SIGEVOLution

newsletter of the ACM Special Interest Group on Genetic and Evolutionary Computation

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Issue 1

in this issue

Editorial

No doubt many readers are busy preparing to head to Denver for GECCO 2016. In this issue we take a look backwards and forwards to two other conferences that have also seen much recent activity from the SIGEVO community – EvoSTAR 2016 held in Porto, Portugal in April, and to PPSN 2016, to be held in Edinburgh, Scotland in September. From EvoSTAR 2016, we report on the best paper awards, and the award for outstanding contribution to evolutionary computation in Europe, won this year by Penousal Machado from the University of Coimbra in Portugal in particular for recognition of his work developing a more creative expression of AI. Warmest congratulations to Penousal! EvoSTAR hosted two keynote speeches: from Richard Forsyth, an early GP pioneer, and from Kenneth Sörensen on the use of metaphors in meta-heuristics. The talks sparked a great deal of debate, and we present here a perspective on the former talk written by James McDermott and summary of the latter talk written by Sörensen himself. The two articles represent the personal opinions of the respective authors and are published in the spirit of impartial reporting of the conference.

Looking forward, the newsletter also previews PPSN 2016, highlighting the recently announced best-paper nominations and abstracts from the three keynote speakers. There's also an overview of the exciting programme of workshops and tutorials. Don't forget to register, and take advantage of a hands-on tutorial on Evolutionary Robotics or brush up on your theory of Evolutionary Computation to highlight just a few of the varied options available. As I write this, the UK may have just voted to leave Europe, but Scotland most certainly did not, and we warmly welcome everyone from Europe and the rest of the world to the beautiful city of Edinburgh in September!

With both GECCO and PPSN it's a busy summer for the community - enjoy both conferences - and do get in touch if you would like to write an article on anything that catches your interest.

Emma Hart

The front cover image was generated using the Unplugged Evolutionary Algorithm.
F. Fernández de Vega, C. Cruz, P. Hernández, L. Navarro, V. Albarrán, L. Espada.

Call for Papers: Special Issue on Automated Design and Adaptation of Heuristics for Scheduling and Combinatorial Optimisation

Journal of Genetic Programming and Evolvable Machines

http://static.springer.com/sgw/documents/1567168/application/pdf/GENP+CFP+-+Automated+Design.pdf

Scheduling and combinatorial optimisation problems appear in many practical applications in production and service industries and have been the research interest of researchers from operations research and computer science. These problems are usually challenging in terms of both complexity and dynamic changes, which requires the development of innovative solution methods. Although the research in this field has made a lot of progress, designing effective algorithms/heuristics for scheduling and combinatorial optimisation problems is still a hard and tedious task. In the last decade, there has been a growing interest in applying computational intelligence (particularly evolutionary computation) techniques to help facilitate the design of scheduling algorithms and many state-of-the-art methods have been developed.

This special issue aims to present the most recent advances in scheduling and combinatorial optimisation with a special focus on automated heuristic design and self-adaptive algorithms. This includes (1) offline approaches to automatically discover new and powerful algorithms/heuristics for scheduling and combinatorial optimisation problems, and (2) online approaches which allow scheduling algorithms to self- adapt during the solving process. We encourage papers employing variable-length representations for scheduling algorithms.

Important Date: Submission deadline: Oct. 1, 2016

Guest Editors: Dr. Su Nguyen, Victoria University of Wellington, New Zealand, Dr. Yi Mei, Victoria University of Wellington, New Zealand, Dr. Mengjie Zhang, Victoria University of Wellington, New Zealand

EVOSTAR 2016 - Porto

The town of Porto overlooking the Duoro River in Portugal was the location for the 19th edition of the co-located **EvoStar conferences** held from 30 March to 1 April 2016 and incorporating

- **EuroGP**, the 19th European Conference on Genetic Programming
- **EvoAPPLICATIONS**, 19th European Conference on the Applications of Evolutionary Computation
- **EvoCOP**, the 16th European Conference on Evolutionary Computation in Combinatorial Optimisation
- **EvoMUSART**, the 5th International Conference on Evolutionary and Biologically Inspired Music, Sound, Art and Design

EvoStar arose out of workshops originally developed by EvoNet, the Network of Excellence in Evolutionary Computing, established by the European Commission. These events represent a continuity of research collaboration stretching back over 20 years.

A total of 126 papers were presented in 28 conference sessions over two and a half days, and for the first time, all papers were invited to present a talk in a series of long and short presentations and all papers were encouraged to present a poster in one of the two poster sessions.

Local organisers **Ernesto Costa** and **Penousal Machado** from the University of Coimbra prepared a delightful programme of social events including the conference dinner in one of Porto's oldest port wineries.

EvoStar 2016 Invited Talks

The Evolution of BEAGLE: Confessions of a mongrel rule-breeder

By Richard Forsyth (www.richardsandesforsyth.net)

EuroGP 2016 co-chair ***James McDermott*** *describes the EvoStar opening keynote talk given by* ***Dr Richard Forsyth****. An early GP pioneer, Richard Forsyth's talk covered some interesting interesting historical pathways and included a description of his BEAGLE system developed in 1981.*

What are the features of an evolutionary computation or related system which might lead us to judge that it is a genetic programming system? We answer this question implicitly all the time, when judging whether a paper is on-topic for a GP conference or journal. But we must also answer it when judging a historical question, that is, when, where and by whom GP was invented.

Richard Forsyth, in a fascinating keynote address at Evo* 2016, recounted some of this history. He started by digging out some of the earliest uses in print of the term "genetic programming'' including his own in 1979. These referred to the programming of DNA, something biologists have only recently achieved, rather than to any type of evolutionary computation system. He also referred to some well-known milestones in GP history, going back to Turing, and mentioning Barricelli, Fogel et al, Holland and others, along the way to GP in the modern sense as described by Cramer, Schmidhuber, and especially Koza.

In the next part of his talk, Forsyth told EvoStar participants about his system BEAGLE, which was first described in the journal Kybernetes in 1981. According to Forsyth, the BEAGLE system of 1981 used syntax-aware mutation and recombination on variable-length, tree-structured genotypes which represented executable expressions. BEAGLE was remarkably prescient in having a scheme to combat bloat -- something practitioners still struggle with 35 years later -- and a selection scheme other than the then-popular fitness-proportionate selection. Perhaps the main deficiency of the BEAGLE of 1981 was that it had little direct impact on the field, though it was developed during the mid-1980s into a moderately successful commercial product which could perform both classification and regression, exporting its results as executable code in C, Pascal or Fortran.

Forsyth then probed further into the question of what makes a GP system. He proposed some 13 features as being important, if not essential. He listed 24 papers describing evolutionary systems, many commonly quoted in GP histories -- each system possessing some, but not all of the features. Playing on a "Eureka''-type anecdote (quoted from Popular Science) about Koza's invention of GP in an airliner high above Greenland, Forsyth proposed a weighting formula for these features to come up with an "altitude" score for each of the 24 papers, fancifully representing how close they came to being unmistakably and fully-realised GP. Forsyth acknowledged that the weightings might be argued over, as might some of the less important factors; but it seems clear that the overall picture would not change much. In this picture, BEAGLE flew well above its predecessors, even though later systems flew higher still. It would certainly be regarded as on-topic in any modern GP conference or journal. It seems fair to call it the first tree-structured GP system.

