



# Matthew Andres Moreno

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## Education

*Dual Ph.D.*, in Computer Science and Ecology, Evolutionary Biology, & Behavior (GPA: 4.0/4.0) Expected: December 2022

Research Advisor: Dr. Charles Ofria

Michigan State University, East Lansing, MI

*Bachelors of Science* in Mathematics, Computer Science (GPA: 3.96/4.0) May 2017

Minor in Chemistry

University of Puget Sound, Tacoma, WA

## Skills

*Programming Languages:* Python, C, C++

*Miscellaneous:* L<sup>A</sup>T<sub>E</sub>X, Git, HTML/CSS, Docker, Jekyll, Sphinx

## Projects and Research Experience

Digital Evolution Laboratory — Michigan State University, East Lansing, MI

Summer 2017 — present

- *Graduate Student*

- Advisor: Dr. Charles Ofria

- Dissertation Committee: Dr. Charles Ofria, Dr. Emily Dolson, Dr. Bill Punch, Dr. Wolfgang Banzhaf

- Dissertation: “Understanding the Role of Major Transitions in the Evolution of Biological Complexity”

Otis C. Chapman Honors Thesis — University of Puget Sound, Tacoma, WA

Fall 2016, Spring 2017

- *Student Researcher*

- Conducted a review of evolutionary computing literature and synthesize a theoretical analysis of evolvability in collaboration with advisor Dr. America Chambers and reader Dr. Adam Smith

- Performed computational experiments with Genetic Regulatory Network models to probe the relationship between phenotypic plasticity and evolvability.

- Prepared and delivered general-audience oral presentations at NW Honors Symposium and at the University of Puget Sound.

Mathematical Biosciences Institute (MBI) Research Experience for Undergraduates — Newark, NJ

Summer 2016

- *Student Researcher*

- Designed and numerically evaluated an individual-based set of differential equations to model the foraging behavior of ants over uneven terrain, analyzed predictions of the model over various experimental conditions.

- Collaborated with advisors Dr. Jason Graham and Dr. Simon Garnier in the Swarm Lab at the New Jersey Institute of Technology to develop and execute project.

- Prepared and delivered oral and poster presentations at a capstone conference in Columbus, Ohio.

- Participated in seminars and workshops on mathematical biology coordinated by MBI at The Ohio State University.

COMAP Mathematical Contest in Modeling — Tacoma, WA

Spring 2015, 2016, 2017

- *Contest Participant*

- Collaborated in a small team of three students for four days to develop a mathematical model in response to a prompt.

- Communicated results in a journal-style paper describing our model and outlining recommendations to policy makers.

- In 2017, developed a model of vehicular traffic in the greater Seattle area to assess the impact of self-driving cars on commuter travel delays. Our model predicted that, in certain areas, designating lanes for exclusive use of autonomous would become advantageous once these vehicles constitute approximately 5% of traffic volume. Our team received a “Finalist” designation in the competition, ranking among the top 11 of 1,527 participating teams.

- In 2016, developed a model of satellite fragmentation events and the subsequent disbursement of debris in orbit to investigate the feasibility of quick-response efforts to neutralize debris generated by satellite explosions and collisions; our model suggested that, although technically feasible, such efforts would be economically impractical without a significant reduction in launch costs. Our team received received an “Honorable Mention” designation in the competition.

- In 2015, developed an epidemiological model to investigate the spread of Ebola virus disease and make recommendations on vaccine distribution; our model suggested that regional travel restrictions would not significantly curb the Ebola epidemic in West Africa and that efficient distribution of any vaccination should be prioritized over uniform or widespread distribution.

NASA Undergraduate Research Scholarship — Tacoma, WA

Summer 2015

- *Student Researcher*

- Designed, applied for grant funding, and carried out project to develop algorithms for automated extraction of mouse ultrasonic vocalizations from noisy recordings in collaboration with advisor Dr. Adam Smith.

- Developed and tested filtering algorithms inspired by the Sobel Edge detection method that, after being trained on human-annotated spectrograms of mouse vocalizations, distinguish between true mouse vocalization signals and background noise, achieving 75% accuracy at 25% recall.

