

# GECCO-2002

*Proceedings of the Genetic and  
Evolutionary Computation Conference*

*A Joint Meeting of the Seventh Annual Genetic Programming  
Conference (GP-2002) and the Eleventh International  
Conference on Genetic Algorithms (ICGA-2002)*

July 9–13, 2002

New York City, New York

*Edited by*

W. B. Langdon

E. Cantú-Paz

K. Mathias

R. Roy

D. Davis

R. Poli

K. Balakrishnan

V. Honavar

G. Rudolph

J. Wegener

L. Bull

M. A. Potter

A. C. Schultz

J. F. Miller

E. Burke

N. Jonoska

**MORGAN KAUFMANN PUBLISHERS  
SAN FRANCISCO, CALIFORNIA**

All-electronic production, design, type, and manufacturing management  
provided by Professional Book Center, Denver, Colorado

Cover logo by Gerardo Valencia and Gabriela Coronado

Cover design by Professional Book Center, Denver, Colorado

Morgan Kaufmann Publishers

Editorial Office:

340 Pine St., 6th Floor

San Francisco, CA 94104

E-mail: [mkp@mkp.com](mailto:mkp@mkp.com)

<http://www.mkp.com>

Ph: 800-745-7323 or 415-392-2665

ISBN 1-55860-878-8

Copyright © 2002 by Morgan Kaufmann Publishers

All rights reserved.

Printed in the United States

No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means—electronic, mechanical, photocopying, recording, or otherwise without the prior written permission of the publisher.

05 04 03 02 4 3 2 1

# PREFACE

These proceedings contain the papers presented at the fourth annual Genetic and Evolutionary Computation conference (GECCO-2002). The conference was held in New York City, July 9–13, 2002.

The GECCO series of international conferences are a unique series of events, drawing together in one time and place (and proceedings) the increasing diversity of evolutionary computational techniques. The conference is a truly global event, which this year attracted submissions from more than 27 countries across all continents. Although GECCO-2002 was the union of the Seventh Annual Genetic Programming Conference and the Eleventh International Conference on Genetic Algorithms, it included leading edge scientific work on many strands of research (from artificial life to software engineering from ant systems to scheduling, from evolutionary programming to philosophy), as well as real world applications and industrial computing. It is sponsored by the International Society for Genetic and Evolutionary Computation (ISGEC), and presented in cooperation with the American Association for Artificial Intelligence (AAAI).

In addition to the presentation of papers (these proceedings) the conference included 13 workshops, 29 tutorials by leading specialists in each field and presentation of “late breaking papers.”

The first GECCO conference, in 1999, combined the International Conference on Genetic Algorithms (which had met biennially since 1985) and the Genetic Programming Conference (then in its fourth year of annual meetings) to produce a single larger meeting, bringing together researchers from the many diverse research areas that together comprise the field of genetic and evolutionary computation. The conference was a success and the following year brought not only GECCO-2000 but also a new organization, the International Society for Genetic and Evolutionary Computation (ISGEC), with a mission to run the GECCO conference and to support the field in several other ways. These include support for the *Evolutionary Computation* and *Genetic Programming and Evolvable Machines* journals as well as the intimate biennial “Foundations of Genetic Algorithms” workshop on theoretical aspects of all evolutionary computation algorithms. This year has brought the link to *Journal of Hydroinformatics*. Details about ISGEC can be found on-line at <http://www.isgrec.org/>.

There are several innovations this year. First, these proceedings are available electronically in CD-ROM format. Second, the new Evolutionary Computing in Industry track (which has its

own proceedings). ECI was specifically designed to deal with both learning and disseminating widely within commerce and manufacturing the numerous benefits of using all manner of evolutionary approaches to solve practical problems. Third, the introduction of best at GECCO prizes.

In spite of world events the number of submissions to this the fourth GECCO conference is only marginally down (within 10%) on last year. This is strong support for the combined conference, and I am sure there will be many more GECCOs to come. Planning for GECCO-2003, to be held in Chicago, 12–16 July, is already underway (details will be available from <http://www.isgrec.org/>).

The ISGEC by-laws contain explicit guidance on the organization of the conference, including the following principles:

- (i) The GECCO conference shall be a broad-based conference encompassing the whole field of genetic and evolutionary computation.
- (ii) Papers will be published and presented as part of the main conference proceedings only after being peer reviewed. No invited papers shall be published (except for those of up to three invited plenary speakers).
- (iii) The peer review process shall be conducted consistent with the principle of division of powers performed by a multiplicity of independent program committees, each with expertise in the area of the paper being reviewed.
- (iv) The determination of the policy for the peer review process for each of the conference’s independent program committees and the reviewing of papers for each program committee shall be performed by persons who occupy their positions by virtue of meeting objective and explicitly stated qualifications based on their previous scientific research activity.
- (v) Emerging areas within the field of genetic and evolutionary computation shall be actively encouraged and incorporated in the activities of the conference by providing a semi-automatic method for their inclusive into the activities of the conference (with some procedural flexibility being extended to such emerging new areas).
- (vi) The percentage of submitted papers that are accepted as regular papers (i.e., papers other than one-page poster papers) shall not exceed 50%.

These principles, along with the time and energy contributed by many people to ensure that they were upheld, are largely

responsible for the success of the conference and for the diversity and high quality of the papers in these proceedings.

A total of 322 papers were submitted for double blind scientific peer review. Of these, 160 were accepted for full publication and presentation at the conference, resulting in an acceptance rate of 50%. An additional 70 papers were accepted for poster presentation at the conference (with single-page abstracts in these proceedings).

Many people worked hard to make this conference a reality. In particular the following people deserve the gratitude of the entire genetic and evolutionary computation community for their outstanding contributions to the GECCO conference:

- General Chair, Erick Cantú-Paz, and Business committee members, David Goldberg and John Koza for tireless guidance on every aspect of the organization and administration of the conference.
- Past conference organizers Lee Spector, Erik Goodman, and Darrell Whitley.
- Melinda Allred, Elizabeth Ericson, Carol Hamilton, and Erin Hogan (who stepped in at a critical juncture) of the AAI for outstanding efforts staffing and administering the conference.
- Gerardo Valencia for web programming and design.
- Kumara Sastry as the electronic publicity chair.
- The staff of Professional Book Center.
- The staff of Morgan Kaufmann Publishers.
- Sponsors who made generous contributions to support student travel grants:
  - Naval Research Laboratory
  - American Association for Artificial Intelligence
  - Philips Research
  - Air Force Office of Scientific Research
  - DaimlerChrysler

In the distributed organization of GECCO, the track chairs are critical and deserve special thanks:

- Artificial life, Adaptive behavior, Agents & Ant Colony Optimization: Karthik Balakrishnan and Vasant Honavar
- DNA and Molecular Computing: Natasha Jonoska
- Evolutionary Robotics: Mitchell A. Potter and Alan C. Schultz

- Evolvable Hardware: Julian Miller
- Evolutionary Scheduling & Routing: Edmund Burke
- Evolution Strategies & Evolutionary Programming: Guenter Rudolph
- Genetic Algorithms: Keith Mathias
- Genetic Programming: Riccardo Poli
- Learning Classifier Systems: Larry Bull
- Methodology, Pedagogy, and Philosophy: Erick Cantú-Paz
- Real World Applications: Rajkumar Roy and David Davis
- Search-based Software Engineering: Joachim Wegener

The conference was held in cooperation and/or affiliation with:

- The American Association for Artificial Intelligence (AAAI).
- Evonet: The Network of Excellence in Evolutionary Computation
- The Fourth NASA/DoD Workshop on Evolvable Hardware (EH-2002)
- The Parallel Problem-Solving From Nature conferences (PPSN)
- *Evolutionary Computing*
- *Genetic Programming and Evolvable Machines*
- *Journal of Scheduling*
- *International Journal of Hydroinformatics*

The most important contributions to this conference, however, were made by the researchers who submitted their work, reviewed the work of others, presented tutorials, organized workshops, made suggestions to the organizers, and participated in countless other ways in the preparations for the conference. GECCO is the fruit of the collective efforts of a large and diverse community of researchers, all of whom should be proud of the exciting conference they helped to create.

*W. B. Langdon, Proceedings Editor-in-Chief  
GECCO-2002  
Computer Science  
University College, London*

# GECCO-2002 CONFERENCE ORGANIZATION

## CONFERENCE COMMITTEE

General Chair, Erick Cantú-Paz, *Lawrence Livermore National Laboratory*

Proceedings Editor-in-Chief, William B. Langdon, *University College, London*

Business Committee

David Goldberg, *University of Illinois*

John Koza, *Stanford University*

Program Committee Chairs

Genetic Programming: Riccardo Poli, *University of Essex*

Genetic Algorithms: Keith Mathias, *TRW*

Evolutionary Strategies and Evolutionary Programming:  
Guenter Rudolph, *Parsytec Computer GmbH, Germany*

Real World Applications: Rajkumar Roy, *Cranfield University*;  
David Davis, *Nutech Solutions, Inc.*

Alife, Adaptive Behavior, Agents, and Ant Colonies:

Vasant Honavar, *Iowa State University*;

Karthik Balakrishnan, *Fireman's Fund Insurance Company*

DNA and Molecular Computing: Natasha Jonoska,  
*University of South Florida*

Evolutionary Computing in Industry: David Davis, *Nutech Solutions, Inc.*; Rajkumar Roy, *Cranfield University*

Evolutionary Robotics: Mitchell A. Potter, *Naval Research Laboratory*; Alan C. Schultz, *Naval Research Laboratory*

Evolutionary Scheduling and Routing: Edmund Burke,  
*University of Nottingham*

Evolvable Hardware: Julian Miller, *University of Birmingham, UK*

Learning Classifier Systems: Larry Bull, *University of the West of England*

Methodology, Pedagogy, and Philosophy: Erick Cantú-Paz,  
*Lawrence Livermore National Laboratory*

Search-Based Software Engineering: Joachim Wegener,  
*DaimlerChrysler AG*

Workshops Chair: Alwyn Barry, *Bath University*

## WORKSHOP ORGANIZERS

Alwyn Barry (workshop coordinator)

Wolfgang Banzhaf and James A. Foster, *Biological Applications of Evolutionary Computation*

Peter J. Bentley, *ISGEC Workshop on Standards*

Claudio Bonacina, Cefn Hoile, Paul Marrow, and Robert E. Smith, *Evolutionary Computation and Multi-Agent Systems (ECOMAS 2002)*

Peter Cowling and Graham Kendall, *Scheduling: Bringing Together Theory and Practice*

