

William H. Sandholm

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January 1, 2018

Education

Ph.D., 1998, Kellogg Graduate School of Management, Northwestern University.
A.B., 1992, Dartmouth College. Summa cum laude.

Appointments

Richard E. Stockwell Chair in Economics, University of Wisconsin, 2017 to present.
Professor of Economics, University of Wisconsin, 2005–2017.
Associate Professor of Economics, University of Wisconsin, 2002–2005.
Assistant Professor of Economics, University of Wisconsin, 1998–2002.

Grants, Fellowships, and Awards

External

National Science Foundation Grant (“Best Experienced Payoff Dynamics and Cooperative Play in Extensive Form Games”), 2017-2020.
Army Research Office Grant (“Large Deviations in Multi-Agent Systems”), 2017-2020.
National Science Foundation Grant (“Equilibrium Breakdown and Equilibrium Selection in Evolutionary Game Theory”), 2015-2017.
National Science Foundation Grant (“Deterministic and Stochastic Equilibrium Selection in Evolutionary Game Theory”), 2012-2015.
National Science Foundation Grant (“Evolutionary Game Theory and Applications”), 2009-2012.
National Science Foundation Grant (“Rationality, Irrationality, and Transition Dynamics in Evolutionary Game Theory”), 2006-2009.
National Science Foundation CAREER Award (“Evolution in Games: Theory and Applications”), 2001-2006.
State Farm Companies Foundation Dissertation Fellowship, 1997-1998.
National Science Foundation Graduate Fellowship, 1993-1996.
AACSB/GMAC National Doctoral Fellowship in Business and Management, 1992-1993.

Internal

Vilas Associate, University of Wisconsin, 2015-2017.
Epstein Faculty Fellowship, University of Wisconsin, 2014-2017.
Kellett Mid-Career Award, University of Wisconsin, 2010.
Hamel Faculty Fellowship, University of Wisconsin, 2009-2010.
Romnes Faculty Fellowship, University of Wisconsin, 2006.
Graduate School Research Award, University of Wisconsin, 2001-2002 and 2006-2007.

Research

Book

Population Games and Evolutionary Dynamics. MIT Press, 2010.

Software

Abed: Agent-Based Evolutionary Dynamics (with Luis Izquierdo and Segis Izquierdo).
[luis-r-izquierdo.github.io/abed](https://github.com/luis-r-izquierdo/abed).

Dynamo: Phase Diagrams for Evolutionary Game Dynamics (with Emin Dokumaci and Francisco Franchetti). www.ssc.wisc.edu/~whs/dynamo.

EvoDyn-3s (with Luis Izquierdo and Segis Izquierdo).
[luis-r-izquierdo.github.io/EvoDyn-3s](https://github.com/luis-r-izquierdo/EvoDyn-3s).

Articles in refereed journals

“*EvoDyn-3s: A Mathematica Computable Document to Analyze Evolutionary Dynamics in 3-Strategy Games* (with Luis Izquierdo and Segis Izquierdo).
SoftwareX 7 (2018), 226-233.

“*Riemannian Game Dynamics*” (with Panayotis Mertikopoulos). *Journal of Economic Theory* 177 (2018), 315-364.

“*Sample Path Large Deviations for Stochastic Evolutionary Game Dynamics*” (with Mathias Staudigl). *Mathematics of Operations Research* 43 (2018), 1348-1377.

“*Learning in Games via Reinforcement and Regularization*” (with Panayotis Mertikopoulos). *Mathematics of Operations Research* 41 (2016), 1297-1324.

“*Large Deviations and Stochastic Stability in the Small Noise Double Limit*” (with Mathias Staudigl). *Theoretical Economics* 11 (2016), 279-355.

“*Sampling Best Response Dynamics and Deterministic Equilibrium Selection*” (with Daisuke Oyama and Olivier Tercieux). *Theoretical Economics* 10 (2015), 243-281.

