

Roger Allan Pearce

Research Interests

Graph Algorithms, Parallel Algorithms, External Memory Algorithms, Data-Intensive Computing, Machine Learning, Optimization, Computational Science, High-Performance Computing (HPC)

Education

2013 **Ph.D., Computer Science, Texas A&M University**, College Station, Texas, USA.

Research Focus: Parallel & External Memory Graph Algorithms

Adviser: Dr. Nancy M. Amato

Dissertation: "Scalable Parallel Algorithms for Massive Scale-free Graphs"

2004 **B.S., Computer Engineering, Texas A&M University**, College Station, Texas, USA.

Senior Honors Thesis: "Extracting Optimal Paths from Roadmaps for Motion Planning"

Honors and Awards

2020 Global Security/Z Program team Silver Award, Lawrence Livermore National Laboratory

2017, 2018, 2019 **IEEE HPEC GraphChallenge Champion**

- "One Quadrillion Triangles Queried on One Million Processors" [7]
- "K-truss decomposition for Scale-Free Graphs at Scale in Distributed Memory" [15]
- "Triangle counting for scale-free graphs at scale in distributed memory" [21]

2017, 2018 Outstanding Mentor Award, Lawrence Livermore National Laboratory

- For mentorship of graduate and undergraduate students.

2017 Best Paper Award, **IEEE International Workshop on High-Performance Big Data Computing** [23]

- "Performance evaluation of scale-free graph algorithms in low latency Non-Volatile Memory"

2011 Computation Directorate Noteworthy Achievement Award, Lawrence Livermore National Laboratory

2009 **LSP Fellow (Lawrence Scholar Program)**, Lawrence Livermore National Laboratory

2006 **GAANN Fellow (Graduate Assistance in Areas of National Need)**, Texas A&M University

2003 University Undergraduate Research Fellow, Texas A&M University

- First place for senior honors thesis in category of engineering and physics

1999 Member of Eagle Scout Association

Recent Professional Experience

2013 – Present **Center for Applied Scientific Computing, Lawrence Livermore National Laboratory**.

PI and co-PI of multiple research projects investigating distributed algorithms for graph analytics on High-Performance Computing (HPC) systems. Supervised 3 post-docs, 15 Ph.D., and 5 undergraduate students. Selected HPC graph analytics research contributions include novel algorithms for: Pattern Matching [17, 22, 19], Triangle Counting [21], K-Truss [15], Eccentricity [12], BFS (Distributed-GPU) [14], and Streaming Graphs [10, 24]. Selected systems research contributions include: communication optimizations for irregular algorithms [9] , algorithms for Non-Volatile Memory (NVM & NVRAM) [23, 26].

2009 – 2013 **Graduate Fellowship, Lawrence Livermore National Laboratory**, Adviser: Dr. Maya Gokhale.

Awarded Lawrence Scholar Program (LSP) fellowship. Developed highly-parallel asynchronous graph traversal algorithms for massive real-world graphs. Applied asynchronous techniques to External Memory using NAND Flash devices [34]. Developed scalable techniques for processing massive scale-free graphs in distributed memory [28, 29].

2004 – 2009 **Graduate Research Assistant, Parasol Lab, Texas A&M Univ.**, Adviser: Dr. Nancy Amato.

Applied machine learning techniques to robotic motion planning problems [38, 41, 42]. Developed tools and metrics to analyze the evolution of sampling based motion planning algorithms [37, 39, 40]. Improved sampling techniques using graph structural information [35].

Lawrence Livermore National Laboratory

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2007, 2008	Summer Intern , Lawrence Livermore National Laboratory, Developed an I/O profiling tool using dynamic interposition libraries. Researched techniques for implementing external memory graph algorithms. Experimented with distributed file systems and <i>Hadoop MapReduce</i> . Member of <i>Storage Intensive Super Computing (SISC)</i> group [36].	Adviser: Dr. Maya Gokhale.
2001 – 2004	Undergrad Research Assistant , Parasol Lab, Texas A&M Univ., Developed autonomous navigation and localization algorithms for mobile robots [45, 44]. Researched path optimization algorithms for robotics using roadmaps [43].	Adviser: Dr. Nancy Amato.
2003	Software Developer , CAPSHER Technology, Inc., Bryan, TX, USA.	

