

EvoAPPLICATIONS 2015 – abstracts and programme

EvoAPPS 1 : INDUSTRIAL APPLICATIONS, WED 11:20-13:00

(APPs topics: GAMES+STOC)

Many-Objective Optimization of a Hybrid Car Controller

Tobias Rodemann, Kaname Narukawa, Michael Fischer, Mohammed Awada

Hybrid cars are considered to be a promising approach for providing individual mobility with lower CO₂ -emissions without compromising on affordability and driving range. In order to reach these targets a highly efficient control (energy management) is required. In mass production vehicles control is often organized using simple, quick and easy to understand rule-based systems. Such a rule-base typically contains a moderate number of parameters which can be tuned using methods like evolutionary algorithms to improve performance. However, prior work basically targets a minimization of fuel consumption. In this work we present a many-objective evolutionary optimization that considers up to 7 objectives in parallel. We outline the additional optimization challenges that arise due to the large number of objectives and demonstrate that a substantial performance increase, over all objectives, can be achieved.

Optimising the scheduling and planning of urban milk deliveries

Neil Urquhart

This paper investigates the optimisation of the delivery of dairy products to households in three urban areas. The requirement for the optimisation to be part of the existing business process has determined the approach taken. The solution is maintained in an existing customer database, with manual amendments as customers are added and deleted. The optimization challenge is to take this solution, reduce the distance travelled, and balance the load across rounds making the minimum number of changes to the delivery network. The approach taken utilizes an Evolutionary Algorithm for ordering deliveries and a multi-agent approach to reassigning deliveries between rounds. The case study suggests that distance traveled may be reduced by up to 19%, the deviation between round lengths may be considerably reduced, with only ~10% of customers being moved between rounds.

Multi-Noisy-Hard-Objective Robust Design of Balanced Surface Acoustic Wave Filters Based on Prediction of Worst-Case Performance

Kiyoharu Tagawa, Shoichi Harada

This paper presents a novel computer-aided design method of Surface Acoustic Wave (SAW) filters which are widely used in the modern RF circuits of mobile communication systems. The performance of a SAW filter is specified by a number of criteria. Besides, the performance is deteriorated due to the uncertainties of physical coefficients and design parameters. In the multi-noisy-objective optimization problem of the SAW filter, the worst-case performance of a solution is considered based on the upper bounds of respective noisy-objective functions

predicted statistically by multiple sampling. For finding various solutions for the problem effectively, a new evolutionary algorithm is proposed with three sample saving techniques. Finally, the influence of noise on the SAW filter is discussed through analysis of the obtained solutions.

Evolutionary Optimization of Smart Buildings with Interdependent Devices

Ingo Mauser, Julian Feder, Jan Mueller, Hartmut Schmeck

To enable a more efficient utilization of energy carriers, energy management systems (EMS) are designed to optimize the usage of energy in future smart buildings. In this paper, we present an EMS for buildings that uses a novel approach towards optimization of energy flows. The system is capable of handling interdependencies between multiple devices consuming energy, while keeping a modular approach towards components of the EMS and their optimization. Evaluations of the EMS in a realistic scenario, which consists of a building with adsorption chiller, hot and cold water storage tanks as well as combined heat and power plant, show the ability to reduce energy consumption and costs by an improved scheduling of the generation of hot and chilled water for cooling purposes.

Clustering local tourism systems by Threshold Acceptance

Joseph Andria, Giacomo Di Tollo

Despite the importance of tourism as a leading industry in the development of a country's economy, there is a lack of criteria and methodologies for the detection, promotion and governance of local tourism systems. We propose a quantitative approach for the detection of local tourism systems that are optimal with respect to geographical, economic, and demographical criteria. To this end, we formulate the issue as an optimization problem, and we solve it by means of Threshold Acceptance, a meta-heuristic algorithm which allows us not to predefine the number of clusters and to allow some geographic areas not to belong to any cluster.

EvoAPPS 2 : STOCHASTIC & DYNAMIC ENVIRONMENTS, WED 14:15-15:55

(APPs topics: STOC+COMPLEX)

Applying Ant Colony Optimization to Dynamic Binary-Encoded Problems

Michalis Mavrovouniotis, Shengxiang Yang

Ant colony optimization (ACO) algorithms have proved to be able to adapt to dynamic optimization problems (DOPs) when stagnation behaviour is addressed. Usually, permutation-encoded DOPs, e.g. dynamic travelling salesman problems, are addressed using ACO algorithms whereas binary-encoded DOPs, e.g., dynamic knapsack problems, are tackled by evolutionary algorithms (EAs). This is because of the initial developments of the algorithms. In this paper, a binary version of ACO is introduced to address binary-encoded DOPs and compared with existing EAs. The experimental results show that ACO with an appropriate pheromone evaporation rate outperforms EAs in most dynamic test cases

An experimental study of combining Evolutionary Algorithms with KD-Tree to solving dynamic optimisation problems

Trung Thanh Nguyen, Ian Jenkinson, Zaili Yang

This paper studies the idea of separating the explored and unexplored regions in

the search space to improve change detection and optima tracking. When an optimum is found, a simple sampling technique is used to estimate the basin of attraction of that optimum. This estimated basin is marked as an area already explored. Using a special tree-based data structure named KD-Tree to divide the search space, all explored areas can be separated from unexplored areas. Given such a division, the algorithm can focus more on searching for unexplored areas, spending only minimal resource on monitoring explored areas to detect changes in explored regions. The experiments show that the proposed algorithm has competitive performance, especially when change detection is taken into account in the optimisation process. The new algorithm was proved to have less computational complexity in term of identifying the appropriate sub-population/region for each individual. We also carry out investigations to find out why the algorithm performs well. These investigations reveal a positive impact of using the KD-Tree.

Coevolutionary intransitivity in games: A landscape analysis

Hendrik Richter

Intransitivity is supposed to be a main reason for deficits in coevolutionary progress and inheritable superiority. Besides, coevolutionary dynamics is characterized by interactions yielding subjective fitness, but aiming at solutions that are superior with respect to an objective measurement. Such an approximation of objective fitness may be, for instance, generalization performance. In the paper a link between rating- and ranking-based measures of intransitivity and fitness landscapes that can address the dichotomy between subjective and objective fitness is explored. The approach is illustrated by numerical experiments involving a simple random game with continuously tunable degree of randomness.

Making IDEA-ARIMA efficient in Dynamic Constrained Optimization Problems

Patryk Filipiak, Piotr Lipinski

A commonly used approach in Evolutionary Algorithms for Dynamic Constrained Optimization Problems forces re-evaluation of a population of individuals whenever the landscape changes. On the contrary, there are algorithms like IDEA-ARIMA that can effectively anticipate certain types of landscapes rather than react to changes which already happened and thus be one step ahead with the dynamic environment. However, the computational cost of IDEA-ARIMA and its memory consumption are barely acceptable in practical applications. This paper proposes a set of modifications aimed at making this algorithm an efficient and competitive tool by reducing the use of memory and proposing the new anticipation mechanism.

EvoAPPS 3 : COMPLEX SYSTEMS, WED 16:20-18:00

(APPs topics: COMPLEX+FIN)

Hierarchic Genetic Search with α -Stable Mutation

Adam Obuchowicz, Maciej Smolka, Robert Schaefer

The paper analyzes the performance improvement imposed by the application of α -stable probability distributions to the mutation operator of the Hierarchic Genetic Strategy (HGS), in solving ill-conditioned, multimodal global optimization problems in continuous domains. The performed experiments range from standard benchmarks (Rastrigin and multi-peak Gaussian) to an advanced inverse parametric problem of the logging measurement inversion, associated with the oil

and gas resource investigation. The obtained results show that the application of α -stable mutation can first of all decrease the total computational cost. The second advantage over the HGS with the standard, normal mutation consists in finding much more well-fitted individuals at the highest-accuracy HGS level located in attraction basins of local and global fitness minimizers. It might allow us to find more minimizers by performing local convex searches started from that points. It also delivers more information about the attraction basins of the minimizers, which can be helpful in their stability analysis.