In the remainder of his talk, Forsyth described a modern re-implementation of his system, demonstrating its use and output on some example problems. He also posed challenges to the audience, asking whether GP is stuck at a local optimum, and why recent successes in machine learning have not been making use of GP.

Dr. Forsyth's early contribution to GP and his telling of GP history were warmly acknowledged by Evo* conference attendees.

James McDermott, EuroGP 2016 co-chair, University College Dublin, Ireland, June 2016

Metaphors in metaheuristics: a symptom of a deeper ailment?

By Kenneth Sörensen

***Prof Kenneth Sörensen** from the University of Antwerp in Belgium is founder and current coordinator of the EURO working group EU/ME – the metaheuristics community, the largest online platform for researchers in metaheuristics worldwide. He is also associate editor of the Journal of Heuristics, International Transactions in Operational Research, and 4OR.*

His article below is based on his keynote talk given at EvoStar2016 asking whether the recent flood of "novel" metaphor-based methods means a rethink is now needed. This view is the personal opinion of the author.

Does paracetamol alleviate pain? The answer to that question is an unambiguous yes. Yes: on average, in most people, if one does not die from overdosing on it, paracetamol does alleviate pain, and its effect is stronger than that of a placebo. Apparently, the medical sciences have succeeded in gathering so much evidence for the pain-relieving qualities of paracetamol, that the answer to the question whether paracetamol really has an effect is no longer open for discussion.

Does homeopathy work? Again, the answer to that question is unambiguous: no, homeopathy has no effect beyond that of a placebo. Of course, I am talking about the "real" homeopathy, i.e., the combinatorial dilution of a substance in the (idle) hope that it will cure the disease or discomfort that it causes in undiluted form. Again, the medical sciences have obtained enough evidence to classify homeopathy with other "alternative" practices like bloodletting and faith healing. Interestingly, when you make this statement to a large enough group of people, there will be at least one who will object with an argument somewhat like the following. "I'm not so sure that [alternative medicine X] does not work. My aunt Sandra used to have a terrible rash. She went to every possible doctor she could find, but no-one could help her and the whole of the medical community had given up on her. But then she went to a homeopath, and he gave her some pills and after a few days she was cured, and she never had that rash again." As a scientist, you will no doubt see the fallacy in this argument. First of all, the evidence is anecdotal, and therefore should carry very little weight. Secondly, there is a perfectly rational explanation for the miracle healing of aunt Sandra: the placebo effect. If aunt Sandra was really cured by the homeopathic medicine she took, humanity would have to dramatically change the way it thinks about the way not only medicine works, but chemistry and physics too.

The field of medicine has been able to answer some of its core questions with something approaching certainty. How about the field of metaheuristics? Does a variable-size tabu list outperform one with fixed size? Even though this question is much closer to our own field of research, and does not seem to be much harder than the previous two questions, the answer is that we do not know. Another question: is a stochastic acceptance criterion (like in simulated annealing) better than a deterministic one (like in threshold accepting). Again: we have no idea. You might have read a paper or two on a specific algorithm for a specific problem where one or the other turned out to be better, but this kind of "aunt Sandra"-evidence is just as anecdotal and should carry little weight in determining the answer.

So, why has the field of medicine been able to answer its fundamental questions and, more importantly, why has the field of metaheuristics not been able to do the same? It appears that two of

our community's fetishes are at the core of the problem.

First, we have wasted too much time in unproductive research, and have allowed things to pass as research that do not deserve that title. I am talking specifically of our fetish with "novelty" and the indiscriminate use of metaphors to motivate the development of a frankly ridiculous number of "novel" methods. Metaphors are not wrong in themselves, and have served the community well as the inspiration for powerful new methods. However, methods whose only novelty is the metaphor they are based upon, should not be considered valuable research. Ants, bees, bacteria, wolves, cats, cuckoos, eagles, fireflies, fish, glowworms, krill, monkeys, bats, dolphins, green herons, Egyptian vultures, and virtually every other type of animal all have been used as the basis for a "novel" metaheuristic, as have imperialist societies, anarchic societies, clouds, consultants, the big bang, black holes, gravity, lightning, electromagnetism, "intelligent" water drops, river formation, the water cycle, musicians playing music, etc. The list is virtually endless.

There are many types of problems with these approaches, that should disqualify them as serious research. Most papers on metaphor-based metaheuristics extensively use the language of the metaphor, which makes these papers very hard to read, and makes it almost impossible to discern the contribution (if any) of the novel algorithm. In many cases, the process underlying the metaphor does not perform any optimization (e.g., the big bang, big crunch), or make sense at all (e.g., "intelligent" water drops). How can we expect a metaheuristic to function well if it is based on processes that do not optimize anything? Also, it is a trivial (and even fun, I must admit) exercise to think of any process and develop a metaheuristic loosely based on it.

Some exceptions notwithstanding, papers on metaphor-based algorithms are usually low-quality papers. The algorithms they described are usually far from innovative, and are tested on small instances of easy problems, so that any claims of "excellent performance" remain, at best, untested. It is clear that the metaheuristics community cannot keep supporting (explicitly or implicitly) these fringes: the negative image that this will undoubtedly result in, will at some point start to influence our careers, funding opportunities, etc.

Importantly, papers on metaphor-based methods have started to appear in regular, respected journals in the field. Of course, every journal publishes papers that, in hindsight, should not have been accepted, but it is clear that the community should be more careful in selecting what it publishes. How else are newcomers to the field supposed to distinguish serious research? Fortunately, many journals have started to update their editorial policies and now explicitly prohibit papers that propose a (meta)heuristic and do not formulate it in a metaphor-free language. As a side note: it is incomprehensible that journals do not ask authors to disclose their source code to reviewers. As some recent cases show, cheating is simply too easy in our field.

A second fetish that has countered the development of the field of metaheuristics as a research field is that with "performance". We have turned our research field into a game where it is important to "beat" "competitors" by creating the "best-performing" algorithm. Over 20 years ago, John Hooker clearly demonstrated that this practice is detrimental to the development of the field as a whole. Today, however, it is still as widespread as ever: papers only get published if they present algorithms that are in some way "better" than other algorithms, regardless of the insight into the functioning of that algorithm, or in optimization algorithms in general, that can be gained. There is therefore very little incentive for researchers to investigate whether a fixed-size tabu list is better or worse than a variable-size one, or whether stochastic acceptance criteria are better than deterministic ones. It is only through controlled experimentation (where a single factor such as the acceptance criterion is varied and the others are kept constant), structured reviews and meta-analyses, that the community will advance its knowledge and finally be able to answer its fundamental questions. This will, however, require a fundamental paradigm shift in the community.

As a conclusion, the metaheuristics community is in need of an update of its standards. Most importantly, its focus should shift away from the development of "novel" methods and methods that "beat" other methods, to research that increases our understanding of heuristic optimization algorithms. Only then will we be able to start formulating answers to our fundamental questions.