Yaochu Jin, Sushil J. Louis, and Khaled M. Rasheed,  
*Approximation and Learning in Evolutionary Computation*

Sibylle Mueller, Nicol Schraudolph, and Petros Koumoutsakos,  
*Learning and Adaptation in Evolutionary Computation*

Michael O'Neill and Conor Ryan, *Grammatical Evolution Workshop (GEWS 2002)*

Ian Parmee, *Towards Interactive Evolutionary Search and Exploration Systems*

Franz Rothlauf, *Representations for Genetic and Evolutionary Algorithms*

Rajkumar Roy and Ashutosh Tiwari, *Evolutionary Computing for Optimisation in Industry*

Oswaldo Velez-Langs, Angelica de Antonio, and Ricardo Imbert Paredes, *Intelligent Interface and Interactive Agents Through Evolutionary Computation (IIATEC)*

R. Paul Wiegand and Kenneth A. De Jong, *Understanding Coevolution: Theory and Analysis of Coevolutionary Algorithms*

Sean Luke, Conor Ryan, and Maarten Keijzer, *Graduate Student Workshop*

## TUTORIAL SPEAKERS

Peter J. Bentley, *Creative Evolutionary Systems*

Erick Cantú-Paz, *Parallel Genetic Algorithms*

Carlos Coello, *Multiobjective Genetic Algorithms*

Dipankar Dasgupta, *Immune System Computing*

Kenneth De Jong, *Evolutionary Computation: A Unified Overview*

David E. Goldberg, *Design of competent Genetic Algorithms*

David Grierson and P. Hajela, *Evolution of Engineered Structures*

Robert Heckendorn, *Introduction to Genetic Algorithms*

Tetsuya Higuchi, *Evolvable Hardware*

Christian Jacob, *Visualization in Evolutionary Computation*

Charles Karr, *Introduction to Adaptive Geno-Fuzzy Systems*

John Koza, *Introduction to Genetic Programming*

W. B. Langdon and R. Poli, *Genetic Programming Theory I & II*

Barbara Minsker and Patrick Reed, *Making Genetic Algorithms work in the real world: Guidelines from competent Genetic Algorithms theory*  
Martin Middendorf, *Ant Colony Optimization*  
Martin Pelikan, *Probabilistic Model Building Genetic Algorithms*  
Daniel Polani and Thomas Uthmann, *Evolution of Sensors*  
Ingo Rechenberg, *Bionics: Building on Bio-Evolution*  
Ingo Rechenberg, *Introduction to Evolution Strategies*  
Peter Ross, *Evolutionary Scheduling & Routing*  
Jonathan Rowe, *Genetic Algorithms Theory*  
Conor Ryan and Michael O'Neill, *Grammatical Evolution*

Sonia Schulemburg, *Modelling Real & Artificial Financial Markets*  
Mitchell A. Potter and Alan C. Schultz, *Evolutionary Robotics*  
Lee Spector, *Quantum Computing for Genetic Programming*  
Wolfgang Stolzmann and Pier Luca Lanzi, *Introduction to Classifier Systems*  
Joachim Wegener and Mark Harman, *Software Testing via Evolutionary Computing*  
Darrell Whitley, *Beyond No Free Lunch theorem*  
Annie S. Wu, *Genetics 101*

# MEMBERS OF THE PROGRAM COMMITTEE

|                          |                          |                           |                      |
|--------------------------|--------------------------|---------------------------|----------------------|
| Emile Aarts              | Brian Carse              | Marco Dorigo              | Andreas Geyer-Schulz |
| Jesus S. Aguilar-Ruiz    | Weng Tat Chan            | Leandro dos Santos Coelho | Robert Ghana-Hercock |
| Hernan E. Aguirre        | Junghuei Chen            | Kathryn A. Dowsland       | Royston Goodacre     |
| Akiko Aizawa             | Shu-Heng Chen            | Gerry Dozier              | Erik D. Goodman      |
| Javier Alcaraz Soria     | Yen-Wei Chen             | Nicole Drechsler          | V. Scott Gordon      |
| Lee Altenberg            | Runwei Cheng             | Rolf Drechsler            | Jens Gottlieb        |
| Martyn Amos              | Olivier Chocron          | Stefan Droste             | Buster Green         |
| P. P. Angelov            | P. Chongstitvatana       | Rémy Dupas                | Garry Greenwood      |
| Dirk Arnold              | John Clark               | Michael G. Dyer           | John Grefenstette    |
| Daniel Ashlock           | Manuel Clergue           | Marc Ebner                | Hans-Gerhard Groß    |
| Vladan Babovic           | David A. Coley           | Peter Eggenberger         | Darko Grundler       |
| Thomas Bäck              | Philippe Collard         | A. E. Eiben               | Pauline Haddow       |
| Karthik Balakrishnan     | Pierre Collet            | Norberto Eiji Nawa        | Vasant Honavar       |
| Helio J. C. Barbosa      | Silvano P. Colombano     | Anikó Ekárt               | Hisashi Handa        |
| Alwyn Barry              | Clare Bates Congdon      | Michael Emmerich          | David Harlan Wood    |
| Theodore C. Belding      | Oscar Cerdón             | Hector Erives             | Mark Harman          |
| Fevzi Belli              | David Corne              | Larry J. Eshelman         | William E. Hart      |
| Michael Bender           | Luis Correia             | Matthew Evett             | Inman Harvey         |
| Adam Prügel-Bennett      | Ernesto Costa            | Francine Federman         | Robert B. Heckendorn |
| Keith Bennett            | Peter Cowling            | Francisco Fernández       | Francisco Herrera    |
| Peter J. Bentley         | Frederick L. Crabbe      | Bogdan Filipic            | Jeffrey W. Herrmann  |
| Tommaso F. Bersano-Begey | B. G. W. Craenen         | Peter John Fleming        | Jürgen Hesser        |
| Hans-Georg Beyer         | Kelly D. Crawford        | Stuart Flockton           | Rob Hierons          |
| David Binkley            | Joseph Culberson         | Dario Floreano            | John H. Holmes       |
| Jacek Blazewicz          | Keshav Dahal             | Terence C. Fogarty        | Tadashi Horiuchi     |
| Andrea Bonarini          | Rajarshi Das             | Gianluigi Folino          | Jeffrey Horn         |
| Lashon Booker            | Dipankar Dasgupta        | Cyril Fonlupt             | Daniel Howard        |
| Peter A. N. Bosman       | Kerstin Dautenhahn       | Carlos M. Fonseca         | Hitoshi Iba          |
| Leonardo Botacci         | David Davis              | Stephanie Forrest         | Christian Igel       |
| Klaus Bothe              | Ivanoe De Falco          | Stan Franklin             | Hisao Ishibuchi      |
| Juergen Branke           | Hugo de Garis            | Alex A. Freitas           | Masaya Iwata         |
| Wilker Shane Bruce       | Paulo A. de Souza        | Chunsheng Fu              | Christian Jacob      |
| Peter Brucker            | Anthony G. Deakin        | Alex Fukunaga             | Cezary Z. Janikow    |
| Bill P. Buckles          | Kalyanmoy Deb            | John C. Gallagher         | Thomas Jansen        |
| Edmund K. Burke          | A. Santos del Riego      | Michael L. Gargano        | Fernando Jiménez     |
| Martin Butz              | Antonio Della Cioppa     | Josep M. Garrell i Guiu   | Yaochu Jin           |
| Stefano Cagnoni          | Dirk Devogelaere         | Max H. Garzon             | Bryan Jones          |
| Xiaoqiang Cai            | José Javier Dolado Cosín | Alessio Gaspar            | Natasha Jonoska      |
| Erick Cantú-Paz          | Julian Dorado            | Michel Gendreau           | Aguilar Jose         |

|                         |                            |                                |                         |
|-------------------------|----------------------------|--------------------------------|-------------------------|
| Bryant A. Julstrom      | Jean-Arcady Meyer          | Hartmut Pohlheim               | Jane Shaw               |
| M. A. Kaboudan          | Christoph Michael          | Marie-Claude Portmann          | John W. Sheppard        |
| Janusz Kacprzyk         | Zbigniew Michalewicz       | Walter D. (Don) Potter         | Martin Shepperd         |
| T. G. Kalganova         | Martin Middendorf          | Jean-Yves Potvin               | Hisashi Shimodaira      |
| Lila Kari               | Risto Miikkulainen         | Alexander Pretschner           | Olivier Sigaud          |
| Charles L. Karr         | Mitsunori Miki             | Joao Carlos F. Pujol           | Anabela Simões          |
| Sanza T. Kazadi         | Julian Miller              | Bill Punch                     | Mark C. Sinclair        |
| Maarten Keijzer         | Chilukuri K. Mohan         | A B Rad                        | Moshe Sipper            |
| Didier Keymeulen        | Francesco Mondada          | Amr Radi                       | Jim Smith               |
| Michael Kirley          | David Montana              | Günther Raidl                  | Robert E. Smith         |
| Joshua Knowles          | Byung-Ro Moon              | Khaled M. Rasheed              | Alan Soper              |
| Mario Koeppen           | Frank W. Moore             | V J Rayward-Smith              | Andreas Spillner        |
| Tim Kovacs              | J. Manuel Moreno Arostegui | Colin Richard Reeves           | Louis Steinberg         |
| Natalio Krasnogor       | Heinz Muehlenbein          | Marek Reformat                 | Chris Stephens          |
| Thiemo Krink            | Masaharu Munetomo          | John Reif                      | Soraya Rana Stevens     |
| Sam Kwong               | Kazuyuki Murase            | Robert G. Reynolds             | Harmen Sthamer          |
| W. B. Langdon           | Tadahiko Murata            | Rick Riolo                     | Adrian Stoica           |
| Pier Luca Lanzi         | Zensho Nakao               | José Cristóbal Riquelme Santos | Wolfgang Stolzmann      |
| Gilbert Laporte         | Tomoharu Nakashima         | Juan Romero                    | Thomas Stützle          |
| Jesper Larsen           | Bart Naudts                | Marc Roper                     | Joe Suzuki              |
| Claude Le Pape          | Mircea GH Negoita          | Justinian Rosca                | Gil Syswerda            |
| Kemal Leblebiciođlu     | Filippo Neri               | Alejandro Rosete-Suárez        | Keiki Takadama          |
| Martin Lefley           | Stefano Nolfi              | Peter Ross                     | Uwe Tangen              |
| K. S. Leung             | Peter Nordin               | Franz Rothlauf                 | Ernesto Tarantino       |
| Ik Soo Lim              | Bryan A. Norman            | Jonathan E. Rowe               | Gianluca Tempesti       |
| C. T. Lin               | Wim Nuijten                | Rajkumar Roy                   | Hugo Terashima-Marin    |
| Derek S. Linden         | Martin J Oates             | Elizabeth M. Rudnick           | Sam R. Thangiah         |
| Fernando G. Lobo        | Gabriela Ochoa             | Conor Ryan                     | Dirk Thierens           |
| Jason Lohn              | Markus Olhofer             | Kazuhiro Saitou                | Adrian Thompson         |
| Sushil J. Louis         | Bjorn Olsson               | Ralf Salomon                   | Ashutosh Tiwari         |
| José A. Lozano          | Michael O'Neill            | Nobuo Sannomiya                | Marco Tomassini         |
| Manuel Lozano           | Ibrahim H. Osman           | Eugene Santos Jr.              | Andy Tomlinson          |
| Sean Luke               | Ben Paechter               | Kumara Sastry                  | Vassili Toropov         |
| Eduard Lukschandl       | Charles C. Palmer          | Yuji Sato                      | Jim Torresen            |
| Evelyne Lutton          | Jan Paredis                | Hidefumi Sawai                 | Paolo Toth              |
| Spiros Mancoridis       | Domenico Parisi            | J. David Schaffer              | Michael Trick           |
| Bernard Manderick       | Gary Parker                | Hartmut Schmeck                | Edward Tsang            |
| Elena Marchiori         | I. C. Parmee               | Marc Schoenauer                | Yasuhiro Tsujimura      |
| W. N. Martin            | Witold Pedrycz             | Lutz Schoenemann               | Shigeyoshi Tsutsui      |
| Carlos Martin-Vide      | Martin Pelikan             | Sonia Schulenburg              | Andy M. Tyrrell         |
| Dirk Christian Mattfeld | Francisco Baptista Pereira | Michele Sebag                  | Thomas Uthmann          |
| Nicholas Freitag McPhee | Marek Perkowski            | Nadrian C. Seeman              | Manuel Vazquez-Outomuro |
| Lisa Meeden             | Sanja Petrovic             | Sandip Sen                     | Oswaldo Vélez-Langs     |
| Filippo Menczer         | Frederick Petry            | Bernhard Sendhoff              | J. L. Verdegay          |
| Ole J. Mengshoel        | Chrisila Pettey            | Franciszek Seredynski          | Hans-Michael Voigt      |
| Anil Menon              | Rolf Pfeifer               | Jonathan L. Shapiro            | Michael D. Vose         |
| Juan J. Merelo Guervós  | Fernando Moura Pires       |                                | Israel A. Wagner        |



