

# Cristopher Moore

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July 22, 2017

## 1 Education

Born March 12, 1968 in New Brunswick, New Jersey.

Northwestern University, B.A. in Physics, Mathematics, and the Integrated Science Program, with departmental honors in all three departments, 1986.

Cornell University, Ph.D. in Physics, 1991. Philip Holmes, advisor. Thesis: “Undecidability and Unpredictability in Dynamical Systems.”

## 2 Employment

|   |                       |
|---|-----------------------|
| Professor, Santa Fe Institute   | 2012–present          |
| Professor, Computer Science Department with a joint appointment in the Department of Physics and Astronomy, University of New Mexico, Albuquerque | 2008–2012             |
| Associate Professor, University of New Mexico   | 2005–2008             |
| Assistant Professor, University of New Mexico   | 2000–2005             |
| Research Professor, Santa Fe Institute  | 1998–1999             |
| City Councilor, District 2, Santa Fe  | 1994–2002             |
| Postdoctoral Fellow, Santa Fe Institute   | 1992–1998             |
| Lecturer, Cornell University  | Spring 1991           |
| Graduate Intern, Niels Bohr Institute/NORDITA, Copenhagen   | Summers 1988 and 1989 |
| Teaching Assistant, Cornell University Physics Department   | Fall 1986–Spring 1990 |
| Computer programmer, Bio-Imaging Research, Lincolnshire, Illinois   | Summers 1984–1986     |

## 3 Other Appointments

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| Visiting Professor, École Normale Supérieure           | October–November 2016  |
| Visiting Professor, Northeastern University            | October–November 2015  |
| Visiting Professor, University of Michigan, Ann Arbor  | September–October 2005 |
| Visiting Professor, École Normale Supérieure du Lyon   | June 2004              |
| Visiting Professor, Institut Universitaire de France   | June 2003              |
| Visiting Professor, Université Paris 7 (Denis Diderot) | June 2001 and 2002     |

External Faculty, Santa Fe Institute  
Visiting Professor, École Polytechnique

2000–present  
September 1999

## 4 Honors and awards

Fellow, American Mathematical Society, class of 2016  
Fellow, American Physical Society, elected 2014  
University of New Mexico School of Engineering Outstanding Senior Faculty Award for Excellence in Research, 2007  
University of New Mexico School of Engineering Outstanding Junior Faculty Award for Excellence in Teaching, 2002  
University of New Mexico School of Engineering Outstanding Junior Faculty Award for Excellence in Research, 2002  
National Science Foundation Graduate Fellowship, 1986-1989  
Clark Award for Best Teaching Assistant, 1987  
Marcy Award for Undergraduate Independent Study, 1986  
Richter Fellowship for Undergraduate Independent Study, 1985  
Phi Beta Kappa, 1985

## 5 Public lectures and educational outreach

Sending Secrets: Security and Privacy in a Quantum World. Complex Data Systems Distinguished Lecture, University of South Florida, October 2016; John von Neumann Public Lecture Series in Complexity and Computation, Wisconsin Institute for Discovery, January 2015; Santa Fe Institute Community Lecture, April 2011  
The Majesty of Music and Mathematics, co-organized with the Santa Fe Symphony (David Felberg, conductor). November 2013.

## 6 Recent invited talks, lecture series, and colloquia

Lectures on Random Constraint Satisfaction Problems. Hausdorff Center for Mathematics, Bonn, July 2017  
Lectures on Computational Complexity and Belief Propagation. Boulder Condensed Matter Summer School, July 2017  
American Institute of Mathematics Workshop on Connecting Communities via the Block Model, May 2017  
Joint Probability and Computer Science Theory Seminar, Cornell, April 2017  
Institute for Data Science Seminar, University of Rochester, December 2016  
Data Science Colloquium, École Normale Supérieure, November 2016  
Statistical Physics Seminar, Institut de Physique Théorique, CEA Saclay, October 2016  
Physics Colloquium, École Normale Supérieure, October 2016  
Mathematics and Statistics Colloquium, University of South Florida, October 2016

Workshop on Theoretical Foundations for Statistical Network Analysis. Isaac Newton Institute, Cambridge, July 2016

Theoretical Physics Seminar, Otto-von-Guericke University, Magdeburg, July 2016

Turing Lectures on Complexity, Phase Transitions, and Inference. ICTS, Tata Institute of Fundamental Research, Bangalore, June 2016

Workshop on Networks: Learning, Information and Complexity. Institut Henri Poincaré, May 2016

Simons Institute Workshop on Random Instances and Phase Transitions, May 2016

Theory of Computing Seminar, Caltech, April 2016

Simons Institute Workshop on Approximate Counting, Markov Chains and Phase Transitions, February 2016

CNLS Conference on Physics Informed Machine Learning, January 2016

Lectures on Computation, Phase Transitions, and Networks. Northeastern University, October-November, 2015

Distinguished Lecture, Computer Science, University of Massachusetts Amherst, November 2015

Applied and Interdisciplinary Mathematics Seminar, Northeastern University, November 2015

CMSA Colloquium (Center for Mathematical Sciences and Applications), Harvard, October 2015

Lectures on Physics, Computation, Phase Transitions, and Networks. Beg Rohu Summer School on Statistical Physics, Biology, Inference and Networks. August-September, 2015

Groups and Interactions in Data, Networks, and Biology. Carnegie Mellon University, May 2015

SITP Seminar (Stanford Institute for Theoretical Physics), Stanford, May 2015

RAIN Seminar (Research on Algorithms and Incentives in Networks), Stanford, May 2015

Distinguished Lecture, Computer Science, UC Santa Cruz, May 2015

Invited Speaker, NIPS Workshop on Networks: From Graphs to Rich Data, December 2014

