Alp Dener

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Research Interests

Optimization: PDE-constrained Problems, Gradient-based Algorithms, Sensitivity Analysis, MDO Architectures
Machine Learning: Physics Informed Neural Networks, Constrained Training Methods, Supervised Learning
Scientific Computing: High Performance Computing for Optimization, Reusable Scientific Software

Education

Rensselaer Polytechnic Institute December 2017
Aeronautical Engineering, Ph.D.

University of Maryland, Baltimore County May 2012
Mechanical Engineering, B.S.

Work Experience

Postdoctoral Appointee – Argonne National Laboratory Feb 2018–Present
Mathematics and Computer Science Division Supervisor: Todd S. Munson
- Principal developer on Toolkit for Advanced Optimization (TAO) and contributor to PETSc
- Research large-scale optimization algorithms with efficient treatment of nonlinear constraints
- Promote TAO, expand its user base, and provide software support for external researchers

Graduate Research Assistant – Rensselaer Polytechnic Institute Feb 2013–Dec 2017
Optimal Design Lab Supervisor: Jason E. Hicken
- Investigate PDE-constrained multi-disciplinary design optimization problems
- Research gradient-based, reduced-space, matrix-free optimization algorithms
- Develop a parallel-agnostic optimization library tailored for large-scale engineering systems

Undergraduate Research Assistant – University of Maryland, Baltimore County Oct 2010–May 2011
Joint Center for Earth Systems Technology Supervisor: Gergely Dolgos
- Construction of an optical aerosol measurement instrument
- Design and manufacture of high-precision optical component mounts
- Propose instrument mounting solutions for the NASA GSFC science fleet aircraft

Honors & Awards

- AIAA Student Paper Competition - 1st Place 2018
  - Category: Multidisciplinary Analysis and Optimization

Publications and Presentations

Journal Articles

Dener, Alp, M Andres Miller, et al. (2020). "Training neural networks under physical constraints using a stochastic augmented Lagrangian approach (submitted)". In: *Journal of Computational Physics*.

Miller, M Andres et al. (2020). "Encoder-decoder neural network for solving the nonlinear Fokker-Planck-Landau collision operator in XGC (accepted)". In: *Journal of Plasma Physics*.

Mills, Richard Tran et al. (2020). "Toward Performance-Portable PETSc for GPU-based Exascale Systems (submitted)". In: *IEEE Transactions on Parallel and Distributed Systems (Special Section on Innovative R&D toward the Exascale Era)*.

Dener, Alp and Jason E Hicken (2017). "Matrix-free Algorithm for the Optimization of Multidisciplinary Systems". In: *Structural and Multidisciplinary Optimization, Springer*. DOI: 10.1007/s00158-017-1734-0.

Hicken, Jason E and Alp Dener (2015). "A Flexible Iterative Solver for Nonconvex, Equality-constrained Quadratic Subproblems". In: *Journal on Scientific Computing, SIAM*. DOI: 10.1137/140994496.

Refereed Proceedings

Dener, Alp, Adam Denchfield, and Todd S Munson (June 2019). "Preconditioning nonlinear conjugate gradient with diagonalized quasi-Newton". In: *Proceedings for the Platform for Advanced Scientific Computing Conference*. Zurich, Switzerland. DOI: 10.1145/3324989.3325712.

Dener, Alp and Todd S Munson (June 2019). "Accelerating Limited-Memory Quasi-Newton Convergence for Large-Scale Optimization". In: *International Conference on Computational Science*. Faro, Portugal. DOI: 10.1007/978-3-030-22744-9_39.

Dener, Alp, Jason E Hicken, et al. (June 2018). "Enabling Modular Aerostructural Optimization: Individual Discipline Feasible without the Jacobians". In: *2018 Multidisciplinary Analysis and Optimization Conference, AIAA AVIATION Forum*. Atlanta, GA, USA. DOI: 10.2514/6.2018-3570.

Dener, Alp, Pengfei Meng, et al. (Jan. 2016). "Kona: A Parallel Optimization Library for Engineering-Design Problems". In: *57th AIAA/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference, AIAA SciTech Forum*. San Diego, CA, USA. DOI: 10.2514/6.2016-1422.

