

*Commenced Publication in 1973*

Founding and Former Series Editors:

Gerhard Goos, Juris Hartmanis, and Jan van Leeuwen

## Editorial Board

David Hutchison

*Lancaster University, UK*

Takeo Kanade

*Carnegie Mellon University, Pittsburgh, PA, USA*

Josef Kittler

*University of Surrey, Guildford, UK*

Jon M. Kleinberg

*Cornell University, Ithaca, NY, USA*

Alfred Kobsa

*University of California, Irvine, CA, USA*

Friedemann Mattern

*ETH Zurich, Switzerland*

John C. Mitchell

*Stanford University, CA, USA*

Moni Naor

*Weizmann Institute of Science, Rehovot, Israel*

Oscar Nierstrasz

*University of Bern, Switzerland*

C. Pandu Rangan

*Indian Institute of Technology, Madras, India*

Bernhard Steffen

*University of Dortmund, Germany*

Madhu Sudan

*Massachusetts Institute of Technology, MA, USA*

Demetri Terzopoulos

*University of California, Los Angeles, CA, USA*

Doug Tygar

*University of California, Berkeley, CA, USA*

Gerhard Weikum

*Max-Planck Institute of Computer Science, Saarbruecken, Germany*

Nicolas Monmarché El-Ghazali Talbi  
Pierre Collet Marc Schoenauer  
Evelyne Lutton (Eds.)

# Artificial Evolution

8th International Conference  
Evolution Artificielle, EA 2007  
Tours, France, October 29-31, 2007  
Revised Selected Papers

## Volume Editors

Nicolas Monmarché

Ecole Polytechnique de l'Université de Tours, Laboratoire d'Informatique  
64 avenue Jean Portalis, 37200 Tours, France

E-mail: [nicolas.monmarche@univ-tours.fr](mailto:nicolas.monmarche@univ-tours.fr)

El-Ghazali Talbi

Université des Sciences et Technologies de Lille  
Laboratoire d'Informatique Fondamentale de Lille (LIFL)  
Bât. M3, 59655 Villeneuve d'Ascq, France  
E-mail: [el-ghazali.talbi@lifl.fr](mailto:el-ghazali.talbi@lifl.fr)

Pierre Collet

Université Louis Pasteur, Laboratoire des Sciences de l'Image, de l'Informatique et  
de la Télédétection (LSIIT) Strasbourg  
Parc d'innovation, Boulevard Sébastien Brant, BP 10413, 67412 Illkirch, France  
E-mail: [Pierre.Collet@lsiit.u-strasbg.fr](mailto:Pierre.Collet@lsiit.u-strasbg.fr)

Marc Schoenauer

INRIA Saclay - Île-de-France, LRI  
Université de Paris-Sud  
Bât. 490, 91405 Orsay, France  
E-mail: [marc.schoenauer@inria.fr](mailto:marc.schoenauer@inria.fr)

Evelyne Lutton

INRIA Saclay - Île-de-France  
Parc Orsay Université  
4 rue Jacques Monod, 91893 Orsay, France  
E-mail: [evelyne.lutton@inria.fr](mailto:evelyne.lutton@inria.fr)

Library of Congress Control Number: 2008925337

CR Subject Classification (1998): F.1, F.2.2, I.2.6, I.5.1, G.1.6, J.3

LNCS Sublibrary: SL 1 – Theoretical Computer Science and General Issues

ISSN 0302-9743

ISBN-10 3-540-79304-6 Springer Berlin Heidelberg New York

ISBN-13 978-3-540-79304-5 Springer Berlin Heidelberg New York

This work is subject to copyright. All rights are reserved, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, re-use of illustrations, recitation, broadcasting, reproduction on microfilms or in any other way, and storage in data banks. Duplication of this publication or parts thereof is permitted only under the provisions of the German Copyright Law of September 9, 1965, in its current version, and permission for use must always be obtained from Springer. Violations are liable to prosecution under the German Copyright Law.

Springer is a part of Springer Science+Business Media

[springer.com](http://springer.com)

© Springer-Verlag Berlin Heidelberg 2008

Printed in Germany

Typesetting: Camera-ready by author, data conversion by Scientific Publishing Services, Chennai, India  
Printed on acid-free paper SPIN: 12257629 06/3180 5 4 3 2 1 0

# Preface

This book is based on the best papers presented at the 8th Conference on Artificial Evolution, EA<sup>1</sup> 2007, held in Tours (France). Previous EA meetings took place in Lille (2005), Marseille (2003), Le Creusot (2001), Dunkerque (1999), Nimes (1997), Brest (1995), and Toulouse (1994).

