EvoNet

EvoNews

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Newsletter of the EvoNet Network of Excellence in Evolutionary Computing Issue 7, Spring 1998

Technology Transfer

It goes without saying that students of evolutionary computing benefit from industrial placements – they obtain hands-on experience of real-world problems. But what do the placement providers stand to gain? A good deal, judging from the experience of some EvoNet members.

Intelligent Applications Ltd – a leading supplier of knowledge-based gas turbine condition monitoring systems – has run two EC-related industrial placements, one to investigate creating a predictive model for the output of a gas turbine, and one to create a novelty detector for some of the data from a gas turbine.

> 'It broke the ground on a new approach so that we could more confidently pursue it ourselves.'

The project results were good, but more importantly, 'It gave us exposure to a technology and its potential application to our area,' reports Managing Director Dr Robert Milne. 'It broke the ground on a new approach so that we could more confidently pursue it ourselves.'

Another EvoNet member, Tensing GeoInformatica, builds components for use in Geographical Information Systems. The company tends towards non-traditional GIS fields such as tracking and tracing, and command and control. With more and more customers requiring special algorithms relating to routing and cartographic label placing, Tensing saw a need to develop more flexible optimization environments for those areas where traditional heuristics proved inadequate.

The company took on two placement students to investigate building a GA based framework for route-planning algorithms.

'The first student's work was good,' reports Tensing's Rob Bieling, 'Especially the overview he gave us of the field. The second student is just finishing her work, but it looks like her results may work out into the first basics of the tool we need.'

Bieling believes that industrial placements can bring a number of benefits – allowing companies to complete projects that would not otherwise have been tackled; helping them to identify potential employees, and strengthening useful links with academic institutions.

Janet Bruten of Hewlett-Packard Laboratories agrees. Three years ago HP offered an EC-related placement to Nahum Zaera, a Masters student at COGS, in Sussex. 'Nahum's project was jointly supervised by myself and Dr Dave Cliff, who was then at Sussex COGS. Nahum was trying to evolve simple schooling behaviour.' In this case, the placement proved more successful in highlighting the limitations of the EC approach than in evolving realistic schooling. However, HP were sufficiently interested in the research to ask the student to stay on for a further three months at the end of his MSc placement.

'Nahum investigated an area that we didn't have the resources to look at ourselves,' reports Bruten. 'The project also led to a closer collaboration with Dave Cliff, which continues.'

The message is clear: students benefit from the opportunity to tackle real world problems; companies benefit from the opportunity to explore a new technology without committing themselves to further investment. With this in mind, EvoNet's new web-based industrial placement registers will provide a one-stop information shop for students looking for EC-related placements, and for companies looking for student collaborators. For more information on the registers, turn to page 3.

ABOUT EVONET

Evolutionary computing can be used to 'breed' progressively better solutions to the complex logistical problems faced by industry and commerce.

The European Commission has recognised it as one of the important new technologies of our time, and has funded a Network of Excellence in Evolutionary Computing, EvoNet, to assist in the transfer of knowledge and expertise to the manufacturing and service sectors.

As well as academic institutions and research groups, members of EvoNet include some of the key players in European industry – British Aerospace, Daimler-Benz, Dassault Aviation, Hewlett Packard Laboratories, Institut Francais de Petrol, Rolls Royce, SGS-Thomson and Siemens among others.

Membership of EvoNet is free and provides easy access to information about:

- training, conferences, workshops
- commercial applications of evolutionary computing techniques
- consultancy
- where to get advice and assistance
- collaborative research opportunities.

Companies, academic institutions, or interested individuals wishing to join, should contact: EvoNet, Dept of Computer Studies, Napier University, 219 Colinton Road, Edinburgh EH14 1DJ.

☎ +44 (0) 131 455 4218/4305 (voice)
+44 (0) 131 455 4440 (fax)
💻 evonet@dcs.napier.ac.uk

EvoNet Flying Circus

– a resource for all

Turn to your computer, fire up your web browser, type in the URL *http://www.dcs.napier.ac.uk/evonet/,* follow the link to the Flying Circus and you'll find a website devoted to slides, lecture notes and demos about evolutionary computing.

Whether you're a lecturer looking for teaching materials, a student searching for information, or just someone who wants to find out about evolutionary computing, the EvoNet Flying Circus represents an attractive and user-friendly resource – freely available for you to download.

Over the past two years, Training Committee members and other volunteers across EvoNet have committed a great many hours to building up the Flying Circus. What do they hope to achieve from sharing their knowledge?

To Training Committee chair Gusz Eiben the long-term benefits are clear. 'Training is closely related to marketing and PR,' he points out. 'The more people know about EC, the more they will be ready to apply it.' He cites as an example a 50,000 ECU project he is running with the NL Ministry of Transportation – solely because one of the Ministry's employees attended a course on evolutionary computation and saw its potential to solve a traffic light optimization problem.

'Ultimately we want as many people as possible to be aware of the potential of evolutionary computation for powerful applications, and we want to assist in creating such applications,' says Eiben.

'Disseminating information can create an initial interest, because evolutionary computing is an appealing subject and people want to know more about it and play around with it. It also makes people aware of this new technology and its ability to solve problems better, faster, or cheaper than other techniques. Without being informed they would not consider an evolutionary problem-solver as an option.

'Stimulating that initial interest is very important: scientific curiosity generates research into the phenomenon of evolutionary problem solving, which in turn can lead to the novel insights, tricks and subtechniques that make evolutionary problem-solvers more powerful. I am convinced that making information on EC readily available does contribute to the objective of increasing the number of successful EC applications.'

Work on developing the Flying Circus is on-going, with the ultimate aim of assembling a comprehensive collection of materials that can be used at three different levels.

'I am convinced that making information on EC readily available does contribute to the objective of increasing the number of successful EC applications.'

'At the first level, we provide information that can be consumed in 15 minutes, giving an impression of what EC is and what it can do for you. This should serve everybody with the necessary minimal background – students, hobbyists, scientists from other disciplines, decision makers,' Eiben explains.

'We also aim to provide more detailed information for self-study and experimentation at a second level, for those who are interested in the technical details and are willing to spend more time learning about EC.'

At the third level, the Flying Circus is a resource for teachers and lecturers who want to teach EC and need educational material for workshops, symposia or courses lasting up to a whole semester. As Eiben points out, 'Providing free educational materials can lower the threshold for somebody setting up a course on EC. This again can stimulate research and applications.'

Feedback

On the whole, feedback from those who have used the FC materials has been very positive.

'The demos we have collected so far represent a useful tool,' says Eiben. 'To see an evolutionary algorithm working can be more convincing than 20 shiny slides.'

'Also the idea of setting up a ready to use presentation in PowerPoint was a good one. It allows people to give a good looking introduction with minimal effort.' Some people adapt, redesign or rewrite parts of the materials. This, says Eiben, is as it should be – as long as EvoNet is credited for providing the basis of the presentation. 'After all, it's the person giving the lecture who has to answer the questions afterwards and defend everything that's been said.'

The Training Committee's immediate

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plan for the Flying Circus is to reproduce it in the form of a CD-ROM, which should be available at the PPSN conference in September. In addition to the original website materials and any new contributions, the CD-ROM will include a video explaining how EAs are used in industry, and an HTML user interface, so that the disk can be easily navigated with a web browser.

Jano van Hemert, who is working on the preliminary design, explains: 'If we take care to make it easy to use, it should be possible to use the CD-ROM as a business card, leaving it behind you when you visit an organisation so that people can have a look afterwards or just play with some demos.'

Contributions

In the meantime the search is on for more materials to extend the website and the CD-ROM. As well as more slides on specific EC subjects, the Training Committee is looking for demos or summaries of successful real-world applications. 'We need contributions in this category to convince our audience of the power of EC in practical situations,' says Eiben.

> 'It should be possible to use the CD-ROM as a business card.'

While demonstrations are particularly welcome, Eiben appreciates that a summary in the form of a couple of PowerPoint slides is much easier to make – and to take the burden off contributors, the Training Committee is willing to develop slides if the necessary information is provided.

Although he accepts that in industry the need to preserve a competitive advantage means that most successful real-world applications cannot be publicised, Eiben believes that companies developing applications for customers could benefit from contributing demonstrations to the Flying Circus. 'It is our policy to credit all contributors, and anyone submitting a demo can personalise it with their logo. In other words, such a demo could be of commercial value in attracting would-be customers.'

Anyone wishing to contribute material to the Flying Circus should contact:

- Dr Gusz Eiben (gusz@wi.leidenuniv.nl)
- Jano van Hemert (jvhemert@wi.leidenuniv.nl)

EC Courses

MSc in Machine Learning and Adaptive Computing
Based at the Intelligent Computer Systems Centre, University of the West of England, this one-year full-time Masters course consists of a six-month taught component and a placement period of approximately five months.
http://www.ics.uwe.ac.uk/edu/mlac1.html
admin@ics.uwe.ac.uk
☎ +44 (0)117 9656261 ext. 3183

Advanced Undergraduate Course in Genetic Programming and Systems
Based at the Logic Systems Laboratory, Swiss Federal Institute of Technology, Lausanne, this course is taught in French.
http://lslwww.epfl.ch/pages/teaching/cours_lsl/spg/home.html

Graduate Course in Evolutionary Algorithms
Based at the Centre for Applied Computer Science in Berlin, this two-semester course is taught in German.
☎ +49-30-6392-1616 (voice)
+49-30-6392-1602 (fax)
voigt@gfai.de
http://www.informatik.hu-berlin.de/Institut/struktur/ki

Post-graduate Course in Optimization by Artificial Evolution and Applications
Based at the Centre for Applied Mathematics at the École Polytechnic, Paris, this course is taught in French. Please note that this course is given inside a numerical analysis program, and is thus oriented toward optimization of applied maths problems.
☎ +33 (0)169 33 46 19 (voice)
+33 (0)169 33 30 11 (fax)
Marc.Schoenauer@polytechnique.fr

Graduate Course in Evolutionary Algorithms
Based at the Department of Computer Science, Leiden University, this course is available to evening students as well as those who wish to attend during the day. The course runs for 14 weeks, and involves two lectures a week and an additional obligatory programming exercise.
☎ +31 71 527 7060 (voice)
+31 71 527 6985 (fax)
gusz@wi.leidenuniv.nl
http://www.wi.leidenuniv.nl/home/gusz/eas-eng.html
☎ +49-231-9700-366
+49-231-9700-959
baeck@icd.de

EvoNet Registers

To support companies, students and academics who want to learn more about evolutionary computing techniques, EvoNet plans to construct three web-based registers.

