Donghwan Kim

Contact Information

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Research Interests

Optimization for Machine Learning, Generalization in Machine Learning

Academic Appointment

KAIST, Daejeon, Republic of Korea

Assistant Professor of Mathematical Sciences Dept. Aug. 2018 - present

Education

University of Michigan, Ann Arbor, MI USA

Ph.D., Electrical Engineering: Systems Aug. 2014

- Thesis: Accelerated optimization algorithms for statistical 3-D X-ray CT image reconstruction
- Advisor: Prof. Jeffrey A. Fessler

M.S.E., Electrical Engineering: Systems May 2011

Seoul National University, Seoul, Republic of Korea

B.S., Electrical Engineering Feb. 2009

Academic Experience

Dartmouth College, Hanover, NH USA

Research Instructor of Math Dept. Jul. 2017 - Jul. 2018

- Advisor: Prof. Anne Gelb

Harvard University, Cambridge, MA USA

Postdoctoral Research Fellow of SEAS Sep. 2015 - Mar. 2016

- Advisor: Prof. Demba Ba

University of Michigan, Ann Arbor, MI USA

Postdoctoral Research Fellow of EECS Dept. Jun. 2014 - Aug. 2015, Jun. 2016 - Jun. 2017
Graduate Student Research Assistant of EECS Dept. Jan. 2010 - May 2014

- Advisor: Prof. Jeffrey A. Fessler

Submitted Papers / In Preparation

- A. Alacaoglu, **D. Kim** and S. J. Wright "Extending the reach of first-order algorithms for nonconvex min-max problems with cohypomonotonicity." [arXiv e-print 2402.05071].
- S. Lee and **D. Kim**, "Semi-anchored multi-step gradient descent ascent method for structured nonconvex-nonconcave composite minimax problems," [arXiv e-print 2105.15042].

Journal/ Conference Papers

- J. Chae, K. Kim and **D. Kim**, "Two-timescale extragradient for finding local minimax points," ICLR, 2024. [arXiv e-print 2305.16242].
- J. Chae, K. Kim and **D. Kim**, "Open Problem: Is there a first-order method that only converges to local minimax optima?," COLT, 2023.
- S. Lee and **D. Kim**, "Fast extra gradient methods for smooth structured nonconvex-nonconcave minimax problems," NeurIPS, 2021. [arxiv e-print 2106.02326].
- **D. Kim**, "Accelerated proximal point method for maximally monotone operators," *Mathematical Programming, Series A*, vol. 190, no. 1, pp. 57-87, Nov. 2021. [arXiv e-print 1905.05149].