EvoStar 2016 Best Paper Awards

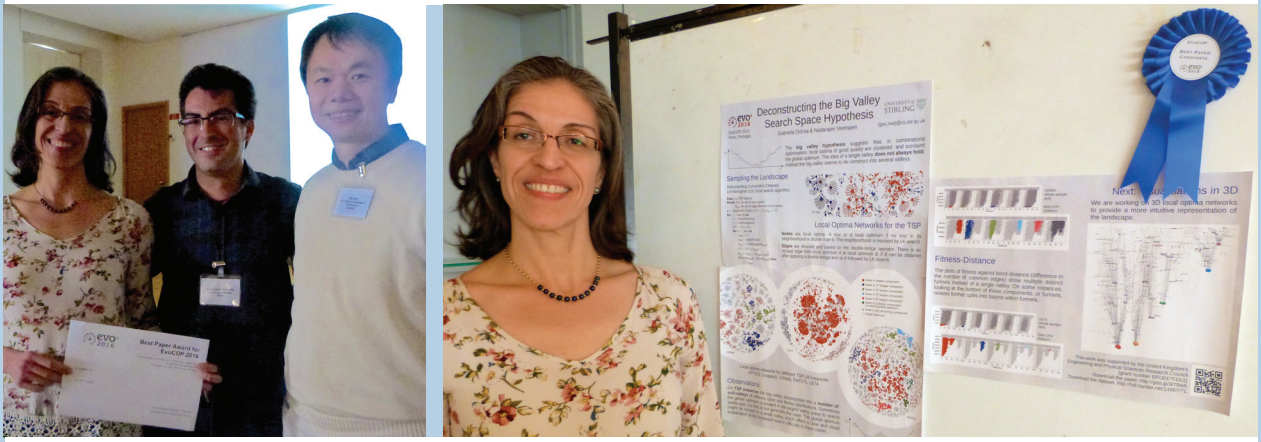
19th European conference on Genetic Programming (EuroGP)

The EuroGP 2016 Award was presented to Paweł Liskowski and Krzysztof Krawiec for their paper Surrogate Fitness via Factorization of Interaction Matrix

Best EuroGP2016 paper award winners ***Krzysztof Krawiec*** *and* ***Paweł Liskowski*** *presented by EuroGP chairs Malcolm Heyword and James McDermott*

16th European conference on evolutionary computation in combinatorial optimization (EvoCOP)

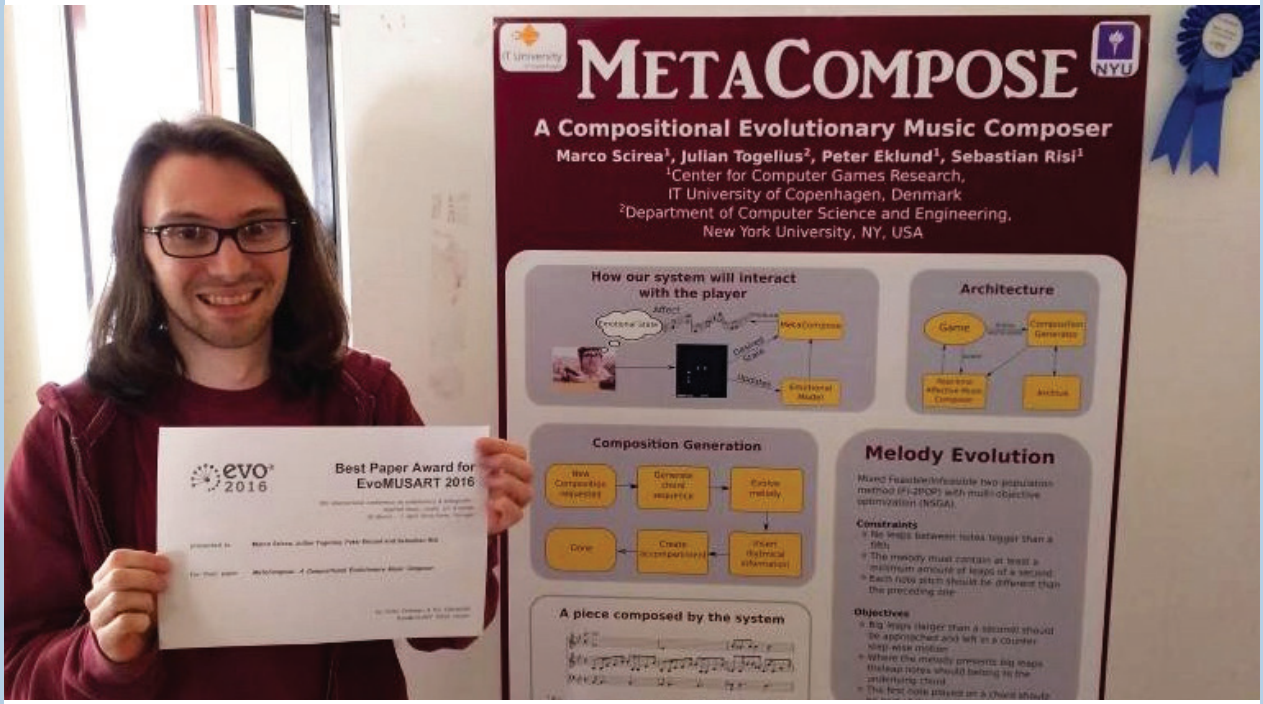
The EvoCOP 2016 Award was presented to Gabriela Ochoa and Nadarajen Veerapen for their paper Deconstructing the Big Valley Search Space Hypothesis



Best paper EvoCOP 2016 award winner ***Gabriela Ochoa***
presented by EvoCOP chairs Francisco Chicano and Bin Hu

5th international conference on evolutionary & biologically-inspired music, sound, art & design (EvoMUSART)

The EvoMUSART 2016 Award went to Marco Scirea, Julian Togelius, Peter Eklund and Sebastian Risi for their paper MetaCompose: A Compositional Evolutionary Music Composer and was presented by EvoMUSART 2016 chairs Colin Johnson & Vic Ciesielski



Best paper EvoMUSART 2016 award winner **Marco Scirea**

19th European conference on the Applications of Evolutionary Computation (EvoAPPS)

Seven papers were nominated for best EvoAPPS 2016 paper award, reflecting the diversity of topics covered by the 13 tracks of the EvoAPPLICATIONS conference which this year presented 73 accepted papers. The track chairs commended the high quality of best paper candidates and eventually selected the best EvoAPPS 2016 paper from the EvoENERGY track awarding it to Marlon Braun, Thomas Dengiz, Ingo Mauser, Hartmut Schmeck for their paper Comparison of Multi-objective Evolutionary Optimization in Smart Building Scenarios

Best paper EvoAPPS 2016 award winners **Ingo Mauser & Marlon Braun**

presented by EvoStar Coordinator Jennifer Willies with EvoAPPS Coordinator Giovanni Squillero in the background

EvoStar Outstanding Contribution Award

Each year the EvoStar community presents the EvoStar award in recognition of an outstanding contribution to evolutionary computation in Europe, with particular emphasis on academic distinction and mentoring for European bio-inspired research, preferably in collaboration with members of the EvoStar community.

The 2016 EvoStar award was presented to **Penousal Machado** from University of Coimbra in Portugal for a career developing a more creative expression of AI. Penousal Machado co-founded the EvoMUSART workshop in 2003 and was instrumental in turning it into a conference in 2012. Also a former EuroGP co-chair, his main research interest is in the application of EC techniques to the development of artificial artists and computer-aided creativity systems, including the development of NEvAr an interactive evolutionary art tool which was further refined to perform aesthetic judgments. He is currently Scientific Director of the Computational Design and Visualisation Lab at the University of Coimbra (http://cdv.dei.uc.pt/authors/penousal-machado).

Friend and colleague **Ernesto Costa** gave an emotional tribute at the award ceremony where previous recipients joined together to present the 2016 EvoStar award.