■ **A register of all MSc courses in Europe on the subject of evolutionary computing and genetic algorithms**
Academic institutions wishing to publicise EC-related courses should complete the web-based form available at http://krypton.ugr.es/~pedro/cgi-bin/msc_course.cgi.

■ **A register of evolutionary computing MSc students seeking industrial placements**
Students wishing to be placed on the register should e-mail the EvoNet office at evonet@dcs.napier.ac.uk.

■ **A register of companies offering industrial placements**
Companies wishing to offer industrial placements should e-mail the EvoNet office (evonet@dcs.napier.ac.uk) providing brief details about the work of the company and about the proposed placement.

The registers will provide a one-stop information shop for students looking for courses and placements, and for companies looking for student collaborators. So that the registers can be up-and-running ready for the 1999 academic year, all interested parties should contact EvoNet with their details as soon as possible.

ESSEC'98

As part of its commitment to information exchange and technology transfer, EvoNet holds its first summer school this July. ESSEC'98 offers participants an opportunity to gain a solid grounding in evolutionary techniques, familiarise themselves with general principles and explore topics of specific interest.

The five-day event offers an impressive programme of speakers and an unusually broad and balanced coverage of evolutionary computing.

'This was possible for two reasons,' explains local organiser Gilles Venturini. 'Firstly, the field is so well represented in Europe that it is not difficult to find specialists in every evolutionary technique. Secondly, EvoNet support allows us to keep registration fees very low (250 ECUs for students) while guaranteeing very high quality lectures.'

Although evolutionary techniques can be described in terms of simple concepts and can be easily applied to many domains, their behaviour is difficult to analyse and the reasons for success or failure are often unclear. For this reason, the summer school will focus on both theory and practice. Venturini hopes that by the end of the summer school, participants will be able to 'design efficient evolutionary techniques for solving real-world problems, while at the same time being aware of theoretical guidelines that will help them to avoid many unsuccessful trials.'

In order to maximise the interaction between participants and lecturers, the organisers have scheduled an informal session into the programme. 'We have allowed time for discussions and questions at the end of each lecture,' says Venturini. 'But we thought we would go one step further by holding a more flexible session, where participants can ask questions on any related topic, and direct discussions toward areas of particular interest to them.'

For many, though, the most exciting aspect of the summer school will be the practical session, where participants will gain hands-on experience of several demonstration packages. They will be able to monitor population statistics, observe how parameters and strategies effect diversity and premature convergence, and assess the potential of evolutionary computation for themselves.

'We did our best to make this summer school accessible to a wide public with only an initial and basic background in computer science, mathematics or engineering,' says Venturini. 'No specific prior knowledge of evolutionary techniques is required.'

EvoNet Summer School on Evolutionary Computation

To be held at Tours, France, 13–17 July 1998

The aim of the international summer school on evolutionary computation is to provide participants from academia or industry with a theoretical and practical understanding of evolutionary algorithms (EAs), their foundations, their applications to various domains and related topics.

Venue

ESSEC'98 will be held in the School of Computer Science for Industry, University of Tours, and will last five days. The local organisation will provide the participants with on-site student residences and hotels. The social programme will consist of a special dinner and a visit to one of Touraine's world-famous castles (such as Chambord or Chenonceaux).

Registration Fees

The registration fees include the proceedings, breakfasts, coffee breaks, lunches and the social programme:

	Before 12 June	*After 12 June*
Students	250 Ecus	300 Ecus
Academia	400 Ecus	450 Ecus
Industry	550 Ecus	600 Ecus

Further Information

✉ ESSEC'98, E3i
Universite de Tours
64 Avenue Jean Portalis
37200 Tours FRANCE

☎ +33-2-47-36-14-14 (voice)
+33-2-47-36-14-22 (fax)

💻 essec98@univ-tours.fr
http://www.e3i.uni-tours.fr/essec98/

Programme

Theory of Evolutionary Algorithms
Th. Baeck (Dortmund University)

Introduction to Evolutionary Programming
Th. Baeck (Dortmund University)

Genetic Programming
W. Banzhaf (Dortmund University)

Ant Colony Optimization
M. Dorigo (Universite Libre de Bruxelles)

Dynamic, Adaptive and Self-adaptive Parameter Control in EAs
A. E. Eiben (Leiden University)

Artificial Life
P. Husbands (University of Sussex)

Introduction to Evolutionary Computation
Z. Michalewicz (Aarhus University)

Introduction to Genetic Algorithms
Z. Michalewicz (Aarhus University)

Heuristic Methods in Evolutionary Algorithms
Z. Michalewicz (Aarhus University)

Demonstrations and Hands-on Experience
B. Paechter (Napier University)

Applications of Evolutionary Algorithms
M. Schoenauer (Ecole Polytechnique)

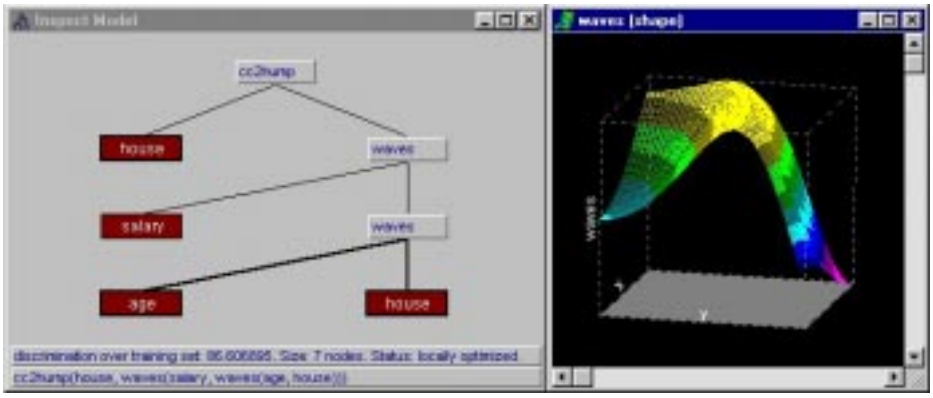
Evolution Strategies – Origin, Contemporary Incarnations, and Applications
H-P. Schwefel (Dortmund University)

Machine Learning
M. Sebag (Ecole Polytechnique)

Informal Session
Panel comprising all summer school lecturers.
All lessons will be given in English.

OMEGA! GAs predict customer behaviour

Cap Gemini in the Netherlands and KiQ Ltd in the UK have co-developed a system called Omega to provide a high-performance predictive model development environment.



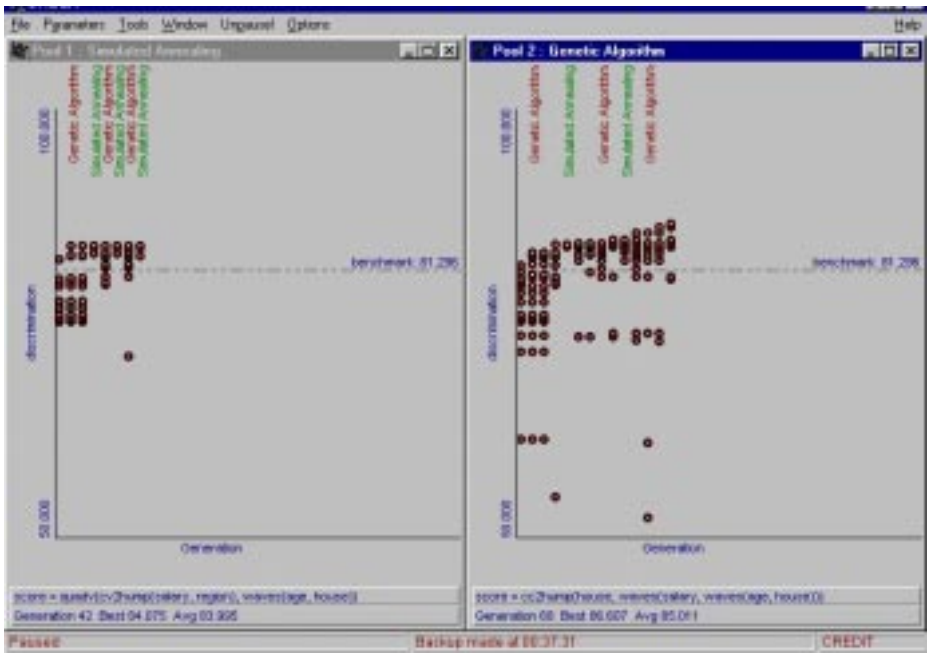
Producing models via symbolic regression, Omega is designed to solve marketing, credit and insurance modelling problems. Recent applications also include stock prediction and industrial modelling.

Omega uses several genetic algorithm flavours to produce highly predictive models that describe a behavioural profile in a given database. For example, based on a customer portfolio with known behaviour, Omega is able to separate loyal from non-loyal customers or profitable from non-profitable customers by generating a mathematical model. This model can then be applied to predict the behaviour of customers outside the known portfolio. This modelling approach is applicable to creditscoring, targeting marketing mailings, loyalty modelling and fraud detection, which are areas where Omega has more than once outperformed competitive techniques like neural networks, logistic regression, decision trees, discriminant analysis and rough data modelling.

