

# Joshua J. Daymude

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PhD Student, Computer Science

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## Education

### Academic History

- 2016 – Present **Computer Science (Ph.D.)**, *Arizona State University*, Tempe, Arizona, USA, 4.00 GPA.
- 2012 – 2016 **Computer Science (B.S.) & Mathematics (B.S.)**, *Barrett, the Honors College at Arizona State University*, Tempe, Arizona, USA, Summa Cum Laude, 4.00 GPA.
- 2011 – 2012 **Extracurricular Studies**, *Stanford Online High School*, Palo Alto, California, USA.
- 2008 – 2012 **High School Diploma**, *Valencia High School*, Valencia, California, USA, 4.44 GPA.

### Notable Accomplishments (Undergraduate)

- August 2015 – **Honors Thesis**, *Compression in Self-Organizing Particle Systems*, Arizona State University.
- April 2016 In our work on self-organizing particle systems, we describe programmable matter as a collection of simple computational elements (particles) with limited computational power that each perform fully distributed, local, asynchronous algorithms to solve system-wide problems of movement, configuration, and coordination. In this thesis, we investigate three different versions of the *compression* problem, in which the particle system gathers as tightly together as possible. We provide algorithms which solve each version and analyze the correctness and running times of each. Lastly, we briefly discuss contributions to the problem of *leader election*, in which a particle system elects a single leader.
- January 2015 – **Computer Science Capstone Project**, *Modding for Minecraft*, Arizona State University.
- December 2015 The ASU computer science capstone is a year-long software engineering project in which an agile team of students in their senior year partner with companies in the Phoenix area. I lead our team of six as we worked for CodaKid, a startup in Scottsdale, Arizona which uses source code modifications to the game *Minecraft* to educate children ages 6–14 on the fundamentals of object-oriented programming. Our team was responsible for (1) creating code modifications and lesson plans to be used in classroom settings and (2) developing installers to package and deliver necessary software to online users.

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## Research

- August 2016 – **A Distributed and Stochastic Framework for Active Matter**, Arizona State University, USA.
- Present In collaboration with Dr. Dana Randall and Dr. Daniel Goldman at the Georgia Institute of Technology, I work under Dr. Andréa Richa to develop a theoretical framework for task-oriented active matter. We establish close analogies between swarm robotics and physical systems, studying both their macroscopic emergent collective behavior and the distributed and stochastic algorithmic decisions made by individual robots which underpin their systems-level behavior.
- April 2014 – **Self-Organizing Particle Systems**, Arizona State University, USA.
- Present I conduct research under Dr. Andréa Richa in the areas of programmable matter and self-organizing systems from the perspective of distributed algorithms and theory. Under our amoebot model, we develop fully local, distributed algorithms which enable individual computational particles to self-organize and solve problems of movement and coordination without any centralized control. A small sample of such problems include shape formation, compression, bridging, and coating. Each algorithm is rigorously analyzed for correctness, runtime, and practical efficiency in an effort to capture many assumptions and physical properties of implemented systems in our general, theoretical model. For more, see [sops.engineering.asu.edu](http://sops.engineering.asu.edu).
- June 2015 – **Self-Organizing Particle Systems**, Universität Paderborn, Germany.
- August 2015 I continued my research in self-organizing particle systems with our collaborators in Paderborn, Germany through RISE, a research assistant exchange program sponsored by the German Academic Exchange Service (DAAD). I worked alongside their Ph.D. students to accomplish (1) a visual simulation of our leader election algorithm, originally presented at DNA21, and (2) several algorithms which solve *hole elimination*, along with corresponding proofs of correctness and a competitive analysis between the proposed algorithms.

August 2012 – **STARS Leadership Corps**, Arizona State University, USA.

May 2013 I worked under Dr. Winslow Burleson to make High Performance Computing more accessible to K–12 students by curating and developing content for a self-guided learning website. I was personally responsible for (1) writing tutorials which covered the basics of the OpenMPI protocol and (2) developing interactive activities for elementary school students that demonstrated the power of concurrency and the cost of parallel overhead.

## Publications

### Book Chapters

January 2019 **Computing by Programmable Particles**, *Joshua J. Daymude, Kristian Hinnenthal, Andréa W. Richa, and Christian Scheideler*, Distributed Computing by Mobile Entities, pp. 615–681.

