Helen Xu

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Research Overview

I study theoretically and practically efficient parallel algorithms because as Moore's law ends, efficient algorithms will be one of the major ways to gain performance for new applications. In particular, I have recently investigated sparse graph and matrix problems because of their ubiquity and susceptibility to mathematical analysis.

Current Position

Mar 2022 - Present **Grace Hopper Postdoctoral Scholar in Computing Sciences**, Lawrence Berkeley National Laboratory.
Host: Dr. Aydın Buluç.

Education

Feb 2022 **Ph.D. in Computer Science**, Massachusetts Institute of Technology.
Thesis: The Locality-First Strategy for Developing Efficient Multicore Algorithms.
Advisor: Prof. Charles E. Leiserson.

May 2016 **B.S. with Honors in Computer Science**, Stony Brook University.
Thesis: Write-optimized Skip Lists.
Advisor: Prof. Michael A. Bender.
Awards: Ranked first in the 2016 graduating class of over 100 students and received the Undergraduate Teaching Assistant Award (top 1% of TAs in the CS department).

Publications

Published 14 peer-reviewed conference papers (10 full papers and 4 short papers) in top venues for algorithms and systems including SIGMOD, PODS, SPAA, and IPDPS.

Conference Publications

ALENEX '23 *Optimizing Search Layouts in Packed Memory Arrays*. Brian Wheatman, Randal Burns, Aydın Buluç, and **Helen Xu**. To appear at the SIAM Symposium on Algorithm Engineering and Experiments (ALENEX), 2023.

ESA '22 *When Are Cache-Oblivious Algorithms Cache Adaptive? A Case Study of Matrix Multiplication and Sorting*. Arghya Bhattacharya, **Helen Xu**, Abiyaz Chowdhury, Rathish Das, Rezaul A. Chowdhury, Rob Johnson, Rishab Nithyanand, Michael A. Bender. In European Symposium on Algorithms (ESA), 2022.

ACDA '21 *Multidimensional Included and Excluded Sums*. **Helen Xu**, Sean Fraser, and Charles E. Leiserson. In SIAM Conference on Applied and Computational Discrete Algorithms (ACDA), 2021.

SIGMOD '21 *Terrace: A Hierarchical Graph Container for Skewed Dynamic Graphs*. Prashant Pandey, Brian Wheatman, **Helen Xu**, and Aydın Buluç. In ACM SIGMOD International Conference on Management of Data (SIGMOD), 2021.

ALENEX '21 *A Parallel Packed Memory Array to Store Dynamic Graphs*. Brian Wheatman and **Helen Xu**. In SIAM Symposium on Algorithm Engineering and Experiments, 2021 (ALENEX).

APOCS '21 *Beyond Worst-case Analysis of Multicore Caching Strategies*. (in alphabetical order) Shahin Kamali and **Helen Xu**. In SIAM Symposium on Algorithmic Principles of Computer Systems (APOCS), 2021.

SPAA '20 *Closing the Gap Between Cache-Oblivious and Cache-Adaptive Analysis*. (in alphabetical order) Michael A. Bender, Rezaul A. Chowdhury, Rathish Das, Rob Johnson, William Kuszmaul, Andrea Lincoln, Quanquan C. Liu, Jayson Lynch, and **Helen Xu**. In ACM Symposium on Parallelism in Algorithms and Architectures (SPAA), 2020.

SPAA '18 *Cache-Adaptive Exploration: Experimental Results and Scan-Hiding for Adaptivity*. (in alphabetical order) Andrea Lincoln, Quanquan C. Liu, Jayson Lynch, and **Helen Xu**. In ACM Symposium on Parallelism in Algorithms and Architectures (SPAA), 2018.

IPDPS '18 *A Fill Estimation Algorithm for Sparse Matrices and Tensors in Blocked Formats.* Peter Ahrens, **Helen Xu**, and Nicholas Schiefer. In IEEE International Parallel and Distributed Processing Symposium (IPDPS), 2018.

PODS '17 *Write-Optimized Skip Lists*. (in alphabetical order) Michael A. Bender, Martin Farach-Colton, Rob Johnson, Simon Mauras, Tyler Mayer, Cynthia Phillips, and **Helen Xu**. In ACM Symposium on Principles of Database Systems (PODS), 2017.

Peer-Reviewed Short Publications

HPEC '20 *Work-Efficient Parallel Algorithms for Accurate Floating-Point Prefix Sums*. Sean Fraser, **Helen Xu**, and Charles E. Leiserson. In IEEE High Performance Extreme Computing Conference (HPEC), 2020.

