# Laxman Dhulipala

# Employment

- July 2022 Assistant Professor, University of Maryland, College Park, MA, Present Department of Computer Science and UMIACS.
- July 2022 Research Scientist, Google Research NYC, Present Scalable parallel algorithms for clustering and graphs.
- June 2021 Visiting Researcher, Google Research, New York City, NY, 2022 Scalable shared-memory clustering algorithms.
- Sep 2020 Postdoctoral Researcher, Massachusetts Institute of Technology, Cambridge, MA,
- June 2021 With Julian Shun.

# Education

- Aug 2015 Ph.D. in Computer Science, Carnegie Mellon University, Pittsburgh, PA,
  - Aug 2020 Thesis: Provably Efficient and Scalable Shared-Memory Graph Processing Advisor: Guy E. Blelloch
    Nominated for the ACM Doctoral Dissertation Award
    Honorable Mention in CMU SCS Doctoral Dissertation Award.
- Aug 2010 B.S. in Computer Science, Carnegie Mellon University, Pittsburgh, PA,
- May 2014 Phi Beta Kappa, University Honors, and College Honors.

#### Awards

- 2024 ACM Paris Kanellakis Award
- 2023 Allen Newell Award for Research Excellence, awarded by the Carnegie Mellon School of Computer Science
- 2023 Won the NeurIPS'23 Competition Track: Big-ANN (Filtering)
- 2023 Best Research Paper Runner-up at the International Conference on Very Large Data Bases (VLDB), 2023
- 2022 Best Paper Award at the ACM Symposium on Parallelism in Algorithms and Architectures (SPAA), 2022
- 2020 Nominated for the ACM Doctoral Dissertation Award
- 2020 Honorable Mention for the CMU SCS Doctoral Dissertation Award
- 2020 Memorable Paper Award Finalist at the Non-Volatile Memories Workshop (NVMW'20)
- 2019 Distinguished Paper Award at the ACM SIGPLAN Symposium on Programming Language Design and Implementation (PLDI), 2019
- 2018 Best Paper Award at the ACM Symposium on Parallelism in Algorithms and Architectures (SPAA), 2018
- 2014 Allen Newell Award for Excellence in Undergraduate Research
- 2014 Yahoo! Undergraduate Research Award
- 2014 Phi Beta Kappa

2014 University Honors, College Honors, upon graduation from CMU SCS

• Grants

NSF SHF: Collaborative Research: SHF: Medium: A Scalable Graph-Based Approach to 364,000 Clustering

Laxman Dhulipala (PI). The award for UMD is \$364,000. Collaborative effort with Ellis Hershkowitz (Brown) and Julian Shun (MIT).

NSF SATC: Collaborative Research: SaTC: CORE: Medium: Graph Mining and Network 1,200,000 Science with Differential Privacy: Efficient Algorithms and Fundamental Limits Laxman Dhulipala (co-PI), with Aravind Srinivasan (UMD). The award for UMD is \$400,000. Collaborative effort with Ravi Tandon (U. Arizona) and Anil Vullikanti (U. Virginia).

#### Publications

SPAA'24 Optimal Parallel Algorithms for Dendrogram Computation and Single-Linkage Clustering Laxman Dhulipala, Xiaojun Dong, Kishen N. Gowda, and Yan Gu

