

# Austin Reilley Benson

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<http://arbenson.github.io>

## Professional Experience

D. E. Shaw & Co.	
Quantitative Analyst, Equities	2021–
Cornell University	
Assistant Professor, Department of Computer Science	2018–2021
Additional field affiliations: Applied Mathematics, Data Science	
Postdoctoral Associate, Department of Computer Science	2017–2018
<i>Summer internships</i>	
Google	2015, 2016
Sandia National Laboratories	2014
HP Labs	2013
Google	2011, 2012

## Education

Stanford University	
PhD, Computational and Mathematical Engineering	2017
MS, Computational and Mathematical Engineering	2017
University of California, Berkeley	
BS, Electrical Engineering and Computer Sciences (EECS)	2012
BA, Applied Mathematics	2012

## Awards and Honors

NSF Faculty Early Career Development Program (CAREER) Award	2021
Kavli Fellow, Kavli Frontiers of Science, National Academy of Sciences	2020
JPMorgan Chase Faculty AI Research Award	2020
Best Research Paper Award, KDD '19	2019
Best Research Paper Award Runner-up, ASONAM '19	2019
LAA Early Career Speaker, International Linear Algebra Society	2019
Outstanding program committee member, WSDM '19	2019
Stanford Gene Golub Doctoral Dissertation Award	2017
Teaching Fellow, ICME, Stanford University	2016
Office of Technology Licensing Stanford Graduate Fellowship	2012

## All Research Papers

75. Nonlinear Feature Diffusion on Hypergraphs. Francesco Tudisco, Konstantin Prokopchik, Austin R. Benson. Proceedings of the International Conference on Machine Learning (ICML), 2022.
74. fauci-email: a json digest of Anthony Fauci's released emails. Austin R. Benson, Nate Veldt, David F. Gleich. Proceedings of the International AAAI Conference on Web and Social Media (ICWSM), 2022. Code and data: <https://github.com/nveldt/fauci-email>.

