SANMUKH RAO KUPPANNAGARI

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PROFESSIONAL PREPARATION

University of Southern California *Fall 2020*
Post-Doctoral Training in Computer Engineering
Ming Hsieh Department of Electrical and Computer Engineering

University of Southern California *Summer 2018*
PhD in Computer Engineering
Ming Hsieh Department of Electrical and Computer Engineering
Thesis Title: Discrete Optimization for Supply Demand Matching in Smart Grids
Thesis Advisor: Dr Viktor Prasanna, Professor - Electrical and Computer Engineering

Indian Institute of Technology, Guwahati *May 2011*
Bachelor of Technology, Computer Science and Engineering

RESEARCH FOCUS

The overarching goal of my research to develop a 4P - Performance, Portable, Productive, and Power-efficient framework that optimizes deployment of Deep Learning models across multiple dimensions - execution time, energy, and power on emerging heterogeneous AI accelerators to enable scientific and engineering domain experts seamlessly incorporate AI into their applications.

APPOINTMENTS

• James C. Wyant Assistant Professor in Computer and Data Sciences, Case Western Reserve University, Fall '22 - present

• Senior Research Associate, University of Southern California, Los Angeles, Fall '20 - Summer '22.

• Post Doctoral Scholar - Research Associate, University of Southern California, Los Angeles, Fall '18 - Fall '20.

• Intern, US Army Research Laboratory, Playa Vista, CA, Summer '17.

• Intern, MathWorks Inc., Natick, MA, Summer '14.

• Member Technical Staff, Adobe Systems Inc., India, Summer '11 - Summer '13.

ACTIVE FUNDED PROPOSALS

• U.S. National Science Foundation, " Collaborative Research: SCIPE: Interdisciplinary Research Support Community for Artificial Intelligence and Data Sciences". PI (CWRU): Vipin Chaudhary, **Co-PIs: Sanmukh R. Kuppannagari**, Satish Viswanath, David Wilson, Roger French.

• U.S. National Science Foundation, "SaTC: CORE: Small: Accelerating Privacy Preserving Deep Learning for Real-time Secure Applications". PI: Viktor K. Prasanna, **Co-PI: Sanmukh R. Kuppannagari**

• U.S. National Science Foundation, "CNS Core: Small: AccelRITE: Accelerating ReInforcemenT Learning based AI at the Edge Using FPGAs". PI: Viktor K. Prasanna, **Co-PI: Sanmukh R. Kuppannagari**

CURRENT RESEARCH PROJECTS

• *Performance Portable Productive Convolutional Neural Network Deployment:* Develop a python based framework to allow seamless deployment of CNN models on a variety of heterogeneous platforms while obtaining high performance.

• *Energy Aware Deep Learning:* Develop a framework to perform multi-dimensional optimization of Deep Neural Network deployment targeting energy, maximum power, and execution time as objectives.

• *Privacy Preserving Large Language Models:* Develop high performant Homomorphic Encryption based Transformer models to enable privacy preserving Large Language Models (LLM).

• *Automated TEM Diffraction Pattern Classification:* Develop an end to end automated pipeline for the manually intensive task of TEM diffraction pattern classification using Deep Learning Models.

TEACHING EXPERIENCE

- CSDS 340 - Introduction to Machine Learning. CWRU. Spring 2024.
- CSDS 451 - Designing High Performant Systems for AI. CWRU. Fall 2023.
- CSDS 391 - Introduction to Artificial Intelligence. CWRU. Spring 2023.
- CSDS 600 - Special Topics: Designing High Performant Systems for AI. CWRU. Fall 2022.

SYNERGISTIC ACTIVITIES

University Service

- Academic Integrity Board, AY 2023-24.
- CDS Colloquium Series Committee Chair, AY 2023-24.
- CDS Excellence Awards Committee, AY 2023-24.
- Graduate Students Affairs Committee, AY 2022-23.
- CDS Colloquium Series Committee, AY 2022-23.

Organization

- General Co-Chair; IEEE/ACM International Conference on High Performance Computing, Data and Analytics (HiPC) 2023-24.
- Technical Committee Member, PhD Forum Co-Chair; IEEE International Parallel and Distributed Processing Symposium, 2023-24.
- Technical Committee Member; IEEE International Conference on Computer Aided Design (ICCAD), 2022-23.
- Technical Committee Member; IEEE High Performance Extreme Computing Virtual Conference (HPEC), 2021-23.
- Vice General Co-Chair; IEEE/ACM International Conference on High Performance Computing, Data and Analytics (HiPC) 2022-23.
- Program Committee Member; IEEE/ACM International Conference on High Performance Computing, Data and Analytics (HiPC) 2020-22.
- Production Chair; Publicity Chair; Web chair; IEEE/ACM International Conference on High Performance Computing, Data and Analytics (HiPC) 2020-21.