Authors were invited to present original work relevant to artificial evolution, including, but not limited to: evolutionary computation, evolutionary optimization, co-evolution, artificial life, population dynamics, theory, algorithms and modeling, implementations, application of evolutionary paradigms to the real world (industry, biosciences, ...), other biologically inspired paradigms (swarm, artificial ants, artificial immune systems, ...), memetic algorithms, multi-objective optimization, constraint handling, parallel algorithms, dynamic optimization, machine learning and hybridization with other soft computing techniques.

Papers submitted to the conference were reviewed by at least three members of the International Program Committee, and 30 out of the 62 submissions were selected to be presented at the Conference. As for the previous editions (see, in the same collection, volumes 1063, 1363, 1829, 2310, 2936, and 3871), 27 of those papers were revised according to the reviewers' comments, and are now included in this volume, resulting in a 43.5% acceptance rate for this volume.

We would like to thank the Program Committee for the conscientious work during the paper selection stage of this conference. We are also very grateful to the Organizing Committee for their efficient work and dedication to provide a pleasant environment for conference attendees. We take this opportunity to thank the different partners whose financial and material support contributed to the success of the conference: PolytechTours, University of Tours, DGA, Ministère de l'Éducation Nationale, de l'Enseignement Supérieur et de la Recherche, City of Tours, INRIA, AFIA, Région Centre, ROADEF, and EA association. Last but not least, we thank all the authors who submitted papers, and the authors of accepted papers for revising and sending their final versions on time.

December 2007

Nicolas Monmarché  
El-Ghazali Talbi  
Pierre Collet  
Marc Schoenauer  
Evelyne Lutton

---

<sup>1</sup> As with previous editions of the conference, the EA acronym is based on the original French name “Évolution Artificielle”.

# **Évolution Artificielle 2007 – EA 2007**

October 29–31, 2007

Université François Rabelais, Tours, France  
8th International Conference on Artificial Evolution

## **Steering Committee**

Pierre Collet, Université Louis Pasteur de Strasbourg, France  
Evelyne Lutton, INRIA Futurs, France  
Nicolas Monmarché, Université François Rabelais de Tours, France  
Marc Schoenauer, INRIA Futurs, France  
El-Ghazali Talbi, Université de Lille 1, France

## **Organizing Committee**

Sébastien Aupetit, Laboratoire d’Informatique, Université de Tours, France  
Romain Clair, Laboratoire d’Informatique, Université de Tours, France  
Sonia Colas, Laboratoire d’Informatique, Université de Tours, France  
Colette Gatefait, Laboratoire d’Informatique, Université de Tours, France  
Pierre Gaucher, Laboratoire d’Informatique, Université de Tours, France  
Thierry Henocque, Laboratoire d’Informatique, Université de Tours, France  
Nicolas Monmarché, Laboratoire d’Informatique, Université de Tours, France  
Arnaud Puret, Laboratoire d’Informatique, Université de Tours, France  
Alexis Sepchat, Laboratoire d’Informatique, Université de Tours, France  
Mohamed Slimane, Laboratoire d’Informatique, Université de Tours, France

## **Program Committee**

Anne Auger, INRIA, France  
Sébastien Aupetit, LI, Université de Tours, France  
Christian Blum, ALBCOM, Universitat Politècnica de Catalunya, Spain  
Jürgen Branke, Institute AIFB, University of Karlsruhe, Germany  
Nicolas Bredèche, INRIA, France  
Edmund Kieran Burke, University of Nottingham, UK  
Stefano Cagnoni, Università di Parma, Italy  
Alexandre Caminada, UTBM, Laboratoire SET, France  
Erick Cantu-Paz, Yahoo! Inc., USA  
Uday K. Chakraborty, University of Missouri St. Louis, USA  
Alastair Channon, University of Birmingham, UK  
Carlos A. Coello Coello, CINVESTAV-IPN, Mexico

