Piyush Sao

Curriculum Vitae

Education

2018	**Doctor of Philosophy**, *Georgia Institute of Technology*, Atlanta, GA, USA
	Computational Science and Engineering
	Thesis: *Scalable and Resilient Sparse Linear Solvers*
	Advisor: Dr. Richard Vuduc
2016	**Master of Science**, *Georgia Institute of Technology*, Atlanta, GA, USA, GPA-4.0/4
	Computational Science and Engineering
2011	**Master of Technology**, *Indian Institute of Technology, Madras*, India, *GPA-8.5/10*
	Electrical Engineering, Specialization: Microelectronics and VLSI design
2011	**Bechelor of Technology**, *Indian Institute of Technology, Madras*, India, *GPA-8.5/10*
	Electrical Engineering, Minor: Theoretical Computer Science

Experience

August 2019–Present	**Research Scientist** , *Computational Data Analytics Group*, Oak Ridge National Laboratory, Oak Ridge, TN
August 2018–July 2019	**Postdoctoral Research Associate**, *Computer Science Research Group*, Oak Ridge National Laboratory, Oak Ridge, TN
2011–2018	**Graduate Reseach Assistant**, *Georgia Institute of Technology*, Atlanta, GA
May–August 2014	**Summer Intern**, *Parallel Computing Lab, Intel Corporation*, Santa Clara, CA
May–August 2013	**Summer Intern**, *Computational Research Division, Lawrence Berkeley National Laboratory*, Berkeley, CA

Awards & Honors

Professional Awards

2022	**ORNL Special Performance Award**, For outstanding research contributions in the Computer Science and Mathematics Division
2022	**SC22 Gorden-Bell Finalist**, (Media), Finalist for submission "Exaflops biomedical knowledge graph analytics"
2022	**SIAM PP22 Best Paper Prize**, (Link), Winner of the SIAM Activity Group on Supercomputing Best Paper Prize; (SIAM News), (ORNL News)
2021	**R&D 100 Award Finalist**, (Link)
2020	**SC20 Gorden-Bell Finalist**, (Link), Finalist for submission "Scalable Knowledge Graph Analytics at 136 PetaFlop/s"
2019	**ORNL Outstanding Postdoctoral Research Associate**, For outstanding research contributions in the Computer Science and Mathematics Division
2019	**Graph500**, (Link), Member of the technical team that placed the Summit Supercomputer at ORNL 4th in the prestigious Graph500 List

Conference Travel Awards

2016	**HPDC**, Travel award recipient
2014	**SIAM Parallel Processing**, Travel award recipient
2014	**Copper-Mountain**, Travel award recipient

| 2015 | **IPDPS**, Travel award recipient |

Academic Awards

2006	**Indian National Mathematics Olympiad**, Selected as one of 35 awardees (100th percentile)
2006	**All India Rank 651 in IIT-JEE**, Top 0.2 percent of 300,000 applicants
2006	**National Standard Examination in Physics**, (Link), Awarded to top 1 percent (99th percentile)

Undergraduate Scholarship

| 2009 | **DAAD-WISE**, Recipient of German Academic Exchange Service-Working Internships in Science and Engineering Scholarship (awarded to approximately 300 undergraduate students in India) |
| 2010 | **CRUISE fellowship**, Awardee of CRUISE (Computing Research Undergraduate Computing Research Undergraduate Intern Summer Experience-CRUISE Program) fellowship Site: http://www.cse.gatech.edu/research/cruise |

Publications

Google Scholar Profile

https://scholar.google.com/citations?user=M3J5vrUAAAAJ, Accessed on March 31, 2023,

Citations:793 (Since 2018: 319)
h-index: 9 (Since 2018: 8)
i10-index:8 (Since 2018: 8)

Conference papers

[1] Prokopenko, Andrey ; **Sao, Piyush** ; Lebrun-Grandie, Damien: A single-tree algorithm to compute the Euclidean minimum spanning tree on GPUs. In: *Proceedings of the 51st International Conference on Parallel Processing*, 2022, S. 1–10

[2] Kannan, Ramakrishnan ; **Sao, Piyush** ; Lu, Hao ; Kurzak, Jakub ; Schenk, Gundolf ; Shi, Yongmei ; Lim, Seung-Hwan ; Israni, Sharat ; Thakkar, Vijay ; Cong, Guojing u. a.: Exaflops biomedical knowledge graph analytics. In: *2022 SC22: International Conference for High Performance Computing, Networking, Storage and Analysis (SC)* IEEE Computer Society, 2022, S. 61–71