- **D. Kim** and J. A. Fessler, "Optimizing the efficiency of first-order methods for decreasing the gradient of smooth convex functions," *J. Optim. Theory Appl.*, vol. 188, no. 1, pp. 192-219, Jan. 2021. [arXiv e-print 1803.06600].
- K. Kim, **D. Kim**, J. Yang, G. El Fakhri, Y. Seo, J. A. Fessler and Q. Li, "Time of flight PET reconstruction using non-uniform update for regional recovery uniformity," *Med. Phys.*, vol. 46, no. 2, pp. 649-64, Feb. 2019.
- **D. Kim** and J. A. Fessler, "Adaptive restart of the optimized gradient method for convex optimization," *J. Optim. Theory Appl.*, vol. 178, no. 1, pp. 240-63, Jul. 2018. [arXiv e-print 1703.04641].
- **D. Kim** and J. A. Fessler, "Generalizing the optimized gradient method for smooth convex minimization," *SIAM J. Optim.*, vol. 28, no. 2, pp. 1920-50, 2018. [arXiv e-print 1607.06764].
- **D. Kim** and J. A. Fessler, "Another look at the fast iterative shrinkage/thresholding algorithm (FISTA)," *SIAM J. Optim.*, vol. 28, no. 1, pp. 223-50, 2018. [arXiv e-print 1608.03861]
- **D. Kim** and J. A. Fessler, "Accelerated dual gradient-based methods for total variation image denoising/deblurring problems," *IEEE Conf. Acoust. Speech Sig. Proc.*, pp. 6230-4, 2017.
- **D. Kim** and J. A. Fessler, "On the convergence analysis of the optimized gradient method," *J. Optim. Theory Appl.*, vol. 172, no. 1, pp. 187-205, Jan. 2017. [arXiv e-print 1510.08573]
- **D. Kim** and J. A. Fessler, "Optimized first-order methods for smooth convex minimization," *Mathematical Programming, Series A*, vol. 159, no. 1, pp. 81-107, Sep. 2016. [arXiv e-print 1406.5468]
- **D. Kim** and J. A. Fessler, "An optimized first-order method for image restoration," *Proc. IEEE Intl. Conf. on Image Processing.*, pp. 3675-9, 2015.
  ⋆ **Received top** 10% **paper recognition**
- **D. Kim** and J. A. Fessler, "Distributed block-separable ordered subsets for helical X-ray CT image reconstruction," *Proc. Intl. Mtg. on Fully 3D image Recon. in Rad. and Nuc. Med.*, pp. 138-41, 2015.
- **D. Kim**, S. Ramani, and J. A. Fessler, "Combining ordered subsets and momentum methods for accelerated X-ray CT image reconstruction," *IEEE Trans. Med. Imag.*, vol. 34, no. 1, pp. 167-78, Jan. 2015.
- **D. Kim** and J. A. Fessler, "Optimized momentum steps for accelerating X-ray CT ordered subsets image reconstruction," *Proc. Third Intl. Mtg. on image formation in X-ray computed tomography*, pp. 103-6, 2014.
- **D. Kim**, D. Pal, J.-B. Thibault, and J. A. Fessler, "Accelerating ordered subsets image reconstruction for X-ray CT using spatially nonuniform optimization transfer," *IEEE Trans. Med. Imag.*, vol. 32, no. 11, pp. 1965-78, Nov. 2013.
- **D. Kim** and J. A. Fessler, "Ordered subsets acceleration with relaxed momentum for X-ray CT image reconstruction," *Proc. IEEE Nuc. Sci. Symp. Med. Im. Conf.*, 2013.
  ⋆ **Student paper competition finalist**
- **D. Kim**, S. Ramani, and J. A. Fessler, "Accelerating X-ray CT ordered subsets image reconstruction with Nesterov's first-order methods," *Proc. Intl. Mtg. on Fully 3D image Recon. in Rad. and Nuc. Med.*, pp. 22-5, 2013.
- **D. Kim**, S. Ramani, and J. A. Fessler, "Ordered subsets with momentum for accelerated X-ray CT image reconstruction," *Proc. IEEE Conf. Acoust. Speech Sig. Proc.*, pp. 920-3, 2013.
- **D. Kim**, D. Pal, J.-B. Thibault, and J. A. Fessler, "Improved ordered subsets algorithm for 3D X-ray CT image reconstruction," *Proc. Second Intl. Mtg. on image formation in X-ray computed tomography*, pp. 378-81, 2012.
- **D. Kim** and J. A. Fessler, "Parallelizable algorithms for X-ray CT image reconstruction with spatially non-uniform updates," *Proc. Second Intl. Mtg. on image formation in X-ray computed tomography*, pp. 33-7, 2012.

- J. A. Fessler and **D. Kim**, "Axial block coordinate descent (ABCD) algorithm for X-ray CT image reconstruction," *Proc. Intl. Mtg. on Fully 3D image Recon. in Rad. and Nuc. Med.*, pp. 262-5, 2011.
- **D. Kim** and J. A. Fessler, "Accelerated ordered-subsets algorithm based on separable quadratic surrogates for regularized image reconstruction in X-ray CT," *Proc. IEEE Intl. Symp. Biomed. Imag.*, pp. 1132-7, 2011.

Technical Reports

- **D. Kim** and J. A. Fessler, "Fast dual proximal gradient algorithms with rate $O(1/k^{1.5})$ for convex minimization," [arXiv e-print 1609.09441].