## VIII Organization

Philippe Collard, Laboratoire I3S UNSA-CNRS, France  
Pierre Collet, LSIIT, Université de Strasbourg, France  
Daniel Delahaye, Air Navigation Research Center, France  
Clarisse Dhaenens, LIFL - University of Lille, France  
Nicolas Durand, DSNA/R&D, France  
Marc Ebner, Universität Würzburg, Germany  
Cyril Fonlupt, LIL - Université du Littoral - Côte d'Opale, France  
Marian Gheorghe, University of Sheffield, UK  
Jean-Louis Giavitto, IBISC - CNRS & Université d'Evry, France  
Jens Gottlieb, SAP AG, Germany  
Manuel Graña, Universidad del País Vasco, Spain  
Steven Gustafson, GE Global Research, USA  
Jin-Kao Hao, Université d'Angers, France  
Laetitia Jourdan, INRIA Futurs/LIFL, France  
Petros Kefalas, City College, Thessaloniki, Greece  
Natalio Krasnogor, University of Nottingham, UK  
Nicolas Lassabe, IRIT/UT1, France  
Claude Lattaud, Université René Descartes Paris 5, France  
Pierre Liardet, Université de Provence, France  
Jean Louchet, INRIA, France  
Evelyne Lutton, INRIA, France  
Nouredine Melab, INRIA Futurs, Université de Lille1, France  
Zbigniew Michalewicz, University of Adelaide, Australia  
Nicolas Monmarché, LI, Université de Tours, France  
Miguel Nicolau, INRIA, France  
Gabriela Ochoa, University of Nottingham, UK  
Gustavo Olague, CICESE, Mexico  
Martin Pelikan, University of Missouri in St. Louis, USA  
David Alejandro Pelta, University of Granada, Spain  
Philippe Preux, LIFL, Université de Lille, France  
Gnther Raidl, Vienna University of Technology, Austria  
Jean-Philippe Rennard, GEM, France  
Celso Ribeiro, Universidade Federal Fluminense, Brazil  
Denis Robilliard, LIL - Université Littoral Cote d'Opale, France  
Guenter Rudolph, University of Dortmund, Germany  
Marc Schoenauer, INRIA, France  
Michele Sebag, CNRS, France  
Patrick Siarry, Université de Paris 12, France  
Terence Soule, University of Idaho, USA  
Antoine Spicher, Université d'Evry, France  
Thomas Stuetzle, IRIDIA, Université Libre de Bruxelles, Belgique  
Hideyuki Takagi, Kyushu University, Japan  
El-Ghazali Talbi, LIFL - Lille, France  
German Terrazas Angulo, University of Nottingham, UK  
Olivier Teytaud, INRIA, France

Shigeyoshi Tsutsui, Hannan University, Japan  
Shengxiang Yang, University of Leicester, UK  
Eckart Zitzler, ETH, Switzerland

## Invited Talks

Adaptive Business Intelligence, Zbigniew Michalewicz  
Puzzle Based Learning (Invited Tutorial), Zbigniew Michalewicz

## Sponsoring Institutions

École Polytechnique de l'Université de Tours  
Université François Rabelais de Tours  
Conseil Régional du Centre  
Ville de Tours  
Institut National de Recherche en Informatique et en Automatique (INRIA)  
Délégation Générale pour l'Armement (DGA)  
Ministère de l'Éducation Nationale de l'Enseignement Supérieur et de la Recherche  
Association Française d'Intelligence Artificielle (AFIA)  
Société française de Recherche Opérationnelle et Aide à la Décision (ROADEF)

# Table of Contents

## Genetic Programming

Treating Noisy Data Sets with Relaxed Genetic Programming . . . . .	1
<i>Luis Da Costa, Jacques-André Landry, and Yan Levasseur</i>	
Cost-Benefit Investigation of a Genetic-Programming Hyperheuristic . . . . .	13
<i>Robert E. Keller and Riccardo Poli</i>	
Automatic Design of Vision-Based Obstacle Avoidance Controllers Using Genetic Programming . . . . .	25
<i>Renaud Barate and Antoine Manzanera</i>	
Generating SAT Local-Search Heuristics Using a GP Hyper-Heuristic Framework . . . . .	37
<i>Mohamed Bader-El-Den and Riccardo Poli</i>	

