

Curriculum Vitae

Cosma Rohilla Shalizi

Personal

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Sex	Male
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Education

1993–2001: University of Wisconsin at Madison, Physics Department, Ph.D.
Thesis title: *Causal Architecture, Complexity and Self-Organization for Time Series and Cellular Automata*. Advisers: James P. Crutchfield (physics) and David Griffeth (mathematics)
1990–1993: University of California at Berkeley, Physics Department, B.A.

Scholarships and Fellowships

1993–1994: Fellowship, UW-Madison Physics Department, in the high energy phenomenology group.
1990–1993: Chancellor's Scholar, UC-Berkeley.

Research, Teaching, and Other Work Experience

Research

2007–: External faculty, Santa Fe Institute.
2006–: Assistant Professor, Department of Statistics, Carnegie Mellon University.
2005–2006: Visiting Assistant Professor, Department of Statistics, Carnegie

Mellon University.

2002–2005: Postdoctoral Research Fellow, Center for the Study of Complex Systems, University of Michigan.

2001–2002: Postdoctoral Fellow, Santa Fe Institute, in the Dynamics of Learning group.

1998–2001: Graduate Fellow, Santa Fe Institute, in the Computation, Dynamics and Inference and Adaptive Computation groups.

1997: Research assistant to Professor David Griffeth, Mathematics Department, UW-Madison.

Teaching

Student evaluations, when available to me, are at <http://bactra.org/teaching/>.

2006–: Assistant Professor, Statistics Department, CMU. Courses taught: data mining (36-350), advanced theory of stochastic processes (36-754).

2005–2006: Visiting Assistant Professor, Statistics Department, CMU. Engineering statistics and quality control (36-220), stochastic processes (36-754).

2005, 2006: Lecturer, statistical inference and prediction, SFI Beijing Complex Systems Summer School.

2002: Instructor, foundational and methodological issues in complex systems, SFI Complex Systems Summer School.

2001: Instructor, foundations of complex systems (probability, statistics, networks), SFI Complex Systems Summer School.

2000: Instructor for probability, statistics and stochastic processes, SFI Complex Systems Summer School.

1996: Teaching assistant at UW-Madison for Psychology-Anthropology-Zoology-Neuroscience 619, “Biology of Mind”, a writing-intensive interdisciplinary course on the biological foundations of behavior, cognition, and consciousness, and their evolution.

1994–1997: TA, Physics Department, UW-Madison. Taught discussion and lab sections for a range of introductory physics courses.

Other Work

1998–1999: Co-editor, Alife Online website (<http://alife.santafe.edu>). HTML coding, design, dealing with the public.

1997: Web design for the UW-Madison Physics Department.

1990: Technical adjutant, National Institute for Child Health and Human Development (NIH). Assisted Dr. Tom Markello in lab protocols for the study of inherited lipid storage disorders.

Computer Skills

Programming Languages: Logo, Basic, Lisp, Object-Oriented Scheme, Fortran 77, Fortran 90, C, StarLogo, Perl, Forth, Java, R.

Scripting and Mark-up Languages: L^AT_EX, HTML, Expect.

Systems: Amiga, Unix (BSD, NextStep, Solaris), Cellular Automaton Machine 8, Mac OS X.

Professional Activities

Reviewer for *Advances in Complex Systems*; *Artificial Life*; *Behavioral & Brain Sciences*; *Biosystems*; *Chaos*; *Complexity*; *The Computer Journal*; *Europhysics Letters*; *Foundations of Physics*; *IEEE Transactions on Neural Networks*; *IEEE Transactions on Signal Processing*; *Inverse Problems*; International Colloquium on Automata, Languages and Programming; International Joint Conference on Neural Networks; *International Journal of Theoretical and Applied Finance*; International Parallel and Distributed Processing Symposium; *Journal of Physics A*; *Journal of Theoretical Biology*; *Mathematical Reviews*; MIT Press; *Neural Computation*; Oxford University Press; Perseus Books, Advanced Books Program; *Philosophy of Science*; *Physica A*; *Physica D*; *Physical Review A*; *Physical Review E*; *Physical Review Letters*; *Physics Letters A*; *Statistics in Medicine*; University of Chicago Press; World Scientific Publishing.

