evolutionary algorithms networks. This paper addresses the neural network regularization problem from a multi-objective optimization point of view. The dynamic weighted aggregation (DWA) method and the elitist non-dominated sorting genetic algorithm (NSGA-II) are used and compared to optimize the structure and parameters of the neural network. Instead of a single network, a number of neural networks with a spectrum of model complexity can be obtained in asingle run. As a natural by-product of the multi-objective optimization approach to neural network regularization,neural network ensembles can be easily constructed using the obtained networks with different levels of model complexity.

tyre-suspension system number of design variables and objectives have to be taken into account. Two models have been used, both validated on data coming from an instrumented car, a diff. equation based model and a NN model. Up to 23 objfs have been defined, at least 14 of which showing reciprocal strict clash. A fuzzy definition of optima, being a generalization of Pareto- optimality, is applied to the problem. The result is that subsets of Pareto-optimal solutions (a big portion of the entire search space) can be properly selected provided simple inputs from the designer. The obtained optimal solutions are compared with the reference vehicle and with the optima previously obtained.

Rules stage of the design process. While a previous work focused on parameterized designs with fixed configurations (which led to the development of the PAMUC method for solving multicriteria constrained problems within EAs), the models analyzed here are enriched by the presence of topological variables. Therefore, in order to create realistic designs, fulfilling not only technical requirements but also technological constraints expressed as rules, an original approach is proposed: PAMUC II. It consists in integrating an inference engine within the EA, and repairing the individuals violating the rules. PAMUC II is illustrated on a mechanical benchmark and a poppet valve.

single-objective (SO) problems. Previously proposed MO extensions have mostly taken the form of an SO SA optimising a composite function of the objectives. We propose an MO SA utilising the relative dominance of a solution as the system energy for optimisation, eliminating problems associated with composite objective functions. We also propose a method for choosing perturbation scalings promoting search both towards and across the Pareto front. We illustrate the SA's performance on standard test problems. The new SA is shown to promote rapid convergence to the true Pareto front with a good coverage of points across it.

Approach Computation, Evolutionary Optimization in Dynamic Environments level GA to evolve strategies that perform better than known good strategies on a test bed of mathematical optimization problems. We examine the effects of the meta-level components and parameters on the problem set in order to help others in choosing the components and parameters for their meta-GAs.

genetic algorithm (LLGA), introduces the tightness time model for a single building block, and develops the connection between sequential behavior and the tightness time model. By integrating the first-building-block model based on sequential behavior, the tightness time model, and the connection between these two models, a convergence time model is then constructed and empirically verified. The proposed convergence time model explains the exponentially growing time required by LLGA when solving uniformly scaled problems.

continuous optimization. Salomon's evolutionary gradient search procedure is a hybrid strategy that obtains gradient estimates by borrowing the idea of random variations from evolutionary computation. The present paper applies successful tools and ideas from the theory of evolution strategies to the evolutionary gradient search framework. Performance laws are derived that shed light on the strategy's performance and the influence of its parameters. Comparisons with evolution strategies are presented, and the issue of genetic repair in evolutionary gradient search is discussed. The practically relevant problem of noisy objective function measurements is addressed.

Scheme in Evolutionary Algorithms algorithms as it has nice theoretical properties which help in theoretical analysis. In this paper we propose an annealing schedule for Boltzmann selection scheme based on a hypothesis that selection pressure should increase as evolutionary process goes on and distance between two selection intensities should decrease for the process to converge. To formalize these aspects, we develop formalism for selection mechanisms and we derive an annealing schedule called Cauchy annealing schedule. We demonstrate the novelty of proposed annealing schedule using simulations results.

multi-agents algorithm (MAA). In order to improve optimization capability, we introduced the reinforcement learning and several processes into this MAA. Optimization capability of this algorithm was compared in traveling salesman problem and it provided better optimization results than the conventional MAA and genetic algorithm.

Golomb Rulers Rulers is presented. The proposed approach uses a binary representation to codify the marks contained in a ruler. Standard genetic operators are used. During evaluation, insertion and correction procedures are applied in order to improve the algorithm performance. Experimental results show that this approach is effective and capable of identifying good solutions. Furthermore, a comprehensive study is performed to understand the role of insertion and correction. Results reveal that the first method is essential to the success of the search process, whereas the importance of the second one remains unclear.

it with a genetic algorithm for k-medoid clustering of large data sets, which is an NP-hard optimization problem. The local search heuristic selects k medoids from the data set and tries to efficiently minimize the total dissimilarity within each cluster. In order to deal with the local optimality, the local search heuristic is hybridized with a genetic algorithm and then the Hybrid K- medoid Algorithm (HKA) is proposed. Our experiments show that, compared with previous genetic algorithm based k-medoid clustering approaches - GCA and RARw- GA, HKA can provide better clustering solutions and do so more efficiently.

algorithms, Combinatorial & numerical optimization run - is a recognised and widespread problem. Traditional techniques to combat program bloat are program size limitations or parsimony pressure (penalty functions). These techniques suffer from a number of problems, in particular their reliance on parameters whose optimal values it is difficult to a priori determine. In this paper we introduce POPE-GP, a system that makes use of the NSGA-II multiobjective evolutionary algorithm as an alternative, parameter-free technique for eliminating program bloat. We test it on a classification problem and find that while vastly reducing program size, it does improve generalisation performance.

in recent years. Included are brief discussions of various parameters. Modifications to adapt to different and complex environments are reviewed, and real world applications are listed.

using Speciation continuously varying dynamic environment is described. To achieve this, a form of speciation allowing development of parallel subpopulations is used. The model employs a mechanism to encourage simulataneous tracking of multiple peaks by preventing overcrowding at peaks. Possible metrics for evaluating the performance of algorithms in dynamic, multimodal environments are put forward. Results are appraised in terms of the proposed metrics, showing that the technique is capable of tracking multiple peaks and that its performance is enhanced by preventing overcrowding. Directions for further research suggested by these results are put forward.

Grammatical Swarm evolution classification problems, and illustrates the Particle Swarm algorithms' ability to specify the construction of programs. Each individual particle represents choices of program construction rules, where these rules are specified using a Backus-Naur Form grammar. Two problem instances are tackled, for the first problem we generate solutions that take the form of conditional statements in a C-like language subset, and for the second problem we generate simple regular expressions. The results demonstrate that it is possible to generate programs using the Grammatical Swarm technique with a performance similar to the Grammatical Evolution evolutionary automatic programming approach.

and Particle Swarm Red Teams that have been used successfully as intrusion detection systems (IDSs). In this paper we compare a genetic hacker with 12 evolutionary hackers based on particle swarm optimization (PSO) that have been effectively used as vulnerability analyzers (red teams) for AIS-based IDSs. Our results show that the PSO-based red teams that use Clerc's constriction coefficient outperform those that do not. Our results also show that the three types of red teams (genetic, basic PSO, and PSO with the constriction coefficient) have distinct search behaviors that are complimentary. This result suggests that red teams based on 'Genetic Swarms' may hold the most promise.

Yet the authors have no knowledge of any efforts to create a computer player for Lemmings. This paper presents a scaled down version of Lemmings and offers an evolutionary approach to solving maps. Scripts are evolved using a genetic algorithm. Results show that this approach is able to solve increasingly complex maps.

testing of commercial computer games. After identifying unwanted results or behavior of the game, we propose to develop measures on how near a sequence of game states comes to the unwanted behavior and to use these measures within the fitness function of a GA working on action sequences. This allows to find action sequences that produce the unwanted behavior, if they exist. Our experimental evaluation of the method with the FIFA-99 game and scoring a goal as unwanted behavior shows that the method is able to find such action sequences, allowing for an easy reproduction of critical situations and improvements to the tested game.

programs fight in the memory of a virtual computer. An evolutionary assembly-program generator, is used to evolve efficient programs, and the game is exploited to evaluate new evolutionary techniques. The paper introduces a new migration model that exploits the polarization effect and a new hierarchical coarse-grained approach applicable whenever the final goal can be seen as a combination of semi-independent sub goals. Additionally, two general enhancements are proposed. Analyzed techniques are orthogonal and broadly applicable to different real-life contexts. Experimental results show that all these techniques are able to outperform a previous approach.

expert systems written in C/C++. As such, many of the rules are parameterized with values, which are set by the software designer and finalized at compile time. The effectiveness of parameter values is dependent on the knowledge the programmer has about the game. Furthermore, parameters are non-linearly dependent on each other. This paper presents an efficient method for using a genetic algorithm to evolve sets of parameters for bots which lead to their playing as well as bots whose parameters have been tuned by a human with expert knowledge about the game's strategy. This indicates genetic algorithms as being a potentially useful method for tuning bots

Inferring Gene Regulatory Networks from artificial data sets of DNA microarray experiments. We introduce an enhancement to the Evolutionary Algorithm optimization process to infer the parameters of the non-linear system given by the observed data more reliably and precisely. Due to the limited number of available data, the inferring problem is highly under-determined and ambiguous. Further on, the problem often is highly multi-modal and therefore appropriate optimization strategies become necessary. We propose to use an island model to maintain diversity in the EA population to prevent premature convergence and to raise the probability of finding the global optimum.

from experimental DNA microarray data. We introduce enhancements to this optimization process to infer the parameters of sparsely connected non-linear systems given by the observed data more reliably and precisely. Due to the limited number of available data the inferring problem is under-determined and ambiguous. Further on, the problem often is multi-modal and therefore appropriate optimization strategies become necessary. In this paper we propose a new method, which evolves the topology as well as the parameters of the mathematical model to find the correct network. This method is compared to standard algorithms found in the literature.

Bioinformatics and Computational Biology classification of transcriptome (gene expression) data. In such applications GP can produce accurate predictive models that generalize well and use only very few gene expression values. It is often suggested that the selected genes are therefore of biological significance in discriminating the classes. The paper presents a preliminary study of successful parsimonious GP models to investigate the extent to which the selected variables contribute to the classification. The work is based on a readily available and well studied dataset that represents gene expression values for two groups of patients with different forms of Leukaemia.

identify local patterns in gene expression data. Most of these algorithms represent greedy strategies that are heuristic in nature: an approximate solution is found within reasonable time bounds. This paper addresses the question whether additional run-time resources can be exploited in order to improve the outcome of the greedy algorithms. To this end, we propose a general framework that embeds such biclustering methods as local search procedures in an evolutionary algorithm. We demonstrate on one prominent example that this approach achieves significant improvements in the quality of the biclusters when compared to the application of the greedy strategy alone.

Genetic Algorithm Approach wide applications in transportation planning and Intelligent Transportation System (ITS). In transportation, the path finding problem is usually defined as the shortest path (SP) problem in terms of distance, time, cost, or a combination of criteria under a deterministic environment. However, in real life situations, the environment is often uncertain. In this paper, we develop a simulation-based genetic algorithm to find multi-objective paths in stochastic networks. Numerical experiments are presented to demonstrate the algorithm feasibility.

Identification Reader Locations in Transportation Networks objective automatic vehicle identification (AVI) reader location problem studied in this paper. The objectives are: (1) minimizing the number of AVI readers, (2) maximizing the coverage of origin-destination (O-D) pairs, and (3) maximizing the number of AVI readings. These three objectives are strategically designed to catch the maximum number of trips covering the maximum number of O- D pairs with the minimum number of AVI readers. In order to study the trade- off among the three objectives, non-dominated solutions are retained and analyzed. The results show that there is a trade-off between the quality (objectives 2 and 3) and cost (objective 1) of coverage.

Evolutionary Algorithms enhance multiobjective evolutionary algorithms by performing a distributed search based on local dominance. In this method, we first transform all fitness vectors of individuals to polar coordinate vectors in the objective function space. Then we divide the population into several sub-populations by using declination angles. We calculate local dominance for individuals belonging to each sub- population based on the local search direction, and apply selection, recombination, and mutation to individuals within each sub-population. We pick up NSGA-II and SPEA2 as two representatives of multiobjective evolutionary algorithms and enhance them with our method.

being increasingly investigated. Kauffman's NK-Landscapes, particularly, have been the center of several studies and are considered as a good test problem generator. However, epistasis and NK-Landscapes in the context of multiobjective evolutionary algorithms are almost unexplored subjects. In this work we present an extension of Kauffman's NK-Landscapes to multiobjective MNK-Landscapes. In order to meaningfully use them as a benchmark tool we first need to understand how the parameters of the landscapes relate to multiobjective concepts. This paper is a first step towards understanding the properties of MNK-Landscapes from a multiobjective standpoint.

algorithms, Particle swarm & differential evolution multiobjective optimization is introduced. The algorithm is equipped with a domination selection operator to enhance its performance by favoring non-dominated individuals in the populations. Preliminary experimental results on widely used test problems are promising. Comparisons with the VEGA approach are provided and discussed.

Algorithms algorithms, Swarm Intelligence usi ng multi-objective optimization algorithms with a new set of physically motivate d objective functions. The new approach is validated in the parametrization of the bonded terms for the homologeous series of primary alcohols. Multi-Objective Evolutionary Algorithms (MOEAs) and particularly Multi-Objective Particle Swarm Optimization (MOPSO) are applied. The results show that in this case MOPSO finds solutions with higher co nvergence than the MOEA method. Physical analysis of the results confirms the performance of the MOPSO method an d the choice of objective functions.

problems. In a first time, we recall some related works which provide a frame to our work. Particularly, we recall the existence of deceptive problems which are proved to be hard to optimize, the definitions of the five scenarios of knowledge in optimization problem, and some works which already discuss the reach of NFL theorem. In the next part, we give a short overview of how NFL works and discuss its significance with regards to complexity. This leads to the observation that the notion of structure of optimization problems is missing in NFL use. Then, we prove that k-coloring problems respect such a notion of structure, for any k.

are investigated. With representation of functions as strings, the sets of test functions and search results are identical. Search algorithms are treated as operators on distributions on functions. Distributions characterized as block uniform are fixed points for all algorithms. Search preserves the identity of the nearest fixed point and the distance to that point. In practice, distributions of test functions are not block uniform, and conservation properties hold to a degree that depends upon distance to the nearest fixed point. Randomized search moves the distribution closer to the fixed point. For a random walk the distribution of results is the fixed point.

functions. It is shown that for algorithm a performing better on a set of functions than algorithm b, there has to be another subset of functions on which b performs better in average than a. As an alternate to this, the diversity of an algorithm will be considered in this paper in more detail. The total number of possible algorithms will be computed and compared with the number of algorithm instances that a random search or a population-based algorithm can have. It comes out that the number of different random searches is vanishing small, if compared to the number of algorithms, but that population-based algorithms are principally able to provide any algorithm.

Spaces in Genetic Searches Algorithms (EAs). In GAs, a solution is considered as a phenotype and the chromosome representation is the genotype. In a canonical GA, the genotypic search space could be tightly couped with the phenotypic solution space under a specific encoding scheme. Variants of the canoncial GAs are developed based on how the problem is represented in both the genotypic space and phenotpic space. This paper focuses on GAs that utilitize both genotypic and phenotypic spaces and investigates some of the effects of the coupling of the two spaces.

and Other Search Algorithms Computation, Evolutionary Multiobjective Optimization solutions to optimization problems produced by evolutionary algorithms more robust to mutation than those produced by other classes of search algorithms? We explore this question in a model system based on bivariate real functions. Bivariate real functions serve as a well understood model system that is easy

to visualize. Both the number and robustness of optimal solutions found in multiple trials with several typical optimization algorithms were compared. In the majority of the function landscapes explored the tournament selection algorithm found optimal solutions which were significantly more robust to mutation than those discovered by the other algorithms.

Problems: Metric Spaces vs Pretopological Spaces space. If the structure of this landscape can be characterized, it will be possible to extract valuable clues about the best way to search through genotype space for the optimal solution. These high-dimensional landscapes are metric spaces. But an alternative view is to treat the genotypes as part of a pretopology, which has no regular structure. This paper discusses the two representations and argues why one of them is better suited for combinatorial optimization problems.

optimization satisfaction algorithms using genetic programming. The aim is to overcome the difficulties associated with matching algorithms to specific constraint satisfaction problems. A representation is introduced that is suitable for genetic programming and that can handle both complete and local search heuristics. In addition, the representation is shown to have considerably more flexibility than existing alternatives, being able to discover entirely new heuristics and to exploit synergies between heuristics. In a preliminary empirical study it is shown that the new framework is capable of evolving algorithms for solving the well-studied problem of boolean satisfiability testing.

Societies of Hill-Climbers hill-climbers (GSoHCs and ESoHCs) for solving recurrent DisCSPs. Our results show that: (1) the GSoHCs outperform the ESoHCs, (2) the GSoHCs and ESoHCs the use virtual constraints have better performance than those that do not, (3) GSoHCs and ESoHCs which discover multiple solutions per occasion have better performance than those that discover fewer solutions per occasion, and (4) thrashing that results from a dynamic virtual constraint set may adversely affect the performance of genetic and evolutionary search on recurrent DisACSPs.

Infeasible Individuals of Constrained Optimization Problems algorithms when evolutionary algorithms are used for solving constraint optimization problems. This paper proposes a novel approach to balance the feasible and infeasible individuals. Feasible and infeasible individuals are divided into two groups: feasible group and infeasible group. The evaluation and ranking of these two groups are performed separately. Parents for reproduction are selected from the two groups by a parent selection method. Stochastic ranking method is modified to evaluate and rank the infeasible group. The experimental results show that the proposed method is capable of improving the performance of the stochastic ranking method.

problems using genetic algorithms. The main emphasis of this algorithm is to be problem independent and to produce consistent results in terms of the quality of feasible solutions. The elitist scheme is used to assure consistent results and to help guide the stochastic search to the more fruitful regions of the parameter space. We have used rank based fitness assignment and have experimented with two ranking schemes. Our algorithm has performed well providing at least one feasible solution for every run of the algorithm and producing results that are comparable to the best published before.