SPAA '20 *Brief Announcement: Multicore Paging Algorithms Cannot Be Competitive*. (in alphabetical order) Shahin Kamali and **Helen Xu**. In ACM Symposium on Parallelism in Algorithms and Architectures (HPEC), 2020.

ICONS '19 *Dynamic Programming with Spiking Neural Computing*. (in alphabetical order) James Aimone, Ojas Parekh, Cynthia Phillips, Ali Pinar, William Severa, and **Helen Xu**. In International Conference on Neuromorphic Systems (ICONS), 2019.

HPEC '18 *Packed Compressed Sparse Row: A Dynamic Graph Representation*. Brian Wheatman and **Helen Xu**. In IEEE High Performance Extreme Computing Conference (HPEC), 2018.

Under Review

A Compressed Packed Memory Array with Fast Parallel Batch Updates. Brian Wheatman, Randal Burns, Aydın Buluç, and **Helen Xu**.

Optimizing Compression Schemes for Parallel Sparse Tensor Algebra. **Helen Xu**, Tao B. Schardl, Michael Pellauer, and Joel S. Emer.

Awards

2022 **Grace Hopper Fellowship in Computing Sciences** *for two years of postdoctoral study at Berkeley Lab.*

2022 **Argonne Training Program for Extreme-Scale Computing (ATPESC),** *a fully-funded two-week course on high-performance computing (awarded to about 80 researchers).*

2021 **Finalist for Best Student Presentation** *at ACDA 2021.*

2020 **Rising Stars Workshop** *held virtually at UC Berkeley.*

2020 **Chateubriand Fellowship** *for Spring 2020 at ENS Lyon.*

2016 **National Physical Science Consortium (NPSC) Graduate Fellowship,** *awarded for six years of graduate study.*

2016 **Undergraduate Teaching Assistant Award,** *awarded to around 1% of TAs in the department of Computer Science at Stony Brook University.*

2015 **NSF Research Experience for Undergraduates Supplement,** *awarded for one year of undergraduate research.*

2013-2016 **Christian Mata Scholarship for Excellence in Computer Science,** *awarded to the top ranked computer science student in every year at Stony Brook University.*

Research Experience

Feb 2022 - present **PASSION Laboratory** *Lawrence Berkeley National Laboratory*, Berkeley, CA.
Developing algorithms and data structures for sparse graph and tensor applications.
Mentor: Dr. Aydın Buluç.

Sep 2016 - Feb 2022 **Supertech Group** *Massachusetts Institute of Technology*, Cambridge, MA.
Designed, analyzed, and implemented parallel and cache-friendly algorithms for shared-memory multicores.
Mentor: Prof. Charles E. Leiserson.

Summer 2020 **Architecture Research Group** *NVIDIA Research*, Westford, MA.
Created and evaluated compressed data structures for sparse tensor computations.
Mentor: Dr. Michael Pellauer.

Spring 2020 **Resource Optimization: Models, Algorithms, and Scheduling Group** *ENS Lyon*, Lyon, France.
Studied algorithms for multi-resource job scheduling with theoretical guarantees.
Mentors: Professors Loris Marchal, Frederic Vivien, and Anne Benoit.

Summer 2019 **Systems and Networking Group** *Microsoft Research*, Cambridge, UK.
Developed and implemented algorithms for novel parallel machine learning accelerators.
Mentor: Dr. Nuno Lopes.

Summer 2016 **Discrete Mathematics and Optimization Group** *Sandia National Laboratories*, Albuquerque, NM.
Simplified and refined randomized I/O-efficient data structures.
Mentor: Dr. Cindy Phillips

Summer 2015 **Systems and Security Research Group** *Sandia National Laboratories*, Livermore, CA.
Designed and implemented a network event tracking database using an existing write-optimized fractal tree index.
Mentor: Dr. Tom Kroeger

Teaching

Qualifications

2021 **Kaufman Teaching Certificate Program (KTCP)** *Teaching and Learning Lab*, Massachusetts Institute of Technology, Cambridge, MA.

- Completed a semester-long course consisting of developing teaching skills via weekly workshops.
- Prepared and delivered a teaching demo on algorithms to a general audience and provided peer feedback.

Experience

2017 - 2018 **Teaching Assistant for Performance Engineering of Software Systems** *Department of Electrical Engineering and Computer Science*, Massachusetts Institute of Technology, Cambridge, MA.

- Received an average overall rating of 6.2 out of 7 points.
- Led weekly recitations (TA-led tutorial sessions) and office hours.
- Developed the course cloud infrastructure, including the course development environment and tools suite.
- Coordinated with instructors to write and grade homeworks and exams.
- Helped students with assignments on the course discussion forum.