Within Omega an adaptive genetic algorithm is employed to generate the models. The adaptation scheme consists of, among others, mutation and crossover alteration, targeted increase of diversity in the populations (via simulated annealing), and migration and simplification operations.

Omega has been applied to sociological and financial data many times. On average, two populations containing 20 individuals and about 2,000 generations are sufficient to generate good models for an average problem consisting of a large number of cases (varying from 2,000 to 100,000) and many variables (varying from 5 to 500). In this area of problems, where the relationship between behaviour and variables is complex and noisy, the genetic algorithms really prove their worthiness.

Omega can also be applied to physical measurement data in order to seek underlying physical models. However, in financial modelling other problems arise. Robustness and generalisation are important factors that determine the quality of a model. Thus, in order to prevent overfitting, customised operators are used as building blocks for the models. These operators are developed over multiple model development cycles and provide a robust means of mathematically describing sociological relationships.



In addition to good performance, the use of genetic algorithms within Omega offers great flexibility to state the fitness measures in business terms: optimise profit, maximise response rate for a given volume, etc. This approach does not limit the shape or complexity of the building blocks that constitute a model: simple models will automatically be chosen when applicable, complex non-linear models are selected when necessary to represent real-life behaviour.

Recently, a Dutch bank specialising in personal lending carried out a comparison between Omega and its established credit scoring system based on expert knowledge. Comparative measures were based on client portfolio volume and credit risk. From the bank's customer database a sample was taken containing information such as personal details (age, income, gender, etc.), loan details (loan amount, credit type, etc.) and miscellaneous details such as postal codes. The behaviour to be modelled was based on the amount of time that repayment was in arrears for each customer. This highly correlates with individual credit risk.

The model development database sample contained 28 variables describing over 10,000 applicants, of which 30% were accepted. Of the accepted, i.e. the current client portfolio, 13% showed bad repayment behaviour. After a validation period, the Omega model yielded a significant improvement in both quality (decrease of credit risk) and portfolio volume, by respectively 15% and 16%. As credit risk and client volume are predominant factors in determining the overall profits of the bank, even slight variations can have a large impact on the bank's results. Estimates indicate annual gains of approximately $1,000,000 for one credit line alone.

For further information, contact Arnold Koudijs (akoudijs@inetgate.capgemini.nl).

GENETIC PRAGMATISM

– an exclusive interview with JOHN KOZA

Back in the early sixties, when the University of Michigan offered the world's only BA course in Computer Science, one of the first undergraduates that John Holland taught was a young man who went on to set up a company that built computer systems for state lotteries and printed instant lottery tickets. For a time it looked at if John Koza's only claim to fame would be the invention of the scratch card.

No doubt some in the old guard of AI orthodoxy would have preferred things to stay that way. But it was not to be. From his first high-school encounter with computers, Koza was hooked. He was fascinated with the idea of automatic program induction – with getting computers to solve problems without explicitly programming them.

'I don't think there's anybody who's ever studied computers who hasn't at least thought about how we can get them to write their own programs,' he says.

Throughout his fourteen years in industry, he thought about it. He attended AI and machine learning conferences, he kept pace with the literature and, of course, he followed the development of Holland's ideas about the genetic algorithm.

By 1987, when he returned to academia, his thoughts were beginning to crystallise. 'It occurred to me that perhaps you could combine genetic algorithms with the basic thrust of AI, which was to get computers to do things automatically – that perhaps you could evolve a population of programs.'

He looked around for a vehicle on which to test his conjecture. Enter LISP, the classical AI programming language, and the LISP machine, a computer ubiquitous in computer science labs at the time, which was designed to allow easy manipulation of LISP expressions.

Nowadays most people use their favourite language (usually C, sometimes Java, C++ or Mathematica) for genetic programming. But back in the eighties the availability of LISP machines was crucial for Koza's early experiments in breeding programs. 'They made it practical,' he explains, 'Because they provided tools for manipulating programs. You could run them, and then you could hack at them and manipulate them as data and then you could run them again. Now you can do all that with any computer by coding, but it's a lot of aggravation and no-one wants to go through a mountain of drudge work just to test a conjecture that they don't know for sure is going to work.'

The conjecture was this: that by subjecting code to Darwinian natural selection and biologically inspired operations such as recombination, mutation, inversion, gene duplication and deletion you could get computers to solve problems without explicitly programming them.

> 'You can close your eyes to the first few applications and dismiss them for ten or twelve good reasons, but as the evidence starts piling up it gets harder and harder to ignore.'

The robust approach that Koza pioneered is known as Genetic Programming or GP. What chiefly distinguishes it from other evolutionary techniques is the choice of representation. Solution chromosomes explicitly represent a computer program which is executed and given a fitness score dependent on how well it performs the required task.

The technique includes a neat, LISP-inspired method of ensuring that when crossover occurs between parent programs the resulting child programs remain syntactically valid.

A GP program can be envisaged as a tree whose multiple branches subdivide at nodes. Each node of the tree is a function, or a control structure such as 'if .. else', whose arguments are either other functions or terminals (variables, constants or functions without arguments). For instance, in a robotics problem a terminal might return a value from input sensors or an instruction to unconditionally perform an action.

Since 1992, when he published his first book (a solid tome entitled *Genetic Programming: On the Programming of Computers by Means of Natural Selection*), Koza has refined his method, most notably by adding automatically defined functions which allow for code reuse.

But, as he points out, work on GP has not been confined to his group at Stanford. 'People have added all these bells and whistles – index memory, relational memory, matrix memory, stacks and lists and queues. Practically every programming technique you could find in a computer science book, somebody has written a paper showing that GP can be successfully used in that way.'

In fact more than 800 papers have been published on GP since 1992 and, as you read this, 51 PhD students are preparing theses on the subject. Last month Europe enjoyed its first conference on genetic programming and next year the major international GA and GP conferences will merge, in a grand symbolic gesture of reconciliation.

But ask John Koza if he thinks GP has finally arrived and he is as cautious as a general fielding questions about the state of battle.

'We've got a toehold,' he concludes. 'Mainly through persistence and what some people call the water torture technique. You can close your eyes to the first few papers and the first few applications and dismiss them for ten or twelve good reasons, but as the evidence starts piling up it gets harder and harder to ignore.'

Ten years on, it's easy to forget that the first examples of GP were greeted with jeers and hoots of derision. 'There was incredible hostility to genetic programming,' Koza remembers. 'And most of it was centred in the genetic algorithm community – which is curious because the GA community on the whole has been excluded from the mainstream AI and machine learning community.'

Koza's team at Stanford responded by test-driving GP in a variety of problem do-

mains – from mathematical function induction to classification and robotics.

'In the early years when computers weren't as fast as they are today, we tended to redo all the toy problems that were out there in machine learning and AI. At the time it was interesting and important to show that this new technique could solve the proof of principle problems.'

However, Koza is a practitioner rather than a theoretician. He doesn't spend a lot of time tweaking control parameters or experimenting with population sizes. He is, as he says himself, very goal oriented – something he puts down to his time in industry.

'You ask yourself, Why am I doing this? What am I trying to accomplish? Where is this going? Questions that are not always uppermost in the minds of academics.'

As a result the focus of the Stanford team's work has shifted towards real world tasks and areas where GP can achieve non-trivial results. 'We've tried to resist the tendency to concentrate on theoretical or academic problems,' he explains. 'And we've made a considered effort to find problems to solve that we can argue are competitive with human performance, because that's the test that matters at the end of the day.'

Koza believes that his third book (which will be on sale this autumn) contains about twenty examples where GP produced results that are clearly competitive with human performance. Three come from the field of computational molecular biology, where evolved programs classified proteins more accurately than published human written algorithms.

> 'Design is what you'd expect evolution to be good at. That's what it does: it designs all these animals and plants.'

Another example was the GP solution to the Gacs cellular automata problem. Although the problem itself is abstract in the extreme, the GP solution meets Koza's criteria of being competitive with human performance because mathematicians have vied for twenty years to come up with ever better solution algorithms. Nevertheless, the solution produced by GP remained unbeaten for three years – until it was toppled last month by the combined force of coevolution and a genetic algorithm.

However, for Koza, the most important and fruitful area has proved to be electronic circuit design. 'About two thirds of the twenty examples that we at Stanford claim are competitive with human performance are circuit examples,' he says.

To design analogue circuits, humans rely on heuristics, precedent and a process of trial and error. It is, as Koza himself remarks, 'an artform'.

'There is simply no automated method known for designing an analogue electric circuit; no way you can give a general specification and get the circuit. Of course, once you have the circuit you can do mathematics to tell what the behaviour is. But if you start with the behaviour you cannot get the circuit. You can analyse but you can't synthesise.'

But if people find analogue circuit design difficult, can evolved programs do any better? GP has certainly thrown up some startling results.

'We've found any number of text book subcircuits,' Koza reports. 'For example, emitter follower circuits, Darlington-style circuits, have popped out of genetic programming runs, so had we been around in the sixties we could have gotten there first.'

Point out that so far GP has only uncovered subcircuits that were patented thirty or forty years ago, and he's completely unfazed. 'Compared to artificial intelligence forty years behind is great. They're four billion years behind!' he laughs. And it's hard not to follow him to his inevitable conclusion that sooner or later evolution will discover circuits that are patentable in their own right.

His plan, then, is to focus on analogue circuit design and molecular biology problems – both areas he has identified as GP friendly, 'where we can produce results'.

'The biology problems are a bottomless pit because there's so much data coming out just now that needs to be analysed. I think GP is really appropriate for this category of problem, because no-one has the slightest idea what tests to apply. No-one knows what kind of mathematical operations you should perform on a protein sequence to answer a question.'

