

# Prof. Joshua San Miguel

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Department of Electrical  
and Computer Engineering  
UNIVERSITY OF WISCONSIN-MADISON

## Faculty Appointment

Assistant Professor January 2018 - Present  
Electrical and Computer Engineering  
University of Wisconsin-Madison

Affiliate Professor May 2018 - Present  
Computer Sciences  
University of Wisconsin-Madison

## Education

PhD September 2012 - August 2017  
Electrical and Computer Engineering  
University of Toronto  
Advisor: Natalie Enright Jerger

BASc in Engineering Science with Honours September 2007 - April 2012  
Electrical and Computer Engineering  
University of Toronto

## Research Interests

Processor architectures and hardware accelerators  
Approximate computing from circuits to compilers  
Stochastic and unary computing for neuromorphic architectures  
Intermittent systems for energy-harvesting IoT devices  
Interconnection networks for multiprocessors  
Cache hierarchy and memory systems  
Branch prediction, value prediction and prefetching

## Awards and Honors

SC Best Paper Award Nominee	2021
Gerald Holdridge Excellence in Teaching Award	2021
NSF CAREER Award	2021
IEEE Micro Top Picks	2021
ECE Grainger Faculty Scholarship Award	2020
Nominated by ECE Department for ACM Doctoral Dissertation Award	2018
Nominated by ECE Department for CGS/ProQuest Distinguished Dissertation Award	2018
Nominated by ECE Department for Governor General's Gold Medal	2018
IEEE Micro Top Picks Honorable Mention	2017
IBM PhD Fellowship	2016
IEEE Micro Top Picks	2016
HiPEAC Paper Award	2015
NOCS Best Paper Award Nominee	2015
Queen Elizabeth II/Montrose Werry Scholarship in Science and Technology	2015
Bell Graduate Scholarship	2014

## Professional Service

Program Committee ISCA 2022  
Program Committee ASPLOS 2022

Program Committee		IPDPS 2022
Organizer	Undergrad Architecture Mentoring Workshop,	ISCA 2021
Technical Program Chair		NOCS 2021
Program Committee		MICRO 2021
Selection Committee	IEEE Micro Top Picks	2021
Program Committee		HPCA 2021
Organizer	Undergrad Architecture Mentoring Workshop,	MICRO 2020
Technical Program Committee		ENSsys, SenSys 2020
Program Chair	Workshop on Approximate Computing Across the Stack,	ASPLOS 2020
Program Committee		CASES 2020
Program Committee		ISCA 2020
Technical Program Committee		DAC 2020
Program Committee		LCTES 2020
Program Committee	Young Architect Workshop,	ASPLOS 2020
Program Committee		ISPASS 2020
ACM SRC Chair		MICRO 2019
Technical Program Committee		ENSsys, SenSys 2019
Organizer	Wisconsin Architecture Affiliates Meeting	2019
Program Committee	Young Architect Workshop,	HPCA 2019
Program Committee		ISCA 2019
Student Travel Grant Chair		ISPASS 2019
Technical Program Committee		DAC 2019
Finance Chair		ASPLOS 2019
Program Committee		HPCA 2019
Program Committee		MICRO 2018
Program Committee		IISWC 2018
Guest Editor	Special Issue on Approximate Computing,	IEEE Micro 2018
Program Committee	Championship Value Prediction,	ISCA 2018
Program Committee		ISPASS 2018
Program Committee		IPDPS 2018
Program Committee	Workshop on Approximate Computing Across the Stack,	ASPLOS 2017

## Publications – Book Chapters

Approximate Cache Architectures  
 Natalie Enright Jerger and Joshua San Miguel  
 Chapter in Approximate Circuits, Springer, 2019

## Publications – Refereed Conferences

uSystolic: Byte-Crawling Unary Systolic Array  
 Di Wu and Joshua San Miguel  
 IEEE International Symposium on High-Performance Computer Architecture (HPCA), February 2022, 12 pages, 30.5% acceptance

Stay in Your Lane: A NoC with Low-Overhead Multi-Packet Bypassing  
 Hossein Farrokhbakht, Paul Gratz, Tushar Krishna, Joshua San Miguel and Natalie Enright Jerger  
 IEEE International Symposium on High-Performance Computer Architecture (HPCA), February 2022, 12 pages, 30.5% acceptance

Streaming Accuracy: Characterizing Early Termination in Stochastic Computing  
 Hsuan Hsiao, Joshua San Miguel and Jason Anderson  
 Asia and South Pacific Design Automation Conference (ASP-DAC), January 2022, 6 pages, 36.5% acceptance

