

Matthew T. Harrison

Curriculum Vitae

Division of Applied Mathematics

Brown University

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Research Interests

Statistics. Conditional inference, Multiple hypothesis testing, Sequential importance sampling

Neuroscience. Pattern detection in multi-neuronal spiking data, Exploratory data analysis

Information theory. Rate distortion theory, Model selection

Computer vision. Structured statistical models, Natural scene statistics, Perceptual organization

Academic Appointments

Brown University (July 2009 – present)

Assistant Professor, Division of Applied Mathematics

Affiliate Member, Center for Statistical Sciences

Carnegie Mellon University (September 2006 – June 2009)

Visiting Assistant Professor, Department of Statistics

Brown University (June 2005 – July 2006)

Postdoctoral research associate, Division of Applied Mathematics

Mathematical Sciences Research Institute (January - May 2005)

Postdoctoral member, Program in Mathematical, Computational and Statistical Aspects of Vision

Education

Brown University, Ph.D., Applied Mathematics (2005)

Dissertation title: *Discovering compositional structures*

Dissertation advisor: Stuart Geman

Brown University, Sc.M., Applied Mathematics (2000)

University of Virginia, B.A., Mathematics and Cognitive Science (1998)

Fellowships and Awards

National Defense Science and Engineering Graduate Fellowship (1998-2001)
Howard Hughes Medical Institute Predoctoral Fellowship in Biological Sciences (1998)
Jefferson Scholarship, University of Virginia (1994-1998)
Phi Beta Kappa, University of Virginia (1997)

Publications

Submitted manuscripts

J. Miller and M. Harrison. "Exact enumeration and sampling of matrices with specified margins."
M. Harrison. "Valid p-values using importance sampling."

S. Geman, A. Amarasingham, M. Harrison and N. Hatsopoulos. "The statistical analysis of temporal resolution in the nervous system."

Refereed journal articles

M. Harrison and S. Geman. (2009) "A rate and history-preserving resampling algorithm for neural spike trains." *Neural Computation*, 21: 1244-1258.

S. Fujisawa, A. Amarasingham, M. Harrison and G. Buzsaki. (2008) "Behavior-dependent short-term assembly dynamics in the medial prefrontal cortex." *Nature Neuroscience*, 11: 823-833.

M. Harrison and I. Kontoyiannis. (2008) "Estimation of the rate-distortion function." *IEEE Transactions on Information Theory*, 54: 3757-3762.

M. Harrison. (2008) "The generalized asymptotic equipartition property: necessary and sufficient conditions." *IEEE Transactions on Information Theory*, 54: 3211-3216.

B. Anderson, M. Harrison and D. Sheinberg. (2006) "A multielectrode study of IT in the monkey: effects of grouping on spike rates and synchrony." *NeuroReport*, 17: 407-411.

A. Amarasingham, T.-L. Chen, S. Geman, M. Harrison and D. Sheinberg. (2006) "Spike count reliability and the Poisson hypothesis." *Journal of Neuroscience*, 26(3): 801-809.

Refereed conference proceedings

M. Harrison and I. Kontoyiannis. (2006) "On estimating the rate-distortion function." *Proceedings of the 2006 IEEE International Symposium on Information Theory*.

M. Madiman, M. Harrison and I. Kontoyiannis. (2004) "Minimum description length vs. maximum likelihood in lossy data compression." *Proceedings of the 2004 IEEE International*

Symposium on Information Theory.

Book chapters and conference proceedings

J. Miller and M. Harrison. (2010) "A practical algorithm for exact inference on tables." *Proceedings of the 2010 Joint Statistical Meeting.*

M. Harrison and I. Kontoyiannis. (2002) "Maximum likelihood estimation for lossy data compression." *Proceedings of the 40th Allerton Conference on Communication, Control and Computing.*

N. Hatsopoulos, M. Harrison and J. Donoghue. (2001) "Representations based on neuronal interactions in motor cortex." *Progress in Brain Research*, 130: 233-244.

Unpublished technical reports

M. Harrison and S. Geman. (2004) "An exact jitter method using dynamic programming." *APPTS Report #04-3.*

M. Harrison, S. Geman and E. Bienenstock. (2004) "Using statistics of natural images to facilitate automatic receptive field analysis." *APPTS Report #04-2.*

A. Amarasingham, T.-L. Chen, S. Geman and M. Harrison. (2003) "Notes on a spike count variability test." *APPTS Report #03-8.*

M. Harrison. (2003) "The convergence of lossy maximum likelihood estimators." *APPTS Report #03-5.*

M. Harrison. (2003) "Epi-convergence of lossy likelihoods." *APPTS Report #03-4.*

M. Harrison. (2003) "The first order asymptotics of waiting times between stationary processes under nonstandard conditions." *APPTS Report #03-3.*

Conference presentations

M. Harrison. (2010) "Multi-scale multiple hypothesis testing for spike trains." *New England Statistics Symposium 2010.* Boston, MA.

M. Harrison & A. Amarasingham. (2010) "Multi-scale multiple hypothesis testing for spike trains." *ENAR 2010.* New Orleans, LA.

M. Harrison. (2008) "Statistical significance of neural spiking patterns." *CNBC Retreat 2008.* Seven Springs, PA.

M. Harrison, A. Amarasingham and G. Buzsaki. (2008) "Resampling-based methods for multiple hypothesis testing in neurophysiological data." *SAND 4.* Pittsburgh, PA.

M. Harrison, A. Amarasingham and S. Geman. (2007) "Jitter methods for investigating the time scale of dependencies in neuronal firing patterns." *JSM 2007.* Salt Lake City, UT.

M. Harrison, A. Amarasingham and S. Geman. (2006) "Statistical methods for non-repeatable observations in neuroscience." *ICSA 2006 Applied Statistics Symposium*. Storrs, CT.