Editorial board: *Structure and Dynamics: e-Journal of Anthropological and Related Sciences*.

Conference/workshop program committees: Noise in Complex Systems and Stochastic Dynamics (2003, 2004, 2005); Alife X (2006) main conference and workshop on Evolution of Complexity; European Conference on Complex Systems 2006; workshop on Statistical Network Analysis at 23rd International Conference on Machine Learning (ICML 2006); European Conference on Artificial Life (2007)

Member: American Physical Society; American Statistical Association; Bertrand Russell Society; Computational Anthropology Section, American Anthropological Association; IEEE Information Theory Society; Institute of Mathematical Statistics; International Machine Learning Society; Society for Literature and Science.

Union activities: Member of the Teaching Assistants Association at UW-Madison, 1994–2001; Natural Sciences area representative, 1995–1996; Physics Department steward, 1996–1997.

Grant review: Expert evaluator for the “Future and Emerging Technologies” program of the European Commission’s research directorate, 2001–. Referee for the Technology Foundation STW (Dutch national technology research agency), 2003; for the National Environment Research Council (UK), 2004; for the Civilian Research and Development Foundation (US), 2004; for the National Science Foundation (US), 2007.

Research Interests

Prediction and filtering for nonlinear dynamics and spatiotemporal data
Unsupervised learning and non-Bayesian statistical inference

Hidden Markov models and hidden Markov random fields
 Quantitative measures of self-organization and complexity
 Coherence and distributed information in biological computation
 Statistical properties of neurophysiological signals
 Statistical inference for power-law and related distributions
 Organizational aspects of ensemble machine learning
 Influence of social network structure on collective behavior
 Cellular automaton models of pattern formation
 Learning theory for models of statistical causation
 Philosophy of science (causation; induction; reductionism and emergence)

Publications

Papers in Peer-Reviewed Journals and Conferences

1. CRS, Marcelo F. Camperi and Kristina Lisa Klinkner, “Discovering Functional Communities in Dynamical Networks”, pp. 140–157 in Anna Goldenberg *et al.* (eds.), *Statistical Network Analysis: Models, Issues, and New Directions* (New York: Springer-Verlag, 2007) [proceedings of a workshop at ICML 2006]; <http://arxiv.org/abs/q-bio.NC/0609008>
2. CRS, Robert Haslinger, Jean-Baptiste Rouquier, Kristina Lisa Klinkner and Cristopher Moore, “Automatic Filters for the Detection of Coherent Structure in Spatiotemporal Systems”, *Physical Review E* **73** (2006): 036104; <http://arxiv.org/abs/nlin.CG/0508001>
3. Kristina Lisa Klinkner, CRS and Marcelo F. Camperi, “Measuring Shared Information and Coordinated Activity in Neuronal Networks”, pp. 667–674 in Yair Weiss, Bernhard Schölkopf and John C. Platt (eds.), *Advances in Neural Information Processing Systems 18* [NIPS 2005] (Cambridge, Massachusetts: MIT Press, 2006); <http://arxiv.org/abs/q-bio.NC/0506009>
4. Michael T. Gaster, CRS and M. E. J. Newman, “Maps and Cartograms of the 2004 US Presidential Election Results”, *Advances in Complex Systems* **8** (2005): 117–123
5. Matthew J. Berryman, Scott W. Coussens, CRS, Yvonne Pamula, David Parsons, Kurt Lushington, David Saint, Andrew Allison, A. James Martin, Declan Kennedy and Derek Abbott, “Nonlinear Aspects of EEG Signals from Sleep Patients”, pp. 40–48 in Nigel G. Stocks, Derek Abbott and Robert P. Morse (eds.), *Fluctuations and Noise in Biological, Biophysical, and Biomedical Systems III* (Bellingham, Washington: SPIE, 2005); <http://arxiv.org/abs/q-bio.NC/0506015>
6. CRS, Kristina Lisa Klinkner and Robert Haslinger, “Quantifying Self-Organization with Optimal Predictors”, *Physical Review Letters* **93** (2004): 118701, <http://arxiv.org/abs/nlin.A0/0409024>

