Daniel B. Cooney

Department of Mathematics
University of Pennsylvania
209 South 33rd Street
Philadelphia, PA 19104
dbcooney@sas.upenn.edu

Department of Biology
University of Pennsylvania
433 South University Avenue
Philadelphia, PA 19104
danielbcooney@gmail.com

RESEARCH INTERESTS

Mathematical Interests: Dynamical Systems, Applied PDEs, Network and Graphon Modeling
Biological Interests: Theoretical Ecology, Evolutionary Dynamics, Evolutionary Game Theory, Multilevel Selection, Collective Behavior, Pattern Formation

EMPLOYMENT

Simons Postdoctoral Fellow, Center for Mathematical Biology   August 2020 to Present
University of Pennsylvania, Philadelphia, PA, USA
Departments of Mathematics and Biology
Postdoctoral Mentors: Yoichiro Mori and Joshua Plotkin

EDUCATION

Ph.D., Applied and Computational Mathematics   September 2015 to June 2020
Princeton University, Princeton, NJ, USA
Advisor: Simon A. Levin
Dissertation: "PDE Models for Multilevel Selection: The Evolution of Cooperation and the Shadow of Lower-Level Selection"
M.A. awarded in September 2017

A.B., Cum Laude in Mathematics   August 2010 to May 2014
Harvard University, Cambridge, MA, USA
Concentration in Mathematics with Secondary Field in Economics
Senior Thesis: "Rock-Paper-Scissors: An Application of Evolutionary Game Theory to Electoral Politics," advised by Clifford H. Taubes

PUBLICATIONS

8. **D.B. Cooney** (2022). Assortment and Reciprocity Mechanisms for Promotion of Cooperation in a Model of Multilevel Selection. In press, *Bulletin of Mathematical Biology* (*arXiv preprint arXiv:1910.06933*).

7. **D.B. Cooney**, F.W. Rossine, D.H. Morris, & S.A. Levin (2022). A PDE Model for Protocell Evolution and the Origin of Chromosomes via Multilevel Selection. *Bulletin of Mathematical Biology*, *84(109)*, 1-90.

6. **D.B. Cooney** & Y. Mori (2022). Long-Time Behavior of a PDE Replicator Equation for Multilevel Selection in Group-Structured Populations. *Journal of Mathematical Biology*, *85(12)*, 1-67.

5. R. Carmona, **D.B. Cooney**, C.V. Graves, & M. Laurière (2022). Stochastic Graphon Games: I. The Static Case. *Mathematics of Operations Research*, *47(1)*, 750-778.

4. **D.B. Cooney** (2020). Analysis of Multilevel Replicator Dynamics for General Two-Strategy Social Dilemmas. *Bulletin of Mathematical Biology*, *82(6)*, 1-72.

3. **D.B. Cooney** (2019). The Replicator Dynamics for Multilevel Selection in Evolutionary Games. *Journal of Mathematical Biology, 79(1)*, 101-154.

2. **D.B. Cooney**, B. Allen, & C. Veller (2016). Assortment and the Evolution of Cooperation in a Moran Process with Exponential Fitness. *Journal of Theoretical Biology, 409*, 38-46.

1. V. Wong, **D. B. Cooney**, & Y. Bar-Yam (2016). Beyond Contact Tracing: Community-Based Early Detection for Ebola Response. *PLoS Currents: Outbreaks.*

PREPRINTS

3. **D.B. Cooney**, S.A. Levin, Y. Mori, & J.B. Plotkin (2022). Evolutionary Dynamics Within and Among Competing Groups. *arXiv preprint arXiv:2209.02063.*

2. J. Benson, M. Bessonov, K. Burke, S. Cassani, M.V. Ciocanel, **D.B. Cooney**, & A. Volkening (2022). How do classroom-turnover times depend on lecture-hall size? *arXiv preprint arXiv:2206.06199.*

1. **D.B. Cooney***, D.H. Morris*, S.A. Levin, D.I. Rubenstein, & P. Romanczuk (2022). Social Dilemmas of Sociality due to Beneficial and Costly Contagion. *arXiv preprint arXiv:2202.09905.* (* joint first authors)

EXPOSITORY ARTICLES

2. **D.B. Cooney**, S.A. Levin, Y. Mori, & J.B. Plotkin. Modeling Natural Selection at Multiple Levels of Organization *SIAM News Blog*, October 2021.

