

Tyler H. Chang – CV

Building Open Source Software for Machine Learning and Optimization at Argonne National Laboratory

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SUMMARY AND GOALS

I am **passionate about building** robust and scalable software systems to solve complex real-world problems by leveraging state-of-the-art machine learning and optimization methods. I have nearly 8 years of experience building software systems for diverse scientific applications. In that time, I have **led 4 open source projects** and **contributed to 3 others**.

Since my passion is for building more-so than publishing, I am looking for an opportunity to build and scale similar systems in an industrial setting.

RECENT WORK EXPERIENCE

- Jun 2020 - Present. **Postdoctoral appointee: Argonne National Laboratory**, Math and Computer Science Division
- Built production-grade open source software for leveraging machine learning in multiobjective optimization workflows
 - Explored trade-offs between accuracy and latency in neural network architecture search on 1000+ node HPCs
 - Reduced time and cost of material manufacturing by factor of over 100x via active learning in a wet-lab environment
- Aug 2016 - May 2020. **Research fellow: Virginia Tech**, Dept. of Computer Science
- Researched and implemented novel methods for scientific machine learning and numerical optimization
 - Designed parallel algorithms and software for error-bounded machine learning and multiobjective optimization
 - Achieved 3x reduction in performance variability in leadership-class HPC at Argonne via above techniques
- 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

EDUCATION

Ph.D., May 2020, Computer Science, Virginia Polytechnic Institute & State University (Virginia Tech)
B.S., May 2016, Computer Science & Mathematics (double-major), Virginia Wesleyan University, *summa cum laude*

TECHNICAL SKILLS

Mathematical Skills:	numerical optimization, scientific machine learning, approximation theory, computational geometry
Computing Skills:	high-performance computing, open source software design, data structures & algorithms
Languages (expert):	Python, Fortran
Libraries (expert):	BLAS, jax, LAPACK, numpy, OpenMP, scipy
Languages (proficient):	C, C++, Java, Matlab
Libraries (proficient):	CUDA, keras, matplotlib, MPI, pandas, plotly/dash, pytorch, scikit-learn
Tools/Workflow:	CI/CD, GitFlow, GitHub Actions, pytest, qsub, slurm, sphinx

PUBLICLY AVAILABLE SOFTWARE (AS CREATOR OR CO-CREATOR)

4. 2022 - Present. ParMOO: Python library for parallel multiobjective simulation optimization. Release: 0.3.1
Devs: **T. H. Chang** (lead), S. M. Wild, and H. Dickinson In **Python 3**
git: <https://github.com/parmoo/parmoo> **68 stars** Used by: Argonne, Meta, Imperial College London, and more
3. 2017 - Present. DelaunaySparse: Interpolation via a sparse subset of the Delaunay triangulation.
Devs: **T. H. Chang** (lead), T. C. H. Lux, and L. T. Watson In **Fortran 2003** with **C, Python**, and CL interfaces
git: <https://github.com/vtopt/DelaunaySparse> **17 stars** Used by: Argonne, LLNL, DC Children's Hospital, and more
currently in discussion for inclusion in scipy "interpolate" module
2. 2020 - 2022. VTMOP: Solver for blackbox multiobjective optimization problems.
Devs: **T. H. Chang** (lead) and L. T. Watson In **Fortran 2008** with **Python** interface
git: <https://github.com/vtopt/VTMOP>
1. 2019 - 2020. QAML: Quantum annealing math library.
Devs: T. C. H. Lux (lead), **T. H. Chang**, and S. S. Tipirneni In **Python 3**
git: <https://github.com/tchlux/qaml>

SELECTED PUBLICATIONS (FROM 32 INDEXED ON SCHOLAR)

