

ILYA NEMENMAN Los Alamos National Laboratory

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born January 8, 1975, in Minsk, Belarus Los Alamos, NM 87545

CV last updated on November 19, 2007

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EDUCATION

Princeton University, Physics, PhD 2000

San Francisco State University, Physics, MS 1997

Santa Clara University, Physics/Math, BS 1995

Belarusian State University, Theoretical Physics, 1991 – 1994

APPOINTMENTS

since 2005 Technical Staff Member, CCS-3, Los Alamos National Laboratory

2004 – 2005 Associate Research Scientist, Joint Centers for Systems Biology, Columbia University Medical Center, New York

2001 – 2004 Postdoctoral Scientist, Kavli Institute for Theoretical Physics, UC Santa Barbara

2000 – 2001 Postdoctoral Scientist, NEC Research Institute, Princeton, New Jersey

1998 – 1999 Research Scientist, Gravity Probe B (GP-B), HEPL, Stanford University.

1997 – 1997 Student Researcher, L3 experiment, CERN/PPE, Geneva

CONCURRENT APPOINTMENTS

since 2007 Visiting Scientist, New Mexico Consortium, Los Alamos, NM

since 2007 Center for Nonlinear Studies Affiliate, Los Alamos National Laboratory

TEACHING EXPERIENCE

2007 The q-bio Summer School on Cellular Information Processing, organizer and instructor

2006 – 2007 Los Alamos Summer School, instructor

2004 – 2005 Columbia University, Department of Biomedical Informatics, co-instructor, Computational

Biology: Functional and Integrative Genomics

2002 UCSB, Department of Statistics; NYU, Courant Institute, Bioinformatics group, visiting instructor, lecture series in Statistical Inference

1999–2001 Marine Biological Laboratory, Woods Hole, MA, teaching assistant, Methods in Computational Neuroscience

1997–1999 Princeton University, Department of Physics, teaching assistant

1995-1996 San Francisco State University, Department of Physics, teaching assistant

HONORS AND AWARDS

National Science Foundation Scholar, StatPhys 22, 2004

Outstanding Teaching Assistant, Department of Physics, Princeton University, 1999

Graduate Student Distinguished Achievement Award, SFSU, 1997

Outstanding Teaching Assistant, Department of Physics, SFSU, 1996

Belarusian State University Honorary Stipend, 1993–1994

Belarusian National High School Physics Olympiad, Winner, 1991

RESEARCH GRANTS

NSF-OCI-0749348 , “Peta-scale computing infrastructure: High Performance Neural Computing”, co-PI, preliminary award notice received

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NIH/NCI/1R01CA132629 “Differential Metabolic Analysis of Tumor Progression”, PI (multiple PIs), 2007–2012

DOE/LANL/LDRD/20080391ER “Stochastic Transport on Networks: Efficient Modeling And Applications to Epidemiology”, PI, 2007–2010 (8% funding rate)

DOE/LANL/LDRD/20080138DR “Genomes to Behavior: Predicting Bacterial Response by Constrained Network Interpolation”, co-investigator, 2007–2010 (8% funding rate)

DOE/LANL/LDRD/20070649PRD2 “Noise in Biochemical Networks: Rigorous Analysis with Field-Theoretic Tools”, PI, 2007–2010

NIH/NIGMS-1R21GM080216 “System-wide Study of Transcriptional Control of Metabolism”,

co-PI, 2007–2009

NSF-ECS-0425850 “QSB: Optimal information processing in biological networks”, co-PI, 2004–2008

NSF-ECS-0332479 “SGER: Developing learning theory for genetic network inference”, co-PI, 2003–2005

SYNERGISTIC ACTIVITIES

Steering committees: LANL Biological and Environmental Research / Systems Biology strategic planning committee; New Mexico Consortium Neural Computing strategic planning thrust leader; LANL Neuroscience strategy team; LANL Information Sciences planning group
School organization: The q-bio Summer School on Cellular Information Processing, 2007-2008, Los Alamos, NM

