truck. The advantages of this state are reduced loading, unloading time, and reduced vehicle costs. To investigate this problem, the developed mathematical model was used to obtain the appropriate solution to solve the mathematical model and to determine the validity and accuracy of the modeling using optimization software such as GAMS and MATLAB. At small sizes to which optimization software can find the optimal solution, GAMS optimization software was used to solve the mathematical model. For medium and large sizes where optimization software cannot find the optimal solution, MATLAB software and ALO, Memetic, and ACOR algorithms were used to solve the mathematical model and the efficiency of this algorithm was tested to solve such problems. The results showed that the feasibility of the proposed approach and demonstrated good performance of the ALO algorithm in solving this problem.

Key Words: ALO algorithm, cross docking, direct shipment, truck scheduling.

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Abstract

This study examines the efficiency of various topologies of deep learning networks (a superior approach to modeling and fitting socio-economic time series) in load demand forecasting using the data collected from a four-year period of households in Kurdistan City, Iran. Since the consumption pattern is a nonlinear and complex curve with a strong delayed dependency pattern, its prediction is not accurate by conventional statistical methods and the error reduction of this prediction has a significant effect on reducing production costs, unwanted squandering and fines. In this study, full-connected, recurrent, and also hybrid of them were investigated using the mean efficiency of absolute error percentage and mean square error index. When the input of the neural network was in the form of tensor, designing the structure of the deep neural network would be straightforward. In this case, the network can be implemented with a linear stack of layers sequentially. Although the sequential the sequential model is so common, it is inflexible when the input data is not in the form of tensor, e.g., Figure 4. Besides, in a forecasting model, each determinant might need a different type of neural networks such as CNN, LSTM or GRU. To overcome this challenge, we innovatively proposed parallel deep branches in our framework to represent the history of each determinant individually. The parallel branches process their determinants by using RNN and Dense networks. Then, the branches were merged together through concatenated and dense layers. The results indicated the superiority of the network topology as a combination of all connected and reciprocating models for modeling and predicting consumption. This superiority, due to the nonlinear nature of complexity, the strong attachment to the data of previous periods, and the existence of different degrees of delay in the exogenous variables of the problem can be fully justified. Considering that for excited peak load prediction, exogenous variables of the model (representing different atmospheric conditions) and artificial variables are included, this model has acceptable stability, compared to the models presented in previous studies.

Key Words: Load demand forecasting, deep neural network, full-connected networks, hybrid models.

IMPROVING CROSS DOCKING SYSTEMS BY ENABLING LOAD INTEGRATION

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Abstract

In order to reduce costs and increase the efficiency of the supply chain system, cross docking is one of the most important warehousing management strategies for combining products from different providers to different customers. Products in inbound trucks are gathered from suppliers and then are passed through customers using outbound trucks through the cross docking. Cross docking is one of the innovative product distribution strategies to minimize unnecessary inventory and improve the customer service level. Truck scheduling plays an important role in cross docking system. Cross docking works best for companies that distribute large volumes of merchandise and/or operate a large number of stores. Cross docking systems handle a large number of items in a short amount of time. The advantages of cross docking systems include increased inventory turnover, thus reduced inventory, increased customer responsiveness, and better control of the distribution operation. In this study, a special state of cross docking is considered in which inbound truck can also be used as outbound

Key Words: Nurse scheduling problem, nurses' preferences, uncertainty, fuzzy model, averaging fuzzy operator.

AN ACCELERATED BENDERS DECOMPOSITION ALGORITHM FOR SUSTAINABLE POWER GENERATION AND TRANSMISSION EXPANSION PLANNING UNDER UNCERTAINTY CONSIDERING DISRUPTION RISK AND ECONOMIC, ENVIRONMENTAL, AND SOCIAL ASPECTS: A CASE STUDY IN IRAN