2014 - 2015 **Teaching Assistant for Discrete Mathematics** *Department of Computer Science*, Stony Brook University, Stony Brook, NY.

Students Advised

Ph.D.

2018-present **Brian Wheatman**, Johns Hopkins University.
Hosted at Berkeley Lab in Summer 2022.

2020-present **Arghya Bhattacharya**, Stony Brook University.

Masters theses

Feb 2023 (expected) **Amanda Li**, MIT.
Overcoming the Insert-Query Tradeoff in Key-Value Stores.

June 2020 **Sean Fraser**, MIT.
Optimizing Parallel Prefix Sums for Scientific Computing.

June 2019 **Brian Wheatman**, MIT (co-advised with Tim Kaler).
Image Alignment and Dynamic Graph Analytics : Two Case Studies of How Managing Data Movement Can Make (Parallel) Code Run Fast.

June 2019 **Stephanie Ren**, MIT (co-advised with Tao B. Schardl).
Vector-Aware Space Cuts in Stencil Computations.

Technical Talks and Presentations

Invited Seminars

Optimizing Dynamic Graph Processing on Multicores with the Locality-First Strategy

- Lawrence Berkeley National Laboratory, 2022.
- University of California, Berkeley, 2022.

Data Structure Design for Skewed Dynamic Graphs

- MIT Fast Code Seminar, 2021.
- Williams CS Colloqium, 2021.

Updatable Data Compression Formats for Hierarchical Fiber Abstraction

- NVIDIA Research, 2020.

A Fill-Estimation Algorithm for Sparse Matrices and Tensors in Blocked Formats

- Tel Aviv University, 2019.
- University of California, Berkeley, 2022.

Conference Talks

Multidimensional Included and Excluded Sums

- *Finalist for Best Student Presentation* at ACDA, 2021.

Beyond Worst-case Analysis of Multicore Caching Strategies
- APOCS, 2021.

Work-Efficient Parallel Algorithms for Accurate Floating-Point Prefix Sums
- HPEC, 2020.

Multicore Paging Algorithms Cannot Be Competitive
- SPAA, 2020.

Dynamic Time Warping in Strongly Subquadratic Time: Algorithms for the Low-Distance Regime and Approximate Evaluation
- ICALP, 2019 (filling in for Bill Kuszmaul).

Cache-Adaptive Exploration: Experimental Results and Scan-Hiding for Adaptivity
- SPAA, 2018.

Write-Optimized Skip Lists
- PODS, 2017 (Joint talk with Tyler Mayer).
- Guest lecture in MIT's advanced performance engineering course, 2017.

Posters

A Parallel Packed Memory Array for Dynamic Graphs
- Rising Stars Poster Session, 2020.

A Fill-Estimation Algorithm for Sparse Matrices and Tensors in Blocked Formats
- CSAIL Alliances Poster Session, 2018.

Performance Engineering Discussions

Software Performance Engineering at the End of Moore's Law
- Jane Street Symposium, 2020.

Leiserchess Codewalk
- Guest lecture in Performance Engineering of Software Systems (MIT 6.172), 2018.

Communication Workshops

NSF Graduate Research Fellowship Statements Workshop
- MIT EECS Communication Lab, 2020 and 2021.

Research Qualifying Examination Workshop
- MIT EECS Communication Lab, 2019 and 2021.

Professional Service

2022 **Artifact Evaluation Program Committee Member** *for PPoPP*.

2022 **Availability Reviewer** *for SIGMOD*.

2021-present **Program Committee Member** *for ALENEX (2022, 2023), SPAA (2022, 2023), SEA (2023)*.

2018-present **Paper Reviewer** *for BigData (2023), JPDC (2022), ICPP (2021), ACDA (2021), WADS (2021), SPAA (2021, 2020), EuroPar (2020), SOSA (2020), SODA (2019, 2018), ESA (2019, 2022)*.

2018 - 2022 **Communication Lab Advisor** *with the MIT Electrical Engineering and Computer Science Communications Lab.*

Communication Lab Page: `http://mitcommlab.mit.edu/eecs/`

- Reviewed over 50 papers, talks, statements, and CVs via peer coaching.
- Created and implemented a partnership with Professor Saman Amarasinghe's research group to jointly prepare conference presentations via weekly meetings.
- Prepared and led workshops for the NSF Graduate Research Fellowship application (2020, 2021) and the PhD research qualifying exam presentation (2019, 2021).
- Wrote articles about core technical communications topics, such as thesis proposals and paper abstracts.

2017 **Co-president** *of MIT Graduate Women in Course 6 (GW6).*

Webpage: `http://gw6.scripts.mit.edu/`

- Organized events several times per month for graduate women in the department, including professional development and social activities.

References

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