

Editorial

Optimization Theory, Methods, and Applications in Engineering 2013

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1. Introduction

Optimization theory and methods have been applied in many fields to handle various practical problems. In light of advances in computing systems, optimization techniques have become increasingly important and popular in different engineering applications. The aim of this special issue is to present some recent developments in the area of optimization theory, methods, and applications in engineering. This special issue involves 44 original papers, selected by the editors and related to the various researches themes on optimization theory, methods, and applications in engineering. According to the characteristics of the accepted papers, the special issue is organized in the following six parts and each part is composed of several important papers to the part's scope.

2. Optimization Methods

Y. Gao et al. present a branch and bound reduced algorithm for quadratic programming problems with quadratic constraints. The algorithm determines the lower bound of the optimal value of original problem by constructing a linear relaxation programming problem. To improve the degree of approximation and the convergence rate of acceleration, a rectangular reduction strategy is also used in the algorithm.

Y. C. Zhang et al. propose an improved self-adaptive particle swarm optimization (IDPSO) algorithm with detection function to solve multimodal function optimization problems. The evolution direction of each particle is redirected dynamically by tuning the three parameters of IDPSO in the evolution process to overcome the premature convergence of PSO in a short time. Numerical results on several benchmark functions indicate that the IDPSO strategy outperforms other variants of PSO.

"A review of piecewise linearization methods" by M.-H. Lin et al. introduces recent advances in piecewise linearization methods and analyzes the computational efficiency of various piecewise linearization methods.

"Sensitivity analysis of the proximal-based parallel decomposition methods" by F. Ma et al. shows that the range of the involved parameters can be enlarged, while the convergence can be still established.

X. Wang studies a new class of optimization problems and develops a strong duality theory for stochastic separated continuous conic programming. A polynomial-time approximation algorithm is also presented to solve the stochastic separated continuous conic programming problem with any predefined accuracy.

The paper "Tightness of semidefinite programming relaxation to robust transmit beamforming with SINR constraints"

by Y. Wang and R. Shi considers a multiuser transmit beamforming problem under uncertain channel state information subject to SINR constraints in a downlink multiuser MISO system. A natural semidefinite programming (SDP) relaxation problem is proposed to solve the robust beamforming problem. The main contribution of this paper is to establish the tightness of the SDP relaxation problem under proper assumption, which means that the SDP relaxation problem definitely yields rank-one solutions under the assumption.

3. Information System

“An analytical framework of a deployment strategy for cloud computing services: a case study of academic websites” by C.-H. Chen et al. analyzes network behavior to assess and compare the costs and risks associated with traditional local servers versus those associated with cloud computing to determine the appropriate deployment strategy. An analytic framework of a deployment strategy that consists of two mathematical models and the analytical hierarchy process is proposed to analyze the costs and service level agreements of services involving using the traditional local servers and platform as service platforms in the cloud.

The paper *“The reputation evaluation based on optimized hidden Markov model in e-commerce”* by L. Chang et al. presents a reputation evaluation mechanism based on the optimized hidden Markov model, which is called PSOHMM. The algorithm takes full advantage of the search mechanism in particle swarm optimization (PSO) algorithm to strengthen the learning ability of HMM and PSO has been modified to guarantee interval and normalization constraints in HMM. Compared to average and beta reputation evaluation mechanism, PSOHMM reflects the behavior changes of sellers more quickly in e-commerce systems.

“An efficient approximate algorithm for disjoint QoS routing” by Z. Yu et al. formulates the disjoint QoS routing problem as a 0-1 integer linear programming with the objective function using an adaptive penalty function. An efficient algorithm is designed to solve the formulated model to obtain the optimal solution efficiently. The simulation experiments validate the effectiveness of the proposed heuristic algorithm.

The paper *“Enterprise information security management based on context-aware RBAC and communication monitoring technology”* by M.-Y. Wu and M.-H. Yu proposes an information security management approach that is based on context-aware role-based access control (RBAC) and communication monitoring technology to achieve enterprise information security management. The main contribution of this work is the potential it provides to both reduce information security incidents, such as internal information leakage, and allow for effective cost control of information systems.

“Building a smart e-portfolio platform for optimal e-learning objects acquisition” by C.-K. Ke et al. proposes an optimal selection approach determining a reasonable e-learning object from various candidate e-learning objects to assist student learning in a modern e-portfolio platform. The main contribution of this work is the demonstration of an effective e-learning object selection method which is easy to

implement within an e-portfolio platform and which makes it smarter.

