

Lecture Notes in Computer Science

865

Edited by G. Goos, J. Hartmanis and J. van Leeuwen

Advisory Board: W. Brauer D. Gries J. Stoer



Terence C. Fogarty (Ed.)

Evolutionary Computing

AISB Workshop

Leeds, U.K., April 11-13, 1994

Selected Papers

Springer-Verlag

Berlin Heidelberg New York

London Paris Tokyo

Hong Kong Barcelona

Budapest

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CR Subject Classification (1991): F.1, F.2.2, I.2.6, I.2.8-9, I.5.1, I.5.4, J.3

ISBN 3-540-58483-8 Springer-Verlag Berlin Heidelberg New York

CIP data applied for

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Printed in Germany

Typesetting: Camera-ready by author

SPIN: 10479154

45/3140-543210 - Printed on acid-free paper

Preface

This volume contains the post-workshop proceedings of a workshop on evolutionary computing sponsored by the Society for the Study of Artificial Intelligence and Simulation of Behaviour (AISB) and held at the University of Leeds, England, 11–13 April 1994. The workshop brought together most of the people doing research on evolutionary computing in the UK and some colleagues from abroad. Thirty-seven papers were presented at the workshop selected on the basis of abstracts refereed by the organising committee. This was composed of the following people:

Terry Fogarty, University of the West of England, Bristol,
Ray Paton, University of Liverpool,
Nick Radcliffe, University of Edinburgh,
Phil Husbands, University of Sussex,
Colin Reeves, Coventry University,
Dave Corne, University of Edinburgh,
Peter Fleming, University of Sheffield.

After the workshop a full paper version of each presentation was reviewed by three referees drawn from the organising committee and the following additional referees:

Jonathan Shapiro, Manchester University,
Geoff Miller, University of Sussex,
Peter Hancock, University of Stirling,
Marco Dorigo, Free University of Brussels,
Peter Ross, University of Edinburgh,
Hugh Cartwright, Oxford University,
Stuart Flockton, University of London.

On the basis of the advice of the referees, which took into consideration scientific progress made at the workshop, twenty-two papers were selected and revised for publication in this volume. In addition two authors, Ray Paton and Colin Reeves, were invited to contribute papers.

This volume only gives a partial, though polished, view of the proceedings of the workshop and would not be complete without a report on the workshop itself.

In June 1993 Steve Greig of Napier University suggested the holding of a European evolutionary computation conference. The “powers that be” did not see the need for one and so, despite widespread support in the UK, he did not pursue the idea. At about the same time I was filling out a questionnaire and suggested that the AISB hold more workshops in my area of research, i.e., evolutionary computation in general and classifier systems in particular. When the AISB asked me to organise a workshop on evolutionary computation I put the idea to the other organisers, who all agreed to help.

I drew up a call for papers and posted it to all UK researchers who had expressed an interest in Steve Greig's original proposal and on all the relevant electronic bulletin boards.

I received next to nothing up to the day the call for papers expired. Then over 40 abstracts arrived. These were refereed by the organisers – eighteen were selected for presentation as talks and twelve as posters. I invited the organisers to present papers and the show was on the road.

The workshop turned out to be more like a conference at which the various people working in the area in the UK and some guests from abroad presented their work. Some of this was familiar and built on work already published but much of it was novel.

The first day was taken up with presentations of work on the application of evolutionary computation to problems in robotics, signal processing and control. These are particularly active areas for the application of evolutionary computing.

There were two papers demonstrating the use of genetic algorithms to design control systems for real robots. Marco Dorigo of the Free University of Brussels told us about his work on behaviour based control implemented as a set of interacting classifier systems. He demonstrated, with the help of a video, a small robot that uses his techniques to learn some simple behaviours. Adam Fraser of Salford University explained how two genetically programmed robots have learned to co-operate with each other in transporting a shared load. He showed us one of the robots and proposed a general architecture for intelligent control.

The IEEE recently organised a whole workshop on adaptive computing, including genetic algorithms, for signal processing applications, and there were three papers in this area presented at this workshop. Stuart Flockton from Royal Holloway, University of London, described a genetic algorithm for optimising the coefficients of recursive digital filters that guarantees filter stability. David Beasley from University of Wales College of Cardiff presented his method of expansive coding that reduces the complexity of algorithms used in digital signal processing using a genetic algorithm. Julian Miller of Napier University showed how genetic algorithms can be used to optimise Reed-Muller expressions.

The next three papers were on classifier systems for control. Classifier systems, for the uninitiated, are rule-based classification or control systems that are optimised with genetic algorithms. The genetic algorithm is used to optimise either the whole rule-base or individual rules. I presented my paper comparing the use of genetic algorithms and classifier systems in optimising rule-sets for controlling a cart-pole simulation. Tony Pipe of the University of the West of England, Bristol compared the performance of a classifier system and a genetically optimised neural implementation of an adaptive heuristic critic. Andy Fairley of Liverpool University examined the evolutionary stability of the bucket brigade in a classifier system using evolutionary game theory.

The second day was less specialised and covered biological foundations of evolutionary computation, the theory of genetic algorithms, selection, and applications in scheduling. All of the posters were also presented on this day.