### Refereed Journal Papers

Submitted **A Markov Chain Algorithm for Compression in Self-Organizing Particle Systems**, *Sarah Cannon, Joshua J. Daymude, Dana Randall, Andréa W. Richa*, Submitted to the Journal of the ACM.

December 2018 **A Stochastic Approach to Shortcut Bridging in Programmable Matter**, *Marta Andrés Arroyo, Sarah Cannon, Joshua J. Daymude, Dana Randall, Andréa W. Richa*, Natural Computing, 17(4) pp. 723–741.

December 2018 **Phototactic Supersmarticles**, *William Savoie, Sarah Cannon, Joshua J. Daymude, Ross Warkentin, Shengkai Li, Dana Randall, Andréa W. Richa, Daniel I. Goldman*, Artificial Life and Robotics, 23(4) pp. 459–468.

March 2018 **On the Runtime of Universal Coating for Programmable Matter**, *Joshua J. Daymude, Zahra Derakhshandeh, Robert Gmyr, Alexandra Porter, Andréa W. Richa, Christian Scheideler, Thim Strothmann*, Natural Computing, 17(1) pp. 81–96.

### Conference Proceedings Refereed Papers

Accepted **Convex Hull Formation for Programmable Matter**, *Joshua J. Daymude, Robert Gmyr, Kristian Hinnenthal, Irina Kostitsyna, Christian Scheideler, Andréa W. Richa*, To appear at the 21st International Conference on Distributed Computing and Networking (ICDCN 2020).

September 2019 **A Local Stochastic Algorithm for Separation in Heterogeneous Self-Organizing Particle Systems**, *Sarah Cannon, Joshua J. Daymude, Cem Gokmen, Dana Randall, Andréa W. Richa*, Approximation, Randomization, and Combinatorial Optimization (APPROX/RANDOM 2019), pp. 54:1–54:22, Boston, MA, USA.

August 2019 **Simulation of Programmable Matter Systems Using Active Tile-Based Self-Assembly**, *John Calvin Alumbaugh, Joshua J. Daymude, Erik D. Demaine, Matthew J. Patitz, and Andréa W. Richa*, DNA Computing and Molecular Programming – 25th International Conference (DNA25), pp. 140–158, Seattle, WA, USA.

July 2018 **Brief Announcement: A Local Stochastic Algorithm for Separation in Heterogeneous Self-Organizing Particle Systems**, *Sarah Cannon, Joshua J. Daymude, Cem Gokmen, Dana Randall, Andréa W. Richa*, Proceedings of the 2018 ACM Symposium on Principles of Distributed Computing (PODC 2018), pp. 483–485, London, UK.

September 2017 **A Stochastic Approach to Shortcut Bridging in Programmable Matter**, *Marta Andrés Arroyo, Sarah Cannon, Joshua J. Daymude, Dana Randall, Andréa W. Richa*, DNA Computing and Molecular Programming – 23rd International Conference (DNA23), pp. 122–138, Austin, TX, USA.

September 2017 **Improved Leader Election for Self-Organizing Programmable Matter**, *Joshua J. Daymude, Robert Gmyr, Andréa W. Richa, Christian Scheideler, Thim Strothmann*, Algorithms for Sensor Networks (ALGOSENSORS 2017), pp. 127–140, Vienna, Austria.

- July 2016 **A Markov Chain Algorithm for Compression in Self-Organizing Particle Systems**, Sarah Cannon, Joshua J. Daymude, Dana Randall, Andréa Richa, ACM Symposium on Principles of Distributed Computing (PODC 2016), pp. 279–288, Chicago, IL, USA.

### Other Publications

- December 2017 **The Amoebot Model**, Joshua J. Daymude, Andréa W. Richa, Christian Scheideler, Available at <https://sops.engineering.asu.edu/sops/amoebot>.
- October 2017 **Phototactic Supersmarticles**, Sarah Cannon, Joshua J. Daymude, William Savoie, Ross Warkentin, Shengkai Li, Daniel I. Goldman, Dana Randall, Andréa W. Richa, Appeared at the 2nd International Symposium on Swarm Behavior and Bio-Inspired Robotics (SWARM 2017), Kyoto, Japan.
- March 2016 **Leader Election and Shape Formation with Self-Organizing Programmable Matter**, Joshua J. Daymude, Zahra Derakhshandeh, Robert Gmyr, Thim Strothmann, Rida A. Bazzi, Andréa W. Richa, Christian Scheideler, CoRR/arXiv:1503.07991.

