Anima Anandkumar

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Current Research Interests

High-dimensional statistics and large-scale machine learning with a focus on learning probabilistic latent variable models and analysis of non-convex algorithms.

Current Appointment

Assistant Professor at Electrical Engineering and Computer Science *Since August 2010*
University of California, Irvine, CA, USA.

Education

Doctor of Philosophy in Electrical Engineering with minor in Applied Mathematics *July 2009*
advised by Prof. Lang Tong, Electrical & Computer Engr, Cornell University, Ithaca, NY, USA.

Bachelor of Technology in Electrical Engineering with minor in Theoretical Comp. Science *May 2004*
Indian Institute of Technology Madras, Department of Electrical Engineering, Chennai, India.

Awards and Honors

1. **Air Force Office of Sponsored Research (AFOSR) Young Investigator Award (YIP) 2015**
2. **Alfred P. Sloan Research Fellowship 2014**
3. **Microsoft Faculty Fellowship 2013**
4. **ARO Young Investigator Award (YIP) 2013**
5. **NSF CAREER Award 2013.**
6. **ACM SIGMETRICS 2011 Best Paper Award.**
7. **Best Thesis Award 2009** by ACM SIGMETRICS Society.
8. **IEEE Signal Processing Society Young Author Best Paper Award 2008**.
9. **Fran Allen IBM PhD Fellowship 2008-09**.
10. **Best Paper Award,** International Conference on Acoustic, Speech & Signal Processing 2006.

Previous Appointments

Visiting Researcher at Microsoft Research New England *April-Dec. 2012*
Cambridge, MA, USA.

Post-doctoral Associate at the Laboratory of Information & Decision Systems *July 2009-July 2010*
with Prof. Alan Willsky, MIT, Cambridge, MA, USA.

Graduate Research Intern at IBM Watson Research *Summer 2007 and 2008*
with Dr. Chatschik Bisdikian and Dr. Dakshi Agrawal, Hawthorne, NY, USA.

Principal Research: High Dimensional Learning

Preprints (Available on Webpage)

[1] Animashree Anandkumar, Prateek Jain, Yang Shi, and U. N. Niranjan. Tensor vs matrix methods: Robust tensor decomposition under block sparse perturbations. *Arxiv*, abs/1510.04747, 2015.

[2] M. Janzamin, H. Sedghi, and A. Anandkumar. Beating the perils of non-convexity: Guaranteed training of neural networks using tensor methods. *arXiv preprint arXiv:1506.08473*, 2015.

[3] Tejaswi Nimmagadda and Anima Anandkumar. Multi-object classification and unsupervised scene understanding using deep learning features and latent tree probabilistic models. *arXiv preprint arXiv:1505.00308*, 2015.

[4] Anima Anandkumar and Hanie Sedghi. Learning mixed membership community models in social tagging networks through tensor methods. *ArXiv 1503.04567*, 2015.

[5] H. Sedghi and A. Anandkumar. Provable Tensor Methods for Learning Mixtures of Generalized Linear Models. *Preprint*, Dec. 2014.

[6] Anima Anandkumar, Rong Ge, and Majid Janzamin. Analyzing tensor power method dynamics: Applications to learning overcomplete latent variable models. *arXiv preprint arXiv:1411.1488*, 2014.

[7] F. Huang, U.N. Niranjan, J. Perros, R. Chen, J. Sun, and A. Anandkumar. Scalable Latent Tree Model and its Application to Health Analytics. *Preprint*, Feb. 2015.

Journal Publications

[8] Furong Huang and Animashree Anandkumar. Convolutional dictionary learning through tensor factorization. In *Special Proceedings of Journal of Machine Learning Research (JMLR)*, volume 44, pages 1–10, 2015.

[9] Hanie Sedghi, Majid Janzamin, Niranjan Naresh, and Animashree Anandkumar. Performance analysis of feast: Feature extraction using score function tensors. In *Special Proceedings of Journal of Machine Learning Research (JMLR)*, volume 44, 2015.

[10] F. Huang, U.N. Niranjan, M. Hakeem, and A. Anandkumar. Fast online tensor methods for learning latent variable models. *ArXiv 1309.0787, accepted to JMLR*, Sept. 2013.

[11] A. Anandkumar, D. Hsu, M. Janzamin, and S. M. Kakade. When are Overcomplete Topic Models Identifiable? Uniqueness of Tensor Tucker Decompositions with Structured Sparsity. *ArXiv 1308.2853, accepted to JMLR*, Aug. 2013.

[12] A. Anandkumar, R. Ge, D. Hsu, S. M. Kakade, and M. Telgarsky. Tensor Methods for Learning Latent Variable Models. *J. of Machine Learning Research*, 15:2773–2832, 2014.

