

Adam S. Charles

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Research Interests

Signal processing, machine learning, neural imaging, cybernetics, computational neuroscience, efficient sensing of structured signals.

Education

2015	Ph.D. in Electrical and Computer Engineering (GPA = 4.0) Thesis: <i>Dynamics and correlations in sparse signal acquisition</i> Advisor: Dr. Christopher J. Rozell	Georgia Institute of Technology
2009	M.E in Electrical and Computer Engineering (<i>Summa Cum Laude</i> , GPA = 3.8) Thesis: <i>Adjustable Subband Allocation Algorithm for Critically Sampled Subband Adaptive Filters</i>	Cooper Union
2009	B.E in Electrical and Computer Engineering (<i>Summa Cum Laude</i> , GPA = 3.8)	Cooper Union

Positions

2015-Present	Princeton University	Post-Doctoral Fellow
2016-Present	Princeton University	Assistant Instructor
2009-2015	Georgia Institute of Technology	Research Assistant
2009	Georgia Institute of Technology	Teaching Assistant
2007-2009	Southwest Research Institute	Intern
2008-2009	Cooper Union	Teaching Assistant

Honors and Awards

2016	Georgia Tech Sigma Xi 2015 Best Doctoral Thesis Award
2015	Selected as a recipient of funding from T32 training grant, "NRSA Training Grant in Quantitative Neuroscience"
2015	Georgia Tech Electrical and Computer Engineering Graduate Research Excellence Award
2014	Georgia Tech Center for Information and Signal Processing (CSIP) Outstanding Research Award
2010	1st Place, Science Applications International Corp. (SAIC) Georgia Tech student paper competition
2009	Harold S. Goldberg Leadership Prize (Cooper Union)
2009	Dale E. Zand Prize for Outstanding Achievement in Electrical Engineering (Cooper Union)
2009	Honorable Mention, IEEE Region 1 2009 paper contest
2005-2009	Cooper Union deans list
2008	Inducted to Eta Kappa Nu
2007	Inducted to Tau Beta Pi
2006	Inducted to National Society of Collegiate Scholars
2005	3rd place Team Engineering Award, International Science and Engineering Fair
2005	Special award from the American Assn. for Artificial Intelligence (AAAI), Intl. Sci. and Eng. Fair
2005	Robert Luby Jr. Award "For excellence in scientific research", Intl. Sci. and Eng. Fair

Professional Affiliations

2017-present	Society for Neuroscience (SfN)
2013-present	IEEE Signal Processing Society
2012-present	American Association for the Advancement of Science (AAAS)
2012-present	Society for Industrial and Applied Mathematics (SIAM)
2009-present	Institute of Electrical and Electronics Engineers (IEEE)

Professional Service

Co-Organizer:	2018 Joint Princeton University and Institute for Advanced Study Symposium on the Mathematical Theory of Deep Learning
Technical Program Chair:	2017 Computational Advances in Multi-Sensor Adaptive Processing (CAMSAP) Conference
Co-Organizer:	Special Session on <i>Low-dimensional dynamical systems in signal processing and data analysis</i> at the 2017 Computational Advances in Multi-Sensor Adaptive Processing (CAMSAP) Conference
Co-Organizer:	Workshop on <i>New methods for understanding neural dynamics and computation</i> at the 2017 Computational and Systems Neuroscience (CoSyNe) Conference
Co-Organizer:	Workshop on <i>Dimensionality reduction for the analysis and interpretation of high-dimensional neural datasets</i> at the 2016 Computational and Systems Neuroscience (CoSyNe) Conference
Session Co-Chair:	2015 Information Theory and Applications Workshop
Reviewer:	International Conference on Artificial Intelligence and Statistics (AISTATS)
Reviewer:	Journal of Neuroscience
Reviewer:	AWM/Springer Proceedings of the Women in Data Science and Mathematics (WiSDM) workshop
Reviewer:	Journal of Computational Neuroscience
Reviewer:	Conference on Cognitive, Computational Neuroscience
Reviewer:	PLOS Computational Biology
Reviewer:	eLife
Reviewer:	IEEE Transactions on Signal Processing
Reviewer:	Conference on Neural Information Processing Systems (NIPS)
Reviewer:	Sampling Theory and Applications (SampTA)
Reviewer:	IEEE International Symposium on Information Theory
Reviewer:	IEEE Transactions on Molecular, Biological, and Multi-Scale Communications
Reviewer:	IEEE Signal Processing Letters
Reviewer:	IEEE Transactions of Geoscience and Remote Sensing
Reviewer:	IEEE Journal of Special Topics in Applied Earth Observations and Remote Sensing
Reviewer:	IEEE Geoscience and Remote Sensing Letters
Reviewer:	Remote Sensing Letters
Reviewer:	Applied Optics
Code Reviewer:	Nature Neuroscience

