

Benjamin (Ben) Wesley Priest (he/they)

CONTACT INFORMATION	Postdoctoral Researcher Center for Applied Scientific Computing Lawrence Livermore National Laboratory	Cell: +1-937-681-1935 E-mail: priest2@llnl.gov
RESEARCH INTERESTS	Efficient analysis of large, dynamic datasets: sketching, streaming algorithms, machine learning, high performance computing, graph algorithms, numerical linear algebra, compressed sensing, graph theory, optimization, network analysis, and theory of deep learning.	
EDUCATION	Thayer School of Engineering at Dartmouth College , Hanover, VT, USA Ph.D., Engineering (GPA 4.0) 09/2015 – 02/2019 <ul style="list-style-type: none">- Advisor: Professor George Cybenko- Thesis: Sublinear Approximations of Vertex Centrality in Evolving Graphs The Ohio State University , Columbus, OH, USA B.S., Mathematics, (GPA 3.62 <i>Cum Laude</i>) 09/2007 – 06/2011 B.S., Computer and Information Science, (GPA 3.62 <i>Cum Laude</i>) 09/2007 – 06/2011	
RESEARCH EXPERIENCE	Lawrence Livermore National Laboratory , Livermore, CA, USA Center for Applied Scientific Computing . Supervisors: Dr. Geoff Sanders , Dr. Michael Schneider and Dr. Roger Pearce Computing Scientist 02/2021 – present <ul style="list-style-type: none">- Co-designed <code>MuyGPs</code>, a cross-validation and nearest neighbors-based Gaussian process training algorithm- Developed <code>MuyGPys</code>, a pure numpy implementation of <code>MuyGPs</code>, which supports several research efforts at LLNL including cosmology, climate, and orbital emulation Postdoctoral Researcher 04/2019 – 02/2021 <ul style="list-style-type: none">- Wrote <code>croquis</code>, an efficient HPC software library implementing novel algorithms using random matrix projections to embed and approximately cluster massive graphs- Built <code>DegreeSketch</code>, an HPC library for fast local query approximation in labeled graphs- Developed high performance software scalably approximating Gaussian Process inference, including kernels dual to the infinite width limit of deep neural networks- Utilized GP neural kernels to solve problems in reinforcement learning and image classification, and working on applications to deep learning on quantum computing hardware Computation Student Intern 05/2018 – 01/2019 <ul style="list-style-type: none">- Built novel distributed codes for estimating local triangle counts using cardinality sketches- Developed sophisticated communication protocols in a big-data environment- Designed YGM library for improving performance of HPC algorithms with irregular computational load and communication patterns Dartmouth College , Hanover, NH, USA Thayer School of Engineering . Advisor: Professor George Cybenko Research and Teaching Assistant 09/2015 – 02/2019 <ul style="list-style-type: none">- Developed novel sublinear-space sketching algorithms to estimate popular centrality indices and local structural features including triangle counts in large distributed graphs- Contributed to Moving Target and Adaptive Cyber Defense research, designing game- and graph-theoretic models to quantify and track advanced persistent threats- Taught courses in applied machine learning, with an emphasis on deep learning while leading a team of TAs	

MIT Lincoln Laboratory, Lexington, MA, USA
 Cyber Analytics and Decision Systems. Supervisor: Dr. Kevin M. Carter

Assistant Research Scientist

08/2011 – 07/2015

- Designed and implemented novel machine learning algorithms to deduce human and machine behavior from network protocol traffic
- Planned and implemented cognitive multi-agent systems to perform high-fidelity network traffic generation for network-scale simulation experiments
- Evaluated moving target cyber defenses by building a multi-agent simulation platform

Air Force Institute of Technology, Wright-Patterson Air Force Base, OH, USA
 Program Encryption Group. Supervisor: Professor J. Todd McDonald

Engineering Technician GS-05

Summer, 2008 & 2009

- Developed encryption metrics for circuits using abstract interpretation semantic models

TECHNICAL
EXPERTISE

Mathematics

Applied Mathematics
 Real Analysis
 Measure Theory
 Graph Theory
 Combinatorics

Computer Science and Engineering

Distributed & parallel algorithms
 Streaming algorithms & sketching
 Data structures