[13] M. Janzamin and A. Anandkumar. High-Dimensional Covariance Decomposition into Sparse Markov and Independence Domains. *J. of Machine Learning Research*, 15:1549–1591, 2014.

[14] A. Anandkumar, R. Ge, D. Hsu, and S. M. Kakade. A Tensor Approach to Learning Mixed Membership Community Models. *J. of Machine Learning Research*, (15):2239–2312, June 2014.

[15] Anima Anandkumar, Dean P Foster, Daniel Hsu, Sham M Kakade, and Yi-Kai Liu. A spectral algorithm for latent dirichlet allocation. *Algorithmica*, 72(1):193–214.

[16] A. Anandkumar and R. Valluvan. Learning Loopy Graphical Models with Latent Variables: Efficient Methods and Guarantees. *Annals of Statistics*, 41(2):401–435, 2013.

[17] A. Anandkumar, V. Y. F. Tan, F. Huang, and A. S. Willsky. High-dimensional structure learning of Ising models: local separation criterion. *The Annals of Statistics*, 40(3):1346–1375, 2012.

[18] A. Anandkumar, V. Y. F. Tan, F. Huang, and A. S. Willsky. High-Dimensional Gaussian Graphical Model Selection: Walk-Summability and Local Separation Criterion. *J. Machine Learning Research*, 13:2293–2337, Aug. 2012.

[19] A. Anandkumar, A. Hassidim, and J. Kelner. Topology discovery of sparse random graphs with few participants. *J. of Random Structures and Algorithms*, 43, June 2013.

[20] Y. Liu, V. Chandrasekaran, A. Anandkumar, and A. Willsky. Feedback Message Passing for Inference in Gaussian Graphical Models. *IEEE Tran. on Signal Processing*, 60(8):4135–4150, Aug. 2012.

[21] M.J. Choi, V.Y.F. Tan, A. Anandkumar, and A. Willsky. Learning latent tree graphical models. *J. of Machine Learning Research*, 12:1771–1812, May 2011.

[22] V.Y.F. Tan, A. Anandkumar, and A. Willsky. Learning Markov forest models: analysis of error rates. *J. of Machine Learning Research*, 12:1617–1653, May 2011.

[23] V.Y.F. Tan, A. Anandkumar, and A. Willsky. A large-deviation analysis for the maximum likelihood learning of tree structures. *IEEE Tran. on Information Theory*, 57(3):1714–1735, March 2011.

[24] V.Y.F. Tan, A. Anandkumar, and A. Willsky. Learning Gaussian tree models: analysis of error exponents and extremal structures. *IEEE Tran. on Signal Processing*, 58(5):2701–2714, May 2010.

Conference Publications (Limited List)

[25] Yining Wang, Hsiao-Yu Tung, Alexander Smola, and Animashree Anandkumar. Fast and guaranteed tensor decomposition via sketching. In *Proc. of NIPS*, 2015.

[26] Forough Arabshahi, Furong Huang, Animashree Anandkumar, and Carter T Butts. Modeling dynamic social interactions via conditional latent tree models. In *Proc. of ICDM*, Nov. 2015.

[27] A. Anandkumar, R. Ge, and M. Janzamin. Learning Overcomplete Latent Variable Models through Tensor Methods. In *Conf. on Learning Theory*, July 2015.

[28] P. Netrapalli, Niranjan U. N., S. Sanghavi, A. Anandkumar, and P. Jain. Provable Non-convex Robust PCA. In *Proc. of Neural Information Processing (NIPS)*, Dec. 2014.

[29] H. Sedghi, A. Anandkumar, and E. Jonckheere. Guarantees for Stochastic ADMM in High Dimensions. In *Proc. of Neural Information Processing (NIPS)*, Dec. 2014.

[30] Hanie Sedghi and Anima Anandkumar. Provable methods for training neural networks with sparse connectivity. In *NIPS Deep Learning Workshop*, 2014.

[31] L. Song, A. Anandkumar, B. Dai, and B. Xie. Nonparametric Estimation of Multi-View Latent Variable Models. In *Proc. of ICML*, June 2014.

[32] A. Agarwal, A. Anandkumar, P. Jain, P. Netrapalli, and R. Tandon. Learning Sparsely Used Overcomplete Dictionaries. In *Conference on Learning Theory (COLT)*, June 2014.

[33] A. Anandkumar, D. Hsu, M. Janzamin, and S. M. Kakade. When are Overcomplete Topic Models Identifiable? Uniqueness of Tensor Tucker Decompositions with Structured Sparsity. In *Neural Information Processing (NIPS)*, Dec. 2013.

[34] A. Anandkumar, R. Ge, D. Hsu, and S. M. Kakade. A Tensor Spectral Approach to Learning Mixed Membership Community Models. In *Conference on Learning Theory (COLT)*, June 2013.