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Abstract

Integrated planning of power generation and transmission expansion is very complicated in the presence of uncertainties in future electricity demand, fuel prices, greenhouse gas emissions, and disturbances. It becomes more complex whenever several sustainability policies related to greenhouse gas emissions, allowable noise level, and social acceptance are adopted. These policies significantly influence the total operational cost and network configuration of a power system. Hence, the managers of power systems should carefully decide on such policies and then precisely apply them to the planning phase. There are optimization models for integrated expansion planning of power systems in such situations; however, they cannot be solved exactly and efficiently in practice. This may produce very misleading insights into the impact of different sustainability policies since the accuracy level of optimization procedure is unknown. To fill this research gap, this paper presents an efficient exact algorithm for an existing multi-stage stochastic programming model that is developed for integrating two planning tasks of generation and transmission expansion for a centralized power system. The model considers the disruption risk and all the three sustainability aspects: economic, social, and environmental. The algorithm is developed based on Benders decomposition, and enhanced by acceleration techniques where multi-cut optimality cuts are used. The algorithm initially solves the relaxation of the master problem to find a good feasible solution using a rounding algorithm combined with a scenario selection procedure. The rounding algorithm is first used to determine the fixed first-stage variables, and then the deterministic equivalent model is solved for the selected scenarios to determine the unfixed first-stage variables. The resulting solution provides a set of effective cuts for the master problem and consequently better bounds in the next iterations. The computational results show the efficiency of the algorithm when compared with the solution method that directly solves the extended equivalent form of the two-stage model using exiting mixed-integer linear programming solvers. The proposed Benders decomposition algorithm enables us to practically find optimal solutions for cases with a large number of uncertainty scenarios. The results for a case study in Iran are also included.

Key Words: Generation expansion planning, transmission expansion planning, sustainable development, multi-stage stochastic programming, benders decomposition algorithm for mixed-integer programming.

APPLICATION OF DEEP LEARNING MODELS BASED ON FULLY-CONNECTED AND RECURRENT NEURAL NETWORKS TO RESIDUAL PEAK LOAD FORECASTING

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Abstract

Literature indicates that the statistical process control approach is capable of improving the quality of surgical processes. The use of this approach in the case of real surgical processes is an attractive contribution for researchers. Since risk factors of each patient before a surgery are different potentially, the use of a control chart approaching risk-adjusted is addressed by researchers.

The sensitivity of a model to small shift types of the mortality odds ratio is very important for monitoring the quality of a surgery process. Although different schemes have been proposed by researchers to monitor the performance of a medical team, based on the authors' knowledge this research for the first time proposes a risk-adjusted double exponentially weighted moving average (RADEWMA) approach to monitor the mortality rate. The numerical performance analysis of this paper based on average run length (ARL) term for the cardiac surgery addresses that the sensitivity of the proposed risk-adjusted scheme is superior compared to other risk-adjusted chart of literature.

In this research the performance of the proposed model is compared comprehensively with risk adjusted P chart (RAP), risk adjusted exponentially weighted moving average (RAEWMA), and risk adjusted cumulative sum (RACUSUM). In this paper for analyzing the performance comparatively, the simulated data is produced based on UK Center for Cardiac Surgery data in the period of 1992-1994. This data is referred to 2218 patients with heart surgery. In this simulation to estimate the parameters of the logistic regression, Parsonnet number is used as an explanatory variable. The comparative performance analysis is reported for different shift cases. The comparative report is analyzed statistically for different values of parameters. For statistical analyzing SPSS software is also used. The new proposed scheme to monitor the mortality odds ratio, can be used in different surgeries of a hospital effectively.

Key Words: Statistical process control, risk adjusted double exponentially weighted moving average control chart (RADEWMA), ARL, cardiac surgery.

INVESTIGATING UNCERTAINTIES IN NURSE SCHEDULING PROBLEM USING FUZZY MATHEMATICAL MODELING APPROACH

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Abstract

Nowadays, the health systems consume a significant share of the budget in each country. Hospitals are considered as the largest organizations to provide the healthcare services. Nurses as one of the major portion of hospitals' human resources consume a considerable part of the hospitals' annual budget. From this point of view, the hospitals' managers must arrange the available nurses efficiently. This problem is worsened by the shortage of the available nurses in many countries. In this setting, the Nurse Scheduling Problem (NSP) has received significant attention in recent years. In this problem, the aim is to assign the shifts to the nurses by satisfying the requirements during the planning horizon. Several factors such as hospital managers' policies, labor laws, governmental regulation, and the status of the nurses at the end of the previous planning horizon should be considered for assigning the shifts to the nurses. Several mathematical models and heuristic and meta-heuristic algorithms have been proposed to solve the NSP by considering various assumptions and constraints. In the real-world problems, the good quality solutions can be obtained by considering the uncertainty concepts in the research problem. In this point of view, in the current study, the uncertainty concepts are considered in the nurse scheduling problem. It can be stated that the nurses' preferences for the working shifts cannot be deterministically specified. For this reason, first, a mathematical programming model is developed to maximize the nurses' preferences to work in their favorable shifts. Then, a fuzzy mathematical modeling approach based on the averaging fuzzy operator is proposed to investigate the uncertainty concepts on the nurses' preferences for the working shifts. Then, some random test problems are generated and solved to evaluate the performance of the developed fuzzy model. Regarding the obtained results, it can be stated that high quality schedules are generated by the proposed fuzzy model.