- Presented results and methodology at a poster session on campus attended by faculty, summer research students, and other students.

US Department of Agriculture Horticultural Crops Research Unit — Corvallis, OR

Jun. 2013 – Jun. 2017

- *Biological Science Aide*

- Collected data for patent applications, performed plant propagation, assisted with field maintenance.

John Fowler Laboratory at Oregon State University — Corvallis, OR

Summer 2011, 2012

- *Laboratory Assistant*

- Performed experimental inquiry into the role of the exocyst complex in *Arabidopsis thaliana* culminating in a symposium presentation.

## Publications

### Journal Publications

Matthew Andres Moreno, Alexander Lalejini, & Charles Ofria. (In Press). Matchmaker, matchmaker, make me a match: Geometric, variational, and evolutionary implications of criteria for tag affinity. *Genetic Programming and Evolvable Machines* [↗](#)

Matthew Andres Moreno, Emily Dolson, & Charles Ofria. (Under Revision). hstrat: a Python Package for phylogenetic inference on distributed digital evolution populations. *Journal of Open Source Software* [↗](#)

Matthew Andres Moreno, & Charles Ofria. (2022). Exploring evolved multicellular life histories in an open-ended digital evolution system. *Frontiers in Ecology and Evolution*, 10. <https://doi.org/10.3389/fevo.2022.750837> [↗](#)

Alexander Lalejini, Matthew Andres Moreno, & Charles Ofria. (2021). Tag-based regulation of modules in genetic programming improves context-dependent problem solving. *Genetic Programming and Evolvable Machines*, 22(3), 325–355. <https://doi.org/10.1007/s10710-021-09406-8> [↗](#)

Matthew Andres Moreno, & Charles Ofria. (2019). Toward Open-Ended Fraternal Transitions in Individuality. *Artificial Life*, 25(2), 117–133. [https://doi.org/10.1162/artl.a\\_00284](https://doi.org/10.1162/artl.a_00284) [↗](#)

Rex A Cole, Valera V Peremyslov, Savannah Van Why, Ibrahim Moussaoui, Ann Ketter, Renee Cool, Matthew Andres Moreno, Zuzana Vejlupekova, Valerian V Dolja, & John E Fowler. (2018). A broadly conserved NERD genetically interacts with the exocyst to affect root growth and cell expansion. *Journal of Experimental Botany*, 69(15), 3625–3637. <https://doi.org/10.1093/jxb/ery162> [↗](#)

### Conference Papers

Matthew Andres Moreno, Emily Dolson, & Charles Ofria. (2022). *Hereditary Stratigraphy: Genome Annotations to Enable Phylogenetic Inference over Distributed Populations* [64], Vol. ALIFE 2022: The 2022 Conference on Artificial Life. 64. [https://doi.org/10.1162/isal.a\\_00550](https://doi.org/10.1162/isal.a_00550) [↗](#)

Matthew Andres Moreno, Wolfgang Banzhaf, & Charles Ofria. (2018). Learning an evolvable genotype-phenotype mapping, In *Proceedings of the genetic and evolutionary computation conference*, Kyoto, Japan, Association for Computing Machinery. <https://doi.org/10.1145/3205455.3205597> [↗](#)

### Workshop Papers

Matthew Andres Moreno, Santiago Rodriguez Papa, & Charles Ofria. (2021a). Case study of novelty, complexity, and adaptation in a multicellular system, In *Ooe4: The fourth workshop on open-ended evolution*, Prague, Czech Republic [↗](#)

Matthew Andres Moreno, Santiago Rodriguez Papa, & Charles Ofria. (2021b). Conduit: A c++ library for best-effort high performance computing, In *Proceedings of the genetic and evolutionary computation conference companion*, Lille, France, Association for Computing Machinery. <https://doi.org/10.1145/3449726.3463205> [↗](#)

Matthew Andres Moreno, Santiago Rodriguez Papa, & Charles Ofria. (2021c). Conduit: A c++ library for best-effort high performance computing, In *The 6th international workshop on modeling and simulation of and by parallel and distributed systems (msps 2020)*, Barcelona, Sapin [↗](#)

