

# Table of Contents

## Theory

On the Quality Gain of $(1, \lambda)$ -ES Under Fitness Noise .....	1
<i>Hans-Georg Beyer and Silja Meyer-Nieberg</i>	
Fitness Distributions and GA Hardness .....	11
<i>Yossi Borenstein and Riccardo Poli</i>	
Experimental Supplements to the Theoretical Analysis of EAs on Problems from Combinatorial Optimization .....	21
<i>Patrick Briest, Dimo Brockhoff, Bastian Degener, Matthias Englert, Christian Gunia, Oliver Heering, Thomas Jansen, Michael Leifhelm, Kai Plociennik, Heiko Röglin, Andrea Schweer, Dirk Sudholt, Stefan Tannenbaum, and Ingo Wegener</i>	
The Ising Model: Simple Evolutionary Algorithms as Adaptation Schemes .	31
<i>Patrick Briest, Dimo Brockhoff, Bastian Degener, Matthias Englert, Christian Gunia, Oliver Heering, Thomas Jansen, Michael Leifhelm, Kai Plociennik, Heiko Röglin, Andrea Schweer, Dirk Sudholt, Stefan Tannenbaum, and Ingo Wegener</i>	
Evolutionary Algorithms with On-the-Fly Population Size Adjustment . . . . .	41
<i>A.E. Eiben, Elena Marchiori, and V.A. Valkó</i>	
Search Space Features Underlying the Performance of Stochastic Local Search Algorithms for MAX-SAT .....	51
<i>Holger H. Hoos, Kevin Smyth, and Thomas Stützle</i>	
Bridging the Gap Between Theory and Practice . . . . .	61
<i>Thomas Jansen and R. Paul Wiegand</i>	
A Reduced Markov Model of GAs Without the Exact Transition Matrix ..	72
<i>Cheah C.J. Moey and Jonathan E. Rowe</i>	
Expected Runtimes of a Simple Evolutionary Algorithm for the Multi-objective Minimum Spanning Tree Problem .....	81
<i>Frank Neumann</i>	
On the Importance of Information Speed in Structured Populations .. . . . .	91
<i>Mike Preuss and Christian Lasarczyk</i>	
Estimating the Number of Solutions for SAT Problems . . . . .	101
<i>Colin R. Reeves and Mériéma Aupetit-Bélaidouni</i>	

Behavior of Evolutionary Algorithms in Chaotically Changing Fitness Landscapes . . . . .	111
<i>Hendrik Richter</i>	
Expected Rates of Building Block Discovery, Retention and Combination Under 1-Point and Uniform Crossover . . . . .	121
<i>Cameron Skinner and Patricia Riddle</i>	
An Analysis of the Effectiveness of Multi-parent Crossover . . . . .	131
<i>Chuan-Kang Ting</i>	
On the Use of a Non-redundant Encoding for Learning Bayesian Networks from Data with a GA . . . . .	141
<i>Steven van Dijk and Dirk Thierens</i>	
Phase Transition Properties of Clustered Travelling Salesman Problem Instances Generated with Evolutionary Computation . . . . .	151
<i>Jano I. van Hemert and Neil B. Urquhart</i>	
A Simple Two-Module Problem to Exemplify Building-Block Assembly Under Crossover . . . . .	161
<i>Richard A. Watson</i>	
Statistical Racing Techniques for Improved Empirical Evaluation of Evolutionary Algorithms . . . . .	172
<i>Bo Yuan and Marcus Gallagher</i>	

## New Algorithms

LS-CMA-ES: A Second-Order Algorithm for Covariance Matrix Adaptation . . . . .	182
<i>Anne Auger, Marc Schoenauer, and Nicolas Vanhaecke</i>	
Learning Probabilistic Tree Grammars for Genetic Programming . . . . .	192
<i>Peter A.N. Bosman and Edwin D. de Jong</i>	
Sequential Sampling in Noisy Environments . . . . .	202
<i>Jürgen Branke and Christian Schmidt</i>	
Evolutionary Continuous Optimization by Distribution Estimation with Variational Bayesian Independent Component Analyzers Mixture Model . .	212
<i>Dong-Yeon Cho and Byoung-Tak Zhang</i>	
Spread of Vector Borne Diseases in a Population with Spatial Structure . .	222
<i>Dominique Chu and Jonathan Rowe</i>	
Hierarchical Genetic Algorithms . . . . .	232
<i>Edwin D. de Jong, Dirk Thierens, and Richard A. Watson</i>	

