# Tyler H. Chang

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Mathematics & Computer Science (MCS) Division
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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)
- *Advisor: Prof. Layne Watson*
- *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
- Designed and implemented a Python framework for building and deploying multiobjective optimization solvers
- Deployed optimization solvers for particle accelerator design, material discovery (see projects), and DFT modeling

Aug 2016 - May 2020.     **Cunningham fellow: Virginia Tech**, Dept. of Computer Science
- Designed parallel algorithms and software for predicive modeling, blackbox optimization, and computational geometry
- Applied solvers to model and tune HPC systems (see projects) to control performance variability

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

2023. **ParMOO**: Python library for parallel multiobjective simulation optimization. Release: 0.2.1
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 (lead), **T. H. Chang**, and S. S. Tipirneni        Primary Prog. Lang: `Python 3`
git: `https://github.com/tchlux/qaml`

# Publications

## Publications In-Press

**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. *To appear in 11th Intl. Conf. on Learning Representation (ICLR 2023), Workshop on Machine Learning for Materials (ML4Materials)*. url: `https://openreview.net/forum?id=8KJS7RPjMqG`

## Publications Under Review

**T. H. Chang** and S. M. Wild. Designing a framework for solving multiobjective simulation optimization problems. Submitted to Advances in Engineering Software, Apr 2023. Preprint: `https://arxiv.org/abs/2304.06881`.

## Peer-Reviewed Journal Articles

2023. T. C. H. Lux, L. T. Watson, **T. H. Chang**, and W. I. Thacker. Algorithm 1031: MQSI—Monotone quintic spline interpolation. *ACM Transactions on Mathematical Software* 49(1), Article 6, 17 pages. `doi: 10.1145/3570157`

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`

2023. N. Neveu, **T. H. Chang**, P. Franz, S. Hudson, and J. Larson. Comparison of multiobjective optimization methods for the LCLS-II photoinjector. *Computer Physics Communication* 283, Article 108566, 10 pages. `doi: 10.1016/j.cpc.2022.108566`

2023. 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. *Journal of Quality Technology* 55(1), pp. 88–103. `doi: 10.1080/00224065.2022.2035285`

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. Orlando, FL, USA. `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. Fairfax, VA, USA. `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. Fairfax, VA, USA. `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*, 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*, 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

2023. **T. H. Chang**, S. M. Wild, and H. Dickinson. *ParMOO: Python library for parallel multiobjective simulation optimization*. Technical Report Version 0.2.1. Argonne National Laboratory, Lemont, Illinois, USA. url: `https://parmoo.readthedocs.io/_/downloads/en/latest/pdf/`

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.

# Funding

## Current

Mar 2023 - Sep 2023.    A Scalable Multi-Physics Optimization Framework for Particle Accelerator Design.
*ANL LDRD: 2023 LDRD Seed* (LDRD 2023-0246).
Type: ANL LDRD seed award.    Budget: $50K.
**Role: co-PI.**    PI: G. Chen (ANL).

## Past Proposals (rejected)

FY 2023.    Assessing the Quality of Scientific Data Sets for Machine Learning.
*ANL LDRD: 2023 LDRD Seed*.
Type: full proposal (3 pages + appendices).    Budget: $25K.    Length: 7 months.
**Role: PI.**

FY 2023.    Statistical and Mathematical Innovations for Next Generation Facilities.
*DOE ASCR: 2022 Mathematical Multifaceted Integrated Capability Centers (MMICCS)* (DE-FOA-0002704).
Type: full proposal (20 pages + appendices).    Budget: $12.7M.    Length: 5 years.
**Role: investigator.**    Dir: R. Joseph (GA Tech). Institution Lead: Z. Di (ANL).

FY 2023.    Visual Analytics for Complex Network Workflows to Accelerate Science into Decision Making.
*DOE ASCR: Data Visualization for Scientific Discovery, Decision-Making, and Comm.* (DE-FOA-0002726).
Type: full proposal (16 pages + appendices).    Budget: $2.7M.    Length: 3 years.
**Role: key personnel.**    PI: G. Chin (PNNL).    Institution Lead: T. Munson (ANL).

FY 2023.    Accelerating Multi-Objective Neural Architecture Search.
*ANL CELS: 2022 LDRD Advanced Computing Expedition*.
Type: short proposal (1 paragraph + admin info.).    Budget: $33.6K.    Length: 8 weeks.
**Role: co-PI.**    With: S. Khairy (ANL).

FY 2021.    FAIR Delaunay Benchmarking of Scientific AI Workflows.
*DOE ASCR: FAIR Frameworks for Data and AI Models* (LAB 20-2306).
Type: full proposal (13 pages + appendices).    Budget: $2.1M.    Length: 3 years.
**Role: key personnel.**    PI: A. Gillette (LLNL).    Institution Lead: Z. Di (ANL).

