

Sam Kriegman

Curriculum Vitae

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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

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

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 (*in press*).
Biological underpinnings of lifelong learning machines.
Nature Machine Intelligence, 4.
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, 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. 63/261,258
pending “Engineered Multicellular Organisms”. US PCT/US2021/013105.

SERVICE

2021 Co-organizing, Computational design of soft robots workshop [*in review*]
2019– Co-developer, [Voxcraft](#): a low-cost, open-source soft robot kit for ages 12+
2017– Co-organizer, [Virtual Creatures Competition](#): an exhibition of simulated artificial life.

EDITORSHIPS

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

REVIEWER

The American Naturalist
Artificial Life
IEEE Transactions on Robotics
IEEE Robotics and Automation Magazine
The International Journal of Robotics Research
Frontiers in Robotics and AI
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

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

UNDERGRADS

2018– [David Matthews](#): Differentiable physics.

INVITED TALKS

invited [Apr, 2022] “Sim2real for biological robots”. [Workshop on soft robot design optimization.](#)

- invited* [Feb, 2022] “Computer-designed organisms”. [Leonardo Art Science Evening Rendezvous \(LASERs\)](#).
invited [Feb, 2022] “Fractal robots”. Evolutionary and Learning Machines Meetup.
- 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”. 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*.

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 “[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.