Emergence of Cooperation in the Prisoner's Dilemma Driven by Conformity

Marco Alberto Javarone, Antonio Emanuele Atzeni, Serge Galam

We study the relations between strategies in game theory and the conformity. The latter is a behavior deemed relevant in social psychology and, as shown in several works, it strongly influences many social dynamics. We consider a population of agents that evolves in accordance with a payoff matrix which embodies two main strategies: cooperation and defection. In particular, agents play a game (e.g., the Prisoner's Dilemma) by choosing between these two strategies, in order to increase their payoff, i.e., their gain. During the evolution of the system, agents can change strategy according to an update rule, i.e., they can play sometimes as cooperators and sometimes as defectors. Usually, rules to update the strategy are driven by the payoffs of the neighbors of each agent. For instance, an agent imitates its best neighbor, i.e., the one having the highest payoff among the other neighbors. In this context, 'imitation' means to adopt the strategy of another agent. In order to study if and how the emergence of cooperation can be affected by a social influence, we provide agents with two different behaviors, i.e., conformity and nonconformity, they use to select their strategy. Numerical simulations show that conformity strongly affects these dynamics, as cooperation emerges in the population, even under conditions of the games that usually lead, almost all agents, to play as defectors.

An Experimental Evaluation of Multi-Objective Evolutionary Algorithms for Detecting Critical Nodes in Complex Networks

Mario Ventresca, Kyle Harrison, Beatrice Ombuki-Berman

Identifying critical nodes in complex networks has become an important task across a variety of application domains. In this paper we propose a multi-objective version of the critical node detection problem, which aims to minimize pairwise connectivity in a graph by removing a subset of K nodes. Interestingly, while it has been recognized that this problem is inherently multi-objective since it was formulated, until now only single-objective algorithms have been proposed. After explicitly stating the new multi-objective problem variant, we then give a brief comparison of six common multi-objective evolutionary algorithms using sixteen common benchmark problem instances. A comparison of the results attained by viewing the algorithm as a single versus multi-objective problem is also conducted. We find that of the examined algorithms, NSGAII generally produces the most desirable approximation fronts. We also demonstrate that while related, the best multi-objective solutions do not translate into the best single-objective solutions.

Self-Balancing Multimemetic Algorithms in Dynamic Scale-Free Networks

Rafael Nogueras, Carlos Cotta

We study the behavior and performance of island-based multimemetic algorithms,

namely memetic algorithms which explicitly represent and evolve memes alongside solutions, in unstable computational environments whose topology is modeled as scale-free networks, a pattern of connectivity observed in real-world networks, such as peer-to-peer systems. We consider the utilization of self-balancing strategies in order to efficiently adjust population sizes to cope with the phenomenon of churn, as well as the dynamic re-wiring of connections in order to deal with connectivity losses caused by node failures. A broad experimental evaluation on different problems and computational scenarios featuring diverse volatility conditions shows that the combination of these two strategies leads to more robust performance, in particular in situations in which churn rates are large.

EVOAPPS POSTERS, WED 18:00 - 19:30

Studying the Geographical Cluster Paging with delay constraint in Registration Areas with the Algorithm NSGAI

Victor Berrocal-Plaza, Miguel A. Vega-Rodriguez, Juan M. Sanchez-Perez

The mobility management strategy based on registration areas is one of the most popular strategies to manage the subscribers' mobility in current Public Land Mobile Networks. For it, the network cells are arranged in continuous and non-overlapped sets in order to partially track the subscribers' movement. In this way, the network knows the location of its subscribers at a registration area level and the paging should only be performed in the cells within the last updated registration area. The paging scheme studied in this work is the geographical cluster paging, a probabilistic paging in which it is assumed that the probability of finding a mobile station (i.e. the subscriber's terminal) decreases as we move away from the last updated network cell following a normal distribution. The main appeal of this paging scheme is that we can considerably reduce the signaling traffic (with respect to the simultaneous paging) without including new elements in the network. Furthermore, we analyze it for different probability thresholds and considering delay constraints. On the other hand, we use our implementation of the Non-dominated Sorting Genetic Algorithm II (NSGAI) with the aim of finding the best possible sets of non-dominated solutions. Results show that each probability threshold has its own non-dominated region in the objective space, and that the signaling traffic can be reduced by about 30% (with respect to the simultaneous paging).

Investigating Fitness Measures for the Automatic Construction of Graph Models

Kyle Harrison, Mario Ventresca, Beatrice Ombuki-Berman

Graph models are often constructed as a tool to better understand the growth dynamics of complex networks. Traditionally, graph models have been constructed through a very time consuming and difficult manual process. Recently, there have been various methods proposed to alleviate the manual efforts required when constructing these models, using statistical and evolutionary strategies. A major difficulty associated with automated approaches lies in the evaluation of candidate models. To address this difficulty, this paper examines a number of well-known network properties using a proposed meta-analysis procedure. The meta-analysis demonstrated how these network measures interacted when used together as classifiers to determine network, and thus model, (dis)similarity. The analytical results formed the basis of a fitness evaluation scheme used in a genetic programming (GP) system to automatically construct graph models for complex

networks. The GP-based automatic inference system was used to reproduce two well-known graph models, the results of which indicated that the evolved models exemplified striking similarity when compared to their respective targets on a number of structural network properties.

Evolutionary Training of Robotised Architectural Elements

Claudio Rossi, Pablo Gil, William Coral

We present our work on the training of robotised architectural components of intelligent buildings, focusing on main architectural components and features such as facades, roofs and partitions. The parameters governing such components may be either quantitative (such as temperature, humidity, configuration of the elements) or qualitative (such as ergonomics and aesthetics), which cannot easily be described by mathematical parameters. Due to their complexity, it is often impossible -or at least impractical, to hardcode suitable controllers for such robotised structures. Thus, we propose the use of Artificial Intelligence learning techniques, concretely Evolutionary Algorithms, so that the user can teach the robotised components how to behave in response to changing environmental conditions or user preferences. This idea is tested on an intelligent rooftop with variable geometry, that learns optimal configurations with respect to ambient light during training sessions.

Heat Map Based Feature Selection: A Case Study for Ovarian Cancer

Carlos Huertas, Reyes Juárez-Ramírez

Public health is a critical issue, therefore we can find a great research interest to find faster and more accurate methods to detect diseases. In the particular case of cancer, the use of mass spectrometry data has become very popular but some problems arise due to that the number of mass-to-charge ratios exceed by a huge margin the number of patients in the samples. In order to deal with the high dimensionality of the data, most works agree with the necessity to use pre-processing. In this work we propose an algorithm called Heat Map Based Feature Selection (HmbFS) that can work with huge data without the need of pre-processing, thanks to a built-in compression mechanism based on color quantization. Results shows that our proposal is very competitive against some of the most popular algorithms and succeeds where other methodologies may fail due to the high dimensionality of the data

PowerSurge: A Serious Game on Power Transmission Networks

Sebastian von Mammen, Fabian Hertwig, Florain Obermayer, Patrick Lehner

In this paper, we present an interactive serious game about power transmission systems. The system familiarizes novices with the basic design and behavior of such systems. Using simple drag and drop interactions, power plants and consumers are placed and connected in a virtual landscape that is presented from an isometric perspective. A series of tutorials fosters the user's mastery in building and controlling a complex system. The advanced user is challenged by tasks such as the redesign of an established power infrastructure to integrate a large percentage of regenerative power plants. Next to the interface, we detail the model that drives the simulation. The methodologies presented in this paper can be applied to a wide range of serious games about complex network designs.

