

Editorial

Mathematical Tools of Soft Computing

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Soft computing is a fast-growing research area. Many successful applications in diverse fields using the soft computing techniques have been reported. This special issue represents the recent developments of the mathematical tools and algorithms of soft computing to solve formal and practical problems arising from engineering areas. We have collected twenty-five papers in this special issue, which are summarized as follows.

In the paper “*A mathematical design of genetic operators on $GL_n(\mathbb{Z}_2)$* ” by Y. Yoon and Y.-H. Kim, the authors analyze the space of all nonsingular binary matrices (i.e., $GL_n(\mathbb{Z}_2)$), which is often used for the change of basis in binary representation and this is the encoding usually adopted in genetic algorithm. Some possible encodings and their corresponding recombination operators for evolutionary algorithms are proposed.

A new method to compute the approximating explicit B-spline curve to a given set of noisy data points is proposed in the paper “*Firefly algorithm for explicit B-spline curve fitting to data points*” by A. Gálvez and A. Iglesias. The proposed method computes all parameters of the B-spline fitting curve of a given order, which is required to solve a difficult continuous, multimodal, and multivariate nonlinear least squares optimization problem. The powerful metaheuristic firefly algorithm is utilized to numerically solve this optimization problem. Three real-world problems are used to illustrate the proposed method.

In the paper “*Cyber-EDA: estimation of distribution algorithms with adaptive memory programming*” by P.-Y. Yin and H.-L. Wu, the authors consider the estimation of distribution algorithm (EDA) which aims to explicitly model the probability distribution of the quality solutions to the underlying

problem. In contrast to classical evolutionary algorithms (EAs), EDA framework is flexible and is able to handle inter-variable dependence, which usually imposes difficulties in classical EAs. The adaptive memory programming is adopted in this study to enhance the performance of classic EDA by deriving a better approximation for the true distribution of the target solutions.

A multiobjective fuzzy nonlinear programming approach to enhance the long-term yield competitiveness of a semiconductor manufacturing factory is proposed in the paper “*Enhancing the long-term yield competitiveness of a semiconductor manufacturing factory using a multiobjective fuzzy nonlinear programming approach*” by T. Chen and Y.-C. Wang. A real example is employed to illustrate the applicability of the proposed methodology.

In the paper “*Approximate solution of n th-order fuzzy linear differential equations*” by X. Guo and D. Shang, the authors investigate the approximate solution of the n th-order fuzzy linear differential equations with coefficient functions retaining the sign by the undetermined fuzzy coefficients method. The differential equations are converted to a crisp system of linear equations. The fuzzy approximate solution of the fuzzy linear differential equation is then obtained by solving the crisp linear equations. Some numerical examples are given to illustrate the proposed method.

In the paper “*Using the fuzzy linguistic preference relation approach for assessing the importance of risk factors in a software development project*” by S.-T. Lu et al., the fuzzy linguistic preference relation approach is employed to assess the relative degree of impact of risk factors in software development project for two expert groups working in technology enterprises and software development companies. It is claimed that

the proposed approach not only facilitates the information collecting for making pairwise comparisons but also eliminates inconsistencies in the collected information.

The 3D marine ecosystem dynamical model is considered in the paper “*Optimization of the spatiotemporal parameters in a dynamical marine ecosystem model based on the adjoint assimilation*” by X. Li et al. By utilizing spatiotemporal biological parameterizations, the adjoint variational method is applied to a 3D marine ecosystem dynamical model. Some real experiment results are provided.

To identify risk items, measure risk value objectively, and establish risk assessment matrix of airports is the major task of airport safety. In the paper “*Assessing the risks of airport airside through the fuzzy logic-based failure modes, effect, and criticality analysis*” by C.-M. Feng and C.-C. Chung, the Failure Modes, Effect, and Criticality Analysis (FMECA) are used to define the decision factors of probability, severity, and detectability of airport risks. The authors also design a questionnaire and apply fuzzy logic to discover the importance of decision factors, to find out the threshold value of risk assessment matrix, and to prioritize the airport risks. A case study is provided to demonstrate the modeling process and analysis procedure.

