Artemy Kolchinsky

CONTACT

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EDUCATION

Indiana University, Bloomington, IN, 2015
Ph.D. in Informatics (focus in Complex Systems), Minor in Cognitive Science
Thesis: "Measuring Scales: Integration and Modularity in Complex Systems"
Committee: Luis M. Rocha (chair), Yong-Yeol Ahn, Randall Beer, Alessandro Flammini, Olaf Sporns

New York University, New York, NY, 2004
B.A. Magna Cum Laude, Individualized Study (concentration in Complex Systems)

ACADEMIC POSITIONS

Santa Fe Institute, Santa Fe, NM, Dec 2015-Present
Postdoctoral fellow

Massachusetts Institute of Technology, Cambridge, MA, 2015-2016
Visiting scientist

Instituto Gulbenkian de Ciência, Oeiras, Portugal, 2009-2010 and Summer 2008/2011/2012
Visiting researcher at FLAD Computational Biology Collaboratorium

Indiana University, Bloomington, IN, 2011-2015
Research assistant with Ph.D. adviser Luis M. Rocha

INDUSTRY

LinkedIn Corporation, Mountain View, CA, Summer 2014
Data science internship. Supervisor: Mathieu Bastian

PUBLICATIONS

A. Kolchinsky, D.H. Wolpert, "Work, entropy production, and thermodynamics of information under protocol constraints ", *Physical Review X*, *in press*. arxiv

A. Kolchinsky, D.H. Wolpert, "Thermodynamic costs of Turing Machines", *Physical Review Research*, 2020. pdf

D.H. Wolpert and **A. Kolchinsky**, "The thermodynamics of computing with circuits", *New Journal of Physics*, 2020. pdf

A. Kolchinsky and B. Corominas-Murtra, "Decomposing information into copying versus transformation", *Royal Society Interface*, 2020. pdf

A.M. Saxe, Y. Bansal, J. Dapello, M. Advani, **A. Kolchinsky**, B.D. Tracey, D.D. Cox, "On the information bottleneck theory of deep learning", *Journal of Statistical Mechanics*, 2019. pdf code

A. Kolchinsky, B.D. Tracey, D.H. Wolpert, "Nonlinear information bottleneck", *Entropy*, 2019. pdf

A. Berdahl, C. Brelsford, C. De Bacco, M. Dumas, V. Ferdinand, J.A. Grochow, L. Hébert-Dufresne, Y. Kallus, C.P. Kempes, **A. Kolchinsky**, D. B. Larremore, E. Libby, E.A. Power, C.A. Stern, B.D.Tracey, "Dynamics of beneficial epidemics", *Scientific Reports*, 2019. pdf

E.A. Hobson, V. Ferdinand, **A. Kolchinsky**, J. Garland, "Rethinking animal social complexity measures with the help of complex systems concepts", *Animal Behaviour*, 2019. pdf

D.H. Wolpert, **A. Kolchinsky**, J.A. Owen, "A space–time tradeoff for implementing a function with master equation dynamics", *Nature Communications*, 2019. pdf

A. Avena-Koenigsberger, X. Yan, **A. Kolchinsky**, M. van den Heuvel, P. Hagmann, O. Sporns, "A spectrum of routing strategies for brain networks", *PLoS Computational Biology*, 2019. pdf

A. Kolchinsky, B.D. Tracey, S. Van Kuyk, "Caveats for information bottleneck in deterministic scenarios", *International Conference on Learning Representations (ICLR)*, 2019. pdf code

J.A. Owen, **A. Kolchinsky**, D.H. Wolpert, "Number of hidden states needed to physically implement a given conditional distribution", *New Journal of Physics*, 2019. (correction) pdf

A. Kolchinsky and D.H. Wolpert, "Semantic information, autonomous agency, and nonequilibrium statistical physics", *Royal Society Interface Focus*, 2018. pdf code

A.M. Saxe, Y. Bansal, J. Dapello, M. Advani, **A. Kolchinsky**, B.D. Tracey, D.D. Cox, "On the information bottleneck theory of deep learning", *International Conference on Learning Representations (ICLR)*, 2018. pdf code

A. Kolchinsky, N. Dhande, K. Park, Y.Y. Ahn, "The Minor Fall, the Major Lift: Inferring emotional valence of musical chords through lyrics", *Royal Society Open Science*, 2017. pdf data code

A. Kolchinsky, D.H. Wolpert, "Dependence of dissipation on the initial distribution over states", *Journal of Statistical Mechanics*, 083202, 2017. pdf

A. Kolchinsky, B.D. Tracey, "Estimating mixture entropy with pairwise distances", *Entropy*, 2017. (correction) pdf code

A. Kolchinsky, A.J. Gates, L.M. Rocha, "Modularity and the spread of perturbations in complex dynamical systems," *Physical Review E*, 2015. pdf code

A. Kolchinsky, A. Lourenço, H. Wu, L. Li, L.M. Rocha, "Extraction of pharmacokinetic evidence of drug-drug interactions from the literature," *PLOS One*, 2015. pdf

