

2017 IEEE International Conference on Rebooting Computing (ICRC 2017)

**Washington, DC, USA
8-9 November 2017**



**IEEE Catalog Number: CFP17G30-POD
ISBN: 978-1-5386-1554-6**

**Copyright © 2017 by the Institute of Electrical and Electronics Engineers, Inc.
All Rights Reserved**

Copyright and Reprint Permissions: Abstracting is permitted with credit to the source. Libraries are permitted to photocopy beyond the limit of U.S. copyright law for private use of patrons those articles in this volume that carry a code at the bottom of the first page, provided the per-copy fee indicated in the code is paid through Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923.

For other copying, reprint or republication permission, write to IEEE Copyrights Manager, IEEE Service Center, 445 Hoes Lane, Piscataway, NJ 08854. All rights reserved.

****** This is a print representation of what appears in the IEEE Digital Library. Some format issues inherent in the e-media version may also appear in this print version.***

IEEE Catalog Number:	CFP17G30-POD
ISBN (Print-On-Demand):	978-1-5386-1554-6
ISBN (Online):	978-1-5386-1553-9

Additional Copies of This Publication Are Available From:

Curran Associates, Inc
57 Morehouse Lane
Red Hook, NY 12571 USA
Phone: (845) 758-0400
Fax: (845) 758-2633
E-mail: curran@proceedings.com
Web: www.proceedings.com

CURRAN ASSOCIATES INC.
proceedings
.com

Committees.....	ix
Sponsors.....	x
Plenary and Opening Talks.....	xi
Schedule.....	xiii

1A: Neuromorphic Computing 1

A Spike-Timing Neuromorphic Architecture	1
<i>Aaron J. Hill, Jonathon W. Donaldson, Fredrick H. Rothganger, Craig M. Vineyard, David R. Follett, Pamela L. Follett, Michael R. Smith, Stephen J. Verzi, William Severa, Felix Wang, James B. Aimone, John H. Naegle, and Conrad D. James</i>	
Feature Learning Using Synaptic Competition in a Dynamically-Sized Neuromorphic Architecture	9
<i>Stanisław Woźniak, Angeliki Pantazi, Yusuf Leblebici and Evangelos Eleftheriou</i>	
Achieving Swarm Intelligence with Spiking Neural Oscillators	16
<i>Yan Fang and Samuel J. Dickerson</i>	
Auditory Neural Pathway Simulation	20
<i>Reginald N. Meeson</i>	
Energy-Efficient Single-Flux-Quantum Based Neuromorphic Computing	24
<i>Michael L. Schneider, Christine, A. Donnelly, Stephen E. Russek, Burm Baek, Matthew R. Pufall, Peter F. Hopkins, and William H. Rippard</i>	

1B: Beyond CMOS

Advanced Packaging and Heterogeneous Integration to Reboot Computing	28
<i>Saptadeep Pal, Subramanian S. Iyer, and Puneet Gupta</i>	
Low-Power and Secure Lightweight Cryptography Via TFET-Based Energy Recovery Circuits	34
<i>Himanshu Thapliyal, T. S. S. Varun, and S. Dinesh Kumar</i>	

Hybrid Topologies for Reconfigurable Matrices Based on Nano-Grain Cells..... 38
Kevin Cheng, Sébastien Le Beux, and Ian O'Connor

A New Concept for Computing Using Interconnect Crosstalks..... 46
*Naveen kumar Macha, Vinay Chitturi, Rakesh Vijjapuram,
Md. Arif Iqbal, Sehtab Hussain, and Mostafizur Rahman*

**Heterogeneous Technology Configurable Fabrics for Field-Programmable
Co-Design of CMOS and Spin-Based Devices**..... 48
Ronald F. DeMara, Arman Roohi, Ramtin Zand, and Steven D. Pyle

2A: Neuromorphic Computing 2

**Improved Deep Neural Network Hardware-Accelerators Based
on Non-Volatile-Memory: The Local Gains Technique** 52
*Irem Boybat, Carmelo di Nolfo, Stefano Ambrogio, Martina Bodini,
Nathan C. P. Farinha, Robert M. Shelby, Pritish Narayanan,
Severin Sidler, Hsinyu Tsai, Yusuf Leblebici,
and Geoffrey W. Burr*

A Comparison between Single Purpose and Flexible Neuromorphic Processor Designs 60
David J. Mountain, Mark M. McLean, and Christopher D. Krieger

**In-Memory Execution of Compute Kernels Using Flow-Based Memristive
Crossbar Computing**..... 69
*Dwaipayan Chakraborty, Sunny Raj, Julio Cesar Gutierrez,
Troyle Thomas, and Sumit Kumar Jha*

