Eddie Lee physics of emergent things

Big questions

What are the mathematical laws that constrain living matter like society and biology? I am inspired by concepts, intuition, and models from statistical physics to search for fundamental principles in collective behavior that connect biology and society.

Education

2014-2019 Ph.D. in Physics from Cornell University
Quantitative modeling of collective behavior. Advised by Paul Ginsparg

2008-2012 A.B. in Physics & Certificate in Biophysics from Princeton University
Degree awarded cum laude

Work experience

2021-2025 Postdoctoral fellow at Complexity Science Hub Vienna
Independent position with PhD student. Universality & scaling in social dynamics

2020-2021 Program Postdoctoral Fellow at Santa Fe Institute
Universality & scaling in conflict dynamics. Metabolic scaling in biology

2018-2019 Santa Fe Institute Graduate Fellow
Funding for work on conflict dynamics & statistical physics of voting through Omega Miller program

2015-2018 National Science Foundation Graduate Research Fellow
Theoretical analysis of plastic deformation & experiments in virtual reality for exploring interpersonal coordination of motion

Grants, honors, awards

2022 Austrian Science Fund ESPRIT Fellowship
Early career award, €300,000

2017 STIR grant from Army Research Office
"Determining the limits of human coordination" (drafted by me), PI Itai Cohen, $60,000

2015 Dirksen Congressional Center Dissertation Grant
Influential voters in Congress

NSF Graduate Research Fellowship
Competitive national competition to fund graduate education

2011, 2012

Kusaka Memorial Prize
For excellence in undergraduate research

Publications

Lee, E. D. & Cantwell, G. T. Valence and interactions in judicial voting. Philosophical Transactions of the Royal Society A 20230140 (2024) doi:10.1098/rsta.2023.0140.

Lee, E.D., Kempes, C. P. & West, G. B. Idea engines: A unified theory of innovation and obsolescence from markets and genetic evolution to science. Accepted at PNAS (2023).

Kushwaha, N. & **Lee, E.D.** Discovering the mesoscale for chains of conflict. PNAS Nexus 2, pgad228 (2023). DOI: https://doi.org/10.1093/pnasnexus/pgad228

Lee, E.D., Chen, X. & Daniels, B.C. Discovering sparse control strategies in neural activity. PLoS Comput Biol 18, e1010072 (2022). DOI:https://dx.plos.org/10.1371/journal.pcbi.1010072.

Lee, E.D., Kempes, C.P. & West G.B. Growth, death, and resource competition in sessile organisms. PNAS 118, e2020424118 (2021). DOI:https://doi.org/10.1073/pnas.2020424118

Lee, E.D., Daniels, B.C., Myers, C.R., Krakauer, D.C. & Flack, J.C. Scaling theory of armed-conflict avalanches. Phys. Rev. E 102, 042312 (2020). DOI:https://doi.org/10.1103/PhysRevE.102.042312

Lee, E.D., Katz, D.M., Bommarito II, M.J. & Ginsparg, P.H. Sensitivity of collective outcomes identifies pivotal components. Journal of The Royal Society Interface 17 (2020). DOI:https://doi.org/10.1098/rsif.2019.0873

Lee, E.D., Esposito, E. & Cohen, I. "Audio cues enhance coordination of motion when visual cues are scarce." Journal of the Royal Society Interface, 16(154) (2019). DOI:https://doi.org/10.1098/rsif.2018.0903

Lee, E.D. & Daniels, B.C. "Convenient Interface to Inverse Ising (ConIII): A Python 3 Pack- age for Solving Ising-Type Maximum Entropy Models." Journal of Open Research Software, 7(3):1–8 (2019). DOI:https://doi.org/10.5334/jors.217

Lee, E.D. "Partisan Intuition Belies Strong, Institutional Consensus and Wide Zipf's Law for Voting Blocs in US Supreme Court." Journal of Statistical Physics 173(6):1722–1733 (2018). DOI:https://doi.org/10.1007/s10955-018-2156-0

Lee, E.D., Daniels, B.C., Krakauer, D.C. & Flack, J.C. "Collective Memory in Primate Conflict Implied by Temporal Scaling Collapse." Journal of the Royal Society Interface, 14:20170223 (2017). DOI:http://dx.doi.org/10.1098/rsif.2017.0223

Sethna, J.P., Bierbaum, M.K., Dahmen, K.A., Goodrich, C.P., Greer, J.R., Hayden, L.X., Kent-Dobias, J.P., **Lee, E.D.**, Liarte, D.B., Ni, X. & Quinn, K.N."Deformation of crystals: Connections with statistical physics." Annual Review of Materials Research, 47(14):1–13 (2017). DOI:https://doi.org/10.1146/annurev-matsci-070115-032036

Lee, E.D., Broedersz, C.P. & Bialek, W. "Statistical Mechanics of the US Supreme Court." Journal of Statistical Physics, 160(2):275–301 (2015). DOI:https://doi.org/10.1007/s10955- 015-1253-6

Working papers

Lee, E.D., Daniels, B.C., Myers, C.R., Krakauer, D.C. & Flack, J.C. "Emergent regularities and scaling in armed conflict data," arXiv:1903.07762, 2019. https://arxiv.org/abs/1903.07762.

