Narayana P. Santhanam
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Professional experience

- Associate Professor, University of Hawaii, 2015-.
- Assistant Professor, University of Hawaii, 2009-2015.
- Postdoctoral researcher, UC Berkeley, 2007-2008.
  (Department of Electrical Engineering and Computer Science)
- Intern, IBM Almaden Research Center, Lossy compression algorithms [55], 2005.
- Graduate Student Researcher, UC San Diego, 2000-2006.
  (compression, probability estimation, statistical learning, statistics)

Education

- Ph.D. (2006) (with Prof. A. Orlitsky), University of California, San Diego;
- M.S. (2003) (with Prof. A. Orlitsky), University of California, San Diego;
- B. Tech (2000), Indian Institute of Technology, Madras.

Professional service

- Associate Editor, IEEE Transactions on Information Theory, 2017-2020 (Source coding), 2020-2023 (Source coding, statistics, learning).
- Technical Program Committee, International Conference on Machine Learning 2019, IEEE Symposium on Information Theory (ISIT) 2020, 2019, 2018, ISIT 2016, ISIT 2015, ISIT 2014, COMSNET 2015, COMSNET 2014, Information Theory Workshop 2010
- Tutorials chair, IEEE Symposium on Information Theory, 2014
- Technical Program Committee Chair, International Symposium on Information Theory and its Applications, 2012
- Member, The Institute of Electrical and Electronics Engineers
  Societies: Information Theory, Communications, Signal Processing
  Reviewer, (among others) IEEE Transactions on Information Theory, IEEE Transactions on Communications, SIAM Review, Annals of Applied Statistics, Annals of Statistics, Journal of Machine Learning Research, COLT.

Major Awards and Recognitions

- Member of the NSF Center for Science of Information (2014) and PI from the University of Hawaii (2015-.).

- 2006 IEEE Information Theory Society Best Paper Award for [61]. This is awarded annually by the Information Theory Society for a publication published anywhere within the prior two calendar years. Past recipients have included Lempel-Ziv algorithms (basis of a majority of commercial compression algorithms today, including WINZIP) and the RSA algorithm (basis of commercial encryption schemes today used on the Internet to transmit data).
- 2003 Capocelli Prize for [70].

Funding and Grants

- PI of NSF award CCF-1619452 (roughly $500k) to study slow mixing Markov processes. The grant studies how to interpret and work around bias introduced by Markov sampling, in particular before the samples reflect stationary properties of the Markov chain. We use this, among others, for community detection in graphs. 2016-2020.
- PI of seed grants "Dynamics and Inference in Stochastic Models of Epidemics on Networks" (160k$) from the Center for Science of Information, 2018-2021.
- Member of the NSF Center for Science of Information, a science and technology center established by the NSF. The University of Hawaii was inducted as the 11th university of this prestigious center, headed by Narayana Santhanam, and the funding assigned to UH till 2020 is more than 750k$ thus far. 2015-2021.
- Principal Investigator (PI) of CCF-1065632 (roughly $400k) from the National Science Foundation (NSF) which examined the interplay of statistics and information theory, as well as applied them to classification.
- co-PI of NSF award CCF-1018984 (roughly $400k, split between Alek Kavćic and NS) to understand and to communicate over channels influenced by prior history (memory) of data sent over them. Such channels are ubiquitous in on-chip connections, high speed data centers, and magnetic recording.
- co-PI of NSF award EECS-1029081 (rougly $400k, split between UH and CMU) to study how to organize a smart grid based on pricinples arising from information theory and communications. Specifically, to analyze distributed (message passing) techniques to organize a smart grid, as well to understand privacy issues using statistical and information theoretic tools, some of which were developed by NS.

Special meetings, workshops, dissemination

The nature of my research is fundamentally interdisciplinary, involving problems in statistics, theoretical computer science, biology, error control coding theory, machine learning, finance and mathematics. These connections are also actively being studied by several researchers from diverse backgrounds. To faciliate dissemination and foster collaborations, we organized the following workshops, which have also incorporated tutorials for both our work and allied fields.

- Co-organizer for proposed workshop "Connecting local and global information" in Honolulu, HI (2020).
- Co-organizer for the workshop "Information theory, learning and big data" sponsored by the Simon's Institute for the Theory of Computing, Berkeley, CA in Spring 2015.

