

# SANMUKH RAO KUPPANNAGARI

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## PROFESSIONAL PREPARATION

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### 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

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- *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.
- *Data Driven Modeling and Optimization for Smart Energy Systems:* Develop data driven combinatorial optimizations, approximation algorithms and Reinforcement Learning algorithms to minimize the cost of smart grid operations.

## APPOINTMENTS

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- Senior Research Associate, University of Southern California, Los Angeles, Fall '20 - present.
- 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

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- 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

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

- Accelerating Reinforcement Learning on Heterogeneous CPU-FPGA nodes [[FPL-DEMO21](#), [FPGA21](#), [FPGA20](#), [RAW20](#), [FCCM20](#), [HPEC20b](#)].
- Accelerating Privacy Preserving Machine Learning on FPGAs [[ISC21](#), [FPL21](#)].
- Data Driven Analytics and Optimization for Increased Solar Penetration [[ISGT20](#), [SUST20](#), [EEN-ERGYW19](#), [EENERGY19](#), [IoTDI19](#), [SGCOMM18](#), [LOCS19](#), [SUST18a](#)].
- 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

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- EE 457 - Computer Systems Organization. Fall 2014, Spring 2015, Fall 2015, Fall 2016. Instructor: Prof Gandhi Puvvada (gandhi@usc.edu)
- EE 451 - Parallel and Distributed Computing. Spring 2016, Spring 2017. Instructor: Prof Viktor K. Prasanna (prasanna@usc.edu)

## SYNERGISTIC ACTIVITIES

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### Organization

- Special Issue Guest Editor; Special Issue “Applications of IoT and Cloud Computing in Smart Grids” in Electronics (ISSN 2079-9292).

- Technical Committee Member; 2021 IEEE High Performance Extreme Computing Virtual Conference (HPEC), 2021.
- Program Committee Member; IEEE/ACM International Conference on High Performance Computing, (HiPC) 2020-21.
- Publicity Chair; Web chair; IEEE/ACM International Conference on High Performance Computing, (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) 2019.

### **Reviewer Experience**

- 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; IEEE Transactions on Dependable and Secure Computing, 2020.
- Reviewer; Journal of Computers and Electrical Engineering, Elsevier, 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.
- Reviewer; IEEE Transactions on Sustainable Computing (TSUC), 2018, 2019.
- Judge; EE Research Festival, University of Southern California, 2018, 2019.

## **MENTORING EXPERIENCE**

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### **PhD**

- Chi Zhang - Reinforcement Learning for Safety in Smart Grids.
- Chung Ming Chueng - Data Analytics, Smart Grids.
- Rachit Rajat - Acceleration of Reinforcement Learning on Edge FPGA Devices.
- Yuan Meng - Acceleration of Reinforcement Learning on Edge FPGA Devices.
- Sasindu Wijeratne - Accelerating Graph Analytics on Cloud Platforms with FPGAs.
- Tian Ye - Accelerating Privacy Preserving Deep Neural Networks on FPGAs.
- Athanasios Rompokos - Mobile Energy Storage Scheduling for Smart Grid Management.
- Yang Yang - Accelerating Hash Table on FPGA. Accelerating Privacy Deep Neural Networks on FPGAs.

### **Masters/Bachelors**

- Yao Fu - Missing Data Imputation in smart grids using Spatio Temporal Modeling.
- Nivedita Suresh - Discrete Optimization for Net-Load Balancing in Smart Grids.

- Xiangchong Liu - Live Energy Map for Visualization of Energy in Smart Grids.
- Stefan Binna - Cyber Physical Security in Smart Grids.
- Akshit Goel - Parallel Graph Sampling on FPGAs.

## AWARDS

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- Outstanding 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

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### Accelerating Graph Analytics/AI

- [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.
- [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 Homomorphic Encrypted Convolution". In: *The International Conference on Field-Programmable Logic and Applications (FPL) 2021*. 2021.
- [RAW20] Yuan Meng, Sanmukh R. Kuppannagari, Rachit Rajat, Ajitesh Srivastava, Rajgopal Kannan, and Viktor K Prasanna. "QTAcel: 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. "QTAcel: 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

- [SUST20] Chung Ming Cheung, Sanmukh Rao Kuppannagari, Rajgopal Kannan, and Viktor K Prasanna. “Disaggregation of Behind-The-Meter Solar Generation and Energy Storage 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 Chelmiss, 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 Chelmiss, 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 Smart-Grids”. In: *The 2015 International Conference on Computational Science and Computational Intelligence (CSCI)*. 2015.