The paper *“Ant colony optimization for social utility maximization in a multiuser communication system”* by M.-H. Lin et al. presents an efficient ant colony optimization algorithm to allocate each user’s limited power on different channels for maximizing social utility (i.e., the sum of all individual utilities). The proposed algorithm adopts an initial solution that allocates more power on the channel with a lower background noise level. Besides, the cooling concept of simulated annealing is integrated into the proposed method to improve the convergence rate during the local search of the ant colony optimization algorithm. A number of experiments are conducted to validate the effectiveness of the proposed algorithm.

“Heuristics for synthesizing robust networks with a diameter constraint” by H. Nagarajan et al. addresses the problem of finding a network that maximizes the algebraic connectivity of the network while ensuring that the length of the shortest path joining any two nodes in the network is within a given bound. This article presents k-opt and tabu search heuristics for finding feasible solutions for this network synthesis problem. Computational results are also presented to corroborate the performance of the proposed algorithms.

J. Lai et al. propose a fairness-based admission control (FAC) scheme for the original I-frame acceleration mechanism to enhance its scalability by decreasing the bandwidth demands. Based on the channel changing history of every client, the FAC scheme can intelligently decide whether or not to conduct the I-frame acceleration for each channel change request. Comprehensive simulation experiments demonstrate the potential of their proposed FAC scheme to effectively optimize the scalability of the I-frame acceleration mechanism, particularly in commercial breaks.

Y. Xing et al. introduce two techniques (state space search and branch and bound) in artificial intelligence to tackle the problem of path-wise test data generation. An optimization method is also proposed to reduce the search space. The results of empirical experiments show that the search is conducted in a basically backtrack-free manner to ensure both test data generation with promising performance and its excellence over some currently existing static and dynamic methods in terms of coverage. The results also demonstrate that their proposed method is applicable in engineering.

4. Industrial Engineering and Manufacturing Systems

L. Cui et al. propose a new improved quantum evolution algorithm with a mixed local search procedure for solving capacitated vehicle routing problems (CVRPs). The obtained results from the testing of CVRP benchmarks demonstrate the superiorities of the proposed algorithm over the PSO, SR-1, and SR-2. The authors also provide a profound analysis on the experimental results.

“Analysis of positioning error for two-dimensional location system” by Y. Jiang et al. investigates the positioning error using different positioning techniques for two-dimensional

location system. The simulation results illustrate that the performance of TDOA is always superior to TOA without the time synchronization using the same reference nodes.

The paper “*A new model for the regulation width of waterway based on hydraulic geometry relation*” by N. Zhi-hui et al. proposes a new model of the width of channel regulation on hydraulic geometry relation. The numerical results show that the proposed calculation method is feasible and it could be a useful reference for the design of waterway regulation.

“*Forecasting electrical energy consumption of equipment maintenance using neural network and particle swarm optimization*” by X. Jiang presents an approach for forecasting electrical energy consumption of equipment maintenance based on artificial neural network (ANN) and particle swarm optimization (PSO). Experimental results demonstrate that the approach provides much better accuracies than some other competitive methods on the test data.

K.-C. Yang et al. adopt backpropagation neural network model and gray relation analysis as tools to analyze the fault detection and classification (FDC) data for detecting the semiconductor machine outliers. The findings indicate that machine deteriorates quickly after continuous use for 6 months.

In “*2D Dubins path in environments with obstacle*” by D. Yang et al., an effective algorithm is presented to obtain the shortest path in environments with an obstacle which consists of no more than five segments. The paper recapitulates the achievement about the Dubins path as well as some precise proofs which are important but omitted by Dubins.

D.-Y. Cheng et al. propose two analytical models to analyze the optimal sampling period based on communication behaviors, traffic conditions, and two consecutive fingerprint positioning locations from the same call and estimating vehicle speed. The experimental results show that the optimal sampling period is 41.589 seconds when the average call holding time was 60 s, and the average speed error rate was only 2.87%.

H. Li et al. deal with the tractor and semitrailer routing problem with full truckload between any two depots of the network and propose an integer programming model with the objective of minimizing CO₂ emissions per ton-kilometer. A two-stage approach with the same core steps of the simulated annealing in both stages is designed to solve the problem. Computational experiments on small scale randomly generated instances support the feasibility and validity of the heuristic algorithm.

