

# Eran Agmon, Ph.D.

## Research & Teaching Interests

- Computational systems biologist trained in mathematical modeling, machine learning, and complex systems.
- Published models at several scales of biological phenomena including molecular dynamics, metabolic networks, lipid membranes, whole cells, microbial colonies, neural systems, and organisms in dynamic environments.
- Interested in applying multiscale modeling and machine learning to map and interpret complex biological data, simplify the integration of diverse models, and speed up the rate of scientific discovery.

## Education and Training

- 2017–present **Postdoctoral Research Fellow**, *Department of Bioengineering, Stanford University.*  
NIH F32 Postdoctoral Fellowship
- 2016–2017 **Postdoctoral Research Scientist**, *Department of Biological Sciences, Columbia University.*
- 2016 **Joint Ph.D., Informatics and Computing (complex systems track), and Cognitive Science**,  
*Indiana University.*  
NSF IGERT Fellowship, Dynamics of Brain-Body-Environment Systems
- 2011 **M.Sc., Systems Science**,  
*Portland State University.*
- 2009 **B.S., Cognitive Science (minor in Biology)**,  
*University of California, San Diego.*

## Research Experience

- 2018–present **Integrative, multi-scale modeling in computational biology**, *Stanford University*  
*Advisor: Markus W. Covert,*  
• I led the development of Vivarium – a software tool that can make any mechanistic model into a module that can be wired together in multi-scale composite models.
- 2017–present **Whole-cell model of *Escherichia coli***, *Stanford University*  
*Advisor: Markus W. Covert,*  
• I worked with computational modelers, software engineers, and experimentalists to build the most comprehensive computational model of *E. coli* in the world.
- 2016–2017 **Molecular model of membranes, lipid homeostasis, and cell death**, *Columbia University,*  
*Advisor: Brent R. Stockwell,*  
• I developed a coarse-grained molecular model of lipid membrane composition associated with a type of cell death called ferroptosis. This predicted the deformation and degradation of the membrane, which was later experimentally validated by collaborators.
- 2013–2016 **Artificial protocell model (dissertation research)**, *Indiana University,*  
*Committee: Randall D. Beer (chair), Colin Allen, Peter M. Todd, James A. Glazier,*  
• I developed a spatial model of a protocell that emerges from the co-construction of metabolism and membrane. I applied a perturbation-based analysis to quantify the simulated cells' robustness, plasticity, fragility, and viability.

- 2015 **Cellular model of tumor progression**, *Indiana University*,  
 Sponsor: Amit Hagar,  
 • Worked on a Cellular Potts model of tumors cells and their environments, focusing on the altered metabolic state known as the Warburg effect.
- 2011-2013 **Computational model of action-switching agents**, *Indiana University*,  
 Advisor: Randall D. Beer,  
 • I built a computational model to investigate the dynamics of embedded agents that can autonomously switch between actions, and applied a genetic algorithm for parameter search.
- 2011 **Spiking neural model of sensory processing**, *Portland State University*,  
 Advisor: Patrick Roberts,  
 • Built a spiking neural model of sensory processing in the electroreception of Mormyrid electric fish, which demonstrated their adaptive response to changing environments.

## Publications

### Manuscripts in preparation and under review

Hickey, J.W., **Agmon, E.**, Covert, M.W., and Nolan, G.P. (in preparation). Integration of CODEX imaging with agent-based models of tumor/t-cell interactions.

**Agmon, E.**, Spangler, R.K., Skalnik, C.J., Poole, W., Morrison, J.H., Peirce, S.M., and Covert, M.W. (in review). Vivarium: an interface and engine for integrative multi-scale modeling in computational biology.

Skalnik, C.J., **Agmon, E.**, Spangler, R.K., Talman, L., Morrison, J.H., Peirce, S.M., and Covert, M.W. (in review). Whole-Colony Modeling of *Escherichia coli*.

