

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 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**.

I believe that making existing methods work for real problems (as opposed to publishing the next big thing) is an under-valued skill in my current field, so **I am looking for an opportunity to build in industry**.

RECENT WORK EXPERIENCE

Jun 2020 - Present. **Postdoctoral appointee: Argonne National Laboratory**, MCS Division

- Built production-grade open source software for leveraging machine learning in numerical 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 blackbox 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: Machine learning surrogate-assisted simulation optimization on HPCs. 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: Interpretable machine learning via Delaunay interpolation.
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: Parallel solver for computationally expensive 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: Library for converting Python code into quantum annealing circuits.
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)

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>
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
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
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

- 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**
- 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**
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

- 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)
- 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)
- 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

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