Parallel cooperation for large-scale multiobjective optimization on feature selection problems

Dragi Kimovski, Julio Ortega, Andrés Ortiz, Raúl Baños

Recently, the interest on multiobjective optimization problems with a large number of decision variables has grown since many significant real problems, for example on machine learning and pattern recognition, imply to process patterns with a high number of components (features). This paper deals with parallel multiobjective optimization on high-dimensional feature selection problems. Thus, several parallel multiobjective evolutionary alternatives based on the cooperation of subpopulations are proposed and experimentally evaluated by using some synthetic and BCI (Brain-Computer Interface) benchmarks. The results obtained show different improvements achieved in the solution quality and speedups, depending on the parallel alternative and benchmark profile. Some alternatives even provide superlinear speedups with only small reductions in the solution quality.

Collaborative Diffusion on the GPU for Path-finding in Games

Craig McMillan, Emma Hart, Kevin Chalmers

Exploiting the powerful processing power available on the GPU in many machines, we investigate the performance of parallelised versions of pathfinding algorithms in typical game environments. We describe a parallel implementation of a collaborative diffusion algorithm that is shown to find short paths in real-time across a range of graph sizes and provide a comparison to the well known Dijkstra and A* algorithms. Although some trade-off of cost vs path-length is observed under specific environmental conditions, results show that it is a viable contender for pathfinding in typical real-time game scenarios, freeing up CPU computation for other aspects of game AI.

A Multiobjective Evolutionary Algorithm for Personalized Tours in Street Networks

Ivanoe De Falco, Umberto Scafuri, Ernesto Tarantino

The paper presents a novel optimizer to plan multiple-day walking itineraries, tailored to tourists' personal interests, in a street network modeled as a graph. The tour is automatically designed by maximizing the number of the Points of Interest (POIs) to visit as a function of both tourists' preferences and requirements, and constraints such as opening hours, visiting times and accessibility of the POIs, and weather forecasting. Since this itinerary planning is classified as an NP--complete combinatorial optimization problem, a multiobjective evolutionary optimizer is here proposed. Such an optimizer is proven to be effective in designing personalized multiple-day tourist routes.

A Projection-Based Approach for Real-time Assessment and Playability Check for Physics-Based Games

Mohammad Shaker, Noor Shaker, Mohamed Abou-Zleikha, Julian Togelius

This paper introduces an authoring tool for physics-based puzzle games that supports game designers through providing visual feedback about the space of interactions. The method proposed accounts for the type and physical properties of the different game components. An area of influence, which identifies the possible space of interaction, is identified for each component. The influence areas of all

components in a given design are then merged considering the components' type and the context information. The tool can be used offline where complete designs are analyzed and the final interactive space is projected, and online where edits in the interactive space are projected on the canvas in realtime permitting continuous assistance for game designers and providing informative feedback about playability.

Analysis of Diversity Methods for Evolutionary Multi-Objective Ensemble Classifiers

Stefan Oehmcke, Justin Heineremann, Oliver Kramer

Ensemble classifiers are strong and robust methods for classification and regression tasks. Optimizing the classifier becomes a multi-objective optimization problem. In this work, we propose an evolutionary multi-objective algorithm based on non-dominated sorting that balances runtime and accuracy properties of nearest neighbor classifier ensembles and decision tree ensembles. We identify relevant ensemble parameters with a significant impact on the accuracy and runtime. In the experimental part of this paper, we analyze the behavior on typical classification benchmark problems.

How the world was MADE: parametrization of evolved agent-based models for backstory generation

Rubén Héctor García Ortega, Pablo García Sánchez, Juan Julián Merelo Guervós, Maribel García Arenas, Pedro A. Castillo Valdivieso, Antonio Mora García

Generating fiction environments for a multi-agent system optimized by genetic algorithms (with some specific requirements related to the desirable plots), presents two main problems: first it is impossible to know in advance the optimal value for the particular designed fitness function, and at the same time, it creates a vast search space for the parameters that it needs. The purpose of this paper is to define a methodology to find the best parameter values for both, the evolutionary algorithm, and the own fictional world configuration. This design includes running, to completion, a world simulation represented as a chromosome, and assigning a fitness to it, thus composing a very complex fitness landscape. In order to optimize the resources allocated to evolution and to have some guarantees that the final result will be close to the optimum, we systematically analyze a set of possible values of the most relevant parameters, obtaining a set of generic rules. These rules, when applied to the plot requisites, and thus, to the fitness function, will lead to a reduced range of parameter values that will help the storyteller to create optimal worlds with a reduced computation budget.

Object Detection in Natural Images using the Brain Programming Paradigm with a Multi-Objective Approach

Eddie Clemente, Gustavo Olague, Daniel E. Hernández, Jose L. Briseño, Jose Mercado

In the last few decades the human vision system has been the focus of several researches, using it as a model for solving the object detection problem in digital images. In this work this approach is taken to define the algorithm called Artificial Visual Cortex (AVC) which is inspired in the information flow in the human visual cortex. Additionally, a new methodology for image description is proposed, which allows the detection and description of an object in the scene. Furthermore, this paper describes a new multi-objective learning technique called brain programming.

This paradigm is implemented for the training stage of the proposed model in order to classify the \textit{persons} set of the GRAZ-02 image database. The solutions found in this research outperform other techniques in the state-of-the-art.

A Novel Multi-Objectivisation Approach for Optimising the Protein Inverse Folding Problem

Sune S. Nielsen, Grégoire Danoy, Wiktor Jurkowski, Juan Luis Jiménez Laredo, Reinhard Schneider, El-Ghazali Talbi, Pascal Bouvry

In biology, the subject of protein structure prediction is of continued interest, not only to chart the molecular map of the living cell, but also to design proteins of new functions. The Inverse Folding Problem (IFP) is in itself an important research problem, but also at the heart of most rational protein design approaches. In brief, the IFP consists in finding sequences that will fold into a given structure, rather than determining the structure for a given sequence - as in conventional structure prediction. In this work we present a Multi Objective Genetic Algorithm (MOGA) using the diversity-as-objective (DAO) variant of multi-objectivisation, to optimise secondary structure similarity and sequence diversity at the same time, hence pushing the search farther into wide-spread areas of the sequence solution-space. To control the high diversity generated by the DAO approach, we add a novel Quantile Constraint (QC) mechanism to discard an adjustable worst quantile of the population. This DAO-QC approach can efficiently emphasise exploitation rather than exploration to a selectable degree achieving a trade-off producing both better and more diverse sequences than the standard Genetic Algorithm (GA). To validate the final results, a subset of the best sequences was selected for tertiary structure prediction. The superpositioning with the original protein structure demonstrated that meaningful sequences are generated underlining the potential of this work.

Evolving Controllers for Programmable Robots to Influence Non-Programmable Lifeforms: A Casy Study

Payam Zahadat, Thomas Schmickl

In this paper, a decentralized reaction-diffusion-based controller is evolved for a set of robots in an arena interacting with two simulated juvenile bees as non-programmable agents. The bees react to the stimuli that are emitted by the robots. The evolutionary process successfully finds controllers that produce proper patterns which guide the bees towards a number of given targets. The results show a preference of heat as the dominant stimulus causing movement of the bees.

Chromatic Selection -- an Oversimplified Approach to Multi-Objective Optimization

Giovanni Squillero

This short paper introduces the chromatic selection, a simple technique implementable with few tens of lines of code, that enable handling multi-value fitness functions with a single-objective evolutionary optimizer. The chromatic selection is problem independent, requires no parameter tuning, and can be used as a drop-in replacement for both parent and survival selections. The resulting tool will not be a full-fledged multi-objective optimizer, lacking the ability to manage Pareto fronts, but it will efficiently seek a single, reasonable, compromise solution. In several practical problems, the time saved, both in computation and development, could represent a substantial advantage.

Automatic Evolution of Parallel Sorting Programs on Multi-cores

Gopinath Chennupati, R. Muhammad Atif Azad, Conor Ryan

Sorting algorithms that offer the potential for data-parallel execution on parallel architectures are an excellent tool for the current generation of multi-core processors that often require the skilled parallelization knowledge to fully realize the potential of the hardware. We propose to automate the evolution of natively parallel programs using the Grammatical Evolution (GE) approach to utilise the computational potential of multi-cores. The proposed system, Multi-core Grammatical Evolution for Parallel Sorting (MCGE-PS), applies GE mapping along with explicit OpenMP #pragma compiler directives to automatically evolve data-level parallel iterative sorting algorithms. MCGE-PS is assessed on the generation of four non-recursive sorting programs in C. We show that it generated programs that can solve the problem that are also parallel. On a high performance Intel processor, MCGE-PS significantly reduced the execution time of the evolved programs for all the benchmark problems.

