Jayakrishnan Unnikrishnan

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EDUCATION

- **University of Illinois at Urbana-Champaign**
  Ph.D, Dept. of Electrical and Computer Engineering, Aug 2010
  Thesis: Decision-Making under Statistical Uncertainty
  Advisors: Prof. Venugopal V. Veeravalli and Prof. Sean Meyn

  M.S., Dept. of Electrical and Computer Engineering, Oct 2007
  Thesis: Cooperative Sensing for Primary Detection in Cognitive Radio
  Advisor: Prof. Venugopal V. Veeravalli

- **Indian Institute of Technology (IIT), Madras, India**
  B.Tech., Dept. of Electrical Engineering, July 2005
  Thesis: Single Antenna Interference Cancelation for GSM networks
  Advisor: Prof. David Koilpillai

RESEARCH INTERESTS

Signal Processing, Information Privacy, Detection and Estimation, Spatial Sensing, Statistics, Information Theory, Wireless Communications

EMPLOYMENT

Post-doctoral Researcher, Audiovisual Communications Laboratory (LCAV), EPFL *Oct 2010 - present*
Mentor: Prof. Martin Vetterli

- Conducted independent research, presented and published research work, and contributed to research grant proposals and reviews. Research topics include

  - Sampling theory and signal processing for data acquisition with mobile sensors [J5 in the list of publications][J6,J8][C15]
  - Quantification and protection of privacy in data collection and information processing [C16][J9][C17]
  - Optimal matching of statistical datasets [J9]
  - Thresholds for asymptotically optimal hypothesis tests [J7]

- Supervised doctoral and master's students

- Organized and taught master's level classes

Graduate Research Assistant, Coordinated Science Lab, University of Illinois *Aug 2005 - Aug 2010*
Advisors: Prof. Venugopal Veeravalli and Prof. Sean Meyn

- Conducted independent research, and presented and published research work. Research topics include

  - Dimensionality reduction for universal and composite hypothesis testing on large alphabet data [J3][O5]
  - Robust quickest change detection with unknown distributions [J4]
  - Cooperative spectrum sensing for cognitive radio [J1]

  – Reinforcement learning for dynamic spectrum access in cognitive radio systems [J2]

- Supervised undergraduate student projects

Graduate Teaching Assistant, Department of Electrical and Computer Engineering, University of Illinois *Aug - Dec 2009*
Instructor: Prof. Tamer Başar

- Conducted discussion sessions on homeworks and problem-solving techniques

- Graded homework assignments and provided feedback to students

- Delivered substitute lectures

Interim Engineering Intern, QUALCOMM Inc. *May - Aug 2007*

- Designed and evaluated performance of sensing algorithms for detecting television and wireless microphone signals in IEEE 802.22 cognitive radio networks.

- Attended and contributed to meetings of the IEEE working group for establishing the IEEE 802.22 standard for Wireless Regional Area Networks (WRANs).

GRANT-WRITING EXPERIENCE

- Research proposal for the **Junior Research Fellowship** at Imperial College, London, was recommended for the fellowship in January 2014. Sponsor at Imperial: Dr Pier Luigi Dragotti.

- Contributed to a **successful** Swiss National Science Foundation grant application "Non-linear Sampling Methods" May 2012. PI: Martin Vetterli.

TEACHING EXPERIENCE

- **Co-teacher** for master's level course on Mathematical Foundations of Signal Processing in Fall 2013, École Polytechnique Fédérale de Lausanne (co-teachers: Dr. Mihailo Kolundžija and Prof. Martin Vetterli).

  – Prepared and delivered fifteen hours of lectures.
  – Prepared and graded exams; supervised preparation of homework assignments.

- **Co-teacher** for master's level course on Signal Processing: Spaces, Operators and Transforms in Fall 2012, École Polytechnique Fédérale de Lausanne (co-teachers: Dr. Mihailo Kolundžija and Prof. Martin Vetterli).

  – Prepared and delivered fifteen hours of lectures.
  – Prepared and graded exams; supervised preparation of homework assignments.
  – Gave feedback to authors of the textbook "Foundations of Signal Processing" by M. Vetterli, J. Kovacevic and V. Goyal, and was acknowledged in the book for "providing invaluable comments and suggestions."

- **Guest lecturer** for master's level course on Mathematical Signal Processing: Tools and Applications in Fall 2011, École Polytechnique Fédérale de Lausanne (instructors: Dr. Andrea Ridolfi, Dr. Amina Chebira, and Prof. Martin Vetterli).

