# Ilya Nemenman

born January 8, 1975, in Minsk, Belarus CV last updated on April 17, 2008 Current version available at: http://menem.com/~ilya/ Los Alamos National Laboratory PO Box 1663 CCS-3, MS B256 Los Alamos, NM 87545

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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 (Research Assistant Professor), Joint Centers for Sys-
tems Biolo	gy, 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 2008	Information Science and Technology Center Affiliate, Los Alamos National Labo-
ratory	
since 2007	Adjunct Assistant Professor, Department of Physics, University of New Mexico,
Albuquerq	ue, NM
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, Com-	
puational Biology: Functional and Integrative Genomics		
2002	UCSB, Department of Statistics; NYU, Courant Institute, Bioinformatics group, vis-	
iting instructor, lecture series in <i>Statistical Inference</i>		

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, 2008–2011
- 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

Grant refereeing: NSF: Computational Intelligence, Biomedical Engineering, Behavioral Systems Cluster, Cyber-enabled Discovery and Innovation; 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, Golan Bel (LANL) Graduate Students: Etay Ziv (PhD 2007), Sean Escola, Michael Vidne (Columbia) Undergraduate Students: Aly Pesic (Stanford), Misha Shashkov (Berkeley)

#### SUMMARY OF RESEARCH INTERESTS

Using methods of theoretical physics and machine learning to develop functional, coarse-grained models of information processing in systems biology. This includes, in particular, reverse-engineering cellular networks and creation of efficient tools for their modeling and analysis.

Selected publications about our work

- 1. Improving Metabolomic Measurement and Analysis. LANL Science, Technology, and Engineering (STE) Highlights, Nov 7, p. 2, 2007.
- 2. Language of A Fly Proves Surprising. *PhysOrg.com*, Mar 10, 2008.
- 3. The Mind of A Fly: Scientists Tap into The Brains of Flies in An Effort to Improve Artificial

Intelligence. By S. Vorenberg, The Santa Fe New Mexican, Mar 20, 2008.

4. The Fly Code. By N. Maximov, Russian Newsweek, Mar 24, 2008 (in Russian).

## **PUBLICATIONS**

#### Refereed publications

- 1. I Nemenman, GD Lewen, W Bialek, RR de Ruyter van Steveninck. Neural coding of a natural stimuli: Information at sub-millisecond resolution. *PLoS Comput. Biol.* **4**(3): e1000025 (2008).
  - Preliminary version available as: I Nemenman, G Lewen, W Bialek, and R de Ruyter van Steveninck. Neural coding of natural stimuli: information at sub-millisecond resolution. *BMC Neurosci.* **8** (Suppl 2):S7 (2007).
- 2. NA Sinitsyn and I Nemenman. A universal geometric theory of mesoscopic stochastic pumps and reversible ratchets. *Phys. Rev. Lett.* **99**:220408 (2007).
- 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).
- 4. E Ziv, I Nemenman, and C Wiggins. Optimal information processing in small stochastic biochemical networks. *PLoS ONE* **2**(10): e1077 (2007).
- 5. NA Sinitsyn 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).
- 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. A Margolin, I Nemenman, K Basso, U Klein, C Wiggins, G Stolovitzky, Riccardo D Favera, 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. *Experim. 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 W Bialek, 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).

- W Bialek, 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).
- 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. D Dreisigmeyer, J Stajic, I Nemenman, W Hlavacek, M Wall. Determinants of bistability in induction of the *Escherichia coli lac* operon. Submitted to *IET Systems Biology*, special issue "The First q-bio Conference" (2007).
- 2. A Mugler, E Ziv, I Nemenman, and C Wiggins. Many possible functions of biochemical networks with serial regulation. Submitted to *IET Systems Biology*, special issue "The First q-bio Conference" (2007).
- 3. A Margolin, K Wang, A Califano, and I Nemenman. Multivariate dependence and genetic networks inference. Submitted to *PLoS ONE* (2008).
  - 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.
- 4. 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 Genetics* (2008).
- 5. I Nemenman. Inference of entropies of discrete random variables with unknown cardinalities. Submitted to *IEEE Trans. Inf. Thy.* (2005), arXiv:physics/0207009.

## Views, Editorials, Books

- 1. I Nemenman, W Hlavacek, M Wall, J Faeder, and Y Jiang, J Edwards. *The 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. Novel Computing Paradigms: Quo Vadis? *Physica D* 237(10-11), in print (2008).
- 3. J Edwards, J Faeder, W Hlavacek, Y Jiang, I Nemenman, and M Wall. q-bio 2007: a watershed moment in modern biology. *Mol. Syst. Biol.* **3**:148 (2007).
- 4. I Nemenman. *Information Theory and Learning: A Physical Approach*. PhD thesis, Princeton University, Department of Physics, (2000), arXiv:physics/0009032.

- 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.