Youngdae Kim, Ph.D.

Postdoctoral Researcher
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Employment

Postdoctoral Researcher	Argonne National Laboratory, August 2018 – present
Postdoctoral Researcher	University of Wisconsin-Madison, February 2018 – August 2018
Research Aide	Argonne National Laboratory, July 2012 – August 2012
Graduate Research Assistant	University of Wisconsin-Madison, September 2012 – December 2017
Graduate Teaching Assistant	University of Wisconsin-Madison, January 2012 – May 2012
Research Software Engineer	TmaxCore, South Korea, 2009-2010
Software Engineer	Inzen, South Korea, 2002-2005

Education

Ph.D.	University of Wisconsin-Madison, Madison, WI, September 2011 – December 2017 Computer Sciences
M.S.	POSTECH, Pohang, South Korea, 2009 Computer Science and Engineering
B.S.	POSTECH, Pohang, South Korea, 2007 Computer Science and Engineering and Mathematics (double major)

Professional Experience

Argonne National Laboratory (08/2018-Current)

Areas that I have worked or am working on: power system optimization, accelerating nonlinear optimization and PDEs using GPUs, federated learning

- (Oct 2021-present) Developing a computational framework for privacy-preserving federated learning (written in Python): it supports MPI- and gPRC-based federated learning (FL), allowing FL to be performed on a cluster (e.g., Summit) or mixed remote platforms. It is incorporating various adversarial attack models (e.g., model inversion attacks) to simulate and validate its privacy-preserving capability.
- (Feb 2021-present) Developing a GPU-based hyperbolic-parabolic partial differential equations solver (written in C++): it solves PDEs over Cartesian grids solely on GPUs without data transfers between CPUs and GPUs and supports multiple GPUs on a cluster (e.g., Summit) via CUDA-aware MPIs. Currently, on a single Nvidia's V100 GPU, performance is about 200x times faster than on a single CPU core (Intel Xeon Gold 6140@2.3 GHz). For a grid with 256^3 points, it can perform 100 time steps in 2 seconds using 512 GPUs on Summit cluster.
- Developed a GPU-based solver for batch nonlinear programming (written in Julia): it can solve tens of thousands of nonlinear optimization problems in parallel on multiple GPUs using MPI [3]. Currently, it supports Nvidia and AMD GPUs (Summit and Frontier), and work is in progress to support Intel GPUs (Aurora).

– Developed a GPU-compatible ADMM (alternating direction method of multipliers) decomposition method with convergence guarantees for distributed computation of large-scale alternating current optimal power flows on multiple GPUs (written in Julia) [2][3]. It outperforms its CPU implementation with 40 cores by a factor of 35 using 6 GPUs on the Summit supercomputer. Currently, it supports Nvidia and AMD GPUs (Summit and Frontier), and work is in progress to support Intel GPUs (Aurora).

– Developed a real-time optimization algorithm for multiperiod AC optimal power flows (written in Julia) [2]: it computes an approximate solution 75 times faster than when we compute an exact solution and the solution is at high accuracy with errors less than 10^{-4}.

University of Wisconsin-Madison (02/2018-08/2018)

Areas that I have worked on: algorithms and interfaces for variational inequalities and generalized Nash equilibrium problems

– Developed and implemented distributed Nash equilibrium methods (written in C): it uses (overlapped) group decomposition methods to perform a distributed Nash equilibrium computation. It has been included in GAMS.

– Developed a structure-preserving pivotal method for affine variational inequalities (written in C): it uses Lemke's pivoting method to find a solution to affine variational inequalities.

– Implemented a rank-1 block LU update routine (written in C): it is currently being used as one of the linear algebra engines in a commercial software PATH.

TmaxCore (2009-2010)

– Developed device drivers for network interface cards and USB cameras for the Tmax operating system (written in C): by reverse engineering the portable executable file structure of Windows device drivers, I developed a compatibility layer for devices to connect to the Tmax operating system.

Inzen (2002-2005)

– Developed and maintained a rule-based system intrusion detection system (written in C++): for each audit system call provided by a UNIX operating system, the program creates an event and checks abnormality over predefined rules. Rules can detect buffer overflow attacks, unauthorized file accesses, abnormal system calls, abnormal network IP connections, etc.

Software

– ExaAdmm.jl: an ADMM solver for AC optimal power flows on GPUs (written in Julia)

– ExaTron.jl: a batch nonlinear programming solver on GPUs (written in Julia)

– Voltage regulation via mixed complementarity formulations (written in Python, C, and GAMS)

– A real-time optimization of a rolling horizon of multiperiod ACOPFs [2] (written in Julia)

– SELKIE (written in C)

  A meta-solver that implements a group-based decomposition for structured equilibrium problems. It is available in a commercial software GAMS (General Algebraic Modeling System).

– New JAMS for equilibrium programming (written in Delphi)

  A modeling framework for specifying equilibrium problems, such as generalized Nash equilibrium, multiple optimization problems with equilibrium constraints, and quasi-variational inequalities. It is available in a commercial software GAMS (General Algebraic Modeling System). See published Journal article [4].

– Block LU update (written in C)

  A rank-1 update routine for an efficient large-scale optimization. It is currently being used as one of the linear algebra engines in a commercial software PATH.

– PATHVI (written in C)

  A Newton-based complementary pivotal method for variational inequalities. See published Journal article [5].