Roger L. Wainwright  
Juergen Wakunda  
Jean-Paul Watson  
Richard A. Watson  
Ingo Wegener  
Joachim Wegener  
Karsten Weicker  
Nicole Weicker

P. A. Whigham  
Darrell Whitley  
R. Paul Wiegand  
Kay C. Wiese  
Dirk Wiesmann  
Wendy Williams  
Stewart W. Wilson  
Mark Wineberg

Man Leung Wong  
Alden H. Wright  
Annie S. Wu  
Zheng Yi Wu  
Masayuki Yamamura  
Jihoon Yang  
Moritoshi Yasunaga  
John Yen

Tina Yu  
YoungSu Yun  
Ricardo S. Zebulum  
Andreas Zell  
Byoung-Tak Zhang  
Gengui Zhou

# A WORD FROM THE CHAIR OF ISGEC

To those of you just picking up your proceedings at GECCO-2002, welcome to what we believe will be a very exciting chance to exchange ideas about evolutionary computation in its many forms! To those of you who were unable to participate in person in GECCO-2002, I hope you will find these proceedings useful in conveying the exciting advances going on in genetic and evolutionary computation today.

The International Society for Genetic and Evolutionary Computation, sponsoring organization of the annual GECCO conferences, is a young organization, formed through merger of the International Society for Genetic Algorithms (sponsor of the ICGA conferences) and the organization responsible for the annual Genetic Programming Conferences. It depends strongly on the voluntary efforts of many of its members. It is designed to promote not only exchange of ideas among innovators and practitioners of well-known methods such as genetic algorithms, genetic programming, evolution strategies, evolutionary programming, learning classifier systems, etc., but also the growth of newer areas such as artificial immune systems, evolvable hardware, agent-based search, and others. One of the founding principles is that ISGEC operates as a confederation of groups with related but distinct approaches and interests, and their mutual prosperity is assured by their representation in the program committees, editorial boards, etc., of the conferences and journals with which ISGEC is associated. This also insures that ISGEC and its functions continue to improve and evolve with the diversity of innovation that has characterized our field.

The year since GECCO-2001 has seen many changes in our society and in the world. The tragic events of September 11, 2001, certainly caused the leaders of GECCO-2002 to reconsider the siting of the meeting in New York City, as was initially decided before June, 2001. The organizers have chosen to assert their belief that our members and participants would not want to abandon New York in the face of terrorist acts, but rather to demonstrate support for New York as part of the global resolve that terrorism shall not dominate our lives.

The ISGEC has also seen many changes this year, in addition to its growth in membership. David Goldberg's term as the first chair of ISGEC ended in November, 2001, when I was elected to succeed him by the ISGEC's Executive Board. I hope all of you who have been ISGEC members during these first few years understand and appreciate the skill and effort Dave has devoted to nurturing of this new organization—it has not been an easy task. Three members were elected to new five-year terms on the Executive Board at GECCO-2001—Prof. John

Holland and Prof. Darrell Whitley were re-elected to the Board, and Prof. Dr.-Ing. Ingo Rechenberg was newly elected. Since that time, the ISGEC has been active on many issues, through actions of the Board and the three Councils—the Council of Authors, Council of Editors, and Council of Conferences.

The ISGEC:

- has decided that it will continue its sponsorship of the biennial FOGA (Foundations of Genetic Algorithms) workshop, with a strong effort to encourage broad participation by theorists from all areas of evolutionary computation
- has created Best Papers Awards for GECCO, with nominations by reviewers and selection by attendees at GECCO
- is creating ISGEC Fellows and Senior Fellows (for those over the age of 45 years) of the ISGEC, in order to recognize major and long-term contributors to our field, beginning a process that will continue with annual election of two new Fellows and two new Senior Fellows
- has continued to support the two journals, *Evolutionary Computation* and *Genetic Programming and Evolvable Machines*, to which all ISGEC members receive an annual subscription
- continues to seek additional benefits for its members, such as the discounted subscription rates already available from the *Journal of Scheduling* and the *Journal of Hydroinformatics*
- continues to seek better ways to coordinate with organizers of other conferences in this and related fields, so that potential participants can benefit from co-located or nearby conferences in adjacent time periods, to maximize the utility of their travel budgets

The organizers of GECCO-2002 are shown in this front matter, but special thanks are due to Erick Cantú-Paz, General Chair, and Bill Langdon, Editor-in-Chief of the Proceedings, as well as to John Koza and Dave Goldberg, the Business Committee. This year, they have worked to create a new feature for the proceedings—a CD-ROM will now accompany the printed volume. We hope this availability of GECCO proceedings in digital form will prove to be useful for GECCO participants and those who later purchase the proceedings. The Real-World Applications track has also been expanded with the creation of a new track for Evolutionary Computing in

Industry, in an effort to make GECCO participation more attractive to our colleagues in industry. Dave Davis and Rajkumar Roy deserve special thanks for spearheading this effort. This type of continual re-invention is an important component in assuring the future success of GECCO and ISGEC.

Of course, we all owe a great debt to those who chaired or served on the various Core and Special Program Committees that reviewed all of the papers for GECCO-2002. Without their effort, it would not be possible to put on a meeting of this quality. Another group also deserves the thanks of GECCO participants and ISGEC members—the members of the ISGEC Executive Board and Councils, who are listed on the next page. I am particularly indebted to them for their thoughtful contributions to the organization and their continuing demonstrations of concern for the welfare of the ISGEC.

I invite you to communicate with me ([goodman@egr.msu.edu](mailto:goodman@egr.msu.edu)) if you have questions or suggestions for ways ISGEC can be of greater service to its members, or if you would like to get more involved in ISGEC and its functions.

Finally, I hope you will join us at GECCO-2003 in Chicago, July 12–16 (Saturday–Wednesday), 2003. Please check the ISGEC web site, [www.isgrec.org](http://www.isgrec.org), for the details as the planning continues.

*Sincerely,*  
*Erik D. Goodman*  
*ISGEC Chair*

**ISGEC EXECUTIVE BOARD**

Erik D. Goodman (chair), *Michigan State University*  
 David Andre, *University of California–Berkeley*  
 Wolfgang Banzhaf, *University of Dortmund*  
 Kalyanmoy Deb, *Indian Institute of Technology–Kanpur*  
 Kenneth DeJong, *George Mason University*  
 Terence C. Fogarty, *South Bank University, London*  
 David E. Goldberg, *University of Illinois at Urbana–Champaign*  
 John H. Holland, *University of Michigan & Sante Fe Institute*  
 Hitoshi Iba, *University of Tokyo*  
 John R. Koza, *Stanford University*  
 Una-May O’Reilly, *Massachusetts Institute of Technology*  
 Ingo Rechenberg, *Technical University of Berlin*  
 Marc Schoenauer, *Ecole Polytechnique*  
 Lee Spector, *Hampshire College*  
 Darrell Whitley, *Colorado State University*

**COUNCIL OF AUTHORS**

David Andre, *University of California–Berkeley*  
 Plamen P. Angelov, *Dept of Civil and Build Engineering,  
 Loughborough University*  
 Vladan Babovic, *Danish Hydraulic Institute*  
 Wolfgang Banzhaf, *University of Dortmund*  
 Forrest H Bennett III, *Pharmix Corporation*  
 Hans-Georg Beyer, *Dept. of Computer Science XI, University of  
 Dortmund*  
 Juergen Branke, *University of Karlsruhe*  
 Martin Butz, *University of Illinois at Urbana–Champaign*  
 Erick Cantú-Paz, *Center for Applied Scientific Computing,  
 Lawrence Livermore National Laboratory*  
 Runwei Cheng, *Ashikaga Institute of Technology, Japan*  
 David A. Coley, *University of Exeter*  
 Marco Dorigo, *IRIDIA, Université Libre de Bruxelles*  
 Rolf Drechsler, *University of Bremen, Germany*  
 Emanuel Falkenauer, *Optimal Design & Brussels University ULB*  
 Stephanie Forrest, *University of New Mexico*  
 Mitsuo Gen, *University of California–Berkeley, USA & Ashikaga  
 Institute of Technology, Japan*  
 Andreas Geyer-Schulz, *Universität Karlsruhe (TH)*  
 David E. Goldberg, *University of Illinois at Urbana–Champaign*  
 Jens Gottlieb, *SAP AG, Germany*  
 Wolfgang A. Halang, *Fernuniversitaet*  
 John H. Holland, *University of Michigan & Sante Fe Institute*  
 Hitoshi Iba, *University of Tokyo*  
 Christian Jacob, *University of Calgary*  
 Robert E. Keller, *University of Leiden*  
 Dimitri Knjazew, *SAP, Germany*  
 John R. Koza, *Stanford University*