NeurIPS'24 MUVERA: Multi-Vector Retrieval via Fixed Dimensional Encodings

- Laxman Dhulipala, Majid Hadian, Rajesh Jayaram, Jason Lee, and Vahab Mirrokni
- NeurIPS'24 Efficient Centroid-Linkage Clustering MohammadHossein Bateni, Laxman Dhulipala, Willem Fletcher, Kishen N. Gowda, D. Ellis Hershkowitz, Rajesh Jayaram, and Jakub Lacki
  - VLDB'24 **BYO: A Unified Framework for Benchmarking Large-Scale Graph Containers** Brian Wheatman, Xiaojun Dong, Zheqi Shen, Laxman Dhulipala, Jakub Lacki, Prashant Pandey, and Helen Xu
  - ICML'24 Approximate Nearest Neighbor Search with Window Filters Joshua Engels, Benjamin Landrum, Shangdi Yu, Laxman Dhulipala, and Julian Shun
  - ICALP'24 It's Hard to HAC Average Linkage MohammadHossein Bateni, Laxman Dhulipala, Kishen N. Gowda, D. Ellis Hershkowitz, Rajesh Jayaram, and Jakub Lacki
- AMOB'24 Fast, Parallel, and Cache-Friendly Suffix Array Construction Jamshed Khan, Tobias Rubel, Laxman Dhulipala, Erin K. Molloy, and Rob Patro:
- PPoPP'24 **ParlayANN: Scalable and Deterministic Parallel Graph-Based Approximate Nearest Neighbor Search Algorithms.** Magdalen Dobson, Zheqi Shen, Guy E. Blelloch, Laxman Dhulipala, Yan Gu, Harsha Vardhan Simhadri, and Yihan Sun
- PPoPP'24 Parallel Integer Sort: Theory and Practice Xiaojun Dong, Laxman Dhulipala, Yan Gu, and Yihan Sun
- SIGMOD'24 TeraHAC: Hierarchical Agglomerative Clustering of Trillion-Edge Graphs Laxman Dhulipala, Jason Lee, Jakub Łącki, and Vahab Mirrokni
- SIGMOD'24 Parallel Algorithms for Hierarchical Nucleus Decomposition Jessica Shi, Laxman Dhulipala, and Julian Shun

- ALENEX'24 Practical Parallel Algorithms for Near-Optimal Densest Subgraphs on Massive Graphs Pattara Sukprasert, Quanquan C. Liu, Laxman Dhulipala, and Julian Shun
  - WABI'23 Fast, Parallel, and Cache-Friendly Suffix Array Construction Jamshed Khan, Tobias Rubel, Laxman Dhulipala, Erin K. Molloy, and Rob Patro:
  - SPAA'23 PIM-trie: A Skew-resistant Trie for Processing-in-Memory. Hongbo Kang, Yiwei Zhao, Guy E. Blelloch, Laxman Dhulipala, Yan Gu, Charles McGuffey and Phillip B. Gibbons
  - SPAA'23 High-Performance and Flexible Parallel Algorithms for Semisort and Related Problems Xiaojun Dong, Yunshu Wu, Zhongqi Wang, Laxman Dhulipala, Yan Gu, and Yihan Sun
  - VLDB'23 **PIM-tree: A Skew-resistant Index for Processing-in-Memory** Hongbo Kang, Yiwei Zhao, Guy E. Blelloch, Laxman Dhulipala, Yan Gu, Charles McGuffey, and Phillip B. Gibbons
  - TKDE'23 Towards Lightweight and Automated Representation Learning System for Networks Yuyang Xie, Jiezhong Qiu, Laxman Dhulipala, Wenjian Yu, Jie Tang, Richard Peng, and Chi Wang
- NeurIPS'22 Hierarchical Agglomerative Graph Clustering in Poly-Logarithmic Depth Laxman Dhulipala, David Eisenstat, Jakub Łącki, Vahab Mirronki, and Jessica Shi
  - SPAA'22 Parallel Batch-Dynamic Algorithms for k-Core Decomposition and Related Graph Problems Quanquan Liu, Jessica Shi, Shangdi Yu, Laxman Dhulipala, and Julian Shun Best Paper Award
  - PLDI'22 PaC-trees: Supporting Parallel and Compressed Purely-Functional Collections Laxman Dhulipala, Guy E. Blelloch, Yan Gu, and Yihan Sun
  - VLDB'22 Theoretically and Practically Efficient Parallel Nucleus Decomposition Jessica Shi, Laxman Dhulipala, and Julian Shun
  - VLDB'22 ParChain: A Framework for Parallel Hierarchical Agglomerative Clustering using Nearest-Neighbor Chain Shangdi Yu, Yiqiu Wang, Yan Gu, Laxman Dhulipala, and Julian Shun
  - PPoPP'22 The Problem-Based Benchmark Suite (PBBS), V2 Daniel Anderson, Guy E. Blelloch, Laxman Dhulipala, Magdalen Dobson, and Yihan Sun
  - PPoPP'22 ParGeo: A Library for Parallel Computational Geometry Yiqiu Wang, Shangdi Yu, Laxman Dhulipala, Yan Gu, and Julian Shun
  - ICML'21 Hierarchical Agglomerative Graph Clustering in Nearly Linear Time Laxman Dhulipala, David Eisenstat, Jakub Łącki, Vahab Mirronki, and Jessica Shi
  - VLDB'21 Scalable Community Detection via Parallel Correlation Clustering Jessica Shi, Laxman Dhulipala, David Eisenstat, Jakub Łącki, and Vahab Mirrokni

