MING DU Ph.D.

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EXPERIENCE

10/2023 - now **Assistant Computational Scientist**
Argonne National Laboratory, Lemont, IL, USA

- Developed AI algorithms for x-ray science.

03/2023 – 09/2023 **Senior Algorithm Engineer**
04/2021 – 03/2023 **Algorithm Engineer**
KLA Corporation, Ann Arbor, MI, USA

- Developed image processing algorithms for modeling the image formation process in KLA's high-precision photomask inspection systems used for sub-3-nm processes. Implemented algorithm solutions in the C++ codebase.
- Led the development and productization a deep learning algorithm for defect detection, achieving a 10% improvement in precision and a 60% reduction of false positives. Optimized inference throughput using techniques and tools including OpenVINO.
- Using computer vision and data science techniques, developed image correction and artifact removal algorithms that reduced the false positive rate of the photomask inspection system by over 70%.
- Directed an internship project on modeling the artifacts generated in the image formation process using model-augmented deep learning method.

08/2019 – 03/2021 **Postdoctoral Scholar**
Argonne National Laboratory, Lemont, IL, USA

- Developed *Adorym*, a reconstruction framework capable of performing large-scale 2D/3D phase retrieval, image reconstruction, and parameter refinement for multiple x-ray imaging techniques, built on automatic differentiation of *PyTorch*.
- Developed a generative neural network-based method using "deep image prior" to reconstruct clean images from artifact-corrupted images in x-ray multislice ptychography.
- Developed a distributed algorithm for large 2D wavefield propagation on high performance computers (HPCs).
- Led the proposal and research of an ASCR Leadership Computing Challenge (ALCC) project, which is a highly selective HPC resource award, on large-scale 3D reconstruction.

09/2015 – 06/2019 **Ph.D. Candidate**
Northwestern University, Evanston, IL, USA

- Developed *Tomosaic*, a Python software package for beyond-field-of-view x-ray micro-CT. Achieved 3D reconstruction of a whole mouse brain with 10^{13} voxels from 5.8 TB of raw data, using supercomputers at Argonne Leadership Computing Facility.
- Developed an innovative algorithm for 3D phase retrieval under complicated imaging scenarios, utilizing the automatic differentiation capability of deep learning tools.
- Conducted x-ray tomography and ptychography experiments at the Advanced Photon Source.
- Involved in the commissioning of an automated tomography processing pipeline *Automo/Ripple* at beamline 32-ID of the Advanced Photon Source.
- Built an improved theoretical model for dose estimation in the x-ray imaging of thick hydrated specimens.

01/2014 – 06/2014 **Research Intern**
Singapore Institute of Manufacturing Technology, Singapore

- Experimentally studied the pore size dependence of anodic aluminum oxide on voltage and electrolyte temperature.
- Developed a tool for unsupervised data analysis.

EDUCATION

2015 – 2019 **Doctor of Philosophy**, *Northwestern University, Evanston, USA*
Department of Materials Science and Engineering
Advised by Prof. Chris Jacobsen
Thesis title: *To the Breadth, and to the Depth: Scalable 3D Imaging of Extended Objects with High Resolution Using X-ray Microscopy*

2011 – 2015	**Bachelor of Engineering**, *National University of Singapore, Singapore* Department of Materials Science and Engineering

TEACHING

2018 Winter	**Teaching assistant**, *Northwestern University* MSE 395-4: Computational Thermodynamics and Kinetics
2018 Fall	**Teaching assistant**, *Northwestern University* MSE 401: Chemical and Statistical Thermodynamics of Materials
2018 Winter	**Teaching assistant**, *Northwestern University* MSE 361: Crystallography and Diffraction

CERTIFICATES

2023	AWS Certified Machine Learning – Specialty Amazon Web Services Training and Certification
2022	Completed class **EECS 598-008 Deep Learning for Computer Vision** with grade **A** As part-time student at *University of Michigan, Ann Arbor*
2022	Certificates of courses in the **Bayesian Statistics** specialization *Coursera*
2020	Course certificates: **Statistical Thinking in Python**, **Unsupervised Learning in Python** *Datacamp*

PUBLICATIONS

[1] X. Liu , G. Xu , … , M. Du, *et al*. Origin and regulation of oxygen redox instability in high-voltage battery cathodes. *Nature Energy*. 1–10 (2022).

[2] M. Du, X. Huang, C. Jacobsen, Using a modified double deep image prior for crosstalk mitigation in multislice ptychography. *Journal of Synchrotron Radiation*. **8** (2021).