Dener, Alp, Gaetan K W Kenway, et al. (Jan. 2015). "Comparison of Inexact- and Quasi-Newton Algorithms for Aerodynamic Shape Optimization". In: *53rd AIAA Aerospace Sciences Meeting, AIAA SciTech Forum*. Kissimmee, FL, USA. DOI: 10.2514/6.2015-1945.

Dener, Alp and Jason E Hicken (Jan. 2014). "Revisiting Individual Discipline Feasible with matrix-free Inexact-Newton-Krylov". In: *10th AIAA Multidisciplinary Design Optimization Conference, AIAA SciTech Forum*. National Harbor, MD, USA. DOI: 10.2514/6.2014-0110.

Technical Reports

Balay, Satish et al. (2020). *PETSc Users Manual*. Tech. rep. ANL-95/11 - Revision 3.14. Argonne National Laboratory.

Dener, Alp et al. (2020). *TAO Users Manual*. Tech. rep. ANL/MCS-TM-322 - Revision 3.14. Argonne National Laboratory.

Preprints / Working Papers

Dener, Alp et al. (2021). "Toward Constrained Optimization in Machine Learning: An Error-Tolerant Multisecant Method for Training PINNs (in preparation)". In: *arXiv preprint*.

Hicken, Jason E, Pengfei Meng, and Alp Dener (2017). "Error-tolerant multisecant method for nonlinearly constrained optimization". In: *arXiv preprint arXiv:1709.06985*.

Conference Presentations

Dener, Alp, Todd S Munson, et al. (Mar. 2021). *Toward Constrained Optimization in Machine Learning: An Error-Tolerant Multisecant Method for Training PINNs*. SIAM Conference on Computational Science and Engineering.

Dener, Alp (Feb. 2020). *Investigating Quasi-Newton Outer Product Representations on GPUs*. SIAM Conference on Parallel Processing for Scientific Computing.

Dener, Alp, Adam Denchfield, and Todd S Munson (Feb. 2019). *Acelerating Quasi-Newton and Conjugate Gradient Convergence for Large-Scale Optimization*. SIAM Conference on Computational Science and Engineering.

Doctoral Thesis

Dener, Alp (Dec. 2017). "A Modular Matrix-free Approach to Multidisciplinary Design Optimization". PhD thesis. Rensselaer Polytechnic Institute.

Proposal Contributions

"Development of a Machine Learning Toolkit in PETSc", co-investigator, LDRD Prime - Future Computing, 2021-0177, 2021, (funded) **"Frameworks, Algorithms and Scalable Technologies for Mathematics (FASTMath) SciDAC Institute"**, numerical optimizations expert, DOE-ASCR, LAB 20-2223, 2020, (funded) **"Machine Learning and Artificial Intelligence forSimulation Acceleration and Real-Time ScientificDiscovery of Fusion Science on Exascale Computers (MASS)"**, numerical optimization expert, DOE-FES, LAB 20-2224, 2020, (not funded) **"Machine learning enhanced sampling methods for the stochastic multi-fidelity optimization of complex systems"**, numerical optimization expert, DOE-ASCR, LAB 20-2321, 2020, (not funded)

Professional Activities and Service

Referee/Reviewer
- Mathematics of Optimization Research (2018-)
- SIAM Journal on Scientific Computing (2018-)
- Optimization and Engineering (2018-)
- AIAA Journal (2018-)
- DOE SBIR Phase I Review Panel (2019)

Conference Service
- Session Organizer: SIAM CSE19, SIAM CSE21

Argonne Training Program for Extreme-Scale Computing
- Lead Organizer, Numerical Software Track (2021-)
- Organizer, Numerical Software Track (2020)
- Lecturer, Numerical Software Track (2019-)

National Science Bowl
- Questions Judge, Illinois Regionals (2021)

Societies
- American Institute of Aeronautics and Astronautics (2012-)
- Society of Industrial and Applied Mathematics (2012-)
- Mathematical Optimization Society (2018-)
- Institute for Operations Research and the Management Sciences (2018-)

Givens Associates
- Jamal Shabani, Luisiana State University (2021)
- Han Sol Suh, Georgia Institute of Technology (2019)