Selected Synergistic Activities

- 2020 - present Postdoctoral mentor for Dr. Trevor Steil
- 2020 - present Postdoctoral mentor for Dr. Tahsin Reza
- 2017 - 2020 Postdoctoral mentor for Dr. Keita Iwabuchi
- 2019 Presented overview of HPC Graph research at *Graph Fest*, National Security Agency (NSA)
- 2019 Served on the Ph.D. Defense Committee for Dr. Benjamin Priest, advised by Prof. George Cybenko at Dartmouth
- 2019 Served on the Ph.D. Defense Committee for Dr. Tahsin Reza, advised by Prof. Matei Ripeanu at the University of British Columbia (UBC)

Publications

— Peer-reviewed Publications. * denotes students or postdocs I mentored. —

- [1] Benjamin Brock, Aydin Buluç, Timothy G Mattson, Scott McMillan, José E Moreira, **Roger Pearce**, Oguz Selvitopi, and Trevor Steil*. Considerations for a distributed graphblas api. In *2020 IEEE International Parallel and Distributed Processing Symposium Workshops (IPDPSW)*, pages 215–218. IEEE, 2020.
- [2] Ivy Peng, **Roger Pearce**, and Maya Gokhale. On the memory underutilization: Exploring disaggregated memory on hpc systems. In *2020 IEEE 32nd International Symposium on Computer Architecture and High Performance Computing (SBAC-PAD)*, pages 183–190. IEEE, 2020.
- [3] Tahsin Reza*, Matei Ripeanu, Geoffrey Sanders, and **Roger Pearce**. Approximate pattern matching in massive graphs with precision and recall guarantees. In *ACM SIGMOD/PODS International Conference on Management of Data*, 2020.
- [4] Tahsin Reza*, Matei Ripeanu, Geoffrey Sanders, and **Roger Pearce**. Towards interactive pattern search in massive graphs. In *Proceedings of the 3rd Joint International Workshop on Graph Data Management Experiences; Systems (GRADES) and Network Data Analytics (NDA)*, GRADES-NDA'20, New York, NY, USA, 2020. Association for Computing Machinery.
- [5] Trevor Steil*, Scott McMillan, Geoffrey Sanders, **Roger Pearce**, and Benjamin Priest. Kronecker graph generation with ground truth for 4-cycles and dense structure in bipartite graphs. In *2020 IEEE International Parallel and Distributed Processing Symposium Workshops (IPDPSW)*, pages 237–246. IEEE, 2020.
- [6] Keita Iwabuchi*, Lance Lebanoff*, Maya Gokhale, and **Roger Pearce**. Metall: A persistent memory allocator enabling graph processing. In *2019 IEEE/ACM 9th Workshop on Irregular Applications: Architectures and Algorithms (IA3)*, pages 39–44. IEEE, 2019.
- Champion** [7] **Roger Pearce**, Trevor Steil*, Benjamin Priest*, and Geoffrey Sanders. One quadrillion triangles queried on one million processors. In *2019 IEEE High Performance extreme Computing Conference (HPEC)*. IEEE, 2019.
- [8] Ivy Peng, Marty McFadden, Eric Green, Keita Iwabuchi*, Kai Wu, Dong Li, **Roger Pearce**, and Maya Gokhale. Umap: Enabling application-driven optimizations for page management. In *2019 IEEE/ACM Workshop on Memory Centric High Performance Computing (MCHPC)*, pages 71–78. IEEE, 2019.
- [9] Benjamin Priest*, Trevor Steil*, Geoffrey Sanders, and **Roger Pearce**. You've got mail: Building missing asynchronous communication primitives. In *GrAPL 2019: Workshop on Graphs, Architectures, Programming, and Learning*, 2019.
- [10] Scott Sallinen*, **Roger Pearce**, and Matei Ripeanu. Incremental graph processing for on-line analytics. In *2019 IEEE International Parallel and Distributed Processing Symposium (IPDPS)*, 2019.

