ABSTRACTS

Step Change Point Estimation in *g* and *h* Control Charts in Healthcare

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Estimating the real time of a change point in process is one of the main purposes in the statistical process control. On the other hand, it is important to estimate the change point in healthcare processes regarding the relation between quality engineering and hospital epidemiology. Hence, in this paper, maximum likelihood estimators are proposed in *g* and *h* control charts for healthcare systems. We applied Monte Carlo simulation to assess the proposed approaches in terms of accuracy and precision. In addition, there are provided the corresponding cardinality sets and coverage probabilities based on logarithm of the likelihood function. Results indicate that the proposed estimators have a satisfactory performance under different shifts.

Keywords: Healthcare, *g* and *h* Control Charts, Maximum Likelihood Estimator, Statistical Process Control, Step Change Point Estimation.

Probabilistic Approach in Mathematical Programming Model to Solve Redundancy Allocation Problems in a Series-Parallel System with All Unit Discount Policy

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Nowadays, designing and implementing systems with premier features and higher reliability is deemed to be a basic principle for the engineers and users. Because regarding this point can result in the proper use of a system during its lifetime. Reliability refers to a measure of quality versus time factor that is computed by a probability of working without any failure in a given time and under some specific conditions. Since a system consists of many items, which withstand several stress factors, manufacturers commonly employ different solution approaches to increase the reliability. One of the main strategies in this regard is to consider some additional items in parallel to original ones. This is also called redundancy allocation. Different items have different reliability, cost, weight, and importance level. So, making decision on assigning redundant would be of interest under limited budget and volume or weight in system development. Some redundant item is not turned on until the main item works correctly. Hence, a switch and sensors would be considered to monitor the status of the main item and to decide when the redundant must start working. This type is called standby item. In today's competitive world, offering a system with lower total expense, given that its high reliability is maintained, can make the company popular with the customers. Although in recent years, research on optimization have been presented with all unit discount for components of a system, this paper not only addresses the active redundancy strategy, but also it discusses a combination of components with active or cold redundancy strategy. It uses a system that generates the all unit discount to the sum of the components with the two strategies mentioned. Additionally, in order to make the problem more realistic to the real world, failure rate and cost parameters were considered uncertain. To solve two models with the aims of maximizing the reliability and minimizing the cost, chance constrained approach was employed for the constraints of cost and reliability. The proposed model was solved with accurate method using GAMS software. With regard to the model's proper treatment of changes in effective factors proposed in the model, it is concluded that this model is exploitable for optimizing stability in mass production industries where applying the global discount policy leads to some benefits.

Keywords: All Unit Discounts, Probabilistic Programming, Reliability, Redundancy Allocation Problem, Series-Parallel System.

Modeling for System Optimization with Small Dataset Using Neural Network

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The shortage of data is one of the most important problems in system modeling and optimization in industrial applications. Typical modeling techniques are unable to properly model a system with a limited dataset. In this paper, a modeling method for optimization of these systems is proposed. The proposed method has two main steps. In the first step, the model is employed to generate data using neural network. This model determines the correspondence input of each output. In the second step, optimization of the generated model is performed using genetic algorithm. Inputs leading to the specified output can be estimated using the proposed system. Optimality of the system can be explained by an evaluation function. The proposed method was evaluated in two different experiments on a time series and a real data. Results of the experiments were analyzed using mean square error. The experimental results show the capability of the proposed method in system modeling and optimization.

Keywords: System modeling, Optimization, Multi-layer neural network, Genetic algorithm.

Inverse 2-Center Location Problem for Unweighted Tree Networks (A Case Study)
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This paper studies the inverse 2-center location problem by increasing and decreasing the edge length on unweighted tree networks. The goal is to increase and decrease the edge lengths at minimum total cost subject to the given modification bounds such that the predetermined vertices becomes absolute 2-center. In order to demonstrate the practical application of this issue, we consider Bojnourd urban network and two important fire stations of the city as center locations. Moreover, an example is generated for computational analysis. Results show that when the predetermined vertices are close to the ends of the tree, higher cost will be imposed. Yet, in most cases, this condition is impossible.

Keywords: Bojnourd, Center Location, Inverse Location, Unweighted Tree.