  – Also prepared lecture content and homework assignments.

- **Graduate Teaching Assistant** for graduate course on Optimization by Vector Space Methods in Fall 2009, University of Illinois at Urbana-Champaign (instructor: Prof. Tamer Başar).

  – Delivered seven hours of lectures, and facilitated discussions on various problem-solving techniques.
  – Impartially assessed student progress and provided meaningful feedback to aid student progress.

- **Guest lecturer** for graduate course on Detection and Estimation in Spring 2010, University of Illinois at Urbana-Champaign (instructor: Prof. Venugopal Veeravalli).

- **Guest lecturer** for undergraduate course on Fundamentals of Digital Communications in Spring 2009, University of Illinois at Urbana-Champaign (instructor: Prof. Todd Coleman).

- **Reviewer of teaching material** for the Massively Online Open Course (MOOC) on "Digital Signal Processing" taught by Paolo Prandoni and Martin Vetterli on coursera.org in Fall 2012.

MENTORING EXPERIENCE

- Doctoral student Farid Movahedi Naini on thesis research since Spring 2011 at LCAV, EPFL. Currently supervising two research projects "Privacy-preserving function computation by exploiting friendships in social networks, "([C17] in the list of publications) and "De-anonymization via matching statistics" [C16].

- Master's student Pierre Gouedard for the project "De-anonymization of statistical databases", during Spring 2014, LCAV, EPFL.

- Master's student Seyed Moosavi for the project "Random Tomography", during Spring and Fall 2013, LCAV, EPFL.

- Master's student Elio Abi Karam for the project "De-anonymization by Matching Statistics", during Spring and Summer 2013, LCAV, EPFL. The results from this work were reported in a recent paper [C16].

- Master's student Tao Lee for the project "Monitoring Network Structure and Content Quality of Signal Processing Articles on Wikipedia", during summer 2012, LCAV, EPFL. This work led to a conference publication [C14]. I guided and helped Tao in preparing his presentation on our work at the conference.

- Undergraduate student Jason Chang for the project "Decentralized Detection Schemes Applied to Cognitive Radio Networks," during academic year 2006-07 at CSL, UIUC. Results of this work were included in [J1].

At LCAV, I served as the coordinator of student projects during Spring and Fall semesters, 2012 (approximately 15 projects each semester). In this role I reviewed project proposals (approximately 30 proposals each semester) proposed by various graduate students, and organized and graded project presentations given by project students.

AWARDS AND DISTINCTIONS

- Selected for the **Junior Research Fellowship** at Imperial College, London, 2014.

- Paper on "Cooperative Sensing for Primary Detection in Cognitive Radio" (see [J1] in list of publications) has over **350 citations** on Google Scholar and was **nominated for the IEEE Signal Processing Society Best Paper Award** in 2012 and 2013.

- Part of four member team from University of Illinois that won the inter-university **Qualcomm Cognitive Radio Contest 2010** for developing efficient algorithms for detecting wireless microphone signals.

- **E. A. Reid Fellowship Award in Electrical Engineering**, Dept. of ECE, UIUC. Given to a student or students with exceptional promise for an academic career; particularly demonstrating interest in and capability for the instructional program, 2010-11.

- **Vodafone-U.S. Foundation Graduate Fellowship**, College of Engineering, UIUC, towards research and education in wireless communication, 2007-08.

- **Young Engineering Fellowship**, Indian Institute of Science (IISc), Bangalore, 2004. Was invited to work on a research project on image processing at IISc.

- **Merit Certificate**, IIT Madras, 2001 (for securing a rank of 115 out of over 100,000 candidates in IIT-JEE 2001, the entrance examination for admission to Bachelor's degree courses at the Indian Institutes of Technology (IITs)).

- **1$^{\text{st}}$ rank** with record marks in the entrance examination for admission to engineering colleges in the state of Kerala, India, 2001, out of a total of over 34,500 candidates.

PROFESSIONAL ACTIVITIES

- **Technical Program Committee member** for the 6th International Conference on COMmunications and NETworkS (COMSNETS), Bangalore, 2014.

- **Special Session Co-Organizer** for special session on "Signal Processing Education in the Internet Age," at the 38th International Conference on Acoustics, Speech, and Signal Processing (ICASSP), Vancouver, 2013.