Sam Kwong City, *University of Hong Kong*  
 W. B. Langdon, *University College, London*  
 Dirk C. Mattfeld, *University of Bremen*  
 Pinaki Mazumder, *University of Michigan*  
 Zbigniew Michalewicz, *University of North Carolina at  
 Charlotte*  
 Melanie Mitchell, *Los Alamos National Laboratory*  
 Ian Parmee, *University of the West of England & Ad-Comtech*  
 Frederick E. Petry, *Tulane University*  
 Riccardo Poli, *University of Essex*  
 Moshe Sipper, *Ben-Gurion University, Israel*  
 William M. Spears, *University of Wyoming, Laramie*  
 Wallace K. S. Tang, *City University of Hong Kong*  
 Adrian Thompson, *University of Sussex, UK*  
 Michael D. Vose, *University of Tennessee*  
 Man Leung Wong, *Lingnan University, Hong Kong*

**COUNCIL OF EDITORS**

Peter J. Bentley (chair), *University College, London*  
 Edmund Burke, *University of Nottingham*  
 Lance D. Chambers, *Western Australian Department of Transport*  
 Dipankar Dasgupta, *University of Memphis*  
 Francisco Herrera, *University of Granada, Spain*  
 Pinaki Mazumder, *University of Michigan*  
 Eric Michielssen, *University of Illinois at Urbana–Champaign*  
 Witold Pedrycz, *University of Alberta*  
 Elizabeth M. Rudnick, *University of Illinois at Urbana–  
 Champaign*  
 Lee Spector, *Hampshire College*  
 Jose L. Verdegay, *University of Granada, Spain*  
 Darrell Whitley, *Colorado State University*

**COUNCIL OF CONFERENCES**

James A. Foster (chair)  
 foster@cs.uidaho.edu

The purpose of the ISGEC Council of Conferences is to provide information about the many conferences that are available to researchers in the field of Genetic and Evolutionary Computation, and to encourage them to co-ordinate their meetings so as to maximize our collective impact on science.

ACDM Adaptive Computing in Design and Manufacture,  
 April 2003, Edinburgh, Scotland, Ian Parmee  
 (iparmee@ad-comtech.co.uk)

ALIFE Artificial Life, 9–13 December 2002, Sydney, Australia,  
 Russell Standish (R.Standish@unsw.edu.au)

ECAL European Conference on Artificial Life, September,  
 2003, Germany, Wolfgang Banzhaf  
 (banzhaf@cs.uni-dortmund.de)

EH Conference on Evolvable Hardware, 15–18 July 2002  
Washington, D.C., Adrian Stoica  
(adrian.stoica@jpl.nasa.gov)

EuroGP European Conference on Genetic Programming,  
14–16 April 2003, Essex, UK, Terence Soule  
(tsoule@cs.uidaho.edu)

EvoWorkshops Evolutionary Computation Workshops,  
14–16 April 2003, Essex, UK, Stefano Cagnoni  
(cagnoni@ce.unipr.it) and Gunther Raidl  
(raidl@ads.tuwien.ac.at)

FOGA Foundations of Genetic Algorithms, 4–6 September  
2002, Torremolinos, Spain, Ken De Jong  
(kdejong@gmu.edu)

GECCO Genetic and Evolutionary Computation Conference,  
12–16 July 2003, Chicago, James A. Foster  
(foster@cs.uidaho.edu)

ICES Evolvable Systems: From Biology To Hardware,  
18–20 March 2003, Trondheim, Norway, Andrew M Tyrrell  
(amt@ohm.york.ac.uk)

PPSN Parallel Problem Solving from Nature, 7–11 September  
2002, Granada, Spain, J. J. Merelo (jmerelo@geneura.ugr.es)

IWLCS International Workshop on Learning Classifier Sys-  
tems, 7–8 September 2002, Granada, Spain, Wolfgang  
Stolzmann (Wolfgang.Stolzmann@DaimlerChrysler.com)

Please notify the COC chair (James A. Foster at  
foster@cs.uidaho.edu) of additions.

# PAPERS NOMINATED FOR BEST AT GECCO PRIZE

As part of the “double blind” scientific peer review, the following papers were nominated for consideration by the conference for a “Best at GECCO” prize. The final winners were chosen after these papers had been presented in New York by secret ballot of the GECCO registrants.

- Dynamic Search with Charged Swarms, *T. M. Blackwell and P. J. Bentley*, 19
- Intelligent Packets for Dynamic Network Routing Using Distributed Genetic Algorithm, *Suihong Liang, A. Nur Zincir-Heywood, and Malcolm I. Heywood*, 88
- A DNA-based three-state device, *Bernard Yurke and Friedrich C. Simmel*, 147
- Lens System Design and Re-Engineering with Evolutionary Algorithms, *Julie Beaulieu, Christian Gagné, and Marc Parizeau*, 155
- A Modified Compact Genetic Algorithm for the Intrinsic Evolution of Continuous Time Recurrent Neural Networks, *John C. Gallagher and Saranyan Vigrham*, 163
- On The Convergence Properties of a Simple Self-Adaptive Evolutionary Algorithm, *John DeLaurentis, Lauren Ferguson, and William E. Hart*, 229
- An Analysis of the Role of Offspring Population Size in EAs, *Thomas Jansen and Kenneth De Jong*, 238
- On the Dynamics of Evolutionary Multi-Objective Optimisation, *Tatsuya Okabe, Yaochu Jin, and Bernhard Sendhoff*, 247
- A Permutation Genetic Algorithm for Variable Ordering in Learning Bayesian Networks from Data, *William H. Hsu, Haipeng Guo, Benjamin B. Perry, and Julie A. Stilson*, 383
- Archiving with Guaranteed Convergence and Diversity in Multi-Objective Optimization, *Marco Laumanns, Lothar Thiele, Eckart Zitzler, and Kalyanmoy Deb*, 439
- A Comparison of Two Competitive Fitness Functions, *Liviu Panait and Sean Luke*, 503
- Voronoi Quantized Crossover for Traveling Salesman Problem, *Dong-Il Seo and Byung-Ro Moon*, 544
- Efficient Reinforcement Learning through Evolving Neural Network Topologies, *Kenneth O. Stanley and Risto Miikkulainen*, 569
- A re-examination of the Cart Centering problem using the Chorus system, *R. Muhammad Atif Azad, Conor Ryan, Mark E. Burke, Ali R. Ansari*, 707
- A Survey and Analysis of Diversity Measures in Genetic Programming, *Edmund Burke, Steven Gustafson, and Graham Kendall*, 716
- Genetic Programming and Multi-Agent Layered Learning by Reinforcements, *William H. Hsu and Steven M. Gustafson*, 764
- Is the Perfect the Enemy of the Good?, *Sean Luke and Liviu Panait*, 820
- On the Search Biases of Homologous Crossover in Linear Genetic Programming and Variable-length Genetic Algorithms, *Riccardo Poli, Christopher R. Stephens, Alden H. Wright, and Jonathan E. Rowe*, 868
- Hyper-heuristics: learning to combine simple heuristics in bin-packing problems, *Peter Ross, Sonia Schulenburg, Javier G. Marín-Blázquez, and Emma Hart*, 942
- Evolutionary Computation as a Form of Organization, *Alexander Kosorukoff and David Goldberg*, 965
- Genetic Algorithms and Fine-Grained Topologies for Optimization, *Xiaotong Wang, Lawrence Davis, and Chunsheng Fu*, 981
- Evolving Neural Networks for the Classification of Galaxies, *Erick Cantú-Paz and Chandrika Kamath*, 1019
- Gaphyl: An Evolutionary Algorithms Approach for the Study of Natural Evolution, *Clare Bates Congdon*, 1057
- A Genetic Hybrid for Critical Heat Flux Function Approximation, *Yung-Keun Kwon, Sung-Deok Hong, and Byung-Ro Moon*, 1119
- Adaptive Reconfiguration of Data Networks Using Genetic Algorithms, *David Montana, Talib Hussain, and Tushar Saxena*, 1141
- Application of Genetic Algorithms to the Discovery of Complex Models for Simulation Studies in Human Genetics, *Jason H. Moore, Lance W. Hahn, Marylyn D. Ritchie, Tricia A. Thornton, and Bill C. White*, 1150
- Creation of a Learning, Flying Robot by Means of Evolution, *Peter Augustsson, Krister Wolff, and Peter Nordin*, 1279
- A Savings based Ant System for the Vehicle Routing Problem, *Marc Reimann, Michael Stummer, and Karl Doerner*, 1317
- Improving Evolutionary Testing by Flag Removal, *Mark Harman, Lin Hu, Robert Hierons, André Baresel, and Harmen Sthamer*, 1359
- Search Heuristics, Case-Based Reasoning and Software Project Effort Prediction, *Colin Kirsopp, Martin Shepperd, and John Hart*, 1367