- ACDA'21 Parallel Clique Counting and Peeling Algorithms Jessica Shi, Laxman Dhulipala, Julian Shun
- SPAA'21 **The Processing-in-Memory Model** Hongbo Kang, Phillip B. Gibbons, Guy E. Blelloch, Laxman Dhulipala, Yan Gu, and Charles McGuffey
- SIGOPS GeoGraph: A Framework for Graph Processing on Geometric Data Yiqiu Wang, Shangdi Yu, Laxman Dhulipala, Yan Gu, Julian Shun
- VLDB'21 ConnectIt: A Framework for Static and Incremental Parallel Connectivity Algorithms Laxman Dhulipala, Changwan Hong, Julian Shun
- SIGMOD'21 LightNE: A Lightweight Graph Processing System for Network Embedding Jiezhong Qiu, Laxman Dhulipala, Jie Tang, Richard Peng, Chi Wang
- SIGMOD'21 Parallel Index-Based Structural Graph Clustering and Its Approximation Tom Tseng, Laxman Dhulipala, Julian Shun
- APOCS'21 Parallel Batch-Dynamic k-Clique Counting Laxman Dhulipala, Quanquan Liu, Julian Shun, Shangdi Yu
- APOCS'21 **The Read-Only Semi-External Model** Guy E. Blelloch, Laxman Dhulipala, Phillip B. Gibbons, Yan Gu, Charlie McGuffey, Julian Shun
  - VLDB'20 Parallel Graph Algorithms in Constant Adaptive Rounds: Theory meets Practice Soheil Behnezhad, Laxman Dhulipala, Hossein Esfandiari, Jakub Lacki, Vahab Mirrokni, Warren Schudy
  - VLDB'20 Sage: Parallel Semi-Asymmetric Graph Algorithms for NVRAMs Laxman Dhulipala, Charlie McGuffey, Hongbo Kang, Yan Gu, Guy E. Blelloch, Phillip B. Gibbons, Julian Shun
  - SODA'20 Parallel Batch-Dynamic Graphs: Constant Round Algorithms and Lower Bounds Laxman Dhulipala, David Durfee, Janardhan Kulkarni, Richard Peng, Saurabh Sawlani, Xiaorui Sun
- NVMW'20 Semi-Asymmetric Parallel Graph Algorithms for NVRAMs Laxman Dhulipala, Charlie McGuffey, Hongbo Kang, Yan Gu, Guy E. Blelloch, Phillip B. Gibbons, Julian Shun Memorable Paper Award Finalist
  - SPAA'20 ParlayLib A Toolkit for Parallel Algorithms on Shared-Memory Multicore Machines Guy E. Blelloch, Daniel Anderson, Laxman Dhulipala
- GRADES- The Graph Based Benchmark Suite
- NDA'20 Laxman Dhulipala, Jessica Shi, Tom Tseng, Guy E. Blelloch, Julian Shun
- PACT'20 Exploring the Design Space of Static and Incremental Graph Connectivity Algorithms on GPUs Changwan Hong, Laxman Dhulipala, Julian Shun