A Concept for Real-Valued Multi-Objective Landscape Analysis Realized on Biochemical Optimization Problems

Susanne Rosenthal, Bernd Freisleben, Markus Borschbach

Landscape analysis is an established method to provide an insight into the characteristic properties of an optimization problem with the aim of designing a suitable evolutionary algorithm for a given problem. However, these conventional landscape structures require sophisticated notions for multi-objective optimization problems. This work presents a real-valued multi-objective landscape analysis concept that allows the investigation of multi-objective molecular optimization problems. Sophisticated definitions for ruggedness, correlation and plateaus on multi-objective real-valued landscapes are introduced and indicators are proposed for this purpose. This landscape concept is realized on a generic three- and four-dimensional biochemical minimization problem and the results of this analysis are discussed regarding the design principles of a multi-objective evolutionary algorithm.

Fair Resource Allocation Using Multi-Population Evolutionary Algorithm

Tohid Erfani, Rasool Erfani

Resource allocation between selfish agents are performed under centralised and/or distributed mechanisms. However, there are issues in both cases. In centralised solution, although the resources are allocated in an efficient way, the allocation decisions may not be acceptable for some selfish agents making them reluctant to cooperation. In decentralised solution, although the problem is solved from each agent's perspective, the allocation leads to an inefficient usage of provided resources. For example, such an issue is evident in a water network distribution system where different agents share the river water and a central planner (CP) maximises the social welfare to the whole system. Issue arises when the CP solution is not acceptable by some agents. Therefore, a mechanism should be devised to encourage each agent to accept the CP decision. This paper introduces a mechanism in re-distributing the CP revenue value amongst the competing agents based on their contribution to the CP value. To find each user's contribution, this paper develops a parallel evolutionary search algorithm which enables the

agents to autonomously solve their local optimisation problem whilst interacting with the other agents and the whole system. The search evolves towards a solution which is used as an incentive for calculating a fair revenue for each agent. The framework is applied to a river reach with five competitive users. Results show decentralised coupled centralised approaches has the potential to represent mechanisms for a fair resource allocation among competing self-interested agents.

A Benchmark For Virtual Camera Control

Paolo Burelli, Georgios Yannakakis

Automatically animating and placing the virtual camera in a dynamic environment is a challenging task. The camera is expected to maximise and maintain a set of properties --- i.e. visual composition --- while smoothly moving through the environment and avoiding obstacles. A large number of different solutions to the problem have been proposed so far including, for instance, evolutionary techniques, swarm intelligence or ad hoc solutions. However, the large diversity of the solutions and the lack of a common benchmark, made any comparative analysis of the different solutions extremely difficult. For this reason, in this paper, we propose a benchmark for the problem of virtual camera control and we analyse a number of different problems in different virtual environments. Each of these scenarios is described through a set of complexity measures and, as a result of this analysis, a subset of scenarios is selected as the core of the benchmark.

Planning the Deployment of Indoor Wireless Sensor Networks through Multiobjective Evolutionary Techniques

J. M. Lanza-Gutierrez, J. A. Gomez-Pulido, S. Priem-Mendes, M. Ferreira, J. S. Pereira

Wireless sensor networks are widely considered for indoor applications, such as home automation. In this paper, we propose a novel approach, were given a set of low-cost sensors, which can be connected to a plug or powered by batteries, a collector node, and a building plan, including walls and plugs, the purpose is to deploy the sensors attending to four conflicting objectives: average sensitivity area, average energy cost, average reliability, and the total number of sensors deployed. To this end, we consider two multiobjective evolutionary algorithms, NSGA-II and SPEA2. The behaviour of these metaheuristics is studied assuming two quality indicators, hypervolume and set coverage. Checking as NSGA-II provides the best behaviour for our data set.

Applying Non-Dominated Sorting Genetic Algorithm II to Multi-Objective Optimization of a Weighted Multi-Metric Distance for Performing Data Mining Tasks

Muhammad Marwan Muhammad Fuad

Multi-objective optimization (MOO) is a class of optimization problems where several objective functions must be simultaneously optimized. Traditional search methods are difficult to extend to MOO problems so many of these problems are solved using bio-inspired optimization algorithms. One of the famous optimization algorithms that have been applied to MOO is the non-dominated sorting genetic algorithm II (NSGA-II). NSGA-II algorithm has been successfully used to solve MOO problems owing to its lower computational complexity compared with the other optimization algorithms. In this paper we use NSGA-II to solve a MOO

problem of time series data mining. The problem in question is determining the optimal weights of a multi-metric distance that is used to perform several data mining tasks. NSGA-II is particularly appropriate to optimize data mining problems where fitness functions evaluation usually involves intensive computing resources. Whereas several previous papers have proposed different methods to optimize time series data mining problems, this paper is, to our knowledge, the first paper to optimize several time series data mining tasks simultaneously. The experiments we conducted show that the performance of the optimized combination of multi-metric distances we propose in executing time series data mining tasks is superior to that of the distance metrics that constitute the combination when they are applied separately.

EvoAPPS 4 : PATTERN RECOGNITION, THURS 09:30-11:10

(APPs topics: IASP+NUM)

Alternating Optimization of Unsupervised Regression with Evolutionary Embeddings

Oliver Kramer, Daniel Lückehe

Unsupervised regression is a dimensionality reduction method that allows embedding high-dimensional patterns in low-dimensional latent spaces. In the line of research on iterative unsupervised regression, numerous methodological variants have been proposed in the recent past. This work extends the set of methods by evolutionary embeddings. We propose to use a $(1+\lambda)$ -ES with Rechenberg mutation strength control to iteratively embed patterns and show that the learned manifolds are better with regard to the data space reconstruction error than the embeddings generated with naive Gaussian sampling. Further, we introduce a hybrid optimization approach of alternating gradient descent and the iterative evolutionary embeddings. Experimental comparisons on artificial test data sets confirm the expectation that a hybrid approach is superior or at least competitive to known methods like principal component analysis or Hessian local linear embedding.

Hybrid Manifold Clustering with Evolutionary Tuning

Oliver Kramer

Manifold clustering, also known as submanifold learning, is the task to embed patterns in submanifolds with different characteristics. This paper proposes a hybrid approach of clustering the data set, computing a global map of cluster centers, embedding each cluster, and then merging the scaled submanifolds with the global map. We introduce various instantiations of cluster and embedding algorithms based on hybridization of k-means, principal component analysis, isometric mapping, and locally linear embedding. A $(1+1)$ -ES is employed to tune the submanifolds by rotation and scaling. The submanifold learning algorithms are compared w.r.t. the nearest neighbor classification performance on various experimental data sets.

Gaussian Transformation based Representation in Particle Swarm Optimisation for Feature Selection

Hoai Bach Nguyen, Bing Xue, Ivy Liu, Peter Andreae, Mengjie Zhang

In classification, feature selection is an important but challenging task, which requires a powerful search technique. Particle swarm optimisation (PSO) has recently gained much attention for solving feature selection problems, but the current representation typically forms a high-dimensional search space. A new representation based on feature clusters was recently proposed to reduce the dimensionality and improve the performance, but it does not form a smooth fitness landscape, which may limit the performance of PSO. This paper proposes a new Gaussian based transformation rule for interpreting a particle as a feature subset, which is combined with the feature cluster based representation to develop a new PSO-based feature selection algorithm. The proposed algorithm is examined and compared with two recent PSO-based algorithms, where the first uses a Gaussian based updating mechanism and the conventional representation, and the second uses the feature cluster representation without using Gaussian distribution. Experiments on commonly used datasets of varying difficulty show that the proposed algorithm achieves better performance than the other two algorithms in terms of the classification performance and the number of features in both the training sets and the test sets. Further analyses show that the Gaussian transformation rule improves the stability, i.e. selecting similar features in different independent runs and almost always selects the most important features.