Migration of Probability Models Instead of Individuals: An Alternative When Applying the Island Model to EDAs .....	242
<i>Luis delaOssa, José A. Gámez, and José M. Puerta</i>	
Comparison of Steady-State and Generational Evolution Strategies for Parallel Architectures .....	253
<i>Razvan Enache, Bernhard Sendhoff, Markus Olhofer, and Martina Hasenjäger</i>	
Control of Bloat in Genetic Programming by Means of the Island Model ..	263
<i>Francisco Fernández de Vega, German Galeano Gil, Juan Antonio Gómez Pulido, and Jose Luis Guisado</i>	
Saving Resources with Plagues in Genetic Algorithms .....	272
<i>Francisco Fernández de Vega, Erik Cantú-Paz, J.I. López, and T. Manzano</i>	
Evaluating the CMA Evolution Strategy on Multimodal Test Functions ...	282
<i>Nikolaus Hansen and Stefan Kern</i>	
Exploring the Evolutionary Details of a Feasible-Infeasible Two-Population GA .....	292
<i>Steven Orla Kimbrough, Ming Lu, and David Harlan Wood</i>	
An Evolutionary Algorithm for the Maximum Weight Trace Formulation of the Multiple Sequence Alignment Problem .....	302
<i>Gabriele Koller and Günther R. Raidl</i>	
A Novel Programmable Molecular Computing Method Based on Signaling Pathways Regulated by Rho-GTPases in Living MDCK Epithelial Mammalian Cells.....	312
<i>Jian-Qin Liu and Katsunori Shimohara</i>	
Empirical Investigations on Parallelized Linkage Identification .....	322
<i>Masaharu Munetomo, Naoya Murao, and Kiyoshi Akama</i>	
The EAX Algorithm Considering Diversity Loss .....	332
<i>Yuichi Nagata</i>	
Topology-Oriented Design of Analog Circuits Based on Evolutionary Graph Generation .....	342
<i>Masanori Natsui, Naofumi Homma, Takafumi Aoki, and Tatsuo Higuchi</i>	
A Mixed Bayesian Optimization Algorithm with Variance Adaptation ....	352
<i>Jiri Ocenasek, Stefan Kern, Nikolaus Hansen, and Petros Koumoutsakos</i>	

A Swarm Intelligence Based VLSI Multiplication-and-Add Scheme . . . . .	362
<i>Danilo Pani and Luigi Raffo</i>	
Distribution Tree-Building Real-Valued Evolutionary Algorithm . . . . .	372
<i>Petr Pošík</i>	
Optimization via Parameter Mapping with Genetic Programming . . . . .	382
<i>Joao C.F. Pujol and Riccardo Poli</i>	
Multi-cellular Development: Is There Scalability and Robustness to Gain? .	391
<i>Daniel Roggen and Diego Federici</i>	
Constrained Evolutionary Optimization by Approximate Ranking and Surrogate Models . . . . .	401
<i>Thomas Philip Runarsson</i>	
Robust Parallel Genetic Algorithms with Re-initialisation . . . . .	411
<i>Ivan Sekaj</i>	
Improving Evolutionary Algorithms with Multi-representation Island Models . . . . .	420
<i>Zbigniew Skolicki and Kenneth De Jong</i>	
A Powerful New Encoding for Tree-Based Combinatorial Optimisation Problems . . . . .	430
<i>Sang-Moon Soak, David Corne, and Byung-Ha Ahn</i>	
Partially Evaluated Genetic Algorithm Based on Fuzzy c-Means Algorithm . . . . .	440
<i>Si-Ho Yoo and Sung-Bae Cho</i>	

## Applications

Metaheuristics for the Vehicle Routing Problem with Stochastic Demands .	450
<i>Leonora Bianchi, Mauro Birattari, Marco Chiarandini, Max Manfrin, Monaldo Mastrolilli, Luis Paquete, Olivia Rossi-Doria, and Tommaso Schiavinotto</i>	
AntHocNet: An Ant-Based Hybrid Routing Algorithm for Mobile Ad Hoc Networks . . . . .	461
<i>Gianni Di Caro, Frederick Ducatelle, and Luca Maria Gambardella</i>	
A Scatter Search Algorithm for the 3D Image Registration Problem . . . . .	471
<i>Oscar Cordón, Sergio Damas, and José Santamaría</i>	
A Hybrid GRASP – Evolutionary Algorithm Approach to Golomb Ruler Search . . . . .	481
<i>Carlos Cotta and Antonio J. Fernández</i>	

