Sajani Pallegoda Vithana

sajani@seas.harvard.edu | in/sajanivithana | Sajani Vithana

EMPLOYMENT

Harvard University Sep 2023 - present
Postdoctoral Fellow
Advised by: Prof. Flavio Calmon

University of Maryland, College Park Aug 2018 - Aug 2023
Graduate Research/Teaching Assistant

Sri Lanka Technological Campus Nov 2017 - July 2018
Research Assistant

EDUCATION

University of Maryland, College Park Aug 2018 - Aug 2023
PhD - Electrical Engineering **ECE Distinguished Dissertation Award**
Thesis Advisor: Prof. Sennur Ulukus
Thesis Title: Private Information Read-Update-Write with Applications to Distributed Learning

University of Maryland, College Park Aug 2018 - Dec 2022
MS - Electrical Engineering

University of Peradeniya, Sri Lanka Jan 2014 - Oct 2017
BS - Electrical and Electronics Engineering **GPA: 4.00, rank: 1**

RESEARCH INTERESTS

My research addresses foundational challenges in building trustworthy and reliable machine learning systems. I develop information-theoretic frameworks to analyze fundamental performance limits in AI system components, with a particular focus on privacy, fairness, and reliability. Leveraging tools from coding theory, optimization, probability, and statistics, I design robust algorithmic solutions to these challenges. As AI technology evolves, I am dedicated to identifying and addressing emerging societal concerns through rigorous analysis and innovative solutions to ensure that AI systems remain both reliable and trustworthy.

AWARDS, HONORS, FELLOWSHIPS

Best Paper Award, IEEE International Conference on Communications (IEEE ICC)	2023
Clark School Dean's Research Award - Third Place, UMD	2023
ECE Distinguished Dissertation Fellowship Award, UMD	2023
George Harhalakis Outstanding Systems Engineering Graduate Student Award, UMD	2023
Outstanding Graduate Assistant Award, UMD	2022
Information-Theoretic Duets Contest - First Place, IEEE ISIT	2022
NSF - sponsored travel grant, IEEE ICC	2022

ECE Outstanding Teaching Assistant Award, UMD	2019
ECE Teaching and Training Development (TATD) Fellow, UMD	2019
ECE Summer Research Scholarship, UMD	2019
ECE Dean's Fellowship, UMD	2018
Best Paper Award - IEEE ICTer	2017
Ceylon Electricity Board Gold Medal for *Best Performance in Electrical and Electronic Engineering*, UoP	2017
W.M.G. Fernando Prize for Electronic Communications, UoP	2017
E.F. Bartholomeusz Prize for *Best Performance in Engineering Mathematics*, UoP	2014,2015,2017

PUBLICATIONS **(In reverse chronological order)**

Journal Papers:

(J9) **S. Vithana** and S. Ulukus. "*Information-Theoretically Private Federated Submodel Learning with Storage Constrained Databases*", in **IEEE Transactions on Information Theory**, 70(8):6041–6059, August 2024.

(J8) **S. Vithana** and S. Ulukus. "*Private Read-Update-Write with Controllable Information Leakage for Storage-Efficient Federated Learning with Top r Sparsification*", **IEEE Transactions on Information Theory**, 70(5):3669-3692, May 2024.

(J7) **S. Vithana** and S. Ulukus. "*Deceptive Information Retrieval*", in **Entropy**, 26(3):244, March 2024.

(J6) **S. Vithana** and S. Ulukus. "*Private Read Update Write (PRUW) in Federated Submodel Learning (FSL): Communication Efficient Schemes With and Without Sparsification*", **IEEE Transactions on Information Theory**, 70(2):1320-1348, February 2024.

(J5) **S. Vithana**, Z. Wang and S. Ulukus. "*Private Information Retrieval and Its Applications: An Introduction, Open Problems, Future Directions*", in **IEEE BITS Magazine**, 2023.

(J4) **S. Vithana**, K. Banawan, and S. Ulukus. "*Semantic Private Information Retrieval*", in **IEEE Transactions on Information Theory**, 68(4):2635–2652, April 2022.