Algorithms against solving several continuous optimization problems with constraints. Numerical experiments are conducted and comparison is made between constraint handling using several types of penalty and repair operators in case of both elitist and non-elitist implementations of the EDA's. Graphical display and animations of representative runs of the best and worst performers proved useful in enhancing the understanding of how such algorithms work.

objective functions on the vertices. Recently an enhanced operator called hypermutation was developed, proving to be very effective for solving the capacitated p-median problem. We propose a GA with a new heuristic called the nearest four neighbors heuristic (N4N) for solving graph problems requiring a subset of vertices. Genetic algorithms that use each of three mutation operators (simple, hypermutation, N4N) are applied to instances of four representative graph-subset problems. Results show that our N4N heuristic obtained superior results in every test case.

Applications of Cultural Algorithms in Industry and Engineering population- based, stochastic, particle swarm optimizer to identify promising regions of search space that are further locally explored by a Levenberg-Marquardt optimizer. This hybrid method is able to find global optimum for six benchmark problems. It is sensitive to the swarm topology which defines information transfer between particles; however, the hypothesis [1] that a star topology is better for finding the optimum for problems with large number of optima is not supported by this study. It is also seen that in the absence of the local optimizer, particle swarm alone is not as effective. The proposed method is also demonstrated on an industrial catalytic reactor model.

candidate problem solution vectors evolves "social"norms by being influenced by their topological neighbors.The standard Particle Swarm Optimizer may prematurely converge on suboptimal solutions that are not even guaranteed to be local extrema. A new particle swarm optimizer, called stochastic PSO, which is combined with Tabu technique, is presented based on the analysis of the standard PSO. And the global convergence analysis is made using the F.Solis and R.Wets' research results.Finally, several examples are simulated to show that SPSO is more efficient than the standard PSO.

evolutionary computation . It has been found to be extremely effective in solving a wide range of engineering problems, however, it is of low efficiency in dealing with the discrete problems. In this paper, a new discrete particle swarm optimization algorithm based on quantum individual is proposed. It is simpler and more powerful than the algorithms available. The simulations experiments and its application in the CDMA also prove its high efficiency.

individual particle of a PSO system moving in a quantum multi-dimensional space and establish a quantum Delta potential well model for PSO. After that, a trial method of parameter control and QDPSO is proposed. The experiment result shows much advantage of QDPSO to the traditional PSO.

Evolution? the last two decades. Since algorithm performance is problem dependent and parameter sensitive, it is difficult to consider any single approach as of greatest utility over all problems. Despite this, differential evolution (DE) is a numerical optimization approach that requires hardly any parameter tuning and is very efficient and robust on both benchmark and real-world problems. However, the results presented in this paper demonstrate that standard methods of evolutionary optimization are able to outperform DE on noisy problems when the fitness of candidate solutions approaches the fitness variance caused by the noise.

the use of random number generators. The dynamics of the particle swarm seem to influence its performance. Alternative algorithms are investigated.

Cooperation interactions without mistakes. In extending the realism of the Iterated Prisoner's Dilemma (IPD) game, prior evolutionary approaches included intermediate choices or mistakes (noise). This study takes a step further using a co-evolving population of neural networks playing the IPD game with both intermediate choices and noise. Several issues will be addressed, which include the evolution of cooperation and the evolutionary stability in the presence of noise and more choices. Our experimental study shows that noise has a negative impact on the evolution of cooperation, but could improve, surprisingly, the evolutionary stability.

Optimisation (PSO) to evolve strategies for the Iterated Prisoner's Dilemma (IPD). Strategies evolved by the lesser known Binary PSO algorithm are compared to strategies evolved by neural networks that were trained using PSO. Evolved strategies are compared against well-known game theory strategies, with positive results. The presence of noise during IPD interactions are also investigated, and evolved strategies are compared against the same well-known game theory strategies in a noisy environment.

adaptive agents and non-adaptive agents playing Iterated Prisoner's Dilemma (IPD). IPD is much studied in the game theory, machine learning and evolutionary computation communities as a model of emergent cooperation between self- interested individuals. Each poses the players' task in its own way, making assumptions about the rationality of the players, and whether learning takes place at the group (evolutionary) level or at the individual level. In this paper, we report on a simulation study that attempts to bridge these gaps. In our simulations, we find that a kind of equilibrium emerges, with adaptive agents surviving by exploiting a larger number of non-adaptive ones.

and Learning methods. It is applied to competitive games to learn online the current opponent strategy and to adapt the system counter-strategy appropriately. We compared our system for the iterated prisoner's dilemma and rock-paper-scissors with three other methods against different typical game strategies as opponents. Results show that our system performs best in most cases and is able to adapt its strategy online to the current opponent. Moreover we could show that a good prediction of the opponent is no guaranty for a good payoff, since a good prediction is often the result of a poor opponent strategy which leads to a low payoff for both players.

for Two Player Games games. Analysis is typically more time-consuming than evolution. As a result, analysis of strategies produced by an EC system is often lacking or restricted to the extraction of superficial summary statistics. This study presents a technique for extracting a functional signature from evolved agents. This signature can be used as a visualization of agent behavior in games with two moves and also provides a numerical target for clustering and other forms of automatic analysis. This study develops fingerprints in the context of the iterated prisoner's dilemma but they can be computed

for any two player simultaneous game with a finite set of moves.

models of animal contests. It intends to model contests in which animals gain progressively more accurate estimates of relative fighting ability by means of repeated bouts of fighting. We report on simulated evolution of strategies in modified versions of the game and compare our results with theoretical predictions for the original model. Outcomes of these simulations corroborate some, but not all theoretical predictions for the Sequential Assessment Game. In particular, our results suggest that theoretical analyses of the Sequential Assessment Game with information asymmetry need to take into account factors that have hitherto been ignored in the literature.

Data conceptual design systems that support implicit learning through the succinct visual presentation of data relating to both variable and objective space. Various perspectives of multi-objective design information support a constantly improving understanding of both subjective and quantitative relationships between variables and objectives. This information emerges from cluster- oriented genetic algorithm output and is further defined by appropriate data mining and visualization techniques. The intention is to support implicit learning and reduce complexity through the presentation of differing perspectives relating to solution / objective interaction and dependencies

Constraints Selection with Shrinkable Search Space evolutionary computation algorithm. The main contribution of this paper is a diversity control mechanism embedded into the selection operator of an evolutionary algorithm that can be used (with little or no modification) to solve both single-objective and multi-objective optimization problems. We present a detailed description of the PAS^4 algorithm, and illustrate its capabilities by solving several engineering design problems and some test functions from a well-known benchmark in evolutionary optimization. Additionally, PAS4 is also used to solve continuous and discrete multiobjective engineering optimization problems.

Steel Structures in Tall Buildings generative cellular automata-based representations in evolutionary structural design. First, recent developments in evolutionary design representations and an overview of cellular automata are presented. Next, a complex problem of topological design of steel structural systems in tall buildings is briefly described. Further, morphogenic evolutionary design is introduced and exemplified by cellular automata representations. The paper also reports the initial results of several structural design experiments whose objective was to determine feasibility of the proposed approach. Finally, initial research conclusions are provided.

Preservation design & evolvable hardware the flow of information in an evolutionary algorithm. This study uses graph based algorithms for a thermal design problem, placing baffles in a wood burning stove intended for use in Nicaragua. The problem is challanging because fitness evaluations take tens of minutes each. The graph based algorithm preserves diversity and workable stove designs are found.

Problem design & evolvable hardware evolutionary optimization to solve an inverse problem in radiative heat transfer. A QTL is a genetic map on a chromosome that is associated with a specific trait of the creature. QTL's are used to combine useful portions of different candidate solutions in the evolutionary technique. It is useful in all situations where QTL's can be identified apriori, such as radiative heat transfer. It was found that this method is not only faster, but also much more accurate when compared to the standard method of using a single fitness function. This paper demonstrates the effectiveness of QTL's in guiding the evolutionary process.

anthropomorphic symbol design. A design group of 25 subjects used the algorithm to create 100 anthropomophic symbols representing four emotional referents. The symbols underwent comprehension testing using a separate group of 30 subjects. Factor analysis of the nine limb angles comprising each symbol revealed that specific combinations of limb angles differred significantly between symbols based on emotional referent. Comprhension testing results revealed that user symbol comprehesnion of joy symbols was highest while comprhension of anger was lowest. The findings of the current study suggest the IEC algorithms can be sucessfully integrated into user-centered design processes.

Algorithms on Multiobjective 0/1 Knapsack Problems multiobjective genetic local search (S-MOGLS) algorithm. First we explain the basic framework of our S-MOGLS algorithm, which can be easily understood, easily implemented, and efficiently executed with small memory storage and short CPU time. Our S-MOGLS algorithm uses Pareto ranking and a crowding measure in genetic search while it uses a weighted scalar fitness function in local search. Next we examine the performance of various variants of our S- MOGLS algorithm through computational experiments on multiobjective 0/1 knapsack problems. Finally our S-MOGLS algorithm is compared with some well- known evolutionary multiobjective optimization algorithms.

algorithms are almost unexplored subjects. We have presented an extension of Kauffman's NK-

Landscapes to multiobjective MNK-Landscapes and gave some insights into their properties from a multiobjective standpoint. These properties allow us to meaningfully use MNK-Landscapes as a benchmark tool and as a means to understand better the working principles of MOEAs. In this work we present four multi-objective random bit climbers (moRBCs) and use them to study the effects of elitism and population climbing on scalable random epistatic problems. Each moRBC implements a different kind of elitism in order to understand better its working principles.

for solving the sensor planning problem for an active vision system. The application of different representation schemes, that allow to consider either fixed or variable size camera networks in a single evolutionary process, is studied. Furthermore, a novel representation of the recombination and mutation operators is brought forth. The developed methodology is incorporated into a 3D simulation environment and experimental results shown. Results validate the flexibility and effectiveness of our approach and offer new research alternatives in the field of sensor planning.

algorithms assign the fitness to individuals, and how to keep the diversification of individuals. In order to overcome these problems, we suggest a fitness function in MOGA using generalized data envelopment analysis (GDEA). It is shown that GDEA method can approximate Pareto solutions effectively and fast, and generate well-distributed Pareto solutions. Also, we suggest the aspiration-level based GDEA method to generate the most interesting part to an aspiration level of decision maker for choosing a final solution from many Pareto solutions. Finally, we illustrate the effectiveness of GDEA methods through numerical examples.

Adjoining Grammar Guided Genetic Programming as local search operators in a Tree Adjoining Grammar Guided Genetic Programming (TAG3P) system [13]. The results show that, on three standard problems, these operators work better as mutation operators than the more standard sub-tree mutation originally used in [13, 14]. Moreover, for some problems, insetion and deletion can also act effectively as local search operators, allowing TAG3P to solve problems with very small population sizes.

sub-solution, usually called building blocks, instead of discovering and preserving them. One way to overcome this problem is to build a model based on the good individuals, and sample this model to obtain the next population. In this paper, along this line, we propose a new method, Grammar Model-based Program Evolution (GMPE) to evolved GP program. We replace common GP genetic operator with a Probabilistic Context-free Grammar (SCFG). In each generation, an SCFG is learnt, and a new population is generated by sampling this SCFG model. On two benchmark problems we have studied, GMPE significantly outperforms conventional GP, learning faster and more reliably.

Multiobjective evolutionary algorithms execution of genetic programming systems are proposed. Two models are presented, allowing to add and suppress individuals on the basis of some particular events occurring during the evolution. These models allow to find solutions of better quality, to save considerable amounts of computational effort and to find optimal solutions more quickly, at least for the set of problems studied here, namely the artificial ant on the Santa Fe trail, the even parity 5 problem and one instance of the symbolic regression problem. Furthermore, these models have a positive effect on the well known problem of bloat and act without introducing additional computational cost.

due to the massive increase in the size of the search space. Fitness evaluation becomes computationally expensive. We have investigated ways of dealing with these poblems by the evolution of for-loops of increasing semantic complexity. We have chosen two problems – a modified Santa Fe ant problem and a sorting problem – which have natural looping constructs in their solution and a solution without loops is not possible unless the tree depth is very large. We have shown that by conrolling the complexity of the loop structures it is possible to evolve smaller and more understandable programs for these problems.

Network Intrusion Detection Niche Clustering. The UNC is a genetic niching technique for clustering that can handle noise, and is able to determine the number of clusters. The UNC uses the normal samples for generating a profile of the normal space (clusters). Each cluster is characterized by a fuzzy membership function that follows a Gaussian shape defined by the evolved cluster centers and radii.The set of memberships are aggregated using a max-or fuzzy operator in order to determine the normalcy level of a sample. Experiments on synthetic and real data sets, including a network intrusion detection data set, are performed and some results are analyzed and reported.

classifiers for a pattern recognition task such as handwritten digit recognition. Developing elegant solutions for handwritten digit classification is a challenging task. Similarly, design and training of classifiers using genetic programming is a relatively new approach in pattern recognition as compared to other traditional techniques. Several strategies for GP training are outlined and the empirical

observations are reported. The issues we faced such as training time, a variety of fitness landscapes and accuracy of results are discussed. Care has been taken to test GP using a variety of parameters and on several handwritten digits datasets.

Autonomous Crack Detection analysis. Successful automation of crack detection can provide a uniform and timely means for preventing further damage to structures. We have successfully applied convolutional neural networks (CNNs) to online crack detection. As with most artificial neural networks, the CNN is susceptible to multiple local minima, thus complexity and time must be applied in order to avoid becoming trapped within the local minima. This paper employs a standard genetic algorithm (GA) to train the weights of a 4-5x5 filter CNN in order to pass through local minima. This technique resulted in a 92.3+/- 1.4% success rate using 25 GA-trained CNNs presented with 100 crack images.

Computation (IEC) can be used for agent-based model inversion. The first example shows that IEC can be used to discover a model that reproduces synthetic data generated with a very simple model. The second example applies IEC to the inversion of a more sophisticated agent-based model to reproduce real data from a specific market event.

utilizes linkages between problem dimensions or components. An optimization algorithm that uses these relations between components i.e. linkages is expected to arrive at a more optimal solution in fewer computations than one which does not. In developing such an algorithm, we represent the strength of the linkages between components in a linkage matrix. This linkage matrix is sometimes known apriori from the problem itself, but in other cases can be learned by successive adaptations prior to applying the PSO variant. We expect our algorithm to lead quickly to better results.

incorporates a random key representation for particles and a dynamic mutation operator similar to those used in evolutionary algorithms. This algorithm was designed to deal with permutation problems. Our preliminary study shows the algorithm performance when it is applied to a set of instances for the total weighted tardiness problem in single machine environments. Results show that the hybrid HPSO is a promising approach to solve sequencing problems.

on well-known numerical test problems. In this paper, we propose a Supervisor- Student Model in Particle Swarm Optimization (SSM-PSO) that may further reduce computational cost in two aspects. On the one hand, it introduces a new parameter, called momentum factor, into the position update equation, which can restrict the particles inside the defined search space without checking the boundary at every iteration. On the other hand, Relaxation-Velocity-Update strategy that is to update the velocities of the particles as few times as possible during the run, is employed to reduce the computational cost for evaluating the velocity.

Optimization information is shared with individuals in a particle's neighborhood. The kind of neighborhood structure used affects the rate at which information is disseminated throughout the population. Existing work has studied global and simple local topologies, as well as more complex, fixed neighborhood structures. This paper looks at randomly generated, directed graph structures in which information flows in one direction only, and outgoing edges randomly migrate from one source node to another. Experimental evidence indicates that this random dynamic topology, when used with an inertia weight PSO, performs competitively with some existing methods and outperforms others.

Model Lack-of-Fit Situations Process Industry regression model, it is often difficult to propose the appropriate parameter transformation that will make model LOF insignificant. This paper presents the potential of genetic programming (GP) symbolic regression for reducing or eliminating significant second-order linear model LOF. A case study in an industrial setting at The Dow Chemical Company is presented to illustrate this methodology.

Process Industry effects empirical models has been explored on a real industrial case study. A novel methodology based on nonlinear variable selection and model derivation by Genetic Programming has been defined and successfully applied for blown film process effects modeling. The derived nonlinear models are simple, have better performance than the linear models, and predicted behavior in accordance with the process physics.

as the casting temperature, casting speed and coolant flows, that critically affect the safety, quality and productivity of steel production. We have implemented an optimization tool consisting of an optimization algorithm and a casting process simulator. The paper describes the process, the optimization task, and the proposed optimization approach, and shows illustrative results of its application on an industrial casting machine where spray coolant flows were optimized. In the comparative study two variants of an evolutionary algorithm and the downhill simplex method were used, and they were all able to significantly improve the manual setting of coolant flows.

Function and Constraints techniques to the high efficiency deep grinding process. The process is modelled using a fuzzy expert system. This allows understanding gained through theoretical analysis to be combined with empirical data in a solitary model. The objective is to simultaneously minimise the surface temperature and specific grinding energy. A problem constraint is represented within the fuzzy model. It forms an objective representing the degree of infeasibility of the solution.

Networks underdetermined by the data available. We need to understand the plausibility of a recovered GRN, but little is known about the correlation between matching the target expression vector and recovery of the target GRN. Here we explore this and related issues and claim that (i) evolved target GRNs are more reliably reconstructed by evolutionary algorithms (EAs) than are 'random' target GRNs, and (ii) there is often no correlation between the best fit expression vector and recovery of the target GRN. Put together, this suggests that EA methods for biological-GRN reverse-engineering are favoured, even if other methods more closely match the target expression vector(s)

Classification Multiobjective evolutionary algorithms, Real-world applications microarray data has arisen as an important topic over the past decade. From various feature selection methods and classifiers, it is very hard to find a perfect method to classify microarray data due to the incompleteness of algorithms, the defects of data, etc. This paper proposes a sophisticated ensemble of such features and classifiers to obtain high classification performance. Speciated genetic algorithm has been exploited to get the diverse ensembles of features and classifiers in a reasonable time. Experimental results with two well-known datasets indicate that the proposed method finds many good ensembles that are superior to other individual classifiers.