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- [11] Trevor Steil*, Benjamin Priest*, Geoffrey Sanders, **Roger Pearce**, Timothy La Fond, and Keita Iwabuchi. Distributed kronecker graph generation with ground truth of many graph properties. In *2019 IEEE International Parallel and Distributed Processing Symposium Workshops (IPDPSW)*, pages 251–260. IEEE, 2019.
- [12] Keita Iwabuchi*, Geoffrey Sanders, Keith Henderson, and **Roger Pearce**. Computing exact vertex eccentricity on massive-scale distributed graphs. In *2018 IEEE International Conference on Cluster Computing (CLUSTER)*, pages 257–267. IEEE, 2018.
- [13] Jeremy Kepner, Siddharth Samsi, William Arcand, David Bestor, Bill Bergeron, Tim Davis, Vijay Gadepally, Michael Houle, Matthew Hubbell, Hayden Jananthan, Michael Jones, Anna Klein, Peter Michaleas, **Roger Pearce**, Lauren Milechin, Julie Mullen, Andrew Prout, Antonio Rosa, Geoff Sanders, Charles Yee, and Albert Reuther. *Design, generation, and validation of extreme scale power-law graphs*. In *2018 IEEE International Parallel and Distributed Processing Symposium Workshops (IPDPSW)*, pages 279–286. IEEE, 2018.
- [14] Yuechao Pan*, **Roger Pearce**, and John D Owens. Scalable breadth-first search on a gpu cluster. In *2018 IEEE International Parallel and Distributed Processing Symposium (IPDPS)*, pages 1090–1101. IEEE, 2018.
- Champion** [15] **Roger Pearce** and Geoffrey Sanders. K-truss decomposition for scale-free graphs at scale in distributed memory. In *2018 IEEE High Performance Extreme Computing Conference (HPEC)*, pages 1–6. IEEE, 2018.
- [16] Benjamin W Priest*, **Roger Pearce**, and Geoffrey Sanders. Estimating edge-local triangle count heavy hitters in edge-linear time and almost-vertex-linear space. In *2018 IEEE High Performance Extreme Computing Conference (HPEC)*, pages 1–7. IEEE, 2018.
- [17] Tahsin Reza*, Matei Ripeanu, Nicolas Tripoul, Geoffrey Sanders, and **Roger Pearce**. Prunejuice: pruning trillion-edge graphs to a precise pattern-matching solution. In *SC18: International Conference for High Performance Computing, Networking, Storage and Analysis*, pages 265–281. IEEE, 2018.
- [18] Geoffrey Sanders, **Roger Pearce**, Timothy La Fond, and Jeremy Kepner. On large-scale graph generation with validation of diverse triangle statistics at edges and vertices. In *2018 IEEE International Parallel and Distributed Processing Symposium Workshops (IPDPSW)*, pages 287–296. IEEE, 2018.
- [19] Nicolas Tripoul, Hassan Halawa, Tahsin Reza*, Geoffrey Sanders, **Roger Pearce**, and Matei Ripeanu. There are trillions of little forks in the road. choose wisely! In *2018 IEEE/ACM 8th Workshop on Irregular Applications: Architectures and Algorithms (IA3)*, pages 20–27. IEEE, 2018.
- [20] Sam Adé Jacobs, Nikoli Dryden, **Roger Pearce**, and Brian Van Essen. Towards scalable parallel training of deep neural networks. In *Proceedings of the Machine Learning on HPC Environments*, MLHPC’17, pages 5:1–5:9, New York, NY, USA, 2017. ACM.
- Champion** [21] **Roger Pearce**. Triangle counting for scale-free graphs at scale in distributed memory. In *2017 IEEE High Performance Extreme Computing Conference (HPEC)*, pages 1–4. IEEE, 2017.
- Best Paper Nominee** [22] Tahsin Reza*, Christine Klymko, Matei Ripeanu, Geoffrey Sanders, and **Roger Pearce**. Towards practical and robust labeled pattern matching in trillion-edge graphs. In *2017 IEEE International Conference on Cluster Computing (CLUSTER)*, pages 1–12. IEEE, 2017.
- Best Paper** [23] Manu Shantharam, Keita Iwabuchi, Pietro Cicotti, Laura Carrington, Maya Gokhale, and **Roger Pearce**. Performance evaluation of scale-free graph algorithms in low latency non-volatile memory. In *2017 IEEE International Parallel and Distributed Processing Symposium Workshops (IPDPSW)*, pages 1021–1028. IEEE, 2017.
- [24] Scott Sallinen*, Keita Iwabuchi*, Suraj Poudel*, Maya Gokhale, Matei Ripeanu, and **Roger Pearce**. Graph colouring as a challenge problem for dynamic graph processing on distributed systems. In *SC’16: Proceedings of the International Conference for High Performance Computing, Networking, Storage and Analysis*, pages 347–358. IEEE, 2016.
- [25] Julia Bernd, Damian Borth, Carmen Carrano, Jaeyoung Choi, Benjamin Elizalde, Gerald Friedland, Luke Gottlieb, Karl Ni, **Roger Pearce**, Doug Poland, et al. Kickstarting the commons: The yfcc100m and the yli corpora. In *Proceedings of the 2015 Workshop on Community-Organized Multimodal Mining: Opportunities for Novel Solutions*, pages 1–6. ACM, 2015.
- [26] Brian Van Essen, Henry Hsieh, Sasha Ames, **Roger Pearce**, and Maya Gokhale. Di-mmap—a scalable memory-map runtime for out-of-core data-intensive applications. *Cluster Computing*, 18(1):15–28, 2015.
- [27] Brian Van Essen, Hyojin Kim, **Roger Pearce**, Kofi Boakye, and Barry Chen. Lbann: Livermore big artificial neural network hpc toolkit. In *Proceedings of the Workshop on Machine Learning in High-Performance Computing Environments*, page 5. ACM, 2015.