The nonlinear complementarity problem is investigated in the paper “*An improved filter method for nonlinear complementarity problem*” by K. Su et al. This problem can be reformulated as a nonlinear programming problem whose objective function may be nonsmooth. In this case, the authors use decomposition strategy to decompose the nonsmooth function into smooth and nonsmooth parts. Together with the filter method, an improved filter algorithm with decomposition strategy is proposed for solving nonlinear complementarity problem. Under mild conditions, the global convergence is shown.

The prediction of currency volume issued in Taiwan is considered in the paper “*Prediction of currency volume issued in Taiwan using a hybrid artificial neural network and multiple regression approach*” by Y. E. Shao. The regression technique is used for the variable selection of explanatory variables in the hybrid model, and the artificial neural network is used to generate forecasts. A real dataset of Taiwan’s currency from 1996 to 2011 is utilized to illustrate the proposed method.

The job dispatching problem in a wafer fabrication factory is investigated in the paper “*A novel fuzzy-neural slack-diversifying rule based on soft computing applications for job dispatching in a wafer fabrication factory*” by T. Chen and R. Romanowski. The slack-diversifying fuzzy rule is derived from a two-factor tailored nonlinear fluctuation smoothing rule for mean cycle time. The effectiveness of the proposed rule is checked with a simulated dataset.

In the paper “*Improving performance of evolutionary algorithms with application to fuzzy control of truck backer-upper system*” by Y. Alipouri et al., an improved evolutionary algorithm is proposed. The modifications of the proposed method include using Levy distribution function as strategy parameter adaptation, calculating mean point for finding proper region of breeding offspring, and shifting strategy parameters to change the sequence of these parameters. A set of benchmark cost functions is utilized to compare the results of

the proposed method with some other well-known algorithms. Furthermore, the proposed method is applied to optimal fuzzy control design of a truck backer-upper system.

In the paper “*Quantum behaved particle swarm optimization with neighborhood search for numerical optimization*” by X. Fu et al., a new quantum-behaved particle swarm optimization algorithm is proposed, aiming at avoiding the premature convergence in solving complex optimization problems. In this algorithm, one local and one global neighborhood search strategies are utilized to balance exploitation and exploration. Some well-known benchmark functions including multimodal and rotated functions are used to test the effectiveness of the proposed method.

Currently, the development of various communication terminal devices has greatly promoted people’s daily life, but information usage efficiency with these devices decreases rapidly due to the information overload. To solve this problem, a multiterminal based proactive information delivery system is designed and implemented in the paper “*The design and implementation of multiterminal based proactive information delivery system*” by S. Xia et al.

In the paper “*Fast linear adaptive skipping training algorithm for training artificial neural network*” by R. M. Devi, a new fast linear adaptive skipping training algorithm for training artificial neural network is proposed to handle huge training datasets. Some appropriately selected data points are skipped during the training epochs in order to speed up the training process.

Association rule hiding has been playing a vital role in sensitive knowledge preservation when sharing data between enterprises. The aim of association rule hiding is to remove sensitive association rules from the released database such that side effects are reduced as low as possible. In the paper “*Association rule hiding based on intersection lattice*” by H. Q. Le et al., an efficient algorithm is proposed for hiding a specified set of sensitive association rules based on intersection lattice of frequent itemsets.

Location methods that are applicable in global positioning systems, wireless sensor networks, and cellular communication systems are proposed in the paper “*Neural network for WGDOP approximation and mobile location*” by C.-S. Chen et al. Two novel architectures are proposed to approximate weighted geometric dilution of precision, which represents the geometric effect on the relationship between measurement error and positioning error. It is claimed that the proposed methods not only eliminate the poor geometry effects but also significantly improve the location accuracy.