1. **D.B. Cooney**. Report on SIAM DS21. *DS Web: The Dynamical Systems Web*, July 2021.

HONORS & AWARDS

- Best Poster Award, 6th Butler Memorial Conference on Differential Equations and Population Biology, University of Alberta, Edmonton (July 2018)
- Princeton University C.V. Starr Fellowship (2015-2016 academic year)
- NSF Graduate Research Fellowship Honorable Mention in Mathematical Biology (2016) and in Applied Mathematics (2015)
- Harvard Program for Research in Science and Engineering (PRISE) Fellow (Summer 2013)
- Harvard University Certificate of Distinction in Teaching (Fall 2012)

TEACHING EXPERIENCE

- Instructor, University of Pennsylvania
  – Math 5861 / Biology 5860: Mathematical Modeling in Biology   Fall 2022
  – Math 104: Calculus I   Fall 2021
- Assistant in Instruction, Princeton University
  – EEB 533: Topics in Ecology: Theoretical Ecology   Fall 2018
  – MAE 305 / MAT 391: Mathematics in Engineering I   Fall 2018
  – APC 199: Math Alive   Spring 2018
  – MAT 203: Advanced Vector Calculus   Fall 2017
  – MAT 103: Calculus I   Fall 2016, Fall 2018
  – MAT 175: Multivariable Calc for Econ/Life Sci   Fall 2016
- Course Assistant, Harvard University
  – Math 116: Real Analysis, Convexity, and Optimization   Fall 2012, Fall 2013
  – Computer Science 20: Discrete Mathematics for Computer Science   Spring 2013
  – Fun & Games with Discrete Mathematics   Jan. 2012, Jan. 2013
  – Math 23b: Linear Algebra and Real Analysis II   Spring 2012
  – Math 23a: Linear Algebra and Real Analysis I   Fall 2011

- Guest Lecturer
  - Nonlinear Dynamical Systems and Applications, UNESP: São Paulo State University   Jun. 2020

SEMINAR AND COLLOQUIUM TALKS

- Mathematics Colloquium, Dartmouth College, Hanover, NH   Apr. 2022
- Probability Seminar, Indiana University, Bloomington (virtual)   Mar. 2022
- Mathematical Biology Seminar, New Jersey Institute of Technology (virtual)   Mar. 2022
- Mathematical Biology Seminar, Arizona State University (virtual)   Feb. 2022
- Biomathematics Seminar, Virginia Commonwealth University (virtual)   Feb. 2022
- PDE Seminar, Ohio State University (virtual)   Jan. 2021
- Mathematical Biology Seminar, Brandeis University (virtual)   Apr. 2020
- Probability Seminar, Indiana University, Bloomington   Jan. 2020
- Mathematical Biology Seminar, University of Pennsylvania   Jan. 2020
- Applied Mathematics Seminar, University of Victoria   Jul. 2018

MINISYMPOSIUM AND SPECIAL SESSION TALKS

- AMS Special Session on Ecological and Evolutionary Dynamics in Life and Social Science, JMM, Boston, MA   Jan. 2023
- AMS Special Session on Complex Systems in the Life Sciences, JMM, Boston, MA   Jan. 2023
- AMS Special Session on Dynamics of PDEs on Heterogeneous Domains: Theory & Applications, JMM, Boston, MA   Jan. 2023
- AMS Eastern Sectional Meeting, UMass Amherst   Oct. 2022
- MAA MathFest, Philadelphia, PA   Aug. 2022
- Joint Mathematics Meetings (virtual)   Apr. 2022
- AMS Eastern Section Meeting (virtual)   Mar. 2022
- AMS Eastern Section Meeting (virtual)   Mar. 2020
- AMS Western Section Meeting, University of California, Riverside   Nov. 2019
- AMS Southeastern Section Meeting, Auburn University   Mar. 2019
- AMS Eastern Sectional Meeting, University of Delaware   Sep. 2018