73. Diverse and Experienced Group Discovery via Hypergraph Clustering. Ilya Amburg, Nate Veldt, Austin R. Benson. Proceedings of SIAM Data Mining (SDM), 2022. Code: <https://github.com/ilyaamburg/fair-clustering-for-diverse-and-experienced-groups>.
72. Hypergraph Cuts with General Splitting Functions. Nate Veldt, Austin R. Benson, Jon Kleinberg. SIAM Review (SIREV), 2022.
71. A Unifying Generative Model for Graph Learning Algorithms: Label Propagation, Graph Convolutions, and Combinations. Junteng Jia, Austin R. Benson. SIAM Journal on Mathematics of Data Science (SIMODS), 2022. Code and data: <https://github.com/000Justin000/GaussianMRF>.
70. Graph-Based Methods for Discrete Choice. Kiran Tomlinson, Austin R. Benson. arXiv:2205.11365, 2022.
69. Understanding Non-linearity in Graph Neural Networks from the Bayesian-Inference Perspective. Rongzhe Wei, Haoteng Yin, Junteng Jia, Austin R. Benson, Pan Li. arXiv:2207.11311, 2022.
68. Graph Neural Network Modeling of Grain-scale Anisotropic Elastic Behavior using Simulated and Measured Microscale Data. Darren C. Pagan, Calvin R. Pash, Austin R. Benson, Matthew P. Kasemer. arXiv:2205.06324, 2022.
67. Approximate Decomposable Submodular Function Minimization for Cardinality-Based Components. Nate Veldt, Austin R. Benson, Jon Kleinberg. Advances in Neural Information Processing Systems (NeurIPS), 2021. Code: <https://github.com/nveldt/SparseCardDSFM>.
66. Communication-efficient distributed eigenspace estimation. Vasileios Charisopoulos, Austin R. Benson, Anil Damle. SIAM Journal on Mathematics of Data Science (SIMODS), 2021. Code: <https://gitlab.com/vchariso/distributed-eigenspace-estimation>.
65. Generative hypergraph clustering: from blockmodels to modularity. Philip S. Chodrow, Nate Veldt, Austin R. Benson. Science Advances, 2021. Code: <https://github.com/PhilChodrow/HypergraphModularity>.
64. The Generalized Mean Densest Subgraph Problem. Nate Veldt, Austin R. Benson, Jon Kleinberg. Proceedings of the International Conference on Knowledge Discovery & Data Mining (KDD), 2021. Code: <https://github.com/nveldt/GenMeanDSG>.
63. Choice Set Confounding in Discrete Choice. Kiran Tomlinson, Johan Ugander, Austin R. Benson. Proceedings of the International Conference on Knowledge Discovery & Data Mining (KDD), 2021. Code: <https://github.com/tomlinsonk/choice-set-confounding>.
62. Learning Interpretable Feature Context Effects in Discrete Choice. Kiran Tomlinson, Austin R. Benson. Proceedings of the International Conference on Knowledge Discovery & Data Mining (KDD), 2021. Code: <https://github.com/tomlinsonk/feature-context-effects>.
61. Expertise and Dynamics within Crowdsourced Musical Knowledge Curation: A Case Study of the Genius Platform. Derek Lim, Austin R. Benson. Proceedings of the International AAAI Conference on Web and Social Media (ICWSM), 2021. Code: <https://github.com/cptq/genius-expertise>.
60. Higher-order Network Analysis Takes Off, Fueled by Old Ideas and New Data. Austin R. Benson, David F. Gleich, Desmond J. Higham. SIAM News, 2021 (online).
59. Combining Label Propagation and Simple Models Out-performs Graph Neural Networks. Qian Huang, Horace He, Abhay Singh, Ser-Nam Lim, Austin R. Benson. Proceedings of the International Conference on Learning Representations (ICLR), 2021. Code: <https://github.com/CUAI/CorrectAndSmooth>.
58. Planted Hitting Set Recovery in Hypergraphs. Ilya Amburg, Jon Kleinberg, Austin R. Benson. Journal of Physics: Complexity (Special Issue on Higher-Order Structures in Networks and Network Dynamical Systems), 2021. Code: <https://github.com/ilyaamburg/Hypergraph-Planted-Hitting-Set-Recovery>.
57. Nonlinear Higher-Order Label Spreading. Francesco Tudisco, Austin R. Benson, Konstantin Prokopchik. Proceedings of the Web Conference (WWW), 2021. Code: <https://github.com/doublelucker/nhols>.