- CGO'20 **Optimizing Ordered Graph Algorithms with GraphIt** Yunming Zhang, Ajay Brahmakshatriya, Xinyi Chen, Laxman Dhulipala, Shoaib Kamil, Saman Amarasinghe, Julian Shun
- ESA'20 Parallel Batch-Dynamic Trees via Change Propagation Umut Acar, Daniel Anderson, Guy E. Blelloch, Laxman Dhulipala, Sam Westrick
- FOCS'19 Near-Optimal Massively Parallel Graph Connectivity Soheil Behnezhad, Laxman Dhulipala, Hossein Esfandiari, Jakub Lacki, Vahab Mirrokni
- PLDI'19 Low-Latency Processing on Graph Streams Using Purely-Functional Trees Laxman Dhulipala, Guy E. Blelloch, Julian Shun Distinguished Paper Award
- SPAA'19 Massively Parallel Computation via Remote Memory Access Soheil Behnezhad, Laxman Dhulipala, Hossein Esfandiari, Jakub Lacki, Vahab Mirrokni, Warren Schudy Inivited to Special Issue
- SPAA'19 Parallel Batch-Dynamic Graph Connectivity Umut Acar, Daniel Anderson, Guy E. Blelloch, Laxman Dhulipala
- ALENEX'19 Batch Parallel Euler-Tour Trees Thomas Tseng, Laxman Dhulipala, Guy E. Blelloch
  - SPAA'18 Theoretically Efficient Parallel Algorithms Can Be Fast and Scalable Laxman Dhulipala, Guy E. Blelloch, Julian Shun Best Paper Award Inivited to Special Issue
  - SPAA'17 Julienne: A Framework for Parallel Graph Algorithms using Work-efficient Bucketing Laxman Dhulipala, Guy E. Blelloch, Julian Shun
  - KDD'16 **Compressing Graphs and Indexes with Recursive Graph Bisection** Laxman Dhulipala, Igor Kabiljo, Brian Karrer, Guiseppe Ottiviano, Sergey Pupyrev, Alon Shalita
  - DCC'15 Smaller and Faster: Parallel Processing of Compressed Graphs with Ligra+ Julian Shun, Laxman Dhulipala, Guy E. Blelloch
  - SPAA'14 A Simple and Practical Linear-Work Parallel Algorithm for Connectivity Julian Shun, Laxman Dhulipala, Guy E. Blelloch

# Advising

Ph.D. Students. Quinten De Man Kishen Gowda (co-advised with Aravind Srinivasan) Peter Li Tobias Rubel Zhongqi Wang Richard Wen M.S. Students. Benjamin Landrum

#### Undergraduate Students.

Atharva Sharma Mazin Karmajar Spencer Lutz

#### Alumni.

Zheqi Wang (UCR, visiting Ph.D. student) Xiaojun Dong, (UCR, visiting Ph.D. student)

#### Ph.D. Thesis Committee Member.

Brian Wheatman (John Hopkins University) Thomas Rolinger (UMD) Jessica Shi (MIT) Shangdi Yu (MIT)

# Internships and Industry Experience

#### 2019 - 2020 Student Researcher, Google Research, New York City, NY.

• Worked with Jakub Lacki and Vahab Mirrokni on the Graph Mining (OMEGA) team. I worked on developing the theory and practice of the Adaptive MPC (AMPC) model, which resulted in a VLDB'20 paper. On the practical side, our approach and interface for taking advantage of adaptive lookups used in these prototype implementations was adopted more broadly, and is still actively in use for rapidly clustering and analyzing very large graphs (>XT edges). I also continued to work on making our shared-memory parallel algorithms from GBBS usable within Google.

#### Summer Visiting Researcher, Massachusetts Institute of Technology, Cambridge, MA.

2019 • Worked with Julian Shun at MIT CSAIL on parallel algorithms for parallel-dynamic graph algorithms including low-outdegree orientations, dynamic clique-counting, and dynamic graph frameworks.

