Tyler H. Chang

Argonne National Laboratory
Mathematics and Computer Science (MCS) Division
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Research Interests

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

Education

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

B.S., May 2016, Computer Science & Mathematics, Virginia Wesleyan University, *Summa Cum Laude*

Research Experience

(Jun 2020 – Present) **Postdoc: Argonne National Lab**, Math. & Computer Science (MCS) Division

- R&D in multiobjective simulation optimization, parallel computing, and scientific software
- Working on applications in accelerator physics, material manufacturing, and density functional theory

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

- R&D in numerical analysis, math software, algorithms, parallel computing, and data science
- Math & algorithms team in VarSys: A NSF-funded study of HPC performance variability

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

- R&D in multiobjective optimization, funded via U.S. D.O.E. (see awards for details)

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

- R&D in GPU computing and parallelization of NASA's FUN3D CFD kernel on NVIDIA GPUs

(Summer 2014, Winter 2014, Summer 2015, & Winter 2015) **Intern: US Army Research Lab**, Computational Science Division (CSD) & Guidance Technology Branch (GTB)

- CSD — R&D in autonomous driving (Summer 2015) & virtual reality (Winter 2015)
- GTB — R&D in computer vision (Summer 2014) & 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

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

- Awarded by the U.S. Dept. of Energy, Office of Science Graduate Student Research program
- One of 70 proposals funded during 2018, 2nd call for proposals

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

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

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

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

Publicly Available Software

DELAUNAYSPARSE is a software package for computing the Delaunay interpolant in medium to high dimensions. Both serial and parallel drivers are available with interfaces in `Fortran`, `C/C++`, `Python 3.6+`, and command line.

- Role: lead developer
- Download: `https://vtopt.github.io/DelaunaySparse`.

QAML is a `Python` package for embedding polynomial sum of squares minimization problems on the D-Wave quantum annealer.

- Role: developer
- Download: `https://github.com/tchlux/qaml`.

Pending Software

ParMOO is a `Python` library and framework for solving large-scale multiobjective simulation optimization problems, while exploiting any available structures in the simulation. Integrates with `libEnsemble` for portable, scalable parallelism. Code not yet publicly available.

- Role: lead developer

VTMOP is a solver and framework for computationally expensive blackbox multiobjective optimization problems with continuous variables and 2+ objectives. Written in `Fortran`; a `Python` interface is also available through libEnsemble.

- Role: lead developer

Peer-Reviewed Journal Articles

Yueyao Wang, Li Xu, Yili Hong, Rong Pan, **Tyler H. Chang**, Thomas C. H. Lux, Jon Bernard, Layne T. Watson, and Kirk W. Cameron. Design strategies and approximation methods for high-performance computing variability management. Journal of Quality Technology, Vol. 0, No. 0, pp. 1–16. 2022. DOI: 10.1080/00224065.2022.2035285

Li Xu, Thomas C. H. Lux, **Tyler H. Chang**, Bo Li, Yili Hong, Layne T. Watson, Ali R. Butt, Danfeng Yao, and Kirk W. Cameron. Prediction of high-performance computing input/output variability and its application to optimization for system configurations. Quality Engineering, Vol. 33, No. 2, pp. 318–334. 2021. DOI: 10.1080/08982112.2020.1866203

Thomas C. H. Lux, Layne T. Watson, **Tyler H. Chang**, Jon Bernard, Bo Li, Li Xu, Godmar Back, Ali R. Butt, Kirk W. Cameron, and Yili Hong. Interpolation of sparse high-dimensional data. Numerical Algorithms, Vol. 88, No. 1, pp. 281–313. 2021. DOI: 10.1007/s11075-020-01040-2

Tyler H. Chang, Layne T. Watson, Thomas C. H. Lux, Ali R. Butt, Kirk W. Cameron, and Yili Hong. Algorithm 1012: DELAUNAYSPARSE: Interpolation via a sparse subset of the Delaunay triangulation in medium to high dimensions. ACM Transactions on Mathematical Software (TOMS), Vol. 46, No. 4, Article No. 38, pp. 1–20. 2020. DOI: 10.1145/3422818

Li Xu, Yueyao Wang, Thomas C. H. Lux, **Tyler H. Chang**, Jon Bernard, Bo Li, Yili Hong, Kirk W. Cameron, and Layne T. Watson. Modeling I/O performance variability in high-performance computing systems using mixture distributions. Journal of Parallel and Distributed Computing, Vol. 139, pp. 87–98. 2020. DOI: 10.1016/j.jpdc.2020.01.005