SEEC: Stochastic Escape Express Channel  
 Mayank Parasar, Natalie Enright Jerger, Paul Gratz, Joshua San Miguel and Tushar Krishna  
 International Conference for High Performance Computing, Networking, Storage, and Analysis (SC), November 2021, 12 pages, 23.6% acceptance  
 // Best Paper Award Nominee

UNO: Virtualizing and Unifying Nonlinear Operations for Emerging Neural Networks  
Di Wu, Jingjie Li, Setareh Behroozi, Younghyun Kim and Joshua San Miguel  
ACM/IEEE International Symposium on Low Power Electronics and Design (ISLPED), July 2021, 6 pages

Pitstop: Enabling a Virtual Network Free Network-On-Chip  
Hossein Farrokhbakht, Henry Kao, Kamran Hasan, Paul Gratz, Tushar Krishna, Joshua San Miguel and Natalie Enright Jerger  
IEEE International Symposium on High-Performance Computer Architecture (HPCA), February–March 2021, 14 pages, 24.4% acceptance

Normalized Stability: A Cross-Level Design Metric for Early Termination in Stochastic Computing  
Di Wu, Ruokai Yin and Joshua San Miguel  
Asia and South Pacific Design Automation Conference (ASP-DAC), January 2021, 6 pages, 34.2% acceptance

Zero Correlation Error: A Metric for Finite-Length Bitstream Independence in Stochastic Computing  
Hsuan Hsiao, Joshua San Miguel, Yuko Hara-Azumi and Jason Anderson  
Asia and South Pacific Design Automation Conference (ASP-DAC), January 2021, 6 pages, 34.2% acceptance

Bufferless NoCs with Scheduled Deflection Routing  
Chen Chen, Zirui Tao and Joshua San Miguel  
ACM/IEEE International Symposium on Networks-On-Chip (NOCS), September 2020, 6 pages

CAP'NN: Class-Aware Personalized Neural Network Inference  
Maedeh Hemmat, Joshua San Miguel and Azadeh Davoodi  
ACM/ESDA/IEEE Design Automation Conference (DAC), July 2020, 6 pages, 23% acceptance

uGEMM: Unary Computing Architecture for GEMM Applications  
Di Wu, Jingjie Li, Ruokai Yin, Hsuan Hsiao, Younghyun Kim and Joshua San Miguel  
ACM/IEEE International Symposium on Computer Architecture (ISCA), May–June 2020, 13 pages, 18.3% acceptance  
// IEEE Micro Top Picks 2021

DRAIN: Deadlock Removal for Arbitrary Irregular Networks  
Mayank Parasar, Hossein Farrokhbakht, Natalie Enright Jerger, Paul Gratz, Tushar Krishna and Joshua San Miguel  
IEEE International Symposium on High-Performance Computer Architecture (HPCA), February 2020, 13 pages, 19.4% acceptance

CRANIA: Unlocking Data and Value Reuse in Iterative Neural Network Architectures  
Maedeh Hemmat, Tejas Shah, Yuhua Chen and Joshua San Miguel  
Asia and South Pacific Design Automation Conference (ASP-DAC), January 2020, 6 pages, 34.4% acceptance

SWAP: Synchronized Weaving of Adjacent Packets for Network Deadlock Resolution  
Mayank Parasar, Natalie Enright Jerger, Paul Gratz, Joshua San Miguel and Tushar Krishna  
ACM/IEEE International Symposium on Microarchitecture (MICRO), October 2019, 13 pages, 23.0% acceptance

SECO: A Scalable Accuracy Approximate Exponential Function Via Cross-Layer Optimization  
Di Wu, Tianen Chen, Chienfu Chen, Oghenefego Ahia, Joshua San Miguel, Mikko Lipasti and Younghyun Kim  
ACM/IEEE International Symposium on Low Power Electronics and Design (ISLPED), July 2019, 6 pages

In-Stream Stochastic Division and Square Root via Correlation  
Di Wu and Joshua San Miguel  
ACM/ESDA/IEEE Design Automation Conference (DAC), June 2019, 6 pages, 24.8% acceptance

The What's Next Intermittent Computing Architecture  
Karthik Ganesan, Joshua San Miguel and Natalie Enright Jerger  
IEEE International Symposium on High-Performance Computer Architecture (HPCA), February 2019, 13 pages, 19.7% acceptance

