Sam Kriegman **Curriculum Vitae**

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Northwestern University, Evanston, IL 60208
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sam.kriegman@northwestern.edu
Google Scholar. **1088** citations. H-index: **14**.

(*Updated: July 22, 2023.*)

APPOINTMENTS

2022– **Assistant Professor**
Department of Computer Science (50%)
Department of Mechanical Engineering (25%)
Department of Chemical & Biological Engineering (25%)
McCormick School of Engineering, Northwestern University

2022– Core Faculty, Center for Robotics and Biosystems, Northwestern University
2022– Core Faculty, Center for Synthetic Biology, Northwestern University
2022– Faculty, Applied Physics Graduate Program, Northwestern University
2022– Director, Xenobot Lab

2021–2022 **Postdoctoral Fellow**
Wyss Institute for Biologically Inspired Engineering, Harvard University
Allen Discovery Center, Tufts University
Advisor: Michael Levin

2020–2021 **Postdoctoral Associate**
Department of Computer Science, Unversity of Vermont
Advisor: Josh Bongard

2011–2014 Actuarial Analyst, Chubb Insurance

EDUCATION

2016–2020 **Ph.D.**, Computer Science, University of Vermont, USA
Design for an Increasingly Protean Machine.
Advisor: Josh Bongard

2014–2016 **M.S.**, Statistics, University of Vermont, USA
2006–2010 **B.S.**, Applied Mathematics, Ohio University, USA

FUNDING

2023– **CESR** Seed Grant, $120,000. Kriegman portion: $60,000.
S Kriegman and R Truby
Sustainable Design and Fabrication of Intelligent Robots

2023– **Schmidt Futures AI2050 Early Career Fellowship**, $300,000

2023– **TWCF** award, $1,749,983. Kriegman portion: $286,600.
PI: J Foster; co-PIs: C Bergstrom, D Krakauer, S Kriegman, M Mitchell, R Rao.
Building Diverse Intelligences through Compositionality and Mechanism Design

AWARDS

2022 Outstanding Paper of 2021 Award, International Society for Artificial Life

2021 The Cozzarelli Prize, National Academy of Sciences
Outstanding Doctoral Dissertation Award, University of Vermont
Outstanding Paper of 2020 Award, International Society for Artificial Life
Altmetric Top 100, Altmetric

2020 Beazley Designs of the Year, The Design Museum
Top 10 Most Influential BioTech Projects, Project Management Institute
Computer Science Graduate Award, University of Vermont

2015 NASA EPSCoR Fellowship

ARTICLES

12. S Beaulieu, S Kriegman (2023).
Glamour muscles: why having a body is not what it means to be embodied.
ArXiv Preprint, arXiv:2307.08598

11. D Matthews, A Spielberg, D Rus, S Kriegman, J Bongard (2023).
Efficient automatic design of robots.
ArXiv Preprint, arXiv:2306.03263

10. D Blackiston, S Kriegman, J Bongard, M Levin (2023).
Biological Robots: Perspectives on an Emerging Interdisciplinary Field.
Soft Robotics, 10.1089/soro.2022.0142.

9. D Kudithipudi, M Aguilar-Simon, J Babb, M Bazhenov, D Blackiston, J Bongard, AP Brna, S Chakravarthi Raja, N Cheney, J Clune, A Daram, S Fusi, P Helfer, L Kay, N Ketz, Z Kira, S Kolouri, JL Krichmar, S Kriegman, M Levin, S Madireddy, S Manicka, A Marjaninejad, B McNaughton, R Miikkulainen, Z Navratilova, T Pandit, A Parker, PK Pilly, S Risi, TJ Sejnowski, A Soltoggio, N Soures, AS Tolias, D Urbina-Melendez, FJ Valero-Cueva, GM van de Ven, JT Vogelstein, F Wang, R Weiss, A Yanguas-Gil, X Zou, H Siegelmann (2022).
Biological underpinnings of lifelong learning machines.
Nature Machine Intelligence, 4(3): 196-210.