“*Local Stability of Strict Equilibria under Evolutionary Game Dynamics.*” *Journal of Dynamics and Games* 1 (2014), 485-495.

“*Probabilistic Interpretations of Integrability for Game Dynamics.*” *Dynamic Games and Applications* 4 (2014), 95-106.

“*An Introduction to Dynamo: Diagrams for Evolutionary Game Dynamics*” (with Francisco Franchetti). *Biological Theory* 8 (2013), 167-178.

“*Stochastic Approximations with Constant Step Size and Differential Inclusions*” (with

- Grégory Roth). *SIAM Journal on Control and Optimization* 51 (2013), 525-555.
- “Stochastic Imitative Game Dynamics with Committed Agents.” *Journal of Economic Theory* 147 (2012), 2056–2071.
- “Preface: Second DGAA Special Issue on Evolutionary Games” (with Ross Cressman and Christine Taylor). *Dynamic Games and Applications* 2 (2012), 1–3.
- “Large Deviations and Multinomial Probit Choice” (with Emin Dokumaci). *Journal of Economic Theory* 146 (2011), 2151–2158.
- “Preface: DGAA Special Issue on Evolutionary Games” (with Ross Cressman and Christine Taylor). *Dynamic Games and Applications* 1 (2011), 351–353.
- “Survival of Dominated Strategies under Evolutionary Dynamics” (with Josef Hofbauer). *Theoretical Economics* 6 (2011), 341–377.
- “Decompositions and Potentials for Normal Form Games.” *Games and Economic Behavior* 70 (2010), 446–456.
- “Local Stability under Evolutionary Game Dynamics.” *Theoretical Economics* 5 (2010), 27–50.
- “Orders of Limits for Stationary Distributions, Stochastic Dominance, and Stochastic Stability.” *Theoretical Economics* 5 (2010), 1-26.
- “Pairwise Comparison Dynamics and Evolutionary Foundations for Nash Equilibrium.” *Games* 1 (2010), 3-17.
- “Large Population Potential Games.” *Journal of Economic Theory* 144 (2009), 1710-1725.
- “Stable Games and their Dynamics” (with Josef Hofbauer). *Journal of Economic Theory* 144 (2009), 1665-1693.
- “Cultural Integration and Its Discontents” (with Timur Kuran). *Review of Economic Studies* 75 (2008), 201-228.
- “The Projection Dynamic and the Geometry of Population Games” (with Ratul Lahkar). *Games and Economic Behavior* 64 (2008), 565-590.
- “The Projection Dynamic and the Replicator Dynamic” (with Emin Dokumaci and Ratul Lahkar). *Games and Economic Behavior* 64 (2008), 666-683.
- “Robust Permanence and Impermanence for Stochastic Replicator Dynamics” (with Michel Benaïm and Josef Hofbauer). *Journal of Biological Dynamics* 2 (2008), 180-195.
- “Evolution in Bayesian Games II: Stability of Purified Equilibrium.” *Journal of Economic Theory* 136 (2007), 641-667.
- “Simple Formulas for Stationary Distributions and Stochastically Stable States.” *Games and Economic Behavior* 59 (2007), 154-162.
- “Evolution in Games with Randomly Disturbed Payoffs” (with Josef Hofbauer). *Journal of Economic Theory* 132 (2007), 47-69.
- “Pigouvian Pricing and Stochastic Evolutionary Implementation.” *Journal of Economic Theory* 132 (2007), 367-382.
- “Excess Payoff Dynamics and Other Well-Behaved Evolutionary Dynamics.” *Journal of Economic Theory* 124 (2005), 149-170.
- “Evolution in Bayesian Games I: Theory” (with Jeffrey C. Ely). *Games and Economic Behavior* 53 (2005), 83-109.
- “Negative Externalities and Evolutionary Implementation.” *Review of Economic Studies*

