BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors.
Follow this format for each person. **DO NOT EXCEED FIVE PAGES.**

NAME: Kass, Robert E.

eRA COMMONS USER NAME (credential, e.g., agency login): rekass

POSITION TITLE: Maurice Falk Professor of Statistics and Computational Neuroscience, Department of Statistics, Machine Learning Department, and Center for the Neural Basis of Cognition

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
Antioch College, Yellow Springs, OH	BA	1975	Mathematics
University of Wisconsin-Madison, Madison, WI		1975-76	Statistics, Mathematics
University of Chicago, Chicago, IL	PH.D.	1980	Statistics

A. Personal Statement

After several years of research on geometrical methods in statistics, in the mid-1980s I focused on Bayesian inference. In 1997 I joined the Center for the Neural Basis of Cognition (CNBC) here at Carnegie Mellon and the University of Pittsburgh. Following my 9-year term as Head of the Department of Statistics, for the 2004-2005 academic year I took an NSF-sponsored sabbatical leave to concentrate on neuroscience. Since then all of my research has been devoted to statistical methods in neuroscience, with a heavy emphasis on data from single and multiple electrodes in behaving animals. My NIMH grant RO1064537 provides my primary research funding, as it has done since 2001. During that time I have also been a PI, co-PI, or co-investigator on other research grants from NSF, NIBIB, NIMH, NINDS, and NIH-SPARC.

My book *Analysis of Neural Data* with Emery Brown and Uri Eden was published in 2014 and my extensive overview of computational neuroscience, with 24 co-authors, was published in 2018 (the reference is below). In 2008 I also became a core voting faculty member of the Machine Learning Department (MLD) in the School of Computer Science. This reflects the large overlap between machine learning and contemporary statistics, a topic I discussed in a 2021 invited commentary for the journal *Observational Studies*. At this interface, some of my research developed new methods for analyzing MEG data, and recently we have focused on local field potentials (LFPs), for example in a 2021 paper in the premier machine learning venue *NeurIPS,* by Bong, Liu, Ren, Smith, Ventura, and Kass. In addition, a 2018 paper in *eLife* by one of my PhD students provided state-of-the-art denoising of endoscopic calcium imaging data. My experience has also led me to write about fundamental statistical ideas, including a 2016 paper by Kass, Caffo, Davidian, Meng, Yu, and Reid, in *PLoS Computational Biology,* called “Ten simple rules for effective statistical practice,” which has been viewed more than 250,000 times.

I have organized 10 international symposia at the interface between statistics and neuroscience, and I have given tutorial lectures on recent developments in statistical methods for neurophysiology at 13 workshops on computational neuroscience. From 2003 to 2008 and again from 2010 to 2016 I was PI on a series of 3 NSF training grants. From 2006-2022 I was PD on a pair of NIDA R90/T90 training grants that supported our CNBC programs in computational neuroscience. Since 2001 I have supervised or co-supervised 20 PhD students who have worked on analysis of neural data.

B. Positions, Scientific Appointments, and Honors

Positions and Employment

2016- Maurice Falk Professor of Statistics and Computational Neuroscience, Carnegie Mellon University
2008- Professor, Machine Learning Department, Carnegie Mellon University
2005- Adjunct Professor, Center for Neuroscience, University of Pittsburgh
1997- Professor, Neuroscience Institute, prior to 2018 part of the Carnegie Mellon side of the CNBC; Interim Director of the CNBC at Carnegie Mellon, 2015-2018.
1981- Assistant Professor, 1981-1986; Associate Professor, 1986-1992; Professor, 1992-present; Department Head, 1995-2004; Department of Statistics, Carnegie Mellon University
1980-81 NSF Postdoctoral Research Fellow, Department of Statistics, Princeton University

