

# **2012 IEEE 42nd International Symposium on Multiple-Valued Logic**

**(ISMVL 2012)**

**Victoria, British Columbia, Canada  
14 – 16 May 2012**



**IEEE Catalog Number: CFP12034-PRT  
ISBN: 978-1-4673-0908-0**

# 2012 IEEE 42nd International Symposium on Multiple-Valued Logic

## ISMVL 2012

### Table of Contents

Message from the Symposium Chair.....	x
Message from the Program Chair.....	xi
Organizing Committee.....	xii
Program Committee.....	xiii
Reviewers.....	xiv

---

#### Session A1: Wireline and Clocking

Multiple-Valued Time-Based Architecture for Serial Communication Links .....	1
<i>Mostafa Rashdan, James Haslett, and Brent Maundy</i>	
Efficient Data Transmission Using Multiple-Valued Pulse-Position Modulation .....	7
<i>Yasushi Yuminaka and Masaaki Okui</i>	
Systematic Coding Schemes for Low-Power Multiple-Valued Current-Mode Asynchronous Communication Links .....	13
<i>Atsushi Matsumoto, Naoya Onizawa, and Takahiro Hanyu</i>	
Global Multiple-Valued Clock Approach for High- Performance Multi-phase Clock Integrated Circuits .....	19
<i>Rohit P. Menon and Mitchell A. Thornton</i>	

#### Session B1: SAT

Building Automated Theorem Provers for Infinitely-Valued Logics with Satisfiability Modulo Theory Solvers .....	25
<i>Carlos Ansótegui, Miquel Bofill, Felip Manyà, and Mateu Villaret</i>	
Greedy Algorithms, Ordering of Variables, and d-degenerate Instances .....	31
<i>Cong Wang and Andrei A. Bulatov</i>	
Extremely Complex 4-Colored Rectangle-Free Grids: Solution of Open Multiple-Valued Problems .....	37
<i>Bernd Steinbach and Christian Posthoff</i>	

Using Formal Verification and Robotic Evolution Techniques to Find Contradictions in Laws Concerning Police Rules of Engagement .....	45
<i>Terrance Sun, Lawrence Sun, and Marek Perkowski</i>	
<b>Session A2: Quantum Circuits</b>	
Synthesis of Permutative Quantum Circuits with Toffoli and TISC Gates .....	50
<i>Edison Tsai and Marek Perkowski</i>	
ESOP-Inspired Synthesis Method for Ternary Permutative Quantum Circuits .....	57
<i>Sidharth Dhawan and Marek Perkowski</i>	
Using Hasse Diagrams to Synthesize Ternary Quantum Circuits .....	63
<i>Maher Hawash and Marek Perkowski</i>	
Exact Synthesis of Toffoli Gate Circuits with Negative Control Lines .....	69
<i>Robert Wille, Mathias Soeken, Nils Przigoda, and Rolf Drechsler</i>	
<b>Session B2: Algebra and Logic</b>	
Two New Classification Theorems on Residuated Monoids .....	75
<i>Sándor Jenei and Franco Montagna</i>	
Non-deterministic Matrices for Semi-canonical Deduction Systems .....	79
<i>Ori Lahav</i>	
Modal Operators on Non-commutative Residuated Lattices .....	85
<i>Michiro Kondo and Mayuka F. Kawaguchi</i>	
Prime Filters on Residuated Lattices .....	89
<i>Michiro Kondo and Esko Turunen</i>	
<b>Session A3: Arithmetic Circuits</b>	
Asynchronous Stochastic Decoding of Low-Density Parity-Check Codes .....	92
<i>Naoya Onizawa, Vincent C. Gaudet, Takahiro Hanyu, and Warren J. Gross</i>	
Quaternary 1T-2MTJ Cell Circuit for a High-Density and a High-Throughput Nonvolatile Bit-Serial CAM .....	98
<i>Shoun Matsunaga and Takahiro Hanyu</i>	
Unified Current-Source Control for Low-Power Current-Mode-Logic Bit-Serial Circuits .....	104
<i>Shogo Kisara and Michitaka Kameyama</i>	
Formal Design of Multiple-Valued Arithmetic Algorithms over Galois Fields and Its Application to Cryptographic Processor .....	110
<i>Naofumi Homma, Kazuya Saito, and Takafumi Aoki</i>	
Complexity Study of the Continuous Valued Number System Adders .....	116
<i>Babak Zamanlooy, Ashley Novak, and Mitra Mirhassani</i>	

### **Session B3: Decision Diagrams**

Analysis of Multi-state Systems with Multi-state Components Using EVMDDs .....	122
<i>Shinobu Nagayama, Tsutomu Sasao, and Jon T. Butler</i>	
A BDD-Based Approach to Constructing LFSRs for Parallel CRC Encoding .....	128
<i>Elena Dubrova and Shohreh Sharif Mansouri</i>	
Remarks on Shapes of Decision Diagrams and Classes of Multiple-Valued Functions .....	134
<i>Stanislav Stankovic, Radomir S. Stankovic, and Jaakko Astola</i>	
Representation of Incompletely Specified Binary and Multiple-Valued Logic Functions by Compact Decision Diagrams .....	142
<i>Milena Stankovic, Suzana Stojkovic, and Radomir S. Stankovic</i>	
Multi-terminal Multi-valued Decision Diagrams for Characteristic Function Representing Cluster Decomposition .....	148
<i>Hiroki Nakahara, Tsutomu Sasao, and Munehiro Matsuura</i>	