Secondary Structure Prediction with an Evolutionary Algorithm - A Comparison to Known Structures structure of RNA molecules. The EA predicts which specific canonical base pairs will form hydrogen bonds and helices. Three new thermodynamic models were integrated into our EA. The first is based on a modification to our original base pair model. The last two, INN and INN-HB, add stacking-energies using base pair adjacencies. We have tested RNA sequences of lengths 122, 543, and 1494 nucleotides on a wide variety of operators and parameters settings. The accuracy of the predicted structures are compared to the known structures thus demonstrating the benefits of using stacking-energies in structure prediction. Some other improvements to our EA are also discussed.

Discovery parameters of an evolutionary algorithm for similar RNA structure discovery. The effects of population settings such as the number of parents and number of offspring per parent, and method of selection (tournament vs. elitist) on the rate of convergence were investigated relative to a problem with a known RNA structure solution. The results indicate that proper setting of the number of parents and offspring can be used to increase the efficiency of the evolutionary process, suggesting that self-adaptation of the number of parents and offspring in a population might be useful on real-world optimization problems.

Combinatorial & numerical optimization, Poster Session The extracted features are defined as polynomial expressions, which are composed of the original input pattern. These polynomial expressions are searched by coevolutionary genetic programming. We introduce a new fitness function based on competition between individuals. Experiments are performed for some databases of UCI repository using the proposed method and k-Nearest Neighbor rule. Experimental results show that the proposed method can preserve the diversity of populations and improve recognition accuracy on most databases.

Parametrical Problems crossover can outperform standard crossover on parametrical problems. However, up to now, no conclusion has been reached as to what kind of landscape factorial design based crossover outperforms standard crossover on. In this paper we have tested the performance of a factorial design based crossover operator embedded in a classical genetic algorithm and investigated whether or not it outperforms the standard crossover operator on a set of benchmark problems. We found that the factorial design based crossover performed significantly better than the standard crossover operator on landscapes that have a single optimum.

systems. We establish a HW-SW partitioning model based on system's Basic Scheduling Block (BSB) graph and propose a Modified Genetic Partitioning Algorithm (MGPA). By adopting an adaptive fitness function definition and a novel evolving strategy, we enhance the stability, efficiency and result quality of our partitioning algorithm. Experiment results show the algorithm's effectiveness in solving the HW-SW partitioning problem.

attempted with the introduction of artificial intelligence or artificial life. Since the style of a character's behavior is usually designed by a developer, the style is very static and simple. So such a simple pattern of the character cannot satisfy various users and easily makes them feel tedious. A

game should maintain various and complex styles of a character's behavior, but it is very difficult for a developer to design various and complex behaviors of it. In this paper, we adopt the genetic algorithm to produce various and excellent behavior-styles of a character especially focusing on Robocode which is one of promising simulators for artificial intelligence

Evolution electronic circuits reach nanometer scale. Such circuits will need to be constructed so that they are robust, to correct imperfections due to the inevitable fabrication faults in chips with an Avogadro number of components; reversible, to avoid the heat dissipation problem if bits of information are routinely lost during the computational process; and local, for when the switching times reach femto-seconds, which is possible now with quantum optics. We propose an evolutionary engineering based model that meets all these criteria, and provide some experimental results to justify it.

Industry, Poster Session approach for nonlinear system modeling. In this approach, a selection of membership functions makes much effect upon the model performance. It is usually determined by the expert's knowledge for the objective systems. However, it is often difficult to give appropriate membership functions for unknown complex dynamical system without any prior information. In this paper, we deal with the approach to give appropriate fuzzy membership functions based on the observed input and output data using genetic algorithm. Then, an application to identification of nonlinear systems is considered and the availability of the proposed method is illustrated by some numerical examples.

behavior, Poster Session strategies for their organization. This is a difficult task for several reasons, including uncertainty as to future payoffs, and strategic inertia. This study, adopting a swarm metaphor, constructs a simulation model to examine the impact of strategic inertia on the adaptation of the strategic fitness of a population of organizations. The results suggest that a degree of strategic inertia, in the presence of an election operator, can assist rather than hamper adaptive efforts in static and slowly changing environments.

that have been applied to the output of an artificial Genetic Algorithms (GA) in a Scheduling problem.The Genetic Algorithm produces a coarse solution where constraints are not fullfilled at a hundred percentage effectiveness. So heuristic techniques provide a refinement of the solution with one heuristic repairer for each kind of constraint which is not fulfilled.

Poster Session introduction the improved adaptive mutation operation and improved selection operation based on thickness adjustment of artificial immune system into traditional evolutionary programming, a fast immunized evolutionary programming is proposed in this paper. At last, this algorithm is verified by simulation experiment of typical optimization function. The results of experiment show that, the proposed fast immunized evolutionary programming can improve not only the convergent speed of original algorithm but also the computation effect of original algorithm, and is a very good optimization method.

Collegiate institutions such as the entire California State school system have dropped the requirement for students to submit SAT scores to the admissions board for entry. Regardless of the reason, institutions are throwing away information that could possibly give some insight into an applicant's likelihood of success. This paper looks at the question of whether or not SAT scores are a reasonably good of indicator of future collegiate academic success. This theory was tested through the use of a logical rule set created using Genetic Algorithms. Results seem to indicate that SAT scores are in fact, good predictors of future collegiate success.

protocols. The authors report on their attempt to apply evolutionary computations–that is, to place a learning classifier system on individual routers–to solve routing problems. We found that learning classifier systems are capable of fulfilling traditional routing protocol tasks (e.g., establishing routing tables) after a short period of training. Furthermore, they are capable of adapting to changing network environments and choosing the most efficient path available. Results from our experiments show that the system outperforms shortest path algorithms.

to a Pursuit Problem exists cerebral functional localization, which means that a specific part of the cerebrum is activated depending on various kinds of information human receives. The aim of this paper is to build an artificial model to realize functional localization based on Genetic Network Programming (GNP), a new evolutionary computation method recently developed. GNP has a directed graph structure suitable for realizing functional localization brain has. We studied the basic characteristics of the proposed system by making GNP work in a functionally localized way.

Multiobjective evolutionary algorithms, Poster Session fields that otherwise rely heavily on numerical fitness evaluation, very little emphasis has been put on communicating the relevant information for

decision making to the human during the interactive loop. This paper raises the issue of information presentation as a scientific question for interactive evolutionary applications that include automatic fitness evaluation and presents an example for how relevant information display can be for real world problems.

a Test Case parents each time a new individual is created. In this work we show the influence on genetic diversity, quality of results and required computational effort, when applying different crossover methods to a set of hard instances, selected as a test case, of the weighted tardiness scheduling problem in single machine environments under multire-combined approaches. A description of the multirecombination variant used, experiments and preliminary results are reported.

Application on Automatic Negotiation and then investigates some features of the relations. The goal is to find efficient methods to construct the non-dominated set. It is proved that the individuals can be sorted by quick sort. To demonstrate the efficiency of our new method, we propose a Multi-Objective Genetic Algorithm (MOGA) based on quick sort, which is called QKMOGA. We apply QKMOGA on automatic negotiation for Agents. A simple negotiation model between two Agents is described, and the negotiation protocols are constructed with QKMOGA. Two experimental results show that the performance is satisfactory on the diversity and efficiency of the solutions.

Nodes which is extended from other evolutionary computations. Generally, macro instructions are introduced for sub-routines, function localization and so on. In this paper, the new methods of macro instructions are introduced to improve the performances for GNP further more by the mechanism of varying the size of AGMs (Automatically Generated Macro Nodes). This is the mechanism to add and delete nodes according to necessity. In the simulations, comparisons between GNP program only, GNP with conventional AGMs and GNP with variable size AGMs are carried out using the tile world. Simulation results show that the proposed method is better compared with conventional GNP systems.

Estimation technique for a class of competent genetic algorithms called estimation distribution algorithms. Probabilistic models of key sub-solutions are developed to estimate the fitness of some individuals in the population, thereby avoiding computationally expensive function evaluations. The effect of fitness inheritance on the convergence time and population size are modeled and the speed-up obtained is predicted. The results show that an inheritance mechanism which utilizes information on building-block fitnesses provides significant speed-up. For additively separable problems, inheritance reduces the number of evaluations to about half and yields a speed-up of about 2.25.

Sizes for NPC Problems multiobjective Quadratic Assignment Problem. We use the Multiobjective Messy Genetic Algorithm II (MOMGA-II) to determine what role certain building block sizes play in filling up the Pareto Front. Additionally, we investigate the role of the competitive template. The algorithm uses the competitive template by propagating it through all the building block sizes and by randomizing it for each building block size. We show that randomized competitive templates produce better results due to more exploration, and larger building block sizes are more common on the outer edges of the Pareto Front because they fill more chromosome characteristics in the genotype space.

World Time Series which searchs for the necessary minimum quantity of dimensions embedded in the problem for determining the characteristic phase space of the phenomenon generating the time series. The system is inspired in F. Takens theorem and consists of an intelligent hybrid model composed of an artificial neural network combined with a modified genetic algorithm. It is shown how this proposed model can boost the performance of time series prediction of artificially generated time series and real world time series. An experimental investigation is conducted with the introduced method with five time series and the results achieved are discussed and compared with others works.

Problems behavior, Poster Session Algorithm (GA) that was created to promote guided diversity to improve performance in highly multimodal environments. Based a new behavioral model for the SBGA, various modifications are proposed: these include a mechanism for managing dynamic population sizes with population restarts, and communication among the colonies. The enhanced SBGA is compared against the original SBGA system and other multipopulational GA systems on a complex mathematical function (F8F2) and on the NP-complete 0/1 Knapsack problem. In all cases the enhanced SBGA outperformed all other systems, and on the 0/1 Knapsack problem it was the only one to find the global optimum.

A case study in evolving lens shapes Poster Session simulator for geometrical optics different lens shapes in three dimensions were evolved using direct and indirect encodings. Direct and indirect methods were compared for their precision, convergence and efficiency. The results showed that the indirect encoding schemes converged faster than the direct ones, needed less genetic parameters and

scientifically most important, it could be understood why the indirect scheme outperformed the direct one.

Dynamic Environments, Evolutionary Computing in the Process Industry, Poster Session chromosomes and an artificial immune system has been studied. An artificial immune system was designed to support the parallel evolutionary algorithms with hierachical structure. We implemented hybrid and parallel genetic algorithms for design of evolvable controllers. A flexible hierarchical structure with PID, fuzzy and neural controllers can be design by parallel evolutionary algorithms. The adaptive significance of parallel GAs and the comparison with standard GAs are presented.

Session in a single population can retard the GA's ability to specialize emergent behavior, but co-evolution requires a system for evaluation at trial time. If too few combinations of partners are tested, the GA is unable to recognize fit agents; if too many agents are tested, the resultant computation time becomes excessive. We created a system based on punctuated anytime learning that only periodically tests samples of partner combinations to reduce computation time and tested a variety of sample sizes. In this paper, we present a successful method of varying the sample sizes, dependent on the level of fitness, using a box pushing task for comparison.

network activities as normal or abnormal. High detection rates and low false positive rates are two necessary features of succssful AIS. Strong detectors are the basis of creating a successful AIS. Some preliminary experiments showed its promise to encode detectors in the form of data triples. Currently, ther are two types of detectors: binary-coded and constraint-based. This paper compares the two types of detectors using simulated network traffic data. The result showed that the constraint-based had better performance than binary- coded detectors.

Optimization Multiobjective evolutionary algorithms, Poster Session this paper. We proposed to decompose the award function into a set of local award functions. By optimizing this objective function set, the response function with maximum award can be determined. To tackle the optimization problem, a modified Particle Swarm Optimization (PSO) called "Multi-Species PSO (MS-PSO)"is introduced by considering each objective function as a specie swarm. Two sets of experiments are provided to illustrate the performance of MS-PSO. The results show that it returns a more accurate response set within shorter duration by comparing with other PSO methods.

Combinatorial & numerical optimization, Poster Session algorithm and collective behaviors. The new algorithm proposed incorporates the information of the individuals within the society introduced as their talent and the collective behavior of the society in the civilization called the liberty rate. The algorithm has been demonstrated on two benchmark problems and shown promising results for further investigation.

premature convergence problem of PSO algorithm. It is a type of parallel algorithm in which modified PSO and FDR-PSO algorithms are simulated concurrently with frequent message passing between them. This algorithm reduces computation time of FDR-PSO algorithm by improving search efficiency. In order to demonstrate the effectiveness of the proposed algorithm experiments were conducted on six benchmark continuous optimization problems. Results clearly demonstrate the superior performance of the proposed algorithm in terms of solution quality, average computation time and consistency. This algorithm is very much suitable for the implementation in parallel computer.

Recognition Session computer interfaces. This paper describes our initial attempt at recognizing 2D hand poses for application in video-based human-computer interfaces. Specifically, this research focuses on 2-D image recognition utilizing an evolved wavelet-based feature vector. The system is capable of recognizing instances of static ASL fingerspelling with 99.9% accuracy with an SNR as low as 2.

Elliptic Systems numerical optimization, Poster Session performance on a collection of elliptic parameter identification problems. The evolutionary algorithm has a good tolerability for the noise in the observed data. Even when the noise level is up to 10% we can also get such a good result. The result of numerical experiments shows explicitly that the algorithm is very fit for solving this kind of inverse problem but not very sensitive to the noise.

Poster Session more expensive than the other steps in the evolutionary process. Minimizing these evaluations is vital if we want to make genetic programming a viable strategy. In order to minimize the required evaluations, we need to maximize the amount learned from each evaluation. To accomplish this we introduce a new crossover operator for genetic programming, memetic crossover, that allows individuals to imitate the observed success of others. An individual that has done poorly in some parts of the problem may then imitate an individual that did well on those same parts. This results in an intelligent search of the feature-space and, therefore, fewer evaluations.

and Neural Signaling of an Artificial brain containing 10,000 evolved neural net modules system that will control the inter-connectivity and neural signaling of an artificial brain consisting of large numbers (e.g. 10,000s) of evolved neural net modules.

introduced. It is an EA with a representation of quantum chromosomes, whose advantages lies on better diversity of individuals, effective guidiance of wise quantum mutation and the avoidance of prematurity by quantum crossover. Some simulations are given to illustrate its efficiency and better performance than its counterpart. Finally we applied it into the multi-user detection in DS-CDMA, and good results are attained.

Combinatorial & numerical optimization, Poster Session using S-system formalism and construct genetic network models. The proposed method exploits the probabilistic heuristic search and divide-and-conquer approach to generate candidate network structures. In evaluating the network structure, we attempt a primitive integration of other knowledge to the statistical criterion. The robustness analysis uses Z-score to identify significant parameters from results of stochastic search. We evaluated the proposed method on artificially generated data and E.coli mRNA expression data.

In particular, we find a complete set of paths directing an agent from any position in the maze towards a single goal. To this end, we define a sparse direction map, wherein the maze is divided into sectors, each of which contains a direction indicator. Maps are evolved using a simple genetic algorithm. The fitness function samples the efficacy of the map from random starting points, thus estimating the likelihood that agents will find the goal. The framework was effective in evolving successful maps for three different mazes of varying size and complexity, resulting in interesting and lifelike agent behavior suitable for games, but not always the shortest paths.

preliminary design of middleware, GameMosix, that implements the concept. Millions of computers and mobile devices over the Internet play rationality-based games in sharing computational resources. Researchers in computer systems communities are becoming more interested in game theory and evolutionary computing. First, we discuss previous work on game theory and evolutionary game theory applied to computer systems. Then we introduce the design of a preliminary version of RBC middleware architecture and some results from the simulation of the architecture.

Distribution Networks Management algorithms, Real-world applications, Poster Session application of a Fuzzy-Logic-based multiobjective algorithm is presented. The problem of voltage regulation and power losses minimisation is here dealt with. The considered formulation requires the optimisation of two objectives; therefore the use of adequate multiobjective heuristic optimisation methods is needed. The heuristic strategy used for the optimisation is an evolutionary algorithm in which the objectives formulation is based on fuzzy sets theory. Test results on a large distribution system demonstrate that the proposed formulation and approach is feasible for finding a good dispatching schedule for the considered system.

a difficult and commercially significant constrained optimization problem. The Financial Product model, for optimizing mortgage refinancing packages, is introduced. It is a realistic, and very challenging, optimization problem, for which standard solvers leave much to be desired. An untuned two- population genetic algorithm has been remarkably successful in finding good, feasible and nearly optimal solutions. The genetic solver provides important information for management decision making besides simply a good solution to the model. The paper undertakes a case study in order to investigate the details of how and why the two-population GA works.

artificial immune network algorithm planning and localisation is problematic when working in image space (using the appearance of the environment) rather than in Cartesian space (using the geometry of the environment). This is due to computational overhead introduced by the amount of data that needs to be manipulated and high-dimensionality of the image space. We present results from an approach using an artificial immune network algorithm which reduces dimensionality of the image and generates networks useful for navigation and localisation. We use the artificial immune network to link similar images (corresponding to similar poses of the robot) into a network displayed in two dimensions.