Other Experience and Professional Memberships

2018-2022 Sainsbury Wellcome Centre, University College London, Governing Board
2015-2022 Burroughs-Wellcome Fund Scientific Interface Advisory Committee
2015 External Reviewer, Department of Statistics, UC Berkeley, Berkeley, CA
2015 External Reviewer (Chair), Gatsby Computational Neuroscience Unit, University College, London, September
2015 External Reviewer, Department of Biostatistics, Brown University
2012-2017 National Academy of Sciences, Committee on Applied and Theoretical Statistics
2002-2017 Local organizer and program co-organizer, ``Statistical Analysis of Neural Data'' international symposia in Pittsburgh, 2002, 2004, 2006, 2008, 2010, 2012, 2015, 2017
2009-2014 Action Editor, *Neural Computation*
2009-2014 Action Editor, *Journal of Computational Neuroscience*
2006 External Reviewer, Department of California, Santa Barbara
2004-2006 Founding Editor-in-Chief, *Bayesian Analysis*
2004-2008 National Institute of Statistical Science, Board Member
2003-2005 National Academy of Sciences, Board of Mathematical Sciences and its Applications
2003-2006 American Association for the Advancement of Science, Chair-Elect, Chair, Past Chair of the Section on Statistics (U)
1996-1998 American Statistical Association, Chair-elect, Chair, Past Chair, Section on Bayesian Statistical Science
1992-1994 Executive Editor (editor-in-chief), *Statistical Science*
1991-2001 Local organizer and program co-organizer, ``Case Studies in Bayesian Statistics,'' international symposia at Carnegie Mellon, 1991, 1993, 1995, 1997, 1999, 2001, 2003, 2005
1985-2003 Associate Editor, *The Annals of Statistics,* 1985; Associate Editor, *Journal of the American Statistical Association, Theory and Methods*, 1986-1992; Editorial Board member, *Statistics in Medicine*, 1991-1992; Associate Editor, *Biometrika*, 1996-2003

Honors

2017 R.A. Fisher Award and Lecturer (renamed Distinguished Achievement Award and Lectureship), Committee of Presidents of Statistical Societies
2013 Outstanding Statistical Application Award, American Statistical Association
2010 Presidential Lecturer, Biometric Society, Eastern North American Region, Annual Meeting
2005 Miller Visiting Research Professor, University of California, Berkeley
2005 Identified as one of 10 Most-Cited Researchers in the field of Mathematics 1995-2005 (ranked #4), by the Institute for Scientific Information
2002 Elected Fellow, American Association for the Advancement of Science
2002 Institute Medallion Lecturer, Institute of Mathematical Sciences
1992 Special Invited Lecturer, Institute of Mathematical Statistics
1991 Elected Fellow, Institute of Mathematical Statistics
1990 Elected Fellow, American Statistical Association
1981 Leonard J. Savage Award for Outstanding Thesis in Bayesian Statistics and Econometrics

C. Contributions to Science

1. Geometrical methods in statistics

My earliest work was on the geometrical foundations of statistics. Its main purpose was to deepen understanding of fundamental statistical procedures.

a. **Kass, R.E.** (1984) Canonical parameterizations and zero parameter-effects curvature, *Journal of the Royal Statistical Society*, B, 46: 86-92.
b. Amari, S.-I., Barndorff Nielsen, O.E., **Kass, R.E.**, Lauritzen, S. and Rao, C.R. (1987) *Differential Geometry in Statistical Inference*, Institute of Mathematical Statistics Monograph Series, Hayward, CA.
c. **Kass, R.E.** (1989) The geometry of asymptotic inference (with discussion) *Statistical Science*, 4: 188-234.
d. **Kass, R.E.** and Vos, P. (1997) *Geometrical Foundations of Asymptotic Inference*, New York: Wiley.

2. Bayesian statistical methods

The use of Bayes' Theorem to make scientific inferences from data in a variety of contexts was developed initially by Harold Jeffreys in the first half of the 20th century. The main thrust of my work involved modernizing Jeffreys' approach by considering it as a way to attack complicated statistical problems using newly available computational tools. From the mid-1980s through the 1990s I developed Bayesian statistical methods and I evaluated Bayesian reasoning from a pragmatic data analytic perspective; this led to highly-cited publications (e.g., according to the Institute for Scientific Information, I was ranked #4 in citations in the mathematical sciences across a 10 year period, and one of my papers was ranked #1 in citations).

a. **Kass, R.E.** and Steffey, D. (1989) Approximate Bayesian inference in conditionally independent hierarchical models (parametric empirical Bayes models), *Journal of the American Statistical Association*, 84: 717-726.
b. **Kass, R.E.** and Raftery, A. (1995) Bayes factors, *Journal of the American Statistical Association*, 90: 773-795.
c. **Kass, R.E.** and Wasserman, L.A. (1995) A reference Bayesian test for nested hypotheses and its relationship to the Schwarz criterion, *Journal of the American Statistical Association*, 90: 928-934.
d. **Kass, R.E.** and Wasserman, L.A. (1996) The selection of prior distributions by formal rules, Journal of the *American Statistical Association*, 91: 1343–1370.