(J3) M. Ekanayake, **S. Vithana**, H. Ekanayake, A. Rathnayake, R. Abeysekara, S. Oorloff, V. Herath, R. Godaliyadda, P. Ekanayake and A Senaratne, "*Mapping Ilmenite Deposit in Pulmudai, Sri Lanka Using a Hyperspectral Imaging-Based Surface Mineral Mapping Method*", In **Journal of the National Science Foundation of Sri Lanka**, 47(3):271 - 284, September 2019.

(J2) **S. Vithana**, M. Ekanayake, H. Ekanayake, A. Rathnayake, G. Jayatilaka, V. Herath, R. Godaliyadda and P. Ekanayake, "*Adaptive Hierarchical Clustering for Hyperspectral Image Classification: Umbrella Clustering*", In **Journal of Spectral Imaging**, 8(a11), July 2019.

(J1) **S. Vithana**, R. Abeysekara, S. Oorloff, A. Rupasinghe, V. Herath, R. Godaliyadda, P. Ekanayake, "*Comparison of Two Algorithms for Land Cover Mapping Based on Hyperspectral Imagery*", **International Journal on Advances in ICT for Emerging Regions**, 11(1), July 2018.

Conference Papers:

(C18) A. Oesterling, C. Verdun, C. Long, A. Glynn, L. Paes, **S. Vithana**, M. Cardone, F. P. Calmon "*Multi-Group Proportional Representation*", The Thirty-Eighth Annual Conference on Neural Information Processing Systems (**NeurIPS**), December 2024 (accepted).

(C17) S. Jung, A. Oesterling, C. M. Verdun, **S. Vithana**, T. Moon, and F. P. Calmon. "*Measuring Representational Harms in Image Generation with a Multi-Group Proportional Metric*", In **NeurIPS Workshop** on Algorithmic Fairness Through the Lens of Metrics and Evaluation, 2024 (accepted).

(C16) **S. Vithana**, M. Cardone and F.P. Calmon. "*Private Approximate Nearest Neighbor Search for Vector Database Querying*", in IEEE International Symposium on Information theory (**ISIT**), July 2024.

(C15) M. Nomeir, **S. Vithana**, S. Ulukus, "*Asymmetric X-Secure T-Private Information Retrieval: More Databases is not Always Better*", In 58th Annual Conference on Information Sciences and Systems (**CISS**), March 2024.

(C14) A. Aytekin, M. Nomeir, **S. Vithana**, S. Ulukus, "*Quantum Symmetric Private Information Retrieval with Secure Storage and Eavesdroppers*", In IEEE **GLOBECOM Workshops**, December 2023.

(C13) M. Nomeir, **S. Vithana**, S. Ulukus, "*Private Membership Aggregation*", In IEEE Military Communications Conference (**MILCOM**), October 2023.

(C12) **S. Vithana** and S. Ulukus. "*Private Read Update Write (PRUW) with Heterogeneous Databases*", in IEEE International Symposium on Information theory (**ISIT**), June 2023.

(C11) **S. Vithana** and S. Ulukus. "*Rate-Privacy-Storage Trade off in Federated Learning with Top r Sparsification*", in IEEE International Conference on Communications (**ICC**), May 2023. **(Best Paper Award)**

(C10) **S. Vithana** and S. Ulukus. "*Model Segmentation for Storage Efficient Private Federated Learning with Top r Sparsification*", in Conference on Information Sciences and Systems (**CISS**), March 2023.

(C9) **S. Vithana** and S. Ulukus. "*Private Federated Submodel Learning with Sparsification*", in IEEE Information Theory Workshop (**ITW**), November 2022.

(C8) **S. Vithana** and S. Ulukus. "*Rate Distortion Trade off in Private Read Update Write in Federated Submodel Learning*", in **Asilomar** Conference on Signals, Systems and Computers, October 2022.

(C7) **S. Vithana** and S. Ulukus. "*Private Read Update Write (PRUW) with Storage Constrained Databases*", in IEEE International Symposium on Information theory (**ISIT**), June 2022.

