0000000000001976
166. Improvement in treatment abandonment in pediatric patients with cancer in Guatemala (2017). E. Alvarez, M. Seppa, S. Rivas, L. Fuentes, et al. *Pediatr. Blood Cancer* **64**, e26560. doi: 10.1002/pbc.26560

167. Effect of perioperative gabapentin on postoperative pain resolution and opioid cessation in a mixed surgical cohort: A randomized clinical trial (2018). J. Hah, S.C. Mackey, P. Schmidt, R. McCue, K. Humphreys, J. Trafton, B. Efron, et al. *JAMA Surg.* **153**, 303–311. doi:10.1001/jamasurg.2017.4915
168. Anti-HER2 scFv-directed extracellular vesicle-mediated mRNA-based gene delivery inhibits growth of HER2-positive human breast tumor xenografts by prodrug activation (2018). J.H. Wang, A.V. Forterre, J. Zhao, D.O. Frimannsson, A. Delcayre, T.J. Antes, B. Efron, et al. *Mol. Cancer Ther.* **17** no. 5 (May 1), 1133–1142. doi: 10.1158/1535-7163.MCT-17-0827
169. Curvature and inference for maximum likelihood estimates (2018). *Ann. Statist.* **46**, 1664–1692. doi: 10.1214/17-AOS1598
170. Proteomic analysis of monolayer-integrated proteins on lipid droplets identifies amphipathic interfacial  $\alpha$ -helical membrane anchors (2018). C.I. Pataki, J. Rodrigues, L. Zhang, J. Qian, B. Efron, T. Hastie, J. Elias, M. Levitt and R.R. Kopito. *PNAS*, published ahead of print: August 13, 2018. doi: 10.1073/pnas.1807981115
171. A  $g$ -modeling program for deconvolution and empirical Bayes estimation (2018). To appear online *J. Stat. Software* (with B. Narasimhan).
172. Bayes, oracle Bayes, and empirical Bayes (2018). Accepted *Statist. Sci.*