Koza is a modest man. When he talks about what GP can deliver, his comments are measured and based on fact. Nevertheless, there's nothing modest about the way he resources his projects. By mid-summer the team at Stanford will have a 1,000-node parallel computer at its disposal. The full system is intended to have about 1/2 teraflops capacity, making it one of the largest computers in the world. Up till now the Stanford team has worked on a 64 node machine, so this is a quantum leap. Quite clearly someone somewhere is convinced that GP is a sound investment.

Why so big? 'Because the more computer time the better. It used to be generally accepted that as computers got faster

Continued on page 8

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we would solve bigger and better problems. If you looked at the major universities in the fifties, sixties and seventies you used to say, "Gee what computer do they have?" It was a big deal. Now you look at most universities and there aren't any big computers. Everyone has a workstation on their desks and somehow the notion has settled in that computer time doesn't matter. But I don't think that's true. It's like microscopes – if you've got a stronger microscope you can see things that you couldn't see before, you can ask and answer questions that you couldn't previously. To me a thread has been lost. Turing got it right. Turing said in the forties that the speeding up of the computer was the key to progress.'

Koza plans to link the 1,000 nodes of his new computer with standard 100 base T ethernet. Doesn't he envisage a logjam when his nodes communicate with one another? Well... no, actually. 'The truth is that for GP or for any evolutionary based algorithm you don't need much communication at all,' he says. 'We could manage with a ten base T ethernet. We're getting the hundred because it only cost us 10 dollars a card more, but we don't need it.'

This is because he favours an island model, which he describes simply as 'the best way to use evolutionary algorithms on big problems'.

> 'There's never any proof of anything that comes out of engineering development. It just meets the spec and goes out the door!'

'You have isolated populations and a tiny amount of migration so that you get a transfer of information. That's why there's kangaroos in Australia and those big turtles on the Galapagos islands. It's been repeatedly shown to work well for GA and GP. And the result is that GAs and GPs use 100% of the computing power of the parallel computer, whereas by the time you've tortured any other problem into the parallel computer you're only getting 10% or 15% of the usefulness of the machine because of the communication problem. But EAs don't have a communication problem, so they're the perfect category of algorithms for parallel computers.'

For Koza the next few years seem to be mapped out. But how does he see the future for GP in general? He's not a man to make extravagant claims and predictions, but ask him to name one area where GP will probably produce results in the next few years and he doesn't hesitate.

'The design area in general. Design is what you'd expect evolution to be good at. That's what it does: it designs all these animals and plants.

'GP looks likely to excel in areas where you're not looking for a perfect airtight solution. It never enters the mind of an engineer that he would get a perfect design. It's always a matter of just satisfying practical requirements that are often competing and at odds with each other.

'When you talk to electrical engineers they seem unsurprised that evolution would do well.' Here his face breaks into a smile, as if talking to practitioners and fellow pragmatists was one of the joys of his work.

'Engineers have a totally different attitude from the knee-jerk reaction of most mathematicians or theoretical computer scientists who say, "What is this undefined probabilistic method? Where's the proof?" Who cares where the proof is! There's never any proof of anything that comes out of engineering development. It just meets the spec and goes out the door!'

SOUND*Bytes* from the panel discussion at EuroGP'98

Bill Langdon

The standard defence against the No Free Lunch theorem is to say: 'We in GP are only interested in problems where GP does better than random search.' Which is fine, except there's a whole bunch of papers where people have worked on a problem where GP is above the random line, but not so much as to make any difference. So what I would contend is that we in GP are actually interested in problems around this point where random search is also a pretty good technique.

John Koza

I think the proof of the pudding is that hundreds of people have written papers and they all do random search in generation zero, so on every single applications paper there is a set of statistics which shows how miserably random search did on their problem. It's a smallish sample but it establishes a probability with perhaps a wider variance. And if you're using a population of 10,000 or 5,000 or 50,000, it's a perfectly good sample. It may be a fiftieth of the whole run but it's still a non-trivial view of random search.

Gusz Eiben

I did a questionnaire around those industrialists that were here. What do they want? They want an overview of promising application areas, instead of a list of interesting sub-techniques. They want case studies of problems they see as relevant. They want arguments about why EC or GP is better than the technique they've been using for years. Many of us are working on UNIX workstations, but our possible partners are using laptops and PCs and want something that works fast on a PC. They want cheap consultancy and an easy toolbox for pilot studies, to give them the fast feedback that indeed we can handle their problem.

Riccardo Poli

The idea of a toolbox is nice. But the No Free Lunch theorem is a cloud in our skies, and the point is in order to beat that sort of thing and do well in search we need to feed some knowledge into the system. Now in the general problem solver you try to avoid that, but it will come back in the fitness function – you can't avoid it. If you don't design the fitness function properly, the landscape is going to be very rugged and it's not going to solve the problem, or it will solve the problem through an expenditure of computational effort that will be comparable to random search. Whenever we start to tackle a problem we have to do some analysis of the data, discover the regularities beforehand, twiddle with

EuroGP'*98*: Conference Report

More than 60 people attended the First European Workshop on Genetic Programming (EuroGP'98) in Paris this April to see presentations, invited talks and posters. It was a great opportunity to exchange experience and information, and for interaction among researchers from a variety of backgrounds and research areas.

The first day began with a two-hour tutorial on GP given by Robert Keller followed by John Koza's invited talk. Among other things, John introduced two new tools for modularisation in GP: automatically defined loops and automatically defined iteration.

After lunch, the oral presentations began with a session on experimental and theoretical studies. Riccardo Poli surveyed the state of the art on GP schema theory and presented new results which corroborate the building block hypothesis. Una-May O'Reilly presented work done in collaboration with David Goldberg on the effect of different primitive sets on the shape and size of the programs evolved by GP. Bill Langdon reported on results of GP runs based on mutation which support the hypothesis that code growth (bloat) is inherent in variable size representations. Finally, Nikolay Nikolaev described a new mutation operator for language induction problems and its fitness landscape.

In the evening there was a poster session, where a variety of work involving the application of GP to robotics and marketing, object-oriented GP, etc. was presented.

The second day began with a session on algorithms, representations and operators. Ricardo Aler presented a new algorithm to exploit and spread throughout the population the best automatically defined functions discovered in each generation. Takuya Ito described a new crossover operator in which the choice of the crossover points is biased so as to select more frequently subtrees near the root. Bill Langdon presented results in which the solution space of the ant problem had been extensively sampled and suggested that random search does not do much worse than GP on this problem, thus raising a number of questions in the light of the No-Free-Lunch theorem. Michael O'Neill presented work on a new form of grammar-based GP based on linear genomes.

The afternoon session was devoted to applications of GP. Marcus Conrads presented work in which GP was used to evolve speaker-independent speech recognition algorithms. Joao Pujol gave a talk on his work on the evolution of recurrent neural networks using a very efficient GP-inspired evolutionary algorithm. Stefano Cagnoni presented work on a new pattern recognition method based on non-uniform cellular automata applied to an image classification task. An application of GP to the evolution of coupled map lattices for the density classification problem was presented by Mat Nordhal.

In the evening, there was a late-breaking paper poster session followed by a panel discussion, chaired by John Koza. This gave the audience the opportunity to discuss with leading researchers in the field fundamental issues on the ability of GP to do better than other machine learning and search techniques as well as the future of GP and Evolutionary Computation in general as paradigms to solve hard problems in industry and commerce.

We look forward to meeting you all at EuroGP'99 in Goteborg.

Joao C. F. Pujol and Riccardo Poli

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the parameters, and that's knowledge elicitation whether you like it or not. Again, designing the right fitness function means that you're biasing your system towards finding the solution. So these search algorithms are in a sense amplifiers of our own ability to search – not a lot more, so far at least. Obviously the more powerful computers become, the more we will get from these search algorithms so they will beat humans over and over again. Perhaps they will not beat each other a lot.

Wolfgang Banzhaf
On the question of whether GP is competitive with other machine learning techniques, I perceive neural nets as our main competitor and I think that a fantasy free way forward is to look at the problems neural nets try to solve and attack them with GP methods. Another comment concerns problems that are very complicated and that require a lot of time to solve. At the moment they are probably only amenable to parallel computers. In seven years we will have 15 times or more the speed of today and I think that time works for methods like GP that use iterative improvement and probably random events.

Riccardo Poli
I'm not sure we need to compare with neural nets to get this technique accepted. In principle we are superior: we are not limited to Gaussian functions or additive weights or to certain activation functions or topologies. We are a step ahead and we need to keep GP one step ahead. Comparing with all the other techniques on lots of benchmark problems might absorb a lot of our ability to explore and improve this technique.

John Koza
In 1995 when the 3-argument Boolean parity functions were being thrown at GP as if we had something to be ashamed of in terms of our performance, John Holland advised our group not to fall into the trap of playing with all these nano-problems. Just go out there and solve some real problems and people will pay attention. A certain amount of toy problems should be done, but we should focus on doing big things and important things and not get into micro debates with people over parity functions or whether hill climbing really works. We know it doesn't work. The earth isn't flat.

Peter Nordin
Maybe we should direct research towards making it easier to interpret the symbolic output, because this is something unique. Computers like programs – they are designed to execute programs. And I think this fact means that we can tie down to lower levels in a computer and we might gain efficiency and speed through that. It allows the freedom to choose the function set, which might also be something we can exploit, for instance by trying to find out what kinds of function sets are good for different problems, and to have packages for industry when they ask us for help.

Evolutionary Image Analysis and Signal Processing

http://www.dcs.napier.ac.uk/evonet/Coordinator/evoiasp.htm

EvoNet's new working group on Evolutionary Image Analysis and Signal Processing (EvoIASP) will foster co-operation among R&D teams in industry and academia, and lead the development of this technology.

'There is a need to increase industrial awareness about the application of evolutionary computing to complex domains such as IASP,' explains the group's co-chair Stefano Cagnoni. 'Not only in view of the fact that the recent availability of huge computational power at low costs has made it possible to start obtaining interesting results, but also in view of the possible actual development of industrial products designed using such techniques.'