Matthew Andres Moreno, & Charles Ofria. (2018). Understanding fraternal transitions in individuality, In *Ooe3: The third workshop on open-ended evolution*, Tokyo, Japan [↗](#)

### Extended Abstracts

Matthew Andres Moreno, Emily Dolson, & Charles Ofria. (2022). Hereditary stratigraphy: Genome annotations to enable phylogenetic inference over distributed populations, In *Proceedings of the genetic and evolutionary computation conference companion*, Boston, Massachusetts, Association for Computing Machinery. <https://doi.org/10.1145/3520304.3533937> [↗](#)

### Preprints

Matthew Andres Moreno, Santiago Rodriguez Papa, Alexander Lalejini, & Charles Ofria. (2021). Signalgp-lite: Event driven genetic programming library for large-scale artificial life applications. arXiv. <https://doi.org/10.48550/ARXIV.2108.00382> [↗](#)

Matthew Andres Moreno, & Charles Ofria. (2022). Best-effort communication improves performance and scales robustly on conventional hardware. arXiv. <https://doi.org/10.48550/ARXIV.2211.10897> [↗](#)

## Presentations

### Contributed Talks

Matthew Andres Moreno, Emily Dolson, and Charles Ofria. *Hereditary Stratigraphy: Genome Annotations to Enable Phylogenetic Inference over Distributed Digital Evolution Populations*. ALIFE, Trento, Italy. July 2022.

Matthew Andres Moreno, Emily Dolson, and Charles Ofria. *Hereditary Stratigraphy: Genome Annotations to Enable Phylogenetic Inference over Distributed Digital Evolution Populations*. Evolution, Cleveland, OH. June 2022.

Matthew Andres Moreno, Emily Dolson, and Charles Ofria. *Hereditary Stratigraphy: Genome Annotations to Enable Phyloge-*

