

# 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  
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  
2007 Jim Press Endowed Research Lecture, University of California, Riverside  
2008 Bahadur Memorial Lectures, University of Chicago

2009 The Movies, the Markets, and Mathematics. Lunch briefing on Capitol Hill on behalf of the 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.

S. Geman, A. Amarasingham, M. Harrison, N.G. Hatsopoulos. Conditional Modeling and the Jitter Method of Spike Re-Sampling, *Journal of Neurophysiology*. 2011. (in press)

### ***In Review***

L.-B. Chang, S. Geman, F. Hsieh, C.-R. Hwang. The invariance of waiting times between large returns.

L.-B. Chang and S. Geman. Empirical Scaling Laws and the Aggregation of Non-stationary Data.

### ***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 Lectures** (five years)

At what time scale does the nervous system operate? Department of Statistics, Yale University, January, 2006.

Context and hierarchy in a probabilistic image model. Google Research, New York, NY, May, 2006.

Towards image parsing. Visual Learning and Recognition Workshop, Institute for Mathematics and its Applications, May, 2006.

Representation and computation in natural vision. Collaborative Research in Computational Neuroscience, Principle Investigator Meeting, National Science Foundation, Washington, DC, June, 2006.

Context and hierarchy in a probabilistic image model. IEEE Conference on Computer Vision and Pattern Recognition, June, 2006.

Bio-inspired scene understanding. Conference sponsored by the Office of Naval Research, Washington, DC, July 2006.

Hierarchy in the ventral visual pathway. Center for the Neural Basis of Cognition, Carnegie Mellon University, January, 2007.

Parsing images with context/content sensitive grammars. Workshop on Challenges and Opportunities in Image Understanding, University of Maryland, January, 2007.

Generative models for image understanding. Distinguished Professor S. James Press Endowed Lecture, U. of California, Riverside, April, 2007.

On building strong representations for image understanding, Google Research, Mountain View, CA, May, 2007.

Hierarchy and reusability in image analysis: the Brown school. Meeting to honor David Mumford's 70'th birthday, Newport, RI, June, 2007.

Probabilistic grammars for vision. The Mathematics of Mind, graduate summer school, Institute for Pure and Applied Mathematics, U. of California, Los Angeles, July, 2007.

Some mathematical issues in image analysis. Departamento de Matemática, Universidade de Fortaleza, Brazil, October, 2007.

Some mathematical issues in image analysis. International Workshop on Object Categorization, ICCV 2007, Rio de Janeiro, Brazil, October, 2007.

Compositionality in vision. The Grammar of Vision: Probabilistic Grammar-Based Models for Visual Scene Understanding and Object Categorization, NIPS 2007, Whistler, Canada, December, 2007.

Rare Events in the Financial Markets. Bahadur Lecture, University of Chicago, May, 2008.

On the Peculiar Statistics of Natural Images. Bahadur Lecture, University of Chicago, May, 2008.

The Debacle of the 80's and Rare Events in the Financial Markets. Meeting in honor of Donald Geman's 65'th birthday, Johns Hopkins University, September, 2008.

Google and the Vapnik-Chervonenkis Dimension. Annual Joint Mathematics Meeting, American Mathematical Society, January, 2009.

Google and the Vapnik-Chervonenkis Dimension. Computer Science Department, Princeton University, February, 2009.

Google and the Vapnik-Chervonenkis Dimension. Department of Mathematics & Statistics, Boston University, April, 2009.

Generative Models for Image Analysis. Theory and Practice of Computational Learning, University of Chicago, June, 2009.

Generative Hierarchical Models for Image Analysis. International Workshop on Stochastic Image Grammars, CVPR 2009, Miami, June, 2009.

Stock Prices and the Peculiar Statistics of Rare Events. Department of Statistics, Harvard University, November, 2009.

The Movies, the Markets, and Mathematics. Lunch briefing on Capitol Hill, on behalf of the American Mathematical Society, November, 2009.

Generative Models for Image Analysis. Distinguished Seminar Series on Vision, in honor of Professor Azriel Rosenfeld, Center for Automation Research, University of Maryland, December, 2009.

Orchestrating Computation in Hierarchical Models. Department of Statistics, Columbia University, April, 2010.

Orchestrating Computation in Hierarchical Models. Department of Statistics, University of Connecticut, April, 2010.

Synchrony Detection, the Night Sky Paradox, and Conditional Inference. SANDS, Statistical Analysis of Neuronal Data, Pittsburgh, May, 2010.

Context-sensitive Probabilities by Successive Perturbation. Workshop on The Role of Entropy in Language & Communication, Santa Fe Institute, June, 2010.

Approaches to Vision. DARPA Computer-Vision Workshop, Arlington, June, 2010.

Combinatorial Statistics for Testing Models and Discovering Patterns in Market Data. 2010 Fidelity Quant Summit, Boston, September, 2010.

Challenges to Hierarchical Modeling: Are they Insurmountable? Meeting on Knowledge Representation, Reasoning and Learning for Understanding Scenes and Events, UCLA, September, 2010.

Network Motifs, Sufficient Statistics, and a Biological Model of Relational Representation in the Cortex. Department of Mathematics, Massachusetts Institute of Technology, December, 2010.

Representing Relationships: Conditional Modeling and Sufficiency. Probabilistic Models of Cognition, graduate summer school, Institute for Pure and Applied Mathematics, U. of California, Los Angeles, July, 2011.

Context versus Computation. Probabilistic Models of Cognition, graduate summer school, Institute for Pure and Applied Mathematics, U. of California, Los Angeles, July, 2011.

Hierarchical Representations for the Evaluation of Sensed Data. Mathematics of Sensing, Exploitation and Execution, DARPA, Kickoff Meeting, September, 2011.

Stones in my Shoe. Colloquium in Celebration of the 60<sup>th</sup> Birthday Honor of Hans Rudolf Kuensch, ETH, Zurich, Switzerland, October, 2011.

Remarks on Learning Theory. Department of Statistics, Academia Sinica, November, 2011.

On the Peculiar Statistics of Natural Images. Department of Applied Mathematics, National Chiao Tung University, November, 2011.

Conditional Modeling and the Construction of a Computer Vision System. Department of Applied Mathematics, National Chiao Tung University November, 2011.

Stock Prices and the Statistics of Rare Events. Department of Mathematics, Academia Sinica, November, 2011.

Why are Images Scale Invariant? Department of Mathematics, National Taiwan University, December, 2011.

Parametric Learning Theory. Plenary lecture, annual meeting of the Mathematical Society of the Republic of China, Chung Yuan Christian University, December, 2011.

**Recent Teaching** (five years)

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 (AM1710)

Spring, 2011, Essential Statistics (AM0650)

Spring, 2011, The Efficient Market Hypothesis, Independent Study (AM1970)

## **Recent Funding** (five years)

NSF, ARO, ONR, DARPA

## **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 (in progress)  
Wei-Ying Wang (in progress)