**BIOGRAPHICAL SKETCH**

Provide the following information for the Senior/key personnel and other significant contributors.
Follow this format for each person. **DO NOT EXCEED FIVE PAGES**.

NAME: Dolson, Emily

eRA COMMONS USER NAME (credential, e.g., agency login): dolsone

POSITION TITLE: Postdoctoral Fellow

EDUCATION/TRAINING (*Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.*)

| INSTITUTION AND LOCATION | DEGREE (*if applicable*) | Completion Date MM/YYYY | FIELD OF STUDY |
|---|---|---|---|
| Swarthmore College | B.A | 05/2013 | Biology and Computer Science |
| Michigan State University | Graduate Certificate | 12/2016 | Spatial Ecology |
| Michigan State University | Ph.D. | 05/2019 | Computer Science & Engineering and Ecology, Evolutionary Biology, & Behavior |
| Cleveland Clinic | Postdoctoral | 08/2020 | Translational Hematology and Oncology Research |

**A. Personal Statement**

My highly interdisciplinary background makes me ideally suited to coming up with novel solutions to open problems in medical research. I am fascinated by the question of how we can control the evolution of a wide range of ecological communities. Previously, I have used my knowledge of computer science and ecological and evolutionary theory to advance the current understanding of why evolution-based machine learning algorithms work the way they do and how we can improve them. I have also used these machine learning algorithms as a model system for testing out new ecology and evolutionary theory to apply to biology. By working with a digital system, I can perform experiments that would be impossible *in vitro* or *in vivo*. In particular I have studied the effects of spatial heterogeneity (in micro-environment and in mortality rate) on long-term evolutionary trajectories. Additionally, I have developed techniques for quantifying the mode of evolution in complex ecological communities. Now, I'm applying this work to understanding the process by which cancer evolves resistance to therapy. Because cancer involves a complex ecosystem of cells living in a spatially heterogeneous environment, I am well-situated to help tackle this problem.

Note that many of my publications are in computer science conferences. In computer science, conferences are peer-reviewed and respected venues for publishing scientific findings.


1. Dolson, E.L. & Ofria, C.A. (2017). Spatial resource heterogeneity creates local hotspots of evolutionary potential. European Conference on Artificial Life, 122–29. Lyon, France. MIT Press.

2. Dolson, E.L., Lalejini, A.M., Jorgensen, S.P. & Ofria, C.A. (In press). Interpreting the tape of life: Ancestry-based analyses provide insights and intuition about evolutionary dynamics. Artificial Life Journal. MIT Press.

3. Dolson, E.L., Wiser, M.J. & Ofria, C.A. (2016). The effects of evolution and spatial structure on diversity in biological reserves. The Fifteenth International Conference on Artificial Life, 434–440. Cancun, Mexico.

MIT Press.

## B. Positions and Honors

### Positions and Employment

| | |
|---|---|
| 2013 | Fink Fellow, Hubbard Brook Experimental Forest, North Woodstock, NH |
| 2013 – 2019 | PhD Student, BEACON Center for Evolution in Action, Michigan State University, East Lansing, MI |
| 2019 – | Postdoctoral Fellow, Translational Hematology and Oncology Research, Cleveland Clinic, OH |

### Other Experience and Professional Memberships

| | |
|---|---|
| 2014 – | Member, Association for Computing Machinery |
| 2014 – | Member, International Society for Artificial Life |
| 2016 – | Chair, International Society for Artificial Life Student and Post-doc Group |

### Honors

| | |
|---|---|
| 2019 | Outstanding Student Publication Award, International Society for Artificial Life |
| 2019 | Exceptional Service Award, International Society for Artificial Life |
| 2017 | Outstanding Service Award, Michigan State University Department of Computer Science and Engineering |
| 2013 – 2018 | University Distinguished Fellowship, Michigan State University |
| 2014 – 2018 | NSF Graduate Research Fellowship |
| 2013 | B.A. awarded with honors, Swarthmore College |

## C. Contribution to Science

1. **Quantifying evolutionary processes:** Computational evolution platforms provide us with perfect information about the exact steps that lead up to a given large-scale evolutionary outcome. However, evolution is a noisy process involving a high degree of stochasticity. As a result, extracting insight from the vast quantity of data that computational systems provide requires novel approaches to measurement. I have developed a range of methodological tools for interpreting such data. Specifically, **I have developed two suites of metrics and data visualizations**: one aimed at aggregating the micro-events in the evolutionary process into interpretable patterns, and one aimed at screening for high-level evolutionary patterns. All of these metrics are based on analysis of phylogenies, and so can easily be translated to non-computational systems as well.

    a. **Dolson, E.L.**, Vostinar, A.E., Wiser, M.J. & Ofria, C.A. (2019). The MODES toolbox: Measurements of Open-Ended Dynamics in Evolving Systems. *Artificial Life*. 25(1), 50 – 73.
    b. **Dolson, E.L.**, Lalejini, A.M., Jorgensen, S.P. & Ofria, C.A. (In press). Interpreting the tape of life: Ancestry-based analyses provide insights and intuition about evolutionary dynamics. *Artificial Life*.
    c. **Dolson, E.L.**, Lalejini, A.M. & Ofria, C.A. (2019). Exploring genetic programming representations with MAP-Elites. In *Genetic Programming in Theory and Practice XVI*. Springer.
    d. Wiser, M.J., **Dolson, E.L.**, Vostinar, A.E., Lenski, R.E., & Ofria, C.A. (2018). The Boundedness Illusion: Asymptotic projections from early evolution underestimate evolutionary potential. *PeerJ Preprints*.