Problems evolutionary test-program generation problem. The methodology exploits the defini-tion of distance functions at the genotypic and phenotypic levels to perform a local analysis of an unknown space. A novel hardware accelerator device is used for speeding up test-program evaluations. A complex microprocessor was used as case study. Experiments show how the local analy-sis allowed discovering several characteristics of the task and foreseeing the behavior of the test-program genera-tion.

operators for the off-line path planning problem. Our aim is to study the behavior of an evolutionary algorithm in stationary environments in order to extend it to the on-line path planning problem. The

main difference between the two mutation operators studied is that one of them defines a control mechanism for the extent of exploration. The results show that this last operator improves the quality of the paths found by the algorithm.

Estimation of Nonlinear Models integration and its application of Bayesian filtering, or particle filter (PF). PF evaluates a posterior probability distribution of the state variable based on observations in Monte Carlo simulation using importance sampling. However, the filter performance is deteriorated by degeneracy phenomena in the importance weights. A novel filter called the Evolution Strategies (ES) based PF, was proposed to circumvent this difficulty by recognizing the similarities and the difference of the processes between PF and ES. The filter is applied here to simultaneous state and parameter estimation of nonlinear state space models. Illustrative numerical simulation are presented.

issue is how to encode a document without losing salient information. Current research almost always uses fixed-length vectors based on word (term) frequency (TF) and/or variants thereof. We explore alternative encodings using an evolutionary algorithm (EA). These alternatives use a variety of other features that can be extracted from a document, and the EA explores the space of weighted combinations of these. Tests are able to find encodings which outperform previous results. Among several tentative findings it seems clear that the ideal encoding is highly task-dependent, and we can recommend certain features as useful for specific types of document clustering tasks.

learning method for synthetic character. A behavior is selected by both probabilistic and deterministic methods. The probabilistic method uses the internal states and external sensor information, and the deterministic method which imitates animal's instinct, uses only external sensor information. Both methods are complementary to each other. A user can teach the synthetic character a desired behavior by an interactive training method. The learning algorithm includes the emotional parameters by which the training efficiency is affected. The performance of the synthetic character, Rity, is demonstrated in a 3D virtual world.

to problems whose structure is not well understood, as well as to problems in combinatorial optimization. They have successfully been applied to different kinds of arc routing problems. To start the analysis of evolutionary algorithms with respect to the expected optimization time on these problems, we consider the Eulerian cycle problem. We show that a variant of the well known (1+1) EA working on the important encoding of permutations is able to find an Eulerian tour of an Eulerian graph in expected polynomial time. Altering the operator used for mutation in the considered algorithms, the expected optimization time changes from polynomial to exponential.

binary and Gray coding in the 1+1-EA. The expected first passage time to optimality is used as the metric of comparison. The results indicate that while there is not much difference between the two for all possible functions, Gray coding does not necessarily improve performance for functions which have fewer local optima in the Gray representation than in binary. The relative performance is affected by changes in the algorithm parameter (mutation probability).

in Unimodal Functions algorithms might not be able to sufficiently optimize simple, continuous, unimodal objective functions. Keeping in mind the evolutionary algorithms' high performance especially in the field of global function optimization, getting stuck (also known as premature convergence) at suboptimal function values is mostly attributed to the presence of millions of distracting local optima. This paper describes some examples in which such a behavior occurs. It also gives some explanations of the underlying reasons. These explanations indicate, as a conclusion, that premature convergence might happen very well at continuous, unimodal functions (and thus real-world applications).

approach is based on the concept of evolvability and tends to exploit neutrality in fitness landscape. Despite the fact that natural evolution does not directly select for evolvability, the basic idea behind the Scuba Search heuristic is to explicitly push evolvability to increases. Globally the search process switches between two phases: Conquest-of-the-Waters and Invasion-of-the- Land. A comparative study of the new algorithm and standard local search heuristics on the NKq-landscapes has shown advantage and limit of the scuba search. The qualitative differences between neutral search processes are also analyzed.

Constrained Portfolio Selection Problem a real-valued Evolutionary Algorithm on the constrained portfolio selection problem based on the Markowitz mean-variance model. We also introduce an extension of a real-valued genotype, which increases the performance of the Evolutionary Algorithm significantly, independent of the crossover operator used. This extension is based on the effect that most efficient portfolios only consist of a selection of few assets. Therefore, the portfolio selection problem is actually a combination of a knapsack and continuous parameter problem. We also introduce a repair

mechanism and examine the impact of Lamarckism on the performance of the Evolutionary Algorithm.

expertise for financial time series. The expertise is arrived at via an evolutionary algorithm on the basis of a set of specified trading rules. As in most real-time expert systems, one of the main bottlenecks is the time constraint. In this paper, two approaches were compared using our system, Bourse-Expert, the first based on 350 trading rules, and the second based on 150 particular linear combinations of these 350 rules. Experiments carried out on real data from the Paris Stock Exchange showed that focusing on only 150 rules highly reduced the computation time without significantly reducing the quality of the expertise.

Algorithm Optimization: in Search of an Accurate and Profitable Prediction for Stock Trading finance. The examination of relationships between statistics for economic forecasts evaluation and profitability of investment decisions reveals that only the degree of improvement over efficient prediction shows robust links with profitability. If profits are not observable, this measure is proposed as an evaluation criterion for an economic prediction. Combined with directional accuracy, it could be used in an estimation technique for economic behavior, as an alternative to conventional least squares. Model discovery and performance surface optimization with genetic algorithm demonstrate profitability improvement with an inconclusive effect on statistical criteria.

Computation by means of evolutional computation using the price increments of the immediate past as the environment toward which genomes evolve to fit. Due to randomness and nonstationary nature of financial time series, the predictions must change according to the change of the environment, yet we can use many stylized facts that tickwise motions follow. We have obtained nearly 70% of hitting rate for predicting the direction of the next motion by using the past few ticks in two different learning schemes.

Gaussian Distribution differential evolution Optimization (Co-PSO) to solve constrained optimization problems formulated as min-max problems. Preliminary results demonstrated that Co-PSO constitutes a promising approach to solve constrained optimization problems. However the difficulty to obtain fine tuning of the solution using a uniform distribution became evident. In this paper, a modified PSO using a Gaussian distribution is applied in the context of Co-PSO. The new modified Co-PSO is tested on some benchmark optimization problems and the results show a superior performance compared to the standard Co-PSO.

techniques to infinite impulse response (IIR) adaptive filter structures. Particle swarm optimization (PSO) is similar to the genetic algorithm (GA) in that it performs a structured randomized search of an unknown parameter space by manipulating a population of parameter estimates to converge on a suitable solution. Both techniques are independent of the adaptive filter structure and are capable of converging on the global solution for multimodal optimization problems, which makes them especially useful for optimizing IIR and nonlinear adaptive filters. This paper outlines PSO and provides a comparison to the GA for IIR filter structures.

optimization problem, where certain parameters of a forward model are optimized in order to make the forward modeled spectral reflectance match the spectral reflectance of a given in situ sample. Here, a simulated ocean color dataset is used to test the capability of a recently introduced global optimization process, particle swarm optimization (PSO), compared to the more common genetic algorithm technique. On the test data, the PSO method has been shown to outperform the genetic algorithms (GA) in terms of model error. Also important to the ocean color (often remotely sensed) problem is the speed advantage which PSO affords over GA.

test analysis of semiconductor wafers using evolutionary algorithm techniques to construct Radial Basis Function Neural Networks (RBF NNs) as a classifier. The parameters of a RBF NN (number of neurons, and their respective centers and radii) are often determined by hand or based on methods highly dependent on initial values. In this work, Particle Swarm Optimization algorithm is implemented to build a RBF NN that solves this specific problem. As a primary input source to the network, the system employs electrical binmaps obtained from the test stage of the manufacturing process.

to predator/prey computer games. In our test-bed game, the player has to avoid its predators by escaping through an exit without getting killed. Seeing the game from the predators' viewpoint, we attempt off-line to evolve neural-controlled opponents capable of playing effectively against computer-guided players. Additionally, we present an on-line learning evolutionary mechanism and we demonstrate its efficiency in increasing the predators performance while altering their behavior during play. Opponents following this learning approach show high adaptability to changing player strategies, which provides evidence for the approach's effectiveness against human players.

alternative mechanisms by which cooperative, altruistic traits may evolve. Here we demonstrate that very general versions of Hamilton's inclusive fitness rule (developed by Queller) can be applied to traditional reciprocal altruism models such as the iterated Prisoner's Dilemma. In this way we show that both mechanisms rely fundamentally on the same principle–the positive assortment of helping behaviors. We discuss barriers to this unified view, including phenotype/genotype differences and non-additive fitness (or utility) functions that are typical of reciprocal altruism models. We then demonstrate how Queller's versions of Hamilton's rule remove these obstacles.

the goal of the game is to collect 25 seeds before the other player does. In this paper, we illustrate the importance of problem domain representation, using our own Awari playing program: Ayo. We use a Genetic Algorithm to optimize the weights of the feature evaluation function of Ayo. We play Ayo against a commercially available Awari player, then compare Ayo's results to the results achieved by an older Awari player; one that uses a 7-levels deep mini-max search. Ayo, with a 5-levels deep mini-max search, returns better results, due to better more intelligent representation of the state space.

algorithms. The game has a minimal set of rules that nonetheless offer the possibility for complex behaviour to emerge. Computationally, the game is cheap to simulate, which leads to rapid runs of evolutionary algorithms. This paper describes the rationale behind the development of Cellz, the rules of the game and the software interfaces for the cell controllers. The randomness in the game initialisation leads to extremely noisy fitness functions, which adds to the challenge of evolving high-performance controllers. Initial results demonstrate that an evolved perceptron-type controller can achieve mediocre performance on the single-species game.

Sequence Residue Spatial Distance Prediction sequence is an important factor in the determination of protein three- dimensional structure (tertiary structure). In this paper, we describe a radial basis function neural network, whose hidden centers and radial basis function widths are optimized by a genetic algorithm, for the purpose of predicting three dimensional spatial distance location from primary sequence information. Experimental evidence on soybean protein sequences indicates the utility of this approach.

energy when searching for good protein structures. CHARMm is computationally expensive; therefore, an alternative is needed to expedite search results. In this study we report results of modelling CHARMm with a multilayered perceptron neural network (MLPNN). In the building of a MLPNN to emulate the CHARMm, parameters settings are studied. One such parameter is training generations. Under and over training of the MLPNN is a concern. In this study, special attention is paid to the training of the MLPNN. Finally, the accuracy with which a MLPNN can mimic CHARMm and the time savings realized when using a MLPNN in place of CHARMm are investigated.

Antagonists development. We have developed a pharmacological evolutionary approach for virtual ligand screening. Our tool combines an evolutionary approach and a new pharmacological scoring function. We accessed the accuracy of our approach on estrogen receptor alpha using a ligand database on which competing tools were evaluated. The accuracies of our prediction were 0.64 for the GH score and 0.0091 for the false positive rate when the true positive rate was 1.0. We found that our pharmacophore-based scoring function indeed is able to reduce the number of the false positives. Experiments suggest that GEMDOCK is robust and can be a useful tool for virtual database screening.

Classification via Distributed Heterogeneous Sensors & evolvable hardware environment is critical for increasing protection in critical areas. This paper proposes a strategy for identifying biological agents via distributed sensors with an Artificial Immune System (AIS). The proposed system is composed of networked sensors and nodes, communicating via wireless or wired connections. Detection is based upon the Biological Immune System (BIS) model of antigens and antibodies. Alerts are generated when a measured sample is determined to be a valid biological agent antigen. Biological agent signatures antibodies are continually distributed throughout the system to adapt to changes in the environment or to new antigens.

Genetic Algorithm for Function Optimisation optimisation? This paper reports the initial findings of a comparison between two immune inspired algorithms and a hybrid genetic algorithm for function optimisation. The investigation employs standard benchmark functions, and demonstrates that for these functions the opt-aiNET algorithm, when compared to the B-cell algorithm and hybrid GA, on average, takes longer to find the solution, without necessarily a better quality solution. Reasons for these differences are proposed and it is acknowledge that this is preliminary empirical work. It is felt that a more theoretical approach may well be required to ascertain real performance and applicability issues.

system adaptation, popularized mainly by de Castro and Von Zuben—may have reached something of an impasse. The method requires several parameters that must be tuned, and it normally uses a binary representation that can limit the accuracy of the results. This paper examines the uses and drawbacks of clonal selection, and suggests some new ways forward, based on an analysis of the operators for choosing the amount of mutation and the number of clones. As a result, an effective, real-valued, parameter-free clonal selection algorithm is introduced, called Adaptive Clonal Selection (ACS).

prototype for an intrusion detection system based on it. This framework takes architectural inspiration from the human immune system and brings desirable features to intrusion detection systems, such as automated intrusion recovery, attack signature extraction, and potential to improve behavior-based detection. These features are enabled through intrusion evidence detection. The prototype, called ADENOIDS, is designed to deal with application attacks, extracting signature for remote buffer overflow attacks. The framework and ADENOIDS are described and experimental results are presented.

System artificial immune systems, performs consistently well over a broad range of classification problems. This paper explores the effects of adding non- Euclidean distance measures to the basic AIRS algorithm using four well-known publicly available classification problems having various proportions of real, discrete, and nominal features.

Hydrophilic-Hydrophobic Model Principle using a new mutation operator, the hypermacromutation, and an aging process to tackle the protein structure prediction problem (PSP) in the 2D HP model. The IA presented has only three parameters. To correctly set these parameters we compute the parameter surfaces, the 3D plots of IA success rate in function of the cloning paramater and the maximum age allowed to each B cell. The parameter surfaces show that hypermacromutation and aging operators are key features for generating diversity and searching more properly the funnel landscape of the PSP. Experiments show that the IA we propose is very competitive with the state-of-art algorithms for the PSP.

detectors that have variable coverage. While the detectors can have different kinds of variable properties in the light of this concept, the paper mainly describes the experiments of variable-sized detectors in realvalued space. Effects of the two main control parameters, self radius and expected coverage, are discussed and experimented with both synthesized and real-word datasets. The new approach improves efficiency and reliability without compromising the order of magnitude of complexity.

shipboard firemain's valve and pump controls are usually impossible to test exhaustively. One promising approach, however, is evolutionary testing (ET) in which a genetic algorithm (GA) evolves critical test situations. We evolved challenges (pipe rupture and water demand) to the valve and pump controls of a shipboard firemain system. ET found minor events that collectively produced significant systen failure, and also identified a modification to the ship design that improved system performance. ET can also be used to map the boundary of search space for a given, user-defined criterion. The potential of this powerful, generic technique not just for testing but also for system redesign is thus emphasized.

Computation (IEC) can be applied to Exploratory Data Analysis (EDA). IEC is valuable in an EDA context because the objective function is by definition either unknown a priori or difficult to formalize. In the first example IEC is used to evolve the "true"metric of attribute space. The goal here is to evolve the attribute space distance function until "interesting"features of the data are revealed when a clustering algorithm is applied. In a second example, we show how a user can interactively evolve an auditory display of cluster data. In this example, we use IEC with Genetic Programming to evolve a mapping of data to sound for sonifying qualities of data clusters.

optimization with evolutionary search operators. In this paper we describe an instance of this paradigm designed for the correction of illumination inhomogeneities in images. The algorithm uses the gradient information of an error function embedded in the mutation operator. Moreover, the algorithm is a single-solution population algorithm, which makes it computationally light. The fitness function is defined assuming that the image intensity is piecewise constant and that the illumination bias may be approximated by a linear combination of 2D Legendre polynomials. We call the algorithm Instantaneous Memetic Illumination Correction (IMIC).

Based Approach tuned algorithm's parameters. We propose a methodology that performs this tuning in an effective and efficient algorithmical manner. This approach combines methods from statistical design of experiments, regression analysis, design and analysis of computer experiments methods, and tree-based regression. It can also be applied to analyze the influence of different operators

or to compare the performance of different algorithms. An evolution strategy and a simulated annealing algorithm that optimize an elevator supervisory group controller system are used to demonstrate the applicability of our approach to real-world optimization problems.

simulation or on robots with static physical properties; evolvable hardware is hardly ever used. One of the very rare exceptions is the eyebot on which Lichtensteiger and Eggenberger have evolved simplified insect eye. Even though substantially improved, the evolutionary models currently applied still lack both scalability and noise-resistance. To tackle these problems, this paper proposes a biologically-inspired force model for this class of real-world applications. The simulation results clearly indicate that this model provides a significant improvement over existing limitations. Furthermore, this paper argues that the force model is of more general utility.

Algorithms policies for a given domain without human intervention. The policies are learned over an extensive generic image processing operator library. One of the principal weaknesses of the method lies with the large size of such libraries which can make machine learning process intractable. In this paper we demonstrate how evolutionary algorithms can be used to reduce the size of the operator library thereby speeding up learning of the policy. Experiments in a challenging domain of forestry image interpretation exhibited a 93.3 reduction in the execution time, while maintaining the image interpretation accuracy within 5.5 of optimal.

classical generation scheduling problems in the deregulated and decentralized electricity market place. In this paper a GA based approach has been developed for a system operator to schedule generation in a market akin to that operating in England and Wales. A scheduling problem has been formulated and solved using available trading information at the time of dispatch. The solution is updated after new information is obtained in a rolling fashion. The approach is tested for two IEEE network based problems, and achieves comparable results with a Branch and Bound technique in reasonable CPU time.

single machine environments. The first approach uses, as a dispatching rule the job order provided by a total schedule S generated by an evolutionary algorithm, or by conventional heuristics for a similar static problem: same job features, processing time, due dates and weights. The second approach uses conventional heuristics and a hybrid evolutionary algorithm to reorder jobs in the waiting queue. Details of implementation of the proposed algorithms and results for a group of selected instances are discussed in this work.