(C6) **S. Vithana** and S. Ulukus. "*Efficient Private Federated Submodel Learning*", in IEEE International Conference on Communications (**ICC**), May 2022.

(C5) **S. Vithana**, K. Banawan, and S. Ulukus. "*Semantic Private Information Retrieval from MDS Coded Databases*", in IEEE International Symposium on Information theory (**ISIT**), July 2021.

(C4) **S. Vithana**, K. Banawan, and S. Ulukus. "*Semantic Private Information Retrieval: Effects of Heterogeneous Message Sizes and Popularities*", in IEEE Global Communications Conference (**GLOBECOM**), December 2020.

(C3) M. Ekanayake, H. Ekanayake, A. Rathnayake, **S. Vithana**, V. Herath, R. Godaliyadda, MPB Ekanayake, "*A Semi-Supervised Algorithm to Map Major Vegetation Zones Using Satellite Hyperspectral Data*", In 9th Workshop on Hyperspectral Image and Signal Processing: Evolution in Remote Sensing (**WHISPERS**), September 2018.

(C2) S. Oorloff, R. Abeysekara, **S. Vithana**, A. Rupasinghe, V. Herath, R. Godaliyadda, P. Ekanayake, "*Spectral-Spatial Hybrid Mechanism for Feature Detection Using Spectral Correlation*", In IEEE International Conference on Industrial and Information Systems (**ICIIS**), December 2017.

(C1) **S. Vithana**, R. Abeysekara, S. Oorloff, A. Rupasinghe, V. Herath, R. Godaliyadda, P. Ekanayake. "*Hyperspectral Imaging Based Land Cover Mapping Using Data Obtained by the Hyperion Sensor*", in Seventeenth International Conference on Advances in ICT for Emerging Regions (**IEEE ICTer**), September 2017. **(Best Paper Award)**

Papers Under Review:

(R3) S. Jung, A. Oesterling, C. M. Verdun, **S. Vithana**, T. Moon, and F. P. Calmon. "*Multi-Group Proportional Representation for Text-to-Image Models*". Under review at the Conference on Computer

Vision and Pattern Recognition (CVPR), 2025.

(R2) **S. Vithana**, V. R. Cadambe, F. P. Calmon, H, Jeong. "*Correlated Privacy Mechanisms for Differentially Private Distributed Mean Estimation*". Under review at the IEEE Conference on Secure and Trustworthy Machine Learning (SaTML), 2025.

(R1) A. Alptug, M. Nomeir, **S. Vithana**, S. Ulukus. "*Quantum X-Secure E-Eavesdropped T-Colluding Symmetric Private Information Retrieval*". Under review at IEEE Transactions on Information Theory.

SELECTED PRESENTATIONS

SIAM Conference on Mathematics of Data Science	Oct 2024
Ludwig Maximilian University of Munich (**Invited Talk**)	Sep 2024
Theory and Practice of Differential Privacy (TPDP)	Aug 2024
Conference on Information Sciences and Systems (CISS) (**Invited Talk**)	March 2023
IEEE Information Theory Workshop (ITW) (**Invited Talk**)	Nov 2022
Asilomar Conference on Signals, Systems and Computers	Oct 2022
IEEE International Symposium on Information Theory (ISIT)	June 2022
IEEE International Conference on Communications (ICC)	May 2022
IEEE International Symposium on Information theory (ISIT)	June 2021

RESEARCH EXPERIENCE

Post-doctoral Fellow - Harvard Sep 2023 - present

- Developed algorithms and performed analysis on differentially private distributed mean estimation for private federated learning, using correlated privacy mechanisms among users for improved privacy-accuracy trade-offs and increased resilience against dropouts and colluding users.
- Provided an information-theoretic formulation to the problem of *private approximate nearest neighbor search* for vector database querying, and designed algorithms that ensure perfect privacy.
- Developed metrics and performed analysis on multi-group proportional representation in database retrieval and Generative AI.
- Reported the representational gaps in existing text-to-image generation models and developed an algorithm to mitigate the representational biases in them.
- Contributed to the preparation of a grant proposal on *Information-Theoretic Foundations of Vector Databases*.