“*Classification of hospital web security efficiency using data envelopment analysis and support vector machine*” by H.-Y. Kao et al. proposes the hybrid data envelopment analysis (DEA) and support vector machine (SVM) approaches for efficiency estimation and classification in web security. In the proposed framework, the factors and efficiency scores from DEA models are integrated with SVM for learning patterns of web security performance and provide further decision support. The numerical case study of hospital web security efficiency is demonstrated to support the feasibility of this design.

The paper “*A robust optimization approach to emergency vehicle scheduling*” by X. X. Rong et al. studies the emergency

vehicle scheduling problem under the objective function to minimize the total transportation time with uncertain road travel time. A numerical example is implemented to compare the results of robust optimization method and that of the particle swarm optimization algorithm. The case study shows that the proposed method achieves better performance on computational complexity and stability.

“*A slicing tree representation and QCP-model-based heuristic algorithm for the unequal-area block facility layout problem*” by M. S. Chang and T. C. Ku combines a slicing tree representation and a quadratically constrained program model with harmony search to develop a heuristic method for solving the unequal-area block layout problem. The proposed harmony search-based heuristic is tested on 10 well-known unequal-area facility layout problems from the literature. The results are compared with the previously best known solutions obtained by genetic algorithm, tabu search, and ant system as well as exact methods. New best solutions are found for some problems.

The paper “*A collaborative optimization model for ground taxi based on aircraft priority*” by Y. Jiang et al. establishes a scheduling optimization model by introducing priority of aircraft under collaborative decision-making mechanism, and a genetic algorithm is designed to verify the scheduling model by simulating. Optimization results show that the reliability of the model and the adjusted genetic algorithm has a high efficiency.

J.-F. Camacho-Vallejo et al. highlight the use of game theory to solve the classical problem of the uncapacitated facility location optimization model with customer order preferences through a bilevel approach. An evolutionary algorithm based on the equilibrium in a Stackelberg’s game is proposed to solve the bilevel model. Numerical experimentation is performed in this study and the results are compared to benchmarks from the existing literature in the subject in order to emphasize the benefits of the proposed approach in terms of solution quality and estimation time.

J. Zhang et al. present a multilevel thresholding algorithm for histogram-based image segmentation. The algorithm introduces an adaptive adjustment strategy of the rotation angle and a cooperative learning strategy into quantum genetic algorithm (IQGA). An adaptive adjustment strategy of the quantum rotation introduced in this study helps improving the search ability. The experimental results demonstrate good performance of the IQGA in solving multilevel thresholding segmentation problems by comparing with QGA and GA.

5. Engineering Design

The paper “*Engineering design by geometric programming*” by C.-H. Huang proposes an optimization approach for solving geometric programming (GP) problems. The approach is first to convert all signomial terms in GP into convex and concave terms. Then the concave terms are further treated with the proposed piecewise linearization method. The engineering design problems are also illustrated to evaluate the usefulness of the proposed methods.

"A comparative analysis of nature-inspired optimization approaches to 2D geometric modelling for turbomachinery applications" by A. Safari et al. addresses a comparative performance analysis on some of the most important nature-inspired optimization algorithms with different basis for the complex high-dimensional curve/surface fitting problems. Results illuminate a number of advantages as well as disadvantages of each developed optimization method for such complex geometries' parameterization from several different points of view. In terms of application, the final appropriate parametric representation of geometries in turbomachinery including airfoil curves and/or blade surfaces is an essential, significant component of both aerodynamic profile optimization processes and reverse engineering purposes.

C. Wang et al. propose an accurate calculation formula where the whole flow fields of multistage pumps with three different ring clearances were calculated by using computational fluid dynamics. This research works out the reason why the error of traditional axial force calculation is large when the amount of leakage is relatively large. An accurate calculation formula of axial force on pump is also obtained through the verification of numerical simulation and experiments.

The paper *"Design optimization of a speed reducer using deterministic techniques"* by M.-H. Lin et al. applies an efficient deterministic approach to globally solve speed reducer design problems which is formulated as a generalized geometric programming problem. The study reformulates the original problem into a convex mixed-integer nonlinear programming problem solvable to reach an approximate global solution within an acceptable error. Experiment results from solving a practical speed reducer design problem indicate that this study obtains a better solution compared with other existing methods.