Image analysis and signal processing have important applications in areas as diverse as printing, speech recognition, TV, multimedia, aerial surveillance, noise suppression, satellite and space imaging, machine vision, security surveillance, quality control, medical image and signal analysis, finger print analysis and character recognition.

> 'this technology is now booming and is likely to become central for SMEs in Europe and elsewhere'

Systems developed in these application domains must be robust and fast enough to process large quantities of noisy, incomplete and often inconsistent data. In many cases systems must also be relatively inexpensive and quick to develop, as the small or medium sized enterprises (SMEs) who frequently require them cannot afford long and expensive development and testing cycles. These conflicting requirements are extremely difficult to meet using traditional methods.

In the last few years evolutionary algorithms have been shown to be a very promising tool for the automatic design and optimization of systems for IASP in complex domains of high industrial and social relevance. As was pointed out in the working group's proposal: 'this technology is now booming and it is likely to become central for SMEs in Europe and elsewhere.'

Applications that EvoIASP members are currently working on include:

- 1D/2D pattern recognition and classification
- optimization of 1D/2D filters and detectors
- feature extraction
- quality control
- speech recognition.

The group welcomes new members interested in applying evolutionary algorithms to image analysis and/or signal processing problems. For companies working in the area of IASP, the advantages of joining are two-fold, as Stefano Cagnoni points out. 'Industrial members of EvoIASP are expected to benefit both through learning about evolutionary techniques and by submitting real-world problems to be solved to the other members.'

Those wishing to join EvoIASP should contact Stefano Cagnoni (University of Parma).

cagnoni@ce.unipr.it

Dynamic Optimization Problems

http://ls11-www.informatik.uni-dortmund.de/evonet/

In the domain of optimization mainly static optimization problems are considered. The term static optimization means that one can control all the variables that influence the objective function. But in real world applications the dynamics of the environment can not always be neglected (e.g. in case of on-line control problems). In fact many interesting industrial applications are dynamic optimization problems – for example:

- optimization of traffic light controllers
- elevator allocation
- colour segmentation of video image sequences
- optimal control of a steel rolling mill
- gas engine control.

For dynamic optimization problems the objective function changes (continuously or in discrete steps) over the course of optimization. So there is a (strong) need for optimization strategies that are able to track the optimum. Up to now evolutionary computation techniques, such as genetic algorithms, evolutionary programming and evolution strategies, seem to be the only optimization techniques that can tackle this task satisfactorily.

Several attempts have been made to modify an evolutionary algorithm, so that it can track the optimum of a changing environment. It was observed in all these studies, that the dynamic environment requires the evolutionary algorithm to maintain sufficient diversity for a continuous adaptation to the changes of the landscape. One of the main problems is to keep the induced diversity at a suitable level. The diversity must be high enough to enable the evolutionary algorithm to identify regions of the search space that might become more attractive as the environment changes. On the other hand an actual re-initialization of the population must be prevented. For this reason it seems to be important to match the degree of diversity with the degree of change going on in the environment. The principle of self-adaptation of strategy parameters, as mainly utilised in evolution strategies and evolutionary programming, can be considered to be a promising approach to tackle this problem.

The main objective of the working group is to stimulate the exploitation of evolutionary computation in the field of dynamic optimization problems. The members of our group are already working on the applications mentioned above. The main task is here to adapt existing evolutionary algorithms to the industrial applications and to exploit the full power of the self-adaptation principle. We would like to invite additional industrial members to join our group and to participate in our know-how in the domain of dynamic optimization. Suggestions for problems belonging to the class of dynamic optimization problems are welcome.

Thomas Baeck, Dirk Wiesmann

Evolutionary Computation for Systems, Control and Drives Industry

http://www.elec.gla.ac.uk/groups/control/evonet.htm

The SCONDI Working Group will focus on the use of Evolutionary Computing for system modelling and identification, controller and drive system optimization and design automation.

According to the group's co-ordinator, Dr Yun Li, there is a particular need for research and technology transfer in this area in order to overcome the limitations of the present generation of CAD packages. These, he points out, are 'primarily simulation tools and not design tools.'

'We need to interface EC/optimization tools to these simulators,' he explains, 'in order to transform them into computer-Automated design (cAd) packages for direct design usage.'

Companies that will benefit directly from the work of the group will be those that use CAD packages such as Matlab, Easy5, Saber or SPICE, and those that develop such packages – for example, software OEMs such as SPEED, Analogy, ADI, Boeing, Vector Fields and MathWorks.

Dr Li believes that the group's objectives are 'particularly relevant to the needs of small to medium sized enterprises where automated design could dramatically reduce development costs, improve the quality and competitive edge of designs and products and substantially reduce time-to-market.

'What we will focus on is technology transfer and commercialisation in the form of compiled library code and compiled packages which can be used for stand-alone batch processing and for direct interfacing to existing CAD simulators.'

The Working Group plans to target the following application areas:

- evolutionary and intelligent model growing and fitting
- curve-fitting for bioelectronics and chemometrics
- engine modelling, optimization, management and control
- design automation of conventional linear and nonlinear control systems
- novel neural and fuzzy control systems
- electrical machine and drive design automation

> 'automated design could dramatically reduce development costs, improve the quality and competitive edge of designs and products and substantially reduce time-to-market'

- power electronics CAD and symbolic design
- power systems control and optimization
- system integration and industrial automation.

The group welcomes new members, particularly from industry. 'Companies do not have to already be using evolutionary computation or optimization techniques in order to join the group,' explains Dr Li. 'They need only be interested in exploring the technology.' And he's quite clear about the benefits of membership.

Quite apart from being able to gear the direction of academic work to suit their needs, industrial members will be first:

- to be offered free or favourably charged consultancy work or case-studies by academic members
- to be notified about trends in EC for system modelling and identification, controller and drive system optimization and design automation
- to receive information and research results in EC for system modelling and identification, controller and drive system optimization and design automation
- to contribute to, and receive, relevant benchmarks and benchmark problems
- to be informed of the potential impact of this technology on system, control and drives engineering.

Companies, individuals and academic institutions wishing to join SCONDI should contact Dr Yun Li (University of Glasgow).

Y.Li@elec.gla.ac.uk.

Evolutionary Design

The Evolutionary Design Working Group (EvoDES) will play a key role in promoting co-operation and interaction between academic and industrial groups working on the application of evolutionary methods to real world design problems.

The working group will focus on evolutionary and stochastic, adaptive search algorithms, their application to complex design problems and their integration with the various stages of the design process. Although optimization will play a significant role in the group's activities, other major aspects will include multi-disciplinary design exploration, multi-objective and constraint satisfaction and engineering decision support.

Although research relating to the application of evolutionary techniques to specific, complex detailed design problems is much in evidence, little research effort has been expended investigating the utility of the integration of evolutionary computing with the higher levels of the design process. The overall objective of EvoDES is to address such issues and establish collaborative research and development paths that will result in design search, exploration and optimization strategies that support designers' requirements during the conceptual, embodiment and detailed stages of design.

Other main objectives of the group are to establish:

- **strong avenues of communication in terms of research/technology awareness and transfer between academic research groups, between academic research groups and industry, and between interdisciplinary industrial organisations**
- **the collective ability to identify and assess emerging adaptive computing techniques and to disseminate information as to**

Continued on page 13

Evolutionary Optimization — *New Journal Announcement and Call for Papers*

High quality research and survey papers are solicited for *Evolutionary Optimization,* a new quarterly international journal published on the Internet.

Aims and scope

The subject of evolutionary optimization has recently experienced a remarkable growth. New concepts, methods and applications are being continually proposed and exploited to provide efficient tools for solving a variety of optimization problems. The aim of this international journal is to collect and disseminate the progressive body of knowledge on evolutionary optimization techniques and their applications, via a single organized medium.

Applications of evolutionary optimization cover a wide range of engineering optimization problems, operations research and other related fields. The principal focus of the journal will be the implementation of evolutionary optimization techniques to practice. The journal will be primarily concerned with applications which include aspects of computing techniques that use the model of natural selection and other biologically oriented models to perform the process of optimization.

Evolutionary Optimization will publish invited papers, original research and review papers and short letters. The journal will also have special issues devoted to relevant topics. Book reviews, forthcoming events and software sections of the journal will report the recent developments and advances in the field.

A section of the journal will be devoted to short communications, letters, abstracts and notes. These short papers will be quickly reviewed and published.

Mission statement

Fast Turnaround
The journal will strive by all means to reduce the throughput for the submitted papers, by extensive use of the electronic media in communication and publishing.

Fast Communication
The journal will provide a forum for fast exchange of ideas by means of publishing short letters which will be devoted to results obtained immediately upon their discovery and reports from important events and activities.

Collective Responsibility
The journal tries to make its contribution in the field by collective support of its editors, editorial board and its global network of correspondents. All board members are equally responsible to uphold the mission of the journal.

Active Readers
The journal expects to have active readers which will contribute to the future development of the journal. The journal is open to the readers and new ideas are warmly welcome.

Correspondence

All correspondence should be sent to Sourav Kundu:
☎ +81-76-234-4758 (voice)
+81-76-234-4668 (fax)
💻 sourav@kenroku.ipc.kanazawa-u.ac.jp

Special Issues on Evolutionary Design — Call for papers

Papers are invited for a series of three special issues on Evolutionary Design, to appear in 1999 issue numbers 3 and 5 and 2000 issue number 1 of AIEDAM journal. This exciting new area of research involves the integration of evolutionary computation with many aspects of design, including: conceptual, creative, generative and optimization. The use of evolutionary search techniques allows computers to explore populations of designs in parallel and has shown to be highly successful in generating improved designs for an astonishing range of applications.

Today computers are being used to evolve everything from architecture to spacecraft systems, and from aesthetic bridges to 'virtual creatures'.

