

# CURRICULUM VITA

## STUART GEMAN

**Professor, Division of Applied Mathematics  
Brown University  
Providence, Rhode Island 02912**

### Education

University of Michigan, 1967-1971, B.S., Physics  
Dartmouth Medical School, 1971-1972, National Boards I  
Dartmouth College, 1972-1973, Masters, Physiology  
Massachusetts Institute of Technology, 1973-1977, Ph.D., Applied Mathematics  
(Differential equations with random coefficients, Herman Chernoff, advisor)

### Professional Appointments

Division of Applied Mathematics, Brown University, Assistant Professor, 1977–1981  
Associate Professor, 1981–1985; Professor, 1985 to 1997; James Manning Professor,  
1997-present

### Current Research Interests

Compositional Vision  
Neural Representation and Neural Modeling  
Statistical Analysis of Neurophysiological Data  
Statistical Analysis of Financial Models  
Statistical Analysis of Natural Images

### Honors and Awards

Highest Honors in Physics, University of Michigan 1971  
Presidential Young Investigator Award 1984–1989  
Fellow, Institute of Mathematical Statistics 1984  
Elected, International Statistical Institute, 1991  
Philip J. Bray Award for Excellence in Teaching in the Physical Sciences, Brown  
University, 2001  
Elected, National Academy of Sciences, 2011  
Fellow, American Mathematical Society, 2012  
ISI Highly Cited Researcher  
1986 International Congress of Mathematicians, invited lecture  
1997 Rietz Lecture, Institute of Mathematical Statistics.  
2001 Hotelling Memorial Lectures, University of North Carolina  
2004 Plenary Speaker, IEEE Conf. Computer Vision and Pattern Recognition (CVPR)

2007 Jim Press Endowed Research Lecture, University of California, Riverside  
2008 Bahadur Memorial Lectures, University of Chicago  
2009 Congressional briefing, Capitol Hill, on behalf of American Mathematical Society  
2011 Plenary Speaker, Annual Meeting of the Taiwan Mathematical Society

## **Papers**

### ***Published***

S. Geman and M. Miller. Computer simulation of brainstem respiratory activity. *J. Appl. Physiology*, 41, 1976, 931-938.

S. Geman. Some averaging and stability results for random differential equations. *SIAM J. Appl. Math.*, 36, 1979, 86-105.

S. Geman. Application of stochastic averaging to learning systems. *Brain Theory Newsletter*, 3, 1979, 69-71.

S. Geman. A method of averaging for random differential equations with applications to stability and stochastic approximations. In: *Approximate Solutions of Random Equations*. Ed. A.T. Bharucha-Reid, Elsevier/North-Holland, 1979.

S. Geman. A limit theorem for the norm of random matrices. *Ann. Prob.*, 8, 1980, 252-261.

S. Geman. An application of the method of sieves: functional estimator for the drift of a diffusion. In: *Colloquia Mathematica Societatis Janos Bolyai 32. Nonparametric Statistical Inference*. North-Holland, Budapest, 1980.

S. Geman. Notes on a self-organizing machine. In: *Parallel Models for Associative Memory*. Ed. by J. Anderson and G. Hinton, Lawrence Erlbaum Associates, Hillsdale, N.J., 1981.

S. Geman. The law of large numbers in neural modeling. In: *Mathematical Psychology and Psychophysiology*. Ed. by S. Grossberg, SIAM AMS Proceedings, Vol. 13, 1981.

S. Geman and C.-R. Hwang. Nonparametric maximum likelihood estimation by the method of sieves. *Ann. Stat.*, 10, 1982, 401-414.

S. Geman and C.-R. Hwang. A chaos hypothesis for some large systems of random equations. *Z. Wahrschein. verw. Gebiete*, 60, 1982, 291-314.

S. Geman. Almost sure stable oscillations in a large system of randomly coupled equations. *SIAM J. Appl. Math.*, 42, 1982, 695-703.

S. Geman and D.E. McClure. Characterization of a maximum-likelihood nonparametric

density estimator of kernel type. In: Proceedings of the NASA Workshop on Density Estimation and Function Smoothing. Ed. by L.F. Guseman, Jr., Texas A&M University, 1982.