### Journal publications

11. Covert, M.W., Gillies, T.E., Kudo, T., and **Agmon, E.** (2021). A forecast for large-scale, predictive biology: lessons from meteorology. *Cell Systems*, 12: 6.
10. **Agmon, E.**, and Spangler, R.K. (2020). A multi-scale approach to modeling *E. coli* chemotaxis. *Entropy*, 22: 1101.
9. Macklin, D.N., Ruggero, N.A., Carrera, J., Choi, H., Horst, T.A., Mason, J.C., Sun, G., **Agmon, E.**, DeFelice, M.M., Maayan, I., Lane, K., Spangler, R.K., Gillies, T.E., Paull, M.L., Akhter, S., Bray, S.R., Weaver, D.S., Keseler, I.M., Karp, P.D., Morrison, J.H., and Covert, M.W. (2020). Simultaneous cross-evaluation of heterogeneous *E. coli* datasets via mechanistic simulation. *Science*, 369, eaav3751.
8. Talman, L., **Agmon, E.**, Peirce, S.M., and Covert, M.W. (2019). Multiscale models of infection. *Current Opinion in Biomedical Engineering*, 11, 102-108.
7. **Agmon, E.**, Solon, J., Bassereau, P., and Stockwell, B.R. (2018). Modeling the effects of lipid peroxidation during ferroptosis on membrane properties. *Scientific Reports*, 8(1): 5155.
6. **Agmon, E.** and Stockwell, B.R. (2017). Lipid homeostasis and regulated cell death. *Current Opinion in Chemical Biology*. 39: 83-89.
5. **Agmon, E.**, Gates, A.J., and Beer, R.D. (2016). The structure of ontogenies in a model protocell. *Artificial Life* 22 (4): 499-517.
4. Taylor, T., Bedau, M. A., Channon, A., et al. (2016). Open-Ended Evolution: Perspectives from the OEE1 Workshop in York. *Artificial Life* 22 (3): 408-423.
3. **Agmon, E.**, Gates, A.J., Churavy, V. and Beer, R.D. (2016). Exploring the space of viable configurations in a model of metabolism-boundary co-construction. *Artificial Life*, 22 (2): 153-171.
2. **Agmon, E.**, & Beer, R. D. (2014). The evolution and analysis of action switching in embodied agents. *Adaptive Behavior*, 22(1), 3-20.

1. **Agmon, E.** (2014). Action Switching in Brain-Body-Environment Systems. In *Guided Self-Organization: Inception* (pp. 295-318). Springer Berlin Heidelberg.

### Selected Proceedings

5. Covert, M.W., and **Agmon, E.** (2019). Building whole-cell computational models to predict cellular phenotypes and accelerate discovery. *Proceedings of the Solvay Conference in Chemistry*.
4. **Agmon, E.**, Glazier, J.A, and Beer, R.D. (2017). Structural Coupling of a Potts Model Cell. *Proceedings of the 14th European Conference on Artificial Life 2017*, (pp. 13-20). MIT Press.
3. Virgo, N., **Agmon, E.**, and Fernando, C. (2017). Lineage selection leads to evolvability at large population sizes. *Proceedings of the Fourteenth European Conference on Artificial Life*, (pp. 420-427). MIT Press.
2. **Agmon, E.**, Gates, A.J., and Beer, R.D. (2015). Ontogeny and adaptivity in a model protocell. In P. Andrews, L. Caves, R. Doursat, S. Hickinbotham, F. Polack, S. Stepney, T. Taylor & J. Timmis (Eds.), *Proceedings of the European Conference on Artificial Life 2015* (pp. 216-223). MIT Press. **[Winner of Best Paper Award]**
1. **Agmon, E.**, Gates, A.J., Churavy, V. and Beer, R.D. (2014). Quantifying robustness in a spatial model of metabolism-boundary co-construction. In H. Sayama, J. Rieffel, S. Risi, R. Doursat & H. Lipson (Eds.), *Artificial Life 14: Proceedings of The Fourteenth International Conference on the Synthesis and Simulation of Living Systems* (pp. 514-521). MIT Press.

### Teaching and Mentorship

- 2017-present **Research Mentor**, *Stanford University*,  
 • I mentored several Stanford undergraduates and PhD students in whole-cell modeling projects that involved sophisticated software design, and was carried out by weekly meetings in which I reviewed the students' code, taught systems biology methods, and developed collaborative coding practices.
- 2020 **Co-instructor**, *Build-A-Cell Chemical Reaction Network modeling tutorials*.
- 2019 **Mentor**, *Stanford International Genetically Engineered Machine (iGEM) competition*.
- 2014, 2016 **Associate Instructor**, *Indiana University*,  
 Course: Autonomous Robotics.
- 2013 **Associate Instructor**, *Indiana University*,  
 Course: Brains & Minds, Robots & Computers.

### Other Affiliations

- 2021 **Research Affiliate**, *Center for the Emergence of Life, NASA Ames Research Center, Moffett Field, CA*,  
 • Consulted on machine learning approaches to modeling RNA function and selection at the origin of life.
- 2016–2017 **Visiting Scholar**, *Program in Interdisciplinary Studies, Institute for Advanced Study, Princeton, NJ*,  
 • Co-founded YHouse, a research institute focused on artificial intelligence and the science of awareness.
- 2017 **Visitor**, *Earth-Life Science Institute Origins Network, Tokyo Institute of Technology, Tokyo, Japan*,  
 • Worked with an interdisciplinary group of scientists to model molecular evolution at the origins of life.

