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
GPA: 3.79/4.00

Indian Institute of Technology, Guwahati *May 2011*
Bachelor of Technology, Computer Science and Engineering
Overall CPI: 8.20/10.00

RESEARCH INTERESTS

• *Accelerating AI on Heterogeneous Platforms:* Develop an Application Specific Processor (ASP) to enable high throughput and low latency FPGA implementations of state-of-the-art Deep Reinforcement Learning algorithms.

• *Accelerating Privacy Preserving Machine Learning on FPGAs:* Develop accelerators for Homomorphic Encryption based Machine Learning algorithms to enable development of low-latency privacy preserving machine learning 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.

FUNDED PROPOSALS

• U.S. National Science Foundation, "Collaborative Research:PPoSS Planning: StreamWare - A Scalable Framework for Accelerating Streaming Data Science". PI (USC): Viktor K. Prasanna, **Co-PIs (USC): Sanmukh R. Kuppannagari**, Xuehai Qian.

• 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**

• U.S. National Science Foundation - 1911229, "OAC Core: Small: Scalable Graph Analytics on Emerging Cloud Infrastructure". PI: Viktor K. Prasanna, **Co-PI: Sanmukh R. Kuppannagari**

• U.S. Army Research Office - W911NF1910362, "Graph Theoretic Approaches for Cyber Physical Security in Networks". PI: Viktor K. Prasanna, **Co-PIs: Sanmukh R. Kuppannagari**, Ning Xie, S.S. Iyengar.

RESEARCH EXPERIENCE

Department of ECE, University of Southern California September, 2018 - July, 2022
Research Associate *Los Angeles, CA*

- Accelerating Reinforcement Learning on Heterogeneous CPU-FPGA nodes [FPL-DEMO21, FPGA21, FPGA20, RAW20, FCCM20, HPEC20b, TPDS21, HIPC21a, HIPC21b].
- Accelerating Privacy Preserving Machine Learning on FPGAs [ISC21, FPL21].
- Data Driven Analytics and Optimization for Increased Solar Penetration [FTC21, eEnergyW21, ISGT20, SUST20, EENERGYW19, EENERGY19, IoTDI19, SGCOMM18, LOCS19, SUST18a, HIPC21a].
- Safety and Robustness in Reinforcement Learning for Smart Building Control [BuildSys19].
- Accelerating Graph Analytics on Cloud Platforms with Heterogeneous CPU-FPGA nodes [HPEC19, ParFPGA19, ISC20, HPEC20a, FPT20].

Department of ECE, University of Southern California August, 2013 - August, 2018
Research Assistant *Los Angeles, CA*

- PhD Dissertation: Discrete Optimization for Supply Demand Matching in Smart Grids [Thes18]
- Optimal Net Load Balancing in Smart Grids with High DER penetration [TOSN18, ISGT18, BuildSys17]
- Optimal Customer Selection for Dynamic Demand Response in SmartGrids [ICCS16, CSCI15]
- Lead developer of the DR software which is used to implement Demand Response event in USC SmartGrid for the joint demonstration project between LADWP and USC [IJCAI16]
- Cyber Physical Security in Smart Grids [SUST18b, SUST16].

Army Research Lab June 2017 - August 2017
Summer Intern *Playa Vista, CA*

- Risk-Aware Sequential Decision Making under Model Uncertainties: Applications in Smart Grids [ISGT18].

TEACHING EXPERIENCE

- CSDS 600 - Special Topics: Designing High Performant Systems for AI. CWRU. Fall 2022.
- EE 457 - Computer Systems Organization. USC. Fall 2014, Spring 2015, Fall 2015, Fall 2016.
- EE 451 - Parallel and Distributed Computing. Spring 2016, Spring 2017. USC.
- EE 599 - Parallel Programming. USC. Fall 2021.

SYNERGISTIC ACTIVITIES

Organization

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

Reviewer Experience

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

AWARDS AND HONORS

- 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.

[ISC21] Yang Yang, Tian Ye, Sanmukh R Kuppannagari, Rajgopal Kannan, and Viktor K Prasanna. "FPGA Acceleration of Number Theoretic Transform". In: *ISC High Performance 2021*. 2021.

[FPL21] Tian Ye, Sanmukh R Kuppannagari, Rajgopal Kannan, and Viktor K Prasanna. "Performance Modeling and FPGA Acceleration of Homorphic Encrypted Convolution". In: *The International Conference on Field-Programmable Logic and Applications (FPL) 2021*. 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.

[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.

[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.

[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.

[FPGA20] Rachit Rajat, Yuan Meng, Sanmukh R Kuppannagari, Ajitesh Srivastava, Rajgopal Kannan, and Viktor K Prasanna. "QTAccel: Generic FPGA Design for Q-Table based Reinforcement Learning Accelerators". In: *Proceedings of the 2020 ACM/SIGDA International Symposium on Field-Programmable Gate Arrays*. Abstract Only. ACM. 2020.

[FPT20] Yang Yang, Sanmukh R Kuppannagari, and Viktor K Prasanna. "A High Throughput Parallel Hash Table Accelerator on HBM-enabled FPGAs". In: *International Conference on Field Programmable Technology (FPT) 2020*. 2020.

[ISC20] Yang Yang, Sanmukh R Kuppannagari, Ajitesh Srivastava, Rajgopal Kannan, and Viktor K Prasanna. "FASTHash: FPGA-based High Throughput Parallel Hash Table". In: *ISC High Performance 2020*. 2020.

[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.

[ParFPGA19] Akshit Goel, Sanmukh R Kuppannagari, Yang Yang, Ajitesh Srivastava, and Viktor K Prasanna. "Parallel Totally Induced Edge Sampling on FPGAs". In: *Parallel Computing with FPGAS (ParFPGA2019)*. 2019.

[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.

Data Driven Optimization for Smart Grids

[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.

[TSUSC21] Chi Zhang, Sanmukh Rao Kuppannagari, and Viktor K Prasanna. "Safe Building HVAC Control via Batch Reinforcement Learning". In: *IEEE Transactions on Sustainable Computing* (2021). Under Major Revision.

[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.

[Thes18] Sanmukh Rao Kuppannagari. "Discrete Optimization for Supply Demand Matching in Smart Grids". PhD thesis. University of Southern California, 2018.

[SUST18a] Athanasios A Rompokos, Sanmukh R Kuppannagari, Rajgopal Kannan, and Viktor K Prasanna. "Minimizing Cost of Load Matching in Multiple Micro-Grids Using MESS". In: *2018 IEEE Conference on Technologies for Sustainability (SusTech)*. IEEE. 2018, pp. 1–7.

[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.