CONTRIBUTED TALKS

- Mathematical Models in Ecology & Evolution Conference, University of Reading, UK   Jul. 2022
- SIAM Annual Meeting, Pittsburgh, PA   Jul. 2022
- SIAM Conference on the Life Sciences, Pittsburgh, PA   Jul. 2022
- SIAM Conference on Mathematics of Planet Earth, Pittsburgh, PA   Jul. 2022
- Joint Mathematics Meetings (virtual)   Apr. 2022
- MAA EPaDel Sectional Meeting (virtual)   Apr. 2022
- Northeast Regional Conference on Complex Systems (virtual)   Mar. 2022
- APS March Meeting, Chicago, IL   Mar. 2022
- Dynamics Days US, online   Jan. 2022
- APS Mid-Atlantic Section Meeting, Rutgers University, Piscataway, NJ   Dec. 2021
- IBA Annual Symposium on Biomathematics and Ecology Education and Research (virtual)   Nov. 2021
- Learning, Evolution, and Games Conference (virtual)   Sep. 2021
- Dynamics Day Europe XL, Nice, France (virtual)   Aug. 2021
- SIAM Conference on Applications of Dynamical Systems (virtual)   May 2021
- MAA EPaDel 2021 Virtual Spring Section Meeting, online   Apr. 2021
- Northeast Regional Conference on Complex Systems (virtual)   Apr. 2021

- SMB Annual Meeting (virtual)   Aug. 2020
- SIAM Conference on Mathematics of Planet Earth, Garden Grove, CA (canceled)   Jun. 2020
- SIAM Conference on the Life Sciences, Garden Grove, CA (canceled)   Jun. 2020
- Northeast Regional Conference on Complex Systems (virtual)   Apr. 2020
- Collective Information Processing, Humboldt University of Berlin   Mar. 2020
- Joint Mathematics Meetings, Denver, CO   Jan. 2020
- Flash Talk: Dynamics Days US, Hartford, CT   Jan. 2020
- ICMA VII: Mathematical Modeling and Analysis of Populations in Biological Systems, Arizona State University, Tempe   Oct. 2019
- Levin Fest: A Symposium at the Intersection of Mathematics and Biology, University of Victoria   Jun. 2019
- SIAM Conference on Applications of Dynamical Systems, Snowbird, UT   May 2019
- APS March Meeting, Boston, MA   Mar. 2019
- Joint Mathematics Meetings, Baltimore, MD   Jan. 2019
- Dynamics Days US, Evanston, IL   Jan. 2019
- Workshop on Evolutionary Models of Structured Populations, Max Planck Institute for Evolutionary Biology, Plön, Germany   Sep. 2018
- Finger Lakes Probability Seminar, Syracuse University   Apr. 2017
- 17 talks at Princeton Theoretical Ecology Lab Tea and 6 talks at Princeton PACM Graduate Student Seminar   2015-2022

TALKS FOR UNDERGRADUATE OR GENERAL AUDIENCE
- YSSP Final Colloquium, IIASA, Laxenburg, Austria   Aug. 2017
- Leverett House Murdock Thesis Dinner, Harvard University   May 2014
- Harvard Undergraduate Mathematics Colloquium   Nov. 2013
- Harvard PRISE Final Presentation   Aug. 2013

