ILYA NEMENMAN

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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 2009   Associate Professor, Departments of Physics and Biology, Emory University
2005 – 2009   Technical Staff Member, R&D Scientist-4, 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 2010   Population Biology, Ecology, and Evolution Graduate Program, Emory University
since 2010   Neuroscience Graduate Program, Emory University
since 2011   External Research Associate, Info-metrics Institute, American University, Washington, DC
since 2010   External Associate, Vanderbilt Institute for Integrative Biosystems Research and Education (VIIBRE), Nashville, TN
since 2009   Computational and Life Sciences Strategic Initiative Core Faculty, Emory University
2007 – 2010   Visiting Scientist, New Mexico Consortium, Los Alamos, NM
2007 – 2009   Affiliate, Executive Committee Member, Center for Nonlinear Studies, Los Alamos National Laboratory
2008 – 2009   Information Science and Technology Center Science Council, LANL
2007 – 2008   Adjunct Assistant Professor, Department of Physics, University of New Mexico, Albuquerque, NM

TEACHING EXPERIENCE

since 2009   Emory University: Introductory Physics, Computational Neuroscience, Stochasticity in Biology, Physical Biology: Information Processing in Biological Systems, Quantum Field Theory
2011   *The q-bio Conference on Cellular Information Processing*, tutorial
2007 – 2010   *The q-bio Summer School on Cellular Information Processing*, organizer and instructor
2009   *Information Processing in Biology* summer school, Beijing University, China
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

2012	Vice Chair nomination, Division of Bioogical Physics, American Physical Society
2011	Physical Biology: *Highlight of 2010* recognition of Bel et al., 2010
2011	Executive Committee nomination, Division of Biological Physics, American Physical Society
2009	Distingusihed Performance Award Nomination, LANL
2009	SPOT Award, Computer and Computational Sciences Division, LANL
2004	National Science Foundation Scholar (declined), StatPhys 22
1999	Outstanding Teaching Assistant, Department of Physics, Princeton University
1997	Graduate Student Distinguished Achievement Award, SFSU
1996	Outstanding Teaching Assistant, Department of Physics, SFSU
1993–1994	Honorary Stipend, Belarusian State University, Minsk, Belarus
1991	Winner, Belarusian National High School Physics Olympiad

RESEARCH SUPPORT

Current

ARO/60704-NS-II "Improving image segmentation with adaptive, recurrent, spiking neural network models of the primary visual cortex", PI, 2011-2012

HFSP/RGY0084/2011 "Adaptive behavior of *C. elegans* in complex sensory environments", PI (multiple PIs), collaborative program requiring multiple international investigators, 2011-2014

NIH/NCI/7R01CA132629 "Differential Metabolic Analysis of Tumor Progression", co-PI, 2007–2012

NIH/NIGMS/2R13GM082162-03 "Information processing In cellular signaling and gene regulation", PI (multiple PIs; contact PI for 2009-2011), *The q-bio Conference* support grant, 2011-2014

Completed

DOE/LANL/LDRD/20090001DR "Synthetic Cognition Through Peta-scale Modeling of Mammalian Visual Cortex", 2008–2011, co-PI in 2008-2009, collaborator since 2009

NSF-OCI-0749348 "Peta-scale computing infrastructure: High Performance Neural Computing", co-PI, 2008–2011

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

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

ADVISEES

Postdocs: *Emory*: Sorin Tanase Nicola (now Assistant Professor, Uppsala University), Martin Tchernookov; *LANL*: Nikolai Sinitsyn (now LANL Staff Member), Golan Bel (now Assistant Professor, Ben Gurion University), Brian Munsky (now LANL Feynman Distinuished Postdoctoral Fellow).

Graduate Students: Vijay Singh, Jakub Otwinowski, George Leung (all Emory).

Graduate Students co-Advised: Etay Ziv (PhD 2007, Columbia), Andrew Mugler (PhD 2010, Columbia).

Summer Students: Aly Pesic (Stanford), Misha Shashkov (Berkeley), Pradeep Bandaru, Sean Escola, Michael Vidne (Columbia), Wiet de Ronde (AMOLF), Bryan Daniels (Cornell).

PUBLICATIONS

Submitted

1. I Nemenman. Gain control in molecular information processing: Lessons from neuroscience. Submitted, 2011.

Refereed

1. I Nemenman. Coincidences and estimation of entropies of random variables with large cardinalities. *Entropy* **13**, 2013-2023, 2011.

2. S Tanase Nicola and I Nemenman. Fitness in time-dependent environments includes a geometric phase contribution. *J R Soc Interf*, doi:10.1098/rsif.2011.0695, 2011.

3. R Cheong, A Rhee, J Wang, I Nemenman, and A Levchenko. Information transduction capacity of noisy biochemical signaling networks. *Science* **334**, 354, 2011.

4. V Gintautas, M Ham, B Kunsberg, S Barr, S Brumby, C Rasmussen, J George, I Nemenman, L Bettencourt, G Kenyon. Model cortical association fields account for the time course and dependence on target complexity of human contour perception. *PLoS Comp Biol* **7**, e1002162, 2011.

5. J Otwinowski, S Tanase Nicola, and I Nemenman. Speeding up evolutionary search by small fitness fluctuations. *J Stat Phys* **144**, 367, 2011.

6. Y Wei, X Wang, J Liu, I Nemenman, A Singh, H Weiss, and B Levin. The population dynamics of bacteria in physically structured habitats and the adaptive virtue of random motility. *Proc Natl Acad Sci USA* **108**, 4047, 2011.

7. P Bandaru, M Bansal, and I Nemenman. Mass conservation and inference of metabolic networks from mass spectrometry data. *J Comput Bio* **18**, 147, 2011.