#### Summer Research Intern, Google Research, New York City, NY.

- 2018 Worked with Jakub Lacki on the Graph Mining (OMEGA) team. I worked on sharedmemory clustering algorithms on large-memory, multicore machines. I also studied several theoretical problems in the MPC model with sublinear space per machine. Our results improved on prior work for fundamental graph problems including graph connectivity, and is conditionally optimal for a wide range of graphs, based on a well known conjecture.
- Summer Research Intern, Google Research, Mountain View, CA.
  - 2017 Worked with Zoya Svitkina on the Discrete Algorithms team. I studied load-balancing algorithms that maximize redundancy and minimize load-imbalance, both theoretically and in the context of algorithms deployed in Google data centers. Our algorithms led to significant improvements in load balance in practice while ensuring high redundancy.

#### 2014–2015 Software Engineer, Facebook, Menlo Park, CA.

• Worked on the Infrastructure Optimization team on algorithms for partitioning, embedding and reordering massive graphs. My work during this year resulted in a publication in KDD.

## Research Visits

- Aug 2019 Dagstuhl Workshop on Algorithms for Big Data, Schloss Dagstuhl, Wadern, Germany.
- Apr 2019 Microsoft Research (Algorithms Group), Redmond, WA. Hosted for a week-long visit by Janardhan Kulkarni and Richard Peng.

## Patents

2018 Cache efficiency by social graph data ordering. US Grant (US10025867B2).

# Teaching Experience

Courses

- Fall 2024 Instructor, CMSC451, University of Maryland, Design and Analysis of Computer Algorithms.
- Spring 2024 Instructor, CMSC858N, University of Maryland, Scalable Parallel Algorithms and Data Structures.
  - Fall 2023 Instructor, CMSC451, University of Maryland, Design and Analysis of Computer Algorithms.
- Spring 2023 Instructor, CMSC858N, University of Maryland, Scalable Parallel Algorithms and Data Structures.
  - Fall 2022 Instructor, CMSC451, University of Maryland, Design and Analysis of Computer Algorithms. Workshops
  - June 2024 Workshop Chair, SPAA 2024, Nantes, France, Highlights of Parallel Computing (HOPC'24) (link).
  - June 2024 Workshop Chair, SPAA 2024, Nantes, France, Workshop on Recent Advances in Parallel and Concurrent Data Structures) (link).
  - July 2023 **Tutorial Organizer and Presenter**, SPAA 2023, Orlando, Florida, Tutorial on Approximate Nearest Neighbor Search (ANNS) – Techniques and Open Problems.
  - July 2023 Workshop Chair, SPAA 2023, Orlando, Florida, Highlights of Parallel Computing (HOPC'23) (link).
  - July 2022 Workshop Organizer, SPAA 2022, Philadelphia, Pennsylvania, Workshop on Large-Scale Graph Processing (link).
  - July 2022 Workshop Presenter, ICML 2022, Baltimore, Maryland, Workshop on Graph Mining and Learning.
  - February **Tutorial Organizer and Presenter**, PPoPP 2020, San Diego, California, 2020 Abstractions and Algorithms for Efficiently Programming NVRAMs.
- March 2016 **Tutorial Organizer and Presenter**, PPoPP 2016, Barcelona, Spain, Large-Scale Graph Processing in Shared Memory.
- 2016–2018 Graduate Teaching Assistant for Algorithms in the Real World (15-853), Undergraduate Complexity Theory (15-455), Graduate Algorithms (15-750)

Earlier Course Experience

- Spring 2018 T.A. for Algorithms in the Real World (15-853).
- Spring 2017 T.A. for Undergraduate Complexity Theory (15-455).
- Spring 2016 T.A. for Graduate Algorithms (15-750).
- Spring 2014 T.A. for Computational Geometry (15-456).
- Spring 2014 T.A. for Algorithm Design and Analysis (15-451).
- Spring 2013 T.A. for Parallel Data Structures and Algorithms (15-210).
  - Fall 2012 T.A. for Introduction to Functional Programming (15-150).