[3] **Sao, Piyush** ; Lu, Hao ; Kannan, Ramakrishnan ; Thakkar, Vijay ; Vuduc, Richard ; Potok, Thomas: Scalable All-pairs Shortest Paths for Huge Graphs on Multi-GPU Clusters. In: *Proceedings of the 30th International Symposium on High-Performance Parallel and Distributed Computing*, 2020, S. 121–131

[4] Schuman, Catherine D. ; Kay, Bill ; Date, Prasanna ; Kannan, Ramakrishnan ; **Sao, Piyush** ; Potok, Thomas E.: Sparse Binary Matrix-Vector Multiplication on Neuromorphic Computers. In: *2021 IEEE International Parallel and Distributed Processing Symposium Workshops (IPDPSW)* IEEE, 2021, S. 308–311

[5] Kannan, Ramakrishnan ; **Sao, Piyush** ; Lu, Hao ; Herrmannova, Drahomira ; Thakkar, Vijay ; Patton, Robert ; Vuduc, Richard ; Potok, Thomas: Scalable knowledge graph analytics at 136 petaflop/s. In: *SC20: International Conference for High Performance Computing, Networking, Storage and Analysis* IEEE, 2020, S. 1–13

[6] **Sao, Piyush** ; Kannan, Ramakrishnan ; Gera, Prasun ; Vuduc, Richard: A supernodal all-pairs shortest path algorithm. In: *Proceedings of the 25th ACM SIGPLAN Symposium on Principles and Practice of Parallel Programming*, 2020, S. 250–261

[7] **Sao, Piyush** ; Kannan, Ramakrishnan: Multifrontal Non-negative Matrix Factorization. In: *International Conference on Parallel Processing and Applied Mathematics* Springer, 2019, S. 543–554

[8] **Sao, Piyush** ; Engelmann, Christian ; Eswar, Srinivas ; Green, Oded ; Vuduc, Richard: Self-stabilizing Connected Components. In: *2019 IEEE/ACM 9th Workshop on Fault Tolerance for HPC at eXtreme Scale (FTXS)* IEEE, 2019, S. 50–59

[9] **Sao, Piyush** ; Kannan, Ramakrishnan ; Li, Xiaoye ; Vuduc, Richard: A Communication-avoiding 3D Sparse Triangular Solve Algorithm. In: *International Conference on Supercomputing.* Phoenix AZ, Accepted, June 26-28 2019

[10] **Sao, Piyush** ; Li, Xiaoye S. ; Vuduc, Richard: A communication-avoiding 3D LU factorization algorithm for sparse matrices. In: *Proceedings of the IEEE International Parallel and Distributed Processing Symposium (IPDPS).* Vancouver, BC, Canada, May 2018

[11] **Sao, Piyush** ; Liu, Xing ; Vuduc, Richard ; Li, Xiaoye: A Sparse Direct Solver for Distributed Memory Xeon Phi-accelerated Systems. In: *Parallel and Distributed Processing Symposium (IPDPS), 2015 IEEE International* IEEE, 2015, S. 71–81

[12] **Sao, Piyush** ; Vuduc, Richard ; Li, Xiaoye S.: A distributed CPU-GPU sparse direct solver. In: *European Conference on Parallel Processing* Springer, 2014, S. 487–498

[13] **Sao, Piyush** ; Vuduc, Richard: Self-stabilizing iterative solvers. In: *Proceedings of the Workshop on Latest Advances in Scalable Algorithms for Large-Scale Systems* ACM, 2013, S. 4

[14] **Sao, Piyush** ; Green, Oded ; Jain, Chirag ; Vuduc, Richard: A Self-Correcting Connected Components Algorithm. In: *Proceedings of the ACM Workshop on Fault-Tolerance for HPC at Extreme Scale* ACM, 2016, S. 9–16

Journal Articles

[1] Li, Xiaoye S. ; Lin, Paul ; Liu, Yang ; **Sao Piyush**: Newly Released Capabilities in Distributed-memory SuperLU Sparse Direct Solver. In: *ACM Transactions on Mathematical Software* (2022)