A. Kolchinsky, M.P. van den Heuvel, A. Griffa, P. Hagmann, L.M. Rocha, O. Sporns, J. Goñi, "Multi-scale integration and predictability in resting state brain activity," *Frontiers in Neuroinformatics*, 2014. pdf

A. Rossi, F.J. Parada, **A. Kolchinsky**, A. Puce, "Neural correlates of apparent motion perception of impoverished facial stimuli I: A comparison of ERP and ERSP activity," *NeuroImage*, 2014. pdf

A. Kolchinsky, A. Lourenço, L. Li, L.M. Rocha, "Evaluation of linear classifiers on articles containing pharmacokinetic evidence of drug-drug interactions," *Proc Pacific Symposium on Biocomputing*, 2013. pdf

A. Kolchinsky and L.M. Rocha, "Prediction and modularity in dynamical systems," *Proc of European Conf. on the Synthesis and Simulation of Living Systems (ECAL)*, 2011. pdf

A. Kolchinsky, A. Abi-Haidar, J. Kaur, A.A. Hamed, L.M. Rocha, "Classification of protein-protein interaction full-text documents using text and citation network features," *IEEE/ACM Transactions on Computational Biology and Bioinformatics*, 7(3), 2010. pdf

PREPRINTS

A. Kolchinsky and D.H. Wolpert, "The state dependence of integrated, instantaneous, and fluctuating entropy production in quantum and classical processes", arXiv:2103.05734, 2021. arxiv

F.C. Sheldon, **A. Kolchinsky**, F. Caravelli, "The computational capacity of memristor reservoirs", arXiv:2009.00112, 2020. arxiv

A. Kolchinsky, "A novel approach to multivariate redundancy and synergy", arXiv:1908.08642, 2019. arxiv

C. Gokler, **A. Kolchinsky**, Z. Liu, I. Marvian , P. Shor, O. Shtanko, K. Thompson, D. Wolpert, S. Lloyd, "When is a bit worth much more than $kT \ln 2$?", arXiv:1705.09598, 2017. arxiv

A. Kolchinsky, I. Marvian, C. Gokler, Z. Liu, P. Shor, O. Shtanko, K. Thompson, D. Wolpert, S. Lloyd, "Maximizing free energy gain", arXiv:1705.00041, 2017. arxiv

TALKS

Invited

02/2021 - *Origins of Life: The Possible and the Actual* workshop, Santa Fe Institute
"Fundamental thermodynamic constraints and trade-offs in origin of life"

7/2020 - *ICTP Seminar Series*, Abdus Salam International Center for Theoretical Physics
"Bounds on entropy production and thermodynamics of information under protocol constraints"

2/2020 - *AI Seminar Series*, Information Sciences Institute, Los Angeles, CA
"Machine Learning through the information bottleneck"

7/2019 - *ISTI Seminar Series*, Los Alamos National Lab, Los Alamos, NM
"Machine Learning through the information bottleneck"

6/2018 - *Connectomics Lecture Series*, Universidad Diego Portales, Santiago, Chile
"Machine learning, 'deep neural networks', and the brain"

4/2018 - *Meeting of the Society for the Neural Control of Movement*, Santa Fe, NM
"Machine learning, 'deep neural networks', and the brain"

4/2018 - *SITE Santa Fe* (contemporary art museum)
"Life, entropy, and the 2^{nd} law of thermodynamics"

11/2017 - Seoul National University
"Science at the Santa Fe Institute" (w/ V. Ferdinand)

8/2017 - *Thermodynamics & Computation: Towards a New Synthesis*, Santa Fe Institute
"Statistical physics of Turing Machines" (w/ D.H. Wolpert)

10/2016 - *Statistical Physics, Information Processing and Biology*, Santa Fe Institute
"Dependence of dissipation on the initial distribution" (w/ D.H. Wolpert)

2/2016 - Information Sciences Institute, Los Angeles, CA
"Multi-scale integration & modularity in complex systems"

Contributed

6/2020 - *Stochastic thermodynamics in complex systems*, Complexity Science Hub, Vienna, Austria
"Entropy production & thermodynamics of information under protocol constraints"

5/2019 - *Seminar*, Max Planck Institute for Mathematics in the Sciences, Leipzig, Germany
"A novel measure of multivariate redundant information"

3/2019 - *American Physical Society March Meeting*, Boston, MA
"Thermodynamics of Turing Machines" (w/ D.H. Wolpert)

3/2018 - *American Physical Society March Meeting*, Los Angeles, CA
"Thermodynamic costs, initial distributions, and Bregman divergences" (w/ D.H. Wolpert)

1/2018 - *Information theory and non-equilibrium thermodynamics beyond the Shannon-Gibbs framework*, Complexity Science Hub, Vienna, Austria
"Entropy in stochastic thermodynamics"

12/2017 - *Complexity, Criticality & Computation International Biannual Symposium*, University of Sydney
"Grounding semantic information in the dynamics of non-equilibrium systems" (w/ D.H. Wolpert)