Sampling Algorithms population is generated according to the estimated probability density model of the parent instead of using recombination and mutation operators. In previous papers, we have proposed an edge histogram based sampling algorithm (EHBSA) based on probabilistic model-building genetic algorithms (PMBGAs) and showed they work well on sequencing problems; the TSP and flow shop scheduling problems. In this paper, we apply EHBSA for solving capacitated vehicle routing problems (CVRP). The results showed EHBSA work fairly well on the CVRP and it also worked better than well-known traditional two-parent recombination operators.

balancing in parallel algorithms. Thus, we propose a classification of the distributed load balancing algorithms according to the different possibilities for each characteristic of the algorithm. This classification allows the codification of each load balancing strategy, thus making possible to apply a genetic search to optimize the characteristic of the distributed load balancing procedure used for the type of parallel application at hand, taking into account the parallel platform where it is implemented.

evolvable hardware Genetic Algorithm for constructing non-preemptive schedules for soft real-time parallel applications represented as directed acyclic graphs. The execution time requirements of the applications' tasks are assumed to be stochastic and are represented as probability distribution functions. The approach presented here produced shorter schedules than other popular list scheduling approaches for a majority of sample problems. Furthermore, the stochastic schedules provide a mechanism for predicting the probability of the application completing when the execution time available is less than the worst case requirement.

Function Optimization but not Neural Net Evolution brains that consist of tens of thousands of evolved modules that are assembled according to the designs of human brain architects. The bottleneck with this approach is the slow evolution time of the modules. However, using Michalski's machine learning based evolutionary algorithms, such as "LEM the usual evolution time can be reduced by a factor of hundreds[7]. The authors hoped that this breakthrough would allow neural net modules to be evolved more quickly. Unfortunately, it appears that the LEM approach does not work well with the evolution of dynamic neural nets - this may be due to the explosion of attribute-variable pairs during

the machine-learning mode.

hardware, Real-world applications, Combinatorial & numerical optimization, STGP be formulated as a non-linear optimization problem with variable number of parameters. In this paper, a strongly-typed genetic programming is applied to solve an abstract version of this problem successfully. It is argued that this problem can be used as a potential benchmark problem for evaluating techniques and investigating issues in strongly typed genetic programming, topologically open-ended synthesis by genetic programming, and simultaneous topological and parametric search

image restoration. In this paper we propose an on-chip solution for image restoration using an on-chip evolvable hardware method. The corrupted image is considered to be the environment of evolvable hardware structures, which are restoring the original through phenotypic evolution. We compare our solution with some classical techniques for image restoration.

Approach optimization, Real-world applications topologies and data management systems for data-intensive applications, enabling all of a network's clients to communicate and access servers efficiently, while minimizing design cost. iCAD chooses network hardware technologies, determines the data management system (selecting and placing servers; allocating files into servers) and integrates the data management system with the network. An object-oriented chromosome tree is used to explicitly represent all input and decision parameters. A compound crossover is formulated to merge two trees without repair. The experiment indicates the effectiveness of iCAD in finding good designs in a short time.

design & evolvable hardware for humanoid robots to learn a cooperative transportation task. In case of object transportation with two humanoid robots, mutual position shifts may occur due to the body swinging of robots. Therefore, it is necessary to correct the position in a real-time manner. Many efforts are needed to develop the position shift correction system. We propose to solve the problem by learning required behaviors with two learning algorithms. Successful cooperation of two HOAP-1 humanoid robots in the transportation task obtained by Classifier System and Q-learning has been confirmed experimentally in our work.

within an information ecosystem to serve the needs of the Tocorime Apicu search engine in its search for ever-changing ISPs hosting Web services sources which are prone to drastic change over a relatively short period of time. Web probes mark ISPs hosting Web services in order to formulate customized routes (up-to-date router tables) by emulating scouting and foraging honeybees. This exploration model enlists Web probe, scout, and forager dispatchers to form a crucial component of the Tocorime Apicu search engine which builds the document warehouse for the Web page indexers.

Genetic Programming Evolutionary Computation (GP) that probes for an upper bound to the amount of heterogeneity that can be represented by a single individual. Although GP's variable-length representation would suggest that there is no upper bound, our results indicate otherwise. The results provide insight into the dynamics that occur during the course of a GP run.

Evolutionary Computation approach in understanding the dynamics that underlie genetic programming (GP). Emphasis is given toward understanding the relationship between problem difficulty and the loss of diversity. The visualizations raise questions about diversity and problem solving efficacy, as well as the role of the initial population in determining solution outcomes.

fitness landscape for genetic search. The concept of neutrality originates from Kimura's neutral theory. Thus, it can be expected that the dynamics of artificial evolution in the landscapes including neutrality would be described by using techniques in population genetics. In this work, computer simulations are conducted by using a standard genetic algorithm in order to investigate the characteristics of the Nei's standard genetic distance systematically. By the results of the computer simulations, the consistencies with Kimura's neutral theory and Ohta's nearly neutral theory are confirmed in artificial evolution through the Nei's genetic distance.

Evolutionary Algorithm algorithms, Combinatorial & numerical optimization systems. The combined action of selection and variation is expressed as a stochastic operator acting on the space of populations. The long term behavior of selection and variation is studied separately. Then the combined effect is analyzed by characterizing the attractor and stationary measure of the dynamics. As a main result it is proved that the stationary measure is supported on populations made up of optimizers. Also, some experiments are carried out in order to visualize the evolvable populations, the attractor sets and the stationary measure. Some geometric properties of such sets are discussed.

Analysis fitness landscapes in one-dimensional continuous space by drift analysis. The work expends the existing results in the discrete space into the continue space. A fitness landscape, in this paper,

is regarded as the behaviour of an evolutionary algorithm on fitness functions. Based on the drift analysis, easy fitness landscapes are thought to be a “short-distance” landscape, which is easy for the evolutionary algorithm to find the optimal point; and hard fitness landscapes then are as a "far-distance"landscape, which the evolutionary algorithm had to spend a long time to find the optimal point.

Fitness Functions function is obscured by random noise. This interferes with the evaluation and selection process and adversely affects the performance of the algorithm. We present a study of noise compensation techniques designed to better counteract the negative effects of noise. We introduce new algorithms that vary the number of samples used per candidate based on the amount of noise present at that point in the search space. Results show that these algorithms are significantly better than the traditional technique used by the optimisation community and that noise compensation is indeed a difficult task that warrants further investigation.

Problem Difficulty increasing interest from the community of genetic algorithms and researchers have developed a variety of approaches into genetic algorithms to solve these problems. In order to compare their performance an important issue is the construction of standardized dynamic test environments. Based on the concept of problem difficulty this paper proposes a new dynamic environment generator using a decomposable trap function. With this generator it is posssible to systematically construct dynamic environments with changing and bounding difficulty and hence we can test different genetic algorithms under dynamic environments with changing but controllable difficulty levels.

Evolution Strategies in Dynamic Environments is not to find a good solution, but to track the moving best solution. It is well-known that evolutionary algorithms (EA) can cope with this requirement. A main attribute of many EA is the self-adaptability. The functioning of this feature depends on the setting of several EA parameters. In case of evolution strategies (ES) it is still unknown under which conditions the algorithm is able to converge against the optimum. Our investigations concern different population sizes mu and lambda as well as the correlation between the best function value and the diversity of the population at every generation on some selected test functions.

Non-Stationary Optimization Problems non-stationary optimization problems (NSPs) are investigated in this paper. In the GA investigated, each gene is associated with an independent mutation probability. The knowledge obtained during the evolution is utilized to update the mutation probabilities. If the modification of a set of genes is useful when the problem changes, the mutation probabilities of these genes are increased. In this way, the search in the solution space is concentrated into regions associated with the genes with higher mutation probabilities. The class of NSPs where this GA can be interesting and its limitations are investigated.

techniques and in computational resources permit the development of effective systems for dynamic optimisation, resulting in a need for objective methods to compare different techniques. This may be seen as a multi-objective problem, trading off time complexity against effectiveness; benchmarks must compare techniques across the Pareto front, not just a single point. We propose benchmarks for the Dynamic Travelling Salesman Problem, adapted from the CHN-144 benchmark for the static TSP. We demonstrate the use of the benchmark, and illustrate the information that can be gleaned from analysis of algorithm performance.

Dynamic Fitness Landscapes dynamic environments can be improved by the use of life-time adaptation. We show that life-time adaptation can result in EAs that outperform traditional EAs in both static and dynamic environments. We also propose improvements to current dynamic benchmark fitness functions for both the combinatorial and continuous domain, which we have termed Random Dynamics NK-landscapes and Structued Moving Peaks Landscapes, respectively.

map the available syntactic information onto a set of relevant conceptual entities. We propose an evolutionary optimization of semantic annotation relevance which leverages information on resource contents, with respect to a subset of a given ontology, and performs several ontology navigation steps for extracting the set of most expressive annotations. The fitness function of the algorithm is strongly time dependent since the set of annotations to be refined may vary according to user requests,to changes in the domain ontology and is related to the granularity of the annotation set.

Synthesis investigated. The goal is the analysis of some fitness functions based in mutual information and what problems prevent them from common use. We identify and find a clear explanation to them, thereafter, we propose new fitness functions and ran several experiments to investigate their effect on the search space, convergence time, and quality of solutions.

Circuits Multiobjective evolutionary algorithms less power circuits , the problem of logic circuit

design has become a multiobjective optimization problem. In this paper, multiobjective optimization of logic circuits based on a fuzzified Ant Colony (ACO) algorithm is presented. The results obtained using the proposed algorithm are compared to those obtained using SIS in terms of area, delay and power for some known circuits. It is shown that the circuits produced by the proposed algorithm are better as compared to those obtained by SIS.

in the Process Industry development of effective test vector generation for single and multiple fault detection in VLSI circuits. The genetic operators (selection, crossover, and mutation) are applied to the CNF-satisfiability problem for the generation of test vectors for growth faults in Programmable Logic Arrays (PLAs). The CNF- constraints satisfaction problem has several advantages over other approaches used for PLA testing.

Learning by Estimating Distributions in EC intelligent and interactive environment. Holonic modeling and agent oriented technology provides us with these units. Especially, the use of learning algorithms within such dynamic environments is the key factor for their success. In this paper, we use the well known Q learning algorithm of reinforcement learning (RL) in evaluating production orders within a supply chain management (SCM) framework and making decisions with respect to these evaluations. We introduce our SCM model and show that RL performs better than traditional tools for dynamic problem solving in daily business. We also show cases where RL fails to perform efficiently.

algorithm based path-planning algorithm for local obstacle avoidance (local feasible path) of a mobile robot in a given search space. The method tries to find not only a valid path but also an optimal one. The objectives are to minimize the length of the path and the number of turns. The proposed path-planning method allows a free movement of the robot in any direction so that the path-planner can handle complicated search spaces.

Estimation for Automated Visual Inspection Applications model-assisted matching and pose estimation for automated visual inspection applications. Unlike the past works reported in literature, this approach does not consider the matching between the model and the image of the object to be essential step prior to pose estimation. A set of matched vertices sequence and poses are hypothesized using a newly proposed composite chromosome structure and these are genetically evolved until a reasonably accurate pose is determined. Our algorithm demonstrates its robustness against noise as well as missing and spurious object vertices.

Election into Cooperstown Baseball Hall of Fame election, all of them use the same method for building a model: regression analysis. Problems with this include the fact that regressions are continuous functions, and thus have trouble modeling binary problems. In regression models, since the results are continuous it is possible to get an answer other than just 1 or 0 for a binary problem. Instead, through the use of genetic algorithms, a logical rule, which can evaluate any example to either true or false (1 or 0) can be found. The rules found by this system are extremely accurate, with training accuracies around 99 percent and testing accuracies just lower at 97 percent.

paper is divided into two parts. The first part proposes a concept of parallel EP. Four numerical functions are used to compare the performance between the serial algorithm and the parallel algorithm. In the second part, we apply parallel EP to a more complicated problem - an evolving neural networks problem. The results from this problem show that the parallel version is not only faster than the serial version, but the parallel version also more reliably finds optimal solutions.

systems. The hydro unit commitment has great influence on the system's efficiency and it must be considered at the pre-dispatch level. The proposed approach determines a hydro unit startup/shutdown schedule and its corresponding power output schedule for the next day. The model formulated is a mixed optimization problem and a hybrid approach based on a Genetic Algorithms(GAs) and a continuous non- linear optimization techniques. The methodology decomposes the problem in two sub-problems: the first one determines the startup/shutdown schedule using a GAs technique; and the second sub-problem calculates the power output of all committed hydro units selected by the GAs.

communication structure on Distributed Memory machines for a given algorithm is not a straightforward task. Assuming that a parallel algorithm consists of consecutive stages, a Genetic Algorithm is proposed to find the best number of processors and the best data distribution method to be used for each stage of the parallel algorithm. Steady state genetic algorithm is compared with transgenerational genetic algorithm using different crossover operators. A computation intensive, a communication intensive and a mixed implementation are utilized in the experiments. The performance of GA provides satisfactory results for these illustrative examples.

optimization evolutionary computation community. The ability of algorithms to discover and maintain

multiple optima is of great importance - in particular when several global optima exist or when other high-quality solutions might be of interest. In this paper, the differential evolution algorithm (DE) is extended with a crowding scheme making it capable of tracking and maintaining multiple optima. The introduced CrowdingDE algorithm is compared with a DE using the well-known sharing scheme that penalizes similar candidate solutions. In conclusion, the introduced CrowdingDE outperformed the sharing-based DE algorithm on fourteen commonly used benchmark problems.

applications since there are many areas where a human cannot explore. Different means of control have been investigated for unmanned vehicles with various algorithms like genetic algorithms, evolutionary computations, neural networks etc. This paper presents the application of Particle Swarm Optimization (PSO) for collective robotic search. The performance of the PSO algorithm depends on various parameters called quality factors and these parameters are determined using a secondary PSO. Results are presented to show that the performance of PSO algorithm and search is improved for a single and multiple target searches.

& numerical optimization swarm optimization algorithm. Our proposal uses a simple criterion based on closeness of a particle to the feasible region in order to select a leader. Additionally, our algorithm incorporates a turbulence operator that improves the exploratory capabilities of our particle swarm optimization algorithm. Despite its relative simplicity, our comparison of results indicates that the proposed approach is highly competitive with respect to three constraint-handling techniques representative of the state-of-the-art in the area.

Swarm Optimization & differential evolution multi-objective optimization methods. Because in general it is not possible to determine this set, a restricted amount of solutions are typically delivered in the output to decision makers. In this paper, we propose a new method using multi-objective particle swarm optimization to cover the Pareto-optimal front. The method works in two phases. In phase 1 the goal is to obtain a good approximation of the Pareto-front. In a second run subswarms are generated to cover the Pareto-front. The method is evaluated using different test functions and compared with an existing covering method using a real world example in antenna design.

Tardiness Problem solve the single-machine weighted tardiness problem. For this purpose, we propose a heuristic rule, which we call Smallest Dimension Value (SDV), to enable the discrete particle swarm optimization algorithm to be applied to all class of sequencing problems, which are NP-hard in the literature. Simple but very efficient local search is embedded in the particle swarm optimization algorithm. The results show that the particle swarm algorithm combined with an iterated insert+interchange VNS local search is able to find the optimal and best-known solutions on all insatances of widely used benchmarks from the OR libary.

games with broad appeal. One of the challenges concerns creating lifelike nonplayer characters that can adapt their behavior in light of the current and prospective situation. This adaptation should be inherently novel, unrepeatable, yet within the bounds of realism. Evolutionary algorithms provide a suitable method for generating such behavior. This paper provides background on the entertainment software industry and on a platform for evolving nonplayer characters with genetic and behavioral traits.

house. The player can play a "basic strategy"that offers an approximately break-even wager. When also taking the distribution of cards played in prior hands into account, the odds can favor the player. Strategies have been developed by examining different situations in the game and computing the optimum play for each setting. However, the decisions made at one setting affect the probabilities of being in other settings during the course of play. Simulation provides the basis for optimizing blackjack strategies as a whole, as opposed to in a piecemeal fashion. This paper reports on experiments conducted to evolve basic and counting strategies for blackjack.

tour problem, and its performance is compared against standard depth-first search with backtracking. The binary encoding is described, along with a simple repair technique which can be used to extend tours that have reached impasse. The repair method is powerful enough on its own to find complete tours, given randomly generated bitstrings. But when used in conjunction with a genetic algorithm, considerably more solutions are found. Depth-first search is shown to find more solutions under certain conditions, but the genetic algorithm finds solutions more consistently for arbitrary initial conditions.