Patents and Disclosures

- *U.S. Patent* No. 9,721,361, D. Pal, E. Drapkin, J.-B. Thibault, S. Srivastava, R. Thome, M. McGaffin, J. A. Fessler, **D. Kim**, "Systems and methods for parallel processing of imaging information."
- *U.S. Patent* No. 9,489,752, **D. Kim**, S. Ramani, J. A. Fessler, L. Fu, and B. K. B. De Man, "Ordered subsets with momentum for X-ray CT image reconstruction."
  ⋆ **Licensed to a medical imaging vendor**
- *U.S. Patent* No. 8,958,660, D. Pal, **D. Kim**, J. H. Cho, J. A. Fessler, J.-B. Thibault, Z. Yu, S. Srivastava, L. Fu, and B. K. B. De Man, "Method and apparatus for iterative reconstruction."

Honors and Awards

Excellence in Teaching Award, College of Natural Sciences, KAIST	2022
Soo-Young Lee Teaching Innovation Award (Excellence Prize), KAIST	2021
TJ Park Young Professor Fellowship, POSCO TJ Park Foundation	2020 - 2021
Top 10% Paper Recognition, IEEE Intl. Conf. on Image Processing	2015
Finalist, Student Paper Competition, IEEE Nuc. Sci. Symp. Med. Im. Conf.	2013
Conference Trainee Grant, IEEE Nuc. Sci. Symp. Med. Im. Conf.	2013
Student Travel Award, Intl. Mtg on Fully 3D image Recon. in Rad. and Nuc. Med.	2013
Rackham Travel Grant, University of Michigan	2011, 2012, 2013
KLA-Tencor Graduate Fellowship, KLA-Tencor Corporation	2010
National Science and Technology Scholarship, Korea Science and Engineering Foundation	2004

Invited/ Contributed Talks

"The power of gradient descent in machine learing"

– KAI-X Mathematics Summer School, Korea, 2023.

"Two-time-scale extragradient converges to local minimax points"

– KSIAM Spring Conference, Korea, 2023.
– KMS Spring Meeting, Korea, 2023.
– HKUST-KAIST-NUS Joint Workshop on Applied and Comp. Mathematics, Hong Kong, 2023.

"AI Learning and optimization"

– School of Business and Technology Management, Colloquium, KAIST, Korea, 2023.

"Two-time-scale gradient method for nonconvex-nonconcave minimax optimization"

– Int'l Conf. on Matrix Theory and Appl. (ICMTA), Korea, 2022.
– KAIA/NAVER Fall Conference, Korea, 2022.

"Semi-anchored multi-step gradient method for nonconvex-nonconcave minimax optimization"

– Workshop on Fast Optimization Algorithms in the Big Data Era, NUS, Singapore, 2022.
– Global KMS International Conference, Korea, 2022.

"Gradient methods for minimax optimization"

– Industrial and Management Eng. Dept. Seminar, Postech, Korea, 2023.
– BK Big Data Colloquium, Chonnam Nat'l Univ., Korea, 2022.

– SAARC Workshop, KAIST, Korea, 2022.

"A review of extragradient methods for minimax optimization"

– Math. Dept. Colloquium, Kyungpook Nat'l Univ., Korea, 2022.
– Workshop on AI for Industrial Mathematics, NIMS, Korea, 2022.

"Bilevel optimization for machine learning"

– KSIAM Spring Conference, Korea, 2022.

"Fast extra gradient method for smooth structured nonconvex-nonconcave minimax problems"

– SIAM Conference on Optimization, USA, 2023.
– AORC Workshop, Sunkyunkwan University, Korea, 2021.
– SAARC Workshop on Mathematics and Machine Learning, KAIST, Korea, 2021.

"Fast gradient methods for decreasing the gradients in minimization and minimax problems"

– Korean Mathematical Society (KMS) Spring Meeting, Korea, 2021.

"First-order methods and their acceleration for large-scale optimization"

– Hanoi National University of Education (HNUE), VIASM-HUS-HNUE-KAIST Joint Mathematical Meeting, Vietnam, 2019.

"Accelerated Douglas-Rachford operator splitting method for variational problems"

– KSIAM Annual Meeting, Korea, 2019.