## Swarm Intelligence

Magnetic Resonance Image Segmentation Based on Two-Dimensional Exponential Entropy and a Parameter Free PSO . . . . .	50
<i>Amir Nakib, Yann Cooren, Hamouche Oulhadj, and Patrick Siarry</i>	
Mimetic Variations on Stigmergic Swarm Paintings . . . . .	62
<i>Paulo Urbano</i>	
Minimal and Necessary Conditions for the Emergence of Species-Specific Recognition Patterns . . . . .	73
<i>Nicolas Brodu</i>	
Artificial Ants for the Optimization of Virtual Keyboard Arrangement for Disabled People . . . . .	87
<i>Sonia Colas, Nicolas Monmarché, Pierre Gaucher, and Mohamed Slimane</i>	

## Combinational and Multi-objective Optimization

Self-organization and Evolution Combined to Address the Vehicle Routing Problem . . . . .	100
<i>Jean-Charles Créput and Abderrafiaâ Koukam</i>	
An Evolutionary Algorithm for the Block Stacking Problem . . . . .	112
<i>Tim Hohm, Matthias Egli, Samuel Gaehwiler, Stefan Bleuler, Jonathan Feller, Damian Frick, Richard Huber, Mathias Karlsson, Reto Lingenhag, Thomas Ruetimann, Tom Sasse, Thomas Steiner, Janine Stocker, and Eckart Zitzler</i>	

A Study of Evaluation Functions for the Graph K-Coloring Problem . . . . .	124
<i>Daniel Cosmin Porumbel, Jin-Kao Hao, and Pascale Kuntz</i>	
Genetic Branch-and-Bound or Exact Genetic Algorithm? . . . . .	136
<i>Cédric Pessan, Jean-Louis Bouquard, and Emmanuel Néron</i>	
Aerodynamic Topology Optimisation Using an Implicit Representation and a Multiobjective Genetic Algorithm . . . . .	148
<i>Windo Hutabarat, Geoffrey T. Parks, Jerome P. Jarrett, William N. Dawes, and P. John Clarkson</i>	
Direct and Indirect Representations for Evolutionary Design of Objects . . . . .	160
<i>Juraj Plavcan and Pavel Petrovic</i>	
Adaptive and Assortative Mating Scheme for Evolutionary Multi-Objective Algorithms . . . . .	172
<i>Khoi Le and Dario Landa-Silva</i>	
<b>Theory in GA and ES</b>	
The Cooperative Royal Road: Avoiding <i>Hitchhiking</i> . . . . .	184
<i>Gabriela Ochoa, Evelyne Lutton, and Edmund Burke</i>	
Conditioning, Halting Criteria and Choosing $\lambda$ . . . . .	196
<i>Olivier Teytaud</i>	
Log-Linear Convergence and Optimal Bounds for the $(1 + 1)$ -ES . . . . .	207
<i>Mohamed Jebalia, Anne Auger, and Pierre Liardet</i>	
<b>Applications of EAs</b>	
Evolution Strategies for Laser Pulse Compression . . . . .	219
<i>Riccardo Fanciulli, Lars Willmes, Janne Savolainen, Peter van der Walle, Thomas Bäck, and Jennifer L. Herek</i>	
Fully Three-Dimensional Tomographic Evolutionary Reconstruction in Nuclear Medicine . . . . .	231
<i>Aurélie Bousquet, Jean Louchet, and Jean-Marie Rocchisani</i>	
A Study of Crossover Operators for Gene Selection of Microarray Data . . . . .	243
<i>Jose Crispin Hernandez Hernandez, Béatrice Duval, and Jin-Kao Hao</i>	
Searching for Glider Guns in Cellular Automata: Exploring Evolutionary and Other Techniques . . . . .	255
<i>Emmanuel Sapin and Larry Bull</i>	

A Genetic Algorithm for Generating Improvised Music . . . . .	266
<i>Ender Özcan and Türker Erçal</i>	
Unsupervised Learning of Echo State Networks: A Case Study in Artificial Embryogeny . . . . .	278
<i>Alexandre Devert, Nicolas Bredeche, and Marc Schoenauer</i>	
Enhanced Genetic Algorithm with Guarantee of Feasibility for the Unit Commitment Problem . . . . .	291
<i>Guillaume Sandou, Stéphane Font, Sihem Tebbani, Arnaud Hiret, and Christian Mondon</i>	
On the Design of Adaptive Control Strategies for Evolutionary Algorithms . . . . .	303
<i>Jorge Maturana and Frédéric Saubion</i>	
Improvement of Intelligent Optimization by an Experience Feedback Approach . . . . .	316
<i>Paul Pitiot, Thierry Coudert, Laurent Geneste, and Claude Baron</i>	
<b>Author Index . . . . .</b>	329