

Jascha Sohl-Dickstein, PhD

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SKILLS

- Machine learning (deep learning, energy based models, Monte Carlo techniques, Bayesian statistics, convex optimization, directed graphical models, Markov fields)
- Physics (non-equilibrium statistical mechanics, thermodynamics, microfluidics, Lagrangian mechanics, classical mechanics, quantum mechanics, waves, electricity and magnetism, circuits)
- Computational Neuroscience (modeling of primary visual cortex, statistics of natural stimuli, Ising models of polytrode data, phase coupling, neuroanatomy, medical image processing)
- Programming (Scientific Python, MATLAB, C, Perl, SQL)
- Mathematics (differential/information geometry, differential equations, linear algebra, abstract algebra, calculus, wavelet and Fourier analysis)

PROFESSIONAL EXPERIENCE

Visiting Scholar, 2012-2014 and Postdoctoral Scholar, 2014-present
Stanford University, Applied Physics
Stanford, CA

- Developed Hamiltonian Monte Carlo sampling algorithm which largely eliminates proposal rejection, and mixes approximately twice as fast
- Developed new optimization technique that combines benefits of quasi-Newton methods and stochastic gradient descent, exceeding performance of both
- Used Boltzmann machines to infer functional connectivity and other properties from brain recordings
- Ongoing project using non-equilibrium statistical mechanics to model arbitrary probability distributions

Academic Resident, 2012-2014

Khan Academy (online education site focused on K-12 math, > 74 million users)
Mountain View, CA

- Built computer models of students, used to propose curricula and predict performance (models involve compressed sensing, hidden Markov models, non-linear Kalman filters, regression, support vector machines)
- Coordinated collaborations with outside researchers

Research Associate, Mars Exploration Rovers, 2001-2005

Jet Propulsion Laboratory
Pasadena, CA

- Scientific programming
- Physics-based modeling of optical properties of Martian dust
- Mission operations
- Database creation and management

EDUCATION

PhD, Biophysics, May 2012

University of California at Berkeley, Berkeley, CA

- Thesis Title: *Efficient Methods for Unsupervised Learning*
- Adviser: [Bruno Olshausen](#)
- Invented new parameter estimation method for intractable probabilistic models
 - Employs concepts from dynamical systems and statistical physics
 - Up to 10x faster than competing techniques
 - “Distinguished Paper Award” at ICML 2011
- Built probabilistic models of natural images and video

- Bilinear model, highest likelihood model of natural image patches at publication
- Trained Lie group model of transformations in natural video, and used resulting model for video compression
- Created device enabling human ultrasonic echolocation for the blind
- Other projects involving sampling algorithms, statistics of mammogram images, and energy based models

BA, Physics, May 2001

BA, College Scholar program (in Quantum Computing), May 2001

Cornell University, Ithaca, NY

INVITED TALKS

- Massachusetts Institute of Technology, Boston, Massachusetts (2015)
- *RE.WORK Deep Learning Summit*, San Francisco, California (2015)
- University of California at Davis, Davis, California (2015)
- *Bay Area Machine Learning Symposium*, UC Berkeley, Berkeley, California (2014)
- University of Southern California, Los Angeles, California (2014)
- *Statistical Mechanics Foundations of Complexity*, Santa Fe Institute, Santa Fe, New Mexico (2014)
- *Data Driven Education Workshop*, NIPS, Tahoe, California (2013)
- *Frontier of Statistical Physics and Information Processing*, Kyoto University, Kyoto, Japan (2013)
- *Personalized Learning Workshop*, Rice University, Houston, Texas (2013)
- Center for Integrative Neuroscience, Tübingen, Germany (2012)
- Los Alamos National Lab, New Mexico (2012)
- RIKEN Brain Science Institute, Tokyo, Japan (2011)
- *Instructor, CIFAR Summer School*, University of Toronto, Toronto, Canada (2010)
- Max Planck Institute, Tübingen, Germany (2009)