# Invited Talks

- 2024 Efficient Algorithms for Graph-Based Hierarchical Agglomerative Clustering, Theory Seminar, John Hopkins.
- 2023 **Parallel Batch-Dynamic Graph Representations**, Workshop on Dynamic Graphs and Algorithm Design, Simons Institute, UC Berkeley.
- 2023 Building Scalable and Practical Batch-Dynamic Graph Algorithms, The Cornell, Maryland, Max Planck Pre-doctoral Research School 2023.
- 2022 Efficient Algorithms and Systems for Dynamic and Streaming Graphs, Theory-in-Practice Workshop, IDEAL, Northwestern University, IL.
- 2022 Advances in Parallel Clustering, Workshop on Graph Mining and Learning, ICML'22, Baltimore, MD.
- 2021 Provably Efficient and Scalable Shared-Memory Graph Processing, Department Seminar at University of Maryland, College Park, MD.
- 2021 Provably Efficient and Scalable Shared-Memory Graph Processing, *IC Colloqium at EPFL*, Lausanne, Switzerland.
- 2020 Provably Efficient and Scalable Shared-Memory Graph Processing, CS Colloqium at UC Riverside, Riverside, CA.
- 2020 Parallel Semi-Asymmetric Graph Processing, Google Research (Algorithms and Optimization Group), New York City, NY.
- 2019 Fast and Theoretically-Efficient Parallel Graph Processing on Static and Dynamic Graphs, *Microsoft Research*, Redmond, WA.
- 2019 Algorithms and Systems for Processing Massive Static and Evolving Graphs, MIT Fast Code Seminar, Cambridge, MA.
- 2019 Low-Latency Graph Processing using Compressed Purely-Functional Trees, Dagstuhl Workshop on Algorithms for Big Data, Schloss Dagstuhl, Wadern, Germany.
- 2018 Low-Latency Graph Processing using Compressed Purely-Functional Trees, Google Research (Algorithms and Optimization Group), New York City, NY.
- 2018 Shared-Memory Parallelism at Google, Google Research (Graph Mining Group), New York City, NY.
- 2017 Shared-Memory Parallel Graph Algorithms, Google Research (Algorithms Seminar), Mountain View, CA.

#### Departmental Service

- 2024–Present Faculty Search Committee, Dept. of Computer Science, UMD College Park
- 2024–Present **High School Programming Contest: Lead Organizer**, Dept. of Computer Science, UMD College Park (2025)
- 2023–Present High School Programming Contest: Problem Setter and Presenter, Dept. of Computer Science, UMD College Park (2023, 2024)
  - 2023–2024 Fellowship Awards Committee, Dept. of Computer Science, UMD College Park

Professional Service

- 2024–Present SPAA Proceedings Chair
- 2024–Present PPoPP Proceedings Chair

- 2024–Present **PPoPP Sponsorship Chair**
- 2023–Present SPAA Publicity Chair
  - 2024 DISC 2024 Program Committee
  - 2023 PPoPP 2024 Program Committee
  - 2023 IPDPS 2024 Program Committee
  - 2023 SPAA 2023 Program Committee
  - 2023 PPoPP 2023 Program Committee
  - 2023 ALENEX 2023 Program Committee
  - 2022 PPoPP 2022 External Review Committee
  - 2021 ESA 2021 Program Committee
  - 2021 SC 2021 Poster Committee
  - 2021 HIPC 2021 Program Committee
  - 2020 JMLR Editorial Board Reviewer
  - 2020 PLDI'20 Artifact Evaluation Committee
  - 2020 CMU CSD Faculty Hiring Committee (one of two student members)
  - 2016, 2020 Parallel Reading Group Organizer (seminar at CMU)

**Journal Reviewer.** JMLR {'20,'19,'18}, ACM TOPC {'23, '21, '20,'19,'18,'17}, ACM TOMS'21, IEEE TPDS'16

**Reviewer.** ITCS'22, POPL'22, PPoPP'22, PLDI'21, DISC'21, VLDB {'20, '22}, SODA {'23, '22, '21, '20}, SPAA {'22, '21, '20,'19,'18,'17,'16}, ESA {'21,'20,'19}, IPDPS {'21, '18}, SIGMETRICS'20, DCC'18, SPIRE'18