8. S Kriegman, D Blackiston, M Levin, J Bongard (2021).
Kinematic self-replication in reconfigurable organisms.
Proceedings of the National Academy of Sciences, 118(49): e2112672118.

7. D Blackiston, E Lederer, S Kriegman, S Garnier, J Bongard, M Levin (2021).
A cellular platform for the development of synthetic living machines.
Science Robotics, 6(52): eabf1571.

6. D Shah, J Powers, L Tilton, S Kriegman, J Bongard, R Kramer-Bottiglio (2021).
A soft robot that adapts to environments through shape change.
Nature Machine Intelligence, 3(10): 51-59.

5. D Shah, B Yang, S Kriegman, M Levin, J Bongard, R Kramer-Bottiglio (2020).
Shape Changing Robots: Bioinspiration, Simulation, and Physical Realization.
Advanced Materials, 33(19): 2002882.

4. S Kriegman, D Blackiston, M Levin, J Bongard (2020).
A scalable pipeline for designing reconfigurable organisms.
Proceedings of the National Academy of Sciences, 117(4): 1853-1859.
(*A perspective article on this work by P. Ball can be found here.*)

3. S Kriegman (2019).
Why virtual creatures matter.
Nature Machine Intelligence, 1(10): 492.

2. S Kriegman, N Cheney, J Bongard (2018).
How morphological development can guide evolution.
Scientific Reports, 8(1): 13934.

1. F Corucci, N Cheney, S Kriegman, J Bongard, C Laschi (2017).
Evolutionary developmental soft robotics as a framework to study intelligence and adaptive behavior.
Frontiers in Robotics and AI, 4: 34.

Peer-reviewed Conference Publications

11. S Kriegman, A-M Nasab, D Blackiston, H Steele, M Levin, R Kramer-Bottiglio, J Bongard (2021).
Scale invariant robot behavior with fractals.
Robotics: Science and Systems (RSS), 10.15607/RSS.2021.XVII.059

10. J Powers, R Grindle, S Kriegman, L Frati, N Cheney, J Bongard (2020).
Morphology dictates learnability in neural controllers.
Artificial Life Conference (ALife), 52-59.

9. S Kriegman, A-M Nasab, D Shah, H Steele, G Branin, M Levin, J Bongard, R Kramer-Bottiglio (2020).
Scalable sim-to-real transfer of soft robot designs.
IEEE Conference on Soft Robotics (RoboSoft), 359-366, 10.1109/RoboSoft48309.2020.9116004.

8. D Matthews, S Kriegman, C Cappelle, J Bongard (2019).
Word2vec to behavior: morphology facilitates the grounding of language in machines.
IEEE Conf. on Intelligent Robots and Systems (IROS), 4153-4160, 10.1109/IROS40897.2019.8967639.

7. S Kriegman, S Walker, D Shah, M Levin, R Kramer-Bottiglio, J Bongard (2019).
Automated shapeshifting for function recovery in damaged robots.
Robotics: Science and Systems (RSS), 10.15607/RSS.2019.XV.028
(*A perspective article on this work by H. Hauser can be found here.*)

6. S Beaulieu, S Kriegman, J Bongard (2018).
Combating catastrophic forgetting with developmental compression.
Genetic and Evolutionary Computation Conference (GECCO), 386-393, 10.1145/3205455.3205615.

5. S Kriegman, N Cheney, F Corucci, J Bongard (2018).
Interoceptive robustness through environment-mediated morphological development.
Genetic and Evolutionary Computation Conference (GECCO), 109-116, 10.1145/3205455.3205529.

4. J Powers, S Kriegman, J Bongard (2018).
The effects of morphology and fitness on catastrophic interference.
Artificial Life Conference (ALife), 606-613.