# Advising

Jun 2022 - Aug 2022.    Manisha Garg (Urbana-Champaign), NSF MSGI at Argonne
- Project: Model agnostic sampling techniques for generating design-of-experiments

- Project resulted in software package (pre-release) and conference article (in preparation)

Jun 2022 - Aug 2022.     Hyrum Dickinson (Urbana-Champaign), DOE SULI at Argonne
- Project: Visualization tools for the ParMOO library
- Project resulted in a new feature in ParMOO v0.2.0 and credit in our user documentation

# Mentoring

Aug 2022.     Srinivas Eswar (postdoc at Argonne), via Argonne Navigator Program

Mar 2021.     Bosco Ndemeye (PhD student at Univ. of Oregon), via SIAM CSE Mentoring Program

# Teaching

Jan 2022 - Present.     **Adjunct Professor: College of DuPage**, Dept. of Computer and Info. Science
- Spring 2022. CIS 2531: Introduction to Python Programming (online)

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

Jan 2013 - Dec 2015.     **Subject Tutor: Virginia Wesleyan University**, Learning Center
- Spring 2013 - Fall 2014. All undergraduate courses in calculus, computer science, and statistics

# Talks and Presentations

## Invited Conference Talks

Mar 2023. ParMOO: a Python library for parallel multiobjective simulation optimization. *SIAM Conference on Computational Science and Engineering (CSE 2023)*, Amsterdam, Netherlands.

Sep 2022. Geometric considerations when surrogate modeling. *SIAM Conference on Mathematics of Data Science (MDS 2022)*, San Diego, CA, USA.

Jul 2021. Surrogate modeling of simulations for multiobjective optimization applications. *SIAM Conference on Optimization (OP 2021)*, 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.

## 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.

## Contributed Talks

Jul 2022. ParMOO: a parallel framework for multiobjective simulation optimization problems. *Seventh International Conference on Continuous Optimization (ICCOPT 2022)*, Bethlehem, PA, USA.

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.

## Posters and Lightning Talks

Oct 2022. ParMOO: a Python library for parallel multiobjective simulation optimization (lightning talk). *FASTMath All-Hands Meeting*, Denver, CO, USA.

May 2022. ParMOO: parallel multiobjective optimization in python (poster). *The Argonne, Chicago, Michigan, Northwestern, Toyota, Wisconsin (ACMNTW) Workshop on Optimization and Machine Learning*, Evanston, IL, USA.

Feb 2020. VarSys: managing variability for high performance computers, cloud computing systems, and computer security (poster). *Virginia Tech, Graduate Student Recruitment Weekend, Lab Poster Session*, Blacksburg, VA, USA.

Aug 2019. An adaptive weighting scheme for multiobjective optimization (lightning talk). *Argonne National Laboratory, LANS SASSy Seminar Series*, Lemont, IL, USA.

Mar 2019. VarSys: managing variability for high performance computers, cloud computing systems, and computer security (poster). *Virginia Tech, Graduate Student Recruitment Weekend, Lab Poster Session*, Blacksburg, VA, USA.

Sep 2018. A polynomial time algorithm for multivariate interpolation in arbitrary dimension via the Delaunay triangulation (lightning talk). *Virginia Tech, CS GSC: Lightning Talks*, Blacksburg, VA, USA.

Mar 2018. VarSys: managing variability for high performance computers, cloud computing systems, and computer security (poster). *Virginia Tech, Graduate Student Recruitment Weekend, Lab Poster Session*, Blacksburg, VA, USA.

Aug 2014. Real-time target identification in Matlab with OpenCV (poster). *US Army Research Laboratories, Summer Student Poster Symposium*, Aberdeen, MD, USA.

# 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 HPC, Networking, Storage, and Analysis (Supercomputing) 2021
- 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

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|---|---|
| Nov 2022 - Present. | **Organizing Committee: FASTMath Institute Seminar Series** |
| Dec 2022 - Jan 2023. | **Hiring Committee: MCS Division** |
| Oct 2022 - Dec 2022. | **Technical Reviewer: Sustainable Research Pathways** |
| Mar 2022 - Apr 2022. | **Red Team Reviewer: ASCR Pre-proposals** |

## Virginia Tech

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|---|---|
| Aug 2017 - May 2020. | **Founding Member: Computer Science Graduate Counsel** |
| Dec 2018 - Mar 2019. | **Lead Student Organizer: Computer Science Graduate Preview Weekend** |

# Post-Dissertation Courses and Certifications

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|---|---|
| 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 |

# Misc. Travel Awards

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|---|---|
| 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

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|---|---|
| **Languages:** | Python, Fortran, C/C++, Java, Matlab |
| **OS:** | MacOS, Unix/Linux |
| **Markup:** | HTML/CSS, GNU Make, TeX/LaTeX/bibTeX |
| **Libraries:** | numpy, pandas, scipy, matplotlib, keras, sklearn, MPI, OpenMP, CUDA, BLAS, LAPACK |
| **Tools/Frameworks:** | pytest, sphinx, slurm, CI/CD, GitHub Actions, GitFlow |