S. Geman. Cross-validation for densities and regressions. Proceedings of the NASA Workshop on Density Estimation and Function Smoothing. Ed. by L.F. Guseman, Jr., Texas A&M University, 1982.

Y.-S. Chow, S. Geman, and L.-D. Wu. Consistent cross-validated density estimation. *Ann. Stat.*, 11, 1983, 25-38.

S. Geman and D. Geman. Stochastic relaxation, Gibbs distributions, and the Bayesian restoration of images. *IEEE-PAMI*, 6, 1984, 721-741.

S. Geman. The Method of Sieves. *Encyclopedia of Statistical Sciences*, Volume 5. Ed. S. Kotz and N.L. Johnson, John Wiley & Sons, 1985.

S. Geman and D.E. McClure. Bayesian image analysis: An application to single photon emission tomography. 1985 Proceedings of the American Statistical Association. Statistical Computing Section, 1985, 12-18.

S. Geman. The spectral radius of large random matrices. *Ann. Prob.*, 14, 1986, 1318-1328.

S. Geman and C.-R. Hwang. Diffusions for global optimization. *SIAM J. Control and Optimization*, 24, 1986, 1031-1043.

D. Geman and S. Geman. Bayesian image analysis. *Disordered Systems and Biological Organization*. Ed. E. Bienenstock, F. Fogelman, G. Weisbuch. NATO ASI Series, Vol. F20, Springer-Verlag, Berlin, 1986.

D. Geman, S. Geman, and C. Graffigne. Locating texture and object boundaries. *Pattern Recognition Theory and Application*. Ed. P. Devijver. NATO ASI Series, Springer-Verlag, Heidelberg, 1986.

D. Geman and S. Geman. Discussion of: "On the statistical analysis of dirty pictures" by Julian Besag, *J. R. Statist. Soc. B*, 48, 1986, 259-302.

S. Geman and C. Graffigne. Markov random field image models and their applications to computer vision. Proceedings of the International Congress of Mathematicians 1986. Ed. A.M. Gleason, American Mathematical Society, Providence, 1987.

S. Geman and D.E. McClure. Statistical methods for tomographic image reconstruction. Proceedings of the 46th Session of the International Statistical Institute, *Bulletin of the ISI*, 52, 1987.

- S. Geman. Experiments in Bayesian Image Analysis. Bayesian Statistics 3. Ed. J.M. Bernardo, M.H. DeGroot, D.V. Lindley and A.F.M. Smith, Oxford University Press, 1988.
- S. Geman. Stochastic relaxation methods for image restoration and expert systems. Maximum Entropy and Bayesian Methods in Science and Engineering (Vol. 2). Ed. G.J. Erickson and C.R. Smith, Kluwer Academic Publishers, 1988.
- D. Geman, S. Geman, C. Graffigne, and P. Dong. Boundary detection by constrained optimization. IEEE-PAMI, 12, 1990, 609-628.
- S. Geman, E. Bienenstock, and R. Doursat. Neural networks and the bias/variance dilemma. Neural Computation, 4, 1991, 1-58.
- D. Geman and S. Geman. Discussion of: "Bayesian image restoration, with two applications in spatial statistics" by J.E. Besag and A. Mollié, Annals of the Institute of Statistical Mathematics, 43, 1991.
- S. Geman, D.E. McClure, and D. Geman. A nonlinear filter for film restoration and other problems in image processing. CVGIP: Graphical and Image Processing, 54, 1992, 281-289.
- S. Geman, K. Manbeck, and D.E. McClure. A comprehensive statistical model for single photon emission tomography. In: Markov Random Fields: Theory and Applications. Eds. R. Chellappa and A. Jain. Academic Press, Boston, 1993, 93-130.
- E. Bienenstock and S. Geman. Discussion of: "Neural networks and statistical perspectives" by B. Cheng and D.M. Titterington, Statistical Science, 9, 1994, 36-38.
- E. Bienenstock and S. Geman. Comment on: "The Hebbian paradigm reintegrated: Local reverberations as internal representations," by D.J. Amit, Behavioral and Brain Sciences, 18, 1995, 627-628.
- E. Bienenstock and S. Geman. Compositionality in neural systems. The Handbook of Brain Theory and Neural Networks. Ed. M.A. Arbib. MIT Press, Cambridge, 1995.
- H. Künsch, S. Geman, and A. Kehagias. Hidden Markov random fields. Annals of Applied Probability, 5, 1995, 577-602.
- C. Raphael and S. Geman. A grammatical approach to mine detection. Proceedings of SPIE, 3079, 1997, 316-332.
- Z. Chi and S. Geman. Estimation of probabilistic context-free grammars, Computational Linguistics, 24, 1997, 299-305.
- E. Bienenstock, S. Geman, and D. Potter. Compositionality, MDL Priors, and Object