2. **Evolutionary trajectories in spatially heterogeneous environments:** Most populations in the real world exist in spatially heterogeneous environments (i.e. environments in which different regions of space are unique). This reality contrasts with the homogeneous environments used in most theoretical work. Using computational model systems, I have laid the groundwork for extending eco-evolutionary theory to a spatially heterogeneous context. In particular, I have showed that **spatial heterogeneity influences the evolutionary trajectory** that a population takes through the space of possible genotypes. Thus, it is theoretically possible to use landscape composition as a tool for controlling the outcome of evolution.

    a. **Dolson, E.L.** & Ofria, C.A. (2017). Spatial resource heterogeneity creates local hotspots of evolutionary potential. European Conference on Artificial Life, 122–29. Lyon, France. MIT Press.

b. **Dolson, E.L.,** Wiser, M.J. & Ofria, C.A. (2016). The effects of evolution and spatial structure on diversity in biological reserves. The Fifteenth International Conference on Artificial Life, 434–440. Cancun, Mexico. MIT Press.
c. **Dolson, E.L.** Perez, S.A., Olson, R.S., & Ofria, C.A. (2017). Spatial resource heterogeneity increases diversity and evolutionary potential. *bioRxiv*. doi:10.1101/148973

3. **Improving evolutionary computation with eco-evolutionary dynamics:** Evolutionary computation is a machine learning technique that uses evolutionary dynamics to find solutions to computational problems. I have **demonstrated that it is mathematically identical to many models of biological evolution and ecology**. In so doing, I have laid the groundwork for improving the state of the art of evolutionary computation through the application of theory developed in biology. Simultaneously, I have shown that we can effectively use evolutionary computation research as a source of pilot data for evolutionary theory research. The field of evolutionary computation has a wealth of well-understood and non-trivial fitness landscapes, making it particularly well-suited as a model system for research on steering evolving ecological communities.

a. **Dolson, E.L.**, Banzhaf, W. & Ofria, C.A. (2018). Ecological Theory Provides Insights about Evolutionary Computation. *PeerJ Pre-prints*.
b. **Dolson, E.L.**, Banzhaf, W. & Ofria, C.A. (2018). Applying ecological principles to genetic programming. In *Genetic Programming in Theory and Practice XV*. Springer.
c. Hernandez, J.G., Lalejini, A.M., **Dolson, E.L.**, & Ofria, C.A. (2019). Random subsampling improves performance in lexicase selection. *GECCO '19 Companion: Genetic and Evolutionary Computation Conference*. Prauge, Czech Republic. ACM.

**Complete List of Published Work in MyBibliography:**

https://www.ncbi.nlm.nih.gov/myncbi/emily.dolson.1/bibliography/public/

## D. Research Support and Scholastic Performance

**Completed Research Support**

BEACON Center for Evolution in Action Internal Grant Ofria (PI) 09/01/18–3/31/19
Synthesizing Concepts within Evolution in Action
The goal of this project was the creation of an interdisciplinary synthesis paper on population diversity in evolution. The resulting work brings together perspectives on diversity from researchers in ecology, evolutionary biology, and evolutionary computation.
Role: Helped write, supported by

BEACON Center for Evolution in Action Internal Grant Ofria (PI) 09/01/17–3/31/19
Harnessing Eco-Evolutionary Dynamics for Open-Ended Evolution of Intelligence
The goal of this project was to solidify the theoretical basis of evolutionary computation algorithms by importing eco-evolutionary theory from biology.
Role: Helped write, supported by

**Scholastic Performance**

| YEAR | COURSE TITLE | GRADE |
|---|---|---|
| | MICHIGAN STATE UNIVERSITY | |
| 2013 | Advanced Computer Architecture | 4.0 |
| 2013 | Population and Community Ecology | 4.0 |
| 2014 | Multi-disciplinary Research Methods for the Study of Evolution | 4.0 |
| 2014 | Selection Topics in Computer Science: Large-scale Data Analysis | 4.0 |
| 2014 | Evolutionary Biology | 3.5 |
| 2014 | Evolutionary Computation | 4.0 |

| | | |
|---|---|---|
| 2014 | Statistical Methods for Ecology and Evolution | 4.0 |
| 2014 | Selected Topics in Plant Biology: Teaching Biology | 4.0 |
| 2015 | Design and Theory of Algorithms | 4.0 |
| 2015 | Landscape Ecology | 4.0 |
| 2015 | Spatial Ecology | 4.0 |
| 2015 | Spatial Data Analysis | 4.0 |

Level required for a passing grade: 2.0 or above