- netic Inference over Distributed Digital Evolution Populations*. The Sixth Annual Ecology, Evolution, & Behavior Research Symposium, East Lansing, MI. May 2022.
- Matthew Andres Moreno, Santiago Rodriguez Papa, and Charles Ofria. *Case Study of Novelty, Complexity, and Adaptation in a Multicellular System*. BEACON Congress, East Lansing, MI. August 2021
- Tait Weicht, Matthew Andres Moreno, and Charles Ofria. *Moving scientific computation into the browser*. BEACON Congress, East Lansing, MI. August 2021.
- Santiago Rodriguez Papa, Matthew Andres Moreno, Alexander Lalejini, and Charles Ofria. *SignalGP-Lite: Event Driven Genetic Programming Library for Large-Scale Artificial Life Applications*. BEACON Congress, East Lansing, MI. August 2021.
- Charles Ofria, Emily Dolson, and Matthew Andres Moreno. *Empirical: A Scientific Software Library for Research, Education, and Public Engagement*. BEACON Congress, East Lansing, MI. August 2021.
- Matthew Andres Moreno. *Lessons Learned Administering a Summer Workshop*. BEACON Congress, East Lansing, MI. August 2021.
- Matthew Andres Moreno, Santiago Rodriguez Papa, and Charles Ofria. *Case Study of Novelty, Complexity, and Adaptation in a Multicellular System*. The Fourth Workshop on Open-Ended Evolution (OEE4) at ALIFE, Prague, Czech Republic. July 2021.
- Matthew Andres Moreno, Santiago Rodriguez Papa, and Charles Ofria. *Conduit: A C++ Library for Best-effort High Performance Computing*. ACM Workshop on Parallel and Distributed Evolutionary Inspired Methods (PDEIM) at GECCO, Lille, France. July 2021.
- Matthew Andres Moreno and Charles Ofria. *Spatial constraints and kin recognition can produce major evolutionary transitions in individuality*. BEACON Congress, East Lansing, MI. August 2020.
- Alexander Lalejini, Matthew Andres Moreno, and Charles Ofria. *Evolving Signal-driven Digital Organisms with SignalGP*. Evolution of Complex Life Conference, Atlanta, GA. May 2019.
- Matthew Andres Moreno, Wolfgang Banzhaf, and Charles Ofria. *Learning an Evolvable Genotype-Phenotype Mapping*. BEACON Congress, East Lansing, MI. August 2018.
- Matthew Andres Moreno and Charles Ofria. *Understanding Fraternal Transitions in Individuality*. The Third Workshop on Open-Ended Evolution (OEE3) at ALIFE, Tokyo, Japan. July 2018.
- Matthew Andres Moreno, Wolfgang Banzhaf, and Charles Ofria. *Learning an Evolvable Genotype-Phenotype Mapping*. The Genetic and Evolutionary Computation Conference, Kyoto, Japan. July 2018.
- Matthew Moreno, Jason Graham, and Simon Garnier. *Modeling the Collective Behavior of Ants on Uneven Terrain*. Phi Sigma Undergraduate Research Symposium, University of Puget Sound. April 2017.
- Matthew Moreno, Jason Graham, and Simon Garnier. *Modeling the Collective Behavior of Ants on Uneven Terrain*. Joint Mathematics Meetings, Atlanta, GA. January 2017.
- Matthew Moreno. *Evolvability in Evolving Artificial Neural Networks*. NW Honors Research Symposium, Seattle Pacific University. November 2016.
- Invited Talks**
- Matthew Andres Moreno. *Workshop for Avida-Ed Software Development: Highlights and Outcomes*. Active LENS Congress. August 2022.
- Matthew Moreno. *COMAP Mathematical Competition in Modeling 2017*. Spring Experiential Learning Symposium, University of Puget Sound. April 2017.
- Posters**
- Matthew Andres Moreno. *Hereditary stratigraphy: genome annotations to enable phylogenetic inference over distributed populations*. The Genetic and Evolutionary Computation Conference (GECCO), Boston, MA. July 2022.
- Matthew Andres Moreno, Santiago Rodriguez Papa, and Charles Ofria. *Conduit: A C++ Library for Asynchronous High-performance Computing Applications*. The 6th International Workshop on Modeling and Simulation of and by Parallel and Distributed Systems (MSPDS), Barcelona, Spain. March 2021.
- Matthew Andres Moreno and Charles Ofria. *Empirical: a C++ library to support efficient, reliable, and accessible scientific software*. CppCon Poster Session, Aurora, CO. September 2019.
- Matthew Andres Moreno and Charles Ofria. *A Digital Framework for Fraternal Transitions in Individuality*. Evolution of Complex Life, Atlanta, GA. May 2019.
- Matthew Andres Moreno. *Plasticity and Evolvability in a Genetic Regulatory Network Model*. BEACON Congress, East Lansing, MI. August 2017.
- Matthew Andres Moreno. *Plasticity and Evolvability in a Genetic Regulatory Network Model*. ALIFE, Tokyo, Japan. July 2017.
- Matthew Moreno, Jason Graham, and Simon Garnier. *Modeling the Collective Behavior of Ants on Uneven Terrain*. Fall Symposium, University of Puget Sound. September 2016.
- Matthew Moreno and Adam Smith. *Automated Extraction of Mouse Vocalizations from Noisy Recordings*. Fall Symposium, University of Puget Sound. September 2015.
- Seminar Presentations**