Recognition. In: Advances in Neural Information Processing Systems 9. M.C. Mozer, M.I. Jordan, and T. Petsche, eds., MIT Press, 1998.

Z. Chi and S. Geman. On the consistency of minimum complexity nonparametric estimation. *IEEE Trans. Inf. Theory*, 44, 1998, 1968-1973.

M. Johnson, S. Geman, S. Canon, Z. Chi, and S. Riezler. Estimators for stochastic “unification-based” grammars. *Proceedings of the Association for Computational Linguistics*, 1999.

S. Geman. Compositionality. *Brown University Faculty Bulletin*, Spring, 1999.

S. Geman. Hierarchy in machine and natural vision. *Proceedings of the 11th Scandinavian Conference on Image Analysis*, 1999.

S. Geman and K. Kochanek. Dynamic programming and the graphical representation of error-correcting codes. *IEEE Trans. Inf. Theory*, 47, 2001, 549-568.

S. Geman, D.F. Potter, and Z. Chi. Composition systems. *Quarterly of Applied Mathematics*, LX, 2002, 707-736.

S. Geman and M. Johnson. Probabilistic grammars and their applications. In: *International Encyclopedia of the Social & Behavioral Sciences*. N.J. Smelser and P.B. Baltes, eds., Pergamon, Oxford, 2002, 12075-12082.

S. Geman and M. Johnson. Dynamic programming for parsing and estimation of stochastic unification-based grammars. *Proceedings of the 40th Annual Meeting of the Association for Computational Linguistics*, 2002.

N. Hatsopoulos, S. Geman, A. Amarasingham, and E. Bienenstock. At what time scale does the nervous system operate? *Neurocomputing*, Volumes 52-54, June 2003, 25-29.

S. Geman and M. Johnson. Probability and statistics in computational linguistics, a brief review. In: *Mathematical foundations of speech and language processing*. Johnson, M.; Khudanpur, S.P.; Ostendorf, M.; Rosenfeld, R. (Eds.), 2004, X, ISBN: 0-387-20326-5, Pages 1-26.

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

Y. Jin and S. Geman. Context and hierarchy in a probabilistic image model. *CVPR* (2), 2006, 2145-2152.

S. Geman. Invariance and selectivity in the ventral visual pathway. *Journal of Physiology – Paris*, 100 (2006), 212-224.