Data Science and Processing

Probability & Random Variables
 Statistics & Estimation
 Machine learning & deep learning
 Numerical Optimization
 Stochastic Processes
 Information Theory
 Communication Theory

Programming and Scripting Languages

C/C++, Python, Bash,
 Julia, Java, R, MATLAB

Distributed Computing

MPI, Hadoop MapReduce, Lustre

Analytical Software

Keras, TensorFlow, PyTorch, Mathematica

Utility Software

Git, GitHub/Gitlab/Bitbucket
 \LaTeX , \BibTeX

Microsoft, LibreOffice, Google Suite

Operating Systems

Apple OS X
 Linux, RedHat, and other UNIX variants

Interpersonal

Teamwork and communication
 Leadership and mentoring
 Public and technical speaking

PEER-REVIEWED
CONFERENCE
PUBLICATIONS

- [1] Trevor Steil, Tahsin Reza, Keita Iwabuchi, **Benjamin W. Priest**, Geoff Sanders, and Roger Pearce. Tripoll: Computing Surveys of Triangles in Massive-Scale Temporal Graphs with Metadata. In *Proceedings of the International Conference for High Performance Computing, Networking, Storage and Analysis*, SC. 2021. arXiv:2107.12330.
- [2] Imène R. Goumiri, Amanda L. Muyskens, Michael D. Schneider, **Benjamin W. Priest**, and Robert E. Armstrong. Star-Galaxy Separation via Gaussian Processes with Model Reduction. In *Proceedings of the Advanced Maui Optical and Space Surveillance Technologies Conference*, AMOS. 2020. arXiv:2010.06094.
- [3] **Benjamin W. Priest**, Alec Dunton, and Geoffrey Sanders. Scaling Graph Clustering with Distributed Sketches. In *Proceedings of the IEEE High Performance Extreme Computing Conference*, HPEC. **Graph Challenge Champion**. 2020. arXiv:2007.12669.
- [4] Imène R. Goumiri, **Benjamin W. Priest**, and Michael D. Schneider. Reinforcement Learning via Gaussian Processes with Neural Network Dual Kernels. In 2020 IEEE Conference on Games. CoG. 2020. arXiv:2004.05198.
- [5] Trevor Steil, Scott McMillan, Geoffrey Sanders, Roger Pearce, and **Benjamin W. 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. 2020.

- [6] Roger Pearce, Trevor Steil, **Benjamin W. Priest**, and Geoffrey Sanders. One Quadrillion Triangles Queried on One Million Processors. In *Proceedings of the IEEE High Performance Extreme Computing Conference*, HPEC. **Graph Challenge Champion**. 2019.
- [7] **Benjamin W. Priest**, Trevor Steil, Geoffrey Sanders, and Roger Pearce. You’ve Got Mail (YGM): Building missing asynchronous communication primitives. In *2019 IEEE International Parallel and Distributed Processing Symposium Workshops*, IPDPSW. 2019.
- [8] Trevor Steil, **Benjamin W. 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. 2019.
- [9] **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 *Proceedings of the IEEE High Performance Extreme Computing Conference*, HPEC. 2018.
- [10] Luan Hoy Pham, Massimiliano Albanese, and **Benjamin W. Priest**. A quantitative framework to model advanced persistent threats. In *Proceedings of the 15th International Conference on Security and Cryptography*, SECRIPT. **Best Paper Award**. 2018.
- [11] **Ben W. Priest**, Era Vuksani, Neal Wagner, Brady Tello, Kevin M. Carter, and William W. Streilein. Agent-based simulation in support of moving target cyber defense technology development and evaluation. In *Proceedings of the 18th Symposium on Communications & Networking, 2015 ACM Spring Simulation Multi-Conference*, CNS/SpringSim. 2015.
- [12] Kevin M. Carter, Ramona S. Caceres and **Ben Priest**. Characterization of latent social networks discovered through computer network logs. In *Networks in the Social and Information Sciences workshop of the 29th Annual Conference on Neural Information Processing Systems*, NIPS. 2015.
- [13] **Ben Priest** and Kevin M. Carter. Characterizing latent user interests on enterprise networks. In *Proceedings of the Twenty-Seventh International Florida Artificial Intelligence Research Society Conference*, FLAIRS. 2014.
- [14] Kevin M. Carter, Rajmonda S. Caceres, and **Ben Priest**. Latent community discovery through enterprise user search query modeling. In *Proceedings of the 37th International ACM SIGIR Conference on Research & Development in Information Retrieval*, SIGIR. 2014.
- [15] Kevin Gold, Zachary J. Weber, **Ben Priest**, Josh Ziegler, Karen Sittig, William W. Streilein, and Mark Mazumder. Modeling how thinking about the past and future impacts network traffic with the GOSMR architecture. In *International conference on Autonomous Agents and Multi-Agent Systems*, AAMAS. 2013.
- [16] **Ben Priest** and Kevin Gold. Utility discounting explains informational website traffic patterns before a hurricane. In *Proceedings of the 22nd International World Wide Web Conference*, WWW. 2013.
- [17] Kevin Gold, **Ben Priest**, and Kevin M. Carter An expectation maximization approach to detecting compromised remote access accounts. In *Proceedings of the Twenty-Sixth International Florida Artificial Intelligence Research Society Conference*, FLAIRS. 2013.