4. 2023. **T. H. Chang**, J. R. Elias, S. M. Wild, S. Chaudhuri, and J. A. Libera. A framework for fully autonomous design of materials via multiobjective optimization and active learning: challenges and next steps. *In 11th Intl. Conf. on Learning Representation (ICLR 2023), Workshop on Machine Learning for Materials (ML4Materials)*. **url**: <https://openreview.net/forum?id=8KJS7RPjMqG>
3. 2023. **T. H. Chang** and S. M. Wild. ParMOO: a Python library for parallel multiobjective simulation optimization. *Journal of Open Source Software* 8(82), Article 4468, 5 pages. **doi**: 10.21105/joss.04468
2. 2022. **T. H. Chang**, L. T. Watson, J. Larson, N. Neveu, W. I. Thacker, S. Deshpande, and T. C. H. Lux. Algorithm 1028: VTMO: Solver for blackbox multiobjective optimization problems. *ACM Transactions on Mathematical Software* 48(3), Article 36, 34 pages. **doi**: 10.1145/3529258
1. 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

NOTABLE CONTRIBUTIONS TO PUBLICLY AVAILABLE SOFTWARE

3. 2023 - Present. DeepHyper: Scalable asynchronous neural architecture & hyperparameter search for deep learning
My Contributions: DeepHyper team member adding multiobjective search features and benchmark problems
git: <https://github.com/deephyper/deephyper> **Python 3** **254 stars**
2. 2019 - Present. libEnsemble: Python toolkit for coordinating asynchronous dynamic ensembles of calculations
My Contributions: Adding new “generator” techniques and providing example use-cases
git: <https://github.com/Libensemble/libensemble> **Python 3** **59 stars**
1. 2016. Fun3D: Fully unstructured Navier-Stokes (by NASA Langley)
My Contributions: Optimizing block-sparse linear system solver for parallelization on NVIDIA GPUs
web: <https://fun3d.larc.nasa.gov> **Fortran** **90**

FUNDING AND AWARDS

Research Funding Raised

3. Mar 2024 - Present. **Key contributor (multiobjective search thrust lead)**, \$400K/y for 1 year. *High performance computing for development of critical thermodynamic inputs for next generation thermal barrier coatings*, external grant (HPC for Manufacturing, DE-AC02-05CH11231)
2. Mar 2023 - Sep 2023. **Co-PI (design optimization thrust lead)**, \$50K/y for 1 year. *A Scalable Multi-Physics Optimization Framework for Particle Accelerator Design*, institutional seed funding (LDRD 2023-0246)
1. Jun 2019 - Dec 2019. **Primary awardee**, \$3K/mo for 6 months. *An Adaptive Weighting Scheme for Multiobjective Optimization*, DOE award for PhD students (DE-SC0014664)

Awards and Accomplishments

4. Jan 2021. Nominee for Outstanding Dissertation Award, Virginia Tech, Graduate School
3. Apr 2016. Outstanding Student in Computer Science & Mathematics, Virginia Wesleyan University
2. Feb 2016. ACM International Collegiate Programming Competition (ICPC), winning team for CNU site, VA, USA
1. Feb 2015. ACM International Collegiate Programming Competition (ICPC), winning team for CNU site, VA, USA

LEADERSHIP AND SERVICE

Interns Advised

- Jun 2022 - Aug 2022. Manisha Garg (UIUC), NSF MSGI (PhD student intern) at Argonne
Jun 2022 - Aug 2022. Hyrum Dickinson (UIUC), DOE SULI (undergraduate intern) at Argonne

Teaching

- Jan 2022 - Present. **Adjunct Professor: College of DuPage**, Dept. of Computer and Info. Science (Intro to Python)
Jan 2020 - May 2020. **Instructor of Record: Virginia Tech**, Dept. of Computer Science (Data structures and algorithms)

Journal / Conference Referee

INFORMS Journal on Computing (2023–Present); ACM Trans. Mathematical Software (2021–Present); ICIAM (2023); Supercomputing (2021); Visual Computer Journal (2021); Quantum Information Processing (2021); JMLR (2019); IEEE SoutheastCon (2018–2020)

Minisymposium Organizer

Multiobjective Optimization Software track in SIAM Conference on Optimization (2021); Geometric Methods for Machine Learning track in SIAM Conference on Computational Science and Engineering (2021)