- Taught a tutorial on reworking statistics for the big data regime at SPCOM 2014, Bangalore, India
- Organizer for a session on big data at **IEEE ITW** at Seville, Spain in September 2013.
- Workshop sponsored by the **NSF Center for Science of Information**, Spring 2013 at University of Hawaii. The three day workshop collected leading researchers from 10 universities across the US who are interested in high dimensional statistics and was primarily discussion oriented.
- Workshop sponsored by the **Banff Institute for Research in Science**, Alberta, Canada from Oct 23-28, 2011. 42 participants drawn from diverse fields such as finance, statistics, information theory, biology, coding theory, and machine learning, from both industry and academia, and from premier organizations in Canada, UK, Italy, South Korea, and Hong Kong in addition to the US.
- Workshop sponsored by the **NSF** and the **American Institute of Math**, on probability estimation. Co-organized with Prof. Alon Orlitsky and Krishna Viswanathan from Aug 31 to Sep 4, 2009. 25 participants from statistics, information theory, natural language processing and machine learning, representing several US universities, Cornell Univ, MIT, HP Labs, Qualcomm Inc., Johns Hopkins University, Oregon Health and Science Univ, Stanford University, University of Illinois (Urbana-Champaign), Univ of Texas Austin, Univ of CA, San Diego, and Yale Univ.

Research interests

Statistical problems in biology, electrical engineering and computer science, Prediction problems in finance, Information theory (in particular source coding), Statistical learning and regularization, High dimensional problems in statistics, Signal processing, Coding for communications, Combinatorial and probabilistic algorithms for compression and communications, Detection and estimation, Communication and signal processing, communication and statistical issues in Smart Grids.

Publications

A selected list of my publications is included at the end. For a complete list, please see my web page. Journal publications are: [13, 18, 21, 22, 72, 23, 24, 3, 29, 53, 56, 60, 61, 67], while the rest are conference publications. In papers [50]- [71], all authors are **ordered alphabetically** and all authors should be considered equal contributors.

Teaching

- Undergraduate probability (EE342), digital communication (EE442), machine learning (EE445), basic circuits (EE 213) as well as graduate machine learning (EE693D), error control coding for communication (EE648 and EE649) at the University of Hawaii, Manoa.

  All these courses have incorporated innovative techniques, for example—EE 442 has involved building digital communication links via sound, using speakers and microphones as antenna; EE 445 incorporates projects in cancer classification; and EE 342 involved demonstrations of, among others, Kruskal Card count games.
- Have advised more than a dozen students for their design projects (EE 296, 396 and 496).
- Co-developed an Academic Quarter length course combining principles of information with machine learning, "Universal compression, probability estimation, and learning", Winter 2005 and 2006 with

Prof. A. Orlitsky. Subsequently extended it to an Academic semester length course, offered in Fall 2009 at the University of Hawaii, Manoa.

Computer skills

Expert level in C/C++, familiar with Java; Python; scripting tools Tcl/Tk, Perl, Awk, Bash etc.; scientific software Matlab, R, Maple; extensively use several platforms, system administration in Linux.

Students

(Graduate students, listed alphabetically)

- Meysam Asadi (PhD), graduated Summer 2016
- Jason Castiglione (PhD) expected to graduate in 2021
- John Halloran (MS), graduated
- Maryam Hosseini (PhD), graduated Fall 2018
- Nemat Iri (MS), graduated
- Kevin Oshiro (MS), graduated Fall 2017
- Ramezan Paravi (PhD), graduated Spring 2015
- Changlong Wu (PhD), expected to graduate in 2021
- Ian Umetsu (MS), graduated

(Undergraduate students)
Served as advisor for several undergraduate projects. Students in the last five years are (alphabetically) Katherine Dolma, Charles Dickens, Cody Driver, Mathew Fall, Chi Jow, Saugat Kuinkel, Makiko Kuwahara, Alex Lee, Kevin Oshiro, Caroline Eugine Shin, Dasan Sparks, and Grace Tobin.

(K-12 mentoring)
Work with University of Hawaii outreach programs to mentor high school students over 6 weeks of summer and encourage them to take up STEM disciplines. Students mentored in the last three years are Jennifer Chun, Danielle Woods, Bryson Inafuku and Brandon Wong.

Note: Journal publications are: [13, 18, 21, 22, 23, 3, 24, 29, 53, 56, 60, 61, 67], while the rest are conference publications. In papers [50]–[71], all authors are ordered alphabetically by last name.