- 72 (2005), 885-915.
- "Evolution and Equilibrium under Inexact Information." *Games and Economic Behavior* 44 (2003), 343-378.
- "On the Global Convergence of Stochastic Fictitious Play" (with Josef Hofbauer). *Econometrica* 70 (2002), 2265-2294.
- "Evolutionary Implementation and Congestion Pricing." *Review of Economic Studies* 69 (2002), 667-689.
- "Almost Global Convergence to p -Dominant Equilibrium." *International Journal of Game Theory* 30 (2001), 107-116.
- "Preference Evolution, Two-Speed Dynamics, and Rapid Social Change." *Review of Economic Dynamics* 4 (2001), 637-679.
- "Potential Games with Continuous Player Sets." *Journal of Economic Theory* 97 (2001), 81-108.
- "Evolution, Population Growth, and History Dependence" (with Ady Pauzner), *Games and Economic Behavior* 22 (1998), 84-120.
- "History Independent Prediction in Evolutionary Game Theory." *Rationality and Society* 10 (1998), 303-326.
- "Simple and Clever Decision Rules in a Model of Evolution." *Economics Letters* 61 (1998), 165-170.

Articles in edited volumes

- "Population Games and Deterministic Evolutionary Dynamics." In H. P. Young and S. Zamir, eds., *Handbook of Game Theory*, Vol. 4, 703-775. North Holland, 2015.
- "Stochastic Evolutionary Game Dynamics: Foundations, Deterministic Approximation, and Equilibrium Selection." In K. Sigmund, ed., *Evolutionary Game Dynamics*, 111-141. American Mathematical Society, 2011.
- "Evolutionary Game Theory." In R. A. Meyers, ed., *The Encyclopedia of Complexity and Systems Science*, 3176-3205. Springer, 2009. (Reprinted in R. A. Meyers, ed., *Computational Complexity: Theory, Techniques, and Applications*, 1000-1029. Springer, 2012.)
- "Deterministic Evolutionary Dynamics." In S. N. Durlauf and L. E. Blume, eds., *The New Palgrave Dictionary of Economics*, 2nd edition, vol. 2, 457-461. Macmillan, 2008.
- "Learning and Evolution in Games: Overview". In S. N. Durlauf and L. E. Blume, eds., *The New Palgrave Dictionary of Economics*, 2nd edition, vol. 5, 56-60. Macmillan, 2008.

Book reviews

- "Strategic Learning and its Limits by H. Peyton Young." *Games and Economic Behavior* 63 (2008), 417-420.
- "Evolutionary Dynamics and Extensive Form Games by Ross Cressman." *International Review of Economics and Finance* 15 (2006), 136-140.

Working papers

- "Best Experienced Payoff Dynamics and Cooperation in the Centipede Game" (with Segis Izquierdo and Luis Izquierdo).
- "Hamilton-Jacobi Equations with State Constraints and Optimal Transition Paths for

- Stochastic Stability” (with Hung Tran and Srinivas Arigapudi).
- “An Introduction to *ABED*: Agent-Based Simulation of Evolutionary Game Dynamics” (with Luis Izquierdo and Segis Izquierdo).
- “Schelling Redux: An Evolutionary Dynamic Model of Segregation” (with Emin Dokumaci and Francisco Franchetti).
- “Stability for Best Experienced Payoff Dynamics” (with Luis R. Izquierdo and Segis S. Izquierdo).

Work in progress

- “Convergence, Cycling, and Chaos under Evolutionary Game Dynamics: A Monte Carlo Experiment” (with Francisco Franchetti and J. Clinton Sprott).
- “Cyclic Decompositions for Stochastic Stability” (with Jonathan Newton).
- “Imitative Dynamics Need Not Eliminate Dominated Strategies” (with Panayotis Mertikopoulos and Yannick Viossat).
- “Latticed Logit Choice” (with Panayotis Mertikopoulos).
- “Latticed Replicator Dynamics” (with Panayotis Mertikopoulos).
- “Large Deviations and Stochastic Stability in the Large Population Limit” (with Mathias Staudigl).
- “Selection Problems for State-Constrained Hamilton-Jacobi Equations and the Double Limits for Stochastic Stability in Games” (with Hung Tran).
- “‘Test Two and Adopt the Better’ Leads to Cooperation in the Centipede Game” (with Luis R. Izquierdo and Segis S. Izquierdo).