7. CRS and Kristina Lisa Klinkner, “Blind Construction of Optimal Non-linear Recursive Predictors for Discrete Sequences”, pp. 504–511 in Max Chickering and Joseph Halpern (eds.), *Uncertainty in Artificial Intelligence: Proceedings of the Twentieth Conference [UAI 2004]* (Arlington, Virginia: AUAI Press, 2004), <http://arxiv.org/abs/cs.LG/0406011>
8. CRS, “Functionalism, Emergence and Collective Coordinates”, *Behavioral and Brain Sciences* **27** (2004): 635–636
9. CRS, “Optimal Nonlinear Prediction of Random Fields on Networks”, *Discrete Mathematics and Theoretical Computer Science*, **AB(DMCS)** (2003): 11–30; <http://arxiv.org/abs/math.PR/0305160> (proceedings of the conference “Discrete Models for Complex Systems 2003”)
10. CRS and James P. Crutchfield, “Information Bottlenecks, Causal States, and Statistical Relevance Bases: How to Represent Relevant Information in Memoryless Transduction”, *Advances in Complex Systems*, **5** (2002): 91–95; <http://arxiv.org/abs/nlin.A0/0006025>
11. Wim Hordijk, CRS and James P. Crutchfield, “An Upper Bound on the Products of Particle Interactions in Cellular Automata”, *Physica D* **154** (2001): 240–258; <http://arxiv.org/abs/nlin.CG/0008038>
12. CRS and James P. Crutchfield, “Computational Mechanics: Pattern and Prediction, Structure and Simplicity”, *Journal of Statistical Physics* **104** (2001): 817–879; <http://arxiv.org/abs/cond-mat/9907176>
13. James P. Crutchfield, David P. Feldman and CRS, “Comment on ‘Simple Measure for Complexity’”, *Physical Review E* **62** (2000): 2996–2997; <http://arxiv.org/abs/nlin.CD/9907001>
14. Cristopher Moore, Mats G. Nordahl, Nelson Minar and CRS, “Vortex Dynamics and Entropic Forces in Antiferromagnets and Antiferromagnetic Potts Models”, *Physical Review E* **60** (1999): 5344–5351; <http://arxiv.org/abs/cond-mat/9902200>
15. James P. Crutchfield and CRS, “Thermodynamic Depth of Causal States: Objective Complexity via Minimal Representation”, *Physical Review E* **59** (1999): 275–283; <http://arxiv.org/abs/cond-mat/9808147>

Invited and Contributed Papers

1. CRS, “Methods and Techniques in Complex Systems Science: An Overview”, pp. 33–114 in Thomas S. Deisboeck and J. Yasha Kresh (eds.), *Complex Systems Science in Biomedicine* (New York: Springer-Verlag, 2006); <http://arxiv.org/abs/nlin.A0/0307015>

2. CRS and Kristina Lisa Klinkner, “Quantifying Self-Organization in Cyclic Cellular Automata”, pp. 108–117 in Lutz Schimansky-Geier, Derek Abbott, Alexander Neiman and Christian Van den Broeck (eds.), *Noise in Complex Systems and Stochastic Dynamics* (Bellingham, Washington: SPIE, 2003); <http://arxiv.org/abs/nlin.A0/0507067>
3. Derek Abbott, Paul C. W. Davies and CRS, “Order from Disorder: The Role of Noise in Creative Processes. A Special Issue on Game Theory and Evolutionary Processes — Overview”, *Fluctuation and Noise Letters*, vol. 2, no. 4 (December 2002)