56. Random Graphs with Prescribed K-Core Sequences: A New Null Model for Network Analysis. Katherine Van Koevering, Austin R. Benson, Jon Kleinberg. Proceedings of the Web Conference (WWW), 2021. Code: <https://github.com/ktvank/Random-Graphs-with-Prescribed-K-Core-Sequences>.
55. Higher Order Information Identifies Tie Strength. Arnab Sarker, Jean-Baptiste Seby, Austin R. Benson, Ali Jadbabaie. arXiv:2108.02091, 2021.
54. Edge Proposal Sets for Link Prediction. Abhay Singh, Qian Huang, Sijia Linda Huang, Omkar Bhalerao, Horace He, Ser-Nam Lim, Austin R. Benson. arXiv:2106.15810, 2021. Code: <https://github.com/CUAI/Edge-Proposal-Sets>.
53. Graph Belief Propagation Networks. Junteng Jia, Cenk Baykal, Vamsi K. Potluru, Austin R. Benson. arXiv:2106.03033, 2021. Code: <https://github.com/000Justin000/GBPN>.
52. Higher-order Homophily is Combinatorially Impossible. Nate Veldt, Austin R. Benson, Jon Kleinberg. arXiv:2103.11818, 2021. Code: <https://github.com/nveldt/HypergraphHomophily>.
51. Better Set Representations For Relational Reasoning. Qian Huang, Horace He, Abhay Singh, Yan Zhang, Ser-Nam Lim, Austin R. Benson. Advances in Neural Information Processing Systems (NeurIPS), 2020. Code: <https://github.com/CUVL/SSLR>.
50. Entrywise convergence of iterative methods for eigenproblems. Vasileios Charisopoulos, Austin R. Benson, Anil Damle. Advances in Neural Information Processing Systems (NeurIPS), 2020. Code: <https://github.com/VHarisop/entrywise-convergence>.
49. Residual Correlation in Graph Neural Network Regression. Junteng Jia, Austin R. Benson. Proceedings of the International Conference on Knowledge Discovery & Data Mining (KDD), 2020. Code: <https://github.com/000Justin000/gnn-residual-correlation>.
48. Minimizing Localized Ratio Cut Objectives in Hypergraphs. Nate Veldt, Austin R. Benson, Jon Kleinberg. Proceedings of the International Conference on Knowledge Discovery & Data Mining (KDD), 2020. Code: <https://github.com/nveldt/HypergraphFlowClustering>.
47. Choice Set Optimization Under Discrete Choice Models of Group Decisions. Kiran Tomlinson, Austin R. Benson. Proceedings of the International Conference on Machine Learning (ICML), 2020. Code: <https://github.com/tomlinsonk/choice-set-opt>.
46. Neighborhood and PageRank methods for pairwise link prediction. Huda Nassar, Austin Benson, David F. Gleich. Social Network Analysis and Mining (SNAM), 2020. Code: <https://github.com/nassarhuda/pairseed>.
45. Network Interpolation. Thomas Reeves, Anil Damle, Austin R. Benson. SIAM Journal on Mathematics of Data Science (SIMODS), 2020. Code: <https://github.com/tr-maker/networkinterpolation>.
44. Measuring Directed Triadic Closure with Closure Coefficients. Hao Yin, Austin R. Benson, Johan Ugander. Network Science, 2020. Code: <https://github.com/arbenson/ClosureCoefficients.jl>.
43. Random Walks on Simplicial Complexes and the normalized Hodge 1-Laplacian. Michael T. Schaub, Austin R. Benson, Paul Horn, Gabor Lippner, Ali Jadbabaie. SIAM Review (SIREV), 2020.
42. Clustering in graphs and hypergraphs with categorical edge labels. Ilya Amburg, Nate Veldt, Austin R. Benson. Proceedings of the Web Conference (WWW), 2020. Code: <https://github.com/nveldt/CategoricalEdgeClustering>.
41. Frozen Binomials on the Web: Word Ordering and Language Conventions in Online Text. Katherine Van Koevering, Austin R. Benson Jon Kleinberg. Proceedings of the Web Conference (WWW), 2020. Code: <https://github.com/ktvank/Frozen-Binomials>.
40. Using cliques with higher-order spectral embeddings improves graph visualizations. Huda Nassar, Caitlin Kennedy, Shweta Jain, Austin R. Benson, David F. Gleich. Proceedings of the Web Conference (WWW), 2020. Code: <https://github.com/nassarhuda/GLANCE>.