6. Multicriteria Decision Making

"A hybrid multiple criteria decision making model for supplier selection" by C.-M. Wu et al. applies a hybrid multiple criteria decision making model which is a combination of fuzzy Delphi method, ANP, and TOPSIS to select the optimal supplier. A real case is presented to illustrate the usefulness of the proposed model.

The paper *"A novel nonadditive collaborative-filtering approach using multicriteria ratings"* by Y.-C. Hu presents a new collaborative-filtering approach using multicriteria ratings, in which a nonadditive technique in multicriteria decision making, namely, the Choquet integral, is used to aggregate multicriteria ratings for unrated items. The applicability of the proposed approach to the recommendation of the initiators on a group-buying website is examined. Experimental results demonstrate that the generalization ability of the proposed approach performs well compared with other similarity-based collaborative-filtering approaches using multicriteria ratings.

"Bargaining in patent licensing negotiations under stochastic environments: an experimental study" by Y.-N. Yang and Y.-J. Chiu conducts experiments of a bargaining game between

licensors and licensees by introducing a "second-chance" negotiation for licensors in a context of ultimatum game. The experimental results reveal that the introduction of the "second-chance" negotiation for licensors has significant impacts on behaviors of the licensors and licensees.

X. Han et al. use an input-oriented model to measure the energy consumption productivity change from 1999 to 2008 of fourteen industry sectors in China as decision-making units. The results show that only four sectors experienced effective energy consumption throughout the whole reference period. It also shows that these sectors always lie on the efficiency frontier of energy consumption as benchmarks. The other ten sectors experienced inefficiency in some two-year time periods and the productivity changes were not steady.

7. Operations and Supply Chain Management

The paper *"Coordination scheme for restructuring business operation of the single period newsvendor problem"* by C.-C. Chyu and I.-P. Huang presents a coordination scheme for a single period newsvendor problem when both supplier and retailer of the supply chain agree to change the business operation from a market decision power sharing system to a unique decision-maker system. An example is provided to illustrate the two models and the proposed coordination scheme, along with managerial insights on the models' benefits.

"Determining the optimum ordering policy in multi-item joint replenishment problem using a novel method" by W.-T. Ho investigates the joint replenishment problem (JRP) involving multiple items where economies exist for replenishing several items simultaneously. Cycle time division and recursive tightening methods are developed to calculate an efficient and optimal replenishment policy for JRP in this paper. The complexity of cycle time division and recursive tightening methods is $O(N \log N)$, where N represents the number of items involved in the problem.

M. Narenji et al. address the competition between two supply chains and their corresponding elements are modeled following the evolutionary games approach. Mathematical models for analyzing internal and external competition issues are developed under four different scenarios. The best price and delivery time policy of chains are illustrated by numerical examples.

S. Yang et al. consider an inventory model for perishable products with stock-dependent demand under inflation. The objective is to minimize the retailer's net present value of cost. Numerical experiments show that there is an optimal cycle length to minimize the present value of cost and a solution procedure is given to find the optimal solution.

The paper *"Optimal ordering policy of a risk-averse retailer subject to inventory inaccuracy"* by L. Zhu et al. investigates a risk-averse retailer within a newsvendor framework considering inventory inaccuracy stemming both from permanent shrinkage and temporary shrinkage. The study shows monotonicity between the retailer's ordering policy and his risk aversion degree. A numerical analysis provides managerial

insights for risk-averse retailers considering RFID technology investment.

“Mediating dynamic supply chain formation by collaborative single machine earliness/tardiness agents in supply mesh” by H. Yang et al. investigates the possibilities of applying the collaborative single machine earliness/tardiness (CSET) in a supply mesh, and the corresponding allocation schemes are experimentally studied in simulations. The results based on samples from the US textile industry show that by using intelligent agents under the CSET model it is possible to automatically find an ideal group of trading partners from a supply mesh out of many possibilities.

The paper *“On the transformation mechanism for formulating a multiproduct two-layer supply chain network design problem as a network flow model”* by M. Gan et al. explores a novel modeling method and develops a network flow model (NFP) for solving manufacturer-center two-layer supply chain design problem. To verify the effectiveness and efficiency of the model and algorithms, the performance measurement experiments have been conducted. The experimental results show that compared with MIP model solved by genetic algorithm (GA) and benders decomposition algorithm (BD), the novel NFP model and the improved network simplex algorithm are effective and more efficient.

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