ILYA NEMENMAN

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born January 8, 1975, in Minsk, Belarus
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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 2008 R&D Scientist, Level 4, Los Alamos National Laboratory
2005 – 2008 Technical Staff Member, CCS-3, Los Alamos National Laboratory
2004 – 2005 Associate Research Scientist (Research Assistant Professor), 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 2008 Information Science and Technology Center Science Council Member, Los Alamos National Laboratory
since 2007 Adjunct Assistant Professor, Department of Physics, University of New Mexico, Albuquerque, NM
since 2007 Visiting Scientist, New Mexico Consortium, Los Alamos, NM
since 2007 Center for Nonlinear Studies Affiliate, Los Alamos National Laboratory

TEACHING EXPERIENCE

2007-2008 *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, *Compuational 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

DE/LANL/LDRD/20090001DR , "Synthetic Cognition Through Peta-scale Modeling of Mammalian Visual Cortex", co-PI, 2009–2012
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
DOE/LANL/LDRD/20080138DR "Genomes to Behavior: Predicting Bacterial Response by Constrained Network Interpolation", co-investigator, 2007–2010
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; DOE/GTL KnowledgeBase planning; 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; *Principles of Biological Computation*, 05/2008, 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, Brian Munsky (LANL)
Graduate Students: Etay Ziv (PhD 2007), Sean Escola, Michael Vidne (Columbia)
Undergraduate Students: Aly Pesic (Stanford), Misha Shashkov (Berkeley), Pradeep Bandaru (Columbia)

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 and studies of learning and adaptation in molecular and neural systems.

Selected publications about our work

1. Supercomputer simulates human visual system. *slashdot.org*, June 13, 2008.
2. Roadrunner supercomputer puts research at a new scale. *LANL Press Release*, June 12, 2008.
3. Improving Metabolomic Measurement and Analysis. *LANL Science, Technology, and Engineering (STE) Highlights*, Nov 7, p. 2, 2007.
4. Language of A Fly Proves Surprising. *PhysOrg.com*, Mar 10, 2008.
5. 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.
6. The Fly Code. By N. Maximov, *Russian Newsweek*, Mar 24, 2008 (in Russian).

PUBLICATIONS

Refereed publications

1. NA Sinitsyn, N Hengartner and I Nemenman. Coarse-graining stochastic biochemical networks: quasi-stationary approximation and fast simulations using a stochastic path integral technique. Submitted, 2008.
2. A Mugler, E Ziv, I Nemenman, C Wiggins. Serially-regulated biological networks fully realize a constrained set of functions. *IET Systems Biology*, in press, 2008
3. D Dreisigmeyer, J Stajic, I Nemenman, W Hlavacek, and M Wall. Determinants of bistability in induction of the Escherichia coli lac operon. *IET Systems Biology*, in press, 2008.
4. 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).
5. NA Sinitsyn and I Nemenman. A universal geometric theory of mesoscopic stochastic pumps and reversible ratchets. *Phys. Rev. Lett.* **99**:220408 (2007).
6. 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).
7. E Ziv, I Nemenman, and C Wiggins. Optimal information processing in small stochastic biochemical networks. *PLoS ONE* **2**(10): e1077 (2007).
8. NA Sinitsyn and I Nemenman. Berry phase and pump effect in stochastic chemical kinetics. *EPL* **77**, 58001 (2007).
9. A Margolin, K Wang, WK Lim, M Kustagi, I Nemenman, and A Califano. Reverse engineering cellular networks. *Nature Protocols* **1**(2):663-672 (2006).
10. 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).
11. 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).
12. I Nemenman. Fluctuation-dissipation theorem and models of learning. *Neural Comp.* **17**(9): 2006-2033 (2005).
13. 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).

14. C Wiggins and I Nemenman. Process pathway inference via time series analysis. *Experim. Mech.* **43**(3):361-370 (2003).
15. A Silbergleit, I Nemenman, and I Mandel. On the interaction of point charges in an arbitrary domain. *Techn. Phys.* **48**(2):146-151 (2003).
16. A Silbergleit, I Mandel, and I Nemenman. Potential and field singularity at a surface point charge. *J. Math. Phys.* **44**(10):4460-4466 (2003).
17. 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).
18. 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).
19. W Bialek, I Nemenman, and N Tishby. Complexity through nonextensivity. *Physica A* **302**:89-99 (2001).
20. W Bialek, I Nemenman, and N Tishby. Predictability, complexity, and learning. *Neur. Comp.* **13**:2409-2463 (2001).
21. 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).
22. J Naud, I Nemenman, M Van Raamsdonk, and V Periwal. Minimal subtraction and the Callan-Symanzik equation. *Nucl. Phys. B* **540**:533-539 (1999).
23. 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).
24. 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.

Views, Editorials, Books

1. I Nemenman, W Hlavacek, J Edwards, J Faeder, Y Jiang, M Wall, Editorial: Special Issue dedicated to the First q-bio Conference on Cellular Information Processing. *IET Systems Biology*, in press, 2008.
2. C Teuscher, I Nemenman, and F Alexander. Novel Computing Paradigms: Quo Vadis? *Physica D* **237**:10-11 (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.

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.