- Program Committee Member; 23rd IEEE International Symposium On Real-Time Distributed Computing - poster/demo track.
- Program Committee Chair; First Workshop on DataScience for Future Energy Systems, HiPC 2019.
- Program Committee Member; The 9th International Workshop on Computing and Networking for IoT and Beyond, ICDCN Workshop 2020.
- Program Committee Member; 1st International Workshop on Societal Computing for the Internet of Things & You (SoCIeTY), ICDCN Workshop 2020.
- Publicity Chair; Web chair; 26th IEEE/ACM International Conference on High Performance Computing, (HiPC) 2019.
- Web chair; 25th IEEE/ACM International Conference on High Performance Computing,(HiPC) 2018.

Judging and Panels

- Judge: HackCWRU Hackathon, 2024.
- Reviewer: NSF Panel, GRFP, 2024.
- Reviewer: NSF Panel, CSSI, 2024.
- Reviewer: NSF Panel, TTP, 2023.
- Reviewer: Herbold Fellowship - CWRU, 2023.
- Judge: EE Research Festival, University of Southern California, 2018, 2019.

Journal Reviews

- IEEE Transactions on Circuits and Systems; 2023.
- IEEE Transactions on Sustainable Computing (TSUC), 2018, 2019, 2022, 2023.
- IEEE Transactions on Smart Grid, 2022.
- IEEE Transactions on Computers, 2022.
- IEEE Transactions on Knowledge and Data Engineering, 2022.
- ACM Computing Surveys, 2022.
- Journal of Experimental Algorithms, 2021.
- IEEE Transactions on Cloud Computing, 2020, 2021.
- Journal of Parallel and Distributed Computing, 2020.
- Sustainable Energy, Grids and Network, 2019 - 2021.
- Journal of Computers and Electrical Engineering, Elsevier, 2020-21.
- IEEE Transactions on Dependable and Secure Computing, 2020.
- IEEE Access, 2018, 2020.
- Sensors, MDPI, 2020.
- Algorithms, MDPI, 2020.
- IEEE BigData, 2019.
- Methods of Information in Medicine, 2019.

STUDENT ADVISING

PhD

- Nathaniel Tomczak - Automated TEM Diffraction using Machine Learning; Energy Aware Transformer Models. Spring 2023 - present.
- William Huang - Energy Aware Transformer Models. Fall 2023 - present.
- Changxin Li - Performance Portable CNN Deployment. Spring 2024 - present.

Masters

- Alex Vaslow - Image Processing applications in security. M.S. Project. Spring 2023 - present.
- Hieu Tran - Privacy Preserving Transformer Models. M.S. Thesis. Spring 2024 - present.
- Yash Malhotra - Assignment framework for CSDS 451. Course Producer. Spring 2024 - present.

Undergraduate

- Abhinav Khanna - LLM based convolution SYCL code generation. Spring 2023 - present.
- Mariam Hasan - Spatio Temporal GNN acceleration. Spring 2023 - present.
- Omar Loudghiri - Privacy Preserving Transformer Models. Spring 2022 - present.
- Timothy Cronin - Performance Portable Python Framework for DNN deployment. Spring 2024 - present.
- Wiam Skakri - Collaborative Filtering based DNN Performance Prediction. Spring 2024 - present.
- Rithvik Kasarla - LLM applications for Healthcare. Spring 2024 - present.

AWARDS AND HONORS

- Gutti Memorial Teaching Award, Tau Beta Pi (CWRU), AY 2023-24.
- Teaching Excellence Award, Computer and Data Sciences, AY 2022-23.
- Mentor Fellowship, Fall 2023.
- UCITE Learning Fellowship, Fall 2022.
- James C. Wyant Endowed Professorship, Fall 2022-2025.
- Outstanding Student Paper Award - "Efficient Neighbor-Sampling-based GNN Training on CPU-FPGA Heterogeneous Platform," IEEE HPEC, 2021.
- Outstanding Student Paper Award - "How to Efficiently Train Your AI Agent? Characterizing and Evaluating Deep Reinforcement Learning on Heterogeneous Platforms," IEEE HPEC, 2020.
- USC Ming Hsieh Institute (MHI) Ph.D. Scholar Finalist, Fall 2017.
- USC Ming Hsieh Department of Electrical Engineering Charles L. Weber Outstanding Teaching Assistant Honorable Mention, Spring 2017.
- USC Ming Hsieh Department of Electrical Engineering, Best Research Poster - Honorable Mention, 7th Annual EE Research Festival, Fall 2016.