ARXIV
PAPERS

- [18] James J. Buchanan, Michael D. Schneider, Robert E. Armstrong, Amanda Muyskens, **Benjamin W. Priest**, and Ryan J. Dana. Gaussian Process Classification for Galaxy Blend Identification in LSST. arXiv preprint arXiv:2107.09246 (2021). [Submitted to the NPJ Astrophysical Journal]
- [19] Amanda Muyskens, **Benjamin W. Priest**, Imène Goumiri, and Michael D. Scheider. MuyGPs: Scalable Gaussian Process Hyperparameter Estimation using Local Cross-Validation. arXiv preprint arXiv:2105.01106 (2021). [Submitted to the SIAM Journal on Scientific Computing]
- [20] Amanda L. Muyskens, Imène R. Goumiri, **Benjamin W. Priest**, Michael D. Scheider, Robert E. Armstrong, and Jason M. Bernstein. Star-Galaxy Image Separation with Computationally Efficient Gaussian Process Classification. arXiv preprint arXiv:2104.14581 (2021). [Submitted to the NPJ Astronomical Journal]
- [21] Matthew Otten, Imène R. Goumiri, **Benjamin W. Priest**, and Michael D. Schneider. Quantum Machine Learning using Gaussian Processes with Performant Quantum Kernels. arXiv preprint arXiv:2004.11280 (2020). [Submitted to NPJ Quantum Information]

WORKING
PAPERS

- [22] **Benjamin W. Priest**. DegreeSketch: Distributed Cardinality Sketches on Massive Graphs with Applications. arXiv preprint arXiv:2004.04289 (2020).
- [23] Alec Dunton, **Benjamin W. Priest**, and Amanda Muyskens. Fast Gaussian Process Posterior Mean Prediction using MuyGPs. **[In Preparation]**
- [24] Imène R. Goumiri, Alec Dunton, Amanda Muyskens, and **Benjamin W. Priest**. Time Series Completion of Satellite Light Curves Using Fast Gaussian Process Inference. **[In Preparation]**
- [25] **Benjamin W. Priest**, Alec Dunton, and Geoffrey Sanders. Distributed Clustering of Scale-Free Graphs using Subspace Embeddings. **[In Preparation]**.
- [26] Amanda Muyskens, **Benjamin W. Priest**, Imène R. Goumiri, and Michael D. Schneider. An Analysis of the Sensitivity of Kernel Hyperparameters on the Kriging Weights. **[In Preparation]**.

OTHER
CONFERENCE
PUBLICATIONS

- [27] **Benjamin W. Priest** and George Cybenko. Approximating centrality in evolving graphs: toward sublinearity. In *Proceedings of the 2017 SPIE Defense + Security Conference*, SPIE D+S. 2017.
- [28] **Benjamin W. Priest** and George Cybenko. Efficient inference of hidden Markov models from large observation sequences. In *Proceedings of the 2016 SPIE Defense + Security Conference*, SPIE D+S. 2016.