Here are excerpts from Ernesto Costa's presentation :

In choosing the 2016 recipient of the "EvoStar Award for Outstanding Contribution to Evolutionary Computation in Europe", it is worth reminding ourselves that the selection process as well as the winner are splendid examples of a fundamental trilogy present in science and in life: Memory, Love and Time.

Memory, for we are fortunate to have many researchers who deserve this award, and we carefully looked to the past and summarized the contributions of each of the potential candidates.

Love, for even if we try hard to be objective in our judgment, we are all influenced by emotional links to researchers as people interacting with other people.

Time, for a decision was needed before the conference, and as scientists, we invoked mathematics to help us to reduce the initial set of potential candidates and, by consensus and respecting our natural differences, to a singleton, The One!

It gives me great pleasure to announce this EvoStar award, and again I'll ask for help from the trilogy: Memory, Love and Time.

Memory. This year's recipient has been present at EvoStar almost since the first day and, over time, the quality of his scientific work has been recognized in so many different ways. He was responsible for the development of a scientific domain that appeals to our senses, and to the appearance, and sustainability, of one of the most successful evolutionary computation events.

Love. He is unique, almost as a piece of art. Looking at the way he dresses, specially the shirts he wears, we could say he is truly John Koza's offspring. As all artists, he needs an audience, a group of loving followers, and to simplify things he was able to clone himself into many. As happens in the biological realm, this was an error prone process that end up in many … mutated copies, a group of high quality, promising, designers. The Chosen One is someone who often tries to appear tough, but he is perceived by his followers as he truly is: a sweet soft heart.

Time. So it is now time to announce the name of this year's winner, The Special One, and I will call him by his true name.The 2016 EvoStar Award for Outstanding Contribution to Evolutionary Computation in Europe is my dear colleague and friend **Foot-On-Salt Stone-Axe** (aka Penousal Machado).

Penousal Machado receiving his EvoStar award from Ernesto Costa and previous recipients including Julian Miller, Stefano Cagnoni, Wolfgang Banzhaf and Bill Langdon

Penousal Machado (right) with Leo Vanneschi and Wolfgang Banzhaf

Previous recipients of the EvoStar award include

2015 Leonardo Vanneschi & Anna I Esparcia-Alcazar (Copenhagen)
2014 Terence C. Fogarty (Granada)
2013 Elena Marchiori & Una-May O'Reilly (Vienna)
2012 Günther Raidl (Malaga)
2011 Julian Miller (Torino)
2010 Marco Tomassini (Istanbul)
2009 Ernesto Costa & Stefano Cagnoni (Tübingen)
2008 Marc Schoenauer & William Langdon (Napoli)
2007 Wolfgang Banzhaf & Ricardo Poli (Valencia)
2006 Jennifer Willies (Budapest)

The 20th anniversary edition of EvoStar will be held in Amsterdam from 19-21

The four conferences of EuroGP, EvoAPPS, EvoCOP and EvoMUSART will be co-located in central Amsterdam at De Bazel, the elegant Art Deco-furnished, former banking offices used by the Dutch Royal family.

evo* 2017

A retrospective collection of photographs taken at previous EvoStar events spanning 20 years will be presented.

Evert Haasdijk from VU University Amsterdam, Netherlands is local chair.

CfPs are available at the EvoStar website, www.evostar.org and the submission deadline is 1 November 2016.

www.ppsn2016.org

The 14th International Conference on Parallel Problem Solving from Nature (PPSN XIV) is organised by Edinburgh Napier University and will be held at the John McIntyre Centre, Edinburgh, Scotland, UK from 17-21 September 2016. This biennial conference aims to bring together researchers and practitioners in the field of Natural Computing.

PPSN 2016 will showcase a wide range of Natural Computing topics in 93 papers, 16 tutorials and 4 workshops.

Edinburgh is the capital of Scotland and a wonderful place to visit, a city steeped in history, with an interesting topography including seven hills and views as far as the sea. Edinburgh Castle sits in the centre as part of the medieval Old Town and looks down on the Georgian "New" Town. In August the city hosts the largest arts festival in the world. The central venue for PPSN is located next to an extinct volcano, Arthur's Seat, which is now a large public park. You will find lots to see and do while in Edinburgh and PPSN registration includes an open-top bus tour of Edinburgh.

The early registration deadline is available until 25 June 2016. A 25% student discount is available to matriculated students from recognised academic institutions studying for degrees in subjects relevant to natural computing.

PPSN registration	**Early Reg to 25 June**	**Late Reg 26 June – 12 Sept**
Regular	**500 GBP**	**675 GBP**
Student	**375 GBP**	**510 GBP**

All prices above are shown in British pounds sterling. The single registration fee allows access to all tutorials, workshops and all conference sessions over five days and includes lunches and coffee breaks at the conference venue and also one ticket for the conference dinner and any other social events arranged by the conference organisers. Also included is a USB stick containing the PPSN2016 conference proceedings.

PPSN 2016 Keynote Speakers

Open-Endedness in Simulation: a definition and its consequences

Susan Stepney, University of York, UK


Susan Stepney

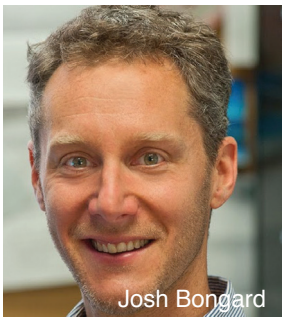
Abstract

Open-ended behaviour in simulated systems is one goal of artificial life, yet the term “open-ended” is rarely defined. Here I discuss a recent definition in terms of models and meta-models, and its consequences for discovering multi-scale open-endedness in computer simulations.

Since 2012 Susan Stepney has been Director of the York Centre for Complex Systems Analysis. She is on the board of directors of the International Society for Artificial life, and is a member of EPSRC’s ICT Strategic Advisory Team. Her current research interests include unconventional models of computation, complex systems, artificial chemistries, emergence, open-ended evolution, and bio-inspired computing.

Parallel problem solving through crowds and machines

Josh Bongard, University of Vermont, USA


Josh Bongard

Abstract

Cloud robotics, and the internet of things, is enabling ever-larger combinations of people and machines to solve increasingly challenging problems. In this talk I will outline some of our work to recruit large numbers of non-experts to solve various problems in robotics by drawing on the twin human instincts to build and to teach. I will first describe the DotBot project, in which participants build the body plans of simulated robots, while search methods improve the controllers for them. I will then explain how features were learned from the human-designed robots to empower a subsequent, fully automated system in which computers optimized robot bodies and brains. I will conclude by introducing the Twitch Plays Robotics project, in which participants teach robots how to ground the symbols of human languages in action and social prediction.

Josh is currently the Veinott Professor of Computer Science at the University of Vermont. His research foci include evolutionary robotics, crowdsourcing, and machine science.