[2] Gera, Prasun ; Kim, Hyojong ; **Sao Piyush** ; Kim, Hyesoon ; Bader, David: Traversing large graphs on GPUs with unified memory. In: *Proceedings of the VLDB Endowment* 13 (2020), Nr. 7, S. 1119–1133

[3] **Sao Piyush** ; Li, Xiaoye S. ; Vuduc, Richard: A communication-avoiding 3D algorithm for sparse LU factorization on heterogeneous systems. In: *Journal of Parallel and Distributed Computing* (2019)

[4] Lee, Dongryeol ; **Sao Piyush** ; Vuduc, Richard ; Gray, Alexander G.: A distributed kernel summation framework for general-dimension machine learning. In: *Statistical Analysis and Data Mining: The ASA Data Science Journal* 7 (2014), Nr. 1, S. 1–13

Thesis Book chapters and Extended reports

[1] **Sao, Piyush**: *Model Order Reduction Techniques for VLSI Circuit Simulation*, IIT Madras, Diplomarbeit, 5 2011

[2] **Sao, Piyush**: *Scalable and Resilient Sparse Linear Solvers*, Georgia Institute of Technology, Diss., 8 2018. https://smartech.gatech.edu/handle/1853/60233

[3] Li, Xiaoye S. ; Demmel, James W. ; Gilbert, John R. ; Grigori, Laura ; **Sao, Piyush** ; Shao, Meiyue ; Yamazaki, Ichitaro: SuperLU Users' Guide / Lawrence Berkeley National Laboratory. 2016. – Forschungsbericht

[4] Graves, Jeffrey A. ; Blum, Thomas F. ; **Sao, Piyush** ; Chi, Miaofang ; Kannan, Ramakrishnan: FUNNL: Fast Nonlinear Nonnegative Unmixing for Alternate Energy Systems. In: *Knowledge-Guided Machine Learning.* Chapman and Hall/CRC, 2023, S. 261–286

[5]   Engelmann, Christian ; Ashraf, Rizwan ; Hukerikar, Saurabh ; Kumar, Mohit ; **Sao, Piyush**: Resilience Design Patterns: A Structured Approach to Resilience at Extreme Scale (Version 2.0) / Oak Ridge National Lab.(ORNL), Oak Ridge, TN (United States). 2022. – Forschungsbericht

Patents and Inventions disclosure

2022   **Knowledge graph analytics kernels in high performance computing**, *Kannan, R.,* **Sao, P. K.**, *Lu, H., Herrmannova, D., Thakkar, V., Patton, R. M., Vuduc, R. W., & Potok, T. E.*, US Patent App. 17/389,862, Feb 3
Google Patents
https://patents.google.com/patent/US20220035832A1/en
Application filed by UT Battelle LLC: Jul 30, 2021
Status: Pending

2022   **U.S. Copyright Registration Certificate**, Title*: DSNAPSHOT, Registration Number*: TXu 2-314-193, *Effective Date*: 2022-05-05, ORNL
Authors:
○ Drahomira Herrmannova
○ Ramakrishnan Kannan
○ Hao Lu
○ Robert M Patton
○ Thomas E Potok
○ Piyush K Sao

Research Grants and Funding

2020–2023   **Principal Investigator**, *Next generation sparse solvers STRUMPACK/SUPERLU*, Exascale Computing Project, Department of Energy, $480,000 USD

2022–2027   **Co-Principal Investigator**, *Sparsitute: Mathematical Multifaceted Integrated Capability Center (MMICC)*, Office of Advanced Scientific Computing Research, Department of Energy, $2.5 million USD
https://sparsitute.lbl.gov/people

2020–2024   **Co-Principal Investigator**, *ASCENDS-II (Advances in Machine Learning to Improve Scientific Discovery at Exascale and Beyond)*, Department of Energy, $1,200,000
Contributing to the development of advanced machine learning techniques to enable scientific discovery on exascale computing systems.