- T.-L. Chen and S. Geman. On the minimum entropy of a mixture of unimodal and symmetric distributions. *IEEE Trans. Inf. Theory*, 54(7), 2008, 3166-3174.
- M. Harrison and S. Geman. A rate and history-preserving resampling algorithm for neural spike trains. *Neural Computation*, 21, 2009, 1244-1258.
- Lo-Bin Chang, Ya Jin, Wei Zhang, Eran Borenstein, and Stuart Geman. Context, Computation, and Optimal ROC Performance in Hierarchical Models. *IJCV*, 93(2), 2011, 117-140.
- Amarasingham, M. Harrison, N.G. Hatsopoulos, S. Geman. Conditional Modeling and the Jitter Method of Spike Re-Sampling, *Journal of Neurophysiology*, 107(2), 2012, 517-531.
- L.-B. Chang and S. Geman. Empirical scaling laws and the aggregation of non-stationary data. *Physica A*, 392(20), 2013, 5046-5052.
- L.-B. Chang, S. Geman, F. Hsieh, and C.R. Hwang. Invariance in the recurrence of large returns and the validation of models of price dynamics. *Physical Review E*, 88(2), 2013, 022116-1:022116-15.
- T.-L. Chen and S. Geman. Image Warping Using Radial Basis Functions. *J. of Applied Statistics*, 41(2), 2014, 242-258.
- G. Zhou, S. Geman, and J.M. Buhmann. Sparse feature selection by information theory. *Proceedings of the IEEE 2014 International Symposium on Information Theory*, 2014, 626-930.
- D. Geman, S. Geman, N. Hallonquist, and L. Younes. A visual Turing test for computer vision systems. *PNAS*, vol. 112(12), 2015, 3618-3623.
- A. Amarasingham, S. Geman, and M. Harrison. Ambiguity and non-identifiability in the statistical analysis of neural codes. *PNAS*, vol. 112(20), 2015, 6455–6460.
- D. Geman and S. Geman. Science in the age of selfies. *PNAS*, vol. 113(34), 2016, 9384–9387.
- L.-B. Chang, E. Borenstein, W. Zhang, and S. Geman. Maximum likelihood features for generative image models. *Annals of Applied Statistics*, vol. 11(3), 2017, 1275-1308.

### ***In Review***

### ***Abstracts/Posters***

- A. Date, E. Bienenstock, and S. Geman. A Statistical Technique for the Detection of

Fine Temporal Structure in Multi-Neuronal Spike Trains, Soc. Neurosci. Abstr., 25: 568.5 (1999).

A. Date, E. Bienenstock, and S. Geman. A Statistical Tool for Testing Hypothesis about the Temporal Resolution of Neural Activity, Soc. Neurosci. Abstr., 26: 828.6 (2000).

N.G. Hatsopoulos, A. Amarasingham, E. Bienenstock, S. Geman and J.P. Donoghue. Assessing Precise Temporal Patterns of Spikes among Cortical Neurons, Soc. Neurosci. Abstr., 27: 63.1 (2001).

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.

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

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.

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

### ***Patents***

K. Manbeck, C. Yang, D. Geman, and S. Geman. Cadence Editing. US 6,542,199, 2003.

K. Manbeck, C. Yang, D. Geman, and S. Geman. Video Field Labeling. US 6,624,844, 2003.

C. Yang, K. Manbeck, S. Geman, D. Geman. Format Conversion. US 7,064,792, 2006.

K. Manbeck, J. Cassidy, S. Geman, D. Geman, and D. McClure. High Resolution Color Conforming. US 7,113,223, 2006.

K. Manbeck, D. Geman, S. Geman, and M. Orton. Automated Color Control in Film-to-Digital Transfer. US 7,068,838, 2006.

### ***Technical Reports and Supplements***

S. Geman. On a common sense estimator for the drift of a diffusion. Reports On Pattern Analysis No. 79, Division of Applied Mathematics, Brown University, 1979.

S. Geman. Sieves for nonparametric estimation of densities and regressions. Reports on

Pattern Analysis No. 99, Division of Applied Mathematics, Brown University, 1981.

S. Geman and W.B. Levy. Limit behavior of experimentally derived synaptic modification rules. Reports on Pattern Analysis No. 121, Division of Applied Mathematics, Brown University, 1982.

B. Davis and S. Geman. The application of neurobiological and statistical concepts to machine intelligence. Reports on Pattern Analysis No. 129, Division of Applied Mathematics, Brown University, 1983.

D. Geman and S. Geman. Relaxation and annealing with constraints. Complex Systems Technical Report No. 35, Division of Applied Mathematics, Brown University, December, 1987.

S. Geman, K. Manbeck, and D.E. McClure. Statistical methods for reconstruction in emission computed tomography. Technical Report, Division of Applied Mathematics, Brown University, 1993.

S. Geman, A. Kehagias, and H. Künsch. Consistent estimation of stationary processes and stationary random fields. Technical Report, Division of Applied Mathematics, Brown University, 1993.