[3] M. Du, S. Kandel, J. Deng, X. Huang, A. Demortiere, T. T. Nguyen, R. Tucoulou, V. D. Andrade, Q. Jin, C. Jacobsen, Adorym: a multi-platform generic X-ray image reconstruction framework based on automatic differentiation. *Opt Express*. **29**, 10000 (2021).

[4] M. Du, Z. (Wendy) Di, D. Gürsoy, R. P. Xian, Y. Kozorovitskiy, C. Jacobsen, Upscaling X-ray nanoimaging to macroscopic specimens. *J Appl Crystallogr*. **54**, 386–401 (2021).

[5] P. Huang, M. Du, M., Hammer, A., Miceli, C. Jacobsen, Fast digital lossy compression for X-ray ptychographic data. *Journal of Synchrotron Radiation*. **28,** 292–300 (2021).

[6] S. Ali, M. Du, M. F. Adams, B. Smith, C. Jacobsen, Comparison of distributed memory algorithms for X-ray wave propagation in inhomogeneous media. *Opt Express*. **28**, 29590 (2020).

[7] M. Du, D. Gürsoy, C. Jacobsen, Near, far, wherever you are: simulations on the dose efficiency of holographic and ptychographic coherent imaging1. *J Appl Crystallogr*. **53**, 748–759 (2020).

[8] M. Du, Y. S. G. Nashed, S. Kandel, D. Gürsoy, C. Jacobsen, Three dimensions, two microscopes, one code: Automatic differentiation for x-ray nanotomography beyond the depth of focus limit. *Sci Adv*. **6**, eaay3700 (2020).

[9] J. Prasad, A. Balwani, E. Johnson, J. Miano, V., Sampathkumar, V. De Andrade, K. Fezzaa, M. Du, *et al*. *Scientific Data.* 358 (2020)

[10] R. Vescovi[1], M. Du[1], *et al.*, Tomosaic: efficient acquisition and reconstruction of teravoxel tomography data using limited-size synchrotron X-ray beams. *Journal of Synchrotron Radiation*. **25** 1478–1489 (2018). [2]

[11] M. Du, R. Vescovi, K. Fezzaa, C. Jacobsen, D. Gürsoy, X-ray tomography of extended objects: a comparison of data acquisition approaches. *J Opt Soc Am*. **35**, 1871 (2018).

[12] M. A. Gilles, Y. S. G. Nashed, M. Du, C. Jacobsen, S. M. Wild, 3D x-ray imaging of continuous objects beyond the depth of focus limit. *Optica*. **5**, 1078–1086 (2018).

[13] Shahbazi, J. Kinnison, R. Vescovi, M. Du, R. Hill, M. Joesch, M. Takeno, H. Zeng, N. M. da Costa, J. Grutzendler, N. Kasthuri, W. J. Scheirer, Flexible Learning-Free Segmentation and Reconstruction of Neural Volumes. *Scientific reports*. **8**, 1448 (2018).

[14] R. Chard, R. Vescovi, M. Du, H. Li, K. Chard, S. Tuecke, N. Kasthuri, I. Foster, (2018), *AI-Science'18: Autonomous Infrastructure for Science*, pp. 1–7.

[15] M. Du, R. Vescovi, R. Chard, N. Kasthuri, C. Jacobsen, E. Dyer, D. Gursoy, *Biophotonics Congress: Biomedical Optics Congress 2018 (2018), paper BF4C.2*.

[16] M. Tondravi, W. Scullin, M. Du, R. Vescovi, V. D. Andrade, C. Jacobsen, K. P. Kording, D. Gursoy, E. Dyer, A Pipeline for Distributed Segmentation of Teravoxel Tomography Datasets. *Microscopy and Microanalysis*. **24**, 166–167 (2018).

[17] M. Du, C. Jacobsen, Relative merits and limiting factors for x-ray and electron microscopy of thick, hydrated organic materials. *Ultramicroscopy*. **184**, 293–309 (2018).

[18] C. J. Jacobsen, V. D. Andrade, J. Deng, M. Du, D. Gursoy, Y. S. Nashed, T. Peterka, (2016), *Digital Holography and Three-Dimensional Imaging*, p. W2A.12.

[19] M. Du, X. Yin, C. Tang, T. J. Huang, H. Gong, Takovite-derived 2-D Ni/Al double hydroxide monolayer and graphene hybrid electrodes for electrochemical energy storage applications with high volumetric capacitance. *Electrochimica Acta*. **190**, 521–530 (2016).

[20] X. Yin, T. J. Huang, C. Tang, M. Du, L. Sun, Z. Shen, H. Gong, Significantly different mechanical properties and interfacial structures of Cu2ZnSn(S,Se)4 films prepared from metallic and sulfur-contained precursors. *Solar Energy Materials and Solar Cells*. **134**, 389–394 (2015).