Talks and Posters

SPAA'23   **Communication Optimal Sparse LU Factorization for Planar Graphs**, *Orlando, FL*, Jun. 16-19, 2023, **Scheduled

ICIAM'23   **Avoiding Communication in Sparse Graph All Pair Shortest Path Problem**, **Scheduled*, Tokyo, Japan

SIAM CSE'23   **Communication-Avoiding Algorithms for Sparse Triangular Matrices**, *Feb. 26-Mar. 3, 2023*, Amsterdam, Netherlands

SIAM PP'22   **A Communication-Avoiding 3D Algorithm for Sparse LU Factorization on Heterogeneous Systems**, *Invited Plenary Talk; Winner, SIAG Supercomputing Best Paper Award 2022*, Virtual (Seattle, WA)

HPDC'21   **Scalable All-pairs Shortest Paths for Huge Graphs on Multi-GPU Clusters**, *Accepted*, Virtual

SIAM PP'20   **Communication-Avoiding Sparse Direct Solvers for Linear Systems & Graph Problems**, *Feb. 12-15, 2020*

PPoPP'20   **A Supernodal All-pairs Shortest Path Algorithm**, *San Diego, CA*, Feb. 2020

PPAM'19   **Multifrontal Non-negative Matrix Factorization**, *Bialystok, Poland*, Sep. 8-11, 2019

FTXS'19   **Self-stabilizing Connected Components**, *Denver, CO*

ICS'19	**A Communication-Avoiding 3D Sparse Triangular Solver**, *Phoenix, AZ*, Jun. 26-28
SIAM CSE'17	**A Self-Correcting Connected Components Algorithm**, *Atlanta, GA*
SIAM CSE'17	**Scalable Sparse Direct Solver for Hybrid Architectures**, *Atlanta, GA*
CM'16	**Scalable Sparse Direct Solver for Hybrid Architectures**, *Copper Mountain, CO*
FTXS'16	**A Self-Correcting Connected Components Algorithm**, *Kyoto, Japan*
IPDPS'15	**A Sparse Direct Solver for Distributed Memory Xeon Phi-accelerated Systems**, *Hyderabad, India*
SIAM LA'15	**A Sparse Direct Solver for Distributed Memory GPU and Xeon-Phi Accelerated Systems**, *Atlanta, GA*
SC'13	**Self-stabilizing Iterative Solvers**, *Denver, CO*
PMAA'14	**Self-stabilizing Iterative Solvers**, *Lugano, Switzerland*
CM'14	**Self-stabilizing Iterative Solvers**, *Copper Mountain, CO*
SIAM PP'14	**Self-stabilizing Iterative Solvers**, *Portland, OR*
EuroPar'14	**A Distributed CPU-GPU Sparse Direct Solver**, *Porto, Portugal*
IGWA'09	**Discretization of Convection-Diffusion Type Equation**, *IIT-Roorkee, India*

Professional Activities

Reviewer for

- International Journal of High Performance Computing Applications (IJHPCA)
- ACM Transactions on Parallel Computing
- SIAM Journal on Scientific Computing (SISC)
- Parallel Computing Journal (ParCO)
- ACM Transactions on Mathematical Software (ACM TOMS)
- Journal of Computational Science (JoCS)

Program Committee Member

- Supercomputing: SC20, SC22
- International Parallel and Distributed Processing Symposium: IPDPS 2021, IPDPS 2022, IPDPS 2023
- International Conference on Parallel Processing: ICPP 2022
- ACM International Conference on Supercomputing (ICS): ICS 2022, ICS 2023
- International Conference on Supercomputing: ISC 2022 - Posters
- Smokey Mountain Conference: SMC 2021, SMC 2022, SMC 2022
- High-Level Parallel Programming Models and Supportive Environments: HIPS 2022

Professional Society Memberships

- Society for Industrial and Applied Mathematics (SIAM)
- Association for Computing Machinery (ACM)
- Institute of Electrical and Electronics Engineers (IEEE)

Computer skills

Language	Proficient in *C* and *Python*, *C*++
Parallel Programming	MPI, OpenMP, CUDA
Scientific Packages	Matlab, NumPy (python), Pandas, LAPACK,
Visualization	Matlab, Matplotlib, d3.js, GraphViz, Inkscape
General Purpose	SQL, Latex, Git

References

Dr. Richard Vuduc
Associate Professor
Georgia Institute of Technology
266 Ferst Drive
Atlanta, GA 30332
email: richie@cc.gatech.edu
Tel: 404-385-3355
Web: vuduc.org

Dr. Xiaoye Sherry Li
Senior Scientist
Lawrence Berkeley National Laboratory
One Cyclotron Rd
Berkeley, CA 94720
email: xsli@lbl.gov Tel: 510-486-6684
Fax: 510-486-5812
web: crd-legacy.lbl.gov/~xiaoye