FULL LIST OF PUBLICATIONS

AI/ML Acceleration

[FCCM22] Yang Yang, Sanmukh R Kuppannagari, Rajgopal Kannan, and Viktor K Prasanna. "FPGA Accelerator for Homomorphic Encrypted Sparse Convolutional Neural Network Inference". In: *2022 IEEE 30th Annual International Symposium on Field-Programmable Custom Computing Machines (FCCM)*. IEEE. 2022, pp. 1–9.

[CF22] Yang Yang, Sanmukh R Kuppannagari, Rajgopal Kannan, and Viktor K Prasanna. "NTTGen: a framework for generating low latency NTT implementations on FPGA". In: *Proceedings of the 19th ACM International Conference on Computing Frontiers*. 2022, pp. 30–39.

[ISPDC22] Tian Ye, Sanmukh Rao Kuppannagari, Ceasr AF De Rose, Sasindu Wijeratne, Rajgopal Kannan, and Viktor K Prasanna. "Estimating the Impact of Communication Schemes for Distributed Graph Processing". In: *IEEE International Symposium on Parallel and Distributed Computing (ISPDC)*. 2022.

[HIPC21b] Yuan Meng, Sanmukh R Kuppannagari, Rajgola Kannan, and Viktor K Prasanna. "How to Avoid Zero-Spacing in Fractionally-Strided Convolution? A Hardware-Algorithm Co-Design Methodology". In: *2021 IEEE International Conference on High Performance Computing, Data, and Analytics (HiPC)*. IEEE. 2021.

[FPGA21] Yuan Meng, Sanmukh R Kuppannagari, Rajgopal Kannan, and Viktor K Prasanna. "DYNAMAP: Dynamic Algorithm Mapping Framework for Low Latency CNN Inference". In: *Proceedings of the 2021 ACM/SIGDA International Symposium on Field-Programmable Gate Arrays*. ACM. 2021.

[TPDS21] Yuan Meng, Sanmukh Rao Kuppannagari, Rajgopal Kannan, and Viktor K Prasanna. "PPOAccel: A High-Throughput Acceleration Framework for Proximal Policy Optimization". In: *IEEE Transactions on Parallel and Distributed Systems* (2021). To Appear.

[FPL-DEMO21] Nathaniel Peura, Yuan Meng, Sanmukh R Kuppannagari, Rajgopal Kannan, and Viktor K Prasanna. "FGYM: Toolkit for Benchmarking FPGA based Reinforcement Learning Algorithms". In: *The International Conference on Field-Programmable Logic and Applications (FPL) - Demo Track 2021*. 2021.

[HPEC21] Bingyi Zhang, Sanmukh Kuppannagari, Rajgopal Kannan, and Viktor Prasanna. "Efficient Neighbor-Sampling-based GNN Training on CPU-FPGA Heterogeneous Platform". In: *2021 IEEE High Performance Extreme Computing Conference (HPEC)*. IEEE. 2021.

[HIPC21a] Chi Zhang, Sanmukh R Kuppannagari, and Viktor K Prasanna. "Parallel Actors and Learners: A Framework for Generating Scalable RL Implementations". In: *2021 IEEE International Conference on High Performance Computing, Data, and Analytics (HiPC)*. IEEE. 2021.

[FCCM20] Yuan Meng, Sanmukh R Kuppannagari, and Viktor K Prasanna. "Accelerating Proximal Policy Optimization on CPU-FPGA Heterogeneous Platforms". In: *Proceedings of the 28th IEEE International Symposium on Field-Programmable Custom Computing Machines (FCCM)*. IEEE. 2020.

[RAW20] Yuan Meng, Sanmukh R. Kuppannagari, Rachit Rajat, Ajitesh Srivastava, Rajgopal Kannan, and Viktor K Prasanna. "QTAccel: Generic FPGA Design for Q-Table based Reinforcement Learning Accelerators". In: *Proceedings of the 27th Reconfigurable Architectures Workshop (RAW)*. IEEE. 2020.