BOOK CHAPTERS

- [29] Geoffrey Sanders, Roger Pearce, **Benjamin W. Priest**, and Trevor Steil. Massive-Scale Distributed Triangle Enumeration and Applications. In: David Bader (Ed.), *Processing Very Large Graphs*, [In Preparation]
- [30] **Benjamin W. Priest**, George Cybenko, Satinder Singh, Massimiliano Albanese and Peng Liu. Online and Scalable Adaptive Cyber Defense. In: Michael Wellman (Ed.), *Adversarial and Uncertain Reasoning for Adaptive Cyber Defense*, ch. 11, pp. 232-261. 2019. Springer.

CONFERENCE
TALKS

- [31] **Benjamin W. Priest**, Alec Dunton, and Geoffrey Sanders. Scaling Graph Clustering with Distributed Sketches. At: *2020 High Performance Extreme Computing Conference*, HPEC 2020. Waltham, CA, USA (virtual conference), 21–25 September 2020.

- [32] **Benjamin W. Priest** and George Cybenko. Approximating centrality in evolving graphs: toward sublinearity. At: *2017 SPIE Defense + Security Conference*, SPIE D+S. Anaheim, CA, USA, 9–13 April 2017.
- [33] **Benjamin W. Priest** and George Cybenko. Efficient Inference of hidden Markov models from large observations sequences. At: *2016 SPIE Defense + Security Conference*, SPIE D+S. Anaheim, CA, USA, 17–21 April 2016.
- [34] **Benjamin W. Priest**, Era Vuksani and Neal Wagner. Agent-based simulation in support of moving target cyber defense technology development and evaluation. At: *18th Symposium on Communications & Networking, 2015 ACM Spring Simulation Multi-Conference*, CNS/SpringSim. Alexandria, VA, USA, 12–15 April 2015.
- [35] **Benjamin W. Priest** and Kevin M. Carter. Characterizing latent user interests on enterprise networks. At: *2014 International Florida Artificial Intelligence Research Society Conference*, FLAIRS. Pensacola Beach, FL, USA, 21–23 May 2014.
- INVITED TALKS [36] **Benjamin W. Priest**. High-fidelity enterprise network emulation using the GOSMR architecture. In: *2014 MIT Lincoln Laboratory Cyber and Net-Centric Workshop*, CNW. June, 2014.
- POSTER PRESENTATIONS [37] **Benjamin W. Priest**, Roger Pearce, and Geoffrey Sanders. Estimating edge-local triangle count heavy hitters in edge-linear time and almost-vertex-linear space. At: *GraphChallenge Workshop at the IEEE High Performance Extreme Computing Conference*, HPEC. 25–27 September 2018.
- [38] **Benjamin W. Priest**, Roger Pearce, and Geoffrey Sanders. Efficient Sublinear Estimation of Local Triangle Count Heavy Hitters. At: *2018 Summer Student Poster Symposium at Lawrence Livermore National Laboratory*. 9 August 2018.
- [39] Kevin M. Carter, Rajmonda Caceres and **Ben Priest** Characterization of latent social networks discovered through computer network logs. At: *Networks in the Social and Information Sciences workshop of the 29th Annual Conference on Neural Information Processing Systems*, NIPS. Montreal, Canada, 12 December 2015.
- [40] **Ben Priest** and Kevin Gold Utility discounting explains informational website traffic patterns before a hurricane. At: *22nd International World Wide Web Conference*, WWW. 2013. Rio de Janeiro, Brazil, 13–17 May 2013.
- GRANTS **In Preparation**
- [1] Co-PI, “Scalable Single-Pass Compressive Autoencoders”, LLNL LDRD Feasibility Study, \$150,000. October 1, 2022 to September 30, 2023.
- Awarded**
- [2] Co-I, “MuyGPs: Non-Stationary Gaussian Processes at HPC Scales”, LLNL LDRD ER, \$850,000/year. October 1, 2021 to September 30, 2024.
- [3] Co-I, “Scalable Uncertainty Quantification Using Gaussian Processes Surrogate Models”, LLNL LDRD 21-FS-037, \$100,000. January 1, 2021 to September 30, 2021.
- [4] Co-I, “Interactive Exploratory Graph-Enabled Data Analytics at HPC Scales”, LLNL LDRD 21-ER-020, \$500,000/year. October 1, 2020 to September 30, 2022.
- [5] Co-PI, “Scalable Approximate Graph Clustering”, LLNL LDRD 20-FS-037, \$150,000. February 1, 2020 to September 30, 2020.