- Matthew Andres Moreno, Emily Dolson and Charles Ofria. *Hereditary Stratigraphy: Genome Annotations to Enable Phylogenetic Inference over Distributed Digital Evolution Populations*. Summer Research Opportunities Program (SROP) Facilitator Chalk Talks, East Lansing, MI. June 2021.
- Matthew Andres Moreno and Charles Ofria. *Developing Digital Models of Multicellularity*. Summer Research Opportunities Program (SROP) Facilitator Chalk Talks, East Lansing, MI. June 2020.
- Matthew Andres Moreno and Charles Ofria. *Developing Digital Models of Multicellularity*. Summer Research Opportunities Program (SROP) Facilitator Chalk Talks, East Lansing, MI. June 2019.
- Matthew Andres Moreno and Charles Ofria. *Developing Digital Models of Multicellularity*. Summer Research Opportunities Program Facilitator Chalk Talks, East Lansing, MI. June 2019.
- Matthew Andres Moreno and Charles Ofria. *Understanding Fraternal Transitions in Individuality*. BEACON Seminar, East Lansing, MI. September 2018.
- Matthew Moreno. *Investigating the Relationship Between Plasticity and Evolvability in a Genetic Regulatory Network Model*. Math/CS Day, University of Puget Sound. April 2017.
- Jordan Fonseca, Jesse Jenks, and Matthew Moreno. *MCM: Impact of Autonomous Vehicles on Seattle Traffic*. Math/CS Day, University of Puget Sound. April 2017.
- Matthew Moreno. *Evolvability and Plasticity in a Genetic Regulatory Network Model*. Math & Computer Science Department Seminar, University of Puget Sound. April 2017.
- Matthew Moreno. *Evolvability: What Is It and How Do We Get It?*. Otis C. Chapman Honors Program Thesis Presentation, University of Puget Sound. March 2017.
- Matthew Moreno and Becky Hanscam. *Relieving the Space Jam: Assessment of a Quick-Response Satellite Mission to Neutralize Debris from Orbital Fragmentation Events*. Math/CS Day, University of Puget Sound. April 2016.
- Matthew Moreno. *Mathematical Contest in Modeling: Eradicating Ebola*. Math/CS Day, University of Puget Sound. May 2015.

#### **Guest Lectures**

- Matthew Andres Moreno. *Near-future Digital Evolution Power-ups*. CS 361: Artificial Life and Digital Evolution, Carleton College. November 2022.
- Matthew Andres Moreno. *NP Completeness 'n' Such*. CSE 431: Algorithm Engineering Guest Lecture, Michigan State University. November 2021.
- Alexander Lalejini and Matthew Andres Moreno. *Digital Evolution*. CSE 848: Survey of Evolutionary Computation Guest Lecture, Michigan State University. October 2019.

#### **Grants & Fellowships**

- Recipient of National Science Foundation Graduate Research Fellowship (national award; 17% acceptance rate; 2018)
- Recipient of Blake and Mary Krueger University Distinguished Fellowship (institutional award; 0.2% acceptance rate; 2017)
- Recipient of BEACON Science and Technology Center Top Up Fellowship (departmental award; 2017)

#### **Academic Awards**

- MSU EEB Research Symposium Best Contributed Talk, 3rd Place (conference award; 40% acceptance rate; 2022)
- Outstanding Doctoral Student Mentor Award, nominated (institutional award; 2022)
- COMAP Mathematical Competition in Modeling Finalist (international award; 0.7% acceptance rate; 2017)
- Recipient of National Science Foundation Graduate Research Fellowship Program Honorable Mention (national award; 2017)
- Recipient of Edward Goman Outstanding Senior Award (departmental award, mathematics and computer science; 2017)
- Recipient of Roderick MacArthur Award for an Outstanding Honors Thesis Presentation (departmental award; 2017)
- Member of Otis C. Chapman Honors Program (2013-2017)
- Member Phi Beta Kappa, Pi Mu Epsilon, Phi Kappa Phi, Upsilon Pi Epsilon

#### **STEM Community Activities**

- Michigan State University, Summer Research Opportunities Program (SROP) facilitator (2019, 2020, 2021, 2022)
  - Led weekly chalk talk sessions for sixteen students to practice and iteratively develop the foundation for their final presentations, providing verbal coaching and written feedback.
  - Prepared written feedback on iterative drafts of student documents: annotated bibliography, resume, personal statement, and final research paper.
  - Held weekly one-on-one meetings with eight students to check in on their personal wellbeing, make sure they were receiving adequate support from their research group, plan for upcoming deadlines, outline new documents, and discuss feedback on draft documents.
  - Cohort consisted of majority underrepresented students.
- Michigan State University, Workshop for Avida-Ed Software Development (WAVES) lead coordinator (2020, 2021)
  - Led proposal to redirect unspent Avida-ED funds for Summer 2020 to create paid, 10-week fully-remote research opportunities for early-career scientists and software engineers; reprised workshop in 2021.
  - Negotiated approval from grant stakeholders, distributed call for applicants, designed workshop admissions criteria, organized reviewer pool, and chaired committee to reach consensus-based and equity-minded admissions decisions on 91 (2020) workshop applications.
  - Recruited 13 (2020), 8 (2021) graduate, post-graduate, and faculty mentors to work one-on-one with workshop participants on software or science projects of mutual choosing.