Lee, E. D., Kwan, A. P., Hanel, R., Bhatt, A., Neffke, F. Following the information footprint of firms. Preprint at http://arxiv.org/abs/2210.07418 (2022). Under review.

Lee, E. D., Flack, J. C., Krakauer, D. C. Constructing stability: optimal timescales of adaptation. Preprint at https://arxiv.org/abs/2209.00476 (2022). Under review.

Lee, E.D. Closely estimating the entropy of sparse graph models. Preprint at http://arxiv.org/abs/2301.04768 (2023).

Research presentations (selected)

2024

Session on Statistical Physics of Political Systems, Keynote speaker, DPG March meeting

2023

"Rethinking a statistical mechanics of voting," Complexity in Law & Governance, Vanderbilt Law School

"Idea engines: Unifying innovation & obsolescence from markets & evolution to science," invited minisymposium, SIAM Dynamical Systems, Portland

"Scaling in the information costs of firms," *Santa Fe Institute seminar*

"Discovering components, mechanism, and structure" *in "The Database of Religious History and Cultural Evolutionary Analysis," Santa Fe Institute working group*

"Diversity and universality in the laws of life," *Visualizing Complexity Science Workshop, Complexity Science Hub Vienna*

"Idea engines," *Complex Systems Seminar, Physics, Northwestern*

"The multiple scales of armed conflict," *Theoretical Ecology Lab Tea, Princeton*

"Idea engines," *NetSI, Northeastern*

"Following the information footprint of firms," *INET, Oxford*

"Growth, death, and resource competition in sessile organisms," *Exeter*

"Following the information footprint of firms," *Methodology seminar, LSE*

"A theory of innovation and obsolescence," *Imperial College, Complex Systems Seminar*

"Idea engines," *Kings College, Disordered Systems*

Group

"Fluctuations in growth, death, and resource competition in sessile organisms," *Potsdam Institute for Climate Science, Keynote speaker, ESRI*

2022 "Idea engines," *Colloquium on Complex and Biological Systems, Potsdam University*

"Idea engines," *Dutch Institute for Emergent Phenomena*

"Innovation, obsolescence, & the space of the possible," *Organized workshop with invited participants*

2021 "Growth, death, and resource competition in sessile organisms" *University of Bristol, Engineering Mathematics seminar*

"Measuring institutional integrity with the judiciary," *Organized working group with invited participants*

2019 "Emergent regularities and scaling in armed conflict data," *SIAM, online minisymposium "Modeling collective human behavior in social systems"*

"Dynamics of growth, death, and resource competition in sessile organisms," *March APS*

"Coarse-graining armed conflict," *March APS, Boston*

2018 "Keeping it together: How humans coordinate motion with low information," *March APS, Los Angeles*

"Collective memory in primate conflict implied by temporal scaling collapse," *Bifi, Zaragoza*

"Renormalization group & armed conflict" *Santa Fe Institute*

2016 "Statistical physics of collective behavior" *Santa Fe Institute*

"Voting in the Supreme Court, conflict in pigtailed macaques, & statistical physics," *Santa Fe Institute*

Service & outreach

Reviewer for American Political Science Review, Cliodynamics, Journal of Statistical Mechanics, MDPI Social Sciences, Nature Communications Physics

Neuroscience Letters, Physica A, PLoS Computational Biology, PLoS One, Royal Society Open Science, Science Advances, NPJ Complexity

2020 Colloquium Committee Chair
STEM Santa Fe volunteer
Math festival for middle-schoolers

2019-2020 Participant in Letters to Pre-Scientist
Pen pal program with elementary school students

2018 Cornell Center for Material Research outreach volunteer
Physics Dept. colloquium committee student representative

2017 Physics representative to Graduate & Professional Student Assembly

2015-2016 Education Outreach Initiative Wisconsin Institute for Discovery
Developed and taught curriculum on complex systems for middle school students in coordination with the Discovery Outreach Center

2014 Lecturer at Humanities Hackathon at Wisconsin Institute for Discovery
A weeklong course about using R for the digital humanities

2012 Volunteer physics tutor at Princeton High School
After school help sessions with students in physics

Media

2021 Conflict research cited in Bloomberg Opinion by Niall Ferguson
"Cascading Conflicts: What is the Science of Violence?" Santa Fe Council on Int'l Relations
Panelist in conversation moderated by policy analyst Rachel Kleinfeld

2020 Swing voter work covered by Cornell Chronicle and SFI Press

2019 Conflict research covered by Cornell Chronicle

2018 Conflict research covered in Cosmos Magazine

2014 Supreme Court paper covered in the Cornell Chronicle and Ars Technica

Supreme Court paper covered in *Wired*