39. Retrieving Top Weighted Triangles in Graphs. Raunak Kumar, Paul Liu, Moses Charikar, Austin R. Benson. Proceedings of the International Conference on Web Search and Data Mining (WSDM), 2020. Code: <https://github.com/raunakkmr/Retrieving-top-weighted-triangles-in-graphs>.
38. Over-parametrized neural networks as under-determined linear systems. Austin R. Benson, Anil Damle, Alex Townsend. arXiv:2010.15959, 2020.
37. Augmented Sparsifiers for Generalized Hypergraph Cuts with Applications to Decomposable Submodular Function Minimization. Austin R. Benson, Jon Kleinberg, and Nate Veldt. arXiv:2007.08075, 2020.
36. Neural Jump Stochastic Differential Equations. Junteng Jia, Austin R. Benson. Advances in Neural Information Processing Systems (NeurIPS), 2019. Code: <https://github.com/000Justin000/torchdiffeq/tree/jj585>.
35. Modeling and Analysis of Tagging Networks in Stack Exchange Communities. Xiang Fu, Shangdi Yu, Austin R. Benson. Journal of Complex Networks, 2019. Code: <https://github.com/yushangdi/stack-exchange-cotagging>.
34. Unsupervised learning of dislocation motion. Darren C. Pagan, Thien Q. Phan, Jordan S. Weaver, Austin R. Benson, Armand J. Beaudoin. Acta Materialia, 2019.
33. Automated Grain Yield Behavior Classification. Darren C. Pagan, Jakob Kaminsky, Wesley A. Tayon, Kelly E. Nygren, Armand J. Beaudoin, Austin R. Benson. The Journal of The Minerals, Metals & Materials Society (JOM), 2019.
32. Computing Tensor  $Z$ -eigenvectors with Dynamical Systems. Austin R. Benson, David F. Gleich. SIAM Journal on Matrix Analysis and Applications (SIMAX), 2019. Code: <https://github.com/arbenson/TZE-dynsys>.
31. Pairwise Link Prediction. Huda Nassar, Austin R. Benson, David F. Gleich. Proceedings of the International Conference on Advances in Social Networks Analysis and Mining (ASONAM), 2019. **Best Research Paper Award Runner-up**. Code: <https://github.com/nassarhuda/pairseed>.
30. Graph-based Semi-Supervised & Active Learning for Edge Flows. Junteng Jia, Michael T. Schaub, Santiago Segarra, Austin R. Benson. Proceedings of the International Conference on Knowledge Discovery & Data Mining (KDD), 2019. Code: [https://github.com/000Justin000/ssl\\_edge](https://github.com/000Justin000/ssl_edge).
29. Network Density of States. Kun Dong, Austin R. Benson, David Bindel. Proceedings of the International Conference on Knowledge Discovery & Data Mining (KDD), 2019. **Best Research Paper Award Winner**. Code: <https://github.com/kd383/NetworkDOS>.
28. Three hypergraph eigenvector centralities. Austin R. Benson. SIAM Journal on Mathematics of Data Science (SIMODS), 2019. Code: <https://github.com/arbenson/Hyper-Evec-Centrality>.
27. Link Prediction in Networks with Core-Fringe Data. Austin R. Benson, Jon Kleinberg. Proceedings of the Web Conference (WWW), 2019. Code: <https://github.com/arbenson/cflp>.
26. Choosing to grow a graph: Modeling network formation as discrete choice. Jan Overgoor, Austin R. Benson, Johan Ugander. Proceedings of the Web Conference (WWW), 2019. Code: <https://github.com/janovergoor/choose2grow>.
25. Random Spatial Network Models with Core-Periphery Structure. Junteng Jia, Austin R. Benson. Proceedings of the International Conference on Web Search and Data Mining (WSDM), 2019. Code: [https://github.com/000Justin000/spatial\\_core\\_periphery](https://github.com/000Justin000/spatial_core_periphery).
24. Sampling Methods for Counting Temporal Motifs. Paul Liu, Austin R. Benson, Moses Charikar. Proceedings of the International Conference on Web Search and Data Mining (WSDM), 2019. Code: <https://gitlab.com/paul.liu.ubc/sampling-temporal-motifs>.
23. The Local Closure Coefficient: A New Perspective On Network Clustering. Hao Yin, Austin R. Benson, Jure Leskovec. Proceedings of the International Conference on Web Search and Data Mining (WSDM), 2019. Code: <https://github.com/arbenson/ClosureCoefficients.jl>.