Then, the results and sensitivity analyses are presented in detail. The results showed that conducting imperfect maintenance actions would reduce the total costs, while increasing order-up-to-level.

Key Words: Maintenance planning, spare parts inventory management, deteriorating system, imperfect preventive maintenance, monte carlo simulation.

THE FEASIBILITY OF WAREHOUSE STORAGE ASSIGNMENT OPTIMIZATION USING STRESS FLUX AND FINITE ELEMENT METHOD

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Abstract

Given the necessity of fundamental and structural changes in the production and manufacturing industries to fulfill the industry 4.0 paradigm, the proposal of new ideas and frameworks for operations management of production and manufacturing system is inevitable. This challenge is enhanced by the essential need for the development of industrial platforms to fulfill the requirements of fundamental changes in industry 4.0 paradigm like sustainability, agility, rehabilitation, and flexibility. Thus, through the realization of new technologies and the necessity of increasing the pace and accuracy of productivity, a fundamental transformation must be enabled for many traditional concepts and operations management methods to be upgraded for the requirements of modern digital production and manufacturing industries. One of the dominant areas for this transformation is believed by researchers to be modern storage problem. This research focuses on traditional methods proposed for storage assignment problem and struggles for new methods and definitions for industry 4.0 based storage assignment concepts. At the first step, the paper proposes a new definition of storage assignment and layout problem for fulfilling the agility of storage mechanism in terms of automated store and retrieval process (AS/RS) in modern inventories. Then, considering the shortcomings of traditional algorithms for storage assignment problem, the paper contributes a new algorithm inspired from mechanical engineering discipline to analysis and optimization of storage assignment problem. The proposed new algorithm backed by stress distribution analogy and the help of Finite Element Method and minimum total potential energy theory proposes a new model for storage assignment optimization. The efficiency of the proposed algorithm in terms of calculation time and the quality of optimum answer is analyzed and investigated through numerical examples. Also, the results of illustrating the advantages of the new algorithm in comparison with traditional algorithms are discussed considering the requirements of industry 4.0 paradigm.

Key Words: Warehouse, storage assignment problem, stress, finite element method (FEM), total potential energy, industry 4.0.

MONITORING MORTALITY RATE OF THE CARDIAC SURGERY USING RISK-ADJUSTED DOUBLE EXPONENTIALLY WEIGHTED MOVING AVERAGE SCHEME

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Abstract

With increasing the value of optimized production plan and cost of equipment as well as raising the degree of difficulty to change spare parts and equipment, the importance of maintenance planning has doubled. Therefore, we can conclude that nowadays, the necessity of integrating production and maintenance planning is realized for the entire industrial owner and it is going to be the main concern of industrial owners to find the ways which help them optimize their costs. This study presented a new methodology to optimize the production and maintenance planning simultaneously. In terms of the environment, the carbon emission policy was applied. Therefore, the manufacturer should adhere to the emission limitations, which are placed on a company that emits carbon into the environment; otherwise, they should pay penalty. To control the cost of penalty, two types of production strategy including green and regular strategies were applied. In green strategy, the material and fuel were recyclable. Thus, it did less damage to environment but it was more expensive than the regular one. This essay seeks to optimize the amount of production of each strategies by balancing the amount of production with each kind of strategy and we should optimize the cost of production. To formulate the mathematical model, we consider costs of Preventive Maintenances (PMs) and mean of Corrective Maintenance (CM) as objective values to determine the production rate and number of PMs. By using MATLAB program, we could solve the model for two types of algorithm including Genetic and VDO algorithm and compare the solution together. Overall, it was concluded that in small-sized problems, VDO can answer more quickly than GA; yet, they were the same in terms of the solution quality. For some problems, VDO had the best solution, while GA could give the best solution to some other problems. However, overall, their function was somehow equal.

Key Words: Joint optimization of maintenance and production planning, carbon emission, genetic algorithm, vibration damping optimization algorithm.

