

Tyler H. Chang

Argonne National Laboratory
Mathematics and Computer Science (MCS) Division
9700 S. Cass Ave., Bldg. 240, Lemont, IL 60439

Email: tchang@anl.gov
Website: <http://thchang.github.io>
GitHub: <http://github.com/thchang>

Research Interests

Numerical optimization, machine learning, analysis of algorithms, parallel computing, and scientific software

Education

Ph.D., May 2020, Computer Science, Virginia Polytechnic Institute & State University (Virginia Tech)

- Thesis: *Mathematical Software for Multiobjective Optimization Problems*; *Outstanding Dissertation Award* finalist

B.S., May 2016, Computer Science & Mathematics (double-major), Virginia Wesleyan University

- *Summa cum laude*; 2x *ACM ICPC* site champion; 8x *Dean's list*; 4x *all-ODAC (conference)* for varsity tennis

Research Experience

(Jun 2020 – Present) **Postdoc: Argonne National Laboratory**, Mathematics and Computer Science Division

- Built, tested, and documented a Python framework for deploying multiobjective optimization solvers
- Deployed optimization solvers for accelerator design, material manufacturing, and inverse problems
- Advised graduate and undergraduate interns and contributed to research proposals

(Aug 2016 – May 2020) **Cunningham Fellow: Virginia Tech**, Dept. of Computer Science

- Designed parallel algorithms and software for multivariate interpolation and blackbox optimization
- Applied solvers to problems in HPC performance modeling and performance tuning
- Conducted fundamental research in approximation theory and computational geometry

(Jun 2019 – Dec 2019) **SCGSR Awardee: Argonne National Laboratory**, MCS Division

- Conducting research in multiobjective optimization software via DOE SCGSR program (see awards)

(Feb 2016 – Aug 2016) **Research Assistant: Old Dominion University**, Dept. of Computer Science

- Aided in parallelizing NASA's FUN3D CFD kernel on NVIDIA GPUs using CUDA and MPI

(Summer 2015 & Winter 2015) **Intern: US Army Research Labs**, Computational Science Division

- Accelerating software for real-time optimal control (Summer 2015) & using AR technology for info viz (Winter 2015)

(Summer 2014 & Winter 2014) **Intern: US Army Research Labs**, Guidance Technology Branch

- Using OpenCV for real-time sensing (Summer 2014) & developing software for embedded systems (Winter 2014)

Notable Awards & Accomplishments

(2021) **Nominee for Outstanding Dissertation Award: Virginia Tech**, Graduate School

- Finalist for Outstanding Dissertation Award, nominated by CS faculty for 2020 dissertation

(2016, 2017, 2018, 2019) **Pratt/Davenport Leadership Fellow: Virginia Tech**, College of Engineering

- Supplemental awards given by the College of Engineering on a per-year basis

(2018) **SCGSR Award: U.S. Dept. of Energy**, Office of Science (SC)

- One of 70 proposals funded by Graduate Student Research Program (SCGSR) during 2018, 2nd call for proposals

(2016) **Cunningham Doctoral Fellowship: Virginia Tech**, Graduate School

- The Cunningham doctoral fellowship guarantees 4 years of funding to new doctoral students

(2016) **Outstanding Student in Computer Science & Mathematics: Virginia Wesleyan University**

- One of 2 students selected by Depts. of Mathematics and Computer Science at Spring 2016 VWU Honors Convocation

Publicly Available Software

2022. **ParMOO**: Python library for parallel multiobjective simulation optimization. Release: 0.1.0.

Devs: **T. H. Chang** (lead) and S. M. Wild. Primary Prog. Lang: Python 3.

git: <https://github.com/parmoo/parmoo>

2022. **VTMOP**: Solver for blackbox multiobjective optimization problems.

Devs: **T. H. Chang** (lead). Primary Prog. Lang: Fortran 2008.

git: <https://github.com/vtopt/VTMOP>

2020. **DelaunaySparse**: Interpolation via a sparse subset of the Delaunay triangulation.