3. S Kriegman, C Cappelle, F Corucci, A Bernatskiy, N Cheney, J Bongard (2017).
Simulating the evolution of soft and rigid-body robots.

Genetic and Evolutionary Computation Conference (GECCO), 1117-1120, 10.1145/3067695.3082051.

2. S Kriegman, N Cheney, F Corucci, J Bongard (2017).
A minimal developmental model can increase evolvability in soft robots.
Genetic and Evolutionary Computation Conference (GECCO), 131-138, 10.1145/3071178.3071296.

1. S Kriegman, M Szubert, J Bongard, C Skalka (2016).
Evolving spatially aggregated features from satellite imagery for regional modeling.
Parallel Problem Solving from Nature (PPSN), 707-716.

PATENTS

2022 "Engineered multicellular ciliated organisms and the kinematic self-replication thereof". US2022/0220437.
2021 "Engineered multicellular organisms". US PCT/US2021/013105; WO 2022/005527.

SERVICE

2022 Co-organizer, CD-SoRo (computational design of soft robots) workshop, IROS conference. Kyoto, Japan.
2022– Program committee member, ALife conference.
2019– Co-developer, Voxcraft: a low-cost, open-source soft robot kit for ages 12+
2017–2022 Co-organizer, Virtual Creatures Competition and Workshop.

EDITORSHIPS

2020– Review Editorial Board, *Frontiers in Robotics and AI*

MEMBERSHIP

2022– International Society of Artificial Life (ISAL)
2022– Association of Computing Machinery (ACM)
2022– Institute of Electrical and Electronics Engineers (IEEE)

REVIEWER

Nature Machine Intelligence
Soft Robotics
Artificial Life
IEEE Transactions on Robotics
IEEE Robotics and Automation Magazine
IEEE Transactions on Cognitive and Developmental Systems
The International Journal of Robotics Research
Frontiers in Robotics and AI

INTERNAL

2022– PhD Admissions Committee, Dept of Computer Science.
2022– Graduate Studies Committee, Dept of Mechanical Engineering
2022 Academic Career Panel, Center for Synthetic Biology Retreat

TEACHING

Winter 2023 Comp Sci 396: Artificial Life: **128 students.** Crosslisted as Chem Eng 395 & Mech Eng 495.

ADVISING

STAFF

2022– David Matthews: Differentiable robots.

PHD'S

2023– Luke Strgar: tbd (Comp Sci).
2023– Chen Yu: tbd (Comp Sci).
2023– Muhan Li: Generative robotics (Comp Sci).
2022– Antara Sen: Biophysics (co-advising; applied physics).
2022– Tyler Hummer: Evolvable hardware (Mech Eng).

MASTERS

2023– Lingji Kong: Large language robots (Comp Sci).
2023– Isabel Zhong: Robot learning (Biomedical Eng & Comp Sci).
2023– Lindsay Bogar: Evolutionary robotics (Comp Sci).
2023 Elaine Liu: Modular robots (Mech Eng).

UNDERGRADS

2023– Dylan Wu: Symbol grounding (Comp Sci & Linguistics).
2023– Talia Ben-Naim: Neuromorphic robots (Comp Sci).
2023– Elli Beres: Growing robots (Math & Comp Sci).
2023– Shirley Zhang: tbd (Comp Sci).

OTHER

2023– Eliot Dunn: Robotics (High School intern).

INVITED TALKS

July 2023 "From artificial intelligence to artificial life". The American Academy of Arts and Sciences.
Apr 2023 "AI-generated organisms". Illinois Institute of Technology.
Mar 2023 *Animal Robot* Screening and Discussion. AAAS Annual Meeting, Washington, DC.