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## Presentations

### Invited Talks

- November 2018 **Self-Organizing Particle Systems: an Algorithmic Approach to Programmable Matter**, 2nd Workshop on Self-Organization in Swarm of Robots (WSSR 2018), Tokyo, Japan.

### Conference Talks

- September 2019 **A Local Stochastic Algorithm for Separation in Heterogeneous Self-Organizing Particle Systems**, International Conference on Randomization and Computation (RANDOM) 2019, Boston, MA, USA.
- April 2019 **Stochastic Algorithms for Programmable Matter**, Discrete Math Seminar, Arizona State University, Tempe, AZ, USA.
- October 2017 **A Stochastic Approach to Shortcut Bridging in Programmable Matter**, Algorithms, Combinatorics, and Optimization (ACO) Student Seminar, Georgia Institute of Technology, Atlanta, GA, USA.
- July 2017 **Local Stochastic Algorithms for Compression and Shortcut Bridging in Programmable Matter**, Biological Distributed Algorithms (BDA) 2017, Washington D.C., USA.
- July 2017 **Convex Hull Formation for Programmable Matter**, Biological Distributed Algorithms (BDA) 2017, Washington D.C., USA.
- July 2015 **Compaction and Expansion in Self-Organizing Particle Systems**, DAAD Research Internships in Science and Engineering (RISE) Scholars Meeting 2015, Heidelberg, Germany.

### Poster Presentations

- April 2019 **Self-Organizing Particle Systems: an Abstraction of Programmable Matter**, Achievement Rewards for College Scientists (ARCS) Awards Dinner 2019, Phoenix, AZ, USA.
- April 2018 **Self-Organizing Particle Systems: an Abstraction of Programmable Matter**, Achievement Rewards for College Scientists (ARCS) Awards Dinner 2018, Phoenix, AZ, USA.
- July 2017 **Compression and Shortcut Bridging in Self-Organizing Particle Systems**, Google Ph.D Intern Research Conference (PIRC) 2017, Mountain View, California, USA.
- April 2016 **Compression in Self-Organizing Particle Systems**, Barrett Celebrating Honors Symposium (BCHS) 2016, Arizona State University, USA.
- August 2015 **Compaction and Expansion in Self-Organizing Particle Systems**, Biological Distributed Algorithms (BDA) 2015, Boston, Massachusetts, USA.

- July 2015 **Compaction and Expansion in Self-Organizing Particle Systems**, Structural Information and Communication Complexity (SIROCCO) 2015, Montserrat, Spain.
- April 2015 **Compaction in Self-Organizing Particle Systems**, Fulton Undergraduate Research Initiative (FURI) Symposium 2015, Arizona State University, USA.
- April 2015 **Self-Organizing Particle Systems**, Barrett Celebrating Honors Symposium (BCHS) 2015, Arizona State University, USA.

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## Teaching Experience

### Courses Taught

- Fall 2019 **CSE 598: Markov Chain and Monte Carlo Methods**, *Instructor of Record*, Arizona State University, Course Evaluation: 4.54/5, Instructor Evaluation: 4.81/5.
- March 2018 – December 2018 **Markov Chain and Monte Carlo Methods**, *Instructor*, Arizona State University, (Informal Weekly Seminar).

### Students Supervised

- 2018 – Present **Ryan Yiu**, *Graduate Research Assistant*, Arizona State University.
- 2018 – Present **Joseph Briones**, *Undergraduate Research Assistant*, Arizona State University.
- 2019 – Present **Ziad Abdelkarim**, *Undergraduate Research Assistant*, Arizona State University.
- 2018 – 2019 **Christopher Boor**, *Undergraduate Research Assistant*, Arizona State University.
- 2017 – 2019 **Kevin Lough**, *Undergraduate Research Assistant*, Arizona State University.
- 2017 – 2018 **Cem Gökmen**, *Undergraduate Research Assistant*, Georgia Institute of Technology.