POSTER PRESENTATIONS
- SIAM Conference on Analysis of Partial Differential Equations (virtual)   Mar. 2022
- SMB Annual Meeting (virtual)   Jun. 2021
- SIAM Workshop on Network Sciences (virtual)   Jul. 2020
- SMB Annual Meeting, Montreal, QC   Jul. 2019
- Conference on the Evolution of Complex Life, Georgia Tech, Atlanta   May 2019
- LMS School on PDEs in Mathematical Biology, ICMS, Edinburgh, UK   Apr. 2019
- KI-Net Young Researchers Workshop on Kinetic Descriptions in Theory and Applications, University of Maryland, College Park   Oct. 2018
- 6th Butler Memorial Conference on Differential Equations and Population Biology, University of Alberta, Edmonton   Jul. 2018
- XXXV Dynamics Days US, Durham, NC   Jan. 2016

TRAVEL GRANTS
- SIAM Early Career Travel Grant, SIAM Conference on the Life Sciences   July 2022
- Collaborate@ICERM Funding to participate in small working group on "Mathematical Models of Pedestrian Movement in Large Lecture Halls"   Jun. 2021
- SIAM Student Travel Grant, SIAM Workshop on Network Science (in-person conference canceled due to Covid-19)   Jul. 2020
- AMS Graduate Student Travel Grant, Joint Mathematics Meetings   Jan. 2020

- SIAM Student Travel Grant, SIAM Conference on Applications of Dynamical Systems May 2019
- AMS Graduate Student Travel Grant, AMS Fall Eastern Sectional Meeting Sep. 2018

WORKSHOPS & SUMMER SCHOOLS

- LMS Research School on "PDEs in Mathematical Biology", ICMS, Edinburgh, UK Apr. 2019
- Global Biosocial Complexity Initiative Winter School on "Agent-Based Modeling of Social-Ecological Systems", Arizona State University Jan. 2019
- MBI Current Topics Workshop on"Collective Behavior and Emergent Phenomena in Biology", Ohio State University Sep. 2018
- AMS Mathematics Research Community on "Agent-Based Modeling in Biological and Social Systems", West Greenwich, RI Jun. 2018
- "Winter Workshop on Complex Systems", University of Utrecht, Netherlands Feb. 2018
- KI-Net Workshop on "Mean-field modeling and multiscale methods for complex physical and biological systems", UC Santa Barbara Sep. 2016
- KI-Net Summer School on "Quantum and Kinetic Theory for Complex Systems", UC Santa Barbara Jun. 2016
- AIM workshop on "Mathematics Inspired by Immuno-Epidemiology", San Jose, CA Aug. 2015
- IPAM summer school on "Games and Contracts for Cyber-Physical Security" Jun. 2015

ACADEMIC SERVICE

<u>Minisymposium Organizer</u>

- "Multiscale Approaches to Modeling Ecological and Evolutionary Dynamics", AMS Southeastern Sectional Meeting, Georgia Institute of Technology (with O.J. Chu, D.D. Patterson, and C.M. Saad-Roy) March 2023
- "Mathematical Modeling of Ecology and Evolution: From Infectious Disease to the Evolution of Cooperation", Joint Mathematics Meetings, Boston, MA (with B. Allen, O.J. Chu, and C.M.Saad-Roy) Jan. 2023
- "Mathematical Modeling of Biological and Social Systems", AMS Western Sectional Meeting, University of Utah (with D. Gomez and H. Kim) Oct. 2022
- "Game-Theoretic and Agent-Based Approaches to Modeling Biological and Social Systems", AMS Eastern Sectional Meeting, University of Massachusetts, Amherst (with O.J. Chu) Oct. 2022
- "Modeling Biological and Social Systems Using Evolutionary Game Theory", SIAM Conference on the Life Sciences, Pittsburgh, PA Jul. 2022
- "Mathematical Modeling of Population Dynamics across Scales: from Immuno-Epidemiology to Multilevel Selection", Joint Mathematics Meetings, Seattle, WA (with C.M. Saad-Roy) Apr. 2022
- "Mathematical Methods for Ecology and Evolution in Structured Populations", AMS Eastern Sectional Meeting, online (with O.J. Chu and C.M. Saad-Roy) Mar. 2022
- "Collective Behavior and Social Evolution", SMB Annual Meeting, online (with O.J. Chu) June 2021
- "Dynamical Systems Approaches for Biological and Cultural Evolution'', SIAM Conference on Applications of Dynamical Systems, online (with O.J. Chu and C.M. Saad-Roy) May 2021
- "Emergence and Stability of Population Structure and Biological Aggregates Across Scales", SMB Annual Meeting, online (with O.J. Chu) Aug. 2020
- "Mathematical Methods for Ecology and Evolution in Structured Populations", online session held in place of in-person AMS Sectional Meeting (with O.J. Chu and C.M. Saad-Roy) Mar. 2020