[35] A. Anandkumar, D. Hsu, A. Javanmard, and S. M. Kakade. Learning Bayesian Networks with Latent Variables. In *Proc. of Intl. Conf. on Machine Learning*, June 2013.

[36] A. Anandkumar and R. Valluvan. Learning Loopy Graphical Models with Latent Variables: Efficient Methods and Guarantees. In *Proc. of Neural Information Processing (NIPS)*, Dec. 2012.

[37] A. Anandkumar, D. P. Foster, D. Hsu, S. M. Kakade, and Y. K. Liu. A Spectral Algorithm for Latent Dirichlet Allocation. In *Proc. of Neural Information Processing (NIPS)*, Dec. 2012.

[38] A. Anandkumar, D. Hsu, F. Huang, and S.M. Kakade. Learning Mixtures of Tree Graphical Models. In *Proc. of Neural Information Processing (NIPS)*, Dec. 2012.

[39] M. Janzamin and A. Anandkumar. High-Dimensional Covariance Decomposition into Sparse Markov and Independence Domains. In *Proc. of International Conf. on Machine Learning*, June 2012.

[40] A. Anandkumar, D. Hsu, and S.M. Kakade. A Method of Moments for Mixture Models and Hidden Markov Models. In *Proc. of Conf. on Learning Theory*, June 2012.

[41] A. Anandkumar, V. Y. F. Tan, and A. S. Willsky. High-Dimensional Graphical Model Selection: Tractable Graph Families and Necessary Conditions. In *Proc. of Neural Information Processing (NIPS)*, Dec. 2011. *Oral Presentation, AR 1%.*

[42] A. Anandkumar, K. Chaudhuri, D. Hsu, S.M. Kakade, L. Song, and T. Zhang. Spectral Methods for Learning Multivariate Latent Tree Structure. In *Proc. of Neural Information Processing (NIPS)*, Dec. 2011.

[43] A. Anandkumar, A. Hassidim, and J. Kelner. Topology Discovery of Sparse Random Graphs With Few Participants. In *Proc. of ACM SIGMETRICS*, June 2011. **Winner of Best Paper Award**.

[44] M. A. Khajehnejad, J. Yoo, A. Anandkumar, and B. Hassibi. Summary Based Structures with Improved Sublinear Recovery for Compressed Sensing. In *Proc. of IEEE ISIT*, July 2011.

Other Research: Signal Processing, Networks & Info. Theory

Journal Publications (Limited List)

[45] Amod JG Anandkumar, Animashree Anandkumar, Sangarapillai Lambotharan, and Jonathon A Chambers. Robust rate maximization game under bounded channel uncertainty. *Vehicular Technology, IEEE Transactions on*, 60(9):4471–4486, 2011.

[46] A. Anandkumar, J.E. Yukich, L. Tong, and A. Swami. Energy Scaling Laws for Distributed Inference in Random Networks. *IEEE J. Selec. Area Comm.*, 27(7):1203–1217, Sept. 2009.

[47] A. Anandkumar, L. Tong, and A. Swami. Detection of Gauss-Markov Random Fields with Nearest-neighbor Dependency. *IEEE Tran. Information Theory*, 55(2):816–827, Feb. 2009.

[48] A. Anandkumar, N. Michael, A.K. Tang, and A. Swami. Distributed algorithms for learning and cognitive medium access with logarithmic regret. *Selected Areas in Communications, IEEE Journal on*, 29(4):731–745, 2011. **Best Readings on Cognitive Radio by IEEE Comsoc society**.

[49] A. Anandkumar, L. Tong, and A. Swami. Distributed Estimation Via Random Access. *IEEE Tran. Information Theory*, 54(7):3175–3181, July 2008.

[50] A. Anandkumar and L. Tong. Type-Based Random Access for Distributed Detection over Multiaccess Fading Channels. *IEEE Tran. Signal Proc.*, 55(10):5032–5043, Oct. 2007. **IEEE Signal Processing Society 2008 Young Author Best Paper Award**.

Conference Publications (Limited List)

[51] F. Huang and A. Anandkumar. Fast, Concurrent and Distributed Load Balancing under Switching Costs and Imperfect Observations. In *Proc. of IEEE INFOCOM*, Apr. 2013.

[52] T. He, A. Anandkumar, and D. Agrawal. Index-based sampling policies for tracking dynamic networks under sampling constraints. In *Proc. of IEEE INFOCOM*, May 2011. *AR 15.96%*.

[53] P. Balister, B. Bollobas, A. Anandkumar, and A.S. Willsky. Energy-latency tradeoff for in-network function computation in random networks. In *Proc. of IEEE INFOCOM*, May 2011. *AR 15.96%*.

[54] A. Anandkumar, N. Michael, and A.K. Tang. Opportunistic Spectrum Access with Multiple Users: Learning under Competition. In *Proc. of IEEE INFOCOM*, San Deigo, USA, March 2010. *AR 17%*.