Dec 2022 *Berggruen Institute x Lucy McRae Salon*. Honor Fraser Gallery, Los Angeles.
Oct 2022 "Selection, the impersonal engineer". AI-Driven Labs Workshop, Argonne National Laboratory.
Sept 2022 "AI-generated organisms". New Faculty Invited Lecture, Northwestern ChBE Retreat.
May, 2022 "Everything I wish I'd known about the academic job market.". MEC Lab, University of Vermont.
Apr, 2022 "Simulating xenobots and xenohybrid machines.". Workshop on software for soft robotics research.
Apr, 2022 "Sim2real for biological robots". Workshop on soft robot design optimization, IEEE RoboSoft Conf.
Mar, 2022 "From Biology to Bots and Back". Luddy School, Indiana University.
Mar, 2022 "From Biology to Bots and Back". CS Colloquium, Northwestern University.
Feb, 2022 "Computer-designed organisms". *Leonardo Art Science Evening Rendezvouz*, Stanford University.
Feb, 2022 "From Biology to Bots and Back". MIT.
Feb, 2022 "Fractal robots". Evolutionary and Learning Machines Group, Vrije Universiteit Amsterdam.
Feb, 2022 "From Biology to Bots and Back". New York University.
Jan, 2022 "From Biology to Bots and Back". Vanderbilt University.

Sept, 2021 "AutoCAD for XenoBOT". Autodesk.
July, 2021 "Evolutionary robotics in a nutshell". ISAL Summer School.
July, 2021 "Sim2Life: AI-generated biological constructs". Cross Roads.
Mar, 2021 "Protean machines". The Creative AI Lab, IT University of Copenhagen.
Mar, 2021 "Living robots". *The Int'l Workshop on Embodied Intelligence*.
Mar, 2021 "How to evolve your robot". Guest lecture, Introduction to Soft Robotics, Yale University.

Oct, 2020 "Living deepfakes". Guest lecture for the MIT Media Lab's Deepfakes course (MAS.S60).
Apr, 2020 "Computer designed organisms". *Artificial Life Virtual Seminar Series*.
Feb, 2020 "Living robots for biomedicine". Biomedical Engineering Society, University of Vermont.

MISC. LECTURES

July, 2021 "Fractal robots in 5 minutes". *Robotics: Science and Systems (RSS).*
May, 2020 "Sim2real for soft robot designs". *IEEE International Conference on Soft Robotics (RoboSoft).*
June, 2019 "Shapeshifting robots". *Robotics: Science and Systems (RSS)* in Freiburg, Germany.

SELECTED MEDIA COVERAGE

to appear "The Tao of Trek". *Smithsonian Channel* (Paramount+)
Apr, 2023 "Meet xenobots, tiny machines made out of living parts". *Popular Science*
Mar, 2023 "Animal Robot" documentary. *Scientific American and the Howard Hughes Medical Institute*
Feb, 2023 "Scientists Are Growing Mini Brains in the Lab. Are They... Conscious?". *Popular Mechanics*
Feb, 2023 "Here come the xenobots". *BBC Science Focus*

Oct, 2022 "These Robots Are Self-Replicating. Or Are They?". *Pioneer Works magazine*
Sept, 2022 "Xenobot". *Dictionary.com*
Aug, 2022 "What on earth is a xenobot?". *Aeon magazine*
July, 2022 "Virtual critters evolve bodies that help them learn". *Science News for Students*
Feb, 2022 "The Uncanny Valley of Xenobots". *Nautilus Magazine*
Jan, 2022 "**Scientists create 'robots' that are capable of reproduction (with Jericka Duncan)**". ***CBS Evening News***