Temporal regulation of collective behavior to generate different structures: learning from the vasculature

Katie Bentley, Harvard Medical School, USA


Katie Bentley

Abstract

Through integrated agent-based computational modeling with in vitro and in vivo experimentation we have recently uncovered that the speed and specific dynamic properties of collective decision-making among endothelial cells ultimately determines the morphology of the blood vascular network that is generated. Lateral inhibition via Notch-Dll4 signaling of neighboring cells is required to select migratory cells to lead new blood vessel sprouts. Our computational model predicted that the speed of this collective decision making process to select the cells migratory or inhibited states over time is affected by changes to tissue environment leading to drastic changes in branch spacing and vessel diameter. In experimental studies we have now validated that these predictions are correct, indicating an important new temporal mechanism for the switch to abnormal vessel growth in cancer and potentially many other diseases. Indeed we have also found first evidence that other pathways within the cells themselves can modulate collective decision deliberation times leading again to the morphogenesis if different vascular tree structures. This work has important ramifications for the field of vascular biology and therapeutic interventions targeting abnormal vascular growth in many diseases such as cancer and retinopathy. Also it represents a potentially interesting new temporal mechanism to exploit in bio-inspired collective systems.

Dr. Bentley was appointed Assistant Professor of Pathology, Harvard Medical School and group leader of the Computational Biology Laboratory at the Center for Vascular Biology Research, Beth Israel Deaconess Medical Center, Boston (2013). She is also Associate Professor at the Rudbeck Laboratories, University of Uppsala, Sweden to lead a second vascular modeling lab integrated within their vascular biology department. Dr Bentley is on the Board of Directors for the International Society of Artificial Life.

The following PPSN tutorials and PPSN workshops will run over the weekend of 17-18 September:

Darrell Whitley	Tutorial : Gray Box Optimization in Theory
Benjamin Doerr	Tutorial : Theory of evolutionary computation
Julian Miller, Patricia Ryser-Welch	Tutorial : Graph-based and Cartesian Genetic Programming
Dirk Sudholt	Tutorial : Theory of Parallel Evolutionary Algorithms
Giovanni Squillero, Alberto Tonda	Tutorial : Promoting Diversity in Evolutionary Optimization: Why and How
Dimo Brockhoff	Tutorial : Evolutionary Multi-objective Optimization
Enrique Alba	Tutorial : Intelligent Systems for Smart Cities
Mike Preuss, Michael G. Epitropakis	Tutorial : Advances on Multi-modal optimization
Stjepan Picek	Tutorial : Evolutionary Computation in Cryptography
Jacqueline Heinerman, Gusz Eiben, Evert Haasdijk, Julien Hubert	Tutorial : Evolutionary robotics – a practical guide to experiment with real hardware
Nelishia Pillay	Tutorial : Evolutionary Algorithms and Hyper-Heuristics
Luigi Malago	Tutorial : A Bridge between Optimization over Manifolds and Evolutionary Computation
JJ Merelo	Tutorial : Implementing evolutionary algorithms in the cloud
Carlos Fonseca, Andreia Guerreiro	Tutorial : The Attainment Function Approach to Performance Evaluation in EMO
Per Kristian Lehre, Pietro Oliveto	Tutorial : Runtime Analysis of Evolutionary Algorithms: Basic Introduction
Boris Naujoks, Jörg Stork, Martin Zaefferer, Thomas Bartz-Beielstein	Tutorial : Meta-Modell Assisted (evolutionary) optimization
Neil Urquhart	Workshop : Intelligent Transportation
Colin Johnson, Krzysztof Krawiec, Alberto Moraglio, Michael O'Neill	Workshop : Semantic Methods in Genetic Programming
Nadarajen Veerapen, Gabriela Ochoa	Workshop : Landscape-Aware Heuristic Search
Wei Pang, George M. Coghill	Workshop : Artificial Immune Systems in Big Data Analytics and Real World Problem Solving
Ahmed Kheiri, Rhyd Lewis, Ender Ozcan	Workshop : Natural Computing in Scheduling and Timetabling
Mike Preuss, Michael G. Epitropakis, Xiaodong Li	Workshop : Advances in Multi-modal Optimization

PPSN 2016 Tutorials

Gray Box Optimization in Theory and Practice Tutorial

Darrell Whitley, Colorado State University (USA)

This tutorial will cover Gray Box Complexity and Gray Box Optimization for kbounded pseudo-Boolean optimization. These problems can also be referred to at Mk Landscapes, and included problems such as MAX-kSAT, spin glass problems and NK Landscapes. Mk Landscape problems are a linear combination of M subfunctions, where each subfunction accepts at most k variables. Under Gray Box optimization, the optimizer is given access to the set of M subfunctions. If the set of subfunctions is k-bounded and separable, the Gray Box optimizer is guaranteed to return the global optimum with 1 evaluation. If a problem is not deceptive, the Gray Box optimizer also returns the global optimum after 1 evaluation. This means that simple test problems from ONEMAX to "Trap Functions" are solved in 1 evaluation in O(n) time under Gray Box Optimization. If a tree decomposition exists with a fixed bounded tree width, then the problem can be solved using dynamic programming in O(n) time. If the tree decomposition is bounded by lg(n), then the problem can be solved by dynamic programming in O(n^2) time. Even for those problems that are not trivially solved, Gray Box optimization also makes it possible to exactly compute Hamming distance 1 improving moves in constant time. Thus, neither mutation nor enumeration of the Hamming neighborhood are necessary. Under many conditions it is possible to calculate the location of improving moves in a Hamming distance radius r neighborhood, thus selecting improving moves several moves ahead. This also can be done in constant time. There also exists deterministic forms of recombination that provably return the best possible offspring from a reachable set of offspring. Partition Crossover relies on localized problem decomposition, and is invariant to the order of the bits in the representation. The methods identify partitions of nonlinear interaction between variables. Variables within a partition must be inherited together. However, bits in different partitions can be linearly recombined. Given p partitions, recombination can be done in O(n) time such that crossover returns the best solutions out of 2^p offspring. The offspring can also be proven to be locally optimal in the largest hyperplane subspace in which the two parents reside. Thus, Partition Crossover is capable of directly moving from known local optima to new, high quality local optima in O(n) time. These innovations will fundamentally change both Local Search and Evolutionary Algorithms. Empirical results show that combining smart local search with Partition Crossover results in search algorithms that are capable of finding globally optimal solutions for nonlinear problems with a million variables in less than 1 minute.

Theory of Evolutionary Computation Tutorial

Benjamin Doerr, Ecole Polytechnique de Paris (France)

Theoretical research has always accompanied the development and analysis of evolutionary algorithms, both by explaining observed phenomena in a very rigorous manner and by creating new ideas. Since the methodology of theory research is very different from experimental or applied research, non-theory researcher occasionally find it hard to understand and profit from theoretical research. Overcoming this gap in our research field is the target of this tutorial. Independent of particular theoretical subdisciplines or methods like runtime analysis or landscape theory, we aim at making theory accessible to researchers having little exposure to theory research previously. In particular,

- we describe what theory research in EC is, what it aims at, and showcase some of key findings of the last 15 years,
- we discuss the particular strengths and limitations of theory research,
- we show how to read, understand, interpret, and profit from theory results.

Graph-based and Cartesian Genetic Programming Tutorial

Julian Miller & Patricia Ryser-Welch, University of York (UK)

Genetic Programming is often associated with a tree representation for encoding expressions and algorithms. However, graphs are also very useful and flexible program representations which can be applied to many domains (e.g. electronic circuits, neural networks, algorithms). Over the years a variety of representations of graphs have been explored such as: Parallel Distributed Genetic Programming (PDGP) , Linear-Graph Genetic Programming, Enzyme Genetic Programming, Graph Structured Program Evolution (GRAPE) and Cartesian Genetic Programming (CGP). Cartesian Genetic Programming (CGP) is probably the best known form of graph-based Genetic Programming. It was developed by Julian Miller in 1999-2000. In its classic form, it uses a very simple integer address-based genetic representation of a program in the form of a directed graph. CGP has been adopted by a large number of researchers in many domains. In a number of studies, CGP has been shown to be comparatively efficient to other GP techniques. It is also very simple to program. Since its original formulation, the classical form of CGP has also undergone a number of developments which have made it more useful, efficient and flexible in various ways. These include the addition of automatically defined functions (modular CGP), self-modification operators (self-modifying CGP), the encoding of artificial neural networks (GCPANNs) and evolving iterative programs (iterative CGP).

