
Preface

Artificial evolutionary systems are computer systems, inspired by ideas from natural evolution and related phenomena. The field has a long history, dating back to the earliest days of computer science, but it has only become an established scientific and engineering discipline since the 1990s, with packages for the commonest form, genetic algorithms, now widely available.

Researchers in the Asia-Pacific region have participated strongly in the development of evolutionary systems, with a particular emphasis on the evolution of intelligent solutions to highly complex problems. The Asia-Pacific Symposia on Intelligent and Evolutionary Systems have been an important contributor to this growth in impact, since 1997 providing an annual forum for exchange and dissemination of ideas. Participants come primarily from East Asia and the Western Pacific, but contributions are welcomed from around the World.

This volume features a selection of fourteen of the best papers from recent APSIES. They illustrate the breadth of research in the region, with applications ranging from business to medicine, from network optimization to the promotion of innovation.

It opens with three papers in the general area of business and economics. Orito and colleagues extend previous work on the application of evolutionary algorithms to index fund optimization by incorporating local search in an unusual way: using the genetic search to maximize the coefficient of determination between the fund's return rate and the market index (but not necessarily finding a linear relationship), and then using local search to optimize the linearity. They demonstrate that this approach outperforms direct search, yielding funds that perform substantially better as a surrogate for the Tokyo Stock Price Index from 1997 to 2005.

Guo and Wong investigate the problem of learning Bayesian Networks from incomplete data. They modify their group's previous hybrid evolutionary algorithm for learning from complete data. It uses essentially Friedman's Structural Expectation Maximization (SEM) algorithm as the outer loop, with a variant of their evolutionary algorithm in the inner loop, replacing SEM's hill-climbing phase. It differs from previous algorithms, which use the expected value to replace missing values, in using a more sophisticated data completion process, which permits the use of decomposable scoring metrics (specifically, information-based metrics) in the search process. They use the algorithm in a direct-marketing application, demonstrating improved performance on that problem, though the technique would clearly extend to other domains – DNA chip analysis, ecological data – where missing values cause serious difficulties.

Katai and his colleagues consider cooperative or 'local' currencies, and investigate the design of such currencies to promote social and economic goals. They base their analysis on fuzzy theory, and obtain interesting new results on the desirable operation of such systems.

Networks have become a key area of complex systems research, with applications ranging from communications to transport problems to the organisation of web pages. The next six papers exemplify this trend, examining various aspects of network theory.

Leu and Namatame consider the problem of failure resilience in networks, such as power distribution or communications networks. They apply evolutionary algorithms to optimising the robustness of such networks to link failure, and are able to demonstrate that, under certain circumstances, they are able to preserve important linkage properties of the networks (notably, scale-freeness), while improving the failure resilience.

While Leu and Namatame consider robustness to link breakages in networks, Newth and Ash consider instead robustness to disturbance, and the linearity of network response. Again, they apply an evolutionary algorithm to optimise robustness. They observe an interesting property, that the optimised networks they evolve exhibit hub-and-star like topology, suggesting that this structure has inherent stability properties.

Komatsu and Namatame propose a heterogeneous flow control mechanism for protecting communications networks from attacks such as DDoS. They distinguish between altruistic protocols such as tcp, and uncontrolled protocols such as udp, using open-loop congestion control mechanisms such as drop-tail for the former, and closed-loop such as RED and CHOCe for the latter. Using simulations on a range of network topologies, they demonstrate good performance in controlling excess traffic by comparison with homogeneous protocols, and propose extensions of this approach to higher layers in the protocol stack.

Lin and Gen concentrate on the problem of network routing, specifically on finding Shortest Path Routes (SPR) for Open Shortest Path First (OSPF) routing protocols. They propose a new priority-based representation and genetic algorithm for this problem, and demonstrate its performance through a range of numerical experiments.

Network flow problems are a classic problem in the optimization literature; Gen, Lin and Jo extend the usual problem, of maximizing network flow, into a bi-criteria problem, maximizing network flow while minimizing network cost. They report on a variant evolutionary multi-objective optimization algorithm incorporating Lamarckian local search, and demonstrate its performance on a range of test problems.

A second paper from the same authors considers applications in logistics network design, starting from the design of the network, and extending to vehicle routing and automated vehicle dispatch. They introduce a priority-based Genetic Algorithm for the task, applying variants to all three problems, with good results.

The final paper on network problems, by Lin and Gen, approaches the problem of bi-criteria design of networks from a more general perspective. To illustrate their approach, they tackle three separate design problems:

1. Shortest path, in which the conflicting objectives are to minimize transmission delay while at the same time minimizing network cost
2. Spanning tree, in which the conflicting objectives are as above (i.e. minimizing both transmission delay and network cost)

3. Network flow, in which the conflicting objectives are to maximize network flow while at the same time minimizing network cost

The authors compare a number of representations and algorithms for these problems, generating interesting results showing that complex versions of these problems can realistically be solved with today's algorithms.

Sawazumi et al. investigate mechanisms to promote human creativity, proposing a method based on "serendipity cards", cards containing detailed information about a theme. In so doing, they introduce a number of ideas and contexts from the Japanese literature on idea generation not well known outside of Japan.

Cornforth et al tackle an important medical problem, that of recognition of medical problems from imagery. Specifically, they concentrate on the issue of medical image segmentation, in the context of assessment of retinopathy due to diabetes. They combined wavelet data extraction methods with Gaussian mixture Bayesian classifiers, generating substantially improvements over simpler methods, though not quite matching expert-level human performance.

Gen et al tackle another highly practical problem, the problem of job-shop scheduling in a shop where some machines may substitute for others for particular operations (in the classical job-shop scheduling problem, each operation can be performed on precisely one machine). They introduce a new multi-stage genetic algorithm, comparing it with the state of the art in the field. They demonstrate very substantially improved performance over a classical genetic algorithm, and GA augmented with a form of local search, especially on hard problems. They demonstrate some improvement in comparison with a particle-swarm/simulated annealing hybrid method, though the differences are small.

Wong and Wong round out the volume with a paper showing that impressive speed of evolutionary algorithms may be obtained at relatively low cost, through implementation on graphics processing units. They obtain very impressive performance indeed on a range of benchmark optimization problems, especially for large population sizes.

Overall, the papers represent just a sample of the wide range of research in intelligent and evolutionary systems being conducted in the Asia-Pacific region.. The growing maturity of its research culture portends an increasing contribution to international research across the range of the sciences, and in intelligent systems in particular. We hope this volume can serve as a stepping stone in this process, introducing some of the work to a wider audience, and at the same time increasing international awareness of one of this Asia-Pacific forum.

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