Conference organization: The q-bio Conference on Cellular Information Processing, 2007–2008, Santa Fe, NM; CNLS Annual Conference on Information Sciences and Technology, 05/2008, Santa Fe, NM; Unconventional computation: Quo Vadis?, 03/2007, Santa Fe, NM; Grand Challenges in Neural Computation, 02/2007, Santa Fe, NM; NIPS’03 workshop on Estimation of entropy and information of undersampled probability distributions, 12/03, Whistler, BC

Long program organization: KITP program Understanding the brain Conference program committees: RECOMB satellite workshop on Systems Biology, 11/2007; The

Second DREAM Conference, 12/2007; Information Theory and Statistical Learning, 06/2008

Refereeing: NIPS, Neural Computation, J. Neurophysiol., Phys. Rev., Biosystems, Pattern Analysis and Applications, Stochastic Modeling and Applications, RECOMB, DREAM, Trends in Cognitive Sciences, BMC Bioinformatics, BMC Systems Biology, PLoS ONE, JOSA, EURASIP Bioinformatics/Systems Biology, Physica D, IEEE Trans. Neur. Net.

Grant refereeing: NSF: Computational Intelligence, Biomedical Engineering, Behavioral Systems Cluster; DOE SBIR/STTR; Israeli Science Foundation

Software: NSB entropy estimation, nsb-entropy.sf.net

Memberships: American Physical Society, New York Academy of Sciences

ADVISEES

Postdocs: Nikolai Sinitsyn, Ricardo Marti-Arbona (LANL)

Graduate Students: Etay Ziv (PhD 2007), Sean Escola, Michael Vidne (Columbia)

Undergraduate Students: Aly Pesic (Stanford)

SUMMARY OF RESEARCH INTERESTS

Using methods of theoretical physics and machine learning for developing functional, coarsegrained models of information processing (signal transduction, learning, adaptation, . . .) in biochemistry, cellular regulation, and neuroscience. This includes, in particular, reverse-engineering cellular networks and creation of efficient tools for their modeling and analysis.

Publications about our work

1. Improving Metabolomic Measurement and Analysis. LANL Science, Technology, and Engineering (STE) Highlights, Nov 7, p. 2, 2007.

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SELECTED REFERENCES

William Bialek (Princeton; thesis advisor), Francis Alexander (LANL), Peter Balsam (Columbia), Andrea Califano (Columbia), Curtis Callan (Princeton), Randy Gallistel (Rutgers), David Gross (UCSB), William Hlavacek (LANL), Rao Jammalamadaka (UCSB), Rob de Ruyter van Steveninck (Indiana University), Naftali Tishby (Hebrew University), Michael Wall (LANL), Chris Wiggins (Columbia)

PRESENTATIONS

Mar 2008 APS March Meeting, Invited talk

Oct 2007 Emory University, Computational Life Sciences seminar

Oct 2007 UCSD Center for Theoretical Biological Physics seminar

Oct 2007 Fall Western Section AMS Meeting, Methods for Heterogeneous Data Analysis Workshop, invited talk

Oct 2007 Santa Fe Institute workshop on High-Level Perception and Low-Level Vision: Bridging the Semantic Gap, invited talk