- Served 17 (2020), 10 (2021) early-career participants with 76% (2020), 70% (2021) self-identifying as members of underadvantaged groups in computer science.
- Wrote and delivered four full-day asynchronous onboarding tutorials introducing Avida-ED, C++, WebAssembly, and web design.
- Arranged and co-led weekly 90-minute topic-driven seminars with lecture and discussion components.
- Facilitated weekly all-hands meetings to check in on progress, troubleshoot barriers, and spitball ideas.
- Created workshop website and organized participant blog posts on project work and outcomes.
- Devised and implemented community-building interventions, such as weekly social “warm-up” activities leading into enrichment seminars.
- Performed *post hoc* analysis of participant survey data, revealing success in building programming language-specific proficiency among participants, particularly with respect to “catching up” members of underadvantaged groups.
- Michigan State University, MSU High School Programming Competition proctor & tech support (2021)
- Michigan State University, PyGame workshop co-lead instructor (2018, 2019)
  - Prepared and co-instructed a one week intensive introduction to Python and video game design for high school students.
  - Worked one-on-one with students to design video games for live demonstration at a end of the week symposium and tackle programming challenges along the way.
- Macdonald Middle School, assistant in general and intervention mathematics classrooms (2017-2018)
  - Worked four hours weekly in a sixth grade geometry classroom and a seventh grade math intervention classroom.
  - Worked one-on-one and with small groups of students outside of the classroom to help students keep up with class material or cover new topics.
  - In the classroom, assisted students with questions and worked one-on-one to keep students engaged with class material.
- BEACON Elementary Science Nights outreach at Donley, Marble, Whitehills, Glencairn, Murphy, Hiawatha, and Beagle Elementary Schools (2017-2018)
- BEACON outreach at MSU Science and Engineering Festival (2018)
  - Along with other NSF BEACON members, led hands-on activities to engage kids with key evolutionary ideas like natural selection and natural history.
- University of Puget Sound Center for Writing, Learning, & Teaching, tutor and academic consultant (2015-2017)
  - Helped mathematics students work through assignments, led study sessions to prepare students for examinations, and provided a safe and supportive environment to discuss frustrations and build self-confidence.
  - Conducted academic advising appointments, working with students develop organization, communication, and time-management skills, particularly in the context of executive function or other impairments.
  - Liaised with faculty members to discuss coursework and support students.
  - Developed, led, and participated in professional development activities for student staff.
- University of Puget Sound, computer science departmental mentoring program co-coordinator (2017)
  - Recruited upperclassmen mentors to lead small groups of underclassmen in computer science activities.
  - Planned and led social, brain teaser, and coding activities.
  - Publicized program through departmental announcement, posters, and classroom visits.
- National Conference on Peer Tutoring in Writing, session chair and volunteer (2016)
- Jason Lee Middle School Access to College Days, student panelist (2016)
- University of Puget Sound Access Services, access coach for Tuesday Night Tutoring (2016)
  - Met with local middle and high school students for two hours weekly in an informal helproom setting on the University of Puget Sound campus.
  - Tutored homework material, shared study skills, and worked to make higher education feel approachable by building relationships with students and discussing college life.
- Oakland High School, volunteer (2016)
  - Worked with Communities in Schools for two hours weekly at a credit-recovery-focused alternative high school in Tacoma, WA.
  - Co-led an after-school Homework Club, aiming to help students complete assignments and feel more connected to the school.
  - Served as a classroom assistant, answering student questions and keeping students engaged with class material.