Computer Science Colloquium, Harvard, November 2014

Microsoft Research Colloquium, Microsoft Research New England, November 2014

Computer Science Colloquium, Rutgers, October 2014

PACM Colloquium, Princeton, October 2014

Keynote Lecture on Optimization and Inference in Networks, Institute d'Études Scientifiques de Cargese, September 2014

Lectures on Representation Theory and Quantum Computation, IMA Summer School on Modern Applications of Representation Theory, University of Chicago, August 2014

Distinguished Lecture Series on Complex Systems, Sandia National Laboratory, July 2014

Invited speaker, SIAM Workshop on Network Science, Chicago, July 2014

Invited speaker, Analysis of Algorithms, Paris, June 2014

Plenary speaker, NetSci 2014, Berkeley, June 2014

Joint Computer Science and Physics Colloquium, Northeastern University, April 2014

Laboratory of Information and Decision Sciences (LIDS) seminar, MIT, April 2014

Invited speaker, American Physical Society March Meeting, Session on Algorithms from Statistical Physics and the Physics of Algorithms, March 2014

Invited speaker, Statistical Mechanics Conference, Rutgers, December 2013

Statistics Colloquium and Probability Seminar, University of Chicago, November 2013

Computer Science Colloquium, Indiana University, Bloomington, October 2013

Statistics Seminar and Complex Systems Seminar, University of Michigan, October 2013

Lectures on Statistical Physics, Optimization, Inference, and Message-Passing Algorithms. Les Houches, September 2013

Cornell Probability Summer School, Cornell University, July 2013

Golosino Seminar on Inference, Compressed Sensing, Machine learning and Statistical Physics, ESPCI, Paris, June 2013

LIAFA Séminaire Algorithmique distribuée et graphes, Université Paris Diderot, June 2013

Workshop on Natural Algorithms and the Sciences, Princeton, May 2013

Computer Science Colloquium, University of New Mexico, April 2013

Probability Seminar and Computer Science Theory Seminar, UC Berkeley, November 2012

Featured Speaker, Physics and Astronomy Complex Systems Seminar, Northwestern University, October 2012

Institute for Advanced Study, Computer Science/Discrete Mathematics Seminar, October 2012

LIAFA Séminaire Algorithmique distribuée et graphes, Université Paris Diderot, July 2012

Invited plenary speaker, Turing Centenary Workshop on The Incomputable, June 2012

IPAM Workshop on Mathematical Challenges in Graphical Models and Message-Passing Algorithms, January 2012

NASA Quantum Future Technologies Conference, January 2012

## 7 Publications

### 7.1 Books and book chapters

C. Moore and S. Mertens, *The Nature of Computation*. Oxford University Press, 2011.

A. Decelle, J. Hüttel, A. Saade, and C. Moore, “Computational Complexity, Phase Transitions, and Message-Passing for Community Detection.” In *Statistical Physics, Optimization, Inference, and Message-Passing Algorithms*. F. Krzakala, F. Ricci-Tersenghi, L. Zdeborová, R. Zecchina, E. W. Tramel, L. F. Cugliandolo, Eds., Oxford University Press, to appear.

A. Percus, G. Istrate, and C. Moore, Eds., *Computational Complexity and Statistical Physics*. Oxford University Press, 2005.

D. Griffeath and C. Moore, Eds., *New Constructions in Cellular Automata*. Oxford University Press, 2003.

C. Moore, “Limiting the Computational Power of Recurrent Neural Networks: VC Dimension and Noise.” J. Kolen and S. Kremer, Eds., *A Field Guide to Dynamical Recurrent Networks*. IEEE Press, 2001.

### 7.2 Articles in journals, peer-refereed conference proceedings, and preprints

J. Banks, C. Moore, and R. Kleinberg, “The Lovász Theta Function for Random Regular Graphs and Community Detection in the Hard Regime.” *Proc. 21st Intl. Workshop on Randomization and Computation (RANDOM ’17)*, to appear.

X. Zhang, C. Moore, and M.E.J. Newman, “Random graph models for dynamic networks.” *European Physical Journal B*, to appear.

C. Moore, “The Computer Science and Physics of Community Detection: Landscapes, Phase Transitions, and Hardness.” *Bulletin of the EATCS* 121, 25–61 (2017).

J. A. Grochow and C. Moore, “Matrix multiplication algorithms from group orbits.” Preprint,

arxiv.org/1612.01527.

C. De Bacco, E. A. Power, D. B. Larremore, and C. Moore, “Community detection, link prediction, and layer interdependence in multilayer networks.” *Physical Review E*, to appear.

J. Banks, C. Moore, R. Vershynin, N. Verzelen, and J. Xu, “Information-theoretic bounds and phase transitions in clustering, sparse PCA, and submatrix localization.” Proc. IEEE International Symposium on Information Theory (ISIT 2017).

A. Godoy-Lorite, R. Guimera, C. Moore, and M. Sales-Pardo, “Accurate and scalable social recommendation using mixed-membership stochastic block models.” *Proc. National Academy of Sciences* 113 (50) 14207–14212 (2016).

T. Lesieur, C. De Bacco, J. Banks, F. Krzakala, C. Moore, and L. Zdeborová, “Phase transitions and optimal algorithms in high-dimensional Gaussian mixture clustering.” Proc. 54th Allerton Conference on Communication, Control, and Computing (2016).

E. Allender, J. A. Grochow, and C. Moore, “Graph Isomorphism and circuit size.” Submitted.

A. Z. Jacobs, J. A. Dunne, C. Moore, and A. Clauset, “Untangling the roles of parasites in food webs with generative network models.” Submitted.

T. P. Hayes and C. Moore, “Lower bounds on the critical density in the hard disk model via optimized metrics.” Submitted.

J. Banks, C. Moore, J. Neeman and P. Netrapalli, “Information-theoretic thresholds for community detection in sparse networks.” Proc. 29th Ann. Conf. on Learning Theory (COLT 2016).