Design of an Efficient Search Algorithm for P2P Networks Using Concepts from Natural Immune Systems . . . . .	491
<i>Niloy Ganguly, Geoff Canright, and Andreas Deutsch</i>	
A Novel Ant Algorithm for Solving the Minimum Broadcast Time Problem . . . . .	501
<i>Yehudit Hasson and Moshe Sipper</i>	
Designing Multiple-Use Primer Set for Multiplex PCR by Using Compact GAs . . . . .	511
<i>Yu-Cheng Huang, Han-Yu Chuang, Huai-Kuang Tsai, Chun-Fan Chang, and Cheng-Yan Kao</i>	
Robust Inferential Sensors Based on Ensemble of Predictors Generated by Genetic Programming . . . . .	522
<i>Elsa Jordaan, Arthur Kordon, Leo Chiang, and Guido Smits</i>	
Searching Transcriptional Modules Using Evolutionary Algorithms . . . . .	532
<i>Je-Gun Joung, Sok June Oh, and Byoung-Tak Zhang</i>	
Evolution of Voronoi-Based Fuzzy Controllers . . . . .	541
<i>Carlos Kavka and Marc Schoenauer</i>	
Analyzing Sensor States and Internal States in the Tartarus Problem with Tree State Machines . . . . .	551
<i>DaeEun Kim</i>	
Evolving Genetic Regulatory Networks for Hardware Fault Tolerance . . . . .	561
<i>Arne Koopman and Daniel Roggen</i>	
Evolving Dynamics in an Artificial Regulatory Network Model . . . . .	571
<i>P. Dwight Kuo, André Leier, and Wolfgang Banzhaf</i>	
The Application of Bayesian Optimization and Classifier Systems in Nurse Scheduling . . . . .	581
<i>Jingpeng Li and Uwe Aickelin</i>	
An Evolutionary Approach to Modeling Radial Brightness Distributions in Elliptical Galaxies . . . . .	591
<i>Jin Li, Xin Yao, Colin Frayn, Habib G. Khosroshahi, and Somak Raychaudhury</i>	
Conference Paper Assignment Using a Combined Greedy/Evolutionary Algorithm . . . . .	602
<i>Juan Julián Merelo-Guervós and Pedro Castillo-Valdovieso</i>	
A Primer on the Evolution of Equivalence Classes of Bayesian-Network Structures . . . . .	612
<i>Jorge Muruzábal and Carlos Cotta</i>	

The Infection Algorithm: An Artificial Epidemic Approach for Dense Stereo Matching . . . . .	622
<i>Gustavo Olague, Francisco Fernández de Vega, Cynthia B. Pérez,     and Evelyne Lutton</i>	
Optimising Cancer Chemotherapy Using Particle Swarm Optimisation and Genetic Algorithms . . . . .	633
<i>Andrei Petrovski, Bhavani Sudha, and John McCall</i>	
An Evolutionary Algorithm for Column Generation in Integer Programming: An Effective Approach for 2D Bin Packing . . . . .	642
<i>Jakob Puchinger and Günther R. Raidl</i>	
An Improved Evaluation Function for the Bandwidth Minimization Problem . . . . .	652
<i>Eduardo Rodriguez-Tello, Jin-Kao Hao, and Jose Torres-Jimenez</i>	
Coupling of Evolution and Learning to Optimize a Hierarchical Object Recognition Model . . . . .	662
<i>Georg Schneider, Heiko Wersing, Bernhard Sendhoff,     and Edgar Körner</i>	
Evolution of Small-World Networks of Automata for Computation . . . . .	672
<i>Marco Tomassini, Mario Giacobini, and Christian Darabos</i>	
Recognizing Speed Limit Sign Numbers by Evolvable Hardware . . . . .	682
<i>Jim Torresen, Jorgen W. Bakke, and Lukas Sekanina</i>	
Dynamic Routing Problems with Fruitful Regions: Models and Evolutionary Computation . . . . .	692
<i>Jano I. van Hemert and J.A. La Poutré</i>	
Optimising the Performance of a Formula One Car Using a Genetic Algorithm . . . . .	702
<i>Krzysztof Wloch and Peter J. Bentley</i>	
<b>Multi-objective Optimisation</b>	
An Inexpensive Cognitive Approach for Bi-objective Optimization Using Bliss Points and Interaction . . . . .	712
<i>Hussein A. Abbass</i>	
Finding Knees in Multi-objective Optimization . . . . .	722
<i>Jürgen Branke, Kalyanmoy Deb, Henning Dierolf,     and Matthias Osswald</i>	
Multi-objective Parallel Tabu Search . . . . .	732
<i>Daniel Jaeggli, Chris Asselin-Miller, Geoff Parks, Timoleon Kipouros,     Theo Bell, and John Clarkson</i>	