Other Activities

2016-Present	Organizer: Princeton computational neuroscience journal club
2011-2012	Manager: Lab server
2011-2012	Coordinator: Lab group

Teaching Experience

2016	Assistant Instructor at Princeton University for NEU314: Mathematical Tools for Neuroscience
2014	Guest Lecture: “Inferring Materials in Hyperspectral Imaging using Maximum A-Posteriori Estimation”
2012	Guest Lecture: “Causal Inference of Sparse Time-dependent Signals”
2011-Present	Undergraduate student mentor
2009	Teaching Assistant at Georgia Tech for ECE3075: Probability and Stochastic Processes
2009	Teaching Assistant at Georgia Tech for ECE4270: Digital Signal Processing
2008	Teaching Assistant at Cooper Union for ECE101: Communication Theory
2008	Teaching Assistant at Cooper Union for ECE114: Digital Signal Processing
2008-2009	MATLAB Seminar Instructor at Cooper Union

Journal Papers

- [J1] A. S. Charles and C. J. Rozell. Learning dictionaries of dynamics for sparse signal tracking. 2018. Submitted
- [J2] N. P. Bertrand*, A. S. Charles*, J. Lee, P. B. Dunn, and C. J. Rozell. Earth mover’s distance for sparse dynamic filtering. 2018. Submitted. *Joint first author

- [J3] R. She, B. Jelfs, A. S. Charles, , and R. H. M. Chan. Network modeling of short over-dispersed spike-counts: A hierarchical parametric empirical bayes framework. 2018. Submitted
- [J4] A. S. Charles*, M. Park*, J. Patrick Weller, Gregory D. Horwitz, and J. W. Pillow. Dethroning the fano factor: a flexible, model-based approach to partitioning neural variability. *Neural Computation*, 30(4):1012–1045, 2018. *Joint first author
- [J5] A. Song*, A. S. Charles*, S. A. Koay, J. L. Gauthier, S. Y. Thiberge, J. W. Pillow, and D. W. Tank. Volumetric two-photon imaging of neurons using stereoscopy (vTwINS). *Nature Methods*, 14(4):420–426, Apr. 2017. *Joint first author
- [J6] A. S. Charles, D. Yin, and C. J. Rozell. Distributed sequence memory of multidimensional inputs in recurrent networks. *Journal of Machine Learning Research*, 18(7):1–37, 2017
- [J7] A. S. Charles, A. Balavoine, and C. J. Rozell. Dynamic filtering of time-varying sparse signals via ℓ_1 minimization. *IEEE Transactions on Signal Processing*, 64(21):5644–5656, 2016
- [J8] A. S. Charles, H. L. Yap, and C. J. Rozell. Short term network memory capacity via the restricted isometry property. *Neural Computation*, 26(6), June 2014
- [J9] A. S. Charles and C. J. Rozell. Spectral superresolution of hyperspectral imagery using reweighted- ℓ_1 spatial filtering. *IEEE Geoscience and Remote Sensing Letters*, 11(3):602–606, March 2014
- [J10] A. S. Charles, P. Garrigues, and C. J. Rozell. A common network architecture efficiently implements a variety of sparsity-based inference problems. *Neural Computation*, 24(12):3317–3339, 2012
- [J11] S. Shapero, A. S. Charles, C. J. Rozell, and P. Hasler. Low power sparse approximation on reconfigurable analog hardware. *IEEE Journal on Emerging and Selected Topics in Circuits and Systems*, 2(3):530–541, 2011
- [J12] A. S. Charles, B. A. Olshausen, and C. J. Rozell. Learning sparse codes for hyperspectral imagery. *IEEE Journal of Selected Topics in Signal Processing*, 5(5):963–978, 2011