# CONTENTS

## ARTIFICIAL LIFE, ADAPTIVE BEHAVIOR, AGENTS AND ANT COLONY OPTIMIZATION

|  |     |
|--|-----|
| Coverage and Generalization in an Artificial Immune System<br><i>Justin Balthrop, Fernando Esponda, Stephanie Forrest, and Matthew Glickman</i> . . . . .            | 3   |
| A Racing Algorithm for Configuring Metaheuristics<br><i>Mauro Birattari, Thomas Stützle, Luis Paquete, and Klaus Varrentrapp</i> . . . . .                           | 11  |
| Dynamic Search with Charged Swarms<br><i>T. M. Blackwell and P. J. Bentley</i> . . . . .   | 19  |
| Ant Colony Optimization for the Edge-Weighted $k$ -Cardinality Tree Problem<br><i>Christian Blum</i> . . . . .   | 27  |
| On a Particularity in Model-Based Search<br><i>Christian Blum, Michael Sampels, and Mark Zlochin</i> . . . . .   | 35  |
| An Ant System Algorithm for Graph Bisection<br><i>Thang N. Bui and Lisa C. Strite</i> . . . . .  | 43  |
| The Evolution of Variable Learning Rates<br><i>John A. Bullinaria</i> . . . . .  | 52  |
| Adaptive Control utilising Neural Swarming<br><i>Alex v. E. Conradie, Risto Miikkulainen, and Christiaan Aldrich</i> . . . . .                                       | 60  |
| Particle Swarm Optimization Applied to the Atomic Cluster Optimization Problem<br><i>R. J. W. Hodgson</i> . . . . .  | 68  |
| Option Valuation with Generalized Ant Programming<br><i>Christian Keber and Matthias G. Schuster</i> . . . . .   | 74  |
| Effects of Agent Representation on the Behavior of a Non-Reciprocal Cooperation Game<br><i>Nicole P. Leahy</i> . . . . .   | 82  |
| Intelligent Packets for Dynamic Network Routing Using Distributed Genetic Algorithm<br><i>Suibong Liang, A. Nur Zincir-Heywood, and Malcolm I. Heywood</i> . . . . . | 88  |
| Agent Support for Genetic Search in an Immunological Model of Sparse Distributed Memory<br><i>Keith E. Mathias and Jason S. Byassee</i> . . . . .                    | 97  |
| Studies on the Dynamics of Ant Colony Optimization Algorithms<br><i>Daniel Merkle and Martin Middendorf</i> . . . . .  | 105 |
| Continual Coevolution through Complexification<br><i>Kenneth O. Stanley and Risto Miikkulainen</i> . . . . .   | 113 |

|   |     |
|---|-----|
| Cross-Validation in Multiagent-based Simulation: Analyzing Evolutionary Bargaining Agents<br><i>Keiki Takadama, Yutaka L. Suematsu, Norberto E. Nawa, and Katsunori Shimohara</i> . . . . . | 121 |
|---|-----|

## ARTIFICIAL LIFE, ADAPTIVE BEHAVIOR, AGENTS AND ANT COLONY OPTIMIZATION POSTER PAPERS

|   |     |
|---|-----|
| Ant Algorithm for Construction of Evolutionary Tree<br><i>Shin Ando and Hitoshi Iba</i> . . . . .   | 131 |
| Behavioural Selection Pressure Generates Hierarchical Genetic Regulatory Networks<br><i>Josh C. Bongard and Rolf Pfeifer</i> . . . . .    | 132 |
| Solving Approximation Problems by Ant Colony Programming<br><i>Mariusz Boryczka and Zbigniew J. Czech</i> . . . . .                       | 133 |
| Evolution of Asynchronous Cellular Automata: Finding the Good Compromise<br><i>Mathieu S. Capcarrere</i> . . . . .                        | 134 |
| An Ant Colony Approach for The Steiner Tree Problem<br><i>Sanjoy Das, Shekhar V. Gosavi, William H. Hsu, and Shilpa A. Vaze</i> . . . . . | 135 |
| An Individual-Based Approach to Multi-level Selection<br><i>T. Lenaerts, A. Defaweux, P. van Remortel, and B. Manderick</i> . . . . .     | 136 |

## DNA AND MOLECULAR COMPUTING

|  |     |
|--|-----|
| Algorithmic Self-Assembly of DNA Tiles and its Application to Cryptanalysis<br><i>Olivier Pelletier and André Weimerskirch</i> . . . . . | 139 |
| A DNA-based three-state device<br><i>Bernard Yurke and Friedrich C. Simmel</i> . . . . .   | 147 |

## EVOLVABLE HARDWARE

|   |     |
|---|-----|
| Lens System Design and Re-Engineering with Evolutionary Algorithms<br><i>Julie Beaulieu, Christian Gagné, and Marc Parizeau</i> . . . . .                                 | 155 |
| A Modified Compact Genetic Algorithm for the Intrinsic Evolution of Continuous Time Recurrent Neural Networks<br><i>John C. Gallagher and Saranyan Vigrabam</i> . . . . . | 163 |
| Evolving Fault Tolerance on an Unreliable Technology Platform<br><i>Morten Hartmann, Frode Eskelund, Pauline C. Haddow, and Julian F. Miller</i> . . . . .                | 171 |

|   |     |  |     |
|---|-----|--|-----|
| An Evolvable Micro-controller or what's new about mutations?<br><i>Uwe Tangen</i> . . . . .   | 178 | Efficient Discretization Scheduling in Multiple Dimensions<br><i>Laura A. Albert and David E. Goldberg</i> . . . . .   | 271 |
| <b>EVOLVABLE HARDWARE POSTER PAPER</b>  |     | Eugenic Evolution Utilizing a Domain Model<br><i>Matthew Alden, Aard-Jan van Kesteren, and Risto Miikkulainen</i> . . . . .  | 279 |
| An Improved Genetic Algorithm for the Inference of Finite State Machine<br><i>Nattee Niparnan and Prabhas Chongstitvatana</i> . . . . .   | 189 | An adaptive penalty scheme in genetic algorithms for constrained optimization problems<br><i>Helio J. C. Barbosa and Afonso C. C. Lemonge</i> . . . . .                                    | 287 |
| <b>EVOLUTIONARY PROGRAMMING</b>   |     | Expediting Genetic Search with Dynamic Memory<br><i>Jason S. Byassee and Keith E. Mathias</i> . . . . .  | 295 |
| Evolutionary Programming Based Stratified Design Space Sampling<br><i>Brian K. Beachkofski and Gary B. Lamont</i> . . . . .   | 193 | Feature Subset Selection by Estimation of Distribution Algorithms<br><i>Erick Cantú-Paz</i> . . . . .  | 303 |
| Adding Knowledge and Efficient Data Structures to Evolutionary Programming: A Cultural Algorithm for Constrained Optimization<br><i>Carlos A. Coello Coello and Ricardo Landa Becerra</i> . . . . . | 201 | On Random Numbers and the Performance of Genetic Algorithms<br><i>Erick Cantú-Paz</i> . . . . .  | 311 |
| Convergence velocity of an evolutionary algorithm with self-adaptation<br><i>Mikhail A. Semenov</i> . . . . .   | 210 | Fitness Inheritance in Multi-Objective Optimization<br><i>Jian-Hung Chen, David E. Goldberg, Shinn-Ying Ho, and Kumara Sastry</i> . . . . .  | 319 |
| A Hybrid Data Mining Approach to Discover Bayesian Networks Using Evolutionary Programming<br><i>Man Leung Wong, Shing Yan Lee, and Kwong Sak Leung</i> . . . . .                                   | 214 | Isomorphism, Normalization, and a Genetic Algorithm for Sorting Network Optimization<br><i>Sung-Soon Choi and Byung-Ro Moon</i> . . . . .  | 327 |
| <b>EVOLUTIONARY PROGRAMMING POSTER PAPER</b>  |     | More Effective Genetic Search for the Sorting Network Problem<br><i>Sung-Soon Choi and Byung-Ro Moon</i> . . . . .   | 335 |
| Search Step Size Control in Fast Evolutionary Programming<br><i>Yong Liu and Xin Yao</i> . . . . .  | 225 | Evolutionary Concept Learning<br><i>Federico Divina and Elena Marchiori</i> . . . . .  | 343 |
| <b>EVOLUTION STRATEGIES</b>   |     | The Effect of Cost Distributions on Evolutionary Optimization Algorithms<br><i>César Galindo-Legaria and Florian Waas</i> . . . . .  | 351 |
| On The Convergence Properties of a Simple Self-Adaptive Evolutionary Algorithm<br><i>John DeLaurentis, Lauren Ferguson, and William E. Hart</i> . . . . .   | 229 | Genetic Algorithms: Combining Evolutionary and 'Non'-Evolutionary Methods in Tracking Dynamic Global Optima<br><i>Simon M. Garrett and Joanne H. Walker</i> . . . . .                      | 359 |
| An Analysis of the Role of Offspring Population Size in EAs<br><i>Thomas Jansen and Kenneth De Jong</i> . . . . .   | 238 | A Genetic Algorithm with Self-Distancing Bits but No Overt Linkage<br><i>William A. Greene</i> . . . . .   | 367 |
| On the Dynamics of Evolutionary Multi-Objective Optimisation<br><i>Tatsuya Okabe, Yaochu Jin, and Bernhard Sendhoff</i> . . . . .   | 247 | Exploring the Parameter Space of a Genetic Algorithm for Training an Analog Neural Network<br><i>Steffen G. Hohmann, Johannes Schemmel, Felix Schürmann, and Karlheinz Meier</i> . . . . . | 375 |
| <b>EVOLUTION STRATEGIES POSTER PAPER</b>  |     | A Permutation Genetic Algorithm for Variable Ordering in Learning Bayesian Networks from Data<br><i>William H. Hsu, Haipeng Guo, Benjamin B. Perry, and Julie A. Stilson</i> . . . . .     | 383 |
| Co-evolution with the Bierwirth-Mattfeld hybrid scheduler<br><i>David J. John</i> . . . . .   | 259 | Balancing Learning and Evolution<br><i>Michael Hüsken and Christian Igel</i> . . . . .   | 391 |
| <b>GENETIC ALGORITHMS</b>   |     | Fuzzy Rule Selection by Data Mining Criteria and Genetic Algorithms<br><i>Hisao Ishibuchi and Takashi Yamamoto</i> . . . . .   | 399 |
| Partnering Strategies for Fitness Evaluation in a Pyramidal Evolutionary Algorithm<br><i>Uwe Aickelin and Larry Bull</i> . . . . .  | 263 |  |     |