A. Ghasemian, P. Zhang, A. Clauset, C. Moore, and L. Peel, “Detectability thresholds and optimal algorithms for community structure in dynamic networks.” *Physical Review X* 6, 031005 (2016).

C. Moore, “The phase transition in random regular exact cover.” *Annales l’Institut Henri Poincaré D, Combinatorics, Physics and their Interactions*, 3 (3) 349–362 (2016).

V. Dani, T. P. Hayes, C. Moore, and A. Russell, “Codes, lower bounds, and phase transitions in the symmetric rendezvous problem.” *Random Structures and Algorithms* 49(4) 742–765 (2016).

H. Youn, L. Sutton, E. Smith, C. Moore, J. F. Wilkins, I. Maddieson, W. Croft, and T. Bhattacharya, “On the universal structure of human lexical semantics.” *Proc. National Academy of Sciences*, 113(7) 1766–1771 (2016).

P. Zhang, C. Moore, and M. E. J. Newman, “Community detection in networks with unequal groups.” *Physical Review E* 93 012303 (2016).

S. Lovett, C. Moore, and A. Russell, “Group representations that resist random sampling.” *Random Structures and Algorithms* 47(3) 605–614 (2015).

M. Shrestha, S. Scarpino, and C. Moore, “Message-passing approach for recurrent-state epidemic models on networks.” *Physical Review E* 92 022821 (2015).

C. Moore and A. Russell, “Optimal  $\epsilon$ -biased sets with just a little randomness.” *SIAM J. Discrete Math.* 29(3) 1303–1311 (2015).

C. Moore and A. Russell, “Approximate representations, approximate homomorphisms, and low-dimensional embeddings of groups.” *SIAM J. Discrete Math.* 29 (1) 182–197 (2015).

H. Dinh, C. Moore, and A. Russell, “Limitations of single coset states and quantum algorithms for code equivalence.” *Quantum Information and Computation* 15 260–294 (2015).

C. Moore and A. Russell, “Heat and Noise on Cubes and Spheres: The Sensitivity of Randomly Rotated Polynomial Threshold Functions.” Preprint, arXiv:1408.5425.

P. Zhang and C. Moore, “Scalable detection of statistically significant communities and hierarchies: message-passing for modularity.” *Proc. National Academy of Sciences* 111 (51) 18144–18149 (2014).

P. Zhang, C. Moore, and L. Zdeborová, “Phase transitions in semisupervised clustering of sparse

networks.” *Physical Review E* 90 052802 (2014).

M. Shrestha and C. Moore, “A message-passing approach for threshold models of behavior in networks.” *Physical Review E* 89 022805 (2014).

F. Caccioli, M. Shrestha, C. Moore, and J. D. Farmer, “Stability analysis of financial contagion due to overlapping portfolios.” *J. Banking and Finance* 46 233–245 (2014).

G. Ver Steeg, C. Moore, A. Galstyan, and A. E. Allahverdyan, “Phase transitions in community detection: a solvable toy model.” *Europhysics Letters* 106 48004 (2014).

C. Moore and L.J. Schulman, “Tree codes and a conjecture on exponential sums.” *Proc. 5th Innovations in Theoretical Computer Science (ITCS ’14)* 145–154.

R. Impagliazzo, C. Moore, and A. Russell, “An entropic proof of Chang’s inequality.” *SIAM J. Discrete Math.*, 28(1) 173–176 (2014).

X. Yan, J. Jensen, F. Krzakala, C. Moore, C. Shalizi, L. Zdeborová, P. Zhang, and Y. Zhu, “Model Selection for Degree-corrected Block Models.” *J. Stat. Mech.* 5 P05007 (2014). Conference version in *Workshop on Social Network and Social Media Analysis, NIPS ’12*.

Y. Zhu, X. Yan, and C. Moore, “Oriented and Degree-generated Block Models: Generating and Inferring Communities with Inhomogeneous Degree Distributions.” *J. Complex Networks* 2(1) 1–18 (2014). Conference version in *Workshop on Social Network and Social Media Analysis, NIPS ’12*.

F. Krzakala, C. Moore, E. Mossel, J. Neeman, A. Sly, L. Zdeborová, and P. Zhang, “Spectral redemption in clustering sparse networks.” *Proc. National Academy of Sciences* 110 (52) 20935–20940 (2013).

V. Dani, J. Diaz, T. P. Hayes, and C. Moore, “The power of choice for random satisfiability.” *Proc. 17th Intl. Workshop on Randomization and Computation (RANDOM ’13)* 484–496.

S. Chen, C. Moore, and A. Russell, “Small-Bias Sets for Nonabelian Groups: Derandomizing the Alon-Roichman Theorem.” *Proc. 17th Intl. Workshop on Randomization and Computation (RANDOM ’13)* 436–451.

Y. Zhu, X. Yan, L. Getoor, and C. Moore, “Scalable text and link analysis with mixed-topic link models.” *Proc. 19th Int. Conf. on Knowledge Discovery and Data Mining (KDD ’13)* 473–481.

S. Mertens and C. Moore, “The complexity of the fermionant, and immanants of constant width.” *Theory of Computing* 9 (6) 273–282 (2013).

C. D. Brummitt, P. D. H. Hines, I. Dobson, C. Moore, R. M. D’Souza, “Transdisciplinary electric power grid science.” *Proc. National Academy of Sciences* 110 (30) 12159 (2013).

S. Mertens and C. Moore, “Continuum percolation thresholds in two dimensions.” *Physical Review E* 86 (2012) 061109.

C. Moore and A. Russell, “Approximating the permanent via nonabelian determinants.” *SIAM J. Computing* 41 (2012) 332–355.