22. Incrementally Updated Spectral Embeddings. Vasileios Charisopoulos, Austin R. Benson, Anil Damle. arXiv:1909.01188, 2019. Code: <https://github.com/VHarisop/inc-spectral-embeddings>.
21. Simplicial closure and higher-order link prediction. Austin R. Benson, Rediet Abebe, Michael T. Schaub, Ali Jadbabaie, Jon Kleinberg. Proceedings of the National Academy of Sciences (PNAS), 2018. Code: <https://github.com/arbenson/ScHoLP-Tutorial>.
20. Found Graph Data and Planted Vertex Covers. Austin R. Benson, Jon Kleinberg. Advances in Neural Information Processing Systems (NeurIPS), 2018. Code: <https://github.com/arbenson/FGDnPVC>.
19. Sequences of Sets. Austin R. Benson, Ravi Kumar, Andrew Tomkins. Proceedings of the International Conference on Knowledge Discovery & Data Mining (KDD), 2018. Code: <https://github.com/arbenson/Sequences-of-Sets>.
18. Higher-order clustering in networks. Hao Yin, Austin R. Benson, Jure Leskovec. Physical Review E (PRE), 2018. Code: <https://github.com/arbenson/HigherOrderClustering.jl>.
17. A discrete choice model for subset selection. Austin R. Benson, Ravi Kumar, Andrew Tomkins. Proceedings of the International Conference on Web Search and Data Mining (WSDM), 2018. Code: <https://github.com/arbenson/discrete-subset-choice>.
16. Local higher-order graph clustering. Hao Yin, Austin R. Benson, Jure Leskovec, David F. Gleich. Proceedings of the International Conference on Knowledge Discovery & Data Mining (KDD), 2017. Code and data: <http://snap.stanford.edu/mappr>.
15. Motifs in temporal networks. Ashwin Paranjape, Austin R. Benson, Jure Leskovec. Proceedings of the International Conference on Web Search and Data Mining (WSDM), 2017. Code and data: <https://snap.stanford.edu/temporal-motifs>.
14. The spacey random walk: a stochastic process for higher-order data. Austin R. Benson, David F. Gleich, Lek-Heng Lim. SIAM Review (SIREV), 2017. Code: <https://github.com/arbenson/spacey-random-walks>.
13. Higher-order organization of complex networks. Austin R. Benson, David F. Gleich, Jure Leskovec. Science, 2016. Code and data: <https://snap.stanford.edu/higher-order>.
12. General tensor spectral co-clustering for higher-order data. Tao Wu, Austin R. Benson, David F. Gleich. Advances in Neural Information Processing Systems (NeurIPS), 2016. Code: <https://github.com/wutao27/GtensorSC>.
11. Modeling user consumption sequences. Austin R. Benson, Ravi Kumar, Andrew Tomkins. Proceedings of the International World Wide Web Conference (WWW), 2016.
10. On the relevance of irrelevant alternatives. Austin R. Benson, Ravi Kumar, Andrew Tomkins. Proceedings of the International World Wide Web Conference (WWW), 2016.
9. Improving the numerical stability of fast matrix multiplication. Grey Ballard, Austin R. Benson, Alex Druinsky, Benjamin Lipshitz, Oded Schwartz. SIAM Journal on Matrix Analysis and Applications (SIMAX), 2016. Code: <https://github.com/arbenson/fast-matmul>.
8. Tensor spectral clustering for partitioning higher-order network structures. Austin R. Benson, David F. Gleich, Jure Leskovec. Proceedings of the SIAM International Conference on Data Mining (SDM), 2015. Code: <https://github.com/arbenson/tensor-sc>.
7. A framework for practical parallel fast matrix multiplication. Austin R. Benson, Grey Ballard. Proceedings of the Symposium on Principles and Practice of Parallel Programming (PPoPP), 2015. Code: <https://github.com/arbenson/fast-matmul>.
6. Scalable methods for nonnegative matrix factorizations of near-separable tall-and-skinny matrices. Austin R. Benson, Jason D. Lee, Bartek Rajwa, David F. Gleich. Advances in Neural Information Processing Systems (NeurIPS), 2014. **Selected for spotlight presentation.** Code: <https://github.com/arbenson/mrnmf>. Data: <https://www.cs.cornell.edu/~arb/data>.



5. Learning multifractal structure in large networks. Austin R. Benson, Carlos Riquelme, Sven Schmit. Proceedings of the International Conference on Knowledge Discovery & Data Mining (KDD), 2014.
4. A parallel directional Fast Multipole Method. Austin R. Benson, Jack Poulson, Kenneth Tran, Björn Engquist, Lexing Ying. SIAM Journal on Scientific Computing (SISC), 2014. Code: <https://github.com/arbenson/ddfmm>.
3. Silent error detection in numerical time-stepping schemes. Austin R. Benson, Sven Schmit, Robert Schreiber. International Journal of High Performance Computing Applications (IJHPCA), 2014. Code: <https://www.cs.cornell.edu/~arb/silent.html>.
2. Direct QR factorizations for tall-and-skinny matrices in MapReduce architectures. Austin R. Benson, David F. Gleich, James Demmel. Proceedings of the IEEE International Conference on Big Data (BigData), 2013. Code: <https://github.com/arbenson/mrtsqr>.
1. The Gamma-Ray Imaging Framework. Austin R. Benson, Mark S. Bandstra, Daniel H. Chivers, Timothy Aucott, Ben Augarten, Cameron Bates, Adam Midvidy, Ryan Pavlovsky, James Siegrist, Kai Vetter, Ben Yee. IEEE Transactions on Nuclear Science, 2013. Code: <https://github.com/bearing/grif>.