Conference Papers

- [C1] A. S. Charles and J. W. Pillow. Additive continuous-time joint partitioning of neural variability. *Proceedings of the Conference on Cognitive Computational Neuroscience (CCN), Philadelphia, PA, USA*, September 2018
- [C2] A. S. Charles, H. L. Yap, D. Lin, and C. J. Rozell. Short-term sequence memory: Compressive effects of recurrent network dynamics. *Proceedings of the Conference on Cognitive Computational Neuroscience (CCN), Philadelphia, PA, USA*, September 2018
- [C3] N. P. Bertrand, J. Lee, A. S. Charles, P. Dunn, and C. J. Rozell. Sparse dynamic filtering via earth mover’s distance regularization. *Proceedings of the IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP), Calgary, Alberta, Canada*, April 2018
- [C4] M. Shvartsman, N. Sudaram, M. C. Aoi, A. S. Charles, T. L. Wilke, and J. D. Cohen. Matrix-variate models for fMRI analysis. *The International Conference on Artificial Intelligence and Statistics (AISTATS), Playa Blanca, Lanzarote, Canary Islands*, April 2018
- [C5] A. S. Charles, N. P. Bertrand, J. Lee, and C. J. Rozell. Earth-mover’s distance as a tracking regularizer. *Proceedings of the IEEE International Workshop on Computational Advances in Multi-Sensor Adaptive Processing (CAMSAP), Curacao, Dutch Antilles*, December 2017
- [C6] A. S. Charles, A. Song, S. A. Koay, D. W. Tank, and J. W. Pillow. Stochastic filtering of two-photon imaging using reweighted ℓ_1 . *Proceedings of the IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP), New Orleans, Louisiana*, Mar 2017
- [C7] A. S. Charles and C. J. Rozell. Convergence of basis pursuit de-noising with dynamic filtering. *Proceedings the IEEE Global Conference on Signal and Information Processing (GlobalSIP), Atlanta, Georgia*, December 2014
- [C8] A. S. Charles, D. Yin, and C. J. Rozell. Can random linear networks store multiple long input streams? *Proceedings the IEEE Global Conference on Signal and Information Processing (GlobalSIP), Atlanta, Georgia*, December 2014
- [C9] A. S. Charles and C. J. Rozell. Dynamic filtering of sparse signals using reweighted ℓ_1 . *Proceedings of the IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP), Vancouver, Canada*, May 2013

- [C10] A. S. Charles, A. Ahmed, A. Joshi, S. Conover, C. Turnes, and M. A. Davenport. Cleaning up toxic waste: Removing nefarious contributions to recommendation systems. *Proceedings of the IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP)*, Vancouver, Canada, May 2013
- [C11] H. L. Yap, A. S. Charles, and C. J. Rozell. The restricted isometry property for echo state networks with application to sequential memory capacity. *Proceedings of the Statistical Signal Processing Workshop (SSP)*, Ann Arbor, Michigan, August 2012
- [C12] M. S. Asif, A. S. Charles, J. Romberg, and C. J. Rozell. Estimation and dynamic updating of time-varying signals with sparse variations. *Proceedings of the IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP)*, Prague, Czech Republic, May 2011
- [C13] A. S. Charles, M. S. Asif, J. Romberg, and C. J. Rozell. Sparsity penalties in dynamical system estimation. *Proceedings of Conference for Information Sciences and Systems (CISS)*, Baltimore, Maryland, March 2011
- [C14] A. S. Charles, A. A. Kressner, and C. J. Rozell. Causal sparse decompositions of audio signals. *Proceedings of the IEEE Digital Signal Processing Workshop, Sedona, Arizona*, January 2011. (Nominated for best student paper)
- [C15] A. S. Charles, B. A. Olshausen, and C. J. Rozell. Sparse coding for spectral signatures in hyperspectral images. *Proceedings of the Asilomar Conference on Signals, Systems and Computers, Pacific Grove, California*, November 2010