Professional Activities

Short-term appointments

- Visiting Professor, Stockholm School of Economics, various dates.
- Visiting Professor, École Polytechnique, Spring 2013.
- Visiting Scholar, University of Neuchâtel, various dates.
- Visiting Scientist, Simons Institute, UC-Berkeley, October 2015.
- Visiting Scholar, University of Paris VI, Spring 2013.
- Visiting Scholar, University of Queensland, February 2013.
- Visiting Scholar, Bielefeld University, May 2012.
- Visiting Scholar, University of Chile, March 2012.
- Visiting Scholar, Hitotsubashi University, December 2009.
- Visiting Scholar, University of Avignon and INRIA, November 2007.
- Visiting Scholar, University of Vienna, November 2006.
- Visiting Scholar, University of Paris VI, November 2006.
- Visiting Scholar, University of Southern California, March 2003.
- Visiting Scholar, University of Tokyo, June 2002.

Panel memberships

- National Science Foundation Panelist (ICES), 2012.

National Science Foundation Panelist (Economics), 2006-2008.
National Science Foundation Panelist (Human and Social Dynamics), 2004.

Advisory roles

Army Research Office, Network Science Division, Strategy Planning Meeting, 2017.

Editorial positions

Associate Editor, *Mathematics of Operations Research*, 2017 to present.
Associate Editor, *Journal of Dynamics and Games*, 2012 to present.
Associate Editor, *Dynamic Games and Applications*, 2010 to present.
Associate Editor, *Theoretical Economics*, 2010 to present.
Advisory Editor, *Games and Economic Behavior*, 2009 to present.
Associate Editor, *International Journal of Game Theory*, 2008 to present.
Associate Editor, *Journal of Economic Theory*, 2005 to present.
Associate Editor, *Journal of Economic Behavior and Organization*, 2004–2010.
Coeditor, special issues on Evolutionary Games, *Dynamic Games and Applications*, 2011–2012.

Positions in professional organizations

Council of the Game Theory Society, 2013 to present.

Conference program committees

Fifth World Congress of the Game Theory Society, 2016.
NBER/NSF/CEME Mathematical Economics Conference, 2014.
Twenty-fifth Stony Brook International Conference on Game Theory (co-chair), 2014.
Fourth World Congress of the Game Theory Society, 2012.
International Conference on Network Games, Control, and Optimization, 2011.
Midwest Economic Theory Meeting (chair), 2010.
Fourteenth International Symposium on Dynamic Games and Applications, 2010.
First Symposium on Algorithmic Game Theory, 2008.

Refereeing

Government agencies: Social Sciences and Humanities Research Council of Canada,
National Fund for Scientific and Technological Development (Chile), Czech Science
Foundation, European Research Council, Agence Nationale de la Recherche (France),
Israel Science Foundation, Portuguese Foundation for Science and Technology,
Economic and Social Research Council (UK), Army Research Office (USA), National
Science Foundation (USA).