Selected list of publications

[1] C. Wu and N. Santhanam. Non-uniform consistency of online learning with random sampling. In *Proceedings of the 32nd International Conference on Algorithmic Learning Theory*, 2021.

[2] C. Wu and N. Santhanam. Prediction with finitely many errors almost surely. In *Proceedings of The 24th International Conference on Artificial Intelligence and Statistics*, 2021.

[3] N. Santhanam, V. Anantharam, and W. Szpankowski. Data driven weak universal compression. Submitted for publication. Full version available form arXiv.

[4] C. Wu and N. Santhanam. Entropy property testing with finitely many errors'. In *Proceedings of IEEE Symposium on Information Theory*, Virtual conference due to covid-19, 2020.

[5] C. Wu and N. Santhanam. Almost uniform sampling from neural networks. In *Proceedings of the 54th Annual Conference on Information Sciences and Systems*, 2020.

[6] C. Wu and N. Santhanam. Prediction with eventual almost sure guarantees. In preparation. Full version available from arXiv.

[7] C. Wu and N. Santhanam. Being correct eventually almost surely. Proceedings of IEEE Symposium on Information Theory, 2019.

[8] M. Hosseini and N. Santhanam. Tail redundancy and its connections with universal compression. Proceedings of IEEE Symposium on Information Theory, 2019.

[9] M. Hosseini and N. Santhanam. On the tail redundancy of memoryless sources. Under preparation, 2019.

[10] C. Wu, M. Hosseini, and N. Santhanam. Redundancy of unbounded memory markov sources with continuity conditions. In *Proceedings of IEEE Symposium on Information Theory*, 2018.

[11] N. Santhanam. Resampling procedures for data with Markov dependencies. Workshop on Information Theoretic Methods in Science and Engineering, 2017. Held in Paris, France.

[12] K. Oshiro, C. Wu, and N. Santhanam. Jackknife estimation for Markov processes with no mixing constraints. In *Proceedings of IEEE Symposium on Information Theory*, 2017.

[13] M. Asadi, E. Haratsch, A. Kavcic, and N. Santhanam. Flash Memories: ISPP renewal theory and flash design tradeoffs. *IEEE Journal on Selected Areas in Communications.*, 34(9):2325–2335, 2016.

[14] M. Hosseini and N. Santhanam. Single letter characterization of average-case strong redundancy of compressing memoryless sequences. In *Allerton conference on Communication, Control and Computing*, 2015.

[15] M. Hosseini and N. Santhanam. On the redundancy of memoryless sources over countable alphabets. In *International symposium on information theory and its applications*, 2015.

[16] R. Paravi and N. Santhanam. Modeling community detection using slow mixing random walks. In *IEEE International conference on big data*, 2015.

[17] M. Asadi, E. F. Haratsch, A. Kavcic, and N. P. Santhanam. Write Process Modeling in MLC Flash Memories Using Renewal Theory . In *IEEE Symposium on Information Theory*, June 2015.

[18] N. Santhanam and V. Anantharam. Agnostic insurance of model classes. *Journal of Machine Learning Research*, 2015. Full version available from arXiv doc id: 1212:3866.

[19] X. Huang, M. Asadi, A. Kavcic, and N.P. Santhanam. All-bit-line MLC flash memories: Optimal detection strategies . In *IEEE International Conference on Communications (ICC)*, pages 3883–3888, June 2014.

[20] N. Santhanam, V. Anantharam, A. Kavcic, and W. Szpankowski. Data driven weak universal redundancy. In *Proceedings of IEEE Symposium on Information Theory*, Jul 2014.

[21] M. Asadi, R. Paravi, and N. Santhanam. Stationary and transition probabilities in slow mixing, long memory Markov processes. *IEEE Transactions on Information Theory*, 60(9), September 2014.

[22] N. Santhanam, A. Sarwate, and J. Woo. Redundancy of exchangeable estimators. *Entropy*, 16(10):5339–5357, 2014. Full version available from arXiv.

[23] M. Asadi, X. Huang, A. Kavcic, and N. Santhanam. Optimal detector for multilevel NAND flash memory channels with intercell interference. *IEEE Journal on Selected Areas of Communication*, 32(5):825–835, 2014.

[24] M. Hosseini and N. Santhanam. Characterizing asymptotic redundancy of memoryless sources over countable alphabets in terms of single letter marginals. *Entropy*, Jul 2014. Full version available from arXiv.

