

## Sam Kriegman

## Curriculum Vitae

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### APPOINTMENTS

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- 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

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- 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

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- 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

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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.

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#### 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).  
[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 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

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*pending* “Engineered Multicellular Organisms and the Kinematic Self-Replication Thereof”. App. No. 63/261,258  
*pending* “Engineered Multicellular Organisms”. US PCT/US2021/013105.

#### SERVICE

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2022 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

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##### 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

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- [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](#).  
Feb, 2022 “Computer-designed organisms”. *Leonardo Art Science Evening Rendezvous*, Stanford University.  
Feb, 2022 “Fractal robots”. 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”. 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

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- 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.