Oct 2007 DOE/BER seminar, Washington, DC

Jul 2007 CNS'2007 workshop on Methods of Information Theory in Computational Neuroscience, invited talk
Jul 2007 CNS'2007, contributed plenary talk
May 2007 7th Understanding Complex Systems symposium, invited talk
Apr 2007 UCLA Biomath department seminar
Apr 2007 Caltech CNS seminar
Apr 2007 KITP/UCSB program on Evolution of Molecular Networks seminar
Mar 2007 CNLS conference on Unconventional Computation: Workshop on Neural Computation, invited talk
Feb 2007 UNM SIBBS: Seminar in Biological and Biomedical Sciences
Sep 2006 LANL TSC capability workshop Advanced Methods for Data Analysis, contributed talk
Sep 2006 DIMACS workshop on Dialogue on Reverse Engineering Assessment and Methods (DREAM), contributed talk
Aug 2006 LANL TSC capability workshop Complex Networks, contributed talk
Aug 2006 UNM/CS seminar
Aug 2006 International Conference on Molecular Systems Biology, Munich, Germany, contributed plenary talk
Apr 2006 Indiana University Biocomplexity seminar
Apr 2006 Santa Fe Institute seminar
Apr 2006 UNM Cancer Research Center seminar
Mar 2006 New Mexico Bioinformatics Symposium, Santa Fe, NM
Jan 2006 LANL, D-1 seminar
Dec 2005 NIPS'05 Computational Biology Workshop, contributed talk
Nov 2005 Baylor College of Medicine, Neuroimaging Laboratory seminar
Nov 2005 Texas A&M College Station, Models for Genetic Regulatory Networks conference, invited talk
Nov 2005 IAS, Princeton, Systems Biology seminar
Oct 2005 Rutgers, BioMaPs seminar
Jul 2005 University of Washington, Seattle, Biophysics and Physiology seminar
Jun 2005 UCSF, Computational Biology seminar
Jun 2005 CSHL, Computational Neuroscience seminar
Jun 2005 Columbia, C2B2 seminar
Apr 2005 LANL, CCS-3/CNLS seminar
Apr 2005 Cornell, LASSP/Physics colloquium
Apr 2005 IBM Watson research center, physics seminar
Mar 2005 Columbia, Computational Neuroscience seminar
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Feb 2005 Harvard, Bauer Center for Genomics Research seminar
Feb 2005 University of Michigan, Ann Arbor, Physics colloquium
Jan 2005 University of Maryland, College Park, Computational Neuroscience seminar
Dec 2004 Rutgers Statistical Mechanics Meeting, contributed talk
Dec 2004 NIPS 2004 workshop on Computational Biology, Whistler, BC, contributed talk.
Dec 2004 LANL, Theoretical Biology/CNLS seminar
Nov 2004 NEU, physics colloquium
Nov 2004 BU, Biodynamics lab seminar
Sep 2004 UCSB, KITP, Understanding the Brain program seminar
Apr 2004 UCLA, IPAM, Proteomics colloquium
Apr 2004 UCSF, Keck neuroscience center seminar
Mar 2004 NYU, CS colloquium
Mar 2004 LANL, CNLS seminar
Mar 2004 Columbia, C2B2 seminar
Mar 2004 IBM Watson Research Center, Systems Biology and Functional Genomics group seminar
Mar 2004 Rockefeller University, Center for Studies in Physics and Biology colloquium
Dec 2003 NIPS'03 workshop on Entropy Estimation, opening talk

Nov 2003 KITP, UCSB, Pattern formation program seminar
 Oct 2003 Columbia University, Computational biology seminar
 Mar 2003 KITP, UCSB colloquium
 Feb 2003 UCSB, Statistics, short lecture series
 Dec 2002 NIPS-2002 workshop on Universal learning, invited talk
 Dec 2002 NIPS-2002 workshop on Negative results and open problems, contributed talk
 Nov 2002 CalTech's complexity club seminar
 Nov 2002 Princeton, Theoretical biophysics group seminar
 Oct-Nov 2002 Courant Institute, NYU, Bioinformatics group, short lecture series
 Oct 2002 Columbia University, Applied Mathematics seminar
 Oct 2002 Courant Institute, NYU, Bioinformatics seminar
 May 2002 UCSB, Statistics Department, colloquium
 Mar 2002 ITP, UCSB, Director's blackboard lunch talk
 Dec 2001 Contributed spotlight talk at NIPS-2001.
 Oct 2001 ITP, UCSB colloquium
 Mar 2001 Contributed talk at Conference on Frontiers in physics of complex systems, Dead Sea, Israel
 May 2001 NYU Courant Institute / Center for Neuroscience seminar
 Feb 2001 Rockefeller University, Center for Studies in Physics and Biology colloquium
 Jan 2001 MIT Cognitive Science, seminar
 Nov 2000 New England Complex Science Institute colloquium
 Nov 2000 Contributed talk at NIPS-2000
 Apr, Aug 2000 NEC Research Institute, Princeton, NJ, Biophysics seminar
 Jan 2000 Hebrew University, Machine Learning seminar
 Jul 1998 Gravity Probe B, Theory Group seminar
 Aug 1997 CERN/PPE/L3 seminar
 Jul 1994 Belarusian State University, Theoretical Physics seminar