[25] M. Asadi, R. Paravi, and N. Santhanam. Markov processes: estimation in the undersampled regime. In *Allerton conference on computing, communication and control*, October 2013.

[26] M. Asadi, R. Paravi, and N. Santhanam. Estimation of transition and stationary probabilities of slow mixing markov processes. In *IEEE Information Theory Workshop*, September 2013.

[27] M. Asadi, R. Paravi, and N. Santhanam. Estimation in markov processes. In *Workshop on Information Theoretic methods in Science and Engineering*, August 2013.

[28] M. Asadi, R. Paravi, and N. Santhanam. Estimation in long memory, slow mixing channels. In *ISIT Symposium on Information Theory*, July 2013.

[29] N. Santhanam and M. Wainwright. Information theoretic limits of graphical model selection in high dimensions. *IEEE Transactions on Information Theory*, 57(12):4117–4134, July 2012.

[30] N. Santhanam. Ballot boxes, catalan numbers and lossy compression. Information Theory and Applications, Feb 2013.

[31] N. Santhanam and V. Anantharam. Universal algorithms: making a case for pointwise convergence. In *Allerton Conference on Communication, Control, and Computing*, September 2012.

[32] F. Farnoud, N. Santhanam, and O. Milenkovic. Alternating markov chains for distribution estimation. In *Proceedings of IEEE Symposium on Information Theory*, 2012.

[33] N. Santhanam and V. Anantharam. Agnostic insurance tasks and their relation to compression. In *International conference on signal processing and communications (SPCOM)*, 2012.

[34] N. Santhanam and V. Anantharam. Prediction over countable alphabets. In *Conference on Information Sciences and Systems*, 2012.

[35] N. Santhanam and V. Anantharam. Prediction and compression: comparisons from an information theoretic perspective. Information Theory and Applications, Feb 2012.

[36] N. Santhanam and D. Modha. Lossy compression algorithms for memoryless sources. Information Theory and Applications, Feb 2011.

[37] N. Santhanam and V. Anantharam. What risks lead to ruin. In *Allerton Conference on Computing, Communication and Control*, Oct 2010.

[38] Wei Dai, Olgica Milenkovic, and N. Santhanam. Inferring protein protein interactions via low rank matrix completion. In *Invited talk in Systems Biology, 8th International Conference of Numerical Analysis and Applied Mathematics*, 2010.

[39] N. Santhanam and M. Madiman. Redundancy of exchangeable estimators. In *Allerton Conference on Computing, Communication and Control*, Oct 2010.

[40] N. Santhanam and M. Madiman. Patterns and exchangeability. In *Proceedings of IEEE Symposium on Information Theory*, 2010.

[41] J. Acharya, H. Das, A. Orlitsky, S. Pan, and N. Santhanam. Classification using pattern probability estimators. In *Proceedings of IEEE Symposium on Information Theory*, 2010.

[42] N. Santhanam. Patterns, probability and graphs. Information Theory and Applications, Feb 2010.

[43] N. Santhanam, O. Milenkovic, and B. Vasic. Information theoretic modeling of gene interactions. In *Information Theory Workshop*, Volos, Greece, 2009.

[44] F. Farnoud, O. Milenkovic, and N. Santhanam. Small sample distribution estimation over sticky channels. In *Proceedings of IEEE Symposium on Information Theory*, Seoul, South Korea, 2009.

[45] F. Farnoud, O. Milenkovic, and N. Santhanam. Unraveling sticky channels. Information Theory and Applications, Feb 2009.

[46] N.P. Santhanam and M.J. Wainwright. High dimensional ising models. In *Annual Allerton Conference on Communication, Control, and Computing*, sep 2008.

[47] N.P. Santhanam and M.J. Wainwright. Information-theoretic limits of graphical model selection in high dimensions. In *Proceedings of IEEE Symposium on Information Theory*, jul 2008.

[48] H. Das, A. Orlitsky, N.P. Santhanam, and J. Zhang. Further results on relative redundancy. In *Proceedings of IEEE Symposium on Information Theory*, jul 2008.

[49] N.P. Santhanam and M.J. Wainwright. Learning sparse graphical models. Information theory and Applications, 2008.

[50] A. Orlitsky, N.P. Santhanam, and J. Zhang. Reflections on universal compression of memoryless sources. In *Information theory newsletter*, 2007.