### **Invited Address I**

Quantum Computing, Cryptography and Compilers .....	154
<i>Michele Mosca</i>	

### **Session C1: Quantum Circuits**

Linear Reversible Circuit Synthesis in the Linear Nearest-Neighbor Model .....	157
<i>Ben Schaeffer and Marek Perkowski</i>	
Optimal Quantum Circuits of Three Qubits .....	161
<i>Md. Mazder Rahman and Gerhard W. Dueck</i>	
The Roots of the NOT Gate .....	167
<i>Alexis De Vos and Stijn De Baerdemacker</i>	
Optimizing the Mapping of Reversible Circuits to Four-Valued Quantum Gate Circuits .....	173
<i>Mathias Soeken, Zahra Sasanian, Robert Wille, D. Michael Miller, and Rolf Drechsler</i>	

### **Session D1: Switching Theory**

Several Remarks on Index Generation Functions .....	179
<i>Dan A. Simovici, Marius Zimand, and Dan Pletea</i>	
Multiple-Valued Input Index Generation Functions: Optimization by Linear Transformation .....	185
<i>Tsutomu Sasao</i>	
Banzhaf Index and Boolean Difference .....	191
<i>Yoshinori Yamamoto</i>	
Gröbner Bases over Cyclic Post Algebras .....	197
<i>Blanca Fernanda López Martinolich</i>	

## Session C2: Mixed-Signal Design

Energy Efficiency of Multi-bit delta-sigma Modulators Using Inverter-based Integrators .....	203
<i>Hiroaki Kotani, Ryoto Yaguchi, and Takao Waho</i>	
Current-Source-Sharing Differential-Pair Circuits for a Low-Power Fine-Grain Reconfigurable VLSI Architecture .....	208
<i>Xu Bai and Michitaka Kameyama</i>	
Process-Variation-Resilient OTA Using MTJ-based Multi-level Resistance Control .....	214
<i>Masanori Natsui, Takaaki Nagashima, and Takahiro Hanyu</i>	

## Session D2: Exploring New Roads

Mosaics, Fermat, Walsh (Aller guten Dinge sind drei) .....	220
<i>Claudio Moraga</i>	
SIFAR: Self-Identification of Lags of an Autoregressive TSK-based Model .....	226
<i>Alejandro Veloz, Rodrigo Salas, Héctor Allende-Cid, and Héctor Allende</i>	
Probabilistic Logic Programming with Well-Founded Negation .....	232
<i>Spyros Hadjichristodoulou and David S. Warren</i>	

## Session C3: Biomedical/Sensors

Issues in Multi-valued Multi-modal Sensor Fusion .....	238
<i>Majid Janidarmian, Zeljko Zilic, and Katarzyna Radecka</i>	
Modeling Medical System Threats with Conditional Probabilities Using Multiple-Valued Logic Decision Diagrams .....	244
<i>Theodore W. Manikas, David Y. Feinstein, and Mitchell A. Thornton</i>	
A Fault-Tolerant Area-Efficient Current-Mode ADC for Multiple-Valued Neural Networks .....	250
<i>Farinoush Saffar, Mitra Mirhassani, and Majid Ahmadi</i>	

## Session D3: Clones

Clones of Incompletely Specified Operations .....	256
<i>Jelena Colic, Hajime Machida, and Jovanka Pantovic</i>	
Hierarchies of Local Monotonicities and Lattice Derivatives for Boolean and Pseudo-Boolean Functions .....	262
<i>Miguel Couceiro, Jean-Luc Marichal, and Tamás Waldhauser</i>	
GAP vs. PAG .....	268
<i>Miguel Couceiro, Erkkö Lehtonen, and Tamás Waldhauser</i>	

## Session E1: Special Session to Honour Ivo G. Rosenberg

Centralizing Monoids on a Three-Element Set .....	274
<i>Hajime Machida and Ivo G. Rosenberg</i>	
The Cardinality of the Set of All Clones Containing a Given Minimal Clone .....	281
<i>Dmitry Zhuk</i>	
A Survey on Intersections of Maximal Partial Clones of Boolean Partial Functions .....	287
<i>Miguel Couceiro and Lucien Haddad</i>	
Semirigid Systems of Equivalence Relations .....	293
<i>Christian Delhomme, Masahiro Miyakawa, Maurice Pouzet, Ivo G. Rosenberg, and Hisayuki Tatsumi</i>	

## Session F1: Quantum Circuits

A Synthesis Flow for Sequential Reversible Circuits .....	299
<i>Mathias Soeken, Robert Wille, Christian Otterstedt, and Rolf Drechsler</i>	
Using the Asynchronous Paradigm for Reversible Sequential Circuit Implementation .....	305
<i>David Y. Feinstein and Mitchell A. Thornton</i>	
Quantum Pseudo-Fractional Fourier Transform Using Multiple-Valued Logic .....	311
<i>Vamsi Parasa and Marek Perkowski</i>	
A New Approach to Online Testing of TGFSOP-based Ternary Toffoli Circuits .....	315
<i>N.M. Nayeem and J.E. Rice</i>	

## Invited Address II

Honouring Ivo G. Rosenberg: His Contributions to ISMVL .....	322
<i>Hajime Machida and Teruo Hikita</i>	

## Session E2: Special Session to Honour Ivo G. Rosenberg

Counting Predicates, Subset Surjective Functions, and Counting CSPs .....	331
<i>Andrei A. Bulatov and Amir Hedayaty</i>	
Triple Representation Theorem for Homogeneous Effect Algebras .....	337
<i>Josef Niederle and Jan Paseka</i>	
List-Homomorphism Problems on Graphs and Arc Consistency .....	343
<i>Benoit Larose and Adrien Lemaître</i>	
Rosenberg-Type Completeness Criteria for Subclones of Slupecki's Clone .....	349
<i>Agnes Szendrei</i>	
On the Generation of (Minimal) Clones Containing Near-Unanimity Operations .....	355
<i>Sebastian Kerkhoff</i>	

<b>Author Index</b> .....	361
---------------------------	-----