V. Dani, C. Moore, and A. Olson, “Tight bounds on the threshold for permuted  $k$ -colorability.” *Proc. 16th Intl. Workshop on Randomization and Computation (RANDOM ’12)* 505–516.

C. Moore, “A Complex Legacy.” *Nature Physics* 7 (2011) 828–830.

H. Bauke, C. Moore, J.-B. Rouquier, and D. Sherrington, “Topological phase transition in a network model with preferential attachment and node removal.” *Euro. Phys. J. B* 83 (2011) 519–524.

A. Decelle, F. Krzakala, C. Moore, and L. Zdeborová, “Asymptotic analysis of the stochastic block model for modular networks and its algorithmic applications.” *Physical Review E* 84 (2011) 066106.

A. Decelle, F. Krzakala, C. Moore, and L. Zdeborová, “Phase transition in the detection of modules in sparse networks.” *Physical Review Letters* 107 (2011) 065701.

J. Machta, S. DeDeo, S. Mertens, and C. Moore, “Parallel complexity of random Boolean circuits.”

- J. Stat. Mech.* P04015 (2011).
- C. Moore and A. Russell, “A graph integral formulation of the circuit partition polynomial.” *Combinatorics, Probability, and Computing* 20 (2011) 911–920.
- H. Dinh, C. Moore, and A. Russell, “McEliece and Niederreiter Cryptosystems That Resist Quantum Fourier Sampling Attacks.” *Proc. 31st Annual Cryptology Conference (CRYPTO ’11)* 761–779.
- V. Dani and C. Moore, “Independent sets in random graphs from the weighted second moment method.” *Proc. 15th Intl. Workshop on Randomization and Computation (RANDOM ’11)* 472–482.
- C. Moore, X. Yan, Y. Zhu, J.-B. Rouquier, and T. Lane, “Active learning for node classification in assortative and disassortative networks.” *Proc. 17th Int. Conf. on Knowledge Discovery and Data Mining (KDD ’11)* 841–849.
- S. Kasiviswanathan, C. Moore, and L. Theran, “The rigidity transition in random graphs.” *Proc. 22nd Symp. on Discrete Algorithms (SODA ’11)* 1237–1252.
- S. Hallgren, C. Moore, M. Rötteler, A. Russell, and P. Sen, “Limitations of quantum coset states for Graph Isomorphism.” *J. ACM* 57 (6) (2010). Conference version in *Proc. 38th Symp. on Theory of Computing (STOC ’06)*, 604–617.
- C. Moore, A. Russell, and P. Śniady, “On the impossibility of a quantum sieve algorithm for Graph Isomorphism.” *SIAM J. Computing* 39(6) (2010) 2377–2396. Conference version in *Proc. 39th Symp. on Theory of Computing (STOC ’07)*, 536–545.
- A. Denney, C. Moore, and A. Russell, “Finding conjugate stabilizer subgroups in  $\text{PSL}(2, q)$  and related groups.” *Quantum Information and Computation* 10(3–4) (2010) 282–291.
- Y. Park, C. Moore, and J.S. Bader, “Dynamic networks from hierarchical Bayesian graph clustering.” *PLoS One* 5(1) (2010).
- D. Kempe, M. Salek, and C. Moore, “Frugal and truthful auctions for vertex covers, flows, and cuts.” *Proc. 51st. Foundations of Computer Science (FOCS ’10)* 745–754.
- S. Bravyi, C. Moore, and A. Russell, “Bounds on the quantum satisfiability threshold.” *Proc. 1st Symp. on Innovations in Computer Science (ICS ’10)* 482–489.
- G. Alagic, C. Moore, and A. Russell, “Quantum algorithms for Simon’s problem over general groups.” *ACM Transactions on Algorithms* 6 (2009) 331–345. Conference version in *Proc. 18th Symp. on Discrete Algorithms (SODA ’07)*, 1217–1224.
- D. Achlioptas, A. Clauset, D. Kempe, and C. Moore, “On the bias of traceroute sampling: or, power-law degree distributions in regular graphs.” *J. ACM* 56(4) (2009) 1–28. Conference version in *Proc. 37th Symp. on Theory of Computing (STOC ’05)*, 694–703.
- V. Kalapala and C. Moore, “The phase transition in Exact Cover.” *Chicago Journal of Theoretical Computer Science*, article 5 (2008).
- A. Clauset, C. Moore, and M. E. J. Newman, “Hierarchical structure and the prediction of missing links in networks.” *Nature* 453 (2008) 98–101.
- C. Moore, A. Russell, and L.J. Schulman, “The symmetric group defies strong Fourier sampling.” *SIAM J. Computing* 37 (2008) 1842–1864. Invited paper in special issue for FOCS 2005. Conference version in *Proc. 46th Foundations of Computer Science (FOCS ’05)*, 479–490.
- C. Moore, A. Russell, and U. Vazirani, “A classical one-way function to confound quantum adversaries.” Preprint, arXiv:quant-ph/0701115.
- R.M. D’Souza, P.L. Krapivsky, and C. Moore, “The power of choice in growing trees.” *European J. Phys. B* 59 535–543 (2007).
- C. Moore and A. Russell, “For distinguishing conjugate hidden subgroups, the Pretty Good Measurement is as good as it gets.” *Quantum Information and Computation* 7 (2007) 752–765.

