Sam Kriegman **Curriculum Vitae**

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APPOINTMENTS

2021– **Postdoctoral Fellow**, Wyss Institute for Biologically Inspired Engineering
Harvard University
Advisor: Michael Levin

2021– **Postdoctoral Fellow**, Allen Discovery Center
Tufts University
Advisor: Michael Levin

2020–2021 **Postdoctoral Associate**, Vermont Complex Systems Center
University 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

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

8. S Kriegman, D Blackiston, M Levin, J Bongard. (*in press*).
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).

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

pending "Kinematic Self Replication in Engineered Multicellular Organisms". App. No. 63/261,258
pending "Engineered Multicellular Organisms". US PCT/US2021/013105.

SERVICE

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

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

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

Nov, 2021 "Living robots made in a lab have found a new way to self-replicate, researchers say". *NPR*
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 "Mesmerizing Video Shows How Tiny 'Living Robot' Xenobot Cells Reproduce". *Newsweek*
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 "Giant Moon rocket, living robots and quantum computer – January's best science images". *Nature*
Feb, 2020 "Tiny machines made from the stem cells of frogs". *The Intelligence (Economist Radio)*
Feb, 2020 "Meet the Xenobot, the World's First-Ever 'Living' Robot". *Seeker*
Jan, 2020 "The religious, moral, and ethical implications of Xenobots". *BBC Radio 4 Sunday*
Jan, 2020 "A research team builds robots from living cells". *The Economist*
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 the announcement of Xenobots.