Conference Abstracts

- [A1] J. L. Gauthier, A. S. Charles, D. W. Tank, and J. W. Pillow. Robust identification and removal of false transients in calcium fluorescence imaging data. *Society for Neuroscience (SfN)*, San Diego, California, September 2018
- [A2] M. Shvartsman, N. Sudaram, M. C. Aoi, A. S. Charles, T. L. Wilke, and J. D. Cohen. Matrix-normal models for fMRI analysis. *Organization for Human Brain Mapping (OHBM)*, Singapore, June 2018
- [A3] M. Shvartsman, N. Sudaram, M. C. Aoi, A. S. Charles, T. L. Wilke, and J. D. Cohen. Matrix-normal models for fMRI analysis. *Computational and Systems Neuroscience (CoSyNe)*, Denver, Colorado, March 2018
- [A4] M. Shvartsman, N. Sudaram, M. C. Aoi, A. S. Charles, T. L. Wilke, and J. D. Cohen. Matrix-variate models for fMRI analysis. *Neural Information Processing Systems (NIPS) Workshops, Long Beach, California*, December 2017
- [A5] J. Lee, A. S. Charles, N. P. Bertrand, and C. J. Rozell. An optimal transport tracking regularizer. *Neural Information Processing Systems (NIPS) Workshops, Long Beach, California*, December 2017
- [A6] A. Song, A. S. Charles, S. Y. Thiberge, J. L. Gauthier, S. A. Koay, J. W. Pillow, and D. W. Tank. Volumetric two-photon imaging via stereoscopy and two-photon calcium imaging simulator. *Emerging Tools for Acquisition and Interpretation of Whole-Brain Functional Data*, Ashburn, Virginia, November 2017
- [A7] J. L. Gauthier, A. S. Charles, D. W. Tank, and J. W. Pillow. Robust estimation of calcium transients by modeling contamination. *Society for Neuroscience (SfN)*, Washington D.C., November 2017
- [A8] J. L. Gauthier, A. S. Charles, J. W. Pillow, and D. W. Tank. Evidence for distinct hippocampal representations of current location and distance to goal. *Society for Neuroscience (SfN)*, Washington D.C., November 2017
- [A9] M. Shvartsman, N. Sudaram, M. C. Aoi, A. S. Charles, T. L. Wilke, and J. D. Cohen. Matrix-variate models for fMRI analysis. *Society for neuroscience (SfN)*, Washington D.C., November 2017
- [A10] A. Song, A. S. Charles, D. W. Tank, and J. W. Pillow. A two-photon microscopy simulation framework for optimizing optics and benchmarking cell-finding algorithms. *Society for Neuroscience (SfN)*, Washington D.C., November 2017
- [A11] A. S. Charles, A. Song, S. A. Koay, J. L. Gauthier, S. Y. Thiberge, D. W. Tank, and J. W. Pillow. Adaptive orthogonal basis pursuit for volumetric two-photon microscopy. *Signal Processing with Adaptive Sparse Structured Representations (SPARS)*, Lisbon, Portugal, June 2017
- [A12] A. S. Charles, D. Yin, and C. J. Rozell. Compression of multiple input streams into recursive neural networks. *Signal Processing with Adaptive Sparse Structured Representations (SPARS)*, Lisbon, Portugal, June 2017