Journals: *ACM Transactions on Economics and Computation*, *AEJ Microeconomics*, *Algorithmica*, *American Economic Review*, *Annals of Applied Probability*, *Annals of Operations Research*, *Applied Mathematics Letters*, *B.E. Journals in Theoretical Economics*, *Biology & Philosophy*, *Central European Journal of Operations Research*, *Econometrica*, *Economic Theory*, *Economics Letters*, *Entropy*, *European Economic Review*, *European Journal of Operations Research*, *Games, Games and Economic Behavior*, *IEEE Control Systems Magazine*, *IEEE Transactions on Automatic Control*, *International Economic Review*, *International Game Theory Review*, *International Journal of Game Theory*, *Journal of Economic Behavior and Organization*, *Journal of Economic Dynamics and Control*, *Journal of Economic Surveys*, *Journal of Economic Theory*, *Journal of Machine Learning Research*, *Journal of Mathematical Economics*, *Journal of Political Economy*, *Journal of Population Economics*, *Journal of Public Economics*, *Journal of the ACM*, *Journal of the European Economic Association*, *Journal of the Royal Society Interface*, *Linear and Multilinear Algebra*, *Mathematical Biosciences and Engineering*, *Mathematical Social Sciences*, *Mathematics of Operations Research*, *Nonlinearity*, *Operations Research*, *Proceedings of the National Academy of Sciences*, *RAND Journal of Economics*, *Rationality and Society*, *Review of Economic Dynamics*, *Review of Economic Studies*, *Research in Economics*, *Scandinavian Journal of Economics*, *Science Advances*, *Scientific Reports*, *SIAM Journal on Applied Dynamical Systems*, *SIAM Journal on Control and Optimization*, *Theoretical Economics*, *Theoretical Population Biology*, *Theory and Decision*, *Theory of Computing Systems*, *Transactions on Economics and Computation*, *Transportation Science B*.

Conferences: American Control Conference, ACM Conference on Economics and Computation, IEEE Conference on Decision and Control, Theoretical Aspects of Reasoning about Knowledge.

Conference presentations and seminars

- 2018: SITE Workshop on Dynamic Games, Contracts, and Markets; Paris Symposium on Games; Arne Ryde Symposium on Learning, Evolution, and Games, Lund University*.
- 2017: UW-Milwaukee, Stony Brook Workshop on Adaptive Learning; Stony Brook International Game Theory Conference.
- 2016: UW-Madison (Mathematics).
- 2015: University of Maryland (Institute for Systems Research); UC-Berkeley (Simons Institute for Theoretical Computer Science) (x2); Washington University in St. Louis, Peyton Young Conference (Oxford); University College London; Oxford University.
- 2014: Banff Workshop on Decentralized Systems; University of Colorado; Bocconi

- University; INRIA (Grenoble); Stony Brook International Game Theory Conference; Conference on Mathematical Aspects of Game Theory and Applications (Roscoff, France); UW-Madison (Wisconsin Institute for Discovery).
- 2013: Hausdorff Institute Workshop on Evolutionary Dynamics and Market Behavior; UW-Madison (Wisconsin Institute for Discovery); École Polytechnique; Paris Game Theory Seminar; Australasian Economic Theory Workshop*.
- 2012: Fourth World Congress of the Game Theory Society (Istanbul)*, Econometric Society Summer Meeting (Evanston); Workshop on Game Dynamics, Hebrew University; Bielefeld University; Colegio Carlo Alberto; Indiana University; URBANICS II (Chillán, Chile)*.
- 2011: UW-Madison (Human, Animal, and Machine Learning); Ohio State University; Conference on Mathematical Aspects of Game Theory and Applications (Toulouse)*; Altenberg Workshop on Strategic Interaction in Humans and Other Animals; University of Montreal–GERAD Spring School on Evolutionary Games (x2); European University Institute; Royal Institute of Technology, Stockholm (x2); National University of Singapore Conference on Economics and Probability; American Mathematical Society Short Course on Evolutionary Game Dynamics (New Orleans) (x2).
- 2010: Cornell University, Second Brazilian Workshop of the Game Theory Society*; Stony Brook International Game Theory Conference*; International Symposium on Dynamic Games and Applications (Banff)*; Banff Workshop on Evolutionary Games; Cowles Foundation Summer Conference; Eleventh Workshop on Optimal Control, Dynamic Games, and Nonlinear Dynamics (Amsterdam)*; UW-Madison (Chemical and Biological Engineering); URBANICS (Marbella, Chile)*; Lund University Workshop on Distributed Decision-Making and Control; University of Kentucky.
- 2009: Hitotsubashi University, Kyoto University, University of Tokyo, Harvard University/MIT; University of Massachusetts; Concordia University; Transatlantic Theory Workshop (Evanston); Cornell CS/Econ Workshop; Army Research Office Workshop on Decision Sciences*; UW-Madison (Mathematics); Econometric Society Winter Meeting (San Francisco).
- 2008: Toulouse School of Economics; Paris Game Theory Seminar; CEPR-PSE Conference on Cultural Dynamics and Diversity; George Washington University SMCS Symposium; University of Texas; UCLA; MIT Workshop on Game Theory and Networked Control Systems; Third World Congress of the Game Theory Society (Evanston); UCSD; Caltech Workshop on Microeconomic Dynamics; Oxford University; Johns Hopkins University.
- 2007: IEEE Conference on Decision and Control (New Orleans); Brown University; University of Avignon; Caltech; UNC-Charlotte; UW-Madison (Complex Systems).