The EH Model: Early Design Space Exploration of Intermittent Processor Architectures  
Joshua San Miguel, Karthik Ganesan, Mario Badr, Chunqiu Xia, Rose Li, Hsuan Hsiao and Natalie Enright Jerger  
ACM/IEEE International Symposium on Microarchitecture (MICRO), October 2018, 13 pages, 21.1% acceptance

The Bunker Cache for Spatio-Value Approximation  
Joshua San Miguel, Jorge Albericio, Natalie Enright Jerger and Aamer Jaleel  
ACM/IEEE International Symposium on Microarchitecture (MICRO), October 2016, 12 pages, 21.6% acceptance

The Anytime Automaton  
Joshua San Miguel and Natalie Enright Jerger  
ACM/IEEE International Symposium on Computer Architecture (ISCA), June 2016, 13 pages, 19.9% acceptance  
// IEEE Micro Top Picks 2017 Honorable Mention

The Runahead Network-On-Chip  
Zimo Li, Joshua San Miguel and Natalie Enright Jerger  
IEEE International Symposium on High-Performance Computer Architecture (HPCA), March 2016, 12 pages, 22.1% acceptance

Doppelganger: A Cache for Approximate Computing  
Joshua San Miguel, Jorge Albericio, Andreas Moshovos and Natalie Enright Jerger  
ACM/IEEE International Symposium on Microarchitecture (MICRO), December 2015, 12 pages, 21.6% acceptance

The Inner Most Loop Iteration Counter: A New Dimension in Branch History  
Andre Sez nec, Joshua San Miguel and Jorge Albericio  
ACM/IEEE International Symposium on Microarchitecture (MICRO), December 2015, 11 pages, 21.6% acceptance  
// IEEE Micro Top Picks 2016  
// HiPEAC Paper Award

Data Criticality in Network-On-Chip Design  
Joshua San Miguel and Natalie Enright Jerger  
ACM/IEEE International Symposium on Networks-On-Chip (NOCS), September 2015, 8 pages  
// Best Paper Award Nominee

Load Value Approximation  
Joshua San Miguel, Mario Badr and Natalie Enright Jerger  
ACM/IEEE International Symposium on Microarchitecture (MICRO), December 2014, 13 pages, 19.4% acceptance

Wormhole: Wisely Predicting Multidimensional Branches  
Jorge Albericio, Joshua San Miguel, Natalie Enright Jerger and Andreas Moshovos  
ACM/IEEE International Symposium on Microarchitecture (MICRO), December 2014, 12 pages, 19.4% acceptance

## Publications – Refereed Journals and Magazines

AirNN: A Featherweight Framework for Dynamic Input-Dependent Approximation of CNNs  
Maedeh Hemmat, Joshua San Miguel and Azadeh Davoodi  
IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems, October 2021, 14 pages

uGEMM: Unary Computing for GEMM Applications  
Di Wu, Jingjie Li, Ruokai Yin, Hsuan Hsiao, Younghyun Kim and Joshua San Miguel  
IEEE Micro, May-June 2021, 7 pages

In-Stream Correlation-Based Division and Bit-Inserting Square Root in Stochastic Computing  
Di Wu, Ruokai Yin and Joshua San Miguel  
IEEE Design and Test, 2021, 6 pages

SHASTA: Synergic HW-SW Architecture for Spatio-Temporal Approximation  
Gokul Subramanian Ravi, Joshua San Miguel and Mikko Lipasti  
ACM Transactions on Architecture and Code Optimization, September 2020, 26 pages

Value Locality Based Approximation with ODIN  
Rahul Singh, Gokul Subramanian Ravi, Mikko Lipasti and Joshua San Miguel  
IEEE Computer Architecture Letters, September–December 2020, 4 pages

The EH Model: Analytical Exploration of Energy-Harvesting Architectures  
Joshua San Miguel, Karthik Ganesan, Mario Badr and Natalie Enright Jerger  
IEEE Computer Architecture Letters, January–June 2018, 4 pages

A Taxonomy of General Purpose Approximate Computing Techniques  
Thierry Moreau, Joshua San Miguel, Mark Wyse, James Bornholt, Armin Alaghi, Luis Ceze, Natalie Enright Jerger and Adrian Sampson  
IEEE Embedded Systems Letters, March 2018, 4 pages

Practical Multidimensional Branch Prediction  
Andre Sez nec, Joshua San Miguel and Jorge Albericio  
IEEE Micro, May–June 2016, 10 pages

#### Publications – Refereed Workshops

Ghostwriter: A Cache Coherence Protocol for Error-Tolerant Applications  
Henry Kao, Joshua San Miguel and Natalie Enright Jerger  
Workshop on Embedded Multicore Systems (ICPP-EMS), August 2021, 10 pages