|   |     |  |     |
|---|-----|--|-----|
| Neuron Reordering for Better Neuro-Genetic Hybrids<br><i>Jung-Hwan Kim and Byung-Ro Moon</i> . . . . .  | 407 | Genetic Algorithms, Efficiency Enhancement, and<br>Deciding Well with Differing Fitness Bias Values<br><i>Kumara Sastry and David E. Goldberg</i> . . . . .  | 536 |
| Exploring a Two-Market Genetic Algorithm<br><i>Steven O. Kimbrough, Ming Lu, David Harlan Wood,<br/>and D. J. Wu</i> . . . . .  | 415 | Voronoi Quantized Crossover for Traveling<br>Salesman Problem<br><i>Dong-Il Seo and Byung-Ro Moon</i> . . . . .  | 544 |
| MOCS: Multi-Objective Clustering Selection<br>Evolutionary Algorithm<br><i>Thomas E. Koch and Andreas Zell</i> . . . . .  | 423 | Robust Evolutionary Algorithms with Toroidal Search<br>Space Conversion for Function Optimization<br><i>Hiroshi Someya and Masayuki Yamamura</i> . . . . .   | 553 |
| Evaluation of the Constraint Method-Based<br>Multiobjective Evolutionary Algorithm (CMEA) for a<br>Three-Objective Optimization Problem<br><i>Sujay V. Kumar and S. Ranji Ranjithan</i> . . . . . | 431 | Jumping Genes-Mutators Can Rise Efficacy of<br>Evolutionary Search<br><i>Alexander V. Spirov and Alexander B. Kazansky</i> . . . . .   | 561 |
| Archiving with Guaranteed Convergence and Diversity<br>in Multi-Objective Optimization<br><i>Marco Laumanns, Lothar Thiele, Eckart Zitzler,<br/>and Kalyanmoy Deb</i> . . . . .                   | 439 | Efficient Reinforcement Learning through Evolving<br>Neural Network Topologies<br><i>Kenneth O. Stanley and Risto Miikkulainen</i> . . . . .   | 569 |
| Maintaining Population Diversity by Minimizing<br>Mutual Information<br><i>Yong Liu and Xin Yao</i> . . . . .   | 448 | Exact Results from a Coarse Grained Formulation of<br>the Dynamics of Variable-length Genetic Algorithms<br><i>Christopher R. Stephens, Riccardo Poli,<br/>Alden H. Wright, and Jonathan E. Rowe</i> . . . . . | 578 |
| Increasing Robustness of Genetic Algorithm<br><i>Jiangming Mao, Kotaro Hirasawa, Jinglu Hu,<br/>and Junichi Murata</i> . . . . .  | 456 | Strategy Parameter Variety in Self-Adaptation of<br>Mutation Rates<br><i>Christopher Stone and Jim Smith</i> . . . . .   | 586 |
| The Point of Point Crossover: Shuffling To Randomness<br><i>Anil Menon</i> . . . . .  | 463 | A Simple Method for Detecting Domino<br>Convergence and Identifying Salient Genes Within<br>a Genetic Algorithm<br><i>Hal Stringer and Annie S. Wu</i> . . . . .   | 594 |
| A Comparison of Memetic Recombination Operators<br>for the Traveling Salesman Problem<br><i>Peter Merz</i> . . . . .  | 472 | Variable Dependence Interaction and Multi-objective<br>Optimisation<br><i>Ashutosh Tiwari and Rajkumar Roy</i> . . . . .   | 602 |
| How Random Generator Quality Impacts Genetic<br>Algorithm Performance<br><i>Mark M. Meysenburg, Dan Hoelting,<br/>Duane McElvain, and James A. Foster</i> . . . . .                               | 480 | Applying Genetic Algorithms to Finding the Optimal<br>Gene Order in Displaying the Microarray Data<br><i>Huai-Kuang Tsai, Jinn-Moon Yang,<br/>and Cheng-Yan Kao</i> . . . . .                                  | 610 |
| LINKGAUGE: Tackling hard deceptive problems with<br>a new linkage learning genetic algorithm<br><i>Miguel Nicolau and Conor Ryan</i> . . . . .  | 488 | Combining Competitive and Cooperative Coevolution<br>for Training Cascade Neural Networks<br><i>Alexander F. Tulai and Franz Oppacher</i> . . . . .  | 618 |
| Setting the Mutation Rate: Scope and Limitations of<br>the $1/L$ Heuristic<br><i>Gabriela Ochoa</i> . . . . .   | 495 | From TwoMax to the Ising Model: Easy and Hard<br>Symmetrical Problems<br><i>Clarissa Van Hoyweghen, David E. Goldberg,<br/>and Bart Naudts</i> . . . . .   | 626 |
| A Comparison of Two Competitive Fitness Functions<br><i>Liviu Panait and Sean Luke</i> . . . . .  | 503 | Simulating Gender Separation with Genetic Algorithms<br><i>Dana Vrajitoru</i> . . . . .  | 634 |
| Combining the Strengths of the Bayesian Optimization<br>Algorithm and Adaptive Evolution Strategies<br><i>Martin Pelikan, David E. Goldberg,<br/>and Shigeyoshi Tsutsui</i> . . . . .             | 512 | A Fixed Point Analysis of a Gene Pool GA<br>with Mutation<br><i>Alden H. Wright, Jonathan E. Rowe, Riccardo Poli,<br/>and Christopher R. Stephens</i> . . . . .  | 642 |
| Why use Elitism and Sharing in a Multi-Objective<br>Genetic Algorithm?<br><i>Robin C. Purshouse and Peter J. Fleming</i> . . . . .  | 520 | Adaptive Non-Uniform Crossover Based on Statistics<br>for Genetic Algorithms<br><i>Shengxiang Yang</i> . . . . .   | 650 |
| Genetic Algorithms, Efficiency Enhancement, and<br>Deciding Well with Differing Fitness Variances<br><i>Kumara Sastry and David E. Goldberg</i> . . . . .   | 528 |  |     |

|   |     |  |     |
|---|-----|--|-----|
| An Enhanced Annealing Genetic Algorithm for Multi-Objective Optimization Problems<br><i>Zhong-Yao Zhu and Kwong-Sak Leung</i> . . . . .   | 658 | Vehicle Routing Problem: Doing it the Evolutionary Way<br><i>Penousal Machado, Jorge Tavares, Francisco B. Pereira, and Ernesto Costa</i> . . . . .  | 690 |
| Why Quality Assessment of Multiobjective Optimizers Is Difficult<br><i>Eckart Zitzler, Marco Laumanns, Lothar Thiele, Carlos M. Fonseca, and Viviane Grunert da Fonseca</i> . . . . . | 666 | A Genetic Algorithm-Specific Test of Random Generator Quality<br><i>Mark M. Meysenburg, Dan Hoelting, Duane McElwain, and James A. Foster</i> . . . . .  | 691 |
| <b>GENETIC ALGORITHMS POSTER PAPERS</b>   |     | Controlling Genetic Algorithms with Reinforcement Learning<br><i>James E. Pettinger and Richard M. Everson</i> . . . . .   | 692 |
| Evolution of adaptive discretization intervals for rule-based genetic learning system<br><i>Jaume Bacardit and Josep M. Garrell</i> . . . . .   | 677 | An Integrated System for Phylogenetic Inference using Evolutionary Algorithms<br><i>Oclair Prado and Fernando J. Von Zuben</i> . . . . .   | 693 |
| Influences of Clustering modifications on the performance of the Genetic Algorithm driven Clustering algorithm<br><i>Dirk Devogelaere and Marcel Rijckaert</i> . . . . .              | 678 | A Genetic Algorithm for Improved Shellsort Sequences<br><i>Robert S. Roos, Tiffany Bennett, Jennifer Hannon, and Elizabeth Zehner</i> . . . . .  | 694 |
| Preserving Diversity in Changing Environments through Diploidy with Adaptive Dominance<br><i>A. Sima Etaner-Uyar and A. Emre Harmanci</i> . . . . .                                   | 679 | The Influence of Binary Representations of Integers on the Performance of Selectorecombinative Genetic Algorithms<br><i>Franz Rothlauf</i> . . . . .   | 695 |
| Genetic Algorithm Wrappers for Feature Subset Selection in Supervised Inductive Learning<br><i>William H. Hsu, Cecil P. Schmidt, and James A. Louis</i> . . . . .                     | 680 | Genetic Algorithm Based Adaptive Control of an Electromechanical MIMO System<br><i>Ivan Sekaj, Martin Foltin, and Michal Gonos</i> . . . . .   | 696 |
| A Markov Chain Analysis of Fitness Proportional Mate Selection Schemes in Genetic Algorithm<br><i>Chien-Feng Huang</i> . . . . .  | 681 | Parametric Study to Enhance Genetic Algorithm's Performance when Using Transformation<br><i>Anabela Simões and Ernesto Costa</i> . . . . .   | 697 |
| A Study of Fitness Proportional Mate Selection Schemes in Genetic Algorithms<br><i>Chien-Feng Huang</i> . . . . .   | 682 | Using GAs to Deal with Dynamic Environments: A Comparative Study of Several Approaches Based on Promoting Diversity<br><i>Anabela Simões and Ernesto Costa</i> . . . . .                                       | 698 |
| Incorporation of Fuzzy Preferences into Evolutionary Multiobjective Optimization<br><i>Yaochu Jin and Bernhard Sendhoff</i> . . . . .   | 683 | Modified Linkage Learning Genetic Algorithm for Difficult Non-Stationary problems<br><i>Abhishek Singh, David E. Goldberg, and Ying-Ping Chen</i> . . . . .  | 699 |
| Multi-Objective Bayesian Optimization Algorithm<br><i>Nazan Khan, David E. Goldberg, and Martin Pelikan</i> . . . . .   | 684 | Bi-directional circular linked lists in fitness caching<br><i>Tapio Tyni and Jari Ylinen</i> . . . . .   | 700 |
| A Hybrid Genetic Search for Circuit Bipartitioning<br><i>Jong-Pil Kim and Byung-Ro Moon</i> . . . . .   | 685 | Application of numerical optimization technique based on real-coded genetic algorithm to inverse problem in biochemical systems<br><i>Takanori Ueda, Nobuto Koga, Isao Ono, and Masahiro Okamoto</i> . . . . . | 701 |
| Visualization of the Fitness Landscape, a Steady-State Genetic Search, and Schema Traces<br><i>Yong-Hyuk Kim and Byung-Ro Moon</i> . . . . .  | 686 | LCGA: Local Cultivation Genetic Algorithm for Multi-Objective Optimization Problems<br><i>Shinya Watanabe, Tomoyuki Hiroyasu, and Mitsunori Miki</i> . . . . .   | 702 |
| Memetic Algorithms for Combinatorial Optimization Problems in the Calibration of Modern Combustion Engines<br><i>K. Knödler, J. Poland, A. Zell, and A. Mitterer</i> . . . . .        | 687 | The Proportional Genetic Algorithm Representation<br><i>Annie S. Wu and Ivan Garibay</i> . . . . .   | 703 |
| Using incremental evaluation and adaptive choice of operators in a genetic algorithm<br><i>Alexander Kosorukoff</i> . . . . .   | 688 | Climbing Unimodal Landscapes with Neutrality: A Case Study of the OneMax Problem<br><i>Tina Yu and Julian Miller</i> . . . . .   | 704 |
| A Hybrid Genetic Algorithm for Optimal Hexagonal Tortoise Problem<br><i>Seung-Kyu Lee, Dong-Il Seo, and Byung-Ro Moon</i> . . . . .   | 689 |  |     |