Devs: **T. H. Chang** (lead) and T. C. H. Lux. Primary Prog. Lang: Fortran 2003.

git: <https://github.com/vtopt/DelaunaySparse>

2019. **QAML**: Quantum annealing math library.

Devs: T. C. H. Lux, **T. H. Chang**, and S. S. Tipirneni. Primary Prog. Lang: Python 3.

git: <https://github.com/tchlux/qaml>

Publications In Press

N. Neveu, **T. H. Chang**, P. Franz, S. Hudson, and J. Larson. Comparison of multiobjective optimization methods for the LCLS-II photoinjector. *To appear in Computer Physics Communication*. doi: 10.1016/j.cpc.2022.108566

T. C. H. Lux, L. T. Watson, **T. H. Chang**, and W. I. Thacker. Algorithm XXXX: MQSI—Monotone quintic spline interpolation. *To appear in ACM Transactions on Mathematical Software*. doi: 10.1145/3570157

Y. Wang, L. Xu, Y. Hong, R. Pan, **T. H. Chang**, T. C. H. Lux, J. Bernard, L. T. Watson, and K. W. Cameron. Design strategies and approximation methods for high-performance computing variability management. *To appear in Journal of Quality Technology*. doi: 10.1080/00224065.2022.2035285

Submissions Under Review

T. H. Chang and S. M. Wild. ParMOO: A Python library for parallel multiobjective simulation optimization. *Submitted to Journal of Open Source Software*, May 2022. JOSS Open Review: <https://github.com/openjournals/joss-reviews/issues/4468>.

Peer-Reviewed Journal Articles

2022. **T. H. Chang**, L. T. Watson, J. Larson, N. Neveu, W. I. Thacker, S. Deshpande, and T. C. H. Lux. Algorithm 1028: VTMOPT: Solver for blackbox multiobjective optimization problems. *ACM Transactions on Mathematical Software* 48(3), Article 36, 34 pages. doi: 10.1145/3529258
2021. L. Xu, T. C. H. Lux, **T. H. Chang**, B. Li, Y. Hong, L. T. Watson, A. R. Butt, D. Yao, and K. W. Cameron. Prediction of high-performance computing input/output variability and its application to optimization for system configurations. *Quality Engineering* 33(2), pp. 318–334. doi: 10.1080/08982112.2020.1866203
2021. T. C. H. Lux, L. T. Watson, **T. H. Chang**, J. Bernard, B. Li, L. Xu, G. Back, A. R. Butt, K. W. Cameron, and Y. Hong. Interpolation of sparse high-dimensional data. *Numerical Algorithms* 88(1), pp. 281–313. doi: 10.1007/s11075-020-01040-2
2020. **T. H. Chang**, L. T. Watson, T. C. H. Lux, A. R. Butt, K. W. Cameron, and Y. Hong. Algorithm 1012: DELAUNAYSPARSE: Interpolation via a sparse subset of the Delaunay triangulation in medium to high dimensions. *ACM Transactions on Mathematical Software* 46(4), Article 38, 20 pages. doi: 10.1145/3422818
2020. L. Xu, Y. Wang, T. C. H. Lux, **T. H. Chang**, J. Bernard, B. Li, Y. Hong, K. W. Cameron, and L. T. Watson. Modeling I/O performance variability in high-performance computing systems using mixture distributions. *Journal of Parallel and Distributed Computing* 139, pp. 87–98. doi: 10.1016/j.jpdc.2020.01.005
2019. **T. H. Chang**, T. C. H. Lux, and S. S. Tipirneni. Least-squares solutions to polynomial systems of equations with quantum annealing. *Quantum Information Processing* 18(12), Article 374, 17 pages. doi: 10.1007/s11128-019-2489-x