- **Organizer of a special workshop** on promoting contributions to Wikipedia articles on signal processing at ICASSP 2013. Currently building a group of volunteers on Wikipedia for improving articles on signal processing `http://en.wikipedia.org/wiki/Wikipedia:WikiProject_Signal_Processing`.

- **Organizer of a round-table** involving heads of various international Signal Processing societies (IEEE, APSIPA, EURASIP etc.) on improving signal processing articles on Wikipedia at ICASSP 2012, Kyoto.

- **Session Chair** for a session on wireless communications at the Allerton conference on Communications, Control, and Computing, 2011, and for a session on Cognitive Channels at the IEEE International Symposium on Information Theory, 2012.

- Member of the **thesis proposal committee** of doctoral student Zichong Chen at the Audiovisual Communications Laboratory (LCAV), EPFL, Feb. 2012.

- **General Chair** for the Fifth annual CSL student conference, Jan 2010, organized by graduate students of the Coordinated Science Lab, University of Illinois at Urbana-Champaign

    - Formed an organizing committee and chaired over the meetings and coordinated the activities of the committee
    - Invited and hosted distinguished keynote speakers

- Reviewed several papers for journals including IEEE Transactions on Information Theory, IEEE Transactions on Wireless Communications, IEEE Transactions on Signal Processing, IEEE Transactions on Communications, IEEE Transactions on Vehicular Technology, ACM Transactions on Sensor Networks, Journal of Zhejiang University, IEEE Signal Processing Letters and IEEE Communications Letters, and conferences including IEEE International Symposium on Information Theory, Allerton Conference, IEEE International Conference on Acoustics, Speech, and Signal Processing, and IEEE International Conference on Communications

- Member of IEEE, IEEE Signal Processing Society, and the Education Committee of the IEEE Signal Processing Society.

INVITED TALKS/POSTERS (excluding invited conference paper presentations)

- "Mobile Sensing - Challenges and Opportunities,"
  Qualcomm Inc., San Diego, 14 Feb. 2014.
  Workshop on Information Theory and its Applications (ITA), San Diego, 12 Feb. 2014 (*poster*).
  EECS department, University of Michigan, USA, 9 Oct., 2013.
  EECS department, Northwestern University, USA, 8 Oct., 2013.
  Coordinated Science Lab, University of Illinois at Urbana-Champaign, USA, 7 Oct., 2013.

- "Sampling High-Dimensional Bandlimited Fields on Low-Dimensional Manifolds,"
  Numerical Harmonic Analysis Group, Faculty of Mathematics, University of Vienna, 17 April 2013.

- "A Sampling Theory for Mobile Sensing,"
  Biomedical Imaging Group, EPFL, 29 Oct. 2012.

- "Signal Processing and Decision-Making for Sensing Systems,"
  Dept. of EE, The Chinese University of Hong Kong, Hong Kong, 23 July 2012.
  Dept. of ECE, Indian Institute of Science, Bangalore, India, 16 Jan. 2012.

- "Universal and Composite Hypothesis Testing via Mismatched Divergence,"
  Information Processing Group, EPFL, 2 March 2011.

- "Decision-Making under Statistical Uncertainty,"
  Hamilton Institute, National University of Ireland, Maynooth, Ireland, 1 Sept. 2010.
  Dept. of ECE, Indian Institute of Science, Bangalore, India, 18 Aug. 2010.
  Audiovisual communications laboratory, EPFL, 25 May 2010.

- "Minimax Robust Quickest Change Detection,"
  Workshop on Information Theory and its Applications (ITA), San Diego, 3 Feb. 2010.

PUBLICATIONS

Electronic copies of published papers are available at `http://lcav.epfl.ch/people/jayakrishnan.unnikrishnan`.
The most significant papers are highlighted with an asterisk (*).

Journal publications

Published

[J1] (*) J. Unnikrishnan and V. V. Veeravalli, "Cooperative Sensing for Primary Detection in Cognitive Radio" in IEEE Journal of Selected Topics in Signal Processing (JSTSP), Special Issue on Signal Processing and Networking for Dynamic Spectrum Access, vol. 2, no.1, pp. 18-27, Feb. 2008. (*Over 350 citations on Google Scholar as of Feb., 2014.*)

[J2] (*) J. Unnikrishnan and V. V. Veeravalli, "Algorithms for Dynamic Spectrum Access with Learning for Cognitive Radio" in IEEE Transactions on Signal Processing, vol. 58, no.2, pp. 750-760, Feb. 2010.