### Selected Presentations

- Aug. 2020 **"Vivarium: an interface and engine for multi-scale modeling in computational biology"** *Build-A-Cell workshop*, NIST, Gaithersburg, MD.
- Feb. 2020 **"A multi-scale platform for whole-cells and colonies"** *Basement seminar*, Stanford Bioengineering Department.
- Sep. 2017 **"Structural coupling of a Potts model cell,"** *14th European Conference on Artificial Life*, Lyon, France.
- Mar. 2017 **"Computational models of heterogeneous lipid membranes,"** *Frontiers in Computing Systems*, Columbia University, NY.
- Feb. 2017 **"Simulations of Ferroptosis,"** *p53 Multi-Group meeting*, Columbia University, NY.
- July 2016 **"The biological foundations of enactivism,"** *Workshop on the Biological Foundations of Enactivism*, at *Artificial Life 16*, Cancun, Mexico.
- October 2015 **"Ontogeny and adaptivity in a model protocell,"** *Evolutionary Systems Biology Lab. Albert Einstein College of Medicine*, New York, NY.
- October 2015 **"Action switching in embodied, dynamical agents,"** *Workshop on Self-organization in brain-body-environment systems*, University of Cincinnati, OH.
- December 2014 **"The physiology and metabolic closure of organisms,"** *Workshop on the causal factors of robustness and plasticity in living systems*, Bloomington, IN.

### Posters

- January 2020 **"A simulation platform for whole-cell/whole-colony modeling,"** *Build-A-Cell workshop*, NASA Ames, Mountain View, CA.
- August 2019 **"Adding an environment and motility to a large-scale model of *Escherichia coli*,"** *qBio*, San Francisco, CA.
- March 2018 **"Towards a whole-cell model of *E. coli*,"** *Allen Discovery Center*, Stanford, CA.
- Jan. 2017 **"The structure of ontogenies in a model protocell,"** *Expanding Views on the Emergence of the Biosphere*, Tokyo Institute of Technology, Tokyo, Japan.

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### Fellowships and Awards

- 2020 NIH F32 Postdoctoral Fellowship
- 2017 Outstanding Dissertation Award, Indiana University Cognitive Science
- 2015 Best Paper Award, European Conference on Artificial Life
- 2015 1st Place Poster, IGERT Research Showcase
- 2014-2015 NSF IGERT Fellowship in the Dynamics of Brain-Body-Environment Systems
- 2014 Outstanding Teaching Award, Indiana University Cognitive Science
- 2014 1st Place Poster, IGERT Research Showcase
- 2014 Cognitive Science Supplemental Research Fellowship
- 2013 2nd Place Poster, IGERT Research Showcase
- 2011-2015 NSF IGERT Fellowship in the Dynamics of Brain-Body-Environment Systems

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### Selected Workshops and Seminars

- September 2017 Agency in the Physical Sciences, at the European Conference on Artificial Life 17. Lyon, France
- March 2017 Frontiers in Computing Systems. Columbia University
- February 2017 p53 P01 Multi-Group meeting. Columbia University
- January 2017 Expanding Views on the Emergence of the Biosphere: 5th ELSI International Symposium. Tokyo Institute of Technology
- July 2016 The Biological Foundations of Enactivism, at Artificial Life 16. Cancun, Mexico

November 2015	Re-conceptualizing the Origins of Life. Carnegie Institution for Science, Washington D.C.
October 2015	Self-organization in brain-body-environment systems. University of Cincinnati
August 2015	Towards an Integrative Approach to the Study of Awareness. Kobe University, Japan
December 2014	The Causal Factors of Robustness and Plasticity in Living Systems. Indiana University
July 2013	Adaptivity workshop. University of the Basque Country

## Professional Service

Reviewer	IEEE International Conference on Bioinformatics & Biomedicine (BIBM), 2019.
Program cmt	International Conference on Complex Systems (ICCS), 2018.
Associate Editor	Journal of Adaptive Behavior, 2016-present.
Program cmt	Conference on Complex Systems, 2017.
Organizer	Workshop on Agency in the Physical Sciences, at the ECAL 17, September 2017.
Organizer	The Biological Foundations of Enactivism, at Artificial Life 16, July 2016.
Program cmt	Conference on Artificial Life, 2016-2020.
Reviewer	Artificial Life Journal, 2015-present.
Organizer	E-cog: weekly meeting on Embodied, Embedded, and Enactive approaches in Cognitive Science, 2013-2015.
Organizer	Causal Factors of Robustness and Plasticity in Living Systems, 2014.
Organizer	Apophenia: weekly discussions of Complex Systems and Cognitive Science, 2012-2013.
Organizer	IGERT faculty lunches, 2011-2012.