The What’s Next Computing Architecture  
Karthik Ganesan, Joshua San Miguel and Natalie Enright Jerger  
Workshop on Approximate Computing Across the Stack (WAX), March 2018, 3 pages

Texture Cache Approximation on GPUs  
Mark Sutherland, Joshua San Miguel and Natalie Enright Jerger  
Workshop on Approximate Computing Across the Stack (WAX), June 2015, 3 pages

Wormhole Branch Prediction using Multi-Dimensional Histories  
Jorge Albericio, Joshua San Miguel, Natalie Enright Jerger and Andreas Moshovos  
Championship Branch Prediction (CBP-4), June 2014, 4 pages

Load Value Approximation: Approaching the Ideal Memory Access Latency  
Joshua San Miguel and Natalie Enright Jerger  
Workshop on Approximate Computing Across the System Stack (WACAS), March 2014, 6 pages

#### Publications – Technical Reports

A Systolic Approach to Deriving Anytime Algorithms for Approximate Computing  
Joshua San Miguel, Vijayalakshmi Srinivasan, Ravi Nair and Daniel A. Prener  
IBM Research Report RC25600, April 2016

A Taxonomy of Approximate Computing Techniques  
Thierry Moreau, Joshua San Miguel, Mark Wyse, James Bornholt, Luis Ceze, Natalie Enright Jerger and Adrian Sampson  
UW CSE Technical Report UW-CSE-2016-03-01, March 2016

#### Publications – Invited

When Dataflows Converge: Reconfigurable and Approximate Computing for Emerging Neural Networks  
Di Wu and Joshua San Miguel  
IEEE International Conference on Computer Design (ICCD), October 2021, 4 pages

Approximate Hardware Techniques for Energy-Quality Scaling Across the System

Younghyun Kim, Joshua San Miguel, Setareh Behroozi, Tianen Chen, Kyuin Lee, Yongwoo Lee, Jingjie Li and Di Wu  
IEIE/IEEE International Conference on Electronics, Information and Communication (ICEIC), January 2020

## PhD Dissertation

Reading Between the Bits: Uncovering New Insights in Data for Efficient Processor Design  
Joshua San Miguel  
University of Toronto, November 2017  
// Nominated by ECE Department for ACM Doctoral Dissertation Award  
// Nominated by ECE Department for CGS/ProQuest Distinguished Dissertation Award  
// Nominated by ECE Department for Governor General's Gold Medal

## Employment

Postdoctoral Researcher Electrical and Computer Engineering University of Toronto, Toronto, ON	September 2017 – December 2017
Research Assistant Electrical and Computer Engineering University of Toronto, Toronto, ON	September 2012 – August 2017
Teaching Assistant Electrical and Computer Engineering University of Toronto, Toronto, ON	September 2012 – December 2016
Research Summer Intern Exploratory Systems Architecture IBM TJ Watson Research Center, Yorktown Heights, NY	June 2015 – September 2015
Embedded Systems Software Developer, Intern OS Power Team, R&D BlackBerry Limited, Waterloo, ON	May 2010 – August 2011
Embedded Systems Software Developer, Co-op OS Platform Support Team, R&D BlackBerry Limited, Waterloo, ON	May 2009 – August 2009

## Teaching

CS/ECE 757 Advanced Computer Architecture II	Spring 2021
CS/ECE 552 Introduction to Computer Architecture	Fall 2020
CS/ECE 757 Advanced Computer Architecture II	Spring 2020
CS/ECE 552 Introduction to Computer Architecture	Fall 2019
CS/ECE 752 Advanced Computer Architecture I	Spring 2019
CS/ECE 552 Introduction to Computer Architecture	Fall 2018
CS/ECE 757 Advanced Computer Architecture II	Spring 2018

## Former Students

Giri Prasanna Mugunda Krishnan First Employment: Samsung	MS in CS, 2020
Rahul Singh First Employment: PhD, UIUC	MS in ECE, 2020
Shivangi Kamat First Employment: Intel	MS in ECE, 2020
Chen Chen First Employment: PhD, Texas A&M	MS in ECE, 2020
Tejas Shah First Employment: Nvidia	MS in ECE, 2020
Rui Liang First Employment: Qualcomm	BS in ECE, 2020
Yuhua Chen First Employment: MS, UW-Madison	BS in ECE, 2019
Mitali Soni First Employment: Google	MS in ECE, 2019
Oghenefego Ahia First Employment: Google	MS in ECE, 2019
Ram Prasad First Employment: Arm	MS in CS, 2019