[51] N.P. Santhanam, A. Orlitsky, and K. Viswanathan. New tricks for old dogs: Large alphabet probability estimation. In *Information Theory Workshop (invited)*, Lake Tahoe, CA, sep 2007.

[52] A. Orlitsky, N.P. Santhanam, and K. Viswanathan. Population estimation with performance guarantees. In *Proceedings of IEEE Symposium on Information Theory*, 2007.

[53] A. Orlitsky, N.P. Santhanam, K. Viswanathan, and J. Zhang. Limit results on pattern entropy. *IEEE Transactions on Information Theory*, jul 2006.

[54] A. Orlitsky, N.P. Santhanam, and J. Zhang. Relative redundancy of large alphabets. In *Proceedings of IEEE Symposium on Information Theory*, 2006.

[55] D. Modha and N.P. Santhanam. Making the correct mistakes. In *Proceedings of the Data Compression Conference*, 2006.

[56] N. Jevtić, A. Orlitsky, and N.P. Santhanam. A lower bound on compression of unknown alphabets. Theoretical Computer Science, Feb 2005.

[57] A. Orlitsky and N.P. Santhanam. On the redundancy of gaussian distributions. In *Proceedings of the 42nd Annual Allerton Conference on Communication, Control, and Computing*, 2005.

[58] A. Orlitsky, N.P. Santhanam, K. Viswanathan, and J. Zhang. Convergence of profile based estimators. In *Proceedings of the IEEE Symposium on Information Theory*, 2005.

[59] A. Orlitsky, N.P. Santhanam, K. Viswanathan, and J. Zhang. Innovation and pattern entropy of stationary processes. In *Proceedings of the IEEE Symposium on Information Theory*, 2005.

[60] A. Orlitsky and N. Santhanam. Speaking of infinity. *IEEE Transactions on Information Theory*, 50(10):2215—2230, October 2004.

[61] A. Orlitsky, N.P. Santhanam, and J. Zhang. Universal compression of memoryless sources over unknown alphabets. *IEEE Transactions on Information Theory*, 50(7):1469—1481, July 2004.

[62] A. Orlitsky, N.P. Santhanam, K. Viswanathan, and J. Zhang. Limit results on pattern entropy. In *Information Theory Workshop*, 2004.

[63] A. Orlitsky, N.P. Santhanam, K. Viswanathan, and J. Zhang. Information theoretic approach to modeling low probabilities. In *Proceedings of the 42nd Annual Allerton Conference on Communication, Control, and Computing*, 2004.

[64] A. Orlitsky, Sajama, N.P. Santhanam, K. Viswanathan, and J. Zhang. Practical algorithms for modeling sparse data. Proceedings of the 2004 Proceedings of IEEE Symposium on Information Theory.

[65] A. Orlitsky, N.P. Santhanam, K. Viswanathan, and J.Zhang. On modeling profiles instead of values. In *Uncertainty in Artificial Intelligence*, 2004.

[66] A. Orlitsky, N.P. Santhanam, and J. Zhang. Relative redundancy: A more stringent performance guarantee for universal coding. In *Proceedings of IEEE Symposium on Information Theory*, 2004.

[67] A. Orlitsky, N. Santhanam, and J. Zhang. Always Good Turing: Asymptotically optimal probability estimation. *Science*, 302(5644):427—431, October 17 2003. See also *Proceedings of the* 44th *Annual Symposium on Foundations of Computer Science*, October 2003.

[68] A. Orlitsky, N.P. Santhanam, and J. Zhang. Bounds on compression of unknown alphabets. In *Proceedings of IEEE Symposium on Information Theory*, jul 2003.

[69] A. Orlitsky, N.P. Santhanam, K. Viswanathan, and J. Zhang. On compression and modeling of sparse data. In *Third Asian European Workshop on Coding and Information Theory*, jun 2003.

[70] A. Orlitsky and N.P. Santhanam. Performance of universal codes over infinite alphabets. In *Proceedings of the Data Compression Conference*, mar 2003.

[71] N. Jevtić, A. Orlitsky, and N.P. Santhanam. Universal compression of unknown alphabets. In *Proceedings of IEEE Symposium on Information Theory*, 2002.

[72] A. Orlitsky and N. Santhanam. Universal compression of gaussian sources with unknown parameters. Under review as of Aug, 2014. Full version available from arXiv.