Tyler H. Chang, Thomas C. H. Lux, and Sai Sindhura Tipirneni. Least-squares solutions to polynomial systems of equations with quantum annealing. Quantum Information Processing, Vol. 18, No. 12, Article No. 374. 2019. DOI: 10.1007/s11128-019-2489-x

Peer-Reviewed Conference Papers

Tyler H. Chang, Jeffrey Larson, and Layne T. Watson. Multiobjective optimization of the variability of the high-performance Linpack solver. In Proceedings of the 2020 Winter Simulation Conference (WSC), pp. 3081–3092. 2020. DOI: 10.1109/WSC48552.2020.9383875

Tyler H. Chang, Jeffrey Larson, Layne T. Watson, and Thomas C. H. Lux. Managing computationally expensive blackbox multiobjective optimization problems with libEnsemble. In Proceedings of the 2020 Spring Simulation Conference (SpringSim '20), Article No. 31, pp. 1–12. 2020. DOI: 10.22360/springsim.2020.hpc.001

Thomas C. H. Lux, Layne T. Watson, **Tyler H. Chang**, Li Xu, Yueyao Wang, and Yili Hong. An algorithm for constructing monotone quintic interpolating splines. In Proceedings of the 2020 Spring Simulation Conference (SpringSim '20), Article No. 33, pp. 1–12. 2020. DOI: 10.22360/springsim.2020.hpc.003

Thomas C. H. Lux and **Tyler H. Chang**. Analytic test functions for generalizable evaluation of convex optimization techniques. In Proceedings of IEEE SoutheastCon 2020, volume 2, pp. 1–8. 2020. DOI: 10.1109/SoutheastCon44009.2020.9368254

Thomas C. H. Lux, Layne T. Watson, **Tyler H. Chang**, Li Xu, Yueyao Wang, Jon Bernard, Yili Hong, and Kirk W. Cameron. Effective nonparametric distribution modeling for distribution approximation applications. In Proceedings of IEEE SoutheastCon 2020, volume 2, pp. 1–6. 2020. DOI: 10.1109/SoutheastCon44009.2020.9368295

Tyler H. Chang, Layne T. Watson, Thomas C. H. Lux, Sharath Raghvendra, Bo Li, Li Xu, Ali R. Butt, Kirk W. Cameron, and Yili Hong. Computing the umbrella neighbourhood of a vertex in the Delaunay triangulation and a single Voronoi cell in arbitrary dimension. In Proceedings of IEEE SoutheastCon 2018, pp. 1–8. 2018. DOI: 10.1109/SECON.2018.8479003

Thomas C. H. Lux, Layne T. Watson, **Tyler H. Chang**, Jon Bernard, Bo Li, Xiaodong Yu, Li Xu, Godmar Back, Ali R. Butt, Kirk W. Cameron, Yili Hong, and Danfeng Yao. Nonparametric distribution models for predicting and managing computational performance variability. In Proceedings of IEEE SoutheastCon 2018, pp. 1–7. 2018. DOI: 10.1109/SECON.2018.8478814

Tyler H. Chang, Layne T. Watson, Thomas C. H. Lux, Jon Bernard, Bo Li, Li Xu, Godmar Back, Ali R. Butt, Kirk W. Cameron, and Yili Hong. Predicting system performance by interpolation using a high-dimensional Delaunay triangulation. In Proceedings of SpringSim 2018, the 26th High Performance Computing Symposium (HPC '18), Article No. 2, pp. 1–12. 2018. DOI: 10.22360/springsim.2018.hpc.003

Thomas C. H. Lux, Layne T. Watson, **Tyler H. Chang**, Jon Bernard, Bo Li, Li Xu, Godmar Back, Ali R. Butt, Kirk W. Cameron, and Yili Hong. Predictive modeling of I/O characteristics in high performance computing systems. In Proceedings of SpringSim 2018, the 26th High Performance Computing Symposium (HPC '18), Article No. 8, pp. 1–10. 2018. DOI: 10.22360/springsim.2018.hpc.009

Tyler H. Chang, Layne T. Watson, Thomas C. H. Lux, Bo Li, Li Xu, Ali R. Butt, Kirk W. Cameron, and Yili Hong. A polynomial time algorithm for multivariate interpolation in arbitrary dimension via the Delaunay triangulation. In Proceedings of the 2018 ACM Southeast Conference (ACMSE '18), Article No. 12, pp. 1–8. 2018. DOI: 10.1145/3190645.3190680

Thomas C. H. Lux, Layne T. Watson, **Tyler H. Chang**, Jon Bernard, Bo Li, Xiadong Yu, Li Xu, Godmar Back, Ali R. Butt, Kirk W. Cameron, Danfeng Yao, and Yili Hong. Novel meshes for multivariate interpolation and approximation. In Proceedings of the 2018 ACM Southeast Conference (ACMSE '18), Article No. 13, pp. 1–7. 2018. DOI: 10.1145/3190645.3190687