Genetic Programming with Alternative Search Drivers for Detection of Retinal Blood Vessels

Krzysztof Krawiec, Mikołaj Pawlak

A classification task is a test-based problem, with examples corresponding to tests. A correct classification is equivalent to passing a test, while incorrect to failing it. This applies also to classifying pixels in an image, viz. image segmentation. A natural performance indicator in such a setting is the accuracy of classification, i.e., the fraction of passed tests. When solving a classification tasks with genetic programming, it is thus common to employ this indicator as a fitness function. However, recent developments in GP as well as some earlier work suggest that the quality of evolved solutions may benefit from using other search drivers to guide the traversal of the space of programs. In this study, we systematically verify the usefulness of selected alternative search drivers in the problem of detection of blood vessels in ophthalmology imaging.

EvoAPPS 5 : GAME AGENTS, THURS 11:35-13:15

(APPs topics: GAMES+STOC)

Evolving Diverse Strategies Through Combined Phenotypic Novelty and Objective Function Search

Davy Smith, Laurissa Tokarchuk, Chrisantha Fernando

Novelty search is an algorithm which proposes open-ended exploration of the search space by maximising behavioural novelty, removing the need for an objective fitness function. However, we show that when applied to complex tasks, training through novelty alone is not sufficient to produce useful controllers. Alongside this, the definition of phenotypic behaviour significantly effects the strategies of the evolved solutions. Controller networks for the spaceship in the arcade game Asteroids were evolved with five different phenotypic distance

measures. Each of these phenotypic measures are shown to produce controllers which adopt different strategies of play than controllers trained through standard objective fitness. Combined phenotypic novelty and objective fitness is also shown to produce differing strategies within the same evolutionary run. Our results demonstrate that for domains such as video games, where a diverse range of interesting behaviours are required, training agents through a combination of phenotypic novelty and objective fitness is a viable method.

It's time to stop: A comparison of termination conditions in the evolution of game bots

Antonio Fernández Ares, Antonio Mora García, Pablo García Sánchez, Pedro Castillo Valdivieso, Maribel García Arenas, Gustavo Romero López, Juan Julián Merelo Guervós

Evolutionary Algorithms (EAs) are frequently used as a mechanism for the optimization of autonomous agents in games (bots), but knowing when to stop the evolution, when the bots are good enough, is not as easy as it would a priori seem. The first issue is that optimal bots are either unknown (and thus unusable as termination condition) or unreachable. In most EAs trying to find optimal boots fitness is evaluated through game playing. Many times it is found to be noisy, making its use as a termination condition also complicated. A fixed amount of evaluations or, in the case of games, a certain level of victories does not guarantee an optimal result. Thus the main objective of this paper is to test several termination conditions in order to find the one that yields optimal solutions within a restricted amount of time, and that allows researchers to compare different EAs as fairly as possible. To achieve this we will examine several ways of finishing an EA who is finding an optimal bot design process for a particular game, Planet Wars in this case, with the characteristics described above, determining the capabilities of every one of them and, eventually, selecting one for future designs.

General Video Game Evaluation Using Relative Algorithm Performance Profiles

Thorbjorn S. Nielsen, Gabriella A.B. Barros, Julian Togelius, Mark J. Nelson

In order to generate complete games through evolution we need generic and reliably evaluation functions for games. It has been suggested that game quality could be characterised through playing a game with different controllers and comparing their performance. This paper explores that idea through investigating the relative performance of different general game-playing algorithms. Seven game-playing algorithms was used to play several hand-designed, mutated and randomly generated VGD game descriptions. Results discussed appear to support the conjecture that well-designed games have, in average, a higher performance difference between better and worse game-playing algorithms.

The Role of Behavioral Diversity and Difficulty of Opponents in Coevolving Game-Playing Agents

Marcin Szubert, Wojciech Jaśkowski, Paweł Liskowski, Krzysztof Krawiec

Generalization performance of learning agents depends on the training experience to which they have been exposed. In game-playing domains, that experience is determined by the opponents faced during learning. This analytical study investigates two characteristics of opponents in competitive coevolutionary learning:

behavioral diversity and difficulty (performance against other players). To assess diversity, we propose a generic intra-game behavioral distance measure, that could be adopted to other sequential decision problems. We monitor both characteristics in two-population coevolutionary learning of Othello strategies, attempting to explain their relationship with the generalization performance achieved by the evolved solutions. The main observation is the existence of a non-obvious trade-off between difficulty and diversity, with the latter being essential for obtaining high generalization performance.

EvoAPPS 6 : COMPUTER VISION, THURS 11:35-13:15

(APPs topic: IASP)

A Supervised Figure-ground Segmentation Method using Genetic Programming

Yuyu Liang, Mengjie Zhang, Will Browne

Figure-ground segmentation is an important preprocessing phase in many computer vision applications. As different classes of objects require specific segmentation rules, supervised (or top-down) methods, which learn from prior knowledge of objects, are suitable for figure-ground segmentation. However, existing top-down methods, such as model-based and fragment-based ones, involve a lot of human work. As genetic programming (GP) can evolve computer programs to solve problems automatically, it requires less human work. Moreover, since GP contains little human bias, it is possible for GP-evolved methods to obtain better results than human constructed approaches. This paper develops a supervised GP-based segmentation system. Three kinds of simple features, including raw pixel values, six dimension and eleven dimension grayscale statistics, are employed to evolve image segmentors. The evolved segmentors are tested on images from four databases with increasing difficulty, and results are compared with four conventional techniques including thresholding, region growing, clustering, and active contour models. The results show that GP-evolved segmentors perform better than the four traditional methods with consistently good results on both simple and complex images.

A Multi-objective Evolutionary Algorithm for Interaction Systems Based on Laser Pointers

Francisco Chavez, Eddie Clemente, Daniel E. Hernandez, Francisco Fernandez de Vega, Gustavo Olegue

In this paper we face the problem of accurate location of a laser spot that is used as interaction system in real environments. The work presented is compared with previous approaches where different algorithms work with a single objective, using images that has been previously simplified to reduce computing time. Instead, the new approach presented in this paper is capable of processing whole images. The results show that the inclusion of multi-objective methods allows us not only to detect the presence of the laser spot, the single objective in previous works, but also to obtain accurate information of the laser spot in the image, and thus provide the location of the device on which the user wants to act.

Topology-preserving ordering of the RGB space with an evolutionary algorithm

Francisco Florez-Revuelta

Colour mathematical morphology (MM) requires an ordering of the colour space. Many works have been focused on establishing different colour orders mapping a colour space onto a linear ordered space. However, most of them are not validated in terms of topology preservation but in terms of the results once MM operations are applied. This work presents an evolutionary method to obtain total- and P-orderings of a colour space, i.e. RGB, maximising topology preservation. This approach can be used to order a whole colour space as well as to get a specific ordering for an image. These alternatives improve the results obtained with the orderings usually employed, in both topology preservation and noise reduction.

Planar Surfaces Recognition in 3D Point Cloud Using a Real-Coded Multistage Genetic Algorithm

Mosab Bazargani, Luís Mateus, Maria Amélia R. Loja

Most frequent surface shapes of man-made constructions are planar surfaces. Discovering those surfaces is a big step toward extracting as-built/-is construction information from 3D point cloud. In this paper, a real-coded genetic algorithm (GA) formulation for planar surfaces recognition in 3D point clouds is presented. The algorithm developed based on a multistage approach; thereby, it finds one planar surface (part of solution) at each stage. In addition, the logarithmically proportional objective function that is used in this approach can adapt itself to scale and spatial density of the point cloud. We tested the proposed application on a synthetic point cloud containing several planar surfaces with different shapes, positions, and with a wide variety of sizes. The results obtained showed that the proposed method is capable to find all plane's configurations of flat surfaces with a minor distance to the actual configurations.

