

Sam Kriegman

Curriculum Vitae

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[Google Scholar Profile](#)

APPOINTMENTS

- 2021– **Postdoctoral Fellow**, Harvard University
Advisor: Michael Levin, Associate Faculty at the Wyss Institute
- 2021– **Postdoctoral Fellow**, Tufts University
Advisor: Michael Levin, Director of the Allen Discovery Center
- 2020–2021 **Postdoctoral Associate**, University of Vermont
Advisor: Josh Bongard, Director of the Morphology, Evolution & Cognition Laboratory

EDUCATION

- 2016–2020 **Ph.D.**, Computer Science, University of Vermont, USA
[Design for an Increasingly Protean Machine](#).
Advisor: Josh Bongard, Director of the Morphology, Evolution & Cognition Laboratory
- 2014–2016 **M.S.**, Statistics, University of Vermont, USA
- 2006–2010 **B.S.**, Applied Mathematics, Ohio University, USA

AWARDS

- 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

9. D Kudithipudi, . . . , S Kriegman, and many others (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.](#)
Nature 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 Proceedings, 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).
[Interceptive 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 Proceedings, 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.
(Nominated for Best Paper Award.)

PATENTS

pending “Engineered Multicellular Organisms and the Kinematic Self-Replication Thereof”. App. No. 17/647,847
pending “Engineered Multicellular Organisms”. US PCT/US2021/013105.

SERVICE

2022– Program committee member, [ALife conference](#).
2019– Co-developer, [Voxcraft](#): a low-cost, open-source soft robot kit for ages 12+
2017– Co-organizer, [Virtual Creatures Competition and Workshop](#).

EDITORSHIPS

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

REVIEWER

Soft Robotics
The American Naturalist
Artificial Life
IEEE Transactions on Robotics
IEEE Robotics and Automation Magazine
Conference proceedings: *RSS*, *ICRA*, *IROS*, *RoboSoft*, *GECCO*, *ALife*

ADVISING

PHD’S

2020 [Kathryn Walker](#): Modular soft robots.
2019– [Caitlin Grasso](#): Awarded a NSF GRFP to study Xenobots.

MASTERS

2020– [David Matthews](#): Differentiable physics.
2020–2021 [Sida Liu](#): Multi-robot reinforcement learning.
2018 Shawn Beaulieu: Developmental robotics.

UNDERGRADS

2018–2020 [David Matthews](#): Symbol grounding.

INVITED TALKS

- [April 4] “Simulating xenobots and xenohybrid machines.”. [Workshop on software for soft robotics research](#).
[April 4] “Sim2real for biological robots”. [Workshop on soft robot design optimization](#).
Mar, 2022 “From Biology to Bots and Back”. [CS Colloquium](#), Northwestern University.
Feb, 2022 “Computer-designed organisms”. [Leonardo Art Science Evening Rendezvous](#), Stanford University.
Feb, 2022 “Fractal robots”. Evolutionary and Learning Machines Group, Vrije Universiteit Amsterdam.
- 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

- 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, 2022 “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 “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.