Neuromorphic Adaptive Edge-Preserving Denoising Filter 75
Aidana Irmanova, Olga Krestinskaya, and Alex Pappachen James

2B: Special Session on Future EDA: Next Generation Design Automation for Accelerating the Reboot

Still a Fight to Get It Right: Verification in the Era of Machine Learning 81
Shobha Vasudevan

3A: Algorithms and Architectures

Generalize or Die: Operating Systems Support for Memristor-Based Accelerators..... 89
*Pedro Bruel, Sai Rahul Chalamalasetti, Chris Dalton, Izzat El Hajj,
Alfredo Goldman, Catherine Graves, Wen-mei Hwu, Phil Laplante,
Dejan Milojicic, Geoffrey Ndu, and John Paul Strachan*

VoiceHD: Hyperdimensional Computing for Efficient Speech Recognition 97
Mohsen Imani, Deqian Kong, Abbas Rahimi, and Tajana Rosing

Embedding in Neural Networks: A-Priori Design of Hybrid Computers for Prediction..... 105
*Bicky A. Marquez, Jose Suarez-Vargas, Laurent Larger, Maxime Jacquot,
Yanne K. Chembo, and Daniel Brunner*

Convolutional Drift Networks for Video Classification..... 109
*Dillon Graham, Seyed Hamed Fatemi Langroudi, Christopher Kanan,
and Dhireesha Kudithipudi*

A New Approach for Multi-Valued Computing Using Machine Learning..... 117
Wafi Danesh and Mostafizur Rahman

3B: Quantum and Special Purpose Annealers

**An Ising Computer Based on Simulated Quantum Annealing
by Path Integral Monte Carlo Method.....** 124
Takuya Okuyama, Masato Hayashi, and Masanao Yamaoka

An FPGA-Quantum Annealer Hybrid System for Wide-Band RF Detection 130
Zachary K. Baker

Reducing Binary Quadratic Forms for More Scalable Quantum Annealing 138
Georg Hahn and Hristo Djidjev

**Generating Sparse Representations Using Quantum Annealing:
Comparison to Classical Algorithms.....** 146
Nga T. T. Nguyen, Amy E. Larson, and Garrett T. Kenyon

4A: Neuromorphic Computing 3

**A Unified Hardware/Software Co-Design Framework for Neuromorphic
Computing Devices and Applications** 152
*James S. Plank, Garrett S. Rose, Mark E. Dean, Catherine D. Schuman,
and Nathaniel C. Cady*

**Impact of Linearity and Write Noise of Analog Resistive Memory Devices
in a Neural Algorithm Accelerator.....** 160
*Robin B. Jacobs-Gedrim, Sapan Agarwal, Kathrine E. Knisely,
Jim E. Stevens, Michael S. van Heukelom, David R. Hughart,
John Niroula, Conrad D. James, and Matthew J. Marinella*

**An Energy-Efficient Mixed-Signal Neuron for Inherently Error-Resilient
Neuromorphic Systems.....** 170
*Baibhab Chatterjee, Priyadarshini Panda, Shovan Maity,
Kaushik Roy, and Shreyas Sen*

4B: Energy-efficient and Adiabatic Computing

Asynchronous Ballistic Reversible Computing	172
<i>Michael P. Frank</i>	
Synchronised 4-Phase Resonant Power Clock Supply for Energy Efficient Adiabatic Logic	180
<i>Nicolas Jeannot, Gaël Pillonnet, Pascal Nouet, Nadine Azemard, and Aida Todri-Sanial</i>	
Electromechanical Adiabatic Computing: Towards Attojoule Operation	186
<i>Yann Perrin, Ayrat Galisultanov, Hervé Fanet, and Gaël Pillonnet</i>	
Architecture and Dissipation: Thermodynamic Costs of General Purposeness in von Neumann Processors	194
<i>Jared P. Ricci and Neal G. Anderson</i>	

5A: Quantum Computing

Quantum Accelerators for High-Performance Computing Systems	198
<i>Keith A. Britt, Fahd A. Mohiyaddin, and Travis S. Humble</i>	
Reconfigurable and Programmable Ion Trap Quantum Computer	205
<i>Stewart Allen, Jungsang Kim, David L. Moehring, and Christopher R. Monroe</i>	
From the Quantum Moore's Law toward Silicon Based Universal Quantum Computing	208
<i>Enrico Prati, Davide Rotta, Fabio Sebastiano, and Edoardo Charbon</i>	
Physical Constraints on Quantum Circuits	212
<i>Pier Paolo Civalieri and Fernando Corinto, Politecnico di Torino and Árpád Csurgay</i>	