Chaitra Raghunath, **Tyler H. Chang**, Layne T. Watson, Mohamed Jrad, Rakesh K. Kapania, and Raymond M. Kolonay. Global deterministic and stochastic optimization in a service oriented architecture. In Proceedings of SpringSim 2017, the 25th High Performance Computing Symposium (HPC '17), Article No. 7, pp. 1–12. 2017. DOI: 10.22360/springsim.2017.hpc.023

Technical Reports & Dissertation

Andrew K. Gillette and **Tyler H. Chang**. ALGORITHMS: Assessing latent space dimension by Delaunay loss. 2020. Tech. Report, Lawrence Livermore National Laboratory, LLNL-CONF-814930. `https://www.osti.gov/servlets/purl/1756748`.

Tyler H. Chang. Mathematical software for multiobjective optimization problems. 2020. Ph.D. Dissertation, Department of Computer Science, Virginia Polytechnic Institute and State University. Finalist for Virginia Tech's *Outstanding Dissertation Award*. `http://hdl.handle.net/10919/98915`.

In Press

Tyler H. Chang, Layne T. Watson, Jeffrey Larson, William I. Thacker, Shubhangi Deshpande, and Thomas C. H. Lux. Algorithm XXXX: VTMOP: Solver for blackbox multiobjective optimization problems. To appear in ACM Transactions on Mathematical Software, `https://doi.org/10.1145/3529258`.

Under Review

Thomas C. H. Lux, Layne T. Watson, **Tyler H. Chang**, and William I. Thacker. Algorithm XXXX: MQSI—Monotone quintic spline interpolation. Submitted to ACM Transactions on Mathematical Software, August 2020.

Contributed & Invited Talks

Surrogate modeling of simulations for multiobjective optimization applications. SIAM Conference on Optimization (OP). July 2021, virtual event.

Computing sparse subsets of the Delaunay triangulation in high-dimensions for interpolation and graph problems. SIAM Conference on Computational Science and Engineering (CSE). March 2021, virtual event.

Multiobjective optimization of the variability of the high-performance Linpack solver. Winter Simulation Conference (WSC). December 2020, virtual event.

Multiobjective optimization of simulations with PARMOO. Argonne National Laboratory, Postdoctoral Research and Career Symposium. November 2020, virtual event.

Managing computationally expensive blackbox multiobjective optimization problems with libEnsemble. Spring Simulation Conference (SpringSim). May 2020, virtual event.

Algorithms and software for Delaunay interpolation and multiobjective optimization. Sandia National Laboratory, Wind Energy Technology, invited talk. February 2020, virtual event.

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

Algorithms and software for Delaunay interpolation and multiobjective optimization. Sandia National Laboratory, Center for Computing Research, invited talk. January 2020, Albuquerque, NM, USA.

A surrogate for local optimization using Delaunay triangulations. Sixth International Conference on Continuous Optimization (ICCOPT). August 2019, Berlin, Germany.

Computing the umbrella neighbourhood of a vertex in the Delaunay triangulation and a single Voronoi cell in arbitrary dimension. IEEE SoutheastCon. April 2018, St. Petersburg, FL, USA.

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

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

Global deterministic and stochastic optimization in a service oriented architecture. Spring Simulation Conference (SpringSim), High Performance Computing (HPC) Symposium. April 2017, Virginia Beach, VA, USA.

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

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

Professional Services & Activities

Referee (Peer-reviewer):

- The Visual Computer Journal (2021)
- ACM Transactions on Mathematical Software (2021)
- Supercomputing (2021)
- Quantum Information Processing (2021)
- Mathematical and Computer Applications (2021)
- Journal of Machine Learning Research (2019)
- IEEE SoutheastCon (2018 – 2020)

Session Chair (Minisymposium Organizer):

- SIAM Conference on Optimization (2021)
- SIAM Conference on Computational Science and Engineering (2021)
- IEEE SoutheastCon (2018)

Current Professional Memberships:

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

Virginia Tech CS Graduate Counsel:

- Counselor and founding member (Fall 2017 – Fall 2019)
- Organizing professional and social events for current and prospective graduate students

Teaching Experience

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

- Instructor for *CIS 2531: Introduction to Python Programming*
- Responsible for course content creation and instruction

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

- Instructor for *CS 3114: Data Structures and Algorithms* (with projects in Java)
- Responsible for moving course material and infrastructure online due to COVID-19

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

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