Submitted Papers

1. Matthew J. Berryman, Scott W. Coussens, Sarah Blunden, CRS, Andrew Allison and Derek Abbott, “Methods for Analysis of EEG and EOG Data in Sleep Patients”, submitted to *Physiological Measurement*
2. Aaron Clauset, CRS and M. E. J. Newman, “Power-law distributions in empirical data”, submitted to *Reviews of Modern Physics*; <http://arxiv.org/abs/0706.1062>
3. Shinsuke Koyama, Lucia Castellanos Pérez-Bolde, CRS, and Robert E. Kass, “Laplace’s Method in Neural Decoding”, submitted to *Advances in Neural Information Processing* (NIPS 2007)
4. CRS, “The Backwards Arrow of Time of the Coherently Bayesian Statistical Mechanic”, submitted to *Journal of Statistical Mechanics: Theory and Experiment*; <http://arxiv.org/abs/cond-mat/0410063>
5. CRS, “Maximum Likelihood Estimation for q -Exponential (Tsallis) Distributions”, submitted to *Physical Review E*; <http://arxiv.org/abs/math.ST/0701854>
6. CRS and David J. Albers, “Symbolic Dynamics for Discrete Adaptive Games”, submitted to *Physics Letters A*; <http://arxiv.org/abs/cond-mat/0207407>
7. CRS and Cristopher Moore, “What Is a Macrostate? Subjective Observations and Objective Dynamics”, submitted to *Studies in History and Philosophy of Modern Physics*; <http://arxiv.org/abs/cond-mat/0303625>

Talks at Conferences

- “Emergence and the Complexity of Prediction”, at the Philosophy of Science 2006 conference, Vancouver, 2–5 November 2006
- “Optimal Nonlinear Prediction and Self-Organization”, at 2nd “Emergent Organization in Complex Biomolecular Systems” (EMBIO) meeting, Vienna, 22 and 23 May 2006

- “Measuring Shared Information and Coordinated Activity in Stochastic Networks”, at “New Pathways in Complex Systems”, Santa Fe Institute, 26–30 July 2005
- “Emergence, Levels of Description, and the Complexity of Prediction”, at CSIRO workshop “Does Anything Emerge?”, Melbourne, 12–14 May 2005
- “Detecting Information Sharing and Coordination in Network Dynamics”, at SFI workshop on “Robustness in Multiple Overlapping Networks”, 19–26 April 2005
- “Symbolic Dynamics, Coarse-Graining, and Levels of Description in Statistical Physics and Cognitive Science”, at “Symbol Grounding: Dynamical Systems Approaches to Language”, Potsdam, 14–17 March 2005
- “Quantifying Self-Organization and Coherent Structures with Statistical Complexity”, at “Nonlinearity, Stochasticity, Scaling, and Self-Organization in Space Plasmas” at the 2004 American Geophysical Union Fall Meeting, San Francisco, 14 December 2004
- “Blind Construction of Optimal Nonlinear Recursive Predictors for Discrete Sequences”, at “Twentieth Conference on Uncertainty in Artificial Intelligence” (UAI 2004), Banff, 9–11 July 2004
- “Social Science and Complex Systems: A View from Ann Arbor” at “Exsistence Thematic Institute on Complex Systems”, École Normale Supérieure de Lyon, 30 June 2003
- “Predicting Random Fields on Networks” at “Discrete Models for Complex Systems”, ENS-Lyon, 16–19 June 2003
- “Model Averaging, Diversity and Evolutionary Dynamics” at “Science et Gastronomie 2003”, ENS-Lyon, 9–13 June 2003
- “Quantifying Self-Organization in Cyclic Cellular Automata” at “Fluctuations and Noise 2003”, Santa Fe, 1–4 June 2003
- Invited discussant, “Interdisciplinary Work in Progress” conference, Stanford Center for the Study of the Novel, Palo Alto, 4 May 2002
- “Computational Mechanics and Pattern Discovery”, at the SFI/Max Planck Institute for Mathematics in the Sciences Joint Workshop on “Complexity Science in Eastern Europe/Complexity: Unifying Themes for the Sciences and New Frontiers for Mathematics”, Leipzig, 14–18 May 2001