"Accelerated gradient method for convex-concave saddle-point problems"

– The Conf. of the Int'l Fed. of Operational Research Societies (IFORS), Korea, 2021.
– Int'l Conf. on Econometrics and Statistics (EcoSta), Korea, 2021.
– KMS Annual Meeting, Korea, 2019.

"Iterative methods for continuous optimization"

– Tutorial, The AI Korea, Korea, 2019.

"Accelerated proximal point method for maximally monotone operators"

– INFORMS Annual Meeting, USA, 2021.
– Int'l Conf. on Continuous Optimization (ICCOPT), Germany, 2019.
– Int'l Conf. on Matrix Theory and Appl. (ICMTA), Korea, 2019.

"Accelerated proximal point method for maximally monotone operators with applications to ADMM for inverse problems"

– KSIAM Spring Conference, Korea, 2018.

"Accelerated first-order methods for large-scale optimization"

– KAIST-POSTECH Math-AI workshop, 2019.
– The AI Korea, Korea, 2019.
– Comp. Sci. Colloquium, Korea Institute for Advanced Study (KIAS), Korea, 2019.
– KMS Spring Meeting, Korea, 2019.
– Math. Dept. Colloquium, KAIST, Korea, 2019.
– Applied Math. and Stat. Dept. Colloquium, SUNY Korea, Korea, 2019.
– KAIST-Inria Applied Math. Workshop, France, 2019.
– Stat. Dept. Seminar, Seoul National University, Korea, 2019.

"First-order methods for optimization-based inverse problems"

– Inverse Problem Workshop, National Institute for Mathematical Sciences (NIMS), Korea, 2018.

"First-order methods for optimization-based image reconstruction"

– Advanced Nuclear Medicine Physics course, Dept. of Biomedical Sciences, Seoul National University, Korea, 2018.

"Continuous optimization and its application to machine learning"

– Undergrad. Math. Colloquium, KAIST, Korea, 2018.

"Optimized first-order method for decreasing gradient of smooth convex functions"

– KSIAM Annual Meeting, Korea, 2018.
– Int'l Symposium on Mathematical Programming (ISMP), France, 2018.

"Optimizing the efficiency of the first-order methods for convex optimization."

– Math. Dept., KAIST, Korea, 2018.
– Appl. and Comp. Math. Seminar, Dartmouth College, USA, 2018.

"Accelerated gradient methods for large-scale convex optimization."

– Math. Dept. Colloquium, Ewha University, Korea, 2018.
– GSCST, Seoul National University, Korea, 2018.
– ECE Dept., UNIST, Korea, 2018.
– CSE Dept., Yonsei University. Korea, 2018.
– Appl. Algebra and Optim. Research Center (AORC), Sungkyunkwan University, Korea, 2018.
– Math. Dept., Seoul National University, Korea, 2018.
– Math. Dept., KAIST, Korea, 2018.
– Appl. and Comp. Math. Seminar, Dartmouth College, USA, 2018.

"Improving the optimized gradient method for large-scale convex optimization,"

– SIAM Conference on Optimization, Canada, 2017.

"Optimized gradient method for smooth convex minimization."

– Appl. and Comp. Math. Seminar, Dartmouth College, USA, 2017.
– IBM T. J. Watson Research Center, USA, 2017.
– Mitsubishi Electric Research Laboratories (MERL), USA, 2016.
– Int'l Symposium on Mathematical Programming (ISMP), USA, 2015.

"Optimized gradient methods for accelerated statistical 3D X-ray CT image reconstruction."

– SEAS, Harvard University, USA, 2015.

"Accelerated ordered subsets algorithms for model-based 3-D X-ray CT image reconstruction."

– BME Dept., Johns Hopkins University, USA, 2014.

"Accelerated optimization algorithms for statistical 3-D X-ray CT image reconstruction."

– Lab Seminar, Dept. of Biomedical Sciences, Seoul National University, Korea, 2014.
– ECE Dept., UNIST, Korea, 2014.
– Media IT Engineering Program, SeoulTech, Korea, 2014.
– Medical Imaging Seminar, KAIST, Korea, 2013.