SPEA2+: Improving the Performance of the Strength Pareto Evolutionary Algorithm 2 . . . . .	742
<i>Mifa Kim, Tomoyuki Hiroyasu, Mitsunori Miki, and Shinya Watanabe</i>	
An Extension of Generalized Differential Evolution for Multi-objective Optimization with Constraints . . . . .	752
<i>Saku Kukkonen and Jouni Lampinen</i>	
Adaptive Weighted Particle Swarm Optimisation for Multi-objective Optimal Design of Alloy Steels . . . . .	762
<i>Mahdi Mahfouf, Min-You Chen, and Derek Arthur Linkens</i>	
Multi-objective Optimisation by Co-operative Co-evolution . . . . .	772
<i>Kuntinee Maneeratana, Kittipong Boonlong, and Nachol Chaiyaratana</i>	
Sequential Process Optimisation Using Genetic Algorithms . . . . .	782
<i>Victor Oduguwa, Ashutosh Tiwari, and Rajkumar Roy</i>	
On Test Functions for Evolutionary Multi-objective Optimization . . . . .	792
<i>Tatsuya Okabe, Yaochu Jin, Markus Olhofer, and Bernhard Sendhoff</i>	
Multi-objective Optimization of a Composite Material Spring Design Using an Evolutionary Algorithm . . . . .	803
<i>Frédéric Ratle, Benoît Lecarpentier, Richard Labib, and François Trochu</i>	
Dominance Based Crossover Operator for Evolutionary Multi-objective Algorithms . . . . .	812
<i>Olga Rudenko and Marc Schoenauer</i>	
Evolutionary Bi-objective Controlled Elevator Group Regulates Passenger Service Level and Minimises Energy Consumption . . . . .	822
<i>Tapio Tyni and Jari Ylinen</i>	
Indicator-Based Selection in Multiobjective Search . . . . .	832
<i>Eckart Zitzler and Simon Künzli</i>	
<b>Co-evolution</b>	
Intransitivity in Coevolution . . . . .	843
<i>Edwin D. de Jong</i>	
Group Transport of an Object to a Target That Only Some Group Members May Sense . . . . .	852
<i>Roderich Groß and Marco Dorigo</i>	
Hawks, Doves and Lifetime Reproductive Success . . . . .	862
<i>Philip Hingston and Luigi Barone</i>	

## XVIII Table of Contents

Evolutionary Multi-agent Systems . . . . .	872
<i>Pieter J. 't Hoen and Edwin D. de Jong</i>	
Credit Assignment Among Neurons in Co-evolving Populations . . . . .	882
<i>Vineet R. Khare, Xin Yao, and Bernhard Sendhoff</i>	
A Visual Demonstration of Convergence Properties of Cooperative Coevolution . . . . .	892
<i>Liviu Panait, R. Paul Wiegand, and Sean Luke</i>	
Cooperative Coevolution of Image Feature Construction and Object Detection . . . . .	902
<i>Mark E. Roberts and Ela Claridge</i>	
Spatial Embedding and Loss of Gradient in Cooperative Coevolutionary Algorithms . . . . .	912
<i>R. Paul Wiegand and Jayshree Sarma</i>	
A High Performance Multi-objective Evolutionary Algorithm Based on the Principles of Thermodynamics . . . . .	922
<i>Xiufen Zou, Minzhong Liu, Lishan Kang, and Jun He</i>	