Theory of Parallel Evolutionary Algorithms Tutorial

Dirk Sudholt, University of Sheffield (UK)

Evolutionary algorithms (EAs) have given rise to many parallel variants, fuelled by the rapidly increasing number of CPU cores and the ready availability of computation power through GPUs and cloud computing. A very popular approach is to parallelize evolution in island models, or coarse-grained EAs, by evolving different populations on different processors. These populations run independently most of the time, but they periodically communicate genetic information to coordinate search. Many applications have shown that island models can speed up computation time significantly, and that parallel populations can further increase solution diversity. However, there is little understanding of when and why island models perform well, and what impact fundamental parameters have on performance. This tutorial will give an overview of recent theoretical results on the runtime of parallel evolutionary algorithms. These results give insight into the fundamental working principles of parallel EAs, assess the impact of parameters and design choices on performance, and contribute to the design of more effective parallel EAs.

Promoting Diversity in Evolutionary Optimization: Why and How Tutorial

Giovanni Squillero, Politecnico di Torino (Italy) & Alberto Tonda, INRA (France)

Divergence of character is a cornerstone of natural evolution. On the contrary, evolutionary optimization processes are plagued by an endemic lack of diversity: all candidate solutions eventually crowd the very same areas in the search space. Such a “lack of speciation” has been pointed out in the seminal work of Holland in 1975, and nowadays is well known among scholars. It has different effects on the different search algorithms, but almost all are quite deleterious. The problem is usually labeled with the oxymoron “premature convergence”, that is, the tendency of an algorithm to convergence toward a point where it was not supposed to converge to in the first place. Scientific literature contains several efficient diversity-preservation methodologies that ranged from general techniques to problem-dependent heuristics. However, the fragmentation of the field and the difference in terminology led to a general dispersion of this important corpus of knowledge in many small, hard-to-track research lines. Upon completion of this tutorial, attendees will understand the root causes and dangers of “premature convergence”. They will know the main research lines in the area of “diversity promotion”. They will be able to choose an effective solution from the literature, or design a new one more tailored to their specific needs.

Evolutionary Multi-objective Optimization Tutorial

Dimo Brockhoff, INRIA Lille (France)

Many optimization problems are multiobjective, i.e., multiple, conflicting criteria need to be considered simultaneously. Due to conflicts between the objectives, usually no single optimum solution exists. Instead, a set of so-called Pareto-optimal solutions, for which no other solution has better function values in all objectives, does emerge. In practice, Evolutionary Multiobjective Optimization (EMO) algorithms are widely used for solving multiobjective optimization problems. As stochastic blackbox optimizers, EMO approaches cope with nonlinear, nondifferentiable, or noisy objective functions. By inherently working on sets of solutions, they allow the Pareto-optimal set to be approximated in one algorithm run – opposed to classical techniques for multicriteria decision making (MCDM), which aim for single solutions.

Defining problems in a multiobjective way has two further advantages:

- The set of Pareto-optimal solutions may reveal shared design principles (innovization)
- Singleobjective problems may become easier to solve if auxiliary objectives are added (multiobjectivization).

Within this tutorial, we comprehensively introduce the field of EMO and present selected research results in more detail. More specifically, we

- explain the basic principles of EMO algorithms in comparison to classical approaches,
- show a few practical examples motivating the use of EMO, and
- present a general overview of state-of-the-art algorithms and selected recent research results.

Intelligent Systems for Smart Cities Tutorial

Enrique Alba, University of Málaga (Spain)

The concept of Smart Cities can be understood as a holistic approach to improve the level of development and management of the city in a broad range of services by using information and communication technologies. It is common to recognize six axes of work in them: i) Smart Economy, ii) Smart People, iii) Smart Governance, iv) Smart Mobility, v) Smart Environment, and vi) Smart Living. In this tutorial we first focus on a capital issue: smart mobility. European citizens and economic actors need a transport system which provides them with seamless, high-quality door-to-door mobility. At the same time, the adverse effects of transport on the climate, the environment and human health need to be reduced. We will show many new systems based in the use of bio-inspired techniques to ease the road traffic flow in the city, as well as allowing a customized smooth experience for travellers (private and public transport).

This tutorial will then discuss on potential applications of intelligent systems for energy (like adaptive lighting in streets), environmental applications (like mobile sensors for air pollution), smart building (intelligent design), and several other applications linked to smart living, tourism, and smart municipal governance.

Advances on Multi-modal optimization Tutorial

Mike Preuss, University of Dortmund (Germany) & Michael G. Epitropakis, University of Stirling (UK)

Multimodal optimization is currently getting established as a research direction that collects approaches from various domains of operational research and evolutionary computation that strive for delivering multiple very good solutions at once. We discuss several scenarios and list currently employed and potentially available performance measures. Furthermore, many state-of-the-art as well as older methods are compared and put into a rough taxonomy. We also discuss recent relevant competitions and their results and outline the possible future developments in this area.

Evolutionary Computation in Cryptography Tutorial

Stjepan Picek , University of Zagreb (Croatia)

Evolutionary Computation (EC) has been used with great success on various real-world problems. One domain abundant with numerous difficult problems is cryptology. Cryptology can be divided into cryptography and cryptanalysis where although not always in an obvious way, EC can be applied to problems from both domains. This tutorial will first give a brief introduction to cryptology intended for general audience. Afterwards, we concentrate on several topics from cryptography that are successfully tackled up to now with EC and discuss why those topics are suitable to apply EC. However, care must be taken since there exists a number of problems that seem to be impossible to solve with EC and one needs to realize the limitations of the heuristics. We will discuss the choice of appropriate EC techniques (GA, GP, CGP, ES, multi-objective optimization) for various problems and evaluate on the importance of that choice. Furthermore, we will discuss the gap between the cryptographic community and EC community and what does that mean for the results. By doing that, we give a special emphasis on the perspective that cryptography presents a source of benchmark problems for the EC community. This tutorial will also present some live demos of EC in action when dealing with cryptographic problems.

Evolutionary robotics – a practical guide to experiment with real hardware Tutorial

Jacqueline Heinerman, Gusz Eiben, Evert Haasdijk & Julien Hubert, VU University Amsterdam(Netherlands)

Evolutionary robotics aims to evolve the controllers, the morphologies, or both, for real and/or simulated autonomous robots. Most research in evolutionary robotics is partly or completely carried in simulation. Although simulation has advantages, e.g., it is cheaper and it can be faster, it suffers from the notorious reality gap. Recently, affordable and reliable robots became commercially available. Hence, setting up a population of real robots is within reach for a large group of research groups today. This tutorial focuses on the know-how required to utilise such a population for running evolutionary experiments. To this end we use Thymio II robots with Raspberry Pi extensions (including a camera). The tutorial explains and demonstrates the work-flow from beginning to end, by going through a case study of a group of Thymio II robots evolving their neural network controllers to learn collecting objects on-the-fly. Besides the methodology and lessons learned, we spend time on how to code.