[J3] (*) J. Unnikrishnan, D. Huang, S. Meyn, A. Surana, and V. V. Veeravalli, "Universal and Composite Hypothesis Testing via Mismatched Divergence" in IEEE Transactions on Information Theory, vol. 57, no. 3, pp. 1587-1603, March 2011.

[J4] (*) J. Unnikrishnan, V. V. Veeravalli, and S. Meyn, "Minimax Robust Quickest Change Detection" in IEEE Transactions on Information Theory, vol. 57, no. 3, pp. 1604-1614, March 2011.

[J5] (*) J. Unnikrishnan and M. Vetterli, "Sampling High-Dimensional Bandlimited Fields on Low-Dimensional Manifolds" IEEE Transactions on Information Theory, vol. 59, no. 4, pp. 2103–2127, 2013.

[J6] (*) J. Unnikrishnan and M. Vetterli, "Sampling and Reconstruction of Spatial Fields using Mobile Sensors" IEEE Transactions on Signal Processing, vol. 61, no. 9, pp. 2328–2340, 2013.

Submitted

[J7] (*) J. Unnikrishnan and D. Huang, "Weak Convergence Analysis of Asymptotically Optimal Hypothesis Tests" submitted to IEEE Transactions on Information Theory, Oct. 2013.

[J8] (*) K. Gröchenig, J. L. Romero, J. Unnikrishnan, and M. Vetterli, "On Minimal Trajectories for Mobile Sampling of Bandlimited Fields" submitted to Applied and Computational Harmonic Analysis, Dec. 2013.

[J9] (*) J. Unnikrishnan, "Asymptotically Optimal Matching of Observation Sequences to Source Distributions and Training Sequences" submitted to IEEE Transactions on Information Theory, Jan. 2014.

Conference publications

[C1] J. Unnikrishnan and V. V. Veeravalli, "Decentralized Detection with Correlated Observations" in Proc. of Asilomar Conference on Signals, Systems and Computers, Pacific Grove, CA, Nov. 2007 **(invited)**.

[C2] J. Unnikrishnan and V. V. Veeravalli, "Cooperative Spectrum Sensing and Detection for Cognitive Radio" in Proc. of IEEE-GLOBECOM 2007, Washington D. C., Nov 2007.

[C3] J. Unnikrishnan and V. V. Veeravalli, "Dynamic Spectrum Access with Learning for Cognitive Radio" in Proc. of Asilomar Conference on Signals, Systems and Computers, Pacific Grove, CA, Oct. 2008 **(invited)**.

[C4] J. Unnikrishnan and V. V. Veeravalli, "Dynamic Spectrum Access Policies for Cognitive Radio" in Proc. of 47th IEEE Conference on Decision and Control, Cancun, Mexico, Dec. 2008 **(invited)**.

[C5] D. Huang, J. Unnikrishnan, S. Meyn, V. V. Veeravalli, and A. Surana "Statistical SVMs for robust detection, supervised learning, and universal classification" in Proc. of IEEE Information Theory Workshop, Volos, Greece, June 2009.

[C6] J. Unnikrishnan, V. V. Veeravalli, and S. Meyn, "Least Favorable Distributions for Robust Quickest Change Detection" in Proc. of IEEE International Symposium on Information Theory (ISIT), Seoul, Korea, June 2009.

[C7] W. Chen, D. Huang, A. Kulkarni, J. Unnikrishnan, Q. Zhu, P. Mehta, S. Meyn, and A. Wierman, "Approximate Dynamic Programming using Fluid and Diffusion Approximations with Applications to Power Management" in Proc. of 48th IEEE Conference on Decision and Control, Shanghai, China, Dec. 2009.

[C8] J. Unnikrishnan, S. Meyn, and V. Veeravalli, "On Thresholds for Robust Goodness-of-Fit Tests" in Proc. of IEEE Information Theory Workshop, Dublin, Aug. 2010.

[C9] J. Unnikrishnan, "Model-fitting in the presence of outliers" in Proc. of IEEE International Symposium on Information Theory, St. Petersburg, Jul- Aug. 2011.

[C10] J. Unnikrishnan and M. Vetterli, "Sampling Trajectories for Mobile Sensing" in Proc. of Forty-Ninth Annual Allerton Conference on Communication, Control, and Computing, Monticello, Illinois, USA, Sep. 28-30, 2011 **(invited)**.

