ILYA NEMENMAN

born January 8, 1975, in Minsk, Belarus
CV last updated on November 17, 2009
Current version available at:
`http://menem.com/~ilya/`

Emory University
Computational and Life Sciences Strategic Initiative
Departments of Physics and Biology
Atlanta, GA 30322
Tel (404) 727-9286; Fax (404) 727-0873
`ilya.nemenman@emory.edu`

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 (the highest: 6), 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 2009   Computational and Life Sciences Strategic Initiative Core Faculty, Emory University
since 2007   Visiting Scientist, New Mexico Consortium, Los Alamos, NM
since 2008   Information Science and Technology Center Science Council, LANL
since 2007   Affiliate, Executive Committee Member, Center for Nonlinear Studies, Los Alamos National Laboratory
2007 – 2008   Adjunct Assistant Professor, Department of Physics, University of New Mexico, Albuquerque, NM

TEACHING EXPERIENCE

2007 – 2009   *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

Los Alamos National Laboratory Distingusihed Performance Award Nomination, 2009
Los Alamos National Laboratory CCS SPOT Award, 2009
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

NIH/NIGMS/1R13GM082162 01 "Information Processing In Cellular Signaling and Gene Regulation", contact PI: Ilya Nemenman (multiple PIs), *The q-bio Conference* support grant

DOE/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

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

External Advising: DOE/GTL Knowledgebase; NIH/NCI "Physical Science and New Frontiers in Oncology" Think Tank

Internal Advising: LANL Biological and Environmental Research / Systems Biology; New Mexico Consortium Neural Computing; LANL Neuroscience; LANL Information Science

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*

Public events organization: *The q-bio Public Lecture Series*, Santa Fe, NM

Grant refereeing: NSF: Computational Intelligence, Biomedical Engineering, Behavioral Systems Cluster, Cyber-enabled Discovery and Innovation; NIH/NCI; 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), Andrew Mugler (PhD 2010), Sean Escola (PhD 2009)

Undergraduate Students: Aly Pesic (Stanford), Misha Shashkov (Berkeley), Pradeep Bandaru

(Columbia)

COLLABORATORS AND OTHER AFFILIATIONS

William Bialek (Princeton; thesis advisor), Andrea Califano (Columbia; postdoc advisor), Francis Alexander (LANL), Peter Balsam (Columbia), David Dreisigmeyer (Pittsburgh), Jeremy Edwards (UNM), James Faeder (Pittsburgh), Randy Gallistel (Rutgers), Nicolas Hengartner (LANL), William Hlavacek (LANL), Andre Levchenko (Johns Hopkins), Jelena Stajic (Connecticut), Rob de Ruyter van Steveninck (Indiana University), Christof Teuscher (Portland State), Naftali Tishby (Hebrew), Cliff Unkefer (LANL), Pat Unkefer (LANL), Michael Wall (LANL), Chris Wiggins (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, including: reverse-engineering cellular networks, creation of efficient tools for their modeling and analysis, studies of learning and adaptation in sensory systems, and development of large-scale neuromimetic signal processing 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).

PRESENTATIONS

Nov 2010	76th Meeting of the Southeastern Section of APS, Atlanta, GA
Nov 2009	UC Berkeley Bioengineering / Arkin Lab seminar
Nov 2009	Santa Clara University Department of Physics Colloquium
Nov 2009	*Dynamics of signal transduction and of gene-protein regulatory networks* workshop, Mathematical Biosciences Institute, Ohio State University
Sep 2009	*Stochasticity in Biochemical Reaction Networks* workshop, Banff, Alberta, Canada
Jul 2009	*Information Processing in Biology* conference and summer school, Beijing, China
Jun 2009	Vanderbilt University, Biophysics seminar
May 2009	AMOLF (Amsterdam, The Netherlands) colloquium
May 2009	Bernstein Center for Computational Neuroscience, LMU (Munich, Germany) seminar
Mar 2009	APS March Meeting Contributed Talk
Dec 2008	Weizmann Institute, Condensed Matter Theory seminar
Dec 2008	Weizmann Institute, Neurobiology seminar
Dec 2008	Technion, Networks Biology Lab seminar
Nov 2008	Princeton University, Biophysics Theory seminar
Nov 2008	Columbia University, Neurotheory Center seminar
Nov 2008	Columbia University, C2B2 Computational Biology seminar
Nov 2008	Emory University, Physics colloquium
Jul 2008	International Society for Bayesian Analysis World Meeting, contributed talk
May 2008	SFI "Principles of Biological Computation" workshop talk
Apr 2008	Harvard Condensed Matter Theory seminar
Mar 2008	KITP/UCSB program on "Brain anatomy and development" talk

Mar 2008   UCLA Biomathematics Department seminar
Mar 2008   Caltech Bio-circuits / Information Science and Technology seminar
Mar 2008   APS March Meeting, Invited talk
Mar 2008   UC Irvine Physics Colloquium
Feb 2008   Duke University, Physics and Systems Biology Colloquium
Feb 2008   Brown University Physics Colloquium
Feb 2008   University of Pittsburgh, Department of Computational Biology seminar
Jan 2008   Aspen Center for Physics, *Decision Making in Single Cells* conference 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
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

1. B Munsky, G Bel, and I Nemenman. Specificity and Completion Time Distributions of Biochemical Processes. *J Chem Phys*, in press, 2009.

2. G Bel, B Munsky, and I Nemenman. Common complex biochemical processes exhibit simple completion time distributions. *Physical Biology*, in press, 2009.

3. 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.

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

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

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

7. N Sinitsyn, N Hengartner, and I Nemenman. Adiabatic coarse-graining and simulations of stochastic biochemical networks. *Proc Natl Acad Sci (USA)* **106**:10546-10551, 2009.

8. I Nemenman. Nonlinearity, memory, and phase transitions in animal learning. Submitted to *COSYNE 2009*, 2008.

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

10. 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.

11. 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.

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

13. 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.

14. E Ziv, I Nemenman, and C Wiggins. Optimal information processing in small stochastic biochemical networks. *PLoS ONE* **2**(10): e1077, 2007.

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

16. A Margolin, K Wang, WK Lim, M Kustagi, I Nemenman, and A Califano. Reverse engineering cellular networks. *Nature Protocols* **1**(2):663-672, 2006.

17. 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).

18. 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.

19. I Nemenman. Fluctuation-dissipation theorem and models of learning. *Neural Comp.* **17**(9): 2006-2033, 2005.

20. 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.

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

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

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

24. 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).

25. 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).

26. W Bialek, I Nemenman, and N Tishby. Complexity through nonextensivity. *Physica A* **302**:89-99, 2001.

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

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

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

30. 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.

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

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

3. C Teuscher, I Nemenman, and F Alexander. Novel Computing Paradigms: Quo Vadis? *Physica D* **237**:10-11, 2008.

4. 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.

5. 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. I Nemenman. Information theory, multivariate dependence, and genetic network inference. Technical Report NSF-KITP-04-54, KITP, UCSB, 2004. arXiv:q-bio/0406015.

4. I Nemenman. Inference of entropies of discrete random variables with unknown cardinalities. Technical Report, KITP. UCSB, 2002. arXiv:physics/0207009.

5. 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`.

6. I Kominis and I Nemenman. BGO dead crystal correction and shower fitting. Tech. Rep. 2157, *CERN: L3*, 1997. Available at `menem.com/~ilya`.