Evolutionary Algorithms and Hyper-Heuristics Tutorial

Nelishia Pillay,University of KwaZulu-Natal, (South Africa)

Hyper-heuristics is a rapidly developing domain which has proven to be effective at providing generalized solutions to problems and across problem domains. Evolutionary algorithms have played a pivotal role in the advancement of hyper-heuristics, especially generation hyper-heuristics. Evolutionary algorithm hyper-heuristics have been successful applied to solving problems in various domains including packing problems, educational timetabling, vehicle routing, permutation flowshop and financial forecasting amongst others. The aim of the tutorial is to firstly provide an introduction to evolutionary algorithm hyper-heuristics for researchers interested in working in this domain. An overview of hyper-heuristics will be provided. The tutorial will examine each of the four categories of hyper-heuristics, namely, selection constructive, selection perturbative, generation constructive and generation perturbative, showing how evolutionary algorithms can be used for each type of hyper-heuristic. A case study will be presented for each type of hyper-heuristic to provide researchers with a foundation to start their own research in this area. Challenges in the implementation of evolutionary algorithm hyper-heuristics will be highlighted. An emerging research direction is using hyper-heuristics for the automated design of computational intelligence techniques. The tutorial will look at the synergistic relationship between evolutionary algorithms and hyper-heuristics in this area. The use of hyper-heuristics for the automated design of evolutionary algorithms will be examined as well as the application of evolutionary algorithm hyper-heuristics for the design of computational intelligence techniques. The tutorial will end with a discussion session on future directions in evolutionary algorithms and hyper-heuristics.

A Bridge between Optimization over Manifolds and Evolutionary Computation Tutorial

Luigi Malagò, Shinshu University, Japan

The aim of this tutorial is to explore the promising connection between the well-consolidated field of optimization over manifolds and evolutionary computation. In mathematics, optimization over manifolds deals with the design and analysis of algorithms for the optimization over search spaces with admit a non-Euclidean geometry. One of the simplest examples is probably the sphere, where the shortest path between two points is given by a curve, and not a straight line. Manifolds may appear in evolutionary computation in at least two contexts. The simplest one is the case when an evolutionary algorithm is employed to optimize a fitness function defined over a manifold, such as in the case of the sphere, the cone of positive-definite matrices, the set of rotation matrices, and many others. The second one is more subtle, and is related to the stochastic relaxation of a fitness function. A common approach in model-based evolutionary computation is to search for the optimum of a function by sampling populations from a sequence of probability distributions. For instance, this is the case of evolutionary strategies, probabilistic model-building genetic algorithms, estimation of distribution algorithms and similar techniques, both in the continuous and in the discrete domain. A strictly related paradigm which can be used to describe the behavior of model-based search algorithms is that of stochastic relaxation, i.e., the optimization of the expected value of the original fitness function with respect to a probability distribution in a statistical model. From this perspective a model-based algorithm is solving a problem which is strictly related to the optimization of the stochastic relaxation over a statistical model. Notably, statistical models are well-known examples of manifolds, where the Fisher information plays the role of metric tensor. For this reason, it becomes of great interest to compare the standard techniques in the field of optimization over manifolds, with the mechanisms implemented by model-based algorithm in evolutionary computation. The tutorial will consist of two parts. In the first one, a unifying framework for the description of model-based algorithms will be introduced and some standard well-known algorithms will be presented from the perspective of the optimization over manifold. Particular attention will be devoted to first-order methods based on the Riemannian gradient over a manifold, which in the case of a statistical model is known as the natural gradient. In the second part, we will discuss how evolutionary algorithms can be adapted to solve optimization problems defined over manifold, which constitutes a novel and promising area of research in evolutionary computation.

Implementing Evolutionary Algorithms in the Cloud Tutorial

JJ Merelo, University of Granada (Spain)

Creating experiments that can be easily reproduced and converted in a straightforward way into a report involves knowing a series of techniques that are of widespread use in the open source and commercial software communities. This tutorial will introduce this techniques, including an introduction to cloud computing and DevOps for evolutionary algorithm practitioners, with reference to the tools and platforms that can make development of new algorithms and problem solutions fast and reproducible.

The Attainment Function Approach to Performance Evaluation in Evolutionary Multi-objective Optimization Tutorial

Carlos M. Fonseca & Andreia P. Guerreiro, University of Coimbra (Portugal)

The development of improved optimization algorithms and their adoption by end users depend on the ability to evaluate their performance on the problem classes of interest. In the absence of theoretical guarantees, performance must be evaluated experimentally while taking into account both the experimental conditions and the nature of the data collected. Evolutionary approaches to multiobjective optimization typically produce discrete Pareto-optimal front approximations in the form of sets of mutually non-dominated points in objective space. Since evolutionary algorithms are stochastic, such non-dominated point sets are random, and vary according to some probability distribution. In contrast to quality indicators, which map non-dominated point sets to real values, and side-step the set nature of the data, the attainment-function approach addresses the non-dominated point set distribution directly. Distributional aspects such as location, variability, and dependence, can be estimated from the raw non-dominated point set data.

Runtime Analysis of Evolutionary Algorithms: Basic Introduction Tutorial

Per Kristian Lehre, University of Nottingham, (UK) & Pietro S. Oliveto, University of Sheffield, (UK)

Evolutionary algorithm theory has studied the time complexity of evolutionary algorithms for more than 20 years. This tutorial presents the foundations of this field. We introduce the most important notions and definitions used in the field and consider different evolutionary algorithms on a number of well-known and important example problems. Through a careful and thorough introduction of important analytical tools and methods, including fitness- and level-based analysis, typical events and runs, and drift analysis. By the end of the tutorial the attendees will be able to apply these techniques to derive relevant runtime results for non-trivial evolutionary algorithms. In addition to custom-tailored methods for the analysis of evolutionary algorithms we also introduce the relevant tools and notions from probability theory in an accessible form. This makes the tutorial appropriate for everyone with an interest in the theory of evolutionary algorithms without the need to have prior knowledge of probability theory and analysis of randomised algorithms. Variants of this tutorial have been presented at GECCO 2013-2015, attracting well over 50 participants each time. The tutorial will be based on the 'Theoretical analysis of stochastic search heuristics' chapter of the forthcoming Springer Handbook of Heuristics.

Meta-Model Assisted (Evolutionary) Optimization Tutorial

Boris Naujoks, Jörg Stork, Martin Zaefferer, and Thomas Bartz-Beielstein TH Köln (Germany)

Meta-model assisted optimization is a well-recognized research area. When the evaluation of an objective function is expensive, meta-model assisted optimization yields huge improvements in optimization time or cost in a large number of different scenarios. Hence, it is extremely useful for numerous real-world applications. These include, but are not limited to, the optimization of designs like airfoils or ship propulsion systems, chemical processes, biogas plants, composite structures, and electromagnetic circuit design.

This tutorial is largely focused on evolutionary optimization assisted by meta-models, and has the following aims: Firstly, we will provide a detailed understanding of the established concepts and distinguished methods in meta-model assisted optimization. Therefore, we will present an overview of current research and open issues in this field. Moreover, we aim for a practical approach. The tutorial should enable the participants to apply up-to-date meta-modelling approaches to actual problems at hand. Afterwards, we will discuss typical problems and their solutions with the participants. Finally, the tutorial offers new perspectives by taking a look into areas where links to meta-modelling concepts have been established more recently, e.g., the application of meta-models in multi-objective optimization or in combinatorial search spaces.