Peer-Reviewed Conference Papers

2020. **T. H. Chang**, J. Larson, and L. T. Watson. Multiobjective optimization of the variability of the high-performance Linpack solver. In *Proc. 2020 Winter Simulation Conference (WSC)*, pp. 3081–3092, virtual event. doi: 10.1109/WSC48552.2020.9383875
2020. **T. H. Chang**, J. Larson, L. T. Watson, and T. C. H. Lux. Managing computationally expensive blackbox multiobjective optimization problems with libEnsemble. In *Proc. 2020 Spring Simulation Conference (SpringSim '20)*, Article 31, 12 pages, virtual event. doi: 10.22360/springsim.2020.hpc.001
2020. T. C. H. Lux, L. T. Watson, **T. H. Chang**, L. Xu, Y. Wang, and Y. Hong. An algorithm for constructing monotone quintic interpolating splines. In *Proc. 2020 Spring Simulation Conference (SpringSim '20)*, Article 33, 12 pages, virtual event. doi: 10.22360/springsim.2020.hpc.003
2020. T. C. H. Lux and **T. H. Chang**. Analytic test functions for generalizable evaluation of convex optimization techniques. In *Proc. IEEE SoutheastCon 2020 Vol. 2*, 8 pages, Raleigh, NC, USA. doi: 10.1109/SoutheastCon44009.2020.9368254
2020. T. C. H. Lux, L. T. Watson, **T. H. Chang**, L. Xu, Y. Wang, J. Bernard, Y. Hong, and K. W. Cameron. Effective nonparametric distribution modeling for distribution approximation applications. In *Proc. IEEE SoutheastCon 2020 Vol. 2*, 6 pages, Raleigh, NC, USA. doi: 10.1109/SoutheastCon44009.2020.9368295
2018. **T. H. Chang**, L. T. Watson, T. C. H. Lux, S. Raghvendra, B. Li, L. Xu, A. R. Butt, K. W. Cameron, and Y. Hong. Computing the umbrella neighbourhood of a vertex in the Delaunay triangulation and a single Voronoi cell in arbitrary dimension. In *Proc. IEEE SoutheastCon 2018*, 8 pages, St. Petersburg, FL, USA. doi: 10.1109/SECON.2018.8479003
2018. T. C. H. Lux, L. T. Watson, **T. H. Chang**, J. Bernard, B. Li, X. Yu, L. Xu, G. Back, A. R. Butt, K. W. Cameron, Y. Hong, and D. Yao. Nonparametric distribution models for predicting and managing computational performance variability. In *Proc. IEEE SoutheastCon 2018*, 7 pages, St. Petersburg, FL, USA. doi: 10.1109/SECON.2018.8478814
2018. **T. H. Chang**, L. T. Watson, T. C. H. Lux, J. Bernard, B. Li, L. Xu, G. Back, A. R. Butt, K. W. Cameron, and Y. Hong. Predicting system performance by interpolation using a high-dimensional Delaunay triangulation. In *Proc. 2018 Spring Simulation Conference (SpringSim '18)*, Article 2, 12 pages, Baltimore, MD, USA. doi: 10.22360/springsim.2018.hpc.003

2018. T. C. H. Lux, L. T. Watson, **T. H. Chang**, J. Bernard, B. Li, L. Xu, G. Back, A. R. Butt, K. W. Cameron, and Y. Hong. Predictive modeling of I/O characteristics in high performance computing systems. In *Proc. 2018 Spring Simulation Conference (SpringSim '18)*, Article 8, 10 pages, Baltimore, MD, USA. doi: 10.22360/springsim.2018.hpc.009
2018. **T. H. Chang**, L. T. Watson, T. C. H. Lux, B. Li, L. Xu, A. R. Butt, K. W. Cameron, and Y. Hong. A polynomial time algorithm for multivariate interpolation in arbitrary dimension via the Delaunay triangulation. In *Proc. 2018 ACM Southeast Conference (ACMSE '18)*, Article 12, 8 pages, Richmond, KY, USA. doi: 10.1145/3190645.3190680
2018. T. C. H. Lux, L. T. Watson, **T. H. Chang**, J. Bernard, B. Li, X. Yu, L. Xu, G. Back, A. R. Butt, K. W. Cameron, D. Yao, and Y. Hong. Novel meshes for multivariate interpolation and approximation. In *Proc. 2018 ACM Southeast Conference (ACMSE '18)*, Article 13, 7 pages, Richmond, KY, USA. doi: 10.1145/3190645.3190687
2017. C. Raghunath, **T. H. Chang**, L. T. Watson, M. Jrad, R. K. Kapania, and R. M. Kolonay. Global deterministic and stochastic optimization in a service oriented architecture. In *Proc. 2017 Spring Simulation Conference (SpringSim '17)*, Article 7, 12 pages, Virginia Beach, VA, USA. doi: 10.22360/springsim.2017.hpc.023