The object tracking problem is an important research topic in computer vision. The Lucas-Kanade (LK) algorithm is efficient for object tracking in usual situations. In the paper “*Least trimmed squares approach to Lucas-Kanade algorithm in object tracking problems*” by Y.-L. Lin, the trimmed sum of squared errors is adopted as the cost function, instead of the usual sum of squared errors in standard LK method. The resulting estimator is robust against outliers caused by noises and occlusions in the tracking process. Simulations are provided to show that the proposed algorithm outperforms the standard LK method in the sense that it is robust against the outliers in the object tracking problems.

The Forward Least-Squares Approximation Support Vector Machine (FLSA-SVM) is a newly-emerged Least-Square SVM (LS-SVM) whose solution is extremely sparse. In the paper “*Efficient model selection for sparse least-square SVMs*” by X.-L. Xia et al., the authors propose a reduced variant of the FLSA-SVM to reduce the computational complexity and memory requirements. The resulting SVM not only contains a reduced number of support vectors, but also maintains competitive generalization abilities.

In the paper “*Optimization and soft constraints for human shape and pose estimation based on a 3D morphable model*” by D. Zhang et al., an approach is proposed for multiview markerless motion capture based on a 3D morphable human model. This morphable model was learned from a database of registered 3D body scans in different shapes and poses.

In the paper “*Application of a new hybrid fuzzy AHP model to the location choice*” by C.-C. Chou and K.-W. Yu, a new hybrid fuzzy Analytic Hierarchy Process (AHP) algorithm is proposed to deal with the decision-making problems in an uncertain and multiple-criteria environment. The proposed hybrid fuzzy AHP model is applied to the location choices of international distribution centers in international ports from the viewpoint of multiple-nation corporations. The experimental results show that the proposed new hybrid fuzzy AHP model is an appropriate tool to solve the decision-making problems in an uncertain and multiple-criteria environment.

Robust template decomposition for cellular neural networks implementing arbitrary Boolean functions is investigated in the paper “*Robust template decomposition without weight restriction for cellular neural networks implementing arbitrary Boolean functions using support vector classifiers*” by Y.-L. Lin et al. In the past research works using this approach, the control template parameters and thresholds are restricted to assume only a given finite set of integers. In this study, the authors try to remove this restriction. Minterm- and maxterm-based decomposition algorithms utilizing the soft margin and maximal margin support vector classifiers are proposed to design a sequence of robust templates implementing an arbitrary Boolean function.

The behavior and structure optimization for a type of software program whose data exchange processes are represented by nonlinear polynomial systems is considered in the paper “*Approximate bisimulation and optimization of software programs based on symbolic-numeric computation*” by H. Deng and J. Wu. The authors establish a novel formal description, called the nonlinear polynomial transition system, to represent the behavior and structure of the software program. Furthermore, the notion of bisimulation for software programs is proposed based on the equivalence relation of corresponding nonlinear polynomial systems in their nonlinear polynomial transition systems. An example on a multithreading program indicates that the approximate bisimulation relation is feasible and effective in behavior and structure optimization.

Subset problems, including set partitioning, packing, and covering, are formal models for many practical optimization problems. A set partitioning problem determines how the items in one set can be partitioned into smaller subsets.

In the paper “*A hybrid soft computing approach for subset problems*” by B. Crawford et al., the authors propose a hybrid solver based on Ant Colony Optimization (ACO) combined with Arc consistency for solving this kind of problems. The proposed hybrid solver is tested with set covering and set partitioning dataset benchmarks.

In the paper “*Improved computing-efficiency least-squares algorithm with application to all-pass filter design*” by L.-C. Su et al., based on trigonometric identities and uniform sampling of the frequency band of interest, the authors present closed-form expressions to compute the elements of the Toeplitz-plus-Hankel matrix required in the least-squares design of IIR all-pass filters.

It is obvious that the selected topics and collected papers in this special issue cannot be comprehensive. Nonetheless, they represent rich coverage of the mathematical tools of soft computing that we have the pleasure to share with readers.

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