Strategic Computer Gaming computer strategy games. Strategic computer games involve long range planning across complex dynamics and imperfect knowledge presented to players requires them to anticipate opponent moves and adapt their strategies accordingly. Specifically, we learn general routing information from a human player and use case-injected genetic algorithms to incorporate this

acquired knowledge in subsequent planning. Results from a strike planning game show that with an appropriate representation, case injection effectively biases the genetic algorithm toward producing plans that contain important strategic elements used by human players

Windows (SVRPSTW) is studied. The customer demand and the presence of customer are assumed to be uncertain. There is a service time window for each customer, but late arrival at the customer is allowed by adding a penalty into the objective value. The service vehicle returns to the depot whenever its capacity is exceeded, and resumes its collections along the planned route. A mathematical model is developed to describe the behavior of the delivery system. The techniques of genetic algorithms are used to solve this intractable routing problem in order to minimum the total cost. Computational examples are presented to illustrate the effectiveness of the proposed approach.

with Priority Encoding algorithms because of the requirement that each node must be visited exactly once. In response to this critical requirement, many researchers used specialized operators to adapt traditional genetic algorithms. Although some of these operators are useful, they are ad hoc. In this paper, we propose a priority-based encoding scheme instead. We assign priorities to all the edges and then perform a greedy algorithm to find a suboptimal solution. The greedy algorithm constructs a legal tour and the priority encoding makes it possible to follow traditional genetic evolution. This approach retains generality in applications and also gains remarkable experimental results.

problems (TSPs). These criteria are [1] that the ratio at which new edges are introduced into offspring by crossovers should be adjusted appropriately and [2] that the quality of the new edges should be high. The validity of these criteria is demonstrated by comparing several crossovers. Experimental results indicate that the performances of GAs using some previously proposed crossovers can be explained by considering these criteria. Furthermore, experiments with a new crossover designed by modifying a simple crossover called EX in accordance with these criteria demonstrate that the performance of the GA using this modified crossover is improved dramatically.

solving the Traveling Salesman Problem. The strategy of the algorithm is to complement and extend the successful results of a genetic algorithm using a distance preserving crossover by incorporating memory in the form of ant pheromone during the city selection process. The synergistic combination of the DPX-GA with city selection based on probability determined by both distance and previous success incorporates additional information into the search mechanism. This combination into a Hybrid GA facilitates finding quality solutions for TSP problems with lower computation complexity.

networks using a multiobjective evolutionary algorithm and Mathematical Programming. In the multiobjective evolutionary algorithm, several objective functions have been defined to express the goals of the solutions. Some constraints are included as hard objective functions and some has been evaluated through a repairing function to avoid infeasible solutions. In Mathematical Programming the multiobjective optimization is solved using the Constraint Method in Mixed Integer Linear Programming. The results obtained are compared with a hybrid solution, using as a seed of the evolutionary algorithm the results obtained by Mathematical Programming.

Area of Production Research the solution of manufacturing optimization problems. This paper examines the impact of the fast-growing evolutionary multiobjective optimization field in this area of research. A considerable number of significant applications are reported for a wide range of relevant optimization problems. The review of these applications leads to a number of conclusions and establishes directions for future research

Optimization exam proximity problem. In this MOEA, the traditional genetic crossover is replaced by two local search operators. One of the search operators is designed to repair unfeasible timetables produced by the initialization procedure and the mutation operator. The other search operator implements a simplified Variable Neighborhood Search meta-heuristic to improve the proximity cost. The resulting non dominated timetables are compared to four other optimization methods using six enrolment datasets. The hybrid MOEA was able to produce the lowest proximity cost for two datasets and the second lowest cost for the remaining four datasets.

genetic algorithms. Recent studies show that Bayesian optimization can help in solving problems such as these. This paper compares the results acquired from the multiobjective fast messy genetic algorithm (MOMGA-II), multiobjective Bayesian optimization algorithm (mBOA), and the non-dominated sorting genetic algorithm-II (NSGA-II) when applied to three different deception problems. The three deceptive problems studies are: interleaved minimal deceptive problem, interleaved 5-bit trap function, and the interleaved 6-bit bipolar function.

genetic programming Cryptology and Computer Security computation is a classical problem. To

day, it has been mostly and better accomplished by means of cellular automata and not many proposals, inside or outside this paradigm, could claim to be both robust (passing many statistical tests, including the most demanding ones) and fast, as is the case of the proposal we present. Furthermore, we use a radically new approach, where our fitness function is not at all based in any measure of randomness, as is frequently the case in the literature, but of non-linearity. Efficiency is assured by using only very efficient operators, and by limiting the number of terminals in the Genetic Programming implementation.

of a great deal of theoretical research. We have use a simulated annealing approach to find functions with particular desirable cryptographic properties; for functions of a small number of variables, results with properties as good as (and sometimes better than) the best so far have been achieved. The success of this approach is very sensitive to the cost function chosen; here we investigate this property, and describe a meta-search approach to finding the most effective cost function for this class of problems.

that satisfy a wide range of cryptographic criteria including algebraic complexity, high nonlinearity, low autocorrelation and have none of the known weaknesses including linear structures, fixed points or linear redundancy. We demonstrate that the power mappings can be evolved (by iterated mutation operators alone) to generate bijective s-boxes with the best known tradeoffs among the considered criteria. The S-boxes found are suitable for use directly in modern encryption algorithms.

stream ciphers. Their study has attracted a great deal of attention over many years. The development of a variety of cryptosystem attacks has lead to the development of criteria for resilience to such attacks. Some general criteria such as high non-linearity and low autocorrelation have been proposed (providing some protection against attacks such as linear cryptanalysis and differential cryptanalysis). There has been little application of evolutionary search to the development of S-boxes. In this paper we show how a cost function that has found excellent single-output Boolean functions can be generalised to provide improved results for small S-boxes.

Multi-objective Genetic Programming Multiobjective evolutionary algorithms aerial vehicle (UAV) applications using multi-objective genetic programming (GP). We designed four fitness functions derived from flight simulations and used multi-objective GP to evolve controllers able to locate a radar source, navigate the UAV to the source efficiently using on-board sensor measurements, and circle closely around the emitter. Controllers were evolved for three different kinds of radars: stationary, continuously emitting radars, stationary, intermittently emitting radars, and mobile, continuously emitting radars. We selected realistic flight parameters and sensor inputs to aid in the transference of evolved controllers to physical UAVs.

Evolutionary design & evolvable hardware, CBR simplified simulation and get a prototype of the control program then interpret and interpolate it with CBR in the real world environments. Accordingly, our proposed approach consists of two stages: the evolution stage and the adaptation stage. In the first stage, the prototype of the control program is evolved based on abstract primitive behaviors in a highly simplified simulation. In the second stage, the best control program is applied to a physical robot thereby adapting it to the real world environments by using CBR.

Algorithms problems, particularly Job Shop Scheduling (JSP), with varying degrees of success. However despite advances in GA theory, GAs remain a computationally expensive method of approaching scheduling problems. In particular for practical scheduling problems, GAs require extensive resources. We propose a grid based high-throughput computing framework that utilises spare computing capacity, which is distributed across a network, to address real scheduling problems. We use web-services as a gateway to this high-throughput computing environment.

for example, the NSMutation algorithm, require the optimal value of their strategy parameters, e.g., the mutation rate and the detector lifetime indicator, to be tuned manually. A reasonable alternative is to let the evolutionary algorithm determine the settings itself by using self-adaptive techniques. This paper presents a novel evolutionary negative selection algorithm for anomaly detection (non-stationary environments) that outperforms the NSMutation on benchmark tests by using self-adaptive techniques to mutate the mutation step size of the detectors.

numerical optimization Therefore, standard evolutionary computation methods are not practical for such applications. Applying models as a surrogate of the fitness function is a popular approach to handle this restriction. We propose a Controlled Model Assisted Evolution Strategy, which uses a Support Vector Regression by pre- selecting the most promising individuals. The model assistance on the evolutionary optimization process is dynamically controlled by a model quality based on the number of correctly pre-selected individuals. Numerical results from simulations on test functions including noisy functions are presented.

Unified Framework for Surrogate Assisted Optimization surrogate models within the optimization framework. The framework is built upon a stochastic, zero order, population-based optimization algorithm embedded with controlled elitism to ensure convergence in the actual function space. The model accuracy is maintained via periodic retraining and the number of data points required to create the surrogate model is adaptively identified using Calinski Harabasz (CH) index. Results of Kriging and Cokriging are compared with Radial Basis Function models on a set of numerical and engineering design optimization problems.

optimization framework for accelerating the convergence rate of the surrogate- assisted evolutionary optimization framework. Instead of using the exact high-fidelity fitness function during evolutionary search, a Kriging global surrogate model is used to screen the population for individuals that will undergo Lamarckian learning. Numerical results are presented for two multi-modal benchmark test functions to show that the proposed approach leads to a further acceleration of the evolutionary search process.

Optimization solving multi-objective optimization, which is able to adjust its reproduction process to the problem structure. For this purpose, a new algorithm called Voronoi-based Estimation of Distribution Algorithm (VEDA) is proposed. In VEDA, a Voronoi mesh is used to construct a stochastic model, based on which new offspring will be generated. Empirical comparisons of the VEDA with other estimation of distribution algorithms and the popular NSGA-II algorithm are carried out. In addition, representation of Pareto-optimal solutions using a mathematical model rather than a set is also discussed.

tested the hypothesis that the evolved plants would display non-local adaptation, i.e. that the plants would not only adapt to their local environment, but would acquire general skill that would enable them to grow competitively against plants that were never a part of their environment. Statistical tests show that populations of plants that have evolved for a larger number of generations are able to occupy more grid space when played against populations of plants evolved for a shorter time, even if the two competing populations come from entirely different lineages. The plants did not reach an equilibrium after which further evolution failed to improve them.

coevolves Fuzzy Logic rules to play a two-sided zero-sum competitive game. It is based on the TEMPO Military Planning Game that has been used to teach resource allocation to over 20,000 students over the past 40 years. No feasible algorithm for optimal play is known. The coevolved rules, when pitted against human players, usually win the first few competitions. For reasons not yet understood, the evolved rules (found in a symmetrical competition) place little value on information concerning the play of the opponent but rather focus on exploiting the available weapon systems.

cases are viewed as a form of parasite the question of virulence becomes an important feature of the algorithm. This study compares two types of parasites. The impact of coevolution in this study is at odds with intuition and statistically significant. Analysis suggests that disruptive crossover has a key effect. In the presence of disruptive crossover, coevolution may need to be modified to be effective. The key method of dealing with disruptive crossover is tracking the age of the Tartarus agents. Using only older agents to drive coevolution of test cases substantially enhances the performance of one of the two type of coevolution studied.

player Iterated Prisoner's Dilemma (NIPD). We incorporate the notion of forgiveness in strategies and present experimental results which show that higher levels of cooperation and fitness are attainable when strategies are forgiving.

Biological Annotation thousands of gene expression levels in parallel at various time points of the biological process. To investigate general regulatory mechanisms, biologists cluster genes based on their expression patterns. In this paper, we propose a new memetic co-clustering algorithm for expression profiles, which incorporates a priori knowledge in the form of Gene Ontology information. Ontologies offer a mechanism to capture knowledge in a shareable form that is also processable by computers. The use of this additional annotation information promises to improve biological data analysis and simplifies the identification of processes that are relevant under the measured conditions.

for Genotype-Phenotype Translation (CGP), which enables evolutionary optimization of the mapping from genotypic strings to phenotypic trees is proposed. A cell is evolved, and includes a DNA string that codes genetic information and smaller molecules for the mapping from DNA code to computational functionality. Genetic modification of a cell's DNA allows the DNA code and the genotype-to-phenotype translation to coevolve. Building an optimal translation table enhances evolution within a population while maintaining the necessary diversity to explore the entire search space.

Dictyostelium Discoideum tasks in current bioinformatics and functional genomics and is the first step to discover regulatory mechanisms of gene expression. The goal of this paper is to detect class-specific TREs associated with four classes of developmentally regulated genes in Dictyostelium discoideum (Dd) with statistically significant measure. Applying a DP matching to 5' UTR sequences of Dd with generated candidate TREs, we calculate the evaluation score (E- score) for given candidate TREs. Based on the proposed selection criteria of TREs, we choose putative class-specific TREs among candidate TREs in each developmentally regulated class of Dd.

patient samples. Different to existed methods, we propose a novel optimal gene subset selection approach based on genetic algorithms (GAs). Special fitness function is applied in this scheme. Going beyond other methods, this GA-based method automatically determines the members of a predictive gene group, as well as the optimal group size. The evaluation experiments are applied to two data sets. The results and some discussions are presented too.

method of evolutionary computations. Until now, the applicability and availability of GNP to the real-world applications have not been studied. In this paper, Elevator Group Supervisory Control Systems (EGSCSs) are considered as the real- world application for GNP, and it is reported that the design of a controller of EGSCSs has been studied using GNP. From simulations, it is clarified that better solutions are obtained by using GNP than other conventional methods and the availability of GNP to real-world applications is confirmed.

Light Cycles Optimization in a Traffic Network. It is based on three points: The use of Genetic Algorithms as optimization technique, the use of Cellular Automata Simulators within the Evaluation Function, and the use of a Beowulf Cluster as parallel execution environment for this architecture. We also present some tests to demonstrate tha this new architecture is suitable for the problem it solves.

Algorithm Multiobjective evolutionary algorithms electric power plant operation. Because the problems we address have complex combinatorial properties, they are hard to formulate and solve via conventional techniques. We have formulated and solved the following problems. The complexity of the problems are increasing in order: (1) Cost Minimization of electric equipment configuration and the corresponding cabling; (2) The power plant operation patterns; (3) Parallel operation of plural transformers, and (4) Change of the supply voltages to the electric power load.

in Distribution Systems expected energy not supplied (EENS) during restoration process in distribution systems. The solution of the problem provides an effective service restoration strategy that improves system reliability. The proposed optimization algorithm for the problem is a two-stage genetic algorithm. The first stage GA creates radial network configurations and the second stage GA searches for an optimal sequence of switching operations that minimizes EENS for each configuration. For optimizing the whole restoration process, these two stages iteratively interact with each other. The numerical results using a test distribution system demonstrate the performance of the proposed method.

the quality of results produced can vary considerably with the problem and with the parameters chosen and the user must hope or the best or search for problems-specific good parameters. The idea of hyper-heruristics is to search for a good, fast, deterministic algorithm built from easily-understood heuristics that shows good performance across a range of problems. In this paper we show how the idea can be applied to class and exam timetabling problems and report some results.

general idea that Interactive Evolutionary Computation (IEC) can be applied to a range of task allocation problems where the task performers are humans. In this application of IEC, each participant is presented only with the portion of solution corresponding to his/her task (tour). In addition to the subjective evaluation of solutions by the participants, the solutions presented to the participants are pre-optimized according to objective criteria.

a state space of potential solutions. But these systems can become trapped in local optima due to the EA having only generational information. Using the Scouting Algorithm (SA) it is suggested that a cross-generation memory mechanism can be added to modulate fitness relative to how well a region has previously been sampled. Thus, the goal is to allow the Scouting enhanced EA (SEA) to leave well explore regions to find the global optimum more quickly. It will be shown that the SEA does achieve this goal for the problem domain of nonlinear programming (NLP).

measurable characteristics. In evolutionary computation the problem of telling when two problems are similar is both challenging and important. An accurate classification technique would yield large benefits by permitting a researcher to rationally chose algorithm and parameter setting based on past experience. This study uses a standard taxonomic technique, hierarchical clustering, on a set of taxonomic characters derived from a comparative study using graph based evolutionary algorithms.

operators probabilities at the same time is evolving a solution for the optimization problem. Each individual encodes its own operator rates and uses a randomized version of a learning rule mechanism for updating them. Given an individual, one operator is selected according to the encoded rates and applied to such individual to generate an offspring. The operator rates are updated according to the performance reached by the offspring (relative to its parent performance). The behavior of the adaptation mechanism is studied using different operators for both real and binary encoding schemes on several benchmark functions.

classifier. First, a classification problem is divided into several two-class problems following a fuzzy round robin class binarization scheme; next, a fuzzy rule is evolved (not only the condition but the fuzzy sets are evolved (tuned) too) for each two-class problem using a Michigan iterative learning approach; finally, the evolved fuzzy rules are integrated using the class binarization scheme. In particular, heaps encoding scheme is used for evolving the fuzzy rules along with a set of special genetic operators (variable length crossover, gene addition and gene deletion). Experiments are conducted with different public available data sets.

encouraging heterogeneous convergence to multiple optima. With no prior knowledge of the fitness landscapes, sharing distance is usually determined from the number of peaks. We propose a method to estimate the sharing distance and the corresponding population size. Using the Probably Approximately Correct learning theory and the epsilon-cover concept, we develop an algorithm to estimate the granularity of the fitness landscapes. The sharing distance is determined from the granularity and furthermore, the population size is decided. Using the estimated population size and sharing distance, an Evolutionary Algorithm (EA) correctly identifies multiple optima.

Resilience of Social Systems in the Village Multi-Agent Simulation framework to add selected social considerations. Learning was enabled for the selection strategy to cooperate across the kinship network. As agents have more opportunities to exchange resources they produced more complex networks, larger populations, and more resilient systems. Positive experiences were collected within the CA to influence individual strategies. Agent memory recalled the positive cooperating kin and a global memory was maintained to influence the population. These generalizations were used to drive changes in requestor behavior. The results produced a more complex system with greater dependence on hubs sensitive to precipitation.

Evolutionary Optimization in Dynamic Environments cultural learning emerged as the result of meta-level interaction or "Knowledge Swarms"in the belief space. These meta-level swarms induced the swarming of individuals in the population space, "Cultural Swarms". The interaction of these knowledge sources with the population swarms produced three emergent phases of problem solving. In this paper we investigate the extent to which these emergent phenomena are also visible within dynamic environments. We motivate the discussion in terms of a simulation model of a reversible switching surface. We demonstrate how we can program such changes in surface structure using knowledge source interaction in Cultural Algorithms.

Problem flexible job-shop scheduling problem (or FJSP) with recirculation. We show how composite dispatching rules (or CDRs) are used to solve the FJSP so as to provide a bootstrapping mechanism to initialize GENACE. We then adopt a cultural evolutionary architecture to maintain knowledge of schemata and resource allocations learned over each generation. The belief spaces influence mutation and selection over a feasible chromosome representation. Experimental results show that GENACE obtains better upper bounds for 11 out of 13 benchmark problems, with improvement factors of 2 to 48 percent when compared to results by Karcem et al, Brandimarte and CDRs alone.