Technical Reports & Dissertations

2022. **T. H. Chang** and S. M. Wild. *ParMOO: Python library for parallel multiobjective simulation optimization*. Technical Report Version 0.1.0. Argonne National Laboratory, Lemont, Illinois, USA. <https://parmoo.readthedocs.io/en/latest>
2020. A. K. Gillette and **T. H. Chang**. *ALGORITHMS: Assessing Latent Space Dimension by Delaunay Loss*. Technical Report LLNL-CONF-814930. Lawrence Livermore National Laboratory, Livermore, California, USA. <https://www.osti.gov/servlets/purl/1756748>
2020. **T. H. Chang**. *Mathematical Software for Multiobjective Optimization Problems*. Ph.D. Dissertation. Department of Computer Science, Virginia Polytechnic Institute and State University (Virginia Tech), Blacksburg, VA, USA. **Dept. of Computer Science Nominee for Outstanding Dissertation Award**. <http://hdl.handle.net/10919/98915>
2016. **T. H. Chang**. *GPU Saturation for Multiple Matrix-Vector Multiplications*. Bachelor's thesis. Department of Computer Science, Virginia Wesleyan University, Virginia Beach, VA, USA.

Conference Talks

- Sep 2022. Geometric considerations when surrogate modeling. SIAM Conference on Mathematics of Data Science (MDS 2022), San Diego, CA, USA.
- Jul 2022. ParMOO: A parallel solver framework for multiobjective simulation optimization problems. Seventh International Conference on Continuous Optimization (ICCOPT 2022), Bethlehem, PA, USA.
- Jul 2021. Surrogate modeling of simulations for multiobjective optimization applications. SIAM Conference on Optimization (OP 2022), virtual event.
- Mar 2021. Computing sparse subsets of the Delaunay triangulation in high-dimensions for interpolation and graph problems. SIAM Conference on Computational Science and Engineering (CSE 2021), virtual event.
- Dec 2020. Multiobjective optimization of the variability of the high-performance Linpack solver. 2020 Winter Simulation Conference (WSC 2020), virtual event.
- Nov 2020. Multiobjective optimization of simulations with PARMOO. Argonne Postdoctoral Research and Career Symposium, virtual event.
- May 2020. Managing computationally expensive blackbox multiobjective optimization problems with libEnsemble. Spring Simulation Conference (SpringSim '20), virtual event.
- Aug 2019. A surrogate for local optimization using Delaunay triangulations. Sixth International Conference on Continuous Optimization (ICCOPT 2019), Berlin, Germany.
- Apr 2018. Computing the umbrella neighbourhood of a vertex in the Delaunay triangulation and a single Voronoi cell in arbitrary dimension. IEEE SoutheastCon 2020, St. Petersburg, FL, USA.

Apr 2018. Nonparametric distribution models for predicting and managing computational performance variability. IEEE SoutheastCon 2020, St. Petersburg, FL, USA.

Mar 2018. A polynomial time algorithm for multivariate interpolation in arbitrary dimension via the Delaunay triangulation. ACM Southeast Conference (ACMSE '18), Richmond, KY, USA.

Apr 2017. Global deterministic and stochastic optimization in a service oriented architecture. Spring Simulation Conference (SpringSim '17), Virginia Beach, VA, USA.

Apr 2016. GPU saturation for multiple matrix-vector multiplications. Virginia Wesleyan College, Undergraduate Research Symposium, Virginia Beach, VA, USA.