- C. Moore, D. Rockmore, A. Russell, and L.J. Schulman, “The value of strong Fourier sampling: quantum algorithms for affine groups and hidden shifts.” *SIAM J. Computing* 37 (2007) 938–958. Conference version in *Proc. 15th Symp. on Discrete Algorithms* (SODA ’04), 1113–1122.
- C. Moore, G. Istrate, D. Demopoulos, and M.Y. Vardi, “A continuous-discontinuous second-order transition in the satisfiability of random Horn-SAT formulas.” *Random Structures and Algorithms* 31 (2007) 173–185.
- H. Jia, C. Moore, and D. Strain, “Generating hard satisfiable formulas by hiding solutions deceptively.” *J. Artificial Intelligence Research* 28 (2007) 107–118. Conference version in *Proc. 20th Natl. Conf. on Artificial Intelligence* (AAAI ’05), 384–389.
- T. Berger-Wolfe, C. Moore, and J. Saia, “A computational approach to animal breeding.” *Journal of Theoretical Biology* 244 (2007) 433–439.
- C. Moore, D. Rockmore, and A. Russell, “Generic quantum Fourier transforms.” *ACM Transactions on Algorithms* 2 (2006) 707–723. Invited paper in special issue for SODA 2004. Conference version in *Proc. 15th Symp. on Discrete Algorithms* (SODA ’04), 778–787.
- D. Achlioptas and C. Moore, “Two moments suffice to cross a sharp threshold.” *SIAM J. Computing* 36 (2006) 740–762.
- C. Moore and M. Nauenberg, “New periodic orbits for the  $n$ -body problem.” *Journal of Computational and Nonlinear Dynamics* 1 (2006) 271–367. Special issue for Philip Holmes’ 60th birthday.
- A. Coja-Oghlan, C. Moore, and V. Sanwalani, “Counting connected graphs and hypergraphs via the probabilistic method.” *Random Structures and Algorithms* 28 (2006) 289–322. Conference version in *Proc. 8th Intl. Workshop on Randomization and Computation* (RANDOM ’04), 322–333.
- C. Moore, G. Ghoshal, and M. E. J. Newman, “Exact solutions for models of evolving networks with addition and deletion of nodes.” *Physical Review E* 74 (2006) 036121.
- C. R. Shalizi, R. Haslinger, J.-B. Rouquier, K. L. Klinkner, and C. Moore, “Automatic filters for the detection of coherent structure in spatiotemporal systems.” *Physical Review E* 73 (2006) 036104.
- A. Coja-Oghlan, C. Moore, and V. Sanwalani, “MAX  $k$ -CUT and approximating the chromatic number of random graphs.” *Random Structures and Algorithms* 28 (2006) 289–322. Conference version in *Proc. Intl. Colloquium on Automata, Languages and Programming* (ICALP ’03) 200–211.
- V. Kalapala, V. Sanwalani, A. Clauset, and C. Moore, “Scale invariance in road networks.” *Physical Review E* 73 (2006) 026130.
- R. D’Souza, D. Galvin, C. Moore, and D. Randall, “Global connectivity from local geometric constraints for sensor networks with various wireless footprints.” *Proc. 6th Intl. Conf. on Information Processing in Sensor Networks* (IPSN ’06), 19–26.
- A. Clauset, C. Moore, and M. E. J. Newman, “Structural inference of hierarchies in networks.” *Proc. Workshop on Statistical Network Analysis, Intl. Conf. on Machine Learning* (ICML ’06). E. M. Airoldi et al., Eds., *Lecture Notes in Computer Science* 4503, 1–13.
- D. Achlioptas, M. Molloy, C. Moore, and F. Van Bussel, “Rapid mixing for lattice colorings with fewer colors.” *J. Stat. Mech.* (2005) P10012. Conference version in *Proc. Latin American Theoretical Informatics Symposium* (LATIN ’04) 80–89.
- F. Ablyayev, A. Gainutdinova, M. Karpinski, C. Moore, and C. Pollett, “On the computational power of probabilistic and quantum branching programs.” *Information and Computation* 203 (2005) 145–162.
- P. Beame, J. Culberson, D. Mitchell, and C. Moore, “The resolution complexity of random graph  $k$ -colorability.” *Discrete Applied Mathematics* 153 (2005) 25–47.
- D. Achlioptas, H. Jia, and C. Moore, “Hiding satisfying assignments: two are better than one.”