3. Statistical methods in neuroscience

Over the past 20 years I have devoted my research to development and use of statistical methods in neuroscience. While a handful of my publications have involved neuroimaging, the large majority have had to do with neural signals recorded from single and multiple electrodes. Spike trains are sequences of events, the timing of which varies from trial to trial, and in statistics such event-time data are usually represented as *point processes*. In addition, many of my publications have emphasized the development of data analytical tools based on fundamental statistical principles.

a. Brown, E.N., **Kass, R.E.**, and Mitra, P.P. (2004) Multiple neural spike train analysis: state-of-the-art and future challenges, *Nature Neuroscience*, 7: 456-46.
b. **Kass, R.E.**, Ventura, V., and Brown, E.N. (2005) Statistical issues in the analysis of neuronal data, *Journal of Neurophysiology*, 94: 8-25.
c. **Kass, R.E.,** Eden, U.T., and Brown, E.N. (2014) *Analysis of Neural Data*, New York: Springer.
d. **Kass, R.E.** and 24 others (2018) Computational neuroscience: Mathematical and statistical perspectives, *Annual Review of Statistics and its Application*, 5: 183-214.

4. Decoding and brain-machine interface (BCI)

For several years I worked on developing and studying statistical methods for neural prosthetics. My collaborators and I showed how Bayesian approaches could, in principle, produce far better results than suboptimal alternatives, yet, in practice, using closed-loop experiments, subjects often used visual feedback to compensate for defects in decoding methods. We also showed how BCI could be used to probe the neural basis of learning by perturbing the mapping between neural activity and the output of the interfaced device,

such as a cursor on a screen in front of the subject. In a series of experiments we discovered the remarkable fact that brain networks can adapt differentially in populations of perturbed and unperturbed neurons.

a. Brockwell, A.E., Rojas, A. and **Kass, R.E.** (2004) Recursive Bayesian decoding of motor cortical signals by particle filtering, *Journal of Neurophysiology*, 91: 1899-1907.
b. Jarosiewicz, B., Chase, S.M., Fraser, G.W., Velliste, M. **Kass, R.E.**, and Schwartz, A.B. (2008) Functional network reorganization during learning in a brain-machine interface paradigm. *Proceedings of the National Academy of Sciences*,105:19486-19491.
c. Koyama, S., Chase, S.M., Whitford, A.S., Velliste, M., Schwartz, A.B., and **Kass, R.E.** (2009) Comparison of brain-computer interface decoding algorithms in open-loop and closed-loop control, *Journal of Computational Neuroscience*, 29: 73-87.
d. Chase, S., **Kass, R.E.**, and Schwartz, A.B. (2012) Behavioral and neural correlates of visuomotor adaptation observed through a brain-computer interface in primary motor cortex, *Journal of Neurophysiology*,108:624-644.

5. Analysis of multiple spike train and local field potential data

When multiple spike trains and local field potentials are recorded simultaneously there are great opportunities to identify functional relationships among neurons, but there are also statistical subtleties. One series of papers focused on statistical assessment of neural synchrony, where two or more neurons fire at nearly the same time, leading to the 2013 Outstanding Application Award from the American Statistical Association. Recent work has been devoted to recordings from large numbers of neurons, especially across interacting populations of neurons.

a. Zhou, P., Resendez, S.L., Rodriguez-Romaguera, J., Stuber, G.D., Jimenez, J.C., Hen, R., Keirbek, M.A., Neufeld, S.Q., Sabatini, B.L., **Kass, R.E.**, and Paninski, L. (2018) Efficient and accurate extraction of *in vivo* calcium signals from microendoscopic video data, *eLife*, 7:e28728 DOI: 10.7554/elife.28728.
b. Rodu, J., Klein, N., Brincat, S.L., Miller, E.K., and **Kass, R.E.** (2018) Detecting multivariate cross-correlation between brain regions, *Journal of Neurophysiology*, 120: 1962-1972.
c. Klein, N., Siegle, J.H., Teichert, T. and **Kass, R.E.** (2021). Cross-population coupling of neural activity based on Gaussian process current source densities. *PLoS Computational Biology*, 17: e1009601.
d. Chen, Y., Douglas, H., Medina, B.J., Olarinre, M., Siegle, J.H., and **Kass, R.E**. (2022) Population burst propagation across interacting areas of the brain. *Journal of Neurophysiology*, to appear, published online Nov. 2.