

# Roger Allan Pearce

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## 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"

## Professional Experience

- 2013 - present **Center for Applied Scientific Computing**, *Lawrence Livermore National Laboratory*.
- new!* ○ PI of internally funded R&D project investigating persistent memory technologies for exploratory data analytics (EDA) on HPC (FY21-FY23 \$1.5M):
    - Investigating interactive exploratory labeled graph pattern matching [5]
  - new!* ○ LLNL-PI of multi-institution *NSF funded (via UCSF)* project investigating graph analytics for system biology knowledge graph *SPOKE* (FY21-FY22 \$290K).
    - PI of internally funded R&D project investigating graph algorithms on CORAL2 arch (FY19 \$150K).
      - Demonstrated largest *Graph500* to date; 70-trillion edges with distributed out-of-core alg.
      - Demonstrated largest *GraphChallenge* to date; awarded *champion* [8].
    - Co-PI of internally funded R&D project investigating graph algorithms on HPC (FY17-FY19 \$2M); algorithms investigated include:
      - Labeled Graph Pattern Matching [1, 18, 23, 20]
      - *GraphChallenge* Triangle Counting [22] & K-Truss [16]
      - Exact vertex Eccentricity [13]
      - Distributed-GPU Breadth-First Search (BFS) [15]
      - Streaming on-line graph algorithms [11, 25]
    - Selected systems & architecture research contributions include:
      - Distributed communication optimizations for irregular algorithms on HPC [10]
      - System software for Non-Volatile Memory (NVM & NVRAM) [24, 27].
      - Disaggregated memory for HPC [3]
      - Persistent Memory (PM) C++ allocator: *Metall* [7]
    - Supervised 3 post-docs, 15 Ph.D., and 5 undergraduate student interns.
    - Served on 2 Ph.D. Committees as an external member.
    - Served on the *Lawrence Fellowship* review committee as computation representative (2016-Present)
- 2009 - 2013 **Graduate Fellowship**, *Lawrence Livermore National Lab*, Adviser: Dr. Maya Gokhale.
- Awarded Lawrence Scholar Program (LSP) graduate fellowship.
  - Developed asynchronous graph traversal algorithms for massive real-world graphs: *HavoqGT*.
  - Applied asynchronous techniques to External Memory using NAND Flash devices [35].
  - Developed scalable techniques for processing massive scale-free graphs in distributed memory [29, 30].

- 2004 - 2009 **Graduate Research Assistant**, *Parasol Lab*, Texas A&M, Adviser: Dr. Nancy Amato.  
 o Applied machine learning techniques to robotic motion planning problems [39, 42, 43].  
 o Developed techniques to analyze the evolution of sampling based motion planning algs. [38, 40, 41].  
 o Improved motion planning sampling techniques using graph structural information [36].
- 2007, 2008 **Summer Intern**, *Lawrence Livermore National Laboratory*, Adviser: Dr. Maya Gokhale.  
 o Member of *Storage Intensive Super Computing (SISC)* group [37]  
 - Developed an I/O profiling tool using dynamic interposition libraries.  
 - Researched techniques for implementing external memory graph algorithms.  
 - Experimented with distributed file systems and *Hadoop MapReduce*.
- 2001 - 2004 **Undergrad Research Assistant**, *Parasol Lab*, Texas A&M Univ., Adviser: Dr. Nancy Amato.  
 o Developed autonomous navigation and localization algorithms for mobile robots [46, 45].  
 o Researched path optimization algorithms for robotics using roadmaps [44].
- 2003 **Software Developer**, *CAPSHER Technology, Inc.*, Bryan, TX, USA.

## Selected Synergistic Activities

- 2020 - present Postdoctoral mentor for Dr. Trevor Steil (previously at University of Minnesota)
- 2020 - present Postdoctoral mentor for Dr. Tahsin Reza (previously at University of British Columbia)
- 2017 - 2020 Postdoctoral mentor for Dr. Keita Iwabuchi (previously at Tokyo Tech)
- 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)

## Teaching Experience

- Fall 2020 **Guest Lecture**, *Electrical and Computer Engineering Department*, Brigham Young University.  
 o ECEN 521 - Introduction to Algorithm Design Taught by Dr. Scott Lloyd  
 o Lecture topic: graph analytics & applications
- Fall 2008 **Teaching Assistant**, *Computer Science and Engineering Department*, Texas A&M University.
- Spring 2009 o CPSC 181 - Introduction to Computing Taught by Dr. Valerie Taylor  
 o CPSC 626 - Parallel Algorithm Design and Analysis Taught by Dr. Nancy Amato  
 o CPSC 221 Honors - Data Structures and Algorithms Taught by Dr. Nancy Amato
- Summer 2000 **Learning Services Math Tutor**, *Brazosport Community College*, Lake Jackson, TX.  
 o Tutored students in math courses ranging from remedial to Calculus 3

## Honors and Awards

- 2020 Global Security/Z Program team Silver Award, Lawrence Livermore National Laboratory
- 2017, '18, '19 **IEEE HPEC GraphChallenge Champion**  
 - 2019: "One Quadrillion Triangles Queried on One Million Processors" [8]  
 - 2018: "K-truss decomposition for Scale-Free Graphs at Scale in Distributed Memory" [16]  
 - 2017: "Triangle counting for scale-free graphs at scale in distributed memory" [22]
- 2017, 2018 Outstanding Mentor Award, Lawrence Livermore National Laboratory  
 - For mentorship of graduate and undergraduate students.
- 2017 Best Paper Award, *IEEE Int. Workshop on High-Performance Big Data Computing* [24]

- “Performance evaluation of scale-free graph algorithms in low latency Non-Volatile Memory”
- 2011 Computation Directorate Noteworthy Achievement Award, Lawrence Livermore National Lab
- 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

## Publications – Google Scholar Profile

Peer-reviewed Publications. \* denotes students or postdocs I supervised.

- [1] Tahsin Reza\*, Hassan Halawa, Matei Ripeanu, Geoffrey Sanders, and **Roger Pearce**. Scalable pattern matching in metadata graphs via constraint checking. *ACM Transactions on Parallel Computing (TOPC)*, 8(1):1–45, 2021.
- [2] 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.
- [3] 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.
- [4] 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.
- [5] 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.
- [6] 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.
- [7] 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.
- [8] **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. **(Selected Champion)**.
- [9] 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.

- [10] 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.
- [11] 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.
- [12] 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.
- [13] 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.
- [14] 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.
- [15] 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.
- [16] **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. **(Selected Champion)**.
- [17] 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.
- [18] 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.
- [19] 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.
- [20] 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.
- [21] 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.

- [22] **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. **(Selected Champion)**.
- [23] 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. **(Nominated for best paper)**.
- [24] 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. **(Best Paper Award)**.
- [25] 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.
- [26] 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.
- [27] 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.
- [28] 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.
- [29] **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.
- [30] **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.
- [31] 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.
- [32] 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.
- [33] 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.

- [34] 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.
- [35] **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.
- [36] **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.
- [37] 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).
- [38] 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.
- [39] 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.
- [40] 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.
- [41] 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.
- [42] 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.
- [43] 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.
- [44] 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.
- [45] 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.
- [46] 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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## Collaborators and Co-Editors

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