PEER REVIEWED PUBLICATIONS

- J Sohl-Dickstein, E Weiss, N Maheswaranathan, S Ganguli. Modeling arbitrary probability distributions using nonequilibrium thermodynamics. *Under Review*
- J Sohl-Dickstein, CM Wang, BA Olshausen. Learning and inference in high dimensional Lie group models, and their application to natural movies. *Under Revision*
- K Kinch, J Bell III, W Goetz, J Johnson, J Joseph, M Madsen, J Sohl-Dickstein. Dust deposition on the decks of the Mars Exploration Rovers: 10 years of dust dynamics on the Panoramic Camera calibration targets. *To Appear in: Earth and Space Science* (2015)
- J Sohl-Dickstein, S Teng, B Gaub, C Rodgers, C Li, M DeWeese, N Harper. A device for human ultrasonic echolocation. *Transactions in Biomedical Engineering* (2015)
- U Koster, J Sohl-Dickstein, CM Gray, B Olshausen. Modeling higher-order correlations within cortical microcolumns. *PLoS Computational Biology* (2014)
- J Sohl-Dickstein, B Poole, S Ganguli. Fast large-scale optimization by unifying stochastic gradient and quasi-Newton methods. *International Conference on Machine Learning* (2014)
- J Sohl-Dickstein, M Mudigonda, M DeWeese. Hamiltonian Monte Carlo Without Detailed Balance. *International Conference on Machine Learning* (2014)
- LS Hamilton, J Sohl-Dickstein, AG Huth, VM Carels, K Deisseroth, S Bao. Optogenetic Activation of an Inhibitory Network Enhances Feedforward Functional Connectivity in Auditory Cortex. *Neuron* (2013)

- L Theis, J Sohl-Dickstein, M Bethge. Training sparse natural image models with a fast Gibbs sampler of an extended state space. *Neural Information Processing Systems* (2012)
- J Sohl-Dickstein. Efficient Methods for Unsupervised Learning of Probabilistic Models. *Ph.D. Thesis, UC Berkeley* (2012)
- CK Abbey, A Nosratieh, J Sohl-Dickstein, K Yang, JM Boone. Non-Gaussian statistical properties of breast images. *Medical physics* (2012)
- J Sohl-Dickstein, P Battaglino, M DeWeese. New method for parameter estimation in probabilistic models: Minimum probability flow. *Physical Review Letters* (2011)
- BJ Culpepper, J Sohl-Dickstein, B Olshausen. Building a better probabilistic model of images by factorization. *International Conference on Computer Vision* (2011)
- J Sohl-Dickstein, P Battaglino, M DeWeese. Minimum probability flow learning. *International Conference on Machine Learning* (2011) **“Distinguished Paper” award**
- A Hayes, J Grotzinger, L Edgar, SW Squyres, W Watters, J Sohl-Dickstein. Reconstruction of Eolian Bed Forms and Paleocurrents from Cross-Bedded Strata at Victoria Crater, Meridiani Planum, Mars. *Journal of Geophysical Research* (2011)
- CM Wang, J Sohl-Dickstein, I Tosik. Lie Group Transformation Models for Predictive Video Coding. *Proceedings of the Data Compression Conference* (2011)
- C Abbey, J Sohl-Dickstein, BA Olshausen. Higher-order scene statistics of breast images. *Proceedings of SPIE* (2009)
- K Kinch, J Sohl-Dickstein, J Bell III, JR Johnson, W Goetz, GA Landis. Dust deposition on the Mars Exploration Rover Panoramic Camera (Pancam) calibration targets. *Journal of Geophysical Research-Planets* (2007)
- JR Johnson, J Sohl-Dickstein, WM Grundy, RE Arvidson, J Bell III, P Christensen, T Graff, EA Guinness, K Kinch, R Morris, MK Shepard. Radiative transfer modeling of dust-coated Pancam calibration target materials: Laboratory visible/near-infrared spectrogoniometry. *Journal of Geophysical Research* (2006)
- J Bell III, J Joseph, J Sohl-Dickstein, H Arneson, M Johnson, M Lemmon, D Savransky In-flight calibration and performance of the Mars Exploration Rover Panoramic Camera (Pancam) instruments. *Journal of Geophysical Research* (2006)
- Parker et al. Stratigraphy and sedimentology of a dry to wet eolian depositional system, Burns formation, Meridiani Planum, Mars. *Earth and Planetary Science Letters* (2005)
- Soderblom et al. Pancam multispectral imaging results from the Opportunity rover at Meridiani Planum. *Science* (2004)
- Soderblom et al. Pancam multispectral imaging results from the Spirit rover at Gusev crater. *Science* (2004)
- Smith et al. Athena microscopic imager investigation. *Journal of Geophysical Research* (2003)
- Bell et al. Mars exploration rover Athena panoramic camera (Pancam) investigation. *Journal of Geophysical Research* (2003)

TECHNICAL
REPORTS

- C Hillar, J Sohl-Dickstein, K Koepsell. Efficient and optimal binary Hopfield associative memory storage using minimum probability flow. *Redwood Technical Report* (2012)
- BF Albanna, C Hillar, J Sohl-Dickstein, MR DeWeese. Minimum and maximum entropy distributions for binary systems with known means and pairwise correlations. *Redwood Technical Report* (2012)
- J Sohl-Dickstein. The natural gradient by analogy to signal whitening, and recipes and tricks for its use. *Redwood Technical Report* (2012)
- J Sohl-Dickstein, BJ Culpepper. Hamiltonian annealed importance sampling for partition function estimation. *Redwood Technical Report* (2011)