- [28] Roger Pearce, Maya Gokhale, and Nancy M Amato. Faster parallel traversal of scale free graphs at extreme scale with vertex delegates. In *SC'14: Proceedings of the International Conference for High Performance Computing, Networking, Storage and Analysis*, pages 549–559. IEEE, 2014.
- [29] Roger Pearce, Maya Gokhale, and Nancy M. Amato. Scaling techniques for massive scale-free graphs in distributed (external) memory. In *IEEE International Parallel & Distributed Processing Symposium (IPDPS)*, 2013.
- [30] Brian Van Essen, Henry Hsieh, Sasha Ames, Roger Pearce, and Maya Gokhale. DI-MMAP – a scalable memory-map runtime for out-of-core data-intensive applications. *Cluster Computing*, pages 1–14, 2013. (To Appear).
- [31] Brian Van Essen, Roger Pearce, Sasha Ames, and Maya Gokhale. On the role of NVRAM in data-intensive architectures: an evaluation. In *IEEE International Parallel & Distributed Processing Symposium (IPDPS)*, Shanghai, China, May 2012.
- [32] Andy Yoo, Allison H. Baker, Roger Pearce, and Van Emden Henson. A scalable eigensolver for large scale-free graphs using 2D partitioning. In *Supercomputing 2011 (SC'11)*, Seattle, WA, November 2011.
- [33] Brian Van Essen, Roger Pearce, Sasha Ames, and Maya Gokhale. On the role of NVRAM in data intensive HPC architectures. In *Workshop on Emerging Supercomputing Technologies*, Tucson, AZ, May 2011.
- [34] Roger Pearce, Maya Gokhale, and Nancy M. Amato. Multithreaded asynchronous graph traversal for in-memory and semi-external memory. In *Supercomputing 2010 (SC'10)*, New Orleans, LA, November 2010.
- [35] Roger Pearce, Marco Morales, and Nancy M. Amato. Structural improvement filtering strategy for PRM. In *Proceedings of Robotics: Science and Systems (RSS)*, Zurich, Switzerland, June 2008.
- [36] Maya Gokhale, Jonathan Cohen, Andy Yoo, W. Marcus Miller, Arpith Jacob, Craig Ulmer, and Roger Pearce. Hardware technologies for high-performance data-intensive computing. In *IEEE Computer*, pages 60–68, April 2008. (Cover Feature).
- [37] Marco A. Morales A., Roger Pearce, and Nancy M. Amato. Analysis of the evolution of c-space models built through incremental exploration. In *Proceedings of IEEE International Conference on Robotics Automation (ICRA)*, Rome, Italy, April 2007.
- [38] Samuel Rodriguez, Shawna Thomas, Roger Pearce, and Nancy M. Amato. RESAMPL: A region-sensitive adaptive motion planner. In *Proceedings of International Workshop on the Algorithmic Foundations of Robotics (WAFR)*, New York City, NY, July 2006.
- [39] Dawen Xie, Marco A. Morales A., Roger Pearce, Shawna Thomas, Jyh-Ming Lien, and Nancy M. Amato. Incremental map generation (IMG). In *Proceedings of International Workshop on the Algorithmic Foundations of Robotics (WAFR)*, New York City, NY, July 2006.
- [40] Marco A. Morales A., Roger Pearce, and Nancy M. Amato. Metrics for analyzing the evolution of c-space models. In *Proceedings of IEEE International Conference on Robotics Automation (ICRA)*, Orlando, FL, May 2006.
- [41] Marco A. Morales A., Lydia Tapia, Roger Pearce, Samuel Rodriguez, and Nancy M. Amato. C-space subdivision and integration in feature-sensitive motion planning. In *Proceedings of IEEE International Conference on Robotics Automation (ICRA)*, Barcelona, Spain, May 2005.
- [42] Marco Morales, Lydia Tapia, Roger Pearce, Samuel Rodriguez, and Nancy M. Amato. A machine learning approach for feature-sensitive motion planning. In *Proceedings of International Workshop on the Algorithmic Foundations of Robotics (WAFR)*, Utrecht/Zeist, The Netherlands, July 2004.
- [43] Jinsuck Kim, Roger Pearce, and Nancy M. Amato. Extracting optimal paths from roadmaps for motion planning. In *Proceedings of IEEE International Conference on Robotics Automation (ICRA)*, Taipei, Taiwan, September 2003.
- [44] Jinsuck Kim, Roger Pearce, and Nancy M. Amato. Feature-based localization using scannable visibility sectors. In *Proceedings of IEEE International Conference on Robotics Automation (ICRA)*, Taipei, Taiwan, September 2003.
- [45] Jinsuck Kim, Roger Pearce, and Nancy M. Amato. Robust geometric-based localization in indoor environments using sonar sensors. In *Proceedings of IEEE/RSJ International Conference on intelligent Robots and Systems (IROS)*, October 2002.

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