## Robotics and Multi-agent Systems

Robustness in the Long Run: Auto-teaching <i>vs</i> Anticipation in Evolutionary Robotics . . . . .	932
<i>Nicolas Godzik, Marc Schoenauer, and Michèle Sebag</i>	
A Self-adaptive Neural Learning Classifier System with Constructivism for Mobile Robot Control . . . . .	942
<i>Jacob Hurst and Larry Bull</i>	
An Approach to Evolutionary Robotics Using a Genetic Algorithm with a Variable Mutation Rate Strategy . . . . .	952
<i>Yoshiaki Katada, Kazuhiro Ohkura, and Kanji Ueda</i>	
Translating the Dances of Honeybees into Resource Location . . . . .	962
<i>DaeEun Kim</i>	
Natural Policy Gradient Reinforcement Learning for a CPG Control of a Biped Robot . . . . .	972
<i>Yutaka Nakamura, Takeshi Mori, and Shin Ishii</i>	
Evaluation of Adaptive Nature Inspired Task Allocation Against Alternate Decentralised Multiagent Strategies . . . . .	982
<i>Richard Price and Peter Tiňo</i>	
A Neuroevolutionary Approach to Emergent Task Decomposition . . . . .	991
<i>Jekanthan Thangavelautham and Gabriele M.T. D'Eleuterio</i>	

Evolving the “Feeling” of Time Through Sensory-Motor Coordination: A Robot Based Model .....	1001
<i>Elio Tuci, Vito Trianni, and Marco Dorigo</i>	

## Learning Classifier Systems and Data Mining

An Artificial Immune System for Fuzzy-Rule Induction in Data Mining ..	1011
<i>Roberto T. Alves, Myriam R. Delgado, Heitor S. Lopes, and Alex A. Freitas</i>	
Speeding-Up Pittsburgh Learning Classifier Systems: Modeling Time and Accuracy .....	1021
<i>Jaume Bacardit, David E. Goldberg, Martin V. Butz, Xavier Llorà, and Josep M. Garrell</i>	
A Simple Payoff-Based Learning Classifier System.....	1032
<i>Larry Bull</i>	
Lookahead and Latent Learning in a Simple Accuracy-Based Classifier System .....	1042
<i>Larry Bull</i>	
Knowledge Extraction and Problem Structure Identification in XCS .....	1051
<i>Martin V. Butz, Pier Luca Lanzi, Xavier Llorà, and David E. Goldberg</i>	
Forecasting Time Series by Means of Evolutionary Algorithms .....	1061
<i>Cristóbal Luque del Arco-Calderón, Pedro Isasi Viñuela, and Julio César Hernández Castro</i>	
Detecting and Pruning Introns for Faster Decision Tree Evolution .....	1071
<i>Jeroen Eggermont, Joost N. Kok, and Walter A. Kosters</i>	
Evolutionary Multiobjective Clustering .....	1081
<i>Julia Handl and Joshua Knowles</i>	
Web Page Classification with an Ant Colony Algorithm .....	1092
<i>Nicholas Holden and Alex A. Freitas</i>	
Oneiric Processing Utilising the Anticipatory Classifier System .....	1103
<i>Julian C. Holley, Anthony G. Pipe, and Brian Carse</i>	
Self-organizing Neural Grove: Efficient Multiple Classifier System Using Pruned Self-generating Neural Trees .....	1113
<i>Hirotaka Inoue and Hiroyuki Narahisa</i>	
Evolutionary Multiobjective Knowledge Extraction for High-Dimensional Pattern Classification Problems .....	1123
<i>Hisao Ishibuchi and Satoshi Namba</i>	

XX Table of Contents

Ensemble Learning with Evolutionary Computation: Application to Feature Ranking .....	1133
<i>Kees Jong, Elena Marchiori, and Michèle Sebag</i>	
Fast Unsupervised Clustering with Artificial Ants .....	1143
<i>Nicolas Labroche, Christiane Guinot, and Gilles Venturini</i>	
A Novel Method of Searching the Microarray Data for the Best Gene Subsets by Using a Genetic Algorithm .....	1153
<i>Bin Ni and Juan Liu</i>	
Using Genetic Programming for Feature Creation with a Genetic Algorithm Feature Selector .....	1163
<i>Matthew G. Smith and Larry Bull</i>	
AgentP Model: Learning Classifier System with Associative Perception ..	1172
<i>Zhanna V. Zatuchna</i>	
<b>Author Index .....</b>	1183