[55] A. Anandkumar, M. Wang, L. Tong, and A. Swami. Prize-Collecting Data Fusion for Cost-Performance Tradeoff in Distributed Inference. In *Proc. of IEEE INFOCOM*, Rio De Janeiro, Brazil, April 2009. *AR 20%*.

[56] A. Anandkumar, C. Bisdikian, and D. Agrawal. Tracking in a Spaghetti Bowl: Monitoring Transactions Using Footprints. In *Proc. ACM Intl. Conf. on Measurement & Modeling of Computer Systems (Sigmetrics)*, Annapolis, Maryland, USA, June 2008. *AR 18%*.

[57] A. Anandkumar, L. Tong, A. Swami, and A. Ephremides. Minimum Cost Data Aggregation with Localized Processing for Statistical Inference. In *Proc. of INFOCOM*, pages 780–788, Phoenix, USA, April 2008. *AR 20%*.

[58] A. Anandkumar and L. Tong. A Large Deviation Analysis of Detection over Multi-Access Channels with Random Number of Sensors. In *Proc. of ICASSP'06*, volume IV, pages 1097–1101, Toulouse, France, May 2006. **Best Paper Award**.

Book Chapters

[59] A. Anandkumar, A. Ephremides, A. Swami, and L. Tong. Routing for Statistical Inference in Sensor Networks. In S. Haykin and R. Liu, editors, *Handbook on Array Processing and Sensor Networks*, chapter 23. John Wiley & Sons, 2009.

Invention Disclosures

[60] A. Anandkumar and D. Agrawal and C. Bisdikian and T. He, and S. Perelman. Selective Instrumentation For Distributed Applications For Transaction Monitoring. *US 8433786 B2*, April 2013.

Teaching

Special topics in ML (2015), Signals & Systems (2012-15), Large-scale ML (2014), Stat. Learning Theory (2014), Estimation Theory (2011-15), Special Topics in Learning (2013, 2015), Random Processes (2010-11).

Funding

AFOSR YIP, ONR (PI), Sloan fellowship, Microsoft faculty fellowship, Microsoft Azure for research, NSF BigData (PI), ARO Young Investigator Award (YIP), NSF Career (PI), NSF CCF (PI).

Service

TPC for ICML 2012-16, AISTATS 2016, NIPS 2014, UAI 2013-14, SIGMETRICS 2014-16, ISIT 2014-15, AAAI 2013-16, SPCOM 2012, ACM MOBIHOC 2011-2013, IEEE INFOCOM 2011-2012, Intl. Symposium of Information Theory and its App. 2012.

Assoc. Editor for IEEE Tran. on Signal Processing, Reviewer for JMLR, Annals of Statistics, IEEE Tran. on Information Theory.

Organizer of the workshop on optimization and matrix methods at Fields institute (Feb. 2015), non-convex optimization at NIPS 2015, tensor methods at Dagstuhl in 2016.

Recipient of IBM grant of $30,000 as part of Fran Allen award to mentor female students. University.

In the News

O'Reilly Data Show Podcast: Anima Anandkumar on tensor decomposition techniques for machine learning,

http://radar.oreilly.com/2015/05/the-tensor-renaissance-in-data-science.html

Announcement of AFOSR YIP, Feb. 2015.

http://www.wpafb.af.mil/news/story.asp?id=123436763

Announcement of the Sloan fellowship, Feb. 2014

http://www.eng.uci.edu/news/2014/2/anandkumar-receives-early-career-sloan-research-fellowship-her-work-machine-learning
http://www.sloan.org/sloan-research-fellowships/2014-sloan-research-fellows/

Announcement of Microsoft faculty award, July 2013.

http://research.microsoft.com/en-us/collaboration/awards/msrff_all.aspx#2013

http://www.eng.uci.edu/news/2013/6/microsoft-research-names-anima-anandkumar-faculty-fellow.

Interview at faculty summit: http://research.microsoft.com/apps/video/?id=200507.

Announcement of Windows Azure for Research Award winners, (Oct. 2013)

http://blogs.msdn.com/b/msr_er/archive/2013/11/05/october-2013-windows-azure-for-research-award-winners.aspx#!

Article on Sizing Samples in ACM Technews and MIT news September 2010.

http://technews.acm.org/archives.cfm?fo=2010-09-sep/sep-01-2010.html

http://web.mit.edu/newsoffice/2010/sizing-samples-0825.html

Article on Fran Allen Fellowship in Cornell News December 2008.

http://www.news.cornell.edu/stories/Dec08/AnandkumarAward.html

Article on Anita Borg Scholars in Google Press Release March 2007.

http://www.google.com/intl/en/press/pressrel/anitaborg07.html

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`http://newport.eecs.uci.edu/anandkumar/Resume/CV.pdf`