Tyler H. Chang

Argonne National Laboratory
Mathematics & Computer Science (MCS) Division
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Website: https://thchang.github.io
GitHub: https://github.com/thchang

Interests

Numerical optimization, machine learning, computational geometry, analysis of algorithms, and scientific software

Education

Ph.D., May 2020, Computer Science, Virginia Polytechnic Institute & State University (Virginia Tech)
- *Thesis: Math. Softw. for Multiobjective Optimization Problems; Outstanding Dissertation Award nominee*

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.   **Postdoctoral appointee: Argonne National Laboratory**, MCS 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 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

Dec 2015 - Jan 2016.   **Intern: US Army Research Labs**, Computational Science Division
May 2015 - Aug 2015.   **Intern: US Army Research Labs**, Computational Science Division
- Accelerating software for real-time optimal control (summer) & using AR technology for info viz (winter)

Dec 2014 - Jan 2015.   **Intern: US Army Research Labs**, Guidance Technology Branch
May 2014 - Aug 2014.   **Intern: US Army Research Labs**, Guidance Technology Branch
- Using OpenCV for real-time sensing (summer) & developing software for embedded systems (winter)

Awards

2021.   **Nominee for Outstanding Dissertation Award: Virginia Tech**, Graduate School
2019.   **Davenport Leadership Fellowship: Virginia Tech**, College of Engineering
2018.   **SCGSR Award: DOE Office of Science**, Graduate Student Research (SCGSR) Program

2018.	**Pratt Fellowship: Virginia Tech**, College of Engineering
2017.	**Pratt Fellowship: Virginia Tech**, College of Engineering
2016.	**Cunningham Doctoral Fellowship: Virginia Tech**, Graduate School
2016.	**Davenport Leadership Fellowship: Virginia Tech**, College of Engineering
2016.	**Outstanding Student in Computer Science & Mathematics: Virginia Wesleyan University**

Publicly Available Software

2022. **ParMOO**: Python library for parallel multiobjective simulation optimization. Release: 0.1.0
Devs: **T. H. Chang** (lead), S. M. Wild, and H. Dickinson   Primary Prog. Lang: `Python 3`
git: `https://github.com/parmoo/parmoo`

2022. **VTMOP**: Solver for blackbox multiobjective optimization problems.
Devs: **T. H. Chang** (sole)   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

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`

Publications 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`.

Publications In Preparation

T. H. Chang and S. M. Wild. Designing a framework for solving multiobjective simulation optimization problems. $\sim 80\%$ completion.

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: VTMOP: 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 2020)*, 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 and 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. url: `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. url: `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**. url: `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.

Talks

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 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 and Colloquia

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

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

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

Tutorials and 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. *Univeristy of Chicago, Pritzker School of Molecular Engineering, guest lecture*, virtual event.

Professional Services and 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)

Professional Membership

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

Institutional Services

Argonne

Nov 2022 - Present.   **Organizing Committee: FASTMath Institute Seminar Series**
- Providing input on topics and recruiting seminar speakers

Nov 2022.   **Technical Reviewer: Sustainable Research Pathways**
- Providing technical reviews of faculty and student submissions to SRP program

Virginia Tech

Aug 2017 - May 2020. **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, Comp. Sci. Graduate Preview Weekend**
  - Organized recruitment events for prospective graduate students and coordinated meetings with faculty

Advising

Jun 2022 - Aug 2022. Manisha Garg (PhD student at UIUC), intern at Argonne via NSF MSGI program
  - Project: Model agnostic sampling techniques for generating design-of-experiments

Jun 2022 - Aug 2022. Hyrum Dickinson (Undergrad at UIUC), intern at Argonne via DOE SULI program
  - Project: Visualization tools for the ParMOO library

Post-Dissertation Courses

Jul 2022. *Distributionally Robust Optimization*, ICCOPT Summer School
Jul 2022. *Mathematical Optimization in Julia with JuMP*, ICCOPT Summer School
Aug 2020. *Probability, Geometry, and Computation in High Dimensions Boot Camp*, Simons Institute Workshop
Jul 2020. *Advanced Python*, LinkedIn Learning

Teaching

Jan 2022 - Present. **Adjunct Professor: College of DuPage**, Dept. of Computer and Information Science
  - CIS 2531: Introduction to Python Programming

Jan 2020 - May 2020. **Instructor of Record: Virginia Tech**, Dept. of Computer Science
  - CS 3114: Data Structures and Algorithms (in Java)

Jan 2013 - Dec 2015. **Subject Tutor: Virginia Wesleyan University**, Learning Center
  - Tutored undergraduate courses in calculus, computer science, and statistics

Misc. Travel Awards

Feb 2021. *SIAM Early Career Travel Award*, $160 to cover SIAM CSE 2021 registration
Apr 2020. *Virginia Tech Computer Science Graduate Travel Award*, $400 to attend SpringSim 2020
Aug 2019. *Virginia Tech Graduate Student Association Travel Fund*, $225 to attend ICCOPT 2019
Jun 2019. *Virginia Tech Computer Science Graduate Travel Award*, $600 to attend ICCOPT 2019
Apr 2019. *ICCOPT Travel Grant Program*, €450 to attend ICCOPT 2019
Apr 2018. *Virginia Tech Graduate Student Association Travel Fund*, $225 to attend IEEE SoutheastCon 2018
Mar 2018. *Virginia Tech Computer Science Graduate Travel Award*, $400 to attend IEEE SoutheastCon 2018
Aug 2016. *Virginia Tech Cunningham Travel Fund*, $1000 unrestricted travel fund for Cunningham fellow

Technical Skills

Programming Langs:	Python, Fortran, C/C++, Java, Matlab
Operating Systems:	MacOS, Unix/Linux
Markup Languages:	HTML/CSS, Markdown, reStructuredText, YAML, LaTeX, plain TeX
Tools + Frameworks:	numpy, pandas, scipy, matplotlib, tensorflow.keras, sklearn, PIL, OpenCV, pytest, sphinx, PyPI/pip, conda-forge, MPI, OpenMP, CUDA, Slurm, BLAS, LAPACK, git, GitHub Actions, GitFlow