[HPEC20b] Yuan Meng, Yang Yang, Sanmukh Kuppannagari, Rajgopal Kannan, and Viktor Prasanna. "How to Efficiently Train Your AI Agent? Characterizing and Evaluating Deep Reinforcement Learning on Heterogeneous Platforms". In: *2020 IEEE High Performance Extreme Computing Conference (HPEC)*. IEEE. 2020, pp. 1–7.

[HPEC20a] Ruizhi Zhang, Sasindu Wijeratne, Yang Yang, Sanmukh R Kuppannagari, and Viktor K Prasanna. "A High Throughput Parallel Hash Table on FPGA using XOR-based Memory". In: *2020 IEEE High Performance Extreme Computing Conference (HPEC)*. IEEE. 2020, pp. 1–7.

[HPEC19] Sanmukh R Kuppannagari, Rachit Rajat, Rajgopal Kannan, Aravind Dasu, and Viktor K Prasanna. "IP Cores for Graph Kernels on FPGAs". In: *2019 IEEE High Performance Extreme Computing Conference (HPEC)*. IEEE. 2019.

[FPGA15] Sanmukh R Kuppannagari and Viktor K Prasanna. "Efficient Generation of Energy and Performance Pareto Front for FPGA Designs". In: *Proceedings of the 2015 ACM/SIGDA International Symposium on Field-Programmable Gate Arrays*. Abstract Only. ACM. 2015, pp. 273–273.

[HPEC14] Sanmukh R Kuppannagari, Ren Chen, Andrea Sanny, Shreyas G Singapura, Geoffrey Phi C Tran, Shijie Zhou, Yusong Hu, Stephen P Crago, and Viktor K Prasanna. "Energy performance of fpgas on perfect suite kernels". In: *2014 IEEE High Performance Extreme Computing Conference (HPEC)*. IEEE. 2014, pp. 1–6.

[IGCC14] Sanmukh R Kuppannagari, Yusong Hu, and Viktor K Prasanna. "High level performance model based design space exploration for energy-efficient designs on fpgas". In: *International Green Computing Conference*. IEEE. 2014, pp. 1–6.

Applied AI/ML

[HPEC23] Nathaniel Tomczak and Sanmukh Kuppannagari. "Automated Indexing Of TEM Diffraction Patterns Using Machine Learning". In: *2023 IEEE High Performance Extreme Computing Conference (HPEC)*. IEEE. 2023, pp. 1–7.

[TSUSC22a] Chung Ming Cheung, Sanmukh Rao Kuppannagari, Ajitesh Srivastava, Rajgopal Kannan, and Viktor K Prasanna. "Behind-the-Meter Solar Generation Disaggregation at Varying Aggregation Levels Using Consumer Mixture Models". In: *IEEE Transactions on Sustainable Computing* (2022).

[TSUSC22b] Chi Zhang, Sanmukh Rao Kuppannagari, and Viktor K Prasanna. "Safe Building HVAC Control via Batch Reinforcement Learning". In: *IEEE Transactions on Sustainable Computing* (2022).

[FTC21] Chung Ming Cheung, Sanmukh Rao Kuppannagari, and Viktor K Prasanna. "Socio-Demographic Characteristics Prediction using Soft Clustering of Load Consumption Data". In: *2021 Future Technologies Conference (FTC)*. 2021.

[eEnergyW21] Sanmukh R Kuppannagari, Yao Fu, Chung Ming Chueng, and Viktor K Prasanna. "Spatio-Temporal Missing Data Imputation for Smart Power Grids". In: *Proceedings of the Twelfth ACM International Conference on Future Energy Systems*. 2021, pp. 458–465.

[SUST20] Chung Ming Cheung, Sanmukh Rao Kuppannagari, Rajgopal Kannan, and Viktor K Prasanna. "Disaggregation of Behind-The-Meter Solar Generation and Energy Storge Resources". In: *2020 IEEE Conference on Technologies for Sustainability (SusTech)*. 2020.

[ISGT20] Chung Ming Cheung, Sanmukh Rao Kuppannagari, Rajgopal Kannan, and Viktor K Prasanna. "Load Demand User Profiling in Smart Grids with Distributed Solar Generation," in: *2020 IEEE Power & Energy Society Innovative Smart Grid Technologies Conference (ISGT)*. IEEE. 2020.

[EENERGYW19] Chung Ming Cheung, Sanmukh Rao Kuppannagari, Rajgopal Kannan, and Viktor K Prasanna. "Towards Improved Real-Time Observability of Behind-Meter PhotoVoltaic Systems: A Data-Driven Approach". In: *Proceedings of the Tenth ACM International Conference on Future Energy Systems*. ACM. 2019, pp. 447–455.