- Journal of Artificial Intelligence Research* 24 (2005) 623–639. Conference version in *Proc. 19th Natl. Conf. on Artificial Intelligence (AAAI '04)*, 131–136.
- A. Clauset and C. Moore, “Accuracy and scaling phenomena in Internet mapping.” *Physical Review Letters* 94 (2005) 018701.
- C. Moore, G. Istrate, D. Demopoulos and M. Vardi, “A continuous-discontinuous second-order transition in the satisfiability of random Horn-SAT formulas.” *Proc. 9th Intl. Workshop on Randomization and Computation (RANDOM '05)*, 414–425.
- A. Clauset, M.E.J. Newman, and C. Moore, “Finding community structure in very large networks.” *Physical Review E* 70 (2004) 066111.
- J. Kari and C. Moore, “Rectangles and squares recognized by two-dimensional automata.” In *Theory Is Forever, Essays Dedicated to Arto Salomaa on the Occasion of His 70th Birthday*. J. Karhumäki, H. Maurer, G. Paun, and G. Rozenberg, Eds. *Lecture Notes in Computer Science* 3113 (2004) 134–144.
- M. Lachmann, M.E.J. Newman, and C. Moore, “The Physical Limits of Communication, or why any sufficiently advanced technology is indistinguishable from noise.” *American Journal of Physics* 72 (2004) 1290–1293.
- D. Achlioptas and C. Moore, “The chromatic number of random regular graphs.” *Proc. 8th Intl. Workshop on Randomization and Computation (RANDOM '04)*, 219–228.
- H. Jia and C. Moore, “How much backtracking does it take to color random graphs? Rigorous results on heavy tails.” *Proc. 10th Intl. Conf. on Principles and Practice of Constraint Programming (CP '04)*. *Lecture Notes in Computer Science* 3258 (2004), 742–746.
- H. Jia, C. Moore, and B. Selman, “From spin glasses to hard satisfiable formulas.” *Proc. 7th Intl. Conf. on Theory and Applications of Satisfiability Testing (SAT '04)*, 12–19.
- C. Morgan, D. Stefanovic, C. Moore, and M. N. Stojanovic, “Building the components for a biomolecular computer.” *Proc. 10th Intl. Meeting on DNA Computing (DNA 10, '04)*.
- C. R. Shalizi and C. Moore, “What Is a Macrostate? Subjective Observations and Objective Dynamics.” Preprint, arXiv:cond-mat/0303625.
- D. Achlioptas and C. Moore, “Almost all graphs of degree 4 are 3-colorable.” *Journal of Computer and System Sciences*, 67 (2003) 441–471. Invited paper in special issue for STOC 2002. Conference version in *Proc. 34th Symp. on Theory of Computing (STOC '02)* 199–208.
- M. Campagnolo, C. Moore, and J. F. Costa, “An analog characterization of the Grzegorczyk hierarchy.” *Journal of Complexity* 18 (2002) 977–1000.
- C. Moore and I. Pak, “Ribbon tile invariants from signed area.” *Journal of Combinatorial Theory Ser. A*. 98 (2002) 1–16.
- F. Green, S. Homer, C. Moore, and C. Pollett, “Counting, fanout, and the complexity of quantum ACC.” *Quantum Information and Computation* 2(1) (2002) 35–65.
- D. Achlioptas and C. Moore, “The asymptotic order of the  $k$ -SAT threshold.” *Proc. 43rd Foundations of Computer Science (FOCS '02)* 779–788.
- F. Ablayev, C. Moore, and C. Pollett, “Quantum branching programs of bounded width.” *Proc. 29th Intl. Colloquium on Automata, Languages and Programming (ICALP '02)* 343–354.
- C. Moore, I. Rapaport, and E. Rémila, “Tiling groups for Wang tiles.” *Proc. 13th Symp. on Discrete Algorithms (SODA '02)* 402–211.
- C. Moore and A. Russell, “Quantum walks on the hypercube.” *Proc. 6th Intl. Workshop on Randomization and Approximation Techniques in Computer Science (RANDOM '02)* 164–178.
- D. Achlioptas and C. Moore, “On the two-colorability of random hypergraphs.” *Proc. 6th Intl.*

- Workshop on Randomization and Approximation Techniques in Computer Science* (RANDOM '02) 78–90.
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- C. Moore and M. Nilsson, “Parallel quantum computation and quantum codes.” *SIAM J. Computing* 31(3) (2001) 799–815.
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- M. Campagnolo and C. Moore, “Upper and lower bounds on continuous-time computation.” *Proc. 2nd Intl. Conf. on Unconventional Models of Computation* (UMC '00) 135–153.
- M. Lachmann, C. Moore, and I. Rapaport, “Who wins Domineering on rectangular boards?” In R.J. Nowakowski, Ed., *More Games of No Chance* (MSRI Workshop on Combinatorial Games,

2000) 307–315.

C. Moore and D. Eppstein, “One-dimensional peg solitaire, and duotaire.” In R.J. Nowakowski, Ed., *More Games of No Chance* (MSRI Workshop on Combinatorial Games, 2000) 341–350.

D.M. Barrington, P. McKenzie, C. Moore, P. Tesson, and D. Thérien, “Equation satisfiability and program satisfiability for finite monoids.” *Proc. 25th Intl. Symp. on Mathematical Foundations of Computer Science* (MFCS '00) 172–181.

M. Campagnolo and C. Moore, “An analog characterization of the subrecursive functions.” *Proc. 4th Real Numbers and Computers* (RNC '00) 91–110.

M.E.J. Newman and C. Moore, “Glassy dynamics in an exactly solvable spin model.” *Physical Review E* 60 (1999) 5068–5072.

C. Moore, M.G. Nordahl, N. Minar, and C. Shalizi, “Vortex dynamics and entropic forces in antiferromagnets and antiferromagnetic Potts models.” *Physical Review E* 60 (1999) 5344–5351.

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P. Koiran and C. Moore, “Closed-form analytic maps in one and two dimensions can simulate universal Turing Machines.” *Theoretical Computer Science* 210(1) (1999) 217–223, Special Issue on Real Numbers.

C. Moore, “Predicting non-linear cellular automata quickly by decomposing them into linear ones.” *Physica D* 111 (1998) 27–41.

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C. Moore, “Dynamical recognizers: real-time language recognition by analog computers.” *Theoretical Computer Science* 201 (1998) 99–136.

C. Moore, “Finite-dimensional analog computers: flows, maps, and recurrent neural networks.” *Proc. 1st Intl. Conf. on Unconventional Models of Computation* (UMC '98).

C. Moore and M. Nordahl, “Lattice Gas Prediction is P-complete.” Preprint, arXiv:comp-gas/9704001.

C. Moore, “Majority-vote cellular automata, Ising dynamics, and P-completeness.” *Journal of Statistical Physics* 88 (1997) 795–805.

C. Moore, “Quasi-linear cellular automata.” *Physica D* 103 (1997) 100–132.

C. Moore and T. Boykett, “Commuting cellular automata.” *Complex Systems* 11 (1997) 55–64.

C. Moore, “Dynamical recognizers: real-time language recognition by analog computers.” In F. Cucker and M. Shub, Eds., *Foundations of Computational Mathematics*. Springer-Verlag (1997).

D. Griffeath and C. Moore, “Life without death is P-complete.” *Complex Systems* 10 (1996) 437–447.

C. Moore, “Recursion theory on the reals and continuous-time computation.” *Theoretical Computer Science* 162 (1996) 23–44.

C. Moore and A. Drisko, “Algebraic properties of the block transformation on cellular automata.” *Complex Systems* 10(3) (1996) 185–194.