However, despite the success of these methods, many questions remain unanswered. For example: should we continue to use evolutionary computation as generative tools, instead of simply optimizers? How can we convince designers of the fact that an unpredictable, unexplainable, stochastic method is of use to them? Can we use ideas from other fields, including biology, to increase the capabilities of our computational models? What are the best ways to interface evolutionary search with existing analysis tools? Is there a future in using evolutionary computation in design, or will its limitations (e.g. being unable to backtrack or 'undo' stages of evolution) ultimately prevent us from tackling unsimplified real-world problems?

Topics

Papers should contain original and unpublished material, describing the use of evolutionary techniques for design problems. Relevant topics include:

- evolutionary optimization of designs
- evolutionary generative design
- creative evolutionary design
- conceptual evolutionary design
- representations suitable for evolutionary design
- the integration of aesthetics or techniques from Artificial Life in evolutionary design
- investigations of key aspects within evolutionary design systems, e.g. creation or interfacing of fitness functions, multiobjective optimization, constraint handling, variable-length chromosomes, epistasis.

Deadline

The deadline for full papers is 1 July 1998. Submissions should follow the usual AIEDAM style and should be in Postscript format. Please notify the guest editor, Dr P. J. Bentley, immediately via email of your intention to submit a paper.
💻 P.Bentley@cs.ucl.ac.uk

Journal of Computing and Information Technology

Special Issue on Evolutionary Computing
Guest Editor: Uday K. Chakraborty
Submission Deadline: June 29, 1998

Announcement and call for papers

The *Journal of Computing and Information Technology* is a quarterly refereed international journal, addressing the areas of computer science, modelling and simulation, information systems and information technology.

For the special issue on evolutionary computing, original unpublished research articles (in English) are invited in the following areas:

- evolutionary algorithms (EAs)
  - genetic algorithms (GAs)
  - evolution strategies (ESs)
  - evolutionary programming (EP)
  - genetic programming (GP)
- theory of EAs (mathematical description of EA-behaviour)
- design of new, improved EAs
- hybrid systems (e.g. neuro-fuzzy-GA, EAs in conjunction with local search)
- applications of EAs to problems of practical importance.

Instructions to authors

Manuscripts should not normally exceed 10,000 words in length. Please provide a title page containing the title of the paper, names and affiliations of the authors, and mailing address, e-mail address, telephone and fax numbers of the corresponding author. Four hard copies (not faxes) of the manuscript should be submitted to the guest editor.

✉ Uday K. Chakraborty
Dept of Computer Science and Engineering
Jadavpur University
Calcutta 700032INDIA
☎ +91 33 473 1138 (voice)
+91 33 473 4266 (fax)
uday@jadav.ernet.in
http://www.srce.hr/cit/home.html

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their utility in the design domain

- **a framework that supports and encourages collaborative, novel research proposals that explore emerging evolutionary computing techniques and/or further advance established evolutionary computing technologies**
- **the means to identify short and medium term industrial benefits and to identify a development path that ensures such benefits are realized**
- **dissemination of information relating to new design developments and current design practice relevant to evolutionary computing**
- **the promotion and support of student, academic and industrial staff exchange within the evolutionary design domain.**

The first meeting of initial members of EvoDES took place on 22 April, to establish initial activities and discuss the structure and objectives of the group.

An important aspect of this discussion concerned the relationship between EvoDES and the UK EPSRC funded Engineering Network in Adaptive Computing in Design and Manufacture. This recently established Network has similar aims to EvoDES and it was therefore decided that the groups should be run concurrently sharing a common website and acting in a complementary manner.

It is also intended to collaborate with ERUDIT, the European Network in Soft Computing, following on from their major interest in design illustrated by the IDEAS symposium on Intelligent Design held as a concurrent activity during EUFIT '97. The intention is to establish a strong European-wide activity in this area that, although concentrating upon evolutionary computing, also involves other aspects of computational intelligence.

Membership was also discussed and it is envisaged that differing levels of group membership will be available, ranging from 'active' membership (which infers significant involvement in group activities) to 'passive' membership (for those members requiring information and wishing to attend seminars, tutorials, etc.) and 'associate' membership (for groups or individuals outside the European Union who are working within this area and are also members of EvoNet).

Another important aspect involves increasing industrial involvement. It is likely that active membership of the group will therefore be restricted to those nodes who can introduce an industrial organisation to the working group who will then commit themselves to active involvement.

It is intended to arrange both awareness days aimed primarily at industry and more concentrated advanced workshops for academic and industrial research groups. The first such workshop, to be run collaboratively with ACDM-Net, is provisionally planned for April '99. Active members of the group will be expected to arrange local awareness days and workshops to ensure sufficient cover of the member States.

It was also decided that the group would not restrict its activities to engineering design but would consider design to be generic across a wide range of activities, e.g. architectural, chemical, industrial, product, art, etc.

Any groups or individuals who would like to actively participate in the work of EvoDES should contact Ian Parmee (iparmee@plymouth.ac.uk) indicating the extent of their current work/research in this area.

Ian Parmee

Important Reminder

Have you filled in your EvoNet membership form?

http://krypton.ugr.es/~pedro/cgi-bin/indiv_form.cgi

21–30 June 1998

WSC3: Third On-line World Conference on Soft Computing in Engineering Design and Manufacturing on the WWW at Cranfield, Bath, Nagoya, East Lansing, Cape Town, Bombay and Moscow

Contact: Conference Chair
☎ +44 (0)1234 754073 ext. 2860 (voice)
+44 (0)1234 750852 (fax)
💻 wsc3@cim.cranfield.ac.uk
http://www.cranfield.ac.uk/wsc3/

*24–26 June 1998

MENDEL'98: 4th International Mendel Conference on Genetic Algorithms, Optimization Problems, Fuzzy Logic, Neural Networks, Rough Sets Brno, Czech Republic

Contact: MENDEL'98 Secretary
☎ +420-5-41143334 (voice)
+420-5-744979 (fax)
💻 mendel98@fme.vutbr.cz
http://www.fme.vutbr.cz/html/UAI/confs/men98.html

26–29 June 1998

ALIFE VI: Sixth International Conference on Artificial Life, University of California, Los Angeles

Contact: Titus Brown
☎ 626 564 8708 (fax)
💻 alife6@alife.org
http://alife6.alife.org/

June

*20–23 July 1998

5th International Conference on Artificial Intelligence in Design '98, Portugal
Short papers are invited for a half-day workshop on Evolutionary Design, to take place on the weekend before the conference
Deadline: 31 May 1998

Contact: Dr P. J. Bentley
💻 p.bentley@cs.ucl.ac.uk
http://www.cs.ucl.ac.uk/staff/P.Bentley/evdes.html

22–25 July 1998

GP-98: The Third Annual Genetic Programming Conference, University of Wisconsin in Madison, Wisconsin

Contact
💻 gp@aaai.org (admin.)
koza@cs.stanford.edu (Prof. John Koza, GP-98 Chair)
http://www.genetic-programming.org

22–25 July 1998

SGA-98: Symposium on Genetic Algorithms-1998, The University of Wisconsin, Madison

Contact: GP-98 Conference
☎ 415-328-3123 (voice)
415-321-4457 (fax)
💻 gp@aaai.org
http://www.genetic-programming.org

25–27 August 1998

EUROMICRO Workshop on Computational Intelligence, Vaesteraas, Sweden

Contacts: K. Temme, Nigel Steele
💻 temme@ls1.informatik.uni-dortmund.de
nsteele@coventry.ac.uk
http://ls1-www.informatik.uni-dortmund.de/English/Conferences.html
http://www.idt.mdh.se/forskning/cus/euromicro/

*2–5 September 1998

PARELEC '98: International Conference on Parallel Computing in Electrical Engineering, Bialystok, Poland

Contact: Dr Ivanoe De Falco
☎ ++39-81-5904222 (voice)
++39-81-5608330 (fax)
💻 ivan@irsip.na.cnr.it
http://falco.man.bialystok.pl/parelec98

7–10 September 1998

EUFIT '98: 6th European Congress on Intelligent Techniques and Soft Computing, Aachen, Germany

Contact: EUFIT '98
☎ +49 2408 6969 (voice)
+49 2408 94582 (fax)
💻 eufit@mitgmbh.de
http://www.mitgmbh.de/elite/eufit.html

September

*15–16 October 1998

ANTS'98: From Ant Colonies to Artificial Ants – First International Workshop on Ant Colony Optimization Brussels, Belgium

Deadline: 31 May 1998

Contact: Marco Dorigo
☎ +32-2-6503169 (voice)
+32-2-6502715 (fax)
💻 ants98@iridia.ulb.ac.be
http://iridia.ulb.ac.be/ants98/ants98.html

*24–27 November 1998

SEAL'98: The Second Asia-Pacific Conference on Simulated Evolution And Learning Canberra, Australia

Deadline (abstracts): 19 June 1998

Contact: Dr Xin Yao
☎ +61 2 6268 8184 (voice)
+61 2 6268 8581 (fax)
💻 **SEAL98@cs.adfa.oz.au.**

6–9 January 1999

International Conference on Evolutionary Computation in Engineering, Indian Institute of Technology Madras, Chennai, India

1999

Contact: Dr S. Mohan
☎ 91-44-2351365 ext. 3466/3464 (voice)
91-44-2350509/ 91-44-2352545 (fax)
💻 mpecskm@nus.edu.sg,
mohan@civil.iitm.ernet.in
http://www.msci.memphis.edu/~dasgupta /EC-India/CFP.html

1–3 July 1998

VW'98: First International Conference on Virtual Worlds, International Institute of Multimedia, Paris, France

Contact: Jean-Claude Heudin
☎ +33 01.41.16.75.70 (voice)
+33 01.41.16.75.75 (fax)
Jean-Claude.Heudin@devinci.fr
http://www.devinci.fr/home/iim/vw98/vw98.htm