Apr 2014. The new Mastermind. Virginia Wesleyan College, Undergraduate Research Symposium, Virginia Beach, VA, USA.

Seminars & Colloquia

Feb 2020. Algorithms and software for Delaunay interpolation and multiobjective optimization. Sandia National Laboratory, Wind Energy Technology Division Candidate Seminar, virtual event.

Feb 2020. Algorithms and software for Delaunay interpolation and multiobjective optimization. Argonne National Laboratory, Mathematics and Computer Science Division Candidate Seminar, Lemont, IL, USA.

Jan 2020. Algorithms and software for Delaunay interpolation and multiobjective optimization. Sandia National Laboratory, Center for Computing Research Candidate Seminar, Albuquerque, NM, USA.

Tutorials & Guest Lectures

Oct 2022. An introduction to multiobjective simulation optimization with ParMOO. The Science Academy, Science Circle Cohort, guest speaker, virtual event. Recording: <https://www.youtube.com/watch?v=gQha8URLEHM>

May 2022. An introduction to multiobjective simulation optimization with ParMOO. University of Chicago, Pritzker School of Molecular Engineering, guest lecture, virtual event.

Advising

(Jun–Aug 2022) Manisha Garg, NSF MSGI at Argonne National Laboratory

- Project: Model agnostic sampling techniques for generating design of experiments

(May–Aug 2022) Hyrum Dickinson, US DOE SULI at Argonne National Laboratory

- Project: Visualization tools for the ParMOO Library

Professional Services & Activities

Journal Referee:

- ACM Transactions on Mathematical Software (2021–Present)
- The Visual Computer Journal (2021)
- Quantum Information Processing (2021)
- MDPI: Mathematical and Computer Applications (2021)
- Journal of Machine Learning Research (2019)

Conference Reviewer:

- Int. Conf. for High Performance Computing, Networking, Storage, and Analysis 2021 (SC '21)
- IEEE SoutheastCon 2020
- IEEE SoutheastCon 2019
- IEEE SoutheastCon 2018

Minisymposium Organizer:

- SIAM Conference on Optimization (2021)
- SIAM Conference on Computational Science and Engineering (2021)

Current Professional Memberships:

- ACM (2015 – Present)
- SIAM (2016 – Present)
- MOS (2022 – Present)

Institutional Service

Argonne

(Nov 2022 – Present) **Organizing Committee: FASTMath Institute Seminar Series**

- Providing input and recruiting speakers for FASTMath seminar series

(Nov 2022) **Technical Reviewer: Sustainable Research Pathways Submissions**

- Providing technical reviews of faculty and student submissions

Virginia Tech

(Aug 2017 – May 2019) **Founding Member: Virginia Tech Computer Science Graduate Counsel**

- Organized professional and social events for graduate students and communicated student concerns to faculty

(Mar 2019) **Primary Student Organizer: Virginia Tech Computer Science Graduate Preview Weekend**

- Organized recruitment events for prospective graduate students and coordinating meetings with faculty

Post-Dissertation Courses

Distributionally Robust Optimization, July 2022, ICCOPT Summer School

Mathematical Optimization in Julia with JuMP, July 2022, ICCOPT Summer School

Probability, Geometry, and Computation in High Dimensions Boot Camp, Aug 2020, Simons Institute Workshop

Advanced Python, July 2020, LinkedIn Learning

Teaching Experience

(Jan 2022 – Present) **Adjunct Professor: College of DuPage**, Dept. of Computer & Info. Science

- Online lectures and course material preparation for *CIS 2531: Introduction to Python Programming*

(Jan 2020 – May 2020) **Instructor of Record: Virginia Tech**, Dept. of Computer Science

- In-person and online (due to COVID-19) lectures for *CS 3114: Data Structures and Algorithms* (in Java)

(Jan 2013 – Dec 2015) **Subject Tutor: Virginia Wesleyan University**, Learning Center

- Subject tutor for undergraduate courses in calculus, computer science, and statistics