C. Moore, “Braids in classical dynamics.” *Physical Review Letters* 70 (1993) 3675–3679.

C. Moore, “Generalized one-sided shifts and maps of the interval.” *Nonlinearity* 4 (1991) 727–745.

C. Moore, “Generalized shifts: undecidability and unpredictability in dynamical systems.” *Nonlinearity* 4 (1991) 199–230.

C. Moore, “Undecidability and unpredictability in dynamical systems.” *Physical Review Letters* 64 (1990) 2354–2357.

C. Moore, “Comment on ‘Space-time as a causal set.’” *Physical Review Letters* 60 (1988) 655.

## 8 Teaching

### 8.1 Courses taught at UNM

|   |   |
|---|---|
| Introduction to the Theory of Computation (grad)      | Spring '04, '07–'12   |
| Data Structures and Algorithms                        | Spring and Fall '02, Fall '03, '04, '06                           |
| Physics and Computation                               | Spring '00, Spring '01, Spring and Fall '02, Spring '04, Fall '10 |
| Introduction to Quantum Computation                   | Fall '04, Spring '08, Fall '11                                    |
| Combinatorics, Probability, and Computation           | Fall '06  |
| Introduction to the Theory of Computation (undergrad) | Spring '03  |
| Theoretical Foundations of Computer Science           | Fall '03  |
| Intermediate Object-Oriented Programming              | Fall '00, Fall '01  |

### 8.2 Courses taught elsewhere

Summer 2005–2016: Santa Fe Institute Complex Systems Summer School, Santa Fe.

January 2003: Complex Systems Summer School. Valparaiso, Chile.

Summer 2001, 2002: Santa Fe Institute Complex Systems Summer School, Budapest.

Spring 2001: Short Course on Computational Complexity for the NSF Physics Graduate Student Fellowship program at the Santa Fe Institute.

Spring 1991: Cornell University, “Components, Systems, and Society: Science and Engineering in a Social Context” (with Zellman Warhaft, Mechanical and Aerospace Engineering).

### 8.3 Students supervised

Munik Shrestha, Ph.D., Physics, 2015, “Statistics of Epidemics in Networks by Passing Messages.” Currently a postdoc at the University of Vermont.

Yaojia Zhu, Ph.D. Computer Science, 2013, “Community Detection in Complex Networks.” Now a data scientist at Microsoft.

Xiaoran Yan, Ph.D. Computer Science, 2013, “Model Selection for Stochastic Block Models.” Currently a postdoc at ISI at the University of Southern California.

Aaron Denney, Ph.D. Physics, 2012, “Quantum Algorithms, Symmetry, and Fourier Analysis.”

Tiffany Pierce, M.S. Computer Science, 2008, “Inference of Large-Scale Structure in Networks.”

Haixia Jia, Ph.D. with distinction, Computer Science, 2007, “Hard Problems with Hidden Solutions.”

Aaron Clauset, Ph.D. with distinction, Computer Science, 2006, “Structural Inference and the Statistics of Networks.” After a postdoc at the Santa Fe Institute, Aaron is now an Assistant Professor in Computer Science at the University Colorado-Boulder.

Vishal Sanwalani, Ph.D. with distinction, Computer Science, 2005, “Applications of the Probabilistic Method to Random Graphs.” Postdocs at the University of Waterloo and at Microsoft Research.

Vamsi Kalapala, M.S. 2005, “Results on Phase Transitions and Scale Invariance.”

Douglas Strain, M.S. 2005.

Qian Liang, M.S. 2003, “The Evolution of Mulan, Some Studies in Game-Tree Pruning and Evaluation Functions in the Game of Amazons.” Now at Microsoft.

Manuel Campagnolo. Ph.D. 2002 from the Lisbon University of Technology (co-advised with José Felix Costa). “Computational Complexity of Real-valued Recursive Functions and Analog Circuits.” Now Professor of Mathematics at the Lisbon University of Technology.

## 9 Professional activities

### 9.1 Editorial, juries, and external review

Chair, Lars Onsager Prize Committee, American Physical Society, 2016

Member, Lars Onsager Prize Committee, American Physical Society, 2015

Technical Advisory Group, HRL 2014

Jury, Turing Centenary Research Fellowship and Scholar Competition, 2012

External Review Panel, CIFAR Quantum Information Processing Program, 2012

Associate Editor, *Journal of Complex Networks*, 2012–

Associate Editor, *SIAM Journal on Discrete Mathematics*, 2010–

Editorial Board, *Journal of Statistical Mechanics: Theory and Experiment*, 2004–2007

### 9.2 Organizing and program committees

Program Committee, Symposium on Theory of Computing (STOC) 2017

Program Committee, International Colloquium on Automata, Languages and Programming (ICALP) 2016, Track C

Program Committee, Foundations of Computer Science (FOCS) 2015

Program Committee, Workshop on Mining Networks and Graphs (SDM) 2015

Program Committee (Chair), Workshop on Randomization and Computation (RANDOM) 2014

Organizing Committee, SIAM Workshop on Network Science, 2014

Co-organizer (with Jon Machta and Stephan Mertens), Deep Computation in Statistical Physics. Santa Fe Institute, 2013

Co-organizer (with Aaron Clauset and Mark Newman), Structure, Statistical Inference, and Dynamics in Networks: From Graphs to Rich Data. Santa Fe Institute, 2013

Co-organizer (with Sue Coppersmith, Jon Machta, Alan Middleton, and Lenka Zdeborová), Workshop on Disorder, Algorithms, and Complexity. Aspen Center for Physics, Summer 2012

Co-organizer (with Misha Chertkov, Raissa D’Souza, and Paul Hines), Power Grids as Complex Networks. Santa Fe Institute, 2012

Program Committee, Workshop on Complex and Communication Networks, GLOBECOM 2011

Program Committee, Intl. Conf. on Theory and Applications of Satisfiability Testing (SAT) 2011