Programming Skills

C, C++, Julia, Python, CUDA, MPI, MATLAB, AMPL, GAMS

Publications (See Google scholar)

Book Chapters

[1] Youngdae Kim, Sven Leyffer, Todd Munson. MPEC methods for bilevel optimization. In *Bilevel optimization: advances and next challenges*, Springer, 2020.

Journals

[1] Noam Goldberg, Steffen Rebennack, Youngdae Kim, Vitaliy Krasko, Sven Leyffer. MINLP formulations for continuous piecewise linear function fitting. *Computational Optimization and Applications*, 2021

[2] Youngdae Kim, Mihai Anitescu. A real-time optimization with warm-start of multiperiod AC optimal power flows. *Electric Power Systems Research*, 2020

[3] Wonjun Chang, Michael C. Ferris, Youngdae Kim, Thomas F. Rutherford. Solving stochastic dynamic programming problems: a mixed-complementarity approach. *Computational Economics*, 2020

[4] Youngdae Kim, Michael C. Ferris. Solving equilibrium problems using extended mathematical programming. *Mathematical Programming Computation*, 11(3): 457-501, 2019

[5] Youngdae Kim, Olivier Huber, Michael C. Ferris. A structure-preserving pivotal method for affine variational inequalities. *Mathematical Programming, Series B*, 168(1-2): 93-121, 2018

[6] Noam Goldberg, Youngdae Kim, Sven Leyffer, Thomas D. Veselka. Adaptively refined dynamic program for linear spline regression. *Computational Optimization and Applications*, 58(3): 523-541, 2014

[7] Youngdae Kim, Ilhwan Ko, Wook-shin Han, Hwanjo Yu. iKernel: Exact indexing for support vector machines. *Information Sciences*, 257(1): 32-53, 2014

[8] Hwanjo Yu, Jinha Kim, Youngdae Kim, Seung-won Hwang, Young Ho Lee. An efficient method for learning nonlinear ranking SVM functions. *Information Sciences*, 209(20): 37-48, 2012

[9] Youngdae Kim, Gae-won You, Seung-won Hwang. Ranking strategies and threats: a cost-based pareto optimization approach. *Distributed and Parallel Databases*, 26(1): 127-150, 2009

Conferences

[1] Youngdae Kim, Mihai Anitescu. A real-time optimization with warm-start of multiperiod AC optimal power flows. The 21st *Power Systems Computation Conference*, 2020

[2] Hwanjo Yu, Ilhwan Ko, Youngdae Kim, Seung-won Hwang, Wook-shin Han. Exact indexing for support vector machines. In Proc. of the *ACM SIGMOD Conference on Data Management*, June 12-16, 2011, Athens, Greece, pp. 709-720

[3] Hwanjo Yu, Youngdae Kim, Seung-won Hwang. RV-SVM: An efficient method for learning ranking SVM. *Pacific-Asia Conference on Knowledge Discovery and Data Mining*, 426-438, 2009

[4] Youngdae Kim, Gae-won You, Seung-won Hwang. Escaping a dominance region at minimum cost. *International Conference on Database and Expert Systems Applications*, 800-807, 2008

[5] Youngdae Kim, Seung-won Hwang. Approximate boolean + ranking query answering using wavelets. *International Conference on Web-Age Information Management*, 17-24, 2008

Technical Reports

[1] Sihan Zeng, Alyssa Kody, Youngdae Kim, Kibaek Kim, Daniel K. Molzahn. A reinforcement learning approach to parameter selection for distributed optimization in power systems. Submitted 2021

[2] Youngdae Kim, Kibaek Kim. Accelerated computation and tracking of AC optimal power flow solutions using GPUs. Submitted 2021

[3] Youngdae Kim, François Pacaud, Kibaek Kim, Mihai Anitescu. Leveraging GPU batching for scalable nonlinear programming through massive Lagrangian decomposition. Submitted 2021

[4] Youngdae Kim, Kibaek Kim. A mixed complementarity problem approach for steady-state voltage and frequency stability analysis. Submitted 2021

[5] Anirudh Subramanyam, Youngdae Kim, Michel Schanen, François Pacaud, Mihai Anitescu. A globally convergent distributed Jacobi scheme for block-structured nonconvex constrained optimization problems. Submitted 2021

[6] Mihai Anitescu, Kibaek Kim, Youngdae Kim, Daniel Maldonado, François Pacaud, Vishwas Rao, Michel Schanen, Sungho Shin, Anirudh Subramanyam. Targeting exascale with Julia on GPU for multiperiod optimization with scenario constraints. Submitted 2021

[7] Michel Schanen, Daniel Adrian Maldonado, François Pacaud, Alexis Montoison, Mihai Anitescu, Kibaek Kim, Youngdae Kim, Vishwas Rao, Anirudh Subramanyam. Julia as portable high-level language for numerical solvers of power flow equations on GPU architectures. 2021

Grants

- NeuralOpt: large-scale differentiable optimization neural layer (PI, $25,000 from LDRD Seed)

Service

Journals reviewed for

Journal of Global Optimization, Mathematics of Computation, Mathematical Methods of Operations Research, Mathematical Programming, Mathematical Programming Computation, Optimization Methods and Software, SIAM Journal on Optimization, SIAM Journal on Scientific Computing, SN Operations Research Forum