## Press Coverage of Research

High-level description of several years of research on higher-order network analysis:

[How Big Data Carried Graph Theory Into New Dimensions \(Quanta Magazine\)](#)

For the *ICLR* paper “Combining Label Propagation and Simple Models Out-performs Graph Neural Networks”:

[Cornell & Facebook AI Simplified Graph Learning Approach Outperforms SOTA GNNs \(Synced\)](#)

For the *ICWSM* paper “Expertise and Dynamics within Crowdsourced Musical Knowledge Curation: A Case Study of the Genius Platform”:

[Crowdsourced Expertise \(Data Skeptic Podcast\)](#)

For the *PNAS* paper “Simplicial closure an higher-order link prediction”:

[Predicting future combos, from rap songs to pharmaceuticals \(Cornell Chronicle\)](#)

[Algorithm predicts which rappers will work together \(Futurity\)](#)

For the *Science* paper “Higher-order organization of complex networks”:

[Stanford-led effort creates a new way to analyze and control networks \(Stanford News\)](#)

[Mathematical framework offers a more detailed understanding of network relationships \(Phys.org\)](#)

[Mathematical Framework that Prioritizes Key Patterns in Networks Aims to Accelerate Scientific Discovery \(DARPA\)](#)

## Advising and Mentoring

### PhD students

Feicheng Wang · D. E. Shaw & Co. Intern	2022
Kiran Tomlinson · Computer Science	2019–2021
Ilya Amburg · Applied Mathematics	2018–2022
Junteng Jia · Computer Science	2018–2021

### Postdoctoral researchers

Jonas Juul · Cornell CAM Postdoc	2020–2021
Nate Veldt · Cornell CAM Postdoc	2019–2021

### Undergraduate students

Qian Huang · Cornell Computer Science & Mathematics	2019–2021
<i>Finalist, CRA Outstanding Undergraduate Researcher Award, 2020 &amp; 2021</i>	
<i>Recipient, Computer Science Department Prize for Academic Excellence</i>	

Abhay Singh · Cornell Computer Science	2019–2021
Horace He · Cornell Computer Science & Mathematics	2019–2021
<i>Honorable Mention, CRA Outstanding Undergraduate Researcher Award, 2020</i>	
Derek Lim · Cornell Computer Science & Mathematics	2019–2020
<i>Honorable Mention, CRA Outstanding Undergraduate Researcher Award, 2021</i>	
Jakob Kaminsky · Cornell Computer Science	2019
Leah Ajmani · Cornell Computer Science & Philosophy	2018–2019
Shangdi Yu · Cornell Computer Science & Operations Research	2018–2019
<i>Recipient, Computer Science Department Prize for Academic Excellence</i>	
Xiang (Felix) Fu · Cornell Computer Science & Operations Research	2018–2019

## Teaching Experience

### Instructor, Cornell University

CS 4220/Math 4260: Numerical Analysis: Linear and Nonlinear Problems (49 students)	Spring 2021
CS 6210: Matrix Computations (33 students)	Fall 2020
CS 6241: Numerical Methods for Data Science (36 students)	Spring 2020
CS 2850/INFO 2040/ECON 2040/SOC 2090: Networks (642 students)	Fall 2019
CS 6241: Numerical Methods for Data Science (46 students)	Spring 2019
CS 2850/INFO 2040/ECON 2040/SOC 2090: Networks (615 students)	Fall 2018

### Instructor, Stanford University

CME 193: Introduction to Scientific Python	Spring 2013
CME 193: Introduction to Scientific Python (created course)	Winter 2013