PUBLICATIONS

Refereed publications

1. NA Sinitzyn and I Nemenman. A universal geometric theory of mesoscopic stochastic pumps and reversible ratchets. To appear in *Phys. Rev. Lett.* (2007), arXiv:0705.2057.
2. I Nemenman, GS Escola, WS Hlavacek, PJ Unkefer, CJ Unkefer, ME Wall. Reconstruction of metabolic networks from high-throughput metabolite profiling data: in silico analysis of red blood cell metabolism. *Ann. N.Y. Acad. Sci.* **1115**:102115 (2007).
3. E Ziv, I Nemenman, and C Wiggins. Optimal information processing in small stochastic biochemical networks. *PLoS ONE* **2**(10): e1077 (2007).
4. I Nemenman, GD Lewen, WBialek, RR de Ruyter van Steveninck. Neural coding of a natural stimulus ensemble: Uncovering information at sub-millisecond resolution. Submitted *PLoS Biology* (2007).
 - Preliminary version available as: I Nemenman, G Lewen, WBialek, and R de Ruyter van Steveninck. Neural coding of natural stimuli: information at sub-millisecond resolution. *BMC Neurosci.* **8** (Suppl 2):S7 (2007).
5. NA Sinitzyn and I Nemenman. Berry phase and pump effect in stochastic chemical kinetics. *EPL* **77**, 58001 (2007).
6. A Margolin, K Wang, WK Lim, M Kustagi, I Nemenman, and A Califano. Reverse engineering cellular networks. *Nature Protocols* **1**(2):663-672 (2006).
7. K Wang, I Nemenman, N Banerjee, A Margolin, and A Califano. Genome-wide discovery of modulators of transcriptional interactions in human B lymphocytes. In *Lecture Notes in Computer Science, '3909, Proceedings of Research in Computational Molecular Biology: 10th Annual International Conference, RECOMB 2006*, pp. 348 - 362 (Springer: Berlin / Heidelberg, 2006).
8. AMargolin, I Nemenman, K Basso, UKlein, CWiggins, GStolovitzky, RiccardoDFavera, and A Califano. ARACNE: An algorithm for reconstruction of genetic networks in a mammalian cellular context. *BMC Bioinformatics* **7**(Suppl. 1):S7 (2006).
9. I Nemenman. Fluctuation-dissipation theorem and models of learning. *Neural Comp.* **17**(9):

2006-2033 (2005).

10. I Nemenman, W Bialek, and R de Ruyter van Steveninck. Entropy and information in neural spike trains: Progress on the sampling problem. *Phys. Rev. E* **69**:056111 (2004).

11. C Wiggins and I Nemenman. Process pathway inference via time series analysis. *Exp. Mech.* **43**(3):361-370 (2003).

12. A Silbergleit, I Nemenman, and I Mandel. On the interaction of point charges in an arbitrary domain. *Techn. Phys.* **48**(2):146-151 (2003).

13. A Silbergleit, I Mandel, and I Nemenman. Potential and field singularity at a surface point charge. *J. Math. Phys.* **44**(10):4460-4466 (2003).

14. I Nemenman, F Shafee, and W Bialek. Entropy and inference, revisited. In TG Dietterich, S Becker, and Z Ghahramani, editors, *Adv. Neural Inf. Proc. Syst. 14* (MIT Press: Cambridge, MA, 2002).

15. I Nemenman and W Bialek. Occam factors and model-independent Bayesian learning of continuous distributions. *Phys. Rev. E* **65**(2):026137 (2002).

• Preliminary version available as: I Nemenman and WBialek, *Learning Continuous Distributions: Simulations With Field Theoretic Priors*. In T Leen, T Dietterich, and V Tresp, eds. *Adv. Neural Inf. Proc. Syst. 13*, pp. 287-293 (MIT Press: Cambridge, MA, 2001).