[21] M. Du, X. Yin, H. Gong, Effects of triethanolamine on the morphology and phase of chemically deposited tin sulfide. *Materials Letters*. **152**, 40–44 (2015).

[1] Co-first authors with equal contributions.

[2] The outcome of this work is used in production at the AdvancedPhoton Source.

CONFERENCE SPEECHES & TALKS

[1] "Applications of automatic differentiation in image reconstruction and experimental parameter refinement for 3D microscopy*,* " *23rd Euro AD Workshop*, Virtual. (2020).

[2] "Three dimensions, two microscopes, one code: Automatic differentiation for x-ray nanotomography beyond the depth of focus limit*,* " *ALCF Simulation, Data, and Learning Workshop*, Lemont, U.S.A. (2019).

[3] "A Multifunctional Tool for X-Ray Ptychographic and Holographic 3D Imaging Beyond the Depth-of-Focus Limit*,* " *Gordon Research Seminar - X-ray Science*, Easton, U.S.A. (2019).

[4] "Using Automatic Differentiation for Coherent Diffraction Imaging and Reconstructing Beyond Depth of Focus (co-presented with Saugat Kandel)*,* " *Ptycho Developer 2019*, Berkeley, U.S.A. (2019).

[5] "3D object reconstruction beyond the depth-of- focus limit using automatic differentiation*,* "*Coherence 2018*, Port Jefferson, U.S.A. (2018).

[6] "An automated pipeline for the collection, transfer, and processing of large-scale tomography data*,* "*Biophotonics Congress: Biomedical Optics Congress 2018*, Hollywood, U.S.A. (2018).

MEDIA COVERAGE

[1] Andre Salles, Filling in the blanks: How supercomputing can aid high-resolution X-ray imaging. ALCF News Center (2020). [Link]

[2] ALCF, ALCF supercomputers power scientific breakthroughs in 2020. ALCF News Center (2020). [Link]

[3] Sally Johnson, Extreme 3-D. DEIXIS Magazine. (2021). [Link]

AWARDS AND ACCOMPLISHMENTS

2020	**Most active reviewers of 2019** awarded by the Optical Society of America.
2020	**Team leader** of an ASCR Leadership Computing Challenge (ALCC) proposal granted by Advanced Scientific Computing Research of the U.S. Department of Energy (24 projects awarded in total).
2019	**Contributed to** an LDRD-funded proposal (2019-0441, $80K/year over 2 years).
2019	**Contributed to** a proposal of the ALCF Data Science Program (awarded 0.25 M nodes hours over 2 years).
2015	**Materials Research Society (Singapore) Medal**.

PROFESSIONAL ACTIVITIES

2020 – 2021	**Principal Investigator** of an ASCR Leadership Computing Challenge (ALCC) project titled "Distributed large wavefield propagation and 3D reconstruction beyond the depth of focus limit".
2020	**Selected attendee** of the Argonne Training Program on Extreme-Scale Computing (ATPESC) (~76 candidates selected internationally).
2020	**Co-organizer** of workshop titled "Advances in Phase Retrieval Methods for High-resolution X-ray Imaging" in 2020 APS/CNM User Meeting.
2018 – present	**Reviewer** of more than 17 manuscripts submitted to *Optics Express*, *Applied Optics*, *Optics Letters*, *Biomedical Optics Express*, and *IUCrJ*. (Verified peer review records available on Publons with WoS ResearcherID V-4905-2019)
2018 – present	**Member**, The Optical Society of America.

EXTRACURRICULAR ACTIVITIES

2018 – 2019	**Member**, Northwestern University Society of Physics Students
2017	**Volunteer**, Baxter Symposium at Northwestern University
2013 – 2015	**Co-chair**, Movement for Intellectually Disabled of Singapore (Fernvale branch)

2014 | **Chair**, Movement for Intellectually Disabled of Singapore (Fernvale branch) summer camp

SKILLS

Experimental: X-ray microtomography and ptychography at synchrotron beamlines; scanning electron microscopy
Programming: Python, MATLAB, Mathematica, C, C++, R, SQL, Linux, LaTeX, Git
Technical skills: Deep learning, image processing, computer vision, inverse problem solving, non-linear optimization, computational imaging, parallel computing, cloud computing (AWS)
Other skills: 3D computer graphics (Adobe After Effects, Blender; made a 3D animation showcasing the research outcome of our group, which was displayed at the Department of Energy's Booth during the SC'19 conference); computer aided design (Autodesk Fusion 360)

LANGUAGES

English: Fluent **Chinese:** Native **Japanese:** Beginner **German:** Beginner