Two Stage Assembly Flow Shop Scheduling Problem with Aging Effect, Limit Access to Work, and Preventive Maintenance
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This paper studies the two-stage assembly flow shop problem (TAFSP) considering aging effects of the machines and preventive maintenance activities. At the first stage, *m-1* parallel machines process parts of each jobs, and at the second stage, related parts of the jobs are assembled by one assembly machine. As the machines work on the jobs, their tools get aged. Aging effects on the machines causes that they will not be able to complete the jobs in the same time could as they were new or when they are operating jobs immediately after their preventive maintenance activity. Processing times of the job are related to the positions, in which it is located after the last preventive maintenance. The job that is operated in a position immediately after the preventive maintenance activity on a machine has its standard processing time. However, the processing time of the jobs operated in the further positions increase based on the number of the positions. The machines return to the initial condition after each preventive maintenance activity. The objective is to schedule the jobs on the machines and determine when the preventive maintenance activities get done on them in order to minimize the total weighted tardiness and maintenance costs. An integer mathematical model is presented for the problem and its validation is shown by solving an example in

small scale. Since two-stage assembly flow shop problem is NP-hard, in order to solve the problem in medium and large scale two meta-heuristic algorithms, hybrid genetic algorithm (HGA) and hybrid particle swarm optimization (HPSO) are proposed. These algorithms are the hybrid version of genetic algorithm and particle swarm optimization representatively with simulated annealing. The algorithms are tuned by using Taguchi method, and are used to solve many numerical examples. Finally, the statistical analysis illustrates that the performance of HPSO is better than HGA.

Keywords: Aging Effect, Genetic Algorithm, Preventive Maintenance, Simulated Annealing, Two-Stage Assembly Flow Shop Problem.

Mathematical Model for Fleet Assignment with Maintenance and Aircraft Ramping Scheduling

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The problem of routing and maintenance programming is one of the most important complex issues of aviation systems. Therefore, the factors that increase the delays and costs and make the passengers unsatisfied must be identified. Among these factors, is the time required for airplane ramping, inspection and maintenance operations that directly affect flight delay and related costs. This paper provides two new models for maintenance programming based on flight hours and scheduling of airplane ramp operations, which minimizes costs and delays. Two mathematical models are solved in GAMS and sensitivity analysis is performed for each. Results of sensitivity analysis show that an increase in the number of aircraft in maintenance model reduces costs, and an increase in the number of machines in ramping model reduces delays. So, based on the result, good performance of the models reduces the costs and delays.

Keywords: Aircraft Routing, Maintenance, Mathematical Modeling, Ramping.

A Scenario-Based Robust Optimization Model for a Periodic Vehicle Routing Problem with Time Windows under Uncertainty by Using a Differential Evolution Algorithm

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This paper provides a model for evaluating the efficiency of a periodic vehicle routing problem (PVRP) to get the short routes with maximum sale by providing suitable services to customers before delivering the goods by other competitor distributors. In the goods distribution with short lifetime that customers need a special device for keeping them, the arriving time to customers influence on the sales amount, in which classical VRPs are unable to calculate this kind of assumptions. According to real world applications, the arriving time of the competitors is uncertain because of customer demands, traffic, weather conditions, and the like. A scenario approach is employed to handle the uncertainty of the arriving time of rivals. The purpose of this paper is to solve this problem by optimizing the sale of products to customers before delivering the products to other competitor distributors in an uncertain condition by robust optimization. To evaluate the presented model, a number of test problems are solved by two strategies of a differential evolution (DE) algorithm. Results are compared with those obtained by the CPLEX method in GAMS in small and medium sizes. To evaluate the proposed algorithm for solving large-scale problems, some solutions are implemented, and the results are compared in term of their accuracy. The computational results represent the capability of the proposed DE strategies in solving large-scale problems in a reasonable time.

Keywords: Differential Evolution, Periodic Vehicle Routing Problem, Robust Optimization, Uncertainty.

Mathematical Modeling and Solving Flexible Job-Shop Production Scheduling with Reverse Flows

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One of the important issues in the field of flexible job-shop production scheduling is reverse flows within a single production unit, as is the case in the assembly/disassembly plants. This paper studies the flexible job-shop scheduling by employing reverse flows approach, which consists of two flows of jobs at each stage in opposite directions. The problem can be used only if you have two flows: the first one going from first stage to last stage, and the second flow going from last stage to first stage. Then, a mathematical model of problem is provided to minimize the maximal completion time of the jobs (i.e., the makespan). Because of the complexity solving and proving that this problem ranked on NP-hard problems, we proposed meta-heuristic algorithm genetic (GA). Also, The parameters of these algorithm GA and their appropriate operators are obtained by the use of the Taguchi experimental design. The computational results validate outperforms proposed algorithm GA.