5B: Novel Architectures and Near-memory Computing

Rebooting the Data Access Hierarchy of Computing Systems	216
<i>Wen-meí W. Hwu, Izzat El Hajj, Simon Garcia de Gonzalo, Carl Pearson, Nam Sung Kim, Deming Chen, Jinjun Xiong, and Zehra Sura</i>	
The Superstrider Architecture: Integrating Logic and Memory Towards Non-Von Neumann Computing	220
<i>Sriseshan Srikanth, Thomas M. Conte, Erik P. DeBenedictis, and Jeanine Cook</i>	
NNgine: Ultra-Efficient Nearest Neighbor Accelerator Based on In-Memory Computing	228
<i>Mohsen Imani, Yeseong Kim, and Tajana Rosing</i>	
Socrates-D: Multicore Architecture for On-Line Learning	236
<i>Yangjie Qi, Raqibul Hasan, Rasitha Fernando, and Tarek Taha</i>	

6A: Optical Computing

An Energy-Efficient Reconfigurable Nanophotonic Computing Architecture Design: Optical Lookup Table.....	244
<i>Zhen Li, Christelle Monat, Sébastien Le Beux, Xavier Letartre, and Ian O'Connor</i>	
Multi-Level Optical Weights in Integrated Circuits.....	252
<i>Stefan Abel, David J. Stark, Felix Eltes, Daniele Caimi, Jean Fompeyrine, and John E Ortmann</i>	
On-Chip Passive Photonic Reservoir Computing with Integrated Optical Readout	255
<i>Matthias Freiberger, Andrew Katumba, Peter Bienstman, and Joni Dambre</i>	
Towards On-Chip Optical FFTs for Convolutional Neural Networks.....	259
<i>Jonathan K. George, Hani Nejadriahi, and Volker J. Sorger</i>	
Spatial-Spectral Materials for High Performance Optical Processing	263
<i>Zeb W. Barber, Calvin Harrington, Krishna Rupavatharam, Charles Thiel, Trent Jackson, P.B. Sellin, Craig Benko, and Kristian Merkel</i>	
Demonstration of a Coherent Tunable Amplifier for All-Optical Ising Machines	267
<i>T. Van Vaerenbergh, G. J. Mendoza, D. Kielpinski, J. S. Pelc, N. Tezak, R. Bose, C. Santori and R.G. Beausoleil</i>	

6B: Probabilistic Computing and Nonlinear Dynamics

On the Physical Underpinnings of the Unusual Effectiveness of Probabilistic and Neural Computation	270
<i>Sandip Tiwari and Damien Querlioz</i>	
Computing Based on Material Training: Application to Binary Classification Problems	274
<i>E. Vissol-Gaudin, A. Kotsialos, C. Groves, C. Pearson, D.A. Zeze, and M.C. Petty</i>	
Nonlinear Dynamics and Chaos for Flexible, Reconfigurable Computing.....	282
<i>Behnam Kia and William Ditto</i>	
A Thermodynamic Treatment of Intelligent Systems.....	290
<i>Natesh Ganesh</i>	
Magneto-Electric Approximate Computational Circuits for Bayesian Inference.....	294
<i>Sourabh Kulkarni, Sachin Bhat, Santosh Khasanvis and Csaba Andras Moritz</i>	

Invited Poster

A Bayesian Stochastic Machine for Sound Source Localization	302
<i>Raphael Frisch, Raphaël Laurent, Marvin Faix, Laurent Girin, Laurent Fesquet, Augustin Lux, Jacques Droulez, Pierre Bessi`ere, and Emmanuel Mazer</i>	
Structure Discovery for Gene Expression Networks with Emerging Stochastic Hardware.....	310
<i>Sourabh Kulkarni, Sachin Bhat, and Csaba Andras Moritz</i>	
Design of Computing Circuits using Spatially Localized DNA Majority Logic Gates.....	314
<i>Aby Konampurath George and Harpreet Singh</i>	
Routing Congestion Aware Cell Library Development for Monolithic 3D ICs	321
<i>Chen Yan and Emre Salman</i>	
Hybrid Cryogenic Memory Cells for Superconducting Computing Applications.....	325
<i>Jeng-Bang Yau, Yat-Kiu-Kent Fung, and Gerald W. Gibson</i>	
Neuromorphic Computation Using Quantum-Dot Cellular Automata.....	328
<i>Enrique P. Blair and Scott Koziol</i>	
CMOS Based Scalable Cryogenic Control Electronics for Qubits.....	332
<i>C. Degenhardt, L. Geck, A. Kruth, P. Vliex, and S. van Waasen</i>	
Securing Data Centers, Handheld Computers, and Networked Sensors against Viruses and Rootkits.....	336
<i>Earle Jennings</i>	
Author Index.....	345