There are a number of psychologists and biologists active in the area of evolutionary computation and two of them presented papers at this workshop. Geoffrey Miller of the University of Sussex reviewed the biological theory of sexual selection and some of its possible applications in search, optimisation, and diversification. He used simulation results to illustrate some key points. Ray Paton of the University of Liverpool presented some insights from biological systems including mechanisms acting on strings both as independent identities and within ecologies.

There were two papers on the theory of genetic algorithms and one on selection methods in various evolutionary algorithms. The first theory paper presented a novel and interesting formulation of genetic algorithms while the second extended some well established work in the field of Walsh coefficients. Jonathan Schapiro of Manchester University presented a statistical mechanical formulation of the dynamics of genetic algorithms. He used this theory to make some predictions for a test problem - search for the low energy states of a random spin chain - and confirmed it with experiments. Paul Field of Queen Mary and Westfield College presented a generalisation of partition coefficients and Walsh coefficients to nonbinary alphabets. Peter Hancock of the University of Stirling compared selection methods in evolutionary algorithms. His experiments covered genetic algorithms, evolution strategies and evolutionary programming. A polite discussion on the pros and cons of the different selection methods was sparked off by this talk.

A lot of research has been done on the use of genetic algorithms for scheduling and the next two scheduled papers demonstrated the application of the techniques developed to solve real scheduling problems. Unfortunately the second of them had to be rescheduled to Wednesday but I will mention them both here. Dave Corne of Edinburgh University described the optimisation of timetables using his genetic algorithm based system in various universities in the UK. Hugh Cartwright of Oxford University discussed how a genetic algorithm can be implemented to handle a full industrial flowshop taking into account that the flowshop operates continuously and must be able to adjust the order in which products are made as new requests are received.

The poster session in the afternoon of the second day consisted of the presentation of the following twelve papers:

- A Genetic Algorithm for University Timetabling, by Edmund Burke, David Elliman and Rupert Weare, University of Nottingham,
- Learning Anticipatory Behaviour Using a Delayed Action Classifier System, by Brian Carse, University of the West of England, Bristol,
- The Co-evolution of Classifier Systems in a Competitive Environment, by Keith W. Chalk and George D. Smith, The University of East Anglia,
- Genetic Algorithms and Directed Adaptation, by John Coyne and Ray Paton, University of Liverpool,
- Evolving Go Playing Strategy in Neural Networks, by Paul Donnelly, Patrick Corr, Danny Crookes, The Queen's University of Belfast,
- Walsh and Partition Functions Made Easy, by Paul Field, Queen Mary and Westfield College,

- A Unified Parallel Genetic Algorithm, by A. Kapsalis, G. D. Smith, and V. J. Rayward-Smith, The University of East Anglia,
 Applying a Restricted Mating Policy to Determine State Space Niches Using Immediate and Delayed Reinforcement, by Chris Melhuish and Terence C. Fogarty, University of the West of England, Bristol,
 Building New Spatial Interaction Models Using Genetic Programming, by Stan Openshaw and Ian Turton, Leeds University,
 Optimising a Presentation and Assessment Timetable Using Evolutionary Algorithms, by Ben Paecher, Napier University,
 S.L.O.P. – A Self Learning Othello Player, Using a Genetic Algorithm, by David J. Wickham and Leslie Morss, Napier University of Edinburgh,
 Ecosystems, Environments and Energy: HABITANTS and Their Habitat, by Benedict Wrightman, University of Wales College of Cardiff.

The last day was taken up with talks on the use of local search techniques, multi-objective optimisation and applications of genetic programming.

The use of the genetic algorithm for global search has long been established but the use of genetic operators which do local search is gathering momentum. This is demonstrated in the four papers at the workshop in this area. Lawrence Bull of the University of the West of England, Bristol presented an evolutionary algorithm that was a hybrid of the genetic algorithm for global search combined with an evolutionary strategy for local search. Andy Fairley of the University of Liverpool introduced some new genetic operators for use on high level representations. Nick Radcliffe of Edinburgh University introduced a representation-independent formalism for using local search and demonstrated it on a travelling sales-rep problem. Colin Reeves of Coventry University explored a perspective which views genetic algorithms as a generalisation of neighbourhood search methods.

There were two papers on multi-objective optimisation, one of which was in fact presented the day before to allow the speaker to attend two meetings scheduled at the same time, but I will mention them both here. Carlos Fonseca of the University of Sheffield discussed current evolutionary approaches to multi-objective optimisation, drawing attention to issues such as how they affect the fitness landscape, and the implications of that for the search process. Phil Husbands of the University of Sussex described his work on distributed coevolutionary genetic algorithms for multi-criteria and multi-constraint optimisation.

Finally, there were two papers in the relatively new area of genetic programming. Bill Buckles of Tulane University in the USA showed how genetic programming can be applied to an information retrieval system to improve Boolean query formulation. Howard Oakley of the Institute of Naval Medicine demonstrated how genetic programming can be used for the forecasting of chaotic series in the face of short datasets with significant amount of noise.

The workshop was a good reflection of the state of research in evolutionary computation in the UK. It showed that there is a viable community of researchers in this country working on evolutionary computation and its application to significant scientific, commercial, and industrial problems. This was facilitated by the AISB, and

I would like to thank Ann Blandford of the MRC Applied Psychology Unit, Cambridge, and Charlie Brown of Leeds University for all the hard work they put in to make the workshop a success.

**Terence C. Fogarty
University of the West of England, Bristol
16 August, 1994**

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