Dec, 2021 "Here are our favorite cool, funny and bizarre science stories of 2021". *Science News*
Dec, 2021 "Living robots that are capable of self-replicating created in US lab". *BBC Science Focus*
Dec, 2021 "Scientists Create 'Living Machines' With Algorithms, Frog Cells". *Bloomberg Businessweek*
Dec, 2021 "**It's not science fiction. Scientists have really made robots that reproduce**". ***NPR Weekend Edition***
Dec, 2021 "Living robots made in a lab have found a new way to self-replicate, researchers say". *NPR*
Dec, 2021 "Self replicating xenobots". *BBC World Service*
Dec, 2021 "The creation of self-replicating biobots". *BBC Science in Action*
Dec, 2021 "Diving Into The Strange World Of Xenobots". *Science Friday*
Dec, 2021 "'Living robots' made of frog cells found a way to reproduce". *CNBC: The News with Shepard Smith*
Dec, 2021 "Scientists unveil 'Pac-Man' living robots". *ABC News*
Dec, 2021 "Xenobots – US Scientists Create Tiny Living Robots That Can Reproduce". *Voice of America*
Dec, 2021 "100 years of robots: How technology – and our lives – have changed". *Chicago Tribune*
Dec, 2021 "UVM researchers make strides in 'living robot' reproduction". *WCAX (CBS 3)*
Dec, 2021 "Tiny living machines called xenobots can create copies of themselves". *Science News*
Dec, 2021 "Pac-Man-shaped blobs become world's first self-replicating biological robots". *Live Science*
Dec, 2021 "Stephen Colbert's Cyborgasm". *The Late Show with Steven Colbert*
Dec, 2021 "World's First Living Robots Can Now Reproduce, Say Scientists". *The Onion*
Dec, 2021 "'Xenobot' Living Robots Can Reproduce". *The Scientist*
Dec, 2021 "Scientists Unveiled the World's First Living Robots... Now, They Can Reproduce". *Smithsonian Magazine*
Dec, 2021 "Tiny living Pac-Man robots have learned how to reproduce". *CNN*
Nov, 2021 "These living robots made of frog cells can now reproduce, study says". *Washington Post*
Nov, 2021 "World's first living robots can now reproduce, scientists say". *New York Post*
Nov, 2021 "'Amazing science': researchers find xenobots can give rise to offspring". *The Guardian*
Nov, 2021 "World's first living robots can now reproduce, scientists say". *CNN*
Nov, 2021 "Daily briefing: Multicellular living robots build their own offspring". *Nature*
Nov, 2021 "Scientists made tiny xenobots out of frog cells. Now they say those robots can reproduce.". *USA Today*
Nov, 2021 "Xenobots that self-replicate created by scientists". *The Times*
Nov, 2021 "World's first 'living robots' start to reproduce". *The Telegraph*
Nov, 2021 "AI Just Designed The World's First Living Robot That Can Make Babies". *Forbes*
Nov, 2021 "Researchers behind the world's first living robot have found a way to make it reproduce". *Business Insider*
Nov, 2021 "Xenobots, the World's First Living Robots, Are Now Capable of Reproducing". *People Magazine*
Nov, 2021 "Mesmerizing Video Shows How Tiny 'Living Robot' Xenobot Cells Reproduce". *Newsweek*
Nov, 2021 "'Living robots' can self-replicate, furthering hope for regenerative medicine". *Fast Company*
Nov, 2021 "Living robots made from frog cells can replicate themselves in a dish". *New Scientist*

Nov, 2021 "Robots built from frog cells have unlocked the ability to self-replicate". *Popular Science*

Hundreds of additional articles appeared in the global press following our third xenobots paper.

Nov, 2021 "The Machine That Feels". *CBC TV*
Jun, 2021 "Biological Robots May Soon Build You a Better Heart". *Bloomberg Moonshot*
Jun, 2021 "The World's First "Living" Robots Just Got an Upgrade, Meet Xenobot 2.0". *Seeker*
Apr, 2021 "Frog stem cell research changes what we know about how organisms are built". *Washington Post*
Apr, 2021 "Robots made out of frog cells". *Science Friday*
Mar, 2021 "Cells Form Into 'Xenobots' on Their Own". *Quanta Magazine*
Mar, 2021 "Living robots made from frog skin cells can sense their environment". *New Scientist*
Mar, 2021 "Frog skin cells turned themselves into living machines". *Science News*