- [A13] A. S. Charles, J. Lee, N. P. Bertrand, and C. J. Rozell. Dynamic filtering with earth mover's distance regularization. *Signal Processing with Adaptive Sparse Structured Representations (SPARS)*, Lisbon, Portugal, June 2017
- [A14] A. S. Charles and J. W. Pillow. Continuous-time partitioning of binned spike counts. *Computational and Systems Neuroscience (CoSyNe)*, Salt Lake City, Utah, February 2017
- [A15] J. L. Gauthier, A. S. Charles, J. W. Pillow, and D. W. Tank. Robust estimation of calcium transients by modeling contamination. *Computational and Systems Neuroscience (CoSyNe)*, Salt Lake City, Utah, February 2017
- [A16] A. Song, A. S. Charles, J. L. Gauthier, S. A. Koay, D. W. Tank, and J. W. Pillow. Two-photon microscopy simulation for optics optimization and benchmarking. *Computational and Systems Neuroscience (CoSyNe)*, Salt Lake City, Utah, February 2017
- [A17] A. S. Charles, H. L. Yap, D. Yin, and C. J. Rozell. Short-term sequence memory in recurrent networks. *Neural Information Processing Systems (NIPS) Workshops*, Barcelona, Spain, December 2016
- [A18] N. P. Bertrand, H. L. Yap, and A. S. Charles C. J. Rozell. Efficient randomized filtering for dimensionality reduction in electrophysiology data. *Neural Information Processing Systems (NIPS) Workshops*, Barcelona, Spain, December 2016
- [A19] A. Song, A. S. Charles, S. Y. Thiberge, J. L. Gauthier, S. A. Koay, J. W. Pillow, and D. W. Tank. Two-photon imaging of neurons using stereoscopy (twins). *Society for Neuroscience (SfN)*, San Diego, California, November 2016
- [A20] A. S. Charles and C. J. Rozell. Learning a dynamics dictionary for time-varying sparse signals. *Signal Processing with Adaptive Sparse Structured Representations (SPARS)*, Cambridge, United Kingdom, July 2015
- [A21] A. S. Charles and C. J. Rozell. Robust estimation of sparse time-varying signals. *Information Theory and Applications Workshop (ITA)*, La Jolla, California, February 2015. Invited contribution
- [A22] C. J. Rozell, M. Zhu, A. S. Charles, H. L. Yap, and M. Norko. The role of sparsity in visual perception. *Conference on Biologically Inspired Cognitive Architectures (BICA)*, Cambridge, Massachusetts, November 2014
- [A23] A. S. Charles, C. J. Rozell, and N. Tufillaro. Sparsity based spectral super-resolution and applications to ocean water color. *International Geoscience and Remote Sensing Symposium, (IGARSS)*, Québec, Canada, May 2014. Invited contribution
- [A24] A. S. Charles and C. J. Rozell. Stochastic filtering via reweighted ℓ_1 . *Signal Processing with Adaptive Sparse Structured Representations (SPARS)*, Laussane, Switzerland, July 2013
- [A25] A. S. Charles, H. L. Yap, and C. J. Rozell. Using compressed sensing to study sequence memory capacity in networked systems. *Signal Processing with Adaptive Sparse Structured Representations (SPARS)*, Laussane, Switzerland, July 2013
- [A26] A. A. Kressner, A. S. Charles, and C. J. Rozell. Causal locally competitive algorithm for the sparse decomposition of audio signals. *IEEE Womens Workshop on Communications and Signal Processing*, Banff, Canada, July 2012
- [A27] A. S. Charles, H. L. Yap, , and C. J. Rozell. Short-term memory in neural networks via the restricted isometry property. *Computational Neuroscience Meeting (CNS) Workshop on Methods of Information Theory in Computational Neuroscience*, Atlanta, Georgia, July 2012
- [A28] C. J. Rozell and A. S. Charles. Spectral super-resolution of hyperspectral images. *SIAM Conference on Imaging Science*, Philadelphia, Pennsylvania, May 2012
- [A29] C. J. Rozell and A. S. Charles. Recursive estimation of dynamic signals with sparsity models via reweighted ℓ_1 minimization. *Janelia Farm Conference on Machine Learning, Statistical Inference, and Neuroscience*, Ashburn, Virginia, May 2012
- [A30] A. S. Charles, H. L. Yap, and C. J. Rozell. Short-term memory capacity in recurrent networks via compressed sensing. *Janelia Farm Conference on Machine Learning, Statistical Inference, and Neuroscience*, Ashburn, Virginia, May 2012
- [A31] H. L. Yap, A. S. Charles, and C. J. Rozell. Short-term memory capacity in recurrent networks via compressed sensing. *Challenges in Geometry, Analysis and Computation: High-dimensional Synthesis*, Yale University, New Haven, Connecticut, June 2012