[EENERGY19] Sanmukh Kuppannagari, Rajgopal Kannan, and Viktor K Prasanna. "Approximate Scheduling of DERs with Discrete Complex Injections". In: *Proceedings of the Tenth ACM International Conference on Future Energy Systems*. ACM. 2019, pp. 204–214.

[LOCS19] Ajitesh Srivastava, Sanmukh R Kuppannagari, Rajgopal Kannan, and Viktor K Prasanna. "Minimizing Cost of Smart Grid Operations by Scheduling Mobile Energy Storage Systems". In: *IEEE Letters of the Computer Society* 2.3 (2019), pp. 20–23.

[BuildSys19] Chi Zhang, Sanmukh R Kuppannagari, Rajgopal Kannan, and Viktor K Prasanna. "Building HVAC Scheduling Using Reinforcement Learning via Neural Network Based Model Approximation". In: *Proceedings of the 6th ACM International Conference on Systems for Energy-Efficient Built Environments*. ACM. 2019.

[IoTDI19] Chi Zhang, Sanmukh R Kuppannagari, Chuanxiu Xiong, Rajgopal Kannan, and Viktor K Prasanna. "A cooperative multi-agent deep reinforcement learning framework for real-time residential load scheduling". In: *Proceedings of the International Conference on Internet of Things Design and Implementation*. ACM. 2019, pp. 59–69.

[SUST18b] Stefan Binna, Sanmukh R Kuppannagari, Dominik Engel, and Viktor K Prasanna. "Subset Level Detection of False Data Injection Attacks in Smart Grids". In: *2018 IEEE Conference on Technologies for Sustainability (SusTech)*. IEEE. 2018, pp. 1–7.

[ISGT18] Sanmukh R Kuppannagari, Rajgopal Kannan, and Viktor K Prasanna. "NO-LESS: Near optimal curtailment strategy selection for net load balancing in micro grids". In: *2018 IEEE Power & Energy Society Innovative Smart Grid Technologies Conference (ISGT)*. IEEE. 2018, pp. 1–5.

[TOSN18] Sanmukh R Kuppannagari, Rajgopal Kannan, and Viktor K Prasanna. "Optimal Discrete Net-Load Balancing in Smart Grids with High PV Penetration". In: *ACM Transactions on Sensor Networks (TOSN)* 14.3-4 (2018), p. 24.

[SGCOMM18] Chi Zhang, Sanmukh R Kuppannagari, Rajgopal Kannan, and Viktor K Prasanna. "Generative adversarial network for synthetic time series data generation in smart grids". In: *2018 IEEE International Conference on Communications, Control, and Computing Technologies for Smart Grids (SmartGridComm)*. IEEE. 2018, pp. 1–6.

[BuildSys17] Sanmukh R Kuppannagari, Rajgopal Kannan, and Viktor K Prasanna. "Optimal net-load balancing in smart grids with high PV penetration". In: *Proceedings of the 4th ACM International Conference on Systems for Energy-Efficient Built Environments*. ACM. 2017, p. 27.

[IJCAI16] Sanmukh R Kuppannagari, Rajgopal Kannan, Charalampos Chelmis, and Viktor K Prasanna. "Implementation of Learning-Based Dynamic Demand Response on a Campus Micro-Grid". In: *The 25th International Joint Conference on Artificial Intelligence*. IJCAI-Demo Track. 2016.

[ICCS16] Sanmukh R Kuppannagari, Rajgopal Kannan, Charalampos Chelmis, Arash S Tehrani, and Viktor K Prasanna. "Optimal Customer Targeting for Sustainable Demand Response in Smart Grids". In: *Procedia Computer Science* 80 (2016), pp. 324–334.

[SUST16] Charith Wickramaarachchi, Sanmukh R Kuppannagari, Rajgopal Kannan, and Viktor K Prasanna. "Improved protection scheme for data attack on strategic buses in the smart grid". In: *2016 IEEE Conference on Technologies for Sustainability (SusTech)*. IEEE. 2016, pp. 96–101.

[CSCI15] Sanmukh R Kuppannagari, Rajgopal Kannan, and Viktor K Prasanna. "An ILP based Algorithm for Optimal Customer Selection for Demand Response in SmartGrids". In: *The 2015 International Conference on Computational Science and Computational Intelligence (CSCI)*. 2015.