Dec, 2020 "The big scientific breakthroughs of 2020". *The Week*
Dec, 2020 "The 10 Most Spectacular Scientific Advances of 2020". *La Razón (Spain)*
Dec, 2020 "Part Robot, Part Frog: Xenobots Are the First Robots Made From Living Cells". *Discover Magazine*
Nov, 2020 "The Xenobot Future Is Coming – Start Planning Now". *Wired*
Apr, 2020 "Meet the Xenobots: Virtual Creatures Brought to Life". *New York Times*
Apr, 2020 "What if, Instead of the Internet, We Had Xenobots? ". *New York Times*
Feb, 2020 "Living Robots". *TalkSport Radio*
Feb, 2020 "Giant Moon rocket, living robots and quantum computer – January's best science images". *Nature*
Feb, 2020 "Meet the Xenobot, the World's First-Ever 'Living' Robot". *Seeker*
Feb, 2020 "Living robots built from frog cells". *BBC Science Focus*
Feb, 2020 "Tiny machines made from the stem cells of frogs". *The Intelligence (Economist Radio)*
Jan, 2020 "A research team builds robots from living cells". *The Economist*
Jan, 2020 "The religious, moral, and ethical implications of Xenobots". *BBC Radio 4 Sunday*
Jan, 2020 "Scientists use stem cells from frogs to build first living robots". *The Guardian*
Jan, 2020 "Xenobot: how did earth's newest lifeforms get their name? ". *The Guardian*
Jan, 2020 "Meet the xenobot: world's first living, self-healing robots created from frog stem cells". *CNN*
Jan, 2020 "Scientists create first living, self-healing robots (on-air with Fredricka Whitfield)". *CNN*
Jan, 2020 "Meet Xenobot, an Eerie New Kind of Programmable Organism". *Wired*
Jan, 2020 "Scientists Assemble Frog Stem Cells Into First 'Living Machines'". *Smithsonian Magazine*
Jan, 2020 "World's First 'Living Machine' Created Using Frog Cells and Artificial Intelligence". *Scientific American*
Jan, 2020 "These tiny living robots could help science eavesdrop on cellular gossip". *Popular Science*
Jan, 2020 "These Are the First Living Robots: Machines Made from Frog Stem Cells". *Popular Mechanics*
Jan, 2020 "Behold the xenobots – part frog, part robot. But are they alive?". *Christian Science Monitor*
Jan, 2020 "Scientists at UVM, Tufts create 'living robots'". *Boston Globe*
Jan, 2020 "How tiny 'biobots' could enter bodies to clean arteries and administer drugs". *The Times*
Jan, 2020 "Living robots created as scientists turn frog cells into 'entirely new life-forms'". *The Telegraph*
Jan, 2020 "'Robots vivientes' hechos a partir de tejido de ranas, llamados Xenobots". *Noticieros Televisa*
Jan, 2020 "Living Robots, Designed By Computer". *Science Friday*
Jan, 2020 "Living robots". *BBC World Service*
Jan, 2020 "These 'xenobots' are living machines designed by an evolutionary algorithm". *MIT Technology Review*
Jan, 2020 "The 'xenobot' is the world's newest robot – and it's made from living animal cells". *CTV News*
Jan, 2020 "World's First 'Living Robot' Invites New Opportunities And Risks". *Forbes*
Jan, 2020 "Tiny 'xenobots' made from cells could heal our bodies and clean the environment". *Fox News*
Jan, 2020 "World's first 'living robots' are made from the stem cells of frogs". *New York Post*
Jan, 2020 "Algorithm Designs Robots Using Frog Cells". *The Scientist*
Jan, 2020 "Xenobots: 1st living robots made from stem cells". *ESPN*
Jan, 2020 "Xenobot". *Wikipedia*

Hundreds of additional articles appeared in the global press following our announcement of Xenobots.