**GENETIC PROGRAMMING**

- A re-examination of the Cart Centering problem using the Chorus system  
*R. Muhammad Atif Azad, Conor Ryan, Mark E. Burke, and Ali R. Ansari* . . . . . 707
- A Survey and Analysis of Diversity Measures in Genetic Programming  
*Edmund Burke, Steven Gustafson, and Graham Kendall* . . . . . 716
- Fitness Distance Correlation and Problem Difficulty for Genetic Programming  
*Manuel Clergue, Philippe Collard, Marco Tomassini, and Leonardo Vanneschi* . . . . . 724
- Size Control via Size Fair Genetic Operators in the PushGP Genetic Programming System  
*Raphael Crawford-Marks and Lee Spector* . . . . . 733
- Evolving chess playing programs  
*R. Groß, K. Albrecht, W. Kantschik, and W. Banzhaf* . . . . . 740
- Breeding Algebraic Structures — An Evolutionary Approach to Inductive Equational Logic Programming  
*Lutz Hamel* . . . . . 748
- Machine Vision: Exploring Context with Genetic Programming  
*Daniel Howard, Simon C. Roberts, and Conor Ryan* . . . . . 756
- Genetic Programming and Multi-Agent Layered Learning by Reinforcements  
*William H. Hsu and Steven M. Gustafson* . . . . . 764
- Adaptive Hierarchical Fair Competition (AHFC) Model for Parallel Evolutionary Algorithms  
*Jianjun Hu, Erik D. Goodman, Kisung Seo, and Min Pei* . . . . . 772
- Structure Fitness Sharing (SFS) for Evolutionary Design by Genetic Programming  
*Jianjun Hu, Kisung Seo, Shaobo Li, Zhun Fan, Ronald C. Rosenberg, and Erik D. Goodman* . . . . . 780
- Inference of Differential Equation Models by Genetic Programming  
*Hitoshi Iba and Erina Sakamoto* . . . . . 788
- Abstention Reduces Errors—Decision Abstaining N-Version Genetic Programming  
*Kosuke Imamura, Robert B. Heckendorn, Terence Soule, and James A. Foster* . . . . . 796
- Collaborating with a Genetic Programming System to Generate Modular Robotic Code  
*Jeremy Kubica and Eleanor Rieffel* . . . . . 804
- Convergence Rates for the Distribution of Program Outputs  
*W. B. Langdon* . . . . . 812
- Is the Perfect the Enemy of the Good?  
*Sean Luke and Liviu Panait* . . . . . 820
- Lexicographic Parsimony Pressure  
*Sean Luke and Liviu Panait* . . . . . 829
- An Analysis of Random Number Generators for a Hardware Implementation of Genetic Programming using FPGAs and Handel-C  
*Peter Martin* . . . . . 837
- Crossover Operators for a Hardware Implementation of GP using FPGAs and Handel-C  
*Peter Martin and Riccardo Poli* . . . . . 845
- Using schema theory to explore interactions of multiple operators  
*Nicholas Freitag McPhee and Riccardo Poli* . . . . . 853
- Evolving Compression preprocessors with genetic programming  
*Johan Parent and Ann Nowe* . . . . . 861
- On the Search Biases of Homologous Crossover in Linear Genetic Programming and Variable-length Genetic Algorithms  
*Riccardo Poli, Christopher R. Stephens, Alden H. Wright, and Jonathan E. Rowe* . . . . . 868
- Iterative Refinement of Computational Circuits using Genetic Programming  
*Matthew J. Sreeter, Martin A. Keane, and John R. Koza* . . . . . 877

**GENETIC PROGRAMMING POSTER PAPERS**

- Comparison of Evolving Against Peers and Fixed Opponents Using Corewars  
*Jason Cooper and Chris Hinde* . . . . . 887
- Open BEAGLE: A New C++ Evolutionary Computation Framework  
*Christian Gagné and Marc Parizeau* . . . . . 888
- How Statistics Can Help in Limiting the Number of Fitness Cases in Genetic Programming  
*Mario Giacobini, Marco Tomassini, and Leonardo Vanneschi* . . . . . 889
- A New Model to Realize Variable Size Genetic Network Programming  
*Hironobu Katagiri, Kotaro Hirasawa, Jinglu Hu, and Junichi Murata* . . . . . 890
- Controlling the Genetic Programming Search  
*Emin Erkan Korkmaz and Göktürk Üçoluk* . . . . . 891
- MB GP in Modelling and Prediction  
*Carlos Oliver-Morales and Katya Rodríguez Vázquez* . . . . . 892
- Self-Improvement for the ADATE Automatic Programming System  
*Roland Olsson and Brock Wilcox* . . . . . 893

- Evolving Readable Perl  
*Mark S. Withall, Chris J. Hinde,  
 and Roger G. Stone* . . . . . 894

## LEARNING CLASSIFIER SYSTEMS

- Lookahead and Latent Learning in ZCS  
*Larry Bull* . . . . . 897
- Accuracy-based Neuro and Neuro-Fuzzy  
 Classifier Systems  
*Larry Bull and Toby O'Hara* . . . . . 905
- XCS Applied to Mapping FPGA Architectures  
*Martin Danek and R. E. Smith* . . . . . 912
- A Modified Classifier System Compaction Algorithm  
*Chunsheng Fu and Lawrence Davis* . . . . . 920
- A Comparison between ATNoSFERES and XCSM  
*Samuel Landau, Sébastien Picault, Olivier Sigaud,  
 and Pierre Gérard* . . . . . 926
- Coevolving different knowledge representations with  
 fine-grained parallel Learning Classifier Systems  
*Xavier Llorà and Josep M. Garrell* . . . . . 934
- Hyper-heuristics: learning to combine simple heuristics  
 in bin-packing problems  
*Peter Ross, Sonia Schulenburg,  
 Javier G. Marín-Blázquez, and Emma Hart* . . . . . 942

## LEARNING CLASSIFIER SYSTEMS POSTER PAPERS

- Towards the Use of XCS in Interactive  
 Evolutionary Design  
*Larry Bull, David Wyatt, and Ian Parmee* . . . . . 951
- An Experimental Comparison of Genetic and Classical  
 Concept Learning Methods  
*Gabriella Kókai, Zoltán Tóth, and Szilvia Zvada* . . . . . 952
- Cooperative concept learning by means of a  
 distributed GA  
*Filippo Neri* . . . . . 953

## METHODOLOGY, PEDAGOGY, AND PHILOSOPHY

- On the Use of Negative Selection in an Artificial  
 Immune System  
*Marc Ebner, Hans-Georg Breunig,  
 and Jürgen Albert* . . . . . 957
- Evolutionary Computation as a Form of Organization  
*Alexander Kosorukoff and David Goldberg* . . . . . 965
- The Turing Ratio: Metrics for Open-Ended Tasks  
*Hassan Masum, Steffen Christensen,  
 and Franz Oppacher* . . . . . 973
- Genetic Algorithms and Fine-Grained Topologies  
 for Optimization  
*Xiaotong Wang, Lawrence Davis,  
 and Chunsheng Fu* . . . . . 981

## METHODOLOGY, PEDAGOGY, AND PHILOSOPHY POSTER PAPER

- JEO: Java Evolving Objects  
*M. G. Arenas, B. Dolin, J. J. Merelo, P. A. Castillo,  
 I. Fdez de Viana, and M. Schoenauer* . . . . . 991

## REAL WORLD APPLICATIONS

- Designing Crushers with a Multi-Objective  
 Evolutionary Algorithm  
*L. Barone, L. While, and P. Hingston* . . . . . 995
- Learning Composite Operators for Object Detection  
*Bir Bhanu and Yingqiang Lin* . . . . . 1003
- Grammatical Evolution and Corporate  
 Failure Prediction  
*Anthony Brabazon, Michael O'Neill,  
 Robin Matthews, and Conor Ryan* . . . . . 1011
- Evolving Neural Networks for the Classification  
 of Galaxies  
*Erick Cantú-Paz and Chandrika Kamath* . . . . . 1019
- Alignment of Protein Structures with a Memetic  
 Evolutionary Algorithm  
*B. Carr, W. Hart, N. Krasnogor, J. Hirst, E. Burke,  
 and J. Smith* . . . . . 1027
- A genetic algorithm with sequential niching for  
 discovering small-disjunct rules  
*Deborah R. Carvalho and Alex A. Freitas* . . . . . 1035
- Symbolic Regression in Design of Experiments:  
 A Case Study with Linearizing Transformations  
*Flor A. Castillo, Ken A. Marshall, Jim L. Green,  
 and Arthur K. Kordon* . . . . . 1043
- Using Genetic Algorithms To Solve The Yard  
 Allocation Problem  
*Ping Chen, Zhaohui Fu, and Andrew Lim* . . . . . 1049
- Gaphyl: An Evolutionary Algorithms Approach for the  
 Study of Natural Evolution  
*Clare Bates Congdon* . . . . . 1057
- Learning in *RoboCup* Keepaway using Evolutionary  
 Algorithms  
*Anthony Di Pietro, Lyndon While,  
 and Luigi Barone* . . . . . 1065
- Exploring Multiple Design Topologies Using Genetic  
 Programming and Bond Graphs  
*Zhun Fan, Kisung Seo, Ronald C. Rosenberg,  
 Jianjun Hu, and Erik D. Goodman* . . . . . 1073
- An Immunogenetic Technique to Detect Anomalies in  
 Network Traffic  
*Fabio A. González and Dipankar Dasgupta* . . . . . 1081
- Design Optimization of N-Shaped Roof Trusses  
*Karim Hamza, Haitham Mahmoud,  
 and Kazuhiro Saitou* . . . . . 1089