Systems simulator uses a genetic algorithm to evolve a population of neural networks to solve a presented set of problems. The simulator has been designed to facilitate experimentation in combining different forms of learning (evolutionary algorithms and neural networks). We present results obtained in simulations designed to examine the effect of individual life–time learning on the population's performance as a whole.

transportation system based on conventional fuels to one based on an alternative fuel, such as hydrogen, requir-ing a new support infrastructure. The model allows two types of agents, vehicle owners and hydrogen fuel suppliers, to interact on a grid of roads representing a metropolitan region, and shows how their initial placement on the grid can lead either to successful or to unsuccessful transitions.

population and a belief space. Two Cultural Algorithms are applied, with one supporting white box testing and the second black box testing. The two populations communicate with each other by

means of a shared belief space. This is applied to the calibration of a multi-agent system by allowing for evolution of near optimal parameters. The Cultural approach is employed to abstract coefficients of pricing strategies that are applied to a complex model of durable goods. This model simulates consumer behaviors as applied in the context of economic recession.

for survivability in high radiation environments. This paper presents a novel approach based on Evolvable Hardware. The key idea is to reconfigure a programmable device, in-situ, to compensate, or bypass its degraded or damaged components. The paper demonstrates the approach using a JPL-developed reconfigurable device, a Field Programmable Transistor Array (FPTA), which shows recovery from radiation damage when reconfigured under the control of Evolutionary Algorithms.

Faster Execution in a Larger Solution Space design of digital circuits. Simulated Evolution (SimE) is used in this paper due to it simplicity and customizability to combinatorial problems. A tree data structure based circuits are evolved. Thus, a larger solution space is investigated. In addition, a new pattern based goodness measure is presented.

as the media for problem solving. It has been argued that because such components are human designed and intentionally have predictable responses, they may not be the optimal medium to use when trying to get a naturally inspired search technique to solve a problem. Evolution has been demonstrated as capable of exploiting the physical properties of material to form solutions, however, by giving evolution only conventional components, we may be limiting ourselves to solving certain problems. Using liquid crystal as the evolution substrate, we demonstrate that it is possible to evolve systems, including a tone discriminator, in materio.

Hardware Experiments research, particularly if intrinsic investigations are conducted. Although test bench design is straight-forward, in practice its construction has numerous pitfalls. This paper describes the automated test bench used in the Adaptive Systems Laboratory at Portland State University. We identify the problems we encountered in the making the test bench operational and how those problems were resolved. Finally, we offer some guidelines others will find useful when constructing their own evolvable hardware test benches.

hardware (TGP) is proposed in this paper. The main difference between TGP and other GP techniques is that TGP does not explicitly store the evolved computer programs. TGP is applied for evolving digital circuits for the even-parity problem. Numerical experiments show that TGP outperforms standard GP with several orders of magnitude.

greatest level of specialization team members must be evolved in separate populations, but finding acceptable partners for evaluation at trial time is difficult. Testing too few partners blinds the GA from recognizing fit solutions while testing too many partners makes the computation time unmanageable. We developed a system based on punctuated anytime learning that periodically tests a number of partner combinations to select a single individual from each population to be used at trial time. We previously tested our method with a two agent box-pushing task. In this work, we show the efficiency of our method by applying it to the Predator-Prey scenario.

Evolutionary Computation and Games domain. We apply this technique to the evolution of goal scoring behavior in soccer players and show that layered learning is able to find solutions comparable to standard genetic programs more reliably. The solutions evolved with layers have a higher accuracy but do not make as many goal attempts. We compared three variations of layered learning and find that maintaining the population between layers as the encapsulated learnt layer is introduced to be the most computationally efficient. The quality of solutions found by layered learning did not exceed those of standard genetic programming in terms of goal scoring ability.

Distributed Problem Solving Based on Evolutionary Computation and Anytime Algorithms Real-world applications Evolutionary Computation as design of bounded rational agents. The approach specifies optimal programs rather than optimal actions, and is based on process algebras and anytime algorithms. The search method described in this paper is so general than many other search algorithms, including evolutionary search methods, become its special case. In this paper, we present a practical design of the programming language and environment targetting real-time complex domains. As AI systems move into more complex domains, all problems become real-time, because the agent will never have long enough time to solve the decision problem exactly.

A simple baseline and two program induction technique are run on this task. A technique for initializing populations with evolved agents is also explored. The simpler of the two program induction methods is found to be superior as is initialization with evolved agents.

Theory of evolutionary algorithms to each gene based on the contribution of that gene to the

fitness of the individual. Although the proposed model is not "parameter free through a number of experiments we show that the parameters for this model are significantly insensitive to the landscape of the problems compared with the mutation rate in conventional GA, implying that this model could deal effectively with a wide range of problems the requirement to set the mutation rate empirically.

represented as finite state machines that choose to drink or not based on flower type. Fitness evaluation is a multi-year simulation including a simple model of polination of flowers by the virtual bees. A positive rate of specialization is observed and the model is discussed.

that avoid unwanted cross hybridizations. Methods from the theory of codes based on formal languages are employed. These algorithms are implemented in user-friendly software, CodeGen, which contains a collection of language-theoretic objects adaptable to various related tasks. Lists of code words may be stored, viewed, altered and retested. Implemented in Visual Basic 6.0, its interface allows for lists of code words to be assembled at varying levels of acceptability from a single main window.

research area for biologists. Association rules is an important task of knowledge discovery that can be applied to the analysis of gene expression in order to identify patterns of genes and regulatory network. Association rules discovery may be modelled as an optimization problem. In this paper, we propose a multicriteria model for association rules problem and present a Genetic Algorithm designed to deal with association rules on DNA microarray data, in order to obtain associations between genes. Hence, we expose the main features of the proposed Genetic Algorithm. We emphasize on specificities for the association rule problem and on its multicriteria aspects.

Computation occurs between words, affects the reliability and efficiency of the computation. An in vitro selection protocol has been developed that selects maximally mismatched DNA sequences. The protocol is analyzed, and a probabilistic model of the protocol is developed. The analysis shows that the selection probability should obey a Poisson distribution for a large number of trials. The analysis shows the protocol's ability to produce maximally mismatched words.

Abiotic Data Previously, we have quantified the quality of retrieval of genomic information in simulation [6]. Here, the ability of two types of DNA-based memories to store abiotic data and retrieve semantic information is evaluated for soundness and compared to state-of-the-art symbolic methods available, such as LSA (Latent Semantic Analysis) [17]. Their ability is poor when performed without a proper compaction procedure. However, when the corpus is summarized through a selection protocol based on PCR or a training procedure [3] to extract useful information, their performance is much closer to that of LSA, according to human expert ratings.

for other Fredkin gates. Each gate is designed to operate at a particular time step, although many different gates can operate simultaneously. Thus, arbitrary circuits of Fredkin gates can be constructed, including computers. An example application is given: a depth-two decision tree circuit that directs control and data from one gate to the next.

Forest Industry Ecosystem Balance Chart, based on the theory of Five Elements, which is the traditional Chinese philosophy. There are five kinds of elements (cells) in Five Elements Balance Chart, i.e. Wood, Fire, Earth, Metal, and Water. Ancient Chinese thought used the relations of creating and controlling within the Five Elements to analogize the relationship between all situations and beings. The transition rules are constructed according to the principle of creating and controlling. A simulation model of the forest industry ecosystem is presented to demonstrate the proposed approach. The Five Elements Balance Chart can well evaluate the balance status of the ecosystem.

Real-world applications hypermutation operators in its implementation is presented. Mutation operators to be used are identified initially. In every mutation operation, the fitness gain achieved by the employed mutation operator is computed and stored. Accordingly, mutation operators are assigned fitness values based on the amount fitness improvements they achieve over a number of previous generations. These fitness values are used to determine operator selection probabilities. This approach is used for the solution of well-known numerical optimization problems for which optimal results are achieved in reasonable computation times even for the very difficult problem instances.

Problem large effect on their performance. One of the more recent classes of meta-heuristics, ant colony optimisation, is examined in terms of both the heuristic used to select solution components and the local search heuristics used to improve solutions. Static and adaptive heuristic control strategies are developed, as well as neighbourhood oriented local search transition operators, that are able to obtain good solutions to large and tightly constrained generalised assignment problem instances.

Distribution System Strategical Planning Multiobjective evolutionary algorithms Ant colony Search

Algorithm, MOACS, is here presented. The application domain is that of dynamic planning for electric distribution systems. A time horizon of H years has been considered during which the distribution system is modified according to the loads and to external requirements. The objectives considered most important for utilities in strategical planning are: the decrease of the expected number of interruptions per year and customer and the choice for the lowest cost strategy. The Authors have formulated a new dynamic optimization algorithm to treat hard MO problems such as the one of strategical planning.

Distribution Systems locations and ratings of capacitors in a distribution network for reactive power compensation. The approach is multilevel. Two separate tables of pheromones are maintained by the algorithm. Ants generate solution stochastically, based on these pheromone tables. The pheromone tables are updated periodically, so that pheromones accrue more along better solutions. Results obtained by the proposed algorithm have been compared with earlier schemes. We conclude that the proposed approach is an effective approach for optimally placing capacitors in a distribution system.

cooperative behaviour of its constituent wireless nodes. Precision in routing demands that all network nodes portray persistent benevolent behaviour. This is however, difficult to achieve and so a number of malicious nodes participate in the route discovery process only to sabotage the network. In this paper we present a novel and pragmatic mechanism for establishing trust in ad-hoc networks using swarm intelligence. The proposed mechanism is based upon maintaining and sharing pheromone (trust) levels so as to find trustworthy routes. We believe that our model will be most suited to ad-hoc networks that can be created on-the-fly without any trust infrastructure.

multi-objective optimization. Using the SEAMO algorithm (a simple evolutionary algorithm for multi-objective optimization) as a basis, it demonstrates how it is possible to obtain a better spread of results if subpopulations of various sizes are used in a simple hierarchical framework. Three alternative hierarchical models are tried and the results compared.

because one generally wishes to find the whole front of Pareto-optimal solutions. Thus, parallelizing EMO is an important issue. Since we are looking for a number of Pareto-optimal solutions with different trade-offs between the objectives, it seems natural to assign different parts of the search space to different processors. In this paper, we propose the idea of cone separation which is used to divide up the search space by adding explicit constraints for each process. We show that the approach is more efficient than simple parallelization schemes, and that it also works on problems with a non-convex Pareto-optimal front.

0/1 knapsack problem using epsilon -dominance world problems. The problem is NP-Complete. The multiobjective 0/1 knapsack problem is a generalization of the 0/1 knapsack problem in which multiple knapsacks are considered. A new evolutionary algorithm for solving multiobjective 0/1 knapsack problem is proposed in this paper. This algorithm used a epsilon-dominance relation for direct comparison of two solutions. Several numerical experiments are performed using the best recent algorithms proposed for this problem. Experimental results clearly show that the proposed algorithm outperforms the existing evolutionary approaches for this problem.

Networks Optimization, Evolutionary Optimization in Dynamic Environments networks has led to many researchers exploring alternate solutions with the use of heuristic based techniques. The rationale underlying the use of heuristic based priorities in achieving multiple objectives appears to be ad hoc and unclear due to the complex interactions among the various objectives. However these uncertainties can be effectively modeled using fuzzy set theory. This paper introduces the notion of multi-objective route selection in mobile ad hoc networks (MANET) using evolutionary fuzzy cost function to deliberately calculate cost adaptively. Simulation results show the superiority of the proposed technique over conventional MANET routing schemes.

Main Effect of Genes algorithms (GAs). The resulting estimates can not only be used to understand the domination of genes in a GA but also employed to tailor the mutation rate in the GA. A new approach to varying the mutation rate across the representation and over the run of the GA depending on estimates of the main effect of genes is proposed. We demonstrate the use of the proposed method for solving uncapacitatied facility location problems. For many well-known benchmark problems, the proposed method yields better results than the previously used method.

and Evolutionary Algorithms on Numerical Benchmark Problems optimization optimization (PSO) have been suggested during the last decades offering improved performance on selected benchmark problems. Recently, another search heuristic termed differential evolution (DE) has shown superior performance in several real-world applications. In this paper we evaluate the performance of DE, PSO, and EAs regarding their general applicability as numerical optimization techniques. The comparison

is performed on a suite of 34 widely used benchmark problems. The results from our study show that DE generally outperforms the other algorithms. However, on two noisy functions, both DE and PSO were outperformed by the EA.

and Evolutionary Societies of Hill-Climbers: A DisACSP Perspective Evolutionary intelligent agents such as genetic SoHCs(GSoHCs), and an evolutionary SoHC(ESoHC) are developed for solving randomly generated distributed asymmetric constraint satisfaction problems (DisACSPs). We compare GSoHCs using different distributed restricted forms of crossovers. The GSoHCs are also compared with an ESoHC and a simple SoHC without evolutionary operators. Results show similar performance of single-point, two-point, and uniform crossover. Both GSoHC and ESoHC have better performance than SoHC. Results also show that the modified two-point crossover outperforms the other recombination operator on DisACSPs that are not near the phase transition.

the Generalized Generation Gap Model Real-world applications implementation of the Parent Centric Operator (PCX) within the Generalized Generation Gap (G3) model using five test functions of 10, 20 and 50 dimensions. Our study indicates that G3-PCX performs fairly well on most functions, but its performance is not good for highly nonlinear, multidimensional problems (Rastrigin, Ackley, Griewangk). We observed the same behaviour of G3-PCX while designing a 22 element Yagi-Uda Antenna for gain maximization (known to be a highly nonlinear problem). We derived a simple variant G3-PCX-II using a Roulette wheel based parent selection scheme which performs better than G3-PCX on the highly nonlinear multidimensional problems.

problems. While genetic algorithms (GA) have been very popular in the clustering field, particle swarm optimization (PSO) and differential evolution (DE) are rather unknown. In this paper, we report results of a performance comparison between a GA, PSO and DE for a medoid evolution clustering approach. Our results show that DE is clearly and consistently superior compared to GAs and PSO, both in respect to precision and robustness of the results for hard clustering problems. We conclude that DE rather than GAs should be primarily considered for tackling partitional clustering problems with numerical optimization.

optimization the problems with eqaulity constraints is presented. The feasible space of such problems may be similiar to ridge function class, which is hard for applying swarm algorithms. To enter the solution space more easily, the relaxed quasi feasible space is introduced and shrinked adaptively. The experimental results on benchmark functions are compared with the performance of other algorithms, which show its efficiency.

Combinatorial & numerical optimization by employing the small inertia weight, according to experimental analysis on a simplified model, which with fast convergence. Then by recognizing and replacing inactive particles according to the process deviation information of device parameters, the fluctuation is introduced so as to driving the irreversible evolution process with better fitness. The testing on benchmark functions and an application example for device optimization with designed fitness function indicates it improves the performance effectively.

computing. Recent software advances have allowed collections of heterogeneous computers to be used as a concurrent computational resource. In this work we explore how Differential Evolution can be parallelized, using a ring–network topology, so as to improve both the speed and the performance of the method. Experimental results indicate that the extent of information exchange among subpopulations assigned to different processor nodes, bears a significant impact on the performance of the algorithm. Furthermore, not all the mutation strategies of the Differential Evolution algorithm are equally sensitive to the value of this parameter.

package. This work is part of a larger project whose main goal is to investigate the emergence of cooperation and communication in response of (scalable) environmental challenges. The specific goals of the experiments reported here include 1) the study a number of extensions of the classical SugarScape model, 2) to compare two radically different approaches to communication among the individuals of the population. Our results demonstrate that a number of the presented extensions should be taken up in future experiments in artificial societies, and that the decentralised communication protocol has negative effects on the system behaviour.

Resources (MAS) using an Adapted Pittsburgh style Classifier System. This work is an extension of a Minimal Model of Communication which consists in making two agents communicating and playing a naming game with a limited number of situations to recognize. We complexify that model by increasing both the number of agents within the MAS and the number of words that can be used by agents. We studied how confusion may emerge through communication and how agents use their available cognitive

ressources in order to learn to communicate. We pointed out that further study with new measures is needed in order to better understand how communication evolves in a genetic based MAS.

dilemma on a toroidal grid. The agents consist of a finite state machine specialized for playing iterated prisoner's dilemma with a simple tag recognition capability. The populations are allowed to evolve for 10,000 generations and the world is stored every 500 generations. Saved populations are placed in competition with populations from generation 10,000. This procedure is repeated for varying levels of overall mutation rate, with and without tags, and varying frequencies of tag related mutations. Non-local adaptation is observed in these populations, however, tags seem to slow the acquisition of non-local adaptation.

middle game and the end game. In this paper, evolutionary neural networks, evolved via an evolutionary strategy, are used to develop opening game playing strategies for the game. This paper focuses on the opening, using a 13x13 size of board. A feed forward neural network player is played against a static player (Gondo), for the first 30 moves. Then Gondo takes the part of both players to play out the remainder of the game. Two experiments are presented which indicate that learning is taking place.

Substances for Inference of Genetic Networks genetic networks by S-system. NSS-EA is an excellent method form the viewpoints of "efficient search of a set of satisfactory structures"and "search of structures satisfying biological knowledge". However, it has a problem from the viewpoint of "search of the true structure". To solve the problem, first, we improve the parameter search process by using multiple time course data when evaluating genetic networks. Second, we propose four new structure-search operators taking account of mutual interactions among substances. We show the effectiveness of the proposed improvements by applying it a five-substance benchmark problem.

Computational Biology rapid increase of the size of gene networks, it has become more realistic to identify the collaborating genes in the network, which will facilitate the behavioral study of the groups and the network as a whole. In our previous paper, we presented a layered approach for visualizing gene regulatory networks. In this paper, we present a 3D layout model for visualizing gene networks, which clusters the correlated genes depending on their causal relationships. To demonstrate the effectiveness of the approach, we visualize real gene networks of different sizes. The experimental results show the superiority and usefulness of the new model when compared with previous results.