Seminars and Other Talks

- “Discovering Functional Communities in Dynamical Networks”, seminar, Center for Statistics and the Social Sciences, University of Washington-Seattle, 8 November 2006

- “Self-Organization and Coherent Structures”, seminar, Complexity Colloquium, University of North Carolina-Chapel Hill, 22 February 2006
- “Automatic Filters for the Detection of Coherent Structure in Spatiotemporal Systems”, seminar, Center for Automated Learning and Discovery, Carnegie Mellon University, 29 November 2005
- “Coarse-graining, Symbolic Dynamics and Collective Coordinates: How Physicists Deal with Large, Complex Systems, and Why Cognitive Scientists Might Care”, colloquium, Institute for Research in Cognitive Science, University of Pennsylvania, Philadelphia, 1 April 2005
- “Automatic Identification of Coherent Structures in Cellular Automata”, seminar, Max Planck Institute for Mathematics in the Sciences, Leipzig, 18 March 2005
- “Quantifying Self-Organization and Coherent Structures with Statistical Complexity”, nonlinear dynamics and complex systems seminar, Physics Department, University of Illinois, Urbana-Champaign, 10 February 2005
- “Reconstructing Predictive Hidden-State Models from Time Series”, seminar, Statistics Department, Carnegie-Mellon University, Pittsburgh, 20 December 2004
- “Predicting Random Fields on Networks”, seminar, Computer Science Department, University of California-Irvine, 10 December 2004
- “Building Predictive Hidden-State Models from Time Series”, special lecture, Department of Computing Science, University of Alberta, 16 November 2004
- “Shared Information and Coordinated Activity in Distributed Systems”, Socio-Technical Infrastructure for Electronic Transactions seminar, School of Information, University of Michigan-Ann Arbor, 25 March 2004
- “Discovering Hidden Markov Models from Time Series”, seminar, Applied Research Laboratory, Pennsylvania State University, 16 July 2003
- “Building Predictors from Time Series, with an Application to Networks”, seminar, Center for the Study of Complex Systems, University of Michigan-Ann Arbor, 12 September 2002
- “Optimal Nonlinear Prediction and Filtering: A Thousand Household Uses”, lecture, SFI Computational Economics Summer School, Santa Fe, July 2002
- “Causal Synchrony”, presentation, DARPA TASK Program Meeting, Washington, D.C., 9 January 2002
- “Pattern Discovery Techniques for Social Science”, lecture, SFI Computational Economics Summer School, Santa Fe, 20 July 2001

- “Pattern Discovery in Networks”, presentation, 18 July 2001, Air Force Office of Scientific Research workshop “Infospherics: Science for Building Large-scale Global Information Systems”, George Mason University, Fairfax, Virginia, 17–19 July 2001
- “Spatiotemporal Emergent Structures from Causal Architecture”, seminar, Center for the Study of Complex Systems, University of Michigan-Ann Arbor, 22 March 2001
- “ ϵ -Transducers: Computational Mechanics of History-Dependent Transduction”, presentation at the SFI/Chinese Academy of Sciences (PRC) Working Group Meeting, Santa Fe, 15 August 2000
- “Computational Mechanics”, seminar, Center for the Study of Complex Systems, University of Michigan-Ann Arbor, 16 December 1999
- “Unique Optimal Predictors for Stochastic Processes”, UW-Madison Probability Seminar, 4 March 1999
- “You Call This Physics?”, Graduate Student Mini-Colloquium, Physics Department, UW-Madison, 23 February 1999
- “Two Lectures on Computational Mechanics”, in conjunction with the SFI Complex Systems Summer School, 18–19 June 1998
- “Uncovering Structure and Understanding How Nature Computes”, University of Wisconsin-Madison Chaos and Complex Systems Seminar, 16 September 1997
- “Digital Boiling, and Other Exciting Things”, UW-Madison C&CS Seminar, 29 April 1997
- “Is the Primordial Soup Done Yet? Quantifying Self-Organization, Especially in Cellular Automata”, UW-Madison C&CS Seminar, 30 April 1996. Online at <http://bactra.org/Self-organization/soup-done/>

