

# Artemy Kolchinsky

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<b>EDUCATION</b>	<b>Indiana University</b> (Bloomington, IN, USA), 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 <b>New York University</b> (New York, NY, USA), 2004 B.A. Magna Cum Laude, Individualized Study (concentration in Complex Systems)	
<b>ACADEMIC POSITIONS</b>	<b>University of Tokyo</b> (Tokyo, Japan), Jan 2022-Present Postdoctoral fellow with postdoctoral advisor Sosuke Ito <b>Santa Fe Institute</b> (Santa Fe, NM, USA), Dec 2015-Dec 2021 Postdoctoral fellow with postdoctoral advisor David H. Wolpert <b>Instituto Gulbenkian de Ciência</b> (Oeiras, Portugal), 2009-2010 and Summer 2008/2011/2012 Visiting researcher at FLAD Computational Biology Collaboratorium <b>Indiana University</b> (Bloomington, IN, USA), Sep 2011-May 2015 Research assistant with Ph.D. advisor Luis M. Rocha	
<b>INDUSTRY</b>	<b>LinkedIn Corporation</b> (Mountain View, CA, USA), Summer 2014 Data science internship. Supervisor: Mathieu Bastian	
<b>PUBLICATIONS</b>	<b>A. Kolchinsky</b> and D.H. Wolpert, “Dependence of integrated, instantaneous, and fluctuating entropy production on the initial state in quantum and classical processes”, <i>Physical Review E</i> , 2021. <a href="#">pdf</a> <b>A. Kolchinsky</b> , D.H. Wolpert, “Work, entropy production, and thermodynamics of information under protocol constraints”, <i>Physical Review X</i> , 2021. <a href="#">pdf</a> <b>A. Kolchinsky</b> and D.H. Wolpert, “Entropy production given constraints on the energy functions”, <i>Physical Review E</i> , 2021. <a href="#">pdf</a> <b>A. Kolchinsky</b> , D.H. Wolpert, “Thermodynamic costs of Turing Machines”, <i>Physical Review Research</i> , 2020. <a href="#">pdf</a> D.H. Wolpert and <b>A. Kolchinsky</b> , “The thermodynamics of computing with circuits”, <i>New Journal of Physics</i> , 2020. <a href="#">pdf</a> <b>A. Kolchinsky</b> and B. Corominas-Murtra, “Decomposing information into copying versus transformation”, <i>Royal Society Interface</i> , 2020. <a href="#">pdf</a> A.M. Saxe, Y. Bansal, J. Dapello, M. Advani, <b>A. Kolchinsky</b> , B.D. Tracey, D.D. Cox, “On the information bottleneck theory of deep learning”, <i>Journal of Statistical Mechanics</i> , 2019. <a href="#">pdf</a> <a href="#">code</a> <b>A. Kolchinsky</b> , B.D. Tracey, D.H. Wolpert, “Nonlinear information bottleneck”, <i>Entropy</i> , 2019. <a href="#">pdf</a> ( <i>Entropy</i> 2021 Best Paper Award) A. Berdahl, C. Brelsford, C. De Bacco, M. Dumas, V. Ferdinand, J.A. Grochow, L. Hébert-Dufresne, Y. Kallus, C.P. Kempes, <b>A. Kolchinsky</b> , D. B. Larremore, E. Libby, E.A. Power, C.A. Stern, B.D. Tracey, “Dynamics of beneficial epidemics”, <i>Scientific Reports</i> , 2019. <a href="#">pdf</a> E.A. Hobson, V. Ferdinand, <b>A. Kolchinsky</b> , J. Garland, “Rethinking animal social complexity measures with the help of complex systems concepts”, <i>Animal Behaviour</i> , 2019. <a href="#">pdf</a> <b>A. Kolchinsky</b> , B.D. Tracey, S. Van Kuyk, “Caveats for information bottleneck in deterministic scenarios”, <i>International Conference on Learning Representations (ICLR)</i> , 2019. <a href="#">pdf</a> <a href="#">code</a>	

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](#)

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*, 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*, 2010. [pdf](#)

## PREPRINTS

**A. Kolchinsky**, “A thermodynamic threshold for Darwinian evolution”, arXiv:2112.02809, 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

5/2022 - *Workshop on Stochastic Thermodynamics III*, University of Tokyo (virtual)  
T.B.D.

2/2022 - *Physics Department Colloquium Series*, University of Rochester (virtual)  
“A thermodynamic threshold for Darwinian evolution”

12/2021 - *Universal Biology Institute Seminar Series*, University of Tokyo (virtual)  
 “A thermodynamic threshold for Darwinian evolution”

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 (virtual)  
 “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<sup>nd</sup> 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”

## GRANTS

2019 - Foundational Questions Institute (FQXi-RFP-IPW-1912), \$118,100, Co-Investigator (PI: David Wolpert)  
 “The role of constraints in the thermodynamics of intelligence”

2016 - Foundational Questions Institute (FQXi-RFP-1622), \$128,319, Co-Investigator (PI: David Wolpert)  
 “Observers as self-maintaining non-equilibrium systems”

2016 - NSF INSPIRE (CHE-1648973), \$999,947, co-author (PI: David Wolpert)  
 “Tradeoffs in the Thermodynamics of Computation: A New Paradigm for Biological Information-Processing”

2016 - NSF (1620462), \$770,000, co-author (PI: David Wolpert)  
 “Information Networks and the Evolution of Social Organizations”

## TEACHING

### Online courses

2018 - “Fundamentals of machine learning” (w/ B.D. Tracey), Complexity Explorer from the Santa Fe Institute  
 Designed and delivered a 12-part online course on basics of machine learning [\[link\]](#)

### Workshops, lectures, and tutorials

6/2019 - Santa Fe Institute Complex Systems Summer School, Santa Fe, NM  
 Two lecture series on machine learning and its research frontiers

3/2019 - Santa Fe Institute, Santa Fe, NM  
 Tutorial on “Machine learning with TensorFlow”

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

11/2017 - Seoul National University, Seoul  
 Week-long workshop on “Thermodynamics, evolution, and inference through the lens of information theory”  
 (w/ V. Ferdinand)

11/2017 - ACTioN/Trustee Meeting, Santa Fe Institute, Santa Fe, NM  
Lecture on “Machine learning: A guide for the perplexed” (w/ B. D. Tracey)

5/2010 - Instituto Gulbenkian de Ciência, Oeiras, Portugal  
Assisted with week-long “Bayesian brain” educational module

### **Teaching Assistant at 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” [\[link\]](#)

Developed and ran a 5-part computational lab series

Fall 2008-Spring 2009 - “I210 Information Infrastructure” (Python programming)

### **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**

Guest editor: *Entropy* special issue on “Thermodynamics and Information Theory of Living Systems” [link](#)

Reviewer (physics): *New Journal of Physics*, *Physical Review Letters*, *Physical Review Research*, *Frontiers in Physics*, *Journal of Physics A*, *Physica A*.

Reviewer (biology): *J R Soc Proceedings B*, *PLoS Computational Biology*, *Theory in the Biosciences*.

Reviewer (information theory and machine learning): *Entropy*, *ICLR*, *Transactions on Pattern Analysis and Machine Intelligence*, *Kybernetika*, *Applied Sciences*.

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