PPSN 2016 Workshops

Intelligent Transportation Workshop

Neil Urquhart

URL: http://www.soc.napier.ac.uk/~40000408/ppsn/

This workshop will bring together researchers using nature inspired computing to support intelligent transportation, allowing them to present and discuss ideas and concepts with their peers. Topics for discussion include (but are not limited to):

- Optimisation of goods deliveries
- Optimisation of mobile workforce
- Use of nature inspired computing techniques will real world transport related data and APIs
- Traffic and transport management

Landscape-Aware Heuristic Search Workshop

Nadarajen Veerapen, Gabriela Ochoa

URL: http://www.cs.stir.ac.uk/events/ppsn2016-landscape/

Fitness landscape analysis and visualisation can provide significant insights into problem instances and algorithm behaviour. The aim of the workshop is to encourage and promote the use of landscape analysis to improve search algorithms and their understanding. Examples include landscape analysis as a tool to inform the design of algorithms, landscape metrics for online adaptation of search strategies, mining landscape information to predict instance hardness and algorithm runtime. The workshop seeks to bring together researchers interested in landscape analysis and in exploiting problem structure to develop informed search strategies. The workshop provides a unique opportunity to present existing work, propose new ideas or put forward position statements.

Natural Computing in Scheduling and Timetabling Workshop

Ahmed Kheiri, Rhyd Lewis, Ender Ozcan

URL: http://ahmedkheiri.bitballoon.com/ppsn2016workshop/

The aim of this workshop is to bring together researchers and practitioners to share their experiences and report on emerging approaches in solving real-world scheduling problems. A particular interest will be on approaches that give a deeper insight into scheduling problem classes, and that enable the exploitation of structural information during the automated search for a solution to a given problem. General purpose approaches used for automated generation of heuristics for solving single and multi-objective scheduling problems and issues related to development of such approaches are also of particular interest.

Advances in Multi-modal Optimization

Mike Preuss, Michael G. Epitropakis, Xiaodong Li

URL: http://www.epitropakis.co.uk/ppsn2016-niching/

The workshop attempts to bring together researchers from evolutionary computation and related areas who are interested in Multimodal Optimization. This is a currently forming field, and we aim for a highly interactive and productive meeting that makes a step forward towards defining it. The Workshop will provide a unique opportunity to review the advances in the current state-of-the-art in the field of Niching methods. Further discussion will deal with several experimental/ theoretical scenarios, performance measures, real-world and benchmark problem sets and outline the possible future developments in this area. Positional statements, suggestions, and comments are very welcome!

The following papers have been nominated for PPSN206 Best Paper Awards :

Andreia Guerreiro and Carlos Fonseca
Hypervolume Sharpe Ratio Indicator: Formalization and First Theoretical Results

Youhei Akimoto and Nikolaus Hansen
Online Model Selection for Restricted Covariance Matrix Adaptation

Pascal Kerschke, Hao Wang, Mike Preuss, Christian Grimme, André Deutz, Heike Trautmann and Michael Emmerich
Towards Analyzing Multi-modality of Multi-objective Landscapes

Duc-Cuong Dang, Per Kristian Lehre, Tobias Friedrich, Timo Koetzing, Martin S. Krejca, Pietro S. Oliveto, Dirk Sudholt and Andrew M. Sutton
Emergence of Diversity and its Benefits for Crossover in Genetic Algorithms

Michael Hellwig and Hans-Georg Beyer
Evolution under Strong Noise: A Self-Adaptive Evolution Strategy Can Reach the Lower Performance Bound – the pcCMSA-ES

Sam Kriegman, Marcin Szubert, Josh Bongard and Christian Skalka
Evolving Spatially Aggregated Features From Satellite Imagery for Regional Modeling

Vesa Ojalehto, Dmitry Podkopaev and Kaisa Miettinen
Towards automatic testing of reference point-based interactive methods

Martin Pilat and Roman Neruda
Feature Extraction for Surrogate Models in Genetic Programming

Momodou Sanyang and Ata Kaban
REMEDA: Random Embedding EDA for optimizing functions with intrinsic dimension

Jorge Gomes, Miguel Duarte, Pedro Mariano and Anders Lyhne Christensen
Cooperative Coevolution of Control for a Real Multi-robot System

Research opportunities

Sentient Technologies, a Machine Learning startup in San Francisco, has multiple research positions open in

- evolutionary computation
- deep learning
- recurrent neural networks
- blackbox optimization
- data science,
- computer vision.

Sentient was founded by the same entrepreneurs who created the technology behind Siri. Emerging from stealth in 2015, Sentient is currently the world's best funded AI startup, and has already deployed products in stock trading and e-commerce, with possible expansions to healthcare, finance, and cyberphysical systems in the future. These products were made possible by original research in evolutionary computation and deep learning, as well as massive computing power: Sentient has developed grid computing technology that harnesses millions of CPUs and thousands of GPUs around the globe, amounting to the largest intelligent system in the world.

In line with the recent trend of merging academic and industry research, several academic faculty are involved in research at Sentient as employees, advisors, or collaborators, including Peter Bartlett (Berkeley), Nello Christianini (Bristol), David Helmbold (UCSC), Chris Holmes (Oxford), Risto Miikkulainen (UTexas), and Caleb Harper (MIT). Sentient also participates in (and sponsors) conferences such as AAAI Symposia, GECCO, and NIPS. If you are going to one of those conferences, please stop by to chat!

Positions are open immediately, and in the near future, for

- new PhDs
- senior research scientists
- visiting faculty, and
- student interns.

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To find out more, please contact risto.miikkulainen@sentient.ai, or check out our website at sentient.ai

About this newsletter

SIGEVOlution is the newsletter of SIGEVO, the ACM Special Interest Group on Genetic and Evolutionary Computation. To join SIGEVO, please follow this link: [WWW]

Contributing to SIGEVOlution

We solicit contributions in the following categories:

Art: Are you working with Evolutionary Art? We are always looking for nice evolutionary art for the cover page of the newsletter.

Short surveys and position papers: We invite short surveys and position papers in EC and EC related areas. We are also interested in applications of EC technologies that have solved interesting and important problems.

Software: Are you are a developer of an EC software and you wish to tell us about it? Then, send us a short summary or a short tutorial of your software.

Lost Gems: Did you read an interesting EC paper that, in your opinion, did not receive enough attention or should be rediscovered? Then send us a page about it.

Dissertations: We invite short summaries, around a page, of theses in EC-related areas that have been recently discussed and are available online.

Meetings Reports: Did you participate to an interesting EC-related event? Would you be willing to tell us about it? Then, send us a short summary, around half a page, about the event.

Forthcoming Events: If you have an EC event you wish to announce, this is the place.

News and Announcements: Is there anything you wish to announce, such as an employment vacancy? This is the place.

Letters: If you want to ask or to say something to SIGEVO members, please write us a letter!

Suggestions: If you have a suggestion about how to improve the newsletter, please send us an email.

Contributions will be reviewed by members of the newsletter board.

We accept contributions in LATEX, MS Word, and plain text.

Enquiries about submissions and contributions can be emailed to editor@sigevolution.org

All the issues of SIGEVOlution are also available online at: www.sigevolution.org

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