8. N Sinitsyn and I Nemenman, Time-dependent corrections to effective rate and event statistics in Michaelis-Menten kinetics. *IET Syst Biol* **4**, 409, 2010.

9. A Margolin, K Wang, A Califano, and I Nemenman. Multivariate dependence and genetic networks inference. *IET Syst Biol* **4**, 428, 2010.

10. G Bel, B Munsky, and I Nemenman. The simplicity of completion time distributions for common complex biochemical processes. *Physical Biology* **7**, 016003, 2010.

11. B Munsky, I Nemenman, and G Bel. Specificity and Completion Time Distributions of Biochemical Processes. *J Chem Phys* **131**, 235103, 2009.

12. K Wang, M Saito, B Bisikirska, M Alvarez, W Lim, P Rajbhandari, Q Shen, I Nemenman, K Basso, A Margolin, U Klein, R Dalla-Favera, and A Califano. Genome-wide identification of post-translational modulators of transcription factor activity in human B cells. *Nature Biotech* **27**, 829, 2009.

13. W de Ronde, B Daniels, A Mugler, N Sinitsyn, and I Nemenman. Mesoscopic statistical properties of multistep enzyme-mediated reactions. *IET Syst Biol* **3**, 429, 2009.

14. A Mugler, E Ziv, I Nemenman, and C Wiggins. Quantifying evolvability in small biological networks. *IET Syst Biol* **3**, 379, 2009.

15. G Bel and I Nemenman. Ergodic and non-ergodic anomalous diffusion in coupled stochastic processes. *New J Phys* **11** 083009, 2009.

16. N Sinitsyn, N Hengartner, and I Nemenman. Adiabatic coarse-graining and simulations of stochastic biochemical networks. *Proc Natl Acad Sci (USA)* **106**, 10546, 2009.

17. A Mugler, E Ziv, I Nemenman, and C Wiggins. Serially-regulated biological networks fully realize a constrained set of functions. *IET Syst. Biol.* **2**, 313, 2008.

18. D Dreisigmeyer, J Stajic, I Nemenman, W Hlavacek, and M Wall. Determinants of bistability in induction of the *Escherichia coli lac* operon. *IET Syst. Biol.* **2**, 293, 2008.

19. I Nemenman, GD Lewen, W Bialek, RR de Ruyter van Steveninck. Neural coding of 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.

20. NA Sinitsyn and I Nemenman. A universal geometric theory of mesoscopic stochastic pumps and reversible ratchets. *Phys. Rev. Lett.* **99**, 220408, 2007.

21. 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**, 102, 2007.

22. E Ziv, I Nemenman, and C Wiggins. Optimal signal processing in small stochastic biochemical networks. *PLoS ONE* **2**, e1077, 2007.

23. NA Sinitsyn and I Nemenman. Berry phase and pump effect in stochastic chemical kinetics. *EPL* **77**, 58001, 2007.

24. A Margolin, K Wang, WK Lim, M Kustagi, I Nemenman, and A Califano. Reverse engineering cellular networks. *Nature Protocols* **1**, 663, 2006.

25. 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 (Springer: Berlin / Heidelberg, 2006).

26. 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.

27. I Nemenman. Fluctuation-dissipation theorem and models of learning. *Neural Comp.* **17**(9), 2006, 2005.

28. 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.

29. C Wiggins and I Nemenman. Process pathway inference via time series analysis. *Experim. Mech.* **43**, 361, 2003.

30. A Silbergleit, I Nemenman, and I Mandel. On the interaction of point charges in an arbitrary domain. *Techn. Phys.* **48**, 146, 2003.

31. A Silbergleit, I Mandel, and I Nemenman. Potential and field singularity at a surface point charge. *J. Math. Phys.* **44**, 4460, 2003.

32. 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).

33. I Nemenman, and W Bialek. Occam factors and model-independent Bayesian learning of continuous distributions. *Phys. Rev. E* **65**, 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 (MIT Press: Cambridge, MA, 2001).

34. W Bialek, I Nemenman, and N Tishby. Complexity through nonextensivity. *Physica A* **302**, 89, 2001.

35. W Bialek, I Nemenman, and N Tishby. Predictability, complexity, and learning. *Neur. Comp.* **13**, 2409, 2001.

36. 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, 2000.

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

38. 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, 1999.

39. 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, 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**, 45, 1995. In Russian.

Views, Editorials, Books, and Chapters

1. I Nemenman, Information theory and adaptation. In *Quantitative biology: From molecules to Cellular Systems*, ME Wall, ed. (Taylor and Francis, 2011), in press.

2. I Nemenman, J Faeder, W Hlavacek, Y Jiang, M Wall, and A Zilman. Selected papers from the Fourth Annual q-bio Conference on Cellular Information Processing. *Phys Biol* **8**, 050301, 2011.

3. I Nemenman, W Hlavacek, Y Jiang, M Wall, and A Zilman. Editorial: Selected papers from the Third q-bio Conference on Cellular Information Processing. *IET Syst Biol* **4**, 331, 2010.

4. I Nemenman, W Hlavacek, Y Jiang, and M Wall, Editorial: Selected papers from the Second q-bio Conference on Cellular Information Processing. *IET Syst Biol* **3**, 297, 2009.

5. I Nemenman, W Hlavacek, J Edwards, J Faeder, Y Jiang, and M Wall, Editorial: Selected papers from the First q-bio Conference on Cellular Information Processing. *IET Syst Biol* **2**, 203, 2008.

6. C Teuscher, I Nemenman, and F Alexander. Novel Computing Paradigms: Quo Vadis? *Physica D* **237**, 10, 2008.

7. 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.

8. 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`.