EvoAPPS 7 : CONTENT GENERATION & LEARNING IN GAMES, THURS 14:30-16:10

(APPs topic: GAMES)

A Procedural Method for Automatic Generation of Spelunky Levels

Noor Shaker, Walaa Baghdadi, Fawzya Shams Eddin, Rawan Al-Omari, Ziena Alhalawani, Mohammad Shaker

Spelunky is a game that combines characteristics from 2D platform and rogue-like genres. In this paper, we propose an evolutionary search-based approach for the automatic generation of levels for such games. A genetic algorithm is used to generate new levels according to aesthetic and design requirements. A graph is used as a genetic representation in the evolution process to describe the structure of the levels and the connections between the rooms while an agent-based method is employed to specify the interior design of the rooms. The results show that endless variations of playable content satisfying predefined difficulty requirements can be efficiently generated. The results obtained are investigated through an expressivity analysis framework defined to provide thorough insights of the generator's capabilities.

Evolving Random Forest for Preference Learning

Mohamed Abou-Zleikha, Noor Shaker

This paper introduces a novel approach for pairwise preference learning through a combination of an evolutionary method and random forest. Grammatical evolution is

used to describe the structure of the trees in the Random Forest (RF) and to handle the process of evolution. Evolved random forests are evaluated based on their efficiency in predicting reported preferences. The combination of these two efficient methods for evolution and modelling yields a powerful technique for learning pairwise preferences. To test the proposed methodology and compare it to other methods in the literature, a dataset of 1560 sessions with detail information about user behaviour and their self-reported preferences while interacting with a game is used for training and evaluation. The method demonstrates ability to construct accurate models of user experience from preferences, behavioural and context data. The results obtained for predicting pairwise self-reports of users for the three emotional states: engagement, frustration and challenge show very promising results that are comparable and in some cases superior to those obtained from state-of-the-art methods.

Procedural Personas as Critics for Dungeon Generation

Antonios Liapis, Christoffer Holmgard, Georgios N. Yannakakis, Julian Togelius

This paper introduces a constrained optimization method which uses procedural personas to evaluate the playability and quality of evolved dungeon levels. Procedural personas represent archetypical player behaviors, and their controllers have been evolved to maximize a specific utility which drives their decisions. A "baseline" persona evaluates whether a level is playable by testing if it can survive in a worst-case scenario of the playthrough. On the other hand, a Monster Killer persona or a Treasure Collector persona evaluates playable levels based on how many monsters it can kill or how many treasures it can collect, respectively. Results show that the implemented two-population genetic algorithm discovers playable levels quickly and reliably, while the different personas affect the layout, difficulty level and tactical depth of the generated dungeons.

A Progressive Approach to Content Generation

Mohammad Shaker, Noor Shaker, Julian Togelius, Mohamed Abou-Zleikha

PCG approaches are commonly categorised as constructive, generate-and-test or search-based. Each of these approaches has its distinctive advantages and drawbacks. In this paper, we propose an approach to Content Generation (CG)-- in particular level generation -- that combines the advantages of constructive and search-based approaches thus providing a fast, flexible and reliable way of generating diverse content of high quality. In our framework, CG is seen from a new perspective which differentiates between two main aspects of the gameplay experience, namely the order of the in-game interactions and the associated level design. The framework first generates timelines following the search-based paradigm. Timelines are game-independent and they reflect the rhythmic feel of the levels. A progressive, constructive-based approach is then implemented to evaluate timelines by mapping them into level designs. The framework is applied for the generation of puzzles for the "Cut the Rope" game and the results in terms of performance, expressivity and controllability are characterised and discussed.

EvoAPPS 8 : COMMUNICATION NETWORKS, THURS 14:30-16:10

(APPs topic: COMNET)

A Novel Grouping Genetic Algorithm for Assigning Resources to Users in WCDMA Networks

Lucas Cuadra, Sancho Salcedo-Sanz, Antonio D. Carnicer, Miguel A. Del Arco, Jose A. Portilla-Figueras

In this work we explore the feasibility of applying a novel grouping genetic algorithm (GGA) to the problem of assigning resources to mobile terminals or users in Wideband Code Division Multiple Access (WCDMA) mobile networks. In particular, we propose: 1) A novel cost function (to be minimized) that contains, in addition to the common load factors, other utilization ratios for aggregate capacity, codes, power, and users without service. 2) A novel encoding scheme, and modifications for the crossover and mutation operators, tailored for resource assignment in WCDMA networks. The experimental work points out that our GGA approach exhibits a superior performance than that of the conventional method (which minimizes only the load factors), since all users receive the demanded service along with a minimum use of the assigned resources (aggregate capacity, power, and codes).

A Fast FPGA-Based Classification of Application Protocols Optimized Using Cartesian GP

David Grochol, Lukas Sekanina, Martin Zadnik, Jan Korenek

This paper deals with design of an application protocol classifier intended for high speed networks operating at 100 Gbps. Because a very low latency is the main design constraint, the classifier is constructed as a combinational circuit in a field programmable gate array. The classification is performed using the first packet carrying the application payload. In order to further reduce the latency, the circuit is optimized by Cartesian genetic programming. Using a real network data, we demonstrated viability of our approach in task of a very fast classification of three application protocols (HTTP, SMTP, SSH).

Parallel Extremal Optimization with Guided State Changes applied to Load Balancing

Eryk Laskowski, Marek Tudruj, Umberto Scaffuri, Richard Olejnik, Ivanoe De Falco, Ernesto Tarantino

The paper concerns parallel methods for Extremal Optimization (EO) applied for processor load balancing for distributed programs. In these methods the EO approach is used which is parallelized and extended by a guided search of next solution state. EO detects the best strategy of tasks migration leading to a reduction of program execution time. We assume a multi-point solution improvement of the guided EO algorithm which provides a parallel search for a solution based on two step stochastic selection during the solution improvement based on two-fitness functions. The load balancing improvements based on EO aim in better convergence of the algorithm and better quality of program execution in terms of the execution time. The proposed load balancing algorithm is evaluated by experiments with simulated parallelized load balancing of distributed program graphs.

A Swarm Intelligence Approach to 3D Distance-based Indoor Localization

Stefania Monica, Gianluigi Ferrari

In this paper, we focus on the application of Wireless Sensor Networks (WSNs) to

the problem of locating static nodes in a three-dimensional indoor environments, assuming to know the position of a few of them, denoted as “beacons”. We consider two different approaches, both based on the Time Of Arrival (TOA) of signals traveling between pairs of nodes, namely: the Two-Stage Maximum-Likelihood (TSML) method and the Particle Swarm Optimization (PSO) algorithm. Simulation results show that the latter allows achieving accurate position estimates even in scenarios where the TSML fails, due to ill-conditioning problems.

EvoAPPS 9 : ROBOTICS, THURS 16:30-18:10

(APPs topic: ROBOT)

On the Tradeoff between Hardware Protection and Optimization Success: A Case Study in Onboard Evolutionary Robotics for Autonomous Parallel Parking

Mostafa Wahby, Heiko Hamann

Making the transition from simulation to reality in evolutionary robotics is known to be challenging. What is known as the reality gap, summarizes the set of problems that arises when robot controllers have been evolved in simulation and then are transferred to the real robot. In this paper we study an additional problem that is beyond the reality gap. In simulations, the robot needs no protection against damage, while on the real robot that is essential to stay cost-effective. We investigate how the probability of collisions can be minimized by introducing appropriate penalties to the fitness function. A change to the fitness function, however, changes the evolutionary dynamics and can influence the optimization success negatively. Therefore, we detect a tradeoff between a required hardware protection and a reduced efficiency of the evolutionary optimization process. We study this tradeoff on the basis of a robotics case study in autonomous parallel parking.