Graduate Research Assistant - UMD Aug 2018 - Aug 2018

- Obtained capacity results with achievable schemes and converse proofs for different variants of semantic private information retrieval using concepts from information theory and coding theory.
- Developed coding schemes to perform private read-write operations in efficient variants of private federated learning.
- Characterized the rate-distortion and rate-privacy-storage trade offs in private read-write operations along with achievable schemes.
- Developed algorithms for practical variants of private federated learning (in relation to private read-write operations), addressing challenges such as storage constraints and enhancing utility with con-

trollable information leakage.

- Contributed to the preparation of two grant proposals on *Private Distributed Learning*.

Research Assistant - SLTC Nov 2017 - July 2018
Undergraduate Researcher - UoP Nov 2016 - Oct 2017

- Conducted high dimensional data analysis on hyperspectral image data using concepts from signal processing and statistics.
- Developed a self-organizing hierarchical clustering algorithm for hyper-spectral image classification and applied it for surface mineral detection applications.

TEACHING EXPERIENCE

ES 250 Information Theory: *Graduate Level* - Harvard Fall 2024
Teaching Fellow

ES 156 Signals and Communications: *Undergraduate Level* - Harvard Spring 2024
Substitute Lecturer: Conducted one lecture on digital communications.

ENEE 322 Signals and Systems: *Undergraduate Level* - UMD Fall 2020
Teaching Assistant

ENEE 439M Introduction to Machine Learning: *Undergraduate Level* - UMD Spring 2020
Teaching Assistant/Substitute Lecturer: Conducted two lectures on deep neural networks.

ENEE 630 Advanced Digital Signal Processing: *Graduate Level* - UMD Fall 2019
Teaching Assistant

ENEE 324 Engineering Probability: *Undergraduate Level* - UMD Spring 2019
Teaching Assistant

ENEE 425 Digital Signal Processing: *Undergraduate Level* - UMD Fall 2018
Teaching Assistant

MENTORING EXPERIENCE

Mentored two **undergraduate summer interns** - Harvard 2024
Heemy Kalam - Interpretability of LLMs
Indra Islas Luz - Fairness in Text-to-Image Generation

Mentored two **first year PhD students** - UMD 2023
Mohamed Nomeir - Private Information Retrieval (published (C14), (C15))
Alptug Aytekin - Quantum Private Information Retrieval (Published (C14))

Mentored three **undergraduate students' senior theses** - UoP 2017-2019
Mevan Ekanayake
Hasantha Ekanayake
Anusha Rathnayake
All three students worked on hyperspectral image processing, and published (J3),(C3).

SERVICE AND PROFESSIONAL ACTIVITIES

Program Committee Member
ACM FAccT 2024

Paper Reviewer 2020-2024
ACM FAccT, NeurIPS, ICLR, IEEE ISIT, IEEE ITW, IEEE ICC
IEEE Transactions on Information Theory
IEEE Transactions on Signal Processing
IEEE JSAC SI - Private Information Retrieval
IEEE JSAC SI - Semantic Communications
IEEE JSAC SI - Information-Theoretic Methods for Trustworthy and Reliable ML

Outreach
Teaching and Training Development (TATD) Fellow - UMD 2019
Mentored teaching assistants in the ECE department and conducted a workshop on "*How to ensure students get the maximum benefit out of a discussion session?*"

Curriculum Developer - "*Nenathambara*" project 2021
Developed online courses focused on enhancing mathematics, programming, and ML knowledge of students in rural areas of Sri Lanka

INTERNSHIP EXPERIENCE

Communications Engineering Intern

ZTE, Sri Lanka Oct 2016 - Jan 2017
Mobitel, Sri Lanka Oct 2015 - Jan 2016

ADDITIONAL ACTIVITIES

Internationally rated chess player 2013-present
Advanced Diploma in Management Accounting - CIMA, UK 2012-2013