16. WBialek, I Nemenman, and N Tishby. Complexity through nonextensivity. *Physica A* **302**:89-99 (2001).

17. W Bialek, I Nemenman, and N Tishby. Predictability, complexity, and learning. *Neur. Comp.* **13**:2409-2463 (2001).

18. R Adler, I Nemenman, J Overduin, and D Santiago. On the detectability of quantum spacetime foam with gravitational-wave interferometers. *Phys. Lett. B* **477**:424-428 (2000).

19. J Naud, I Nemenman, M Van Raamsdonk, and V Periwal. Minimal subtraction and the Callan-Symanzik equation. *Nucl. Phys. B* **540**:533-539 (1999).

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20. I Nemenman and A Silbergleit. Explicit Green's function of a boundary value problem for a sphere and trapped flux analysis in Gravity Probe B experiment. *J. Appl. Phys.* **86**:614-624 (1999).

21. A Minkevich and I Nemenman. On the influence of gravitating vacuum on dynamics of homogeneous isotropic models in gauge-theories of gravity. *Class. Quant. Grav.* **12**:1259-1265 (1995).

• Preliminary version available as: A Minkevich and I Nemenman. On the influence of gravitating vacuum on dynamics of homogeneous isotropic models in gauge-theories of gravity. *Dokl. Akad. Nauk Belar.* **39**(2):45-51 (1995). In Russian.

Submitted manuscripts

1. I Nemenman, N Sinitsyn, A Sengupta. Analysis of stochastic effects in biochemical networks: A practical guide. Submitted to *IET Systems Biology*, special issue "The First q-bio Conference" (2007).

2. A Margolin, K Wang, A Califano, and I Nemenman. Multivariate dependence and genetic networks inference. Submitted to *PLoS ONE* (2007).

• Preliminary version available as: I Nemenman. Information theory, multivariate dependence, and genetic network inference. *Tech. Rep. NSF-KITP-04-54*, KITP, UCSB (2004), arXiv:q-bio/0406015.

3. K Wang, M Saito, I Nemenman, K Basso, A Margolin, U Klein, R Dalla-Favera, and A Califano. Genome-wide identification of transcriptional network modulators in human B cells. Submitted to *Nature* (2007).

4. I Nemenman. Inference of entropies of discrete random variables with unknown cardinalities. Submitted to *IEEE Trans. Inf. Thy.* (2005), arXiv:physics/0207009.

Unrefereed publications, Views, Editorials

1. I Nemenman, W Hlavacek, M Wall, J Faeder, and Y Jiang, J Edwards eds. *Proc. First q-bio Conference on Cellular Information Processing*. To appear in special issue *IET Systems Biology* (2008).

2. C Teuscher, I Nemenman, and F Alexander, eds. *Novel Computing Paradigms: Proc. CNLS workshop on Unconventional Computing*. To appear in special issue *Physica D*. Editorial: "Novel Computing Paradigms: Quo Vadis?" (2008).

3. J Edwards, J Faeder, WHlavacek, Y Jiang, I Nemenman, and MWAll. q-bio 2007: A Watershed Moment in Modern Biology. To appear in Mol. Syst. Biol. News and Views (2007).
4. I Nemenman. Information Theory and Learning: A Physical Approach. PhD thesis, Princeton University, Department of Physics, (2000), arXiv:physics/0009032.
Unpublished work
1. K Wang, N Banerjee, A Margolin, I Nemenman, K Basso, R Dalla Favera, and A Califano. Conditional network analysis identifies candidate regulator genes in human B cells. Unpublished manuscript (2005), arXiv:q-bio/0411003.
2. A Margolin, N Banerjee, I Nemenman, and A Califano. Reverse engineering of yeast transcriptional network using the ARACNE algorithm. Unpublished manuscript (2004). Available at menem.com/~ilya.
3. T Holy and I Nemenman. On impossibility of learning in a reparameterization covariant way. Technical Report NSF-KITP-03-123, KITP, UCSB (2002). Available at menem.com/~ilya.
4. I Kominis and I Nemenman. BGO dead crystal correction and shower fitting. Tech. Rep. 2157, CERN: L3 (1997). Available at menem.com/~ilya.