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## Honors and Awards

- February 2019 **Johnston Endowment Scholar (2019–2020)**, *Achievement Rewards for College Scientists (ARCS) Foundation, Phoenix Chapter*.
- February 2018 **Johnston Endowment Scholar (2018–2019)**, *Achievement Rewards for College Scientists (ARCS) Foundation, Phoenix Chapter*.
- January 2018 **Graduate College Fellowship (Spring 2018)**, *Arizona State University Graduate College*.
- May 2016 **Moeur Award**, *Arizona State University Alumni Association*.
- April 2016 **Dean's Fellowship Award**, *School for Computing, Informatics, Decision Systems Engineering*, Arizona State University.
- March 2016 **Honorable Mention, Graduate Research Fellowship Program**, *National Science Foundation*.
- March 2016 **Research Experience for Undergraduates (REU)**, *National Science Foundation*.
- December 2015 **Honorable Mention, Outstanding Undergraduate Male Researcher Award for Ph.D Granting Institutions**, *Computing Research Association*.
- June 2015 **Research Internships in Science and Engineering (RISE) Scholarship**, *German Academic Exchange Service (DAAD)*, Universität Paderborn, Germany.
- January 2015 **FURI Grant**, *Fulton Undergraduate Research Initiative*, Arizona State University.
- October 2014 **Research Experience for Undergraduates (REU)**, *National Science Foundation*.
- January 2012 **Regional Outstanding: High School Mathematical Contest in Modeling**, *Consortium for Mathematics and its Applications*.
- January 2012 **National Merit Scholar**, *National Merit Scholarship Corporation*.

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## Employment

- May 2019 – **Team Lead Research Intern**, Systems Imagination, Tempe, Arizona, USA.  
August 2019 I led a team of three in researching and implementing state of the art computer vision techniques for semantic and conceptual understanding of visual scenes. We explored many machine learning approaches (both with and without neural networks) to compare their viability for our applications, and ultimately created a hybrid of several sophisticated approaches. My team had high school and undergraduate students, so mentoring and teaching were also important responsibilities of my role.
- May 2017 – **Software Engineering Intern**, Google, Inc., Mountain View, California, USA.  
August 2017 I worked for the Location team within Geo to develop an image-based machine learning approach for determining if a user is at a place or in transit, enabling better recognition of place entries and departures. I obtained TensorFlow training examples for this task from a data processing pipeline I developed to transform location traces into graphical representations on the world map. Using these examples, I trained a convolutional Inception-v4 neural network which achieved a classification accuracy of 88%, verifying the plausibility of this approach and informing directions for future work.
- May 2014 – **Software Engineering Intern**, Jet Propulsion Laboratory, Pasadena, California, USA.  
August 2016 I worked as a software engineer in JPL's Ground Systems Engineering division, focusing on a subsystem of the Deep Space Network (DSN) known as Data Capture and Delivery (DCD). The DCD is responsible for the reliable capture of data received from space-to-ground downlink or generated by tracking activities, and the delivery of such data to mission scientists. My completed projects, spread across three internships with the DCD team, are detailed below.
- **Summer 2016:** Developed an artificial intelligence neural network for bandwidth prediction and an associated training framework from scratch, executed successful neural net training using raw network traffic data from the DCD, and performed detailed analysis of the suitability of various neural net architectures and learning algorithms.
  - **Winter 2014:** Integrated Coverity static analysis into the makefiles of the DCD's source code.
  - **Summer 2014:** Rewrote a large C library responsible for logging accountability data streaming from deep space spacecraft to improve subsystem stability and robustness. Developed a Solaris 10 SMF script for ensuring tracking system reliability even in the case of hardware failure. Developed a Perl script that synchronizes code changes between Git and Harvest repositories. Led experimental projects in iOS, Android, and Google Glass application development to create useful apps for the full-time engineers. Completed an iOS app that synchronizes meeting times across the three DSN headquarters in Australia, Spain, and the United States.
- August 2014 – **Undergraduate Instructor's Assistant**, Arizona State University, Tempe, Arizona, USA.  
December 2014 I assisted Dr. Henry Kierstead in his MAT 208 course, an introduction to pure mathematics for secondary education majors. I held weekly office hours to assist students in small group and one-on-one settings, and prepared detailed homework solutions and original examples for students to reference.
- May 2013 – **AppleCare iOS Tier 1 Advisor**, Apple, Inc., Tempe, Arizona, USA.  
April 2014 I provided frontline over-the-phone technical support to Apple customers seeking help with their iOS devices. During my employment, I received over fifty "Very Satisfied" customer satisfaction reports, with an average of 10–20% of my customers responding each month. This job helped me master both a large area of technical expertise in Apple products as well as vital people skills when navigating challenging and potentially emotional troubleshooting scenarios.