Seminar Organizer

- University of Pennsylvania Mathematical Biology Seminar — Fall 2020, Fall 2021
- Princeton NSF Research Training Grant Seminar Series on "Mathematical Methods for Water Problems" — 2018-2020
- Princeton Theoretical Ecology Lab Tea (with C. Cabal) — Fall 2017

Academic Mentor

- Mentor/Coach for final presentations of undergraduate applied mathematics senior independent work — Spring 2020
- Princeton Mathematics Mentoring Möbius Program — 2017-2020
- Co-mentored Princeton undergraduate Alice Lin on research project "Spatial property rights as a management strategy for common-pool resources" (with D.H. Morris and S.A. Levin) — Summer 2017
- Non-Resident Tutor, Leverett House, Harvard University — 2014-2015

Committee Member

- Alumni Undergraduate Admissions Interviewer, Harvard University — 2021-2022
- Math Club Committee, University of Pennsylvania — 2021-2022
- Rights & Rules Committee, Council of the Princeton University Community — 2019-2020
- Princeton Graduate Student Government Representative for PACM — 2017-2020
- Princeton University Ad Hoc Committee on Campus Recreation — 2017-2020

Referee

Acta Mathematica Scientia	Mathematical Biosciences
BioSystems	New Journal of Physics
Bulletin of Mathematical Biology	PLoS Computational Biology
Games	PLoS One
IEEE Computational Intelligence Magazine	PNAS
IEEE Conference on Decision and Control	Proceedings of the Royal Society, B
Journal of Biological Dynamics	Scientific Reports
Journal of Theoretical Biology	Theory and Decision

Grant Peer Reviewer

- Ecology and Evolution Panel, NRDI Office, Hungary — Apr. 2022

Conference Poster/Talk Judge

- AMS-PME Undergradute Poster Session, Joint Mathematics Meetings — Apr. 2022
- Population Dynamics & Ecology Contributed Talk Sessions, SMB Annual Meeting — Jun. 2021
- Population Dynamics, Ecology, & Evolution Poster Session, SMB Annual Meeting — Aug. 2020

Science Fair Judge

- Montgomery County Science Fair, Fort Washington, PA — Mar. 2022
- Delaware Valley Science Fair, Oaks, PA — Apr. 2021, Apr. 2022

Seminar Discussant

- Economics and Finance Seminar, LUISS Guido Carli, Rome, Italy (held online) — Nov. 2020

SHORT-TERM RESEARCH POSITIONS

Visiting Graduate Researcher   June 2017 — August 2017
International Institute for Applied Systems Analysis   Laxenberg, Austria
Participant in Young Scientists Summer Program (YSSP)

Researcher   September 2014 — August 2015
New England Complex Systems Institute   Cambridge, MA

Undergraduate Researcher   January 2013 — August 2013
Harvard Program for Evolutionary Dynamics   Cambridge, MA

COMPUTER SKILLS

Proficient with Python, Mathematica, MATLAB, LaTeX; Familiar with C

PROFESSIONAL SOCIETIES

Society for Industrial and Applied Mathematics (SIAM): 2015 to present
American Mathematics Society (AMS): 2018 to present
American Physical Society (APS): 2018 to present
Society for Mathematical Biology (SMB): 2020 to present
Mathematical Association of America (MAA): 2021 to present