Declined

- [6] Co-I, “EpochGrafts: Relational Data Fusion via Dynamic Graph Analysis”, LLNL LDRD ER, \$500,000/year. October 1, 2021 to September 30, 2024.
- [7] PI, “Scalable Non-stationary Approximate Gaussian Processes”, DOE ASCR DE-FOA-0002493, \$500,000/year. FY 22/24.
- [8] PI, “Distributed Memory Sketching Algorithms at HPC Scales”, DOE ASCR DE-FOA-0002497, \$400,000/year. FY 22/23.
- [9] PI, “croquis: Distributed Subspace Embeddings for High Performance Computing”, LLNL Tech Base, \$100,000. FY 21/22.

MENTORING

Postdocs

- [1] **Alec Dunton**, Graduate student in Applied Mathematics, University of Colorado Boulder. Fast and scalable Gaussian process approximation in distributed memory. 2021-current.

Students

- [2] **Michał Lisiecki**, Graduate student in Computer Science, University of Oregon. Reinforcement learning benchmarks using Gaussian processes. 2022.
- [3] **Sudharshan Srinivasan**, Graduate student in Computer Science, University of Oregon. Communication optimization for highly non-uniform distributed graph algorithms. Primary adviser: Boyana Norris. 2021.
- [4] **Alec Dunton**, Graduate student in Applied Mathematics, University of Colorado Boulder. Parameter sensitivity of stochastic block models under subspace embeddings. Primary adviser: Alireza Doostan. 2020.

PROFESSIONAL SERVICE

Conference Service

- Program Committee: 28th International AAAI Florida Artificial Intelligence Research Symposium Conference, FLAIRS-28. Hollywood, Florida, USA. May 18-20, 2015.

TEACHING EXPERIENCE

Thayer School of Engineering at Dartmouth College, Hanover, VT, USA

Teaching Assistant

- Instructor for ENGS/QBS 108: Applied Machine Learning **Autumn 2017**
 - Collaborated with instructors to develop course curriculum aimed at graduate engineering and computer science students and taught $\sim 25\%$ of course lecture content.
 - Led team of 4 teaching assistants
 - Provided group and one-on-one assistance to students covering lecture topics
 - Planned, wrote, and graded all student assignments

- Instructor for ENGS 177: Decision Making Under Risk and Uncertainty **Winter 2017**
 - Planned and taught a weekly recitation covering practical machine learning topics
 - Provided ground and one-on-one assistance to students covering lecture topics
 - Wrote student assignments with the assistance of the instructor and provided grading

The Ohio State University, Columbus, OH, USA

Teaching Assistant

- Instructor for CSE 625: Automata and Formal Languages **Summer & Autumn 2010**
 - Planned and taught a weekly recitation covering details and proofs of lecture topics
 - Graded student assignments
- Grader for CSE 560: System Software Design and Development **Summer 2010**
 - Graded student assignments and held office hours

AWARDS

HPEC Graph Challenge

Graph Challenge Champion, 2020.
Graph Challenge Champion, 2019.

SECRYPT

Best Paper Award, 2018.

MIT Lincoln Laboratory

Lincoln Scholar Fellowship, 2015

The Ohio State University

Phi Beta Kappa Inductee, 2010
Bingham Award in Philosophy, 2010
Kenneth Cummings Scholarship, 2008–2011
Distinguished Merit Scholarship, 2007–2011
Ohio Academic Scholarship, 2007-2011

CITIZENSHIP

USA