- 2006: University of Michigan; Institute for Advanced Study, Vienna; University of Vienna; University of Bonn; Paris Game Theory Seminar; Radcliffe Seminar on Dynamic Networks; Columbia University; University of Western Ontario; UC-Berkeley; Stony Brook International Game Theory Conference; Banff Workshop on Evolutionary Game Dynamics; Princeton University; Caltech Learning and Information Workshop; Econometric Society Winter Meeting (Boston).
- 2005: Pennsylvania State University; Concordia University; Ninth World Congress of the Econometric Society (London); Stockholm School of Economics; SIAM Conference on Optimization (Stockholm).
- 2004: Harvard Program for Evolutionary Dynamics; Yale University; Kyoto Game Theory Workshop.
- 2003: UW-Madison (Mathematics); Illinois Conference on Learning and Bounded Rationality; Virginia Tech; University of Chicago; Princeton University; Johns Hopkins University; Washington University in St. Louis; Econometric Society Summer Meeting (Evanston); University of Texas; UCLA; University of Southern California.
- 2002: University of Pennsylvania; Harvard University / MIT; Society for Economic Dynamics Summer Meeting (New York); University of Tokyo (x3); Royal Institute of Technology, Stockholm; Stockholm School of Economics; Case Western Reserve University Learning Conference; Cornell University; Econometric Society Winter Meeting (Atlanta).
- 2001: Stony Brook International Game Theory Conference; Valencia International Game Theory Conference; Midwest Economic Theory Meeting (Madison).
- 2000: Royal Institute of Technology, Stockholm; Stockholm School of Economics; Eighth World Congress of the Econometric Society (Seattle); First World Congress of the Game Theory Society (Bilbao); American Economic Association Annual Meeting (Boston).
- 1999: Northwestern University; Stony Brook International Game Theory Conference.
- 1998: University of Michigan; University of Wisconsin; Columbia University, California Institute of Technology; University of Chicago; Kennedy School of Government-Harvard University.
- 1997: University of Rochester; Washington University in St. Louis; Arne Ryde Symposium on Focal Points, Lund University; Stony Brook International Game Theory Conference.
- 1996: Summer in Tel-Aviv Economic Theory Conference.
- (* denotes plenary, semi-plenary, or keynote lecture)

Advising and Teaching

Ph.D. students

Ratul Lahkar (2007), Emin Dokumaci (2007), Yasushi Asako (2009), Fernando Louge

(2009), Wei Zhang (2009), Ignacio Monzón (2010), Katsuhiko Aiba (2011), Danqing Hu (2011), Dai Zusai (2011), Ryoji Sawa (2012), Jiabin Wu (2014), Man Wah Cheung (2015), George Loginov (2018), Srinivas Arigapudi (current), Ziwei Wang (current).

Graduate teaching

Game theory, microeconomic theory, dynamical systems, stochastic processes.

Undergraduate/MBA teaching

Game theory, probability and statistics.

Book

Vital Statistics: Probability and Statistics for Economics and Business (with Brett A. Saraniti).
Oxford University Press, 2019.

Lecture notes

Lecture Notes on Game Theory and Information Economics.