8/2017 - *Information Engines at the Frontiers of Nanoscale Thermodynamics*, Telluride, CO
"Semantic information, observation and non-equilibrium systems" (w/ D.H. Wolpert)

3/2017 - *American Physical Society March Meeting*, New Orleans, LA
"Dependence of dissipation on the initial distribution" (w/ D.H. Wolpert)

10/2015 - *Information Theory, Ecosystems, & Schrodinger's Paradox* workshop, Santa Fe Institute
"Complexity measures for spatially embedded systems"

9/2015 - *Conference on Complex Systems 2015*, Tempe, AZ
"Modularity and the spread of perturbations in complex dynamical systems" (w/ A.J. Gates, L.M. Rocha)
(awarded "Honorable Mention Paper by a Contributing Student")

10/2013 - *Indiana Neuroimaging Symposium*, Indiana University, Bloomington, IN
"Information, space & structure in the human brain resting state" [poster] (w/ M.P. van den Heuvel, A. Griffa, P. Hagmann, L.M. Rocha, O. Sporns, J. Goñi)

9/2013 - *Guided Self-Organization 6 workshop, European Conf on Complex Systems*, Barcelona, Spain
"Modularity and dynamical timescales in Boolean Networks"

3/2013 - *MBI Rhythms and Oscillations Workshop*, Columbus, OH
"Studying differences in oscillatory synchronization with tensor-factorization" [poster] (w/ F.J. Parada, L.M. Rocha, T. Busey)

1/2013 - *Pacific Symposium on Biocomputing*, Big Island, Hawaii
"Evaluation of linear classifiers on articles containing pharmacokinetic evidence of drug-drug interactions"

12/2011 - *Network Frontier Workshop*, Northwestern University, Evanston, IL
"Prediction and modularity in dynamical systems"

4/2011 - *CISAB Animal Behavior Conference*, Indiana University, Bloomington, IN
"The Umwelt, artificial life, and evolution"

9/2010 - *Guided Self-Organization 3 work*, Indiana University, Bloomington, IN
"Identifying dynamical modules in Boolean network models"

3/2008 - *Interdisciplinary Symposium on the Mind*, University of Toronto
"The Expanded Mind: Mental expansion and the intentional stance"

GRANTS

9/2019 - Foundational Questions Institute (FQXi), "The role of constraints in the thermodynamics of intelligence" (FQXi-RFP-IPW-1912), $118,100, Co-Investigator

8/2016 - Foundational Questions Institute (FQXi), "Observers as self-maintaining non-equilibrium systems" (FQXi-RFP-1622), $128,319, Co-Investigator

TEACHING

Invited Lectures

6/2019 - Santa Fe Institute Complex Systems Summer School, Santa Fe, NM

Workshops

3/2019 - Santa Fe Institute, Santa Fe, NM
"Machine learning with TensorFlow"

6/2017, 6/2018 - Santa Fe Institute, Santa Fe, NM
Introduction to programming and data analysis in Python (w/ V. Ferdinand)

11/2017 - Seoul National University, Seoul
"Thermodynamics, evolution, and inference through the lens of information theory" (w/ V. Ferdinand)

11/2017 - ACtioN/Trustee Meeting, Santa Fe Institute, Santa Fe, NM
"Machine learning: A guide for the perplexed" (w/ B. D. Tracey)

Teaching Assistant

Indiana University, Bloomington, IN
Spring 2014 - "I400 Large-scale Social Phenomena" [link]
Spring 2011 - "I201 Math and logic foundations of Informatics"
Fall 2010 - "I485 Biologically Inspired Computing" [link]
Fall 2008-Spring 2009 - "I210 Information Infrastructure" (Python programming)

Instituto Gulbenkian de Ciência, Oeiras, Portugal
Spring 2010 - "Bayesian brain" educational module

ADVISING

Nicolas Freitas, Santa Fe Institute REU Program, Santa Fe, NM, June-August, 2018
Project: "Scaling of Information in Biochemical Systems"

Francis Cavanna, Santa Fe Institute REU Program, Santa Fe, NM, June-August, 2017
Project: "Investigating the relationship between criticality and Landauer costs using the Ising model"

ACADEMIC SERVICE

Reviewer: *Applied Sciences*, *Entropy*, *PLoS Computational Biology*, CRC Press.

2008-2013 - Started and ran a weekly discussion group on complexity, dynamical systems, and embodiment in cognitive science, Indiana University, Bloomington, IN link

AWARDS & FELLOWSHIPS

2010-2015 - Affiliate of IGERT training program in "Dynamics of brain-body-environment interaction in behavior and cognition"

2012 - 2013 - Lilly Graduate Fellowship, Biocomplexity Institute, Indiana University, Bloomington, IN

2007 - 2009 - Eli Lilly Fellowship, Indiana University, Bloomington, IN,

2004 - Dean's List Gallatin School, New York University, NY

SKILLS

Programming: Python, MATLAB, C, C++, R, Java
Machine learning with Python + Keras, TensorFlow
Web programming, databases/SQL, scalable computing (Hadoop, PIG, Scala)

Languages: Fluency: English, Russian, Spanish / Basic: Portuguese