Editorial Positions

Associate Editor, Numerical Algebra, Control and Optimization 2021

Journal Reviews

- Applied Mathematics and Optimization
- Bulletin of the Korean Mathematical Society
- IEEE Signal Processing Letters
- IEEE Transactions on Biomedical Engineering
- IEEE Transactions on Computational Imaging
- IEEE Transactions on Image Processing
- IEEE Transactions on Medical Imaging
- IEEE Transactions on Neural Networks and Learning Systems
- IEEE Transactions on Signal Processing
- International Journal of Computer Assisted Radiology and Surgery
- Journal of Optimization Theory and Applications
- Journal of Scientific Computing
- Journal of X-ray Science and Technology
- Mathematics of Operations Research

- Mathematical Programming
- Mathematical Programming Computation
- Medical Physics
- Nuclear Instruments and Methods in Physics Research A
- Optimization and Engineering
- Pure and Applied Functional Analysis
- Sensors
- SIAM Journal on Imaging Sciences
- SIAM Journal on Optimization
- SIAM Journal on Scientific Computing

Conference Reviews

- Cairo International Biomedical Engineering Conference (CIBEC 2014),
- Conference on Neural Information Processing Systems (NeurIPS 2021-23),
- Intl. Conf. on Learning Representations (ICLR 2021-24),
- Intl. Conf. on Machine Learning (ICML 2020-23),
- Intl. Conf. on Signal Processing and Communications (SPCOM 2012)

Current Students

- Dong Chul Kim (M.S. Jan. 2019 - Aug. 2020, Ph.D. Sep. 2020 -)
- Jiseok Chae (M.S.-Ph.D. Aug. 2021 -)
- Wonyeong Song (M.S.-Ph.D. Aug. 2021 -)
- Kyuwon Kim (M.S.-Ph.D. Aug. 2022 -)
- Munsik Kim (Ph.D. Sep. 2023 -)
- Kyungjae Lee (M.S.-Ph.D. Feb. 2024 -)

Past Students

- Hyeokjoo Park (Ph.D. Mar. 2020 - Feb. 2024); co-advised by Do Young Kwak
- Keyan Shi (KAI-X Research Internship Jun. 2023 - Aug. 2023)
- Woohyuck Kim (URP, Jan. 2022 - Jun. 2022); next: KAIST GSAI M.S. Program
- Sucheol Lee (M.S.-Ph.D. Mar. 2016 - Feb. 2022); advised since Nov. 2019; next: Samsung Advanced Institute of Technology
- Hyeonmin Lee (M.S. Jan. 2019 - Feb. 2021); next: KAIST ISysE Ph.D. Program
- Euntaek Shin (M.S. Jul. 2019 - Feb. 2021); next: MOBILTECH

Teaching Experience

KAIST, Daejeon, Republic of Korea

- MAS 101 Calculus I (21S, 21F)
- MAS 109 Introduction to Linear Algebra (18F, 20F)
- MAS 110 Linear Algebra for Data Science (22S)
- MAS 250 Probability and Statistics (23S, 24S)
- MAS 364 Matrix Computation and Application (22S)
- MAS 365 Introduction to Numerical Analysis (19S, 20S, 21S, 22F)
- MAS 374 Optimization Theory (19F)
- MAS 473 Introduction to Artificial Intelligence with Mathematics (23F)
- MAS 501 Applied Analysis and Probability for Engineers (23S, 24S)

Dartmouth College, Hanover, NH USA

- MATH 126 Current Problems in Applied Mathematics: Convex Optimization (18W)

Professional Experience

GE Healthcare, Waukesha, WI USA

PhD internship **May 2011 - Aug. 2011**

LIG Nex1 Co,. Ltd. Yongin R&D Center, Yongin, Republic of Korea
Summer internship **Jul. 2006 - Aug. 2006**

Service

Committee, KSIAM MathWorks Challenge	2019
Vice President, Korean Student Association - Graduate, University of Michigan	2014
President, Korean EECS Student Association, University of Michigan	2013

References

Available upon request.