M. Harrison. (2005) "Compositionality." *MSRI Emphasis Week on Perceptual Organization*. Berkeley, CA.

M. Harrison. (2005) "Unsupervised learning of invariances using video." *MSRI Workshop on Visual Recognition*. Berkeley, CA.

M. Harrison and S. Geman. (2004) "Compositional feature detectors." *SIAM 2004 Conference on Imaging Science*. Salt Lake City, UT.

¹ Brown University, Division of Applied Mathematics, Technical Reports on Applied Probability, Pattern Theory, and Statistics (APPTS) can be found at <http://www.dam.brown.edu/ptg/publications.shtml>

Conference posters

A. Amarasingham, M. Harrison and G. Buzsaki. (2008) "Resampling techniques for the statistical investigation of neurophysiological data." *COSYNE 2008*. Salt Lake City, UT.

A. Amarasingham, M. Harrison and S. Geman. (2007) "Jitter methods for investigating spike train dependencies." *COSYNE 2007*. Salt Lake City, UT.

A. Amarasingham, M. Harrison and S. Geman. (2006) "Statistical analysis of neuronal firing patterns with non-repeatable trials." *Third Workshop on Statistical Analysis of Neuronal Data (SAND3)*. Pittsburgh, PA.

B. Anderson, M. Harrison and D. Sheinberg. (2006) "Neuronal synchrony and visual grouping: A multi-electrode study in monkey IT" [Abstract]. *Journal of Vision*, 6(6):65, 65a.

A. Amarasingham, M. Harrison and S. Geman. (2005) "Statistical techniques for analyzing nonrepeating spike trains." *Annual Society for Neuroscience Meeting (SFN) 2005*. Washington, DC.

A. Amarasingham, T.-L. Chen, S. Geman, M. Harrison and D. Sheinberg. (2003) "Spike count variability and the Poisson hypothesis." *Annual Computational Neuroscience Meeting (CNS)*. Alicante, Spain.

Invited Lectures

University of Massachusetts Amherst, Department of Mathematics & Statistics, October 2010

Boston University, Department of Mathematics & Statistics, April, 2010

Brown University, Applied Mathematics Departmental Undergraduate Group, November, 2009

University of Connecticut, Department of Statistics, November, 2009

Sandia National Laboratories, February, 2009

West Virginia University, Department of Statistics, February, 2009

University of Florida, Department of Statistics, February, 2009

University of Virginia, Department of Statistics, February, 2009

Brown University, Division of Applied Mathematics, February, 2009
University of California Berkeley, Department of Statistics, February, 2009
University of Pennsylvania, Department of Statistics, January, 2009
Lehigh University, Department of Mathematics, January, 2009
Yale University, Department of Statistics, December, 2008
Carnegie Mellon University, Department of Statistics, February, 2006
Brown University, Division of Applied Mathematics, January, 2006
Brown University, Brain Sciences Program, November, 2005

Teaching Experience

Computational Probability and Statistics (mostly undergraduate), Brown University (2010)

Probabilistic & Statistical Models of Graphs & Networks (undergraduate, graduate), Brown University (2010)

Recent Applications in Probability and Statistics (undergraduate, graduate), Brown University (2009)

Probability and Mathematical Statistics II (undergraduate, graduate), Carnegie Mellon University (2009)

Intermediate Statistics (graduate), Carnegie Mellon University (2007, 2008)

Probability Theory and Random Processes (undergraduate), Carnegie Mellon University (2007)

Engineering Statistics and Quality Control (undergraduate), Carnegie Mellon University (2006, 2008)

Mathematical Methods in the Brain Sciences² (mostly undergraduate), Brown University (2004, 2005)

11th grade algebra program, "The Met" High School³, Providence, RI (2005 – 2006)

Professional Activities and Service

Member of AMA, ASA, IEEE, SIAM

Ad hoc reviewer for Electronic Journal of Statistics, Entropy, Frontiers in Computational Neuroscience, IEEE Transactions on Information Theory, IEEE Transactions on Signal Processing, Journal of Computational Neuroscience, Journal of Computational Statistics and Data Analysis, Journal on Imaging Sciences, Journal of Neurophysiology, Journal of Neuroscience Methods, Journal of Neural Engineering; Journal of Computational Physics, Neural Computation, NIPS (Neural Information Processing Systems), Neuron, PLoS Computational Biology, SIAM CVPR (International Conference on Computer Vision and Pattern Recognition), ECCV (European Conference on Computer Vision), ISIT (IEEE International Symposium on Information Theory), ITW (IEEE Information Theory Workshop), Statistics and Probability Letters

Presenter at the MSRI / MAA PREP (Professional Enhancement Program) Workshop on the Mathematics of Images, Berkeley, CA, March 2005 (for mathematics teachers who want to incorporate imaging science into their undergraduate courses)

Co-organizer of the weekly postdoctoral seminar, MSRI, Spring 2005

Organizer of the weekly Pattern Theory seminar, Brown University, 2003-2006, 2009-present

Undergraduate mentoring

Nan Zhang, "Estimation of the rate-distortion function", Spring 2007

Aaron DePonceau, "Multi-scale multiple hypothesis testing", Summer 2008

Daniel Frank, "Jitter-corrected cross-correlograms", Summer 2008

² Mathematical Methods in the Brain Sciences targets students in the brain sciences (psychology, neuroscience, etc) with only a calculus background. It introduces topics in differential equations, probability & statistics, information theory, and mathematical programming (MATLAB).

³ The Met (Metropolitan Regional Career and Technical Center) is an experimental, progressive, inner-city highschool where students learn through community internships. It is successful in most areas, but not mathematics education. I designed and taught a remedial algebra class that better adhered to their educational philosophy.