3–8 July 1998

CRW'98: First International Workshop on Collective Robotics, La Cite des Sciences, Paris, at Agents' World '98 (an associated event of ICMAS'98 and Paris'98)

Contact: Alexis Drogoul
Alexis.Drogoul@lip6.fr
http://www-poleia.lip6.fr/~drogoul/paris98/CRW98.html

*15–17 July 1998

LSS'98: 8th IFAC/IFORS/IMACS/IFIP/ Symposium on Large Scale Systems, Theory and Applications, University of Patras Rio, Greece

Contact: Prof. Demos T. Tsahalis
☎ +30-61-997577 (voice)
+30-61-997267 (fax)
ifac.tsahalis@lfme.chemeng.upatras.gr
http://www.lar.ee.upatras.gr/lss98.html

July

27–31 July 1998

4NWGA: The Fourth Nordic Workshop on Genetic Algorithms and Their Applications, Norwegian University of Science and Technology, Trondheim, Norway

Contact: 4NWGA
nwga@uwasa.fi
http://www.uwasa.fi/cs/4NWGA

17–21 August 1998

SAB98: Fifth International Conference of the Society for Adaptive Behaviour – From Animals to Animats, University of Zürich, Zürich, Switzerland

Contact: Rolf Pfeifer
sab98@ifi.unizh.ch
http://www.ifi.unizh.ch/groups/ailab/events/sab98/

*24–25 August 1998

Third International Conference on Hydroinformatics, Danish Hydraulic Institute, Denmark

Contact: Hydroinformatics'98
☎ +45-45 76 95 95 (voice)
+45-45 76 25 67 (fax)
HIC98@dhi.dk
http://www.dhi.dk/HIC98/Welcome.html

August

23–26 September 1998

ICES'98: The Second International Conference on Evolvable Systems – From Biology to Hardware, Swiss Federal Institute of Technology in Lausanne, Switzerland

Contact: Andres Perez
Andres.Perez@di.epfl.ch
http://lslwww.epfl.ch/ices98/

24–26 September 1998

Foundations of Genetic Algorithms 5: A Workshop on Theoretical Aspects of Evolutionary Computation
Amsterdam, Netherlands

Contacts: C. Reeves, W. Banzhaf
C.Reeves@coventry.ac.uk
banzhaf@tarantoga.informatik.uni-dortmund.de
http://www.wi.leidenuiv.nl/CS/AL/foga98. html

27–30 September 1998

Parallel Problem Solving from Nature (PPSN) Amsterdam, The Netherlands

Contacts: T. Baeck, M. Schoenauer
baeck@icd.de
Marc.Schoenauer@polytechnique.fr
http://www.wi.leidenuniv.nl/CS/ALP/ppsn 98. html

*6–9 April 1999

ICANNGA: Fourth International Conference on Artificial Neural Networks and Genetic Algorithms, Portoroz, Slovenia

Deadline: 30 June 1998

Contact: University of Ljubljana
☎ +386 61 1768 387 (voice)
+386 61 1264 647 (fax)
icannga@fri.uni-lj.si
http://cherry.fri.uni-lj.si/icannga99.html

*14–18 July 1999 *(tentative dates)*

GECCO 99: 1999 Genetic and Evolutionary Computation Conference, Orlando, Florida *(tentative location)*

Deadline: 20 January 1999

GECCO 99 will be a combined meeting of the 8th International Conference on Genetic Algorithms (ICGA) and the fourth annual Genetic Programming Conference (GP).

Contact
deg@uiuc.edu (David E. Goldberg)
http://www-illigal.ge.uiuc.edu/gecco/

New entries are indicated with an asterisk.

EvoRobot'98 Conference Report

EvoRobot'98, the First European Workshop on Evolutionary Robotics, was held in Paris on 16–17 April. It was organized around plenary talks, poster sessions and discussion sessions. The workshop was well attended and the sessions were lively with plenty of useful discussion.

Plenary talks dealt with the following topics.

In 'How Co-Evolution Can Enhance the Adaptive Power of Artificial Evolution: Implications for Evolutionary Robotics', S. Nolfi and D. Floreano investigated in what conditions co-evolution can lead to an 'arms race' in which two populations reciprocally drive one another to increasing levels of complexity. Such an approach was illustrated through experiments involving two Khepera robots: a predator equipped with a vision module and a prey moving twice as fast as the predator.

N. Jakobi's talk on 'Running Across the Reality Gap: Octopod Locomotion Evolved in a Minimal Simulation' extended the author's so-called 'minimal simulation' methodology to the automatic design of a neural controller that allows an 8-legged robot to wander around its environment, avoiding objects using its infra-red sensors and backing away from objects that it hits with its bumpers.

The talk by O. Miglino, D. Denaro, G. Tascini and D. Parisi was entitled 'Detour Behaviour in Evolving Robots: Are Internal Representations Necessary?' It showed that internal representations of the environment are not necessary for a Khepera robot to make a detour around an obstacle to reach a target, although such an explanation is often put forward by biologists to explain experimental results obtained with animals.

'Evolving Robot Behaviours with Diffusing Gas Networks' was the title of P. Husbands' talk, which introduced a new type of artificial neural controller inspired by the modulatory effects of freely diffusing gases in real neural networks. Using such controllers, successful behaviours have been consistently evolved in far fewer evaluations than are needed when using conventional neural networks.

M. Wheeler's talk, 'Explaining the Evolved: Homunculi, Modules and Internal Representations', examined why it is hard to explain a certain category of evolved control system using the traditional representation-based explanatory language of cognitive science.

In 'Evolving and Breeding Robots', H. Lund and O. Miglino introduced 'breeding robotics' – an approach that combines shaping, reinforcement learning and evolution. In particular, they showed how children can act as breeders and evolve LEGO robots through an interactive genetic algorithm that achieves desired behaviours.

D. Keymeulen, M. Iwata, K. Konaka, R. Suzuki, Y. Kuniyoshi and T. Higuchi talked about 'Off-Line Model-Free and On-Line Model-Based Evolution for Tracking Navigation Using Evolvable Hardware'. They described how a navigation system for a mobile robot can be evolved using a Boolean function approach implemented on evolvable hardware.

Finally, the talk by J. Chavas, C. Corne, P. Horvai, J. Kodjabachian and J.A. Meyer dealt with the 'Incremental Evolution of Neural Controllers for Robust Obstacle-Avoidance in Khepera'. It showed how a two-stage incremental approach has been used to evolve robust obstacle-avoidance controllers for a Khepera robot and proved to be more efficient than a competing direct approach.

During the poster session, various results from the Centre for Computational Neuroscience and Robotics at Sussex University were presented. These dealt with various methodological aspects and behaviours such as: mutation-locking techniques applied to T-maze navigation; the use of noise to accelerate the evolution of homing behaviour; and applying a minimal simulation approach to football playing. A contribution from Dortmund University was centred on a random morphology robot – a first step towards a physical instantiation of Sims' work on evolving morphologies. Results from Tokyo Institute of Technology were also provided that show how capacities for recognizing various environments can be evolved in a real robot that doesn't use visual sensors and doesn't build any map.

During the first discussion session important issues in evolutionary robotics were raised. Essentially, participants stressed the potential usefulness of simulations; they acknowledged that current realizations do not yet compete with human-designed solutions (except in terms of robustness and minimalism); and appealed for an exploration of the synergies afforded by the combination of evolution, development and learning processes.

The second discussion session focused on future developments and was introduced by a talk from T. Gomi (Applied AI Systems) on current commercial robotic applications that might benefit from evolutionary approaches. A general discussion about which specific recommendations participants could make to EvoNet and the EU for future funding didn't identify any obviously unexplored and promising areas. At the moment, the most reasonable recommendation seems to be helping to further and consolidate current research avenues, although a number of people stressed the need to develop robots with more sophisticated sensori-motor capabilities (e.g. more sophisticated actuators) than are generally used now.

The extended 'after-hours' sessions were also very enjoyable and sparked much interesting debate.

Jean-Arcady Meyer and Phil Husbands

ESPRIT Enterprise Initiative

To help ESPRIT innovators to turn their results into a successful commercial venture, ESPRIT is supporting 'TRAIN IT' – an initiative to provide active assistance and full support in the formulation of business plans.

The co-ordinators of the initiative are Dr Ingo Hussla and Mrs Andrea Thiemann of the Innovation Centre Itzehoe in Germany, who are working in close collaboration with Promotech (France), Merinova (Finland) and Sonderrjyllands Erhvervs Center (Denmark). All four organisations are well recognized experts in technology transfer and IT related matters.

More information about TRAIN IT can be found at http://www.train-it.izet.de/project.htm

Contributions for EvoNews

As the newsletter of EvoNet, EvoNews provides a forum in which the commercial, industrial and academic sectors can share ideas and information about developments in Evolutionary Computing. We are looking for:

Articles
- short articles on industrial applications
- reports of successful collaborations
- inspirational articles about new concepts/approaches

News items
- information about any EC-related events
- news about research grants
- details of new courses
- details of forthcoming relevant publications

Letters
Let us know how EvoNews can best reflect your needs. What items would you like to see in the newsletter?

Contributions should not be over technical (no complicated diagrams or maths). The copy deadline for the Summer issue of EvoNews is 20 July.

ON*LINE*

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GP List
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GA List
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Web Sites

ftp://ftp.egr.msu.edu/pub/EC/
Back issues of GA List, source code and other EA packages. Access using anonymous ftp to ftp.aic.nrl.navy.mil Use a username of anonymous and your own e-mail address as your password.

http://www.dcs.napier.ac.uk/evonet/Coordinator/espfund.htm
ESPRIT funding initiatives web page – information on funding opportunites for software technologies, technologies for components and subsystems, high performance computing and networking, and integration in manufacturing.