Workshops and Journal Special Issues Organized

1. *Theory and Applications of Complex Networks*, IMS panel at the 2006 Joint Statistical Meeting. Seattle, 7 August 2006.
2. *Order out of disorder: the role of noise in creative processes*, special issue of *Fluctuation and Noise Letters* (vol. 2, no. 4, December 2002), editor with Derek Abbott and P. C. W. Davies.
3. *Collective Cognition: Mathematical Foundations of Distributed Intelligence*, co-chair with James P. Crutchfield, Kagan Tumer and David H. Wolpert. Santa Fe, 22–26 January 2002.
Website: <http://www.santafe.edu/~dynlearn/colcog>.

Miscellaneous Manuscripts

1. CRS, *Almost None of the Theory of Stochastic Processes* (2006), draft textbook, <http://www.stat.cmu.edu/~cshalizi/754/>.
2. CRS, Kristina Lisa Klinkner and James P. Crutchfield, “An Algorithm for Pattern Discovery in Time Series” Technical Report, Santa Fe Institute, 2002-10-60; <http://arxiv.org/abs/cs.LG/0210025>.
3. CRS, *Causal Architecture, Complexity and Self-Organization in Time Series and Cellular Automata*, Ph.D. Thesis, UW-Madison (2001), <http://bactra.org/thesis/>.
4. CRS, “Lecture Notes on Probability, Statistics and Stochastic Processes” (2000), <http://bactra.org/prob-notes/>.
5. CRS and James P. Crutchfield, “Pattern Discovery and Computational Mechanics” (2000), cs.LG/0001027.
6. CRS and William A. Tozier, “A Simple Model of the Evolution of Simple Models of Evolution” (1999), <http://arxiv.org/abs/nlin.A0/9910002>. Rejected by *Theoretical Population Biology*.
7. CRS, “Lecture Notes on Computational Mechanics” (1998), <http://bactra.org/comp-mech-lectures/>.

Paid Articles

1. “The Logic of Diversity: The Complexity of a Controversial Concept”, *Santa Fe Institute Bulletin*, **20:1** (2005): 34–38
2. “The world is our laboratory: Myron Scholes and the history of finance”, *Quantitative Finance*, **3:2** (2003): C20–C21.
3. “Growth, Form, Function, and Crashes”, *SFI Bulletin* **15:2** (2000): 6–11.
4. “Modeling Markets”, *SFI Bulletin*, **15:1** (2000): 10–15.
5. “*Homo reciprocans*: Political Economy and Cultural Evolution”, *SFI Bulletin*, **14:2** (1999): 16–20.
6. “What Can Emergence Tell Us About Today’s Eastern Europe?” *SFI Bulletin*, **14:1** (1999): 8–10.
7. “Scientific Models: Claiming and Validating”, *SFI Bulletin*, **13:2** (1998): 8–12.

Book Reviews

I have written over 130 book reviews, reviewing works on physics, complexity, mathematics, economics, cognition, statistics, philosophy of science, machine learning, evolutionary biology and literary theory. A complete list of my reviews, and their full text, are online at <http://bactra.org/reviews/>. Some of them have appeared in the *Bulletin of the London Mathematical Society*, *Physics Today*, and *Quantitative Finance*.