Real-World Reproduction of Evolved Robot Morphologies: Automated Categorization and Evaluation

Eivind Samuelsen, Kyrre Glette

This paper describes the real-world reproduction of a handful of robots selected from a larger sample of simulated models previously generated by an evolutionary algorithm. The five robots, which are selected by automatic clustering to be representative of different morphological niches present in the sample, are constructed in the real world using off-the-shelf motor components, combined with 3D printed structural parts that were automatically generated based on the simulator models. A lab setup, involving evolution of turning gaits for each robot, is used to automate the experiments. The forward walking speeds of the constructed robots are measured, and compared with the simulated speeds. While some of the robots achieve near-identical results, some show a large performance loss compared to their simulated prototypes, underlining the reality gap issue seen in similar previous works.

Evolving Generalised Maze Solvers

David Shorten, Geoff Nitschke

This paper presents a study of the efficacy of comparative controller design methods that aim to produce generalised problem solving behaviours. In this case study, the goal was to use neuro-evolution to evolve generalised maze solving behaviours. That is, evolved robot controllers that solve a broad range of mazes. To address this goal, this study compares objective, non-objective and hybrid approaches to direct the search of a neuro-evolution controller design method. The objective based approach was a fitness function, the non-objective based approach was novelty search, and the hybrid approach was a combination of both. Results indicate that, compared to the fitness function, the hybrid and novelty search evolve significantly more maze solving behaviours that generalise to larger and more difficult maze sets. Thus this research provides empirical evidence supporting novelty and hybrid novelty-objective search as approaches for potentially evolving generalised problem solvers

Evolving Robot Controllers for Structured Environments through Environment Decomposition

Rodrigo Moreno, Andres Faina, Kasper Stoy

In this paper we aim to develop a controller that allows a robot to traverse an structured environment. The approach we use is to decompose the environment into simple sub-environments that we use as basis for evolving the controller. Specifically, we decompose a narrow corridor environment into four different sub-environments and evolve controllers that generalize to traverse two larger environments composed of the sub-environments. We also study two strategies for presenting the sub-environments to the evolutionary algorithm: all sub-environments at the same time and in sequence. Results show that by using a sequence the evolutionary algorithm can find a controller that performs well in all sub-environments more consistently than when presenting all sub-environments together. We conclude that environment decomposition is an useful approach for evolving controllers for structured environments and that the order in which the decomposed sub-environments are presented in sequence impacts the performance of the evolutionary algorithm.

Autonomous Learning of Procedural Knowledge in an Evolutionary Cognitive Architecture for Robots

Rodrigo Salgado, Francisco Bellas, Richard J. Duro

This paper describes a procedure to provide a way for the Multilevel Darwinist Brain evolutionary cognitive architecture to be able to learn and preserve procedural knowledge while operating on-line. This procedural knowledge is acquired in the form of ANNs that implement behaviors in the sense of traditional evolutionary robotics. The behaviors are produced in real time as the robot is interacting with the world. It is interesting to see in the results presented that this approach of learning procedural representations instead of exhaustively selecting the appropriate action every instant of time provides better generalization results and more efficient action sequences

EvoAPPS 10 : RISK MANAGEMENT & SECURITY, THURS 16:30-18:10

(APPs topics: COMNET+RISK)

Heuristics for the design of safe humanitarian aid distribution itineraries

José María Ferrer, María Teresa Ortuño, Gregorio Tirado, Begonia Vitoriano

After a disaster strikes, one of the main activities to be developed from a logistics point of view is the design of humanitarian aid distribution plans. In this work the problem of designing safe feasible itineraries for last-mile distribution under the risk of being assaulted, as well as assuring the equity of the distribution, is addressed. The task of simply finding feasible solutions for this problem is highly complex. In this paper we present a constructive randomized heuristic to generate a variety of solutions within a small computational time, and we also provide some ideas of how to modify this constructive algorithm in order to use it within a metaheuristic framework.

Black Holes and Revelations: Using Evolutionary Algorithms to Uncover Vulnerabilities in Disruption-Tolerant Networks

Doina Bucur, Giovanni Iacca, Giovanni Squillero, Alberto Tonda

A challenging aspect in open ad hoc networks is their resilience against malicious agents. This is especially true in complex, urban-scale scenarios where numerous moving agents carry mobile devices that create a peer-to-peer network without authentication. A requirement for the proper functioning of such networks is that all the peers act legitimately, forwarding the needed messages, and concurring to the maintenance of the network connectivity. However, few malicious agents may easily exploit the movement patterns in the network to dramatically reduce its performance. We propose a methodology where an evolutionary algorithm evolves the parameters of different malicious agents, determining their types and mobility patterns in order to minimize the data delivery rate and maximize the latency of communication in the network. As a case study, we consider a fine-grained simulation of a large-scale disruption-tolerant network in the city of Venice. By evolving malicious agents, we uncover situations where even a single attacker can hamper the network performance, and we correlate the performance decay to the number of malicious agents.

Improving Maritime Awareness with Semantic Genetic Programming and Linear Scaling: Prediction of Vessels Position Based on AIS Data

Leonardo Vanneschi, Mauro Castelli, Ernesto Costa, Alessandro Re, Henrique Vaz, Victor Lobo, Paulo Urbano

Maritime domain awareness deals with the situational understanding of maritime activities that could impact the security, safety, economy or environment. It enables quick threat identification, informed decision making, effective action support, knowledge sharing and more accurate situational awareness. In this paper, we propose a novel computational intelligence framework, based on genetic programming, to predict the position of vessels, based on information related to the vessels past positions in a specific time interval. Given the complexity of the task, two well known improvements of genetic programming, namely geometric semantic operators and linear scaling, are integrated in a new and sophisticated genetic programming system.

The work has many objectives, for instance assisting more quickly and effectively a vessel when an emergency arises or being able to chase more efficiently a vessel that is accomplishing illegal actions. The proposed system has been compared to

two different versions of genetic programming and three non-evolutionary machine learning methods, outperforming all of them on all the studied test cases.

Combining Ensemble of Classifiers by using Genetic Programming for Cyber Security Applications

Gianluigi Folino, Francesco Sergio Pisani

Classification is a really relevant task in the cyber security domain, but it must be able to cope with unbalanced and/or incomplete datasets and must also react in real-time to changes in the data. Ensemble of classifiers are a useful tool for classification in hard domains as they combine different classifiers that together provide complementary information. However, most of the ensemble-based algorithms require an extensive training phase and must be re-trained in case of changes in the data. This work proposes a GP-based framework for generating a function for combining an ensemble, having some interesting properties: the models composing the ensemble are trained only on a portion of the training set, and then they can be combined and used without any extra phase of training; furthermore, in case of changes in the data, the function can be recomputed in an incrementally way, with a moderate computational effort. Experiments conducted on unbalanced datasets and on a well-known cyber-security dataset assess the goodness of the approach.

Automatic Generation of Mobile Malwares Using Genetic Programming

Emre Aydogan, Sevil Sen

The number of mobile devices has increased dramatically in the past few years. These smart devices provide many useful functionalities accessible from anywhere at anytime, such as reading and writing e-mails, surfing on the Internet, showing facilities nearby, and the like. Hence, they become an inevitable part of our daily lives. However the popularity and adoption of mobile devices also attract virus writers in order to harm our devices. So, many security companies have already proposed new solutions in order to protect our mobile devices from such malicious attempts. However developing methodologies that detect unknown malwares is a research challenge, especially on devices with limited resources. This study presents a method that evolves automatically variants of malwares from the ones in the wild by using genetic programming (GP). We aim to evaluate the efficacy of current anti-virus products, using static analysis techniques, in the market. The experimental results show the weaknesses of the static analysis tools available in the market, and the need of new detection techniques suitable for mobile devices.