- [A32] A.S. Charles, H.L. Yap, and C.J. Rozell. Short-term memory capacity in recurrent neural networks via compressive sensing. *Computational and Systems Neuroscience (CoSyNe)*, Salt Lake City, Utah, February 2012
- [A33] A.S. Charles, B. Olshausen, and C.J. Rozell. Learning sparse codes for hyperspectral images. *Duke Workshop on Sensing and Analysis of High-dimensional Data (SAHD)*, Durham, North Carolina, July 2011
- [A34] A. S. Charles and C. J. Rozell. A hierarchical re-weighted- ℓ_1 approach for dynamic sparse signal estimation. *Signal Processing with Adaptive Sparse Structured Representations (SPARS)*, Edinburgh, Scotland, United Kingdom, June 2011

Other Publications

- [O1] A. S. Charles. Interpreting deep learning: The machine learning rorschach test? *Society for Applied and Industrial Mathematics (SIAM) News*, July/August 2018
- [O2] A. S. Charles. Interpreting deep learning: The machine learning rorschach test? *arXiv:1806.00148*, June 2018
- [O3] M. Shvartsman, N. Sudaram, M. C. Aoi, A. S. Charles, T. L. Wilke, and J. D. Cohen. Matrix-variate models for fMRI analysis. *arXiv:1711.03058*, November 2017
- [O4] A. S. Charles. *Dynamics and Correlations in Sparse Signal Acquisition*. PhD thesis, Georgia Institute of Technology, 2015
- [O5] A. S. Charles. Adjustable subband allocation algorithm for critically sampled subband adaptive filters. *The Cooper Union for the Advancement of Science and Art, Albert Nerkin School of Engineering*, pages 1–127, 2009
- [O6] A. S. Charles. Bayesian derivation of the Kalman Filter. January 2011. Connexions: <http://cnx.org/content/m36679/1.1/>

Presentations

- 2018 | Signal processing for functional neural calcium imaging, DSO National Laboratories, Singapore
- 2018 | Matrix-normal models for fMRI analysis, Organization for Human Brain Mapping, Singapore
- 2018 | Modern methods for neural signal processing, Massachusetts Institute of Technology
- 2018 | Modern methods for neural signal processing, University of Michigan
- 2017 | Volumetric two-photon imaging of neurons using spectroscopy (vTwINS), Rutgers University
- 2017 | Distributed short-term memory in recurrent neural networks, Computational and Systems Neuroscience (CoSyNe) Workshops
- 2017 | Volumetric two-photon imaging via spectroscopy, Georgia Tech CSIP Seminar Series
- 2016 | Denoising calcium imaging, Georgia Tech CSIP Seminar Series
- 2014 | Bounds on distributed memory of networked systems, Princeton University
- 2014 | Robust tracking of high-dimensional signals, Rehabilitation Clinic of Chicago
- 2014 | Can an echo-state network remember what you did last summer?, Georgia Tech CSIP Seminar Series
- 2014 | Sparsity based techniques for hyperspectral image analysis, Georgia Tech CSIP Seminar Series
- 2011 | Sparsity penalties in dynamical system estimation, CISS, Baltimore, MD, USA
- 2011 | Causal sparse decompositions of audio signals, DSP Workshop, Sedona, AZ, USA
- 2011 | A hierarchical re-weighted- ℓ_1 approach for dynamic sparse signal estimation, SPARS, Edinburgh, UK
- 2011 | Modern signal processing and sparse coding, The Cooper Union IEEE series