EvoNet Web Sites

There are now four EvoNet mirror web sites in operation:

- **Napier University, Edinburgh**
  http://www.dcs.napier.ac.uk/evonet/
- **Ecole Polytechnique, Paris**
  http://blanche.polytechnique.fr/www.evonet/
- **University of Granada**
  http://krypton.ugr.es/Coordinator/evonet_f.htm
- **University of Dortmund**
  http://ls11-www.informatik.uni-dortmund.de/evonet/

To keep ONLINE up-to-date, please e-mail evonet@dcs.napier.ac.uk with any interesting EC-related ftps, newsgroups, bookmarks or mailing lists.

EvoNet Contacts

Main Contact Point
✉ Evonet, Dept of Computer Studies
Napier University, 219 Colinton Road
Edinburgh EH14 1DJ, UK
☎ +44 (0) 131 455 4218/4305
+44 (0) 131 455 4440
💻 evonet@dcs.napier.ac.uk

Co-ordinator
Prof. Terry Fogarty (address above)
☎ +44 (0) 131 455 4398 (voice)
💻 t.fogarty@dcs.napier.ac.uk

Deputy Co-ordinator
Dr Julian Miller (address above)
☎ +44 (0) 131 455 4318 (voice)
💻 j.miller@dcs.napier.ac.uk

Administrator
Ms Jennnifer Wilies (address above)
☎ +44 (0) 131 455 4218 (voice)
💻 jennifer@dcs.napier.ac.uk

Technical Assistant
Pedro Angel Castillo Valdivieso
Universidad de Granada
☎ +34-58-243163 (voice)
+34-58-243230 (fax)
💻 pedro@krypton.ugr.es

Management Board
💻 evonet.mb@dcs.napier.ac.uk

Prof. Jarmo Alander, University of Vaasa
☎ +358 61 3248444 (voice)
+358 613248 467 (fax)
💻 Jarmo.Alander@uwasa.fi

Prof. Wolfgang Banzhaf, University of Dortmund
☎ +49 231 9700 953 (voice)
+49 231 9700 959 (fax)
💻 banzhaf@ls11.informatik.uni-dortmund.de

Mr Bertrand Braunschweig, DIMA, IFP
☎ +33 147526648 (voice)
+33 147527022 (fax)
💻 Bertrand.Braunschweig@ifp.fr

Ms Janet Bruten, Hewlett-Packard Laboratories
☎ +44 117 9228700 (voice)
+44 117 9228003 (fax)
💻 jlb@hplb.hpl.hp.com

Alexandre Caminada, CNET
☎ +33 8454 4225 (voice)
+33 8454 4396 (fax)
💻 caminada@belfort.cnet.fr

Prof. Marco Colombetti, Politecnico di Milano
☎ +39 2 2399 3525 (voice)
+39 2 2399 3525 (fax)
💻 colombet@elet.polimi.it

Dr Agoston Eiben, Leiden University
☎ +31 71 5277060 (voice)
+31 71 5275819, 5276985 (fax)
💻 gusz@wi.leidenuniv.nl

Prof. Dr. Volkmar Friedrich, Parsytech Eastern Europe
☎ +49 371 5221 114 (voice)
+49 371 5221 104 (fax)
💻 fried@parsytec.de

Dr Monique Gerrets, Cap Volmac
☎ +31 30 2526311 (voice)
+31 30 2527045 (fax)
💻 mgerrets@inetgate.capvolmac.nl

Professor Francisco Herrera, Universidad de Granada
☎ +34 58 244019 (voice)
+34 58 243317 (fax)
💻 herrera@robinson.ugr.es

Dr Philip Husbands, University of Sussex
☎ +44 1273 678556 (voice)
+44 1273 671320 (fax)
💻 philh@cogs.susx.ac.uk

Prof. Ken Jukes, University of the West of England
☎ +44 117 965 6261 (voice)
+44 117 975 0416 (fax)
💻 Ken.Jukes@csm.uwe.ac.uk

Dr Frieder Lohnert, Daimler-Benz AG
☎ +49 30 399 82 239 (voice)
+49 30 399 82 107 (fax)
💻 lohnert@DBresearch-berlin.de

Prof. Bernard Manderick, Vrije Universiteit Brussel
☎ +32 2 629 3720 (voice)
+32 2 629 37 29 (fax)
💻 bernard@arti.vub.ac.be

Dr B. Mantel, Dassault Aviation
☎ +33 1 47 11 44 22 (voice)
+33 1 47 11 45 35 (fax)
💻 mantel@Dassault-aviation.fr

Dr Jean-Arcady Meyer, Ecole Normale Superieure
☎ +33 1 44 32 36 23 (voice)
+33 1 44 32 39 01 (fax)
💻 meyer@wotan.ens.fr

Dr Andrea Pagni, SGS Thomson Microelectronics SRL
☎ +39 39 6035918 (voice)
+39 39 6036129 (fax)
💻 andrea.pagni@st.com

Miss Rachael Pearce, Rolls-Royce plc
☎ +44 1332 246140 (voice)
+44 1332 247129 (fax)
💻 rrasl.ci@dial.pipex.com

Prof. Nicholas Radcliffe Quadstone Ltd
☎ +44 131 220 4491(voice)
+44 131 220 4492 (fax)
💻 njr@quadstone.co.uk

Dr Marc Schoenauer, CMAP Ecole Polytechnique
☎ +33 1 69 33 46 19 (voice)
+33 1 69 33 30 77 (fax)
💻 marc@cmapx.polytechnique.fr

Dr Andrea Tettamanzi, Genetica
☎ +39-2-5468471(voice)
+39.2.55468471 (fax)
💻 genetica@tin.it

Dr Hans-Michael Voigt, Technische Universitat Berlin
☎ +49 30 31472677 (voice)
+49 30 31472658 (fax)
💻 voigt@gafi.de

Dr William Wright, British Aerospace
☎ +44 117 936 6098 (voice)
+44 117 936 3733 (fax)
💻 Andy.Wright@src.bae.co.uk

ABOUT EVONEWS

Consultant Editor: Dr Julian Miller
Editor: Mij Kelly
Editorial Board: Wolfgang Banzhaf, Gusz Eiben, Terry Fogarty (Chair), Ian Parmee, Andrea Tettamanzi, Marc Schoenauer

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For further information about EvoNet, to subscribe to **EvoNews**, to request information to be included in **EvoNews**, or to submit articles for the next issue, please contact:

✉ EvoNet, Dept. of Computer Studies, Napier University, 219 Colinton Road, Edinburgh EH14 1DJ UK
☎ +44 (0) 131 455 4218, 4305 (voice)
+44 (0) 131 455 4440 (fax)
💻 evonet@dcs.napier.ac.uk

EvoNet Committees

Executive
💻 evonet.exec@dcs.napier.ac.uk
- Wolfgang Banzhaf
- Terry Fogarty (Chair)
- Andrea Tettamanzi
- Gusz Eiben
- Ian Parmee
- Marc Schoenauer

Research
💻 evonet.rc@dcs.napier.ac.uk
- Jarmo Alander (Vice-Chair)
- Joachim Born
- Marco Dorigo
- Spyros Kazarlis
- Jean Louchet
- Jean-Arcady Meyer
- George Smith
- Wolfgang Banzhaf (Chair)
- Marco Colombetti
- Inman Harvey
- Robert Keller
- Bernard Manderick
- Colin Reeves

Training
💻 evonet.tc@dcs.napier.ac.uk
- P. Adamidis
- A. E. Eiben (Chair)
- M. Herdy
- A. Keane (Vice-Chair)
- C. Porras
- J. Smith
- E. Torres
- G. Degli Antoni
- J. van Hemert
- P. Husbands
- F.Kursawe
- B. Paecheter
- A. Tettamanzi
- G. Venturini

Industrial Liason
💻 evonet.ilc@dcs.napier.ac.uk
- Terry Fogarty
- Bertrand Mantel
- Ian Parmee (Vice-Chair)
- Marco Tomassini
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- Marcello Melis
- Andrea Tettamanzi
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Electronic Communications
💻 evonet.ecc@dcs.napier.ac.uk
- Jarmo Alander
- Gusz Eiben
- Ken Jukes
- Marc Schoenauer (Chair)
- Wolfgang Banzhaf
- Terry Fogarty
- J. J. Merelo

EvoNet Working Groups

EcTelNet: Evolutionary Computation in Telecommunications
💻 ectel@dcs.napier.ac.uk
ectel-chair@dcs.napier.ac.uk
Dave Corne (Chair) D.W.Corne@reading.ac.uk
George Smith (Chair) gds@sys.uea.uk

EvoGP: Genetic Programming
💻 evogp@dcs.napier.ac.uk
Riccardo Poli (Chair) R.Poli@cs.bham.ac.uk
Wolfgang Banzhaf (Chair)
banzhaf@ls11.informatik.uni-dortmund

EvoStim: Scheduling and Time-Tabling
💻 evostim@dcs.napier.ac.uk
Ben Paechter (Chair) benp@dcs.napier.ac.uk

EvoRob: Evolutionary Robotics
💻 evorob@dcs.napier.ac.uk
Phil Husbands (Chair) philh@cogs.susx.ac.uk

EvoElec: Evolutionary Electronics
💻 evoelec@dcs.napier.ac.uk
Julian Miller (Chair) j.miller@dcs.napier.ac.uk

SCONDI: Systems, Control and Drives Industry
💻 evoscondi@dcs.napier.ac.uk
Yun Li (Chair) Y.Li@elec.gla.ac.uk

EvoDES: Evolutionary Design
💻 evodes@dcs.napier.ac.uk
Ian Parmee (Chair) iparmee@plymouth.ac.uk

EvoIASP: Image Analysis and Signal Processing
💻 evoiasp@dcs.napier.ac.uk
Stefano Cagnoni (Chair) cagnoni@ce.unipr.it

EvoDOP: Design Optimization Problems
💻 evodop@dcs.napier.ac.uk
Thomas Baeck (Chair) baeck@icd.de