EvoAPPS 11 : ENERGY/FINANCE, FRI 09:30-11:10

(APPs topics: ENERGY+FIN)

Multiobjective methodology for assessing the location of distributed electric energy storage

Jose Goncalves, Luis Neves, Antonio Gomes Martins

The perception of the associated impacts among possible management schemes introduces a new way to assess energy storage systems. The ability to define a specific management scheme considering the different stakeholder objectives, both technical and economic, will increase the perception of available installation

options. This paper presents a multiobjective feasibility assessment methodology using an improved version of the Non-dominated Sorting Genetic Algorithm II, to optimize the placement of electric energy storage units in order to improve the operation of distribution networks. The model is applied to a case study, using lithium-ion battery technology as an example. The results show the influence of different charging/discharging profiles on the choice of the best battery location, as well as the influence that these choices may have on the different network management objectives, e.g. increasing the integration of renewable generation. As an additional outcome, the authors propose a pricing scheme for filling the present regulatory gap regarding the pricing scheme to be applied to energy storage in order to allow the exploitation of viable business models.

Generating Directional Change Based Trading Strategies with Genetic Programming

Jeremie Gypteau, Fernando Otero, Michael Kampouridis

The majority of forecasting tools use a physical time scale for studying price fluctuations of financial markets, making the flow of physical time discontinuous. Therefore, using a physical time scale may expose companies to risks, due to ignorance of some significant activities. In this paper, an alternative and novel approach is explored to capture important activities in the market. The main idea is to use an intrinsic time scale based on Directional Changes. Combined with Genetic Programming, the proposed approach aims to find an optimal trading strategy to forecast the future price moves of a financial market. In order to evaluate its efficiency and robustness as forecasting tool, a series of experiments was performed, where we were able to obtain valuable information about the forecasting performance. The results from the experiments indicate that this new framework is able to generate new and profitable trading strategies.

An Evolutionary Optimization Approach to Risk Parity Portfolio Selection

Ronald Hochreiter

In this paper we present an evolutionary optimization approach to solve the risk parity portfolio selection problem. While there exist convex optimization approaches to solve this problem when long-only portfolios are considered, the optimization problem becomes non-trivial in the long-short case. To solve this problem, we propose a genetic algorithm as well as a local search heuristic. This algorithmic framework is able to compute solutions successfully. Numerical results using real-world data substantiate the practicability of the approach presented in this paper.

An energy management system aggregator based on an integrated evolutionary and differential evolution approach

Andreia M. Carreiro, Carlos Oliveira, Carlos Henggeler Antunes, Humberto M. Jorge

The increased penetration of renewable generation in the electric power system has been leading to a higher complexity of grid management due to its inherent intermittency, also with impact on the volatility of electricity prices. Setting the adequate operating reserve levels is one of the main concerns of the System Operator (SO), since the integration of a large share of intermittent generation

requires an increased amount of reserve that is needed to balance generation and load. At the same time, the energy consumption in households has been steadily growing, representing a significant untapped savings potential due to waste and load flexibility (i.e., the possibility of time deferring the use of some loads). An aggregator has been designed to operate as an intermediary between individual energy management systems and the SO/Energy Market, capable of facilitating a load follows supply strategy in a Smart Grid context. The aggregator is aimed at using the flexibility provided by each end-user aggregated into clusters of demand-side resources to satisfy system service requirements, involving lowering or increasing the power requested in each time slot. This contributes to the balance between load and supply, avoiding peaks in the load diagram, and coping with the intermittency of renewable sources, thus offering an attractive alternative to supply side investments in peak and reserve generation. For this purpose, a multi-objective optimization model has been developed to maximize the aggregator profits, taking into account revenues from the SO/Energy Market and payments to end-user clusters, and minimize the inequity between the amounts of load flexibility provided by the clusters to satisfy grid requests. An approach based on an evolutionary algorithm coupled with a differential evolution algorithm has been designed to deal with this model.

Training Financial Decision Support Systems with Thousands of Decision Rules using Differential Evolution with Embedded Dimensionality Reduction *Piotr Lipinski*

This paper proposes an improvement of the training process of financial decision support systems, where evolutionary algorithms are used to integrate a large number of decision rules. It especially concerns the new computational intelligence approaches that try to replace the expert knowledge with their own artificial knowledge discovered using very large models from very large training datasets, where the large number of decision rules is crucial, because it defines the degree of freedom for the further learning algorithm. The proposed approach focuses on enhancing Differential Evolution by embedding dimensionality reduction to process objective functions with thousands of possibly correlated variables. Experiments performed on a financial decision support system with 00\$ decision rules tested on \$ datasets from the Euronext Paris confirm that the proposed approach may significantly improve the training process.

EvoAPPS 12 : CONTINUOUS PARAMETER OPTIMISATION, FRI 09:30-11:10 (APPs topics: NUM+STOC)

Seed Disperser Ant Algorithm: An Evolutionary Approach for Optimization *Wen Liang Chang, Jeevan Kanesan, Jayant Kulkarni Anand*

The Seed Disperser Ant Algorithm (SDAA) is inspired from the evolution of Seed Disperser Ant (*Aphaenogaster senilis*) colony. The ants in the colony are highly related siblings sharing average 75% similarity in genotype. Hence, the genotype of every ant represents variables in binary form that are used to locally search for optimum solution. Once the colony matures, in other words a local optimum solution reached, nuptial flights take place where female genotype copies the male genotype originating from another colony. Once all colonies saturate new young queen emerges to establish new colonies. This diversifies the search for global

optimum. The SDAA is validated by solving four 30 dimensional classical benchmark problems and six composite benchmark functions from CEC 2005 special session. The optimal results are found to be better than the selected state-of-the-art swarm intelligence based optimization.

Neuro-evolutionary Topology Optimization with Adaptive Improvement Threshold

Nikola Aulig, Markus Olhofer

Recently a hybrid combination of neuro-evolution with a gradient-based topology optimization method was proposed, facilitating topology optimization of structures subject to objective functions for which gradient information is difficult to obtain. The approach substitutes analytical sensitivity information by an update signal represented by a neural network approximation model. Topology optimization is performed by optimizing the network parameters by an evolutionary algorithm in order to devise an update signal for each design step. However, the typically very large number of required evaluations renders the method difficult to apply in practice. In this paper, we aim at a more efficient use of computational resources by augmenting the original approach by an adaptive improvement threshold as stopping criterion for the neuro-evolution. The original and augmented methods are studied on the minimum compliance problem for different feature types and different number of hidden neurons. It is demonstrated that the number of evaluations can be reduced by up to 80% with very little change of the resulting objective values and structures.

Evaluating Reward Definitions for Parameter Control

Giorgos Karafotias, Mark Hoogendoorn, A.E. Eiben

Parameter controllers for Evolutionary Algorithms (EAs) deal with adjusting parameter values during an evolutionary run. Many ad hoc approaches have been presented for parameter control, but few generic parameter controllers exist. Recently, successful parameter control methods based on Reinforcement Learning (RL) have been suggested for one-off applications, i.e. relatively long runs with controllers used out-of-the-box with no tailoring to the problem at hand. However, the reward function used was not investigated in depth, though it is a non-trivial factor with an important impact on the performance of a RL mechanism. In this paper, we address this issue by defining and comparing four alternative reward functions for such generic and RL-based EA parameter controllers. We conducted experiments with different EAs, test problems and controllers and results showed that the simplest reward function performs at least as well as the others, making it an ideal choice for generic out-of-the-box parameter control.

A Preference-based Algorithm for Multi-Objective Structural Optimization Problems with Improved Diversity Management Mechanism

Dénis Vargas, Lemonge Afonso, Barbosa Helio, Bernardino Heder

Approaches that combine Multi-objective Evolutionary Algorithms (MOEAs) and information based on the preferences of a Decision Maker (DM) have been proposed in the last years, but scarcely explored in Multi-Objective Structural Optimization Problems (MOSOPs). A difficulty when using this kind of algorithm is to adjust adequately the parameters of the population in order to satisfy the DM's preferences. In this paper, an algorithm with an improved diversity management

mechanism is proposed to solve MOSOPs. The algorithm and two variations of it are applied to three test-problems. Computational results show good performance, converging to the DM's preferred regions of the Pareto front while ensure the desirable diversity.