JOINT OPTIMIZATION OF MAINTENANCE PLANNING AND

SPARE PART INVENTORIES FOR A DETERIORATING SYSTEM SUBJECTED TO PERFECT AND IMPERFECT MAINTENANCE

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Abstract

Regarding the close interaction between spare parts logistics and maintenance planning, this paper presents a model for joint optimization of condition-based maintenance and spare parts inventory of a single-unit deteriorating system. Simultaneous usage of perfect and imperfect preventive maintenance and a novel policy for ordering spare parts are two highlighted contributions of this research. Both positive and negative impacts of imperfect maintenance actions are considered in this paper. Although imperfect maintenance actions are less costly and time-consuming, they restore the system to a state between as-good-as-new and as-bad-as-old. Moreover, each imperfect preventive action may accelerate the speed of the system's deterioration process. The replenishment policy of spare parts was defined based on the deterioration level of the system. Furthermore, the next inspection time at each decision point was predicted based on an integrated approach considering the deterioration level, reliability, and sufficiency of the spare part for performing the expected maintenance operations. Moreover, in this paper, a two-echelon structure with two local suppliers in the first echelon and one main supplier in the second one were considered. The present model aims to determine the best inspection plan, maintenance actions, and order quantity of spare parts while minimizing the total costs. A minimum level of system availability determined by the decision-maker was guaranteed in the proposed model. According to the high complexity of the descriptive model, Monte-Carlo simulation was applied to optimize this complex problem. A real case problem was introduced to illustrate the applicability and advantages of the proposed model.

nificant correlation coefficient than other models, had a more resolution than other models, and eliminated the shortcomings of Classic base models. After the validation of the model, the pharmaceutical companies in Tehran Stock Exchange were evaluated by means of the proposed model and CCR model. The indices of the study were obtained from previous studies and the opinions of experts were taken into account to confirm these indices. The data used in the present study and the actual values of these indices were obtained from "codal.ir website" according to each company's financial status. Moreover, sensitivity analysis was performed on the outputs of these companies. The results showed that Alborz Pharmaceutical and Shafa Pharmaceutical Investment companies were the most effective units in both models, and Farabi Pharmaceutical Company was the most inefficient one. Besides, the results indicated that the units under study showed more sensitivity than the first output.

Key Words: Performance evaluation, data envelopment analysis, common weights, pharmaceutical companies, tehran stock exchange.

SIMULTANEOUSLY OPTIMIZATION OF PRICE AND WARRANTY FOR A FAMILY OF MULTI-PIECE PRODUCT

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Abstract

The increasing importance of customer's trust and demand diversification has turned the attention to warranty policy and supplying a family of products. In this respect, while retaining the benefits of mass production and flexibility each member shows to a specific segment of demand, appropriate models have not been sufficiently developed. This paper presents a maximization profit model by simultaneously optimizing the price and warranty length for products in a family of products through application of Markov chains. A continuous Markov model was used to calculate the steady state probabilities that the products need for warranty services. Then, the optimal prices and warranty lengths for all products were determined using a mathematical model to maximize the profitability of the products. The problem was formulated in two scenarios of fixed time and renewable warranty policies. Given the integer warranty length, the problem was a mixed nonlinear integer programming. Numerical samples for the problems solved by GAMS software and sensitivity analysis for the important parameters were also investigated. The results showed that the model was sensitive mostly in the case of price and warranty length elasticity. Moreover, the share of each product in total production did not change much under the influence of capacity change. This study can help manufacturers optimize the main variables of a product including reliability, price, and warranty period simultaneously at the product development stage (design and engineering). The proposed model can be operationally used by the managers for decision-making on the price and warranty length for a family product.

Key Words: Product family, price, warranty, markov chain, mixed integer nonlinear programming.

JOINT OPTIMIZATION OF MAINTENANCE AND PRODUCTION PLANNING WITH CARBON EMISSION CONSIDERATIONS

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Abstracts of Papers in English

A LINEAR MODEL FOR PERFORMANCE EVALUATION OF DECISION MAKING UNITS WITH DEA AND COMMON WEIGHTS APPROACH CASE STUDY: PHARMACEUTICAL COMPANIES IN TEHRAN STOCK EXCHANGE

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Abstract

Performance evaluation is one of the most significant issues in management taken into consideration by a number of academics and researchers who have developed various parametric and non-parametric methods used for performance measurement and evaluation. Among these models, Data Envelopment Analysis (DEA) is regarded as one of the most widely used models for performance evaluation. DEA is a powerful mathematical tool and a non-parametric technique to measure the relative efficiency of a group of homogeneous Decision-Making Units (DMUs). This approach carried out an evaluation by assigning weights to the inputs and outputs of each decision-making unit. The difference in the input and output weights in this technique is one of the objections to this method that threatens the assessment of the underlying basis. In this study, a model was presented to find a solution to this problem. The proposed model is a one-phase linear model and has less computational complexity than other models. To validate this model, the numerical exam of Kao & Hung (2005) was implemented and the results of the presented model were compared with those of other models; in addition, the Spearman correlation coefficient was calculated. The results showed that the proposed model had a more sig-