S. Geman and K. Manbeck. Experiments in syntactic recognition. Reports on Pattern Analysis No. 158, Division of Applied Mathematics, Brown University, 1993.

S. Geman, K. Manbeck, and D.E. McClure. Coarse-to-fine search and rank-sum statistics in object recognition. Technical Report, Division of Applied Mathematics, Brown University, 1995.

A. Date, E. Bienenstock, and S. Geman. On the temporal resolution of neural activity. Technical Report, Division of Applied Mathematics, Brown University, 1998.

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

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

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

S. Geman. On the formulation of a composition machine. Technical report, Division of Applied Mathematics, Brown University, 2007.

A. Amarasingham, M.T. Harrison, N.G. Hatsopoulos, and S. Geman. (2011) "Conditional modeling and the jitter method of spike re-sampling: supplement." arXiv:1111.4296v1



## **Recent Teaching**

Winter, 2006, Holdem Poker, Independent Study (APMA1960)  
Winter, 2006, Tetris Bot, Independent Study (APMA1960)  
Fall, 2006, Theory of Probability (APMA2630)  
Winter, 2007, Theory of Probability (AM2640)  
Fall, 2007, Recent Applications of Probability and Statistics (APMA2610)  
Fall, 2008, Recent Applications of Probability and Statistics (APMA2610)  
Winter, 2009, Essential Statistics (AM0650)  
Fall, 2009, Information Theory (AM1710)  
Winter, 2010, Essential Statistics (AM0650)  
Fall, 2010, Information Theory (APMA1710)  
Spring, 2011, Essential Statistics (APMA0650)  
Spring, 2011, The Efficient Market Hypothesis, Independent Study (APMA1970)  
Fall, 2012, Computational Probability and Statistics (APMA1690)  
Spring, 2013, Recent Applications of Probability and Statistics (APMA2610)  
Fall, 2013, Computational Probability and Statistics (APMA1690)  
Spring, 2014, Recent Applications of Probability and Statistics (APMA 1740/2610)  
Fall, 2014, Computational Probability and Statistics (APMA1690)  
Spring, 2015, Learning Depth from Optical Flow (CLPS 1980)  
Spring, 2015, Recent Applications of Probability and Statistics (APMA 1740/2610)  
Fall, 2015, Probabilities in Statistical and Quantum Mechanics (APMA1930)  
Fall, 2016, Probabilities in Quantum Mechanics (APMA 1930)

## **Ph.D. Students**

Barry Davis (June, 1982) A neurobiological approach to machine intelligence.  
Aytul Erdal (January, 1983) Cross validation for ridge regression and principle component analysis.  
Alan Lippman (June, 1986) Research on Bayesian methods for expert systems.  
Christine Graffigne (June, 1987) Markov random fields for texture modeling and segmentation.  
John Mertus (June, 1987) New reconstruction methods for single photon emission tomography.  
Kevin Manbeck (May, 1990) Bayesian statistical methods applied to emission tomography with physical phantom and patient data.  
Athanasios Kehagias (June, 1991) Approximation of stochastic processes by hidden Markov models.  
Daniel Potter (December, 1998) Compositional vision models.  
Zhiyi Chi (May, 1998) Probability models for complex systems.  
Kevin Kochanek (May, 1998) Grammatical representation of algebraic codes.  
Shih-Hsiu Huang (May, 2001) An image analysis system.  
Brian Lucena (May 2002) Coarse-to-fine dynamic programming.

Asohan Amarasingham (October, 2003) The statistics of neuronal spike train recordings.  
Ting-Li Chen (October, 2004) On the statistics of natural images.  
Matthew Harrison (December, 2004) Discovering compositional structure.  
Ya Jin (May, 2006) Computation and estimation in image analysis.  
Wei Zhang (May, 2009) Statistical inference and probabilistic modeling in  
compositional vision.  
Lo-Bin Chang (May, 2010) Conditional modeling and conditional inference.  
Jackson Loper (May, 2017) Theory and computation for modern probabilistic models.  
Wei-Ying Wang (May, 2017) Image compression and data clustering: new takes on  
some old problems.  
Guangyao Zhou (in progress)