[C11] J. Unnikrishnan and M. Vetterli, "Sampling and reconstructing spatial fields using mobile sensors" in Proc. of International Conference on Acoustics, Speech, and Signal Processing (ICASSP), Kyoto, Japan, 2012.

[C12] J. Unnikrishnan, "On Optimal Two Sample Homogeneity Tests for Finite Alphabets" in Proc. of IEEE International Symposium on Information Theory (ISIT), Boston, July 2012.

[C13] J. Unnikrishnan and M. Vetterli, "On Sampling a High-Dimensional Bandlimited Field on a Union of Shifted Lattices" in Proc. of IEEE International Symposium on Information Theory (ISIT), Boston, July 2012.

[C14] T. C. Lee and J. Unnikrishnan, "Monitoring Network Structure and Content Quality of Signal Processing Articles on Wikipedia" in Proc. of 38th International Conference on Acoustics, Speech, and Signal Processing (ICASSP), Vancouver, Canada, 2013 **(invited)**.

[C15] J. Unnikrishnan and M. Vetterli, "On Optimal Sampling Trajectories for Mobile Sensing" in Proc. of 10th Intl. Conf. on Sampling Theory and Applications (SampTA), Bremen, Germany, July, 2013.

[C16] (*) J. Unnikrishnan and F. Movahedi Naini, "De-anonymizing Private Data by Matching Statistics," in Proc. of 51st Annual Allerton Conference on Communication, Control and Computing, Monticello, Illinois, 2013 **(invited)**.

Accepted

[C17] F. Movahedi Naini, J. Unnikrishnan, P. Thiran, and M. Vetterli, "Privacy-Enhanced Function Computation by Exploitation of Friendships in Social Networks," to be presented at ICASSP, 2014.

[C18] M. A. Prelee and J. Unnikrishnan, "Sampling 2-D Signals on a Union of Lattices that Intersect on a Lattice," to be presented at ICASSP, 2014.

Other publications, including theses

Published

[O1] J. Unnikrishnan and S. Shellhammer, "Simulation of Eigenvalue based sensing of wireless mics" presentation for plenary meeting of the IEEE 802.22 WG on WRANs, July 2007.

[O2] J. Unnikrishnan, "Cooperative Sensing of Primary Signals in Cognitive Radio Systems," M.S. thesis, University of Illinois at Urbana-Champaign, 2007.

[O3] J. Unnikrishnan, "Decision-Making under Statistical Uncertainty," Ph.D. dissertation, University of Illinois at Urbana-Champaign, August 2010.

Articles in progress

[O4] W. Chen, D. Huang, A. Kulkarni, J. Unnikrishnan, Q. Zhu, P. Mehta, S. Meyn, and A. Wierman, "Approximate Dynamic Programming using Fluid and Diffusion Approximations with Applications to Power Management," in preparation for submission to Automatica, 2014. [Online]. Available: `http://arxiv.org/abs/1307.1759`

[O5] A. Shivanandan, J. Unnikrishnan, and A. Radenovic, "Accounting for limited detection efficiency and localization precision in cluster analysis in single molecule localization microscopy," in preparation, 2014. Available: `http://lcav.epfl.ch/files/content/sites/lcav/files/people/jayakrishnan.unnikrishnan/PALMdraft.pdf`

The publications highlighted with an asterisk (*) are my most significant publications.

Papers [J1,J2] contain my work on spectrum sensing and dynamic spectrum access strategies for cognitive radio, both of which are well cited.

Papers [J3,J4,J7] deal with my work in the intersection of information theory and statistics. They illustrate disadvantages of asymptotically optimal hypothesis tests proposed in recent information theory literature and provide solutions to make them practically useful for statisticians.

Papers [J5,J6,J8] are papers on the topic of mobile sensing. In [J5] we introduce the problem of designing efficient sensor trajectories for sampling bandlimited spatial fields with mobile sensors, and present partial solutions to this problem. In [J8] we identify the optimal design of parallel line trajectories for mobile sensing, and in [J6] we analyze the possibility of implementing spatial filtering using moving sensors.

Papers [C16] and [J9] deal with my work on optimal strategies for de-anonymizing anonymized statistics. They provide optimal methods for evaluating privacy losses incurred by revealing statistics.

CITATION STATISTICS

Total citations: 637
h-index: 8 (from Google Scholar, as of 17 February, 2014.)

REFERENCES

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