Keywords: Flexible Job-Shop, Genetic Algorithm, Production Scheduling, Mathematical Modeling, Reverse Flows, Taguchi Method.

The Fair Revenue Allocation among the Units of an Organization Using DEA

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To develop an organization, its units must be continuously assessed, and awarded according to the assessment results. Otherwise, the inefficient units are located on the margin of safety, and the efficient units get disappointed. In this paper, a way is presented to fairly distribute a common reward among the units of organization. Using data envelopment analysis, this method establishes the share of each unit relative to its performance. To this end, first the minimum and maximum possible shares of each DMU are established. Then, a combination of them is used for identifying its final share. In this method, the shares are objectively determined regardless of personal tastes.

Keywords: Data Envelopment Analysis, Efficiency, Revenue Allocation.

Operating Room Scheduling for Elective Surgeries Considering Downstream Care Units Using Goal Programming

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In a hospital, operating rooms produces a large part of the costs, on the one hand, and a large part of the income, on the other hand. One of the most impressive ways to increase the operating rooms efficiency is using effective ways for programming and scheduling. While this department has a close relation with other departments in the hospital, improving its efficiency will raise patients satisfaction and the whole hospital efficiency and performance. In this paper, a stochastic integer programming model has been developed for operating rooms programming and scheduling, with the aim of minimizing the cost of underutilization and overcapacity in downstream units, including intensive care unit and wards. The model aims to provide a cyclic master surgery scheduling at the tactical level based on hospital strategic decisions. First, it allocates blocks to specialties based on block scheduling strategy, and secondly determines each surgeon's surgery schedule. In addition, to improve the efficiency and reduce the complexity of the model for the large scale cases, the convolution stochastic distribution parts of the model have been exchanged with the expected values and variances of the capacities needed for different days of the week in a corresponding integer goal programming model. Then, different case studies have been generated by changing some of the parameters to show the objective function sensitivity to the changes. Innovation of this research compared to the previous studies is providing the schedules for the surgeons rather than the specialties. This saves time, expenses, and computational operations.

Also, positive half variance of the number of patients in downstream units in each day of the week has been used directly rather than the variance of the number of patients in these units.

Keywords: Block Scheduling Strategy, Downstream Units, Goal Integer Programming, Master Surgery Scheduling, Tactical Surgery Scheduling.

An Approach for Treatment Programming in Intensity Modulated Radiation Therapy (IMRT)

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Intensity modulated radiation therapy is one of the most commonly procedures used for delivering radiation to cancerous tissues. It aims to deliver the prescribed dose in the target volume while minimizing damage to the nearby healthy organs. In this procedure, two decisions being very important are selecting the beam angles and calculating the beam intensities. Although beam angle selection (beam angle optimization) is one of the most important decisions in this procedure, it is often be made manually and based on radio therapist experience and intuition. In order to overcome this drawback, this paper proposes a hybrid approach for automated beam angle selection and intensity computation. The proposed approach first finds a good feasible solution, and then use this solution as a starting point in local neighborhood search to find the local optimal solution. As the results of numerical experiments demonstrate, the proposed hybrid-approach, compared to its corresponding stand-alone methods, finds a better solution quickly and consistently.

Keywords: Beam Angle Optimization, Fluence Map Optimization, Intensity Modulated Radiation Therapy, Treatment Programming.

Developing an Economic Production Quantity Model in Integrated and Non-integrated Three-Layer Supply Chains with an Optimal Inventory Control Policy

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This paper develops an economic production quantity model in a three-layer supply chain with two different structures. This chain composes of a supplier, a manufacturer, and multiple retailers. In this chain, the supplier transforms raw material to the semi-finished product, and sends them to the manufacturer. Then, the manufacturer transmutes them to the finished product, and delivers them to the retailers to satisfy market demand. The retailers replenish their inventory at the same time. The demand of each retailer is different due to essence of various demand customers, and according to the decisions of the chain's members, two structures of non-integrated and integrated supply chains are surveyed. In this paper, we will employ the Stackelberg approach to solve the presented models. The ordering cycle of retailers is the decision variable of the model. The main aim of this study is to develop an inventory and production model in three-layer supply chains to minimize the total cost of chain by utilizing the optimal inventory control policy. At last, numerical examples are presented for each structure of supply chains.

Keywords: Game Theory, Inventory Control, Production Planning, Stackelberg Equilibrium, Supply Chain, Supply Chain Management.