Classification Computational Biology, Learning by Estimating Distributions in EC samples based on gene expressions. Here the classification task is made more difficult by the noisy nature of the data, and by the overwhelming number of genes relative to the number of available training samples in the data set. Moreover, many of these genes are irrelevant for classification and have negative effect on the accuracy and on required learning time for the classifier. In this paper, we propose a new evolutionary computation method to select the most useful subset of genes for molecular classification. We apply this method to three bench-mark data sets and present our unbiased experimental results.

Models population of individuals. In order to improve the search process, several hybrid approaches have been proposed that make use of a local exploitative search technique, such as the Nelder-Meade simplex algorithm. In this paper, the simplex algorithm has been modified for multi-objective optimization, by introducing the concept of fuzzy dominance. A hybrid algorithm, the Fuzzy Dominance based Simplex - Genetic Algorithm (FSGA) has been proposed. This algorithm was shown to be a very effective search strategy when applied to a multi-objective problem in modelling the gene regulatory network of flowering time control of Oryza sativa.

texture analysis. Two major tasks of texture analysis, texture classification and texture segmentation, are studied. Bitmap textures are used in this investigation. In classification tasks, the results show that GP is able to evolve accurate classifiers based on texture features. Moreover by using the presented method, GP is able to evolve accurate classifiers without extracting texture features. In texture segmentation tasks, the investigation shows that a fast and accurate segmentation method can be developed based on GP generated texture classifiers.

Evolutionary Algorithm (QEA). The proposed system is based on elliptical blobs and Principal Components Analysis (PCA). The elliptical blobs in the directional image are used to find the face candidate regions, and then PCA and QEA are employed to verify faces. By PCA, we can obtain the optimal basis but they may not be the optimal ones for discriminating faces from non-faces. Moreover, a threshold value should be selected properly considering the success rate and false alarm rate. To solve these problems, QEA is employed to find out the optimal decision boundary under the predetermined threshold value which distinguishes between face images and non-face images.

Real-Time Object Detection images using a boosted cascade of simple features. In this paper we show how an Evolutionary Algorithm can be used within the Adaboost framework to find new features providing better classifiers. The Evolutionary Algorithm replaces the exhaustive search over all features so that even very large feature sets can be searched in reasonable time. Experiments on two different sets of images prove that by the use of evolutionary search we are able to find object detectors that are faster and have higher detection rates.

Biologically-Inspired Adaptive Mutations operator that reflects vertebrate neuron growth and death rates into an evolutionary algorithm for evolving artificial neural network structures. This paper further investigates this proposed approach by presenting experimental results for two classifier problems.

security of the cryptographic algorithms. The design of S-boxes with genetic algorithms is a recent research focus. For the popular bijective S-boxes, an effective evolutionary strategy is given in this paper, including fitness function, breeding strategy and hill climbing algorithm. Under this strategy, an effective genetic algorithm for 8*8 bijective S-boxes is provided and a large number of S-boxes with high nonlinearity and low difference uniformity can be obtained.

of XTEA cryptographic primitives such as block ciphers or hash functions, was presented by the authors. Here, this cryptanalytic attack is shown to be succesful when applied over reduced round versions of the block cipher XTEA. Additionally, a variant of this genetic attack is introduced and its results over TEA shown to be the most powerful published to date.

Cryptology and Computer Security, Evolutionary design & evolvable hardware, Evolutionary Design Automation generate secure and minimal hardware designs of public-key cryptosystems such as RSA encryption system. We evolve optimal hardware circuits for modular exponentiation, which a cornerstone operation in almost every cryptographic system. The evolved circuits minimize both space (i.e. required gate number) and time (i.e. encryption and decryption time). The evolved designs are shielded against side-channel leakage and hence secure. The structure of the cryptographic circuit is random and so the private key cannot be deduced using known attacks. We compare our results against existing well-known designs which were produced by human designers based on the binary method.

uniform and reversible cellular automata (CA). A class of CA with rules specifically constructed to be reversible is used. The quality of encryption depends on the type of rules used, and randomness of the numbers used in the process of encryption.

of selection pressure. If it is set too low then the rate of convergence towards the optimum is likely to be slow. Alternatively if the selection pressure is set too high the system is likely to become stuck in a local optimum due to a loss of diversity in the population. The recent Fitness Uniform Selection Scheme (FUSS) is a conceptually simple but somewhat radical approach to addressing this problem — rather than biasing the selection towards higher fitness, FUSS biases selection towards sparsely populated fitness levels. In this paper we compare the relative performance of FUSS with the well known tournament selection scheme on a range of problems.

Algorithms decentralized heuristics, and the importance of the induced exploration/exploitation balance on different problems. It is shown that, by choosing synchronous or asynchronous update policies, the selection pressure, and thus the exploration/exploitation tradeoff, can be influenced directly, without using additional ad hoc parameters. Synchronous algorithms of different neighborhood-to-topology ratio, and asynchronous update policies are applied to a set of benchmark problems. Our conclusions show that the update methods of the asynchronous versions, as well as the ratio of the decentralized algorithm, have a marked influence on its convergence and on its accuracy.

Algorithms generation alternation model on real-coded GAs to improve its performance by maintaining adequate diversity of populations. The basic concept is that all of offspring will be alternation candidate with corresponding previous individuals based on angular distance. Clustering offspring according to corresponding individual, and generation alternation is taken place in each cluster. We compared performance of proposed model with previous models, and it showed good performance on benchmark problems. The results indicated the effectiveness of concurrent alternation in a whole population and that angular distance information is adequate metric to maintain right diversity.

Genetic Algorithms is presented. The proposed algorithm enhances the precision of the GAs' solutions by introducing a Gaussian perturbation to the decoding function. This non- deterministic decoding enables individuals to represent any point in the continuum instead of finite discrete points. As the generations evolve, information gathered from the most fit members is continuously used to rearrange the binary representation grid on the search space, thus establishing a search memory such that the best known individual is always positioned at the center of the Gaussian offset.

Array Design antenna array using a novel concurrent PSO (CPSO) and different variations of FDR-PSO algorithms. The design problem is to find element excitations that will result in a sector pattern main beam with low side lobes with additional requirement that the same excitation amplitudes with zero-phase should result in a high directivity, pencil shaped main beam. In order to test the performances of various PSO algorithms, the results of real-coded genetic algorithm is considered.Experiment results clearly indicate the better performance of various FDR-PSO and proposed CPSO algorithms over simple PSO and genetic algorithms in terms of solution quality, and consistency.

Design Automation mechanisms abstracted from developmental biology. For instance, artificial cells endowed with genetic regulatory networks were used to evolve and develop simulated creatures. With the evolution of a simple vermicular structure it is shown that asymmetric cell division is useful for the positioning of cells and that this mechanism can be integrated with other developmental mechanisms such as genetic regulation and cell adhesion to get moving artificial creatures. Surprisingly, the movements were controlled by the genetic regulatory network alone without the need to evolve a neural structure.

Applications space-saving Compact Genetic Algorithm (CGA) variants against a realistic EH control problem. Comparisons are made between the variants and between them and no population and true population versions of the algorithm. A clearly superior algorithm for this application is designated and implications for other EH efforts are considered.

Quantum Cascade of Generalized Ternary Gates size of multi-valued logic for multi-level quantum computing systems. However, synthesizing these quantum circuits is not easy. In this paper we describe a new genetic algorithm based synthesizer for ternary quantum circuits. Our results show some of the synthesized circuits use fewer gates than previously published methods.

carry out learning in a real environment. However, learning is difficult within a real environment. In addition, the acceleration of learning is required for a practical execution. In this paper, we propose an approach to the learning acceleration using data retrieved from the real environment. This consists of the method of automatically constructing the simulator from real data and of learning a robot controller with the simulator. The experimental results suggest that our GP-based technique enables the effective controller learning.

learning safe navigation of multiple robot systems. It is a basic step towards automatic generation of sensorimotor control architectures for completing complex cooperative tasks while using simple reactive mobile robots. Each individual estimates its own performance. When two robots meet each other, the proposed crossover mechanism allows them to improve the mean performance index. In order to accelerate the evolution an adaptive self-mutation is added: the mutation rate is made dependent on the individual performance. Computer simulations and experiments using a team of real mobile robots have demonstrated the rapidity of convergence.

focuses on a subset of the chromosome. It provides a means of doing crossover were only the genes involved in producing the fitness are affected. In this paper, we use it to evolve the parameters for a model that represents the capabilities of a robot. The values of these parameters are evolved as the robot periodically performs an action that is also being performed by the model. Each action performed by the robot does not include every possible turn command so using partial recombination allows the system to only change the parameters involved in the action. Tests show that partial recombination makes a significant difference in the co-evolution of model parameters.

Structured Learning accumulate human-friendly behaviors. To realize it, we use a concept of structured learning which emphasizes the importance of an interactive learning of several modules through interaction with its environment. In a proposed method, a robot obtains hand-to-hand behavior by using an interactive evolutionary computation based on human evaluations estimated by fuzzy state-value functions. Moreover, a self-organizing map is used for clustering human hand positions. And then, a state-value function and a knowledge database are assigned to each clustered positions. Furthermore, the best trajectory is stored in the knowledge database to reuse it in the same situation.

the most traditional methods to find a linear solution to the feature extraction problem, which maximise the ratio between between-class scatter and the within class scatter (Fisher's criterion). We propose a variant of LDA which incorporates the class conjunctions thereby making LDA more robust for the problems in which the within class scatter is quite different from one class to another, while retaining all the merits of conventional LDA. We also integrate an evolutionary search procedure in our algorithm to make it more unbiased to the training samples and to improve the robustness.

Vector Generation generation work by transforming samples from a driving distribution into samples

characterized by given marginals and correlations. The correlations of the transformed random vector are controlled by the driving distribution; sampling a partially specified random vector requires finding an appropriate driving distribution. This paper motivates the use of evolution strategies for solving such problems and compares evolution strategies to conjugate gradient methods in the context of solving a Dirichlet-to-anything transformation. It is shown that the evolution strategy is at least as effective as the conjugate gradient method for solution of the parameterization problem.

through Automatic Speciation (GBML) system. MSWV uses two levels of speciation to achieve various objectives. Different species of individuals are by design assigned to each class in the data set. During training, a second level of speciation is achieved when similar individuals are allowed to automatically cluster and form subspecies. In this paper we are going to show the importance of the automatic speciation in increasing the classification accuracy by maintaining the diversity and increasing the accuracy of the decision rules discovered. Using thirty-six real-world learning tasks we show that MSWV significantly outperforms a number of well known classification algorithms.

has significantly enhanced the ability to generate more flexible databases. However, the calculation of certain features in these databases may be highly resource-consuming. This paper proposes an innovative method for approximating these features by sampling. A discussion of the difficulty of sampling in n- partite graphs is elaborated and an evolutionary algorithm-based method is presented that uses the information from a smaller subset of the graph to infer the amount of sampling needed for the rest of the graph. Experimental results are shown via a publications database on Anthrax for finding the most influential authors in technical community.

context of Genetic Programming. Such a scheme provides the basis for building steadily more complex models until a desired degree of accuracy is reached. The architecture is demonstrated for several data mining datasets. Efficient training on standard computing platforms is retained through the use of the RSS-DSS algorithm for stochastically sampling datasets in proportion to exemplar 'difficulty' and 'age'. Finally, the ensuing empirical study provides the basis for recommending the utility of sum square cost functions in the datasets considered.

Environments which are used for testing evolutionary algorithms in dynamic environments and proposes an easy-to-use test framework. The proposed test framework consists of an event driven environment control mechanism component as well as a scenario creator component which allows the user to experiment with different instances of a problem, incorporating various properties and types of change. The components of the framework interact with each other through a well defined function call interface. The test framework is still in its early stages of development. Extensions and modifications will be made based on the requirements and feedback received from its users.

The grammar contains an axiom, usually a short string, that the grammar expands into a long, complex string. The interpreter then renders the string into an object. The first use of L-systems was to provide morphological models of plants. In this exploratory initial study we use an evolutionary algorithm to evolve interpreters for L-systems. The interpreter is a graphics turtle. For a given L-system the evolutionary algorithm tunes the turtle's parameter to cause it to drive in a constrained area of the Cartesian plane. Multiple L-systems and planar regions are given. In some cases a startlingly small number of optima are located.

on Clustering Technique logic to adaptively tune px and pm for optimization of power electronic circuits throughout the process. By applying the K-means algorithm, distribution of the population in the search space is clustered in each training generation. The proposed adaptation method is applied to optimize a buck regulator that requires satisfying some static and dynamic requirements. The optimized circuit component values, the regulators performance, and the convergence rate in the training are favorably compared with the GAs using fixed px and pm.

Interaction are likely to demonstrate interaction between crossover and mutation, and, what is the practical implication of interaction have been unanswered. We find that as our test function increases in modality the interaction between crossover and mutation becomes statistically significant. We conjecture that for highly modal functions the possibility of interaction between crossover and mutation must be considered. The practical implication of interaction is that when attempting to fine tune a genetic algorithm on a highly multi-modal problem the optimal rates for crossover and mutation cannot be obtained independently.

Population with biased initial population to solve large scale combinatorial optimization problems. The proposed scheme is a master-slave style in which a master node manages searched space of slave nodes and assigns seeds to generate initial population to slaves for their restarting of evolution process.

Our approach allows us as wide as possible searching by all the slave nodes for the beginning periods of the searching and then focused searching by multiple slaves on a certain spaces which seems to include good quality solutions. The computer experiment shows the effectiveness of our proposed scheme.

networks' capacity and reducing the cost of it. In this paper we propose a tabu search (TS) approach to solve the problem with non-standard cost functions. A greedy decoding approach is used to generate the initial solution and then an effective and unique search approach is proposed to produce the neighborhood, which exchange one of the terminals in each concentrator to improve the quality of solution. Simulation results with the proposed TS approach are compared with those using genetic and greedy algorithms. Computer simulations show that our approach achieves very good results in solving this problem.

Flying in Periodic Search Space optimization handling modes for particle swarm. By providing an infinite space that comprises periodic copies of original search space, it avoids possible disorganizing of particle swarm that is induced by the undesired mutations at the boundary. The results on benchmark functions show that particle swarm with Periodic mode is capable of improving the search performance significantly, by compared with that of conventional modes and other algorithms.

Simulated Libmless Wheelless Robot hardware of the fastest possible locomotion of simulated snake-like robot (Snakebot). The realism of simulation is ensured by employing the Open Dynamics Engine software library. Empirical results demonstrate the emergence of sidewinding as fastest locomotion gait. Robustness of the sidewinding is illustrated by the ease with which Snakebot overcomes various types of obstacles. The ability of Snakebot to adapt to partial damage by gradually improving its velocity characteristics is shown. Discovering compensatory locomotion traits, Snakebot recovers completely from single damage and recovers a major extent of its original velocity when more significant damage is inflicted.

hardware, Real-world applications design and how evolutionary approaches can be used to automate the hierarchical design and synthesis process for MEMS. At the system level, the approach combining bond graphs and genetic programming can lead to satisfactory design candidates of system level models that meet the predefined behavioral specifications for designers to tradeoff. At the physical layout synthesis level, the selection of geometric parameters for component devices is formulated as a constrained optimization problem and addressed using a constrained GA approach. A multiple-resonator microsystem design is used to illustrate the integrated design automation idea using evolutionary approaches.

Particle Swarm Optimization evolution In this, a bi-criteria model is used. One of the criteria is well known minisum criterion. The second criterion is a weighted sum of Euclidean distances raised to the power of negative one. This function represents the aggregate undesirable effects of the facility and it is also a minimization problem. The bi-criteria model consists of a linear combination of these two criteria. The proposed model solved by Particle Swarm Optimization provides better results than a previously proposed heuristic.

TSP optimization scheme is introduced. We called it as random Multi-Local-Search (MLS).The MLS is composed of several local search schemes,each of which executes with a predefined probability.The combination of MsMA with the crossover EAX on the Traveling Salesman Problem is studied,and comparisons are also made with some best known MAs. We have found that it is significantly outperforming the known MAs on the selected instances. Furthermore, we have proposed a new crossover named M-EAX,which has more powerful local search ability than the EAX.The experimental results show that the MsMA with M-EAX has given a further improvement to the existing EAX.

evaluate individuals, but the resulting evaluation can be unstable. Recently, general archive-based coevolution methods have become available for which monotonic progress can be guaranteed. The size of these archives may grow indefinitely however, thus limiting their application potential. Here, we investigate how the size of an archive for Pareto-Coevolution may be limited while maintaining reliability. The LAyered Pareto-Coevolution Archive (LAPCA) is presented, and investigated in experiments. LAPCA features a tunable degree of reliability, and is found to provide reliable progress in a difficult test problem while maintaining approximately constant archive sizes.

Strategies populations coevolving on two-bit landscapes is described and investigated with the context of four different partnering strategies. It is shown that even in those simpest models of CGA, the dynamics changes dramatically with different evolutionary scenarios that deserves our attention from the perspective of coevolutionary algorithms design.

Algorithm Co-evolutionary On-Line EA to the guidance of a swarm of multiple missiles, against

multiple targets. The multi-objective algorithm is used to develop a dynamic objective front which is used to trade the spatial distribution of missiles at impact, against the time to impact. Each missile optimises its own performance, based on limited information of the current intended actions of the other missiles. The decision making process is thus distributed between the missiles giving distributed coordination. Results demonstrate the algorithm can form effective leader-less distributed control for multiple missiles against multiple targets in noisy and environments.

seen as the coevolution of two systems: a societal system of vehicle owners and a supply infrastructure that will provide the alternative fuel. We present a Cultural Algorithms model that allows us to assess the impact that initial alternative fuel station distribution and cultural motivation have on alternative fuel adoption, and the role that mass media may play in that adoption.