|  |      |  |      |
|--|------|--|------|
| Application of Genetic Programming to Motorway Traffic Modelling<br><i>Daniel Howard and Simon C. Roberts</i> . . . . .  | 1097 | Hyperspectral Image Analysis Using Genetic Programming<br><i>Brian J. Ross, Anthony G. Gualtieri, Frank Fueten, and Paul Budkewitsch</i> . . . . .   | 1196 |
| Fitness Approximation in Evolutionary Computation – A Survey<br><i>Yaochu Jin and Bernhard Sendhoff</i> . . . . .  | 1105 | Voice Conversion Using Interactive Evolution of Prosodic Control<br><i>Yuji Sato</i> . . . . .   | 1204 |
| A Two Levels Evolutionary Modeling System For Financial Data<br><i>Zhou Kang, Yan Li, Hugo de Garis, and Li-Shan Kang</i> . . . . .  | 1113 | Improving Digital Video Commercial Detectors with Genetic Algorithms<br><i>J. David Schaffer, Lalitha Agnihotri, Nevanka Dimitrova, Thomas McGee, and Sylvie Jeannin</i> . . . . .   | 1212 |
| A Genetic Hybrid for Critical Heat Flux Function Approximation<br><i>Yung-Keun Kwon, Sung-Deok Hong, and Byung-Ro Moon</i> . . . . .   | 1119 | An Application Service Provider Approach for Hybrid Evolutionary Algorithm-based Real-world Flexible Job Shop Scheduling Problem<br><i>Ivan T. Tanev, Takashi Uozumi, and Yoshiharu Morotome</i> . . . . .   | 1219 |
| Search Improvement by Genetic Algorithms with a Semiotic Network<br><i>Sang-yon Lee, Sung-Soon Choi, and Byung-Ro Moon</i> . . . . .   | 1126 | A New Methodology for Emergent System Identification Using Particle Swarm Optimization (PSO) and the Group Method of Data Handling (GMDH)<br><i>Mark S. Voss and Xin Feng</i> . . . . .  | 1227 |
| Antenna Design Using Genetic Algorithms<br><i>Derek S. Linden</i> . . . . .  | 1133 | Automatic Test Data Generation for Structural Testing of Embedded Software Systems by Evolutionary Testing<br><i>Joachim Wegener, Kerstin Buhr, and Hartmut Pohlheim</i> . . . . .   | 1233 |
| Adaptive Reconfiguration of Data Networks Using Genetic Algorithms<br><i>David Montana, Talib Hussain, and Tushar Saxena</i> . . . . .   | 1141 | An Adaptive Genetic Algorithm for Multi Objective Flexible Manufacturing Systems<br><i>Abdulnasser Younes, Hamada Ghenniwa, and Shawki Areibi</i> . . . . .  | 1241 |
| Application of Genetic Algorithms to the Discovery of Complex Models for Simulation Studies in Human Genetics<br><i>Jason H. Moore, Lance W. Hahn, Marylyn D. Ritchie, Tricia A. Thornton, and Bill C. White</i> . . . . . | 1150 | An Evolution Strategies Based Approach to Image Registration<br><i>Jian Zhang, Xiaohui Yuan, and Bill P. Buckles</i> . . . . .   | 1249 |
| Multi Objective Airfoil Design using Single Parent Populations<br><i>Boris Naujoks, Werner Haase, Jörg Ziegenhirt, and Thomas Bäck</i> . . . . .   | 1156 |  |      |
| Multi-Objective Optimisation of Rolling Rod Product Design using Meta-Modelling Approach<br><i>V. Oduguwa and R. Roy</i> . . . . .   | 1164 | <b>REAL WORLD APPLICATIONS POSTER PAPERS</b>   |      |
| Genetic Search for Fixed Channel Assignment Problem with Limited Bandwidth<br><i>Eun-Jong Park, Yong-Hyuk Kim, and Byung-Ro Moon</i> . . . . .   | 1172 | Optimized Interest Metric of Rules and One-to-One Marketing Using Connection Networks<br><i>Sung-Soon Choi and Byung-Ro Moon</i> . . . . .   | 1259 |
| Comparison of Methods for Using Reduced Models to Speed Up Design Optimization<br><i>Khaled Rasheed, Swaroop Vattam, and xiao Ni</i> . . . . .   | 1180 | A Genetic Algorithm for Joint Optimization of Spare Capacity and delay in Self-Healing Network<br><i>H. W. Chong and Sam Kwong</i> . . . . .   | 1260 |
| A Genetic Algorithm for Discovering Interesting Fuzzy Prediction Rules: applications to science and technology data<br><i>Wesley Romão, Alex A. Freitas, and Roberto C. S. Pacheco</i> . . . . .                           | 1188 | A real coded genetic algorithm for the optimisation of reaction rate parameters for chemical kinetic modelling in a perfectly stirred reactor<br><i>L. Elliott, D. B. Ingham, A. G. Kyne, N. S. Mera, M. Pourkashanian, and C. W. Wilson</i> . . . . . | 1261 |
|  |      | Congressional Redistricting Using a TSP-based Genetic Algorithm<br><i>Sean L. Forman</i> . . . . .   | 1262 |

|   |      |
|---|------|
| Efficient Affine 2D-Image Registration using Evolutionary Strategies<br><i>Héctor Fernando Gómez García, Arturo González Vega, Arturo Hernández Aguirre, and Carlos A. Coello Coello</i> . . . . .          | 1263 |
| Piston Pump Mobile Unity Tour Problem: An Evolutionary View<br><i>Marco César Goldberg, Elizabeth Ferreira Gouvêa, and Francisco Dantas de M. Neto</i> . . . . .  | 1264 |
| Using Genetic Algorithms To Optimise Guillotine Cutting Operations<br><i>Alberto Gómez, David de la Fuente, Jose Parreño, and Javier Puente</i> . . . . .   | 1265 |
| Optimization of CDMA based Wireless System<br><i>Alex C. H. Ho and Sam Kwong</i> . . . . .  | 1266 |
| Modeling Convection Coefficients with Genetic Algorithms<br><i>Zhou Ji and Dipankar Dasgupta</i> . . . . .  | 1267 |
| Constructing X-of-N Attributes with a Genetic Algorithm<br><i>Otávio Larsen, Alex A. Freitas, and Julio C. Nievola</i> . . . . .  | 1268 |
| An Efficient Genetic Algorithm for Fixed Channel Assignment Problem with Limited Bandwidth Constraint<br><i>Shouichi Matsui, Isamu Watanabe, and Ken-ichi Tokoro</i> . . . . .                              | 1269 |
| Genetic Programming for Attribute Construction in Data Mining<br><i>Fernando E. B. Otero, Monique M. S. Silva, and Alex A. Freitas</i> . . . . .  | 1270 |
| Evolving Good Recommendations<br><i>Supriya Ujain and Peter J. Bentley</i> . . . . .  | 1271 |
| Evolving Finite Automata with Two-Dimensional Output for DNA Recognition and Visualization<br><i>Edgar E. Vallejo and Fernando Ramos</i> . . . . .  | 1272 |
| Real-World Shop Floor Scheduling by Ant Colony Optimization<br><i>Andre Vogel, Marco Fischer, and Tobias Teich</i> . . . . .  | 1273 |
| A Comparison of Genetic Algorithm Methods in Aerial Spray Deposition Management<br><i>L. Wu, W. D. Potter, K. Rasheed, H. Thistle, J. Ghent, D. Twardus, and M. Teske</i> . . . . .                         | 1274 |
| Functional Test Generation for Digital Integrated Circuits Using a Genetic Algorithm<br><i>Xiaoming Yu, Alessandro Fin, Franco Fummi, and Elizabeth M. Rudnick</i> . . . . .                                | 1275 |
| Multiobjective Evolutionary Algorithm Approach for Solving Integer Based Optimization Problems<br><i>Jesse B. Zydallis, Todd A. Sriver, and Gary B. Lamont</i> . . . . .                                    | 1276 |
| <b>EVOLUTIONARY ROBOTICS</b>  |      |
| Creation of a Learning, Flying Robot by Means of Evolution<br><i>Peter Augustsson, Krister Wolff, and Peter Nordin</i> . . . . .  | 1279 |
| Learning Area Coverage Using the Co-Evolution of Model Parameters<br><i>Gary B. Parker</i> . . . . .  | 1286 |
| <b>EVOLUTIONARY ROBOTICS POSTER PAPERS</b>  |      |
| Sensing and Direction in Locomotion Learning with a Random Morphology Robot<br><i>Karl Hedman, David Persson, Per Skoglund, Dan Wiklund, Krister Wolff, and Peter Nordin</i> . . . . .                      | 1297 |
| Applying Dynamic Networks to Improve Learning Performances of An Evolutionary Behavior Programming System for Mobile Robots in Dynamic Environments<br><i>Jumpol Polwichai and Pradeep Khosla</i> . . . . . | 1298 |
| <b>EVOLUTIONARY SCHEDULING AND ROUTING</b>  |      |
| Balance between Genetic Search and Local Search in Hybrid Evolutionary Multi-Criterion Optimization Algorithms<br><i>Hisao Ishibuchi, Tadashi Yoshida, and Tadahiko Murata</i> . . . . .                    | 1301 |
| A Hybrid Genetic Algorithm for the Vehicle Routing Problem with Time Windows<br><i>Soonchul Jung and Byung-Ro Moon</i> . . . . .  | 1309 |
| A Savings based Ant System for the Vehicle Routing Problem<br><i>Marc Reimann, Michael Stummer, and Karl Doerner</i> . . . . .  | 1317 |
| <b>SEARCH-BASED SOFTWARE ENGINEERING</b>  |      |
| Fitness Function Design to improve Evolutionary Structural Testing<br><i>André Baresel, Harmen Sthamer, and Michael Schmidt</i> . . . . .   | 1329 |
| Instrumenting Programs with Flag Variables for Test Data Search by Genetic Algorithm<br><i>Leonardo Bottaci</i> . . . . .   | 1337 |
| GPTeST: A Testing Tool Based on Genetic Programming<br><i>Maria Cláudia Figueiredo Pereira Emer and Silvia Regina Vergilio</i> . . . . .  | 1343 |
| A New Representation and Crossover Operator for Search-Based Optimization of Software Modularization<br><i>Mark Harman, Robert Hierons, and Mark Proctor</i> . . . . .                                      | 1351 |
| Improving Evolutionary Testing by Flag Removal<br><i>Mark Harman, Lin Hu, Robert Hierons, André Baresel, and Harmen Sthamer</i> . . . . .   | 1359 |

|  |             |
|--|-------------|
| Search Heuristics, Case-Based Reasoning and Software<br>Project Effort Prediction<br><i>Colin Kirsopp, Martin Shepperd, and John Hart . . .</i>  | <i>1367</i> |
| Using Heuristic Search Techniques to Extract Design<br>Abstractions from Source Code<br><i>Brian S. Mitchell and Spiros Mancoridis . . . . .</i> | <i>1375</i> |
| Code Factoring and the Evolution of Evolvability<br><i>Terry Van Belle and David H. Ackley. . . . .</i>  | <i>1383</i> |

## **SEARCH-BASED SOFTWARE ENGINEERING POSTER PAPER**

|  |             |
|--|-------------|
| Evolutionary Testing in Component-Based Real-Time<br>System Construction<br><i>Hans-Gerhard Groß and Nikolas Mayer . . . . .</i> | <i>1393</i> |
| Subject Index . . . . .  | 1395        |
| Author Index . . . . .   | 1399        |