Program Committee, Workshop on Complex and Communication Networks, GLOBECOM 2010

Program Committee, Symposium on Discrete Algorithms (SODA) 2010

Steering Committee, Quantum Information Processing (QIP) 2008, 2009 (Chair), 2010

Program Committee, Workshop on Analysis of Dynamic Networks, December 2008

Co-organizer (with Aaron Clauset), Statistical Inference in Networks. Santa Fe Institute, 2008

Co-organizer (with Sue Coppersmith, Jon Machta, and Alan Middleton), Workshop on Complexity,

Disorder, and Algorithms. Aspen Center for Physics, Summer 2008

Program Committee, Intl. Workshop on Randomization and Computation (RANDOM) 2007

Co-organizer (with Paul Bourguine and Michel Morvan), Scaling in Biological and Social Networks. Santa Fe, 2007

Co-organizer (with Persi Diaconis, Daniel Fisher, and Charles Radin), Phase Transitions in Physics, Computer Science, Combinatorics and Probability. American Institute of Mathematics, 2006

Program Committee, Intl. Conf. on Theory and Applications of Satisfiability Testing (SAT) 2006

Co-organizer (with Michel Morvan), New Perspectives on Complex Systems. Santa Fe, 2005

Program Committee, Intl. Colloquium on Automata, Languages and Programming (ICALP) 2004

Co-organizer (with Rajarshi Das, Irina Rish, and Gerry Tesauro) of the Workshop on Robust Communication Dynamics in Complex Networks. NIPS, Whistler, Canada, 2003

Program Committee, Discrete Models for Complex Systems. Lyon, June 2003

Co-organizer (with Dana Randall), special session of the joint AMS/MAA national meeting on Discrete Models. Baltimore, January 2003

Program Committee, Symposium on Theoretical Aspects of Computer Science (STACS) 2002

Co-organizer (with Allon Percus and Gabriel Istrate), workshop on “Computational Complexity and Statistical Physics.” Santa Fe, 2001

### 9.3 Reviewing

(Computer Science) *Journal of the ACM, SIAM Journal of Computing, Theory of Computing, Journal of Computer and System Sciences, Information and Computation, Theoretical Computer Science, Information Processing Letters, Random Structures and Algorithms, Quantum Information and Computation, Theory of Computing Systems, Discrete and Computational Geometry, IEEE Trans. on Information Theory, IEEE Trans. on Computers, IEEE Trans. on Networks, ACM Trans. on Modeling and Computer Simulation, Computer Networks, Foundations of Computer Science (FOCS), Symposium on Theory of Computing (STOC), Symposium on Discrete Algorithms (SODA), Randomization and Approximation Techniques in Computer Science (RANDOM), Intl. Colloquium on Automata, Languages, and Programming (ICALP), Symposium on Theoretical Aspects of Computer Science (STACS), Mathematical Foundations of Computer Science (MFCS), Computing and Combinatorics Conference (COCOON), Intl. Symposium on Symbolic and Algebraic Computation (ISSAC)*

(Physics) *Physical Review Letters, Nature Physics, Physical Review A, Physical Review E, Physics Letters A, Physica A, Physica D, Europhysics Letters, Communications in Mathematical Physics, Intl. J. Modern Physics C, Computers in Physics*

(Other) *Nature, Science, Proceedings of the National Academy of Sciences, Proceedings of the Royal Society, Nature Physics, PLoS One, Annals of Applied Probability, Annals of Applied Statistics, Journal of Theoretical Biology, Applied Artificial Intelligence, IEEE Trans. Evolutionary Computation, Fluctuation and Noise Letters, Advances in Complex Systems, Chaos, Journal of Complexity, Mathematics Magazine, History and Philosophy of Logic*

## 10 Funding (Principal Investigator)

NSF REU Site, “Computational and Mathematical Modeling of Complex Systems.” \$346,958, 2014–2017.

NSF CCF with Tom Hayes, “The Physics of Markov Chains: Closing the Gap Between Theory and Practice.” \$200,000, 2012–2015.

DARPA GRAPHS with Aaron Clauset and Mark Newman, “Statistical Inference for Detecting Structures and Anomalies in Networks.” \$2.9M, 2012–2016.

NSF CCF with Alex Russell, “Representation-theoretic Techniques for Pseudorandomness and Lower Bounds.” \$240,979, 2011–2014.

McDonnell Foundation with Aaron Clauset and Mark Newman, “Statistical Inference and Machine Learning for Complex Networks.” \$417,576, 2008–2011.

NSF EMT with Alex Russell, “The Quantum Complexity of Algebraic Problems.” \$180,000, 2005–2008.

ARO with Wim van Dam and Alex Russell, “Quantum Algorithms for Algebraic Problems.” \$600,000, 2005–2008.

NSF Medium ITR with Darko Stefanovic and Milan Stojanovic, “Solution-Phase Computation with Enzymatic Networks.” \$3M, 2003–2008.

NSF Small ITR with Alex Russell and Daniel Rockmore, “Complexity-Theoretic Applications of non-Abelian Fourier Analysis.” \$195,000, 2002–2005.

NSF QuBIC with Alex Russell, “Quantum Monte Carlo Algorithms.” \$175,000, 2002–2005.

NSF Physics, “Phase Transitions and Critical Phenomena in NP-complete Problems.” \$166,000, 2002–2006.

NSF Physics, “Computational Complexity in Statistical and Quantum Physics.” \$80,000, 2000–2002.

Los Alamos National Laboratory, “Phase Transitions in NP-complete Problems.” \$25,000, 2002.

Sandia University Research Program (SURP), “Phase Transitions in NP-complete Problems.” \$35,000, 2001–2002.

Sandia University Research Program (SURP), “Tilings and self-assembly.” \$35,000, 2000–2001.